ATTACHMENT B

SCOPE OF WORK and PROJECT TIME LINE
For the "Design, Permitting and Installation of Subdivision-Scale Rainwater Harvesting Systems as a Water Supply Strategy for the Texas Hill Country" project
by
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Scope of Work
This Scope of Work consists of a list and description of the proposed project tasks and of the project deliverables.

Task 1. Data collection, overview, and background of building-scale rainwater harvesting relative to other available water supply strategies.
This task will produce a review and discussion document providing a technical overview of using building-scale rainwater harvesting systems under a collective management regime in conjunction with an organized backup water supply system as the water supply strategy for entire developments. Included in this report will be a description of the proposed strategy, a discussion of how this strategy compares/contrasts with conventional supply strategies, a review of factors that may recommend this strategy, and an overview of the investigations to be conducted to evaluate the merit of pursuing this strategy. Data will be collected from sources such as other states' agencies with rainwater catchment system programs, conservation data available from universities and other sources, and Alliance for Water Efficiency resources, which will be compiled with the significant resources that have already been compiled by the project team.

Deliverables Task 1:
- Summary report identifying relevant strategy components including cost estimates.
- Report summarizing initial model outputs and case scenario development.

Task 2. Yield-demand modeling to evaluate requirements for roofprint and cistern volume and water use profiles relative to the frequency of backup supply deliveries.
This task will provide the delineation of rainwater system physical plant requirements (denoted below) that will serve as the baseline for all further evaluations, analysis and discussions of this strategy. A model, developed by one of this project team's co-principal investigators, will be used to evaluate the performance of a given system configuration over a number of years, through varying cycles of high and low rainfall, utilizing historic rainfall data from local weather stations. The model covers 24 years (1987-2010). The 24 year record contains data for multiple drought periods. In addition, available data for 2011 will be incorporated in order to reflect current near-record drought conditions.

This model uses monthly calculation steps. It was evaluated against a similar model employing daily calculations steps, and it was found that the monthly model produces very similar profiles of backup water supply requirements, which is the critical piece of information provided by this model. Since far less data input labor is required for the monthly model, it is deemed adequate for this purpose.

Model inputs are roofprint, first flush allowance, cistern volume, and daily water use, interior and/or exterior. The model calculates the volume of water that ran off the roof and deducts the water use to

calculate the end-of-month volume in the cistern, the amount of water that overflowed the cistern or the amount of backup water supply that had to be added to the cistern to provide the water used in that month.

It is presumed that future rainfall patterns would not markedly depart from those experienced in the 24 year historical period. The period of record used in the model has been compared with a drought of record model for Austin, which is the only weather station in this region for which records are available throughout the drought of record period. The drought of record model covered the years 1948-1958. The comparison showed that backup supply requirements would have been somewhat higher for the same system configuration as it would have been over the 1987-2010 period to be used in this investigation. The worst case (least rainfall) over a short time period was more severe in the 1948-1958 model scenario. This will, of course, be considered in evaluating a backup supply strategy. A 2011 model will be added and the rainfall data will be filled in as it becomes available to allow examination of system performance through the current drought.

Model results will be analyzed and discussed in project reports and documents and can be used to predict the expected shortfall in supply that may occur, given the roofprint, cistern volume and water use that was input. This then offers an expectation of how much, and how frequently, backup demand would be required in the future. That allows the system designer to choose the most cost efficient system design, considering the costs and operational issues of the backup system, and to set the water use standards that should be met to achieve desired overall system performance.

The model will be used to evaluate:

- roofprint and cistern volume required make the building water-independent for a presumed water use profile, and the most efficient combination of roofprint and cistern to do so;
- amount and frequency of backup water supply incurred, given a roofprint, cistern volume and water use profile, and the most efficient combination of roofprint and cistern for this case;
- the water use profile that can be supported by a given roofprint and cistern volume to attain water independence, or to limit backup supply requirements to a desired standard;
- the impact of an "enhanced conservation factor" when cistern volume drops below a preset level, showing effect of behavior urged by water conservation programs of many water providers;
- the impact of adding irrigation use to the water use profile, showing the increase in required roofprint and cistern volume and/or frequency of backup supply;
- how reuse wastewater derived from rainwater used in the building can blunt that increase in required roofprint and cistern volume and/or frequency of backup supply.

Regarding water use rates, it is noted that a conventional water supply system design presumes standard demand rates which are typically very liberal estimates of what the water use may be. However, when considering a rainwater harvesting strategy, an opposite viewpoint is urged, as it is critical for cost efficiency to determine how low of a usage rate may be adequate. Setting the water use rates to be modeled is therefore a critical factor in the analysis, so the range to be examined will be agreed upon with TWDB and TCEQ prior to conducting the modeling process.

Any number of scenarios can be examined quite expeditiously, once rainfall data for the location to be examined is entered. The model will be used to evaluate several locations in and around the Texas Hill Country, the primary target area for this investigation. This information will frame the choices for developers, builders and system users to arrive at the most expeditious combination of roofprint area, cistern volume, demand control, and backup supply. These in turn would inform them of the various costs – direct and indirect, immediate and on-going – that would be incurred to implement and run a development-wide water supply predicated on the choices made. A report compiling the model results will be produced and shared with participants in the task 4 workshop.

Deliverables Task 2:

- Report summarizing final model outputs and case scenarios.
- Integration of project materials into Texas Hill Country Groundwater website (and related websites)

Task 3. Regulatory review of state and local governments.

The strategy to be investigated envisions that individual buildings would be served by a self-contained rainwater harvesting system. For houses, the current regulatory environment addresses such systems on a similar basis as an individual lot well. Undefined, however, is the threshold for addressing multiple building-scale systems collectively managed and/or uniformly served with an organized backup supply system. Also to be determined is how commercial and multi-family buildings would be addressed, including treatment requirements if these systems were to be classified as public. Local permitting and governance issues must also be examined.

A series of meetings and a workshop will be organized to provide information about the proposed water supply strategy and to invite input from and discussion with TCEQ staff. Agents of local regulatory systems also will be invited to participate in the workshop to discuss local governance of this strategy. Rulings and/or clarifications provided by TCEQ would serve as inputs to the presentations and discussions in the Task 4 workshop.

Deliverables Task 3:

- Meeting/workshop material development, execution and summary information.
- Final report detailing analyses and synthesis of input gathered via meetings, workshops.
- Integration of project materials into Texas Hill Country Groundwater website (and related websites).

Task 4. Stakeholder workshop and stakeholder consultations to obtain information, input, and insights.

Completion of selected project tasks will require information, input and insights from the various parties that would plan, design, permit, implement, operate and govern the rainwater harvesting strategy. Parties identified as sources include developers, builders, architects, planners/engineers, rainwater harvesting practitioners, water purveyors, public interest groups, regulatory agents, and public officials. A workshop will be held, to which all these parties will be offered free attendance, at which the outlines of and arguments for this strategy will be set forth and the results of the modeling process will be reviewed to set the stage for soliciting the attendees' input. The workshop will be organized and run to best stimulate the free exchange of information and insights. Participants will be able to share information, voice concerns, identify issues requiring further attention and to catalog potential barriers to implementing this strategy. Review of model simulations will allow for the development of a model instruction manual and project "tool box". The workshop will also be an opportunity to identify and engage sources of expertise with which follow-up discussions may be held to obtain more detailed information and insights on the opportunities and liabilities of the rainwater harvesting strategy.

Information gathered during this workshop and subsequent meetings will be incorporated into a report and tool box to be distributed to the workshop attendees for review and will eventually be incorporated into the project's outreach and education components.

In order to gauge potential interest in workshop participation, preliminary correspondence was sent to local developers, builders, engineers and rainwater collection system installers requesting statements of interest or commitment if interested. 28 respondents committed to participate, indicating strong stakeholder interest. A list of respondents who would like to participate in workshops, discussions, etc is attached at the end of the proposal.

Deliverables Task 4:

- Integration of project materials into Texas Hill Country Groundwater website (and related websites)
- Final report detailing analyses and synthesis of input gathered via meetings, workshops.

Task 5. Review and evaluation of backup water supply strategy to drought-proof the building-scale rainwater harvesting systems.

Options for provision of assured backup supply to replenish cisterns of the building-scale facilities are preliminarily identified to include:

- a minimal piped water system fed by a community well. The pipes could be sized to deliver water at low flow rates, since the timing of backup supply flows could be controlled to limit flow rates;
- delivery of backup supply in tanker trucks, filled from a tank on the development fed from a community well;
- delivery of backup supply in tanker trucks, filled from a tap to a public water supply.

Issues to be examined are logistics, regulatory requirements – including how this scheme would interact with a water CCN and cost. Backup strategies identified during project research activities, including any available case studies, will be evaluated for feasibility, sustainability, community perception and cost. This task will be at least partially informed by the feedback provided at the stakeholder workshop and any subsequent follow-up discussions. It is intended that a draft document providing review and analysis of backup supply systems will be produced in conjunction with the report detailing workshop activities.

Deliverables Task 5:

- Report providing review and analysis of backup supply system strategies

Task 6. Examination of impacts of the rainwater harvesting strategy on the local hydrologic environment.

This project will address the potential for a large number of rainwater harvesting systems installed in a watershed to impact streamflow and recharge. Potential impacts will be evaluated on a site by site basis (case study sites) by executing hydrologic calculations for undeveloped conditions, developed conditions without rainwater harvesting, and developed conditions with rainwater harvesting. One of the co-principal investigators has been engaged in collaborative efforts with the City of Austin to evaluate the impact of rainwater harvesting systems on stormwater quality management, resulting in modeling that will be a useful input to such an analysis. Additionally, on-going analyses of regional watershed hydrology are being performed with the use of HSPF and similar GIS based decision support systems developed for The Cypress Creek, Blanco and Upper San Marcos watersheds and will be used project impact assessments.

A more broad approach to evaluating potential impacts on the hydrologic environment will include examinations of potential reductions in drawdown of local aquifers and reductions of effects on spring flows. This approach is addressed in Task 9.

Deliverables Task 6:

- Report/findings of hydrologic impact assessment and cost analyses
- Updated project materials added to Texas Hill Country Groundwater website (and related websites)

Task 7. Cost analysis of the rainwater harvesting strategy and comparison with conventional water supply strategies.

In addition to the costs of backup water supply and of running the backup supply system previously discussed, the costs of the building-scale facilities must be evaluated. Cost factors for a building-scale rainwater harvesting system include provision of the required roofprint, the required cistern volume, treatment and pressurization facilities, as well as collection and conveyance appurtenances. The cost analysis will address all these factors and provide cost estimates for implementing, operating and maintaining this rainwater harvesting system. Individual cost components of similar collection systems will be researched and estimates will be reviewed and evaluated in consultation with architects, builders, rainwater harvesting practitioners, and construction tradesmen. It is expected that much of this information would be derived from the stakeholder workshop and follow-up discussions.

Modeling and experience indicate that to be water-independent, or to limit backup supply to minimal levels, considerably more roofprint than is provided by a typical building design would be required. Building concepts to obtain this additional roofprint, and to incorporate required cistern volume, include:

- rain barns to add roofprint, perhaps covering free-standing cisterns;
- various types of free-standing cisterns;
- foundation integrated cisterns;
- what has been termed the "veranda strategy" to create a "Hill Country rainwater harvesting vernacular" house design concept, adding veranda roofs around the building perimeter and building the cistern into the veranda floor, keeping all the facilities outside the house envelope but integrated with it. This strategy adds outdoor living space and shades the walls to reduce cooling loads, factors which would offset a portion of the costs of the added roofprint and the cistern.

The impacts on building cost of these strategies will be evaluated. Costs of all system components and backup supply system will be compared to expected costs of providing a conventional water system (plus the price of water). These analyses will provide an input to evaluating the merit of the rainwater harvesting strategy.

Deliverables Task 7:

- Report summarizing cost analysis

Task 8. Evaluation of impacts on marketability of rainwater harvesting water supply strategy.

Aspects of the rainwater harvesting strategy that may impact on marketability include:

- cost of installing and maintaining the building-scale facilities and running the backup supply system, relative to installing and maintaining a conventional water system and paying for the water;
- practicality of attaining water use rates that would allow affordable building scale systems that would limit backup supply to minimal levels;
- evaluations/perceptions of water quality obtained from rainwater harvesting;
- impacts of drought contingency curtailments in conventional water supply systems vis-à-vis the discipline imparted by a dwindling cistern level.

These factors, along with any others identified in the course of the investigation, will be studied to evaluate the apparent marketability of the building-scale rainwater harvesting water supply strategy, and to elucidate the characteristics of a development that would favor or diminish that strategy. These factors will be reviewed during the stakeholder workshop, and also will be presented to realtors, brokers, builders and lenders for review and comment. What is learned will offer guidance on how competitively developments utilizing the building-scale rainwater harvesting water supply strategy might be marketed.

Deliverables Task 8:

- Report summarizing marketability and sustainability analysis
- updated project materials added to Texas Hill Country Groundwater website (and related websites)

Task 9. Review and analysis of sustainability issues.

An incentive for consideration of the rainwater harvesting water supply strategy is to minimize demands on "conventional" supplies, to render these resources more sustainable in the face of continuing growth, and to blunt the impetus for large-scale water transfer schemes, with their attendant cost and environmental impacts. It is envisioned that developments in the primary target area that use building-scale rainwater harvesting would *displace* a significant amount of development that would have drawn *all* of its water supply from groundwater sources. The potential effects of this rainwater collection supply strategy will be evaluated and reported.

The impact of rainwater harvesting on stormwater management is also a significant factor to consider. Direct rainwater catchment and sequestration can play a significant role. This would be explicitly evaluated in task 5, but it also has sustainability dimensions. Mitigating the impacts of development on the local hydrologic environment is a major thrust of various rules systems which govern stormwater management. This catchment and storage prevents a significant portion of the additional quickflow imparted by development from occurring. Especially when coupled with a wastewater system which utilizes effluent for landscape irrigation, the captured rainwater – which becomes that effluent after serving interior water uses – can even more efficiently perform its plant maintenance function, and some of this irrigation water may percolate to contribute to aquifer recharge and maintenance of baseflow.

It is increasingly being recognized that integrated, watershed-based water resources management can enhance overall water use efficiency. All these sustainability factors will be evaluated in this investigation as an input to determining the merit of the rainwater harvesting strategy.

Deliverables Task 9:

- Report summarizing marketability and sustainability analysis

Task 10. Outreach activities to disseminate project findings/results.

The outcomes of this investigation on rainwater harvesting as a water supply strategy for Central Texas and Hill Country developments will be of interest to numerous groups as set forth in previous Task explanations. Representatives of these groups will be engaged through workshops, online surveys and some one-on-one interviews and small meetings. Thus, the input, questions, recommendations and perceived barriers from each group will be addressed in the workshop summary and final report.

Findings and conclusions of this investigation, including cost of implementation, permitting, operation and maintenance of systems will be packaged as a communication toolbox for dissemination to these various interest groups. The yield/demand model (Task 2) will be included in this toolbox, along with instructions for its use. Additionally, a 60- to 90-minute videotaped program that delivers the findings of the investigation in a webinar-ready format will be developed and delivered on DVD. The Webinar

program will be supported by a powerpoint presentation containing high resolution slide graphics and targeted handouts to support key findings and economic comparisons. An executive summary of the project's final report will be packaged in the toolbox as a brochure design and will be included in a media kit, along with a draft press release announcing the final report, graphic slides, an FAQ sheet, and a contact list for recommended interviews. Further, the toolkit will contain a complete listing of key individuals, interest groups, industry organizations, professional associations, policy makers and regulating agencies which have been a part of this investigation or will likely be interested in the study and its findings. The tool box and related information will be posted on a website developed for increasing access to information regarding Hill Country groundwater resources (currently being developed) and will be linked to several additional regional websites. Karen Ford of White Hat Creative will collaborate with project staff to develop and disseminate the education and outreach materials, as well as to produce the webinar.

Deliverables Task 10:

- Outreach and education materials, tool box, model and user's manual, webinar
- updated project materials added to Texas Hill Country Groundwater website (and related websites)

Task 11. Project monitoring and quality control.

The project will be collaboratively managed by all key staff and overseen by Andrew Sansom, RSI's Executive Director and Dr. Thomas Hardy, RSI's Chief Science Officer. Monitoring and evaluation components will be developed for each task and will include measureable project objectives, structured progress indicators and provisions for collecting data and managing project records.

Key staff members will meet bi-weekly to evaluate work plans and assess progress. Quarterly progress reports will be submitted to TWDB for approval, and will include summaries of activities by task, budget expenditures and difficulties or unexpected results encountered.

Deliverables Task 11:

- Final report including project findings, results and recommendations
- Updated project materials added to Texas Hill Country Groundwater website (and related websites)

Project Action Plan and Timeline

The proposed project time line includes the listed tasks, reporting milestones, final reports, 30-day review period for TWDB staff, and a 30-day period for River Systems Institute to address the comments and submit a final project report.

Project activities will be structured using the following table and progress will be reported quarterly.

Tasks and Reporting Milestones	Sept-Nov 2011 (Q1)	Dec 2011-Feb 2012 (Q2)	Mar-May 2012 (Q3)	Jun-Aug 2012 (Q4)	Aug 31 2012	Sept 30 2012	Oct 30 2012
1: Background research, data collection							
2: Modeling activities • Report summarizing final model outputs and case scenarios.							
3, 4: Workshops, meetings • Final report detailing analyses and synthesis of input gathered via meetings, workshops.							
5, 6: Back up supply review and hydrologic impact assessment • Report providing review and analysis of backup supply system strategies • Report/findings of hydrologic impact assessment and cost analyses							
7: Cost analyses • Report summarizing cost analysis							
8: Marketability evaluation • Report summarizing marketability and sustainability analysis							
9: Sustainability analysis • Report summarizing marketability and sustainability analysis							
10: O&E materials • Outreach and education materials, tool box, model and user's manual, webinar							
11: Results and recommendations							
Submittal of Final Report to TWDB							
Final Report TWDB Review							
Address TWDB Comments							

Activities and reporting schedule (including deliverables to TWDB):

Quarter 1

- data collection, compilation
- identification of relevant strategy components including cost estimates
- submission of report summarizing model outputs and case scenarios
- preparation for meetings and workshops

Quarter 2

- data collection, compilation and identification of relevant strategy components including cost estimates
- meeting/workshop material development, execution and summary information
- updates to report summarizing model outputs and case scenarios
- submission of report detailing input gathered via meetings, workshops
- integration of project materials into Texas Hill Country Groundwater website (and related websites)

Quarter 3

- case studies/modeling outputs, additional modeling activities
- submission of final report detailing analyses and synthesis of input gathered via meetings, workshops
- submission of report providing review and analysis of backup supply system strategies
- submission of report/findings of hydrologic impact assessment and cost analyses
- updated project materials added to Texas Hill Country Groundwater website (and related websites)

Quarter 4

- submission of report summarizing marketability and sustainability analysis
- submission of outreach and education materials, tool box, model and user's manual, webinar
- final report including project findings, results and recommendations
- updated project materials added to Texas Hill Country Groundwater website (and related websites)