dgr

Donald G. Rauschuber & Associates, Inc.

P.O. Box 342707
Austin, Texas 78734
Office: (512) 413-9300
dgrwater@dgrainc.com

Water Engineering
Municipal Engineering

July 29, 2019

Curtis Raetz
Double Horn Water Supply Corporation
101 Double Horn Trail
Spicewood, Texas 78669-8640

RE: DOUBLE HORN WATER SUPPLY CORPORATION (the "DHWSC") WATER SUPPLY EVALUATION REPORT (the "Project")

Dear Mr. Raetz:

The purpose of this Letter Report is to provide the DHWSC with an evaluation of its existing groundwater supplies and to identify potential area water supplies that may be developed in the future.

Background:

DHWSC is a non-profit investor owned utility which operates a public water supply system (PWS ID 0270120) in Burnet County. The DHWSC, holding Water CCN No. 12913, is in good standing with the TCEQ and does not have any known outstanding notice of violations pertaining to its public water system operations.

As shown in Table One, Figure 1 and Attachment A, DHWSC has three (3) public water supply wells. Well No. 1 is designated by the TCEQ as a GUI (groundwater under the direct influence of surface water) water supply well. Well Nos. 2 and 3 are not considered to be a groundwater supply under the direct influence of surface water. These wells may be operated independently or in combination to provide water to DHWSC's centralized water treatment plant/pumping plant as shown in Figure 1. Well Nos. 1 and 2 have a common carrier water supply line located downstream of Well No. 2 that conveys water to the water treatment plant. Well No. 3 has a dedicated water supply line that conveys water to the water treatment plant. Water transmission pressure is maintained via two (2) 2.500-gallon pressure tanks. At the water treatment plant, all well production water flows through Harmsco filters and thence through a water treatment plant and thence to ground storage tanks. Treated water is chlorinated prior to entry to the ground storage tanks. Booster pumps transfer water from the ground storages tanks to DHWSC's water transmission and distribution system. A diagram of DHWSC's water flow-stream is shown in Figure 2.

TABLE 1
DHWSC PUBLIC WATER SUPPLY WELLS

DHWSC WELL NO.	STATE WELL NO.	WELL DEPTH (FT)	AQUIFER	CURRENT PRODUCTION GALLONS PER MINUTE (GPM)	REPORTED SPECIFIC CAPACITY[1] (GPM/FT) OF DRAWDOWN
1	57-39-101	600	Ellenburger – San Saba	70	Unknown
2	57-39-102	100	Trinity (Ellenburger – San Saba)	65	0.62
3	57-39-103	123	Ellenburger – San Saba	100	4.66
TOTAL				235	

FIGURE 1
LOCATION OF DHWSC WELLS AND WATER TREATMENT PLANT

Proprietary Information
Original on file

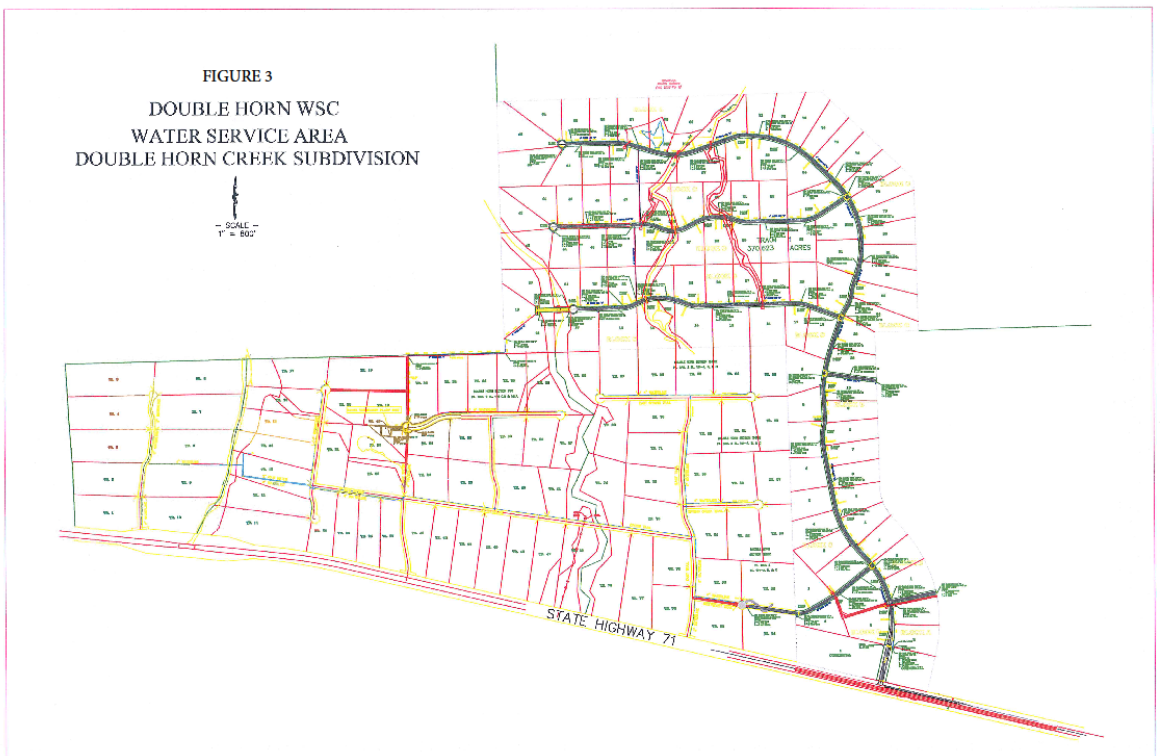
Currently, the DHWSC provides water service to approximately 93 single family residences with a projected build-out of 190 standard 3/4" x 3/4" water meters (single family residences and 7 landscape irrigation water meters). The ultimate projected population within DHWSC's water service area is 475 persons (i.e., 190 connections x 2.5 persons per connection). A copy of the subdivision plat illustrating DHWSC's water service area is shown in Figure 3. Sewer service within the Double Horn Subdivision is provided by privately on-site sewer facilities located on each lot or tract.

[1] A well's specific capacity equals the discharge rate (in gpm) divided by the water level drawdown (in feet).

FIGURE 2
DHWSC WELL WATER SUPPLY AND WATER TREATMENT PLANT FLOW DIAGRAM (EXISTING)

Proprietary Information
Original on file

FIGURE 3
DOUBLE HORN SUBDIVISION



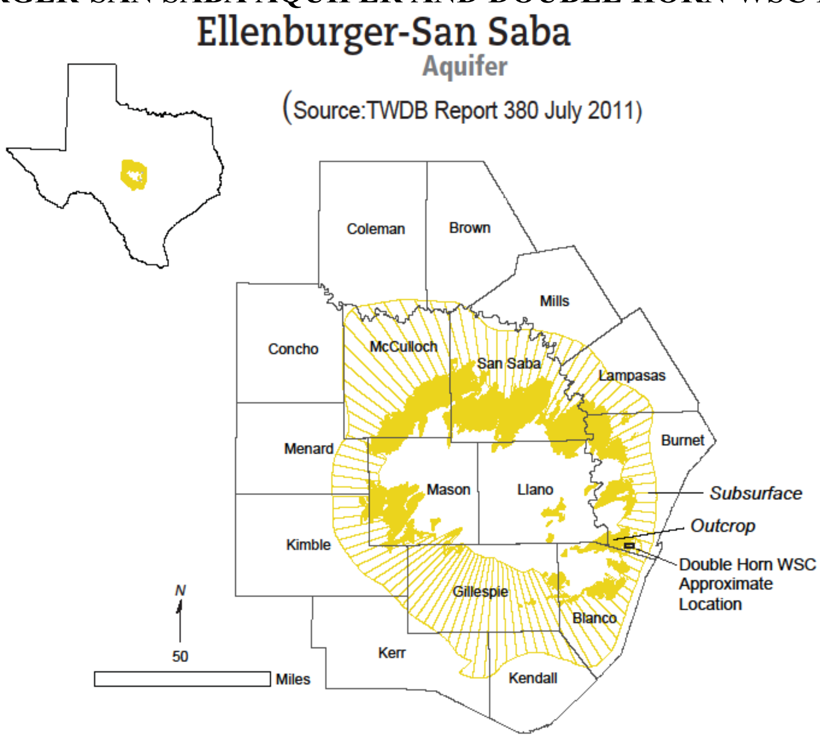
<u>Water Source</u>:

As shown on Table 1, DHWSC's public water supply wells are completed in the Ellenburger – San Saba Aquifer (see Figure 4). This groundwater bearing unit is a minor aquifer that is found in parts of 15 counties in the Llano Uplift area of Central Texas. The aquifer consists of the Tanyard, Gorman, and Honeycut formations of the Ellenburger Group and the San Saba Limestone Member of the Wilberns Formation. The aquifer consists of a sequence of karst limestone and dolomite that crop out in a circular pattern around the Llano Uplift and dip radially into the subsurface away from the center of the uplift to depths of approximately 3,000 feet. Regional block faulting has significantly compartmentalized the aquifer. The maximum thickness of the aquifer is about 2,700 feet. Water is held in fractures, cavities, and solution channels and is commonly under confined conditions. The aquifer is highly permeable in places, as indicated by wells that yield as much as 1,000 gallons per minute and springs that issue from the aquifer, maintaining the base flow of streams in the area.

Most of the groundwater is used for municipal purposes, and the remainder for irrigation and livestock. A large portion of water flowing from San Saba Springs, which is the water supply for the City of San Saba, is thought to be from the Ellenburger–San Saba and Marble Falls aquifers[2].

As shown in Figure 4, DHWSC public water supply wells, are believed to be located at the eastern edge of the outcrop or recharge zone of the Ellenburger – San Saba Aquifer. As such, these wells are subject to water level fluctuations due to local and regional pumpage and to extended drought periods.

FIGURE 4
ELLENBURGER-SAN SABA AQUIFER AND DOUBLE HORN WSC LOCATION




Honeycut Formation, Ellenburger Group, south of San Saba, Texas.


San Saba Limestone Member, southeast of Brady, Texas.

[2] TWDB Report 380, Peter G. George, Ph.D., P.G., Robert E. Mace, Ph.D., P.G. and Rima Petrossian, P.G., July 2011.

Water Quantity:

The Ellenburger-San Saba Aquifer produces good quantities of dependable water supply when wells are drilled and developed in solution cavities and related fractures. The DHWSC public water supply wells yield large volumes of water. However, DHWSC and its predecessor agency (i.e., Four Star Development Company) had to drill numerous test wells and dry holes before hitting sustainable quantities of water located in solution cavities. By far, most domestic/public water wells drilled into the Ellenburger-San Saba Aquifer are either dry holes or yield less than a few gallons per minute of water supply.

As described above, DHWSC's three existing wells have a collective potential to produce approximately 235 gpm.

Water Level Changes:

Water-level changes in aquifers are due to many causes, some may be extremely local, but others are of great regional significance[3]. Changes in recharge to or discharge from an aquifer are the most significant causes of water-level fluctuations. When drought conditions reduce recharge to an aquifer, some of the water discharged may come from storage and the water levels will decline. In time, water levels may be lowered sufficiently to dry up springs or shallow wells. When rainfall resumes, the water removed during the drought may be replaced and water levels rise. In most aquifers there is a constant rebalancing of the forces of recharge and withdrawal and the water table and/or potentiometric surface[4] is moving up and down in an often-cyclic manner. There are cycles of pumpage, recharge, drought, season, etc., all working together in effecting the aquifer.

When a water well is pumped, water levels in the vicinity are drawn down in the shape of an inverted cone with its apex at the pumped well. This "cone of depression" is illustrated in Figure 5. The development of this cone depends on the aquifer's coefficients of transmissivity and storage, and the rate of pumping. As pumping continues, the cone expands and continues to do so until it intercepts a source of replenishment capable of supplying sufficient water to satisfy the pumping demand. This source can be either intercepted as natural discharge or induced recharge. If the quantity of water received from these sources is sufficient to compensate for the water pumped, the growth of the cone will cease and a balance between recharge and discharge is achieved. In areas where recharge or salvageable natural discharge is less than the amount of water pumped from wells, water continues to be removed from storage in the aquifer to supply the deficiency and water levels will continue to decline. This condition is often called "mining."

Where intensive development has taken place in ground-water reservoirs, each well superimposes its own individual cone of depression on the cone of neighboring wells. This results in the development of a regional cone of depression. When the cone of one well overlaps the cone of

[3] TWDB Report 346, Richard Preston, Geologist, et. al., March 1996.

[4] For groundwater "*potentiometric surface*" is a synonym of "*piezometric surface*" which is an imaginary *surface* that defines the level to which water in a confined aquifer would rise were it completely pierced with wells. If the *potentiometric surface* lies above the ground surface, a flowing artesian well results.

another, interference occurs, and an additional lowering of water levels occurs as the wells compete for water by expanding their cones of depression. The amount or extent of interference depends on the rate of pumping from each well, the spacing between wells, the length time of pumping, and the hydraulic characteristics of the aquifer in which the wells are completed. The effects of interference between pumping wells are illustrated in in Figure 6.

FIGURE 5
CONE OF DEPRESSION FROM A WATER-LEVEL DRAWDOWN AROUND A PUMPING WELL
(Source: TWDB Report 346)

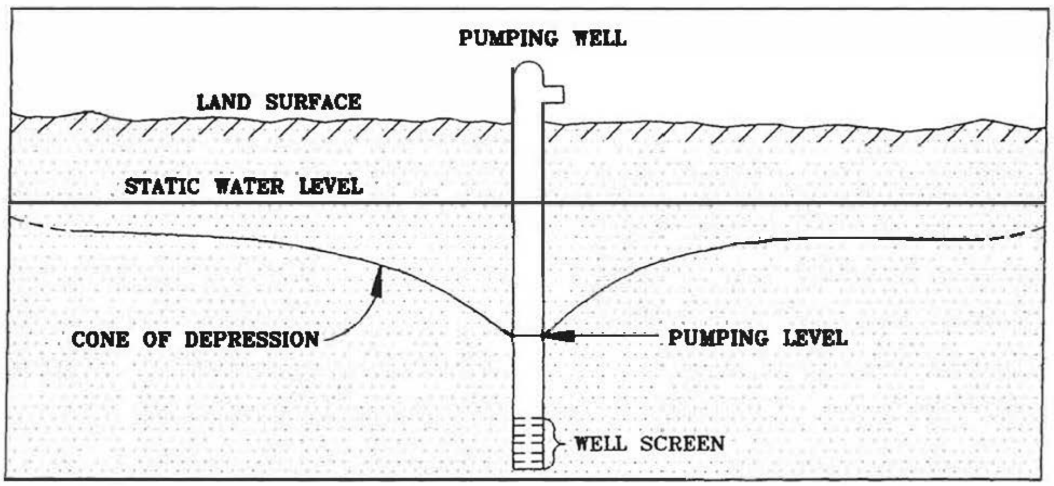
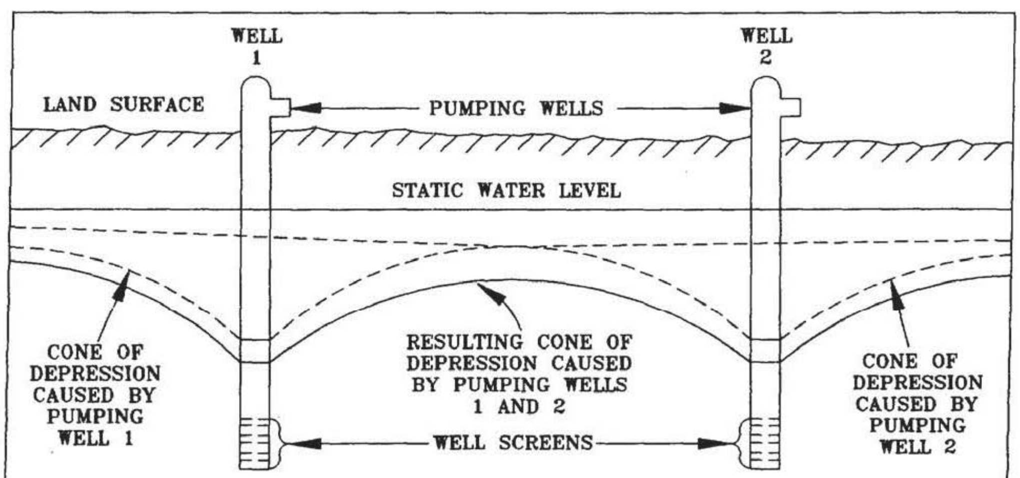


FIGURE 6
ADDED CONE OF DEPRESSION EFFECTS FROM INTERFERENCE BETWEEN TWO PUMPING WELLS
(Source: TWDB Report 346)



Historic water level changes for two (2) Ellenburger – San Saba Aquifer wells are shown in Figure Nos. 7 and 8. Figure 7 is a groundwater level hydrograph for a deep Ellenburger Aquifer well located in Burnet, Texas. As shown in Figure 7, water levels have been trending downward since

April 1961. Figure 8 is a groundwater hydrograph for a shadow Ellenburger Aquifer well located about 4 miles east of Burnet, Texas. This hydrograph indicates an upward trending water level since April 2014, since the Burnet County area has been receiving above normal rainfall over the past several years.

FIGURE 7
DEEP ELLENBURGER WATER LEVEL HYDROGRAPH FOR WELL NO. 5715704 LOCATED IN BURNET, TEXAS

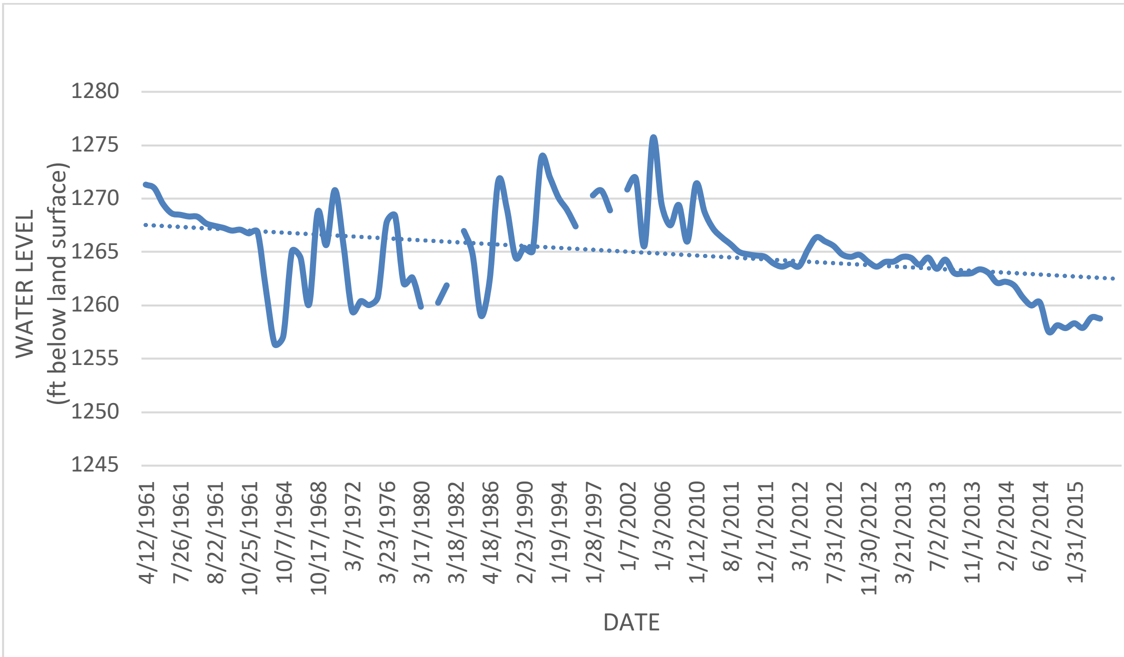
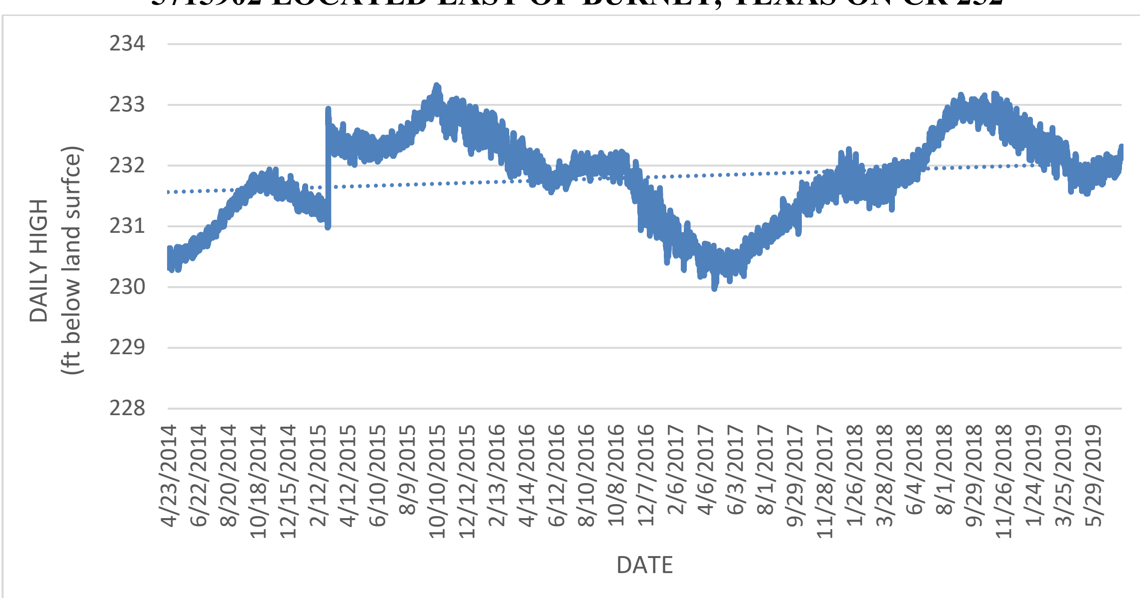


FIGURE 8
SHADOW ELLENBURGER WATER LEVEL HYDROGRAPH FOR WELL NO. 5715902 LOCATED EAST OF BURNET, TEXAS ON CR 252



Water Quality:

Water produced from the Ellenburger – San Saba Aquifer is inherently hard and usually has less than 1,000 milligrams per liter of total dissolved solids. Fresh to slightly saline water extends downdip to depths of approximately 3,000 feet. Elevated concentrations of radium and radon also occur in the aquifer. The aquifer's general water quality for selected constituents is presented in Table Nos. 2 and 3.

TABLE 2. CONSTITUENTS AND PROPERTIES OF GROUNDWATER FROM ELLENBURGER GROUP, ELLENBURGER-SAN SABA AQUIFER (Source: TWDB Report 346)

Constituents and properties ***(number of samples)***	**Average**	**Range**
silica (mg/l) (215)	13	1 - 32
calcium *(* mg/1) *(215)*	90	2 - 276
magnesium (mg/l) (215)	37	1 - 109
sodium (mg/l) (215)	70	0- 2360
potassium (mg/I) (215)	4.4	0.1 - 32.0
strontium (mg/l) (215)	6.0	0.1-25.7
bicarbonate (mg/l) (215)	400	0- 600
sulfate (mg/l) (215)	43	4- 725
chloride (mg/l) (215)	104	6- 3760
fluoride (mg/l) (215)	0.7	0 - 8.2
nitrate *(* mg/l) (215)	10.4	0 - 50.0
total dissolved solids(mg/1)	568	307 - 6486
total hardness (mg/1) (215)	376	8 - 997
gross alpha (pCi/1) (23)	7.4	2.0 - 30.0
gross beta (pCi/1) (8)	18.3	4.1 - 41.0
radium-226 (pCi/1) (5)	3.7	0.2 - 8.0
radium-228 (pCi/1) (5)	8.0	2.1 - 19.0

TABLE 3. CONSTITUENTS AND PROPERTIES OF GROUND WATER FROM THE SAN SABA MEMBER, ELLENBURGER - SAN SABA AQUIFER (Source: TWDB Report 346)

Constituents and properties ***(number of samples)***	**Average**	**Range**
silica (mg/I) (35)	14	7 - 34
calcium (mg/I) (35)	99	60 - 147
magnesium (mg/I) (35)	46	26- 83
sodium (mg/I) (35)	36	5 - 160
potassium (mg/I) (35)	3.2	0.1 - 15.0
strontium (mg/I) (35)	-	-
bicarbonate (mg/I) (35)	452	347 - 509
sulfate (mg/I) (35)	38	8 - 136
chloride (mg/I) (35)	53	7 - 229

fluoride (mg/I) (35)	0.3	0.1 - 0.9
nitrate (mg/I) (35)	7.9	2.9 - 14.6
total dissolved solids(mg/l)	541	358 - 968
total hardness (mg/I) (35)	436	338 - 700

General water quality associated with DHWSC Well No. 3 is shown in Table 4.

TABLE 4
DHWSC WELL NO. 3 SELECTED WATER QUALITY CONSTITUENTS ON SEPT. 15, 2006
(Source: TWDB Well Report for State Well Number 57-39-103)

CONSTITUENT	CONCENTRATION	COMMENTS
Total Iron	0.01 mg/l	SMCL = 30 mg/L
Calcium	93 mg/l	
Magnesium	50.7 mg/l	SMCL = 5.0 μg/L
Sodium	19.7 mg/l	
Manganese	.0012 mg/l	
Chloride	34 mg/l	SMCL = 300 mg/L
Fluoride	0.54 mg/l	SMCL = 2.0 mg/L
Nitrogen, Nitrite (as N)	0.01 mg/l	
Nitrogen, Nitrate, (as N)	0.69 mg/l	MCL = 10.0 mg/L
Sulfate	30.0 mg/l	SMCL = 300 mg/L
Total Aluminum	0.02 mg/l	
Total Hardness	441 mg/l	
Arsenic	0.002 mg/l	MCL = 10.0 μg/ L
Copper	0.043 mg/l	Action Level 1.3 mg/L
Total Alkalinity (CAC03)	394 mg/l	
Total Dissolved Solids	473 mg/l	SMCL = 1,000 mg/L
Radium 226	0.50 PC/L	
Radium 228	1 PC/L	

DHWSC Water Demands:

Under TCEQ TAC §290 rules, DHWSC is required to have a dependable water supply to supply a minimum of 0.6 gpm per connection. With a buildout water service area of 200 connections, DHWSC's TCEQ "buildout" water supply requirement is 120 gpm or 172 acre-feet per year as shown in Table 5.

As shown in Table 6, DHWSC's historic water supply demand per connection is calculated at 0.17 gpm per connection with a projected actual buildout annual water demand of 56 acre-feet per year.

TABLE 5

TCEQ MINIMUM WATER SUPPLY REQUIREMENTS

A	B	C	D	E
BUILD OUT CONNECTIONS	**TCEQ REQUIRED MINIMUM WATER SUPPLY**			
	0.6 GALLONS PER MINUTE PER CONNECTION (GPM)	**GALLONS PER DAY (GALLONS)**	**GALLONS PER YEAR (GALLONS)**	**ACRE-FEET PER YEAR**
200	120	172,800	63,072,000	172

TABLE 6

DHWSC HISTORIC WATER USE ANALYSIS

A	B	C	D
ROW NO.	**YEAR**	**NUMBER OF CONNECTIONS**	**TOTAL ANNUAL WATER SOLD**
1	2016	75	6,451,000
2	2018	94	7,575,000
3	AVERAGE	84.5	7,013,000
4	PROJECTED BUILDOUT	200	
	D	**E**	**F**
	ASSUMED WATER LOSS	**PROJECTED ANNUAL WATER PRODUCTION**	
		GALLONS PER YEAR	**ACRE-FEET PER YEAR**
1	10%	7,096,100	21.8
2	10%	8,332,500	25.6
3	10%	7,714,300	23.7
4	PROJECTED BUILDOUT	18,258,698	**56.0**
	G	**H**	**I**
	PROJECTED WATER PRODUCTION PER CONNECTION		
1	**GALLONS PER YEAR**	**ACRE-FEET PER YEAR**	**GPM PER CONNECTION**
2	94,615	0.29	0.18
3	88,644	0.27	0.17
4	91,293	0.28	0.17
5	AVERAGE	0.28	**0.17**

FINDINGS AND RECOMMENDATIONS:

FINDINGS

DHWSC existing three (3) water supply wells have combined "paper" pumping capacity of 235 gpm (from Table 1). At face value, this is enough capacity to supply 392 single-family water connections under the TCEQ's 0.6 gpm per connection rule (i.e., 235 / 0.6). Based on historical water use of 0.17 gpm per connection (from Table 6), DHWSC could potentially supply water to over 1,000 single-family connections. Although, such level of water service would require DHWSC to secure an exception to the TCEQ's 0.6 gpm per connection rule.

DHWSC's three public water supply wells are located on the outcrop for the Ellenburger – San Saba Aquifer a karst formation where free water exists in cracks, fissures and solution cavities. As such, these wells highly susceptible to (1) rapid water table declines in extended drought conditions and (2) to dewatering/depletion as a function of area and regional water use by purveyors/domestic users who obtain their water supplies from the Ellenburger – San Saba Aquifer and/or from other groundwater aquifers/formations that receive water leakage/contributions from the Ellenburger.

Another unknown associated with the existing DHWSC water supply wells are the cone of depression effects from interference between pumping two or all three DHWSC wells at the same time and the effects of area domestic and commercial pumpage (i.e., household/individual wells, livestock wells, quarry wells and single-family development wells).

Currently the groundwater quality associated with the three existing DHWSC wells is good from a public water supply standpoint. As the area continues to develop with single-family homes and commercial/retail development that utilize on-site sewage facilities (OSSFs), groundwater quality may deteriorate.

RECOMMENDATIONS

The following recommendations are offered:

1. DHWSC should install and maintain water level recorders in each of the three existing wells. Water level data should be collected and evaluated to determine the magnitude of the cone of depression effects from pumping the DHWSC three wells, as well as pumpage from other area wells. In addition, short and long term Ellenburger – San Saba water level declines may be identified more readily and provide DHWSC more time to implement water management strategies.

2. DHWSC may want to consider contracting with the Central Texas Groundwater Conservation District to use DHWSC's Well No. 4 as an Ellenburger – San Saba Aquifer monitor well.

3. Prepare and submit an exception to the TCEQ's 0.6 gpm per connection rule. This effort will involve the collection of daily well production and use data over a 3-year period. If

successful, the DHWSC could avoid future expenditures toward securing additional water supplies.

4. Stay abreast with permitting groundwater production rights with the CTGCD. As more water production permits are issued by the CTGCD, DHWSC will face increased difficulty in securing future water production rights.

5. Since DHWSC's water production wells are in the outcrop of the Ellenburger – San Saba Aquifer, these wells will be the first to decline in production and, possibly, go dry, as aquifer water withdrawals increase. As such, the DHWSC should investigate securing future supplemental water supplies. Currently, identified options (see Figure 9) in order of preference include the following:

   A. City of Marble Falls – The City of Marble Falls secures its water supply from Lake Marble Falls via contract water rights with the Lower Colorado River Authority. The City has extended water improvements, including the construction of an elevated storage tank, to serve the Baylor Scott and White development and other City water users located at the intersection of Texas Highway 71 and U.S. Highway 281. In addition, the City has expanded its Water Certificate of Convenience and Necessity (CCN) No. 11137 to include land located on the east side of Texas Highway 71, as shown in Figure 10. The City's water CCN adjoins the DHWSC's Water CCN 12913 at Double Horn Creek. Extending a water supply line from DHWSC to the City's existing elevated storage tank will cost over (see Attachment B) $914,000. As such, this is not a currently feasible alternative due to cost. However, as the City extends its water service eastward along Texas Highway71 towards DHWSC, this alternative may cost substantially less.

   B. Proprietary Information Original on File currently serves a public water system located approximately 6,900-feet east of existing DHWSC's water infrastructure. The projected capital cost of extending an interconnecting water line is estimated at $458,000 (see Attachment B). This alternative may not be feasible, since S&H Utilities obtain their water supply from the outcrop wells located in the Ellenburger – San Saba Aquifer.

   C. Proprietary Information Original on File approximately 15,000 linear feet by road from DHWSC, is supplied water from Ellenburger wells. The projected capital cost of extending an interconnecting water line is $761,000 (see Attachment B).

   D. Proprietary Information Original on File, although located over 5 miles from DHWSC, has a water supply well that produces over 0.75 million gallons per day. The capital cost of extending an interconnecting water line is $1,800,000 (see Attachment B).

   E. Trinity Aquifer – The DHWSC may drill and develop a deeper Trinity Aquifer well. Although, the Trinity Aquifer underlying the DHWSC's water supply area may not have an ambient water quality that meets or exceeds TCEQ PWS water quality standards without advanced treatment, the DHWSC may be able to blend Trinity water with higher quality Ellenberger Aquifer water to achieve a blended water quality that meets or exceeds PWS standards.

FIGURE 9
IDENTIFIED DHWSC SUPPLEMENTAL WATER SUPPLY ALTERNATIVES

Proprietary Information Original on File

FIGURE 10
RETAIL PUBLIC WATER SUPPLY UTILITIES LOCATED IN THE VICINITY OF DHWSC

Proprietary Information Original on File

If you have any questions concerning this Letter Report, please do not hesitate to contact me.

Respectively submitted,

Donald G. Rauschuber, P.E.
President, DGRA, Inc.

DONALD RAUSCHUBER
39068

TBPE FIRM NO. 8806

dgra, inc.

Donald G Rauschuber & Associates, Inc.
PO BOX 342707, AUSTIN, TEXAS 78734
512-913-9300

Firm: 8806 - 07/29/19