# Information Relevant to Selection of Preliminary DFCs for the Brazos Alluvium and the Yegua-Jackson Aquifer

Presentation to the POSGCD DFC Committee

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# Outline

- Brazos Alluvium
  - General information
  - Drawdown & DFC considerations
  - MAG considerations
- Yegua-Jackson
  - general information
  - GAM info
  - GAM simulation
  - Drawdown and DFC considerations



# **Brazos Alluvium**

- Designated as a minor aquifer
- Average thickness in GMA 12 is about 55 feet
- Aquifer composed of deposits from Brazos River; average hydraulic conductivity ~ 100 ft/day (very permeable)
- No groundwater availability model
- Recent USGS study defined the areal and extent (Shah and Houston, 2007)



# Brazos Alluvium: Areal Extent



### **Brazos Alluvium: Total Thickness**



# Water Level Data

- POSGCD Database
- TWDB Water Well Database
- Reports
  - Follet, C.R., 1974, "Groundwater-Resources of Brazos Counties, Texas" USGS
  - Cronin, James, G and Wilson, C. A., 1967,
    "Groundwater in the Flood-Plain Alluvium of the Brazos River, Whitney Dam to Vicinity of Richmond, TX



#### Well Locations with Water Level Data





#### TWDB Brazos River Alluvium WL Data – Examples in Burleson County



#### TWDB Brazos River Alluvium WL Data – Examples in Brazos County



#### TWDB Brazos River Alluvium WL Data – Examples in Roberson County



# **Saturation Fraction**

WD = Well Depth (ft) (typically drill 1-3 ft below base of alluvium)

DTW = Estimated Depth of Water below ground surface (ft) (not yet corrected for well stick up)

Fraction Saturation = (1 - DTW/WD)



#### Estimated Average Saturation based on Available Water Level Data



# GMA-8 Brazos Alluvium DFC and MAG (TWDB GTA Assessment 07-05 mag)

- DFC for Milam County
  - Maintain 90% saturated thickness after 50 yrs
  - Estimated total thickness = 55 ft
  - Estimated current saturated thickness = 19 ft
- MAG
  - Total annual recharge + (total storage volume/50 year)
  - -464 AFY



### Preliminary DFC Evaluation: Assumptions

- Estimated Precipitation
  - Milam estimated at 37 in/yr (35.5 to 37 in/yr)
  - Burleson estimated at 40 in/yr (38.5 to 40 in/yr)
- Recharge
  - 7.5% of precipitation
- Average Current Saturation
  - Milam ~ 24.5 ft (0.5 \* 49 ft)
  - Burleson ~38.5 ft (0.7 \* 55 ft)



#### Preliminary DFC Evaluation: MAG Based on a TWDB-like Approach

#### **Recharge Component**

			Rech				
County Area in GMA 12		SMA 12	Average Precipitation	Recharge	Recharge	Recharge (AFY)	
	sq. miles	acres	(in/yr)		(""")		
Burleson	129.8	83,073	40	7.5	3.0	20,768	
Milam	19.5	12,450	37	7.5	2.8	2,879	

#### Storage Component

County	Area in GMA 12		Specific Yield	Drawdown (ft)	% Reduction in Saturated	Annual Storage
	sq. miles	acres		()	Thickness	(AFY)
Burleson		83,073	0.15	2	5%	498
	129.8			4	11%	<del>99</del> 7
				5	13%	1,246
				6	16%	1,495
				8	21%	1,994
				10	27%	2,492
		12,450	0.15	2	8%	75
				4	16%	14 <del>9</del>
Milam	19.5			5	20%	187
				6	24%	224
				8	33%	29 <del>9</del>



#### Assumptions Used by TWDB for GMA-8 MAG Calculation

- Recharge
  - Average precipitation = 37 inches/yr
  - Recharge = 7.5% of precipitation
  - Estimated recharge = 464 AFY
- Total Storage
  - Decline in saturated thickness = 1.9 ft
  - Drainage porosity = 15%
  - Total volume = 571 AF
  - Yearly volume = 11.4 AFY



#### **Considerations for MAG Evaluation**

- Water Balance
  - Lateral flow into the Brazos Alluvium from other geologic formations
  - Stream-groundwater interaction
- Estimated Historical Pumping
  - Burleson in 1963 & 1964 is about 10,000 AFY
  - Burleson and Brazos in 1958, 1963, 1964, and 1969 ranged from 16,000 to 32,000 AFY
- POSGCD Brazos Alluvium Permits
  - Estimated from database ~ 45,000 AFY
- <sup>17</sup> Historical permits ~ 40,000 AFY



# Consideration for DFC

- Large Temporal Variation in Water Levels
  - Large compared to DFC values
  - Consider quantifying variation based on historical data
- Possible Solution
  - Consider a 50-yr DFC value in combination with a statistical analysis of a trend in average drawdown values that accounts for temporal variation present in historical data



# Yegua-Jackson Aquifer

- Designated as a minor aquifer
- Located between the Wilcox Formation and the Gulf Coast Aquifer
- Groundwater Availability Model (GAM) finalized in April 2010
- Relatively little information readily accessible for model development
- General a sand-poor aquifer but isolated regions of moderate transmissivity exist



# Model Coverage

Total pumping is less than 20,000 AFY for any given year of record



### Model Layers





# **Distribution of Clayey Deposits**



#### Preliminary Comments Regarding Yegua-Jackson GAM

- Reliable geologic framework
- Sand percentages may be skewed because of bias in analysis of geophysical logs
- Inadequate number of pumping tests and water level to support a reliable calibration
- Pumping distribution in model does not provide a reasonable represention of actual conditions
- Model predictions need to evaluated in light of the model assumptions and approximations



# Wells Used for Pumping (1901 - 1997) Calibration





#### Pumping Over Time: Burleson County



#### Estimated Pumping in Burleson County based on Current Database Information

Model Layer	We	ells	Estimated Pumping (AFY)				
	Exempt	Non	Exempt (1.6 gpm	Permitted	Total		
	слетирі	Exempt	per well)	I emitted			
1	88	3	1,950	232	2,182		
2	317	4	1,620	838	2,458		
3	960	4	102	2,537	2,639		
4	710	2	83	1,877	1,960		
5	0	0	0	0	0		



## Areal Distribution of Pumping (1997)



## Hydraulic Conductivity Values for the Lower Yegua Aquifer



## Average Drawdown from 1900 to 1997

Zone/Aquifer	one/Aquifer		Upper Jackson	Lower Jackson	Upper Yegua	Lower Yegua
	1981	-2.8	-1.9	-1.1	-0.2	-0.2
Washington	1991	-1.3	-1.7	-1.5	-0.6	-0.6
County	1995	-1.0	-1.5	-1.7	-0.8	-0.8
	Average	-2.1	-1.7	-1.2	-0.4	-0.4
	Maximum	0.0	0.0	0.0	0.0	0.0
Lee County	1981	-0.7	-0.3	-0.3	-0.3	-0.3
	1991	-1.4	-0.9	-0.9	-0.9	-0.9
	1995	-1.5	-1.2	-1.2	-1.2	-1.2
	Average	-0.8	-0.6	-0.6	-0.6	-0.6
	Maximum	0.2	0.2	0.2	0.2	0.2
	1981	-1.3	0.2	0.3	0.5	0.5
Burleson	1991	-2.5	-0.7	-0.6	-0.4	-0.4
County	1995	-2.8	-1.1	-1.1	-0.8	-0.8
County	Average	-1.5	-0.3	-0.3	-0.1	-0.1
	Maximum	0.1	1.0	1.1	1.1	1.1
	1981	0.4	0.8	0.7	0.6	0.6
Brazos	1991	0.6	1.3	1.0	0.8	0.8
County	1995	0.7	1.3	0.9	0.7	0.7
County	Average	0.5	0.8	0.6	0.5	0.5
	Maximum	0.8	1.4	1.0	0.8	0.8

Note: negative numbers indicate a raise in the average water level



#### Simulated Water Budget for 1997 (AFY)

Water Budget Component	Groundwater Flux (AFY)			
Recharge	22,459			
Reservoirs	57			
Streams	-11,071			
E.T.	-4,525			
Storage	-2,572			
Lateral Flow	-3,454			
Pumping	-778			

1997 Pumping for Adjacent Districts Brazos Valley = 1658 AFY Lost Pines = 651 AFY



#### 50-yr GAM Simulation: Upper Jackson





#### 50-yr GAM Simulation: Lower Jackson





#### 50-yr GAM Simulation: Upper Yegua





#### 50-yr GAM Simulation: Lower Yegua





#### Average Drawdown for 50-year Simulation

Coologia Formation	Model	Average	Number of
Geologic Formation	Layer	Drawdown (ft)	Dry Cells
Upper Jackson	2	97	1
Lower Jackson	3	100	0
Upper Yegua	4	111	0
Lower Yegua	5	116	0



#### Estimated Average Drawdown Based on Confined and Unconfined Drawdown Limits

Drawdown Limits			Calculated Average Drawdown					
Average drawdown in unconfined area (ft)	% Decline in artesian pressure	Maximum drawdown in confined area (ft)	Layer1	Layer2	Layer3	Layer4	Layer5	All layers
		50	10	49	49	49	49	35
	0.25	75	10	51	58	60	65	43
	0.25	100	10	51	64	69	80	49
10		150	10	51	71	82	104	60
	0.33	50	10	50	50	50	50	35
		75	10	67	68	69	71	48
		100	10	67	77	80	87	56
		150	10	67	88	<b>9</b> 6	114	68
		50	20	49	49	49	49	38
		75	20	51	58	60	65	46
	0.25	100	20	51	64	69	80	53
		125	20	51	68	76	<b>9</b> 2	59
20		150	20	51	71	82	1 <b>04</b>	64
		50	20	50	5 <b>0</b>	50	<b>50</b>	39
	0.22	75	20	67	68	69	71	52
	0.55	100	20	67	77	80	87	5 <del>9</del>
		150	20	67	88	96	114	72



#### Estimated Average Drawdown Based on Confined and Unconfined Drawdown Limits

Drawdown Limits			Calculated Average Drawdown					
Average drawdown in unconfined area (ft)	% Decline in artesian pressure	Maximum drawdown in confined area (ft)	Layer1	Layer2	Layer3	Layer4	Layer5	All layers
		50	15	49	49	49	49	37
	0.05	75	15	51	58	60	65	45
	0.23	100	15	51	64	69	80	51
15		150	15	51	71	82	104	62
	0.33	50	15	50	50	50	50	37
		75	15	67	68	69	71	50
		100	15	67	77	80	87	57
		150	15	67	88	<b>9</b> 6	114	70
	0.25	50	25	49	49	49	49	40
		75	25	51	58	60	65	48
		100	25	51	64	69	80	55
25		150	25	51	71	82	104	65
		50	25	50	50	50	50	41
	0.33	75	25	67	68	69	71	53
		100	25	67	77	80	87	61
		150	25	67	88	96	114	74



# Lowest Measured Percent Saturation



Note: Calculations and figure completed by LGB Guyton and presented to Brazos Valley GCD on 4/8/2010



#### **References for Precipitation Data**

Texas Water Development Board, 1998, Annual Texas Precipitation shapefile

Narasimhan, B., Srinivasan, R., Quiring, S., and Nielsen-Gammon, J.W., 2008, Digital Climatic Atlas of Texas: Texas A&M University, Texas Water Development Board Contract, Report 2005-483-5591, 108 p.

