

WILLCOX REGIONAL FLOOD MITIGATION AND
RECHARGE PROJECT:
**AQUIFER RECHARGE SUITABILITY
RANKING ANALYSIS RESULTS**

COCHISE COUNTY, AZ

PRESENTATION TO COCHISE COUNTY BOARD OF SUPERVISORS

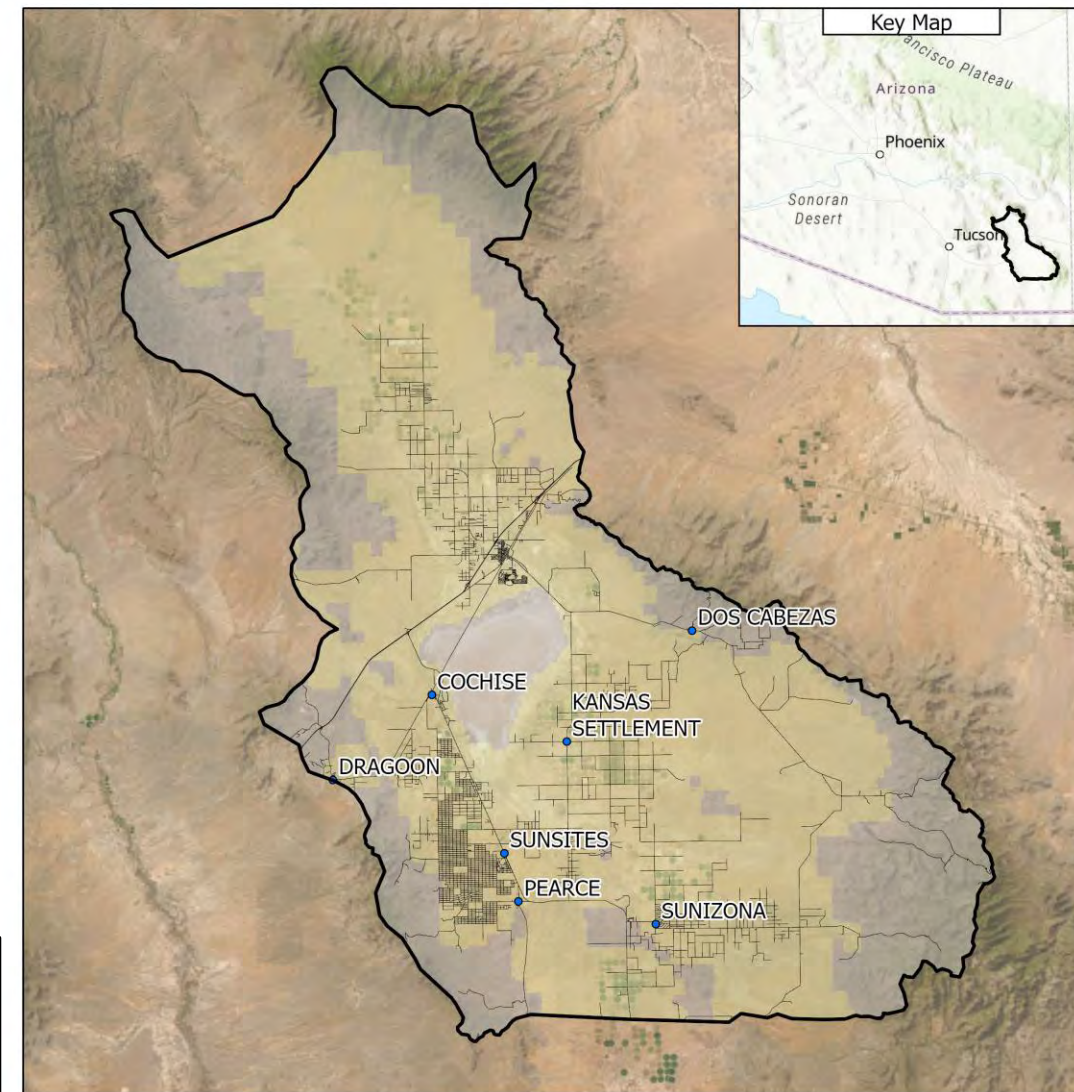
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INTRODUCTION

- Willcox Basin (WB) faces persistent challenges in stormwater management and groundwater sustainability
- JE Fuller and GSA tasked with pre-feasibility study for addressing issues of flooding and stormwater managed aquifer recharge (MAR)
- GSA's goal: Identify areas suitable for stormwater MAR by review of existing hydrologic, geologic, and land-use datasets
 - Part 1. Screening level suitability analysis
 - Part 2. Detailed data review for site selection



Legend

- Willcox Basin
- Communities
- Streets
- Parcels Included in Review
- Parcels Excluded in Review

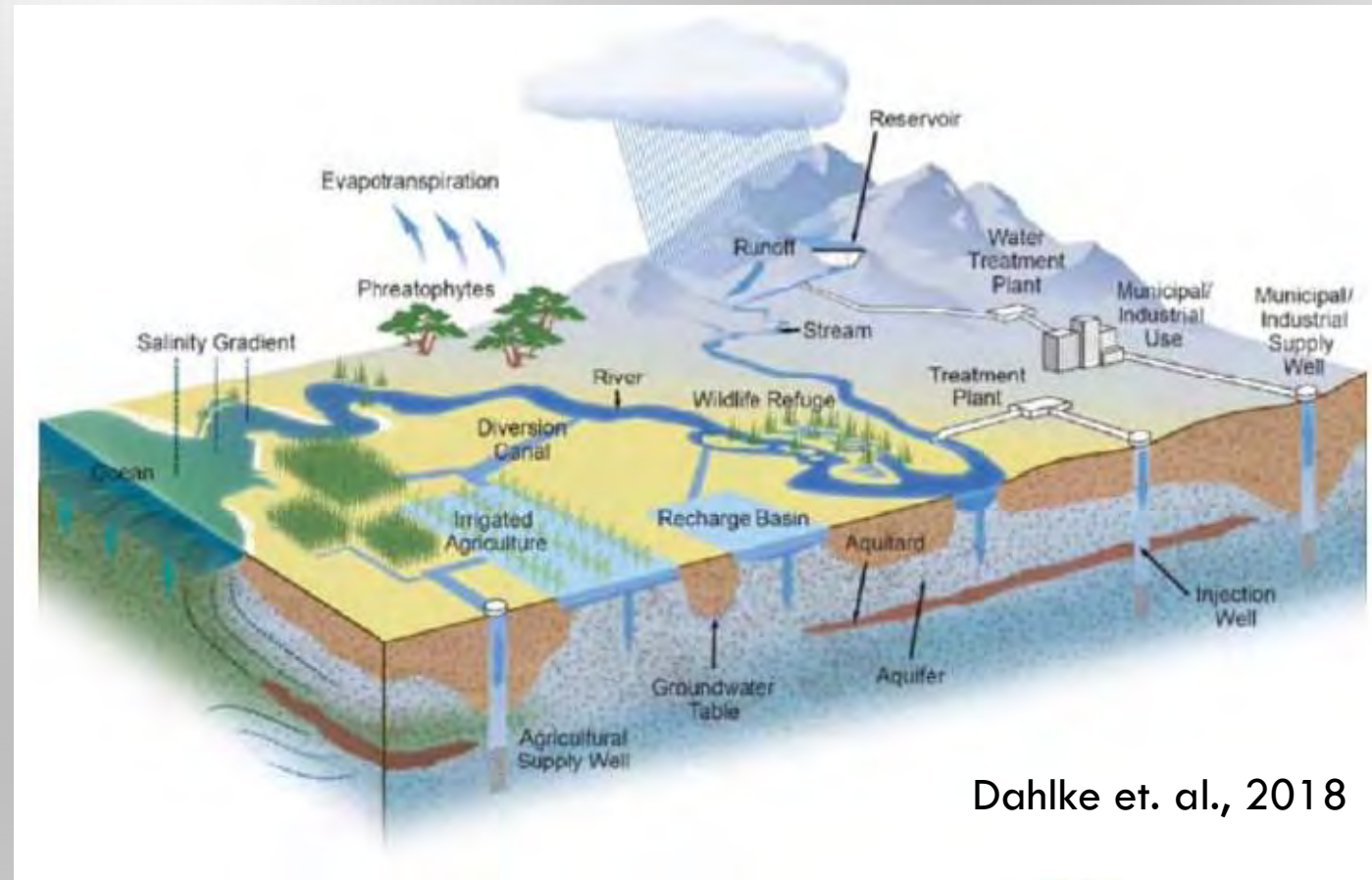
Figure 1. Study Area



HYDROGEOLOGIC CONCEPTUAL MODEL

Suitable sites for stormwater MAR must have:

- Proximity to high-capacity drainages
- Coarse (i.e., sandy or gravelly) soil types
- No subsurface low-permeability layers
- Significant vadose zone storage for recharged water
- Under-developed and convertible land use



Dahlke et. al., 2018

STORMWATER MAR

Methods for the collection and detention of runoff include:

- In-channel systems (gabions, check dams)
- Surface spreading basins (detention or retention)
- Flood-MAR – diversion of flood water into agricultural landscapes
- Groundwater recharge enhancement features (dry wells, infiltration trenches, vertical wick drains)

Example areas of managed aquifer recharge (MAR)



METHODS - PART 1. SCREENING-LEVEL SUITABILITY ANALYSIS

- GIS based hydrogeologic screening assessment
- Develop comprehensive geodatabase
- Discretize basin into parcels
 - PLSS quarter (160 ac) and quarter-quarter (40 ac) sections
- Define criteria and sub-criteria, assign weights, classify attributes, and apply rankings
- Calculate composite ranking value
 - Range = -4 (less suitable) to +4 (more suitable)
- Evaluate data gaps for promising sites
 - Deeper vadose zone profile (permeability, restrictive layers)

Criterion	Sub-Criteria	Weight	Attribute Classification	Ranking
Near Surface Characteristics	Permeability	0.75	> 1 ft/day	1
			0.5 – 1 ft/day	0
			< 0.5 ft/day	-1
	Restrictive Layer	0.25	Not present within 6.5 ft below ground surface (bgs)	1
Present within 6.5 ft bgs			-1	
Subsurface Characteristics	Depth to Groundwater (ft bgs)	0.5	> 100 ft bgs	1
			50 – 100 ft bgs	0
			< 50 ft bgs	-1
	Drawdown from Pumping	0.25	> 50 ft bgs	1
			20 – 50 ft bgs	0
			< 20 ft bgs	-1
Horizontal Hydraulic Conductivity	0.25	> 10 ft / day	1	
		< 10 ft / day	-1	
Land Use	Land Cover	0.25	Shrub, grasslands/herbaceous, barren land, woody wetlands, emergent herbaceous wetlands	1
			Deciduous forest, evergreen forest, mixed forest, pasture/hay, cultivated crops	0
			Open water, developed	-1
	Land Ownership	0.75	Private, Bureau of Land Management	1
U.S. Forest Service, State Wildlife, State Trust Land			0	
U.S. Military, National Park Service			-1	
Water Availability	Proximity to Large Drainage Networks	1	> 10% of parcel area had a large drainage with water depth > 1.5 ft	1
			0.1-10% of parcel area had a large drainage with water depth > 1.5 ft	0
			> 0.1% of parcel area has a large drainage with water depth > 1.5 ft	-1

NEAR SURFACE CHARACTERISTICS – PERMEABILITY

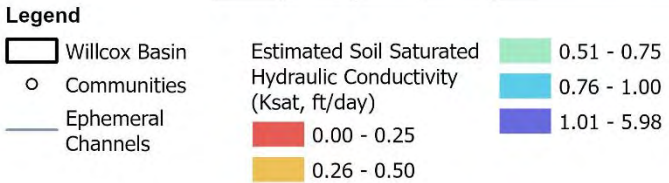
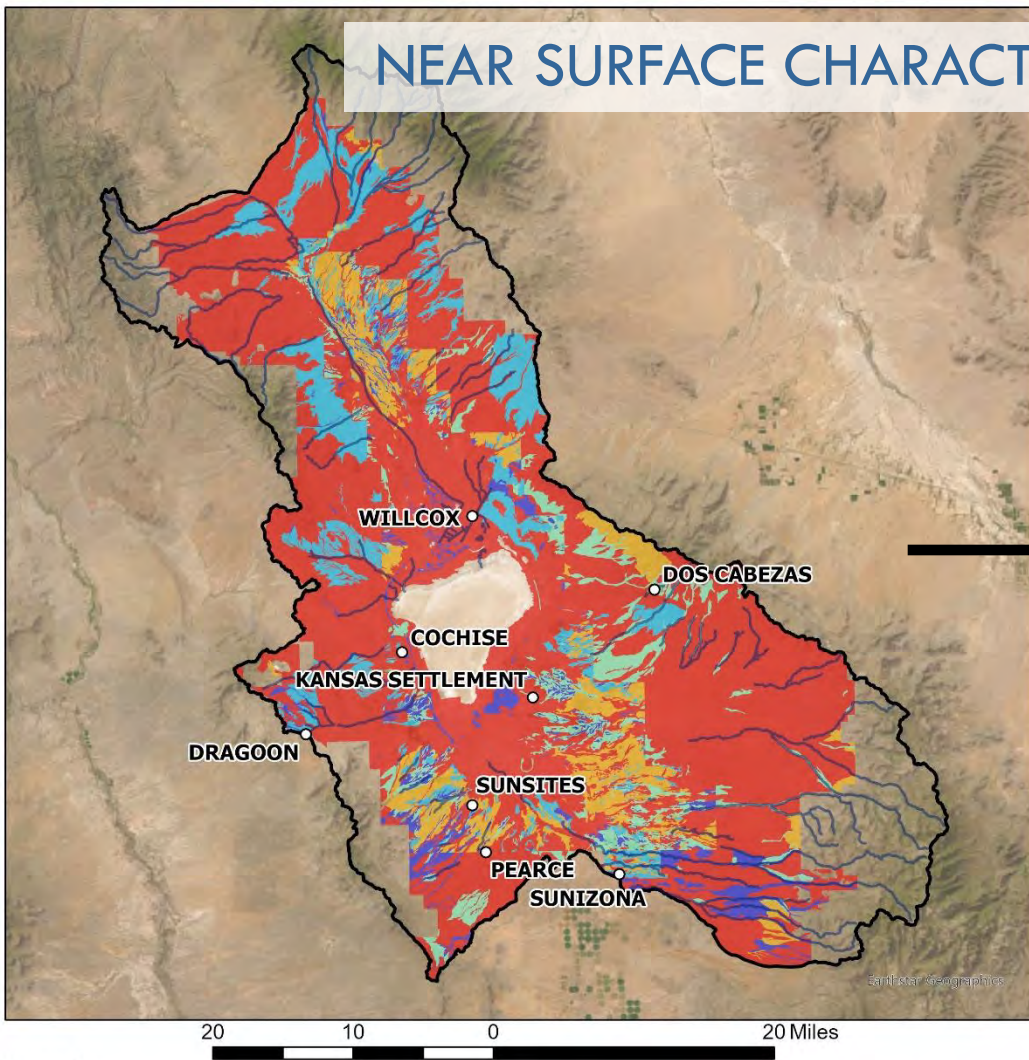


Figure 3. Estimated USDA NRCS Soil Saturated Hydraulic Conductivity (Ksat) Values

Soils data from: USDA, NRCS, Web Soil Survey, <http://websoilsurvey.sc.egov.usda.gov/>
 Accessed January 13, 2025.
 Estimated Ksat calculated as depth interval-weighted geometric mean divided by 10 to approximate expected field performance.

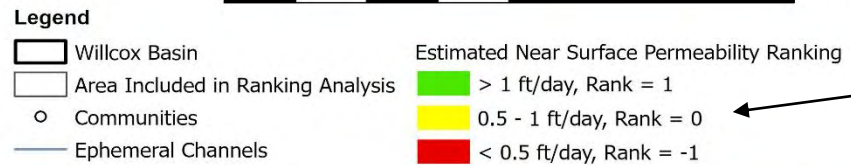
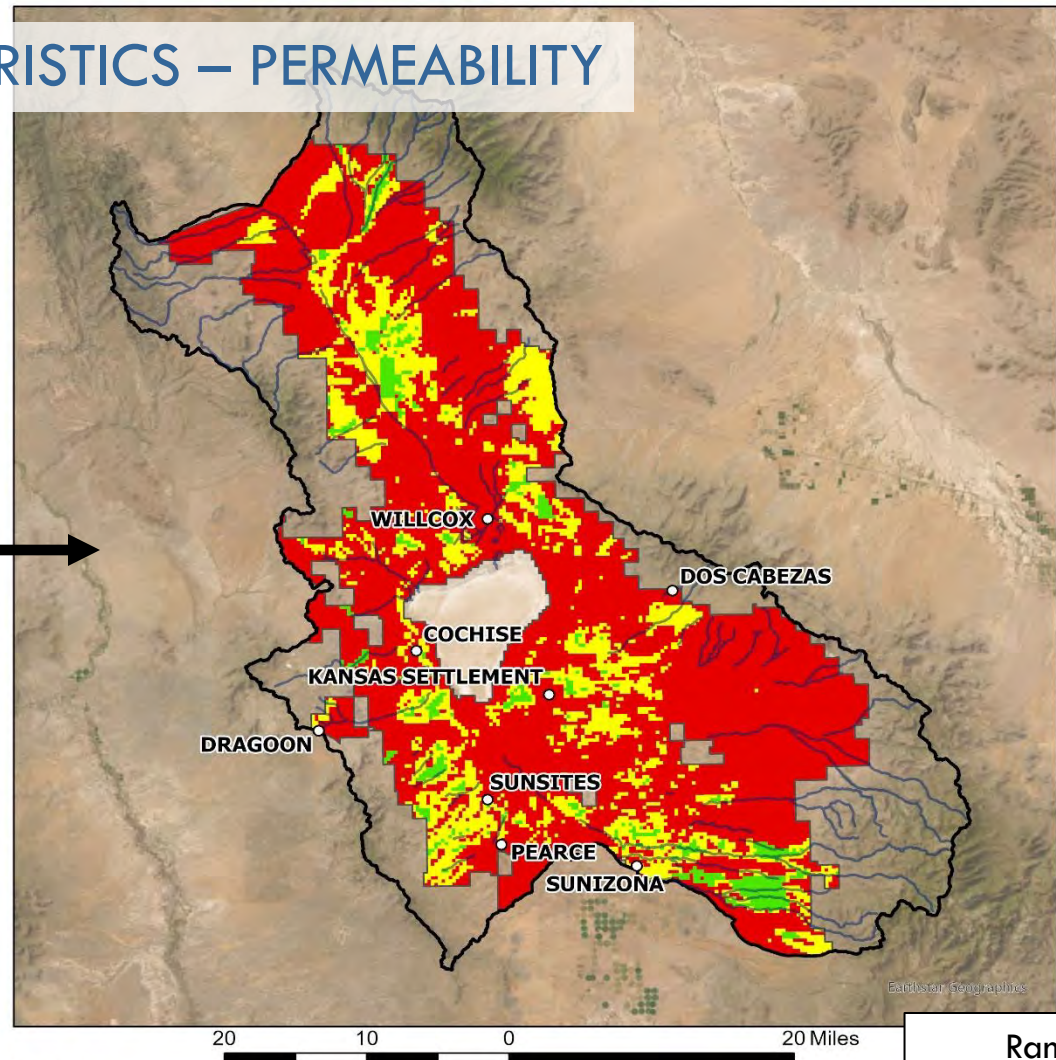
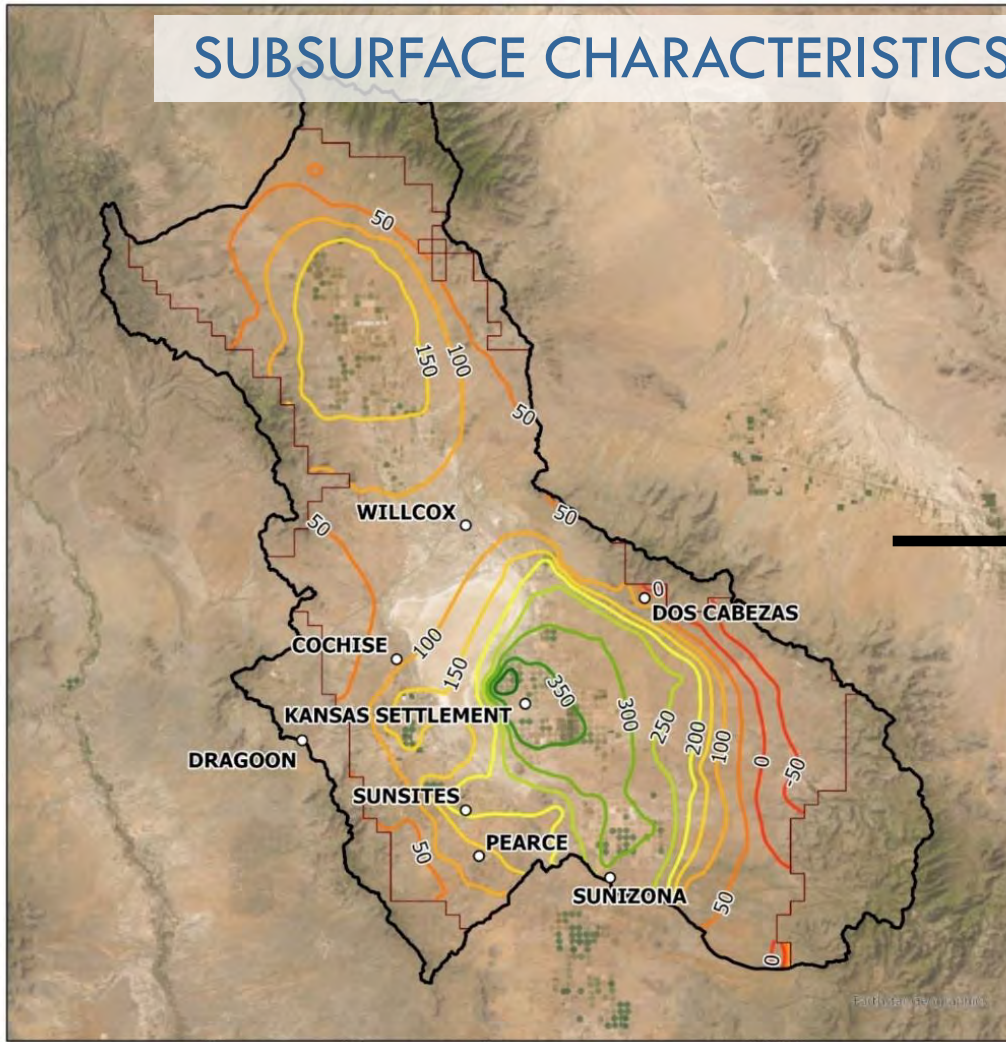


Figure 3. Estimated Near Surface Permeability Ranking (soil saturated hydraulic conductivity, 0-6.5 ft bgs)

Ranking:
 1 = more suitable
 0 = neutral
 -1 = less suitable



SUBSURFACE CHARACTERISTICS – DRAWDOWN FROM PUMPING

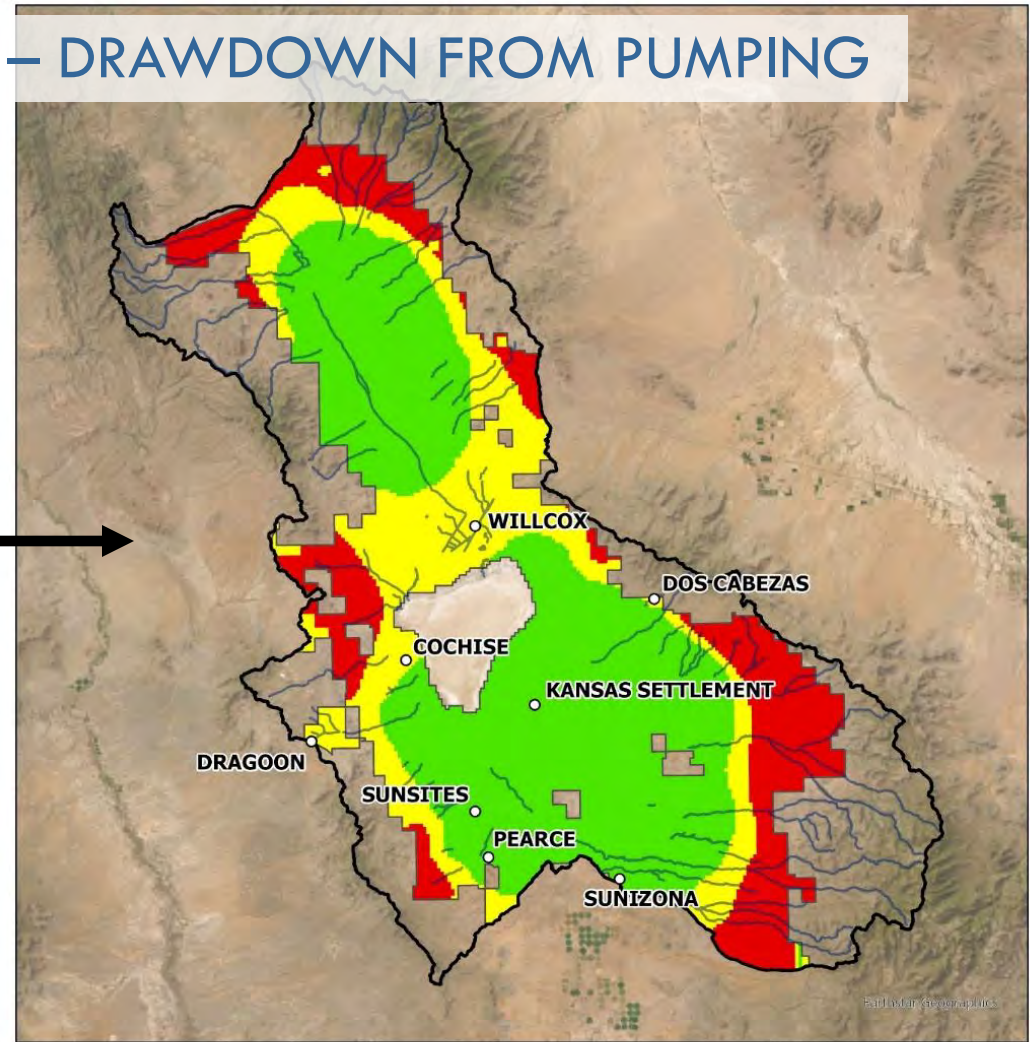


Legend

- Willcox Basin
 - Boundary of Deep Aquifer Unit
 - Communities
- | | |
|--|-----------|
| Simulated Drawdown in Deep Aquifer Unit Between 1940 and 2015 (50 ft Contours) | 51 - 100 |
| 101 - 150 | 151 - 200 |
| 201 - 250 | 251 - 300 |
| -50 - 0 | |
| 1 - 50 | |



Figure 6. Simulated Drawdown in Deep Aquifer Unit (1940-2015)
 Simulated drawdown from: ADWR, Groundwater Flow Model of the Willcox Basin.
<https://www.azwater.gov/hydrology/groundwater-modeling/willcox-model>. Accessed January 10, 2025.



Legend

- Willcox Basin
 - Area Included in Ranking Analysis
 - Communities
 - Ephemeral Channels
- | | |
|---|------------------------|
| Estimated Groundwater Overdraft Ranking | > 50 ft bgs, Rank = 1 |
| 20 - 50 ft bgs, Rank = 0 | < 20 ft bgs, Rank = -1 |



Figure 14. Estimated Groundwater Overdraft Ranking (simulated drawdown in deep aquifer unit, 1940-2015)

WATER AVAILABILITY – PROXIMITY TO LARGE DRAINAGES

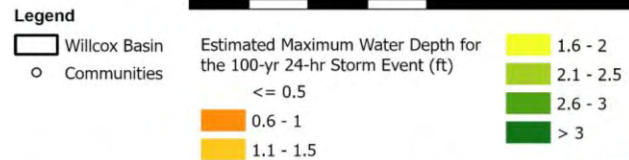
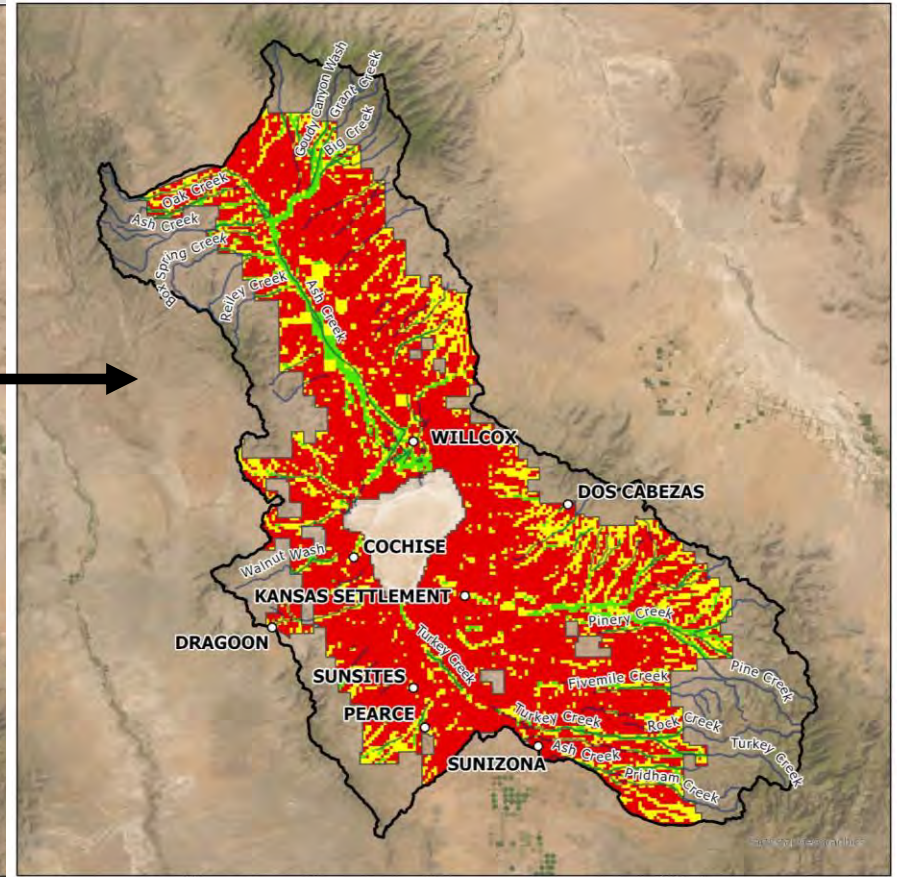
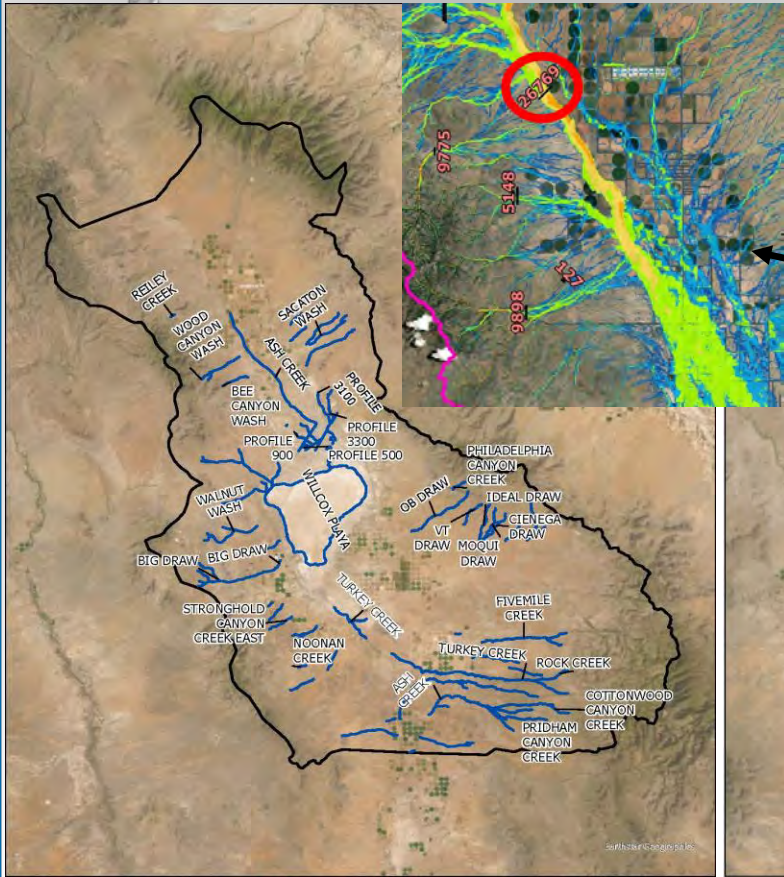


Figure 10. Estimated Maximum Water Depth for the 100-year 24-hour Storm Event
 Maximum water depth results from: JE Fuller's FLO-2D model of Willcox Basin

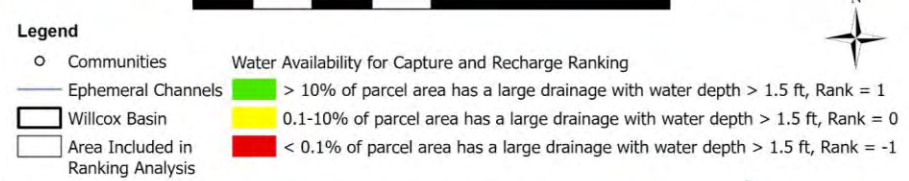
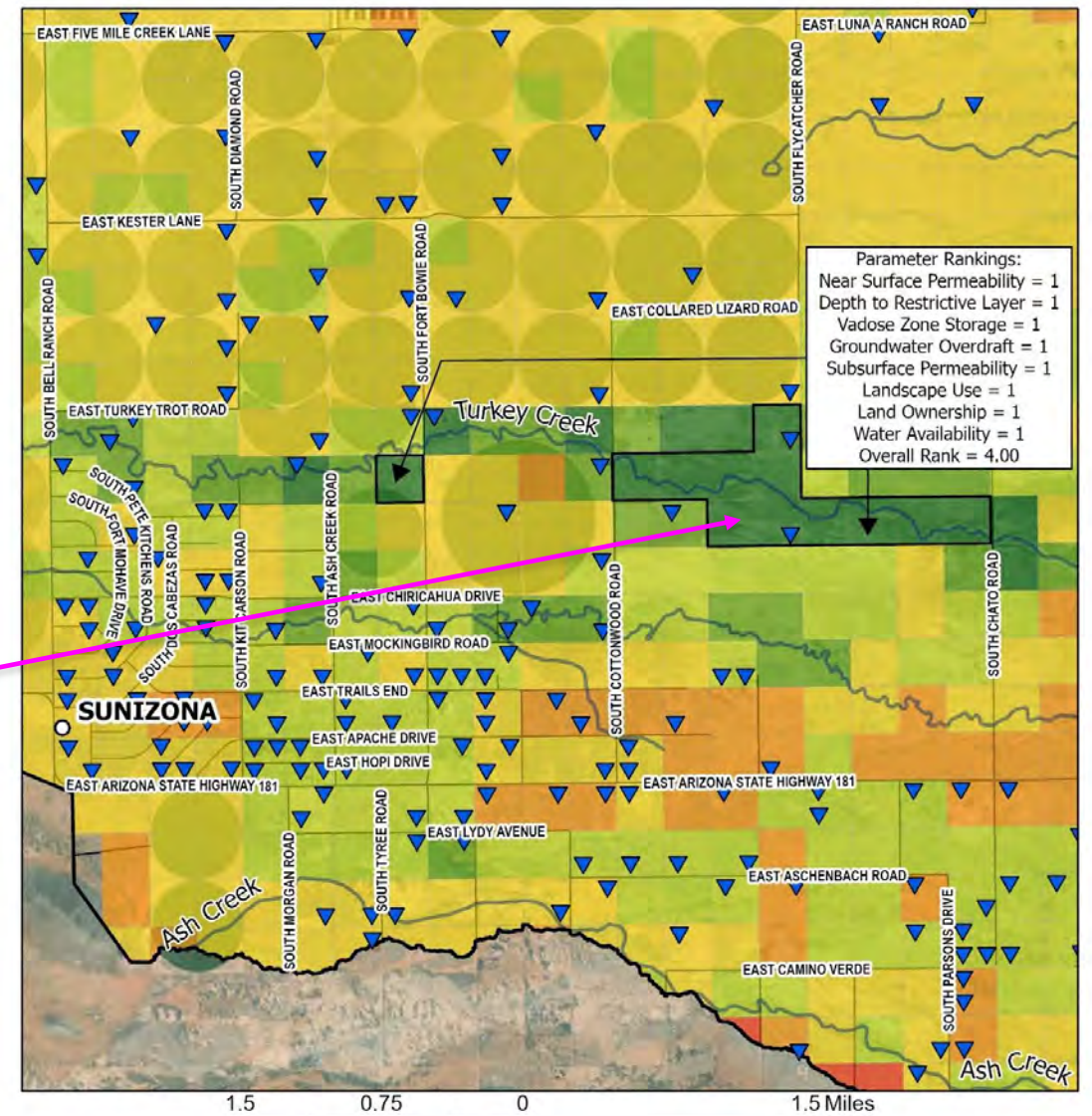
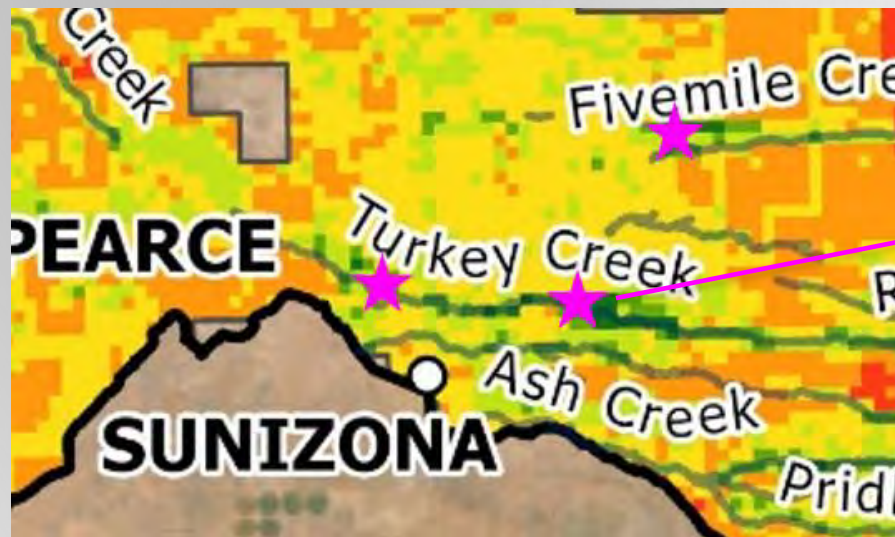


Figure 18. Water Availability for Capture and Recharge Ranking (proximity to large drainages*)
 *A large drainage was defined as a flow path containing ten or more connected grid cells

EXAMPLE HIGHLY RANKED AREA: TURKEY CREEK EAST



Legend

- Willcox Basin
- ▼ Wells with Drill Logs
- Communities
- Ephemeral Channels
- Parcel Composite Recharge Suitability Ranking
 - 2.0 - -1.0
 - 0.9 - 0.0
 - 0.1 - 1.0
 - 1.1 - 2.0
 - 2.1 - 3.0
 - 3.1 - 4.0

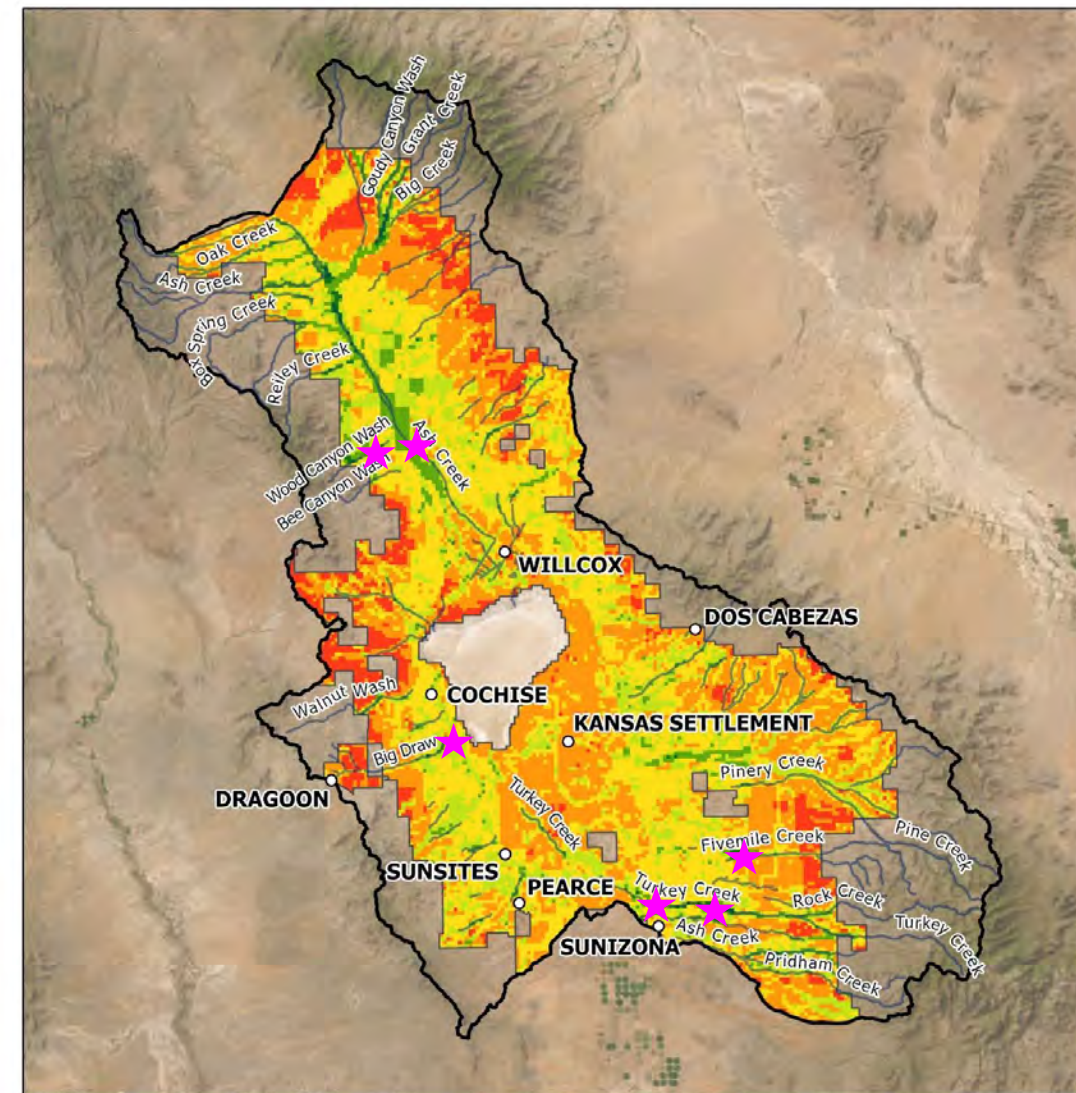


Figure 25. Turkey Creek East Composite Recharge Suitability Ranking

NEXT STEPS

- Part 2 detailed review of suitable areas to include:
 - Stakeholder/Agency/Landowner engagement
 - Deeper vadose zone properties from ADWR well logs and USGS reports
 - Local well groundwater levels
 - Groundwater quality
 - Irrigation and groundwater use characteristics
 - Operations and infrastructure considerations

- Future phases
 - Field investigation to confirm suitability (e.g. geophysics, test pits, boreholes)
 - Engineering/Design



Legend

Willcox Basin	Parcel Composite Recharge Suitability Ranking	1.1 - 2.0
Area Included in Ranking Analysis	-2.0 - -1.0	2.1 - 3.0
Communities	-0.9 - 0.0	3.1 - 4.0
Ephemeral Channels	0.1 - 1.0	

Figure 19. Parcel Composite Recharge Suitability Ranking

Parcels with composite rankings of +2 or greater are recommended for further evaluation of recharge suitability



A wide-angle photograph of a field of wildflowers, primarily purple and yellow, under a dramatic sunset sky. The sun is low on the horizon, casting a warm glow over the scene. The sky is filled with scattered, light-colored clouds. The foreground is dominated by tall, green stems with clusters of purple flowers, interspersed with some yellow and red flowers. The background shows a flat horizon line with some distant trees and utility poles.

THANK YOU!

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