Preliminary Report

Rainwater Harvesting
Restoration Analysis
Glynn Archer School Cisterns

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Disclaimer

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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.

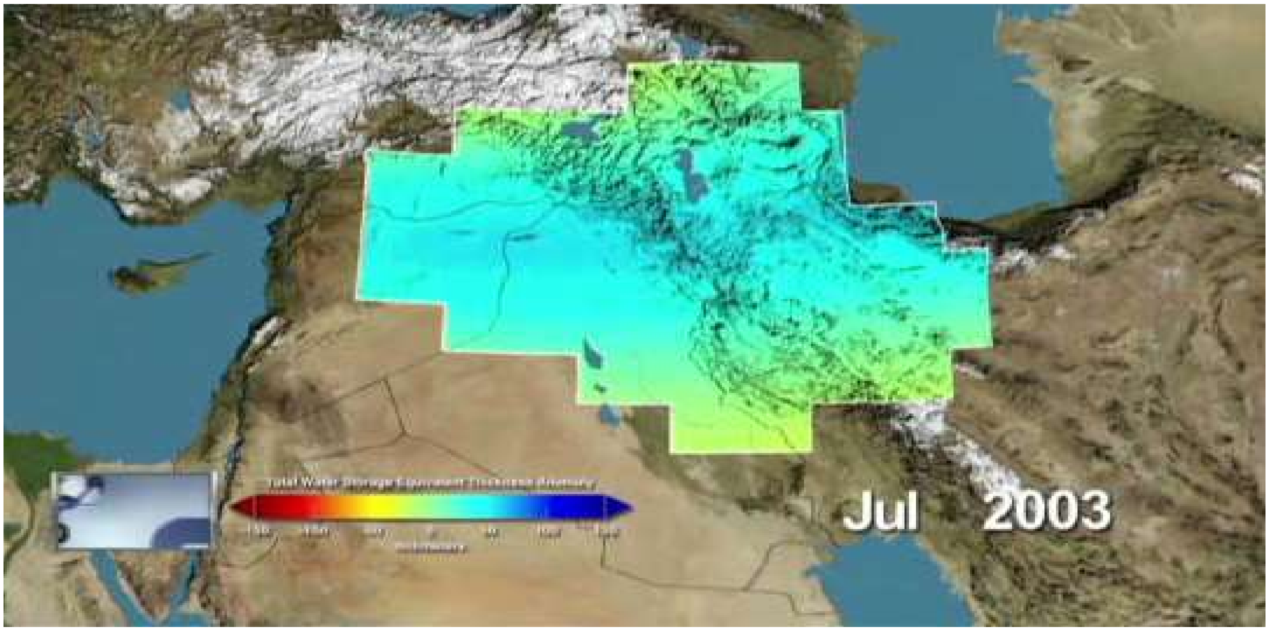
3000 B.C. Pakistan, Afghanistan and Iran used rainwater harvesting primarily for irrigation. A 1,000 years later Viet Nam and India created 150 super large ponds primarily for irrigation. The estimated volume was 1.5 billion cubic feet.

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.

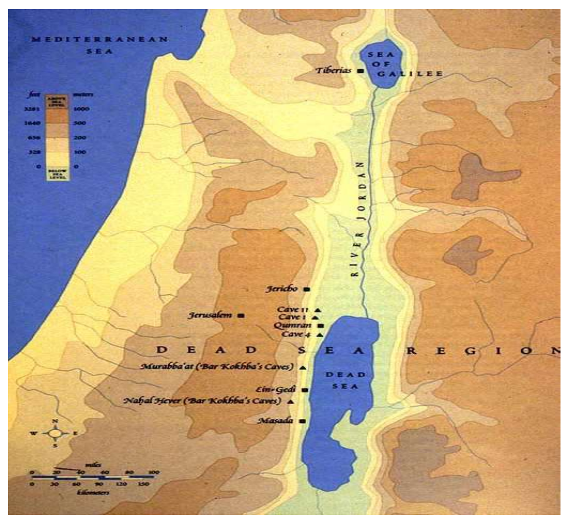
The earliest rain harvesting on record is in 3,000 B.C. when Pakistan, Afghanistan and Iran were some of the first cultures using rainwater harvesting for drinking water and irrigation. They created vast areas for collection of rain. Historians have estimated the volume at 396 billion gallons.

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.



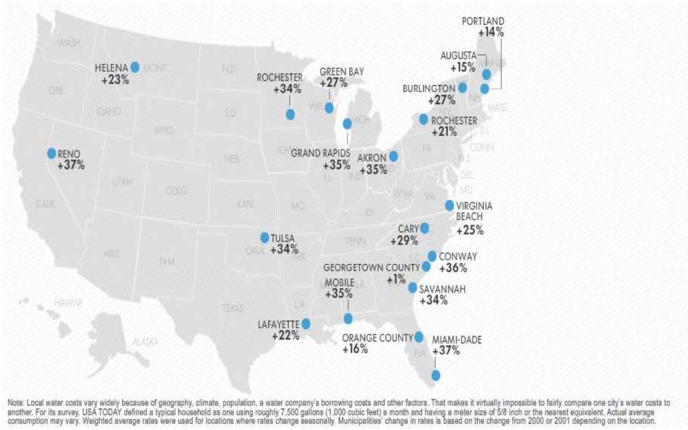
The Red Sea is between Jordan and Israel. Massive at 1200 miles long by 250 miles wide, its 169,000 square miles, the same size as the Pakistan-Afghanistan-Iran-Iraq disappearing aquifer**.**



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**

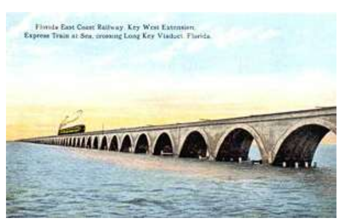


C.) Florida, the Keys and the Future

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").

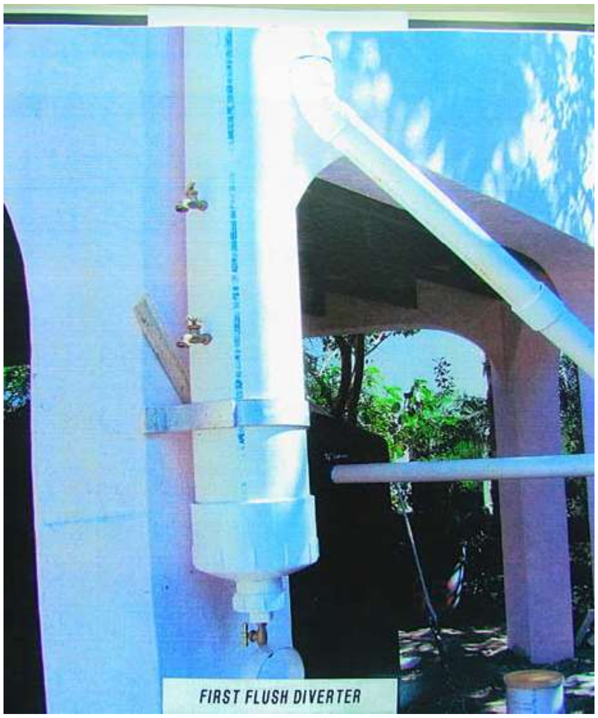
Another possibility is to visually showcase these artifacts for their original purpose in the new system. This would involve using these components as Historic Architectural Focal Point(s) polished, lacquered or antiqued in combination with the copper and galvanized Leaf Catcher(s). They could be converted 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.

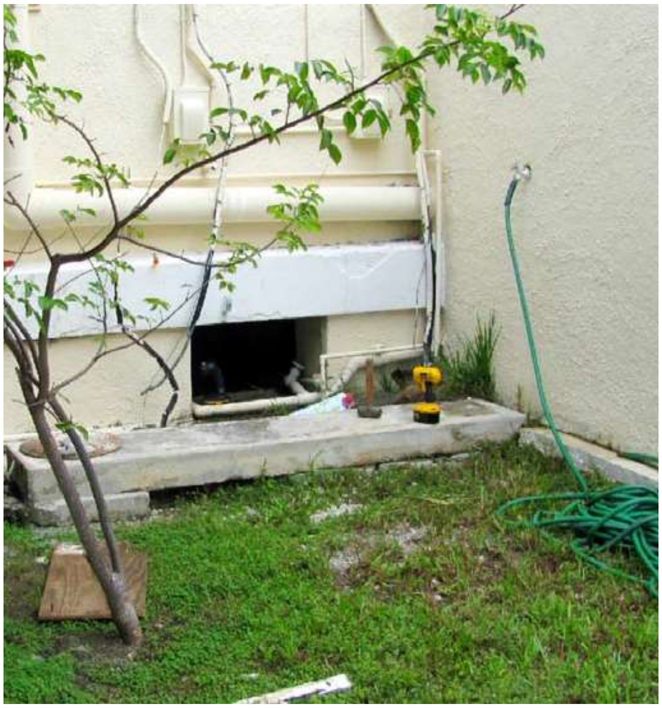


It should be noted that although Leaf Catchers were historically state-of-the-art from the 1800's and are still being used today. But without a working **First Flush Roof Diverter**, they can collect debris and even fecal matter which will later transferred directly into the cistern, creating cistern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

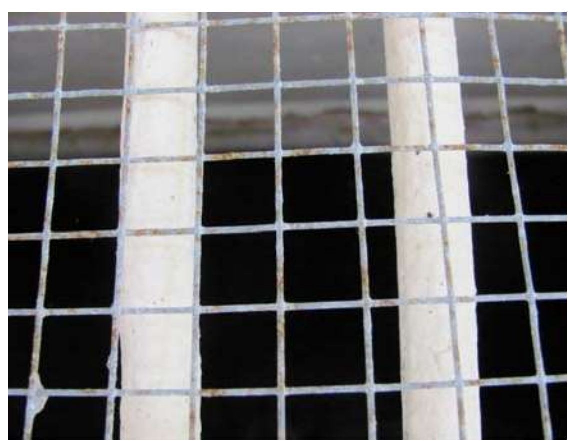
B). OBJECTIVE: Identify existing 1926 cistern dimensions, condition, water volume, historic materials and components for re-use and/or re-purposing in a new RWH system. Endeavor to integrate those cisterns and other existing components as Historic Preservation, Architectural and Educational Focal Points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

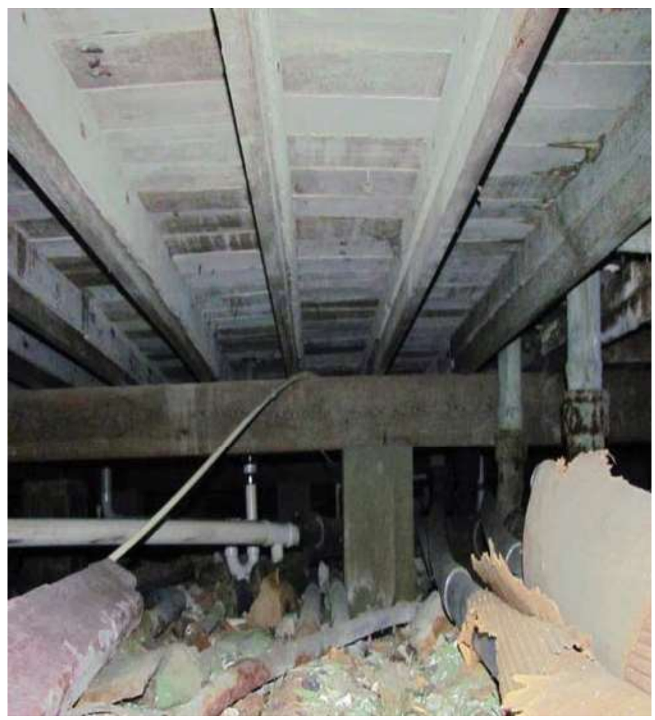
***PRELIMINARY CONCLUSIONS*: The only method of inspection available** was through the crawl spaces in buildings A and B. An inspection of all Cistern Building Crawl Spaces resulted in successful entry only once in each structure. **Building A** has a total or three vented crawl spaces, two of which 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.



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: <u>Indoor</u> <u>and</u> <u>Outdoor</u> water demand information is needed to harvest the available rainwater effectively.

<u>Indoor</u> <u>Design</u> <u>Parameters</u>: 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. **I**n 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 <u>52,000 gallons</u> or 10% of the total annual collection is the <u>ideal</u> 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.**

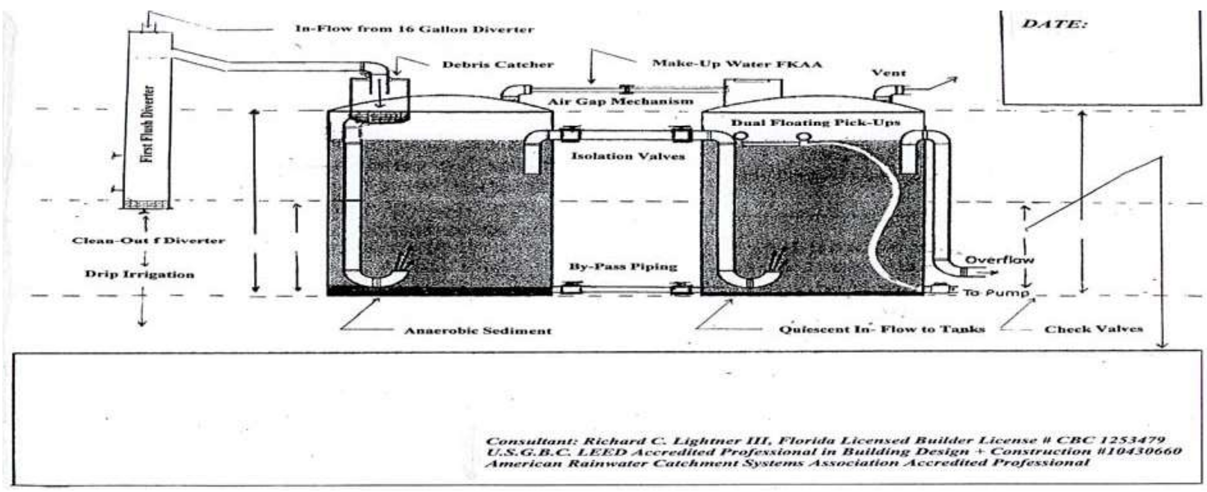
Existing two and three person 1500 square foot homes with cisterns in areas without access to FKAA water such as No Name Key and elsewhere in the Keys, including the 26 acre Sugarloaf Creek Bridge Estate have historically been able to exist with 5,000 gallon cisterns. This is also the average size of 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".

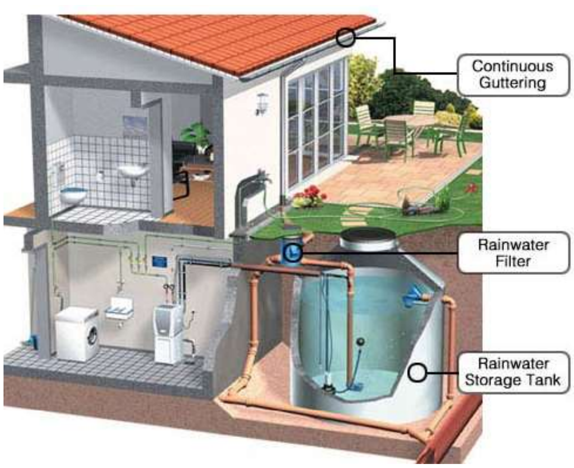
These homes with 5,000 gallons cisterns historically average a total collection of 36,500 annual gallons from the roof. That means that present day and historically, they exist with cisterns which store 13% of their annual total roof rainfall for whole-house residential use. Residential water use is significantly higher then commercial office buildings, but is used as the benchmark for design parameter water storage.

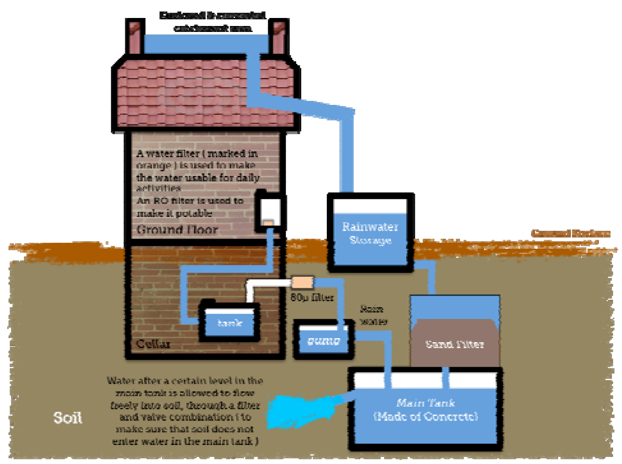
IV. OBJECTIVE: ASSIST in DESIGNING a NEW and INEXPENSIVE RWH SYSTEM for DELIVERY of PURE WATER for ALL BUILDING USES

***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.



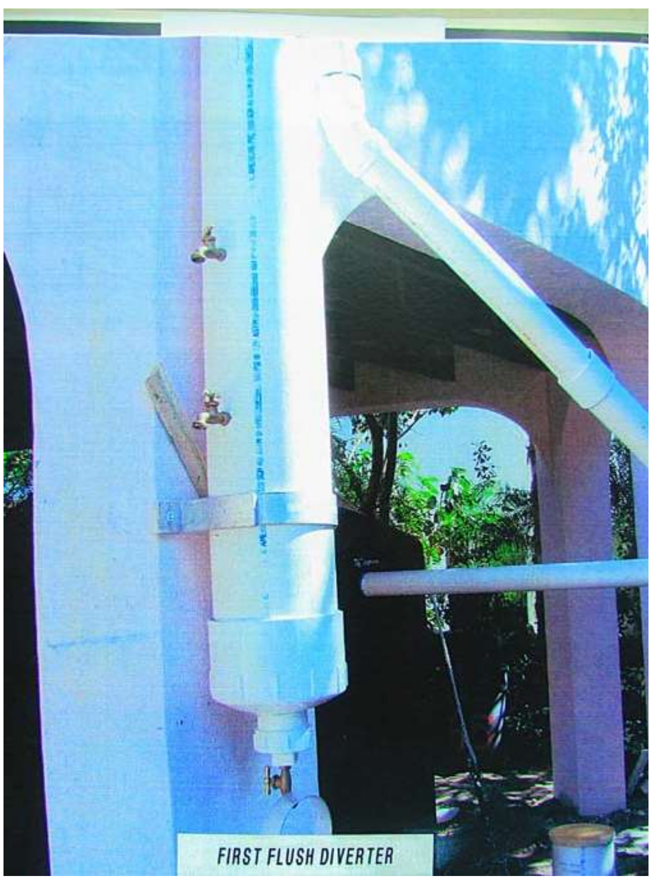




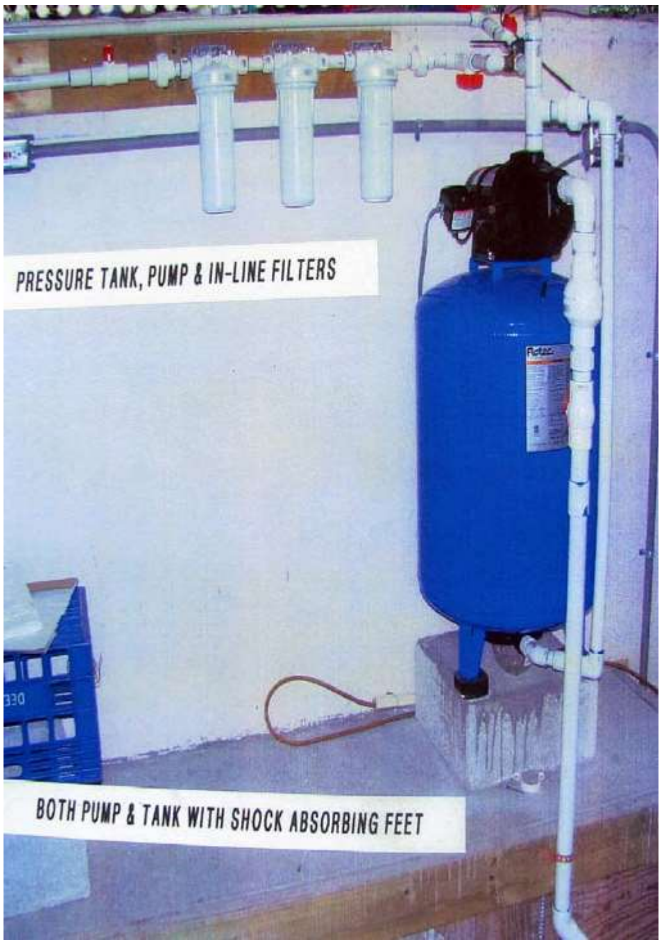
A rainwater equipment room or space should be located as near the cisterns as possible. This minimizes pipe lengths and prevents the need to run additional supply pipes under the building. GFI electrical switches, receptacles, pumps and filtration components should be a minimum of seven feet above sea 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.

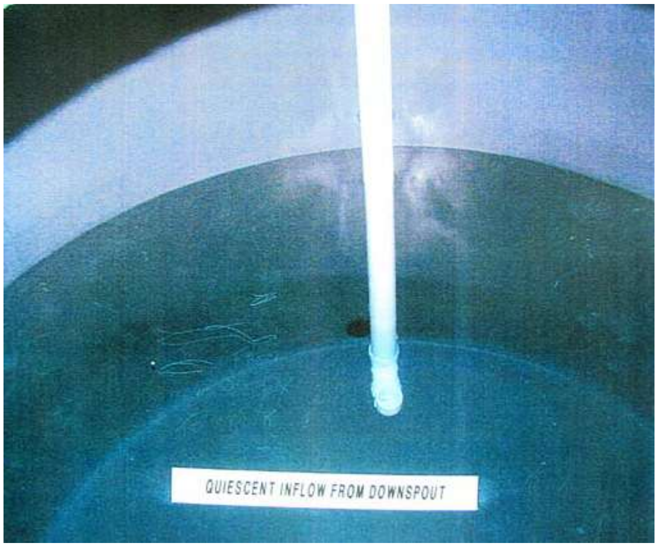
Rainwater falls into the designated Roof Catchment Area sloped from the roofs to gutters and downspout to the middle building systems filling ***First Flush Roof Diverters*** collecting any roof Debris just prior clean water filling the cisterns. They are the first line of defense against any contamination,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

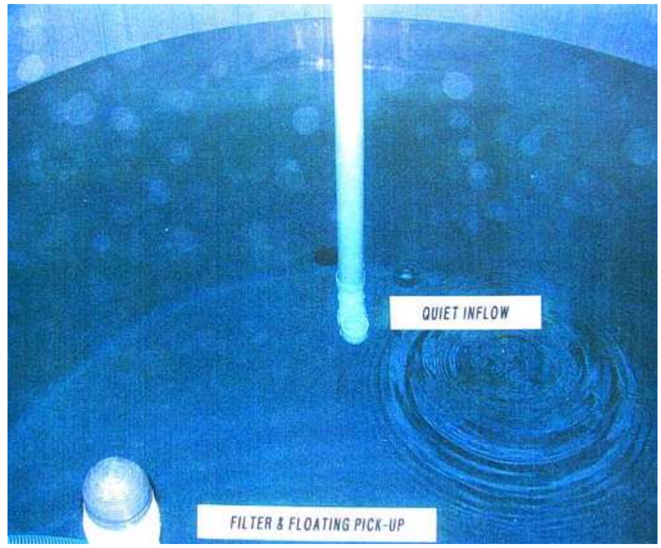


Thereafter the water falls into the cisterns through ***Quiescent Inflow Piping***. This means simply that the incoming roof water is turned back up, to fall gently to the bottom. The stored water will remains clear, as quiet inflow further prevents any possible water turbidly. The water is contained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

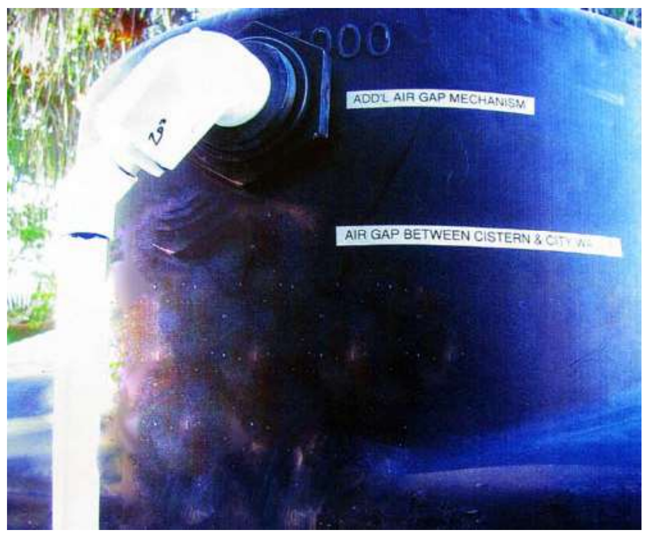




The second of a further two point filtration process is the ***Cartridge Filter Array Station***. This is simply three standard water filters side by side, placed immediately after the water pump on the discharge side. They capture and eliminate any sediments to 5 microns in the water flow. The water 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.**

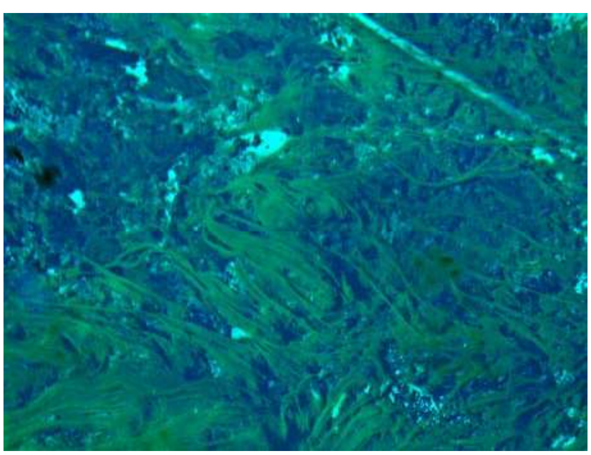
"Rain from a cistern can be used as drinkable water", quotes the Florida Department of Health in this letter addressed to Monroe County and the Florida Keys Aqueduct Authority (Appendix #5)

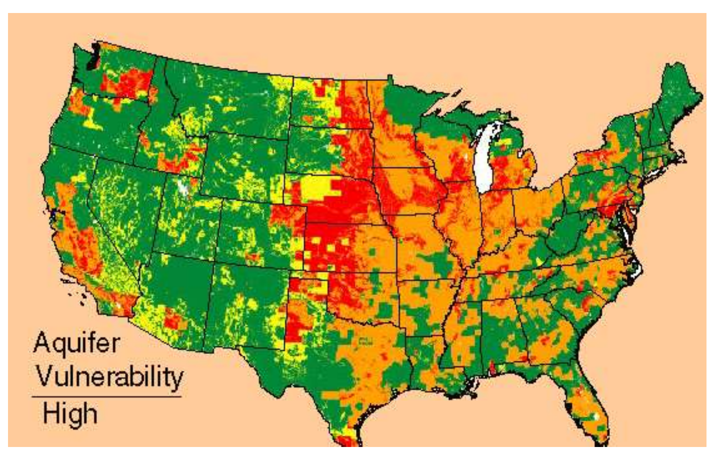
And **National Testing Laboratory Results of collected cistern rainwater have shown no detectable chemical contaminants that are in all utility company and store bought bottled water.** The EPA allows the FKAA and all bottled water companies to process all their water with chemicals that leave measurable 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 <u>**after**</u> **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 <u>System Operator Responsibilities:</u>

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 #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

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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

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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

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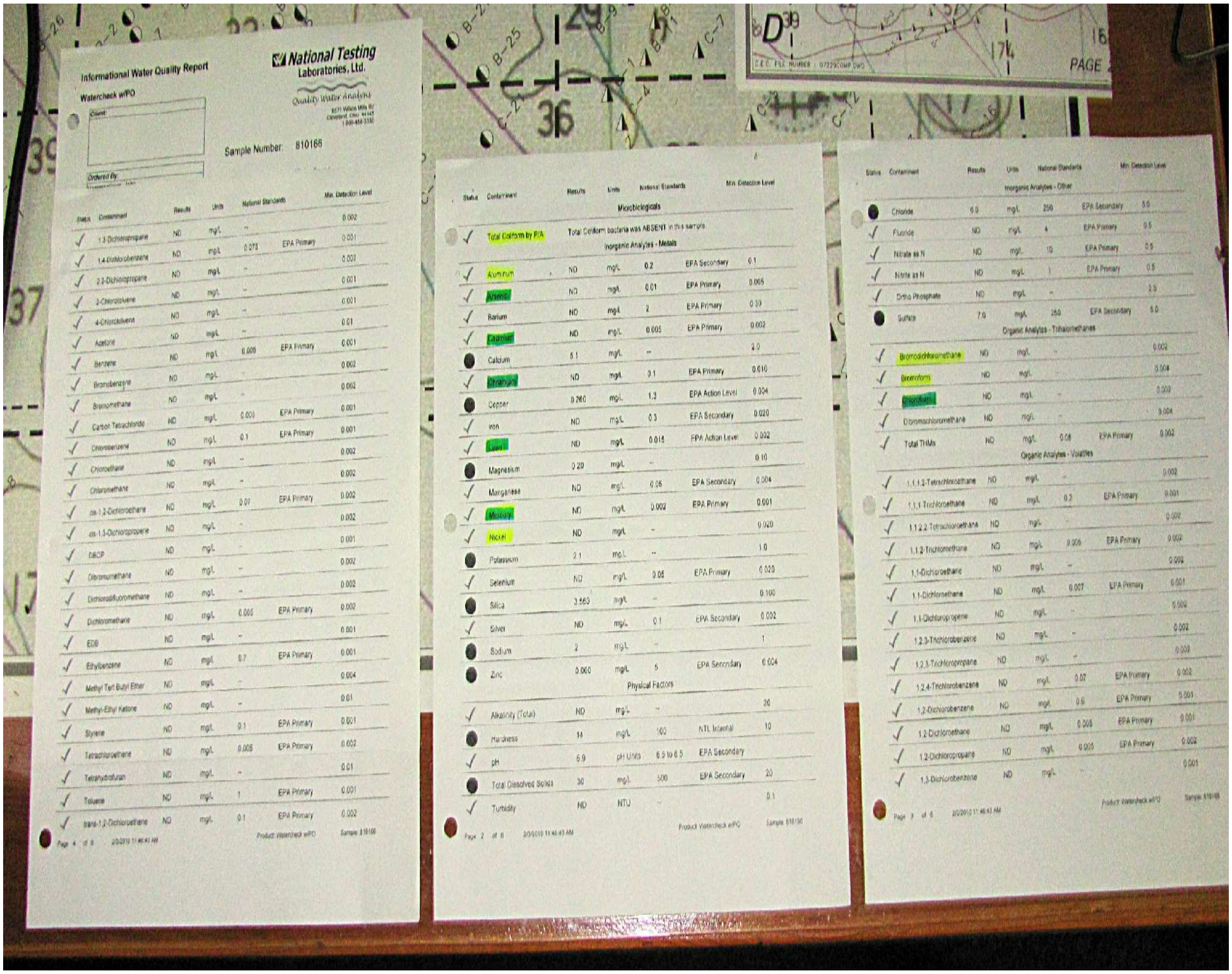

Informational Water Quality Report
National Testing Laboratories, Ltd.
Watercheck w/PO
Sample Number: 810166
Microbiologicals
Total Coliform by P/A
Inorganic Analytes - Metals
Physical Factors
Inorganic Analytes - Other
Organic Analytes - Trihalomethanes
Organic Analytes - Volatiles