QUIDDITY

1575 Sawdust Road, Suite 400
The Woodlands, Texas 77380
Tel: 281.363.4039
www.quiddity.com

January 8, 2025

Mr. Zach Holland
Bluebonnet Groundwater Conservation District
1903 Dove Crossing Lane, Suite A
P.O. Box 269
Navasota, TX 77868
BGCD@bluebonnetgroundwater.org

Re: Non-Exempt Water Well Application1 – Water Well No. 1
Woodhaven West, Ltd.

Dear Mr. Holland:

We are pleased to submit the non-exempt water well registration and water well operating permit applications for a proposed water well ("Water Well No. 1") on behalf of Woodhaven West, Ltd. We are requesting a Phase 1-a Hydrogeologic Report be completed by Bluebonnet Groundwater Conservation District ("BGCD"). This letter also serves a declaration that the well owner will comply with the BGCD management plan, BGCD regulations and actions during drought conditions, and BGCD's well plugging guidelines and report closure to the applicable authorities, including the BGCD, per the requirements of Rule 8.5A1.

Enclosed is the non-exempt water well application package including the following attachments:

- Non-Exempt Water Well Registration Application
- Water Well Operating Permit Application
- Water Well Location Maps
- General Well Construction Diagram

The application fee is included. This fee includes the $75.00 well development fee, $375.00 operating permit application fee, and $1,500.00 phase-1a hydrogeologic report fee.

If you have any questions or comments, please contact me or Jayson V. Taylor, EIT at 281-363-4039.

Sincerely,

Amy W. Stonaker, PE

AWS/jvt
K:\29342\29342-0003-01 Woodhaven West Water Well No. 1 Study Application and Coordination with BGCD\2 Design Phase\Reports\1. BGCD Water Well Application Cover Letter.docx
Enclosures
cc: Mr. Josh Wadley – Woodhaven West, Ltd.

Bluebonnet Groundwater Conservation District
1903 Dove Crossing Lane Suite A, P.O. Box 269
Navasota, TX 77868
Phone: 936-825-7303 Fax: 936-825-7331
Email: BGCD@bluebonnetgroundwater.org

BGCD Well ID #: _____

NON-EXEMPT WATER WELL REGISTRATION APPLICATION

Please complete all questions. Please print or type information, or place an "x" in the appropriate space.

Drill New Well: __x___ Register an Existing Well: _____ Replace Existing Well: _____ Increase Size of Existing Well: _____

Increase Pump Size of Existing Well: _____ Abandon/Cap/Plug Existing Well: _____ Perform Dye Trace: _____

Well Owner Woodhaven West, Ltd. (Attn: Josh Wadley) Phone (713) 255-5966

Address 2450 Fondren Road Suite 210, Houston, TX 77063

Fax: N/A Email: jwadley@landtejas.com

Drilling Company N/A Phone N/A

Address N/A

Fax:N/A Email:N/A

DrillerN/A License#N/A

Well Location: County Waller Well Site Address or Location: Woodhaven West Water Plant 1

Latitude 30°11'41.3"N **Longitude** 95°49'44.4"W

Proposed Water Use: Public Water Supply: ___x___ Industrial: _____ Recreational: _____ Commercial: _____

Hydraulic Fracturing: _____ Transport Outside of District: _____

Proposed depth: 1,000 ft. Aquifer Gulf Coast Date drilling is scheduled to begin N/A

Proposed casing size: 20 in. Proposed casing depth: 650 ft. Pump depth: 500 ft. Pump size 150 hp.

Type Pump**:** Turbine: __X___ Submersible: _____ Windmill: _____ Other (specify): _____

Pump fuel or power source**:** Electricity: __X___ Natural Gas: _____ Wind: _____ Other (specify) _____

Pump Bowls**:** Size 14" # of Stages: 6 Pump Column**:** Inside Diameter: 10 in. Length: 500 ft.

Pump discharge pipe: Size 8 in. Rated pump horsepower: 150 **Pump Discharge**: 800 gpm

Water bearing formation: Evangeline Layer

Estimated Annual Water Production: _____ Acre-Feet or 175,200,000 Gallons

If the water produced from this well will be used in whole or in part on property other than the property where the well is located, **describe the location where the water will be used.** Transportation of water produced and moved to another location may require a District Transportation Permit. See District Rules, Section 10 or contact the District office for information.

The water produced from the proposed water well will only be used to proposed Woodhaven West Estates development (shown in attached land use plan) located wholly within Bluebonnet Groundwater Conservation District.

BLUEBONNET GROUNDWATER CONSERVATION DISTRICT

Permit form approved on: _____ By: _____ Zach Holland, General Manger

(Continued) NON-EXEMPT WATER WELL DRILLING PERMIT FORM (Continued)

The following documentation, attachments and fee payments must accompany this form when it is submitted for consideration by the District.

a. Plat or map showing location of the property and location on property of well for which form is submitted.
b. If owner and/or operator of a well is different from property owner, provide written documentation from property owner authorizing construction and operation of this well.
c. All the information and documentation required for the type and class of well for which authorization is requested by Section 8 of the District Rules and that information and documentation required by Rule 8.5.
d. Forms for non-exempt well authorizations must be accompanied by the information required by Rule 8.5A1:
    a. 8.5A1(e) – a statement of the projected effect of the proposed withdrawal on the aquifer or aquifer conditions, depletion, subsidence, or effects on existing permit holders or other groundwater users in the District;
    b. 8.5A1(f) – the applicant's water conservation plan or a declaration the applicant and subsequent user will comply with the District's management plan;
    c. 8.5A1(g)(2) – well construction diagram;
    d. 8.5A1(g)(3) – a map showing the location of the proposed well or wells, all existing well, hydrologic features, and geologic features located within half (1/2) mile radius of the proposed well or wells site;
    e. 8.5A1(h) – the applicant's well closure plan or a declaration the applicant will comply with well plugging guidelines and report closure to the applicable authorities, including the District.
e. Payment for applicable fees must accompany the form. Additional fees may apply as documented in the District's adopted Fee Schedule.

Well Development Fee	$75.00	
Operating Permit Application Fee	$375.00	
Hydrogeologic Report Fee – applicable if well completed with eight (8) inches or greater inside casing diameter		
	Phase I-a Report (less than 200MG/yr)	Phase I-b Report (> 200MG/yr)
District Prepared Report	$1,500.00	$7,500.00
Applicant Prepared/District Review	$500.00	$1,500.00

f. Forms for new non-exempt wells must be accompanied by an Operating Permit Application and, if appropriate, a Transport Permit Application.

I, the undersigned applicant, hereby agree and certify that:

a. this well will be drilled within 30 feet of the location specified and not elsewhere;
b. I will furnish the District with a copy of the completed driller's log, any electric log, the well completion report, and any water quality test report within 60 days of completion of this well and prior to production of water there from (other than such production as may be necessary to the drilling and testing of such well);
c. in using this well, I will avoid waste, achieve water conservation, protect groundwater quality and the water produced from this well will be for a beneficial use;
d. I will comply with all District and State well plugging and capping guidelines in effect at the time of well closure;
e. I agree to abide by the terms of the District Rules, the District Management Plan, and orders of the District Board of Directors currently in effect and as they may be modified, changed, and amended from time to time;
f. I hereby certify that the information contained herein is true and correct to the best of my knowledge and belief.

Signature: _____ Date: 1/8/2025

Printed Name: Amy W. Stonaker, PE Title: Senior Engineer

Bluebonnet Groundwater Conservation District
303 E. Washington Ave., P.O. Box 269
Navasota, TX 77868
Phone: 936-825-7303 Fax: 936-825-7331
Email: BGCD@bluebonnetgroundwater.org

BGCD Well ID #: _____

WELL OPERATING PERMIT APPLICATION

Please complete all questions. Please print or type information or place an "x" in the appropriate space.

Drill New Well: ___x___ Register an Existing Well: _____ Replace Existing Well: _____ Increase Size of Existing Well: _____

Increase Pump Size of Existing Well: _____ Abandon/Cap/Plug Existing Well: _____ Perform Dye Trace: _____

Well Owner Woodhaven West, Ltd. (Attn: Josh Wadley) Phone (713) 255-5966

Address 2450 Fondren Road Suite 210, Houston, TX 77063

Fax: N/A Email: jwadley@landtejas.com

Drilling Company N/A Phone N/A

Address N/A

Fax: N/A Email: N/A

Driller N/A License#N/A

Well Location: County Waller 911 address of well site N/A

Latitude 30°11'41.3"N **Longitude** 95°49'44.4"W

Proposed Water Use: Public Water Supply: __X____ Industrial: _____ Recreational: _____ Commercial: _____

Hydraulic Fracturing: _____ Transport Outside of District: _____

Status of well as of application date:

_____ Operating Well (Date drilled _____)

_____ Well Completed but not operating (Date Drilled _____)

___X___ Well Development permit attached or awaiting approval

Authorization to produce the following quantity of water annually from this well is: ____175,200,000_____ Gallons

A well operating permit is normally issued for a period of one year (12 months). If a permit for a longer period of time is requested, attach a statement detailing the reasons for a longer permit period and the period of time requested.

If the water produced from this well will be used in whole or in part on property other than the property where the well is located, **describe the location where the water will be used.** Transportation of water produced and moved to another location may require a District Transportation Permit. See District Rules, Section 10 or contact the District office for information.

The water produced from the proposed water well will only be used to proposed Woodhaven West Estates development (shown in attached land use plan) located wholly within Bluebonnet Groundwater Conservation District.

BLUEBONNET GROUNDWATER CONSERVATION DISTRICT

Permit application approved on: _____ By: _____ Zach Holland, General Manger

(Continued) WELL OPERATING PERMIT APPLICATION (Continued)

The following documentation, attachments and fee payments must accompany this application when it is submitted for consideration by the District.

a. Plat or map showing location of the property and location on property of well for which application is submitted.
b. If the owner and/or the operator of well is different from the property owner, provide written documentation from the property owner authorizing construction and operation of this well.
c. All the information and documentation required for the type and class of well for which authorization is requested by Section 8 of the District Rules and in particular that information and documentation required by Rule 8.5.
d. If this permit application is for a well completed with an inside casing diameter of eight (8) inches or greater, or for any of the conditions enumerated in District Rule 8.5 F, a current hydrogeological report (a report completed within 18 months of the date of this application is considered current) shall be submitted with this application.
e. Payment for applicable fees must accompany application. For a non-exempt well the appropriate Operating Permit Application Fee ($375.00 +$750.00 if inside casing diameter is eight (8) inches or greater) must be included.
f. The applicant's water conservation plan and if any subsequent user of the water is a municipality or entity providing retail water services, the water conservation plan of that municipality or entity shall also be provided. In lieu of a water conservation plan, a declaration that the applicant and/or a subsequent user if any subsequent user is a municipality or entity providing retail water services will comply with the District Management Plan.
g. The applicant's Drought Contingency Plan and a copy of any subsequent user's Drought Contingency Plan or a declaration that the applicant or a subsequent user will comply with District rules, policies and Board actions in drought conditions.

I, the undersigned applicant, hereby agree and certify that:

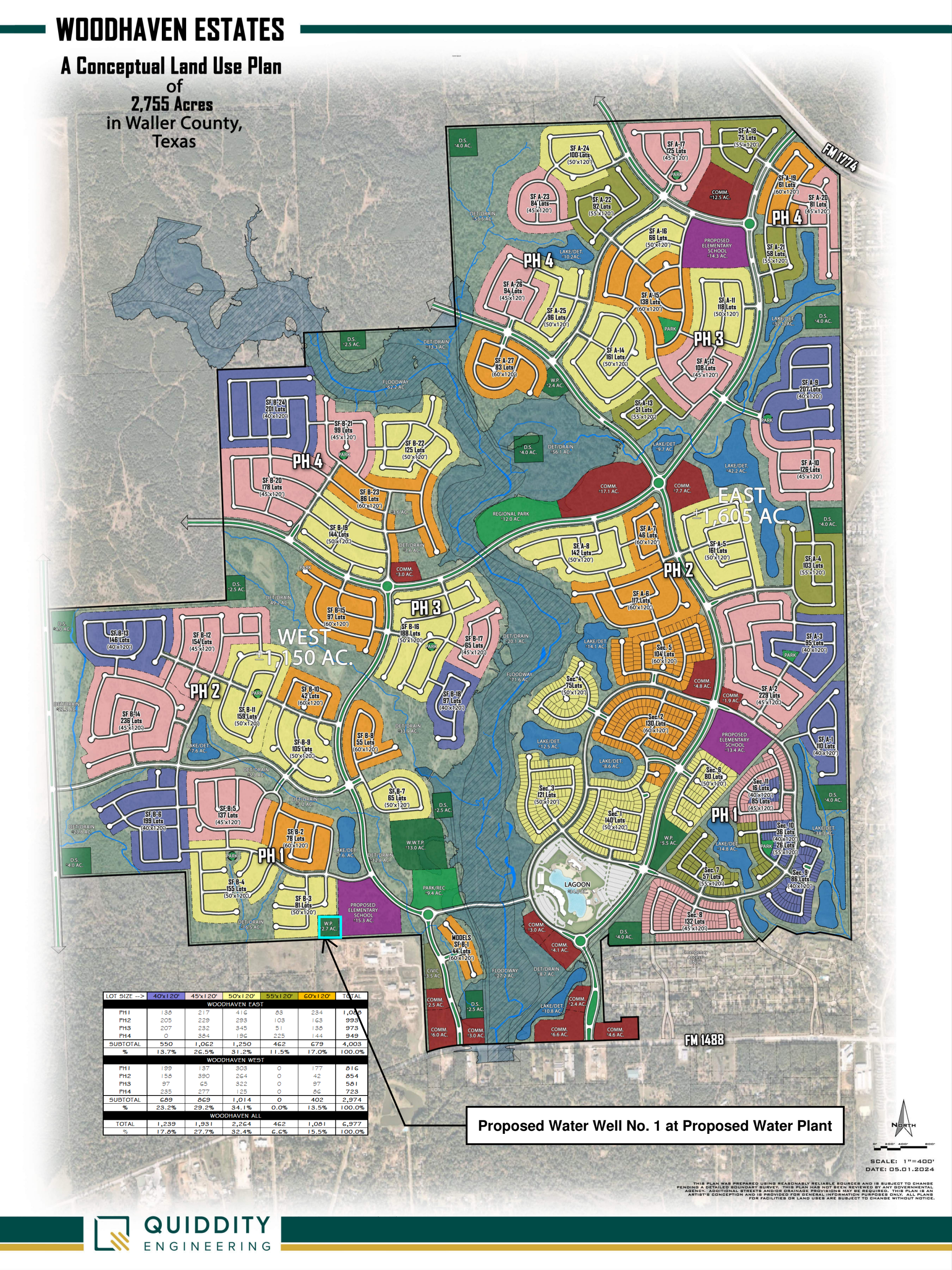
a. in using this well, I will avoid waste, achieve water conservation, protect groundwater quality and the water produced from this well will be for a beneficial use;
b. I will comply with all District and State well plugging and capping guidelines in effect at the time of well closure;
c. I agree to abide by the terms of the District Rules, the District Management Plan and orders of the District Board of Directors currently in effect and as they may be modified, changed and amended from time to time;
d. I hereby certify that the information contained herein is true and correct to the best of my knowledge and belief.

Signature: _____ Date: 1/8/2025

Printed Name: Amy W. Stonaker, PE Title: Senior Engineer

WOODHAVEN ESTATES

A Conceptual Land Use Plan of 2,755 Acres in Waller County, Texas



LOT SIZE -->	40'x120'	45'x120'	50'x120'	55'x120'	60'x120'	TOTAL
WOODHAVEN EAST						
PH1	138	217	416	83	234	1,088
PH2	205	229	293	103	163	993
PH3	207	232	345	51	138	973
PH4	0	384	196	225	144	949
SUBTOTAL	550	1,062	1,250	462	679	4,003
%	13.7%	26.5%	31.2%	11.5%	17.0%	100.0%
WOODHAVEN WEST						
PH1	199	137	303	0	177	816
PH2	158	390	264	0	42	854
PH3	97	65	322	0	97	581
PH4	235	277	125	0	86	723
SUBTOTAL	689	869	1,014	0	402	2,974
%	23.2%	29.2%	34.1%	0.0%	13.5%	100.0%
WOODHAVEN ALL						
TOTAL	1,239	1,931	2,264	462	1,081	6,977
%	17.8%	27.7%	32.4%	6.6%	15.5%	100.0%

Proposed Water Well No. 1 at Proposed Water Plant

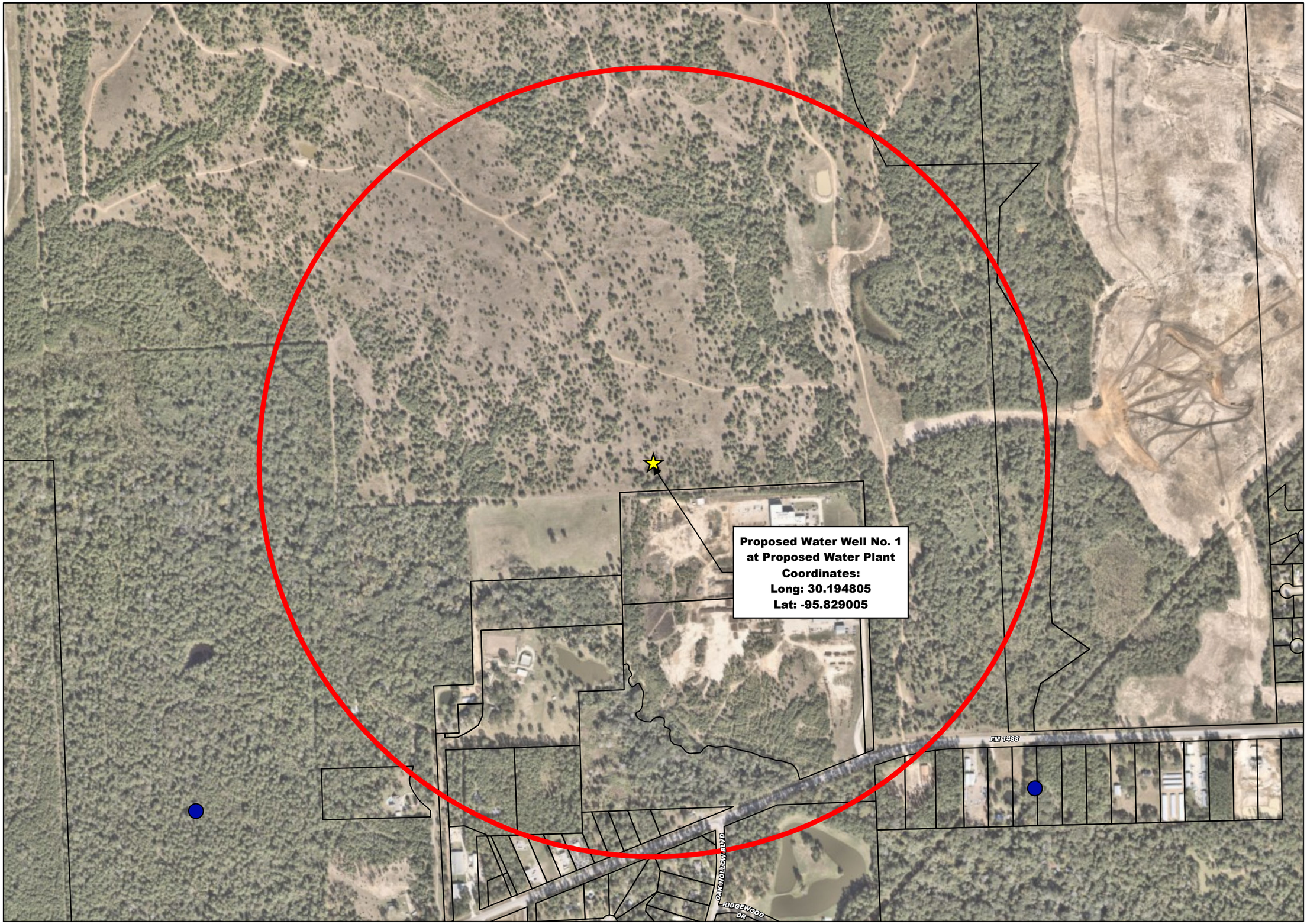
NORTH

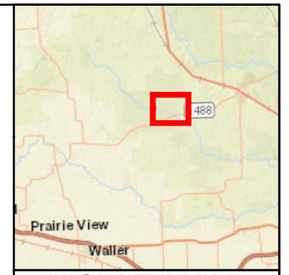
0' 200' 400' 800'

SCALE: 1"=400'

DATE: 05.01.2024

QUIDDITY ENGINEERING





VICINITY MAP
1 INCH = 10 MILES

LEGEND

- Center of Water Plant
- TWDB Groundwater Well
- 1/2 Mile Radius
- Parcels

WATER WELLS WITHIN 1/2 MILE OF PROPOSED WP

WOODHAVEN WEST
WALLER COUNTY, TEXAS

N W E S

0 600

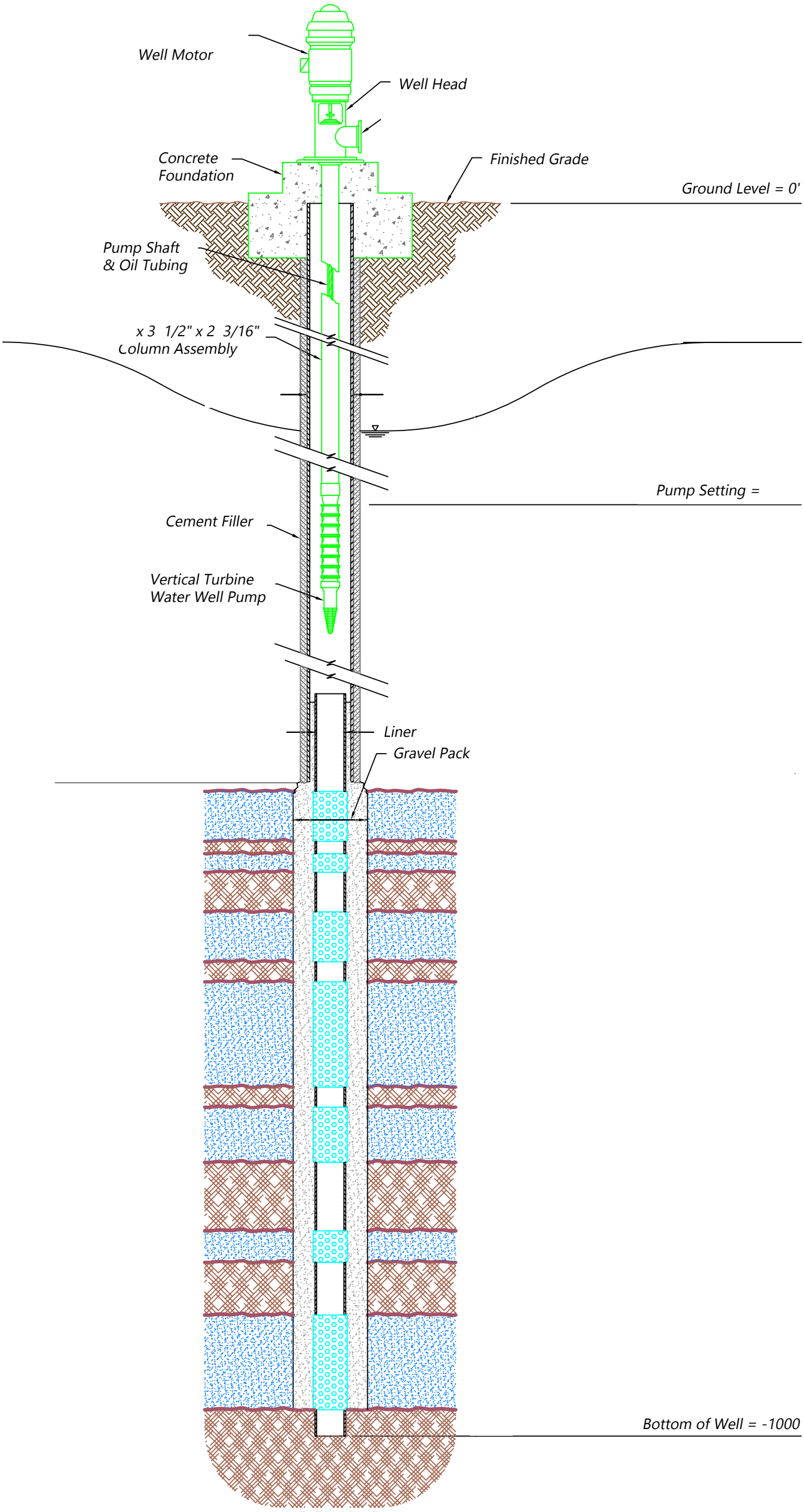
1 INCH : 600 FEET

IMAGERY PROVIDED BY NEARMAP

QUIDDITY

Texas Board of Professional Engineers Registration No. F-23290

Path: V:\Practice Workspace\Corporate Services\GIS\Projects\0_Individuals_Taylor\Woodhaven_West\WaterWells_Map_11x17.mxd Project Number: 29342-0003-01.001 Date: 12/16/2024 User Name: sda1



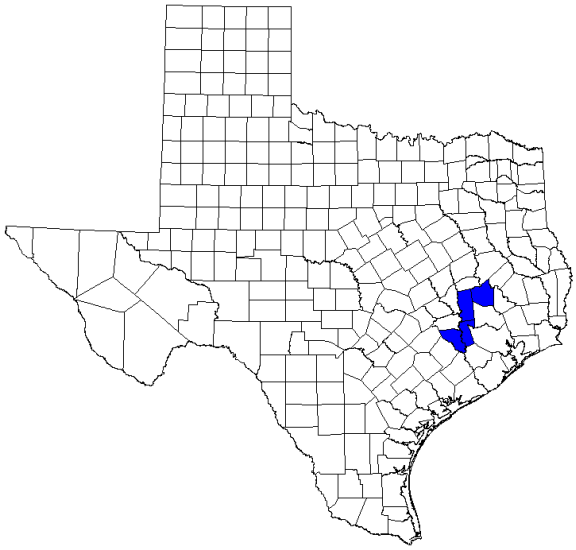
NOT TO SCALE

TYPICAL WATER WELL PROFILE

QUIDDITY

Final Report

Phase 1-b Report:
Woodhaven Estates Water Wells 1 and 2, 1605 Investments, Ltd.
Submitted by Quiddity on July 23, 2024
and
Woodhaven West Water Well 1
Submitted by Quiddity on January 8, 2025



Prepared for:

Zach Holland
General Manager
Bluebonnet Groundwater Conservation District
P.O. Box 269
Navasota, TX 77868-0269

Prepared by:

William R. Hutchison, Ph.D., P.E., P.G.
Independent Groundwater Consultant
909 Davy St.
Brenham, TX 77833
512-745-0599
billhutch@texasgw.com

February 8, 2025
(Revised from original August 5, 2024 Final Report)

Table of Contents

List of Tables

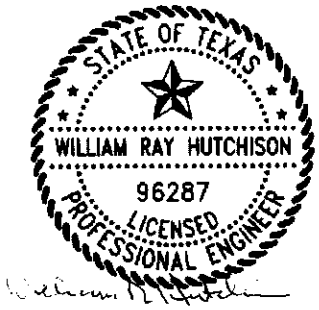
List of Figures

Appendices

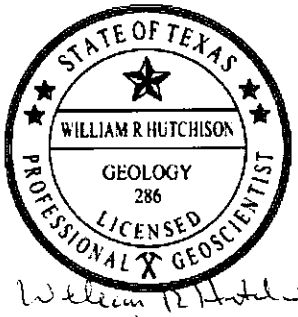
Professional Engineer and Professional Geoscientist Seals

This report was prepared by William R. Hutchison, Ph.D., P.E., P.G., who is licensed in the State of Texas as follows:

- Professional Engineer (Geological and Civil) No. 96287
- Engineering Firm Registration No. 14526
- Professional Geoscientist (Geology) No. 286



2/8/2025



2/8/2025

1.0 Introduction

Quiddity submitted Non-Exempt Water Well Registrations for two wells to the Bluebonnet Groundwater Conservation District (BGCD) on behalf of 1605 Investments Ltd. The wells are named Woodhaven 1 and Woodhaven 2. A final Phase I-b report was issued on August 5, 2024. Well construction has not commenced on these wells.

Quiddity submitted an additional Non-Exempt Water Well Registrations for an additional well named Woodhaven West Water Well No. 1 to the Bluebonnet Groundwater Conservation District (BGCD) that will be part of the same water delivery system. The cover letter is dated January 8, 2025, and was received in an email from Arantza Cabrera on January 20, 2025. Because the well in this new application is part of the same water delivery system as the previous Woodhaven Wells, this phase I-b report represents a revision to the August 5, 2024 Phase I-b report to include all three wells.

The proposed well locations, depths, and estimated total water production are summarized in Table 1.

Table 1. Summary of Proposed Woodhaven Wells 1 and 2 and Woodhaven West 1

Well Number	1	2	West 1
Latitude	30.19822222	30.19738611	30.19480556
Longitude	-95.81285556	-95.81348611	-95.829
Depth (ft)	650	1,000	1,000
Proposed Annual Production (million gallons per year)	131.4	219	175.2

The rules of BGCD require the permit applicant to submit Phase I and Phase II hydrogeologic reports for non-exempt wells with an inside diameter casing of eight inches or greater as part of the permit application process. These reports include hydrogeologic information addressing, and specifically related to, the impacts of the proposed well (e.g. area of influence, drawdown, recovery time, and potential for subsidence).

Because the requested permit amount is greater than 200 million gallons per year, a Phase I-b report is required. In general, the Phase I-b report is intended to be a preliminary report that relies on existing regional information and data, and the Phase II report is intended to be a final report that relies on site specific data, information, test results and analyses.

As required in the Guidelines for Submitting Data and Information and the Preparation of Hydrogeologic Reports in Support of Applications for the Permitted Use of Groundwater (dated April 14, 2023), this report contains the Phase I-a tables and the results of a simulation using the Groundwater Availability Model of the area that adds the proposed wells to the most recent run that was used to establish the desired future condition.

All files associated with this report are available for download at the following location:

https://drive.google.com/drive/folders/1SsgojzRiTZqGqsysG1zaiOsoifNqMPqN?usp=sharing

2.0 Phase I-a Tables

2.1 Well Locations on HAGM Grid

The latitude and longitude data provided in the application were used to convert the location data to x- and y-coordinates in the GAM coordinate system using Surfer, a commercial gridding program. In addition, registered wells within one mile of the proposed well were identified and their latitude and longitude coordinates were also converted to x- and y-coordinates.

The Fortran program *PointRC.exe* was used to find the HAGM cell for the x- and y-coordinates of the proposed production wells and the x- and y-coordinates of the nearby registered wells. The results are summarized in Table 1. Figure 1 presents a map with the locations of the proposed wells and the three nearby registered wells.

Table 2. Well Location Coordinates

Well	Woodhaven 1 (Proposed)	Woodhaven 2 (Proposed)	Woodhaven West 1 (Proposed)	BWLL-0006F	BWLL-4025	BWLL-4471
Depth (ft)	650	1000	1000	275	240	245
Distance to Woodhaven 1 (ft)	0	364	5,241	2,411	7,809	3,398
Distance to Woodhaven 2 (ft)	364	0	4,981	2,088	7,586	3,161
Distance to Woodhaven West 1 (ft)	1,438	1,127	0	966	378	1,831
Latitude (DD)	30.198222	30.197386	30.19480556	30.191667	30.196110	30.189169
Longitude (DD)	-95.812856	-95.813486	-95.829	-95.813889	-95.837500	-95.810277
GAMx (ft)	6241189	6241002	6236148.761	6240953	6233453	6242126
GAMy (ft)	19326618	19326306	19325181.74	19324219	19325556	19323352
HAGM Row	33	33	33	34	33	34
HAGM Column	96	96	96	96	95	96

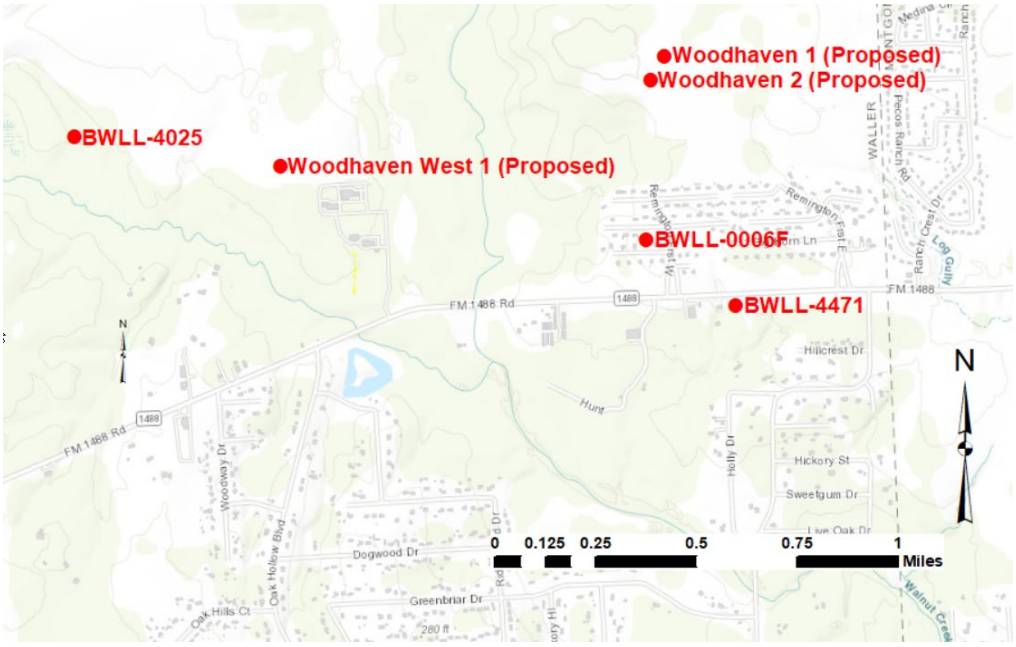


Figure 1. Location Map of Proposed Wells and Nearby Registered Wells

2.2 HAGM Grid Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Woodhaven West Phase I-a Tables.xlsx*. The tab named *gridparam* contains the HAGM grid data and is presented as Table 3. Please note that all model layers for the proposed well location (HAGM Row 33, Column 96) are included.

Please note that the depth of the Woodhaven 2 and Woodhaven West 1 wells (proposed as Jasper Aquifer wells) is 1,000 feet. At this depth, the wells would be completed in the Burkeville Formation according to the HAGM. The top of the Jasper Aquifer at this location is estimated to be 1,112 feet. Drilling and geophysical logs completed during Phase II work (drilling and testing the well) will be used to confirm or modify the depths to the top of the Jasper Aquifer and the completion of the well.

Table 3. HAGM Grid Parameters for Proposed Woodhaven and Woodhaven West Wells

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	33	33	33	33
Column	96	96	96	96
x-coordinate (GAM-ft)	6237766.5	6237766.5	6237766.5	6237766.5
y-coordinate (GAM-ft)	19326808	19326808	19326808	19326808
Surface Elevation (ft MSL)	231	231	231	231
Cell Top Elevation (ft MSL)	231	177	-616	-881
Cell Bottom Elevation (ft MSL)	177	-616	-881	-1594
Cell Thickness (ft)	54	793	265	713
Clay Thickness (ft)	0	306	84	382
Clay Thickness (% of Cell Thickness)	0.00	38.59	31.76	53.58

2.3 HAGM Aquifer Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Woodhaven West Phase I-a Tables.xlsx*. The tab named *HAGMparam* contains the HAGM aquifer parameter data and is presented as Table 4. Please note that all model layers for the proposed well location (HAGM Row 33, Column 96) are included.

Table 4. HAGM Aquifer Parameters for Proposed Woodhaven and Woodhaven West Wells

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	33	33	33	33
Column	96	96	96	96
Hydraulic Conductivity (ft/day)	11.60	2.10	0.02	1.88
Transmissivity (gpd/ft)	4,683	12,456	30	10,009
Leakage (1/day)	2.50E-05	5.00E-07	5.32E-09	0.00E+00
Storativity (dimensionless)	1.00E-01	9.00E-04	2.60E-04	2.95E-04
Elastic Storativity (dimensionless)	2.09E-05	7.43E-05	8.30E-07	9.55E-07
Inelastic Storativity (dimensionless)	2.09E-03	7.43E-03	8.30E-05	9.55E-05

2.4 HAGM Results

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel file named *Woodhaven West Phase I-a Tables.xlsx*. The tab named *HAGMresults* contains the HAGM results and is presented as Table 5. Please note that all model layers for the proposed well location (HAGM Row 33, Column 96) are included.

Table 5. HAGM Results for Proposed Woodhaven and Woodhaven West Wells

County Name	Waller	Waller	Waller	Waller
County Code	237	237	237	237
Outcrop Layer	1	1	1	1
Layer	1	2	3	4
Row	33	33	33	33
Column	96	96	96	96
Groundwater Elevation in 2009 (ft MSL)	207	199	198	32
Groundwater Elevation in 2080 (ft MSL)	161	149	147	-207
DFC Drawdown (ft)	46	50	51	239
Artesian Head (ft)	-24	22	814	913
Subsidence in 2009 (ft)	0.02	0.02	0.02	0.02
Subsidence in 2080 (ft)	0.23	0.23	0.23	0.23
Subsidence from 2009 to 2080 (ft)	0.21	0.21	0.21	0.21
Cell Pumping in 2009 (AF/yr)	0	50.69	0	0
Cell Pumping in 2080 (AF/yr)	0	35.37	0	0

2.5 Theis Parameters

The Excel spreadsheet named *BGCD Parameters.xlsx* contains all the data needed for the review and Phase 1-a calculations. The data for the proposed well were extracted and saved in the Excel

file named *Woodhaven West Phase I-a Tables.xlsx*. The tab named *theisparam* contains the Theis parameters and is presented as Table 6. The Theis parameters are associated with the estimation of drawdown using the Theis equation as described below. Please note that only data from the Evangeline (Layer 2) and Jasper (Layer 4) for the proposed well location (HAGM Row 33, Column 96) are included.

Table 6. Theis Parameters for Proposed Woodhaven Wells

County Name	Waller	Waller
County Code	237	237
Outcrop Layer	1	1
Layer	2	4
Row	33	33
Column	96	96
Drawdown in Production Well at 100 gpm for 36 hours	15.67	20.53
Drawdown 1/2 mile from Production Well at 100 gpm for 36 hours	0.51	1.18
Drawdown 1/2 miles from Production Well at 100 gpm for 1 year	4.95	7.19
Drawdown-Pumping Ratio for Production Well for 36 hours	0.15669	0.20526
Drawdown-Pumping Ratio for 1/2 mile from Production Well for 36 hours	0.00509	0.01183
Drawdown-Pumping Ratio for 1/2 mile from Production Well for 1 yr	0.04955	0.07190

2.6 Theis Results

Groundwater production data from the permit application were used along with the drawdown-pumping ratios contained in Table 6 to develop three estimates of drawdown for each aquifer:

- Scenario 1: drawdown in the production well after 36 hours of pumping at three times the average annual pumping rate.
- Scenario 2: drawdown in a well ½ mile from the production well after 36 hours of pumping at three times the average annual pumping rate.
- Scenario 3: drawdown in a well ½ mile from the production well after one year of pumping at the average annual pumping rate.

Results of these calculations for the Evangeline Aquifer (Layer 2) are presented in Table 7 and the results of these calculations for the Jasper Aquifer (Layer 4) are presented in Table 8.

Table 7. Theis Results for Proposed Woodhaven Well No. 1 (Evangeline)

Production Summary	Value
Annual Permit Production Limit (gallons)	131,400,000
Annual Permit Production Limit (acre-feet)	403
Average Pumping Rate (gpm)	250
Average Pumping Rate (cfd)	48128
3X Average Pumping Rate (gpm)	750

	Evangeline	
Drawdown Calculations	Drawdown-Pumping Ratios	Calculated Drawdown (ft)
Production Well - 36 hours (3X avg pumping)	0.15669	117.52
1/2 mile from Production Well - 36 hours (3X avg pumping)	0.00509	3.82
1/2 mile from Production Well - one year (avg pumping)	0.04955	12.39

Table 8. Theis Results for Proposed Woodhaven Well No. 2 and Woodhaven West No. 1 (Jasper)

Production Summary	Value
Annual Permit Production Limit (gallons)	394,200,000
Annual Permit Production Limit (acre-feet)	1210
Average Pumping Rate (gpm)	750
Average Pumping Rate (cfd)	144385
3X Average Pumping Rate (gpm)	2250

	Jasper	
Drawdown Calculations	Drawdown-Pumping Ratios	Calculated Drawdown (ft)
Production Well - 36 hours (3X avg pumping)	0.20526	461.84
1/2 mile from Production Well - 36 hours (3X avg pumping)	0.01183	26.62
1/2 mile from Production Well - one year (avg pumping)	0.07190	53.93

3.0 Phase I-b Results

Phase I-b requirements include the results of a simulation using the HAGM for the area that adds the proposed wells to the most current model simulation that was used to establish the desired future condition. Because three wells are included in the applications, the HAGM simulation included the pumping from all wells (one in the Evangeline and two in the Jasper).

The documentation of BGCD implementation of the most recent desired future condition simulation is contained in Hutchison (2021). As required in the Phase I-b guidelines, this section of the report contains the results of the simulation:

- Drawdown hydrographs
- Subsidence hydrographs
- Summary tables of drawdown and subsidence
- A county-aquifer level groundwater budget that includes a comparison of the HAGM simulation with the proposed well and the groundwater budget of the desired future condition simulation.

3.1 Drawdown Hydrographs

The Fortran post-processor *getdd.exe* was used to calculate annual drawdown at each of the sites of interest for the simulations. Hydrographs of drawdown attributable to the proposed pumping at the Woodhaven well sites and the nearby wells are presented in:

- Figure 2 (Woodhaven site)
- Figure 3 (BWLL-0006F and BWLL-4471 sites)
- Figure 4 (BWLL-4025 site).

The full set of hydrographs (DFC simulation and DFC + proposed pumping simulations) for all three locations in all four aquifer formations are presented in Appendix A. The attributable drawdown hydrographs presented in Figures 2, 3, and 4 represent the difference between drawdown from the DFC + proposed pumping simulation and the drawdown from the DFC simulation.

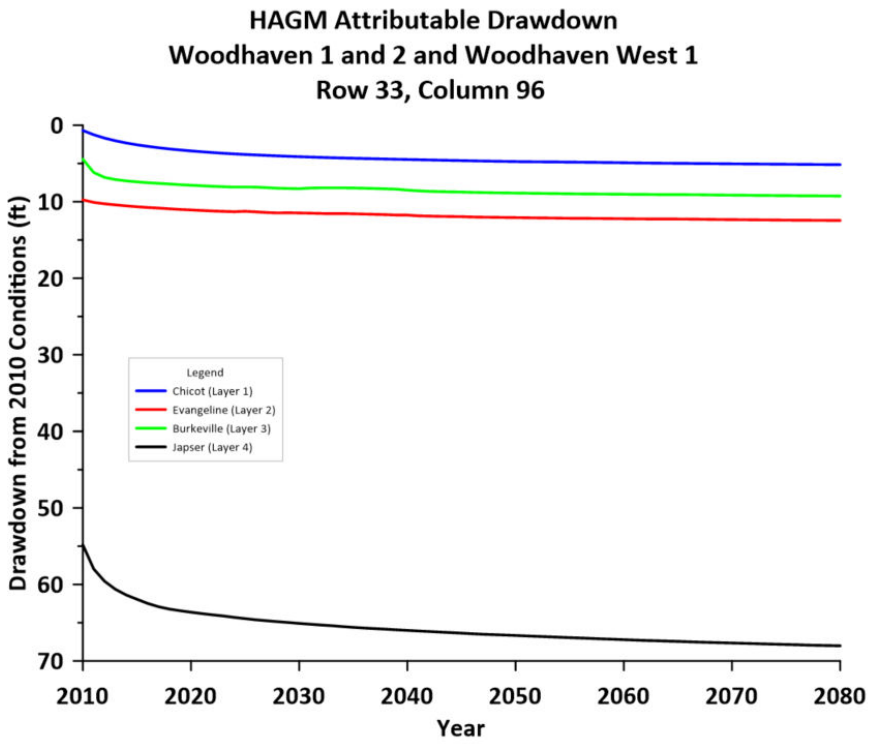


Figure 2. Attributable Drawdown Hydrograph for Woodhaven and Woodhaven West Well Sites

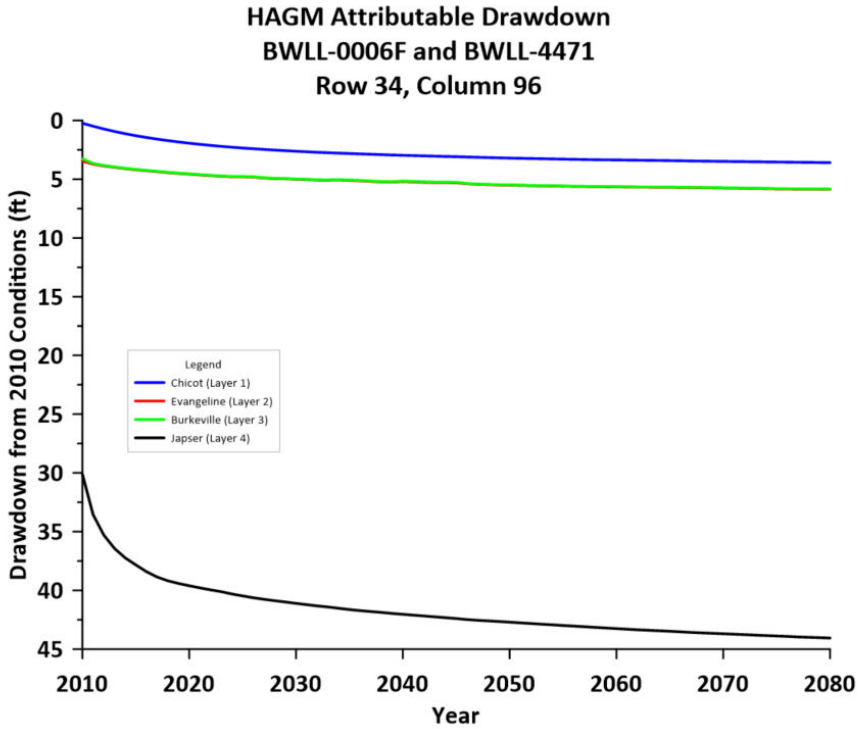


Figure 3. Attributable Drawdown Hydrograph for BWLL-006F and BWLL-4471 Sites

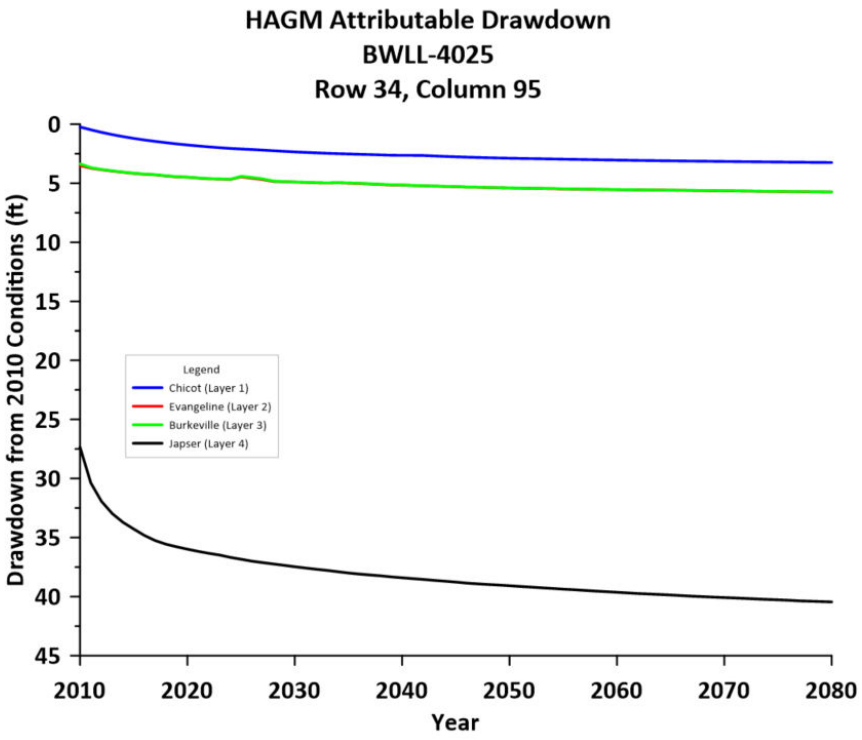


Figure 4. Attributable Drawdown Hydrograph for BWLL-4025 Site

3.2 Subsidence Hydrographs

The Fortran post-processor *getsub.exe* was used to calculate subsidence at each of the sites of interest for the simulations. Hydrographs of subsidence attributable to the proposed pumping at the Woodhaven well sites and the nearby wells are presented in Figure 5.

The full set of hydrographs (DFC simulation and DFC + proposed pumping simulations) for all three locations in all four aquifer formations are presented in Appendix B. The attributable subsidence hydrographs presented in Figure 5 represent the difference between subsidence from the DFC + proposed pumping simulation and the drawdown from the DFC simulation.

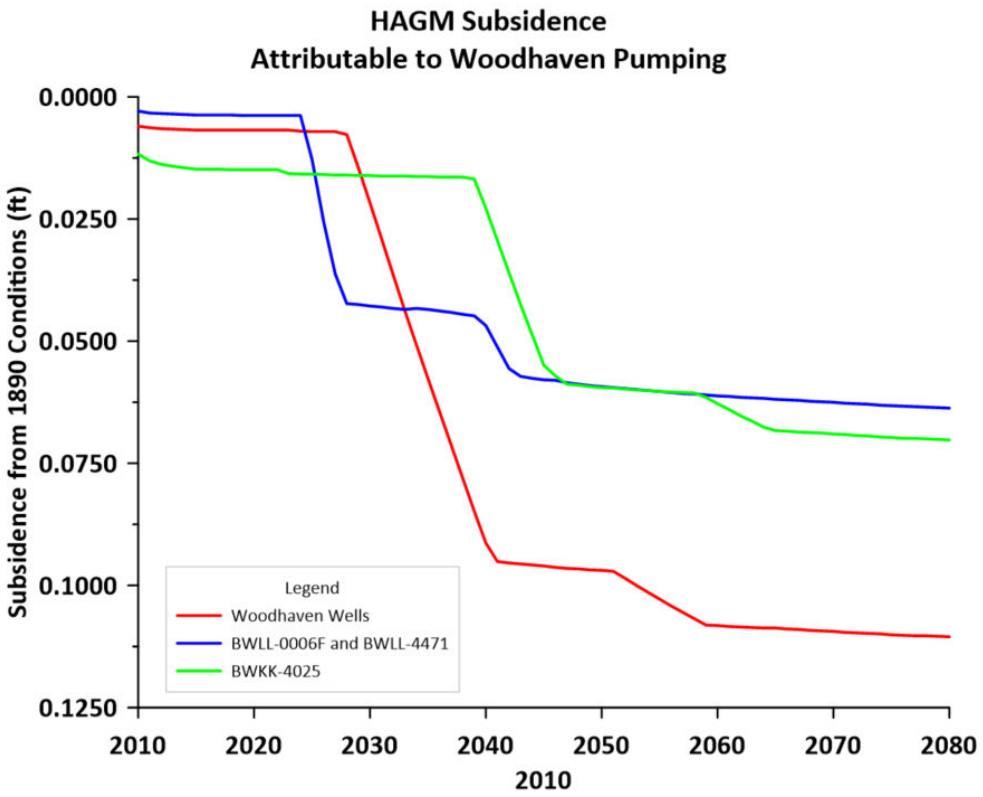


Figure 5. Subsidence Hydrographs for All Sites

3.3 Tabular Summary of Drawdown and Subsidence

The summary of drawdown and subsidence attributable to the proposed pumping for all well locations is presented in Table 9.

Table 9. Tabular Summary of Drawdown and Subsidence

Parameter		Well ID					
		Woodhaven 1 (Proposed)	Woodhaven 2 (Proposed)	Woodhaven West 1 (Proposed)	BWLL-0006F	BWLL-4025	BWLL-4471
Depth (ft)		650	1,000	1,000	275	240	245
Distance to Woodhaven 1 (ft)		0	364	5,241	2,411	7,809	3,398
Distance to Woodhaven 2 (ft)		364	0	4,981	2,088	7,586	3,161
Distance to Woodhaven West 1 (ft)		1,438	1,127	0	966	378	1,831
HAGM Row		33	33	33	34	33	34
HAGM Column		96	96	96	96	95	96
Attributable Drawdown to Proposed Pumping from 2010 to 2080 (ft)	Chicot Aquifer	5.15	5.15	5.15	3.25	3.59	3.25
	Evangeline Aquifer	12.44	12.44	12.44	5.74	5.86	5.74
	Burkeville Formation	9.25	9.25	9.25	5.73	5.84	5.73
	Jasper Aquifer	68.02	68.02	68.02	40.45	44.05	40.45
Subsidence Attributable to Proposed Pumping from 1890 to 2080 (ft)		0.11	0.11	0.11	0.06	0.07	0.06

3.4 Groundwater Budget Comparison

The summary groundwater budget comparison of the DFC simulation and the simulation where the proposed well is added to the DFC simulation is presented in Table 10. An analysis of the source of the proposed pumping is presented in Table 11.

Table 10. Groundwater Budget Summary

	DFC Run (2010 to 2080) (AF/yr)	Woodhaven Run (2010 to 2080) (AF/yr)	Difference (AF/yr)
Inflow			
Recharge and Net Surface Water Inflow (GHB Boundary)	41,382	41,470	88
Interbed Storage (IBS)	2,956	2,989	33
From Austin County (Zone 8)	6,232	6,282	49
From Grimes County (Zone 93)	1,816	2,142	326
From Washington County (Zone 239)	1,243	1,271	29
Total Inflow	53,629	54,154	
Outflow			
Pumping (WEL)	55,495	57,109	1,614
To Fort Bend County (Zone 79)	10,422	10,411	-11
To Harris County (Zone 101)	4,157	4,116	-41
To Montgomery County (Zone 170)	5,922	5,019	-903
Total Outflow	75,996	76,655	
Inflow - Outflow	-22,367	-22,501	-134
Model Calculated Storage Change	-22,366	-22,500	-134
Model Error	-1	-1	

Table 11. Source of Proposed Pumping Analysis

	AF/yr	Percent of Increased Pumping
Pumping Increase	1,614	100.00
Storage Reduction	134	8.27
Induced Inflow		
Recharge and Net Surface Water Inflow (GHB Boundary)	88	5.42
Interbed Storage (IBS)	33	2.07
From Austin County (Zone 8)	49	3.04
From Grimes County (Zone 93)	326	20.23
From Washington County (Zone 239)	29	1.77
Captured Outflow		
To Fort Bend County (Zone 79)	11	0.70
To Harris County (Zone 101)	41	2.54
To Montgomery County (Zone 170)	903	55.95

Please note that over half of the pumping will be captured outflow to Montgomery County, and only 8 percent of the pumped water will be sourced from groundwater storage (about 10 percent if interbed storage is included). The only other component that represents more than 10 percent of the pumping increase is induced inflow from Grimes County (about 20 percent of the pumping).

4.0 Conclusions and Recommendations

The permit application for this well should be approved to proceed to the Phase II activities.

5.0 References

Hutchison, W.R., 2021. Implementation of GMA 14 Desired Future Condition Based on Multi-Metric Simulation (70% Available Drawdown, 1 Foot of Subsidence, 30K Pumping Limit, 2016 Pumping Distribution). Final Report to Zach Holland, General Manager of Bluebonnet Groundwater Conservation District, April 27, 2021, 54p.