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RECEIVED
By Javier Torres, AIA - MCHA at 4:44 pm, Jun 21, 2013

Atlantic Engineering Services

AES

Structural Review
Key West City Hall at Glynn Archer
1302 White Street

Key West, Florida

Prepared for
Bender & Associates Architects, P.A.
410 Angela Street
Key West, FL 33040-7402

Prepared by
Atlantic Engineering Services of Jacksonville
6501 Arlington Expressway, Building B, Suite 201
Jacksonville, FL 32211
(904) 743-4633

AES Project No. **312-295**
June 20, 2013

Pittsburgh ▪ Jacksonville

Atlantic Engineering Services
6501 Arlington Expressway, Building B, Suite 201
Jacksonville, FL 32211
Phone: 904.743.4633 Fax: 904.725.9295
E-mail: jax@aespj.com

June 20, 2013

Mr. Bert L. Bender, RA, LEED AP
Bender & Associates Architects, P.A.
410 Angela Street
Key West, Florida 33040-7402

Re: Design Charette – Structural Condition Review
Key West City Hall at Glynn Archer
Key West, Florida

Project: #312-295
312295_00^RPT_Structural Condition Review.doc

Dear Bert:

I am writing, at the request of Mr. Don Craig, to follow-up on my limited structural condition review during the design charette, to confirm the condition of the structure presented in the Property Condition Assessment, Glynn Archer School dated September 7, 2012, prepared by CH2MHill. My limited structural condition review consisted of a visual review of the structure referenced above on June 11, 2013, and continuing through June 13, 2013. The review was performed by Mark J. Keister, P.E.; Atlantic Engineering Services of Jacksonville (AES).

The Glynn Archer Elementary School located on White Street between Seminary Street and United Street in Key West, Florida is the former Key West High School and consists of two buildings. Building A, with the auditorium was constructed in 1923 and Building B, which was constructed in 1927. Both buildings are two-story structures and the auditorium in Building A is one-story. Construction consists of wood framed roof and floors supported by perimeter concrete walls and interior wood framed walls. The foundations consist of shallow foundations, which bear on the shallow rock. Supporting the wood framed roof over the auditorium are three steel trusses and a wood truss.

On June 11 and 12, 2013, AMEC Environmental & Infrastructure, Inc. (AMEC) performed four, 20 foot rock cores, adjacent to the borings performed by Nutting Engineers of Florida (Nutting), as reported in their Report of Geotechnical Exploration Concrete Core Testing and Foundation Excavations dated August 2012, to confirm the consistency and bearing capacity of the shallow rock. Rock was encountered between 1'-0" to approximately 1'-6" below the surface and was very cohesive with a few voids (see Photographs 1, 2, and 3). In the Nutting report, their rock core compression tests varied from a low of 1,717 psi to a high of 4,229 psi and Nutting recommended a foundation bearing capacity of 4,000 psf. Our experience in Miami Limestone is that it has a minimum contact bearing pressure of between 6,000 psf and 8,000 psf and depending on consistency and voids, can be significantly higher. AMEC will be performing compression tests on eight samples as part of their geotechnical investigation to determine the bearing capacity of shallow foundations bearing on and in this Miami Limestone. There final results and recommendations will be forthcoming.

During our investigation of the ground floor, crawl space and foundations, cisterns were discovered in the southeast corner of Building A (see photographs 4 and 5) and the southeast corner of Building B (see photograph 6). The cistern in Building A was not noted in the CH2MHill report. Also, in Building A, an old abandoned cistern was discovered from a previous structure on the site (see photograph 7). The ground floor timber is in excellent condition and many of the 5-1/2" x 5-1/2" timber beams noted in the CH2MHill report are actually 8"x 8" timber beams (see photograph 8). There were also many framing discrepancies noted from the CH2MHill report. As can be seen in the crawl space photographs, the ground surface is weathered rock and the concrete foundations bear on the rock or are socketed into the rock.

The perimeter concrete walls consist of 11 inch concrete, which widens to 1'-6" or wider at the ground floor and widens again to 2'-0" or wider just above the ground surface and in many cases, the concrete walls widen again in the bearing rock (see photograph 9). The only place in the facility with a thinner concrete wall is the rear wall of the auditorium. The walls observed are in excellent condition with minimal cracking, no spalling and no signs of distress. The CH2MHill report documents 8 inch, concrete walls throughout the facility and recommends that they be reinforced if supporting floor loads, and that the perimeter wall foundations are undersized and need to be underpinned with piling, due to the rock bearing capacity of 4,000 psf. There are no signs of distress in the perimeter concrete walls and they have performed adequately for nearly one hundred (100) years supporting gravity and lateral loads. I see no reason that they cannot continue to support gravity and lateral loads. With their actual thickness of 11inches, they are significantly stronger and more durable than reported in the CH2MHill report. If the recommendation of the AMEC, rock bearing capacity is in the 6,000 psf to 8,000 psf range, the existing wall foundations are adequate and will not require underpinning with deep foundations. In the CH2MHill report, augercast piles, pile caps and grade beams had a combined cost of $398,500.00 and if the existing foundations are adequate and new foundations can bear directly on, or in the rock, augercast piles, pile caps and grade beams will not be required. If only conventional shallow foundations bearing on, or in the rock are needed, this will bring significant savings to the project.

The historic proscenium beam at the auditorium is a 5'-2" deep, wood truss and is in excellent condition (see photographs 10 and 11). This truss is not documented in the CH2MHill report. The auditorium roof consists of roof sheathing on 1- 5/8" x 7-1/2" roof joists at 2'-0" on center, which bear on four rows of two, 1- 5/8" x 11-1/2" wood beams, supported by 6'-6" deep steel trusses in which the bottom chord drops below the historic ceiling and created a coffered auditorium ceiling. The ceiling joists consist of 1-5/8" x 5-1/2" joists at 2'-0" on center, supported by four rows of two, 1-5/8" x 9-1/2" wood beams, also supported by the steel trusses. The CH2MHill report presents 1-5/8" x 5-1/2" roof joists at 2'-0" on center, supported by five rows of wood trusses, supported by 48" deep steel trusses.

At the auditorium roof interface with the second floor, there is an area with an active roof leak and deteriorated roof sheathing (see photograph 12). In this area, there are termite damaged ceiling joists. The auditorium roof beams are in excellent condition and the ceiling beams are in good condition with areas of termite damage (see photograph 13). At the proscenium beam, a diagonal from the ceiling beam to the roof beam has been cut to accommodate ductwork (see photograph 14) and no distress is apparent. It appears that these verticals and diagonals were installed for ease of construction and may not be acting as a truss. The roof and ceiling joists are fire cut into the 11 inch concrete walls and the concrete walls are in excellent condition (see Photographs 15 and 16). The steel trusses, roof and ceiling beam connections to the trusses are in excellent condition with minimal surficial rust (see photographs 17, 18 and 19). The truss bearings are placed integral with the concrete walls and are totally encapsulated in the walls (see photographs 20 and 21). There was one area of corrosion noted in one of the trusses, but this corrosion is surficial and can easily be cleaned and coated (see photograph 22).

The historic stage was a thrust stage with angled end rafters for foot lights (see photograph 23) and the historic stage has been enlarged to its present size. The CH2MHill framing in this area does not correctly depict the actual framing in this area. The stage framing is in excellent condition. The main auditorium floor framing at the stage could not be reviewed due to low crawl room. Its framing and condition could not be confirmed.

At the connecting breezeways, between Buildings A and B, there is significant wood rot and termite damage with active termites (see photographs 24 and 25). The breezeway wood roof framing is supported by concrete columns that are in excellent condition. The CH2MHill report documents these columns as wood columns.

The roofing for both buildings is in poor condition with active leaks. The concrete parapets and cornices are in good condition with no signs of distress other than random cracking in the cornice cement wash (see photographs 26 and 27).

The concrete walls and foundations at Glynn Archer Elementary School are in excellent condition with little cracking and no observed spalling. The minimum concrete wall thickness is 11 inches throughout except at the rear of the auditorium, where it is 8 inches thick. The walls have performed adequately for nearly one hundred (100) years supporting gravity and lateral loads and I see no reason, that they cannot continue to support gravity and lateral loads. With their actual thickness of 11inches, they are significantly stronger and more durable than reported in the CH2MHill report. The existing foundations bear on and in the rock and I am anticipating that the forthcoming AMEC foundation recommendations will recommend a higher rock bearing capacity than recommended in the Nutting report, allowing the existing foundations to be used without being underpinned and new foundations not requiring piles, which will bring significant savings to the project. The auditorium roof and floor structure is in excellent condition except for isolated areas of active roof leaks with deteriorated roof sheathing and termite damage. There are discrepancies in the roof and floor framing as presented in the CH2MHill report and the observed discrepancies are noted above. The discrepancies are not minor and if portions of the existing framing are to be reused, the framing in those areas should be surveyed and verified. The breezeway roof framing between Buildings A and B are in poor condition with significant wood rot and termite damage, along with active termites.

It has been a pleasure serving you as a consulting structural engineer. Please contact our office if there are any questions regarding this correspondence, or if you need any additional information or assistance.

Very truly yours,
ATLANTIC ENGINEERING SERVICES OF JACKSONVILLE
FLORIDA CERTIFICATE OF AUTHORIZATION #791

Mark J. Keister, P.E.
Principal

MJK/drg

MARK J. KEISTER
LICENSE No. 37435
STATE OF FLORIDA
PROFESSIONAL ENGINEER

PHOTOGRAPH 1

PHOTOGRAPH 2

PHOTOGRAPH 3

PHOTOGRAPH 4

PHOTOGRAPH 5

PHOTOGRAPH 6

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PHOTOGRAPH 27

APPENDIX A

EXISTING STRUCTURAL CONDITIONS EVALUATION CRITERIA

Atlantic Engineering Services
6501 Arlington Expressway, Building B, Suite 201
Jacksonville, FL 32211
Phone: 904.743.4633 Fax: 904.725.9295
E-mail: jax@aespj.com

EXISTING STRUCTURAL CONDITIONS
EVALUATION CRITERIA

EXCELLENT	**Meets or exceeds current structural code requirements.** Capable of safely carrying proposed occupancies. No significant vibrations, cracking or deflections. No structural reinforcement or repairs required. Very minor, if any, maintenance required.
GOOD	**Meets current structural code requirements.** Capable of safely carrying proposed occupancies. Deflections, cracking, vibrations may be observable. No structural reinforcement required. Minor structural repairs required. Some significant maintenance repairs required.
FAIR	**Majority of structure meets structural code requirements.** Portions of structure are not capable of carrying proposed occupancies. Deflections, cracking, vibrations, structural distress is observable. Structural reinforcement required in limited portions of the structure. Structural repairs required generally. Many significant maintenance repairs required.
POOR	**Majority of structure does not meet structural code requirements.** Much of the building is not capable of carrying proposed occupancies. Deflections, cracking, vibrations, structural distress commonly observable throughout the structure. Major reinforcement or reconstruction of the structure is required. Major maintenance repairs are required.
EXTREMELY POOR	**Collapse of structure is imminent.** Structure exhibits significant deflections, cracking, vibrations, structural distress. Structure requires extensive reinforcement or reconstruction of impractical scope.

NOTE: Some parts of each definition may not apply

ENGINEERING & INSPECTIONS
UNLIMITED, INC.

August 17, 2012

Mr. Rick Wohlfarth, P.E.
Nutting Engineers of Florida, Inc.
1310 Neptune Drive
Boynton Beach, FL 33426

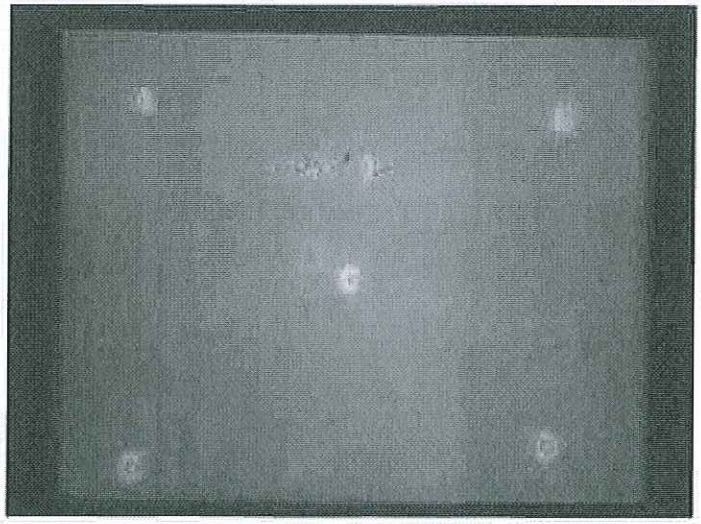
Re: Concrete Radiographic Examination & Ground Penetrating Radar Investigation Glynn Archer School 1300 White Street Key West, FL

Engineering & Inspections Unlimited, Inc. performed non-destructive testing inspections, Ir 192 radiography, Cobalt 60 radiography and Ground Penetrating Radar Scans (GPR). Inspections were performed on Wednesday, August 8, 2012 through Saturday, August 11, 2012 at the Glynn Archer School at 1300 White Street, Key West, FL. The purpose of these inspections is to locate and identify the reinforcing steel in walls and columns and established their spacing in selected areas. Areas inspected were predetermined by Andy Chan, P.E. of Yolles and conveyed to us by Rick Wolfarth, P.E. from Nutting Engineering. Mike Flattery from CH2M Hill was our site contact.

W 100 – Auditorium, First Floor, South Side

A 24" wide x 48" high area was scanned on the southeast side of column 100. The GPR scans showed no steel. A 14" x 17" radiograph was taken in the middle of the area at a height of 38.5" from the floor to the top of the film. No steel was found in the radiograph.

1



W 100 – Auditorium, First Floor, South Side

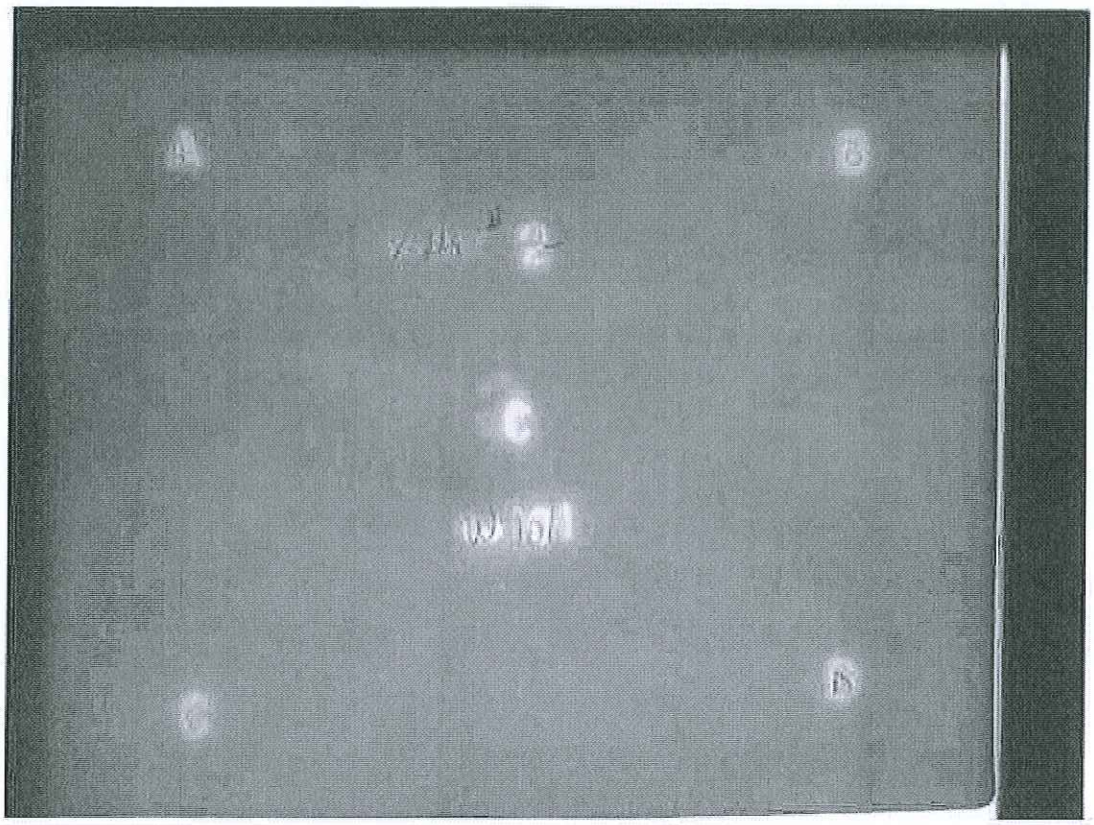
August 17, 2012

Mr. Rick Wohlfarth, P.E.
Nutting Engineers of Florida, Inc.

Page Two

W101 – Auditorium, First Floor, South Side

A 24" wide x 48" high area was scanned on the southwest side of column 100. The GPR scans showed no steel. A 14" x 17" radiograph was taken in the middle of the area at a height of 47" from the floor to the top of the film. No steel was found in the radiograph.



W101 – Auditorium, First Floor, South Side – X-Ray # 2

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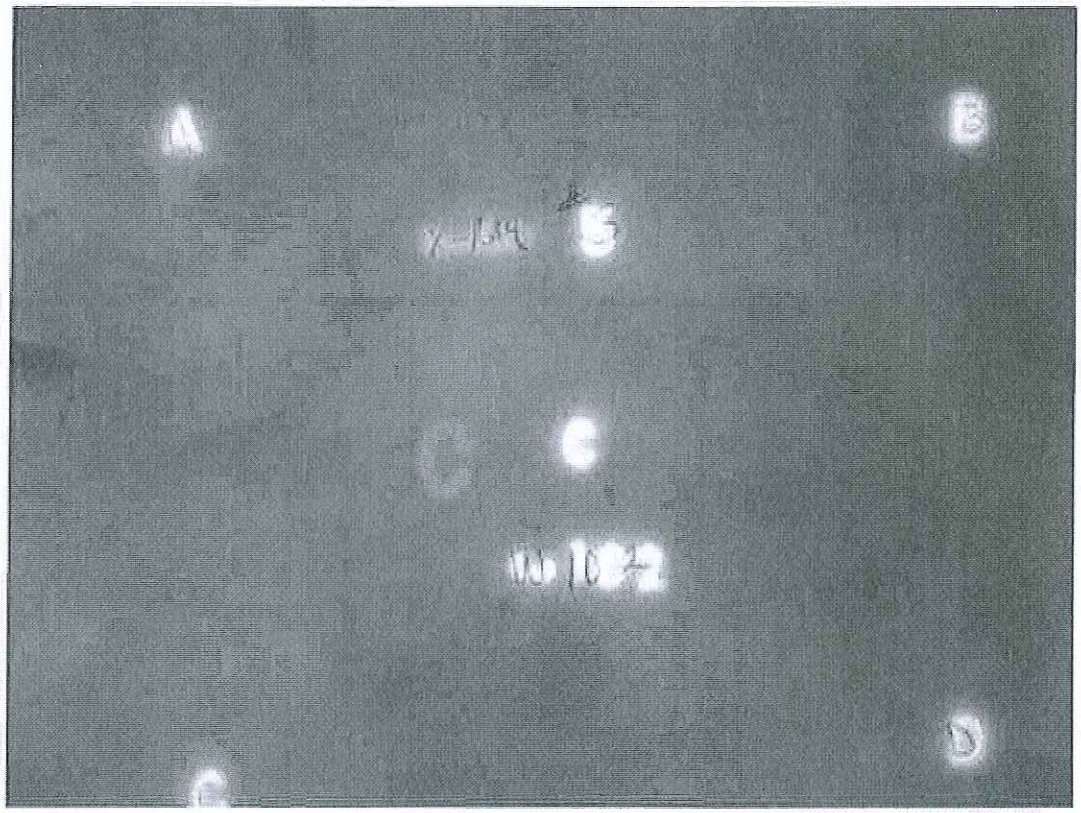
W102 – Auditorium, First Floor, North Side

A 24" wide x 48" high area was scanned on the west side of column 101. The GPR scans showed indications both vertical and horizontal. A 14" x 17" radiograph was taken at the intersecting points of the GPR indications at a height of 32" from the floor to the top of the film. No steel was found in the radiograph.



W 102 – Auditorium – First Floor – North Side – X-Ray # 5

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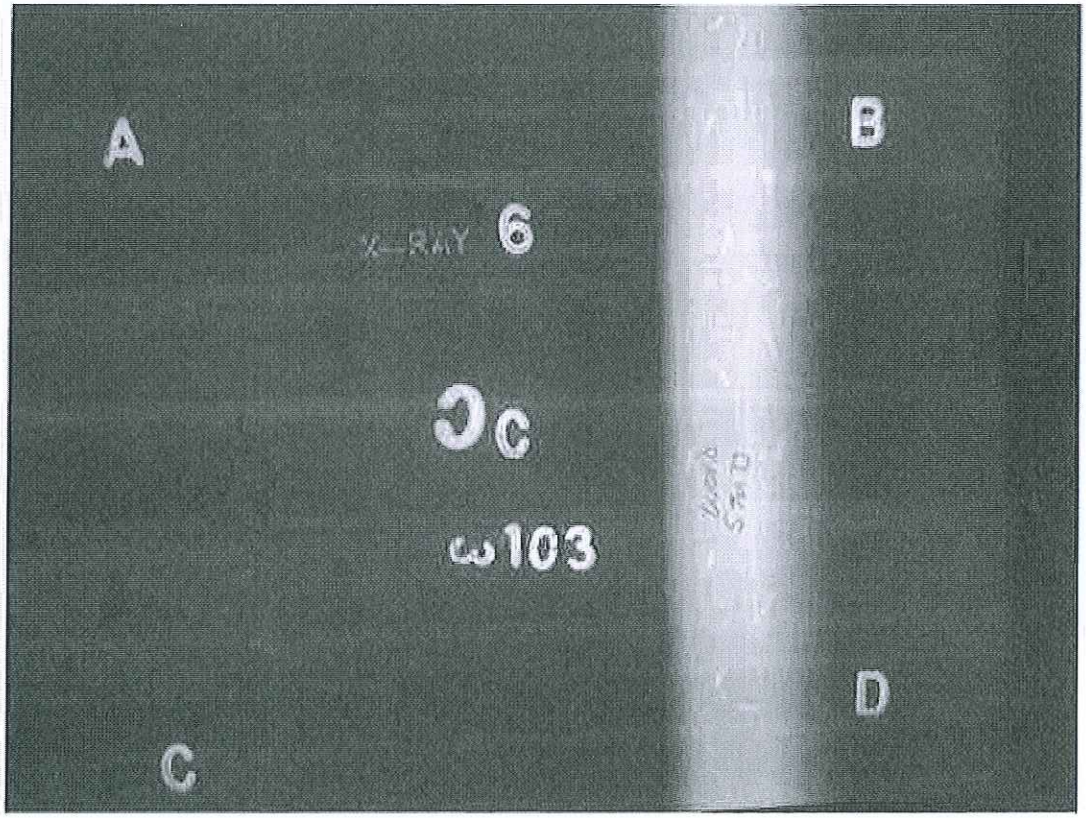
W103 – Auditorium, First Floor, North Side

A 24" wide x 48" high area was scanned on the east side of column 101. The GPR scans showed indications both vertical and horizontal. A 14" x 17" radiograph was taken at the intersecting points of the GPR indications at a height of 44" from the floor to the top of the film. The radiograph showed the wall to be made of wood lathing and plaster. The radiograph confirmed that the GPR indications were a pattern of nail heads.



W 103 – Auditorium, First Floor – North Side – East Side Column 101 X-Ray # 6

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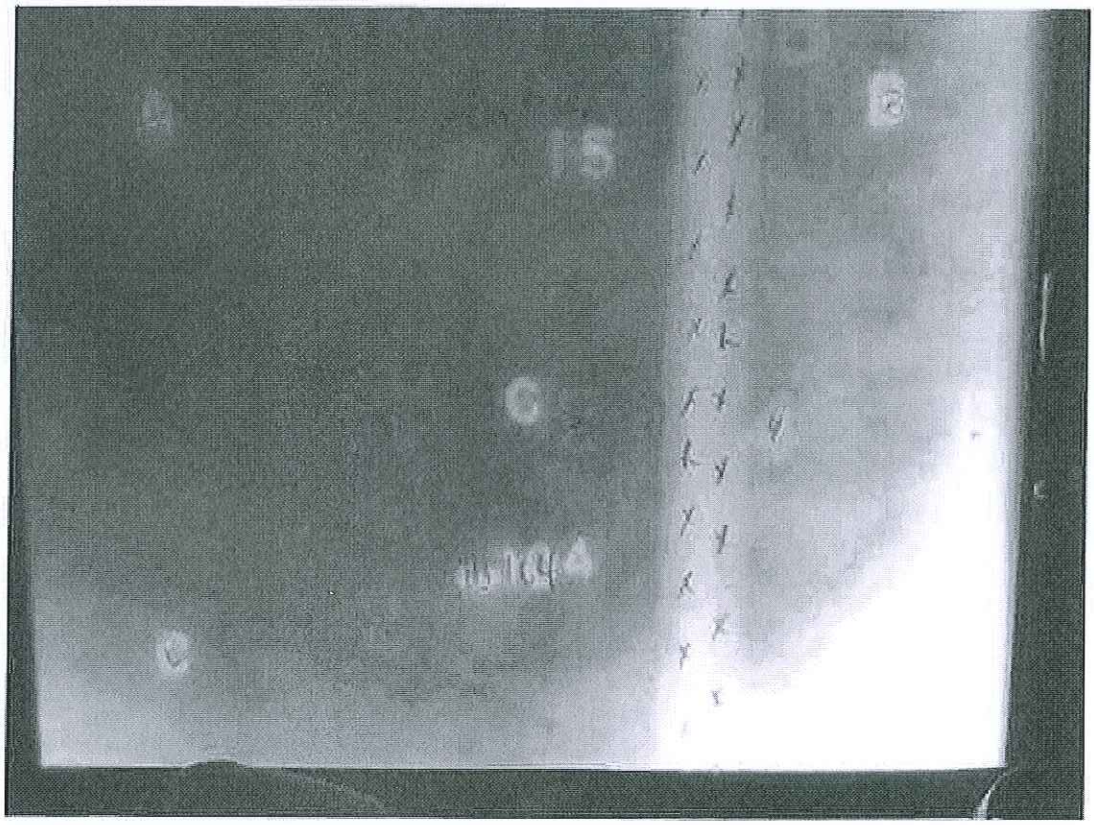
W 104 R – A - Wing, First Floor, Northeast Corner

This area was shifted to the opposite corner due to obstructions.
A 2'high x 3' wide area was scanned southeast wall. The GPR scans showed two overlapping vertical bars at an approximate depth of 6". A 14" x 17" radiograph was taken at a height of 40" from the floor to the top of the film. The bars are deformed rebar and are estimated at 15/16" in diameter.



W 104 R – A - Wing, First Floor, Northeast Corner – X-Ray # 15

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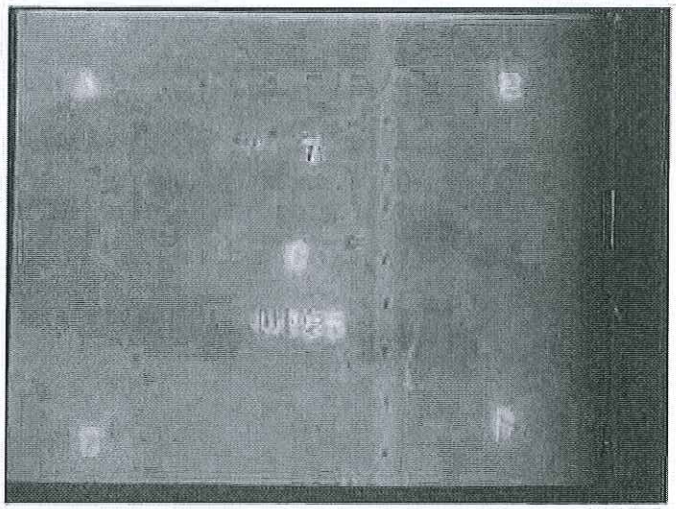
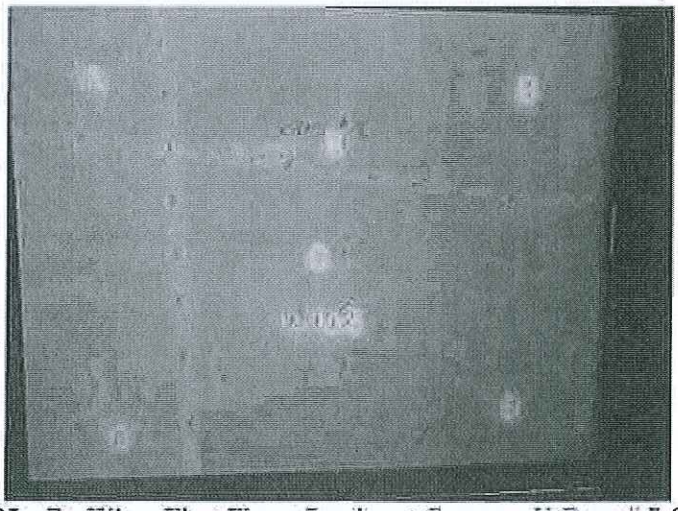
W 105 – B - Wing, First Floor, Southeast Corner

A L-shaped area of 17" high x 4' wide x 38" high was scanned. The GPR scans showed two vertical bars spaced at 26" and one horizontal bar bisecting the bar closest to the corner. These bars were at an approximate depth of 6" to 8". A 14" x 17" radiograph was taken at the bisect. The bars are deformed rebar. The vertical bar is estimated ¼" in diameter. The horizontal bar is estimated at ½" in diameter.

A 2' wide x 4' high area was scanned. The GPR scans showed one vertical and one horizontal bar at an approximate depth of 6" to 8". A 14" x 17" radiograph was taken at the bisect. The bars are deformed rebar. The vertical bar is estimated ¼" in diameter. The horizontal bar is estimated at ½" in diameter.





W 105 – B - Wing, First Floor, Southeast Corner – X-Rays # 7 & # 8

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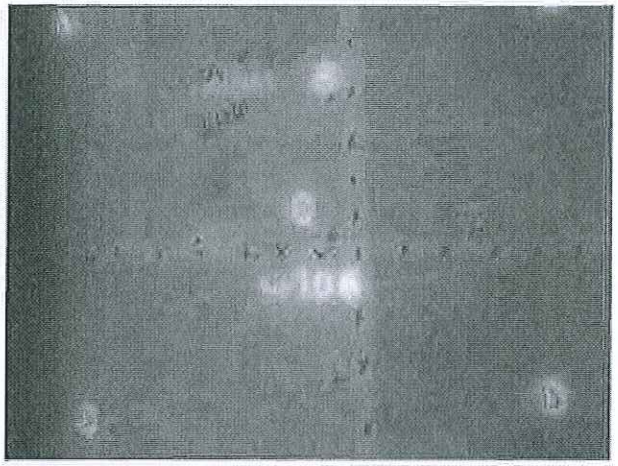
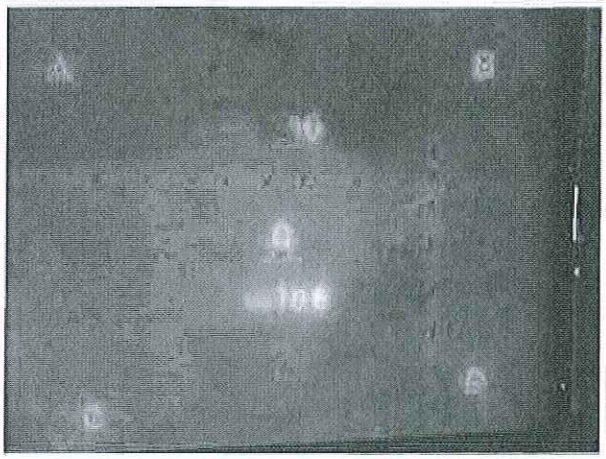
W 106 R – B - Wing, First Floor, Southeast Corner

This area was shifted from room 104 to room 109 due to obstructions.

A area of 36" high x 30" wide was scanned on the southeast wall of the corner. The GPR scans showed one vertical and one horizontal bar. These bars were at an approximate depth of 4" to 8". A 14" x 17" radiograph was taken at the bisect. The bars are deformed rebar. The vertical bar is estimated ½" in diameter. The horizontal bar is estimated at 5/16" in diameter.

A 2' wide x 4' high area was scanned on the northwest wall of the corner. The GPR scans showed one vertical and one horizontal bar at an approximate depth of 8" to 9". A 14" x 17" radiograph was taken at the bisect. The bars are deformed rebar. The vertical bar is estimated at ½" in diameter. The horizontal bar is estimated 5/16" diameter.





W 106 R – B - Wing, First Floor, Southeast Corner – X-Rays # 8 & # 10

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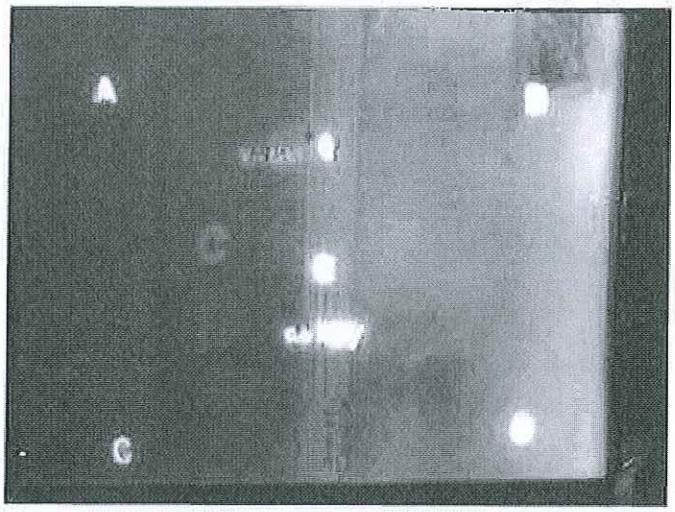
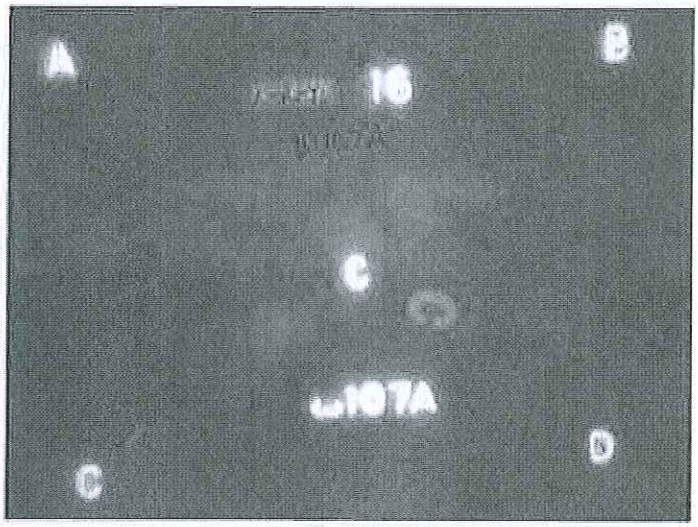
W 107 Auditorium, First Floor, West Side, Backstage

A 5' high x 9' wide area was scanned. The GPR scans showed indications. Two 14" x 17" radiographs were taken at a height of 70" and 65" from the floor to the top of the film. The radiographs showed no steel bars, one radiograph shows exterior conduit.





107 Auditorium, First Floor, West Side, Backstage – X-Rays # 4 & # 16

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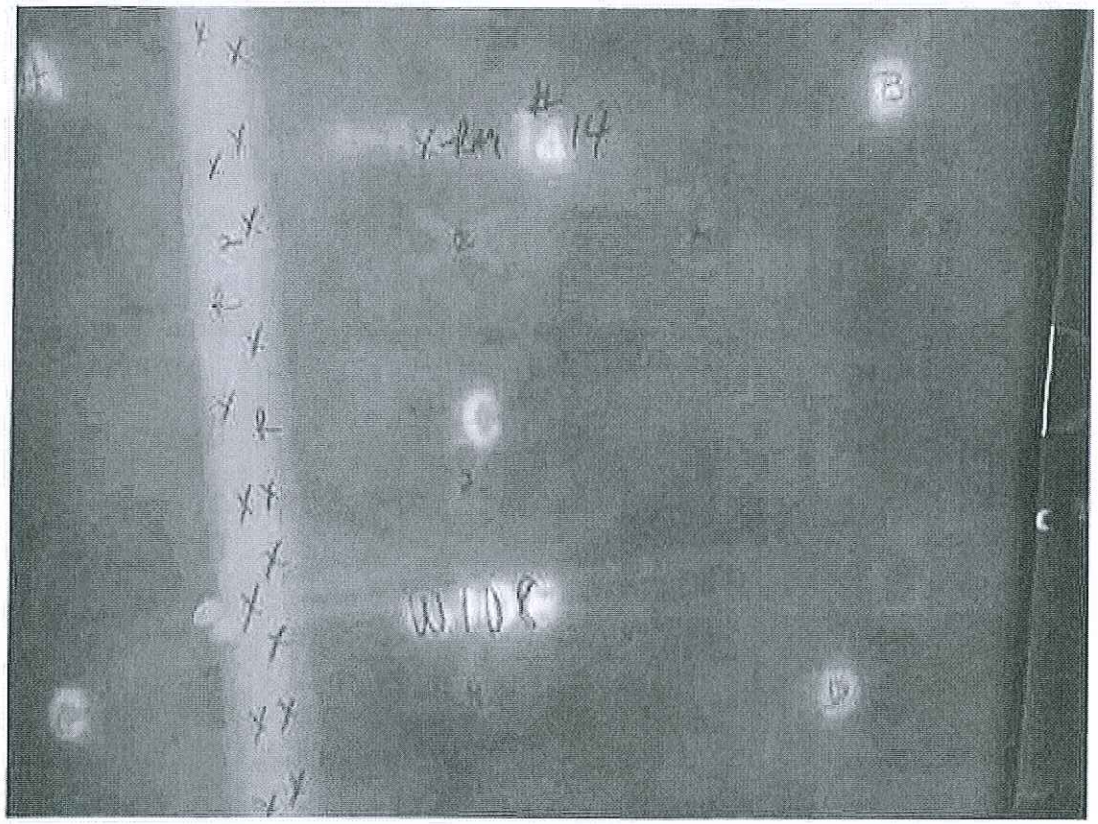
W 108 A - Wing, First Floor, Northwest Corner

A L-shaped area 6' wide x 18" high and 4'high x 3' wide were scanned on the southwest wall. The GPR scans showed three vertical indications at an approximate depth of 6" and spacing at 7". A 14" x 17" radiograph was taken at a height of 34" from the floor to the top of the film. The radiograph shows two overlapping deformed rebar, estimated at ¾" in diameter.



W 108 A - Wing, First Floor, Northwest Corner – X-Ray # 14

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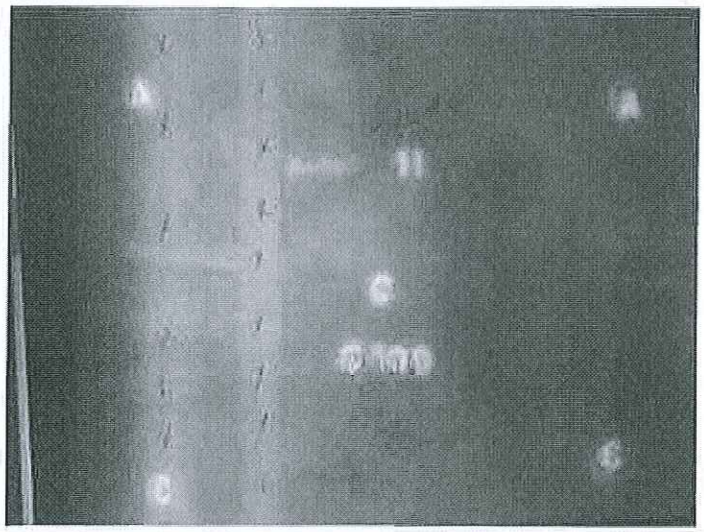
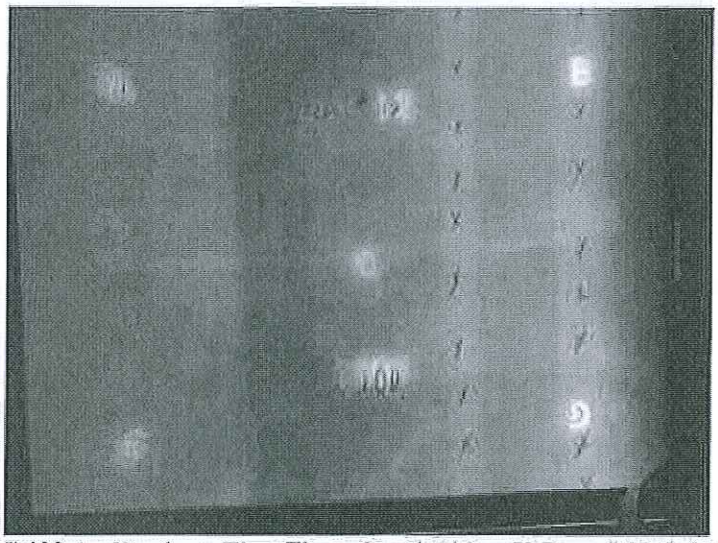
C 100 Auditorium, First Floor, South Side

A 4' high x 2'-1" wide area was scanned. The GPR scans showed vertical and horizontal indications. Two 14" x 17" radiographs were taken across the width of the column, at a height of 66.5" from the floor to the top of the film. The radiographs show two vertical, deformed rebar, at an approximate 6" depth and approximately 5" in from each side of the column. The diameter of the rebar is estimated at 1" in diameter.

The one horizontal indication is at a depth of approximately 6" at a height of 17" from the floor.





C 100 Auditorium, First Floor, South Side – X-Rays # 11 & 12

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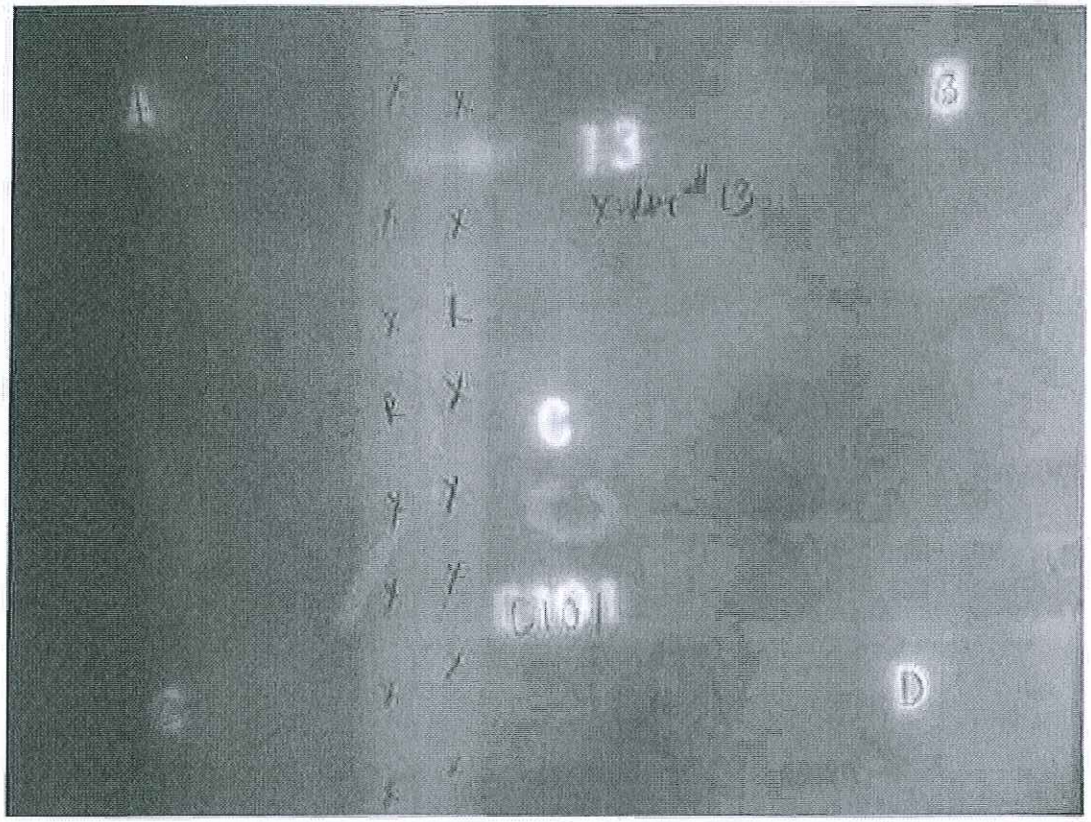
C 101 Auditorium, First Floor, North Side

A 4' high x 2' wide area was scanned. The GPR scans showed a vertical indication. Two 14" x 17" radiographs were taken across the width of the column, at a height of 48" from the floor to the top of the film. The radiographs show two vertical, deformed rebar, at an approximate 6" depth. These rebar are side by side and approximately 5" in from the west side of the column. The diameter of the rebar is estimated at 1" in diameter.



C 101 Auditorium, First Floor, North Side – X-Ray # 13

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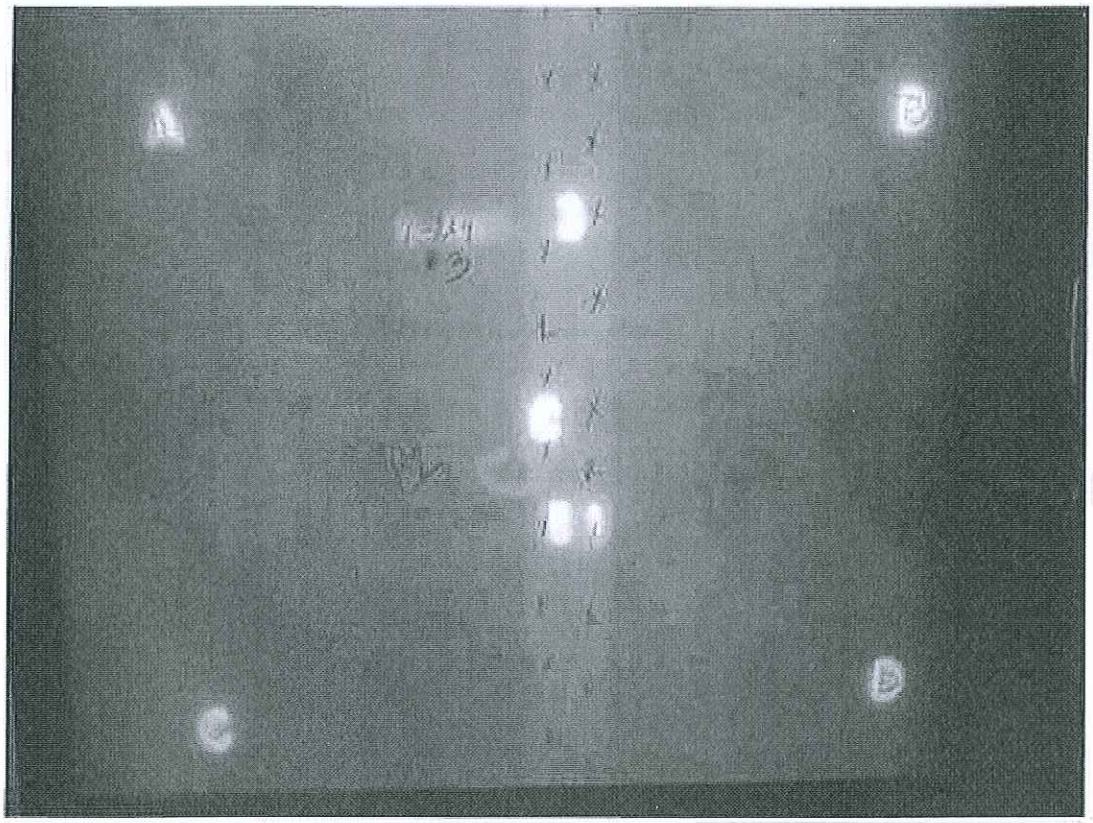
P 1 Auditorium, First Floor, South Side, Between Windows

A 4' high x 2' wide area was scanned. The GPR scans showed two vertical indications. Two 14" x 17" radiographs were taken across the width of the column, at a height of 58" from the floor to the top of the film. The radiographs show two vertical, deformed rebar, at an approximate 3" depth. These rebar are side by side and are on center. The diameter of the rebar is estimated at ½" in diameter.



P 1 Auditorium, First Floor, South Side, Between Windows – X-Ray # 3

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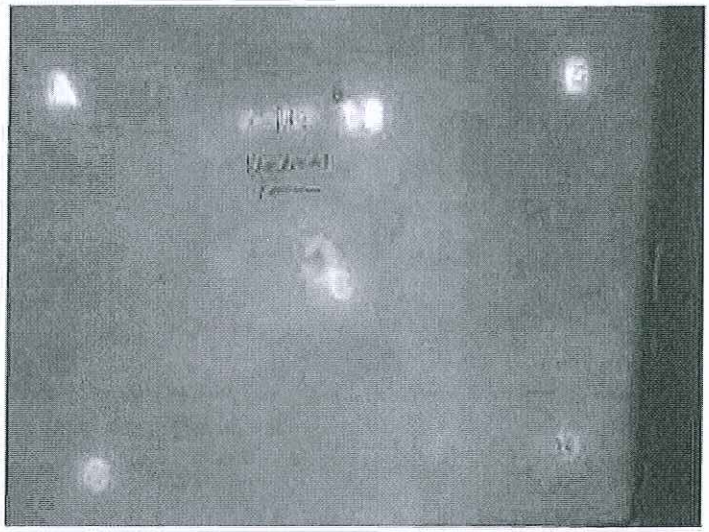
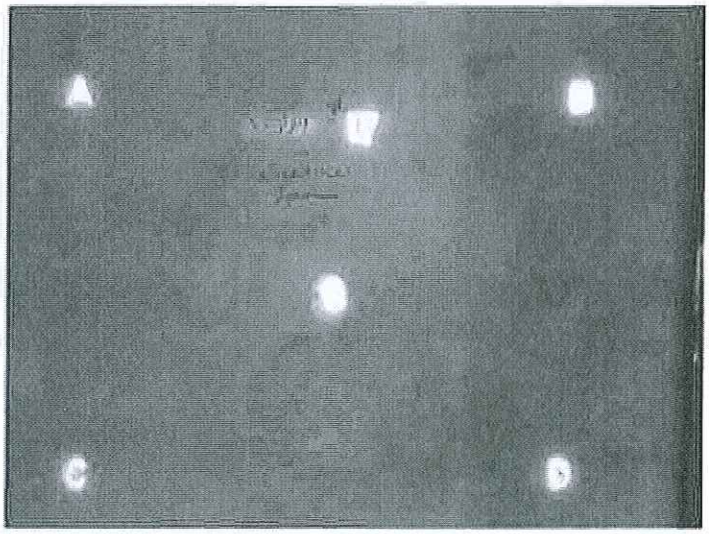
Electrical Room, West Side of Stage, West Corner

No GPR Scans were performed in the electrical room. As directed by Andy Chan, P.E., two radiographs were taken in the west corner on either wall spaced 12" apart in height. The radiographs showed no steel.





Electrical Room, West Side of Stage, West Corner – X-Ray # 17 & 18

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W 200 – B Wing, Second Floor Southeast Corner
Scans were performed on either wall in the corner; however, without radiographic verification, and considering the amount of junk, i.e., nail heads, crimped wire and other ferrous materials that the scans picked up and radiographs verified, we cannot identify any structural steel on the second floor. Access to the second floor for radiographs was not available.

W 200 – B Wing, Second Floor Southwest Corner
Scans were performed on either wall in the corner; however, without radiographic verification, and considering the amount of junk, i.e., nail heads, crimped wire and other ferrous materials that the scans picked up and radiographs verified, we cannot identify any structural steel on the second floor. Access to the second floor for radiographs was not available.

NOMEN-CLATURE	LOCATION	NDT METHOD & AREA SIZE	X-Ray	Bar Depth	Bar Size	Note
W100	Auditorium - First Floor - South Side	GPR - (24" X 48") X-RAY - 14" X 17"	1	No Steel	N/A	
W101	Auditorium - First Floor - South Side	GPR - (24" X 48") X-RAY - 14" X 17"	2	No Steel	N/A	
W102	Auditorium -First Floor - North Side	GPR - (24" X 48") X-RAY - 14" X 17"	5	No Steel	N/A	
W103	Auditorium - First Floor - North Side	GPR - (24" X 48") X-RAY - 14" X 17"	6	No Steel	N/A	
W104 R	A Wing - First Floor - North East Corner Switched to opposite corner due to obstructions	GPR - (2' X 3') X-RAY - 14" X 17"	15	two vertical bars @ 6" depth	15/16"	slight overlap
W105	B Wing - First Floor - South East Corner	GPR - (17" x 54"") GPR (48' x 24") X-RAY - 14" X 17"	7 SE 8 NW	one vertical bar@ 6" depth one horizontal bar @ 6" depth	1/4" 1/2"	corner - both sides
W106 R	B Wing - First Floor - Southeast Corner Switched from room 104 to room 109 due to obstructions	GPR - (36" x 56") GPR (36" x 30") X-RAY - 14" X 17"	9 SE 10 NW	one vertical @ 4" depth one horizontal @ 8" depth	1/2" 5/16"	corner - both sides
W107	Auditorium - First Floor - West Side	GPR - (10'-0" X 4'-0") X-RAY - 14" X 17"	4 16	No Steel	N/A	exterior conduit on film
W108	A Wing - First Floor - North West Corner There are 2 # W103's, this area renamed W108	GPR - (6' x 18") X-RAY - 14" X 17"	14	two vertical @ 6" depth	3/4"	overlapping
C100	Auditorium - First Floor - South Side	GPR (2'-1" x 4') X-RAY 14" x 17"	11 NE 12 SW	two vertical @6 & 7" depth two vertical @6" & 7" depth	1" 1"	
C101	Auditorium - First Floor - North Side	GPR (2' x 4') X-RAY - 14" X 17"	13 SW NE	two vertical @6 & 7" depth one vertical @6" & 7" depth	1"	
W200	A Wing - Second Floor - South East Corner No access for x-ray	GPR - (10'-0" X 5'-0") X-RAY - 14" X 17"		N/A		
W201	B Wing - Second Floor - South West Corner No access for x-ray	GPR - (10'-0" X 5'-0") X-RAY - 14" X 17"		N/A		
P 1	Auditorium - First Floor - South Side - between windows	GPR (2' x 4') X-RAY 14" x 17"	3	two vertical bars @ 3" depth	1/2"	
Electrical Room	Off of Stage in Auditorium	X-RAY 14" x 17"	17 18	No Steel		

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Engineering & Inspections Unlimited, Inc. appreciates this opportunity to provide your project with Nondestructive Testing Services. Should you have any questions or require additional information, Please contact us direct.

Regards,
Donna Frione

ENGINEERING & INSPECTIONS UNLIMITED, INC.

ENGINEERING
ENVIRONMENTAL
ECOLOGICAL

November 20, 2013

Mr. Bert L. Bender, Architect
Bender & Associates Architects, P.A.
410 Angela Street
Key West, FL 33040

Subject: Arborist Assessment of Trees
Former Glynn Archer Elementary School Site
1302 White Street, Key West, FL 33040
E Sciences Proposal Number 1-1702-01

Dear Mr. Bender,

E Sciences, Incorporated (E Sciences) is pleased to provide the following assessment of trees and palms located at 1302 White St, Key West, FL 33040, the site of the former Glynn R. Archer Elementary School and future City Hall operations. The City and its architect, Bender and Associates Architects, P.A. (Bender & Associates), engaged E Sciences to design a new landscape for the site. The new design will incorporate a portion of the existing landscape material and require removal of some existing trees, including trees that are protected under Section 110 of the City's municipal code.

The purpose of this report is to document E Sciences' observations of the health and condition of the trees at the site, and to provide recommendations for preservation, transplantation and/or removal and replacement associated with the new design and in accordance with the City's municipal code. The use of this report for other purposes is prohibited.

METHODOLOGY

On October 10 and 11, 2013, an E Sciences International Society of Arboriculture (ISA) Certified Arborist conducted a ground-based visual assessment of the tree crown, trunk, above-ground roots, and site conditions around the trees to evaluate the structure and health of the trees. The assessment did not include the use of tools.

The assessment included the identification of conditions indicating the presence of health and/or structural deficiencies including, but not limited to: chlorosis; dead, diseased, broken branches, stems, and/or roots; weakly attached branches and co-dominant stems; crossing limbs; mechanical damage and cracks; abnormal growth such as swelling, ribs, flat areas, or seams; indications of decay and cankers; root plate lifting; abnormal trunk flare; lack of trunk flare; soil cracks; grade change; restricted or undermined roots; unusual tree architecture including lean, low live crown ratio, poor taper, and/or crown asymmetry.

E Sciences, INCORPORATED
111 NE First Street, Suite 906 • Miami, FL 33132
ph 786-517-2632 fax 305-397-1556
www.esciencesinc.com

RESULTS AND RECOMMENDATIONS

Following are the observations made at the site, and our recommendations. The tree numbers used below correspond to the tree numbers from the tree survey and disposition table dated July 19, 2013. When trees were identified at the site that were not included in the tree survey, a new tree identification number was generated by adding a letter to the number of a nearby tree.

Tree 1: Royal Poinciana (*Delonix regia*)

Observations: This tree is located in a highly trafficked location at the corner of White Street and Seminary Street. The tree crown structure is typical of the species, as are the surface roots present throughout the root zone. E Sciences observed some decay within old pruning cuts at some of the branch connections. These cuts range from four to eight inches long. Roots show signs of mechanical damage, likely due to mowing. The tree abuts the Seminary Street curb and is impacting the integrity of the curb and street. The curb is likely to be limiting the growth of roots on the south side of the tree. Grass does not grow well under royal poinciana trees and thus erosion has occurred at the base of the tree. This erosion and the lack of root structure to the south create a situation where the tree's stability is compromised. There is concrete in the base of the tree, which likely was used in an attempt to stabilize the area under the tree. The tree is cracking the road and growing over the curb (see photo right).

Rating: Fair

Disposition: Removal and replacement

Recommendation: While this species is visually appealing and iconic to Key West, this particular specimen is located too close to the sidewalk and street. This placement has resulted in potential destabilization of the tree due to lack of root structure to the south and the likelihood of continued damage to the street and curb. E Sciences recommends removing and replacing this tree in association with Sec. 110-327(a) of the City's municipal code.

Trees 2 and 3: Queen Palm (*Syagrus romanzoffiana*)

Observations: These two palm trees are located adjacent to the east side of the building. E Sciences observed slight pencil-necking (narrowing of the trunk) towards the base of the palms. Due to the proximity of the building, the crown of the palms are limited (see photo right). The palms also appear to lack overall vigor, potentially due to poor, alkaline soils typical of the area, lack of nutrients, or premature removal of older fronds.

Rating: Fair

Disposition: Removal and replacement

Recommendation: While this palm is not included in Section 110-254 of the City of Key West or Section 114-102 of the Monroe County Code, it is listed on the Florida Exotic Pest Plant Council (FLEPPC) List of Invasive Plant Species. These specimens are too close to the building to reach their full canopy potential. E Sciences recommends removing these palms and replacing with new, suitable trees.

Tree 4: Alexander Palm (*Ptychosperma elegans*)

Observations: This palm has a slight dogleg and pencil-necking in its trunk but appears generally healthy. No photo is included for this tree.

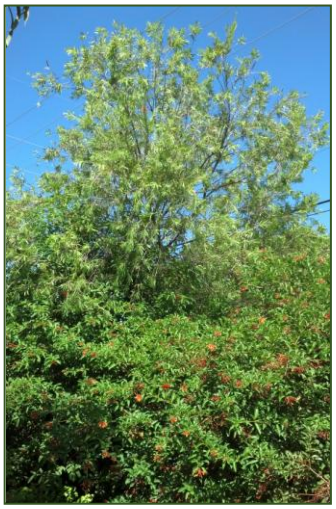
Rating: Fair

Disposition: Removal and replacement

Recommendation: E Sciences recommends removal and replacement.

Tree 5: Weeping Bottlebrush Tree (*Callistemon viminalis*)

Observations: This tree is almost completely engulfed by shrubs and thus is not growing to its canopy potential (see photo right). Very little of the canopy is exposed. The root structure of this tree is poor. The tree leans heavily and is being supported by one rope, which is girdling the tree (see photo left).



Rating: Poor

Disposition: Removal and replacement

Recommendation: This tree is listed on the FLEPPC List of Invasive Plant Species and is in poor condition. E Sciences recommends removal and replacement.

Tree 6: Weeping Bottlebrush Tree

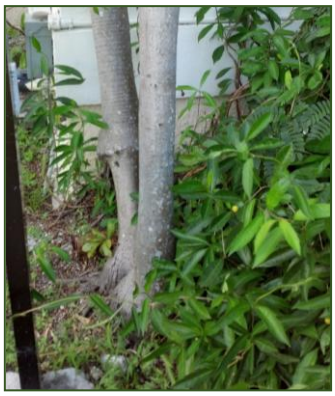
Observations: Like Tree 5, this tree is engulfed by shrubs and thus most of the canopy is missing. This tree also has poor root structure due to large rocks in the soil and erosion caused by roosters living within the shrubs. This tree has a significant lean, has been over pruned, and has stub cuts. No photo is included for this tree.

Rating: Poor

Disposition: Removal and replacement

Recommendation: This tree is listed on the FLEPPC List of Invasive Plant Species and is in poor condition. E Sciences recommends removal and replacement.

Tree 7: Alexander Palm



Observations: This double palm has slight pencil-necking at the base (see photo right), but is otherwise healthy.

Rating: Fair

Disposition: Removal and replacement

Recommendation: If this tree does not fit within the context of the new landscape design, E Sciences recommends removal and replacement.

Tree 8: Queen Palm

Observations: Similar to Trees 2 and 3 this palm is too close to the building and is pencil-necked low in the trunk. No photo is included for this tree.

Rating: Fair

Disposition: Removal and replacement

Recommendation: This palm is listed on the FLEPPC List of Invasive Plant Species. This palm is too close to the building to reach its full canopy potential. E Sciences recommends removal and replacement.

Tree 9, 9a: Queen Palm

Observations: Next to Tree 9 is another queen palm, which will be identified as Tree 9a. Both of these palms are stunted and chlorotic. They are too close to the building and have had too many fronds removed (see photo left).

Rating: Poor

Disposition: Removal and replacement

Recommendation: This palm is listed on the FLEPPC List of Invasive Plant Species. These two palms are too close to the building and in poor condition. E Sciences recommends removal and replacement.

Tree 10: Alexander Palm

Observations: This tree has pencil-necking and some damage at the base of the trunk, as well as a dog-leg (see photo left).

Rating: Fair

Disposition: Removal and replacement

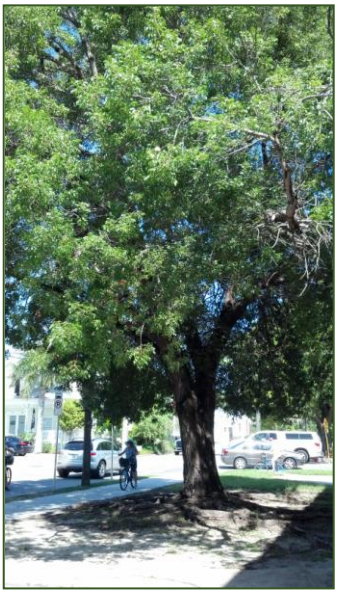
Recommendation: E Sciences recommends removal and replacement.

Tree 11: West Indian Mahogany (*Swietenia mahagoni*)

Observations: This mature tree has two, upright co-dominant leaders low in the tree, and E Sciences observed included bark between the two leaders (see photo right), which reduces the tree's wind tolerance and increases the likelihood of failure. Within the canopy, E Sciences observed a number of dead leaders; some were attached and some were hanging. There are a number of stub cuts within the canopy. The tree has plenty of root space and good root structure. There has been some mechanical root damage.

Rating: Fair

Disposition: Preservation



Recommendation: This mature tree appears to be in good health, but has some structural flaws. See photo left. E Sciences recommends pruning the tree to remove dead wood and hangers from the canopy, correct stub cuts, and to take some weight off of the tree to remove some pressure from the connection between the tree's co-dominant leaders. The root zone should be protected with mulch or another cover to prevent erosion and discourage use of mechanical equipment within the root zone. E Sciences also recommends monitoring the tree annually for structure.

Trees 12 and 13: Cabbage Palm (*Sabal palmetto*)

Observations: Only one tree is located at the corner of White Street and United Street as opposed to the two shown on the tree survey. The remaining tree is a cabbage palm in good condition. Palm fronds are close to the overhead utility line that runs along the south side of United Street but should not interfere with the lines (see photo right).

Rating: Good

Disposition: Preservation

Recommendation: E Sciences recommends preservation.

Tree 14: Seagrape (*Coccoloba uvifera*)

Observations: This tree is placed very close to the building and a concrete pad, both of which will limit the tree's growth (see photo right). E Sciences observed that the tree is leaning away from the school. Only one third of the canopy remains; it appears that major leaders were removed or damaged. There are old wounds and stub cuts present.

Rating: Poor

Disposition: Removal and replacement

Recommendation: E Sciences recommends removal in accordance with Sec. 110-327(a) of the City's municipal code. The tree is in poor condition and close to the building.

Tree 14a: Florida Thatch Palm (*Thrinax radiata*)

Observations: This tree is very close to the building but appears healthy and structurally sound (see photo left).

Rating: Good

Disposition: Not included in tree survey

Recommendation: E Sciences recommends preservation or relocation.

Tree 15, 16, 16a-d: Alexander Palm

Observations: Two of these palms are listed on the tree survey; however, there are six total within this courtyard. E Sciences did not observe any obvious signs of health or structural deficiency with the exception of one double-stemmed palm that is growing through the fence (see photo right). Only palms that are eight feet tall are protected per Sec. 110-321(a)(2).

Rating: Good, poor

Disposition: Two proposed for removal; four not included in survey.

Recommendation: E Sciences recommends removal of palms in good condition only if needed due to conflict with new landscape elements.

Tree 17: Gumbo Limbo (*Bursera simaruba*)

Observations: This tree appears to be in good health and has good structure for a tree of this species (see photo right). E Sciences observed some dead branches, attached and hanging, and some crossing limbs. There is also a small structure attached to the tree with a rope that will soon be girdling the tree.

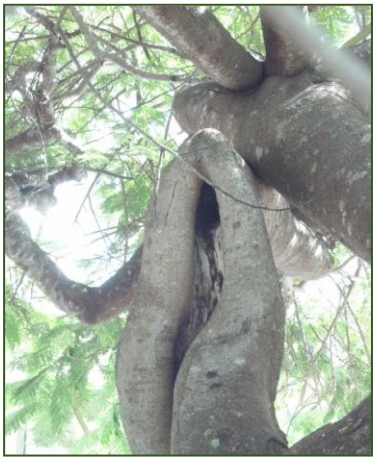
Rating: Good

Disposition: Preservation

Recommendation: While this tree is in relatively good condition, E Sciences recommends removing and replacing this tree due to conflict with new landscape elements

Tree 18 Royal Poinciana

Observations: This tree has major structural flaws, including crossing leaders and bark and major decay throughout the center of the trunk (see photos to the right and left).



Disposition: Preservation

Recommendation: E Sciences recommends removal of this tree in accordance with Sec. 110-327(a) of the City's municipal code. If the City desires to keep this tree due to the canopy it provides, E Sciences recommends structural pruning for correctable defects and frequent monitoring. E Sciences also recommends consultation with an arborist experienced with bracing and propping.

Tree 19: Gumbo Limbo

Observations: This tree is growing too close to the fence and sidewalk and is damaging both. There is an approximate three-inch lift in sidewalk that would be difficult to correct without significant damage to the tree. The tree is growing into the fence. The canopy is small relative to the size of the tree. E Sciences observed crossing limbs within the crown.

Rating: Poor

Disposition: Preservation

Recommendation: E Sciences recommends removal of this tree.

Trees 20 through 26: Cabbage Palm

Observations: These seven cabbage palms appear to be in good health and condition. However, they are all growing close to the utility line along United Street.

Rating: Good

Disposition: Preservation

Recommendation: E Sciences recommends preserving palms that do not conflict with the proposed design: 25 and 26. E Sciences recommends monitoring the remaining palms for utility conflict and removing parasitic trees such as strangler fig (*Ficus aurea*).

Tree 27: Queensland Umbrella (*Schefflera actinophylla*)

Observations: This tree is in poor condition and is conflicting with the building (see photo right). There have been major cuts or breaks in this tree, resulting in large wounds and reduced canopy.

Rating: Poor

Disposition: Removal

Recommendation: E Sciences recommends removing this tree, which is not a protected species per Sec. 110-254 of the City's code and is listed on the FLEPPC list of invasive species.

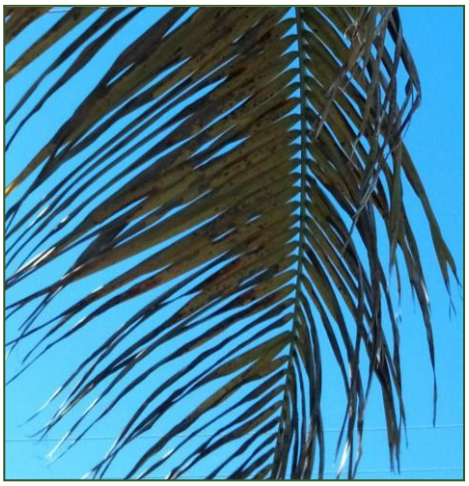
Trees 28 through 36: Cabbage Palm

Observations: These nine cabbage palms appear to be in good health and condition. However, they are all growing close to the utility line along United Street. No photo is included for these trees.

Rating: Good

Disposition: Preservation

Recommendation: E Sciences recommends preserving these palm with the exception of Tree 31, which conflicts with the proposed design. E Sciences recommends monitoring the palms for utility conflict and removing parasitic trees such as strangler fig.



Trees 37 through 39: Coconut Palm (*Cocos nucifera*)

Observations: E Sciences observed fronds that were yellowing, with browning tips and brown spots (see photos left and below). E Sciences also observed cracks in the trunks of these palms.

Rating: Fair

Disposition: Relocation

Recommendation:

E Sciences recommends removal of these palms and replacement.

Trees 40 through 44 (including 42a): Cabbage Palm

***Observations*:** There are six cabbage palms along the north side of the property (south side of United Street) west of the coconut palms. Like the other palms along United Street, these palms are close to the utility lines running along the south side of United Street. The line is currently one or two feet above the palms, with the center of the palms being located two to three feet from the line. These palms are all in good condition. One of the palms has a slight lean (see photo above).

Rating: Good

Disposition: Preservation

Recommendation: E Sciences recommends preserving Trees 40 through 42, which do not conflict with the proposed landscape design. The rest should be removed and replaced.

Tree 45: Strangler Fig

Observations: This tree provides shade for Grinnell Street and visual interest from a number of angles (see photo below). The tree's structure is typical for this species. The tree is growing into the fence on the west side of the property. This is likely to result in damage to the fence.

Rating: Fair

Disposition: Preservation

Recommendation: E Sciences recommends monitoring the health and conditions of this tree every few years. The tree should be maintained for clearance along Grinnell Street.

Tree 46: Royal Poinciana

Observations: This tree conflicts with a utility pole, overhead utilities, and the Seminary Street curb and sidewalk (see photo right). Overall, the tree appears healthy and its structure is typical of a mature specimen of this species. E Sciences observed numerous crossing limbs and some dead leaders within the crown. Branch connections in some locations are compromised due to decay observed associated with previous pruning cuts. Some larger limbs appear to be sprouts from prior damage; these large sprouts are likely to be more

weakly attached than other limbs and are located over a target (sidewalk). Cement has been inserted into gaps in the base of the tree. Root structure was observed to be poor.

Rating: Fair

Disposition: Removal

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's municipal code.

Tree 47: Sandbox Tree (*Hura crepitans*)

Observations: This tree conflicts with the utility lines along Seminary Street and has structural flaws and signs of diminished health and condition. The tree is being impacted at the base by concrete. E Sciences observed numerous hanging and fallen limbs, with a number of dead or decaying limbs likely to fall in the near future. The tree has a substantial lean and decay within old wounds (see photo below).

Rating: Poor

Disposition: Preservation

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's municipal code and replacement. If the City desires preservation, E Sciences recommends structural pruning and crown cleaning. E Sciences also recommends monitoring the condition of this tree annually or biannually.

Tree 48: Sandbox Tree

Observations: This tree conflicts with the utility lines along Seminary Street and has structural flaws and signs of diminished health and condition. E Sciences observed numerous hanging and fallen limbs, with a number of dead or decaying limbs likely to fall in the near future. There are also stub cuts and crossing

leaders with included bark in the crown (see photo below). A fungus was observed growing on one of the larger limbs; this is often a sign if decay within the wood.

Rating: Poor

Disposition: Preservation

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's code and replacement. If the City desires preservation, E Sciences recommends structural pruning and crown cleaning. E Sciences also recommends monitoring the condition of this tree annually or biannually.

Tree 49: Sandbox Tree

Observations: This tree conflicts with the utility lines along Seminary Street and has structural flaws and signs of diminished health and condition. The tree has co-dominant leaders, with included bark and excessive growth at the attachment. E Sciences observed stress cracks along some of the larger limbs and die-back towards the tips of some of the leaders hanging over the street. There is an old wound on the trunk, which is cracked to the base of the tree (see photo right).

Rating: Poor

Disposition: Preservation

Recommendation: E Sciences recommends removal

of this tree per Sec. 110-327(a) of the City's municipal code and replacement. If the City desires preservation, E Sciences recommends structural pruning and crown cleaning. E Sciences also recommends monitoring the condition of this tree annually or biannually.

Tree 50: Sandbox Tree

Observations: This tree is abutting the sidewalk along Seminary Street and is growing over the cement and interfering with the fence behind it (see photo left) which is damaging the sidewalk and the tree. Overall, the crown structure of this tree is poor, with included bark at attachments, crossing and/or pressing leaders (see photo below) and decay visible at the locations of old pruning cuts or breaks. Fungus was observed, which is an indication of decay.

Rating: Poor

Disposition: Preservation

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's municipal code and replacement. If the City desires preservation, E Sciences recommends structural pruning and crown cleaning. E Sciences also recommends monitoring the condition of this tree annually or biannually.

Tree 51: Number not used in tree survey

Tree 52: Jamaican Dogwood (*Piscidia piscipula*)

Observations: This tree has co-dominant leaders (photo left). There are crossing limbs, dead limbs and decay is present in old wounds. E Sciences observed included bark at one of the branch connections.

Rating: Poor

Disposition: Removal

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's municipal code and replacement.

Tree 53: Jamaican Dogwood

Observations: This tree is leaning and has poor root structure. There are crossing leaders, dead limbs and decay is present in old wounds (see photo right).

Rating: Poor

Disposition: Removal

Recommendation: E Sciences recommends removal of this tree per Sec. 110-327(a) of the City's municipal code and replacement.

Tree 54: Alexander Palm

Observations: This four-stemmed palm was observed to be chlorotic (see photo left).

Rating: Fair

Disposition: Removal

Recommendation: If this palm does not fit within the context of the new landscape design, E Sciences recommends removal and replacement.

Tree 55: Alexander Palm

Observations: This two-stemmed palm is in good health and condition. No photo is included for this tree.

Rating: Good

Disposition: Removal

Recommendation: If this palm does not fit within the context of the new landscape design, E Sciences recommends removal and replacement.

Tree 56: Silver Buttonwood (*Conocarpus erectus var. sericeus*)

Observations: This tree is planted in poor soil, but appears to be in good health. The form is typical of this species (see photo right).

Rating: Good

Disposition: Removal

Recommendation: If this tree does not fit within the context of the new landscape design, E Sciences recommends removal and replacement.

Tree 57: Tree of Life (*Guaiacum officinale*)

Observations: This tree is planted in poor soil, but appears to be in good health. The form is typical of this species (see photo left).

Rating: Good

Disposition: Preservation

Recommendation: E Sciences recommends preservation.

Tree 58: Tree of Life

Observations: This tree is planted in poor soil and leans heavily. E Sciences observed some decay and sprouts at the site of previous pruning cuts, which include stub cuts. Because the tree is small, defects are unlikely to pose a risk (see photo right).

Rating: Fair

Disposition: *Preservation*

Recommendation: E Sciences recommends preservation.

Tree 59: No tree in this location

Courtyard Trees

There are trees located within a courtyard surrounded on four sides by buildings (see photo right). These trees include fourteen Alexander palms, one coconut palm, and one umbrella tree. Because the courtyard is surrounded by buildings on all four sides (with one small opening), these trees should be exempt from permitting per Sec. 110-322(b).

SUMMARY OF RECOMMENDATIONS

Following is a summary table that includes the tree number, species, disposition, and E Sciences' recommendations.

Tree Number	Species	Disposition	Recommendation
1	Delonix regia	Remove	Remove
2	Syagrus romanzoffiana	Remove	Remove
3	Syagrus romanzoffiana	Remove	Remove
4	Ptychosperma elegans	Remove	Remove
5	Callistemon viminalis	Remove	Remove
6	Callistemon viminalis	Remove	Remove
7	Ptychosperma elegans	Remove	Remove
8	Syagrus romanzoffiana	Remove	Remove
9	Syagrus romanzoffiana	Remove	Remove
10	Ptychosperma elegans	Remove	Remove
11	Swietenia mahagoni	Remain	Preserve
12	Sabal palmetto	Remain	Preserve
13	no tree	NA	NA
14	Coccoloba uvifera	Remove	Remove
14a*	Thrinax radiata	NA	Preserve or relocate
15	Ptychosperma elegans	Remove	Remove
16	Ptychosperma elegans	Remove	Remove
16a*	Ptychosperma elegans	NA	Remove
16b*	Ptychosperma elegans	NA	Remove
16c*	Ptychosperma elegans	NA	Remove
16d*	Ptychosperma elegans	NA	Remove
17	Bursera simaruba	Remain	Remove
18	Delonix regia	Remain	Remove
19	Bursera simaruba	Remain	Remove
20	Sabal palmetto	Remain	Remove
21	Sabal palmetto	Remain	Remove
22	Sabal palmetto	Remain	Remove
23	Sabal palmetto	Remain	Remove
24	Sabal palmetto	Remain	Remove
25	Sabal palmetto	Remain	Preserve
26	Sabal palmetto	Remain	Preserve
27	Schefflera actinophylla	Remove	Remove
28	Sabal palmetto	Remain	Preserve
29	Sabal palmetto	Remain	Preserve

Tree Number	Species	Disposition	Recommendation
30	Sabal palmetto	Remain	Preserve
31	Sabal palmetto	Remain	Remove
32	Sabal palmetto	Remain	Preserve
33	Sabal palmetto	Remain	Preserve
34	Sabal palmetto	Remain	Preserve
35	Sabal palmetto	Remain	Preserve
36	Sabal palmetto	Remain	Preserve
37	Cocos nucifera	Relocate	Remove
38	Cocos nucifera	Relocate	Remove
39	Cocos nucifera	Relocate	Remove
40	Sabal palmetto	Remain	Preserve
41	Sabal palmetto	Remain	Preserve
42	Sabal palmetto	Remain	Remove
42a*	Sabal palmetto	Remain	Remove
43	Sabal palmetto	Remain	Remove
44	Sabal palmetto	Remain	Remove
45	Ficus aurea	Remain	Preserve
46	Delonix regia	Remove	Remove
47	Hura crepitans	Remain	Remove
48	Hura crepitans	Remain	Remove
49	Hura crepitans	Remain	Remove
50	Hura crepitans	Remain	Remove
51	number not used	NA	NA
52	Piscidia piscipula	Remove	Remove
53	Piscidia piscipula	Remove	Remove
54	Ptychosperma elegans	Remove	Remove
55	Ptychosperma elegans	Remove	Remove
56	Conocarpus erectus var. sericeus	Remove	Remove
57	Guaiacum officinale	Remain	Preserve
58	Guaiacum officinale	Remain	Preserve
59	no tree	NA	NA

*was not included in original tree survey

Preliminary Report

Rainwater Harvesting Restoration Analysis Glynn Archer School Cisterns

Submitted to: Bender & Associates Architects, P.A.

Submitted By:

Richard C. Lightner III

LEED AP BD+C - Water Consultant

U.S. Green Building Council

American Rainwater Catchment Systems Association - AP

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There were many Individual Contributors within those departments, working and retired, include Julie Cheon and Marnie Walterson, Bookie Henriquez, Chuck Freeman, Amber Archer, Sally Smith, Jeff Barrow, Len Rodus and Tom Hambright.

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Disclaimer

The views and initial conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies of Bender & Associates Architects, the FKAA, the County of Monroe or the City of Key West. The information in this Report precludes review of any jobsite Preliminary Design Development Documents and therefore are insufficient for any final conclusions. The mention of commercial products, trade names, or other services does not constitute an endorsement or recommendation.

EXECUTIVE SUMMARY

Out of the historic past and into the historic future, the New City Hall is going to help to define the character of the City of Key West as a demonstrable role model for Global Sustainability in Small Communities. Built in 1926 as the Glynn Archer School, it is a Historic Structure located at 1302 White Street in Key West, Florida.

Rainwater Harvesting Systems (RWH) – the systematic collection and use of rainfall – has been practiced since ancient times 5,000 years ago. Up until a decade ago, rainwater harvesting had been used mostly as a low-cost technology for water supplies in rural areas.

In the past ten years, with increasing water scarcity and contamination of our underground aquifer resources by stormwater and agricultural commercialization in combination with the advent of the new green sustainability, our society is increasingly turning to the sky for clean, unprocessed water for irrigation, building infrastructure use and drinkable water.

In the context of this feasibility study and the restoration of the existing Glynn Archer cisterns, rainfall harvesting is considered a *Low Impact Development Best Management Practice* to help achieve the goal of the *municipal separate storm sewer system*. *These are U.S. Green Building Council LEED [Leadership in Energy and Environmental Design] credits in the categories of Water Efficiency (WE) and Sustainable Site (SS) Stormwater Design and Heat Island Effects.* "The LEED® green building certification program is the nationally accepted benchmark for the design, construction, and operation of green buildings." *The City of Key West is currently in pursuit of a Gold Certification. This Analysis will outline potential additional methodologies to maximize 12 to 16 points towards the highest Platinum Certification of 80+ points (See Appendix #6). It is strongly believed that a goal of 12 LEED Water Efficiency Credits Points can be achieved with immediacy. It's also probable that an additional 1-4 points (13-16 WE Points) can be achieved with the additional use of other strategies to achieve these points*.

So a major goal in this study is to assist in eliminating FKAA water use and maximizing stormwater management for the new Key West City Hall and Offices. This initially entails utilizing excess rain catchment water from the roof for interior toilet and exterior landscaping use. The new system will allow the determination as to the feasibility of utilizing that same rainwater to use as drinkable rainwater water in the future, further reducing FKAA potable water use. The project has also has these overall objectives:

(a) Conduct an inspection of the circa 1920's existing building's cisterns, historical materials, components and their usage and reclamation relevant to modern-day rainwater harvesting.

(b) Thereafter, utilize these existing cisterns and components for the restoration, reuse and/or re-purposing by incorporating them into the new system, if practicable.

(d) Assist in the design of a modern and inexpensive rainwater RWH system for the project.

e.) Determine the total amount of annual rain collected from the roof and existing and/or optimal storage capacity.

(f) Estimate the stormwater reduction volume to the drainage system that is attributable to rainwater harvesting and it's effects of on the water quality of stormwater runoff for the City of Key West and the Biscayne and Floridian Aquifers.

(g.) Assist in determining potential Water Efficient LEED Credit Points toward a USGBC Platinum Certification. The approach is to recreate a modern design of a RWH system incorporating the original historic 1926 cisterns and salvageable components. That study will enable estimating site's possible water-volume reductions of potable and stormwater against a base case. This study is needed to determine building use and savings to the stormwater drainage system for the City of Key West in the future.

The reduction of potable water volume to the building and stormwater drainage system is the first expected advantage to using a RWH system. Landscape plantings are projected to be xeriscape native and minimal, therefore projected outdoor use for irrigation is negligible but will reduce nitrate-nitrogen load to the stormwater drainage system by a projected 10%. If indoor use (e.g. toilet and urinal flushing) in combination with low-volume plumbing fixtures is implemented, the rainwater volume and nitrate load to the stormwater drainage system would be reduced by a projected 60%. If whole building potable utilization plus water features such as bio-swales, rain ponds, and water features are introduced, the reduction could be 100%.

A third advantage is the reduction in the use of potable water for non-potable water needs. If indoor and outdoor uses of rainwater are implemented, along with bio-swales, retention rain or Koi ponds, fountains or other water features, up to 1/2 million gallons of potable water and/or stormwater reduction could be salvaged each year.

At first glance, the stormwater runoff reductions and potable water savings from Glynn Archer's rainwater harvesting could appear to lack significance. However, if the commercial building rainwater harvesting Glynn Archer model is implemented at the watershed scale, assuming the presently being renovated 525 hotel units on South Roosevelt Boulevard plus the 6,600 in Key West, and the 16,000 hotel units in Key's wide watershed were included, there would be in excess of two billion gallons reduction in stormwater volume and savings of potable water from commercial buildings. If all the estimated Keys 30,000 residential units were included, the reduction in stormwater volume and savings of potable water would be reduced a further two billion gallons and highly significant to the Biscayne and Floridian Aquifer. This would in turn reduce the City's carbon footprint by reducing energy requirements. Less potable water would need to be chemically treated, which requires energy (concomitant with it's attendant by-product chemicals) and transportation by pumps from the Biscayne Aquifer 200 miles away.

Final Summary Notes

Although the available amount of fresh water has been relatively constant, our permanent Keys and tourist population will continue to grow. It takes 7-8% of the County's energy to treat and deliver clean water from the underground Biscayne Aquifer. As potable water demand increases it will take even more energy to produce in the very near future and the cost will rise dramatically in the next decade. At the same time, our nuclear energy production methods at Turkey Point use large quantities of water. So, by conserving potable treated water, we are saving valuable water and energy.

Over the past two decades, the mid-state main Floridian Aquifer has become increasingly polluted from nitrogen, pesticides and toxic chemicals from agricultural and the non-sustainable factory farming of animals. All 700 mid-state artisan springs are nitrate and algae contaminated and have diminished in volume as much as 50% as this report documents. Prior periods of low rainfall in Lake Okeechobee have caused communities such as Key West to question both their preparation for these occurrences and the consequences of their inability to respond to drought conditions. Along with current Florida population growth, South Florida municipal systems, small and large, for both potable water supply and storm water treatment are being strained. The solution to these problems is three-fold: reduce water use, reuse water by installing a Rainwater Harvesting Systems both residential and commercially and/or dramatically increase the cost per gallon of water.

In the Keys a typical government office or private sector building plumbing system uses FKAA potable water to satisfy all user demand, and separately sends all site water runoff to a presently inadequate storm water management system. All City of Key West, Monroe County, private sector offices and residences are unnecessarily paying for drinking water for the non-potable applications of landscaping and toilets. In the future, no one will be able to easily respond to rising utility prices or periods of drought.

By employing the Historic existing 1920's Cisterns and Rainwater Collection System, the City of Key West will take advantage of on-site water sources (rainwater and mechanical condensate) to fulfill non-potable water demands of toilet flushing and site irrigation initially and whole building including drinking water use later. The roof will collect 400,000 gallons more water then it can use every year, whether it is utilized or not!

Now is the ideal time to prepare for easy conversion to a whole building potable water system use for all future water demands! This can be accomplished now without cost in the design and construction stages and may be cost prohibitively expensive to add later. No extensive additional piping would need to be added in the future. Simply

design and install plumbing/piping of sealed-off plumbing conduit in the infrastructure for easy access and later easy commissioning (as easy as turning a valve).

Prudent consideration should be given to the foregoing paragraph. And it is mandatory that an ultraviolet light be installed at the end of each filtration chain. It is inexpensive and protects human safety assuring no mistakes will ever be made with the utilization of the system for any purpose.

If the City of Key West implements these relatively inexpensive suggestions in the developmental design stages, it will be taking a historic step toward the future, out of the historic past, erasing its own potable water consumption and overall utility bills and be preparing for low-rainfall periods when potable water is in short supply.

The City will also be insulating itself against the rising cost of water in the near future, minimizing the load on storm water systems including our in-shore and off-shore waters and providing a valuable educational resource about Keys Sustainability for the children, citizens and visitors to Key West and Monroe County.

I. INTRODUCTION

A.) The Past

Rainwater Harvesting (RWH) was independently invented in various parts of the world and on different continents. Rainwater Collection for potable drinking and irrigation has its roots 5,000 years ago with Sardinians, Cretes and Carthaginians. Later Romans were among the first cultures to use massive collection systems for complex distribution. This included cooling their buildings with the condensation from the cisterns beneath.

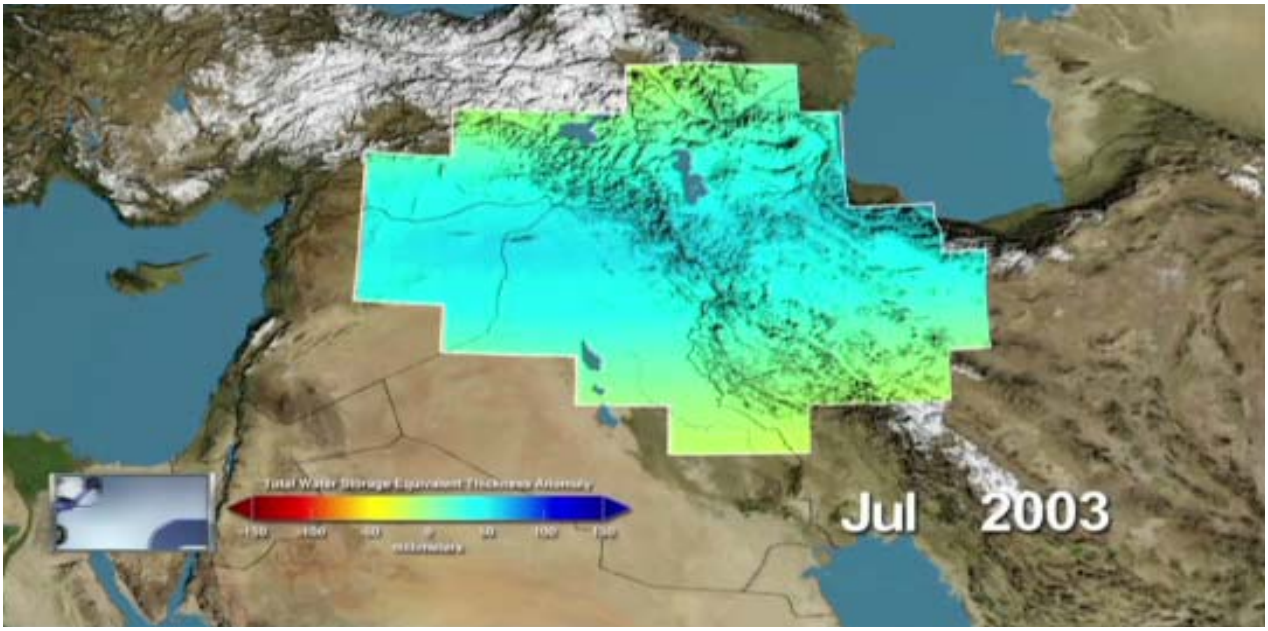
3000 B.C. Pakistan, Afghanistan and Iran used rainwater harvesting primarily for irrigation. A 1,000 years later Viet Nam and India created 150 super large ponds primarily for irrigation. The estimated volume was 1.5 billion cubic feet.

The Incan, Mayans and the Aztecs of 2,000 years ago in South, Central America and Mexico had a rich ancient rainwater collecting technologies including terraced rain collection for farming.

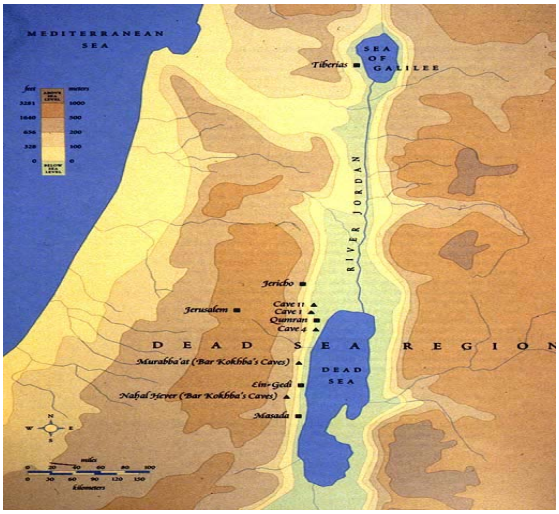
The earliest rain harvesting on record is in 3,000 B.C. when Pakistan, Afghanistan and Iran were some of the first cultures using rainwater harvesting for drinking water and irrigation. They created vast areas for collection of rain. Historians have estimated the volume at 396 billion gallons.

B.) Present Day

Ironically, today in the Middle East in the exact same area of the world where Rainwater Harvesting originated, that volume of freshwater pales in comparison to what a recent report by CNN says is occurring. "NSA reports that in the volatile mid-east, an underground Aquifer the size of the Red Sea is simply disappearing". As seen here, that's a massive amount of water, in the process of being gone forever.



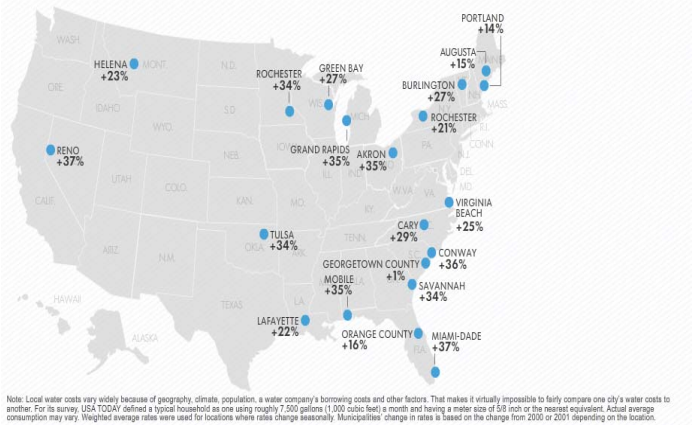
The Red Sea is between Jordan and Israel. Massive at 1200 miles long by 250 miles wide, its 169,000 square miles, the same size as the Pakistan-Afghanistan-Iran-Iraq disappearing aquifer.



Most worrisome is *CNN's, "Mid-East Water Wars"* next phrase, "This depleted aquifer may turn the nuclear world of 'Haves and Have-Nots' to an even more dangerous then nuclear, Water War". One of the Projected Solutions for the area, "Put a price on water so it will be used more efficiently". This mantra is expected to be enacted in the US and globally in the near future.

Related quotes as to the cost of water in the future:

> *"The Cost of utility Water will Rise dramatically in the near future Worldwide",* USA TODAY
> *"Water is Destined to be the Oil of the 21st Century",* **2008 by the CEO of Dow Chemical**
> *"The Price of Water Up 7% Over Last Year in 30 Major U.S. Cities",* **by Brett Walton July 15, 2013**
> *"World Water Prides Rise By 6.7%"*, by Global Water Intelligence Archive

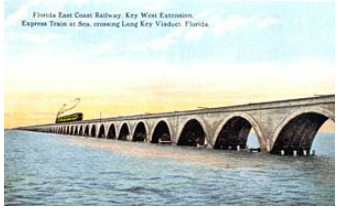


C.) Florida, the Keys and the Future

In the United States up until a decade ago, RWH had been used mostly as a low-cost technology for drought and for water supplies in rural areas when it was expensive or contaminated. In the past ten years, that has dramatically changed with increasing water scarcity and stormwater run-off commercial pollutants contamination of mid-state and Biscayne Aquifers. With the onset of public consciousness and green sustainability, society is increasingly turning to the sky for clean, unprocessed water for irrigation, building infrastructure and pure unprocessed drinkable water use.

In most instances this is not reinventing the wheel, but retreating to what was sustainable and commonplace only a century ago. For 150 years for the earliest settlers of the Keys, there was not a great deal of freshwater. It was very difficult to transport a distance of 150 miles from the mainland to Key Largo and Key West until Henry Flagler's railroad in the 1920's. And there was no pipeline to pump and carry it until the early 1943, 70 years ago, when the Navy built the first one in WW II.

Pipeline across Tavernier Creek ca. 1942



An 1845 south Florida map

For 150 years from 1822, the 4,500 Conch Houses in the largest Historic Preservation District in the United States, primarily used harvested rainwater for their needs. Cisterns beneath the average 1000 square foot Conch Houses typically held approximately 5,000 gallons and could make them sustainable for a full year. Larger commercial buildings, such as this 13 Unit Guesthouse on Howe Street with a 30,000 gallon cistern underneath the floor, were the norm. Many of the Conch Houses in Key West have working Cisterns beneath them today.

II. PROJECT OBJECTIVES and CONCLUSIONS AFTER INSPECTION

The major goal is to determine the feasibility of restoring the existing circa 1920's cisterns and rainwater harvesting system (RWH) for gray water (toilets and urinals), irrigation and stormwater management for the new building use; with the possibility of whole building potable water it the future. Water supply – or rather water scarcity is going to be one of the biggest factors impacting global dynamics in the 21st century. This study has the directive to satisfy the following objectives:

A). OBJECTIVE: Identify any existing historic materials and components for re-use and re-purposing in a new RWH system. Endeavor to integrate those and possible other components as Historic Preservation, Architectural and Educational Focal Points for the community of Key West.

PRELIMINARY CONCLUSIONS:

Both cisterns are in-ground with the beams, joists and the concrete foundations further blocking physical and visual inspection of both Buildings A and B cisterns from the crawl spaces. A full inspection of the cisterns will only be possible in the "selective demolition stage" when the floors may be removed for reclamation within the project.

An inspection of the roof and guttering systems of Buildings A and B resulted in the find of historical cultural antiquities (1920's) in the form of and one 6" x 6" x 28' long copper downspout and Leaf or Debris Catcher on the first and second floor of Building B. Three identical Leaf or Debris Catchers that appear to be galvanized were found on both buildings as well. The original copper 1920's historic '*Rococo'* Downspout and Leaf/Debris Catcher artifacts qualify as "antiquities" and can be seen from the mid-building roof. These components are still attached to the first and second floor West wall of Building B and run continuously through both floors. Historical provenance is still in process on these antiquities, other system components and the interior building fixtures and furnishings.

It is suggested they all be removed from the building as soon as feasible, in event the choice is made to restore and recycle their original use in the new RWH System (Addendum #6, LEED Platinum Points possibly available for Water Efficiently (WE), Sustainable Site (SS)) and "Regional Priority Credits").

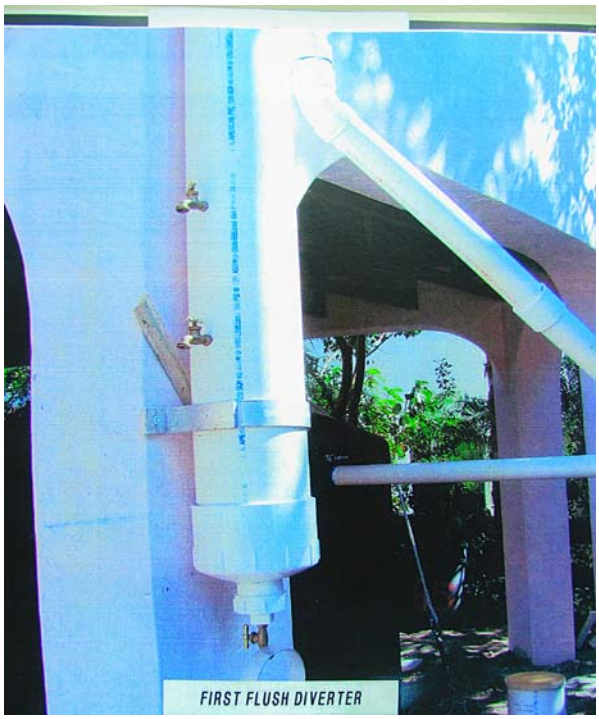
Another possibility is to visually showcase these artifacts for their original purpose in the new system. This would involve using these components as Historic Architectural Focal Point(s) polished, lacquered or antiqued in combination with the copper and galvanized Leaf Catcher(s). They could be converted into a First Flush Roof Diverter(s) and placed at or near the building entrance, hall/garden atrium or elsewhere for viewing.

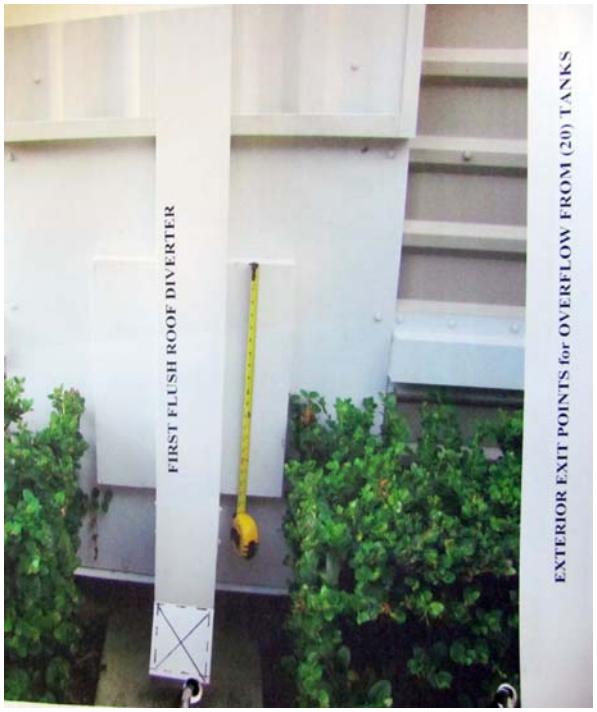
The visual Educational Showcasing of the reclaimed antiques as historic First Flush Roof Diverters was another original concept of the architect, Bert Bender. Those artifacts and their cultural significance will be in danger of being damaged or lost forever to metal scrappers or a dump when demolition begins. Restoration and safety could be as simple as detaching them from the exterior walls, removing the paint, burnishing and placing them in a safe place

At the reciprocal location in Building A opposite, that copper downspout has been removed and the replacement vertical 6" PVC is cut-off with the top. This unsealed pipe can be visually seen as leading directly into the cistern wall from the crawl space beneath. Take note in the photos below, that this is the only crawl space egress that was available to view 1926 existing cistern.

Finding that last historic six inch square 28 foot long copper leader may have been very fortuitous. Both Building A and Building B will require a 50 gallon First Flush Roof Diverter at 10 gallons per 1,000 square feet, to clean the roof. At 1.87 gallons per running foot, that copper leader can contain the exact amount of water were it converted and reused for that purpose on either Building A or B or split for both (Appendix #1).

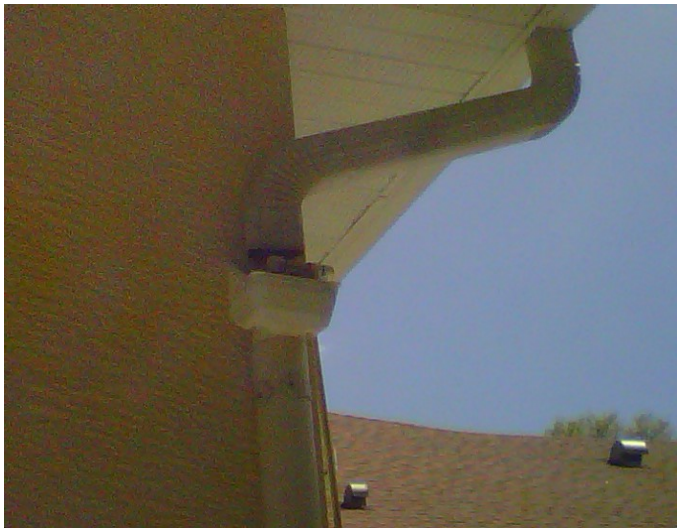
After being restored, if these artifacts were placed for viewing at the architect's office, someone may think of a more creative way(s) to emphasize their historical, architectural, educational and cultural value, consistent with good water and energy management, the value of that local history and it's ongoing role in human green Sustainability.





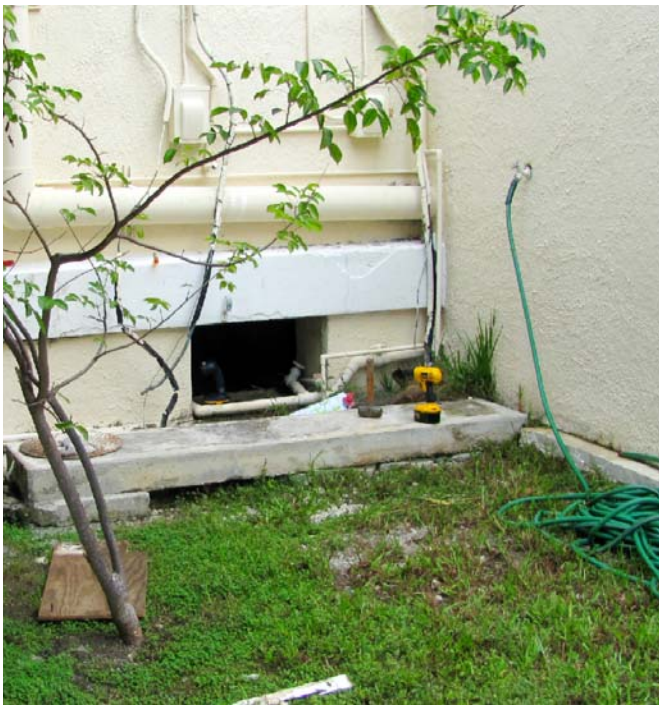
It should be noted that although Leaf Catchers were historically state-of-the-art from the 1800's and are still being used today. But without a working First Flush Roof Diverter, they can collect debris and even fecal matter which will later transferred directly into the cistern, creating cistern contamination.

Here is a case in point from a Tampa on-line consult. The new client had built an adequate 3,000 gallon system which then tested positive for ecoli bacteria upon commissioning. Trying to get rid of the problem, she then sequentially over several months, added a large charcoal filter, then a bigger and better charcoal cartridge filtration array, an osmosis system, and finally a full gas chlorination system. At that point her tank was still contaminated with ecoli. She subsequently called almost in tears and related the problem. Emailed property photos showed an overly-built system and a typical store-bought debris catcher, but no trace of a real First Flush Roof Diverter. In further conversations she revealed that there was a new proliferation of squirrels in her rural area above Tampa.



B). OBJECTIVE: Identify existing 1926 cistern dimensions, condition, water volume, historic materials and components for re-use and/or re-purposing in a new RWH system. Endeavor to integrate those cisterns and other existing components as Historic Preservation, Architectural and Educational Focal Points for the community of Key West.

PRELIMINARY CONCLUSIONS: The only method of inspection available was through the crawl spaces in buildings A and B. An inspection of all Cistern Building Crawl Spaces resulted in successful entry only once in each structure. Building A has a total or three vented crawl spaces, two of which had mesh critter screening and concreted in place #5 rebar in openings that were 7.5 inches by 17" inches. The west crawl space was un-boarded and allowed entry 30 feet back to the Cistern. Foundation beams are nominal 6" x 6" and appear approximately 10 feet apart with nominal 2" x 12" joists. Unfortunately, a determination of cistern height, width or length could not be determined due to obstruction by the floor and foundation walls and that framing. A cut-off 6” pipe in the corner leads down into the crawl space and then enters the cistern in Building A (Appendix #2).

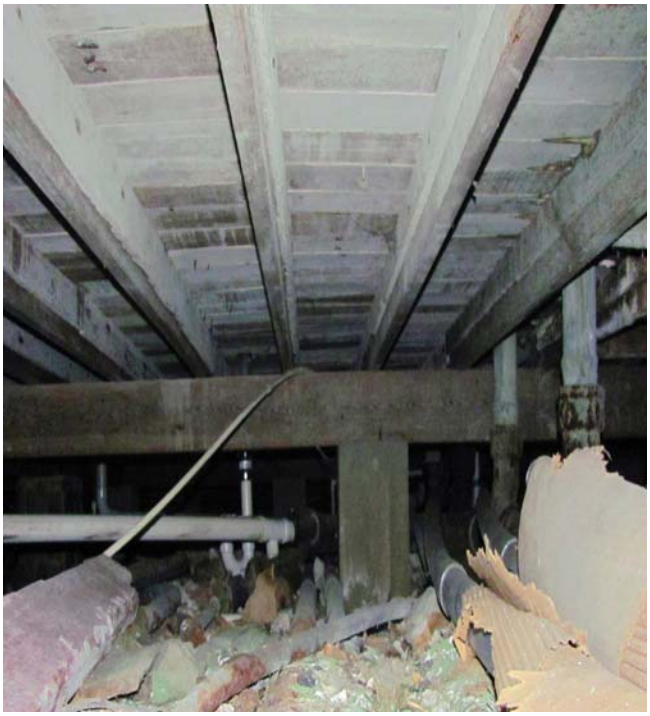


Only Building A allowed entry by key for inspection of the floor above the cistern. A one-inch test coring and replacement of that core, showed the floor to be one to 1” nominal tongue and groove 1900's Dade County soft yellow pine (not the pre-1900 dense pine heartwood) cross-laid directly over the joists. There was evidence of floor

underlayment. This limited inspection did allow a determination that the floor is re-claimable and salvageable for project refinishing, reuse or re-purposing.

Building B also had a total of three crawl spaces, two of which had critter screening and concreted in place #5 rebar in openings that were 7.5 inches by 17" inches. The third crawl space was on the north side of the cistern and allowed entry beneath the building. It was access for electrical and plumbing chases beneath Building B and coming across the exterior hall from Building A. Access to the cistern was once again barred by the hall concrete foundation.

I



An inspection the Roof Catchment Area and Gutters of Buildings A and B shows both to have identical drainage to collection at the lower level middle building. Rainwater then was originally designed to run storage in the two separate cisterns on the southern Angela side and to property. With an apparent lack of cisterns on the United Street side, gutters run to in-ground storm drainage on the North side unless they drain elsewhere underground. That drainage could not be inspected (Appendix #3).

C.) OBJECTIVE: Inspect existing cisterns to determine their condition for cleaning, disinfection, repair and lab testing of water

PRELIMINARY CONCLUSIONS: Initial preliminary cistern inspection exterior or inside was not possible due to a lack of access from above (the floors don't allow entry from above), underneath (the crawl space was either unreachable or blocked by concrete foundations, floor beams and joists, or sides (exterior crawl spaces too small for entry). Access will be possible as soon as selective demolition begins and floors can be removed for inspection and entry.

Historically cisterns of this era and 50 years earlier have been in surprisingly good shape, so barring the unforeseen hidden or concealed deficiency, it is expected these will be equally restorable. The engineers of that era were not constrained to build to “minimum” standards, as they are today. Most designs including concrete, could be described as overbuilt.

The proven method for successful cleaning and disinfecting the inside of a concrete cistern historically has been to remove the accumulated bottom debris and sludge with a trash pump thereafter pressure cleaning the walls and floor. Afterward the cistern is treated with a special solution of sodium and calcium hypochlorite and allowed to soak. This solution will totally disinfect the tank by killing any remaining bacteria, even those that are in the pores of the concrete walls, with the majority of the chemicals dissipating immediately with total disappearance over time.

When it is assured the cistern is thoroughly clean and disinfected, any needed repairs are addressed as well as constructing suitable ingress and egress through cistern ceiling for a lockable manhole (with raised edges to prevent contaminated water entry). At the same time all wall penetrations plus installation of component pump floating filtered water pick-ups, inflow/overflow, by-pass and isolation valves, venting, etc. should be completed. If there is no floor drain or sloped sump area, a permanent sump pump for cleaning should be placed at the lowest portion of the cistern.

The interior walls and any repairs should be covered with a high-quality VOC free masonry sealant and then painted with a VOC free rubberized paint suitable for future potable water use.

As soon as possible, the cistern intake should immediately be attached into any remnant of the gutter system to start collecting rainwater for lab testing, no matter what design or construction stage the project is in.

Thereafter the water should be lab tested for chemicals and purity.

III. DESIGN PARAMETERS for COLLECTION, WATER DEMAND and STORAGE

A.) OBJECTIVE: Determine the annual rainfall for Key West.

CONCLUSION: Key West has an annual average rainfall of 40 inches.

Design Parameters: Annual Key West rainwater volumes have been added for a 30 year period and averaged.

B.) OBJECTIVE: Estimate amount of roof rainwater that may be collected yearly.

CONCLUSION: One-half million (513,040) gallons of rainwater is collected from the roof every year.

Design Parameters: This first depends on rooftop area and expected available rainwater volume and then water demand. So, Roof-Area (sq-ft) x Collection Conversion Factor (0.623) to Estimate Water Volume in Gallons per One Inch of Rainfall Volume x Average Rainfall per Year KW (40 Inches) x Collection Efficiency, (0.9) [Compensates for Losses due to Gutter Over-splash and Evaporation] = Total Annual Rainfall. Therefore, 22,875 sq-ft x 0.623 x 40 x 0.9 = 513,040 Gallons Rainwater Collected Annually.

Additional Benefits: In the event water supplies are cut-off or contaminated in a Hurricane or other emergency, that water would be pure and available free to the public. Or if ever there was a major fire in the wooden Historic Preservation District (or elsewhere), the Fire Department would have up to 50,000 gallons of water available for such an exigency.

C.) OBJECTIVE: Estimate annual water demand for new Key West City Hall/offices.

CONCLUSION: 118,722 gallons yearly is projected water need and use.

Design Parameters: Indoor and Outdoor water demand information is needed to harvest the available rainwater effectively.

Indoor Design Parameters: Water usage for the building is estimated from the number of full time employees working on a daily basis plus the average number of annual visitors to that building. In this case the flushing toilets, urinals and low volume fixtures by the estimated from the building occupancy. It is assumed there will be 113 seated employees and they will be present 225 working days annually. Averaged male and female use of toilet and urinal combined will be 2.6 times per employee daily. Hand washing will occur 66% of visits. There will be 30 visitors daily, 66% of whom will use the bathroom a single time. The auditorium has 183 seats used twice monthly and 33% of those visitors will use bathroom a single time. Water use per bathroom visit is projected to be 1.6 gallons per flush and .11 gallons per sink visit. It is projected that after Preliminary Design Development stages, there

will be significant additional savings utilizing state-of the-art no-water or low water fixtures such as 1.2 gallon flush toilets.

Therefore:	Employees	113 x 225 x 2.6 x 1.6 =	105,768 gallons or water used annually urinals and toilets.
	Visitors	20 x 225 x 1.0 x 1.6 =	7,200 gallons or water used annually urinals and toilets.
	Auditorium	60 x 24 x 1.0 x 1.6 =	2,304 gallons of water used annually urinals and toilets.
	Sink Use	31,365 visits x .11 =	3,450 gallons of water used annually Sink Faucets
			118,722 Total Gallons of Water Used Annually

Outdoor Design Parameters water usage for landscape irrigation can be estimated from expected irrigation application, planned xeriscape, evapotransporation rates and irrigation frequency. It is projected there will be limited use of turfgrass. Native and drought resistant plantings are estimated as minimal and normally designed to need no water. Drip irrigation watering is presently still a part or these equations as these plantings will have significant curb appeal assisting in displaying the historic architectural focal points. Input from the Landscape Architect as to plantings is needed.

D.) OBJECTIVE: Estimate required water storage for all building demands in the new RWH system in gallons.

Design Parameters: The goal of rainwater harvesting is to make the water available throughout the year. A computation to estimate of the quantity of water storage is needed to prevent running out in low periods of rainfall or in drought. Sizing a cistern therefore usually depends on the frequency, amount of rainfall and the demand.

CONCLUSION: Storage of 15,500 gallons or 13% of the annual demand is required water storage for all indoor/outdoor building uses.

Design Parameters: Demand or use is projected to be 118,722 gallons. In the Southern Latitudes and in the Keys, a water storage capacity of 13% of annual rainfall has historically been proven adequate for households or/or office buildings. This allows sufficient storage to exist through extended droughts, as rainfall events are common in the Keys.

E.) OBJECTIVE: Estimate ideal water storage in gallons for all building demands.

CONCLUSION: Storage of 52,000 gallons or 10% of the total annual collection is the ideal water storage for all building uses.

Design Parameters: If early uncorroborated dimensions of the existing cisterns beneath the Glynn Archer building are 52,000 gallons, this represents 10% of annual rainwater collection of 513,040 gallons and 44% of the building demand of 118,722 gallons. This would be preferable and ideal as it fulfills 100% of all toilet, urinal, sink and all potable water requirements now and in the future for any uses including potable (Take note from above that only 13% or 15,500 gallons is required).

So, the most effective storage tank size for the new City Hall and office building has been determined by the existing cisterns sized for the 1926 Glynn Archer School. FKAA in 2010 has listed the school building as having 453 fixtures. With the that new projected annual consumption rate of 325 gallons daily and 119,000 gallons annually, a preliminary suggested storage of 52,000 gallons is therefore the recommended ideal storage.

Additional usage of that surplus of water to rain water features such as bio-swales, rain or Koi ponds, fountains and other water features should be introduced. This is highly recommended as there could be a significant reduction in stormwater runoff and the use of potable FKAA water would contribute additional LEED Credits.

In low-water, or drought areas of the US the ideal storage for residential and office applications is 60% of all annual rainfall. In the Keys, sixty percent of annual rainfall is in June, July, August and September. Rainfall events here in the Southern Latitude and sub-tropics are plentiful throughout most of the rest of the year except in drought conditions. Therefore 13% storage of annual rainfall is considered adequate for whole-house residential use including potable.

Existing two and three person 1500 square foot homes with cisterns in areas without access to FKAA water such as No Name Key and elsewhere in the Keys, including the 26 acre Sugarloaf Creek Bridge Estate have historically been able to exist with 5,000 gallon cisterns. This is also the average size of household cisterns in the 4,500 Conch Houses of the Key West Historic Preservation District. The Sugarloaf Creek Bridge (Sammy's Creek) Estate has a 25,000 gallon concrete cistern similar to Glynn Archer and was filmed in the end of the movie, "Miami Vice".

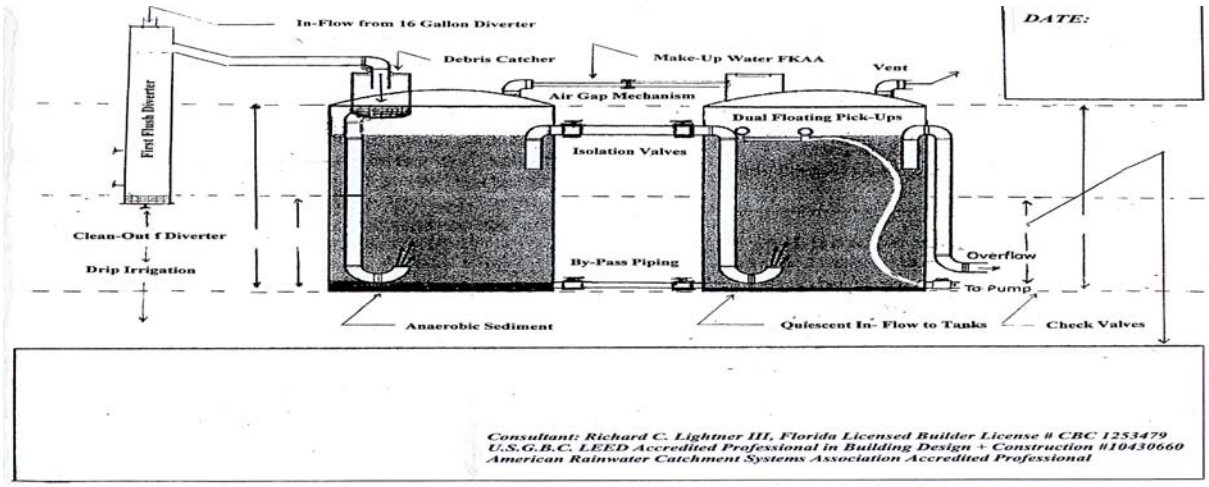
These homes with 5,000 gallons cisterns historically average a total collection of 36,500 annual gallons from the roof. That means that present day and historically, they exist with cisterns which store 13% of their annual total

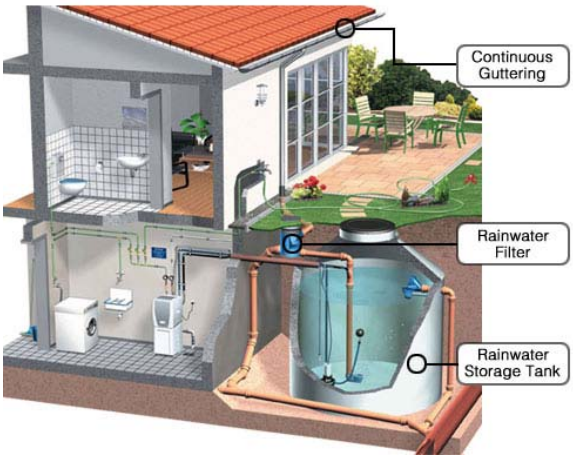
roof rainfall for whole-house residential use. Residential water use is significantly higher then commercial office buildings, but is used as the benchmark for design parameter water storage.

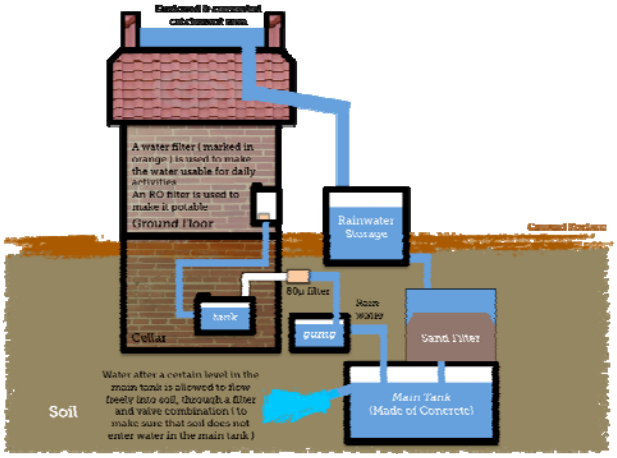
IV. OBJECTIVE: ASSIST in DESIGNING a NEW and INEXPENSIVE RWH SYSTEM for DELIVERY of PURE WATER for ALL BUILDING USES

SOLUTION: The eight needed components and how a RWH system works.

The concept and value of rainwater collection is simple to understand. There can be a variety of system configurations which may lead to confusion. The system schematics below show that variety. Historically In coastal areas closer to sea level, the first one has been the system of choice. Benefits are that it is easily visibility and has access for maintenance or repair. It also has inexpensive piping unions, isolation and by-pass valves favorable for those same reasons. There is less wear and energy use on the pump as it has a recycling pressure tank versus submerged in-tank pumps which cannot be easily maintained or seen until they fail.





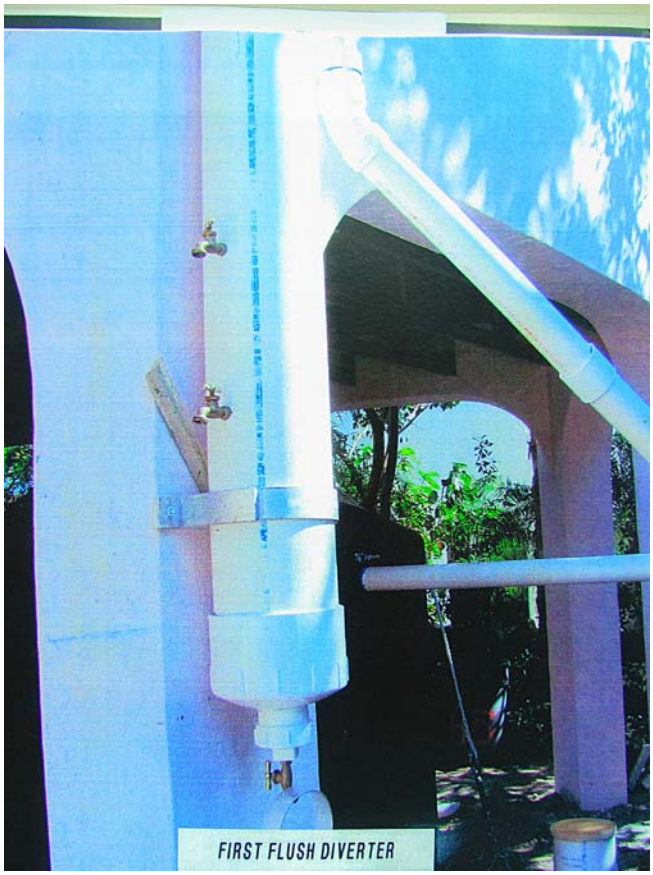


A rainwater equipment room or space should be located as near the cisterns as possible. This minimizes pipe lengths and prevents the need to run additional supply pipes under the building. GFI electrical switches, receptacles, pumps

and filtration components should be a minimum of seven feet above sea level in the event of storm surge. The water in the cisterns will be of no value if it can't be pumped after a hurricane. There should be a sealed, lockable, raised lip manhole and access cover at the cistern top. All accesses and any openings to and from the cistern should be fully screened to prevent mosquito and animal access.

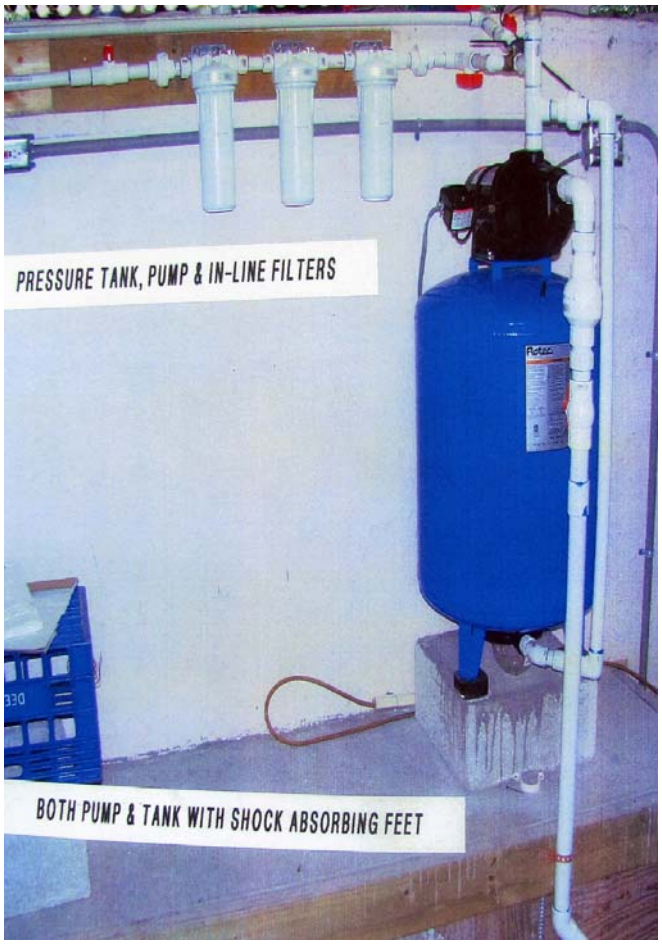
The differences in equipment manufacturers, system sizing, internal tank configurations and site locations may cause changes to the Glynn Archer model, but the water flow diagram will remain the same. Both buildings A and B are basically identical for collection and distribution purposes. Two systems are recommended for ease of build and back-up. The water in both cisterns does not have to be interconnected for equalization and balancing of their levels Redundancy is preferable in the event of emergency, maintenance or repair of the building systems.

Rainwater falls into the designated Roof Catchment Area sloped from the roofs to gutters and downspout to the middle building systems filling *First Flush Roof Diverters* collecting any roof Debris just prior clean water filling the cisterns. They are the first line of defense against any contamination, collecting and getting rid of the first 10 gallons per 1000 square foot of roof, dirt and debris.

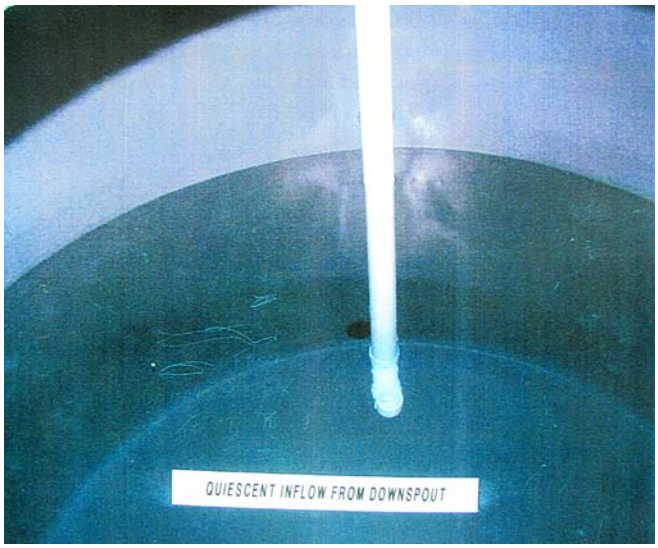


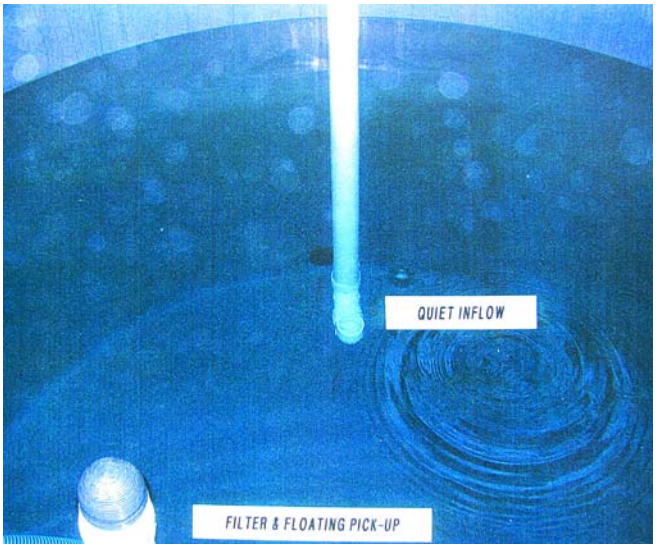
Thereafter the water falls into the cisterns through *Quiescent Inflow Piping*. This means simply that the incoming roof water is turned back up, to fall gently to the bottom. The stored water will remains clear, as quiet inflow further

prevents any possible water turbidly. The water is contained in the cisterns until it is needed for use. Thereafter it is drawn into the building with a combination *Pressure Tank and Pump* located as near the cistern as possible. The tank contains a pressurized air bladder that supplies 92 gallons before the shallow water well pump turns on and re-pressurizes the tank. In response to user demand, the water is pushed from the pressure tank the pumps when sink, urinal or toilet is flushed or timer activated for irrigation. This saves electricity and prolongs the life of the pump, which otherwise would have to continually run while irrigating or when the tap is turned on.

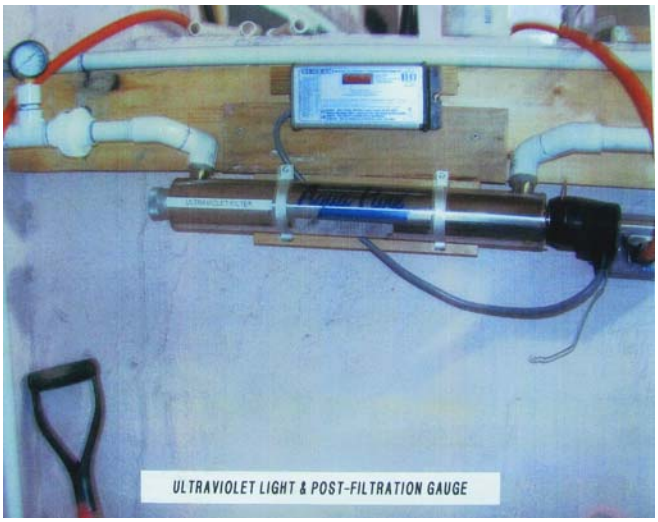


The water is then drawn through a *Floating Filtered Water Pick-Up.* This is a flexible in internal tank hose with a floating filter near the water's surface. It assures that wherever the level in the tank is, the clearest water near that surface will be pre-filtered before it goes to the pump for distribution to its destination.





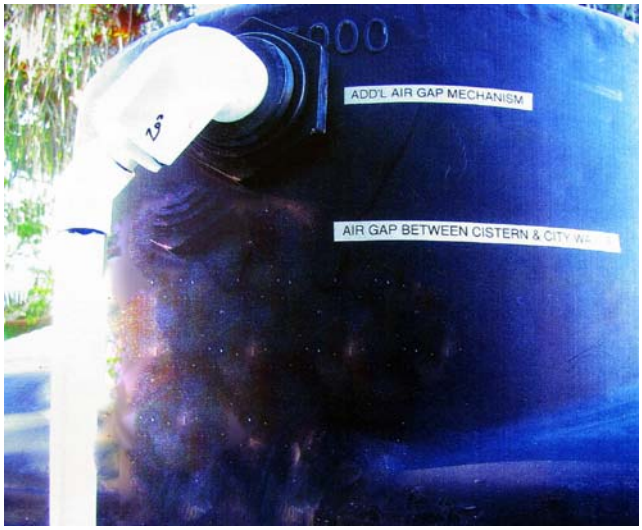
The second of a further two point filtration process is the *Cartridge Filter Array Station*. This is simply three standard water filters side by side, placed immediately after the water pump on the discharge side. They capture and eliminate any sediments to 5 microns in the water flow. The water then flows through a final Cartridge Filter to remove finer suspended particulates and contaminants to 2 microns. An *Ultraviolet Light* is placed after the filter array for the final purification. The water is now pure and contains no trace of the normal chemical by-products of water processing. There will be no trace amounts of the heavy metals mercury, lead, arsenic, chloroform, chromium, barium and cadmium that are present in all utility, processed and bottled water (Appendix #5).



The water now flows to the toilets, urinals, and the irrigation system. This water meets potable water standards and could be used for potable fixtures in the future. Water quality should be lab tested upon commissioning and periodically thereafter to assure there are no contaminants in the system. Two inexpensive water pressure gauges

should be placed in line just after the pump and just after the U/V light. Any drop in water pressure is clearly visible and indicates when filters should be changed. All equipment and components should be located at an easily accessible height with sufficient clearance for ease of maintenance and filter changing. Similarly, isolation valves and break-away unions should be used throughout the system for easy replacement and isolation during cleaning, maintenance or replacement of component parts. Maintenance for the most part, is simply monitoring and logging.

A *Cistern Overflow* of the same size as the inflow from the downspout is needed in each tank to prevent over-pressurization of the cistern or system. Similarly, FKAA makeup water should be available into the cistern in the event of long term drought. That incoming water line should have an *Air-Gap Mechanism* and/or air gap of one foot between the incoming water source and the top level of the cistern water. This prevents any possibility of cross contamination of cistern or FKAA water. If there is too much rainwater, the overflow from near the top of the cistern could be sent to bio-swales, retention or rain ponds, fountains or other water features or directly to the storm system.



V.) OBJECTIVE: DETERMINING THE PURITY OF RAINWATER USED AS DRINKABLE WATER

CONCLUSION of HISTORICAL FINDINGS and FACTS: The use of rain as drinking water is considered both safe and legal according to the Florida Department of Health.

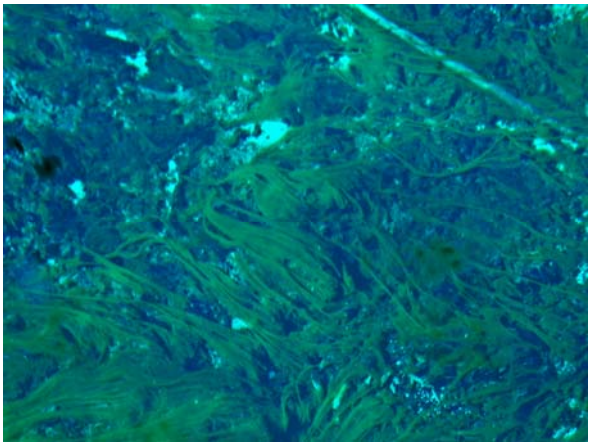
"Rain from a cistern can be used as drinkable water", quotes the Florida Department of Health in this letter addressed to Monroe County and the Florida Keys Aqueduct Authority (Appendix #5)

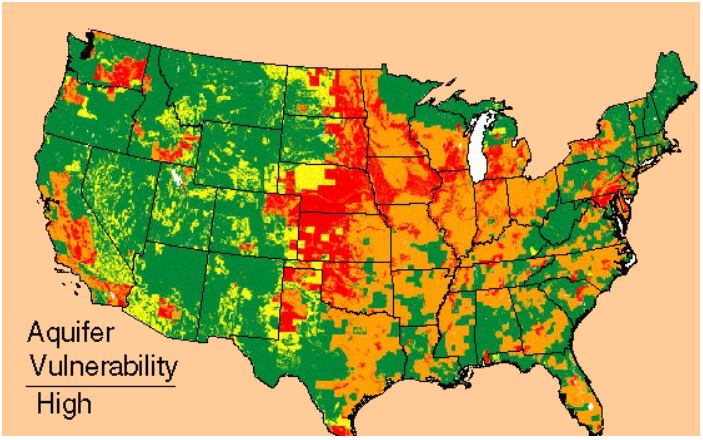
And National Testing Laboratory Results of collected cistern rainwater have shown no detectable chemical contaminants that are in all utility company and store bought bottled water. The EPA allows the FKAA and all bottled water companies to process all their water with chemicals that leave measurable traces low-concentrations of carcinogens and heavy metals. In these tests of cistern water a check mark [√] is good, it means no contaminant was detected. A bullet [•] means no contaminants were found near EPA normally allowable levels (Appendix #5).

Four Companies and a Global Water Business Take-Over - Mom and pop water bottling companies all but disappeared ten years ago. All were acquired by 'Cocoa Cola', 'Pepsi Cola', 'Nestles and 'DS Waters, around the world. Today, September 2013, their most valuable company assets are not bottled soft drinks, which have been on decline since 2008. Their "rock stars" are bottled water which has grown exponentially in that same time period.

Look on any Water Bottle Globally - There will exclusively be those four names. These global conglomerates were aware a decade ago, water was due to become one of the most valuable commodities on earth (Appendix #4).

Central processing and distribution plants were bought out or established by these companies across the US. The 'spring' or 'pure' bottled water is extracted from underground wells or artesian springs near the facility that is then chemically processed. In Florida most are located near Ocala and Silver Springs above the Floridian Aquifer. All 700 artesian springs in Florida are badly agriculturally contaminated and drying up from aquifer drainage/use. Silver Springs famed for "Sea Hunt" and "Creature from the Black Lagoon", is full of nitrate algae, only 50% of its water remains and the bottom can no longer be seen from the top. For those that are old enough, imagine those Weeki Wachee Springs mermaids, barely visible in an algae covered glass tank.





All Florida water utility companies primarily process with chemicals such as chlorine, ammonia, fluoride and desalination, as it housed underground in coral limestone. Desalination plants use excessive amounts of electric

and create a salt-brine that must be disposed of. It is estimated that in the Keys Water treatment and delivery use 7-8% of the County's energy. At the same time, our fossil and nuclear energy production methods at Turkey Point use large quantities of water. So, by conserving potable treated water, we are saving valuable water and energy.

It is Commonly Recognized by the Scientific Community of Today that there has been an overproduction and overuse of pesticides, herbicides, hormones, antibiotics, pharmaceuticals, radiological contaminants and solvents by agricultural and pharmaceutical companies. This in combination with Global coal burning energy plants has resulted in significant contamination of our water and air. This in turn has contaminated our bodies, reef and pelagic oceanic fish, crops, feed animals, with increasing doses of the heavy metals including mercury, lead, arsenic, chloroform, chromium, barium and cadmium which have proven to be carcinogenic. Once in the body they are cumulative and build over a lifetime just as x-rays and ionizing radiation. They may only be partially moved by chelating.

Harvested Rainwater Purity and Cleanliness - Rain is the 'Silver Bullet' of green sustainability, far exceeding Federal and State quality guidelines. It has none of the above disinfectant chemical by-products of processing, which are in all tap and bottled waters. It's mineral free, soft for hair, laundry and household. Residential and commercial units are low cost to system build, retrofit and maintain.

In Key West and the Florida Keys - Our Aqueduct Authority has some of the best drinking water in the state, but it can't measure up to rainwater. All National Testing Lab test results show fewer than 30 parts per million (ppm) of dissolved solids compared to the EPA limit of 500 ppm, no fluoride - no turbidity (it's crystal clear), naturally soft (not NaCl chemically induced), and none of the low-concentrations of carcinogens, pesticides, herbicides, pharmaceuticals, radiological contaminants and solvents that are allowable under EPA standards (Appendix #5).

Key West Community Bottled Water Contamination and Recycling: It should be noted that many small communities in the USA are banning commercial bottled beverages.

Bottled Water Contamination: According to a four-year study conducted by the *"Natural Resources Defense Council" (NRDC)*, one-third of the bottled water tested contained levels of contamination which exceed allowable limits under either state or federal bottled water industry standards or guidelines. As stated above, the FKAA has some of the cleanest and best monitored water in the state, as clean and pure as in any bottled water in the US. So why do Keys citizens continue paying One Dollar ($1.00) per gallon for bottled water, which is guaranteed as clean from the FKAA for One Penny ($.01) per gallon; (a surcharge or premium for the transport and dump fees to purchase bottled water)?

Plastics and Recycling: Another primary reason for these bans is due to the abundance of discarded plastic bottles. And in Key West that plastic has to be transported an additional 150 miles (and its accompanying carbon footprint) and is going to require larger landfills, associated infrastructure and services. In many locations bottled water is more expensive than bottled beer or soda. Making beer or soda requires a tremendous amount of raw water for production which does not even include the water in that drink. Water energy costs to produce bottled water are one third as much as it takes to produce the same quantity of oil!! and that production bottled water becomes waste and enters our already clogged storm sewers.

So in addition to the misconception about health benefits, stated in this report, there are serious problems associated with the production and consumption of bottled water. According to the Beverage Marketing Corporation, Americans bought a total of 63.2 billion liters of water in 20010. The Pacific Institute estimates that producing the bottles for American consumption required more than 27 million barrels of oil, not including the energy for transportation, which in Key West is significantly more. Bottling the water produced more than 2.5 million tons of carbon dioxide. It takes 3 liters of water to produce 1 liter of bottled water and according to the above the statistics, and it may not be as clean as the water supplied by our own FKAA.

Maybe it is time for Key West to cooperatiively join with other smaller municipalities and Monroe County to form a study group of lay and professional people to discuss these and other Keys potable water sustainability issues.

VI. KEY WEST NOT ALONE: US and GLOBAL EXAMPLES of MODERN RWH SYSTEMS

Examples of rainwater harvesting systems can be found all over the US and around the globe. They are far too numerous to list. The International Rainwater Harvesting Alliance website: presents rainfall case studies in several countries. http://www.irha-h2o.org/

Texas is in the forefront of incorporating rainwater catchment systems into new development through property and sales tax incentives (TWDB 2005). Information on Texas rainwater harvesting is provided in the Rainwater Harvesting, Complete Rainwater Solutions website. http://www.rainharvesting.com.au/rain_water_harvesting.asp. *The Lady Bird Johnson Wildflower Center* near Austin, Texas, is a major educational and demonstration site for rainwater harvesting where annually 300,000 gallons of rooftop harvested rainwater is used for wildflower garden landscaping. http://www.wildflower.org/

The American Rainwater Catchment Systems Association (ARCSA), () is the leader in disseminating rainwater education in the US. Their members provide a Photo Gallery including system sizes in collection, storage and a detailed description of components of each built system. http://www.arcsa.org/gallery.html

The City of Portland, Oregon, Office of Sustainable Development website provides great and current rainwater harvesting information in Portland, Oregon. www.portlandoregon.gov/bps/

The Rainwater Harvesting in Delhi, India is found on the website provides information on United Nations Rainwater Harvesting in Developing and Transitional Countries, Latin America and the Caribbean http://www.ecotippingpoints.org/indepth/indiaurbanrain.html.

Australian states have passed legislation which requires rainwater catchment and water management. The Building and Sustainability Index)in New South Wales requires a 40% reduction in mains water usage via low flow fixtures and use or rainwater tanks for outdoor, toilet and laundry water use. New homes in Victoria are required to have either a rainwater tank or a solar hot water heater to reduce water or energy demand. Rainwater catchment has come to Queensland's Development Code setting sizes standards for system installation. http://www.sawater.com.au/sawater

VII. FINDINGS, LIMITATIONS and STUDIES of the WATER QUALIITY/QUANTITY IMPACTS of RWH

In 1926, when Glynn Archer was built, rooftop rainwater was directed into the two (26,000 gallon) cisterns and then onto the property. There was no stormwater drainage system but also relatively little nitrate or other contamination. Today, In the absence of rainfall harvesting system the entire 1/2 million gallons (100%) will flow into the stormwater drainage system annually. And this will increase the Nitrate load as stormwater runs on the ground to drainage on mostly impervious surfaces distributing contaminants into the near-shore and off-shore waters and the 25 million gallon freshwater lens of the already lead and iron contaminated Key West Aquifer below our feet.

The following observations can be projected for Glynn Archer (GA). In a normal year, the rooftop will yield nearly 500,000 gallons of water, whether it is utilized or not. The annual building demand estimated at 120,000 gallons or 24%. The annual irrigation water demand for landscaping corresponds to what is speculated to be 5% or 25,000 gallons of total available rooftop water. Total water demand (indoor plus outdoor) use will then be about 145,000 gallons/year, or about 29% of total available water. This means that:

1) If the building total water demand at the new City Hall and Offices is met in a given year, the water volume to stormwater drainage will be at least reduced by 30%.

2) Since normally, potable water from public FKAA supplies is used for flushing toilets and landscape irrigation, 145,000 gallons/year less water from public water supplies (FKAA) will be used for those purposes.

3.) This reduction of stormwater is directly attributable to the RWH system.

4.) There is available up to 355,000 gallons surplus of water available for additional storage and/or to utilize for water features such as bio-retention cells, bio-swales, rain or Koi ponds, fountains and/or other water features. *Any such features introduced would reduce stormwater normally sent to sewers and result in significant reductions towards Sustainable Site (SS), Water Efficiency (WE) Sustainable Sites (SS) and Regional Priority (RPC) LEED Platinum Credits* (Appendix #6).

5.) This also represents the savings in volume (annual gallons saved) that will not have to be purchased from FKAA.

. 6.) This is also the effect of the buildings(s) RWH capability has on the reduction as a percentage of all Key West stormwater, the Biscayne Aquifer and therefore the state Floridian Aquifer.

The following are studies related to water quality effects and illustrate the significance of rainwater harvesting on water quality and stormwater runoff.

A study by Herrmann and Hasse (1997) describe the development and performance of rainwater utilization systems. The study specifically looks into rainwater harvesting system efficiency and the impact of rainwater harvesting systems on reducing potable water demand and reduction of stormwater volume entering the combined sewer system. Study results show that rainwater harvesting reduces demand on potable (drinking) water. Also it concludes that rainwater harvesting is most effective for the stormwater drainage system when it is applied in multi-story buildings and densely populated districts. In a follow up study Herrmann and Shmida (2005) reported that for a private household, depending on the consumption habits, roof area, and size of storage tank, the average water (drinking water) saving will be 40%.

Crowley (2005) reported results of a neighborhood-level rainwater catchment analysis in Portland, Oregon. A major study objective was to determine the total amount of stormwater that could be collected to if all single family residences used a rainwater harvesting system. A second objective was to identify the ideal cistern size, and indoor water use to maximize amount of water diverted from stormwater system while keeping system cost low. Results were reported for various cistern sizes (110, 500, 1500 or 4500 gallons) and different water uses (all indoor uses, toilet flushing and clothes washing, or toilet flushing only). It was shown that any cistern size will reduce stormwater directed to the combined sewer systems immediately. Reduction in volume to ranged from 30% to 68%. The least overall reduction occurs when water is used for toilet flushing only (30 - 35%). Even the smallest

cistern size (110 gallons) has significant impact on stormwater volume (~30%/year). Most successful cistern size is the 4,500 gallon with 1,500 gallon cisterns the most size efficient for in town homes and condos (more cost efficient and size appropriate).

VIII. RWH SYSTEM START-UP, LAB TESTING, FUTURE MONITORING and MAINTENANCE

Initially Commissioning and testing determines whether or not the system works and if each component is performing to the manufacturer's specifications. The operation and maintenance of a system is the continuous process of checking to see if individual system components are functioning properly, observing storage volume, and monitoring water usage. It is suggested that lab tests of the water be conducted on a monthly basis (and logged) in the event potable water is desired in the future.

Precise and accurate energy monitoring of completed Certified LEED structures after construction, has been a notable previous failure in early LEED projects. Optimistic beliefs in the newly engineered monitoring devices and their computerized chips for proposed "modern" building monitoring and the absence of a designated certified engineer totally responsible for the monitoring of that equipment were identified as the culprits. Energy monitoring now is recommended to be overseen by a Certified Civil Engineering specialist in that new specialty, Energy Monitoring. A previous barrier to such successful monitoring was the reluctance to pay for the time and additional expense after a construction project was completed. But without such successful monitoring over a long period of time there can be no energy use baselines or accurate energy monitoring. This is also mandatory for LEED Points.

It is imperative that inexpensive water meters be in place for all internal and external building usage and irrigation zones for that reason and to monitor water use and for early detection of leaks or problems with system.

Routine maintenance and proper upkeep are directly related to water quality for potable water systems. Incorrect or deficient maintenance of equipment results in lower water quality and increased health risks. Regular testing for contaminants is a key determinant of system function. Each system is unique and has its own subtle variations in performance and functionality. A system operator learns these nuances and keeps the system operating at an acceptable level and his/her responsibilities include:

Monthly Operations and Maintenance System Operator Responsibilities:

One person, the system operator, must be responsible for the upkeep of a Rain Water Harvesting system (RWH). The burden of maintaining a system should rest with a sole individual who takes a keen interest in sustaining the highest quality of water and is capable of recognizing a declining level of performance.

The system operator has the following duties and responsibilities and should be able to accomplish the following in four (4) hours monthly:

- Develop a maintenance plan.
- Replace dirty filters and broken equipment.
- Become familiar with characteristics of contaminants.
- Become familiar with techniques used by system devices to disinfect water.
- Update and store records with duplicates off property.
- Check pressure gauges.
- Test water on a regular basis.
- Record data related to usage and water quality.
- Read each device's Owner's Manual.
- Become familiar with each device's performance specifications.
- Document repairs.
- Inspect and decontaminate storage tanks.
- Recognize a decrease in system performance.
- Monitor storage levels.

APPENDIX #1

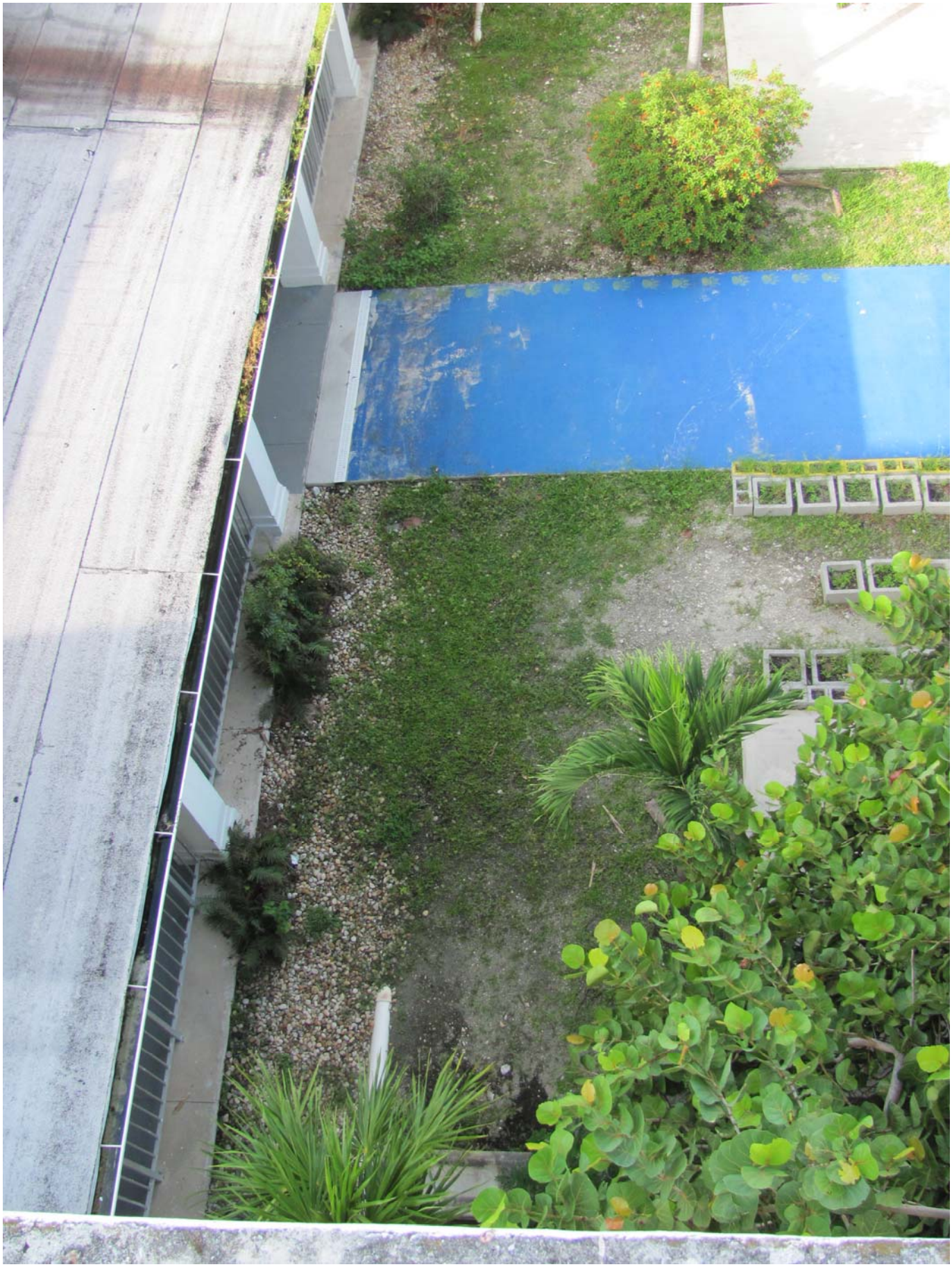
PHOTOS GUTTERS and LEADERS BUILDING A & B

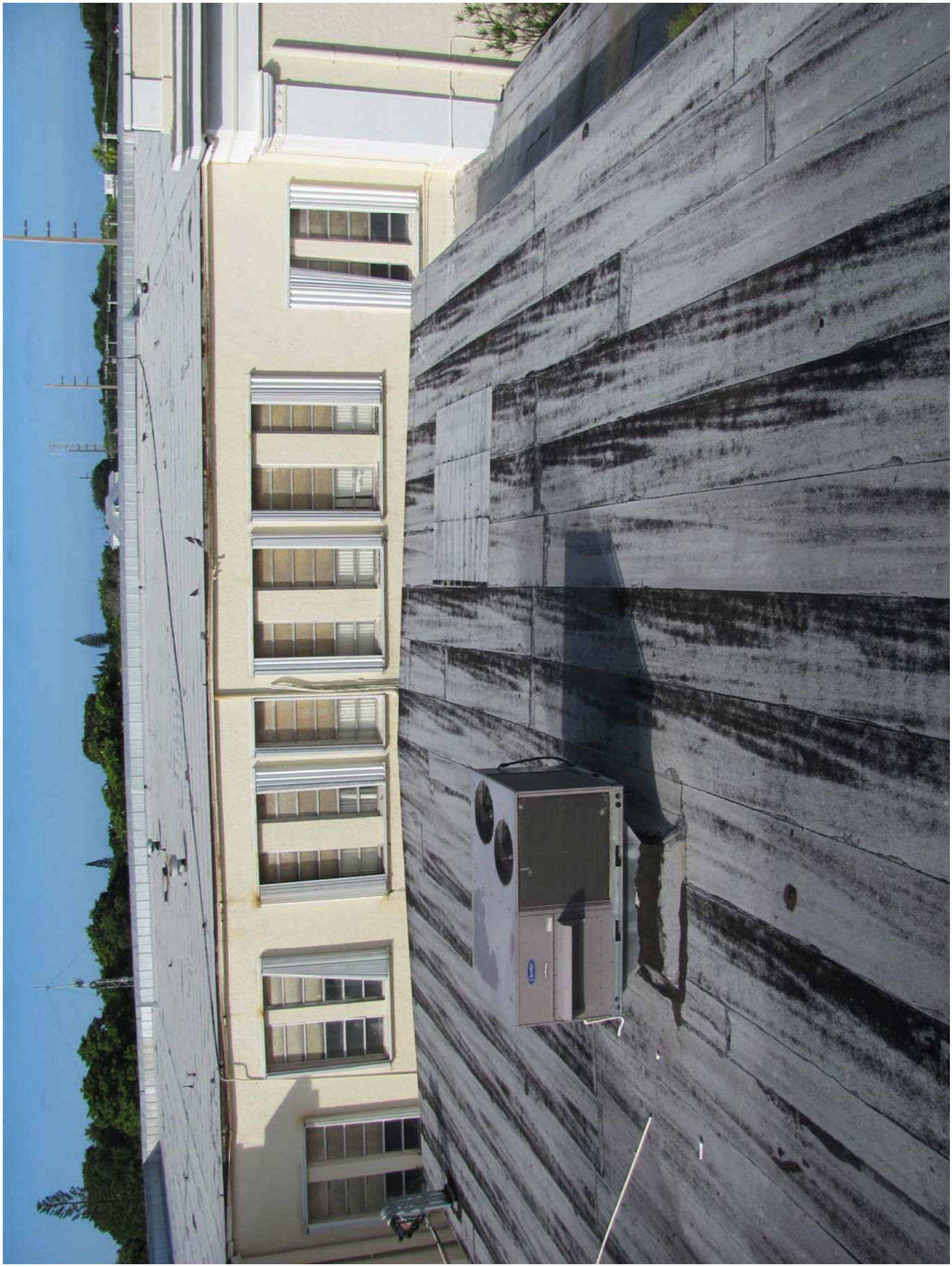
APPENDIX #2

CRAWL SPACES BUILDING A and B

APPENDIX #3

PHOTOS ROOF, MIDDLE and BUILDING A and B





APPENDIX #4

PHOTOS SHOWING GLOBAL BOTTLED WATER CONGLOMERATE OWNERSHIP

DS WATERS AMERICA

PEPSI COLA

24
botellas
de medio litro
Agua Purificada
Nestlé
Pure Life
Cristalina y Pura
24 BOTELLAS PLASTICAS DE 16.9 OZ LIQ.
(1 PINTA, 0.9 OZ LIQ) (500 ml) (405.6 OZ LIQ
(3 GAL, 1 PINTA, 5.6 OZ LIQ) (12 LI EN TOTAL)

NESTLE

Amount Per Serving
Calories 0
% Daily Value
Total Fat 0g 0%
Sodium 0mg 0%
Total Carb 0g 0%
Protein 0g
*Percent Daily Values are based on a 2,000 calorie diet.
PURIFIED WATER, MAGNESIUM SULFATE, POTASSIUM CHLORIDE, SALT ‡
BOTTLED BY A MEMBER OF THE COCA-COLA BOTTLERS' ASSOCIATION, ATLANTA, GA 30327
PRODUCED UNDER AUTHORITY OF THE COCA-COLA COMPANY, ATLANTA, GA 30313
*ADDS A NEGLIGIBLE AMOUNT OF SODIUM
‡MINERALS ADDED FOR TASTE
plantbottle
Z (1 QT 1.8 FL OZ)
0 CALORIES PER 12 FL OZ SERVING

NESTLE

NESTLE

DS WATERS AMERICA

DS WATERS AMERICA

NESTLE

APPENDIX #5

CISTERN WATER TESTS (“Nat’l Testing Lab”)

and

DEPARTMENT of HEALTH ENDORSES CISTERNS for POTABLE WATER

FLORIDA DEPARTMENT OF HEALTH

CHARLIE CRIST
GOVERNOR

ANA M. VIAMONTE ROS, MD, MPH
STATE SURGEON GENERAL

MONROE COUNTY HEALTH DEPARTMENT

1100 SIMONTON STREET
KEY WEST, FLORIDA 33040

ROBERT B. EADIE, JD
ADMINISTRATOR

TEL: 305-809-5610
FAX: 305-809-5619

November 12, 2009

RECEIVED
NOV 13 2009
EXECUTIVE DEPARTMENT

Mr. James C. Reynolds
Executive Director
Florida Keys Aqueduct Authority
1100 Kennedy Dr.
Key West, FL 33040

RE: No Name Key Cisterns

Dear Mr. Reynolds:

This letter is written in response to the inquiry as to whether the use of rainwater cisterns as sources of potable water for residences on No Name Key constitutes an inherent and serious public health threat. Additionally, the question is raised as to whether the Monroe County Health Department will urge the Aqueduct Authority to provide water service to residences that rely on rainwater cisterns for potable water.

In order to assure that the most current and best science was available to guide this response, I consulted with the Bureau of Water Programs of the Division of Environmental Health. Following is the guidance received:

> The Bureau of Water Programs endorses the use of residential rainwater cisterns for non-potable or potable water uses in residences where they are properly installed and maintained. If available, piped potable water from a public system or a private well is the preferred source of water for residential water systems due to the continuous testing of public water systems and wells that tap a less dynamic source of freshwater. However, recognizing that many areas of Florida do not have access to preferred sources, the Florida Plumbing Code (Section 602.3.1) allows for the use of rainwater cisterns as water sources for structures. The utilization of cisterns for potable use requires treatment to prevent water contamination from microbiological pathogens and chemical contaminants. Adequate treatment and system construction with food-grade materials has successfully produced safe drinking water in remote areas of Florida, the U.S., and the Caribbean for many years. The Florida Plumbing Code is administered by the Building Department Authority and requires construction based upon sound plumbing and public health principles. After construction and approval, the continued operation and maintenance of a cistern treatment system is the responsibility of the property owner. The Bureau recommends that the final tap water be analyzed on a regular basis for fecal indicator bacteria such as total coliform and E. coli to validate the effectiveness of the cistern water treatment system. Results of water quality testing can also be used to indicate maintenance requirements.

It is the position of this department that there are no inherent public health concerns that automatically preclude the use of a rainwater cistern for a source of potable water. In fact, from a historical perspective, cisterns have been safely utilized throughout the Keys for a long period of time. Moreover, I am unable to find any recent report of illness caused by drinking water from a cistern. If there are concerns by any one about the safety of his or her drinking water supply, the Monroe County Health Department will test it and provide the results of its analysis.

Given the facts at hand, there are no indications of urgent public health threats arising from the use of rainwater cisterns for drinking water by residences on No Name Key. Unless and until there are concerns that such threats may exist, it is not within the purview of the Monroe County Health Department to urge the Aqueduct Authority to provide water service to No Name Key.

If there are additional questions or matters the Board Members or you wish to discuss, please contact me.

Sincerely,

Robert B. Eadie, JD
Administrator

Watercheck w/PO

Client:

Ordered By:

Quality Water Analysis
6571 Wilson Mills Rd
Cleveland, Ohio 44143
1-800-458-3330

Sample Number: 810166

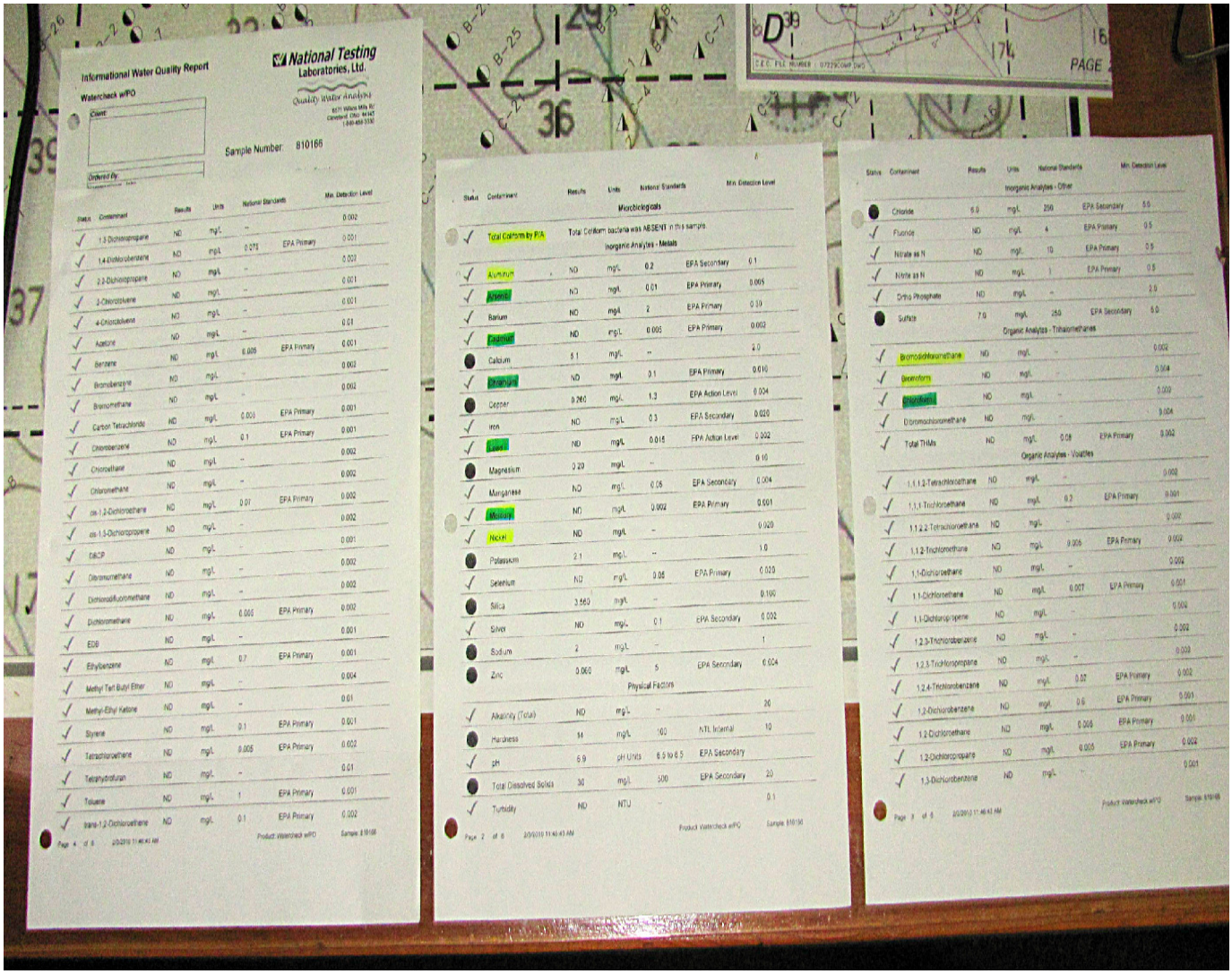
Status	Contaminant	Results	Units	National Standards		Min. Detection Level
✓	1,3-Dichloropropane	ND	mg/L	--		0.002
✓	1,4-Dichlorobenzene	ND	mg/L	0.075	EPA Primary	0.001
✓	2,2-Dichloropropane	ND	mg/L	--		0.002
✓	2-Chlorotoluene	ND	mg/L	--		0.001
✓	4-Chlorotoluene	ND	mg/L	--		0.001
✓	Acetone	ND	mg/L	--		0.01
✓	Benzene	ND	mg/L	0.005	EPA Primary	0.001
✓	Bromobenzene	ND	mg/L	--		0.002
✓	Bromomethane	ND	mg/L	--		0.002
✓	Carbon Tetrachloride	ND	mg/L	0.005	EPA Primary	0.001
✓	Chlorobenzene	ND	mg/L	0.1	EPA Primary	0.001
✓	Chloroethane	ND	mg/L	--		0.002
✓	Chloromethane	ND	mg/L	--		0.002
✓	cis-1,2-Dichloroethene	ND	mg/L	0.07	EPA Primary	0.002
✓	cis-1,3-Dichloropropene	ND	mg/L	--		0.002
✓	DBCP	ND	mg/L	--		0.001
✓	Dibromomethane	ND	mg/L	--		0.002
✓	Dichlorodifluoromethane	ND	mg/L	--		0.002
✓	Dichloromethane	ND	mg/L	0.005	EPA Primary	0.002
✓	EDB	ND	mg/L	--		0.001
✓	Ethylbenzene	ND	mg/L	0.7	EPA Primary	0.001
✓	Methyl Tert Butyl Ether	ND	mg/L	--		0.004
✓	Methyl-Ethyl Ketone	ND	mg/L	--		0.01
✓	Styrene	ND	mg/L	0.1	EPA Primary	0.001
✓	Tetrachloroethene	ND	mg/L	0.005	EPA Primary	0.002
✓	Tetrahydrofuran	ND	mg/L	--		0.01
✓	Toluene	ND	mg/L	1	EPA Primary	0.001
✓	trans-1,2-Dichloroethene	ND	mg/L	0.1	EPA Primary	0.002

Page 4 of 6 2/3/2010 11:45:43 AM Product: Watercheck w/PO Sample: 810166

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
			Inorganic Analytes - Other			
●	Chloride	6.0	mg/L	250	EPA Secondary	5.0
✓	Fluoride	ND	mg/L	4	EPA Primary	0.5
✓	Nitrate as N	ND	mg/L	10	EPA Primary	0.5
✓	Nitrite as N	ND	mg/L	1	EPA Primary	0.5
✓	Ortho Phosphate	ND	mg/L	--		2.0
●	Sulfate	7.0	mg/L	250	EPA Secondary	5.0
			Organic Analytes - Trihalomethanes			
✓	Bromodichloromethane	ND	mg/L	--		0.002
✓	Bromoform	ND	mg/L	--		0.004
✓	Chloroform	ND	mg/L	--		0.002
✓	Dibromochloromethane	ND	mg/L	--		0.004
✓	Total THMs	ND	mg/L	0.08	EPA Primary	0.002
			Organic Analytes - Volatiles			
✓	1,1,1,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,1-Trichloroethane	ND	mg/L	0.2	EPA Primary	0.001
✓	1,1,2,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,2-Trichloroethane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,1-Dichloroethane	ND	mg/L	--		0.002
✓	1,1-Dichloroethene	ND	mg/L	0.007	EPA Primary	0.001
✓	1,1-Dichloropropene	ND	mg/L	--		0.002
✓	1,2,3-Trichlorobenzene	ND	mg/L	--		0.002
✓	1,2,3-Trichloropropane	ND	mg/L	--		0.002
✓	1,2,4-Trichlorobenzene	ND	mg/L	0.07	EPA Primary	0.002
✓	1,2-Dichlorobenzene	ND	mg/L	0.6	EPA Primary	0.001
✓	1,2-Dichloroethane	ND	mg/L	0.005	EPA Primary	0.001
✓	1,2-Dichloropropane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,3-Dichlorobenzene	ND	mg/L	--		0.001

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
			Microbiologicals			
✓	Total Coliform by P/A	Total Coliform bacteria was ABSENT in this sample.				
			Inorganic Analytes - Metals			
✓	Aluminum	ND	mg/L	0.2	EPA Secondary	0.1
✓	Arsenic	ND	mg/L	0.01	EPA Primary	0.005
✓	Barium	ND	mg/L	2	EPA Primary	0.30
✓	Cadmium	ND	mg/L	0.005	EPA Primary	0.002
●	Calcium	5.1	mg/L	--		2.0
✓	Chromium	ND	mg/L	0.1	EPA Primary	0.010
●	Copper	0.260	mg/L	1.3	EPA Action Level	0.004
✓	Iron	ND	mg/L	0.3	EPA Secondary	0.020
✓	Lead	ND	mg/L	0.015	EPA Action Level	0.002
●	Magnesium	0.20	mg/L	--		0.10
✓	Manganese	ND	mg/L	0.05	EPA Secondary	0.004
✓	Mercury	ND	mg/L	0.002	EPA Primary	0.001
✓	Nickel	ND	mg/L	--		0.020
●	Potassium	2.1	mg/L	--		1.0
✓	Selenium	ND	mg/L	0.05	EPA Primary	0.020
●	Silica	3.560	mg/L	--		0.100
✓	Silver	ND	mg/L	0.1	EPA Secondary	0.002
●	Sodium	2	mg/L	--		1
●	Zinc	0.060	mg/L	5	EPA Secondary	0.004
			Physical Factors			
✓	Alkalinity (Total)	ND	mg/L	--		20
●	Hardness	14	mg/L	100	NTL Internal	10
✓	pH	6.9	pH Units	6.5 to 8.5	EPA Secondary	
●	Total Dissolved Solids	30	mg/L	500	EPA Secondary	20
✓	Turbidity	ND	NTU	--		0.1

Page 2 of 6 2/3/2010 11:46:43 AM Product: Watercheck w/PO Sample: 810166



Informational Water Quality Report

Watercheck w/PO

National Testing Laboratories, Ltd.

Quality Water Analysis

8571 Wilkes Mills Rd
Cleveland, Ohio 44147
1-440-468-3330

Client:

Ordered By:

Sample Number: 810166

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
✓	1,3-Dichloropropane	ND	mg/L	--		0.002
✓	1,4-Dichlorobenzene	ND	mg/L	0.075	EPA Primary	0.001
✓	2,2-Dichloropropane	ND	mg/L	--		0.002
✓	2-Chlorotoluene	ND	mg/L	--		0.001
✓	4-Chlorotoluene	ND	mg/L	--		0.001
✓	Acetone	ND	mg/L	--		0.01
✓	Benzene	ND	mg/L	0.005	EPA Primary	0.001
✓	Bromobenzene	ND	mg/L	--		0.002
✓	Bromomethane	ND	mg/L	--		0.002
✓	Carbon Tetrachloride	ND	mg/L	0.005	EPA Primary	0.001
✓	Chlorobenzene	ND	mg/L	0.1	EPA Primary	0.001
✓	Chloroethane	ND	mg/L	--		0.002
✓	Chloromethane	ND	mg/L	--		0.002
✓	cis-1,2-Dichloroethene	ND	mg/L	0.07	EPA Primary	0.002
✓	cis-1,3-Dichloropropene	ND	mg/L	--		0.002
✓	DBCP	ND	mg/L	--		0.001
✓	Dibromomethane	ND	mg/L	--		0.002
✓	Dichlorodifluoromethane	ND	mg/L	--		0.002
✓	Dichloromethane	ND	mg/L	0.005	EPA Primary	0.002
✓	EDB	ND	mg/L	--		0.001
✓	Ethylbenzene	ND	mg/L	0.7	EPA Primary	0.001
✓	Methyl Tert Butyl Ether	ND	mg/L	--		0.004
✓	Methyl-Ethyl Ketone	ND	mg/L	--		0.01
✓	Styrene	ND	mg/L	0.1	EPA Primary	0.001
✓	Tetrachloroethene	ND	mg/L	0.005	EPA Primary	0.002
✓	Tetrahydrofuran	ND	mg/L	--		0.01
✓	Toluene	ND	mg/L	1	EPA Primary	0.001
✓	trans-1,2-Dichloroethene	ND	mg/L	0.1	EPA Primary	0.002

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Status	Contaminant	Results	Units	National Standards		Min. Detection Level
	Microbiologials					
✓	Total Coliform by P/A	Total Coliform bacteria was ABSENT in this sample.				
	Inorganic Analytes - Metals					
✓	Aluminum	ND	mg/L	0.2	EPA Secondary	0.1
✓	Arsenic	ND	mg/L	0.01	EPA Primary	0.005
✓	Barium	ND	mg/L	2	EPA Primary	0.10
✓	Cadmium	ND	mg/L	0.005	EPA Primary	0.002
●	Calcium	5.1	mg/L	--		2.0
✓	Chromium	ND	mg/L	0.1	EPA Primary	0.010
●	Copper	0.260	mg/L	1.3	EPA Action Level	0.004
✓	Iron	ND	mg/L	0.3	EPA Secondary	0.020
✓	Lead	ND	mg/L	0.015	EPA Action Level	0.002
●	Magnesium	0.20	mg/L	--		0.10
✓	Manganese	ND	mg/L	0.05	EPA Secondary	0.004
✓	Mercury	ND	mg/L	0.002	EPA Primary	0.001
✓	Nickel	ND	mg/L	--		0.020
●	Potassium	2.1	mg/L	--		1.0
✓	Selenium	ND	mg/L	0.05	EPA Primary	0.020
●	Silica	3.560	mg/L	--		0.100
✓	Silver	ND	mg/L	0.1	EPA Secondary	0.002
●	Sodium	2	mg/L	--		1
●	Zinc	0.060	mg/L	5	EPA Secondary	0.004
	Physical Factors					
✓	Alkalinity (Total)	ND	mg/L	--		20
●	Hardness	14	mg/L	100	NTL Internal	10
✓	pH	6.9	pH Units	6.5 to 8.5	EPA Secondary	
●	Total Dissolved Solids	30	mg/L	500	EPA Secondary	20
✓	Turbidity	ND	NTU	--		0.1

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Status	Contaminant	Results	Units	National Standards		Min. Detection Level
	Inorganic Analytes - Other					
●	Chloride	5.0	mg/L	250	EPA Secondary	5.0
✓	Fluoride	ND	mg/L	4	EPA Primary	0.5
✓	Nitrate as N	ND	mg/L	10	EPA Primary	0.5
✓	Nitrite as N	ND	mg/L	1	EPA Primary	0.5
✓	Ortho Phosphate	ND	mg/L	--		2.0
●	Sulfate	7.9	mg/L	250	EPA Secondary	5.0
	Organic Analytes - Trihalomethanes					
✓	Bromodichloromethane	ND	mg/L	--		0.002
✓	Bromoform	ND	mg/L	--		0.004
✓	Chloroform	ND	mg/L	--		0.002
✓	Dibromochloromethane	ND	mg/L	--		0.004
✓	Total THMs	ND	mg/L	0.08	EPA Primary	0.002
	Organic Analytes - Volatiles					
✓	1,1,1,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,1-Trichloroethane	ND	mg/L	0.2	EPA Primary	0.001
✓	1,1,2,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,2-Trichloroethane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,1-Dichloroethane	ND	mg/L	--		0.002
✓	1,1-Dichloroethene	ND	mg/L	0.007	EPA Primary	0.001
✓	1,1-Dichloropropene	ND	mg/L	--		0.004
✓	1,2,3-Trichlorobenzene	ND	mg/L	--		0.002
✓	1,2,3-Trichloropropane	ND	mg/L	--		0.003
✓	1,2,4-Trichlorobenzene	ND	mg/L	0.07	EPA Primary	0.002
✓	1,2-Dichlorobenzene	ND	mg/L	0.6	EPA Primary	0.001
✓	1,2-Dichloroethane	ND	mg/L	0.005	EPA Primary	0.001
✓	1,2-Dichloropropane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,3-Dichlorobenzene	ND	mg/L	--		0.001

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APPENDIX #6

ATTAINMENT of LEED PLATINUM CERTIFICATION

APPENDIX #7

AUTHOR'S RAINWATER HARVESTING SYSTEMS *VITAE* as LEED AP BD+C and ARCSA AP

RICHARD (RIC) C. LIGHTNER III - ESTABLISHED LAND-BASED *VITAE*

As a building contractor and real estate broker, his background includes restoration of 150 year old historic residential and guesthouse structures and cisterns in the 4,500 unit Historic Preservation District of Key West since 1978.

As a US Green Building Council member, he is a Green Sustainability and Rainwater Harvesting worldwide Consultant as a "LEED AP BD+C (Leadership in Environmental and Energy Design Accredited Professional in the Building, Design and Construction of Certified Silver, Gold, and Platinum Certified Buildings).

As a Global Rainwater Harvesting Systems (RWH) Consultant (ARCSA AP), he is a “boots in the water” specialist in the design and building of these systems for drinkable water. The largest commercial Rainwater Harvesting and Collection System he has designed was 2.5 million gallons collection annually. Residential Systems average 1,500 to 40,000 Gallons of storage. All were designed and built in Key West Florida Keys, South Florida, Sunset and Star Island on Miami Beach, and in South-Central America.

ESTABLISHED MARINE *VITAE*

Captain Ric Lightner as Project Director (PD), has 45 years experience Captaining and working in the marine environment. A NAUI Dive Instructor, he has safely supervising experienced divers on expedition and novice divers with the National Association of Underwater Instructors exclusively since 1978. (a world-wide non-profit whose credo is safety and education)

In Key West, having personally conducted thousands of 1/2 day Introductory Scuba Courses, he received a Waiver from Lloyds of London as one of three Instructors worldwide, to endeavor to create a new 'Two-Day Scuba" course, resulting in a "Three-Day Scuba Certification" NAUI sanctioned course .

He has testified as an expert witness in Federal Court in the areas of Marine Electronic Search, Survey and Salvage. He has successfully defended his Admiralty Claim/Permit *"Pro Se"* in Federal Court against Mel Fisher and Treasure Salvors. On three separate occasions, before three different Federal Judges, he has also prevented the site from being annexed as part of the Atocha and/or Santa Margarita Spanish Galleon Admiralty Claims.

His immediate goal this summer (2014-15), is to complete an underwater remote sensing survey in combination with Coastal Engineering Consultants and Dr. Michael Stephens. The survey will utilize towed and autonomously underwater vehicles (AUV's) in shallower areas, to create a scientifically complete baseline underwater representation of the survey area. These state-of-the-art U/W vehicles will have integrated computerized dual

gradient proton magnetometer, side-scan sonar and sub-bottom profiler. They will have the capacity to recognize the 'Primary Cultural Deposit" or "Motherlode" of his Spanish Galleon 40 miles west of Key West off the Marquesas Keys.

It is expected that completion of this state-of-the-art survey in 2015, will reveal major marine cultural resources, as well as a Primary Cultural Deposit contiguous with artifacts found to date.

Negotiations have been initialized with the Smithsonian Institute for museum storage and conservation of existing artifacts and later proper marine archaeological recovery.

Concomitant and in the interim, Diver Visual Verification investigations of previously detected underwater anomalies found with earlier models of sidescan, and magnetometer will continue. This will consist of single and multiple day and night [for Charter] expeditions into area in combination with a newly developed educational Diver Verification Certification Program for the visual recognition of underwater antiquities. This course is being developed in combination with NAUI and the existing FKNMS Blue Star Environmental Program guidelines.

Having just completed (September), a three-year report for NOAA and the Florida Keys National Marine Sanctuary, he has been endorsed by NOAA and the FKNMS to continue his search in Sanctuary Waters for his billion dollar Spanish Galleon for an additional three years.

Courtesy of the competition, a fair market share of detractors in Federal Courtrooms and on the streets of Key West and more often than not the local newspaper, "The Key West Citizen", his nickname is 'pirate' (http:/www.treasurekw.com).

The Key West Citizen

Monroe County's Only Daily Newspaper

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Treasure Salvors battles 'pirate'

KEY WEST, Fla. (UPI) — Mel Fisher, the treasure hunter who struck riches on the ocean bottom 10 days ago, has gone to court to battle a boat captain he says is "a modern-day pirate" getting too near his silver and gold.

Fisher asked a federal judge Monday to keep dive boat captain Richard Lightner away from the $400 million mother lode of the sunken galleon Atocha that was found July 20.

Fisher, the president and founder of Treasure Salvors, Inc., accused Lightner of using his firm's research to file claims to fictitious vessels near the Atocha site in an attempt to recover some of the Atocha's scattered bounty.

The Nuestra Senora de Atocha, packed with an estimated $400 million in silver, gold and other treasures, sank in a hurricane in 1622. A second hurricane scattered the wreck across the ocean bottom off the Florida Keys.

Working off Spanish documents about the ship and its sinking, Fisher and his divers searched off Key West for 15 years for the treasure. They found bits of it from time to time, then struck the mother lode earlier this month.

In 1971, Fisher filed a claim for an oblong, 15½-square mile wreck site known as the "Bank of Spain," where he believed the Atocha was. His find proved him correct.

"We're dealing with a treasure of which, in recorded history of men, we have never seen the likes", U.S. District Court Judge Sidney Aronovitz said today in Key West as he directed the federal Marshall Service be consulted for security measures at the start of the hearing on Treasure Salvors' request to extend their protected injunctive search area on the Atocha.

Judge Aronovitz said he wanted a security expert from the U.W. Marshalls' Service to come to Key West and work with Treasure

(See TREASURE, Page 10)