Notes on allotment 07055, Quatro Amigos
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Field visit: 7 Jan 2015

I went on a field visit in early 2015 for proposed infrastructure & herbicide treatments on allotment 07055. Also on the trip were Lisa Philips (BLM range), Mark Hakilla (BLM wildlife), & Dick Shaw (NRCS). I believe Joe David Yeats (permittee) joined us briefly. There was likely another person or two I am forgetting. I assume I wrote up my field notes afterward, but if so it is lost in time. I don't have much to add regarding proposed herbicide treatments, as Lane Hauser's late 2021 field notes echo my 2015 thoughts. His photographs are similar as well, although taken almost 7 years later. In short, I did not think the proposed herbicide treatments were promising. Perennial grasses were sparse in the proposed treatments and the allotment, mostly between 4500 & 4900 ft., is below elevations likely to yield positive gain scores for perennial grasses (excluding *Dasyochloa pulchella* / fluffgrass). A new potential herbicide treatment has been suggested, in an area I have not visited.

I have six plant diversity photopoints (PDPs), summarized in a table below, with photographs following the text (Figs. 4–6). The PDPs & proposed infrastructure are shown in Fig. 1 (next page). The first two PDPs ('quatro amigos 1' & 'quatro amigos 2') are in the center of the allotment in sandy soils with *Sporobolus flexuosus* / mesa dropseed grassland and shrub savanna of *Sporobolus flexuosus* with *Prosopis glandulosa* / mesquite & *Atriplex canescens* / fourwing saltbush. The PDPs are in Lincoln County on the Otero County line. The counties have different soil surveys. Both identify two main components corresponding with the Sandy (R042XC004NM / R042XB012NM) and Deep Sand (R042XC005NM / R042XB011NM) ecological sites. The Otero survey uses MLRA 42, LRU 2 (42.2; codes R042XB*) while the Lincoln survey uses MLRA 42, LRU 3 (42.3; codes R042XC*). This is at the northeastern margin of 42.2, while 42.3 is to southeast. The plant community at the PDPs is a good match for the reference state of 42.2 Deep Sand. The next closest matches are 42.3 Sandy & 42.2 Sandy. The area likely has inclusions of one or both of these. The 42.3 Deep Sand can be excluded, as the ecological site description includes various plants that do not occur in the area. Recent livestock grazing was slight, although tracks & occasional utilization of grasses indicate that cattle can access the area and visit it sparingly. Clipping of *Sporobolus* / dropseeds by small mammals (rabbits? see Fig. 7) was common in 2015 both here and in similar sites east of the allotment (several 'w godfrey' PDPs). The third PDP ('quatro amigos 3') is in a transition between these sandy soils and rockier soils on a small hill. The plant community is similar to the first two PDPs except that the dominant shrub was *Larrea tridentata* / creosote bush. I've created a map of the grasslands / shrub savannas represented by these first three PDPs (Figs. 1 & 3), drawn by hand from aerial imagery.

The next PDP ('quatro amigos 4') is on the north end of the allotment, on basin-floor clayey soils in a patch of *Sporobolus airoides* / alkali sacaton grassland. My species list for this PDP is incomplete. The soil survey indicates that the Gyp Hills (R042XB013NM) and Deep Sand (R042XC005NM) ecological sites account for most of the area. The topography, plant community, and surface soils are not a good match for either, though Gyp Hills is the more plausible of the two. There are patches of gypseous soil to the northeast / upstream, but I saw no obligate gypsophilic plants near the PDP and it was not hilly. I think this photopoint is best understood as a small area of Salt Flats (R042XB036NM) or perhaps as the "deep gypsic" form of Gyp Upland (R042XB006NM). Grassland appears to have been lost from most of the surrounding area, though this patch of grassland was in good condition and did not have much recent evidence of livestock use. Deeply incised gullies to the southeast and northwest may make this spot more difficult for livestock to access, though creating concerns regarding reduced water infiltration and a lowered water table.

The fifth PDP ('quatro amigos 5') is in the northeastern part of the allotment on gypseous clay in gently rolling terrain. It is mapped as Gyp Hills (R042XB013NM) but is not hilly. The "shallow gypsic" form of Gyp Upland (R042XB006NM) is a better fit. Two gypsophilic plants were present, *Tiquilia hispidissima* / hairy crinklemat & *Phacelia integrifolia texana* / gypsum phacelia. The state-and-transition model gives a reference state of *Bouteloua breviseta* / gyp grama & *Sporobolus nealleyi* / gyp dropseed grassland, or these & *Tiquilia hispidissima* codominant. Within the Tularosa Basin, *Bouteloua breviseta* does not appear to get north of Tularosa, so the reference state should presumably be *Sporobolus nealleyi* grassland or subshrub savanna of *Sporobolus nealleyi* & *Tiquilia hispidissima*. I do not recall if there was any *Sporobolus nealleyi* in the area. It was not at the photopoint and, if present nearby, presumably sparse.

The last PDP ('quatro amigos 6') is at the south end of the allotment in *Larrea tridentata* shrubland. Annual grasses from the 2014 monsoon were abundant (primarily *Bouteloua barbata barbata* / sixweeeks grama), perennial grasses were sparse (primarily *Muhlenbergia porteri* / bush muhly within some of the shrubs). The area is mapped as 42.2 Deep Sand and Sandy ecological sites, but the vegetation fits neither well. I am not sure what ecological site it ought to be called.

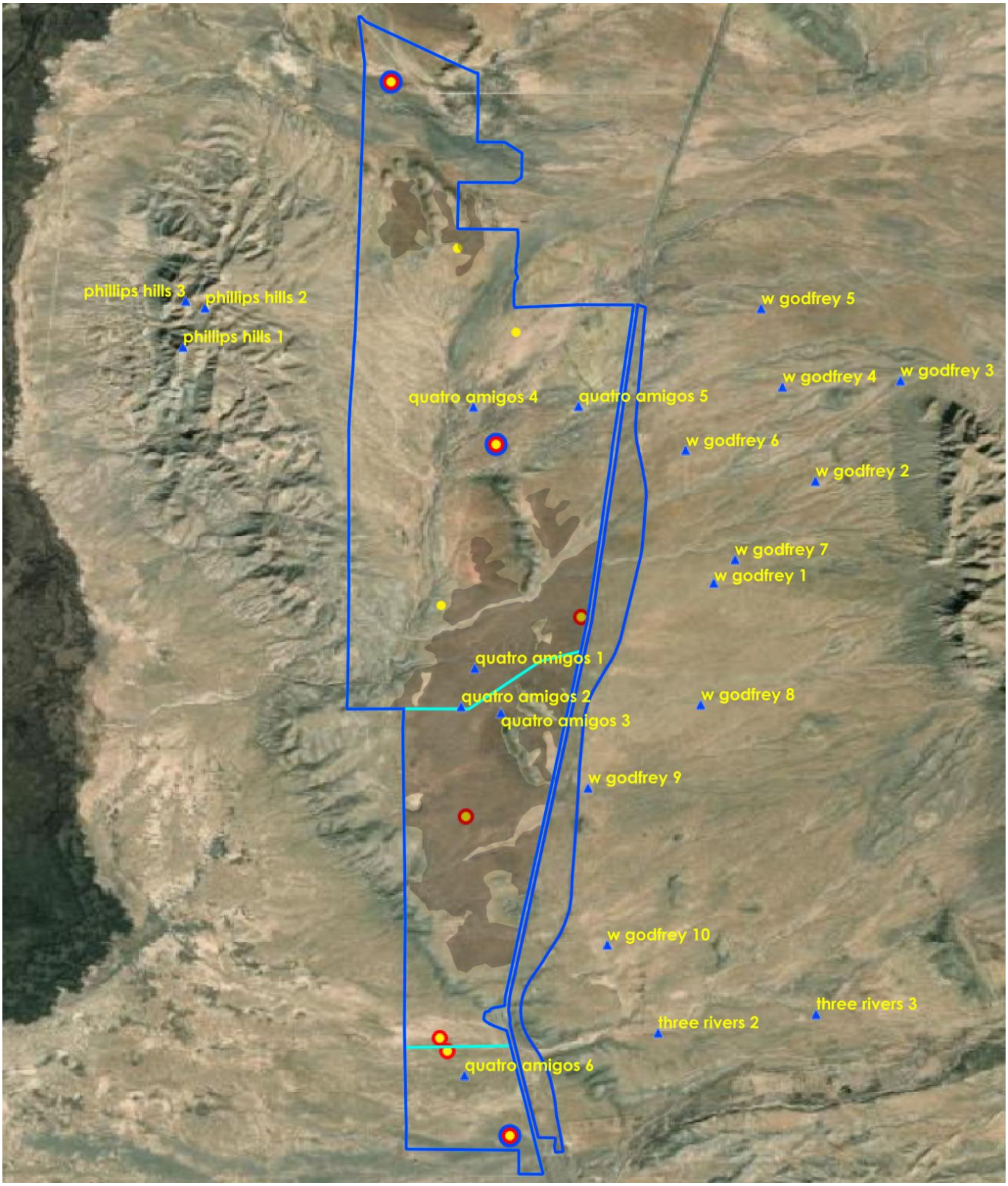

FIGURE 1. Map of 07055 / Quatro Amigos: PDPs (blue triangles, yellow labels); sandy grassland / shrub savanna (darkened polygons); existing fences (blue lines); proposed fences (cyan lines); existing waters (large blue circles); existing plus new waters for "proposal 1" (intermediate red circles); existing plus new waters for "proposal 2" (small yellow circles). "Proposal 1" is current as of Dec 2021. "Proposal 2" has three additional waters to the north. These have been dropped from consideration but are included here in case they provide a useful comparison or reappear in the future.

The allotment as a whole has large areas of grassland & shrub savanna in good condition. This is unusual for grazing allotments in Las Cruces District Office. However, while there is a lot of grass, most of it is not easily accessible to livestock travelling from existing waters. During the 2015 field visit, Mark Hakkila expressed a concern that new water sources could result in decline or loss of the grasslands & shrub savannas. I shared and still share that concern. The alternate viewpoint is that new water sources would reduce grazing pressure near existing waters, allowing these areas to improve, without grazing at the new waters causing grasses to decline. I believe this is possible but probably represents a narrow goldilocks zone in which conditions and grazing decisions are just right. I don't think we can expect much improvement from a moderate reduction in grazing pressure in areas where grasses have largely been lost, although it is possible, and I don't think we can assume grazing will be sufficiently conservative for the life of the infrastructure (presumably over multiple permittees with different concepts & practices) to avoid substantial impacts associated with new waters.

With the existing waters & sparse forage near them, I doubt a permittee could stock the allotment at a rate that would cause substantial declines in the remaining grasslands & shrub savannas. With new waters that becomes an option. We hope current & future permittees make good decisions, of course, but everyone makes mistakes. The history of grassland loss in southern New Mexico suggests this is a very easy mistake to make.

To visualize alternatives, I use the "r.walk" function of GRASS GIS (run via QGIS) to estimate travel cost surfaces—rasters in which the pixel values indicate a travel cost to get to that pixel. Based on a set of origin points, an elevation raster, and an optional second raster with additional travel costs, "r.walk" calculate a pixel-by-pixel travel cost out from the origin points to the entire raster extent. The function uses a fixed cost per unit of travel on level ground. When moving uphill, the amount of elevation gain has a proportional added cost. When moving downhill, there is a threshold. Down gentle slopes, the travel cost is lower than on level ground. Down steep slopes, it is higher. The various level ground & slope travel costs can be modified. I experimented briefly with different values, without apparent improvements in the output. Lacking a reason to choose different values, I used the defaults. The alternative water sources in FIG. 1 give us three different sets of origin points. The eastern sliver of the allotment between U.S. Hwy. 54 & the railroad apparently lacks livestock water sources and is presumably not a viable part of the grazing operation, so I did not include it. For an elevation raster, I am using 10 m resolution USGS NED data. I reprojected all layers to NAD83 UTM Zone 13 because "r.walk" assumes that the elevation raster represents horizontal distance at the same scale & units as vertical distance.

If additional travel costs are given in a second raster, travel costs based on distance and elevation are multiplied by these values. I use a second raster to account for fences and incised gullies. To represent fences I start with a line shapefile, buffer it by 10 m (corresponding with 10 m pixels), and covert the output to a raster in which fences have an aribtrarily high travel cost (1,000,000,000) to make them essentially impassable, leaving other pixels as "no data". The fences are two pixels wide because "r.walk" calculates both diagonal & orthogonal moves. A barrier one pixel wide can often by crossed diagonally without penalty.

Deeply incised gullies can be difficult to cross, often requiring detours to find a spot to descend into them & climb back out. I start with a gully shapefile drawn by hand from aerial imagery, buffer it by 10 m, and convert the polygons to a raster giving gullies a cost of 10 & leaving the remaining pixels as "no data". Given that gullies are two pixels wide, a travel cost of 10 implies that it is 20 times harder to cross a gully than the same ground sans gully. Or we could think of it as an extra 200 m of travel to find a spot to cross. Ideally, we would have information about the effects on cattle of gullies like those on the allotment, but I'm not aware of relevant research. My best guess is that the value should be in the range of 5–20, so I used an intermediate value. Another problem is that gullies are directional. It's often easy to travel along the bottom but hard to cross. My approach treats them as difficult to cross in any direction and I don't have a good solution at present. In any case, I combined the fence & gully rasters, making sure fences took precedence (pixels with a gully & fence get the fence value).

The resulting cost surfaces are shown in FIGS. 2 & 3. I think "r.walk" generally performs well, although it does not account for likely livestock destinations (forage, other waters). The colors and corresponding numerical values represent relative travel cost in the modelled area and don't translate directly to units of time or metabolic cost. The cost surfaces are not grazing pressure predictions. A cost surface could be converted into a grazing prediction by scaling the values based on a particular stocking rate & precipitation scenario. As stocking rate goes down or precipitation goes up, the maps are shifted blue—and vice versa. The permittee's stocking options are constrained by climate & infrastructure. For any given amount of rain, the range of possible stocking rates becomes wider as the portion of the landscape easily accessible to livestock increases. Presumably, then, different infrastructure leads to different permittee decisions. This is difficult to predict but, given a good estimate of the amount & spatial distribution of forage, we could portray the range of possibilities with livestock utilization surfaces created for permitted AUMs and various partial-stocking scenarios. For the moment, I leave that as an exercise for the reader.

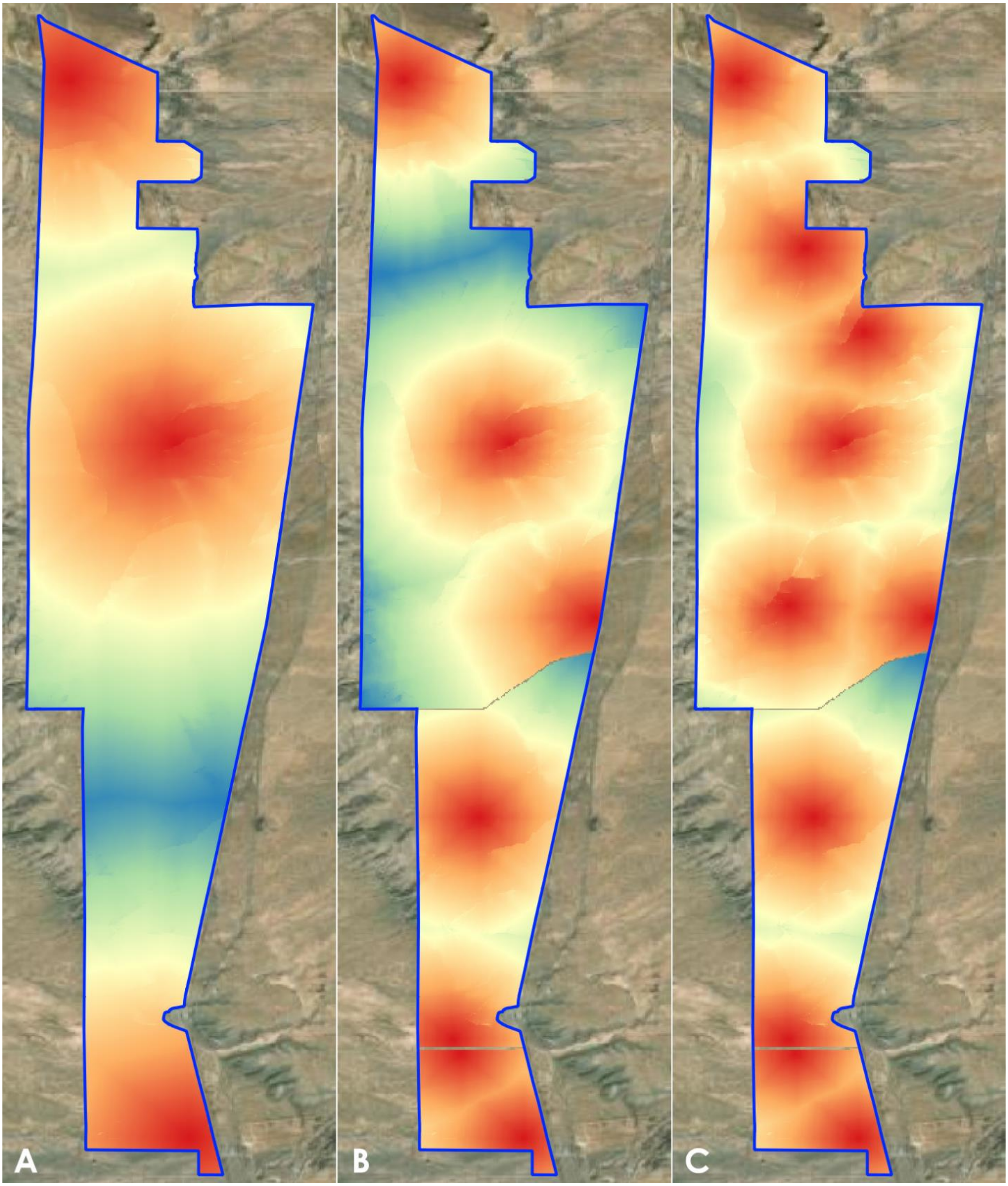

FIGURE 2. Travel cost surfaces for allotment 07055 / Quatro Amigos: A) with existing waters only; B) with the waters as currently proposed in "proposal 1"; C) with the waters of "proposal 2", including three additional waters that have been dropped from the current proposal. The colors are scaled to the maximum and minimum of each cost surface raster: A) 6–4813; B) 6–2852; C) 6–2678.

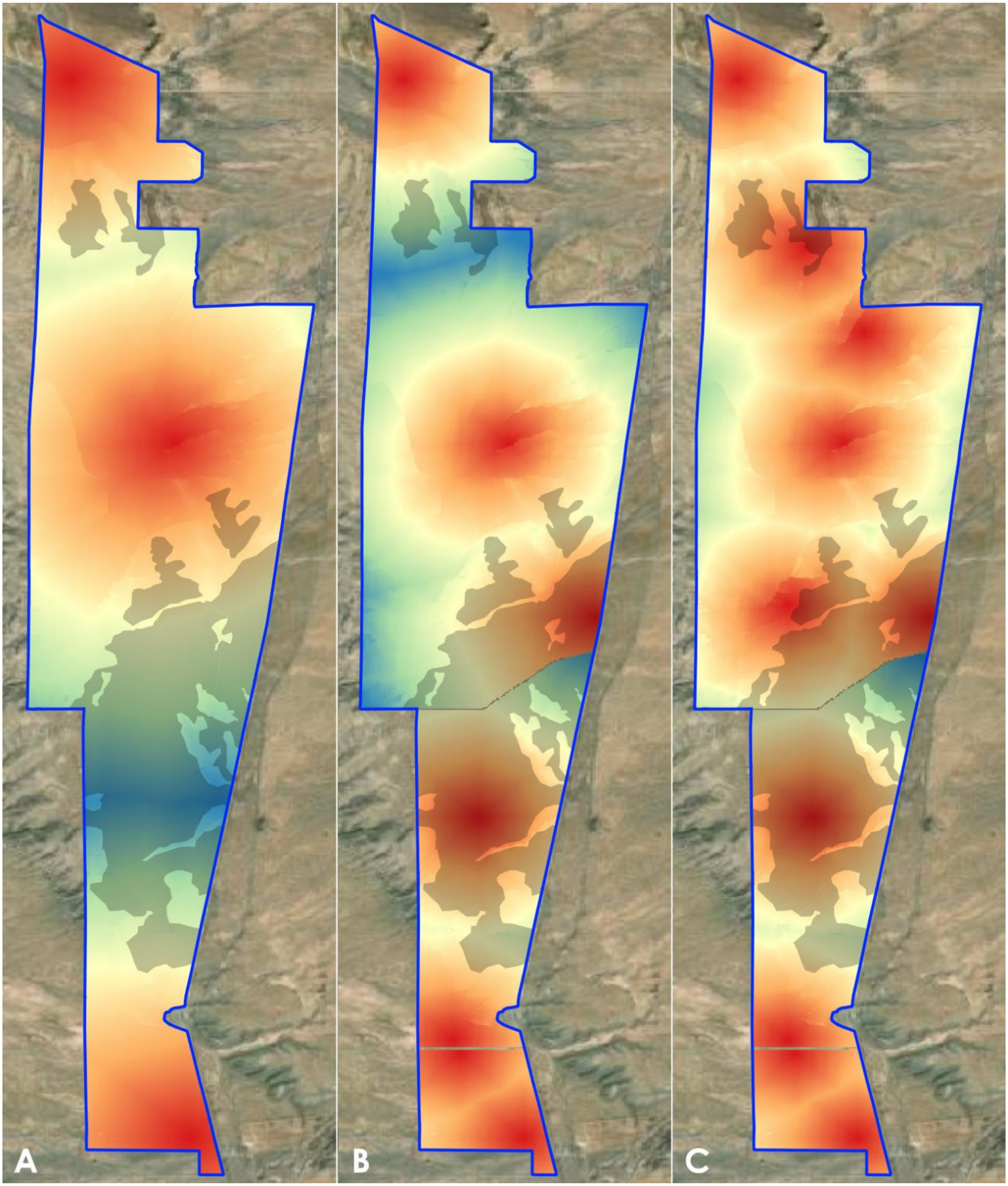

FIGURE 3. The same three travel cost surfaces as in Figure 2 but with sandy grassland / shrub savanna (darkened polygons) included for reference.

		site:	quatro amigos 1	quatro amigos 2	quatro amigos 3	quatro amigos 4	quatro amigos 5	quatro amigos 6
		date:	7 Jan 2015	7 Jan 2015	7 Jan 2015	7 Jan 2015	7 Jan 2015	7 Jan 2015
		latitude:	33.39577	33.38989	33.38889	33.43568	33.43583	33.33349
		longitude:	-106.08815	-106.09027	-106.08421	-106.08843	-106.07228	-106.08975
		elevation:	4650	4630	4680	4740	4860	4520
Agavaceae	*Yucca elata elata*	YUELE	1	1	1			
Amaranthaceae	*Atriplex canescens*	ATCA2	1	1	1			
Amaranthaceae	*Salsola tragus*	SATR12			1			
Amaranthaceae	*Tidestromia lanuginosa*	TILA2	1		1			1
Asteraceae	*Baileya multiradiata*	BAMU						1
Asteraceae	*Gutierrezia microcephala*	GUMI					1	
Asteraceae	*Gutierrezia sarothrae*	GUSA2	1	1				
Asteraceae	*Lorandersonia pulchella*	LORPUL		1				
Asteraceae	*Parthenium incanum*	PAIN2			1			
Asteraceae	*Pectis angustifolia*	PEAN	1	1	1			
Asteraceae	*Picradeniopsis absinthifolia*	PICABS					1	
Asteraceae	*Thymophylla acerosa*	THAC					1	
Asteraceae	*Verbesina encelioides*	VEEN					1	
Brassicaceae	*Descurainia pinnata ochroleuca*	DEPIO2						1
Brassicaceae	*Lepidium montanum*	LEMO2					1	
Cactaceae	*Opuntia macrocentra*	OPMA8						1
Ehretiaceae	*Tiquilia hispidissima*	TIQHISn					1	
Euphorbiaceae	*Euphorbia serpillifolia*	EUPSER					1	
Euphorbiaceae	*Euphorbia serrula*	EUSE6						1
Fabaceae	*Astragalus allochrous*	ASAL6						1
Fabaceae	*Prosopis glandulosa*	PRGL2	1	1	1	1	1	
Hydrophyllaceae	*Phacelia integrifolia texana*	PHINT					1	
Linaceae	*Linum aristatum*	LIAR3		1				
Malvaceae	*Sphaeralcea incana*	SPIN2	1	1	1			
Martyniaceae	*Proboscidea parviflora*	PRPA2	1					
Nyctaginaceae	*Boerhavia torreyana*	BOTO2	1	1	1			
Poaceae	*Aristida purpurea*	ARPU9			1			
Poaceae	*Bouteloua aristidoides*	BOAR	1		1			
Poaceae	*Bouteloua barbata barbata*	BOBAB3	1		1	1	1	1
Poaceae	*Hilaria mutica*	HIMU2				1		
Poaceae	*Muhlenbergia arenacea*	MUAR				1		
Poaceae	*Muhlenbergia porteri*	MUPO2	1		1			1
Poaceae	*Munroa pulchella*	MUNPUL	1	1				
Poaceae	*Scleropogon brevifolius*	SCBR2				1		
Poaceae	*Sporobolus airoides*	SPAI				1		
Poaceae	*Sporobolus contractus*	SPCO4	1	1				
Poaceae	*Sporobolus cryptandrus*	SPCR	1					
Poaceae	*Sporobolus flexuosus*	SPFL2	1	1	1			
Poaceae	*Sporobolus giganteus*	SPGI		1				
Polemoniaceae	*Ipomopsis pumila*	IPPU4						1
Polygonaceae	*Rumex hymenosepalus*	RUHY	1	1	1			1
Zygophyllaceae	*Kallstroemia parviflora*	KAPA			1			
Zygophyllaceae	*Larrea tridentata*	LATR2			1		1	1
		totals:	17	14	17	6	11	11

FIGURE 4. Sites 'quatro amigos 1' (top) and 'quatro amigos 2' (bottom).

FIGURE 5. Sites 'quatro amigos 3' (top) and 'quatro amigos 4' (bottom).

FIGURE 6. Sites 'quatro amigos 5' (top) and 'quatro amigos 6' (bottom).

FIGURE 7. *Sporobolus flexuosus* between 'quatro amigos 1' & 'quatro amigos 2'. Whole plant (top) & clipped stems (bottom).