Hancock Acres Dewatering Study

Sedgwick County...
working for you

PEC PROJECT NO. 35-190516-000-0024

DECEMBER 2019

NICOLE FRANKEN
LICENSED
24782
12/23/2019
KANSAS
PROFESSIONAL ENGINEER

Nicole Franken

PREPARED BY
PROFESSIONAL ENGINEERING CONSULTANTS PA
303 South Topeka Wichita, Kansas 67202 316-262-2691 www.pec1.com

Table of Contents

List of Tables

List of Schematics

List of Figures

List of Appendices

1.0 Introduction

1.1 Purpose

Sedgwick County, Kansas has retained the services of Professional Engineering Consultants, P.A. (PEC) to evaluate the hydrogeologic conditions in the vicinity of the Hancock Acres residential development located near Hillside Avenue and 83rd Street South. The Hancock Acres residential development boundary in relation to the City of Derby (the City), floodways, and floodplain boundaries is shown in Figure 1. The goal of this evaluation is to determine the required infrastructure improvements to prevent groundwater from entering the basements of houses within Hancock Acres without negatively impacting nearby domestic water supply wells, and to determine the costs for the required improvements. The results of this study are intended to provide information for residents of Hancock Acres to help determine whether to proceed with forming an improvement district through the County to construct the proposed dewatering infrastructure.

1.2 Scope

The following tasks were completed as part of this study:

- Review existing hydrogeologic conditions in the vicinity of Hancock Acres;
- Determine preliminary locations for dewatering and observation wells and the associated radius of influence of the dewatering wells;
- Determine the required depth, size, and rate of withdrawal for the dewatering wells;
- Identify and evaluate options for dewatering well infrastructure and provide a summary of the preliminary design;
- Determine location restrictions for proposed dewatering infrastructure such as existing property limits and right-of-way's (ROWs), existing utility locations, existing electrical supply;
- Determine regulatory requirements for the proposed dewatering infrastructure;
- Determine the capital costs and annual Operation and Maintenance (O&M) costs for the proposed dewatering infrastructure; and,
- Determine actions and procedures for implementing the proposed improvements and provide a preliminary schedule for project implementation.

1.3 Background

Hancock Acres was initially developed is the early 1970’s and is located adjacent to the confluence of the M.S. Mitch Mitchell Floodway (the Floodway) and the Arkansas River. The Floodway was constructed in the 1950’s and is located on the north side of Hancock Acres. The Arkansas River is located east of Hancock Acres.

Sedgwick County experienced extended periods of wet weather in 2019, resulting in groundwater elevations rising as a result of infiltration and, in some locations near waterways, surface water hydrogeologic interactions. Rising groundwater levels caused water to enter some basements within Hancock Acres. While some of the homes with groundwater infiltration have not experienced flooding, their sump pump(s) run continuously which results in substantial electrical bills and an increased risk of basement flooding upon sump pump failure. A map indicating which houses within Hancock Acres have sump pump(s) constantly running, have sump pump(s) constantly running and flooding, and which properties have not had issues with groundwater infiltration in 2019 is presented in Appendix A.

Based on discussion between Hancock Acres property owners and the County at a meeting held on July 11, 2019 at the Haysville Library, it was determined that a study was warranted to determine whether residents would be interested in forming an improvement district and what steps need to be taken to implement the project. On August 8, 2019, Sedgwick County hosted a meeting to discuss the groundwater flooding issues with Hancock Acres residents. The County’s Director of Environmental Resources, a Groundwater Management District 2 representative, a WSU professor of hydrogeology and Derby City Council member, a Division of Water Resources representative, a Wichita Area Builders Association representative, and the County’s Public Works Deputy Director attended the meeting. Factors influencing groundwater levels were discussed including the amount and distribution of precipitation, groundwater usage and associated discharges and/or evaporation, stream interaction including baseflow and bank storage, soil types and stratigraphy, topography, recharge rates and recharge zones.

2.0 Existing Conditions

2.1 Surface and Historical Subsurface Elevations

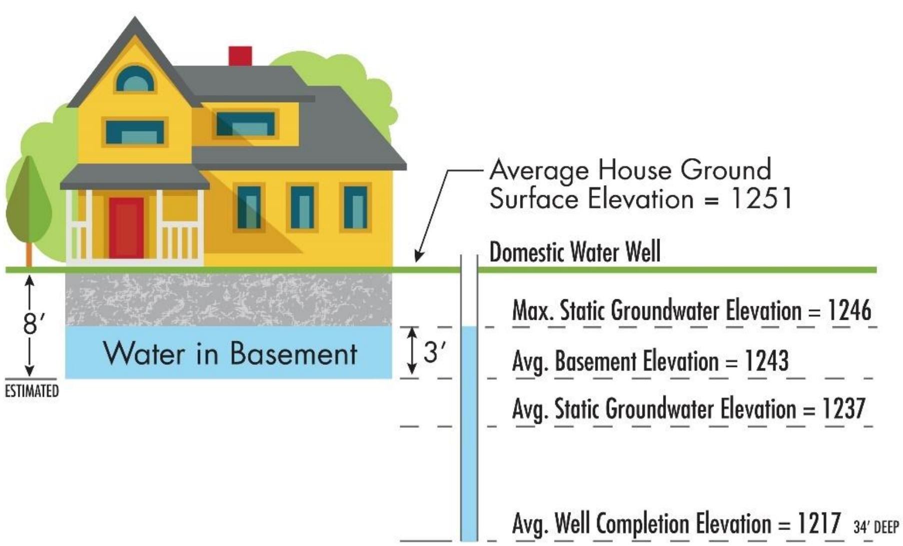
Sedgwick County provided elevations for the houses and wells located within Hancock Acres based on Light Detection and Ranging (LIDAR) measurements. The county also compiled water well information from the Kansas Geological Survey water well database for wells located within Hancock Acres. Estimated basement elevations were provided based on the assumption that each basement is eight feet below the ground surface elevations provided by LIDAR measurements. Elevation information provided by Sedgwick County is summarized in Table 1 and the full dataset is presented in Appendix A. Schematic 1 provides a visual representation of the elevations shown in Table 1.

Table 1: Surface and Subsurface Elevations

	Average	Maximum	Minimum
House Elevation	1251	1253	1248
Basement Elevation [1]	1243	1245	1240
Well Completion Elevation	1217	1235	1190
Static Groundwater Elevation [2]	1237	1246	1225

[1] Assumes a basement depth of eight feet below ground surface elevations. Ground surface elevations based on LIDAR measurements.
[2] Static water elevation at the time of well construction.

Schematic 1: Surface and Subsurface Elevations Schematic



Note: The elevations shown are approximate. Basements were assumed to be eight feet below ground surface.

Since the average static groundwater elevation is 1237, groundwater is typically about six feet below the average basement elevation. Static water levels at the time of well construction were higher than the estimated basement floor elevations for 22 wells. The difference between the static water level at the time of well construction and the estimated basement floor in these 22 wells was 2.3 feet.

2.2 Soil Profiles

The County provided maps showing the surface soil classification (clay or sand) and the surface soil classification in addition to the status of groundwater infiltration for each residence based on available well construction logs. Additionally, the County provided subsurface soil profiles based on the well construction logs. The soil maps and profiles provided by the County are presented in Appendix A.

Based on the map showing both the surface soil classification and status of groundwater infiltration in 2019, it appears more houses experienced basement flooding the further south they are located within the development. The ground surface elevation decreases from north to south and from west to east. Generally, most houses in the north and southwest portions of the development had clay soils while most houses on the east side of the development (closer to the Arkansas River) had sandy soils. Houses with sandy soils all had some groundwater infiltration, and most houses with sandy conditions had basement flooding. Roughly 45% of all the houses in the development experienced basement flooding, 25% of the houses observed no groundwater infiltration issues, 22% were constantly running a sump pump(s), and the status of groundwater infiltration was unknown for 8% of houses in 2019.

2.3 Hydrogeology

PEC retained the services of SCS Engineers (SCS) to evaluate the hydrogeological conditions and to assist in the preliminary design of dewatering wells. Based on SCS's findings, groundwater contributes to surface water flows in the Floodway and the Arkansas River under typical conditions. However, when these waterways experience high water surface levels such as those experienced in 2019, surface water contributes to the groundwater elevations. A technical memorandum summarizing SCS's findings is provided in Appendix B.

3.0 Improvement Options

3.1 Well Locations and Sizing

The technical memorandum prepared by SCS recommends six dewatering wells and five observation wells at the preliminary locations shown in Figure 2. SCS recommends performing a pump test to confirm assumptions made during their modeling efforts before the dewatering design is finalized. All observation wells were recommended to be constructed of four-inch PVC casing and completed at a depth of approximately 30 feet.

SCS had several constraints to work around when preparing the hydrogeologic model. As shown on the cross-section provided by the County (provided in Appendix A), the shale confining layer limits the water column to 20 feet or less. The limited water column reduces the available space for well screens, resulting in larger well diameters. Additionally, the target groundwater level range resulting from the dewatering efforts was constrained by minimizing impact on nearby water supply wells.

The preliminary well sizes, well depths below ground surface (bgs), and discharge rates in gallons per minute (gpm) were determined based on SCS's model results. Additionally, the model results provided the anticipated resulting groundwater table elevations and each well's radius of influence. The preliminary dewatering well specifications are summarized in Table 2.

Table 2: Dewatering Well Specifications

Well Name	Radius(1) (in)	Approximate Depth (ft bgs)	Discharge (ft^3/day)	Discharge (gpm)	Calculated Pumping Surface (ft)	Radius of Influence(2) (ft)
SW-1	7	30	28,875	150	1237.1	500
SW-2	7	30	28,875	150	1237.3	500
NW-2	7	30	67,400	350	1235.9	800
CW-1	7	30	67,400	350	1231.6	800
CW-2	7	30	67,400	350	1232.3	800
NW-1A	7	30	67,400	350	1234.6	800

(1) All dewatering wells are proposed to be constructed of PVC casing and screens that have a radius of 7 inches.

(2) Radius of Influence was estimated from a pump test at Peach Valley Estates in 1999, roughly four miles away from the Hancock Acres residential development. A pump test is recommended prior to final dewatering design.

It is recommended that Variable Frequency Drive (VFD) motors are installed. VFD's would allow the well pump motors to run at varying speeds which would result in varying pumping rates. By utilizing VFDs, the pumping rates can be reduced to slow down the groundwater drawdown to prevent negative impacts on nearby domestic water supply wells. The pumping rate could also be increased when groundwater levels are higher to reduce and/or eliminate groundwater infiltration into basements.

In addition to the six dewatering wells, it is recommended five observations wells be installed to monitor groundwater levels throughout the affected areas. The location, construction, and number of observation wells is flexible and can be refined during final design. The preliminary locations for the proposed observation wells are shown on Figure 2.

3.2 Dewatering Wells Discharge Waterline Alignments

Preliminary pipe sizes were established based on the assumption that all wells would be operating simultaneously at the discharge rates shown in Table 2. The waterlines were sized based on target velocity ranges in the pipe in order to minimize head loss and, as a result, minimize long-term O&M costs from reduced well pump motor horsepower requirements. Lower pump horsepower requirements also reduce capital costs associated with extending electrical service to the proposed sites.

There are two potential dewatering well discharge locations– the Floodway/Arkansas River confluence or the Arkansas River. Three routing options were evaluated, one that would require crossing the levee to the north of the development and two that would convey the groundwater to the Arkansas River to the east. The two options for discharge to the east into the river include installing 14-inch pipe or utilizing the existing drainage ditch along the north side of 83rd Street.

A high-level review of the feasibility of using the drainage ditch was performed using LiDAR contours and excluding the impact of driveway culverts. The existing ditch capacity is adequate to receive flow from the dewatering system during dry conditions but may create areas of standing water or maintenance issues with the minimal slope. In order to utilize the drainage ditch for discharge, a concrete ditch liner is recommended. A detailed HEC-RAS analysis to determine if the existing ditch capacity is adequate for the dewatering system discharge and runoff during rain events was not completed with this evaluation and would require topographic field survey to confirm ditch geometry and culvert crossings.

In order to utilize the existing drainage ditch, a flap gate would be required to prevent flow from the river from draining back towards Hancock Acres. Since the ditch would operate under open channel conditions, pumping would not be appropriate if the water level in the river were higher than the discharge point. Based on the pumping restrictions during high flow events, this option is not considered practical and will not be evaluated further as part of this study.

Both pipe routing options would have similar requirements for obtaining easements within or just outside of resident's backyards. A summary of the discharge locations and length and size of piping required is provided in Table 3. The preliminary discharge piping options are shown on Figures 3 and 4.

Table 3: Dewatering Well Discharge Piping Alignment Evaluation

Routing Option	Discharge Location	Pipe Size (inches)	Length of Pipe
A	Floodway/Arkansas River Confluence	4 8 10 12 14	2,400 1,100 600 1,200 1,000
B	Arkansas River	6 8 10 14	2,000 2,700 900 3,000

3.3 Electrical and Controls

Preliminary calculations were performed for each option to determine the required horsepower (hp) for each well pump. A range of total dynamic head (TDH) for each well pump was calculated based on the anticipated flow rate, range of elevation head, friction head, and minor losses. The maximum expected TDH for each pump was then used to determine the required hp assuming a pump efficiency of 60%. The results of the preliminary calculation are summarized in Table 4.

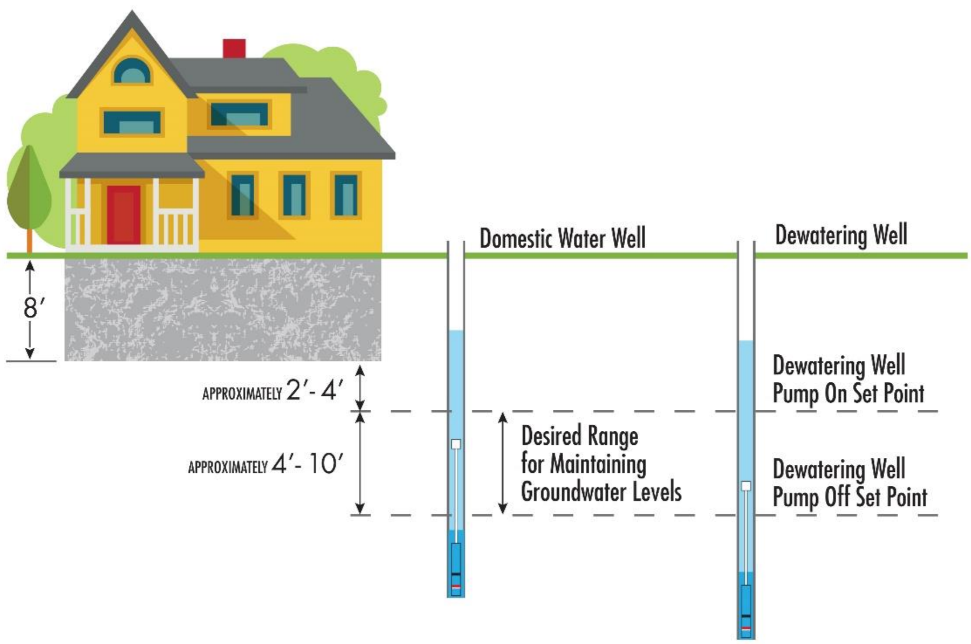
Table 4: Preliminary Pump Sizing

Well	Pump Rate	Option A		Option B	
		Max TDH (ft)	HP	Max TDH (ft)	HP
SW-1	150	68.5	5	44.1	5
SW-2	150	72.4	5	39.3	5
NW-1A	350	38.0	10	69.6	10
NW-2	350	31.8	5	67.7	10
CW-1	350	42.3	10	58.7	10
CW-2	350	50.0	10	53.8	10

Three-phase power is not available at the proposed well sites. Since the well pumps are anticipated to be 15 hp or less, the existing 480-volt, single-phase power source should be adequate. Each well will require the installation of electrical panels that will consist of electrical components from the service provider and control panels to monitor and operate the wells.

A Supervisory Control and Data Acquisition (SCADA) system will be required to control the pumps based on water level measurements from the proposed dewatering wells and observation wells. If the groundwater level increases to a specific level set point, the SCADA system will prompt the pumps to turn on in order to drop the water level below basement elevations. The VFD's will be utilized to ramp up the pump motor speeds until the groundwater level is maintained at a desired elevation. Once these groundwater levels decrease below the level set point, the pump motor speed will decrease to prevent negative impacts to the nearby domestic water supply wells. See Schematic 2 for a visual representation of the proposed dewatering well pump control system.

Schematic 2: Proposed Dewatering Well Pump Controls



Note: Proposed ranges and groundwater elevations are approximate. Exact elevations and depths will vary based on existing house and basement elevations. The desired range for maintaining groundwater levels will be determined and refined during well test pumping and final design. Schematic 2 is intended to provide a visual representation of the purpose for the controls and is not to be interpreted as final design conditions.

During design of the wells and dewatering system, test wells will be installed to verify actual ground water conditions. This testing will confirm drawdown levels, the radius of influence, and aquifer recovery rates. Based on the pump test results, the proposed groundwater level operating parameters can be refined in order to keep the levels below basements and above nearby domestic water supply well's pump suction requirements.

Permanent onsite generators that run on either natural gas or diesel and associated electrical connections and controls are recommended for backup power. Since the nearest natural gas lines are located on the east side of the Arkansas River on 83rd Street, the onsite generators would likely be diesel-powered. The proposed generators would require easements. Ongoing maintenance on each generator would be required to ensure proper operation upon failure of the main power supply.

3.4 Permitting Requirements

Prior to initiating construction for the proposed dewatering wells, dewatering permit applications must be submitted to the Kansas Department of Agriculture's Division of Water Resources (DWR) for review and approval. A DWR representative attended the Groundwater Flooding Meeting on August 8, 2019 to discuss permitting requirements and provide recommendations specific to the Hancock Acres development. DWR recommended either a temporary or term dewatering permit to avoid perfection requirements for permanent water rights. A temporary permit could be used to initiate the project in a timely manner, then a term permit could be pursued in the future to minimize the permit renewal frequency.

Temporary permits can be approved quickly (typically in one week or less) and are valid for up to six months. Temporary permits require records of the volume of water diverted that can be provided to DWR upon request. Term permits take at least three months for review and approval, are limited to five years, require water use reports to be submitted annually, and require installation of flow meters. Term permits must also meet safe yield requirements. The fees for term permits are dependent on the number of acre-feet requested.

There are spacing requirements between the proposed wells and existing domestic or municipal/irrigation water supply wells that must be met. The dewatering wells must be located at least 660 feet from existing domestic wells and ¼ mile from municipal/irrigation wells. Since the spacing requirements cannot be met for the Hancock Acres dewatering wells, DWR will require a waiver.

Based on previous discussions with DWR for similar situations, an agreement with each well owner within a 660-foot radius of the new wells indicating they would not dispute the new well locations and will allow the well installations may be required. These agreements may not be required if evidence is provided to DWR that the operation of the dewatering wells will not cause impairment to the existing wells or public notice is provided through publication in the local newspaper for 3 consecutive weeks. The publication would need to outline the proposed improvements and indicate that any well owner that has an issue with the proposed improvements contact DWR. The actual application for the well construction and the final determination from DWR on their approval will not be completed until it is determined the overall project will move forward.

Existing flows for the Arkansas River were reviewed to determine how the addition of 1,700 gpm (3.79 cubic feet per second (cfs)) would impact future flows and flood elevations. The two-year average flow in the Arkansas River immediately downstream of the confluence with the Floodway (at 83rd Street) is 2,428 cfs. The comparably minimal flow contribution would not negatively impact the flood elevations. It is not anticipated that permitting will be required from DWR or the U.S. Army Corps of Engineers for the discharge of this groundwater. However, a construction permit will be required for the Army Corps of Engineer's review and approval.

4.0 Cost Estimates

Both capital and annual O&M costs were estimated for each waterline alignment option to determine the most economical design for the dewatering infrastructure, as presented in Table 5. Anticipated annual expenses include maintaining the well pumps and electrical equipment, monitoring and repairing breaks or other issues associated with the waterlines, and regular testing of the backup generators. The estimated annual costs assumed that the pumps would run 24 hours a day for 100 days of the year and that electricity costs $0.10 per kilowatt hour.

Table 5: Preliminary Project Cost Estimate (1)

Item Description	Option A	Option B
Capital Costs		
Permitting, Test Pumping, and Construction Oversight	$80,000	$80,000
Waterline Construction	$223,500	$420,600
Dewatering Well and Well Pump (5 hp)(1)	$195,000	$180,000
Dewatering Well and Well Pump (10 hp)(1)	$225,000	$250,000
5 Monitoring Wells	$50,000	$50,000
Meter Vault	$15,000	$15,000
Electrical and Control Systems	$108,000	$108,000
Permanent Onsite Generators	$180,000	$180,000
Valve Assemblies	$6,300	$7,100
Erosion Control/Site Clearing	$65,000	$65,000
Project Costs (Survey, Design, Admin, Inspection, etc.)	$320,340	$421,100
Contingency (20%)	$213,560	$280,740
Total Estimated Capital Cost	$1,681,700	$2,115,550
Annual O&M Cost		
Well Pump and Control System Power (annual)	$11,000	
DWR Reporting (annual)	$1,000	
Well Pump Replacement (every 10 years)	$20,000	
Well Rehabilitation (every 5 years)	$10,000	
Maintenance/Repairs (annual)	$5,000	
Range of Annual Costs	$17,000-$47,000	
Present Value Cost (20 Years)	$2,802,970	$3,236,820

(1) Well and pump costs assume three 5-hp pumps and three 10-hp pumps for option A and two 5-hp pumps for four 10-hp pumps for option B.
(2) Estimated costs do not include costs for easement or right of way acquisition.

As shown in Table 5, Option A is the lowest present value cost option. The capital costs for Option A were further evaluated to determine the anticipated costs to the homeowners on a per lot basis. The estimated cost of $1,631,700 was divided by the 91 existing lots within the study area for a per lot cost of $18,480. The approximate monthly cost for each homeowner was calculated to be $112 per month based on a payoff timeline of 20 years and an annual interest rate of 4.00%. The total monthly payment per homeowner including the estimated loan payment for the capital costs and the annualized estimated O&M costs over a 20-year period is $154.00.

The capital costs for Option B were further evaluated to determine the anticipated costs to the homeowners on a per lot basis for comparison to the costs for Option A. The estimated cost of $2,115,550 was divided by the 91 existing lots within the study area for a per lot cost of $23,248. The approximate monthly cost for each homeowner was calculated to be $141 per month based on a payoff timeline of 20 years and an annual interest rate of 4.00%. The total monthly payment per homeowner including the estimated loan payment for the capital costs and the annualized estimated O&M costs over a 20-year period is $183.00.

5.0 Recommendations

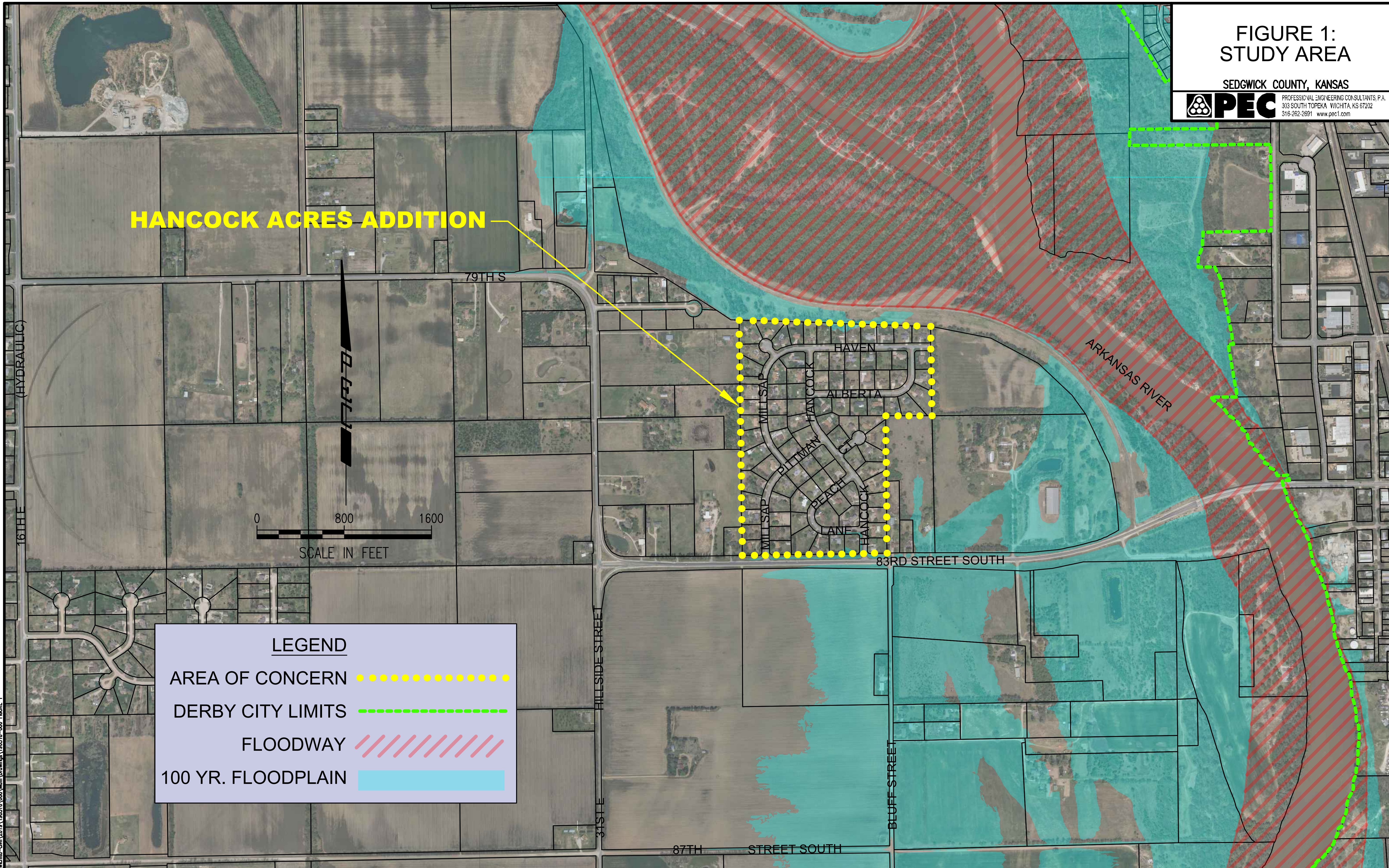
The most economical option to lower the groundwater in the study area is by implementing Option A. This option will require the acquisition of easements and special coordination with the Army Corps of Engineers to cross the levee. Prior to proceeding with final design of the dewatering system, a 72-hour pump test should be performed to refine the assumptions in the hydrogeologic model. The test results will be used to finalize the design of the wells and proposed control systems.

6.0 Project Implementation

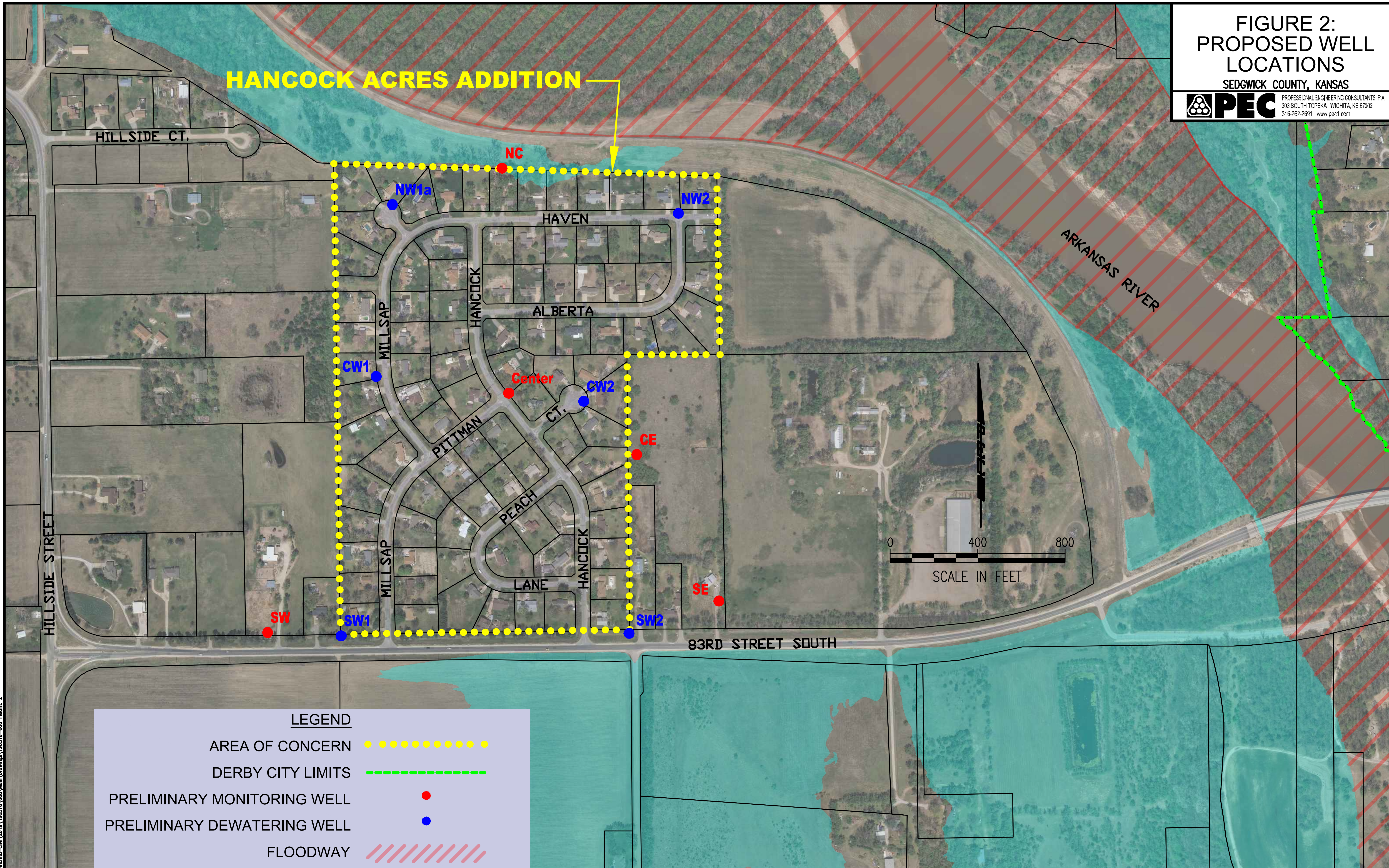
The following is an outline of required actions and procedures for implementing the proposed project:

1. Solicit input on this study from County officials and Hancock Acres residents.
2. If owners are agreeable, create benefit and improvement districts in accordance with Kansas statutes, K.S.A. 19-27 (et.seq) to establish the funding method for moving the project forward (commonly called the "special assessment process"). This includes preparing a petition to the Board of County Commissioners (BOCC) to be signed by either the majority of resident landowners of property to be liable for assessment or the landowners, whether residents or not, of the majority of the area to be assessed. Upon approval of the petition presented, the BOCC will approve an appropriate resolution outlining the requirements for special assessments to be paid by those owners of property within the described benefit district.
3. Establish a design contract with a scope of work that includes performing the recommended pump testing, finalizing the design of dewatering improvements, preparing the required plans and specifications to bid the project, and obtaining required permits.
4. Acquire ROWs and easements, as needed.
5. Relocate existing utilities, as needed.
6. Advertise the bid and provide electronic plans and specifications to bidders. Address bidder questions and prepare addendums as needed.
7. Review bids and award to project to the selected bidder.
8. Commence construction of the project. Construction activities anticipated to be completed within 4 to 6 months after awarding the project to the selected bidder.
9. Submit final payment and perform required accounting for the benefit district and improvement district.

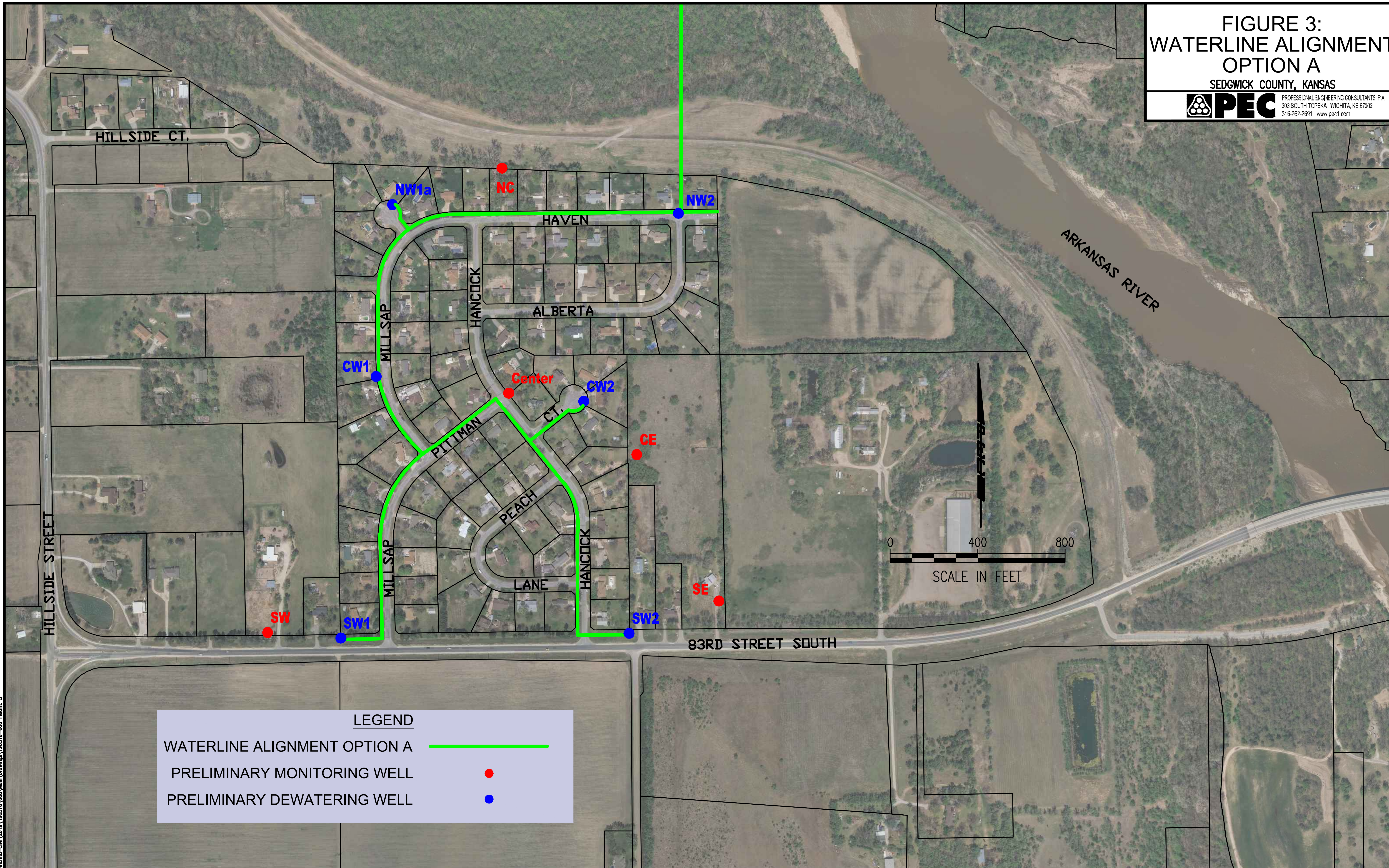
Figures



Saved 10-21-2019 11:42:42 AM by CSL
Plot Scale 1:1 10-21-2019 11:50:20 AM by CSL
U:\Wichita-Civil\2019\190516\000\Muni\Drawings\190516-000 FIGURE 1



Saved 10-21-2019 10:31:16 AM by CSL
Plot Scale 1:1 10-21-2019 11:50:33 AM by CSL
U:\Wichita-Civil\2019\190516\000\Muni\Drawings\190516-000 FIGURE 2



Saved 10-21-2019 11:45:03 AM by CSL
Plot Scale 1:1 10-21-2019 11:50:37 AM by CSL
U:\Wichita-Civil\2019\190516\000\Muni\Drawings\190516-000 FIGURE 3

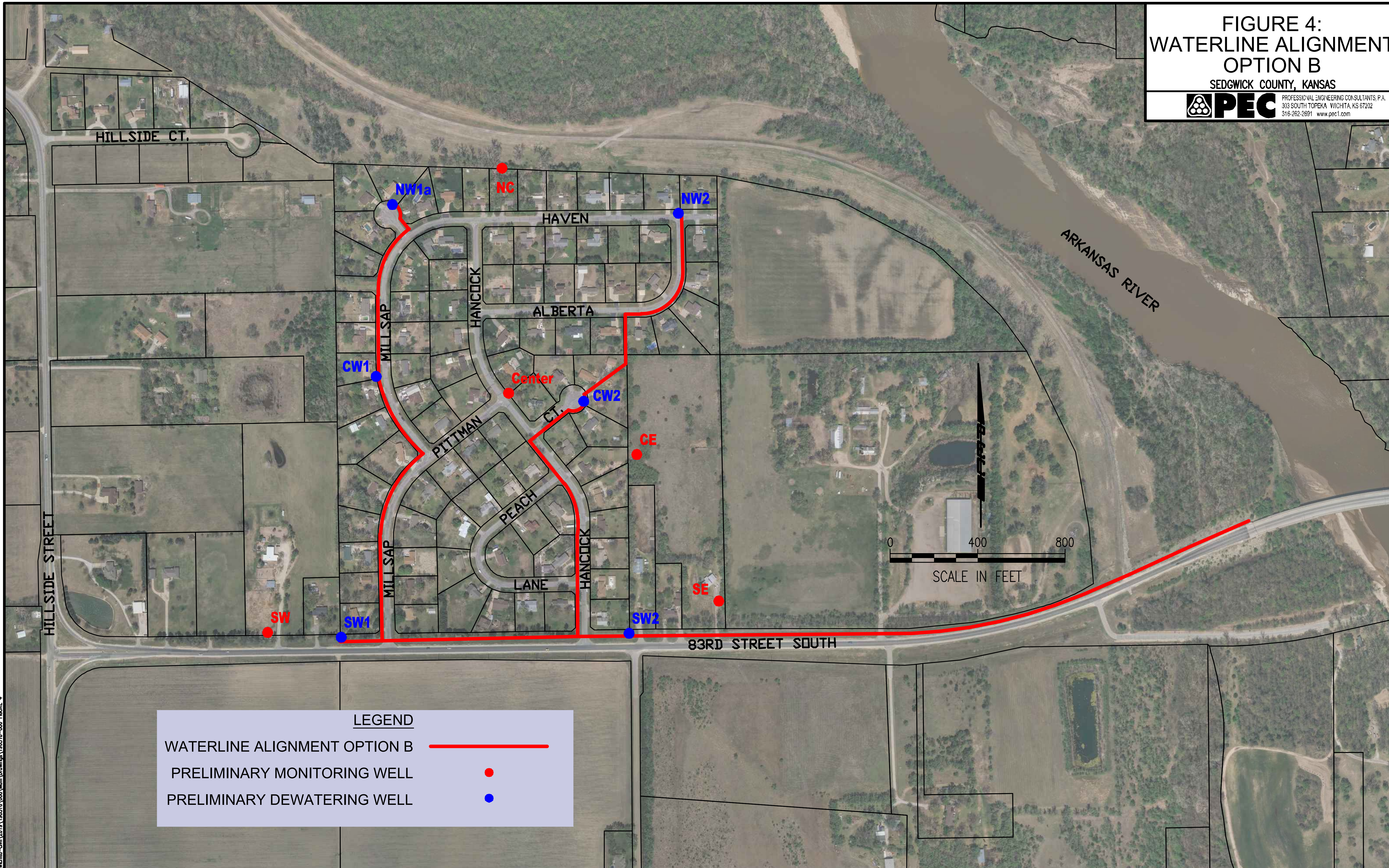


FIGURE 4:
WATERLINE ALIGNMENT
OPTION B
SEDGWICK COUNTY, KANSAS
PEC
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
303 SOUTH TOPEKA WICHITA, KS 67202
316-262-2691 www.pec1.com
ARKANSAS RIVER
HILLSIDE CT.
HILLSIDE STREET
HAVEN
ALBERTA
HANCOCK
MILLSAP
PITTMAN
CT.
PEACH
LANE
83RD STREET SOUTH
NW1a
NC
NW2
CW1
Center
CW2
CE
SE
SW
SW1
SW2
0
400
800
SCALE IN FEET
LEGEND
WATERLINE ALIGNMENT OPTION B
PRELIMINARY MONITORING WELL
PRELIMINARY DEWATERING WELL

Appendix A

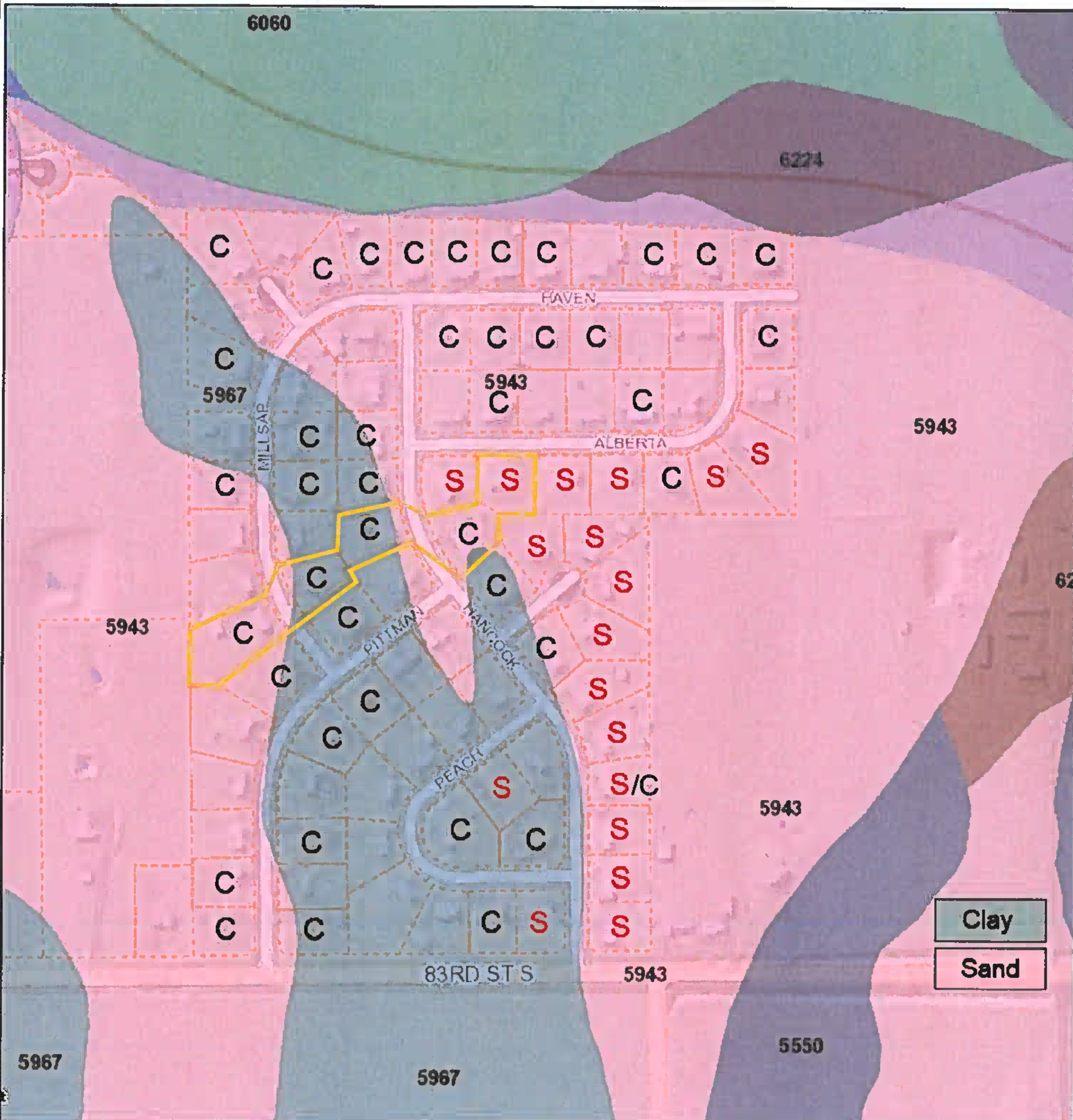
County-Provided Information

Hancock Acres Soil Profile Cross-Section Reference

8231 Millsap Dr.
8230 Millsap Dr.
8229 Hancock Dr.
8202 Hancock Dr.
3809 Alberta Dr.

Hancock Acres

Soils

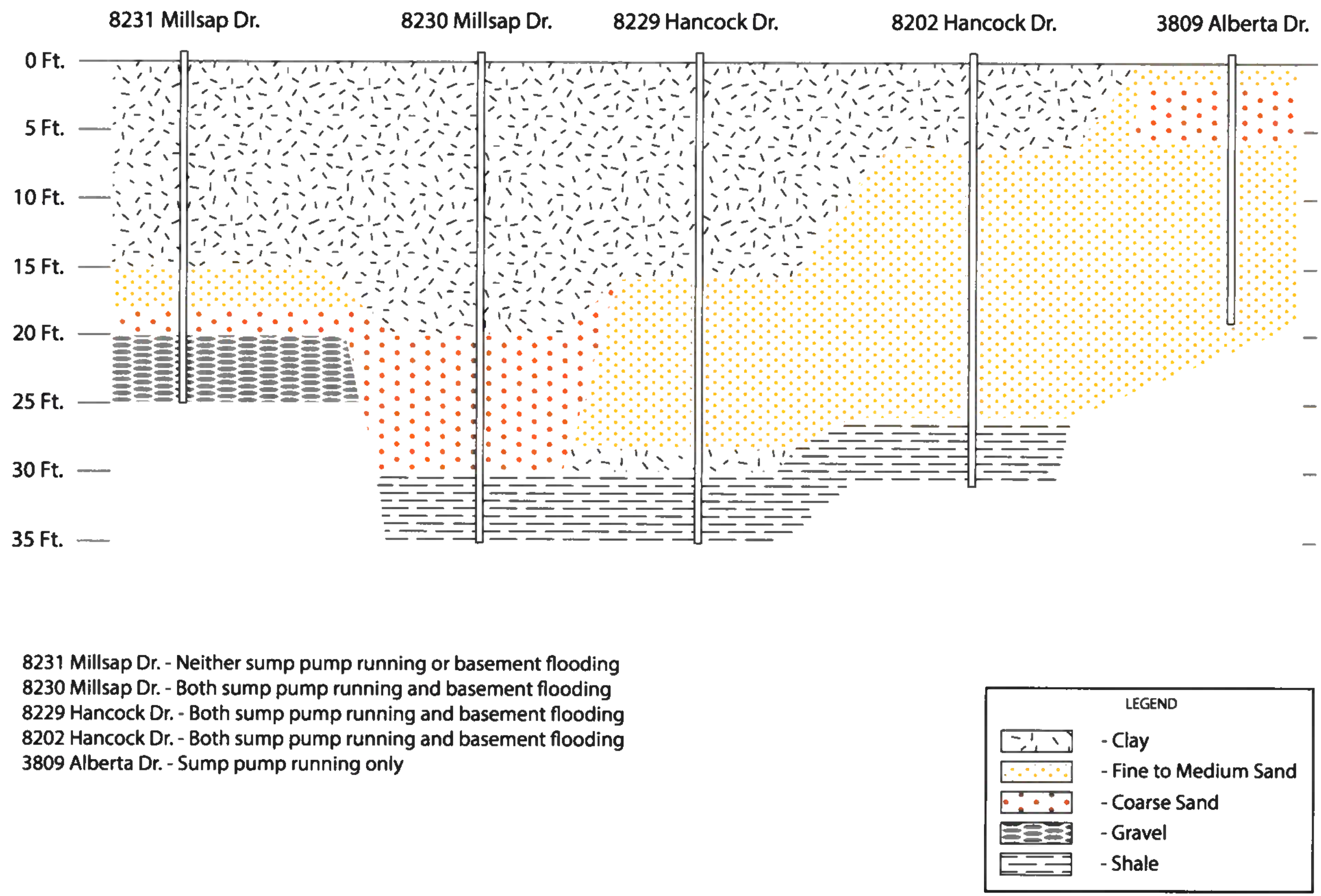


Geographic Information Services
Sedgwick County... working for you

Geographic Information Services
Division of Information & Operations
www.sedgwickcounty.org/gis
525 N. Main, Suite 212, Wichita, KS 67203
Tel: 316.660.9290 Fax: 316.262.1174

Fri Aug 23 13:30:34 GMT-0500 2019

Hancock Acres Soil Profile Cross-Section



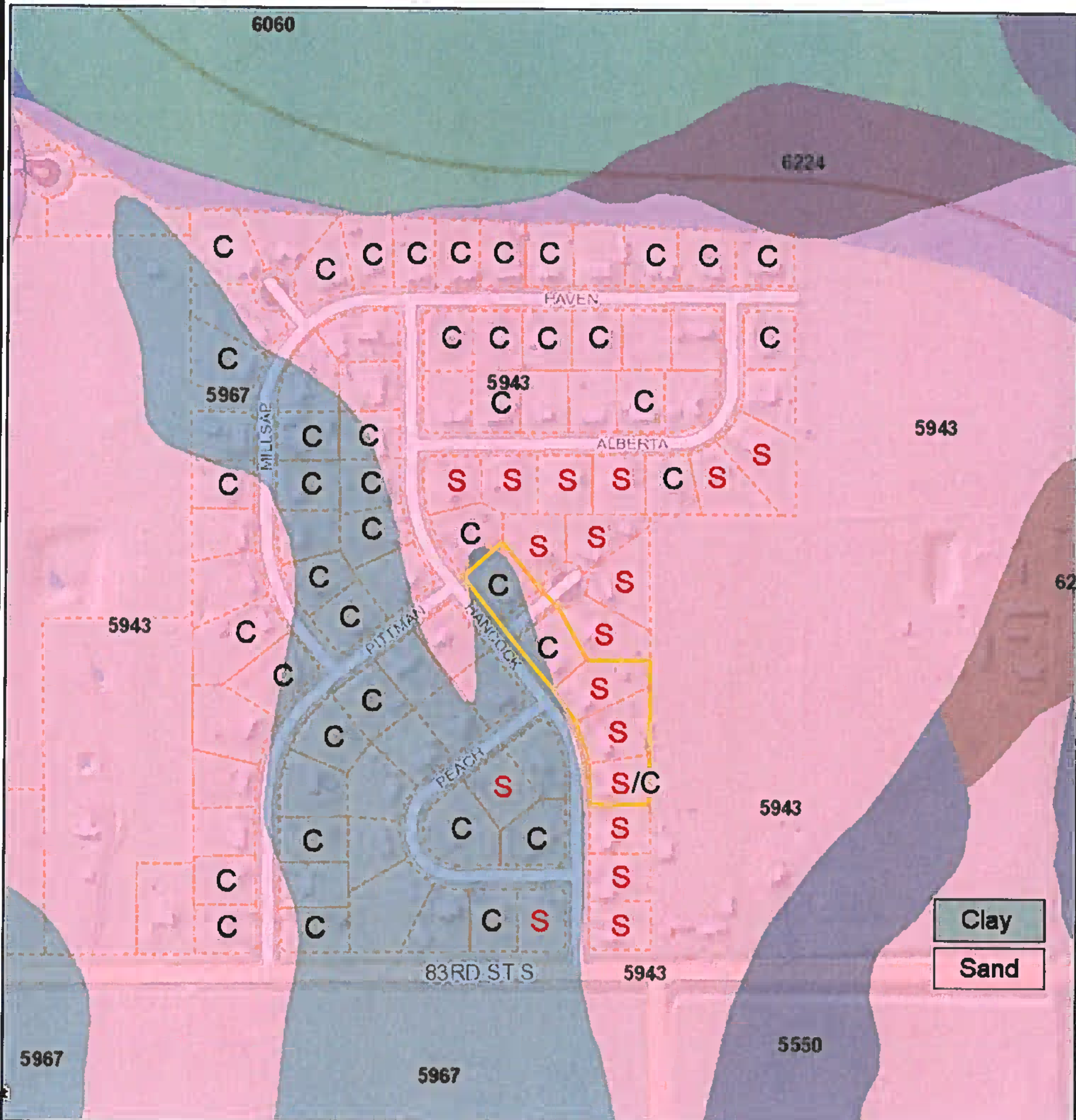
8231 Millsap Dr. - Neither sump pump running or basement flooding
8230 Millsap Dr. - Both sump pump running and basement flooding
8229 Hancock Dr. - Both sump pump running and basement flooding
8202 Hancock Dr. - Both sump pump running and basement flooding
3809 Alberta Dr. - Sump pump running only

Hancock Acres Soil Profile Cross-Section Reference(B)

8218 Hancock Dr.
8252 Hancock Dr.
8260 Hancock Dr.
8300 Hancock Dr.
8320 Hancock Dr.

Hancock Acres

Soils(B)

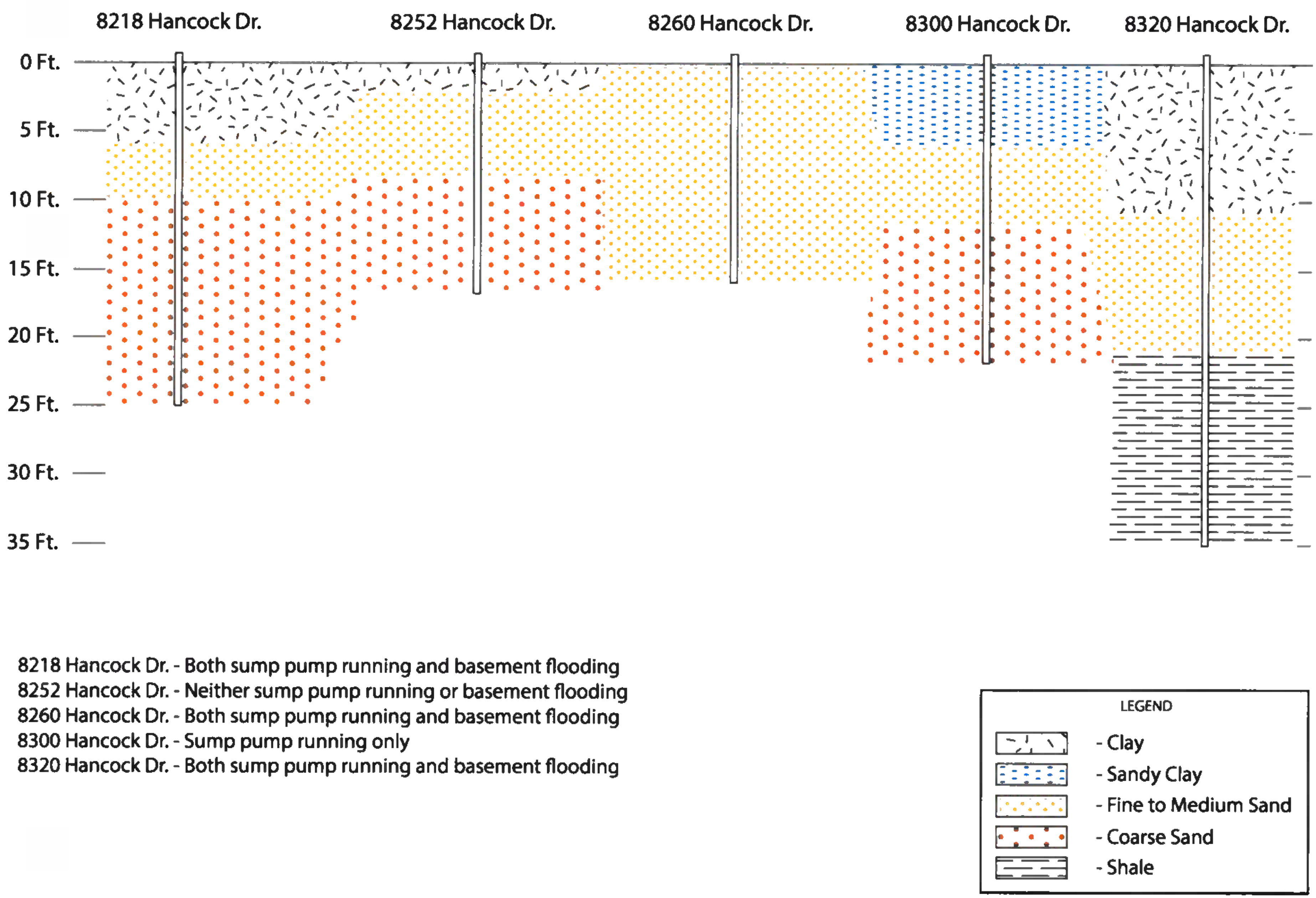


Geographic Information Services
Sedgwick County...
working for you

Geographic Information Services
Division of Information & Operations
www.sedgwickcounty.org/gis
525 N. Main, Suite 212, Wichita, KS 67203
Tel: 316.660.9290 Fax: 316.282.1174

Fri Aug 23 13:30:34 GMT-0500 2019

Hancock Acres Soil Profile Cross-Section(B)



8218 Hancock Dr. - Both sump pump running and basement flooding
8252 Hancock Dr. - Neither sump pump running or basement flooding
8260 Hancock Dr. - Both sump pump running and basement flooding
8300 Hancock Dr. - Sump pump running only
8320 Hancock Dr. - Both sump pump running and basement flooding

Hancock Acres

	Average	Maximum	Minimum
House Elevation	1251	1253	1248
Basement Elevation[1]	1243	1245	1240
Bottom of Well Elev.	1217	1235	1190
Static Water Elev.[2]	1237	1246	1225

(1) Assumes a basement depth of 8 feet

(2) Static water levels at time of construction. Wells were constructed between 1975 and 2015.

Note: Difference in distance from Basement bottom elevation to Well bottom elevation ranged from a minimum of 6.5 feet to a maximum of 53 feet.

Hancock Acres

ADDRESS	LAST NAME	LIDAR Elevation House	LIDAR Elevation Well	Well Depth	Date Drilled	Static Level	8' Basement Elevation	Bottom of Well Elev.	Elevation Difference/ minius 3'Pad	Section 11 T 29 S R 1 E
3609 Haven Ct.	Kunkel	1251	1250	38	11/20/1975	17	1243			NW SW NE NW
				35	1/21/2009	10		1215	28/25	
3600 Haven Ct.	Meusborn	1252	1250	25	6/10/1975	9	1244	1225	19/16	SW NW NE NW
3612 Haven Ct.	McEntire	1252	1250				1244			
3700 Haven Dr.	Newhouse	1252	1250	35	12/22/1975	18	1244	1215	29/26	SE NW NE NW
3701 Haven Dr.	George	1251	1250				1243			
3712 Haven Dr.	Roby	1253	1252	25	8/27/1975	9	1245	1227	18/15	SE NW NE NW
3724 Haven Dr.	Smith	1253	1252	35	12/22/1975	18	1245	1217	28/25	SE NW
3801 Haven Dr.	Locke	1253	1252	35	10/11/1976	15	1245			NW SE NE NW
				30	9/4/1991	15				
				30	8/5/1996	15				
				48	10/4/2012	27		1204	41/38	
3802 Haven Dr.	Bell	1253		38	11/20/1975	20	1245	*1215*	*30/27*	SW NE NE NW
3816 Haven Dr.	Whitson	1252	1252	35	12/22/1975	18	1244	1217	27/24	SW NE NE NW
3817 Haven Dr.	McAdams	1252	1252	35	10/11/1976	15	1244	1217	27/24	NW SE NE NW
3900 Haven Dr.	Salano	1253	1252	35	2/20/1976	15	1245	1217	27/24	SE NE NE NW
3901 Haven Dr.	Lundgren	1253		26	10/16/1995	9	1245	*1227*	*18/15*	NE SE NE NW
3909 Haven Dr.	George	1252	1252	40	6/25/1985	17	1244	1212	32/29	NE SE NE NW
3910 Haven Dr.	Dunham	1252	1252				1244			
4000 Haven Dr.	Black	1252	1252	40	12/31/1993	15	1244	1212	32/29	SW NW NW NE
				40	1/3/1994	15		1212	32/29	
4009 Haven Dr.	Graham	1252	1251				1244			
4010 Haven Dr.	Rankin	1251	1251	32	12/7/1992	15	1243	1219	24/21	SW NW NW NE
4020 Haven Dr.	unk	1251		35	6/6/1984	17	1243	*1216*	*27/24*	SE NW NW NE
				35	6/6/1984	17		*1216*	*27/24*	
3800 Alberta Dr.	Lowry	1251	1251				1243			

ADDRESS	LAST NAME	LIDAR Elevation House	LIDAR Elevation Well	Well Depth	Date Drilled	Static Level	8' Basement Elevation	Bottom of Well Elev.	Elevation Difference minius 3'Pad	Section 11 T 29 S R 1 E
3801 Alberta Dr.	McKinney	1251	1251	17	6/9/1977	7	1243			SW SE NE NW
				30	3/13/1991	11				
				25	3/15/1991	16				
				28	3/15/1991	18				
				30	9/26/2001	15		1221	22/19	
3809 Alberta Dr.	Allen	1252		19	6/10/1977	6.5	1244			SW SE NE NW
				37	12/14/1983	18		*1215*	*29/26*	
3810 Alberta Dr.	Kirtley	1251		40	9/28/1977	15	1243	*1211*	*32/29*	SW SE NE NW
3900 Alberta Dr.	Sutton	1252					1244			
3901 Alberta Dr.	Anderson	1253	1252	19	1/24/1977	7	1245			SE SE NE NW
				17	8/16/1977	6.5				
				35	6/26/2002	18		1217	28/25	
				28	6/28/2002	14				
3908 Alberta Dr.	Pauli	1252	1251				1244			
3909 Alberta Dr.	Roe	1251	1252	17	3/29/1978	7	1243	1235	8./5	SE SE NE NW
4002 Alberta Dr.	Ford	1251	1251	37	9/22/1981	22	1243	1214	29/26	SW SW NW NE
4003 Alberta Dr.	Sutton	1251		32	11/22/1977	15	1243	*1219*	*24/21*	SW SW NW NE
4007 Alberta Dr.	Schock	1250	1250	17	8/7/1978	7	1242			SW SW NW NE
				32	10/2/1999	15		1218	24/21	
				30	10/12/1999	10				
4008 Alberta Dr.	Ball	1251	1251				1243			
4011 Alberta Dr.	McCanless	1251	1250	19	10/25/1977	6.5	1243			SE SW NW NE
				60	3/28/2013	17		1190	53/50	
4015 Alberta Dr.	Powell	1251	1250	32	6/30/1998	15	1243	1218	25/22	SW NW NE
4019 Alberta Dr.	Williams	1251	1251	30	5/18/1994	10	1243			NE SW NW NE
				60	6/16/2014	22		1191	52/49	
8117 Millsap Ave.	Dykens	1250	1250	30	4/19/1975	10	1242	1220	22/19	NW SW NE NW
8118 Millsap Ave.	Foltz	1251	1250				1243			
8123 Millsap Ave.	Mock & Sonka	1252					1244			
8124 Millsap Ave.	Cabral	1251		35	3/20/1976	12	*1243*	*1216*	*27/24*	SE SW NE NW

ADDRESS	LAST NAME	LIDAR Elevation House	LIDAR Elevation Well	Well Depth	Date Drilled	Static Level	8' Basement Elevation	Bottom of Well Elev.	Elevation Difference minius 3'Pad	Section 11 T 29 S R 1 E
8144 Millsap Ave.	Robinson	1251	1250	25	8/29/1975	9	1243			SW SW NE NW
				58	10/4/2012			1192	51/48	SW SW NE NW
8145 Millsap Ave.	Graham	1252	1251	35	1/3/1976	15	1244	1216	28/25	SW SW NE NW
8200 Millsap Ave.	Riggins	1251	1251				1243			
8201 Millsap Ave.	Porter	1253	1252	31	5/14/1998	18	1245	1221	24/21	NW NW SE NW
8221 Millsap Ave.	Townsend	1251	1251				1243			
8230 Millsap Ave.	Cattlett	1251	1250	35	8/5/1996	15	1243	1215	28/25	NW SE NW
8231 Millsap Ave.	Lane	1251	1250	25	7/29/1975	9	1243	1225	18/15	NW NW SE NW
8247 Millsap Dr.	Buffington	1250	1249	28	6/21/1990	18	1242			NW SE NW
				34	6/21/1990	14		1221	21/18	
8300 Millsap Dr.	Appleby	1250	1250	28	7/26/1989	14	1242	1222	20/17	SE NW SE NW
8301 Millsap Dr.	Rogers	1251	1251				1243			
8320 Millsap Dr.	Rulo & Burns	1251	1250				1243			
8321 Millsap Dr.	Ibarra	1250	1249				1242			
8330 Millsap Dr.	Ozbun	1250	1250	30	9/19/1994	12	1242	1220	22/19	NE SE NW
8331 Millsap Dr.	Boyer	1250	1250				1242			
8346 Millsap Dr.	Smith	1249	1249				1241			
8347 Millsap Dr.	Complete Const.	1251	1250	30	8/8/1994	12	1243	1220	23/20	SW SW SE NW
8358 Millsap Dr.	Rundel	1250	1250	23	8/4/1993	5	1242			SE SW SE NW
				35	8/4/1993	15		1215	27/24	
8359 Millsap Dr.	Baker	1252	1251	30	5/26/2015	15	1244	1221	23/20	SW SE NW
8244 Pittman Dr.	Gimben	1249	1249				1241			
8245 Pittman Dr.	Zehr	1250	1250	25	6/4/2003	10	1242			SE SE NW
				27	6/4/2003	11		1223	19/16	
8252 Pittman Dr.	Fasig	1249	1249				1241			
8253 Pittman Dr.	Buller	1250	1250	45	8/27/1985	15	1242	1205	37/34	NE NW SE NW
8260 Pittman Dr.	White	1250	1250	40	9/6/1975	15	1242			SE NW SE NW
				40	7/21/2010	14		1210	32/29	
8243 Peach Ln.	Foulk	1249	1248				1241			
8251 Peach Ln.	Flanders	1248	1248				1240			
8321 Peach Ln.	Shelinbarger	1249	1249				1241			

ADDRESS	LAST NAME	LIDAR Elevation House	LIDAR Elevation Well	Well Depth	Date Drilled	Static Level	8' Basement Elevation	Bottom of Well Elev.	Elevation Difference minius 3'Pad	Section 11 T 29 S R 1 E
8324 Peach Ln.	Williams & Mallory	1249	1248	40	12/29/2011	14	1241	1208	33/30	SE SE NW
8332 Peach Ln.	Tonry	1249	1248	16.5	4/30/1977	6.5	1241			NW SE SE NW
				22	10/5/1979	13				
				40	9/21/2007	9		1208	33/30	
8333 Peach Ln.	Zwiers	1249	1249	35	8/20/1999	10	1241	1214	27/24	NE SW SE NW
8338 Peach Ln.	Mahon	1250	1249	18	5/18/1976	9	1242			NW SE SE NW
				42	7/1/2008	13				
				42	7/1/2008	13		1207	35/32	
8344 Peach Ln.	Schifferdicker	1249	1248	19	1/13/1975	6.5	1241			NE SE SE NW
				38	8/22/2002	12		1210	31/28	
8345 Peach Ln.	Moon	1249					1241			
8357 Peach Ln.	Jackson	1249	1249	32	10/9/1998	14	1241	1217	24/21	SE SE NW
8361 Peach Ln.	Tracy	1249					1241			
8367 Peach Ln.	Linn	1248	1248	21	4/25/1988	11	1240			SE SE NW
				20	4/25/1988	6				
				30	2/21/2002	12		1218	22/19	
8373 Peach Ln.	Utsler	1248		14.5	8/18/1980	5.5	1240	*1233.5*	*6.5/3.5*	SE SE SE NW
8117 Hancock Dr.	D. George Prop.	1252					1244			
8123 Hancock Dr.	Johnson	1251	1250	35	2/20/1976	15	1243			SE SW NE NW
				30	5/28/1991			1220	23/20	
8143 Hancock Dr.	Smith	1251	1250	35	2/20/1976	15	1243	1215	28/25	SE SW NE NW
8202 Hancock Dr.	Young	1250	1249	17	7/21/1976	6	1242			NW NE SE NW
				30	1/9/1992	14		1219	23/20	
8218 Hancock Dr.	Day	1251	1248	17	4/22/1977	7	1243			NW NE SE NW
				25	6/14/1990	10	Recon			
				23	1/22/2004	14				
				35	1/22/2004	14		1213	30/27	
8229 Hancock Dr.	Rogers	1250	1249	35	2/20/1976	15	1242	1214	28/25	NE NW SE NW
8252 Hancock Dr.	Dale	1249	1248	17	4/7/1976	3.5	1241			SE NE SE NW
				34	10/20/2003	10		1214	27/24	
8260 Hancock Dr.	Cupp	1249	1249	16.5	2/26/1976	3.5	1241	1232.5	8.5/5.5	SE NE SE NW

ADDRESS	LAST NAME	LIDAR Elevation House	LIDAR Elevation Well	Well Depth	Date Drilled	Static Level	8' Basement Elevation	Bottom of Well Elev.	Elevation Difference minius 3'Pad	Section 11 T 29 S R 1 E
8300 Hancock Dr.	Wichita Rentals	1248	1248	16.5	9/26/1975	7	1240			SE NE SE NW
				22	4/20/1990	10				
				30	8/5/1998	12		1218	22/19	
				32	10/9/2013	18				
				27	10/9/2013	13				
8320 Hancock Dr.	Beckley	1248	1248	15	1/15/1975	4	1240			NE SE SE NW
				22	5/3/1991	14				
				35	5/3/1991	12		1213	27/24	
8330 Hancock Dr.	Johnson	1249	1248	16.5	7/18/1975	3.5	1241			NE SE SE NW
				28	9/3/1988	13		1220	20/17	
8346 Hancock Dr.	Rhine	1250	1249	15	4/30/1975	3.5	1242			SE SE SE NW
				35	12/24/2004	8		1214	28/25	
8358 Hancock Dr.	Berkowitz	1249	1248	19	4/30/1975	7	1241	1229	12./9	SE SE SE NW
8210 Hancock Ct.	DDL LLC	1251	1249	17	6/9/1978	7	1243			NE NE SE NW
				30	6/3/2002	15		1219	24/21	
				25	6/6/2002	15				
8222 Hancock Ct.	Milburn	1250		17	7/22/1976	5.5	1242	*1233*	*9./6*	NE NE SE NW
8232 Hancock Ct.	Haun	1250	1250	19	7/18/1975	4.5	1242	1231	11./8	NE NE SE NW
8244 Hancock Ct.	1600 Holdings	1250	1249	17	5/18/1976	6	1242	1232	10./7	NE NE SE NW

Red = Plugged

Italic = used house elevation (well not located)

Note: Most recent well info used for for well depth

Appendix B

Hydrogeology Technical Memorandum

September 16, 2019
File No. 27218317.00

MEMORANDUM

TO: Nicole Franken PE
Ryan Glessner PE
FROM: Kevin Hopkins PG
Steve Linehan PE

SUBJECT: Hancock Acres, Derby Kansas. Preliminary Dewatering Calculations

Professional Engineering Consultants (PEC) commissioned SCS Engineers (SCS) to evaluate the potential methods of de-watering the Hancock Acres subdivision (near 83rd Street South and the Arkansas River, Sedgwick County Kansas). During the spring and early summer of 2019 groundwater elevations in this area were at exceptionally high levels, resulting in either high use of sump pumps or basement flooding in the subdivision.

SCS was commissioned to establish the following:

1. Location(s) of dewatering and observation wells.
    a. To the extent possible, locations should be identified with consideration of easements and right-of-ways.
    b. Establish a radius of influence for dewatering wells.
2. Estimate the depth and size of the pumping wells.
3. Estimate the rate of withdrawal for the dewatering wells.

To develop the dewatering plan, and respond to the specifics presented by PEC, SCS conducted a multifaceted study of the project area. Included in this study were data available in the public domain in conjunction with information provided by PEC and the County.

Located near the confluence of the M.S. Mitch Mitchell Floodway (MSMMF) and the Arkansas River, The Hancock Acres subdivisions have two surface features that significantly impact the groundwater elevations in the area. To the north, the MSMMF represents an area of high hydraulic head during peak flow periods, as does the Arkansas River to the east of the subdivision.

Groundwater in the study area is primarily limited to a 20-foot thick section of Pleistocene age sand, and gravel that overlies the comparatively impermeable Permian age Wellington formation. Permeablities of the Pleistocene deposits varies, with published values ranging from 75 to 750 feet/day. Under "typical" conditions, the groundwater elevation is near 1235' to 1236' above mean sea level.

During May and June of 2019, the Derby area, along with most of central Kansas experienced record rainfalls. The nearby McConnell Air Force Base recorded 12.64" in May and, 6.19" inches in June. Near the site, the United States Geological Survey maintains gauging station 07144550. During May 2019, this station recorded the highest monthly mean gage height since accurate records have been maintained (1988). June 2019 was the fifth largest mean gage height. For perspective, based on the 31 correct records, the May gage height was 2.7 times greater than the mean (9.165' v. 3.39') and June was 1.7 times greater than the mean (6.442' v. 3.62').

Under typical conditions, both the MSMMF and the Arkansas River are gaining streams. During this time, groundwater discharges into the receiving water body. However, during times of high surface water elevations, the situation reverses, and the "streams" discharge to groundwater (losing stream). Because of Hancock Acres proximity to both waterways, groundwater elevations can approach elevations of 1246' msl. An elevation of 1246' is three feet greater than the average datum of basement floors in the area, based on information provided by the County.

SCS constructed a hydraulic model of the project area using Gflow 2.2.3. Gflow contains robust algorithms to simulate surface/groundwater interactions that are highly suitable for the geohydrologic conditions in the study area. Using a permeability value of 500 feet per day, a storativity of 0.20, and configuring both the MSMMF and Arkansas River as losing streams, the "baseline" potentiometric surface in the project areas is ~1246' msl.

Dewatering wells were entered into the model to simulate groundwater drawdown. Several conditions constrained the groundwater withdrawal design.

1. The small (20 foot or less) water column would not allow extensive screen lengths; SCS offset this challenge by increasing the well diameter.
2. Excessively low pumping levels were avoided, with the objectives of:
    a. Only managing excessive water.
    b. Protecting the water supply.

Based on the above, the most likely final configuration is six dewatering wells, constructed of 14 inch PVC casing and screens. Table one presents the locations and initial specifications.

Table 1: Preliminary Dewatering Well Locations and Specifications

Dewatering Wells								
	UTM Zone 14 meters		Radius	Discharge	Discharge	Calc. Pumping Surface	Depth	ROI*
Wells	X	Y	FT	Cubic Ft/Day	GPM	MSL (ft)	bgs	ft
SW1	650,896	4,156,259	0.58	28875	150	1237.1	~30	500
SW2	651,360	4,156,273	0.58	28875	150	1237.3	~30	500
NW2	651,342	4,156,831	0.58	67400	350	1235.9	~30	800
CW1	650,881	4,156,548	0.58	67400	350	1231.6	~30	800
CW2	651,367	4,156,533	0.58	67400	350	1232.3	~30	800
NW1a	650,882	4,156,812	0.58	67400	350	1234.6	~30	800

* ROI estimated from pumping test not in the area. Needs refinement.

The locations, construction, and the number of monitoring/observation wells are very flexible. At the minimum, SCS recommends the following observation well configuration:

Table 2: Preliminary Monitoring Well Locations and Expected Localized Drawdown

Monitoring/Level Controls						
	UTM Zone 14 meters		Diameter	Depth	Calculated Potentiometric Surface	Drawdown
Wells	X	Y	inch	ft	ft	ft
Center	651,129	4,156,551	4	~30	1240.4	-5.332
NC	651,123	4,156,829	4	~30	1242.8	-2.908
CE	651,557	4,156,517	4	~30	1242.4	-3.507
SW	650,790	4,156,259	4	~30	1240.7	-5.696
SE	651,584	4,156,252	4	~30	1241.9	-4.312

Before final design, SCS suggests conducting a 72-hour pump test in the Hancock Acres area. Although the assumptions used in developing this preliminary dewatering scheme are consistent with other sites, based on the scientific literature and SCS's experience in the Arkansas alluvial aquifer, all variables require refinement before additional design steps are initiated. Additional information, such as grain size should also be collected during the pump test.