Dominion Water & Sanitation District
9250 E. Costilla Avenue, Suite 210
Greenwood Village, CO 80112

May 30, 2019

Mr. Kevin Reidy
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver, Colorado 80203

Ms. Tracy Kosloff
Colorado Division of Water Resources
1313 Sherman Street, Suite 818
Denver, Colorado 80203

Re: 2019 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

Dear Ms. Kosloff and Mr. Reidy:

Enclosed is the ninth annual report for the Precipitation Harvesting Pilot Study submitted by Leonard Rice Engineers, Inc. on behalf of Dominion Water and Sanitation District serving the Sterling Ranch Development. The annual report documents progress that was made in the 2018/2019 pilot study year, data that was collected, and plans for the 2019/2020 study year.

The 2018/2019 data collection included:

- Climate data have continued to be collected, extending the record for the site-specific data from March 2010 to May 2019.
- Sterling Gulch monitoring and data collection have continued at the surface water station located on Upper Sterling Gulch through October 2018, the station is complete with a trail camera used to documenting hydrologic events in real-time.
- The 2018/2019 pilot study year was the fourth year of data collection at the new lysimeter site.

The 2018/2019 pilot year precipitation was below average (17.53 inches is average (04/2010 - 05/2017)), with a total of 15.12 inches of recorded precipitation at the Sterling Ranch climate station. The largest precipitation event recorded at the Sterling Ranch climate station this project year occurred on July 5th, totaling 0.91 inches over ~3 hours. The event resulted in no observed runoff at the Upper Sterling Gulch flume over that period. If this same storm occurred in Providence Village (Filing 1 ~417 acres/~65% impervious) the estimated precipitation harvested

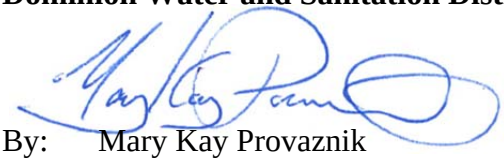
from this one event may have been as much as 15-25 acre-feet. This continues to demonstrate the potential of precipitation harvesting as a physical and legal supply.

With approximately 380 homes now occupied by residents and estimated 700 homes to be occupied by the end of the year. It is not anticipated that the development at Sterling Ranch will slow down anytime soon. The planning and integration of raw water supply, stormwater management, non-potable irrigation systems, and precipitation harvesting has been an important focus of the past year resulting in non-potable and stormwater master plans for the entire site. These masterplans provide the information required to evaluate precipitation harvesting opportunities throughout the site allowing targeted and regional precipitation harvesting to be developed holistically and cost-effectively.

A major milestone of the Sterling Ranch Precipitation Pilot Program was also achieved during the 2018/2019 project year. Supported by a Colorado Water Plan (CWP) grant, Dominion worked with the Colorado Division of Water Resources and Colorado Water Conservation Board to develop a sound and transferrable process for developing regionally applicable factors based on site-specific data from Sterling Ranch as well as a legal framework for navigating the legal requirements associated with developing rainwater as a legal supply. The results and findings of the study have already been utilized by the state in their development of recommended regional factors statewide for use by other applicants during the SWSP process. Dominion is proud to be involved and over the next year, will be working toward an augmentation plan and SWSP application utilizing the legal framework, methods, and data sets resulting from the grant.

Dominion is thankful for the opportunity to work with the State to advance rainwater harvesting statewide. The framework and process resulting from the CWP grant provided a clear path forward for developing rainwater as a viable legal supply while incentivizing additional Pilot Projects. We appreciate and look forward to continuing our work with the Colorado Water Conservation Board and Colorado Division of Water Resources. Thank you for your continued support in developing harvested precipitation as a viable water supply.

Dominion Water and Sanitation District



By: Mary Kay Provaznik
General Manager

cc: DWSD Board of Directors
Encl: 2019 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

July 1, 2019

Mr. Kevin Reidy
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver, CO 80203

Ms. Tracy Kosloff
Colorado Division of Water Resources
1313 Sherman Street, Suite 818
Denver, CO 80203

RE: 2019 Sterling Ranch Precipitation Harvesting Pilot Study Annual Report

Dear Mr. Reidy and Ms. Kosloff,

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

Introduction

Dominion's participation in the Colorado Water Conservation Board's (CWCB) Rainwater Harvesting Pilot Project Program (Program) reflects their commitment to establishing sustainable, defensible, non-potable water supplies for Northwest Douglas County including the Sterling Ranch development. Dominion's participation is in coordination with the Sterling Ranch Community Authority Board and the developers of Sterling Ranch (Sterling Ranch). Sterling Ranch continues 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, including developing a positive example of conservation and efficient resource management. The project continues to transition from planning and data collection to implementation of precipitation harvesting as a viable physical and legal supply. During the 2018-2019 project year, the primary focus has been on: 1) defining the processes and framework required to develop rainwater as a viable legal water supply; 2) refining processes and evaluating data to support an SWSP and augmentation plan; 3) planning and evaluating opportunities to actively harvesting precipitation onsite.

Current Sterling Ranch Development Activity

Development of Sterling Ranch is continuing on the fast track. In the past year, construction of water and wastewater infrastructure for Sterling Ranch's second neighborhood (Accent Village) has commenced. Temporary and permanent stormwater facilities used to accommodate construction activity for Providence and Accent Villages have also been completed. Approximately 380 homes are now occupied by residents, with an estimated 700 homes to be occupied by the end of the year.

The commercial office building known as the Sterling Center is complete with tenants occupying much of the office space. With development fully underway the focus of the next year will be the continued planning and implementation of precipitation harvesting systems for commercial sites and regional stormwater facilities. This will include a draft application for a temporary Substitute Water Supply Plan (SWSP).

Precipitation Harvesting Criteria and Guidelines Update

On January 26, 2016, the Colorado Water Conservation Board Members approved the updated Precipitation Harvesting Criteria and Guidelines based on provisions contained in HB 15-1016. 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 updated criteria and guidelines clarify the development and use of regionally applicable factors as follows:

"Sponsors of projects in areas where Regionally Applicable Factors have been adopted by the Board may propose to use the Regionally Applicable Factor to claim an evapotranspiration credit for the preexisting vegetative cover that was made impermeable through development associated with the pilot project. The evapotranspiration credit may be used prior to the sponsor completing two years of data collection and/or the sponsor's application to the water court. Proposed use of the credit will be reviewed as a part of the State Engineer's SWSP approval process."

During the 2018-2019 project year Dominion has made significant contributions to advancing the development of Regional Factors. Supported by a Colorado Water Plan (CWP) grant, Dominion worked with the Colorado Division of Water Resources (CDWR) and CWCB to develop the peer reviewed process and methods for developing regionally applicable factors based on site-specific data from Sterling Ranch. The grant also supported the development of a legal framework for navigating the legal requirements associated with developing rainwater as a legal supply. The results and findings of the study have been peer reviewed and are currently being finalized for submission to the State. The CDWR has already utilized the data and methods to develop recommended regional factors by Hydrologic Soil Group for use by other applicants during the SWSP process. These methods and factors are to be presented to the CWCB Board at the July 2019 meeting with the updates to the Precipitation Harvesting Criteria and Guidelines scheduled to be finalized at the September 2019 meeting.

Dominion is thankful for the opportunity to work with the State to advance rainwater harvesting statewide. The framework and process resulting from the CWP grant provided a clear path forward for developing rainwater as a viable legal supply while incentivizing additional Pilot Projects.

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 2018-2019 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
- Natural conditions data have been compiled in the 2018-2019 project year supporting the development of an SWSP and augmentation plan;
- In cooperation with the State and supported by a Colorado Water Plan grant, Dominion has completed the peer reviewed process and methods for developing regionally applicable factors based on site-specific data from Sterling Ranch;
- Dominion has completed the planning and evaluation of precipitation harvesting opportunities located in Providence and Prospect Villages based upon the 2017 stormwater standards.

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 Dominion's conceptual planning policies and requirements, including Sterling Ranch's 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 were 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.

Phase 1 of the Pilot Project began with the installation of the measuring devices in 2010 and have been collecting natural conditions data ever since. Now with Sterling Ranch development under way, Dominion is focused on the final planning and implementation of Phase 2 and 3 of the Pilot Project and the development of a regional precipitation harvesting system. These efforts are further discussed in the sections below.

Phase 1: Natural Conditions

The Sterling Gulch watershed is the study basin selected to evaluate natural conditions at Sterling Ranch. A comprehensive monitoring plan has been implemented in Sterling Gulch to collect climate, precipitation, surface runoff, native ET, deep percolation, and ground water data providing the foundation for defining physical yield characteristics and return flow obligations under natural conditions.

Figure 1 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.

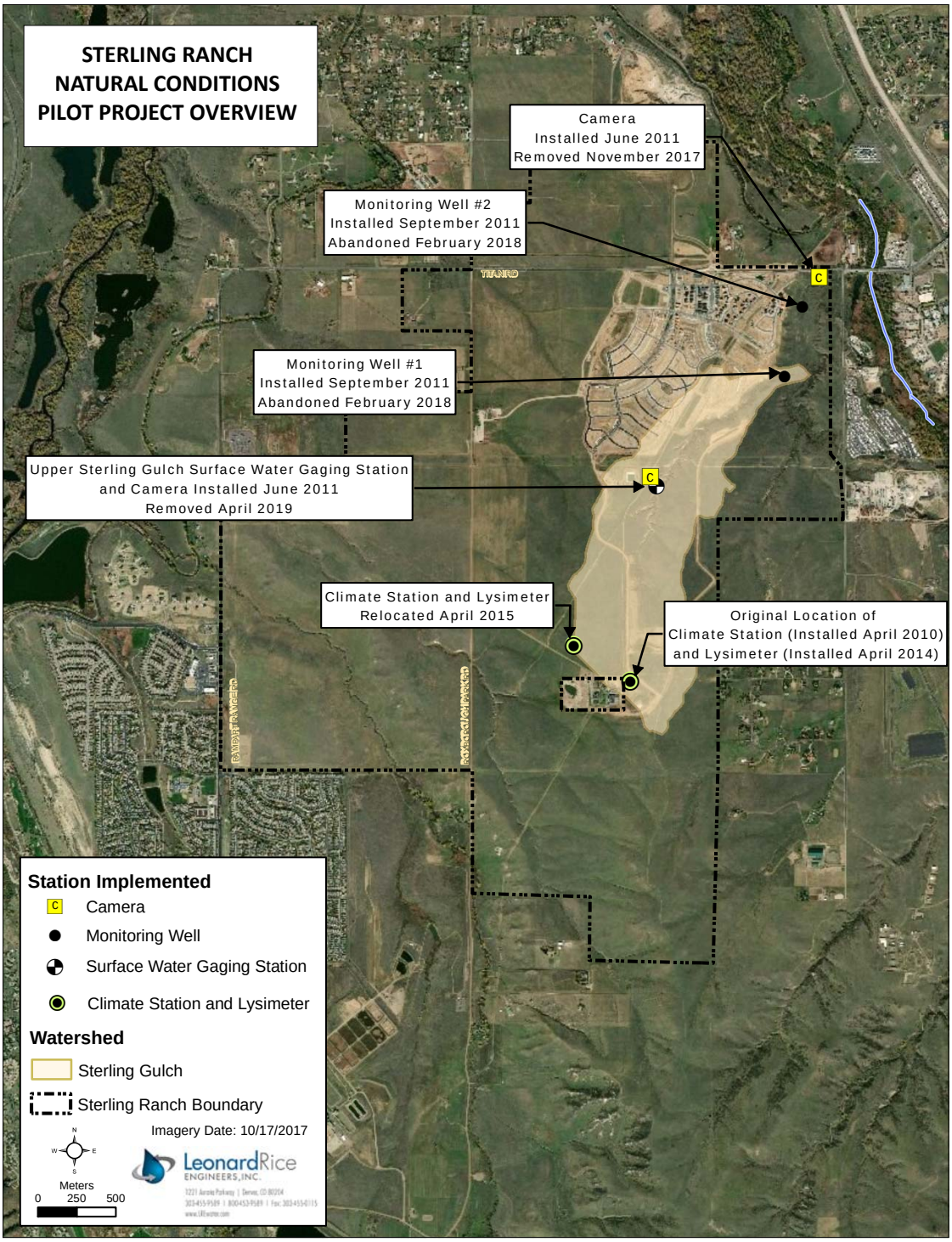


Figure 1 – Sterling Gulch Basin Map

Climate Monitoring Program

2018-2019 Variance from Application: None

The Sterling Ranch Climate Station was installed on March 29, 2010 and moved to new location in April 2015 to avoid construction activity in the area (see **Figure 1 & Figure 2**). 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, and barometric pressure, and soil temperature at varying depths. Most parameters are 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. The original soil temperature sensors at the climate station have been discontinued, with this information being replaced by data recorded at each of the soil moisture sensors associated with the lysimeter. The pyranometer was replaced on 7/12/2018. Solar radiation values reported in June and July of 2018 are invalid.

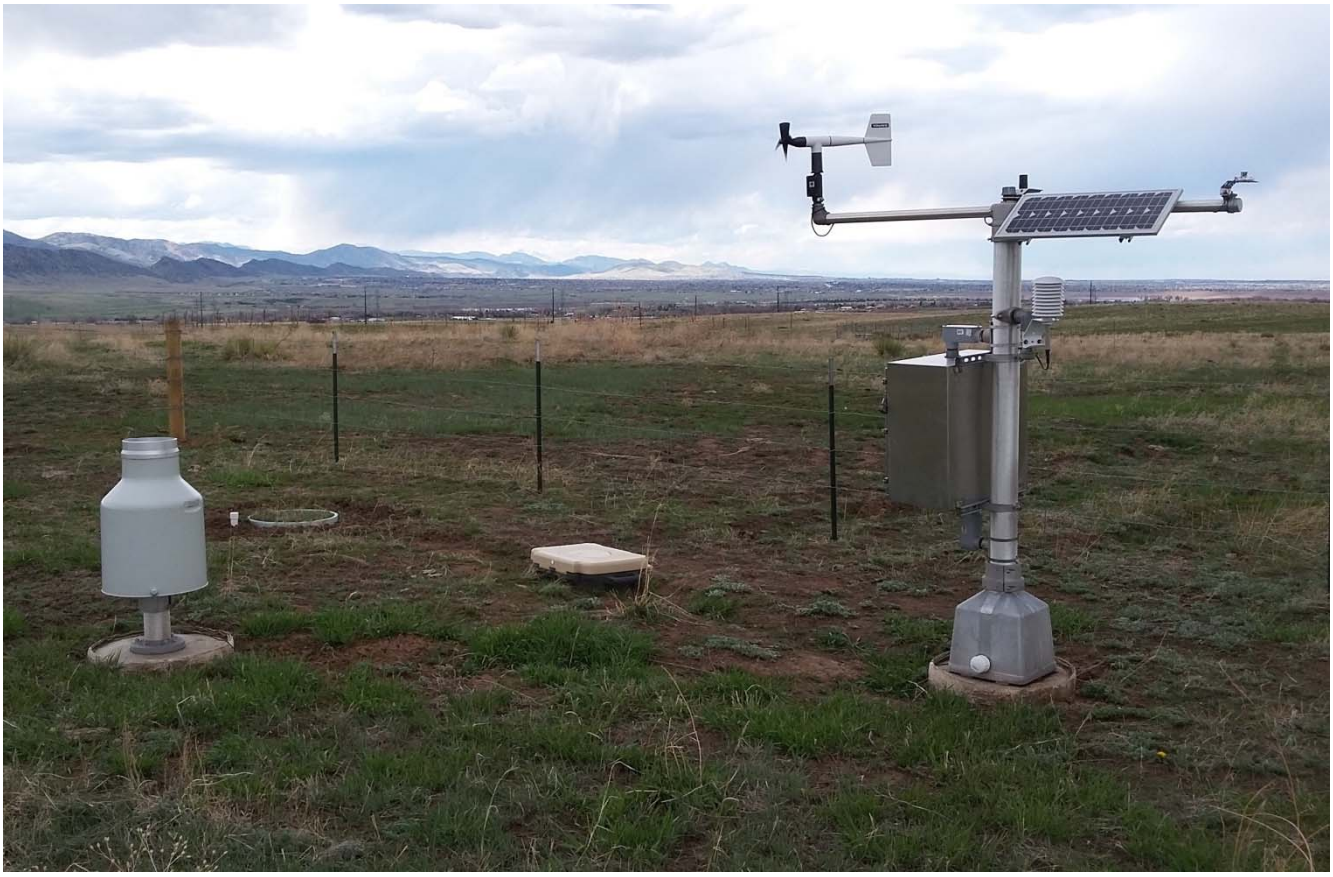


Figure 2 – Sterling Ranch Climate Station (April 2016)

Table 1 – Sterling Ranch Climate Station Monthly Summary

Year	2018							2019				
Month	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Temperature (F)												
Average Temperature	72.2	73.9	71.5	67.3	48.6	38.3	33.6	33.2	30.4	36.5	48.9	50.7
Max Temperature	101.9	97.3	95.6	94.6	85.2	65.3	63.0	63.1	60.0	72.8	76.4	78.6
Min Temperature	48.0	51.4	49.5	36.6	15.6	12.7	3.2	-4.2	-4.3	-2.0	15.1	30.5
Temp Range	53.9	45.9	46.1	58.0	69.6	52.6	59.8	67.3	64.3	74.8	61.3	48.1
Wind (mph)												
Average Velocity	7.3	6.9	7.0	6.8	6.1	6.4	6.5	7.4	7.5	6.3	6.6	5.9
Max Velocity	37.5	28.9	36.0	27.7	27.3	38.3	35.0	44.4	54.3	42.9	43.1	31.3
Solar Radiation ($MJ/m^2/h$)												
Average Radiation*	1.89	1.10	0.90	0.78	0.51	0.40	0.36	0.41	0.55	0.69	0.77	0.81
Max Radiation*	5.87	4.20	4.06	3.50	3.34	2.89	2.17	2.37	3.32	3.79	4.09	4.58
Barometric Pressure (mbar)												
Average BP	821.79	827.88	825.49	824.03	823.84	821.54	821.05	821.08	815.35	821.67	819.39	819.33
Max BP	831.74	838.52	831.76	833.68	835.70	835.23	832.29	832.51	825.10	831.63	829.01	826.25
Min BP	812.41	819.46	815.85	816.17	812.44	803.24	806.62	803.23	803.02	793.00	805.05	806.93
Humidity (%)												
Average Humidity	34.1	45.3	41.7	34.8	56.2	48.1	41.2	49.8	54.3	59.8	52.8	60.8
Max Humidity	97.5	98.9	94.5	90.0	98.6	96.3	94.8	99.4	98.5	99.4	99.4	99.4
Min Humidity	2.6	5.2	8.1	3.2	5.0	6.9	5.7	11.3	12.1	6.6	7.2	13.9

* The pyranometer was replaced on 7/12/2018. Solar radiation values reported in June and July of 2018 are invalid.

Precipitation Monitoring Program

2018-2019 Variance from Application: None

An OTT Pluvio^2 weighing precipitation gage was installed on the climate station site and began collecting data on March 29, 2010 (see **Figure 3**). 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. 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 2018-2019 monitoring season the rain gage measured a total 15.12 inches of precipitation and max intensity rate of 11.99 in/hr, which occurred on May 21, 2019.

Figure 3 – OTT Pluvio^2

Table 2 – Sterling Ranch Precipitation Station Summary

Year	2018							2019				
Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Precipitation (in)												
Monthly Total	1.18	2.45	0.70	0.18	1.72	0.65	0.22	1.50	0.86	1.68	0.99	2.99
Max Intensity (in/hr)	1.93 in/hr	4.13 in/hr	0.86 in/hr	0.44 in/hr	2.31 in/hr	2.37 in/hr	0.00 in/hr	3.76 in/hr	0.41 in/hr	8.23 in/hr	0.96 in/hr	11.99 in/hr

Surface Water Monitoring Program

2018-2019 Variance from Application: None

The surface water monitoring program continued through October 2018 quantifying the site-specific stream flow that accrues to the natural stream system through surface water flows. The Upper Sterling Gulch flume was removed in April 2019 to accommodate the regrading and drainage improvements required for new development. With over seven years of natural condition data collected by the surface water monitoring program and no active sensors currently onsite this surface water monitoring program is being discontinued.

Figure 1 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. Data collection for the 2018-2019 project year occurred only at the Upper Sterling Gulch flume and cameras from July through October 2018.

Recorded Surface Water Events

Figure 4 is the hydrograph for the 2018-2019 project year from June 2018 to May 2019. During this period there were no observed events with greater than 0.10 cfs average discharge recorded at the Upper Sterling Gulch flume.

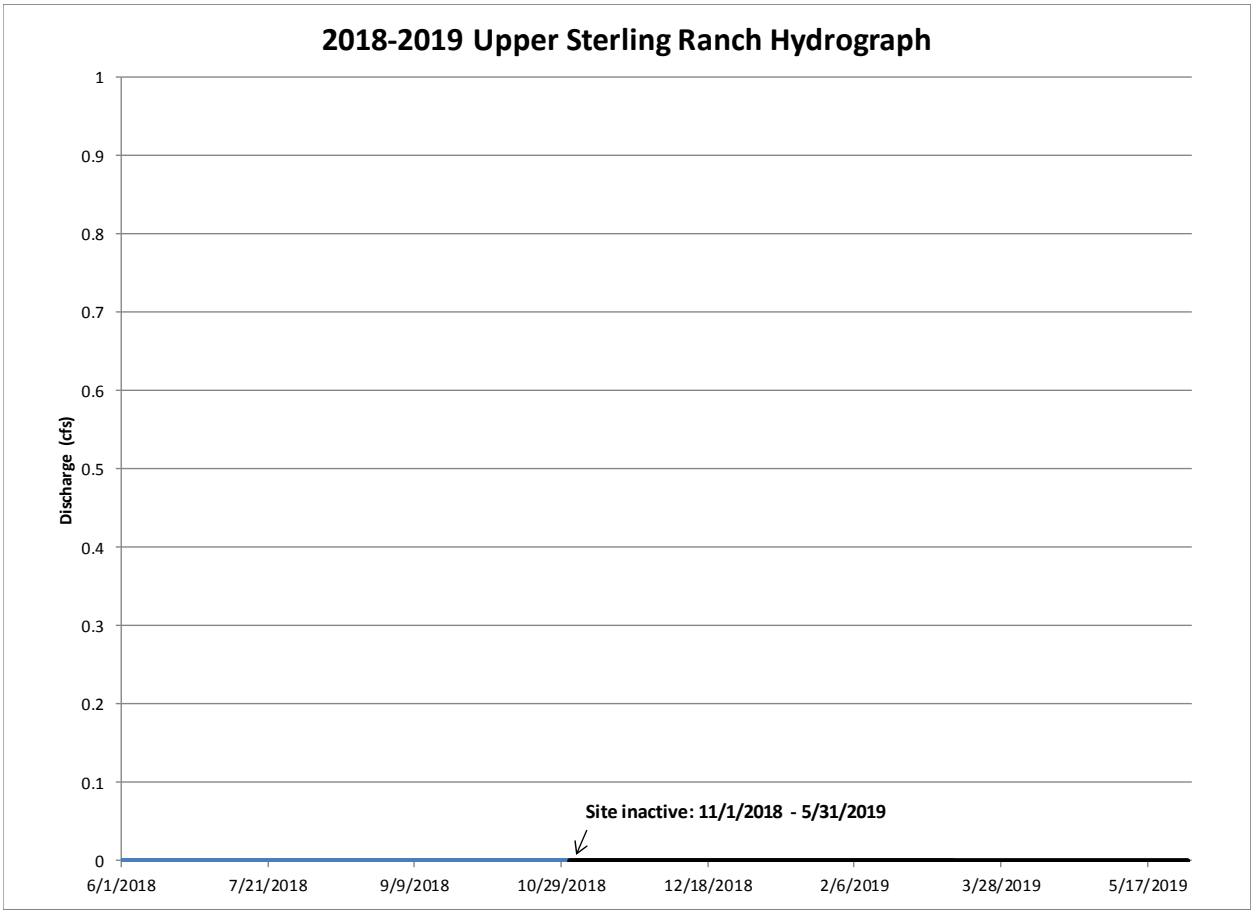


Figure 4 – 2018-2019 Upper Sterling Gulch Hydrograph

Only the trail camera at the Upper Sterling Gulch flume was active from July to October 2018 for the 2018-2019 project year. The trail camera is programed to capture photos every fifteen minutes day and night. With no observed surface water events at the Upper Sterling Gulch flume there were no events documented by the camera.

Native Vegetation (ET) Monitoring Program

2018-2019 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 of Providence Village 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. 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 a new location. 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 is being 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 lysimeter also provides some insight into site-specific soil moisture storage and surface runoff.

The 2018-2019 project year was the fourth year of data collection at the lysimeter. Lysimeter data collected during the 2018-2019 monitoring season is still under review and was not compiled for this report. Historical lysimeter data collected (04/12/2014 to 5/31/2018) has been compiled and will be reported as a part of the Colorado Water Plan Grant project.

Groundwater Monitoring Program

2018-2019 Variance from Application: None – Inactive

As a result of drainage improvements and grading occurring in this area of Sterling Gulch the groundwater monitoring wells were required to be abandoned. On February 21, 2018 both MW-1 and MW-2 were abandoned and plugged based on Colorado Division of Water Resources protocols. Historically, the monitoring wells were operational within Sterling Gulch between September 2011 and February 2018 (see **Figure 1**).

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.

During the 2018-2019 project year, OneRain completed a site visit on February 28, 2019 to maintain and verify the operation of all sensors associated with the Sterling Ranch Climate station. All sensors were found to be operational and reporting accurately. During the site visit OneRain also completed the replacement of the modem. This upgrade to the telemetry system will allow the addition of multiple new sensors and the implementation of real-time monitoring at stormwater facilities throughout the site.

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. During the 2018-2019 project year, data was recovered from the Upper Sterling Gulch flume and cameras from July through October 2018. Six monthly site visits occurred over the 2018-2019 monitoring season with maintenance and data collection occurring each time. Final data recovery occurred at the Upper Sterling Gulch flume prior to its removal in April 2019. Flume data reports were reviewed and found to be reliable, with no major outliers resulting from measurement and program errors.

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

As a result of the Colorado Water Plan (CWP) grant funding, significant progress has been made during the 2018-2019 project year in the development of water budgets and supporting models used to quantify the natural surface and groundwater return flows, and consumptive use. Below is a list of hydrologic models incorporated into the process over the past year:

- Site-Specific Water Balance (Hydrus 1-D)
- Soil Moisture Reservoir Accounting Model (Excel)
- Continuous Runoff Simulation Model (WQ-COSM)
- Alluvial Water Accounting System (AWAS)

These models and methods are the basis for the development of both site specific factors representative of Sterling Ranch and the Dominion service area as well as regional factors benefiting the community. Use of the water budget models and methods listed above are described more thoroughly in the CWP grant task memorandums and final report.

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. Dominion and Sterling Ranch continue to evaluate and collect information about different types of precipitation harvesting designs, equipment, and materials. The information collected under this phase of the project will be applied to new designs.

In July 2018 Sterling Ranch completed construction of a precipitation harvesting park shelter (**see Figure 5**) as a part of the new Sterling Center located in the northwest corner of Providence Village near Titan road. Rainwater is used directly to irrigate the immediate landscape and serves as a

demonstration of rainwater harvesting and Sterling Ranch's commitment to sustainable water resources. An initial investigation has been completed to retrofit the structure with water level sensors for collecting data at the site. Information gathered from the shelter may include total precipitation harvested and capture efficiencies for different storm types. Currently, this is the only structure of its kind planned for the site.

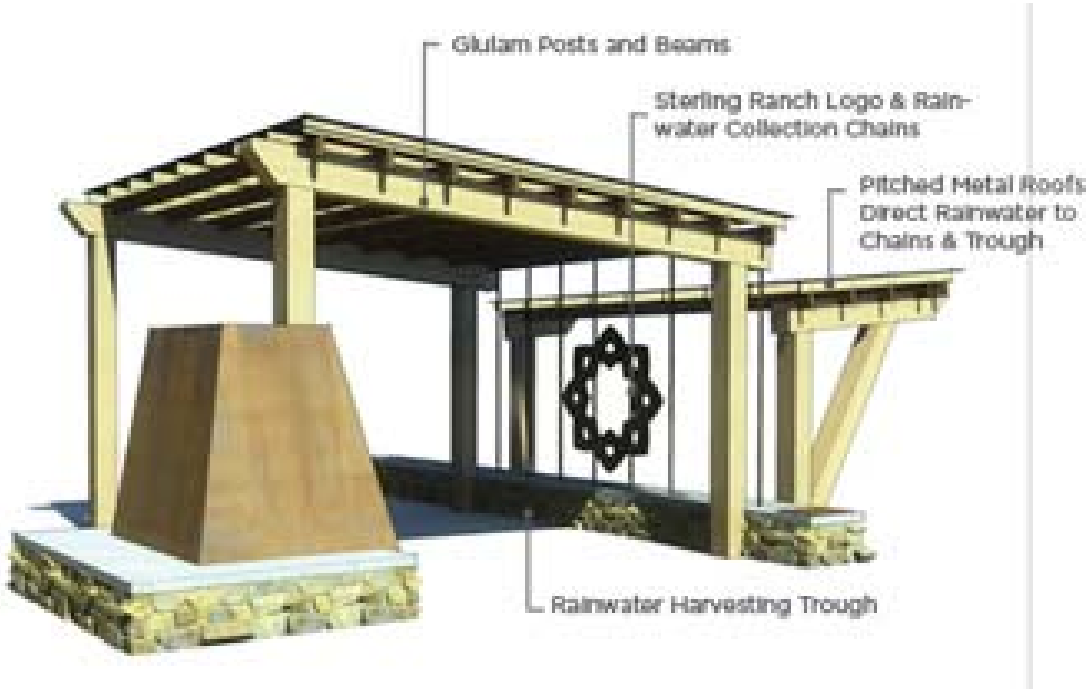


Figure 5 – Precipitation Harvesting Park Shelter

Phase 3: New Precipitation Harvesting Designs

The planning and integration of raw water supply, stormwater management, non-potable irrigation systems, and precipitation harvesting has been an important focus of the past year and has resulted in a non-potable and stormwater master plans for the entire site. These masterplan's provide the information required to evaluate precipitation harvesting opportunities throughout the site. Targeted and regional precipitation harvesting opportunities continue to be the focus as the most cost-effective solutions. **Figure 6** is a map of the Sterling Ranch planned community and villages. At this time the primary opportunities where new precipitation harvesting designs are being evaluated are located in Providence and Prospect Villages.

Providence Village

The first opportunity to evaluate new precipitation harvesting designs on a regional scale is Providence Village. Providence Village, located in the northeast corner of the development adjacent to Titan Road and Sterling Gulch, is the location where the most significant development has taken place. Currently, over 300 homes have been completed and over 400 homes are under construction and major utility and transportation corridors are complete, including multiple permanent and temporary stormwater facilities. Providence Village will be the first location where regional collection to centralized storage will be utilized to monitor and harvest precipitation for non-potable use.

The primary location being evaluated for precipitation harvesting is the Sterling Gulch Interim Pond. This facility is a regional stormwater facility has a capacity of 37.3 AF (100-yr detention volume) and located on the main channel of Sterling Gulch. The final design and construction for this facility was completed during the 2018-2019 project year. A plan view (grading plan) detailing the facility completed by Matrix Design Group is included as **Attachment B**. Currently, the facility is being evaluated to determine the operational strategies and infrastructure requirements for retrofit based upon the stormwater standards defined by Dominion in 2017. The retrofitted facility would be partially lined and potentially deepened to regulate stormwater flows to 1) meet demands directly; 2) move to terminal storage; or 3) store for later use.

Also within Providence Village is the first commercial site known as the Sterling Center, which includes the precipitation harvesting park shelter described above. In addition to the precipitation harvesting park shelter the Sterling Center is the first location where targeted precipitation harvesting may be used to meet local non-potable demands.

Prospect Village

The second opportunity to evaluate new precipitation harvesting designs on a regional scale is Prospect Village. Prospect Village is located in the southwest corner of the development adjacent to Rampart Range Road and Willow Creek and is the next location where development is planned to take place.

Prospect Village is currently in the planning phase with the development of the site to begin over the next year. Two stormwater facilities (East and West Ponds) adjacent to Willow Creek have been identified as potential precipitation harvesting locations. The preliminary drainage plan submitted to the County showing the location of these facilities is included in **Attachment B.** Over the next year Dominion will be working with stormwater engineers to evaluate stormwater facility designs prior to construction. The design considerations are based upon the stormwater standards defined by Dominion in 2017, which include: sizing of facilities and pumps, monitoring requirements, connections to the non-potable system, and easement/access for maintenance of these facilities.

Although several opportunities have been identified there is no data to report on New Precipitation Harvesting Designs for the 2018-2019 project year.

Figure 6 – Sterling Ranch Village Map

Overall Pilot Project Schedule

With construction and home building under way the pilot program is on schedule and continues to progress. Below is a summary of the variances from the original application:

2018-2019 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 (Same as last year)*
- The first surface water monitoring site was installed in June 2011 and is collecting data. *Ahead of schedule = 6 months (Same as last year) – Inactive program (04/2019)*
- Ground water monitoring started in September 2011. *Ahead of schedule = 1 year (same as last year) – Inactive program (02/2018)*
- All planning and implementation of Experimental Harvesting Designs continues to progress as the project progresses. *(Same as last year)*
    - Residential Experimental Site - *Delay = approx. 6.0 years*
    - Commercial Experimental Monitoring Site - *Delay = approx. 6.0 years*
    - Regional Observation Site - *Delay = approx. 6.0 years*
- All New Precipitation Harvesting Designs are planned to begin within the next year. *(Same as last year)*
    - Residential System - Delay = approx. 5 years
    - Commercial System – Delay = approx. 4.5 years
    - Regional System – Delay = approx. 4 years
- We are in our fourth year developing a plan for administering precipitation harvesting, which continues to evolve to incorporate the new information from the Regional Factors CWP grant and updated Precipitation Harvesting Criteria and Guidelines into the plan. Datasets and models supporting an SWSP and augmentation plan have been completed with an application planned to be submitted within the next year - *Delay = approx. 5.5 years (Same as last year)*

Figure 7 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 2018-2019 project year the 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. The evaluation, implementation, operation, and administration of new precipitation harvesting designs have continued to be the focus for the 2018-2019 project year.

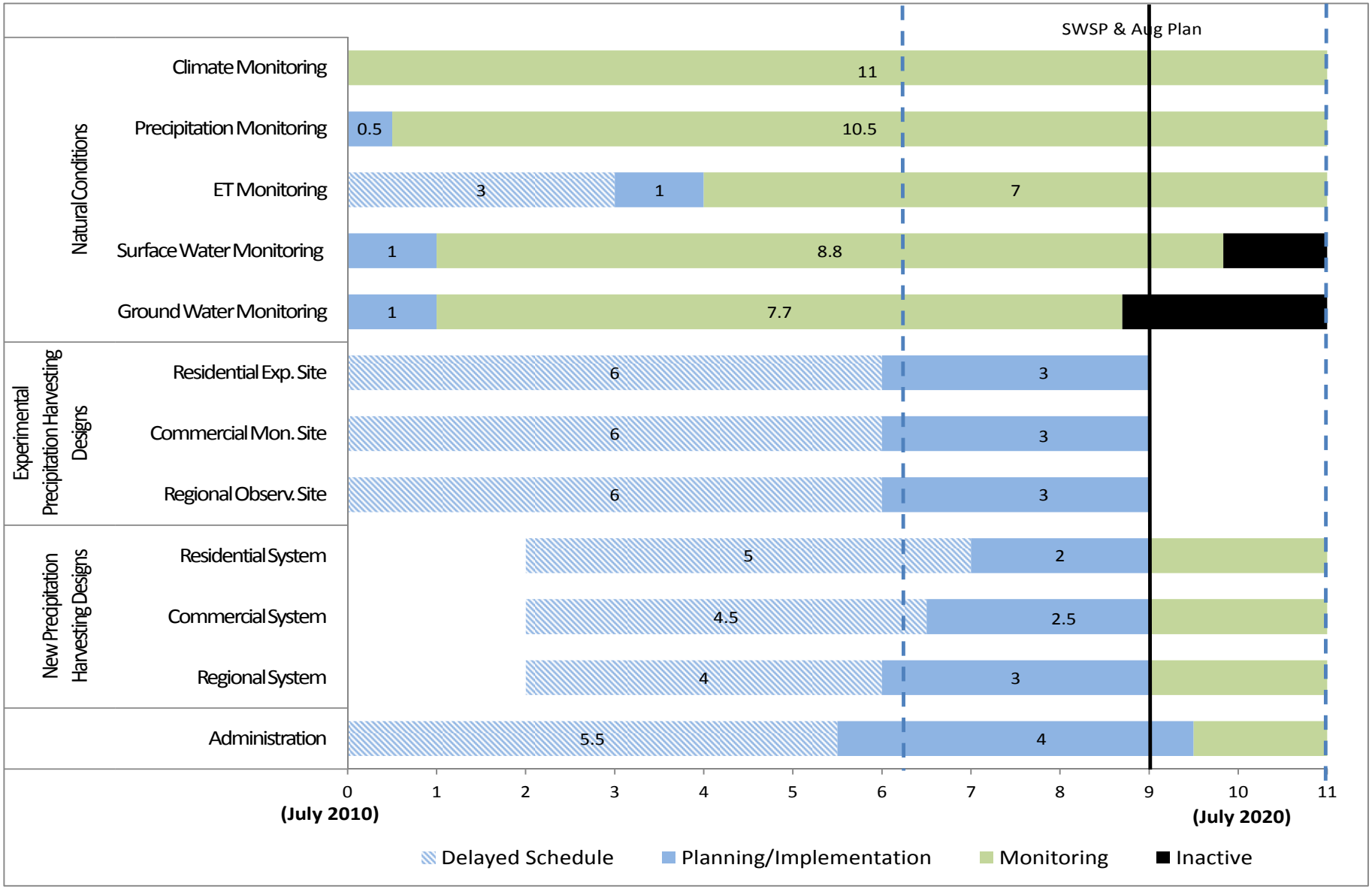


Figure 7 – Updated Pilot Project Schedule

Augmentation Requirements

Currently, there is no precipitation harvesting on Sterling Ranch requiring augmentation at this time. Over the next year, Dominion will be working toward an augmentation plan and SWSP application utilizing the legal framework, methods, and data sets resulting from the CWP grant.

Implementation

As described in the New Precipitation Harvesting Designs section above, several precipitation harvesting opportunities have been identified. However, data is not yet available for describing operation and maintenance of regional or targeted precipitation harvesting facilities.

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

Daily indoor and outdoor metered water use continues to be collected for over 380 homes, the 2018-2019 project year was the second year in which metered water use data was collected at Sterling Ranch. Each home is equipped with a dual-water metering system that provides real-time data on how much water is used at individual lots for outdoor use, and how much is used for indoor use. While the majority of landscapes are still being established, higher than normal outdoor water use is anticipated; as a result the meter data is still under review and has not been compiled for this report. Over the next year, Sterling Ranch and Dominion will continue to collect, compile, and review metered water data used to establish a baseline water budget used to estimate consumptive use, water conservation, and unit costs for precipitation harvesting.

Costs to date

Below is a summary of the primary costs associated with the Pilot Project for the 2018-2019 project year including: climate and lysimeter monitoring, natural conditions monitoring, data management an analysis, regional factor development, and rainwater implementation.

- Climate Station and Lysimeter Monitoring – $6,661*
- Natural Conditions Monitoring and Maintenance – $8,195
- Data Management/Analysis/Reporting – $10,346
- Regional Factor Development (CWP Grant) - $42,102
- Rainwater SWSP and Water Court Application - $30,831
- Rainwater Implementation - $12,633

*includes new modem for climate station

Partnerships and the Sharing of Information

Sterling Ranch and Dominion continue to look for opportunities to engage the water community and to educate them about the Sterling Ranch Pilot Program as well as the importance of pairing precipitation harvesting with water conservation practices.

The precipitation harvesting park shelter demonstration site is one of the best examples of Sterling Ranch's commitment to education, precipitation harvesting, and water conservation practices. This aesthetically pleasing structure illustrates both form and function as it is a supplemental water source to the adjacent WaterWise Plantings. This park shelter shows how smart planning and a commitment to sustainability can result in a significant amenity to the community.

During the 2018-2019 project year, Dominion also actively engaged the stormwater community by partnering with the Urban Watersheds Research Institute (UWRI) to determine the best methods and tools available for the development of regionally applicable factors. The result was a collaborative recommendation and update to the Water Quality Capture Optimization Model (WQ-COSM) to allow for the simulation of continuous precipitation runoff events for variable timesteps. WQ-COSM is the primary model used to develop and evaluate regionally applicable factors.

Dominion's partnership with the State over the past year was strengthened by the collaborative approach used to develop regional factors. Dominion is pleased with the outcome of the CWP Grant and the proposed regional factors as well as the legal framework for the administration of precipitation harvesting as a viable and legal water supply. We recognize the importance of this partnership and look forward to advancing precipitation harvesting together.

Closing

This letter report describes the ninth 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.
Project Manager

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

Attachment B – Stormwater Planning Documents

Know what's below. Call before you dig.

STERLING GULCH INTERIM POND		
STAGE-STORAGE-DISCHARGE		
STAGE	STORAGE	DISCHARGE
ELEV (FT.)	*AC-FT*	*CFS*
5573.5	0.00	0.00
5574.0	0.04	0.47
5575.0	0.18	0.82
5576.0	0.77	1.59
5577.0	2.68	2.17
5578.0	6.67	3.14
5579.0	12.66	3.90
5580.0	20.03	159.73
5581.0	28.04	379.91
5582.0	36.31	421.88
5582.5	40.53	439.52

STERLING RANCH INTERIM POND
100-YEAR DETENTION VOLUME = 37.30 AC-FT
100-YEAR WATER SURFACE ELEVATION = 5582.12
100-YEAR RELEASE RATE = 434 CFS
EURV VOLUME = 11.90 AC-FT
EURV WATER SURFACE ELEVATION = 5579.84

BLUE RIVER AVE.
PINEY RIVER AVE.
STERLING RANCH FILING NO. 1
PROP. REGIONAL TRAIL SEE SHEETS TR02 AND DT02
PROP. MAINTENANCE TRAIL MAX SLOPE 10:1 SEE SHEET TR01 AND DT02
EX. FIS FLOODWAY
100 YEAR WSE = 5582.12
EURV WSE = 5579.84
N. 1608203.34 E. 3132446.14
N. 1608097.35 E. 3132602.73
N. 1608058.39 E. 3132291.53
N. 1608032.97 E. 3132683.28
18" THICK TYPE L RIPRAP
PROP. 3X 54" RCP
PROP. SPILLWAY SEE SHEET DT14
PROP. OUTLET STRUCTURE SEE SHEETS DT10-DT13
PROP. MAINTENANCE TRAIL
N. 1607983.98 E. 3132740.04
N. 1607916.35 E. 3132928.04
PROP. MICROPOOL SEE SHEET DT14
N. 1607866.22 E. 3132306.37
N. 1607865.85 E. 3132953.62
N. 1607761.21 E. 3132239.53
PROP. TRICKLE CHANNEL SEE SHEET DT14
GRADE BOTTOM OF POND TO 4% WITHIN 25-FT OF THE TRICKLE CHANNEL
N. 1607736.37 E. 3132253.80
N. 1607724.29 E. 3132314.35
STERLING GULCH INTERIM POND
PROP. DROP STRUCTURE SEE SHEET DPDT02
N. 1607675.94 E. 3132345.37
N. 1607557.49 E. 3132758.71
N. 1607499.54 E. 3132420.89
N. 1607463.07 E. 3132629.99
REMOVE EXIST. STORM OUTLET STRUCTURE AND PIPE.
EXISTING TRICKLE CHANNEL TO BE REMOVED
EXISTING MAINTENANCE TRAIL TO BE REMOVED
EXISTING RIPRAP TO BE ABANDONED
EXISTING FOREBAY AND RIP-RAP TO BE REMOVED
PROP. STORM SEE SHEET SD01
EAGLE RIVER ST.
STERLING GULCH
EX. FIS FLOODWAY BOUNDARY
FUTURE STERLING RANCH FILING NO. 2
TRACT J
MATCHLINE SEE SHEET GR03
MATCHLINE SEE SHEET GR02

KEY MAP
SCALE: 1" = 2000'

N

SCALE IN FEET
ORIGINAL SCALE

ASSISTANT DIRECTOR OF DEVELOPMENT REVIEW

DATE

THESE CONSTRUCTION PLANS HAVE BEEN REVIEWED BY DOUGLAS COUNTY FOR DRAINAGE IMPROVEMENTS ONLY.

ENGINEERING DIVISION ACCEPTANCE BLOCK

Matrix DESIGN GROUP
1601 BLAKE ST, SUITE 200
DENVER, CO 80202
PH: 303-572-0200
www.MATRIXDESIGNGROUP.COM

STERLING RANCH
COLORADO

STERLING RANCH COMMUNITY AUTHORITY BOARD
8390 E. CRESCENT PKWY, #500
GREENWOOD VILLAGE, CO 80111
PH: 303-779-5710

COLORADO REGISTERED 48153 PROFESSIONAL ENGINEER

DRAWN	FRD
DESIGNED	FRD
REVIEWED	PC
PROJECT NO.	14.718.001
HORZ. SCALE	1"=60'
VERT. SCALE	NA
SUBMITTAL DATE	SEPT 2017

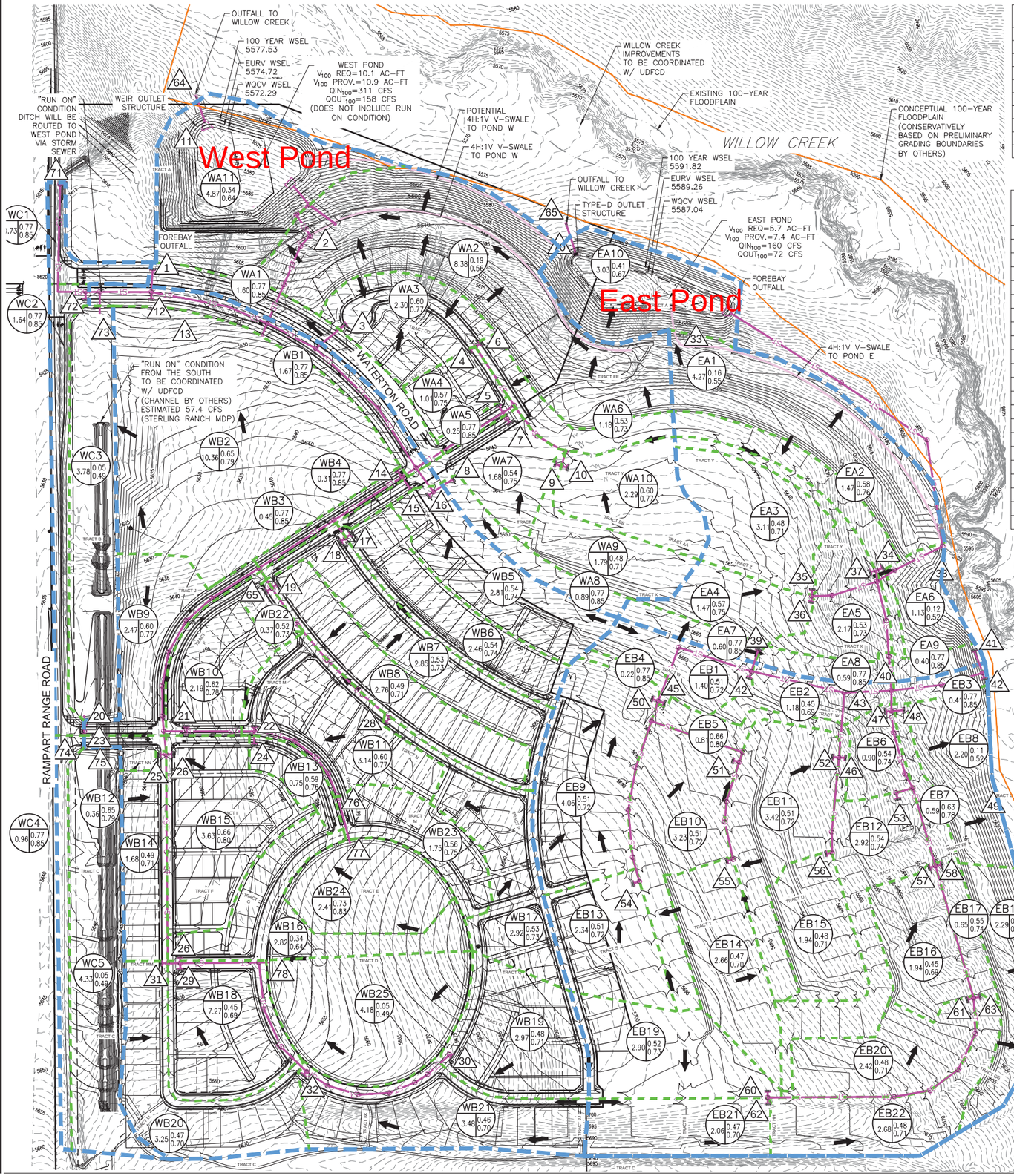
NOTES

DATE	NO.	
09/21/16	1	FIRST SUBMITTAL
01/17/17	2	SECOND SUBMITTAL
05/19/17	3	THIRD SUBMITTAL
06/30/17	4	FOURTH SUBMITTAL
09/11/17	5	FIFTH SUBMITTAL

STERLING RANCH
STERLING GULCH - INTERIM POND
GRADING
INTERIM POND

SHEET
GR01
SHEET 11 OF 89

FILENAME: R:\14.718.001 (Sterling Ranch)\Dwg\Construction Plans\Sterling Gulch Interim Pond\C-11-GR01.dwg PLOT DATE: 9/11/2017 4:42 PM



EA BASINS

BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	C5	C100	Q5 (CFS)	Q100 (CFS)
EA1	33	4.3	16%	0.16	0.55	3.1	18.6
EA2	34	1.5	67%	0.58	0.76	3.0	7.0
EA3	35	2.7	55%	0.48	0.71	5.1	13.7
EA4	36	1.5	66%	0.57	0.75	3.2	7.5
EA5	37	2.2	60%	0.53	0.73	3.8	9.6
EA6	38	1.1	10%	0.12	0.52	0.6	4.6
EA7	39	0.6	90%	0.77	0.85	2.1	4.2
EA8	40	0.6	90%	0.77	0.85	2.2	4.4
EA9	41	0.4	90%	0.77	0.85	1.5	3.0
EA10	70	3.0	41%	0.37	0.65	3.6	11.5

EB BASINS

BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	C5	C100	Q5 (CFS)	Q100 (CFS)
EB1	42	1.4	59%	0.51	0.72	3.3	8.6
EB2	43	1.2	51%	0.45	0.69	2.2	6.1
EB3	44	0.4	90%	0.77	0.85	1.5	3.1
EB4	45	0.2	90%	0.77	0.85	0.8	1.7
EB5	46	0.8	77%	0.66	0.80	2.4	5.3
EB6	47	0.9	62%	0.54	0.74	1.7	4.3
EB7	48	0.6	73%	0.63	0.78	1.8	4.1
EB8	49	2.2	9%	0.11	0.52	0.8	6.9
EB9	50	4.1	58%	0.51	0.72	6.9	17.8
EB10	51	3.2	59%	0.51	0.72	6.0	15.4
EB11	52	3.4	58%	0.51	0.72	6.2	16.1
EB12	53	2.9	61%	0.54	0.74	5.7	14.3
EB13	54	2.3	58%	0.51	0.72	4.9	12.8
EB14	55	2.7	53%	0.47	0.70	4.2	11.4
EB15	56	1.9	55%	0.48	0.71	3.5	9.4
EB16	57	1.9	51%	0.45	0.69	3.1	8.5
EB17	58	0.7	64%	0.55	0.74	1.5	3.7
EB18	59	2.3	25%	0.24	0.59	2.4	11.0
EB19	60	2.9	59%	0.52	0.73	5.5	14.1
EB20	61	2.4	54%	0.48	0.71	4.1	11.0
EB21	62	2.1	53%	0.47	0.70	3.2	8.7
EB22	63	2.7	55%	0.48	0.71	4.5	12.1

WA BASINS

BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	C5	C100	Q5 (CFS)	Q100 (CFS)
WA1	1	1.6	90%	0.77	0.85	4.8	9.7
WA2	2	8.4	19%	0.19	0.56	6.4	34.9
WA3	3	2.3	69%	0.60	0.77	4.4	10.3
WA4	4	1.0	65%	0.57	0.75	2.0	4.8
WA5	5	0.3	90%	0.77	0.85	0.9	1.9
WA6	6	1.2	61%	0.53	0.73	2.0	5.0
WA7	7	1.7	62%	0.54	0.74	2.9	7.3
WA8	8	0.9	90%	0.77	0.85	3.1	6.2
WA9	9	1.8	55%	0.48	0.71	2.5	6.8
WA10	10	2.3	70%	0.60	0.77	4.1	9.5
WA11	11	4.9	37%	0.34	0.64	5.8	19.9

WB BASINS

BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	C5	C100	Q5 (CFS)	Q100 (CFS)
WB1	12	1.6	90%	0.77	0.85	4.9	9.8
WB2	13	10.4	75%	0.65	0.79	25.2	56.0
WB3	14	0.5	90%	0.77	0.85	1.6	3.1
WB4	15	0.3	90%	0.77	0.85	1.2	2.3
WB5	16	2.8	54%	0.54	0.74	4.4	11.8
WB6	17	2.5	62%	0.54	0.74	4.5	11.3
WB7	18	2.9	60%	0.53	0.73	4.9	12.4
WB8	19	2.8	55%	0.49	0.71	4.3	11.4
WB9	20	2.5	80%	0.68	0.81	5.5	11.8
WB10	21	2.2	72%	0.62	0.78	4.7	10.7
WB11	22	3.1	69%	0.60	0.77	7.6	17.7
WB12	23	0.5	76%	0.65	0.79	1.5	3.4
WB13	24	0.8	68%	0.59	0.76	1.7	4.0
WB14	25	1.7	56%	0.49	0.71	2.9	7.6
WB15	26	3.6	70%	0.61	0.77	8.0	18.4
WB16	27	2.8	37%	0.34	0.64	2.6	9.1
WB17	28	2.9	60%	0.53	0.73	5.1	12.7
WB18	29	3.1	58%	0.51	0.72	5.3	13.6
WB19	30	3.0	54%	0.48	0.71	4.7	12.5
WB20	31	3.3	53%	0.47	0.70	4.8	13.1
WB21	32	3.5	53%	0.46	0.70	5.0	13.8
WB22	71	0.4	60%	0.52	0.73	0.9	2.4
WB23	76	1.8	64%	0.56	0.75	3.1	7.7
WB24	77	2.4	85%	0.73	0.83	7.1	14.8
WB25	78	4.2	2%	0.05	0.49	0.5	8.6

WC BASINS

BASIN	DESIGN POINT	AREA (ACRES)	% IMP.	C5	C100	Q5 (CFS)	Q100 (CFS)
WC1	71	0.7	90%	0.77	0.85	2.3	4.6
WC2	72	1.6	90%	0.77	0.85	4.3	8.8
WC3	73	3.8	2%	0.05	0.49	0.6	10.4
WC4	74	1.0	90%	0.77	0.85	2.6	5.3
WC5	75	4.3	2%	0.05	0.49	0.7	11.8

NOTES:

1. EXISTING WILLOW CREEK AND EXISTING WILLOW CREEK FLOODPLAIN ARE SHOWN FRO INFORMATION ONLY. PROPOSED IMPROVEMENTS TO WILLOW CREEK ARE BEING COORDINATED WITH URBAN DRAINAGE AND FLOOD CONTROL DISTRICT AND WILL BE SHOWN IN FUTURE SUBMITTALS.
2. STORM SEWERS, INLETS, AND DRAINAGE FACILITIES ARE CONCEPTUAL AND SHOWN FOR INFORMATION ONLY. DETAILED DESIGN OF THE STORM SEWER SYSTEM WILL BE COMPLETED WITH THE FINAL DRAINAGE REPORT.
3. MANHOLES AND DRAINAGE FEATURES ARE SHOWN AT A LARGER SCALE FOR AESTHETIC PURPOSES.
4. EXISTING CONTOURS SHOWN AT 1' INTERVAL. PROPOSED CONTOURS SHOWN AT 2' INTERVAL.

POND SUMMARY TABLE

POND	IMP	TRIB. AREA	100-YEAR REQ. VOLUME
	%	ACRES	AC-FT
WEST	54%	102.9	10.1
EAST	51%	61.1	5.8

LEGEND

BASIN BOUNDARY
SUB-BASIN BOUNDARY
CONCEPTUAL 100-YEAR FLOODPLAIN
1' DEPTH 4H:1V OPEN CHANNEL V-SWALE
PROPOSED STORM SEWER SYSTEM
PROPOSED TYPE-R INLET
DIRECTION OF FLOW
DESIGN POINT
1
BASIN B 1.25 .85 .95 C5 C100
AREA IN ACRES

N

150 75 0 150 300
SCALE: 1"=150'
ALL DIMENSIONS SHOWN ARE U.S. SURVEY FEET

MARTIN/MARTIN
CONSULTING ENGINEERS
12499 WEST COLFAX AVENUE, LAKEWOOD, COLORADO 80215
303.431.6100 MARTINMARTIN.COM

NOT FOR CONSTRUCTION

STERLING RANCH
PRELIMINARY PLAN NO. 3
PRELIMINARY DRAINAGE PLAN
PROPOSED DRAINAGE PLAN

No.	Issue / Revision	Date	Name
1	ISSUED FOR CONCEPTUAL REVIEW	05/03/18	M/M
2	ISSUED FOR CONCEPTUAL REVIEW	08/27/18	M/M
3	ISSUED FOR 2ND SUBMITTAL	09/13/18	M/M
4	ISSUED FOR 3RD SUBMITTAL	10/24/18	M/M

Job Number 18.0158
Project Manager D. KUNTZ
Design By J.DICKERSON
Drawn By J. DICKERSON
Principal In Charge D. LOVATO

Sheet Number:
D1

PLOT DATE: Wednesday, December 05, 2018 9:38 AM LAST SAVED BY: JDICKERSON
DRAWING LOCATION: G:\LOVATO\18.0158-Sterling Ranch Filing 3\ENG\DRAINAGE\PRELIMINARY DRAINAGE REPORT\DWG\D1.dwg