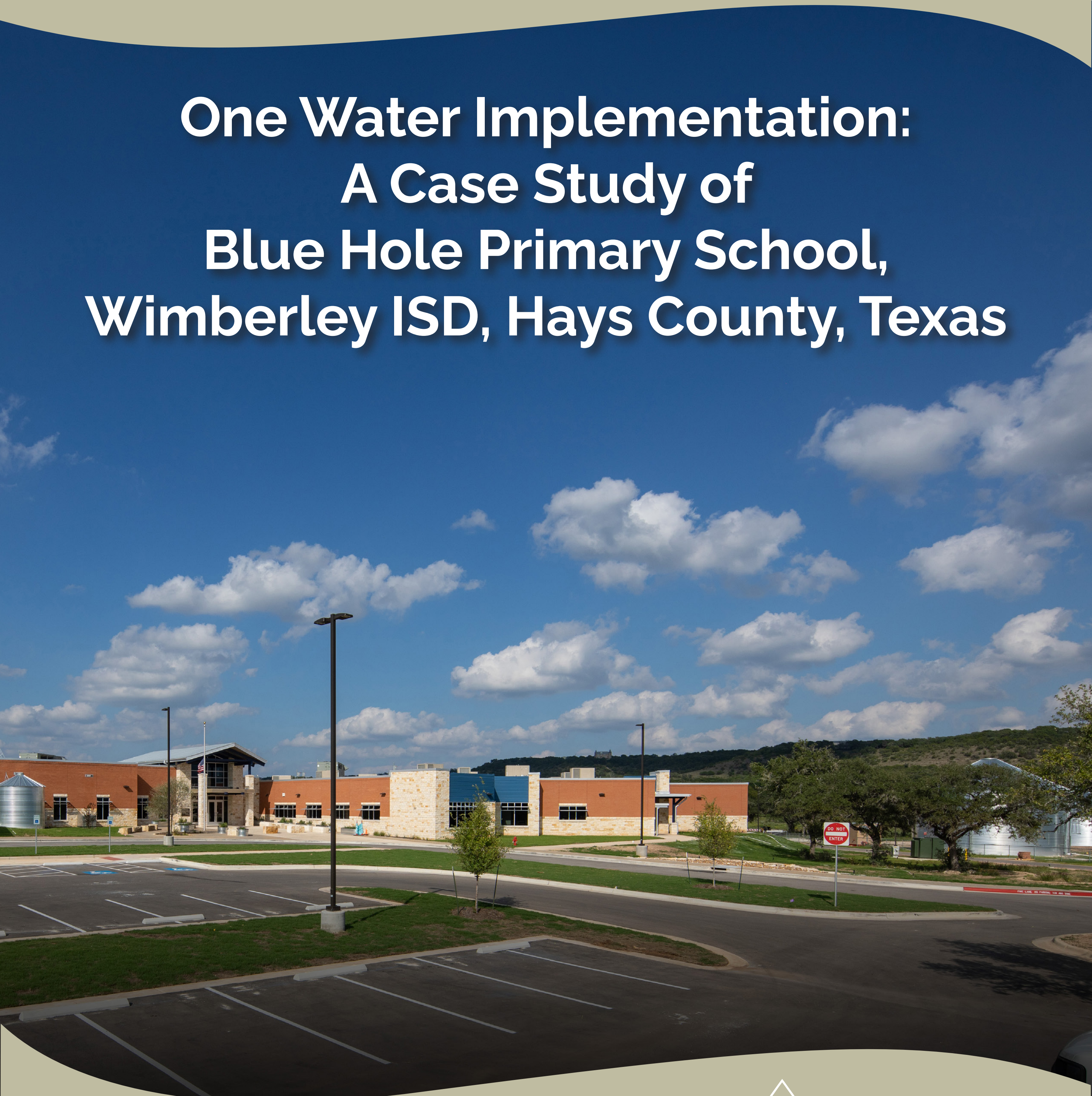
Watershed Association Technical Report
July 2023

# One Water Implementation: A Case Study of Blue Hole Primary School, Wimberley ISD, Hays County, Texas

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*Cover photo: Blue Hole Primary School campus, Ray Don Tilley*


*2020-2021 Blue Hole Primary Second Grade GT Students, Photo by Diana Spangenberg.*


## Abstract

Using innovative One Water concepts to minimize water use and optimize onsite reuse, Wimberley Independent School District's newest campus—Blue Hole Primary—was designed and constructed with strong support from the Wimberley Valley Watershed Association, Texas State's Meadows Center for Water and the Environment, and the community. One Water is an intentionally integrated approach to water that promotes the management of all water—drinking water, wastewater, stormwater, greywater—as a single resource. In an area where water supplies are limited and drought-prone, Blue Hole Primary serves the growing Hill Country communities of Wimberley and Woodcreek with one of the most water efficient and cost-effective approaches ever envisioned for a school campus in Texas.

This case study documents the need for innovative water solutions, bond and investment decisions, incorporated design elements, construction, and first year performance of Blue Hole Primary to serve as a reference, inspiration, and guidance for future projects.

# Need for Innovative Water Solutions

*Sunset at Colemans Canyon*
*Photo by Jonathan Ogren*

## Hill Country Groundwater and Surface Water

Groundwater, wells, springs, and streams are strongly connected in the Hill Country, and spring flow is a measurable indicator of the overall health of the region's groundwater supply (Gary et. al, 2019; Hunt et. al, 2018; Smith et. al, 2013). The limestone hills and valleys have been faulted and eroded through time, so rainfall rapidly infiltrates through the thin soils, faults, and karst features (like caves and sinkholes) to replenish the Trinity and Edwards Aquifers (Hunt et. al, 2020, Wierman et. al, 2010). Springs provide essential baseflow to iconic Hill Country creeks, streams, and rivers. As water travels downstream, karst features in streambeds can funnel it back into the groundwater system, and the process is repeated—it is a well-connected water cycle.

The Trinity and Edwards aquifer systems are both dominated by karstified limestone, but their rock layers were deposited during different time periods, and consequently have different characteristics. The Trinity system has a diverse set of rock layers including the upper and lower Glen Rose limestones, Hensel sandstone, Cow Creek limestone, and the Sligo and Hosston conglomerates (Wierman et. al, 2010). Because of the highly variable properties of the rock layers, the Trinity Aquifer is separated into three aquifer subsystems: the Upper, Middle and Lower Trinity (Hunt et. al, 2020, Wierman et. al, 2010). Trinity rock layers are at the surface or just under thin soils in the western areas of the Hill Country where the rocks that form the Edwards Aquifer have been eroded away through uplift and weathering. Rainfall on the surface—particularly where Middle Trinity rock layers are exposed—recharges the Trinity Aquifer quickly.

*Jumping into Jacobs Well*
*Photo by Carl Griffin; HotShot Media*

Trinity Aquifer springs tend to be smaller and more distributed than Edwards Aquifer springs, but because of their location in the upstream sections of Hill Country watersheds, they play a critical role (Mace et. al, 2000). Trinity springs provide vital baseflow for headwater reaches of rivers, including the Blanco, Pedernales, Guadalupe, Medina, Frio, and Nueces Rivers (TWDB, 2016). Jacob's Well and Pleasant Valley Springs are the largest of these springs and have flows ranging from 0 to 70 cubic feet per second, cfs).

Spring flows have been measured since the early 1900s and continuous monitoring is becoming more prevalent. Long-term flow records are essential to better understand how climate and population have impacted spring flow and streamflow in the Hill Country. Central Texas' frequent floods and droughts are reflected in highly variable spring flow rates. Edwards Aquifer spring flow has long served to set/inform/trigger drought conditions. Establishment of Trinity Aquifer spring records has begun and will be an important tool to inform sustainable groundwater management.

## Population

Texas added more people than any other state in the United States over the last ten years. Overall, all the Hill Country counties populations increased. In particular, from 2010 to 2020, Hays County added 83,960 additional residents, growing by 53%--the fastest growing county in the state (Fig. 1). From 2000 to 2020, the population in Hays County increased from 97,589 to 241,067 residents (Fig. 2).

Hays County residents and businesses rely on groundwater (aquifers) and surface water (lakes and rivers) as water supplies for domestic, livestock, public supply, irrigation, and commercial use. The Trinity and Edwards Aquifers serve as direct supply through wells, and springs flowing from these aquifers provide baseflow to creeks and rivers. Carrizo Aquifer groundwater is transferred via pipeline from eastern counties like Caldwell and Lee to communities along the I-35 corridor. Lakes and run-of-river access from the Guadalupe, Blanco and Colorado Rivers provide surface water supplies. Population increases, associated development and limited water resources stress water supplies and impact aquatic habitat.

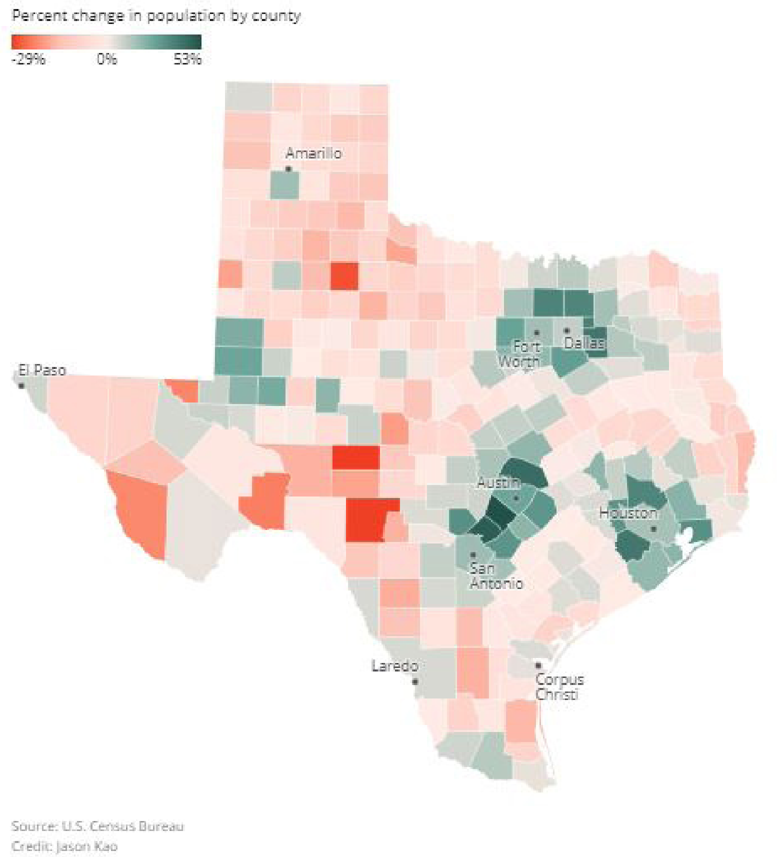



*Figure 1: Percent change in population by County from 2010 to 2020. Figure credit: Texas Tribune.*


*Figure 2: Hays County population (over 18 years old), Texas Demographic Center, 2021*

## Regional Water Supplies

Most Hays County residents depend on groundwater from the Trinity and Edwards aquifers either directly through groundwater wells and groundwater-supplied utilities or indirectly through surface water that benefits from baseflow provided by springs (Fig. 3). In the western portion of the county, wells and groundwater-supplied water utilities rely on the Trinity aquifer as the sole drinking water source. Utilities serving Wimberley and Woodcreek depend on multiple Trinity Aquifer wells and have no access to surface water sources. Some northern Hays County communities have access to surface water through the LCRA. Many rural residents still rely on private wells, and Dripping Springs combines both surface and groundwater to supply its growing population. Along the I-35 corridor, San Marcos, Kyle, Buda, and eastern water supply corporations combine Edwards Aquifer wells with surface water supplied through GBRA and groundwater from the Carrizo Aquifer delivered through pipeline.

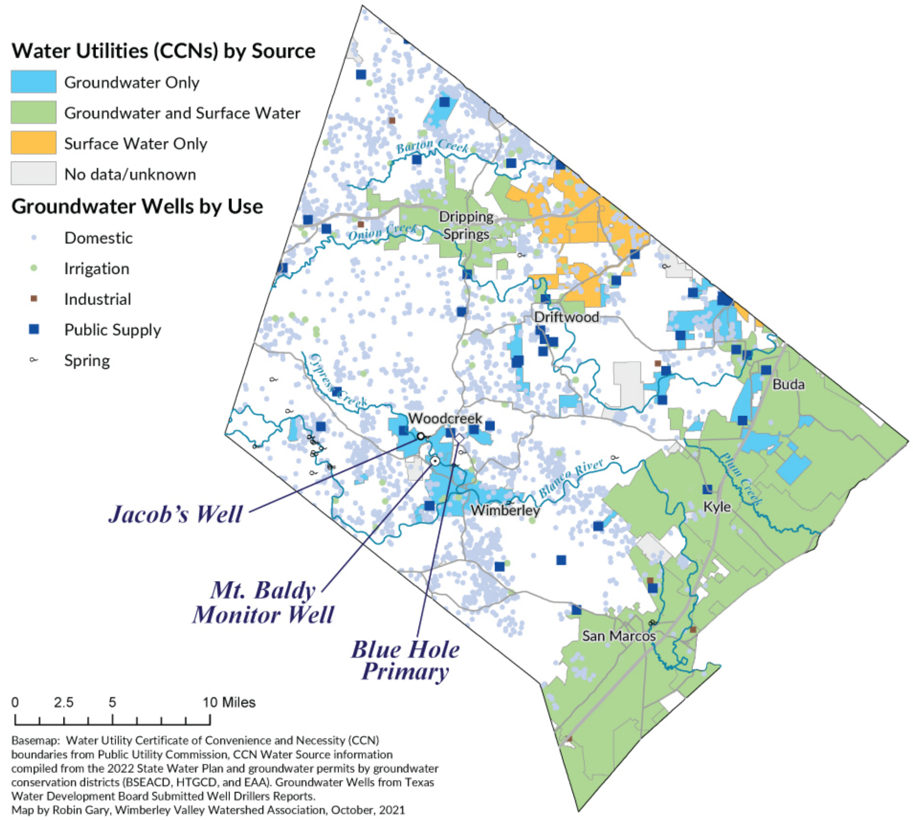



*Figure 3: Water Supplies for Hays County*

The Texas Water Development Board (TWDB) estimates that 30 percent of all surface-water flows in Texas originate from groundwater, and states that groundwater contributions to surface water are greatest around major springs in the Hill Country (TWDB, 2016). Fish and wildlife rely on springs to keep rivers flowing when rainfall is scarce.

Groundwater levels in wells and flow at springs reflect the amount of groundwater stored in source aquifers; higher water levels and spring flow are measured during wet periods, and lower water levels and low to no spring flow during droughts. Large pumping centers and localized heavy groundwater use can lower groundwater levels, causing measurable drawdowns that can impact spring flow. In 1990, the Hill Country Priority Groundwater Management Area was established in response to existing and predicted groundwater shortages in the Trinity Aquifers (Cross and Bluntzer, 1990). Monitor wells, particularly in the Trinity Aquifer, show substantial drawdown near dense groundwater-dependent population centers.

Drought, rainfall, and pumping affect groundwater in the Hill Country. Spring flow records clearly demonstrate seasonal, climatic, and pumping-induced fluctuations in flow in both the Trinity and Edwards springs. Owing to the comparatively thin nature and smaller contributing zone for the Trinity Aquifer, the impact of water level and spring flow fluctuations are more pronounced than those observed in the Edwards Aquifer.

In 2000, after prolonged drought, Cypress Creek made the U.S. Environmental Protection Agency (EPA) impaired stream segment list (also known as the 303(d) list) because of a quantity of dissolved oxygen lower than needed to support aquatic life. Dissolved oxygen levels and suitable aquatic habitat correlate with flow. The degraded water quality correlated with the creek's recorded low flow of 0.33 cubic feet per second (cfs) in July of 2000.

In 2005, the U.S. Geological Survey (USGS) continuous flow gauge at Jacob's Well was established. Initial funding was provided by the Watershed Association and the USGS Coop program, then in 2008, the Guadalupe Blanco River Authority incorporated the Jacob's Well gauge into their USGS contract.

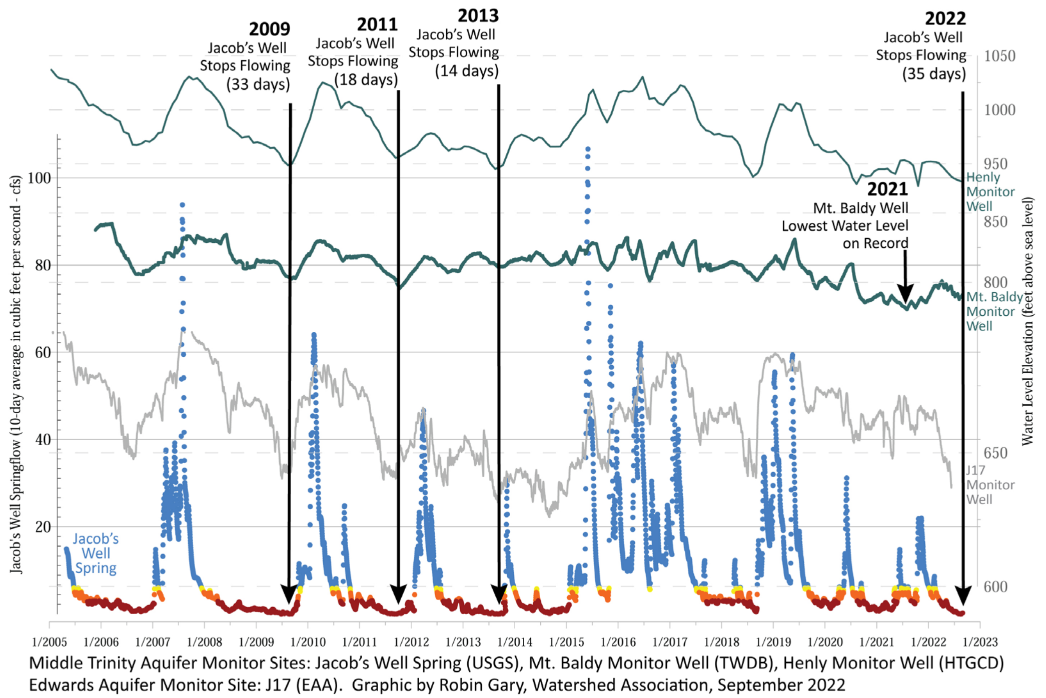



*Figure 4: Spring flow and water levels from 2005 to September 2022. Jacob's Well spring flow is color coded according to HTGCD drought trigger thresholds (Blue: no drought; Yellow: 10% reduction in pumping; Orange: 20% reduction in pumping; Red: 30% reduction in pumping).*

The continuous spring flow record is currently used as a drought trigger for area water suppliers (Fig. 4). In 2008, through a grant from the TCEQ and the EPA, partners led by the Watershed Association and the Meadows Center for Water and the Environment formalized the Cypress Creek Project and began characterization of the watershed and development of a protection plan. As the first voluntary, proactive plan to incorporate groundwater conservation and water quality protection, the Cypress Creek Watershed Protection Plan was approved by TCEQ in 2014. Implementation of the plan, funded through two phases of Clean Water Act 319(h) funding from the EPA and TCEQ, has boosted education, facilitated installation of green infrastructure and alternate water supplies and helped inform policy and monitor water quality. In March 2020, after a lengthy stakeholder process (informed by a scientific technical committee, the Hays Trinity Groundwater Conservation District established the Jacob's Well Groundwater Management Zone to coordinate water use within the springshed to protect groundwater availability and spring flow. However, in May 2020, Cypress Creek was again listed on the 303d list for impaired stream segments because low flows at Jacob's Well and Cypress Creek caused low dissolved oxygen levels and poor aquatic habitat. Jacob's Well flow has reached a daily average flow of zero 6 times in recent history–2000, 2009, 2011, 2013, 2022 and, 2023.

To safeguard groundwater, wells, springs, and streams in the Hill Country, policies need to encourage alternative supplies, enhance reuse and water conservation, strengthen coordinated drought management, and expand land conservation in critical recharge areas (Parten, 2019). Spring flow is a measurable way to track effective policies and practices. Maintaining healthy, flowing springs in the Hill Country benefits all residents and visitors, both human and wildlife alike.

# Wimberley's One Water School


*Wimberley Drought Stage*
*Photo by Robin Gary*

## Wimberley ISD's One Water School

Wimberley is a growing groundwater community in Hays County. Like many Hill Country cities, the tourism-based economy attracts visitors enticed by natural beauty. People travel from across the globe to visit Jacob's Well, Blue Hole, and Cypress Creek and stay to shop, eat, and enjoy. Groundwater from the drought-prone Middle Trinity Aquifer provides flow to Jacob's Well and Cypress Creek and is the sole source of drinking water for the community. Blue Hole Primary's one water approach minimizes reliance on this stressed supply.

When Wimberley ISD announced that it would build a new campus for its primary school it raised several environmental concerns. The additional development would increase water demand on the already stressed Middle Trinity Aquifer. The conversion of native rangeland to a developed site could create stormwater impacts to a wet-weather tributary to Cypress Creek and Cypress Creek itself without thoughtful stormwater infrastructure. Standard construction practices with minimal water conservation practices could create avoidable increases in water use and need for costly wastewater infrastructure to transport raw sewage a long distance through sensitive areas.

Wimberley residents approved a $31.3 million bond project in May 2018 to allow WISD to build a new primary campus with a capacity of 800 students in pre-k through second grade with 40 classrooms, a gymnasium, a library, a cafeteria and several smaller reading and math intervention classrooms. This was the perfect opportunity to put Science, Technology, Engineering and Math (STEM) principles of the One Water approach into practice. The Meadows Center for Water and


*Wimberley ISD Board of Trustees Approves One Water Design with Community Support*
*Photo by Ray Don Tilley*

the Environment shared a vision with the WISD superintendent for a new campus that would incorporate components of the Cypress Creek Watershed Protection Plan, conserving local water supply and protecting water quality. With initial interest from WISD, the Meadows Center partnered with the Watershed Association to further develop an idea for a teaching campus where students can experience science, technology, engineering, and math concepts that minimize water use, safely reuses wastewater, and helps protect our community water supply. Moving from idea to action, The Watershed Association assembled an architectural team to develop a One Water plan for the new primary campus and worked with The Meadows Center and other environmental organizations to build grassroots support for the concept. The One Water Team, as it became known, worked with WISD administrators and contracted architects and engineers to incorporate  One Water elements into a design plan for the new WISD primary school.  To this end, the Watershed Association obtained additional funding to enhance the original project design and construction costs to complete key features of the One Water project as necessary.

The WISD Board of Trustees approved the design for Blue Hole Primary on November 29, 2018. The Board voted unanimously to put the conservation of natural resources at the forefront of the campus master plan by selecting the design that included rainwater and HVAC condensate collection, onsite wastewater treatment and reuse, green stormwater infrastructure, and STEM education—making it the first One Water School in Texas. “We are fortunate to live in a community where support for education is a top priority. Tonight, we are taking this focus on our students a step further, by leading the way in conservation of natural resources for generations to come and also, creating a limitless educational environment,” said Joe Malone, Wimberley ISD Board President. “This team has worked tirelessly to look out for the education goals we have for our students and also build a campus that looks out for their future. We are grateful for the community support of our bond and the added attention to the value of conservation as both a teaching tool and a way to move forward together in being the best stewards of our natural resources,” said Dwain York, Wimberley ISD Superintendent.

## Design Options, Cost Analysis

The cost comparison between Conventional and One Water designs showed a substantial return on investment within 30 years.  By leveraging the One Water design elements rather than standard construction with centralized water/wastewater service, the water consumption footprint was reduced by approximately 90 percent.  Through site-harvested supply and direct onsite reuse, an estimated 237 acre-feet of groundwater would be conserved over 30 years.  The One Water design option projected an estimated annual cost savings between $29,000 and $48,000 per year and a total cost savings over 30 years to exceed $1,000,000 in 2018 dollars (Table 1).

| *Water Subsystem* | *Cost Type* | *Conventional* | *One Water* |
|---|---|---|---|
| *Wastewater & Reuse* | Capital | $750,000 | $446,778 |
| | Annual Operations and Maintenance | $26,695 | $6,000 |
| *Rainwater & AC Condensate Collection* | Capital | $0 | $250,000 |
| | Annual Operations and Maintenance | $19,488 | $10,188 |
| *Stormwater Management (LID & Green Infrastructure)* | Capital | $0 | $125,000 |
| | Annual Operations and Maintenance | $0 | $0 |
| *Summary of all Subsystems* | Capital + 30-year Operations and Maintenance | **$2,135,490** | **$1,307,418** |

*Table 1: Conventional vs. One Water Design Cost Estimates*

Initial capital costs for the One Water design were estimated to be nearly $72,000 over the cost for a conventional build. Given the community benefits associated with minimizing potable water demand, protecting community groundwater supply, and reducing impacts of nonpoint source pollution on Cypress Creek, the Watershed Association secured additional funding to support the innovative One Water design, engineering, and construction. The original, voter-approved bond with the additional community funding made the One Water project feasible. The short-term and long-team economic benefits, sustainable and reliable water/wastewater infrastructure, and unique educational opportunities for WISD staff, students, families, and visitors gained community support. WISD, the Watershed Association, and the Meadows Center entered into a memorandum of understanding to collaborate on the planning, design, and construction funding for the new primary school.

## One Water Elements

Construction officially broke ground at the site on the corner of Ranch Road 12 and Winters Mill Parkway on Monday, July 29, 2019. Teams included architectural design by O'Connell Robertson, project managers from AG|CM, Inc., civil engineering from Doucet & Associates, Inc., wastewater treatment and reuse design by David Venhuizen, P.E., and construction management by Bartlett Cocke. One water construction coordination team included volunteers and staff from the Watershed Association, the Meadows Center, WISD, and AG|CM, Inc. The campus design incorporates One Water elements in the water supply, wastewater treatment and reuse, and stormwater infrastructure (Fig. 5).


*Figure 5: The Blue Hole Primary School One Water Campus. Graphic by Robin Gary..*

### Water Supply

To minimize water demand and protect on the already stressed Middle Trinity aquifer, Jacob's Well, and Cypress Creek, alternate water supplies for nonpotable use were built into the design (Fig. 6). Potable water is provided by the Aqua Texas—Woodcreek System, a groundwater-supplied water utility with wells that directly impact flow at Jacob's Well. Through water efficient fixtures, site-harvested supply and dedicated fire suppression supply tank, the One Water design minimizes the potable water demand and allowed for a smaller connection to the Aqua Texas supply. The smaller connection equates to a lower connection fee and monthly base fee.


*Figure 6: Blue Hole Primary water supply tanks. Photo credit: Ray Don Tilley.*

The campus is equipped with three water storage tanks. The smallest of the three is a 10,000 gallon tank at the front entrance used to irrigate landscaping. Students and visitors can see rainwater collection first-hand through a rain tube located in the library. During rain events, rainwater provides an impressive show as it thunders through the tube. The dedicated fire suppression supply tank is immediately adjacent to the school. It stores 225,602 gallons to be used for interior fire sprinklers, on-site fire hydrants, and direct fire hose connections.

*Figure 7: The plumbing window with color-coded pipes. Photo by Ray Don Tilley.*

The tank with the lowest elevation and widest diameter collects 200,000 gallons of site-harvested rainwater and AC condensate. An extensive scupper, gutter, first-flush-diverter, and piping system delivers rainwater from approximately 80,000 square feet of roof to the site-harvested supply tank. The storage tank elevation and dimensions were established to maximize gravity-feed during rain events. In-line pumps recover more than 12,000 gallons of water from the rainwater collection piping after each rain event. The site-harvested supply provides high-quality, nonpotable water to meet indoor nonpotable demand (toilet flushing). The site-harvested water is filtered, treated by a UV light, then colored with a non-toxic dye for educational purposes before it is routed to 50 toilets and six urinals. A plumbing window shows the color-coded pipes that serve the boys and girls restrooms near the cafeteria. Red and blue pipes are potable hot and cold water, purple pipes are the site-harvested supply, green pipes are the grey and black water, and yellow pipes are vent tubes (Fig. 7).

Engineering analysis shows that given an occupancy of 800 people with an estimated 2.85 gallon per day interior nonpotable water demand, and an average annual precipitation calculated based on data from 1987-2014, the rainwater harvesting system alone will meet the interior demand over 96% of the time (Venhuizen, 2020). To augment the rainwater supply, condensate from 84 AC units on the roof (Fig. 8) are piped to the site-harvested supply tank and is estimated to provide an additional 600 to 1,300 gallons per day. In the rare case of a shortfall or system malfunction, the potable water supply connection serves as a backup and will maintain a minimum water level and supply the school.

*Figure 8: Condensate from 84 roof-top AC units contribute to the site harvested supply. Photo by Robin Gary.*

## Wastewater Treatment and Reuse

With water-conserving features, the school produces less than 5,000 gallons per day of gray/black water, which allows it to be treated onsite rather than requiring costly wastewater infrastructure to transport sewage to the community wastewater treatment facility. An advanced, building-scale wastewater treatment system allows gray and black water produced by the school to be beneficially reused through a subsurface drip irrigation system for a high-quality turf field.

The system uses an Orenco AdvanTex® AX100 high-performance, biofiltration-concept treatment unit with a separate primary septic tank and a separate septic-recirculation tank, duplex pump systems, two recirculation side filter beds, and one effluent side filter bed (Fig. 9). Grey and blackwater flow from the building runs into a primary septic tank. From there it flows into a septic-recirculation tank, where it is joined by recirculation flow from the recirculation side filter beds. An effluent filter on the outlet of the septic-recirculation tank serves to retain solids and so deliver a more highly clarified wastewater into the filter bed dosing tank. A set of duplex pumps in that tank runs wastewater onto the top of the filter bed. The water then flows down through a vertical pleated filter bed by gravity.

*Figure 9: Components of the onsite treatment system during installation. Photo credit: Bob Farmer.*

The system uses an alkalinity feed system, placed on the recirculation drain line, to provide advanced nitrogen reduction. The feed system increases the alkalinity level in the water being treated to maintain nitrification in the filter beds, so that nitrogen can be removed from the wastewater by denitrification in the septic-recirculation tank. The nitrification process reduces alkalinity, so if the source water has low alkalinity, it can be exhausted, and nitrification would cease. With much of the water source that becomes wastewater being site-harvested rainfall, which has very low alkalinity, the alkalinity feed unit maintains optimal alkalinity levels for effective nitrogen removal as water within the filter beds. By optimizing nitrification in the filter beds, the nitrogen level in the effluent pumped to the subsurface drip irrigation field is reduced.

An inline UV treatment before water is routed to field drip irrigation provides extra treatment and a safety factor. While the treated effluent is sequestered underground in the subsurface drip irrigation field, disinfection prior to dispersal provides further protection from any exposure to the effluent water, due for example to line breaks in the field. With recirculation bays, biofiltration, advanced nitrogen reduction, and UV treatment, this system is designed to approach Type 1 effluent water quality limits.

The 1.27 acre (55,440 square feet) subsurface drip irrigation field is located behind the school. Treated effluent is irrigated through an array of 7 miles (36,960 feet) of drip lines with emitters on 1-foot spacings (Fig. 10). The drip lines were capped with 8 inches of loamy fine sand and native soil, then seeded with bermuda grass. The drip irrigation provides safe dispersal of treated effluent and creates a reliable water source for the turf grass on the playing field. An irrigation controller alternately doses eleven zones of drip lines to ensure the entire field is watered. There is little to no odor and students frequently use the playing field during PE and recess.

*Figure 10: The subsurface, drip irrigation system being installed. Photo by Ray Don Tilley.*

## Stormwater Infrastructure

To minimize impacts from converting native rangeland to a developed site, the campus was designed with green stormwater infrastructure used in series to protect surface water flows in the Cypress Creek watershed. Since the project is in the Edwards Aquifer Contributing Zone, the project complied with the TCEQ Edwards Aquifer Protection Program pollution management criteria that requires treatment of 80% of the increased total suspended solids (TSS) load resulting from proposed development. The school was developed on a 19-acre parcel owned by the Wimberley Independent School District (WISD) within a larger 145-acre tract. The school added 5.55 acres of development within the 19-acre parcel, i.e., impervious cover of 29%. To meet the TCEQ requirements, a variety of stormwater management measures were incorporated to remove 4,974 pounds of suspended solids each year.

There are 3,865 square feet of permeable pavers incorporated into the front entry and student pickup area. Permeable pavers are installed with small gaps between the individual pavers,

*Figure 11: Permeable paver system being installed. Photo by Ray Don Tilley.*

allowing for water to move through the paver's voids into the underlying gravel and soil layers at a controlled rate. The substrate below the pavers is a high-porosity aggregate that retains and allows stormwater to readily pass through to aid recharge to the soil and groundwater systems for enhanced treatment and runoff volume reduction (Fig. 11).

A grassy swale runs alongside the road located on the west side of the school site. Swales are vegetated channels that convey stormwater and remove pollutants through sedimentation and allowing runoff to infiltrate.

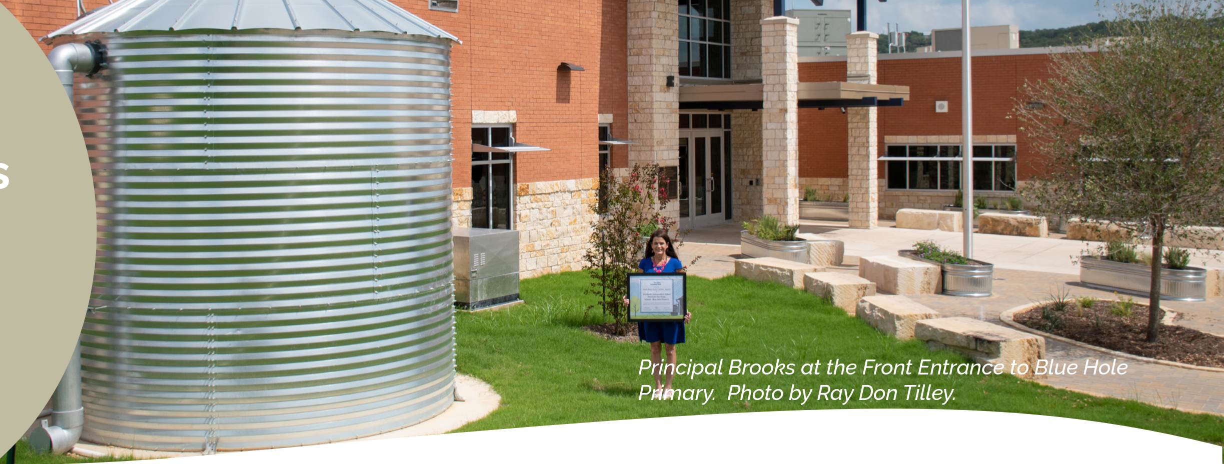
Two rain gardens add stormwater treatment. Rain gardens are small, shallow gardens constructed below grade to collect stormwater runoff (Fig. 12). They use plants to bioremediate pollution and help uptake moisture. Rain gardens are designed to mimic the natural ways water flows over and absorbs into land to reduce stormwater pollution.

*Figure 12: A rain garden after significant rainfall. Photo by Bob Farmer.*

Next in the series of stormwater treatment components are two sets of vegetated filter strips with a total area of 11,733 square feet located within the parent and visitor parking lot. Additional vegetated filter strips located throughout the site combine to a total of 63,623 square feet. These curb-less, grass areas allow stormwater to sheet-flow directly from impervious areas into the vegetation that slows runoff, traps debris and particulates, and allows the plants to uptake and treat pollutants associated with parking lot runoff. These vegetated filter strips provide effective pre-treatment for stormwater prior to entering an extended detention basin.

The campus has two extended detention basins that can hold 105,918 cubic feet, or 792,322 gallons of stormwater runoff within a footprint of 56,845 square feet. These basins temporarily store and mitigate stormwater runoff by slowing runoff, reducing erosion, and promoting pollutant settling. The effective pre-treatment elements (filter strips, permeable pavements, sheet flow) allow for smaller, less obtrusive detention basins that are built within the natural grade on the campus. This resulted in saving many trees and they can be found throughout the basins. Both detention basins are dry during non-precipitation periods and facilitate storm runoff management to protect the receiving streams and not generate an increase in flooding.

# Impact and Implications



*Principal Brooks at the Front Entrance to Blue Hole Primary. Photo by Ray Don Tilley.*

## First Year Performance

Blue Hole Primary opened for students in August 2020 and construction projects were finalized throughout the 2020-2021 school year. The measurable impact of one water components is evident in water utility bills, comparison of water demand based on standard versus one water design, and meter readings. Additional estimates are available for gallons of AC condensate and rainwater collected. However, equally impressive is the impact the design has as a living lab for students and visitors.

Aqua Texas, a groundwater-supplied, investor-owned utility, provides potable water to Blue Hole Primary and both potable water and sewer service to Jacob's Well Elementary. The schools are similar student/staff populations, however Jacobs Well Elementary follows a standard design rather than the one water design used at Blue Hole Primary. During the 2020-2021 school year, school attendance records show that with the exception of one month, Blue Hole Primary had an average of 39 more students than Jacob's Well Elementary (Fig. 13).

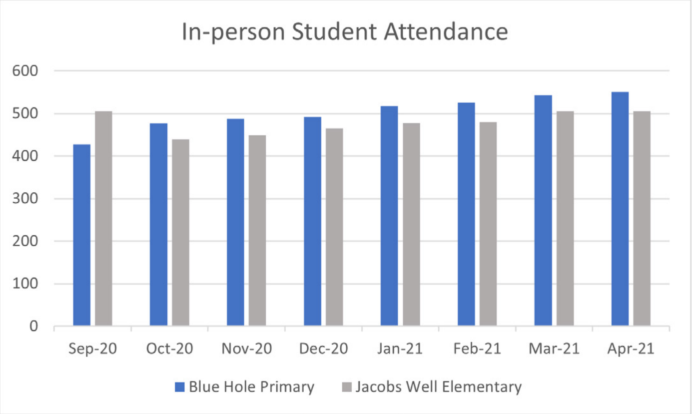



*Figure 13: Student attendence at Blue Hole Primary and Jacob's Well Elementary during the 2020-2021 school year.*


*Blue Hole Primary opens for students in August 2020. Photo by Robin Gary.*

In October 2020, the site-harvested supply system came online. Figure 14 shows potable water use and water and wastewater costs for Blue Hole Primary and Jacob's Well Elementary. From October 2020 to September 2021, Blue Hole Primary used a total of 541,000 gallons and paid $7,630 for the potable water supplied. During the same timeframe, Jacob's Well Elementary used a total of 1,095,800 gallons, paid $15,320 for potable water supplied. Overall, Blue Hole Primary used 49.4% less and paid 49.8% less for potable water. Blue Hole Primary's onsite wastewater treatment and beneficial reuse further reduces operating costs. Jacob's Well Elementary relies on Aqua Texas wastewater service and paid an additional $16,460 in sewage service. Comparing total water and wastewater utility costs for the year, Blue Hole Primary spent $7,630, which is 24% of Jacob's Well Elementary's $31,780. Given today's prices and similar water use, Blue Hole Primary will save Wimberley ISD $724,500 in the next 30 years. In 30 years, the community will benefit because the One Water design will save over 16,632,000 gallons (51 acre-feet).

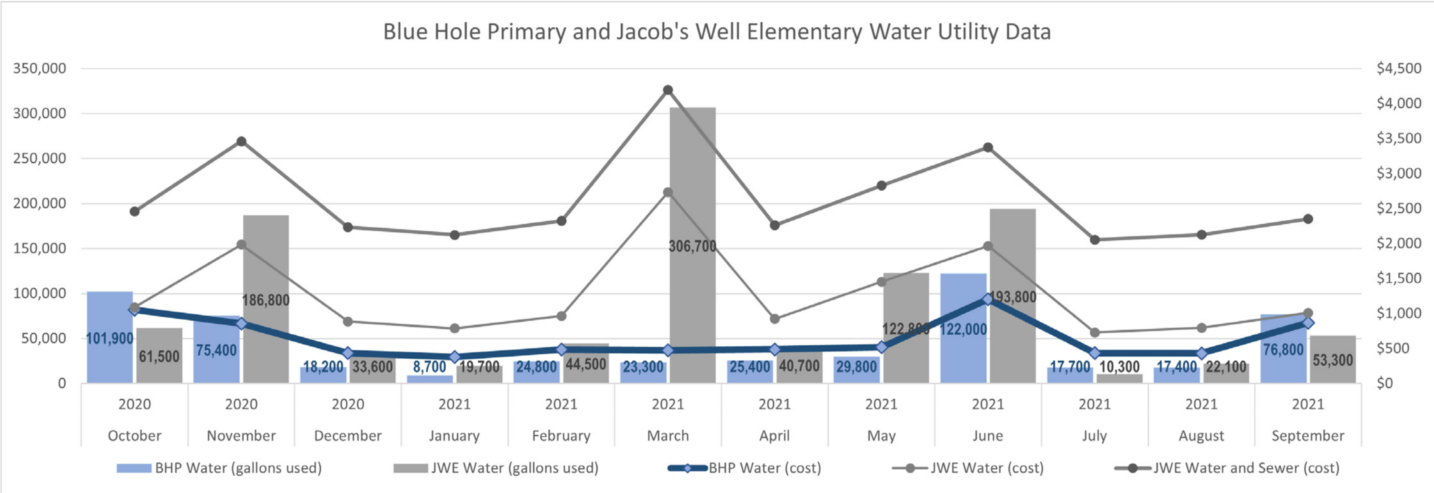



*Figure 14: Comparison of utility costs between one water and standard designs.*

As the One Water systems at Blue Hole Primary moved from concept to startup, efforts were made to minimize operational hiccups. WISD maintenance staff and administrators worked with contractors and designers to understand the school's new water systems, alarms, and features; however, some anomalies exist in the monthly utility data where Jacob's Well Elementary actually out-performed Blue Hole Primary in terms of potable water use.

It is helpful, in this case, to take a deeper look at a more typical month in the first year of operation to better demonstrate the operational capabilities of the Blue Hole Primary water systems.

**April 2021**
**Potable Water Demand Analysis for Blue Hole Primary**

**25,400 gal.** potable water use
**550** students
**22** school days

**2.1 gal. per-student-per-day**
**37.6% of Jacob's Well Elementary use**
**10% of industry standard!**

Blue Hole Primary has a suite of digital meters which provide staff with real-time performance data through a Building Automation System. Snapshots of dashboard readouts taken throughout the year indicate that condensate collection can contribute 2,800 gallons per week during Fall and Spring months when the AC systems are running (Fig. 15). With 1.6-gallon-per-flush toilets, condensate can supply water for 1,750 flushes per week.

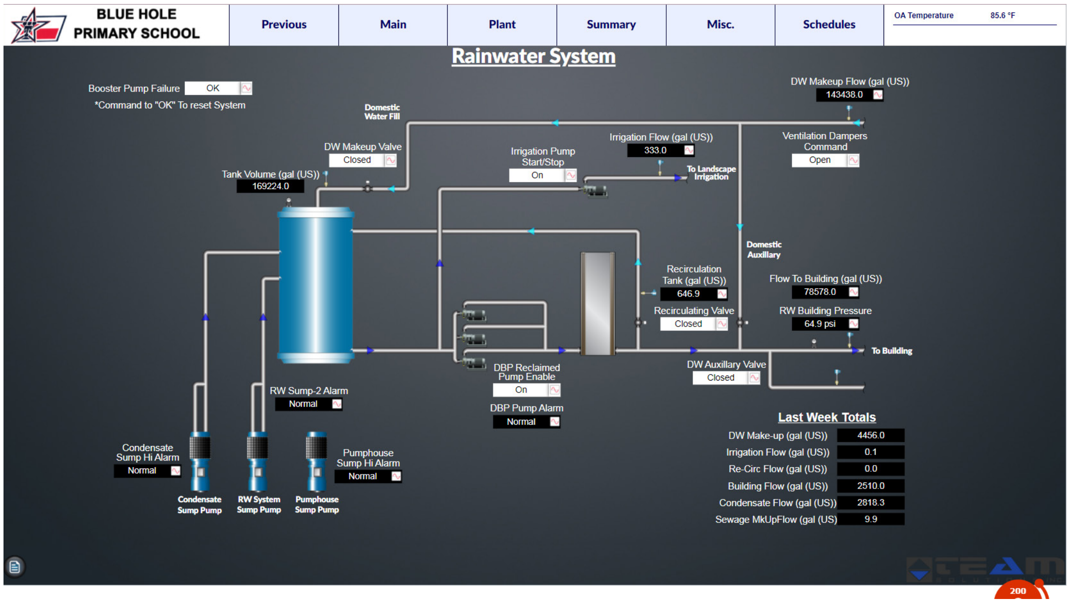



*Figure 15: Building Automation System dashboard showing 2,818 gallons of AC condensate collected in a one week period in September 2021. Image courstesy of WISD.*

The site-harvested supply provides silent water conservation and cost savings, because Blue Hole Primary functions like any other school from the administration, teacher, and student standpoint. However, teaching elements such as the rain tube, plumbing window, blue-colored site-harvested water, and limestone blocks aid in teaching about STEM principles of the One Water design. The school has been a popular tour destination—even during COVID times—for practitioners, scientists, and organizations considering building projects. From the National Onsite Wastewater Recycling Association members to Lake Travis ISD Board and administration and Texas Hill Country Conservation Network partners, the school is a prime example of One Water design in practice. In 2020, the Blue Hole Primary second grade gifted and talented class made a virtual tour video highlighting many of the One Water design elements, and it has been featured at conferences and meetings such as the Hill County Leadership Summit, Rainwater Revival and Hill Country Living Festival, City of Boerne City Council meeting, and Wimberley ISD Trustees, Lake Travis ISD Trustees, Marble Falls ISD Trustees and Comal ISD Trustees meetings.

The One Water School is a quadruple win scenario: 1) The students and families win because their school incorporates STEM principles through innovative design elements and involves the students as part of the solution. 2) The school district benefits because of the lower recurring operating costs than that of a traditional campus. 3) The community benefits because of the low water demand on limited shared water supplies. 4) Society wins because One Water theory has been put into practice where it can be measured, modified and improved to better address water shortage challenges in projects to come.

## Implications

Expanding the utilization of One Water design innovations in alternative water supply, wastewater reuse, and stormwater controls would yield numerous benefits for the Texas Hill Country and communities grappling with water supply shortages. The region has witnessed a significant population increase, the construction of new school campuses, and a housing market struggling to keep up with demand. Consequently, the surging water usage is straining limited groundwater and surface water resources, while direct wastewater discharges pose a threat to the integrity of pristine creeks, rivers, and groundwater aquifers with low phosphorus levels. Embracing One Water concepts presents an innovative approach to decentralized water management and the development of a more resilient, nature-based infrastructure that can adapt to the unpredictable drought and flood cycles experienced in Central Texas.

The declining groundwater levels and diminishing spring flows have prompted local groundwater conservation districts to declare drought conditions in order to secure water availability. Hence, the adoption of alternative water supplies serves to safeguard the community's water resources and preserve natural habitats. Wastewater reuse not only protects the water quality of creeks and rivers but also provides an additional source for nonpotable uses. Similarly, implementing green stormwater infrastructure enhances the quality of runoff, reduces sediment loads, and facilitates infiltration for aquifer recharge.

Design and construction plans are already underway to develop case studies for implementing the comprehensive One Water concept, which has already inspired additional projects within the region. The Hill Country's population is roughly 3.8 million people today and projected to increase to 5.2 million people by 2040—a 35% increase in growth (Texas Hill Country Conservation Network, 2022). Constructing new housing, public buildings, and businesses that utilize only half the water demand of traditional methods would significantly mitigate the environmental impact of new development. Consider the transformative potential if this approach were embraced throughout the Wimberley Valley, Hays County, and the Hill Country region at large. The One Water design represents a practical and scalable solution to extending our already over-allocated water resources and meeting current and future water demands.

*Figure 16: Blue Hole Primary students flying Art4Water kites they decorated and built on the playing field irrigated with subsurface drip reuse water. Photo by Robin Gary.*

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