The Rainwater Harvesting Answer Book | 2nd Edition

by Leading Stormwater Experts

A Collection of Questions and Answers
from Contech's Webinar Series on
Rainwater Harvesting as a Runoff Reduction Tool.

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CONTECH® ENGINEERED SOLUTIONS

URBANGREEN® Stormwater Solutions from Contech®

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Meet the Experts

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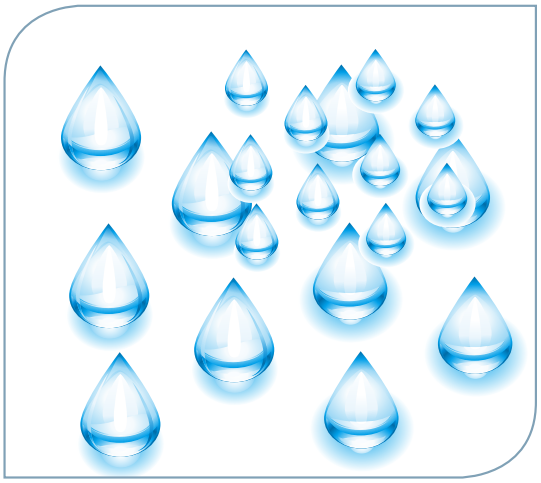
Application Questions



1 Q: How is the harvested water commonly used?

A: Typically, the harvested water is pumped for use in irrigation systems, toilet flushing or other non-potable uses.

2 Q: What kinds of clients/developers are installing these kinds of systems? Military, Commercial Etc.?

A: We have worked on rainwater harvesting designs for a wide range of project types including retail, commercial office, multi-family housing, single-family housing, hospitals, libraries, universities, schools, parks, military bases and more. In addition to runoff reduction and water conservation, many designers are targeting LEED certification.

3 Q: Can harvested water be used for fire suppression?

A: Technically yes. However, Contech has chosen not to provide cisterns for fire suppression applications.

4 Q: If using only rooftop runoff for irrigation and toilet purposes, are the treatment requirements different than that of parking/overland flow?

A: Pollutant loading conditions will vary based on the type of roof, parking lot material, type of development, and maintenance practices. In almost all cases, it is likely the rooftop water will be "cleaner" than the parking runoff. Even though the rooftop water may be cleaner, the same level of treatment would be required for both water sources for the same application because you must remove pollutants of a given size from either source.

Because loading is very likely to be higher for water from the parking lot and finer filtration is recommended for toilet flushing, designers should utilize an automated filtration system if the source water is from the parking lot or the usage is toilet flushing. This will help ensure lower maintenance and more uptime while providing an appropriate level of water quality for the application. For either source, the water should be disinfected for the toilet flushing application.

5 Q: There are chemicals from roofing materials and mechanical systems on the roof. How do you treat the water in cisterns if you want to use the water to water vegetable or fruits grown on the roof top?

A: There are many advocates of harvesting water for gardens, livestock and commercial agriculture. We are not aware of any guidelines that cover this issue specifically, but agencies would likely be conservative, and require more testing or treatment. There are studies that show rain, before it hits the roof or ground, can be sufficiently contaminated by particulates in the atmosphere to cause concern. This is usually near heavy traffic or industrial locations. The roofing material can also contaminate water as you noted, especially asphalt shingles and some metal roofs.

There are also many examples of harvested water with very high water quality, which provides the advantage of a non-chlorinated source which is favorable for crops. For this application, we would recommend testing the runoff from the catchment before deciding on using the water for this application. Based on the results, appropriate treatment could be recommended.

6 Q: I'm looking at trying to recycle pool discharge and backwash water instead of discharging it off-site. Can elements of a rainwater system be applied to this source?

A: Pool water would be relatively clean when only dealing with overflow or pump down flows. Backwash water could have a high degree of biological and particulate content and would not be appropriate for a rainwater harvesting system. That may be managed under greywater regulation and plumbing codes.

7 Q: Is there any risk with washing clothes or dishes with non-potable (harvested) water?

A: Non-potable rainwater should not be used for dish washing unless the water is treated to potable standards, and this is allowed in your jurisdiction. Laundry is a great choice for non-potable water, but final filtration and UV disinfection should be used to ensure proper water quality.

Still have questions? Check The Stormwater Blog for more info!

http://www.conteches.com/Stormwater-Blog

Design Questions

1 Q: What is the smallest size project you have seen rainwater harvesting used?

A: Outside of residential rain barrel systems, we typically see small commercial scale systems starting at 5,000-10,000 gallons. Contech can help you optimize your cistern size using our Runoff Reduction Calculator based on the projects supply and demand.

2 Q: What is make-up water?

A: Make-up water is a secondary water source to supplement the system when the cistern water level is low. For critical demands such as toilet flushing, it is vital to have a make-up or secondary source of water to ensure an uninterrupted flow in the event that the rainwater harvesting cistern does not have sufficient capacity. This is commonly municipal water or well water.

3 Q: How intensive are plumbing codes for non-potable water for indoor uses such as toilet flushing?

A: Plumbing codes can vary widely. The first priority is to follow guidelines and requirements to prevent cross contamination. We recommend chlorination to provide residual disinfection capability for this application.

4 Q: If sprinkler irrigation water is from a pond with no cross connection to public water, do you need purple pipe (to indicate non–potable water) and/or a backflow preventer? If a backflow preventer is required, what type?

A: Local codes vary on this issue. It is good practice to label any fixtures that connect to a non-potable supply. If there is no physical connection between the irrigation system and municipal supply, than cross connection is eliminated. It would still be a good practice to place an irrigation backflow preventer to keep the water from flowing back into the pond. In this case, there would be no way to irrigate if the pond is empty, except filling the pond with a backup supply.

5 Q: Is it practical to retrofit a rainwater harvesting system into an existing building? What might be some of the complications?

A: Yes, it is possible. While practical for irrigation, installing the non-potable piping system within the walls may be cost prohibitive if you are trying to connect numerous bathrooms to the retrofit system.

It would be more practical if a major renovation was underway and the walls were open. If you were supplying one source, like a large HVAC unit, installing a single non-potable line may not be prohibitive. Some designers and owners are thinking ahead and adding the dual plumbing to new buildings and holding off on the actual rainwater harvesting system in anticipation of adding one in the future.

6 Q: How does an increase in parking spaces equal an increase to rental space?

A: In some cities, a certain number of parking spaces are required for a given amount of rental space. If you can add to the parking lot, you could potentially increase your available rental space. This is not the case in all areas, but is common in major cities.

7 Q: How does combining the collection of condensate affect the system?

A. Condensate runoff is a good constant source of water from air conditioning units as the condensate collects on the exterior of the cooling mechanisms and runs down to a conveyance pipe. Sometimes this condensate may contain metals. When condensate is a source for cistern volume, it is a good design practice to bypass the system upstream of the cistern when larger storm events would create flow to an overflow pipe. By positioning the bypass pipe upstream of the cistern where the condensate enters, less of the condensate volume would be bypassed minimizing the issue. If the system overflow outlets to a combined sewer, then this may not be a concern as that would have been the destination of the condensate flow anyway.

8 Q: For large building areas, say 9 acres, does the engineer need to account for roof leader capacity?

A: The building designer typically follows code requirements for draining the roof, so the roof leader, roof drains and downspouts should be sized appropriately, with or without a rainwater harvesting.

9 Q: Where can I find local rainfall data for various areas?

A: NOAA (National Oceanic and Atmospheric Administration) has vast amounts of rainfall data from thousands of gages all over the country, many of them for 50 years or more. You can download smaller data sets or purchase large amounts of data for a modest fee. Contech's Runoff Reduction Calculator uses data from approximately 8,500 gages from 1980-2000. We rejected data from thousands of other gages because there were significant gaps in coverage where the data was deemed faulty or the gage was out of commission.

Whatever your source, it is important to ensure the data is complete and accurate. One participant in our webinar provided the following comment on this subject: "In the Midwest, regional governments such as Sewer Districts, City DPW-Water Depts., and Regional Planning Commissions collect accurate and continuous rainfall data. I can find water data within one mile range of a project in the Milwaukee area from our Sewer District."

10 Q: What computer applications are available for designing these systems and how flexible are they?

A: We have used these three calculators that include runoff reduction and can be useful for designers:

Contech's Runoff Reduction Calculator – Web hosted, very flexible and includes rain data from 8,500 gages across the United States.

NC State – Downloaded program, very flexible, includes data from approximately 15 cities, mostly in NC.

VA Department of Conservation and Recreation – Excel download, moderately flexible, includes rain data from 4 cities in VA. Used by the Virginia Department of Conservation and Recreation to calculate runoff reduction credits.

11 Q: In the example of the cistern in parallel with the surface or subsurface pond; would an overflow from the cistern to the stormwater system not be required in the event the cistern is full, or during cold winter months when irrigation is not necessary in cold climates?

A. For RWH cisterns taking flow from rainfall coated surfaces, an overflow pipe should be employed to convey flows once the tank is full to a downstream stormwater management system. When the downstream stormwater system may have a high water level in relation to the cistern, a flapper style backflow preventer should be utilized.

12 Q: Unless you had an oversized storage system, you would not be able to capture the full stormwater runoff, correct?

A: It is easy to capture the entire stormwater design storm – the challenge is making sure the cistern is drawn down by the next large storm event. This depends as much on the demand for non-potable water as the size of the catchment. We have seen small buildings that use 15,000 gallons per day, and 100% runoff reduction is practical. On the other hand, large warehouses have a lot of roof and don't use much water, so no matter how large your cistern it will fill up and overflow eventually.

Our Runoff Reduction Calculator provides graphs that show the water volume inside the cistern for several years so you can see how often it is full, empty and when overflows occur. Try it out for one of your typical projects to see if rainwater harvesting meets your goals. We're happy to provide a size and cost estimate that takes into account your project variables, so you have a much more accurate estimate than a very broad general cost guideline.

13 Q: For an area with a lot of salts used on parking lots, would you have a separate system for the parking lot vs. rainwater off the roof?

A: You would either have separate systems or manage the combined water based on the source with the lowest water quality. The frequency and type of salting, along with the ratio of parking lot to rooftop, could predict the types of concentrations to expect. There may be significant dilution when combing multiple sources. Depending on the usage application for the capture water, it may be okay. The most conservative approach would be to focus on the rooftop and management the parking lot with a different practice.

14 Q: Can we avoid dual pluming by connecting the make-up water to the tank?

A: No. You will still need a potable line to sinks, showers, and other potable sources, and a non-potable water line to the non-potable applications, such as toilet flushing. The two common ways to provide a back-up water supply are using an air gap, where the back-up water enters the cistern or wet well and is then pumped to the final source, or using a 3-way valve where municipal water directly pressurizes the existing non-potable line when the cistern does not have sufficient water. In either case, a non-potable would be required to service your non-potable applications.

15 Q: All jurisdictions I have worked with require a reduction in the post-developed runoff for a specified storm event, which require large amounts of runoff storage. Is this amount of storage possible, and financially practical, within underground structures?

A: Our Runoff Reduction Calculator allows you to input a design storm depth you need to manage. Overflow up to this depth counts against your runoff reduction and overflow after this depth is discounted. We find cistern sizes are often similar to water quality volumes, which isn't surprising because they are both trying to manage the majority of annual runoff.

One option designers pursue is to optimize your cistern based on your runoff reduction or water savings goals and store the remaining volume in a detention system. Once your cistern volume is full, the overflow can be routed to a detention system. This ensures that your cistern is full and ready for use before spilling over to the detention portion.

16 Q: Does the project's life expectancy vary greatly between private and public sector clients?

A: We have seen a large range in life expectancy requirements in both the private and public sectors. This range is often between 30-100 years and depends on the project type, developer interests, and project specific factors.

17 Q: Is the full capture treatment system considered a stormwater BMP?

A: Yes – A full capture treatment system such as Contech's CDS system is considered a stormwater BMP. Depending on your local regulations, it may be approved for pretreatment or as stand-alone treatment. For rainwater harvesting applications, the pretreatment system often does not need to comply with the stormwater treatment guidelines because the water is being reused and is therefore not discharging to the local stormwater drain.

18 Q: Is there a thermal mass formula to assist in determining the risk of freezing?

A: Areas with prolonged cold temperatures should employ good design practices to prevent freezing of cisterns or mechanical systems. Housing cisterns underground below the frost line or insulating over the tank would be recommended. Rainwater harvesting mechanical systems should be housed in a climate controlled mechanical room. If not used during winter months, the rainwater harvesting mechanical system could be housed in an unheated outdoor enclosure as long as the system is blown out and all the water is removed from freeze prone components.

19 Q: What kind of loading should I expect from a rooftop or parking lot?

A: Loading can vary widely, but based on a variety of research and our own monitoring experience, we recommend using an influent total suspended solids (TSS) concentration or event mean concentration (EMC) value of 40-60 mg/L for typical commercial sites. Keep in mind this is for TSS. Bulk solids can often be significantly more than TSS.

20 Q: Does rainwater harvesting help with LEED credit score?

A: Yes. LEED 2009 (v3) has a total of 12 points available for stormwater, wastewater and water efficiency. Runoff reduction can meet both water quality and water quality requirements for stormwater, which provides 2 points. Reducing or eliminating potable water for outdoor use offers up to 4 points and reducing potable water for indoor use provides up to 4 points. Finally, innovative wastewater strategies offer 2 points and re-using blow down and condensate that would have gone to the treatment plant may meet the objective. You can find more LEED information on Contech products here: http://www.Conteches.com/Markets/Green-Building/LEED.aspx

21 Q: What project-specific support do you provide to engineers (and at what cost) that want to explore this technology?

A: Contech has a team of Design Engineers that are knowledgeable about stormwater treatment, storage, and rainwater harvesting design. Our consulting services are free. Please contact us so we can put you in touch with your local Design Engineer.

22 Q: Can you explain how a double pump setup with the day tank works?

A: When the cistern is empty, a day tank open to the atmosphere provides a convenient point to supply back-up water when a design must meet code requirements for an air-gap between potable supplies and non-potable systems. In this scenario, the pump in the cistern can supply rainwater at high flow rates and low pressure to keep the day tank full. Then a second booster pump supplies the water from the day tank at high pressure to the demand applications. Day tanks can also be used to dose and monitor chlorine.

23 Q: Where does the back flush water go? Is disposal a problem?

A: Back flush water should go to a sanitary sewer. This is usually not a problem.

24 Q: Does your Runoff Reduction Calculator tool assume instantaneous runoff or only daily?

A: Our model assumes all of the runoff from the total daily rainfall occurs instantly and any volume not immediately stored cistern becomes overflow runoff.

25 Q: What type of toilet can be used with harvested rainwater? Are these low flow toilets? Is there a warning label that the toilet does not use potable water?

A: Any type of toilet can be used. Some jurisdictions do require signs that indicate non-potable water, even for toilets.

26 Q: RWH has two downsides: that stored water is not typically needed in winter in northern climates for landscaping, and the tank could be full during rainy seasons. So the RWH system needs an overflow outlet, which may need to be included in the detention system. How do you typically address these issues?

A: An overflow pipe from the cistern can flow to a downstream stormwater management practice when the tank is full. This would include a stormwater detention system that is usually part of most development projects with today's regulations. Also, finding other water reuse options to increase water usage demand (such as toilet flushing) will ensure that the tank volume is emptied.

27 Q: In the Runoff Reduction Calculator, are there any ways to output data to an external excel file to analyze multiple scenarios?

A: You can output a report in PDF or Excel. It is best to download a report and then change the scenario. You can also "option" a project to create different versions for comparison.

28 Q: How do you model snowfall in your design?

A: We total daily precipitation in the model and snowfall is not accounted for separately. It could be argued that snowfall melts over time creating smaller flow rates over a long duration that is easier to manage with rainwater harvesting. For most U.S. climates, snowfall probably does not make a significant difference in predicting the amount of runoff reduction a rainwater harvesting will provide.

29 Q: Are there any issues to be aware for building on top of the storage tanks, such as parking?

A: There are risks with installing a cistern within a building's footprint. Those risks should be evaluated and weighed against project design constraints. The access to the tank should allow maintenance to be performed on the system. Location of the cistern should also allow for excavation and replacement of the tank if future issues arise that may require repair or replacement of the system.

30 Q: In a high water table situation, could the tank float or have a reverse leak?

A: Buoyancy concerns should be evaluated in high water table applications to prevent flotation of underground structures. Items that affect the floatation forces are weight of tank, weight of water in tank (if any), ground water elevation creating a buoyant upward force on the tank and any downward forces holding the tank down like the earth cover above the cistern (saturated or unsaturated depending on ground water elevation) and any additional hold down measures employed if necessary. If ground water is above the bottom of a non-water tight tank, then the water could infiltrate into the tank when the ground water is higher than the water level in the tank. In these instances, the cistern should be designed for zero leakage so that no ground water can infiltrate into the cistern.

31 Q: Do you anchor your pipes to foundation upon installation?

A: Not typically. Underground pipe/cisterns usually do not need to be anchored since the backfill will hold the materials in place after installation. Hold down measures may be required (straps and deadmen etc.) but the buoyant forces can easily be calculated to determine if additional hold down measures are required in addition to the earth cover overburden the backfill provides.

32 Q: Are there any filtration requirements for non-drinking water building usages?

A: Treatment requirements for indoor non-potable uses are determined by local plumbing code. Disinfection is recommended which requires filtration as a pretreatment. Plus, the filtration improves the clarity of the water and which ensures acceptance by users. Ultraviolet disinfection and possibly chlorine treatment are the most common disinfection techniques.

Pre-Treatment Questions

1 Q: With harvesting off parking areas, how do you handle oil and grease?

A: Some pretreatment systems can baffle a large portion of the oil, and your cistern should include a floating outlet or have a submersible pump. In either case, the inlet to the pump is both above the very bottom of the cistern and below the surface. So most of the oil would be trapped at the surface and can be removed during maintenance.

2 Q: Please explain how the first flush containing undesirable contaminants is scalped away to avoid entering the cistern.

A: Opinions vary on the contaminant loading of "first flush" and the term itself has different meanings in a conventional rainwater harvesting context versus a stormwater context. Some stormwater research shows the potential for a seasonal first flush, but suggests pollutant loading during a storm is associated more with rainfall intensity, not the timing.

Many rainwater harvesting guides recommend bypassing the first portion of a storm event, in the range of 0.05". Depending on the rainfall patterns, 0.05" can easily equate to more than 10% of the annual runoff. This is likely a low estimate because it is based on total daily rainfall. However, rainfall often occurs multiple times per day and can create multiple first flush volumes.

Any water bypassed by a first flush diverter still needs to be managed according to the stormwater requirements. We recommend capturing the entire storm if possible when the primary goal is runoff reduction; otherwise we'd let 10%+ of the runoff go past before the first drop is captured.

3 Q: Are there any strategies you can recommend for runoff from parking areas where snow melt chemicals are used so this salted runoff can be saved and reused for irrigation?

A: Dissolved salts and chemicals are not able to be removed from the water with just filtration. You most likely will need an advanced treatment process, like reverse osmosis, to treat the water which may or may not be feasible.

4 Q: Is it wise to separate storage systems for the varying types of water sources; rainwater separate from HVAC and so on?

A: It can make sense to store HVAC condensate in a separate cistern from your roof or hardscape rainwater runoff if you have various demand applications that need different levels of treatment.

An example would be if you collect your HVAC condensate and recycle it back with very little treatment as the make-up water to the HVAC. This may allow you to reduce your treatment level if you can use the roof and hardscape rainwater that has additional pollutants for irrigation or another demand with lower treatment requirements.

5 Q: A watershed council in Los Angeles through their Water Augmentation Study has shown that soils are effective filters of pollutants. If we're infiltrating the stormwater in the landscape and the water table is deep enough, why divert the first flush?

A: We agree that, when possible, pretreating to a higher level and avoiding first flush diversion is the best solution for runoff reduction.

6 Q: Can we switch to 100% capture after the first flush since the stormwater becomes clean? Is there a certain amount to determine that point to switch?

A: We would still recommend pretreatment for the stormwater that is collected after the first flush. This water will still contain organic material and should go through a pretreatment device. We would recommend collecting all of the lower intensity storms up to a certain design storm (such as 1" or 2" depending on the project location), and bypassing the higher storm events.

7 Q: What is the chemical constituent in the first flush?

A: The first flush pollutants will vary greatly depending on the roof type, canopy cover over the roof, project area, etc. This can include metals such as zinc and iron, as well as organic material such as leaves, pine needles, and bird/small animal debris.

8 Q: Why not treat the first flush?

A: We recommend treating the entire low intensity storm and removing first flush diversion from the design if possible. This increases the runoff reduction percentage and amount of water that can be stored for future use.

9 Q: Are there runoff reuse applications that typically don't require first flush diversion, I.E. reuse for irrigation?

A: The requirement for first flush diversion is typically not by application but by governing jurisdiction. If possible, we recommend not diverting the first flush and sending all of the low intensity storm events to pretreatment prior to collection in the cistern.

10 Q: Do you pretreat before bypassing the first flush?

A: Typically pretreatment is done after first flush diversion for only the stored water. Depending on the jurisdiction, treatment may be required for the first flush water prior to discharge into the storm drain.

11 Q: Does rainwater collected from a rooftop need to be pretreated, and what type of pretreatment is recommended?

A: All rainwater collected in the cistern should go through some type of pretreatment, even from a rooftop. Although rainwater from a rooftop is relatively clean, it can still contain leaves, sticks, sediment and other airborne contaminants. It is recommended that a pretreatment device remove sediment down to 100 micron, and provided 100% capture of all contaminants larger than 2.4 mm. Providing this level of pretreatment will help ensure that the filters in the pumping system do not clog prematurely, and that the risk of odors and bacteria developing in the cistern is minimized.

12 Q: After the initial washing of a new roof, will sedimentation remain an issue, especially when using membrane roofing?

A: Enviro-deposition of sediments and organic debris will happen all year round through the normal weather patterns. Though roof surface seems to have an effect on the ability of the roof to hold onto small sediment particles, roof style overall would not seem to discount the need for pretreatment.

13 Q: Can you use a septic tank as full capture pre-treatment?

A: The septic system would be separate from a rainwater harvesting system and would not be able to be used for pretreatment.

14 Q: What is the definition of clean water that comes out of a pretreatment unit?

A: Water exiting a pretreatment unit should not contain debris and will have reduced sediment content.

15 Q: How do you determine the need for a back flush and how that will be achieved?

A: Back flush is required when the filter face is occluded and has a pressure differential across the filter. Back flushing a filter is when a filter is cleaned without taking the filter apart. A back flush cycle could be manually initiated or automatically initiated based on pressure across the screen, time since last flush or volume or water since last flush.

16 Q: If you have a catch basin going directly to (directly above) your cistern or underground detention, is there any way to pretreat this? Does Contech make such a product?

A: There are products in the market that would allow for direct treatment of surface inflow from a catch basin grate. The Contech CDS unit does have a grated inlet design allowing for the CDS unit to act as the catch basin structure.

17 Q: What about pre-treatment and storage of runoff from parking lots?

A: Roof runoff will be the cleanest source of runoff. Parking lots contain pollutants from cars that are hydrocarbons (typically with specific gravities less than water) that can be removed with baffling type treatment units. However, parking lots also contain water soluble pollutants that cannot be effectively removed. Catchment of parking lot runoff may increase the maintenance required of the systems.

18 Q: Given the treatment requirements for non-irrigation use, is there still sufficient cost benefit return?

A: The ROI for rainwater harvesting may not pencil out solely based on water savings, but when stormwater treatment costs and land savings are taken into account, it can make sense.

19 Q: What type of maintenance is required on the CDS hydrodynamic separator when used as pretreatment?

A: The CDS unit provides a very large sediment and floatables storage area. The required maintenance consists of using a vac truck to pump out the sediment and debris that has collected over time (similar to a grease trap). The maintenance frequency will depend on the contaminant load coming to the unit. It is typically recommended that the unit be visually inspected on a periodic basis and pumped out annually.

20 Q: When using city make-up water, do you bypass the treatment methods?

A: When city make-up water is used, it can bypass the final treatment if a 3-way valve with backflow preventer is allowed. In this approach, the municipal water directly pressurizes the non-potable line if the cistern is empty. If this approach is not allowed and an air gap is needed, the water will fill the cistern or wet well and will need to go through the final treatment system because it will be mixed with rainwater.

21 Q: Where does the back flush water from the filter go?

A: The back flush water from the final filter should be connected to the sanitary sewer line. This water will be heavily laden with sediment and should not be directed to the storm drain.

22 Q: If water is to be used solely for toilet flushing, is ultraviolet disinfection required by code?

A: When non-potable water is brought inside the building, the Department of Health becomes involved and disinfection is usually required. For toilet flushing, Contech recommends chlorine disinfection since it provides residual disinfection, unlike ultraviolet.

24 Q: Would 'pre-treatment' occur before reaching the pump, or would a 'grinder' type pump be used to use the raw storm water?

A: Pretreatment should occur prior to storage and pumping. Pretreatment will keep organic material and other pollutants from breaking down in the cistern and causing anaerobic conditions. When the water is needed, the pump will pull from the pretreated stormwater in the cistern and send it through a final filter and any other required treatment (such as disinfection) before it goes to the final use.

25 Q: In your experience, has water quality been an issue in the past for cooling makeup used from cisterns?

A: Contech recommends a higher level of final treatment including disinfection for HVAC make-up water. This is due to airborne diseases such as Legionnaires, where bacteria are transmitted in an aerosol form from an infected water source.

Cistern Questions

1 Q: How does an SRPE tank compare to a FRP tank in terms of structural properties and cost?

A: Contech's SRPE cisterns are installed with structural backfill materials that enable the system (tank and backfill) to be structurally designed to meet project conditions. Typical structural design requirements for most projects under paved areas fall into the H20/H25 design loading category. As long as the minimum cover over the cistern and proper installation and compaction of the backfill materials are achieved, this loading design is met with SRPE cisterns. Higher design loadings can be achieved by increasing the minimum cover requirement. Contact your Contech design engineer to discuss your project specific loading requirements. FRP tanks require an ASTM D2321 Class I, rounded stone for backfill. SRPE can use a Class I,II, or III material. In some cases native material meets the Class II, or III designation. In these cases, native material can be used for backfill of SRPE cisterns thereby reducing installation cost. Cost comparisons between SRPE and FRP will vary greatly depending on cistern size and configuration. In general SRPE will hold a cost advantage in large cistern configurations..

2 Q: What are typical backfilling requirements? Open-graded aggregate around cisterns?

A: Backfill requirements are dependent upon the structural requirements of the material used. Contech's DuroMaxx Steel Reinforced Polyethylene may allow in situ soil for part or the entire fill, depending on the quality of material. Other cisterns may only allow graded stone backfill. The backfill requirements are detailed in our submittal drawings, and can be found within our product pages of our website.

3 Q: Are the Steel Reinforced Polyethylene cisterns rated for potable use?

A: The resin used for the SRPE cisterns has NSF 61 Certification for potable use, but we have not yet submitted the entire system for certification.

4 Q: How are Steel Reinforced Polyethylene cistern segments fused together?

A: Once installed and backfilled, the SRPE product is ready to be sealed. SRPE cisterns are joined by a polyethylene welded coupler. The coupler may be attached by electro-fusion or extrusion welding technology to provide a homogeneous, leak resistant joint.

5 Q: Can the steel reinforced polyethylene (SRPE) cisterns be used in heavy loading conditions, E.G. airport applications? Can they be designed for HS-25 loading?

A: Yes. The minimum cover will increase somewhat, but SRPE cisterns can be used in heavy loading applications. For example, a 96" SRPE cistern requires a minimum cover of 2' for H20 or H25 loading and roughly 4' for E80 (train) loading.

6 Q: Is the steel in the steel reinforced polyethylene cisterns for tensile strength for pressure?

A: The steel ribs provide both compressive strength for buried applications and tensile strength for pressurized conditions. This provides material savings; reducing the amount of plastic and recycled material (steel) to be used.

7 Q: Does Contech's SRPE cisterns come with pre-fab access-points & area-ways for vertically-mounted submersible pumps?

A: We supply at least one access point on all cisterns and often add others depending on the project needs. We have supplied integrated sump extensions in our underground steel reinforced polyethylene cisterns to create a sump for the pump. We prefer to have the pump intake above the bottom of the cistern though, and these are exceptions. Guides, rails and access lines for submersible pumps are usually provided as part of the mechanical system and are added to the cistern after delivery.

8 Q: How long can rain water stay stored in a RWH system?

A. Proper design application of RWH systems can have stored rainwater for long periods of time. Local codes should be reviewed to determine if any storage time limitation applies for a project's location and jurisdictional responsibilities. Also, there are design considerations for long term storage that could be employed to better manage cistern health. These include limiting runoff areas to roof areas for the least amount of influent sediment and pollutant loads, first flush diversion, overflow design for water circulation, venting and vector control, and timed recirculation lines to help aerate, filter, and chemically treat the cistern volume.

9. Q: Are there options for just polyethylene, not steel reinforced cisterns? Are they able to be in loaded areas and under parking lots?

A: There are polyethylene options, but they usually have very limited loading conditions and are only available in relatively small sizes; 2,500 gallons and less. Contech does not offer these types of cisterns.

10 Q: It would seem that the leakage would be more problematic in an arid environment. Your sample showed the 31,500 gallon cistern as full, but that might not be the case if rainfall does not occur often enough. Is that not the case?

A: The 31,500 gal cistern in the example was the SRPE cistern with zero leakage. One example in the webinar used a CMP detention system with 105,000 gal of storage capacity and gasketed joints. Minor leakage is associated with this type of joint. In the example, the "Runoff Reduction Calculator" was used to model the water availability in the detention system based on 20 years of rainfall data. This tool can be used to simulate the water availability in a collection system using rainfall data anywhere in the US and to determine the effect of a leakage rate in an arid environment.

11 Q: How water tight is water tight? What is the allowable leak rate?

A: The water tightness of a holding tank is subjective and could range from completely water tight to having an allowable leak rate commensurate with the application. Typically, RWH cisterns are specified to be water tight with a hydrostatic test or low pressure air test to be performed by the installing contractor after construction to verify water tightness of the system.

12 Q: Is it recommended to circulate the stored water while it is waiting to be utilized?

A: Circulation or aeration can be used if you anticipate a seasonal or sporadic demand. In general, if your demand is year round, the water volume should turn over and additional equipment should not be necessary. Proper pre-treatment is also critical to maintaining a clean cistern. If organic material is left to decompose in the cistern, it can lead to fouling.

13 Q: What filtration should be used for storing rainwater in a structure that cannot act as a settling basin (non-accessible for sediment removal)?

A: It is vital to have access to your storage cistern. Even with a high level of pretreatment, fine sediment can still collect in the cistern. There may need to be repairs made to the calming inlet, or to fix any watertight issues over the life of the cistern. Without access, the cistern would potentially have to be removed and replaced if any problems were found.

14 Q: How do cast-in-place concrete installations compare to precast for large applications?

A: Cast-in-place concrete installations can be great if a unique shape is required, or if the construction timeline is flexible due to the time required to build forms and wait for the concrete to cure properly. Precast concrete offers fast installation and pre-engineered structural designs. For a large area, this can mean freeing up land space faster and moving on to the building development.

15 Q: How far below the surface are the cisterns generally installed?

A. The depth of the tank is determined by a few factors. Gravity pipe flow may require the depth of the tank to be lower in the ground, increasing earth cover. Also, the depth of cover may be dictated by the minimum earth cover required for structural design loading condition. A third factor may be required downward forces by the backfill overburden to offset buoyant forces in high ground water conditions so that the cistern does not become buoyant when empty. Typically, depth of earth cover over the top of the tank ranges from 2-4 ft minimum and with Contech's SRPE material, the tanks can be designed to accommodate most deep bury applications.

16 Q: Can an underground cistern be placed in a berm to avoid excavation? What amount of earth cover is required in this scenario?

A: It is important to support the haunches or bottom half of the cistern designed for underground applications because they are flexible structures. We have placed steel reinforced polyethylene (SRPE) cisterns in racks above ground. While each site is different, a general starting point would be to backfill up to the midpoint of the cistern and only cover the top to meet aesthetic goals.

17 Q: How long can the water remain in the cistern before it becomes stagnant and unusable?

A: This depends on the starting oxygen level in the cistern and the organic load of the influent. This can be days, weeks or even longer depending on the conditions. Proper pretreatment will significantly extend this timeframe and "usability" depends on the application. Operators may accept a different water quality for irrigation than toilet flushing, for example. If this is a concern, or becomes a concern, a small aerator can be added.

18 Q: Can the calming inlet be a baffle instead of pipe?

A: A pipe maximizes the cross sectional area of the flow which reduces velocity and associated kinetic energy. A pipe also allows for a variety of options to turn the flow of water upward from the bottom. A baffle will help, but we recommend a full pipe if possible.

19 Q: With the cistern and retention/detention combination, wouldn't you want the retention and detention prior to the cistern, so the detention/retention is the BMP?

A: The combined system can meet two goals. First, the cistern reduces the quantity of runoff but once full it does not reduce the rate. The detention system is then in place to reduce peak flows. Ideally the cistern is drained frequently, so the detention system is seldom needed and only used for back-to-back storms to reduce peak flows. If the detention/retention system were first, you would either rarely fill your cistern (if the connection is at the top of the detention system) or it would leak out through the detention/retention system and quickly be empty (if connected at the bottom).

20 Q: What are the concerns for building under roadways & streets, if any?

A: Cisterns can be placed under parking lots, roads, and other areas with even higher loading. Many, but not all, cistern materials can be designed for these applications and minimum cover usually increases as loading increases. Our underground Steel Reinforced Polyethylene cistern can be placed in an H20 loading condition with as little as 2 feet of cover for a 96" diameter cistern.

21 Q: Are multiple cisterns typically placed in parallel?

A: Multiple cisterns are often placed in parallel, but it is not uncommon to see them placed end to end, in an L shape, or other combinations. Available space and layout of the conveyance systems usually guide the placement of the cisterns.

22 Q: How do you handle vector control (mosquitos) caused by standing water in cisterns?

A: Most rainwater harvesting guides recommend screened inlets and outlets to provide vector control. Large water traps can be used for overflow connections if necessary. On some projects we have provided screen covers that are placed inside the access risers, or even close off pic holes in manhole lids.

23 Q: How do you know how big the cistern should be?

A: The size of the cistern can be optimized using Contech's Runoff Reduction Calculator to determine the best cistern size based on the project's supply and demand inputs. The size of the cistern can be optimized based on runoff reduction, water savings, or yearly financial savings.

24 Q: Is there an issue of mixing condensate water with rainwater during cistern overflow events?

A: This could be an issue if there are metals in the condensate water and your stormwater system does not enter a combined sewer (where the condensate would have ended up anyway). We suggest designing the system so that the stormwater overflow bypasses before the cistern and overflow does not go through the system. The condensate could be designed the same way, except bypass to the sanitary sewer. This way, the only exit from the cistern is through the treatment system and intended application.

25 Q: What happens at the end of the life of the system? Does this mean that the container is no longer water tight?

A: Cisterns should be inspected annually for solids accumulation, leaks, and structural integrity. As end of life approaches, structural analysis should be performed to determine if the cistern should be repaired, remediated or replaced. In most cases, it would be expected for leakage to occur before structural issues develop. Contech offer's DuroMaxx Steel Reinforced Polyethylene cisterns with a very long design life, as the structural steel is protected by the polyethylene shell.

26 Q: Does the outflow from concrete cisterns show high pH values (> 8.5) that may not comply with state Water Resources Control Board requirements?

A: Concrete cisterns do tend to be basic (high pH) but rainwater also tends to be somewhat acidic (low pH) so a concrete cistern can be beneficial is some cases. It varies widely though, and is dependent on the source of the runoff (asphalt, a shingled roof, grassy area, etc.).

27 Q: Are there any environmental concerns with chemicals leaching out the polyethylene? Even with non-potable uses, some people may be concerned because of the BPH scare in water bottles, this may be a concern with clients who are nervous of plastic chemical leaching).

A: The resin used in Contech's DuroMaxx Steel Reinforced Polyethylene cisterns does have NSF 61 certification for potable use, but this standard may not fully address the concerns of some people. For more sensitive applications like gardening, the local rain chemistry and materials used in the catchment area, piping, and cistern should be vetted against the goals of the user. There are studies that show rain can be sufficiently contaminated by particulates in the atmosphere to cause concern. This is usually near heavy traffic or industrial locations.

The roofing material can also contaminate water; especially asphalt shingles and some metal roofs. There are also many examples of harvested water with very high water quality which provides the advantage of a non-chlorinated source which is favorable for crops. For this application, we would recommend testing the runoff from the catchment before deciding on using the water for this application. Based on the results, appropriate pretreatment and treatment could be recommended.

Cost Questions

1 Q: What is the rule of thumb for system cost? $/CF?

A: The cost for a rainwater harvesting system can vary widely depending on the cistern size, the complexity of the pump and mechanical skid, and the level of pretreatment that is required. For a basic drip irrigation system, a very rough rule of thumb is $1.50/gallon for a 10k-30k gallon cistern and roughly $30k-$50k for the pretreatment, pump, and mechanical skid.

For a larger cistern, the pricing can drop down to $1/gallon for the cistern. The pretreatment, pump, and mechanical system sizing is often completely unrelated to the cistern size. If you imagine a large park with a huge irrigation demand, but very little impervious surface for collection, the cistern size may be very small, and the large landscape area is likely broken into many zones, requiring a similar pump and mechanical system compared to a commercial office building with a much smaller irrigation area.

2 Q: How long it will take to pay off a rainwater harvesting system?

A: ROI is very dependent on sizing and what factors are included in the savings. Over a 20-year life, many systems can surpass breakeven and provide a modest ROI based only on the initial capital cost, future maintenance cost and future water utility savings. Many do not, however, and it can be difficult to justify a system solely on water utility savings.

However, no other stormwater practice can compare to rainwater harvesting because it is the only one that provides a hard dollar value for the volume of water retained on site. On dense or urban sites, the rainwater harvesting system can reduce or eliminate the need for a bioretention system, which provides a developer more space for value added amenities. In many cases, this can quickly provide very healthy ROI for a rainwater harvesting system.

3 Q: How do utilities bill for wastewater generated by fixtures supplied by non-potable sources?

A: Utilities can require a sewer meter to be installed or they may request a water meter coming out of the cistern.

We installed a rainwater harvesting system at one of our manufacturing facilities where we use a lot of wash water. We placed a water meter on both the cistern and the make-up water line. The utility can read the meters to determine sewer volume. As rainwater harvesting becomes more widespread, we expect utilities will figure out how to be paid for the wastewater treatment services they provide.

4 Q: What is the estimated ROI or NPV for a commercial scale rainwater harvesting system?

A: Return on Investment and Net Present Value varies widely depending on specific project variables and there is no correct answer. The three largest factors impacting ROI are initial cost of the system, water utility savings, and the value of land space saved for a stormwater BMP. Using the following assumptions, which will vary widely for any project, we can find a range of NPV's to provide some guides:

- 1 acre impervious area
- Net installed cost of the rainwater harvesting system $70,000 ($100k for rainwater harvesting and $30k saved on bioretention)
- Water rates $0.003/gallon (assumes no sewer savings)
- Net annual maintenance of $1,000 ($1,500 for the rainwater harvesting and $500 saved on bioretention)
- Annual value of a parking space is $2,800 (based on average response from 1,100 webinar participants)
- 30 year life of the system
- Discount rate of 4%

Estimated NPV for a Rainwater Harvesting System Collecting from 1 Acre of Impervious Area

					Value of Water Saved					
Opportunity Cost of Land Space	Land Saved		Parking Spaces	Annual Benefit of Parking	Rainfall Collected (in)	9	18	28	37	46	55
					Gallons Saved	250,000	500,000	750,000	1,000,000	1,250,000	1,500,000
	%	ft^2			Annual Water Savings	$750	$1,500	$2,250	$3,000	$3,750	$4,500
	0%	0	0	$ -		$ (66,000)	$ (53,000)	$ (40,000)	$ (26,770)	$ (13,801)	$0
	1%	436	3	$ 8,370		$ 79,000	$ 92,000	$104,000	$118,000	$131,000	$143,900
	2%	871	6	$ 16,740		$223,800	$236,800	$249,700	$262,700	$275,700	$288,637
	4%	1,742	12	$ 33,480		$513,000	$526,000	$539,000	$552,000	$565,000	$578,000

As a general rule of thumb, it is difficult for a rainwater harvesting system to pencil out on water savings alone. If the value of land saved by eliminating an alternative LID BMP is included, a rainwater harvesting system quickly creates a positive NPV and healthy ROI.

5 Q: What reactions have you received from Water & Sewer Utilities since potable water use is reduced and the utilities loose fees?

A: Most large scale irrigation systems already have a separate meter to be charged for water used and not the associated sewer fees. Utilities that are experienced with rainwater harvesting system will institute reporting of harvested water used when those uses affect sewer water volumes to allow for the municipality to charge for the appropriate level of service their customers are using.

6 Q: Is there any rebate programs for this?

A: Local municipalities with water supply issues may provide rebate programs to help initiate potable water conservation through the use of rainwater harvesting.

System Maintenance Questions

1 Q: What do you do for overflow/dewatering for maintenance?

A: All cisterns should be designed to divert flows around or through the cistern when full. Ideally, maintenance would be timed during a dry period so dewatering would be minimal. Otherwise, the system will have to be dewatered in accordance with local requirements. If make-up water refills the cistern, make sure it is disabled before maintenance begins.

2 Q: Do you have an idea of annual cost to operate a rainwater harvesting system? Maintenance, electricity, etc.

A: The maintenance and operation costs will vary widely depending on the pump size, level of treatment, and volume of water treated. Utility savings usually exceed maintenance cost, so that there is a net savings annually. Proper pretreatment will also reduce maintenance on the cistern and self-cleaning final filters that automatically back-flush reduce maintenance.

3 Q: How is the removed material handled? Is it considered hazardous?

The material that is removed from a pretreatment system or cistern is not hazardous unless there has been a hazardous spill that has contaminated the system. This waste can be sent directly to a landfill for disposal.

4 Q: What amount of maintenance is required for the pre-treatment device?

The CDS unit can be serviced using a vacuum truck to remove the collected sediment in the sump of the unit. The StormFilter requires replacement cartridges and a vacuum truck to perform maintenance. For most rainwater harvesting applications, the CDS unit will be sufficient, but for a higher level of pretreatment, the StormFilter may be a better choice.

5 Q: What is the cleaning frequency of a cistern? At what level do you recommend removal?

Q: We recommend inspecting the cistern quarterly during the first year to help gage the site loading characteristics and amount of sediment that is accumulating in the unit. Typically, these units will require maintenance every 1-2 years, depending on the site conditions. Contech offers cistern options with in-field electrofusion joints, so there is no limit to the volume that we can store.

6 Q: Is it possible to clean out bottom sediment in an underground cistern?

A: Yes. Contech recommends at least one large 36" diameter access opening in the cistern to allow for entry into the unit and cleaning. Maintenance is typically performed using a vacuum truck.

7 Q: Where does the back flush water go? Is disposal a problem?

A: Back flush water should go to a sanitary sewer. This is usually not a problem.

Mechanical System Questions

1 Q: Where is the Pump/Filter skid typically located? Near the cistern, or in the building?

A: The location of the pump/filter skid usually depends on what the collected water is being used for. If the collected water is being used for irrigation, the RWH Mechanical System filter skid is usually located outside of the building adjacent to the cistern. When the collected water is being used for toilet flushing or cooling tower makeup water, the RWH Mechanical System skid is usually located in a climate controlled maintenance room of a building. As the distance increases between the cistern and the pump/filter skid, pressure loss and elevation would affect the pump design due to more pumping pressure being required. Also, additional electrical components to protect the electrical signal may be required when the distance from the RWH Mechanical System skid and the pump location is larger than 100 ft.

2 Q: Is there a temperature requirement for outdoor mechanical system?

A: Areas with prolonged cold temperatures should employ good design practices to prevent freezing of cisterns or mechanical systems. Housing the cisterns unground below the frost line or insulating over the tank would be recommended. Rainwater harvesting mechanical systems should be housed in a climate-controlled mechanical room. If not used during winter months, the mechanical system could be housed in an unheated outdoor enclosure as long as the system is blown out and all the water is removed from freeze prone components.

3 Q: Is there a way for the mechanicals to know when water in the cistern is low and automatically switch to the municipal system?

A: Yes. Most systems incorporate a level sensor that relays the cistern water level to a controller that interfaces with the pump. When the cistern reaches a low set point, the pump will turn off, and make-up water can directly pressurize the line feeding to your non-potable application via a 3-way valve and backflow preventer. In jurisdictions that do not allow direct pressurization of the non-potable line and require an air gap, the low level in the cistern can also control a valve to fill a small portion of the cistern or wet well to allow the pump to continue pumping water to the non-potable demand.

4 Q: How would the engineer develop the mechanical control panel for these systems? Is a turnkey solution provided by the product vendor?

A: Contech offers rainwater harvesting mechanical systems which are turn-key, fully integrated systems consisting of the pumps, filters, disinfection, make up water valves, PLC controls and enclosures necessary. Engineers can specify the equipment and rely upon the winning contractor to procure and assemble the components.

5 Q: What's the footprint on the mechanical system?

A: The mechanical system footprint will vary depending on the final filtration, disinfection, and level of controls. Many systems using a final filter, UV disinfection, a submersible pump that is outside of the control skid, and a control panel will be roughly 3' W x 5' L x 3' H.

6 Q: Do you recommend a dual pump system? Is it more efficient to run two constant flow rate pumps for variable demand vs. one variable pump?

A: Dual pump systems can be used to provide a backup during maintenance activities. They can also be used to help manage rare peak demand instead of one very large pump running all of the time. In some cases, multiple pumps might be useful to supply two very different systems – one for toilet flushing and one for irrigation. For most applications, a single variable speed pump is usually more efficient at delivering a range of flow rates.

7 Q: What is the typical life time of pumps?

A: With proper maintenance pumps can last 10 to 20 years; in some cases longer. Like all mechanical equipment, neglect and abuse will shorten the life dramatically or quickly damage the pump. A robust control system will protect the pump and ensure proper usage and help notify the operator when maintenance issues arise, thus increase the useful life of the pump.

8 Q: Are there any submerged pumps for high flows such as filling water tanks on irrigation trucks?

A: For any application, there is probably a pump designed for the task. Filling a water tank on a truck requires high flow rates but relatively low pressure. It is important to know the both design flow and pressure so that the optimal system can be designed for your application.

9 Q: How do you determine when disinfection is required?

A This is dependent on the local regulations, but we typically recommend disinfection for any indoor use such as toilet flushing or when people will come in contact with the water. These uses might include wash water, spray irrigation, laundry or for HVAC make-up water.

Regulation Questions

1 Q: Are there any issues with rainwater harvesting and water rights issues?

A: Yes, water law can come into play and limit or prohibit rainwater harvesting and it
is important to understand the legality in your state.

There tend to be three views at the state level – restricted, passively or partially approved, and allowed or encouraged. Colorado and Nevada severely limit rainwater harvesting, and it is not an accepted practice for commercial scale projects. Most other western states allow harvesting or provide clarification on what is acceptable. Washington State, for example, allows collection from a rooftop. Water rights are not an issue for many states in the eastern portion of the country. Many states, Texas and Georgia for example, encourage rainwater harvesting.

2 Q: In my state, drainage agencies do not give us credits for using cistern to reduce the quantity of stormwater amount. Have you been able to convince drainage agencies otherwise?

A: Many stormwater regulations now include rainwater harvesting, but there is still a gap in how to calculate the benefits. Washington DC and Virginia for example, both calculate a credit to the amount of stormwater runoff that you are keeping on-site. In many cases, a specific project brings light to the issue and creates an opportunity for discussion with the regulator.

Contech has a Regional Regulator Managers that can help explain the benefits to an agency early in the project design cycle. Please contact us if you'd like support for regulatory acceptance.

3 Q: I'm wondering how much information regulators are requiring to prove there is a need for all the rainwater you claim to be harvesting. Are people asking you to prove the need?

A: Documentation requirements of the benefits of the rainwater harvesting systems vary and would depend on the local municipality or regulatory body reviewing the data. We encourage engineers to work with the mechanical engineer and landscape architect on the project. In many cases, they develop detailed water budgets that may be required for permitting. This is very useful information for designing the rainwater harvesting system and obtaining approval. We developed our Runoff Reduction Calculator to provide these estimates and provide documentation to support the approval process.

4 Q: What are the regulations concerning drawdown? Is toilet flushing alone enough to meet these requirements?

A: Jurisdictions requiring draw down of systems may be considering rainwater harvesting systems as gray water systems. New codes being written on the national level differentiate harvested water and gray water systems with different requirements of treatment, uses and draw down of storage systems. Well written codes for rainwater harvesting do not include draw down times. If your jurisdiction does, you may want to consider researching national codes for precedence that you could help educate your municipality or governing officials. Otherwise, you may need to set up a pump down on a timer to take care of the draw down requirements.

5 **Q: Are there monitoring reporting requirements associated with the use of rainwater harvesting for toilets?**

A: Current CA standards are written around a gray water specification. In the absence of specific indoor non-potable standards for rainwater harvesting usage to flush toilets, you may have to treat to very high water quality standards and monitor for compliance. Local plumbing codes should be researched for other areas of the country.

6 **Q: What about building code restrictions on how long water can be stored for greywater use?**

A: Over time, greywater will turn into blackwater, so many regulations limit maximum holding time to 24 hours. Grey water requires a high level of pretreatment to prevent lint, debris, and floatables from entering the cistern, and a high level of final treatment to ensure proper water quality.

Additional Resources

Learn About Rainwater Harvesting

New stormwater regulations require on-site water management, which can be a design challenge. Rainwater Harvesting is a Low Impact Development tool that can achieve both runoff reduction and water conservation.

Go online (www.ContechES.com/rwh-animation) and watch our video to learn how Rainwater Harvesting offers benefits including:

- Achieve the runoff reduction required for your stormwater permit
- Conserve water resources
- Provide up to 12 LEED Points
- An LID solution with a positive ROI through utility savings

To view the *Rain Water Harvesting Animation*, visit: www.ContechES.com/rwh-animation

Calculate the Benefits of Rainwater Harvesting

The Contech Runoff Reduction Calculator (www.ContechES.com/rwh-calculator) is a free tool that allows users to quickly and easily determine the benefits of a rainwater harvesting system. With the Runoff Reduction Calculator, you can calculate:

- Runoff Reduction and Stormwater Volume Retained On-site
- Water saving and reduction of demand on potable supplies
- Financial savings based on reduced utility fees
- Information to support LEED Credits
- Reports for Stormwater Permit Approval

To use the *Rain Water Harvesting Runoff Reduction Calculator* tool, visit: www.ContechES.com/rwh-calculator

Design Your Own Detention or Infiltration System

DYODS is our exclusive online design tool to help you calculate the quantity of material needed for your detention or infiltration system.

You can even compare between CMP, ChamberMaxx ® and CON/SPAN® systems.

» www.ContechES.com/DYODS

View the Recordings of our RWH Webinar Series

In this four-part webinar series, Contech Engineers, Kathryn Thomason, P.E. and Dave Adams, P.E., educate engineers on engineering a complete rainwater harvesting system for runoff reduction.

Part 1 Rainwater Harvesting as a Runoff Reduction Tool
Part 2 Pretreatment and Cistern Selection for Large Scale Applications
Part 3 Selecting Pumps, Treatment and Controls to Fit Budget and Water Management Goals
Part 4 Optimizing the Design of a Rainwater Harvesting System to Maximize Runoff Reduction

www.ContechES.com/rwh-webinar

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Find all the information you need at www.ContechES.com, including field and laboratory test results, approvals, brochures, design guides, standard details and specifications within the product section of our site.

Quick Links

- Stormwater Solutions Overview – www.conteches.com/stormwater
- Rainwater Harvesting Brochure – www.ContechES.com/rwh
- LID Application Guide – www.ContechES.com/lid
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