STERLING RANCH

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July 1, 2015

Ms. Rebecca Mitchell
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver, CO 80203

Mr. Kevin Rein
Colorado Division of Water Resources
1313 Sherman Street, Suite 818
Denver, CO 80203

RE: 2015 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

Dear Ms. Mitchell and Mr. Rein,

The enclosed letter report is the fifth annual report submitted by Leonard Rice Engineers, Inc. on behalf of the Sterling Ranch Development for the Precipitation Harvesting Pilot Study.

The 2015 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report documents the progress that was made in the 2014/2015 study year including: tasks accomplished during the study year, presentation the data collected, planned tasks for the 2015/2016 study year, and variances to the application that was originally submitted on May 1, 2010.

Tasks accomplished in the 2015/2014 study year for the Pilot Project include:

- Climate data has continued to be collected, extending the record for site specific data from March 2010 to May 2015.
- Continued monitoring and collection of data from the surface water station located on Upper Sterling Gulch. A total of eleven surface water events were observed with the largest measurable event of 3.42 cfs occurring on May 9, 2015.
- Continued use of trail cameras on Sterling Gulch to document hydrologic events in real-time.
- The 2014-2015 project year was the first full year of data collection at the lysimeter site.

- Continued manual water level data collection at the ground water monitoring wells located within Sterling Gulch. To supplement the ground water level monitoring a pressure transducer was installed on July 16, 2014 in MW-1.
- In April 2015, the climate station, precipitation station, and 24-inch lysimeter were relocated approximately 4,600 feet northwest, due to construction activity near the Roxborough Water Treatment Plant.

The 2014/2015 study year was the wettest year to date with a total of 27.95 inches of recorded precipitation at the climate station. Several significant rainfall events occurred, including a rainfall event on July 12, 2014 totaling 2.83 inches, which exceeds the 100-year (2-hour) precipitation event for this area.

In addition to the data collection efforts, Sterling Ranch achieved two major milestones in the 2014-2015 project year that are crucial to the Pilot Project. The first major milestone is that Sterling Ranch received permission from County commissioners on January 27, 2015 to proceed with its first filing. The initial filing, Providence Village, will include 660 single-family residential lots on 325 acres and be the first of nine villages at Sterling Ranch. It is scheduled to break ground this summer with the start of home construction planned in the fall 2015. Providence Village is also the location where the majority of rainwater harvesting is currently planned.

The second milestone occurred on May 29, 2015 with the signing of HB 15-1016 into law. HB 15-1016, among other provisions, directs the CWCB to establish regionally applicable factors that pilot program sponsors can use for substitute water supply plans and augmentation plans that specify the amount of evapotranspiration of preexisting natural vegetative cover. Sterling Ranch is excited about the opportunity to support the State in the development of regional factors characteristic of the Dominion Water and Sanitation District service area and nearby communities.

As the project progresses, we continue to broaden our understanding of precipitation harvesting as a reliable water supply. In the upcoming study year we look forward to working with the Colorado Water Conservation Board and Colorado Division of Water Resources to discuss the updated criteria and guidelines associated with HB 15-1016. Thank you for your continued support in developing harvested precipitation as a viable water supply.

Best Regards,

Mary Kay Provaznik
DWSD & Sterling Ranch Utilities Director

cc: Harold R. Smethills, Jr.
Jack N. Hoagland
Diane Smethills
Beorn Courtney
Greg Roush

Encl: 2015 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

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RE: 2015 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

Dear Ms. Mitchell and Mr. Rein,

This is the fifth annual report addressing the Precipitation Harvesting Pilot Study to be submitted by Leonard Rice Engineers, Inc. (LRE) on behalf of Dominion Water and Sanitation District and the Sterling Ranch Development.

Introduction

The proponents of the Sterling Ranch Development continue to work passionately towards a vision for the land that is in harmony with the area, the community, and the State, and that meets a significant need for housing and infrastructure in Douglas County. Sterling Ranch's participation in the Colorado Water Conservation Board's (CWCB) Rainwater Harvesting Pilot Project Program (Program) is a reflection of their goals for establishing sustainable, defensible, non-potable water supplies for their development, in addition to being a positive example of conservation and efficient resource management. During the 2014-2015 project year, Sterling Ranch has made significant progress achieving those goals receiving both final Douglas County zoning approval for its first filing and support from the Colorado Legislature for HB 15-1016.

Douglas County Zoning

Sterling Ranch received approval from County commissioners on January 27, 2015 to proceed with its first filing of this master planned community. The initial filing, Providence Village, will include 660 single-family residential lots on 325 acres and be the first of nine villages at Sterling Ranch and is scheduled to break ground this summer, with the start of home construction in the fall 2015 (Figure 1). Providence Village is also the location where the majority of rainwater harvesting is currently planned. Sterling Gulch Reservoir will be used to regulate stormwater flows to historic peak discharges, and used to manage rainwater captured for use in the non-potable water system.

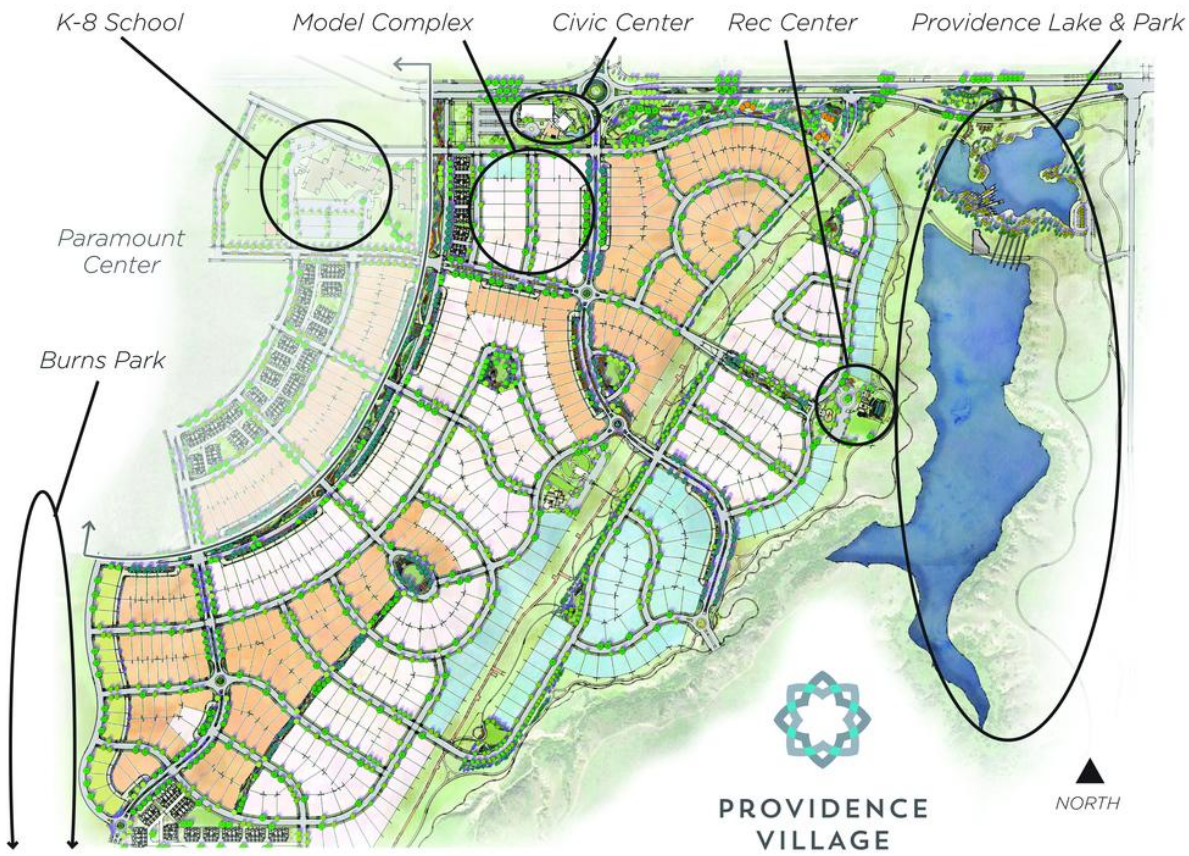

Figure 1 – Providence Village at Sterling Ranch (Filing 1)

Regional Rainwater Harvesting Factors (HB 15-1016)

Over the past year, Sterling Ranch's dedication to the Pilot Program to show rainwater harvesting as a viable water supply has continued to set an example for other developers. Sterling Ranch and Dominion Water and Sanitation District supported House Bill 15-1016 (HB 15-1016), directing the Colorado Water Conservation Board to:

"Update the Criteria and Guidelines By January 1, 2016, with the goal of incentivizing the submission of applications and applying lessons learned from previously approved Pilot Projects"

On May 29, 2015, Governor Hickenlooper signed HB 15-1016 into law. HB 15-1016, among other provisions, directs the CWCB to establish regionally applicable factors that program sponsors can use for substitute water supply plans that specify the amount of evapotranspiration of preexisting natural vegetative cover. The underlying purpose is to encourage more development projects to participate in the program.

Sterling Ranch is excited about the opportunity to support the State in the development of regional factors characteristic of the Dominion Water and Sanitation District service area and nearby communities.

It is also important to note that HB 15-1016 extends the sunset date of the Pilot Projects from January 15, 2019 to January 15, 2025 providing an opportunity for Sterling Ranch to extend collect data as necessary supporting the Pilot Program and allowing time for other developers to participate in the program.

Summary of Pilot Project Progress

Generally, the Sterling Ranch Precipitation Harvesting Pilot Study (Pilot Project) has proceeded on schedule. The variances to the Pilot Project, including the proposed schedule, are described herein. The following tasks were accomplished during the 2014-2015 monitoring season:

- Climate data collection from the Sterling Ranch Climate Station;
- Data collection from the Sterling Ranch Lysimeter;
- Surface water runoff data collection;
- Trail camera data collection of surface water runoff; and
- Data collection from two ground water monitoring wells and one shallow (Datum) well.

These tasks, associated costs, and variances to the overall Pilot Project are further discussed in this report.

CWCB Program and Reporting Requirements

On March 1, 2010, Sterling Ranch provided the "Sterling Ranch Precipitation Harvesting Pilot Study Application" (Application) based on the criteria and guidelines outlined by the CWCB that were established under House Bill 09-1129. The aim of the Program is to use natural conditions data to evaluate precipitation harvesting in Colorado as a legally obtainable water supply and as a water conservation enhancement when paired with advanced outdoor water demand management.

The Application described conceptual Sterling Ranch planning policies and requirements, including their current water conservation plan and the Pilot Project strategies to be implemented that assist in the overall precipitation harvesting design.

The Pilot Project is split into three phases; 1) Natural Conditions, 2) Experimental Precipitation Harvest Designs, and 3) New Precipitation Harvest Designs.

Annual Reporting Requirements

One of the requirements of the Program is to submit an annual progress report (Annual Report) by July 1st of every year that the Pilot Project is in operation. In accordance with Section 37-60-115(6)(a), C.R.S., the Report summarizes each component of the Pilot Project and indicates how the data and findings address Program goals. The CWCB Annual Report Requirements serve as an outline for this report and are included in **Attachment A**. The information required includes:

1. A **description of variances** from the Application including information on any data quality issues that may magnify if results are extrapolated to a larger scale project.
2. **Precipitation harvesting performance metrics**.
3. Pilot Project **implementation plan and estimated water conservation** achieved through pairing precipitation harvesting with advanced outdoor water management.
4. A **description of the climate and hydrologic data collected** to characterize the pre-existing, natural vegetation conditions.

Sterling Ranch Precipitation Harvesting Pilot Project – Progress and Variances

Four objectives were established in the Application that was designed to meet the guidelines and criteria provided by CWCB. They are:

1. Evaluate natural conditions (climate, hydrology, and ET) to quantify the amount of precipitation physically and legally available as a water supply;
2. Evaluate a variety of precipitation collection designs;
3. Evaluate precipitation harvesting paired with advanced outdoor water demand management as a water conservation practice; and
4. Create a baseline set of data to support:
    a) An engineering report in support of a water court application for an augmentation plan to use harvested precipitation, and define a defensible water supply.
    b) Develop sound, transferable, and scalable methodologies for use at other locations in the State of Colorado.

In 2010, the Pilot Project began with the installation of the measuring devices for natural conditions, collecting associated data, and implementation of an educational campaign. These efforts are further discussed in the sections below.

Phase 1: Natural Conditions

Originally, two study basins were proposed to evaluate natural conditions of Sterling Ranch as part of a comprehensive monitoring plan. Currently, monitoring is only occurring in Sterling Gulch basin. The integrated monitoring plan includes measuring climate, precipitation, surface runoff, native ET, deep percolation, and ground water data to provide the foundation for defining physical yield characteristics and return flow obligations.

Figure 2 shows the location of the Sterling Gulch watershed and the location of the implemented monitoring stations within the Sterling Ranch boundary to date. Sterling Gulch is being used to quantify the site-specific amount of precipitation that, under pre-existing natural vegetation conditions, accrues to the natural stream system via surface and ground water return flows. The sections below summarize the progress, variation, and data collected to date for each of the monitoring programs designed to characterize the natural hydrology at the site. **Note that in April 2015, both the climate station and 24-inch lysimeter were relocated approximately 4,600 feet northwest, due to construction activity near the Roxborough Water Treatment Plant.**

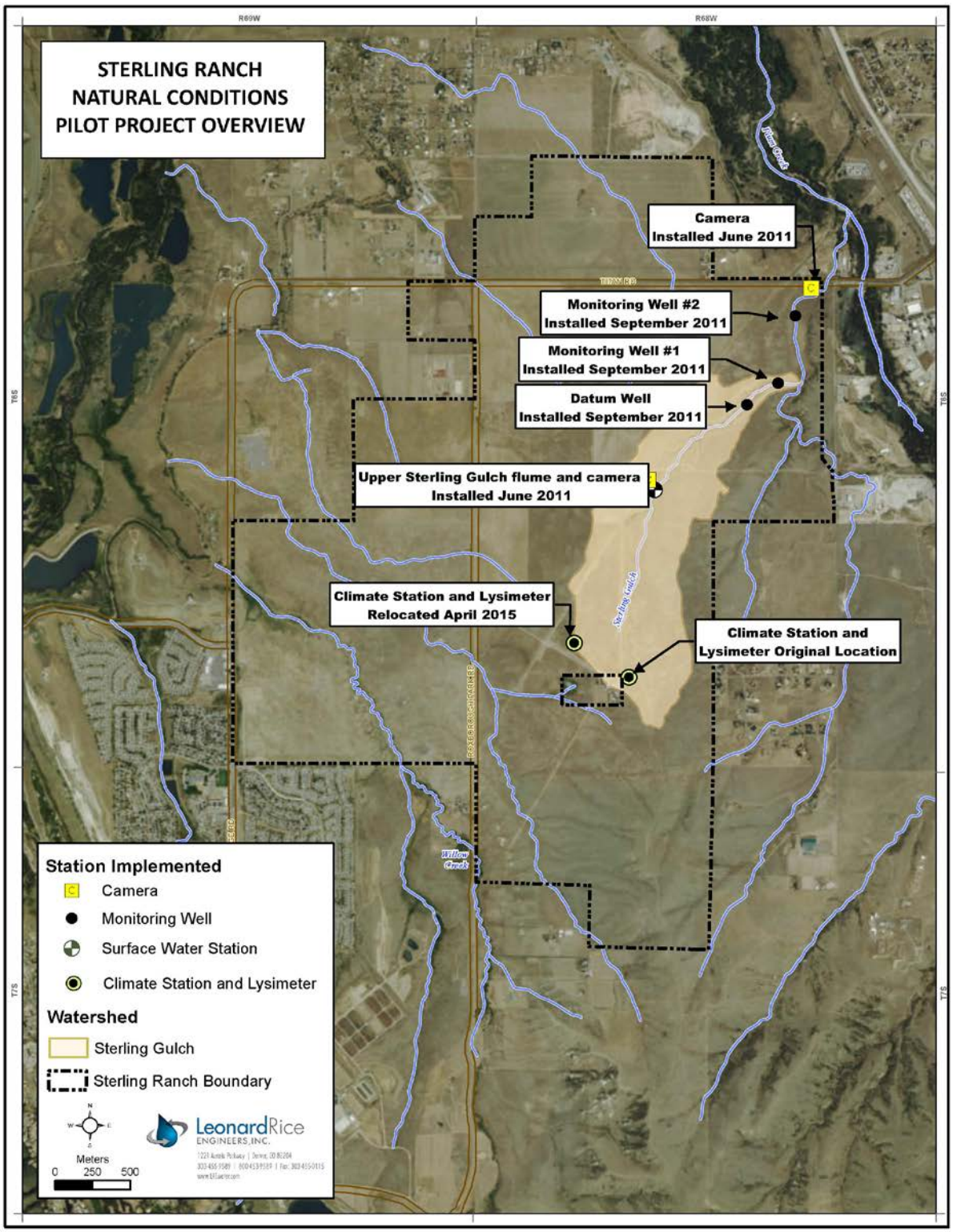

Figure 2 – Proposed Study Basins Map

Climate Monitoring Program

2014-2015 Variance from Application: None

The Sterling Ranch Climate Station was installed on March 29, 2010. The station continues to collect data that is used to characterize local weather patterns, and will be used for the future estimates of native ET. The data collected at the Sterling Ranch site includes net solar radiation, air temperature, wind velocity and direction, relative humidity, barometric pressure, and soil temperature at varying depths. Most data is recorded in 15-minute intervals, transmitted to the Sterling Ranch website, and archived in a centralized database. **Table 1** is a monthly summary of the data collected to date from the Sterling Ranch Climate Station. Note in 2015 the Climate Station was relocated 4,600 feet northwest due to construction activity near the Roxborough Water Treatment Plant. As a result the climate station was not actively collecting data from 11:00 AM on April 22, 2015 through 2:30 PM April 23, 2015. The soil temperature sensors at the climate station have been discontinued, with this information being recorded at each of the soil moisture sensors associated with the lysimeter.

Figure 3 – Sterling Ranch Climate Station (Original Location)

Table 1 – Sterling Ranch Climate Station Monthly Summary

Year	2014							2015				
Month	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr***	**May**
Temperature (F)												
Average Temperature	66.6	71.4	68.0	63.4	54.4	37.3	32.9	35.2	34.9	45.3	47.9	50.7
Max Temperature	92.3	95.9	88.6	92.8	82.1	71.0	67.9	76.0	72.2	79.6	75.1	66.1
Min Temperature	41.6	52.9	49.6	31.8	31.5	-8.5	-13.0	-1.9	2.2	6.4	17.0	36.1
Temp Range	50.7	43.0	39.0	61.0	50.7	79.5	81.0	77.9	70.0	73.2	58.1	30.0
Soil Temp (5 cm) (F)												
Average Temperature	70.7	75.0	69.9	63.7	52.6	38.0	34.5	34.0	37.0	43.5	50.7	-999
Max Temperature	84.5	86.7	80.9	80.1	62.6	46.8	41.5	34.0	41.4	45.0	60.6	-999
Min Temperature	52.3	62.1	57.2	47.9	41.7	29.2	31.9	31.9	32.7	32.0	40.4	-999
Temp Range	43.7	37.1	28.4	33.4	22.2	27.5	12.5	13.0	14.8	30.0	26.1	-999
Soil Temp (15 cm) (F)												
Average Temperature	72.0	77.5	73.2	66.8	50.0	41.0	33.7	32.6	34.7	39.4	51.3	-999
Max Temperature	84.5	86.7	80.9	80.1	62.6	46.8	41.5	34.0	41.4	45.0	60.6	-999
Min Temperature	58.1	68.1	63.1	52.1	40.8	35.5	31.5	31.9	32.6	33.8	41.0	-999
Temp Range	26.4	18.6	17.8	28.0	21.8	11.3	10.0	2.2	8.8	11.2	19.6	-999
Wind (mph)												
Average Velocity	6.2	6.2	5.3	5.3	5.1	5.6	5.4	5.4	5.3	5.5	5.5	5.5
Max Velocity	29.6	37.4	30.0	21.4	27.9	34.9	24.7	27.5	30.0	25.5	31.4	36.7
Average Direction (Deg N)	182.33	187.50	183.32	184.01	181.17	169.00	191.17	82.38	188.44	183.32	189.06	191.89
Solar Radiation (MJ/m2 h)												
Average Radiation	1.07	0.90	0.85	0.70	0.58	0.37	0.32	0.35	0.50	0.75	0.81	0.71
Max Radiation	4.26	4.32	3.79	3.36	3.12	2.40	2.29	2.58	3.24	3.45	4.08	4.19
Barometric Pressure (mbar)												
Average BP	824.44	826.47	825.06	824.35	823.39	820.92	820.90	824.22	822.11	823.51	819.28	821.51
Max BP	826.77	832.36	832.21	834.43	832.26	833.31	833.97	861.97	832.57	833.47	831.25	831.49
Min BP	812.16	820.27	817.08	815.29	812.18	804.75	802.30	812.57	812.65	806.26	806.97	811.14
Humidity (%)												
Average Humidity	42.7	48.9	50.4	52.4	43.7	45.2	51.5	56.1	55.2	43.5	51.2	69.7
Max Humidity	94.0	96.5	92.6	98.3	93.7	95.1	98.5	97.3	97.6	97.3	98.5	98.0
Min Humidity	6.3	9.8	12.5	10.7	8.9	6.1	7.3	8.7	6.6	7.1	5.8	17.9

*The climate station was not actively collecting data from 11:00 AM on April 22, 2015 through 2:30 PM April 23, 2015.

Precipitation Monitoring Program

2014-2015 Variance from Application: None

Figure 4 – OTT Pluvio^2

An OTT Pluvio^2 weighing precipitation gage was installed on the site and began collecting data on March 29, 2010 (see **Figure 4**). The precipitation gage is located at the Sterling Ranch Climate Station and reports data in 15-minute intervals. The data collected at the site includes total accumulation and maximum rainfall intensity. This is the first of many proposed precipitation stations for the Pilot Project (see **Figure 2**). The physical measurement of precipitation is important in characterizing the native water supply, native water demand, and other hydrologic processes. **Table 2** is a summary of the data collected from the Sterling Ranch precipitation station. During the 2014-2015 monitoring season there was a total of 27.95 inches of precipitation accumulated with the max intensity of 7.67 in/hr on September 29, 2014. Note in 2015 the Precipitation Station was also relocated 4,600 feet northwest due to construction activity near the Roxborough Water Treatment Plant. As a result precipitation data was not actively collected from 3:00 PM on April 22, 2015 through 12:00 PM April 28, 2015.

Table 2 – Sterling Ranch Precipitation Station Summary

Year	2014							2015				
Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr*	May
Precipitation (in)												
Monthly Total	1.14	6.85	1.29	4.21	1.43	0.63	0.86	0.56	1.79	1.07	2.45	5.67
Max Intensity (in/hr)	1.29	5.07	4.77	7.67	2.07	0.52	0.60	0.00	0.54	1.27	0.65	2.06

*Note the Precipitation Station was taken off-line on April 22, 2015 through April 28, 2015 and relocated with the climate station, unmeasured precipitation event(s) did occur during this time period.

Surface Water Monitoring Program

2014-2015 Variance from Application: None

The surface water monitoring program was continued during the 2014-2015 monitoring season to quantify the site-specific stream flow that accrues to the natural stream system through surface water flows. To document surface water events in real-time, trail cameras have been added to the plan at the surface monitoring sites within the Sterling Gulch basin.

Figure 2 shows the location of the Upper Sterling Gulch surface water station completed in June 2011 and the location of trail camera used to document surface water events. This surface water station includes a 9-inch Parshall Flume, shaft encoder water level sensor, and data logger.

Recorded Surface Water Events

Eleven major events were recorded at the surface water station during the 2014-2015 project year, with the largest surface water event to date recorded July 12, 2014 at the surface water station. **Figure 5** is the hydrograph for the 2014-2015 project year. In total there were nine days with measurable surface water events recorded at the Upper Sterling Gulch flume. Upper Sterling Gulch flume data are unavailable from September 13, 2014 through October 29, 2014 due to a loss of digital data. During this period the total rainfall accumulation was 3.70 inches with only one storm greater than 0.50 inches. A surface water event of unknown duration likely occurred September 29, 2014 corresponding to a 3-hour storm event totaling 1.11 inches with a max intensity of 7.67 in/hr followed by another 2-hour storm event totaling 0.37 inches with a max intensity of 1.96 in/hr.

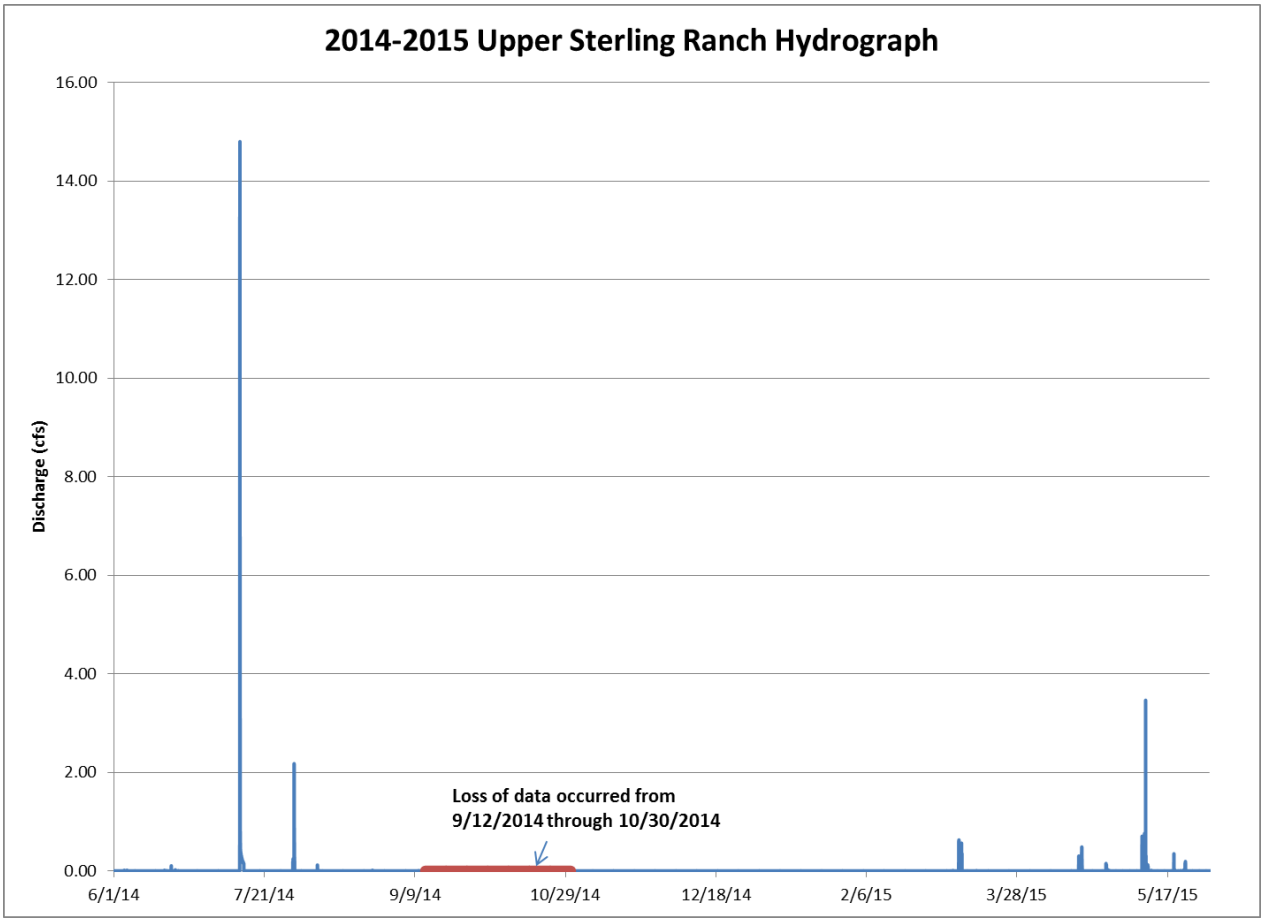

Figure 5 – 2014-2015 Upper Sterling Gulch Hydrograph

July 12, 2014 Event

On July 12, 2014, the National Weather Service issued a flash-flood warning for northwest Douglas County. Between 6 pm and 8 pm, the climate station at Sterling Ranch recorded 2.83 inches of total rainfall in two hours with a maximum intensity of 5.07 in/hr. This storm event also caused significant flooding within the area of Sterling Ranch and in Sterling Gulch as shown below in **Figure 6.**

Figure 6 – Image of the flooding within Sterling Ranch taken from W Titan Road on July 12th, 2014 at 7:42 PM

The 2-hour rainfall event on July 12, 2014 was 2.83 inches, which is greater than a 100-year precipitation event for this area (2.67 inches is the 2-hour, 100-year NOAA Atlas 14 value for Sterling Ranch). This high intensity short duration storm resulted in the largest surface water runoff event to date, inundating the Parshall flume located within Sterling Gulch. Stage data collected at the site indicated a maximum stage of 2.73 feet, which exceeds the rating of the 9-inch Parshall flume and invalidates the flow measurements. High water marks at the site and cross sectional data collected after the event indicate peak flows greater than 100 cfs.

The trail camera located at the Upper Sterling Gulch Flume sustained damage during the July 12, 2015 event and no photographs were recoverable. The camera at Titan Road was not recovered. The remaining ten measurable surface water events are summarized below in **Table 3**.

Table 3 - Summary of Remaining Surface Water Events during 2014-2015 Project Year

Year	2014	2015								
Month/Day	7/30	3/8	3/9	4/17	4/18	5/8		5/9		5/19
Duration										
Beginning Time	11:45	15:30	13:15	12:45	12:45	13:35	11:40	9:05	18:15	3:40
End Time	0:00	21:30	17:30	16:45	15:15	14:50	0:00	11:50	21:45	3:50
Duration (hrs)	12.25	6.00	4.25	4.00	2.50	1.25	0.33	2.75	3.5	0.17
Discharge										
Maximum 15-Minute Average Discharge (cfs)	2.15*	0.63*	0.56*	0.30*	0.49*	0.64	0.35	0.68	3.42	0.24

*Provisional data, programmatic offset under review as a result of siltation in stilling well from the July 12, 2014 event.

Due to the damages sustained to the trail camera during the July 12, 2014 there are no photographs documenting the surface water events summarized in Table 3. Cameras are planned to be replaced in July 2015.

Native Vegetation (ET) Monitoring Program

2014-2015 Variance from Application: None

The design and construction of a single weighing lysimeter began in January 2014. A representative single intact soil core was collected on April 8, 2014 in an area where future precipitation harvesting is planned. The lysimeter was completed and began transmitting data on April 11, 2014. The lysimeter is 24 inches in diameter, 42 inches tall and is equipped with three 500 lb load cells, 4 soil moisture sensors, and a tensiometer controlled vacuum system and tipping bucket (**Figure 7**). The lysimeter was constructed next to the climate station to take advantage of the existing sensors and telemetry infrastructure at the site.

In April 2015 the lysimeter was moved along with the climate station to the new location described earlier in this report. At that time the lysimeter load cells were recalibrated and the soil moisture sensors and vacuum system were tested.

The data collected at the lysimeter will be used to address two important aspects of the pilot study; the actual native vegetation ET and the amount of precipitation that percolates through the soil root zone to the ground water table known as ground water recharge or deep percolation. The lysimeters may also provide some insight on site-specific soil moisture storage and surface runoff. The 2014-2015 project year was the first full year of data collection at the lysimeter. Although data has been collected during the 2014-2015 monitoring season, the data is still under review and was not compiled for this report. Data will be compiled and included in next year's annual report.

Figure 7 – Sterling Ranch Lysimeter and Soil Core Extraction

Ground Water Monitoring Program

2014-2015 Variance from Application: None

Understanding pre-existing ground water interactions on Sterling Ranch is another important component of the water budget. Quantifying the amount, timing, and location of ground water return flows that accrue to the local alluvial aquifer from precipitation events is important when determining augmentation requirements to local streams. The installation of two monitoring wells and one shallow (Datum) well located within Sterling Gulch was completed in September 2011 (see **Figure 2**). **Table 4** below summarizes the manual ground water level data collected at each of the monitoring wells with an M-scope.

Table 4 – Sterling Gulch Monitoring Well Recorded Depth to Ground Water

Year	2014			2015	
Date	**Depth (ft)**	**7/16/2014**	**9/12/2014**	**1/19/2015**	**4/23/2015**
Manual Recorded Depth of Ground Water (ft)					
Datum Well	6.25	Dry	Dry	Dry***	Dry
MW-1	15.30	Dry	N/A**	Dry	Dry
MW-2	17.96	Dry*	Dry*	Dry*	Dry*

*Some condensation/dampness at the bottom of well

**Pressure Transducer installed on July 16, 2014, no manual measurement taken 9/12/2014

***Datum Well was obstructed at depth of 2.75 ft, presumed to be a layer of ice

During the four site visits completed in the 2014-2015 project year all manual water levels measured at each of the three wells indicate wells were dry with no measurable alluvial ground water levels recorded. During the July 16, 2014 site visit, LRE installed a pressure transducer in MW-1 to provide constant measurements of depth to water within the well. Since that time, the device has been measuring and recording water pressure/levels at the bottom of MW-1 every 15 minutes. LRE is still in the process of validating the pressure transducer data, but raw data collected during the 2014-2015 project year indicates alluvial groundwater at MW-1 in the month of July 2014 and during the month of May 2015.

Monitoring Program Maintenance Plan

Since March 2010, OneRain has been the contractor assisting in the monitoring and maintenance of the Sterling Ranch climate station. The design of the monitoring plan is modular, and the maintenance requirement of each monitoring program element is different. Once installed, routine physical inspections of all instrumentation were conducted. Real-time sensors were remotely monitored to verify that they are operating correctly. The data-logging sensors were checked and maintained every time that the data was retrieved. Data reports have been reviewed and found to be consistent, with no major outliers resulting from measurement and program errors.

Beginning in July 2011, Leonard Rice Engineers, Inc. has been responsible for the data collection and maintenance of the Upper Sterling Gulch flume, trail cameras, and monitoring wells. The site has been visited a total of four times over the 2014-2015 monitoring season with maintenance and data collection occurring each time. Each trail camera requires all photos to be downloaded and cleared from the memory card, a fresh set of batteries, and review of settings to make sure the time-lapse mode is operating correctly. At each of the monitoring wells, water level data is collected manually using an M-scope and pressure transducer data has been collected from MW-1.

Climate Station and Lysimeter Relocation

The relocation of the Sterling Ranch climate station and lysimeter occurred April 22nd through April 28th due to construction activity near the Roxborough Water Treatment Plant. The climate station and lysimeter were relocated approximately 4,600 feet northwest, to a future open space area that is still located within the Sterling Gulch watershed. The relocation required disassembly and reassembly of every major system and instrument. As a part of the reinstallation process each of the following systems were inspected: power, telemetry, data logger, and sensors. All systems were found to be working normally. The reinstallation of the lysimeter allowed for the recalibration and testing of the load cells, soil moisture sensors and the vacuum system, resulting in several programmatic and system improvements.

Natural Consumptive Use, Return Flows to the River, Water Budgets, and Models

With most natural conditions monitoring programs in place, it is anticipated that future efforts will be focused on the development and integration of water budgets and modeling. With HB 15-1016 being passed into law, Sterling Ranch anticipates that future modeling efforts will include the development of regional ET coefficients (factors) that can be used to estimate the amount of pre-development ET occurring at the site.

Phase 2: Experimental Precipitation Harvesting Designs

Experimental precipitation harvesting designs is an ongoing planning and implementation effort that evaluates the feasibility of residential, commercial, and regional harvesting designs at the development. Sterling Ranch continues to evaluate and collect information about different types of precipitation harvesting designs, equipment, and materials. There is no data to report on Experimental Precipitation Harvesting Designs for the 2014-2015 project year.

Phase 3: New Precipitation Harvesting Designs

New construction and implementation of planned new precipitation harvesting designs is anticipated to begin within the year with the focus on regional capture designs. Sterling Ranch plans to start to evaluate and collect information about different regional precipitation harvesting systems, equipment, and materials. Implementation and monitoring of the new regional precipitation harvesting system is planned for the initial filing, Providence Village. Providence Village (described above) is also the location where the majority of rainwater harvesting is currently planned. Sterling Gulch Reservoir (aka Providence Lake) will be used to regulate stormwater flows to historic peak discharges, and used to manage rainwater captured for use in the non-potable water system. There is no data to report on New Precipitation Harvesting Designs for the 2014-2015 project year.

Overall Pilot Project Schedule

With final zoning in place, the pilot project continues to progress, with only a slight deviation from schedule. The delay in development has caused some delays in the progress of the pilot project, especially for the developed conditions. With construction and home building starting this summer we expect the pilot program to be back on schedule by next year. Below is a summary of the variances from the original application:

2014-2015 Variance from Application:

- Climate and precipitation monitoring site was installed in March of 2010 and is collecting data. *On Schedule*
- The lysimeter was installed in April 2014 and ET and deep percolation monitoring has begun. *Delay = approx. 3 years*
- The first surface water monitoring site was installed in June 2011 and is collecting data. *Ahead of schedule = 6 months*
- Ground water monitoring started in September 2011. *Ahead of schedule = 1 year*
- All planning and implementation of Experimental Harvesting Designs has been delayed.
    - Residential Experimental Site - *Delay = approx. 4 years*
    - Commercial Experimental Monitoring Site - *Delay = approx. 4.5 years*
    - Regional Observation Site - *Delay = approx. 4.5 years*
- All New Precipitation Harvesting Designs are planned to begin within the next year.
    - Residential System - Delay = approx. 3 years
    - Commercial System – Delay = approx. 2 year
    - Regional System – Delay = approx. 2 year
- The proposed administration plan originally included a preliminary administration report developed for demonstration site as a test for the development of the new sites. Planning and development of administration is planned to begin in the next year with the development regional factors supported by HB- 15 1016 - *Delay = approx. 4.5 years*

Figure 8 shows the proposed timeline with the adjustments made due to the extended schedule as described above. As shown, the climate and precipitation monitoring programs were implemented and began monitoring in 2010. In 2014-2015 natural conditions data collection has resumed with the continuation of lysimeter and ET monitoring. Experimental precipitation harvesting designs is an ongoing planning and implementation effort that evaluates the feasibility of residential, commercial, and regional harvesting designs at the development. New construction and implementation of planned new precipitation harvesting designs is anticipated to begin within the year with the focus on regional capture designs.

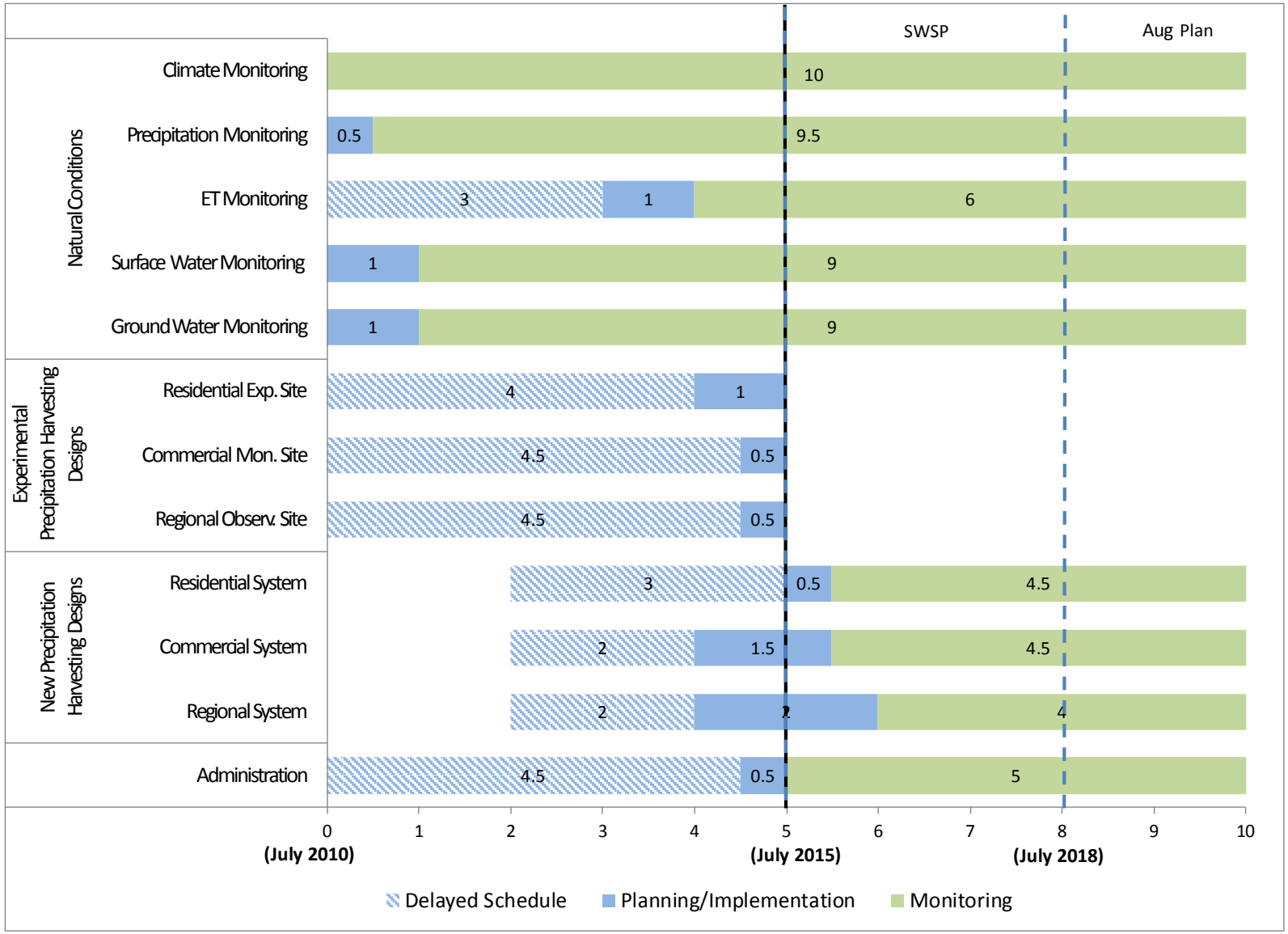

Figure 8 – Updated Pilot Project Schedule

Augmentation Requirements

The augmentation requirements that will be met under an approved Substitute Water Supply Plan are expected to begin within the next year. The regional ET coefficients (factors) described in HB 15-1016 will allow Sterling Ranch to more clearly quantify the augmentation requirements associated with development and rainwater collection under the updated State criteria and guidelines.

Implementation

Collection and irrigation system design have not currently been finalized or implemented. Therefore, no data is yet available for describing operation and maintenance or for estimating collection efficiencies.

Estimated Water Savings, Landscape Plans, Metered Water Use, Consumptive Use and Estimated Water Conservation, and Estimated Unit Cost for Rainwater

Currently there is no new information to provide on the estimated water savings, landscape plans, metered water use, consumptive use, estimated water conservation, and estimate unit cost for rainwater capture and use.

Costs to date

Costs for the Pilot Project have occurred primarily in the efforts for the monitoring of natural conditions. These are summarized below:

Natural Conditions

In 2014-2015; climate station and lysimeter relocation, station maintenance, data collection, data management and reporting were the primary costs. These costs were:

- Climate Station and Lysimeter Monitoring and Relocation – $25,200
- Data Management/Analysis/Reporting – $16,290
- Natural Conditions Monitoring and Maintenance – $7,093

Partnerships and the Sharing of Information

Educational efforts continue to be made during this phase of the Pilot Project to help the community understand the concept of what Sterling Ranch is doing in terms of water conservation and rainwater harvesting. Proof came in the form of two separate but related House Bills presented to the Colorado Legislature during the 2015 session. The first was HB 15-1259, which highlights the benefits of rain barrels and the importance of pairing water conservation practices with rainwater capture. Although HB 15-1259 was unsuccessful, this bill provided several opportunities to engage the water community and educate them about the Sterling Ranch Pilot Program. The second House Bill, HB 15-1016, described above is critical to showing the State and the water community the path forward for developing rainwater as a viable and legal supply.

Group tours of the site and natural conditions monitoring program continue to be provided to public visitors, other water districts, and water providers as an example of the process and steps required to utilizing rainwater as a reliable water supply. Information on how Sterling Ranch has developed these sites and the process used to quantify rainwater as a physical and legal supply continues to be discussed with interested parties throughout the state.

Closing

This letter report describes the fifth year of the Sterling Ranch Precipitation Harvesting Pilot Study. If you have any questions, please feel free to call at 303-455-9589.

Sincerely,

LEONARD RICE ENGINEERS, INC.

Mark Mitisek, P.H.
Senior Project Hydrologist

Greg Roush, P.E.
Chief Operating Officer

Sterling Ranch, Attachment A - CWCB Requirements for Annual Report

1. A description of variances from the Pilot Project application including information on any data quality issues that may magnify if results are extrapolated to a larger scale project.

2. Precipitation harvesting performance metrics, including:
    a) Description of final collection system design with plans and specifications of all system components.
    b) Operation and maintenance plans and any issues encountered.
    c) Meter data of water flowing into the precipitation collection device and estimated capture efficiency.

3. Pilot project implementation plan and estimated water conservation achieved through pairing precipitation harvesting with advanced outdoor water management, including:
    a) A description of the applied method used to capture precipitation and any potable water supply with plans and specifications for all system components including any technology utilized (system programmers, ET controllers, etc.).
    b) Landscaping plans including measured irrigated acres, plan descriptions, theoretical irrigation water requirement methods, results, and water budgets reflecting application efficiencies.
    c) Metered water use from precipitation collection system. Water use will be categorized by use if application varies.
    d) Metered water use from other potable water supplies if the precipitation collection is supplemented. Water use will be categorized by use if application varies.
    e) Comparison of actual consumptive use by category of use to estimated water budgets. Estimate amount of water conserved as a result of the precipitation harvesting.
    f) A landscape maintenance assessment of quality of the landscapes, maintenance issues encountered, and any necessary replacement of plantings. The results of the irrigation system audit and corresponding actions.
    g) Cost to date including design, infrastructure, operations, and maintenance costs. Estimated costs to implement precipitation harvesting system per acre-foot of water saved; and comparison of original projected and actual costs from implementing the precipitation harvesting systems. The cost comparison will include institutional, legal, technical/design, infrastructure, and augmentation water supplies.

4. A description of the climate and hydrologic data collected to characterize the preexisting, natural vegetation conditions including:
    a) A description of the methodology and analysis results toward providing information about the technical ability to reasonably quantify the site-specific amount of precipitation that, under preexisting natural conditions, accrues to the natural stream system via surface and ground water return flows.
    b) A description of the baseline set of data and sound, transferrable methodologies used for measuring local weather and precipitation patterns that account for variations in hydrology and precipitation event intensity, frequency, and duration.
    c) Descriptions of the methodology and analysis results quantifying preexisting natural vegetation consumption; measuring precipitation return flow amounts; identifying surface versus ground water return flow splits; and identifying delayed ground water return flow timing to receiving streams.

d) Quantification of the amount of precipitation that must be augmented to prevent injury to decreed water rights.
e) Description of the location and methods used to collect climate data measurements, with a summary of data including, at a minimum, temperature and precipitation