California's Sustainable Groundwater Management Act:
The Paradox of Local Control of a Precious Public Resource

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AUTHORIZATION TO SUBMIT

This thesis of Tyler Hubbard, submitted for the degree of Master of Science with a Major in Water Resources and titled "California's Sustainable Groundwater Management Act: The Paradox of Local Control of a Precious Public Resource," has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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ABSTRACT

Unlike most states west of the 100th meridian, California has, until recently, never enacted a comprehensive set of regulations to govern consumptive use of groundwater resources, even though groundwater provides between 40 percent and 60 percent of the water used by residents, farmers, business, and municipalities in the state. That changed in 2014, when the California legislature passed the Sustainable Groundwater Management Act (SGMA) in response to one of the worst droughts in the state's history. The years between 2012 and 2014 had been so dry that surface water deliveries to the major agricultural areas of the San Joaquin Valley were cut to almost zero, forcing farmers to pump groundwater at unprecedented rates to make up the shortfall. This, in turn, caused groundwater levels to drop and domestic wells to go dry. SGMA was enacted to reverse this trend and bring the state's groundwater resources into sustainability.

This thesis examines whether a key feature of SGMA – its focus on local control of groundwater management decisions – will frustrate the sustainability goals of the statute. By reviewing a representative sample of the Groundwater Sustainability Plans prepared in compliance with SGMA, the thesis analyzes how the local water agencies in the San Joaquin Valley differ in their approach to groundwater management when compared to local water agencies outside the San Joaquin Valley. This analysis indicates that much of the groundwater overdraft problem in California can be traced to a recent phenomenon where large farming interests in the San Joaquin Valley switched from annual row crops to permanent orchard crops, primarily almonds and pistachios. This change in crop mix has fundamentally altered water usage in the Valley, largely because almonds and pistachios require substantially more water than annual row crops.

Almonds and pistachios, however, are highly profitable, and the farmers who switched to these crops show no interest in converting back to row crops just to save water or improve conditions within their respective subbasin. For this reason, the Groundwater Sustainability Plans prepared by water agencies in the San Joaquin Valley focus almost exclusively on new water supply projects and include few provisions that would address pumping behavior or crop mix. Outside the San Joaquin Valley, however, the water agencies seem more willing to embrace a wide array of actions to achieve sustainability, including pumping restrictions and land fallowing programs. Thus, SGMA appears to create a two-tiered system, one in which San Joaquin Valley farmers can continue to pump as before, while the rest of the overdrafted basins in the state engage in aggressive cutbacks. Without greater guidance and enforcement from the State Water Resources Board and the Department of Water Resources, this two-tiered system may cause SGMA to fail in its objective, which is to bring all overdrafted subbasins, including those in the San Joaquin Valley, into a sustainable condition.

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INTRODUCTION

There is a famous photograph of a man standing next to crop rows in California's San Joaquin Valley, pointing to a telephone pole.[1] The telephone pole has four signs on it. The first three, going top to bottom, give the years 1925, 1955, and 1977. The fourth sign says: "San Joaquin Valley, Subsidence 9M, 1925-1977" – meaning the land in this location has subsided nearly 30 feet (9 meters) in 50 years.[2] Unfortunately, the signs do not explain how or why the land has subsided to such an extent in this particular location.

The answer, we later learn, is unregulated groundwater pumping. Like a sponge that has had the water squeezed out of it, the aquifer beneath the ground's surface has collapsed down to almost nothing, causing the land to sink. When this happens, roads crack, canals crumble, concrete pipes break apart – requiring expensive repairs.[3]

But that's not all. The years of overdraft – i.e., when pumping rates outpace groundwater recharge rates[4] – eventually cause permanent damage to the aquifer itself, such

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[1] Dr. Joseph Poland, "Land Subsidence", United States Geological Society, photograph, circa 1977. https://www.usgs.gov/special-topic/water-science-school/science/land-subsidence?qt-science_center_objects=0#qt-science_center_objects; see also, David Carle, *Introduction to Water in California* (Oakland: University of California Press, 2016), 181.

[2] *Id.*

[3] Kate Fritz, "Shoring Up SGMA: How Advocates Might Use the Holding in *Environmental Law Foundation v. SWRCB* to Support Sustainable Groundwater Management in California," *Environmental News,* 28, no. 1 (Fall 2019): 3. See also, Chelsea Scharf, "California's Groundwater Crisis: A Case for the Regulation of Groundwater Substitution Transfers," 22 *Hastings W.-N.W. J. Env. L. & Pol'y* (Summer 2016): 174.

[4] Cal. Dep't. Water Res., Bulletin 160-13, California Water Plan Update 2013 Glossary 1(Oct. 2003): 3-30, http://www.waterplan.water.ca.gov/cwpu2013/final/index.cfm.

that it no longer has the ability to hold water.[5] This is called "inelastic subsidence" and it has been happening for decades throughout central and southern California.[6] It is one of several adverse impacts of excessive groundwater pumping. Others include general reductions in available water supplies, degraded water quality, increased sea water intrusion, damage to groundwater dependent ecosystems, and loss of surface water flows in those systems where streams and aquifers are hydraulically connected.[7]

Until recently, California, unlike every other state in the western United States, had no system for regulating groundwater use, which is strange given that California uses more groundwater than any other state.[8] That changed in 2014, when years of drought, combined with reduced water deliveries from the Sacramento Bay-Delta, caused farmers in central and southern California to dramatically increase groundwater pumping.[9] In fact, they pumped six million acre-feet more in 2014 than they did in 2011, leading to a host of negative effects.[10]

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5 James Borchers and Michael Carpenter, "Land Subsidence from Groundwater Use in California," a report prepared for Luhdorff & Scalmanini Consulting Engineers (April 2014): 8-10.

6 *Ibid.* See also, Benjamin A. Harris, "Making the Most of El Nino: Stormwater Collection and Rainwater Harvesting as Potential Solutions to Water Shortages in Southern California," 27 *Vill. Envtl. L.J.* (2016): 186.

7 Janet Martinez, Esther Conrad, and Tara Moran, "Upstream, Midstream, and Downstream: Dispute System Design for Sustainable Groundwater Management," 13 *U. St. Thomas L.J*. (Winter 2017): 297-298; Robert Glennon, *Water Follies: Groundwater Pumping and the Fate of America's Fresh Waters* (Washington DC: Island Press, 2003), 3.

8 Jaskaran S. Gill, "Groundwater Managed: California Takes Its First Step Towards Groundwater Sustainability," 25 *S.J. Agric. L. Rev*. (2015/2016): 17; see also, Tina Cannon Leahy, "Desperate Times Call for Sensible Measures: The Making of the California Sustainable Groundwater Management Act," 9 *Golden Gate U. Envtl. L.J.* (2015-2016): 6.

9 Micah Green, "Rough Waters: Assessing the Fifth Amendment Implications of California's Sustainable Groundwater Management Act," 47 *The U. Of Pac. L. Rev.* (2015-2016): 37; see also, Scharf, "California's Groundwater Crisis," 178.

10 Matt Brown, "Managing California's Water: A Look at the Sustainable Groundwater Management Act of 2014," *23 Hastings J. Envt'l & Policy,* no. 1 (2017): 1-23

The California Legislature decided to address the problem by passing the first comprehensive set of groundwater regulations in the state's history.[11] These regulations were contained within three coordinated bills and eventually became known as the "Sustainable Groundwater Management Act" or "SGMA".[12] Many hailed the new law as a long-overdue answer to California's groundwater overdraft problem; others objected to the statute on grounds that it represented an attempt by bureaucrats in Sacramento to micromanage agribusiness in the farm-rich Central Valley.[13] Still others were concerned that SGMA did too little too late, and gave groundwater users too much time to change their behavior and/or find other sources of water.[14]

One of the fundamental tenets of SGMA is that each groundwater basin (or subbasin) is unique and thus sustainable groundwater management is best achieved through local control.[15] Under SGMA, a local groundwater sustainability agency (GSA) must be

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[11] John C. Peck, Rick Illgner, Jakob Wiley and Constance Crittenden Owen, "Groundwater Management: The Movement Toward Local, Community-Based Voluntary Programs," 29 *Kan. J.L. & Pub. Pol'y* (Fall 2019): 30-31.

[12] The three bills are Assembly Bill 1739, 2013-2014 Leg. (Cal. 2014); Senate Bill 1168, 2013-2014 Leg. (Cal. 2014); and Senate Bill 1319, 2013-2014 Leg. (Cal. 2014). John J. Perona, "A Dry Century in California: Climate Change, Groundwater, and a Science-Based Approach for Preserving the Unseen Commons," 45 *Envtl. L.* (Summer 2015): 649, n. 56. The three bills have since been codified in California Water Code sections 10723, et seq.

[13] Martinez, et al., "Upstream, Midstream, and Downstream," 306; Ashley Mettler, "Reducing Overdraft and Respecting Water Rights Under California's 2014 Sustainable Groundwater Management Act: A View From the Kern County Farming Sector," 9 *Golden Gate U. Envtl. L.J.* (Spring 2016): 240; Joseph F.C. DiMento, "The Shape of Groundwater Law: California's New Sustainability Act," *Journal of the Southwest* 59, nos. 1-2 (Spring-Summer 2017): 364, 370-371-393; Michael Kiparsky, Anita Milman, Dave Owen, and Andrew T. Fisher, "The Importance of Institutional Design for Distributed Local-Level Governance of Groundwater: The Case of California's Sustainable Groundwater Management Act," *Water* 9 (2017): 17.

[14] See, e.g., John J. Perona, "A Dry Century in California," 642-643.

[15] *Ibid.,* 646-647. See also, Josh Patashnick, "All Groundwater is Local: California's New Groundwater Monitoring Law," 22 *Stan. L. & Pol'y Rev.* (2011): 321; see also Martinez, et al., "Upstream, Midstream, and Downstream," 302; see also, Louise Nelson Dyble, "Aquifers and Democracy: Enforcing Voter Equal Protection to Save California's Imperiled Groundwater and Redeem Local Government," 105 *Calif. L. Rev.* (October 2017): 1471, 1478-1479; see also, "Enforcing the Sustainable Groundwater Management Act," *California Agriculture* 72, no. 1 (January-March 2018): 18.

established for each basin or subbasin that is determined to be in a moderate to high overdraft condition.[16] Once in place, the GSA must prepare a groundwater sustainability plan (GSP) which (i) describes the current condition of the basin in terms of its hydrology, capacity, demands, water quality, and overdraft status; (ii) analyzes the adverse impacts caused by over-pumping in the basin; and (iii) identifies measures which, if implemented, would allow the basin to achieve sustainability by the year 2040.[17]

As discussed in this thesis, however, SGMA's reliance on local control of groundwater pumping regulation, while understandable and perhaps even necessary, may very well doom the entire effort to failure. By placing so much power in the hands of local water users, and by omitting provisions that would require actual reductions in groundwater pumping or curtailment of any existing groundwater use rights, SGMA lacks the force necessary to bring systemic change to groundwater use patterns over the long-term.[18]

Chapter 1 of the thesis addresses the history of groundwater use and regulation in California. This part of the thesis will focus on the role groundwater plays in California's complex water delivery and use system. Other issues covered in this section include: California water law as it pertains to groundwater use; the relationship between surface water deliveries and groundwater use during wet, normal, and drought years; the effect of crop-mix trends on groundwater use and supplies; and past (largely unsuccessful) efforts to regulate groundwater pumping in the state.

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16 Harris, "Making the Most of El Nino," 201-202.

17 Cal. Water Code § 10727.2. See also, Gill, "Groundwater Managed," 30.

18 Dyble, "Aquifers and Democracy," 1478-1479; Adam Keats and Chelsea Tu, "Not All Water Stored Underground is Groundwater: Aquifer Privatization and California's 2014 Groundwater Sustainability Management Act," 9 *Golden Gate U. Envtl. L.J.* (2016): 95-97.

Chapter 2 of the thesis discusses SGMA, its origins, assumptions, and requirements. This part of the thesis will examine the conditions that gave rise to SGMA's adoption in 2014, and will discuss the underlying assumptions of the statute, especially as they relate to local control of groundwater. This part of the thesis will also discuss SGMA's key components and critically evaluate them for weaknesses that may compromise the objectives of the statute itself. Issues to be addressed include: lack of mandatory pumping reductions; limited enforcement tools; inadequate funding; omission of uniform monitoring and reporting standards; no power to require curtailment; deference to local determinations regarding when a basin or subbasin is not functioning in a sustainable manner; and lack of concern regarding the impact of crop mix on groundwater use.

Chapter 3 of the thesis analyzes a representative sample of GSPs. SGMA required 21 GSAs to prepare, finalize, and submit their groundwater sustainability plans (GSPs) by January 31, 2020. In this part of the thesis, I analyze six of these GSPs to determine if they confirm some of the concerns discussed earlier. Recognizing that each GSP is basin-specific and therefore unique, I will nevertheless be looking for patterns in terms of how the various GSPs address overdraft. For example, do most of the GSPs focus on increasing water imports to the groundwater basin (i.e., recharge strategies), or do they include strong provisions for changing pumping behavior and reducing groundwater use? Do some GSPs include provisions for charging pumping fees? Or do most of them look to other sources of funding, such as state grants and low interest loans?

Chapter 4 attempts to diagnose SGMA's problems and provides a prognosis for its future success or failure. In this part of the thesis, I will identify what I believe are the most serious defects in SGMA, as revealed through my review of the GSPs. I then offer my opinions as to whether SGMA must be modified in the near future if it is to meet the goals and objectives assigned to it.

In Chapter 5, I conclude by trying to place SGMA in relation to California's long-standing reluctance to centrally regulate groundwater use.

Chapter 1: History of Groundwater Use and Regulation in California

A. The Relationship Between Surface Water and Groundwater in California

In normal rainfall years, surface water supplies 60 percent of water demand for both urban and agricultural uses, and groundwater supplies the remaining 40 percent.[19] In dry years, however, those percentages are reversed: groundwater supplies 60 percent of demand, while surface water supplies 40 percent.[20] It should be kept in mind, though, that in some rural parts of the state, all potable water comes from underground, as there are no readily available surface water sources.[21]

But that is only part of the story. To understand when, where, and why *groundwater* overdraft occurs in California, one must first understand how *surface* water in California is distributed. Although California recognizes both riparian and appropriative use water rights, most surface water in California is distributed and secured through water contracts between state and federal water agencies and hundreds of water districts, who then provide the water to their retail customers.[22] This contractual network is required because of a fundamental mismatch between where most of the surface water is located (in the northern part of the state) and where demand for that water is greatest (in the farms and cities in the southern part of the state).[23] To address this mismatch and bring water from the north to the south, in the 1930s the U.S. Bureau of Reclamation, with construction help from the U.S. Army Corps of

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19 Carle, *Introduction to Water in California,* 50.

20 *Ibid.*

21 *Ibid.*

22 *Ibid.,* 94-95.

23 *Ibid.,* 82, 91; see also *In re Bay-Delta, etc.* (2008) 43 Cal.4th 1143, 1152-1153.

Engineers, constructed an elaborate system of pumps, dams, reservoirs, aqueducts, siphons, and canals that diverts millions of acre feet of water each year from the Sacramento Bay-Delta to the farms of central and southern California, most notably the San Joaquin Valley.[24] This is known as the Central Valley Project (CVP), and it is one of three life-lines for agricultural irrigation south of Sacramento, the other two being the State Water Project and the Colorado River.[25]

Two decades after completion of the CVP, it became clear that agricultural production in southern California was growing at a rate beyond what the CVP could supply with water from the north. Ironically, the CVP had been constructed to alleviate extreme groundwater overdraft conditions in the San Joaquin Valley, but the project, once it began delivering cheap, highly-subsidized water, only encouraged farmers to plant and irrigate more land; and the groundwater overdraft problem was never solved.[26] Instead, the plan was for the State of California to build its *own* water delivery system from the Bay-Delta to the San Joaquin Valley and the Southern California cities south of it. This system, known as the State Water Project (SWP) would have its own elaborate network of dams, reservoirs, pumps, siphons, aqueducts, and canals, and it would largely parallel the CVP, but would be located more to the west.[27] On a map, the CVP and SWP look like a kind of artificial Tigris and Euphrates flowing through central and southern California. While the CVP is operated by the U.S. Bureau of Reclamation, the SWP is operated by the California Department of

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24 Carle, *Introduction to Water in California,* 108; Rodd Kelsey, Abby Hart, H. Scott Butterfield, and Dan Vink, "Groundwater Sustainability in the San Joaquin Valley: Multiple Benefits if Agricultural Lands Are Retired and Restored Strategically," *California Agriculture* 72, no. 3 (July-September 2018): 151.

25 Carle, *Introduction to Water in California,* 95-121.

26 *Id.,* 108.

27 *Ibid.,* 95-103.

Water Resources (DWR).[28] Both agencies, however, enter into water contracts with the many local water and irrigation districts that supply water to southern California's farms and cities.

The third piece of the surface water distribution puzzle is the Colorado River, which provides water to the metropolitan areas of San Diego, Riverside, Orange County, and parts of Los Angeles, and is the primary water source for the crop-rich Imperial Valley located just north of the border separating California from Baja, Mexico.[29] Water from the Colorado is diverted from the river and moved west toward Los Angeles via the Colorado Aqueduct, and then the Metropolitan Water District redistributes it to its various sub-purveyors, such as the San Diego County Water Authority.[30] Much of the Colorado water used for farming is controlled by the powerful Imperial Irrigation District (IID), which pulls water not just from the Colorado Aqueduct but also from the All-American Canal that runs from the lower Colorado River along the U.S.-Mexico border and then hooks up to various smaller canals and storage areas within Imperial County.[31]

There are a host of environmental problems and political controversies associated with the north-to-south (and east-to-west) water distribution system described above.[32] But for purposes of this thesis, the most important point is that the CVP, the SWP, and the Colorado River are all over-subscribed, which means they have contracts to deliver more

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28 *Ibid.,* 95, 108.

29 *Ibid.,* 115-117.

30 *Ibid.,* 117-118, 134.

31 *Ibid.,*115-117.

32 *In re Bay-Delta, etc.,* 43 Cal.4th at p. 1153.

water than they actually possess or can get access to.[33] This was not always the case, and in some wet years, the CVP, SWP, and the Colorado have delivered 100 percent of the water allotments in their various contracts. More often than not, however, the deliveries fall short, sometimes drastically short. For example, between 2000 and 2014, the SWP was able to deliver 100 percent of its contractual allotments only once, in 2006.[34] It was able to deliver 90 percent of contractual allotments only two other times, in 2000 and 2005.[35] More recently, CWP has not made good on even 50 percent of its contracted water deliveries, and in 2015 it managed to supply only 5 percent of the water in its contracts.[36] In California, the difference between a user's *contracted* water and the water that a user actually *receives* is called "paper" water.[37] Overall, on average, the CVP, SWP, Colorado, and other local suppliers have allocated more than 350 million acre feet of water, which is about five times the 70 million acre feet available in any given year with good precipitation.[38] So while the surface water distribution system in California gives the *illusion* of having enough supply to meet demand, it does not; much of the so-called supply is paper water. And to the extent climate change causes longer, more frequent and more severe droughts to occur in California, the discrepancy between supply and demand, between contract entitlements and actual deliveries, will only increase. Californians will be drowning in paper water yet still dying of thirst.

33 Carle, *Introduction to Water in California,* 95, 98 [Table 2], 114-115, 119.
34 *Ibid.,* 98 [Table 2].

35 *Ibid.*

36 *Ibid.*

37 *Ibid.,* 95.

38 *Ibid.,* 93-94

B. Reduced Surface Water Deliveries, Increased Groundwater Pumping, and the Impacts of Overdraft

What, then, do farmers and other users in southern California do to make up the difference? They answer is: They pump more groundwater.[39] And while southern California has fewer and smaller above-ground reservoirs than northern California, it has a substantial number of large and accessible groundwater basins and subbasins, from which farmers and other landowners can pump millions of gallons of water, often for free (after subtracting the cost of the well and the electricity needed to run it) and virtually without limitation or regulation.[40] Since its inception, California has maintained a "legal fiction" that groundwater and surface water are separate entities with no hydraulic or operational connection.[41] For this reason, California water law, despite all of its complex rules for allocating surface water, has very little to say with regard to groundwater use and the legal rights that apply to it.[42] Courts in California rarely weigh-in on groundwater matters, except when asked to "adjudicate" rights of competing groundwater users within a specific basin or subbasin.[43] These adjudications are, by their very nature, highly localized in their legal impact and do not

39 Fritz, "Shoring Up SGMA," 3; Matt Brown, "Managing California's Water," 23. See also, Micah Green, "Rough Waters," 25-26.

40 Carle, *Introduction to Water in California,* 52.

41 *Ibid.,* 177; Alida Cantor, Dave Owen, Thomas Harter, Nell Green Nylen, Michael Kiparsky, "Navigating Groundwater-Surface Water Interactions Under the Sustainable Groundwater Management Act," *Center for Law, Energy & the Environment,* UC Berkeley School of Law, Berkeley, CA (2018): 5; John J. Perona, "A Dry Century in California", 645-646.

42 Scharf, "California's Groundwater Crisis," 177.

43 Fritz, "Shoring Up SGMA," 4, citing Alida Cantor et al., "Navigating Groundwater-Surface Water Interactions Under the Sustainable Groundwater Management Act, *Center for Law, Energy & the Environment at UC Berkeley School of Law* (2018): 126, https://doi.org/10.15779/J23P87 or law.berkeley.edu/gw-sw. See also, Lynn M Forsythe, Ida M. Jones, and Deborah J. Kemp, "A Report Card: Progress Under California's Sustainable Groundwater Management Act (SGMA)," 21 *U. Denv. Water L. Rev.* (2018): 207.

contribute to anything approaching a state-wide or systematic approach to groundwater regulation.[44]

Essentially, California law recognizes "overlying" rights to groundwater, which means that the person who owns or leases land overlying a groundwater aquifer can sink a well and pump to his or her heart's content.[45] The only limitation is that aquifers and the water within them are "shared" resources subject to the doctrine of "correlative" use.[46] This means that, theoretically, each overlying landowner may pump as much as he or she wants, provided doing so does not substantially interfere or interrupt the groundwater pumping of any other landowner overlying the same groundwater basin.[47] The *theory* of correlative groundwater rights works perfectly well in *practice* so long as water levels in the groundwater basin remain relatively stable. But when pumping outpaces natural recharge of the groundwater basin, water levels in the aquifer drop, causing a range of problems. Simply put, the priority granted to overlying landowners tends to encourage the "biggest straw" syndrome, which leads to over-pumping and misallocation of groundwater.

At first, reduced groundwater levels may simply require that landowners dig deeper wells and absorb the added cost associated with pushing the water a few more feet up to the

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44 Martinez, et al., "Upstream, Midstream, and Downstream," 303-304; Leon Szeptycki, Esther Conrad, William Blomquist, and Janet Martinez, "A Flexible Framework or Rigid Doctrine? Assessing the Legacy of the 2000 Mojave Decision for Resolving Disputes Over Groundwater in California," 37 *Stan. Envtl. L.J.* (May 2018): 189-190.

45 Leahy, "Desperate Times Call for Sensible Measures," 6, discussing *Katz v. Walkinshaw,* 74 P. 766, 766 (Cal. 1903); sea also, Carle, *Introduction to Water in California,* 177.

46 California law also recognizes "appropriative use" and "prescriptive" rights with respect to groundwater, but these rights, too, are subject to the doctrine of correlative use. Leahy, "Desperate Times Call for Sensible Measures," 9-10, citing The Early Years of Water Rights, St. Water Resources Control Board, http://www.waterboards.ca.gov/about_us/water_boards_structure/history_waterrights.shtml and *City of Pasadena v. City of Alhambra,* 207 P.2d 17, 23 (Cal. 1949). See also, Micah Green, "Rough Waters," 37.

47 *Ibid.* See also DiMento, "The Shape of Groundwater Law," 367.

surface. As the overdraft conditions worsen, however, the aquifer may start to draw water from a hydraulically connected surface stream, causing that stream to lose flow volume.[48] If no such replacement water is available, the aquifer itself may start to collapse under the weight of the land above it. This, in turn, causes the land surface to subside and sink, resulting in major damage to roads, canals, building foundations, dams, reservoirs, and other infrastructure.[49]

The problems don't stop there. Most groundwater basins in central and southern California are made up of multiple aquifers separated by natural geologic barriers, most of which consist of clays or other soils that are difficult for water to penetrate. These barriers, known as aquitards, usually run horizontally across much or all of a given groundwater basin, creating what are typically described as "upper" and "lower" aquifers.[50] When overdraft depletes the upper aquifer to the point where it is no longer a reliable source of groundwater, users will drill new wells that go deep enough to penetrate the clay aquitard and access the lower aquifer below.[51] This tends to make the subsidence problem worse.[52] It also puts in jeopardy the very nature of these deep and ancient water sources, because, unlike the upper aquifers that can be readily recharged through natural and artificial methods, lower aquifers

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48 Leahy, "Desperate Times Call for Sensible Measures," 8, citing Maurice Hall, The Nature Conservancy, Written Testimony on California Water Governance to the Little Hoover Commission 15-16 (Jan. 2010), available at http://www.lhc.ca.gov/studies/201/watergovernance/HallJan10.pdf.

49 NASA, "California Drought Causing Valley Land to Sink," August, 19, 2015, https://nasa.gov/jpl/nasa-california-drought-causing-valley-land-to-sink. Last accessed May 24, 2020; see also Tom G. Farr, Cathleen E. Jones, Zhen Liu, Jet Propulsion Laboratory, California Institute of Technology, *Subsidence in the Central Valley, California,*" prepared for the California Department of Water Resources (2015): 1-2.

50 Farr, et al, "Subsidence in the Central Valley, 1-2.

51 *Ibid.*

52 *Ibid.*

recharge much more slowly and sometimes not at all.[53] Yet, until recently, there were no rules preventing or even regulating groundwater pumping from these aquifers.

Another problem with groundwater overdraft is that the first wells to be adversely affected are usually those installed by homeowners for everyday domestic uses, such as cooking, showering, making coffee, and watering the lawn. Such wells are typically shallow, meaning they have been sunk to just a few feet below the ground surface. As groundwater levels drop, these shallow wells fail, and the households lose their primary (and sometimes only) source of potable water. A 2014 documentary film, "Water and Power", depicts the problems that groundwater overdraft in the San Joaquin Valley has created for the residents of the small town of Porterville, most of whom are farm workers who rely entirely on well water for their fresh water needs.[54] Those wells went dry and remain dry, due to agricultural over-pumping at the local almond orchards.[55] As a result, residents have to use bottled water supplied by charitable organizations for drinking, bathing, and washing dishes.[56] The difficulties these families face show that groundwater overdraft is more than just hydrology; it is social and has distinct environmental justice consequences.

In the coastal regions of central and southern California, over-pumping of groundwater creates special challenges. Here, surface water is harder to come by, in part because many of the farms and towns in these areas are beyond the distributional reach of the CVP and SWP and have few local surface water resources to tap. For this reason, users in

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53 *Ibid.*

54 *Water and Power: A California Heist*, directed by Maria Zenovich (Jigsaw Productions, 2017).

55 *Ibid.* Gill, "Groundwater Managed," 18.

56 *Water and Power;* Gill, "Groundwater Managed," 18.

the coastal zone tend to rely more heavily on groundwater, even in normal rainfall years, than their inland counterparts do. Such reliance, however, comes with its own risks. Many of the groundwater basins along the coast are hydraulically connected, via canyons and other topographic features, to the Pacific Ocean.[57] So long as the prevailing gradient or flow of the groundwater is east-to-west (i.e., toward the ocean), everything is fine; the head pressure of the downward flowing groundwater keeps the seawater from backing up and intruding into the aquifer.[58] Unfortunately, however, years of over-pumping in some coastal areas have caused the groundwater gradient to reverse its course and move in a west-to-east direction.[59] In this situation, the seawater is pulled inland, where it mixes with the freshwater in the aquifer and increases the salinity of the groundwater to a point where it is neither potable and nor usable for crop irrigation.[60]

High salt concentrations in groundwater is not a problem unique to coastal subbasins. Aquifers in much of the San Joaquin Valley also have salinity issues, but for slightly different reasons.[61] Although the valley is a long way from the Pacific Ocean, this was not always the case; millions of years ago, the San Joaquin Valley was part of the seafloor, and the soil in this part of the state has retained some of its ancient marine history in the form of high natural salt levels.[62] In itself, these soil salt levels are not extreme enough to preclude

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57 See, e.g., Fox Canyon Groundwater Management Agency, *Groundwater Sustainability Plan for the Oxnard Subbasin* (December 2019), ES-2, ES-3—ES-4, 2-7—2-12.

58 *Ibid.,* 2-28.

59 *Ibid.,* 2-28—2-32.

60 *Ibid.;* see also, Carle, *Introduction to Water in California,* 181-182.

61 Carle, *Introduction to Water in California,* 166-167.

62 *Ibid.,* 52, 166-167.

farming, but repeated irrigation tends to leach the salts from the soil and mix them into the spent agricultural water.[63] Unless the crop field is extremely well-drained, the now-highly salinized agricultural water percolates downward into the aquifer, where eventually it is pumped up and re-applied to the fields, just with higher salt concentrations.[64] This feedback loop can lead to extremely high salt levels in certain groundwater subbasins, making the water unusable for key crops, such as almonds, which are not particularly salt-tolerant.[65] These conditions, if they expand and become consistent across the entire basin, can create favorable conditions for highly invasive, salt-loving exotic plant species, such as salt cedar, tamarisk (*Arundo donax*), and eucalyptus.[66] Once these species take hold in a given riparian area, they outcompete native vegetation and become very difficult to eradicate.[67]

The same irrigation-driven leaching process that brings salt into the underlying aquifer also carries nitrates, pesticides, herbicides, and heavy metals, such as selenium, into the groundwater as well. Part of the problem is that spent agricultural water, also known as "ag-return" or "tile" water, is difficult to dispose of. While it is easy enough to collect, there is no ready method for getting rid of it. In the 1980s, irrigation districts in the San Joaquin Valley, working with state and federal water agencies, impounded millions of gallons of spent agricultural water into the Kesterson Wildlife Refuge operated by the U.S. Fish and

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63 *Ibid.,* 166-167.

64 *Ibid.*

65 *Ibid*.

66 *Ibid.* Valerie Vartanian, "Destructive Nature of Arundo and Tamarisk," paper presented at *Arundo and Saltcedar: The Deadly Duo: A Workshop on Combatting the Threat from Arundo and Saltcedar,* Ontario, California, June 17, 1998, 1.

67 Vartanian, "Destructive Nature of Arundo and Tamarisk," 1.

Wildlife Service, a popular stop for migrating ducks and other water fowl.[68] It's not clear who thought this would be a good idea, but it resulted in catastrophe. Within a couple of years, the selenium levels in the Kesterson Wildlife Refuge became so high that ducks and other water birds were being born dead or with significant physical deformities.[69] This disaster caused the U.S. Fish and Wildlife Service to close the refuge; and the selenium clean-up continues to this day.[70]

Perhaps the most confounding impact of groundwater overdraft is its effect on surface waters and, more specifically, on surface water *rights*. As mentioned above, California law has long operated on the misperception that surface water and groundwater have no hydraulic connection.[71] Hydrologists, water experts, and water users have known for over a century that this legal fiction is exactly that – a fiction. But it is a fiction that creates all sorts of problems when groundwater pumping in one part of the subbasin causes water levels to drop throughout the aquifer, including those portions that underlie surface streams.[72] The drop in groundwater levels creates a hydraulic pull on the surface stream, drawing water down through the streambed into the aquifer below and causing the stream to lose surface volume.[73] It is not necessarily unnatural for streams to experience reduced instream flows from this kind of hydraulic undertow; many streams "lose" water through their hydraulic

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68 Carle, *Introduction to Water in California,* 54, 167-169.

69 *Ibid.,* 168 [including Figs. 84 and 85], 169.

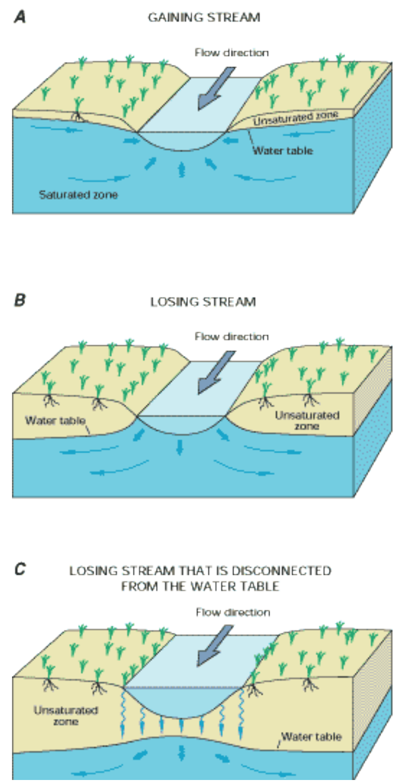
70 *Ibid.,* 169.

71 Michael Kiparsky et al., "Designing Effective Groundwater Sustainability Agencies," 14.

72 Fritz, "Shoring Up SGMA," 3-4. See also, Alida Cantor, et al., "Navigating Groundwater-Surface Water Interactions," 7-8.

73 *Ibid.*

contact with the underlying groundwater basin, at least during part of the year or during droughts.[74] Usually, however, the losses are not significant and the streams return to equilibrium – that is, they "regain" what they have lost – soon after groundwater levels stabilize through an increase in recharge (e.g., rainfall, snowmelt, etc.).[75] The figures at right depict gaining, losing, and disconnected streams.[76]



If, however, the loss of instream flow becomes chronic, it can severely damage the ecosystem of the affected river or stream, disrupting key life history stages for aquatic species, including fish.[77] Loss of instream flow also disrupts life for farmers who rely directly or indirectly on surface water for their irrigation needs. Whether they possess riparian, appropriative, or contractual rights to surface water, these users suffer a diminishment of their rights when surface water is lost. In other western states, such as Idaho, a surface water rights holder in this situation could bring a legal action against the groundwater pumpers he or she believes are responsible and could seek "mitigation" for the loss – a legal process in which the groundwater pumpers must compensate the senior

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[74] Paul M. Barlow and Stanley A. Leake, "Streamflow Depletion by Wells—Understanding and Managing the Effects of Groundwater Pumping on Streamflow," U.S. Geological Survey Circular 1376, Reston, Virginia, 2012, 6-7.

[75] *Ibid.*

[76] "Effects of Groundwater Development on Ground-water Flow to and from Surface-water Bodies", U. S. Geological Survey, https://pubs.usgs.gov/circ/circ1186/html/gw_effect.html.

[77] *Ibid.,* 35.

surface water rights holders by transferring water to them.[78] This remedy does not really exist in California, at least not prior to SGMA's passage in 2014, because California law historically has not recognized any hydraulic connection between surface and groundwater.[79] Consequently, surface rights owners cannot establish the causal link necessary to impose liability on groundwater pumpers. As discussed in Chapter 2, below, SGMA's greatest contribution to modernizing groundwater regulation in California may be its formal recognition that groundwater overdraft can (and often does) adversely affect surface waters and the legal rights attached to them.

C. The Effect of Land Ownership Patterns on Water Distribution and Groundwater Rights in California

Given this wide array of challenges posed by groundwater pumping in central and southern California, one might question why it took the state until 2014 to pass laws regulating groundwater use. After all, every other state west of the 100th meridian has been regulating groundwater pumping for at least 50 years. Part of the answer is tied to the unusual way that land ownership patterns developed in California both before and after it became a state. Most western states were settled with help from the Homestead Act of 1862, which limited land ownership to parcels of 160 acres or less.[80] California was different. As a former Spanish colony and then later part of Mexico, California had a completely different land ownership system.[81] Rather than being distributed upon a grid made up of 160-acre

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78 Idaho Conjunctive Management Rules. IDAPA 37.03.11, et seq.

79 Fritz, "Shoring Up SGMA," 4; Cantor et al., "Navigating Groundwater-Surface Water Interactions," 5.

80 Act of May 20, 1862 (Homestead Act), Public Law 37-64 (12 STAT 392).

81 David Carle, *Water and the California Dream: Historic Choices for Shaping the Future* (Berkeley: Counterpoint Press, 2016), 24-30; Gloria Ricci Lothrop, "Rancheras and the Land: Women and Property Rights in Hispanic California," *Southern California Quarterly* 76, no. 1 (Spring 1994): 61-62; Iris H. W. Engstrand, "California Ranchos: Their Hispanic Heritage," *Southern California Quarterly* 67, no. 3 (Fall 1985): 281-290.

sections, land in California was owned through a patchwork of large ranchos, some of which were enormous, consisting of tens of thousands of acres.[82] When the United States acquired California through the Treaty of Guadalupe, the rancho system was retained, allowing the owners to keep their large holdings or sell them off in whatever amounts they wished.[83] As a result, large parts of California, including portions of the agriculturally-rich Central Valley and Imperial County, are owned by relatively few landowners with vast property holdings.[84] And with vast property comes significant economic and political power.

When the railroads came, land ownership – and California politics – became even more complicated, and these complications necessarily affected whether and how water was regulated. Under the Pacific Railroad Acts of 1862, the U.S Government provided various land grants to certain western railroad companies, such as the Central Pacific Railroad, the Union Pacific Railroad, the Southern Pacific Railroad, and the Western Pacific Railroad.[85] Through these land grants, the railroads were able to own land 10 miles on each side of a rail line, resulting in huge property holdings.[86] What emerges is a situation where huge parts of California are owned by a small group of people. This has had profound impacts on agriculture and who has access to the water "developed" through the CVP and SWP. David Carle, in his *Introduction to Water in California*, describes it this way:

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[82] Engstrand, "California Ranchos," 281-290.

[83] Christine A. Klein, "Treaties of Conquest: Property Rights, Indian Treaties, and the Treaty of Guadalupe Hidalgo," 26 *N.M. L. Rev.* (Spring 1996): 202-203.

[84] Carle, *Introduction to Water in California,* 160. See also, Rodney Steiner, "Large Private Landholdings in California," *Geographical Rev.* 72, no. 3 (July. 1982): 315-326.

[85] David Carle, *Water and the California Dream,* 55-57.

[86] *Ibid.*

> Bureau of Reclamation [CVP] water was meant to serve farms limited to 160 acres, to encourage small farmers who lived on their land. That type of land ownership was never the broad pattern in California, however. Under Spanish and Mexican land grants, just a few individuals owned large ranches. Federal land grants later transferred 11 percent of California's acreage to railroads, with much of the land spanning the Central Valley. A few entrepreneurs manipulated federal homestead, timber, and swampland programs to circumvent acreage limits and acquire massive parcels . . . . A transition from a few large landholdings to many smaller farms was conceivable, but the vision of many thousands of farms limited to 160 acres was never actually realized.[87]

Carle goes on to explain that this concentration of land ownership and economic power was made possible, in part, by the Bureau of Reclamation's failure to enforce the 1902 Reclamation Act's 160-acre rule for CVP water and the Homestead Act's residency requirement.[88] Eventually, Congress amended the CVP acreage limit to 960 acres and deleted the residency requirement altogether.[89] But landowners still disregarded these more relaxed rules, and today "80 percent of the huge farms still exceed 1,000 acres."[90]

The land ownership pattern in California is especially important for SGMA because, as discussed earlier, groundwater rights are tied directly to who owns the land overlying the aquifer.[91] In groundwater basins where a handful of people own the majority of the overlying farmland, policy decisions are likely to favor the interest of the few and powerful over the many and weak. In Chapter 3 of this thesis, I will discuss how this political dynamic is built into SGMA's "local control" model and may eventually cause SGMA to fail in its primary objective, which is to establish a state-wide system of sustainable groundwater use.

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[87] Carle, *Introduction to Water in California*, 112.

[88] *Ibid.*

[89] *Ibid*. See also, Carle, *California Dream*, 173-174.

[90] Carle, *Introduction to Water in California,* p. 112. Carle, *California Dream*, p. 174.

[91] Carle, *Introduction to Water in California,* p. 177.

D. Past Efforts to Regulate Groundwater in California

The common view is that SGMA is California's first effort to systematically regulate and manage groundwater use in the state.[92] This, however, is not entirely correct. Since the early 1900s, there have been numerous attempts to pass laws giving the State of California the power to regulate groundwater use by private individuals and corporations. The first such attempt occurred in 1914, when legislators proposed the Water Commission Act which would have authorized the Department of Water Resources to regulate both surface water and groundwater.[93] But when the bill finally emerged and came up for a vote, the groundwater provisions had been removed.[94] This created a regulatory gap that existed for a full 100 years – until 2014, when SGMA was enacted. During that 100-year period, various groups of legislators tried to rein in groundwater pumping, especially in the agricultural areas of the state. These efforts were usually made in response to drought conditions that lasted longer than the norm, causing cuts in surface water deliveries and a drawdown of groundwater levels due to "compensatory" pumping by farmers.

For example, between 1974 and 1977, a severe drought gripped California.[95] To address the crisis, then-Governor Jerry Brown, Jr. (in his first term) established a Commission to review California Water Rights Law and instructed the Commission to make specific recommendations for legislative changes. In its report to the Governor, the Water

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92 See, e.g., Fritz, "Shoring Up SGMA," 3; Perona, "A Dry Century in California," 643; Harris, "Making the Most of El Nino," 201; Gill, "Groundwater Managed," 18-19.

93 Joseph Sax, "We Don't Do Groundwater: A Morsel of California Legal History," 6 *U. Denv. Water Law Rev.* (2003): 293; see also Leahy, "Desperate Times Call for Sensible Measures," 9.

94 Sax, "We Don't Do Groundwater," 293; Leahy, "Desperate Times Call for Sensible Measures, 9.

95 Leahy, "Desperate Times Call for Sensible Measures," 16.

Rights Commission stated that "in light of severe and extensive groundwater problems in California, the Water Rights Commission recommends that legislation be enacted to deal with groundwater management, adjudication of groundwater rights, and conjunctive use of surface and groundwater resources."[96] Ultimately, however, the California legislature ignored or rejected most of the legislation suggested by the Water Rights Commission. Only Senate Bill 1505, sponsored by John A. Nejedly from Contra Costa County, was enacted.[97] This bill did not seek to regulate groundwater pumping or use; instead, it directed DWR to scientifically investigate the geological and hydrological conditions of California's groundwater basins.[98]

Nevertheless, Senator Nejedly California, in a letter to the then-Director of DWR, Ronald Robie, expressed his hope that SB 1505 was just the beginning of more substantial groundwater legislation to follow in the near future.[99] Others had a very different view. For example, Senator Rose Ann Vuich, a Democrat from Fresno, Tulare, Kings, and Kern Counties (i.e., the heart of San Joaquin Valley), sent an angry letter to Director Robie in response to Nejedly's letter:

> It was with notable dismay that I received a copy of Senator John Nejedly's October 9th letter to you where he suggested the Legislature had future groundwater legislation in mind when passing SB 1505. I can assure you that nothing could be further from my intent and, in fact, others who reviewed SB 1505. Senator Nejedly's feeling that any investigation under SB 1505 would

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[96] *Ibid.,* 16, quoting Governor's Comm'n to Review Cal. Water Rights Law, Final Report 135 (1978).

[97] *Ibid.,* 16.

[98] *Ibid.,* 16.

[99] Leahy, "Desperate Times Call for Sensible Measures," 19, quoting Letter from John A. Nejedly, State Sen., Cal. 7th Dist., to Ronald B. Robie, Dir., Cal. Dep't of Water Res. (Oct. 9, 1979).

> [complement] and provide direction to future groundwater legislation is speculation, if not wishful thinking.[100]

Senator Vuich's words reflect the ethos that has long existed within and among the farming communities of the Central Valley, which is that water is a *local* concern and the state government in Sacramento should not interfere with how farmers in the "breadbasket to the world" conduct their difficult and high-risk business. While it is fair to say that the farm lobby and their representatives in the California legislature have softened their stance over the last 40 years, the sentiments expressed in Senator Vuich's 1979 letter, including its deep distrust of centralized control of water resources, still prevail in the Central Valley.[101] For example, the Groundwater Sustainability Plan (GSP) that the Northern and Central Delta-Mendota Groundwater Sustainability Agency (GSA) recently adopted downplays over-pumping as a major cause of lowered groundwater levels in the Delta-Mendota subbasin. Instead, the GSP blames the overdraft condition of the subbasin primarily on environmental regulations, such as mandatory instream flow requirements, and government-ordered cuts in surface water deliveries from northern California.[102]

In 1992, the legislature passed the Groundwater Management Act, which provided a *voluntary* procedure for water agencies and irrigation districts to follow when developing groundwater plans.[103] As a voluntary program, however, it was not designed to establish a comprehensive structure for managing groundwater on a statewide basis. Then, in 2009,

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100 *Ibid.,* 19, quoting Letter from Rose Ann Vuich, State Sen., Cal. 15th Dist., to Ronald B. Robie, Dir., Cal. Dep't of Water Res. (Nov 16, 1979).

101 *Ibid.,* 21-22; John J. Perona, "A Dry Century in California," 646-647.

102 Northern and Central Delta-Mendota Groundwater Sustainability Agency, *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Regions* (2019), 6-4.

103 Justin Anthony Brown, "Uncertainty Below: A Deeper Look into California's Groundwater Law," *Environs: Envtl. L. & Pol'y* 39, no. 1 (2015-2016): 62.

legislature enacted the California Statewide Groundwater Elevation Monitoring Act (CASGEM), which mandated that the DWR prioritize and assess the state's groundwater basins and subbasins.[104] Although CASGEM did not impose any regulations on groundwater extraction or use, the monitoring data collected through CASGEM would later prove extremely valuable to GSAs attempting to satisfy SGMA.

E. Changes in Crop Mix: The San Joaquin Valley's Move to More Profitable High Water-Use Crops Such as Almonds and Pistachios

In many of the critically overdrafted basins of the San Joaquin Valley, such as Delta-Mendota, growers tend to take the position that the depleted condition of their groundwater aquifers is not so much the result of excessive and irresponsible groundwater pumping, but reduced surface water deliveries from the north – deliveries they thought were secured under contracts with the state and federal government.[105] They point out that in the last 25 years, their contracted water allotments through the SWP and CVP have been substantially cut, sometimes to zero during drought years. According to the GSAs in this region, the reduced water deliveries are being driven by environmental regulations and court decisions that now require both the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation to keep more water in the Bay-Delta and its tributaries for the benefit of the

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104 *Ibid.*

105 This perspective is common among farming communities in the San Joaquin Valley. Mettler, "Reducing Overdraft," 244-245; Meredith T. Niles & Courtney Hammond Wagner, "Farmers Share Their Perspectives on California Water Management and the Sustainable Groundwater Management Act," *California Agriculture* 72, no.1, (January-March) 41.

delta smelt and other fish.[106] The reduced surface water allocations leave farmers in the San Joaquin little choice but to make up the difference by pumping more groundwater.[107]

This explanation, however, is incomplete and potentially misleading. During this same 25-year period, agriculture in the San Joaquin Valley underwent a fundamental change in terms of the types of crops that are grown there. Although the region continues to produce a wide variety of fruits and vegetables, many farmers switched from row crops to nuts – mostly almonds (*prunus dulcis*) and pistachios (*pistacia vera*) – because they generate significantly more profit per-acre.[108] One farmer even described the rapid conversion to almond orchards in the San Joaquin Valley as "California's second gold rush."[109] Unfortunately, however, almonds and pistachios also need a great deal of water and are considered two of the most water-intensive crops when assessed on a per-unit basis.[110] This is largely because almonds and pistachios, unlike most row crops, grow on trees that must be irrigated all year, every year.[111] In other words, nut orchards never go fallow and need constant water-maintenance.

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106 *Ibid.*

107 Fritz, "Shoring Up SGMA," 3; Niles and Wagner, "Farmers Share Their Perspectives," 40;. See also, Kelsey, et al., "Groundwater Sustainability in the San Joaquin Valley," 72, no. 3, 151 (San Joaquin Valley agriculture require large imports of surface water and an annual average groundwater overdraft of 2 million acre-feet).

108 Carle, *Introduction to Water in California,* 170. See also, Cal. Dep't of Food and Agric., California Agricultural Statistics Review 2014-2015 (2015), 2, 7, https://www.cdfa.ca.gov/statistics/PDFs/2015Report. Pdf. See also, Ashley Mettler, "Reducing Overdraft," 243 ("California-grown almonds are the State's second most valuable crop and its top agricultural export. However, almonds also require up to 10 percent of the annual water supply."). See also, DiMento, "The Shape of Groundwater Law," 364-393, 371 ("Small farmer were concerned about their ability to compete with large water users, some of which were 'flipping' land for high-cost crops such as almonds.")

109 Niles and Wagner, "Farmers Share Their Perspectives," 40.

110 *Ibid.*

111 *Ibid.*

The transition to nut growing was breathtaking in its speed and scope. In 1995, for example, approximately 485,000 acres of farmland in California were dedicated to almonds, almost all of it in the San Joaquin Valley.[112] By 2005, that figure had jumped to 700,000 while acreage for virtually every other crop (except pistachios) remained relatively constant or went down.[113] The number of almond acres continued to increase every single year, rain or shine, drought or no drought, from 2005 to 2015, despite significant cuts in surface water deliveries and growing evidence that the groundwater basins within the Valley were being depleted at an alarming rate and causing adverse impacts to residential and municipal wells.[114] According to the California Department of Agriculture, the upward trend of almond acreage has continued and reached 1,390,000 in 2018 (the last full year of available data).[115]

This statement is difficult to square with the requirements of SGMA, which, in part, are intended to *reduce* groundwater depletion in the San Joaquin Valley. Experts now estimate that almonds consume more than 10% of all water in California.[116] Yet, due to SGMA's focus on *local* management of groundwater basins, most of the municipal and residential users in the state have no input in the preparation of the GSPs or how they will be

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112 2018 California Almond Acreage Report, California Department of Food and Agriculture, April 24, 2019, 8.

113 *Ibid.*

114 Justin Gillis and Matt Richtel, "Beneath California Crops, Groundwater Crisis Grows," *The New York Times,* April 6, 2015, http://www.nytimes.com/2015/04/06/science/beneath-california-crops-groundwater-crisis-grows.html? R=0; Carle, *Introduction to Water in California,* 170; Carle, *California Dream,* 201. See also, *Water & Power*.

115 2018 Almond Acreage Report, 1.

116 Mettler, "Reducing Overdraft," 240; Eric Holthaus, "Thirsty West: 10 Percent of California's Water Goes to Almond Farming," *Slate*, May 14, 2014, http://www.slate.com/articles/technology/future tense/2014/05/ 10 percent of California s water goes to almond farming.html.

implemented.[117] Those decisions are left to the same people who own and operate the almond orchards and other farms that overlie the San Joaquin Valley aquifers.[118]

Pistachios in California have followed a trajectory similar to that of almonds. Few farmers grew pistachios prior to the 1990s, but demand for the nut, especially in Asia, brought high profit margins, which led growers to alter their crop mixes and convert significant acreage to pistachio orchards.[119] Like the almond growers, pistachio farmers did not cut back production when surface water became scarce; they simply pumped more groundwater and continued to plant more trees.[120] As a result, pistachio acreage in California (most of it in the San Joaquin Valley) increased from 1,700 in 1977 to 178,000 in 2012.[121] As of 2018, approximately 294,000 acres of California farmland are dedicated to pistachios, and together these pistachio acres consume hundreds of thousands of acre-feet of water per year, much of it drawn from underground aquifers using unmetered pumps.[122] In 2019, the American Pistachio Growers announced that as of 2026 pistachio acreage in California will increase to approximately 392,000.[123]

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117 Dyble, "Aquifers and Democracy," 1510.

118 *Ibid.* See also, Keats and Tu, "Not all Water Stored Underground is Groundwater," 96.

119 Carle, *Introduction to Water in California,* 170.

120 Daniel Geisseler and William R. Horwath, "Pistachio Production in California," California Department of Food and Agriculture and UC Davis, June 2018.

121 *Ibid.*; see also, Carle, *Introduction to Water in California,* 170.

122 Gill, "Groundwater Managed," 38, citing Richard Frank and David Aladjem,"Sharing Groundwater: Legal Issues and Challenges," UC Davis Groundwater Policy Seminar, (January 26, 2015), http://groundwater.ucdavis.edu/SGMA/; see also, Martinez, et al., "Upstream, Midstream, and Downstream," 305 (vast majority of groundwater wells in California are not metered).

123 U.S. Pistachio Future Projections, 2019 to 2026, 2, www.americanpistachios.org.

In a report released in March 2019, the DWR criticized almond and pistachio growers for their disproportionate impact on groundwater levels in the Kern basin, one of the most heavily farmed areas of the San Joaquin Valley.[124] According to the report, groundwater pumping for almonds and pistachios had so depleted the aquifers that the land supporting the nearby California Aqueduct has subsided, causing damage to the aqueduct itself.[125] Ironically, it is the California Aqueduct that brings surface water from the Bay-Delta to the farms and nut orchards of the San Joaquin Valley.

In an era of climate change, longer and more severe droughts, reduced surface water deliveries from the Bay-Delta, projected population increases, and chronic groundwater overdraft conditions,[126] it seems irrational not to question whether the sharp rise in almond and pistachio cultivation in California since 1990 needs to be checked and perhaps reversed.

Yet, none of the GSPs for the almond and pistachio growing regions recommend that this option be investigated. And nothing in SGMA requires a different approach or result, which means that little will change in the short- and medium-term. Meanwhile, a significant portion of California's surface water and groundwater will continue to be used for two nuts that are neither dietary staples nor major domestic use crops. The question is, why don't the GSAs within the various subbasins of the San Joaquin Valley take advantage of the authority granted to them under SGMA and adopt GSPs with measures that encourage (or demand)

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124 Lois Henry, "Nuts Getting a Bad Rap for Sinking the California Aqueduct," January 19, 2020, https://www.bakersfield.com/news/lois-henry-nuts-getting-a-bad-rap-for-sinking-the-california-aqueduct/article_e2491866-39ad-11ea-8fed-43646f71b24b.html

125 *Ibid.*

126 Perona, "A Dry Century in California," 642-643.

less water-intensive crop mixes?[127] As discussed in Chapter 4, below, the answer is complicated, but relates to the fact that SGMA expressly keeps intact existing water rights and continues to allow groundwater pumpers to seek adjudication of groundwater basins.

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[127] See Kelsey, et al., “Groundwater Sustainability in the San Joaquin Valley,” 152 (suggesting that returning to more water-efficient crop mixes will be necessary to achieve sustainability in the San Joaquin Valley).

Chapter 2: Origins, Goals, and Requirements of SGMA

A. The Drought of 2011-2014 and Passage of SGMA

In 2011, California entered into yet another drought, though no one knew at the time how long it would last or how severe it would become. After three years, the drought had not abated; it had only gotten worse, and farmers throughout California were desperate for water. Deliveries from the CVP and SWP were sharply curtailed, which forced farmers to cover the shortfall by pumping more groundwater, even if it meant drilling deeper wells and/or adversely affecting fellow water rights holders. Not surprisingly, this led to extreme overdraft conditions in the Central Valley, which is comprised of the Sacramento Valley north of the Bay-Delta and the San Joaquin Valley south of the Bay-Delta. To put this in perspective, between 2011 and 2014, groundwater levels in some subbasins dropped more than 100 feet, and "the Sacramento and San Joaquin river basins lost 4 trillion gallons of water every year."[128]

By 2014, the situation had become dire, yet the State Water Resources Board and DWR had no effective regulatory tools to address the groundwater overdraft problem in a comprehensive or systematic way. Then, the California Legislature quickly responded by drafting, revising, and passing three related bills – AB 1739, SB 1319, and SB 1168[129] – that together formed the Sustainable Groundwater Management Act of 2014 (SGMA).[130] The speed at which the bills were passed, however, should not be interpreted to mean there was

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128 Carle, *Introduction to Water in California,"* 179.

129 Kiparsky, et al., 3.

130 Justin Brown, "Uncertainty Below," 63.

general agreement among California legislators regarding the content or scope of the proposed law. There was, in fact, significant differences of opinion as to whether and how the State, for the first time in its history, should regulate ground water extraction, use, and management. SGMA, then, was the product of compromise, not consensus.

B. SGMA's Goals and Requirements

The statute itself is lengthy and complex, but its basic tenets are straight-forward. First, SGMA is linked to the findings of DWR Bulletin 118, which identifies 127 groundwater subbasins that the state considers "medium-high to high priority" due to the subbasins' chronic overdraft.[131] These 127 subbasins provide approximately 95% of all groundwater used in the state.[132] In addition, the DWR considers 21 of these 127 subbasins to be "critical" and subject to SGMA's early deadline of January 31, 2020.[133]

Second, SGMA is intended to facilitate "sustainable groundwater management", which the statute defines as "[t]he management and use of groundwater in a manner that can be maintained during the planning implementation horizon without causing undesirable results."[134] SGMA identifies six specific "undesirable results" that must be avoided or eliminated before an overdrafted subbasin is deemed sustainable. These consist of the following:

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131 Leahy, "Desperate Times Call for Sensible Measures," 17-18.

132 "Initial Groundwater Basin Prioritization Under the SGM Act," Cal. Dept. of Water Resources, http://www.water.ca.gov/groundwater/sgm/SGMBasinPriority.cfm (last modified January 15, 2015).

133 *Ibid.,* 34-35.

134 Cal. Water Code § 10721(u).

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon;

(2) Significant and unreasonable reduction in groundwater storage;

(3) Significant and unreasonable seawater intrusion;

(4) Significant and unreasonable water quality degradation;

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses; and

(6) Significant and unreasonable impacts on beneficial uses of interconnected surface waters.[135]

More specifically, SGMA requires that each critically overdrafted subbasin achieve "sustainable yield" [136], which the statute defines as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus that can be withdrawn annually from a groundwater supply without causing an undesirable result."[137]

Third, SGMA does not attempt to address the six undesirable results listed in the statute in a centralized or "top-down" fashion. On the contrary, SGMA seeks to achieve groundwater sustainability through a subbasin-by-subbasin approach, with local water agencies controlling the regulation of groundwater use and the larger sustainability effort. [138]

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135 Cal. Water Code § 10721(x).

136 Nell Green Nylen, Michael Kiparsky, Kelly Archer, Kurt Schnier, and Holly Doremus, "Trading Sustainably: Critical Considerations for Local Groundwater Markets Under the Sustainable Groundwater Management Act," *Center for Law, Energy & the Environment,* UC Berkeley School of Law, Berkeley, CA (2017): 12. See also, Cal. Water Code § 10721(w) (defining "sustainable yield").

137 Cal. Water Code § 10721(w).

138 Kiparsky, et al., "The Importance of Institutional Design," 2.

This emphasis on local control is not unique to SGMA. It is a continuation of the State's long-held position that groundwater is a local resource best managed by the people most familiar with the conditions affecting the subbasin in question. There are many reasons to examine groundwater use on a local level. For example, each subbasin has its own soil and hydrogeologic characteristics that dictate how much water can be effectively and sustainably extracted for irrigation and other uses. Likewise, each subbasin is subject to unique demands on the groundwater resources it provides. The issue, however, is whether local input and local concerns should be converted into local control. SGMA – perhaps as a compromise to farming interests in the Central Valley – takes the position that local governance of groundwater is the best way to address overdraft and generate ideas for achieving sustainable yield.

The focus on local control does not mean that SGMA provides no role for SWRB or DWR. These agencies oversee the overall sustainability effort and will step in if the local agencies fail to meet their duties under the statute. Still, this kind of "backstop" position does not give SWRB or DWR many opportunities to develop groundwater management strategies on a regional or statewide basis. SWRB and DWR are passive in this regard. Under SGMA, the entire process is driven by local interests, which leaves open the potential for "industry capture" and other governance difficulties.[139] The statute's only real enforcement mechanisms are the provisions that give the DWR the right to (i) assume the role of GSA for groundwater basins where no other agency steps forward to take on that responsibility, (ii) reject any GSP that does not provide an adequate and clear pathway to

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139 Fritz, "Shoring Up SGMA," 3.

groundwater sustainability, and (iii) prepare replacement GSPs for those deemed insufficient.[140] Even the powers granted under these provisions, however, are intended to be used only in extreme situations, and only after giving the non-compliant GSAs an opportunity to fix their GSPs and bring them up to standard.[141] SGMA is also silent as to what power the DWR has to intercede in those cases where GSAs fail to implement the measures identified in their GSPs or where the measures are not having their intended effect and the groundwater basin makes no discernible progress toward sustainability.

SGMA facilitates local control by requiring existing local agencies, such as counties and irrigation districts, to form Groundwater Sustainability Agencies (GSAs) for purposes of exercising regulatory jurisdiction over the groundwater subbasin(s) in their respective areas. Establishing a GSA can be complicated, however, because the existing boundaries of counties, irrigation districts, and water agencies do not conform to the contours and physical limits of the affected groundwater subbasin. For, example, some large subbasins underlie the jurisdictions of multiple regulatory entities. In such cases, the various overlying entities typically join together and form a single GSA. In other cases, a governmental agency, such as a county, may have jurisdiction over pieces of more than one groundwater subbasin, which means it may be a member of multiple GSAs.

C. Content Requirements for Groundwater Sustainability Plans

A GSA's primary responsibility is preparing the Groundwater Sustainability Plan (GSP) for the subbasin within its control. SGMA requires that each GSP describe the conditions within the subbasin, especially as they relate to the six undesirable results – i.e.,

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140 Leahy, "Desperate Times Call for Sensible Measures," 36; Cal. Water Code § 10735.2.

141 Cal. Water Code § 10735.2.

groundwater levels, groundwater storage, seawater intrusion, water quality, land subsidence, and impacts to interconnected surface waters. GSPs also must include "water budgets", which are an "accounting of the total groundwater and surface water entering and leaving a basin, including the changes in the amount of water stored."[142] The water budgets are used to assess the extent to which the subbasin is overdrafted. This information will then determine how much water must be conserved in, or added to, the subbasin to reach sustainable yield.

Finally, the GSP are required to identify "projects" and "management actions" which, if implemented, would either bring more water into the subbasin or reduce extractions from the subbasin. The term "projects" typically refers to infrastructure, such as new canals or reservoirs, but can also include things like water transfers and stormwater capture and reuse programs. In most cases, "projects" seek to increase the *supply* of water available to the subbasin, either in the form of direct recharge or in lieu use.[143] By contrast, "management actions" tend to be measures that impose changes in groundwater pumping practices or behaviors. After describing the proposed projects and management actions and calculating how much water each one will add or conserve, the GSP then provides a cost estimate for each measure. Some of the projects and management actions described in a GSP are very expensive, costing hundreds of millions of dollars.

D. Key Omissions From SGMA

It is equally important to understand what SGMA does ***not*** do. SGMA does not alter or diminish any existing water rights, whether they apply to surface water or groundwater.

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[142] Cal. Water Code § 10721(y).

[143] SGMA defines "in-lieu use" as "the use of surface water by persons that could otherwise extract groundwater in order to leave groundwater in the basin. Cal. Water Code § 10721(m).

Nor does SGMA eliminate or affect a water user's ability to seek adjudication of his or her water rights through a court proceeding; this right to adjudication exists even in subbasins that have adopted GSPs. SGMA does not impose or mandate groundwater pumping limits or fees, though it allows GSAs to adopt such limits and fees if they wish.[144] In addition, SGMA does not require that all GSAs use the same groundwater monitoring data. This is likely because data collection can be expensive, and not all GSAs have the financial ability to fund the more intensive groundwater monitoring programs. The downside risk of this concession to economic differences among the various GSAs, however, is that the information which ultimately gets reported to the DWR will be uneven in terms of scope and quality. Finally, SGMA provides no funding for implementing the projects and measures described in the various GSPs. This would appear to be a major hurdle to SGMA's success; yet even those who very much want to see SGMA succeed tend to downplay this critical issue, as if there will always be hundreds of millions of dollars available in the form of grants, loans, and bonds.[145]

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144 Gill, "Groundwater Managed," 31.

145 See, e.g., Nylen, et al. "Trading Sustainably," 41.

Chapter 3: Groundwater Sustainability Plans: Blueprint for Long-term Resource Conservation or Paper Mask for Hiding Continuation of Past Behaviors

As indicated above, the core of SGMA and the key to its success are the Groundwater Sustainability Plans (GSPs) that each GSA must prepare, either individually or jointly in cooperation with fellow GSAs that share the same groundwater subbasin. The GSPs not only describe the hydrological conditions of the subbasin, they also identify the particular overdraft problems that have caused the DWR to place the subbasin on the critical list. Most importantly, the GSPs assess those overdraft problems and devise potential solutions to them, all with a view of achieving groundwater sustainability by the statutory deadline, which is 2040. Generally speaking, all of the GSPs so far submitted to the state follow the same format and include much of the same information, though the depth of that information and the quality of the data falls along a wide spectrum, depending on the amount of money a given GSA decided it could spend on monitoring.[146] Despite these basic similarities, the GSPs differ substantially in terms of their content. The GSPs reflect the unique nature of each subbasin and the special demands it must meet. When it comes to identifying measures for addressing overdraft, some GSPs express great optimism, often because the GSA believes it has access to replacement water that can be used to recharge the diminished aquifers without altering existing pumping behavior among the subbasin's users. Other GSPs are less hopeful, at least in terms of locating recharge sources sufficient to maintain current levels of agricultural production and municipal use.

In the discussion below, I analyze six of the 21 GSPs submitted to the DWR by the January 31, 2020 deadline. Three of the GSPs cover groundwater subbasins in the San

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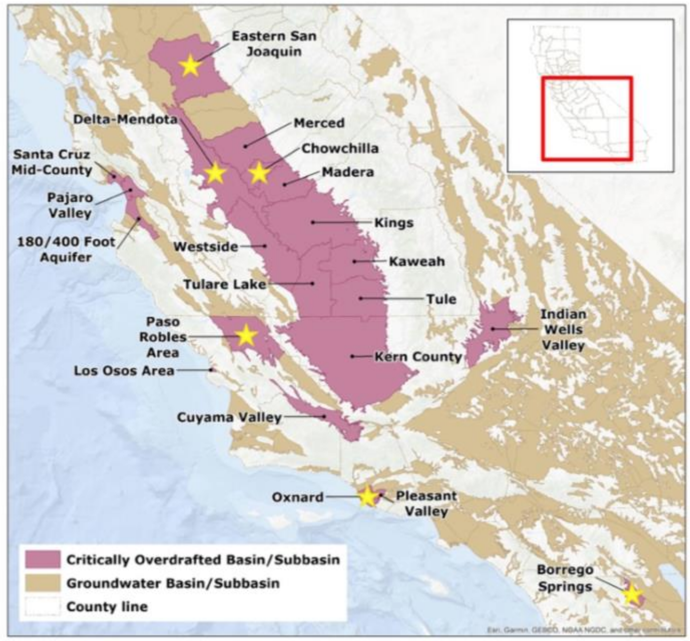
[146] Martinez, et al., "Upstream, Midstream, and Downstream," 305; J. Gage Marchini, "Water Connecting the 'Drops' of California Water Data: Chapter 506: The Open and Transparent Water Data Act," 48 *The U. Of Pac. L. Rev*. (2017): 796.

Joaquin Valley – the Delta-Mendota GSP, the Chowchilla GSP, and the Eastern San Joaquin GSP. A fourth GSP covers the important wine-producing area in Paso Robles, located in San Luis Obispo County, about 45 miles inland of the Pacific Ocean. The fifth GSP addresses the subbasin near Oxnard in Ventura County, which is hydraulically connected to both the Santa Clara River and the Pacific Ocean. The sixth and final GSP analyzed here is the one developed for the Borrego Springs subbasin, which underlies a desert region east of San Diego.[147]

California's Critically Overdrafted Groundwater Basins



Map created from B118 Groundwater Basin Boundaries Published 02/11/2019. This map published 01/2020.

Basin/ Subbasin Number	Basin/Subbasin Name		
3-001	Santa Cruz Mid-County	5-022.06	San Joaquin Valley - Madera
3-002.01	Corralitos - Pajaro Valley*	5-022.07	San Joaquin Valley - Delta-Mendota
3-004.01	Salinas Valley - 180/400 Foot Aquifer	5-022.08	San Joaquin Valley - Kings
3-004.06	Salinas Valley - Paso Robles Area	5-022.09	San Joaquin Valley - Westside
3-008.01	Los Osos Valley - Los Osos Area**	5-022.11	San Joaquin Valley - Kaweah
3-013	Cuyama Valley	5-022.12	San Joaquin Valley - Tulare Lake
4-004.02	Santa Clara River Valley - Oxnard	5-022.13	San Joaquin Valley - Tule
4-006	Pleasant Valley	5-022.14	San Joaquin Valley - Kern County
5-022.01	San Joaquin Valley - Eastern San Joaquin	6-054	Indian Wells Valley
5-022.04	San Joaquin Valley - Merced	7-024.01	Borrego Valley - Borrego Springs
5-022.05	San Joaquin Valley - Chowchilla		

* Approved Alternative to Groundwater Sustainability Plan
** Adjudicated, No Groundwater Sustainability Plan Required

CALIFORNIA DEPARTMENT OF WATER RESOURCES

What emerges from these GSPs is an interesting and potentially distressing pattern. Due to their existing access to CVP and SWP water and the infrastructure to move it, the GSAs that oversee the various subbasins in the San Joaquin Valley believe they can meet their SGMA mandate by "developing" more surface water resources, which can then either

[147] California Department of Water Resources, "California's Critically Overdrafted Groundwater Basins", https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Basin-Prioritization/Files/CODBasins_websitemapPAO_a_20y.pdf?la=en&hash=47CC79C7DFDE8E2D154EC65B3F94EF7E8B36502F. The link was accessed from this page, "Basin Priorization": https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization.

recharge groundwater pumped from the subbasin or be used in place of that water. The GSAs located outside the Central Valley, and thus beyond the reach of the CVP and SWP system, have fewer options for groundwater recharge or "in lieu" water sources. They have no choice but to cut, sometimes substantially, the amount of water pumped from the ground; and this means fallowing otherwise productive crop fields. The result of this disparity among GSAs and the subbasins they control is a transfer of economic power from the outlying areas of California's agricultural industry to the already-dominant San Joaquin Valley. In short, SGMA may result in a further widening of the gap between the "haves" and the "have-nots" of California farming. This potential outcome, if it comes to pass, will create significant challenges for the DWR and the California legislature, as it would undermine the state's long-held position that small-scale farming is just as important as corporate-scale agribusiness.[148]

A. Case Study 1: Northern and Central Delta-Mendota Subbasin GSP

1. Description of the Subbasin

The Northern and Central Delta-Mendota GSP covers a portion of the Delta Mendota Subbasin, one of 21 alluvial basins and subbasins that the DWR identified as being in critical overdraft.[149] The Subbasin encompasses an area of approximately 765,000 acres, of which 316,000 acres are located in the Northern and Central Delta-Mendota regions.[150] Because the

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148 See, Jessica Rudnick, Alyssa DeVincentis, Linda Esteli Mendez-Barrientos, "The Sustainable Groundwater Management Act Challenges the Diversity of California Farms," *California Agriculture,* 70, no. 4 (October-December 2016) 172.

149 "Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Regions," ES-1.

150 *Ibid.,* 1-2.

Delta-Mendota Subbasin is quite large and complex, the various GSAs in this region decided to prepare not one but six (6) GSPs for it, each addressing a specific locality within the subbasin.[151] The Northern and Central Delta-Mendota GSP is one of those six. As described in the GSP, the Delta-Mendota Subbasin is one of 19 subbasins that comprise the San Joaquin Valley Groundwater Basin.[152] Its neighboring subbasins include: Tracy, Easter San Joaquin, Modesto, Turlock, Merced, Chowchilla, Madera, Kings, and Westside.[153] The Northern and Central Delta-Mendota GSP encompasses the area along the northern boundary of the subbasin and lies within the counties of San Joaquin, Stanislaus, Merced, Fresno, and San Benito.[154]

Agriculture is the primary land use type within this portion of the Delta-Mendota region.[155] There are few towns in the region, the largest being the City of Patterson, population 22,124. Farms in this area are served by the Delta-Mendota Canal and the California Aqueduct, which extend nearly the full length of the planning area and "provide water from the CVP and SWP, respectively, to water districts, irrigation districts, and private property owners south of the Sacramento-San Joaquin Delta and throughout the Delta-Mendota Subbasin."[156] This area also has access to surface water from the San Joaquin River to the east and the Kings River to the south.[157] According to the GSP, groundwater in the

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[151] *Ibid.*, ES-1.

[152] *Ibid.,* ES-2.

[153] *Ibid.*

[154] *Ibid.*

[155] *Ibid.*

[156] *Ibid.*

[157] *Ibid.*

Northern and Central Delta-Mendota region "is used as a supplemental water supply source by water purveyors throughout the Delta-Mendota Subbasin, with several entities reliant in whole or in part on groundwater as their primary water supply."[158] Due to the importance of groundwater for agricultural production in the region, and to the long history of overdraft within the subbasin itself, numerous water resource monitoring and resource plans have been in place for a number of years. These include the California Statewide Groundwater Elevation Monitoring (CASGEM) program and the Irrigated Lands Regulatory Program (ILRP).[159] In addition, the various county authorities also impose well standards and permitting requirements.[160] This portion of the subbasin also participates in the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program, an initiative to reduce salt and nitrate impacts, restore groundwater quality, and provide safe drinking water.[161] As discussed below, one of the more difficult tasks assigned to the GSP is reducing the salt concentrations in the subbasin's groundwater. Those concentrations have become elevated due to the soil-leaching effect of repeated and heavy irrigation of farmland.[162]

The Northern and Central Delta-Mendota GSP was not produced by a single GSA. Instead, it was developed by the eight GSAs that have partial jurisdiction over the Northern and Central Delta-Mendota Region. To accomplish this task, two committees were established, one representing the Northern region and one the Central region. The two

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158 *Ibid.*

159 *Ibid.*

160 *Ibid.*

161 *Ibid.,* 2-68.

162 *Ibid.,* 5-46.

committees then joined forces to prepare the GSP.[163] The result is a complex governance structure and a GSP with many moving parts.[164] This is largely due to the size of the subbasin itself and the fact that no existing *surface water* irrigation district or agency has jurisdiction over the entire subbasin.[165]

The Delta-Mendota Subbasin is located in the northwestern portion of the San Joaquin Valley Groundwater Basin, which forms the southern portion of California's long Central Valley.[166] The San Joaquin Valley is a "structural trough up to 200 miles long and 70 miles wide filled with up to 32,000 feet of marine and continental sediments deposited during periodic inundation by the Pacific Ocean and by erosion of the surrounding Sierra Nevada and Coast Range Mountains."[167] The subbasin includes two primary geomorphic units – overflow lands and alluvial fans/plans.[168] The overflow lands are located in the southeastern portion of the Subbasin and are composed of poorly draining soils and a shallow water table. The soil has low hydraulic conductivity, which makes it largely unsuitable for recharging groundwater aquifers.[169] By contrast, the alluvial fans and plains have much better drainage conditions, "with sediments comprised of coalescing and somewhat coarser-grained alluvial fan materials deposited by higher-energy streams flowing out of the Coast Range."[170]

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163 *Ibid.,* 3-1.

164 *Ibid.,* 3-33—3-34.

165 *Ibid*.

166 *Ibid.,* 2-1—2-7.

167 *Ibid.,* 5-2.

168 *Ibid.,* 5-8.

169 *Ibid.*

170 *Ibid.*

The Delta-Mendota Subbasin consists of three sources of groundwater: a zone of very shallow groundwater with a depth of 0 to 10 feet, and two large aquifers, an upper and a lower, that are part of the Tulare Formation.[171] As the GSP explains, the Tulare Formation "is hydrologically the most important geological formation in the Delta-Mendota Subbasin because it contains most of the fresh water-bearing deposits."[172] The Upper Aquifer is separated from the Lower Aquifer by the Corcoran Clay, "a diatomaceous clay or silty clay of lake bed origin which is a prominent aquitard in the San Joaquin Valley . . ."[173] According to the Central Valley Hydrologic Model 2, which was developed by the United State Geological Survey, groundwater storage is greatest within the Upper Aquifer, while the Lower Aquifer has "considerably smaller specific storage values."[174] Most of the *natural* recharge that occurs in the Subbasin takes place in the alluvial fan apex areas along the Coast Range stream channels.[175]

With regard to groundwater quality, the primary concerns of the Delta-Mendota Subbasin are nitrates, total dissolved solids (TDS), and pesticides, though the southern portions of the subbasin also have naturally-occurring selenium and boron that must be managed.[176] TDS includes salt, so TDS figures are typically used as an indicator of groundwater salinity,[177] which is a significant concern not only for purposes of drinking water but for irrigation, since some crops, such as almonds, are not particularly salt-

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171 *Ibid.,* 5-12—5-13.

172 *Ibid.,* 5-8.

173 *Ibid.*

174 *Ibid.,* 5-15.

175 *Ibid.,* 5-8.

176 *Ibid.,*5-34, 5-63

177 *Ibid.,* 5-46.

tolerant.[178] Generally speaking, where drainage is poor, TDS concentrations will increase over time.[179]

The quality of the irrigation drainage or agricultural return water is important since downward percolation of applied irrigation water is the primary mechanism for recharging the subbasin, though some natural recharge occurs along the mountain front along the subbasin's western boundary. Within the Northern and Central Delta-Mendota regions, recharge potential is uneven, mostly due to differences in soil make up. According to the GSP, approximately 103,524 acres of the region (36%) possess moderately good to excellent recharge properties.[180] The remaining 185,261 acres (64%) possess moderately poor to very poor recharge properties.[181] This means that any GSP "sustainability" measure that involves percolation recharge will be limited to approximately one-third of the subbasin. In addition, the Corcoran Clay restricts vertical flow between the Upper and Lower Aquifers; as a result, recharge of the Lower Aquifer is largely limited to those small areas where the Corcoran Clay is not present.[182]

As noted above, the farms and towns that overlie the Delta-Mendota Subbasin receive most of their water from the CVP, with a small portion coming from SWP as well. Groundwater is used to supplement these surface water supplies, except in those few locations where it is the sole water source.

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178 Devinder Sandhu and Biswa R. Acharya, "Mechanistic Insight Into the Salt Tolerance of Almonds, *Progressive Crop Consultant*, October 3, 2019.

179 *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Region,* 5-34.

180 *Ibid.,* 5-83.

181 *Ibid.*

182 *Ibid.,* 5-84.

2. Conditions within the Subbasin

One of the fundamental purposes of any GSP is to establish the baseline groundwater capacity and use levels within the affected basin or subbasin. Only after this information is developed can the GSA prepare an accurate and meaningful "water budget". In evaluating the subbasin's condition, the GSP for Northern and Central Delta-Mendota focuses on six parameters: groundwater elevations, groundwater storage, groundwater quality, land subsidence, interconnected surface water systems, and groundwater dependent ecosystems (GDEs).[183] Note that these six parameters largely track the six "undesirable results" that SGMA requires each GSA to avoid. The only undesirable result not considered in the GSP is seawater intrusion, and this is because the subbasin has no hydraulic connection to the ocean.[184]

- *Groundwater Levels*

For this GSP, groundwater elevation data were available for the time period between 1930 and 2018; for the period between 1850 (statehood) and 1930, the data is sparse, except historical accounts of how land in this area was used.[185] For example, the GSP explains that prior to 1850, most farming in the San Joaquin Valley was either rain-fed or irrigated through diversions from perennial streams.[186] After the railroads came through, demand for agricultural goods increased substantially, driving more extensive efforts to divert surface water from the San Joaquin and Kings Rivers. Improved access to irrigation, however, came

183 *Ibid.,* 5-89.

184 *Ibid.,* 5-121.

185 *Ibid.,* 5-90.
186 *Ibid.,* 5-90—5-91.

at a cost, as many farms did not have adequate means of draining away the spent agricultural water. "By the 1890s and early 1900s, sizable areas of the San Joaquin Valley were being forced out of production by salt accumulation and shallow water tables."[187] The introduction of reliable electric pumps offered a way out of this problem by making deeper, untainted groundwater resources available for irrigation.[188] In what has become a cycle throughout much of California, however, improved access to groundwater led to over-pumping, a drop in groundwater levels, and the leaching of salts.[189] The GSP describes the situation after 1920 as follows:

> Groundwater pumping for irrigation from around 1920 to 1950 drew the water table down as much as 200 feet in areas along the westside of the San Joaquin River (Belitz and Heimes, 1990). Declining water tables were causing higher pumping costs and land subsidence, and farmers were finding poorer quality water as water tables continued to decline. These issues created a desire for new surface water supplies, which would be fulfilled by the Central Valley Project.[190]

The GSP goes on to explain that the Delta-Mendota region began receiving surface water deliveries from the CVP in the 1950s and from the SWP in the 1970s, resulting in a reduction in groundwater pumping and bringing temporary relief to the subbasin.[191] But this did not last. During the droughts of 1976-1977 and 1987-1992, CVP and SWP water deliveries were curtailed, causing farmers to pump more groundwater to meet irrigation demands and drawing down water levels to historic lows.[192] Fortunately, following the end of drought

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187 *Ibid.,* 5-91.

188 *Ibid.*

189 *Ibid.*

190 *Ibid.*

191 *Ibid.,* 5-91—5-92.

192 *Ibid.,* 5-92.

conditions, the aquifers recharged and recovered fairly quickly, in part because surface water deliveries returned to normal or near-normal levels.[193]

This pattern of temporary drawdown followed by recovery of the subbasin when post-drought conditions return is well-established in the available hydrographs. Moreover, those who prepared the GSP believe it will continue and therefore must be considered when devising groundwater sustainability measures: "This pattern of increased drought-driven groundwater pumping, accompanied by declining groundwater elevations, followed by recovery, is a predominant factor to be considered in the sustainable management of the Delta-Mendota Subbasin."[194]

The data provided in the GSP, however, tells a slightly different story. For example, when discussing the Lower Aquifer water levels, the GSP acknowledges that there was a "data gap" from the mid-1980s through 2010, but that "after 2010 levels have a steep decline through 2016."[195] The GSP's discussion of water levels in the Upper Aquifer provides a more confusing and mixed message. On one hand, the GSP indicates that "[w]ells in the Upper Aquifer exhibit decreasing trends to somewhat stable water levels until the mid-1980s, and increasing or stable water levels thereafter."[196] Yet, the GSP later states that "[d]ue to insufficient data, groundwater elevation contour maps for the Lower Aquifer for the seasonal high and low (Spring 2013 and Fall 2013, respectively) could not be accurately prepared."[197]

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193 *Ibid.*

194 *Ibid.*

195 *Ibid.,* 5-93.

196 *Ibid.*

197 *Ibid.,* 5-94.

And where accurate groundwater contour data *is* available, those data show that certain portions of the subbasin have experienced significant drops in groundwater level – as much as 138 feet in some locations.[198] The GSP also acknowledges that "the effects of pumping and the resulting depression of groundwater elevations within the Upper Aquifer in the SJRIP (San Joaquin River Improvement Project) vicinity may result in a more northernly gradient, instead of the natural northeastern flow direction."[199]

One of the shortcomings of the GSP's assessment of groundwater levels is that it tends to focus on post-drought data. That is, the assessment is skewed toward the recovery side of the discussion, where the data show that a return to normal rainfall and snow melt not only improves recharge of the aquifer but also increases surface water deliveries. Under post-drought conditions, there is always an uptick, sometimes a substantial one, in the groundwater levels, at least when measured against levels recorded during the drought period. The problem to be addressed, however, is how to sustain groundwater levels during what are expected to be longer, more severe, and more frequent droughts. The GSP does not really grapple with this issue. Rather, it tends to assume that post-drought recharge, along with restored surface water deliveries, will always return to reset the balance and bring groundwater levels back to normal.

- *Groundwater Storage*

Groundwater levels and groundwater storage, while related, are not the same thing. Whereas groundwater levels are a measurement of the depth one must go before encountering water in a given aquifer or basin, groundwater storage is a measurement of how

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198 *Ibid.,* 5-94—5-95.

199 *Ibid.,* 5-93.

much water actually exists in that aquifer or basin. The Northern and Central Delta-Mendota GSP only had groundwater storage data going back to 2003, but those data are not encouraging and tend to portray a situation that is different from what some of the groundwater level data suggest. Specifically, the GSP states that storage "is negative for 12 out of the 16 years and negative for 4 out of the 8 Wet and Average water year types in both the Upper and Lower Aquifers."[200] Thus, even during wet conditions and improved recharge, groundwater storage in the Upper and Lower Aquifers shows a declining trend.[201]

Although the GSP does not provide a reason for this apparent anomaly, the answer is likely that inelastic land subsidence, which is a direct impact of over-pumping during drought conditions, has collapsed significant portions of the subbasin, making them no longer capable of storing water. This results in a substantial loss of cumulative storage capacity in the subbasin: "Cumulative change in storage declined more rapidly in the Upper Aquifer compared to the Lower Aquifer, declining about 830,000 acre-feet (AF) in the Upper Aquifer and 160,000 feet in the Lower Aquifer between WY 2003 and WY2018."[202] Given that most users draw their water from the Upper Aquifer, this cumulative loss of storage should be a grave concern.

- *Groundwater Quality*

The GSP notes that "[g]roundwater quality is a primary factor in groundwater reliability," and that "constituents of concern, both natural and anthropogenic, can impact human health and agricultural production."[203] The GSP then identifies the "constituents of

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200 *Ibid.,* 5-119.

201 *Ibid.*

202 *Ibid.*

203 *Ibid.,* 5-121.

concern" within the Northern and Central Delta-Mendota Regions as nitrate, total dissolved solids (TDS), and boron, each of which is subject to Water Quality Objectives, for both drinking water and agricultural uses, established by the Central Valley Regional Water Quality Control Board.[204] The subbasin also contains detectable levels of arsenic, selenium, and hexavalent chromium, but according to the GSP, these constituents occur naturally in the Subbasin, are not linked to groundwater levels, and, for this reason, "are not considered manageable as part of this GSP . . ."[205] This is a surprising statement since these constituents, even if naturally-occurring, tend to increase in concentration when spent irrigation water remains in the aquifer and is reapplied to crops. It is for this very reason that farmers, working with local, state, and federal regulatory agencies, are constantly trying to find safe places to dispose or store "ag-return" water with excessive concentrations of selenium.[206] More important, if the groundwater in the subbasin has levels of arsenic, selenium, and/or hexavalent chromium at levels beyond established thresholds, it does not matter whether the constituents are naturally-occurring or man-made. In either case, the groundwater is unusable.

With regard to the three "manageable" constituents of concern – nitrate, TDS (salt), and boron – the GSP determined the following:

- Nitrate concentrations were generally stable and below the Maximum Concentration Level (MCL) of 10 mg/L at most locations in the Upper Aquifer, though some locations showed exceedances. The Lower Aquifer had

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204 *Ibid.*

205 *Ibid.*

206 Carle, "Introduction to Water in California," 167-169.

more wells showing nitrate concentrations above 10 mg/L. Generally, there are locations within both the Upper and Lower Aquifers where nitrate levels are trending upward at a statistically significant rate.[207]

- TDS (salt) concentrations follow a pattern similar to that of nitrate concentrations. Some areas of the subbasin show stable TDS concentrations below the MCL threshold of 1,000 mg/L.[208] In most of the subbasin, however, the TDS concentrations are consistently above 1,000 m/L, often by a wide margin.[209] Perhaps more importantly, both the Upper and Lower Aquifers show "statistically significant temporal trends in TDS concentrations."[210] These numbers and the trends they reveal are important from an agricultural perspective, since the primary cash crop in the Delta-Mendota subbasin are almonds, which do not tolerate salt concentrations in excess of 1,000 mg/L.[211]
- Boron levels, if too high, can also have adverse impacts on crop yield. Thus, although there is no MCL for boron, the GSP sets an "agricultural goal" for boron of 0.7 mg/L.[212] According to the GSP, trends in the Upper Aquifer and Lower Aquifers are "generally stable but relatively high, with some seasonal fluctuations likely resulting from irrigation influences."[213]

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207 *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Regions,* 5-125, 5-135—5-136.

208 *Ibid.,* 5-138.

209 *Ibid.,* 5-138, 5-140—5-141, 5-145.

210 *Ibid.,* 5-139, 5-147—5-148.

211 Sandhu and Acharya, "Mechanistic Insight".

212 *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Region*, 5-150.

213 *Ibid.,* 5-150.

These data suggest that groundwater quality is a significant issue in the Delta-Mendota Subbasin, which may explain why the GSP focuses more on securing and storing more *surface* water than on taking steps to significantly improve the stability of groundwater levels. Simply put, the groundwater in the subbasin is of poorer quality compared to the surface water the GSA hopes to obtain through the various projects described in the GSP. If those surface water enhancements prove successful, farmers and municipalities in the region will no longer have to rely so heavily on groundwater during dry periods.

As discussed in more detail below, the GSP, in its efforts to remedy the *current* groundwater overdraft problems in the North and Central part of the Delta-Mendota Subbasin, again pushes for the development of more surface water resources instead of imposing reductions in groundwater pumping.

- *Seawater Intrusion*

The Delta-Mendota subbasin is not located on or near the coastline, so it does not experience seawater intrusion. Therefore, the GSP does not address it.

- *Land Subsidence and Damage to Surface Infrastructure*

Land subsidence occurs when groundwater levels decline over a long period of time, causing the silt and clay layers (aquitards) to compact. When this happens, the land literally sinks, sometimes by inches, sometimes by yards.[214] This, in turn, causes damage to infrastructure on the land surface, such as roads, canals, pipelines, and dams. Aquifer-system compaction caused by groundwater pumping has resulted in land subsidence throughout the San Joaquin Valley, and the Delta-Mendota subbasin has been among the areas most

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[214] *Ibid.,* 5-155.

affected.[215] For example, land subsidence in Delta-Mendota "has impacted prominent infrastructure of statewide importance, namely the DMC [Delta Mendota Canal] and the California Aqueduct, as well as local canals, causing serious operational, maintenance, and construction-design issues.[216] Subsidence also reduces freeboard and flow capacity in the DMC and California Aqueduct, which has "rippling effects on imported water availability throughout the State."[217] And while some subsidence is reversible (known as "elastic" subsidence), subsidence in much of the Delta-Mendota subbasin is irreversible or "inelastic". As a result, portions of the Subbasin can no longer hold water.[218]

The historical data show that whenever droughts have occurred, groundwater pumping in the Delta-Mendota subbasin increased dramatically, leading to subsidence. Between 1926 and 1980, land in the subbasin dropped approximately 30 feet.[219] Compaction stopped or in some cases was reversed during wet and normal years when surface water deliveries were at or near 100 percent. During the droughts of 1987-1992, 2007-2009, and 2012-2015, surface water deliveries were cut back severely and farmers resorted to aggressive groundwater pumping, causing more subsidence, much of it permanent.[220]

According to the GSP, "subsidence will continue to impact operations of the DMC and California Aqueduct without mitigation."[221] This sets in motion a vicious cycle where

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215 *Ibid.,* 5-154.

216 *Ibid.*

217 *Ibid.*

218 *Ibid.*

219 *Ibid.,* 5-155.

220 *Ibid.,* 5-155—5-156.

221 *Ibid.*, 5-156.

the canal and aqueduct cannot convey the same amount of water as before, resulting in reduced surface water deliveries to farmers in the Subbasin, who then must pump more groundwater to make up for the loss. This draws down groundwater levels even further, causing more compaction and more subsidence.[222] In the Northern & Central Delta-Mendota Region, groundwater is extracted from both the Upper and Lower Aquifers, but the extractions from the Lower Aquifer seem to be responsible for the most serious subsidence conditions. [223]

The available data indicate that subsidence in the Subbasin is not likely to improve, at least not in the near future. This is partly due to farmers converting their fields from row crops to permanent nut orchards and vineyards. As the GSP explains:

> Land use changes in some parts of the San Joaquin Valley are likely to impact future subsidence. Trends toward the planting of permanent crops since 2000, such as vineyards and orchards, and away from non-permanent land uses like rangeland and row crops can result in "demand hardening", which requires stable water supplies to irrigate crops that cannot be fallowed.[224]

Despite recognizing that crop mix and crop choice play a significant role in groundwater pumping behavior, groundwater levels, and land subsidence, the GSP does not recommend or even discuss any program to halt or reverse the conversion of row crop acreage to orchard acreage.

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[222] *Ibid.*

[223] *Ibid.,* 5-127.

[224] *Ibid.,* 5-158.

- *Impacts on Hydraulically Connected Surface Waters and GDEs*

The GSP acknowledges that some surface waters, including the San Joaquin River, are hydraulically connected to groundwater in the Subbasin, at least part of the time.[225] The GSP further recognizes that this hydraulic connection sustains various riparian habitat areas that support a host of sensitive species, including some that are listed as threatened or endangered under state and/or federal law.[226] Yet the GSP does not extensively analyze how and to what extent continued groundwater pumping will affect these species or the habitat they rely on. This is one of the major shortcomings of the GSP, though hardly a unique one.

3. The Subbasin's Water Budget

One of the key components of each GSP is the subbasin "water budget", which is an accounting of water flows into and out of a defined area.[227] These flows are typically broken down in terms of surface water and groundwater, and recorded as total volumes of water transmitted over a given period of time.[228] Each GSP establishes three water budgets for its subbasin: (1) an *historic* water budget based on the amount of water that has flowed in and out of the subbasin over a long span of years, usually 10 or more; (2) a *current* water budget that shows how much water has flowed in and out of the subbasin over the preceding two or three years; and (3) a *future* water budget that estimates the amount of water likely to flow in and out of the subbasin over the next 50 years.[229] The water budgets set the baseline for

225 *Ibid.,* 5-173—5-174.

226 *Ibid.,* 5-176 [Table 5-10]).

227 *Ibid.,* 5-184.

228 *Ibid*.

229 *Ibid.,* 5-186.

determining the subbasin's sustainable yield. Once the sustainable yield figure is known, the GSA can then determine what projects and management measures must be put in place to achieve sustainability by 2040, as required by SGMA.[230]

According to the GSP, Delta-Mendota has historically had a *surface* water budget with average inflows of 718,000 AFY and average outflows of 722,000 AFY.[231] The subbasin's historic *groundwater* budget shows average inflows of 136,000 AFY and average outflows of 204,000 AFY.[232] These number demonstrate that the subbasin has for some time operated at a significant deficit, at least with respect to groundwater volume. It annually consumes/loses an average of 68,000 AFY more groundwater than it takes in. The *current* water budget tells a similar story. While surface inflows (685,000 AFY) and outflows (669,000 AFY) indicate a small net increase, the groundwater inflows (114,000 AFY) are substantially lower than the outflows (203,000 AFY).[233] This results in approximately 88,000 AF of lost groundwater storage each year.[234]

The GSP's *future* water budgets are somewhat curious. The GSP calculates that surface inflows will average 817,000 AFY and outflows 764,000 AFY.[235] The inflow figure is substantially more than the historical average of 718,000 AFY and the current average of 685,000. Yet the GSP does not explain where all of this additional surface water is going to

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230 *Ibid.*

231 *Ibid.,* 5-201.

232 *Ibid.*

233 *Ibid.,* 5-202.

234 *Ibid.*

235 *Ibid.,* 5-204.

come from. The future groundwater numbers are even more striking. Inflows into the aquifers are projected to increase to an average of 169,000 AFY, a jump of more than 30 percent.[236] Again, however, the GSP does not explain what accounts for this increase in groundwater inflows. The GSP also anticipates that over the next 50 years, groundwater outflows will increase to 243,000 AFY on average.[237] This would result in a 50,000 AF loss of storage on average per year.[238] However, during dry some years, the loss of storage will be in excess of 150,000 AFY,[239] which might cause some shallower wells to fail.

The final water budget numbers reflect what surface and groundwater flows will be like in the future after implementation of the GSP's projects and management measures. Surface inflows are anticipated to increase to 830,000 AFY and surface outflows to 778,000 AFY.[240] Groundwater inflows are projected to go up to 181,000 AFY, but outflows are expected to go down from 243,000 to 207,000, presumably as a result of increased surface water supplies.[241] However, even after these proposed projects, the subbasin will still have an average yearly groundwater deficit of 26,000 AFY, and therefore not be on path to sustainability.

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236 *Ibid.,* 5-206.

237 *Ibid.*

238 *Ibid.,* 5-207.

239 *Ibid.*

240 *Ibid.,* 5-216.

241 *Ibid.,* 5-218.

4. Projects and Management Actions

The heart of every GSP is the section that describes the projects and management actions the GSA intends to put in place to achieve sustainability within the subbasin. The Delta-Mendota GSP includes an extensive list of such projects and management actions. Overall, however, the GSP relies much more heavily on projects to secure more surface water (either for direct or in lieu recharge) than it does on measures to manage or reduce groundwater consumption. For example, the GSP discusses 25 potential projects for increasing water supply.[242] These include recycled water collection and reuse projects, including agricultural or tile water recovery programs; numerous groundwater recharge projects; stormwater capture and reuse projects; and new reservoirs for storing surface water.[243]

On the other hand, the GSP's management actions – at least those the GSA plans to implement over the short and medium term – do not appear to have a direct impact on pumping behavior or rates.[244] Pumping fees and fallowing of fields are discussed, but only as potential measures to be considered well into the future if necessary.[245] The GSP does not actually call for pumping fees or fallowing at this time.[246] Nor does it require any reduction in groundwater pumping: "Currently, no pumping restrictions have been proposed for the

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[242] *Ibid.,* 7-3 [Table 7-1], 7-3—7-18.

[243] *Ibid.,* 7-12—7-18. In 2010, the California Legislature passed the Storm Water Resource Planning Act, (Cal.Water Code § 10561(a)), which encourages the use of stormwater capture as a means to achieve groundwater sustainability. Benjamin A. Harris, "Making the Most of El Nino," 195-196.

[244] *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Region,* 7-3—7-18.

[245] *Ibid.,* 7-17.

[246] Gill, "Groundwater Managed," 31 (to promote agricultural growth, water agencies in farming communities typically have not imposed pumping or extraction fees so long as the water is used for irrigation.)

Northern and Central Delta-Mendota Regions . . . ."[247] Instead, all efforts will be directed toward increasing *supply*; little to nothing will be done to reduce *demand*, which explains why the future water budgets show a significant increase in groundwater production/consumption over the GSP's 50-year planning horizon.

5. Cost of the Sustainability Projects and Management Actions

Because the Northern and Central Delta-Mendota GSP focuses primarily on capital improvement projects rather than demand management, the costs to implement the plan are quite high. For example, one of GSP's near-term (Tier 1) project's is the North Valley Regional Recycled Water Program, which has an estimated cost of $96 million.[248] One of the medium-term (Tier 2) projects – a new reservoir at Del Puerto Canyon – is expected to cost $491 million.[249] To fund these and the other projects identified in the GSP, the GSA plans to apply for grants and loans through various federal, state, and local programs.[250] Only if these funding sources fail will the GSA consider charging pumping fees or other assessments to cover the cost of the planned water supply projects.[251]

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247 *Groundwater Sustainability Plan for the Northern and Central Delta-Mendota Region,* ES-9.
248 *Ibid.,* 7-19.

249 *Ibid.*

250 *Ibid.*

251 *Ibid.,* 8-7—8-8.

B. Case Study 2: Chowchilla Subbasin GSP

1. Description of Subbasin

The Chowchilla Subbasin is located within the San Joaquin Valley and underlies approximately 146,000 acres within Madera and Merced Counties.[252] To the west of Chowchilla is the Delta-Mendota Subbasin, and to the northwest is the Merced Subbasin. The Madera Subbasin lies to the south.[253] In the Chowchilla Subbasin, the main surface water sources are the Fresno River and the Chowchilla River.[254]

The Subbasin supports a substantial agricultural industry which consumes about 300,000 acre-feet of groundwater per year.[255] Farms in the area grow a variety of products, but the major cash crops are almonds, walnuts, and pistachios. It appears that local farmers began converting their land from row crops to orchard-based nut crops about 20 years ago, and the trend has continued without interruption ever since. For example, while the acreage for row/field crops steadily declined between 1989 and 2015, nut orchard acreage has increased every single year during that same span of time, going form 17,449 acres in 1989 to 65,699 acres in 2015.[256]

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[252] Chowchilla Subbasin GSP Advisory Committee, *Final Chowchilla Subbasin Sustainable Groundwater Management Act Groundwater Sustainability Plan* (2020), ES-2.

[253] *Ibid.,* ES-1.

[254] *Ibid.,* Figure ES-1.

[255] *Ibid.,* ES-2.

[256] *Ibid.,* p. 2-6 [Table 2-2].

The Subbasin also provides potable water for domestic use, but most towns in the region are small. The largest town is the City of Chowchilla, with a population of approximately 19,000.[257]

The DWR, in its Bulletin 118, identified the Chowchilla Subbasin as "critically overdrafted" and thus subject to SGMA's requirement to prepare and adopt a GSP by January 31, 2020.[258] As explained below, the Subbasin currently exhibits several of the "undesirable results" that groundwater basins must avoid if they are to achieve sustainability – namely, chronic declines in groundwater levels (often leading to failure of domestic wells), land subsidence, reduced groundwater storage, and rising groundwater salinity.[259]

The Chowchilla Subbasin GSP was jointly prepared by four GSAs – the Chowchilla Water District GSA, the Madera County GSA (Chowchilla Subbasin), the County of Merced GSA, and the Triangle T Water District GSA.[260] As explained below, the GSP concludes that for the Subbasin to be sustainable, an additional 134,400 acre feet per year must be either added to or not extracted from the aquifer.[261] To meet this goal, the GSP proposes 12 projects and management actions, most of which are designed to use "surplus surface water" sources and in lieu recharge to offset pumping-related deficits in the aquifer.[262] Except for one demand management program to be implemented by the Madera County GSA only, the

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257 *Ibid.,* ES-2; www.worldpopulationreview.com.

258 Chowchilla Subbasin Groundwater Sustainability Plan, p. 1-1.

259 *Ibid.,* ES-1.

260 *Ibid.,* ES-3—ES-4.

261 *Ibid.,* ES-15.

262 *Ibid.,* ES-1.

GSP does not propose any pumping controls or restrictions. And the Madera County demand management program is quite modest, generating only about 28,000 AFY in groundwater savings.[263] All of the other projects involve capital improvements that would bring more surface water to the Subbasin area, thereby relieving the stress on groundwater. The total cost of these 12 projects is estimated to be approximately $315 million.[264]

2. Subbasin Conditions

To grasp the GSP's approach to groundwater sustainability, it is necessary to understand where users in the Chowchilla area get most of their water. For example, the Madera County GSA (one of the four GSAs that prepared the GSP) relies almost exclusively on groundwater from the Subbasin, though some private entities have riparian and appropriative surface rights as well.[265] By contrast, the Chowchilla Water District GSA receives substantial surface water supplies from the CVP via contracts with the U.S. Bureau of Reclamation, as well as from direct diversions from the Chowchilla River.[266] Consequently, groundwater in the Chowchilla GSA provides supplementary water for agricultural and municipal uses.[267] The County of Merced GSA receives surface water deliveries from the Chowchilla Water District, though individual property owners also divert water from the Chowchilla River if they have riparian or appropriative rights.[268] All

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263 *Ibid.,* ES-15—ES-16.

264 *Ibid.,* ES-17 [Table ES-4].

265 *Ibid.,* 1-6.

266 *Ibid.,* 1-5.

267 *Ibid.*

268 *Ibid.,*1-8.

remaining water demand is fulfilled by privately owned groundwater wells.[269] And in the Triangle T Water District, which serves primarily agricultural uses, some individuals have riparian water rights, but most farmers pump groundwater to irrigate their crops.[270]

Two-thirds of the Chowchilla Subbasin is underlain by the Corcoran Clay, an aquitard that extends throughout much of the San Joaquin basin.[271] According to the GSP, the depth to the top of the Corcoran Clay varies from 50 to 100 feet at its northeastern extent to more than 250 feet in the southwestern portion of the Subbasin.[272] In the western portion of the Subbasin, "the aquifer system is subdivided into an upper unconfined aquifer above the Corcoran Clay and a lower confined aquifer below the Corcoran Clay."[273] In the central and eastern portions of the Subbasin, the Corcoran Clay is shallow or non-existent. In these areas, the aquifer system is semi-confined with discontinuous clay aquitards interspersed among the more coarse-grained materials.[274]

Generally speaking, the upper 800 feet of sediments consist of various layers of coarse-grained sediments, which allows most groundwater wells to produce at close to maximum yield.[275] Though domestic well depths vary across the Subbasin, the most common domestic well depth is between 300 and 400 feet.[276] Agricultural and public supply

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269 *Ibid.*

270 *Ibid.,* 1-10.

271 *Ibid.,* ES-5.

272 *Ibid.,* 2-31.

273 *Ibid.*

274 *Ibid.*

275 *Ibid.,* 2-31.

276 *Ibid.,* 2-33.

wells are drilled a bit deeper, typically between 500 and 750 feet below the surface.[277] Wells dug beyond 1,000 feet deep encounter fine-grained sediments, substantially reducing production yield.[278]

- *Groundwater Levels in the Subbasin*

The GSP provides hydrographs showing groundwater levels for the unconfined groundwater above the Corcoran Clay (or where the Corcoran Clay is absent) and for the Lower Aquifer below the Corcoran Clay.[279] These data show that long-term declines have become prevalent throughout the Subbasin, both in the upper, unconfined aquifer and in the Lower Aquifer.[280] During some wet years, the aquifers receive significant recharge and groundwater levels recover somewhat.[281] Nevertheless, "[o]ver the period of time from the mid-1980s through 2015 there was an annual groundwater level decline of about 5 to 6 feet per year."[282] In one particular year, 2014, groundwater levels dropped between 50 and 150 feet throughout most of the Subbasin.[283] (p. 2-38.) It is worth noting that this gradual but continuous decline in groundwater levels corresponds to the basin-wide conversion from row/field crops to more water-intensive orchard crops like almonds, walnuts, and pistachios.[284] Chronic declines in groundwater levels will eventually cause groundwater

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277 *Ibid.*

278 *Ibid.,* 2-31.

279 *Ibid.,* 2-36—2-37; Figs. 2-52, 2-53, 2-54 .

280 *Ibid.,* 2-36.

281 *Ibid.*

282 *Ibid.,* 2-37.

283 *Ibid.,* 2-38.

284 See *ibid.,* 2-6 [Table 2-2].

wells, especially the shallower domestic ones, to fail, requiring that they be re-drilled to a greater depth.

- *Groundwater Storage in the Subbasin*

Estimates of total groundwater storage within the Chowchilla Subbasin vary quite widely, from a low of 6.5 million AF to a high 13 million AF.[285] According to the GSP, the calculated changes in groundwater levels (discussed above) "translates to changes in groundwater storage estimated to range between -700,000 to -1.3 million AF between 1988 and 2014 and between -800,000 and -1.5 million AF between 1988 and 2016 . . . ."[286] This means that, on average, the Subbasin lost between 27,000 and 57,500 acre feet of water each year during this time period.

- *Groundwater Quality*

As with most subbasins in the San Joaquin Valley, the key groundwater quality constituents in the Chowchilla Subbasin are total dissolved solids (TDS), nitrate, and arsenic.[287] These three compounds have the greatest potential "for presenting broader regional groundwater quality concerns . . . ."[288] As explained above, when TDS concentrations begin to approach 1,000 mg/L, the groundwater becomes too saline for many of the key crops in the region, most notably almonds. In the upper aquifer of the Chowchilla Subbasin, TDS levels are highest in the northwest, where they reach concentrations in excess of 1,000 mg/L.[289] Data from the lower aquifer shows a similar geographic pattern, but the

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285 *Ibid.,* 2-37.

286 *Ibid.,* 2-38.

287 *Ibid.,* 2-39.

288 *Ibid.*

289 *Ibid.,* 2-40.

overall area of high TDS groundwater is larger.[290] Nitrate levels are below the MCL of 10 mg/L in most areas of the Subbasin, but in certain areas where well density is especially high, nitrate levels exceed 10 mg/L.[291] Arsenic levels throughout the basin are below the MCL of 10 µg/L.[292]

- *Land Subsidence*

Although land subsidence in the Chowchilla Subbasin has been minor compared to what has occurred in neighboring Delta-Mendota, it is still a significant concern, especially in the western part of the Subbasin.[293] The available subsidence maps show up to five feet of subsidence in some areas of western Chowchilla,[294] which is more than enough to cause displacement of surface infrastructure, such as roads, canals, and building foundations.

- *Seawater Intrusion*

The Chowchilla Subbasin is located inland of any known or recorded penetration of seawater.[295] Therefore, seawater intrusion is not a management issue or impediment to groundwater sustainability in the Subbasin.

- *Groundwater-Surface Water Interaction and GDEs*

The primary surface waters in Chowchilla Subbasin are the Chowchilla River, Ash Slough, Berenda Slough, and the San Joaquin River.[296] Each of these surface waters is a

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290 *Ibid.*

291 *Ibid.*

292 *Ibid.,* 2-41.

293 *Ibid.*

294 *Ibid.*

295 *Ibid.,* 3-21.

296 *Ibid.*

source of recharge for the Subbasin, but there is little in the way of actual hydraulic interaction between these surface streams and the aquifers below them, as the deepest portion of the stream channels are well above the groundwater levels.[297] Despite this lack of connection, however, the GSP concludes that groundwater pumping along these surface waters, especially the San Joaquin River, could adversely affect groundwater dependent ecosystems (GDEs) in these areas.[298]

3. Water Budgets

As required by SGMA, the Chowchilla Subbasin GSP includes water budgets representing historical, current, and project conditions. Unlike many other GSPs, however, the Chowchilla Subbasin GSP presents its water budget data in a single table, which makes it difficult to distinguish the differences between historical, current, and projected conditions, as well as between surface water and groundwater.[299] Nevertheless, the table does indicate that groundwater pumping in the Subbasin averaged 264,900 AFY between 1989 and 2014 (historical), has increased to 307,600 AFY (based on 1989-2014 average with 2017 land uses assumed), and will drop to 297,800 AFY by 2040 without any GSP projects, and will drop to 248,500 with implementation of the GSP projects.[300] Table 2-25 also shows that, based on these water budget numbers, the Subbasin, without the GSP projects, will experience a deficit

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297 *Ibid.,* pp. 2-41—2-42.

298 *Ibid.,* pp. 2-42—2-45.

299 *Ibid.,* Table 2-25. In fact, the GSP's other water supply and demand tables include figures that do not match those set forth in the Water Budget table (Table 2-25), so it is unclear exactly what water volume and demand numbers are being used for decision-making.

300 *Ibid.,* 2-93, Table 2-25.

of 41,700 AFY for the 50-year period between 2040 and 2090.[301] By contrasts, the Subbasin will enjoy a small surplus of 2,400 AFY during that same 50-year period if all GSP projects and management measures are implemented.[302]

These numbers, however, are somewhat misleading, in that they are all based on the *average* amount of groundwater extracted for agriculture between 1989 and 2014 – 258,510 AFY.[303] What this number does not reveal is that crop mixes in the Chowchilla Subbasin changed substantially between 1989 and 2014, as farmers converted from row crops to orchard crops (primarily almonds and other nuts). This trend has had a substantial impact on water use, including groundwater use:

> Across the subbasin, agriculture has historically been dominated by orchard crops, mixed pasture, alfalfa, and corn. In particular, orchard acreage, which includes primarily almonds and pistachios, has more than tripled since 1989. As these crops have higher consumptive water use requirements than many other commodities grown in the subbasin, groundwater demand has increased in recent years.[304]

The water budget data reflects this trend. Specifically, while the *average* amount of groundwater extracted from the Subbasin between 1989 and 2014 for agriculture was 258,510 AFY, the amount of groundwater extracted for agriculture in 2012 was 305,780 AF and increased steadily each year through 2015, when the amount of groundwater extracted reached 432,110 AF.[305] Thus, the *average* groundwater use number – the figure on which all

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301 *Ibid.,* Table 2-25.

302 *Ibid.,* 2-94, Table 2-25.

303 *Ibid.,* 2-83, Table 2-20; 2-94, Table 2-25.

304 *Ibid.* 2-63.

305 *Ibid., .,* 2-83, Table 2-20; 2-94, Table 2-25.

other projections are based – is about 40 percent less than the groundwater extraction number from the last year of data collection. Given that the increase in groundwater use is due to changes in crop mix that are not likely to be reversed anytime soon, it would seem that the 432,110 AFY number would provide a more accurate baseline for purposes of predicting future groundwater demand. If the GSP were to use this number in its projections, the groundwater deficit during the 2040-2090 timeframe would increase substantially over what is currently reported in Table 2-25, requiring much greater offsets in the form of recharge, in lieu recharge, or demand reductions.

4. Water Supply Projects and Demand Management Actions

Unlike many other GSPs, the Chowchilla Subbasin GSP does not clearly identify how much increased water supply and/or reduced groundwater demand will be required to reach the subbasin's sustainability goals. However, the GSP recommends implementation of 12 projects which, by 2040, should produce 106,000 AFY in the form of recharge or in lieu recharge.[306] In addition, one of the four GSAs – Madera County – will implement a demand management program that is expected to save an additional 28,000 AFY by 2040, bringing the total offset figure to 134,500 AFY.[307]

The cost to put the 12 offset projects in place is significant, estimated at approximately $315 million.[308] While some of the more expensive projects would be deferred until 2035 and 2040, many are scheduled to be implemented in the next two years. These more short-term projects are expected to cost more than $247 million.[309] The GSP

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306 *Ibid.,* 4-2.

307 *Ibid.,* ES-15—ES-16; 4-2.

308 *Ibid.,* ES-17 [Table ES-4].

309 *Ibid.*

provides no direct mechanism for funding these projects, though it gives the GSA the option to charge users a fee to cover some of the costs.[310] Instead, the GSP assumes that most of the projects will be paid for using state and federal grants and low interest loans.[311] These funding sources, however, are not unlimited, and they are the same sources that many of the other GSAs will be tapping when looking for money to pay for their own SGMA projects.

C. Case Study 3: Eastern San Joaquin Subbasin GSP

1. Description of Subbasin

The GSP for the Eastern San Joaquin Groundwater Subbasin was prepared by the Eastern San Joaquin Groundwater Authority, a cooperative GSA comprised of 16 smaller GSAs in the region.[312] The Subbasin is located just southeast of the Sacramento-Bay Delta and underlies a significant portion of the San Joaquin Valley.[313] Its western edge is bounded by the San Joaquin River, which flows northward toward the Delta.[314] The Subbasin's southern boundary is defined by the Stanislaus River, which starts in the Sierra Nevada mountains to the east and flows westerly until it joins the San Joaquin.[315] A number of other surface streams cross through the Subbasin in a similar east-to-west direction, each of them

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310 *Ibid.,* ES-18, 5-6.

311 *Ibid.*

312 Eastern San Joaquin Groundwater Management Authority, *Final Eastern San Joaquin Groundwater Subbasin Groundwater Sustainability Plan* (2019), 1-3.

313 *Ibid.,* ES-2.

314 *Ibid*. It is worth noting, however, that water agencies and other users divert substantial amounts of water from the San Joaquin and, as a result, the river often dries out before completing its journey to the Bay-Delta.

315 *Ibid*.

eventually connecting to the San Joaquin River. These surface waters include Lone Tree Creek, Calaveras River, and Bear Creek. In addition, two larger streams – the Mokelumne River and the Consumnes River – cross through the northern portion of the Subbasin on their way to the Sacramento River which discharges into the Delta.[316]

2. Conditions in the Subbasin

Due to the surface water resources in the Eastern San Joaquin Subbasin, local water agencies obtain most of their water through surface diversions from the San Joaquin, Stanislaus, Consumnes, and Mokelumne Rivers.[317] This water is used for municipal and agricultural purposes, though there are few large towns in the Subbasin area.[318] Note also that direct *local* access to surface water means that local agencies in the Subbasin do not receive imported water from either the State Water Project (SWP) or the federally-operated Central Valley Project (CVP).[319] This is not the case in most other places in the San Joaquin Valley where surface waters are scarce and farmers and residential users must rely on the SWP and/or CVP for most of their water.

- *Groundwater Levels*

Like the rest of the San Joaquin Valley, the Eastern San Joaquin Subbasin cannot meet all of its water demands through surface diversions alone. Users pump groundwater to supplement their surface water allocations, and during dry years and extended droughts, groundwater use increases substantially to make up for the shortfall.[320] Then, when the

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316 *Ibid.*

317 *Ibid.,* 2-120.

318 *Ibid.,* 1-42.

319 *Ibid.,* 2-19.

320 *Ibid.*2-140.

drought ends and precipitation levels return to normal, the groundwater aquifers recover through recharge.[321] Such recharge occurs primarily through deep percolation at key locations within the Subbasin where the soil is coarse-grained and highly-transmissive.[322] Recharge also occurs when streams "lose" water to the underlying aquifer; but this only occurs in those streams, such as the San Joaquin and the Stanislaus rivers, that are hydraulically connected to the groundwater basin.[323] Streams that have no connection to any aquifer do not contribute to groundwater recharge.

The cycle of groundwater depletion during dry period followed by recharge and recovery during wet period has been the historical norm in the San Joaquin Valley since the 19th Century and it continues to inform water use management in the region. The depletion/recovery cycles, however, do not necessarily create a perfect balance between inflows and outflows, and the Subbasin has for many years operated in a deficit or overdraft situation.[324] The first serious signs of stress occurred in the 1980s, when groundwater pumping caused groundwater levels to drop substantially.[325] Many residential wells – which tend to be shallower than irrigation wells – ran dry. The basin-wide response was not to curb groundwater pumping but to design and implement a "well-deepening" program.[326] Through this program, users were able to drill down further into the Subbasin and access the lowered

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321 *Ibid.,* 2-133.

322 *Ibid.*, 2-19.

323 *Ibid.,* 3-21.

324 *Ibid.,* 3-3—3-5.

325 *Ibid.*

326 *Ibid.*

water table.[327] The well-deepening program, which began in 1992, provided a reasonably effective but temporary remedy, though it made the pumping of groundwater more expensive than before, due to the increased energy required to lift the same amount of water from a deeper location.[328]

What the well-deepening program did *not* do was alter groundwater pumping behavior or cause users to pump less. As a result, the Subbasin has continued to operate in a deficit mode. This, in turn, has caused a continued lowering of the water table. Due to this chronic deficit condition, the Department of Water Resources, in its Bulletin 118, identified the Eastern San Joaquin Subbasin as critically overdrafted, which makes the Subbasin subject to SGMA's early GSP preparation requirement.

- *Groundwater Storage and Land Subsidence*

As noted in the GSP, however, the Subbasin has plenty of freshwater, even with the constant depletion by excessive groundwater pumping.[329] The Subbasin's aquifers are large and hold a tremendous amount of water, though much of it lies at depths that are difficult or expensive to reach with groundwater pumps.[330] The fundamental problem in the Eastern Joaquin is not loss of groundwater storage, but the chronic drop in groundwater levels.[331] Unlike other areas in the San Joaquin Valley, such as Delta-Mendota, the Eastern San Joaquin had not experienced severe or widespread land subsidence, in part because the

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327 *Ibid.*
328 *Ibid.*

329 *Ibid.,* 3-11.

330 *Ibid.*

331 *Ibid.,* 3-11.

Subbasin's lower aquifer continues to hold substantial amounts of water and thus is able to keep the land above it from sinking.[332]

- *Seawater Intrusion*

The Eastern San Joaquin also does not need to worry about seawater intrusion. Though the Subbasin is reasonably close to the Bay-Delta, the elaborate levee system within the delta prevents salty/brackish water from the estuary from becoming hydraulically connected to the Subbasin's aquifers.[333]

- *Groundwater Quality*

This does not mean, however, that the Eastern San Joaquin does not have a salinity issue. The soils throughout the Subbasin consist of former marine sediments and rock that are naturally saline.[334] In addition, the long-term and extensive application of irrigation water to those soils tends to leach out the salts and pull them down into the aquifer.[335] Since many of the soil types within the Subbasin do not drain well, those salts accumulate, gradually increasing the salinity of the groundwater.[336] To make matters worse, the freshwater in the Subbasin's lower-most aquifer sits on top of a large store of saline water that is not safe to drink or to use on crops.[337] As groundwater pumping accelerates and groundwater levels drop, the depression cones created by the wells begin to capture some of

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332 *Ibid.,* 3-19.
333 *Ibid.,* 3-17.

334 *Ibid.,* 3-12—3-16.

335 *Ibid.*

336 *Ibid*.

337 *Ibid*., 2-42, 2-46.

the underlying salt water, contaminating the freshwater extracted by the pump.[338] This is one of the negative consequences of the well-deepening program of the early 1990s.

As stated above, salinity levels are typically measured and expressed in the form of Total Dissolved Solids (TDS). In the Eastern San Joaquin Subbasin, TDS concentrations have increased steadily over the last 20 years.[339] In some locations, the TDS levels are much higher than 1,000 mg/L, the upper tolerance limit for salt-sensitive crops.[340] This rise in groundwater salinity is a major concern because many farmers in the Subbasin have converted their operations from low-profit row crops, most of which are fairly salt-tolerant, to high-profit almonds and walnuts, which are not.[341] As a result, salt levels in the Subbasin have to be aggressively managed.

- *Impacts on Surface Waters and GDEs*

SGMA also requires that each GSP evaluate the impacts of groundwater pumping on hydraulically connected surface waters and the biological resources that depend on them. Most of the rivers and streams that flow through the East San Joaquin Subbasin are connected to groundwater at least part of the time.[342] The two largest surface streams – the San Joaquin River and the Stanislaus River – are not only connected to the aquifer beneath them, they draw water from that aquifer most of the year.[343] This means that the San Joaquin and Stanislaus rivers are “gaining” streams. Meanwhile, the other surface waters in the

338 *Ibid*.
339 *Ibid.,* 2-88—2-90.

340 *Ibid.*

341 *Ibid*.

342 *Ibid.,* 2-104—2-105; Fig. 2-71.

343 *Ibid.*

Subbasin area, including the Mokelumne and the Calaveras rivers, "lose" water to the underlying aquifer more than 75 percent of the time.[344] The GSP, however, does not quantify how much any surface stream gains or loses in any given year. The GSP does not assess whether the Subbasin's chronic lowering of the groundwater table may eventually cause the San Joaquin and Stanislaus rivers to go from "gaining" streams to "losing" streams.

Groundwater dependent ecosystems (GDEs) – which SGMA defines as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" – exist throughout the Eastern San Joaquin Subbasin.[345] Most of the GDEs consists of streams and rivers discussed above, as well as the riparian areas along their edges. The Subbasin also supports various wetland GDEs, some of which are connected to streams and some of which are not. Most of the "independent" wetlands are located in the northeast portion of the Subbasin.[346]

Unfortunately, the GSP gives little information on the GDE's within the Subbasin. For example, it states that "[t]he distribution of freshwater fish and wildlife species that may be dependent on GDEs is not well known and is not included in this analysis." [347] This claim seems unlikely, since some of the fish and wildlife that reside in the San Joaquin Valley's streams and riparian areas are listed under the California Endangered Species Act and/or the federal Endangered Species Act and thus have been studied in terms of population abundance and distribution.[348] The GSP also provides little data or analysis regarding the current

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344 *Ibid.*

345 *Ibid.,* Figure 2-73.

346 *Ibid.*

347 *Ibid.,* 2-108.

348 *Id.,* Appx. 1-F.

condition or functionality of the various GDEs shown on Figure 2-73; nor does it assess whether recent trends in groundwater pumping, including chronic lowering of the water table, have adversely affected these GDEs or caused previously-documented GDEs to disappear. An appendix to the GSP does provide a list a list of the freshwater species found in the Eastern San Joaquin Subbasin, but the GSP does not discuss the status of these species or examine how they might be affected by the actions and projects recommended in the GSP.[349]

3. Water Budgets

As required by SGMA, the Eastern San Joaquin GSP includes water budgets for historical, current, and future/projected conditions.[350] Although the Eastern San Joaquin GSP includes water budgets for the stream system, land surface system, and the groundwater system, only the last is of interest here, as the stream and land surface water budgets always balance (the outflows equal the inflows).[351] The *groundwater* budgets, on the other hand, reflect significant change between inflows and outflows under all three water budget scenarios (historical, current, and projected). Specifically, there is a 41,000 AFY deficit under historical conditions, a 48,000 AFY deficit under current conditions, and a 34,000 AFY deficit under projected conditions.[352]

These numbers, however, require closer review. According to the GSP, inflows to the groundwater basin will increase from an average of 811,000 AFY under historical conditions

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[349] *Ibid.,* 2-108—2-113.

[350] *Ibid.,* p. 2-117.

[351] *Ibid.,* Tables 2-13 and 2-14.

[352] *Ibid.,* 2-129 [Table 2-15].

to 959,000 AFY under current conditions and 939,000 AFY under projected conditions.[353] Yet, the GSP does not explain why such dramatic increases will occur, other than to indicate that most of the additional inflows will come from increased percolation of agricultural return water and increased seepage from streams such as the Mokelumne River and the Stanislaus River.[354] On the outflow side of the equation, the GSP predicts that groundwater losses through steam outflow, pumping, and subsurface outflow will increase from 852,000 AFY under historical conditions to 1,007,000 AFY under current conditions and 973,000 AFY under projected conditions.[355] Again, the GSP does not explain why there is such a significant jump in groundwater losses. Table 2-15, however, provides data showing that the increase is attributable solely to expanded agricultural pumping.[356]

When the inflow and outflow numbers are examined together, they suggest that the additional groundwater extracted from the basin for crop irrigation is the same water that eventually percolates back down into the aquifer as an inflow.[357] For this reason, it would be incorrect to assume that some new source of water has been found, or that an existing source can be tapped for more water. Essentially, the water budgets assume that groundwater extractions for agriculture will increase substantially over the next 50 years and that some portion of that groundwater will make its way back to the aquifer via percolation.[358] The recycling of agricultural water is a normal part of water budgeting, but when the recycling

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353 *Ibid.*

354 *Ibid.*

355 *Ibid.*

356 *Ibid.*

357 *Ibid.*

358 *Ibid.*

occurs on this scale, there is the potential for adverse impacts on groundwater quality. The GSP, however, does not address this issue.

In addition, the projected future outflow for the subbasin, especially the groundwater extractions for agriculture, maybe under-predicted. According to the GSP, the projected water budget assumed that "due to projected urban growth, agricultural acreage is expected to decrease by approximately 40,000 acres."[359] The GSP then states that "[w]hile there is agricultural growth anticipated in the eastern areas of the Subbasin and potential conversion of existing agricultural land to permanent irrigated crops, no reliable projections were available to include in the simulation; therefore, no additional agricultural land growth was added to the projected conditions scenario."[360] This means that despite extensive evidence that San Joaquin Valley farmers have been switching from row crops (which can be fallowed and left unirrigated) to almond, walnut, and pistachio orchards (which require permanent, year-round irrigation), the GSP assumed this trend would not continue. As a result, it is likely that the *actual* amount of groundwater extracted from the Subbasin over the next 50 years will be greater than reported in the GSP.

To determine how much new groundwater – either in the form of additional sources or reduced pumping – is needed to make the Subbasin sustainable, the Eastern San Joaquin Groundwater Subbasin GSA developed a "sustainable conditions scenario (model) in which the goal was to bring the long-term (50-year) change in Subbasin groundwater storage to zero."[361] This scenario is based on the projected conditions water budget, but like the other

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359 *Ibid.,* 2-138.

360 *Ibid.*

361 *Ibid.,* 2-141.

Central Valley GSPs, it does not account for climate change, even though SGMA requires that climate change be considered.[362] According to the GSP, the model omitted climate change assumptions "[d]ue to the uncertainty around DWR's climate projections for the 2070 timeframe."[363]

With these assumptions in place, the sustainable conditions scenario "results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (50-year) average change in groundwater storage close to zero."[364] Based on this analysis, the sustainable yield of the Subbasin is 715,000 AFY, plus or minus 10 percent.[365] The GSP then concludes that "[i]n order to achieve a net-zero change in groundwater storage over a 50-year planning period, approximately 78,000 AF/year of direct or in lieu groundwater recharge and/or reduction in agricultural and urban groundwater pumping would need to be implemented."[366]

4. Sustainability Projects and Management Actions

With this goal in mind, the GSP then identifies 23 potential projects which, if implemented, would meet the additional recharge need of 78,000 AFY and allow the Subbasin to achieve sustainability.[367] These projects will either replace groundwater use or supplement groundwater supplies. They include "direct and in-lieu recharge, intra-basin

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362 *Ibid.,* 2-142.

363 *Ibid.*

364 *Ibid.*

365 *Ibid.*

366 *Ibid.*

367 *Ibid.,* ES-9.

water transfers, demand conservation, water recycling, and stormwater reuse."[368] However, the GSP does not recommend or impose reductions in groundwater pumping. Instead, the GSP concludes that the Subbasin's recharge/sustainability needs can be met entirely through additional water supply projects, without any changes in demand or pumping behavior.[369]

Most of the GSP's sustainability projects are modest in terms of cost, at least as compared to some of the projects contemplated in GSPs for other subbasins in the San Joaquin Valley. In fact, the centerpiece of the GSP supply improvement program – a series of long-term water transfers between certain water districts within the Eastern San Joaquin GSA – will not require any capital improvement costs at all, as the infrastructure is already in place. These water transfers are expected to bring 45,000 AFY into the Subbasin as *in lieu* recharge.[370] Thus, this project accounts for more than half of the GSP's sustainability recharge goal of 78,000 AFY. There is a catch, however. The two districts that would be transferring the water – the Oakdale Irrigation District (OID) and the South San Joaquin Irrigation District (SSJID) – get their water from the Stanislaus River, which is tributary to the San Joaquin. [371] The GSP, however, never explains how OID and SSJID will have surplus water to transfer to their sister agencies during drought periods. Put another way, the GSP does not demonstrate that the 45,000 AFY will be available for transfer when it is needed most.

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368 *Ibid.*

369 Some commenters have criticized the notion that the San Joaquin Valley's groundwater overdraft problems can be solved through the development of more imported surface water. See, Benjamin Harris, "Making the Most of El Nino," 218-220.

370 *Ibid.,* 6-6, 6-18—6-19.

371 *Ibid.,* p. 6-18.

D. Case Study 4: Paso Robles Subbasin GSP

1. Description of the Subbasin

The Paso Robles Subbasin is the first GSP discussed here that is not a part of the Central Valley. It is located inland of California's central coast region, within the larger Salinas Valley Basin.[372] It underlies a large portion of eastern San Luis Obispo County, though the only large town within the Subbasin area is the City of Paso Robles.[373] In terms of size, the Subbasin encompasses an area of approximately 436,240 acres (or about 681 square miles).[374] The Subbasin is drained by the Salinas River, whose primary tributaries include the Estrella River, Huer Huero Creek, and San Juan Creek.[375] As explained further below, groundwater provides nearly all the potable and irrigation water used in the Subbasin. In fact, until 2015, all water demands in the area were met with groundwater; since 2015, however, the City of Paso Robles and the community of Shandon have received small amounts of imported water through the Nacimiento Project and the SWP, respectively.[376] Agricultural users – primarily vineyards[377] – account for more than 90 percent of groundwater extracted from the Subbasin; municipal facilities and residences account for less

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372 Paso Robles Subbasin Groundwater Sustainability Agencies, *Paso Robles Groundwater Sustainability Plan*, (2020), ES-1—ES-2. The Paso Robles Subbasin GSP was jointly developed by four GSAs: the City of Paso Robles, Paso Basin (County of San Luis Obispo), San Miguel Community Services District, and the Shandon-San Juan GSA. *Ibid.*

373 *Ibid.,* ES-1.

374 *Ibid.,* 1-2.

375 *Ibid.,* ES-1.

376 *Ibid.*

377 *Ibid.,* Table 3-1. In terms of acreage, vineyards constitute approximately 88 percent of agricultural land in the Subbasin.

than 5 percent of groundwater use.[378] While no part of the Subbasin currently uses wastewater for irrigation or other purposes, the City of Paso Robles is upgrading its wastewater treatment plant and intends to designate the treated water for a variety of non-potable uses.[379]

2. Conditions in the Subbasin

Groundwater elevations within the Subbasin have been declining for many years, which is why DWR designated it as "critical".[380] The Subbasin has two aquifers with different soil types and water permeability: the Alluvium and the Plio-Pleistocene Paso Robles formation.[381] The Alluvium borders streams and rivers. It is typically less than 100 feet thick and consists of coarse sand and gravel.[382] It is highly permeable and provides excellent well production of more than 1,000 gallons per minute.[383] The Paso Robles formation makes up the majority of the Subbasin and is 3,000 feet thick in some locations.[384] It consists of thin layers of sand and gravel interspersed with thicker layers of silt and clay. Due to the composition of its soil, the Paso Robles formation is not particularly permeable and well production from this aquifer is much less than that of the Alluvium.[385] Despite its size in terms of area, the Subbasin does not hold enormous amounts of groundwater. This is

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378 *Ibid.,* Fig. 3-4, Table 3-1.

379 *Ibid.,*3-9.

380 *Ibid.,* ES-1—ES-2.

381 *Ibid.,* ES-3.

382 *Ibid.*

383 *Ibid.,* 4-25.

384 *Ibid.* ES-3.

385 *Ibid.,* ES-3, 4-26.

due to the geologic features of the aquifers described above. For this reason, relatively minor reductions in water inputs or increases in water outputs can strain the Subbasin.

The Paso Robles Subbasin is already regulated under local and regional ordinances. Specifically, in 2015, the County of San Luis Obispo passed the "Water Demand Offset Ordinance", which limits new or expanded irrigated agriculture in areas within the Subbasin unless it is offset by retiring existing irrigated agriculture either on the same property or on a different property in the Subbasin.[386] In addition, the Ordinance identifies areas of severe decline in groundwater elevation. The owners of land overlying these areas may not plant new or additional crops except when converting to less water-intensive crops.[387] Finally, the Ordinance also established the Countywide Water Conservation Program, which is designed "to substantially reduce groundwater extraction in areas that have been certified Level of Severity (LOS) III."[388] With regard to water quality, in 2017, the Regional Water Quality Control Board issued Agricultural Order No. R3-2017-0002, which requires that growers in San Luis Obispo County, which includes the Subbasin, take steps to reduce the amount of nitrate that is leaching into the groundwater.[389]

As shown below, the Paso Robles Subbasin GSP must address falling groundwater levels, chronic loss of groundwater storage, and various water quality issues (namely high salt and nitrate concentrations) before it can reach its sustainability goals. The Subbasin does not have serious problems with seawater intrusion, land subsidence, or groundwater-related

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386 *Ibid.,* 3-28.

387 *Ibid.*

388 *Ibid.,* ES-28.

389 *Ibid.*

impacts on surface water resources, including groundwater-dependent ecosystems. Thus, the GSP does not spend much time on these issues.

Like many subbasins in central California, the Paso Robles Subbasin can trace its current overdraft problem to shifts in agricultural behavior and crop mix. In the 1980s and 1990s, groundwater pumping in the Subbasin declined from approximately 100,000 AFY to about 50,000 AFY, resulting in an increase in groundwater levels and storage.[390] This drop in groundwater pumping corresponded to a basin-wide transition from alfalfa and pasturage to vineyards.[391] Because vineyards require less irrigation than alfalfa and pasturage, pumping demands on the Subbasin went down.[392] This situation did not remain constant, however. By 2007, groundwater extraction again reached 100,000 AFY, mostly due to substantial expansion of new vineyards throughout the Subbasin. Groundwater levels and storage began to decline accordingly.[393] As of 2011, the Subbasin had sustained a net loss of approximately 390,000 AF, with an annual average loss of 12,600 AF.[394] The GSP does not provide any additional data on crop mix; nor does it indicate whether the amount of vineyard acreage has stabilized in the years since 2011. It would appear, however, that vineyards still contribute substantially to the chronic declines in the Subbasin's groundwater.

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[390] *Ibid.,* 6-14.

[391] *Ibid.*

[392] *Ibid.*

[393] *Ibid.*

[394] *Ibid.*

- *Changes in Groundwater Levels*

As mentioned above, the Subbasin consists of two aquifers – an upper aquifer known as the "Alluvium" and a lower, thicker aquifer known as the "Paso Robles Formation". The GSP was unable to obtain reliable or representative data regarding groundwater levels and trends within the Alluvial Aquifer, so the plan does not attempt to draw conclusions as to the status of those groundwater levels.[395] On the other hand, the GSP includes extensive data on groundwater levels within the larger Paso Robles Formation aquifer. These data indicate that "groundwater elevations are lower in 2017 than 1997 throughout most of the Subbasin."[396] In some areas, declines of more than 80 feet have been recorded.[397]

- *Changes in Groundwater Storage*

Between 1981 and 2011, the Alluvial Aquifer lost approximately 20,000 AF of storage.[398] This does not seem like a significant reduction, except that the Alluvial Aquifer is quite thin and does not have tremendous water-bearing capacity. The Alluvial Aquifer lost another 50,000 AF during the drought years of 2011—2016.[399] According to the GSP, however, "[t]he loss of groundwater storage during the drought represents an extreme condition which is not indicative of long-term storage trends in the Alluvial Aquifer."[400]

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395 *Ibid.,* 5-4.

396 *Ibid.,* 5-13.

397 *Ibid.*

398 *Ibid.,* 5-20.

399 *Ibid.*

400 *Ibid.*

Although there is little data available on recent groundwater storage losses within the Alluvial Aquifer, the GSP concludes that storage levels are relatively stable.[401]

In the Paso Robles Formation aquifer, approximately 369,000 AF were removed from storage between 1981 and 2011.[402] That cumulative loss figure went up another 277,000 AF in the drought years between 2011 and 2016, making the total loss 646,000 AF.[403] The GSP describes the causes of this loss of groundwater storage as follows:

> Depletion of groundwater storage generally occurs during dry periods and increases in groundwater in storage generally occur during wet periods . . . . Groundwater pumping decreased during the period from 1981 to 1999 and generally increased from 1999 to 2016. The loss in groundwater in storage in the Paso Robles Formation Aquifer appears to be from a combination of increased pumping since 1999 and a number of dry years with limited recharge.[404]

The graph provided on page 5-23 depicts the sharp decline in groundwater storage within the Paso Robles Formation aquifer. This trend is likely to continue unless water use practices change.[405]

- *Groundwater Quality*

Generally, the groundwater extracted from the Paso Robles Subbasin is suitable for agricultural purposes.[406] It does, however, have two chronic water quality problems that must be managed – elevated levels of TDS (salt) and elevated levels of nitrate.[407] With regard

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401 *Ibid.*

402 *Ibid.,* 5-22.

403 *Ibid.*

404 *Ibid.*

405 *Ibid.,* ES-5.

406 *Ibid.,* 5-27.

407 *Ibid.,* ES-4.

to TDS, the secondary maximum concentration level (SMCL) is 500 milligrams per liter (mg/L), which is within the salt tolerance of most crops.[408] When TDS levels exceed 1,000 mg/L, some crops suffer growth deficiencies. In parts of the Paso Robles Subbasin, TDS levels average well over 500 mg/L and often exceed 1,000 mg/L.[409] Some locations recorded TDS levels over 2,000 mg/L.[410]

Nitrate levels in the Subbasin average less than the primary MCL of 10 mg/L, but parts of the Subbasin occasionally show nitrate levels in excess of 15 mg/L.[411] Such nitrate levels may pose human health risks and thus must be managed accordingly. The GSP concludes that none of the proposed Projects or Management Actions will increase TDS (salt) or nitrate levels in the Subbasin's groundwater.[412] Rather, the proposed Projects and Management Actions, which include pumping restrictions, are intended to improve groundwater levels and thereby reduce concentrations of both TDS and nitrate.

3. Water Budgets

Like all GSPs, the Paso Robles Subbasin GSP includes three different kinds of water budgets: historical, current, and projected/future.

For the *historical* water budget, the GSP uses the 30-years between 1981 and 2011 as the "base period".[413] The GSP does not include the years 2012 through 2016 in this base

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408 *Ibid.,* 5-30.

409 *Ibid.*

410 *Ibid.*

411 *Ibid.,* 5-34—5-36.

412 *Ibid.,* 5-30, 5-35.

413 *Ibid.,* 6-5.

period because these years were characterized by extreme drought and, according to the GSP, do not represent long-term conditions within the Subbasin.[414] The historical water budget data show that *surface* water inflows to the Subbasin have averaged approximately 360,400 AFY, but that during some especially wet years, inflows have reached 500,000 AFY.[415] This wet year "excess" may be of value to the GSA and the people it serves. According to the GSP, "[a]ssuming diversion permits could be obtained, future high flow years may provide opportunities to capture and use excess storm water as a new water supply in the Subbasin."[416] The historical water budget for *groundwater* shows a chronic deficit situation. Inflows average 71,400 AFY while outflows average 84,000 AFY, which means that the Subbasin is losing 12,600 AF of groundwater storage each year.[417] Cumulatively, over the 1981-2011 base period, the Subbasin lost about 390,000 AF of storage.[418] The source of this groundwater deficit is groundwater pumping for agriculture, primarily vineyards.[419]

The data for the *current* water budget is even more concerning. The current water budget is based on water levels recorded during the period of 2012-2016, which corresponds to one of the worst droughts in the state's history.[420] During this period, annual precipitation in the Subbasin was only 62 percent of the historical average, and percolation from local

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[414] *Ibid.,* 6-15.

[415] *Ibid.,* 6-7, 6-9.

[416] *Ibid.,* 6-9.

[417] *Ibid.,* 6-9—6-10, 6-14.

[418] *Ibid.,* 6-14.

[419] *Ibid.,* 6-10—6-11.

[420] *Ibid.,* 6-15.

streams into the groundwater aquifers dropped by 90 percent.[421] Under the *current* water budget, surface water inflows are 87,000 AFY, substantially less than the 30-year historical average of 360,400 AFY.[422] This sharp decline in surface water inflows puts tremendous pressure on groundwater resources. Average groundwater inflows during the 2012-2016 time period fell to 28,900 AFY, less than half the historical average of 71,400 AFY.[423] Groundwater extraction during this same period, however, jumped to 85,800 AFY, contributing to an average annual deficit of 65,400 AF and a cumulative storage loss of 327,000 AF.[424] The GSP determined that during the 2012-2016 period, agricultural pumping increased 18 percent over the historical average, which again shows that when droughts are prolonged and cause a substantial decrease in surface water supplies, users are forced to rely extensively on groundwater.[425]

The *projected/future* water budget is more optimistic. The projected/future water budget covers the 20-year implementation period between 2020 and 2040, but is based on the historical "base period" water data from 1981-2011.[426] In this respect, the Paso Robles Subbasin GSP departs significantly from the other GSPs analyzed in this thesis. The GSPs for the San Joaquin Valley subbasins, for example, use the 50 years between 2040 and 2090 as their *projected/future* water budget coverage period. Importantly, the Paso Robles

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421 *Ibid.*

422 *Ibid.,* 6-16.

423 *Ibid.,* 6-19.

424 *Ibid.,* 6-20, 6-25.

425 *Ibid.,* 6-21.

426 *Ibid.,* 6-25.

Subbasin GSP assumes that agricultural water demand in the Subbasin will remain constant between 2020 and 2040, though there are no specific projections on this topic.[427] Ultimately, the GSP concludes that *surface* water inflows will average approximately 343,000 AFY, which is close to the historical average of 360,400 AFY.[428] The GSP also indicates that *groundwater* inflows will average approximately 69,500 AFY.[429] This figure is just slightly below the historical average of 71,400 AFY. The difference, ironically enough, is due to the improved efficiency of agricultural irrigation practices and technology.[430] Because less water is used per crop acre, less percolates down into the aquifer as agricultural return water.[431] Nevertheless, even under these improved projected/future groundwater conditions, the Subbasin outflows would be in excess of 83,200 AFY, meaning that the Subbasin would still be operating at a deficit.[432]

4. Proposed Projects and Management Actions

Based on the water budgets summarized above, the GSP concludes that "the future sustainable yield for the Subbasin period is estimated to be approximately 61,100 AFY," which translates to an estimated shortfall of 13,700 AFY.[433] This, then, becomes the target figure for purposes of developing projects and strategies for addressing the ongoing overdraft condition of the Subbasin. The GSP identifies six projects and five management actions

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427 *Ibid.,* 6-27.

428 *Ibid.,* 6-29.

429 *Ibid.,* 6-30.

430 *Ibid.,* 6-30.

431 *Ibid.*

432 *Ibid.,* 6-31.

433 *Ibid.*

which, if implemented, would allow the Subbasin to attain its sustainability goal.[434] Most of the proposed projects are modest in size and potential benefit. For example, the first five projects consist primarily of recycled water facilities and expanded deliveries from the existing Naciomento Water Project.[435] Combined, these five projects would produce a net gain of 8,450 AFY of surface water that could then be used to reduce/offset groundwater extraction. The sixth project involves a substantial expansion of a local reservoir. Specifically, the GSP calls for the Salinas Dam and the lake behind it to be enlarged from its current capacity of 23,843 AF to at least 45,000 AF, which is the amount of water to which the City of Paso Robles has existing water and storage rights.[436] This project would allow the dam operator "to schedule summer releases from the storage to the Salinas River, which would benefit the Subbasin by recharging the basin through the Salinas River."[437] According to the GSP, this project would result in small, localized increases in groundwater elevations.[438] The combined capital cost of the six infrastructure projects would be approximately $191 million, which the GSAs would fund using low interest loans.[439]

The dam expansion project, however, may never be implemented, which is why the GSP relies on five management actions to make up the difference. Of the five management actions recommended in the GSP, the ones with the most potential for advancing the

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434 *Ibid.,* 9-18.

435 *Ibid.,* 9-18—9-41.

436 *Ibid.,* 9-41.

437 *Ibid.*

438 *Ibid.,* 9-41, 9-42 [Fig. 9-17].

439 *Ibid.,* 9-19—9-44.

Subbasin toward sustainability are (i) efforts to promote stormwater capture, (ii) efforts to promote voluntary fallowing of agricultural land, and (iii) mandatory pumping limitations in specific areas with chronic overdraft conditions.[440] Unfortunately, the GSP does not quantify how much net benefit the various management actions will achieve. It is therefore impossible to know whether the GSP's overall strategy will meet the sustainability goal of keeping groundwater extractions to 61,100 AFY.

E. Case Study 5: Oxnard Subbasin GSP

1. Description of the Subbasin

The Oxnard subbasin is located on the southern coast of California, just north of Los Angeles. The California Department of Water Resources identified the Oxnard subbasin as a 'high priority' basin largely because of its long-standing struggle with seawater intrusion. Seawater intrusion was first noticed in the basin in the 1930s, which was also during the height of Oxnard's agricultural economy.[441] Since then, Oxnard has transitioned from agricultural to municipal, which has reduced the area's overall water use and groundwater pumping. However, over-pumping and salinity in the Oxnard Subbasin are still big issues, and the seawater intrusion threatens to contaminate the whole aquifer.

The Oxnard Subbasin receives its freshwater from the Santa Clara River. The water seeps through the porous sediment in the riverbed to recharge the aquifer below it. The volume of water in the aquifer drops most drastically in drought years, both from increased

[440] *Ibid.,* 9-10—9-14.

[441] Oxnard Subbasin Groundwater Sustainability Plan, ES-2.

groundwater pumping and from a decrease in the water volume of the Santa Clara River, the aquifer's natural recharge source.

The area above the Oxnard subbasin was once primarily farmland, but has since been developed into towns and cities. Therefore, the primary water users of the subbasin are municipal and agricultural. The water is still used on farms to grow crops such as strawberries, peppers, lettuce, and spinach. It is also used by the City of Oxnard, the City of Port Hueneme, and the County of Ventura. The replacement of agricultural land with residential cities has reduced the area's overall water usage in the past forty years, but the water users are still over-pumping the subbasin to a critical level.

For many other aquifers around the state, the biggest problem caused by over-pumping is loss of water volume, but Oxnard's unique physical characteristics compound the problem of over-pumping by allowing saltwater to move into the aquifer as the freshwater is pumped out. The first of these physical characteristics is that the Oxnard subbasin is adjacent to the Pacific Ocean, and the second is that the subbasin has two underwater canyons that connect the subbasin to the ocean. These canyons are stacked on top of each other, with an impermeable clay layer between them. They function like pipes or canals that allow saltwater to flow into the aquifer from the Pacific Ocean. The unique geological structure of these canyons means that there are more factors to preventing saltwater intrusion than just vertical water levels. The saltwater is kept out by the *pressure* created by the freshwater in the aquifer. Because the stacked canyons create different levels in the aquifer, there are different types of pressure that need to be maintained to prevent intrusion – pressure from the top *and* from the sides.

2. Preparation of the GSP

There are three Groundwater Sustainability Agencies (GSAs) for the Oxnard Subbasin, each with jurisdiction over a different part of the subbasin. These GSAs are (1) the Fox Canyon Groundwater Management Agency GSA; (2) the Camarosa Water District-Oxnard Subbasin GSA; and (3) Oxnard Outlying Areas GSA. However, the three GSAs submitted only one GSP, the FCGMA GSP, which covers the entire Oxnard Subbasin.

The Fox Canyon Groundwater Management Agency (FCGMA), who prepared the GSP, is not a newly-formed GSA. Oxnard has known about saltwater intrusion in its aquifer since the 1930s, and the FCGMA was created by the California State Legislature in 1983 to manage and monitor saltwater intrusion into the Oxnard Subbasin.[442] Since its formation, the FCGMA has placed flowmeters on all groundwater pumps excluding domestic wells, and has issued mandatory reductions in pumping on multiple occasions.[443] Water users of the Oxnard Subbasin are accustomed to oversight and management by the FCGMA, and are therefore likely to respect their authority.

3. Conditions in the Subbasin

The Oxnard GSP prepared by the FCGMA addressed SGMA's six sustainability criteria that the subbasin must avoid to achieve sustainability: (1) chronic lowering of groundwater levels; (2) reduction of groundwater storage; (3) seawater intrusion; (4) degraded water quality; (5) land subsidence; and (6) depletions of interconnected surface water. According to the GSP, the Oxnard subbasin currently has, or is on the path to have, all

[442] Fox Canyon Groundwater Management Agency, Brief History Overview, 1.

[443] Fox Canyon Groundwater Management Agency, Brief History Overview, 7-10.

six of these “undesirable” conditions.[444] However, the GSA concluded that they only needed to focus on maintaining adequate groundwater levels to avoid seawater intrusion because “if the minimum thresholds and measurable objectives for seawater intrusion are achieved, then undesirable results for the other sustainability indicators are avoided”.[445]

- *Groundwater Levels*

Historically, the groundwater levels in the Oxnard subbasin drop during drought years, but recover after the drought has ended. The groundwater levels have not yet recovered from the drought that began in 2011.[446] There are greater water level declines in the part of the subbasin closer to the city and managed by the UWCD, and lesser water level declines in the part of the subbasin adjacent to the ocean. This discrepancy may be caused by seawater intrusion.[447]

- *Groundwater Storage*

The cumulative loss of water storage for the Oxnard Subbasin in the period of 1986 to 2015 is approximately 101,400 AF.[448] However, this number does not account for the seawater that moved into the aquifer as the freshwater was pumped out. The cumulative loss of *freshwater* storage for the Oxnard subbasin in the same period of 1986 to 2015 is approximately 380,200 AF, not including coastal flux.[449]

444 Oxnard Groundwater Sustainability Plan, ES-5.

445 *Ibid.,*ES-5.

446 *Ibid.,* 2-16.

447 *Ibid.,* 2-16.

448 *Ibid.,* 2-26.

449 *Ibid.,* 2-27.

- *Seawater Intrusion*

Seawater Intrusion is the Oxnard Subbasin's greatest concern. The FCGMA measures this seawater intrusion by the chloride levels in the water. The biggest factor in the amount of seawater intrusion is the groundwater elevation. When groundwater elevation levels are above sea level, freshwater flows out of the aquifer into the ocean. When the groundwater levels are below sea level, seawater flows into the aquifer from the ocean.[450] Significantly, "higher groundwater elevations in the aquifer do not tend to flush the seawater back out of the aquifer via the original intrusion pathway".[451] Therefore, higher groundwater elevations during wet years do not undo the seawater intrusion caused by lower groundwater elevations during dry years.

- *Degraded Water Quality*

The water quality of the Oxnard Subbasin has been dropping primarily due to seawater intrusion, which has introduced Total Dissolved Solids (TDS), Chloride, Sulfate, and Boron into the water.[452] The Subbasin also has some problems with Nitrate introduced by agricultural run-off.[453]

- *Land Subsidence*

The area above the Oxnard Subbasin has experienced some minor historical land subsidence, with the ground sinking by a few feet since 1939. However, the "DWR classified the Subbasin as an area that has a medium to high potential for future

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450 *Ibid.,* ES-3.

451 *Ibid.,* 2-28.

452 *Ibid.,* 2-33 – 2-39.

453 *Ibid.,* 2-36.

subsidence", so it is an area of focus for the GSP.[454] The Oxnard GSP concluded that because the groundwater level at which there is no seawater intrusion is higher than the historical low water level, reaching the groundwater level that prevents seawater intrusion will automatically "protect against land subsidence related to groundwater withdrawal".[455]

- *Impacts Interconnected Surface Water and GDEs*

The Oxnard Subbasin is hydraulically connected to both the Santa Clara River and Calleguas Creek. In the period of 1968 to 2015, the Santa Clara River recharged the aquifer through streambed seepage in 26 of 30 years, with an average net recharge of 5,700 acre-ft/yr.[456] In that same 30 year period, the Calleguas Creek recharged the aquifer every single year, with an average net recharge of 3,450 acre-ft/yr.[457] Similar to its approach to Land Subsidence, the Oxnard GSP concluded that it did not need to create a separate plan to address depletions of interconnected surface water because the groundwater levels they plan to maintain to prevent seawater intrusion will also prevent depletions of interconnected surface water.[458]

4. Oxnard Projects and Management Actions

Oxnard plans to use treated wastewater as a new water source. The first three Projects proposed by the Oxnard GSP are (1) to build a Water Purification Facility, (2) to expand that

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454 *Ibid.,* 2-41.

455 *Ibid.,* 3-25.

456 *Ibid.,* 2-42.

457 *Ibid.*

458 *Ibid.,* 3-26.

facility, and (3) to construct a pipe-line to bring treated effluent from the purification facility to the aquifer recharge facility.[459] They plan to use this treated wastewater for aquifer recharge, as well as for land irrigation and agriculture in order to offset the amount of groundwater pumping. In addition, the Oxnard GSA plans to use excess Santa Clara River water to recharge their aquifer. The fourth project proposed by the GSP is to expand a facility adjacent to the Santa Clara river that collects excess flood water and sends it to the aquifer recharge facility.[460] Furthermore, to help these efforts, the GSP proposes to temporarily fallow fields, specifically the fields above portions of the subbasin that suffer from the greatest amount of saltwater intrusion.[461] Lastly, as a management action, the Oxnard GSA will reduce groundwater pumping through a water allocation system that will gradually decrease the amount of water available to historic users.[462]

The beauty of Oxnard's plan is that it is one of the most efficient plans in using the area's own resources. They are not taking water from another source, such as a different aquifer or reservoir, and they are reusing water that would have otherwise been dumped into the Pacific Ocean. They therefore avoid one of the most common negative side-effects of artificial recharge: the taking of water from streams and other surface water systems, with resulting damage to riparian and aquatic habitats. Out of the many GSPs, Oxnard's plan is one of the most feasible – and most likely to achieve sustainability – largely because it is not fixing its own water issues by importing surface water from somewhere else. However, this

[459] *Ibid.,* ES-8 – ES-9.

[460] *Id.,* p. ES-9.

[461] *Ibid.*

[462] *Ibid.*

plan is not 100 percent perfect. There is a negative public perception surrounding the use of treated effluent for agriculture and for refilling a potable aquifer. While treated effluent is clean water, the Oxnard GSAs will face an uphill battle in convincing the public of this.

F. Case Study 6: Borrego Valley Subbasin GSP

1. Description of the Subbasin

Borrego Valley is unincorporated land located in northeastern San Diego County that is surrounded on almost all sides by the Anza-Borrego Desert State Park.[463] It has a desert climate, with very little annual rainfall. The Borrego Subbasin was identified as "critical" by the California DWR because its groundwater levels have declined substantially over the past 65 years. This drop in groundwater levels is primarily concentrated in the Northern and West-Central portions of the aquifer, where there is more pumping. The groundwater levels in the Southern portion of the aquifer, where there is less pumping, have remained relatively stable.[464]

The subbasin is recharged by the streams that come down from the surrounding mountains and disperse across the land in alluvial fans. These streams are part of three distinct watersheds, the Coyote Creek Watershed, the Upper San Felipe Creek Watershed, and the Borrego Valley-Borrego Sink Wash Watershed.[465] A number of these streams, especially those in the Borrego Sink Wash Watershed are ephemeral and disappear in the dry season. The recharge of the aquifer is reliant on, and therefore fluctuates with, the annual

463 Borrego Valley Groundwater Management Agency, *Draft Final Groundwater Sustainability Plan for Borrego Groundwater Basin* (2019), ES-2.

464 *Ibid.*, ES-2

465 *Ibid.,* 2-2

snowfall in the mountains. The natural recharge ranges from less than 1,000 AFY to more than 25,000 AFY, with an average of 5,700 AFY.[466] With no large surface water source in the Borrego Valley GSP Plan Area, and such a small residential population that a wastewater treatment facility is not practical, Borrego Valley does not have the option of artificial recharge.[467] Consequently, it's plan is to reduce the annual water usage of the Borrego community to the level of the average annual natural recharge, 5,700 AFY.

The primary water users of this subbasin are agricultural, residential, and recreational. The vast majority (86.8%) of the land in the Plan Area for the Borrego Valley Subbasin is undeveloped open space.[468] Agriculture uses more water than the residential and recreational users, so it is the focus of the Borrego Valley GSP conservation efforts. Prior to SGMA and this GSP, in 2004, the Borrego Water District began a Water Credits Policy (WCP) which would provide farmers with sellable water credits in exchange for fallowing their fields.[469] So far, this program has fallowed over 600 acres of irrigated land.[470]

2. Conditions in the Subbasin

The Subbasin is divided into three aquifers, the upper, middle, and lower, with the upper aquifer yielding the most water. The upper aquifer is in the northwest of the Subbasin, near Coyote Creek; the middle aquifer is in the center; and the lower aquifer is in the southeast of the Subbasin. Before development in the Subbasin Plan Area, the natural

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466 *Ibid*., 2-48.

467 *Ibid.,* 2-48.

468 *Ibid.,* 2-5.

469 *Ibid.,* 2-16.

470 *Ibid*., 2-17.

groundwater flow was from the northwest of the aquifer near Coyote Creek to the southeast of the aquifer toward Borrego Sink, a natural drainage area.[471]

The three aquifers are distinguishable by the type of soil present in each aquifer. Aquifers do not contain just water; they are also full of gravel, silt, and other sediments. The water fills the spaces between the sediments. Consequently, the coarseness and consolidation of the soil has a large impact on water yield and water movement throughout the aquifer. In the Borrego Subbasin, the upper aquifer has coarse, unconsolidated sediments, including gravel, sand, and silt, which allows for greater hydraulic conductivity and unconfined movement of water.[472] Both the middle and lower aquifers, on the other hand, have leaky or semi-confined movement of water due to partial consolidation of sediments. The middle aquifer has continental deposits of gravel to silt with some consolidation and cementation, while the lower aquifer has partly consolidated continental and lacustrine sediments and, consequently, the greatest restriction on water movement.[473] The different soils in the aquifer affect their yield. The upper aquifer, with the coarse sediments, has yields as high as 2,000 gal/min while the lower aquifer, with the fine, semi-consolidated sediments has a much lower yield.[474] Consequently, most of the wells and pumping are in the upper aquifer.

3. The GSP

The Borrego Valley GSP was prepared by the Borrego Valley Groundwater Sustainability Agency, a joint agency consisting of the Borrego Water District (BWD) and

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471 *Ibid.,* ES-2.

472 *Ibid.,* 2-46.

473 *Ibid.,* 2-47.

474 *Ibid.,* 2-46.

the County of San Diego.[475] As required by SGMA, the GSP addresses the six undesirable conditions related to the overdraft of a groundwater basin: (1) chronic lowering of groundwater levels; (2) loss of groundwater storage; (3) decrease in water quality; (4) seawater intrusion; (5) land subsidence; and (6) damage to connected surface water systems and ecosystems. The GSP determined that the last three undesirable conditions are not relevant to the Borrego Valley Subbasin. However, the Subbasin does have serious problems with chronic lowering of groundwater levels and loss of groundwater storage, and they anticipate future problems with water quality.

- *Groundwater Levels*

The Borrego Valley Subbasin is a relatively small aquifer, and the only water source in the area. This makes the chronic lowering of groundwater levels a serious threat to the Borrego community. Recent measurements of current groundwater levels, collected in Spring 2018, range from a high of 644.76 feet amsl in the northern part of the subbasin to 377.58 feet amsl directly below the primary agricultural area of Borrego Valley. Between 1953 and 2018, groundwater levels "declined by as much as 133 feet in the northern part of the Plan Area".[476] Groundwater levels dropped sharply between 1953 and 1965, during which time grapes were cultivated in Borrego. Levels began declining again, although not as rapidly, in the late 1970s, when farmers began growing citrus crops in the area. It has been dropping consistently since that time.[477]

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475 *Ibid.,* ES-1.

476 *Ibid.,* 2-54.

477 *Ibid.,* 2-55.

- *Groundwater Storage*

The storage capacity of the entire Borrego Valley Subbasin, based on pre-development groundwater levels, is estimated to have been about 5,500,000 AF. However, as the lower aquifer has such a low yield, and it is therefore extremely difficult and costly to extract water from that aquifer, the GSP decided to only look at storage in the upper and middle aquifers, which it considers to be available for use. The amount of groundwater in the upper and middle aquifers was 2,131,000 AF in 1945 (pre-development), 1,900,500 AF in 1980, and 1,566,207 in 2016.

- *Water Quality*

The water quality of the groundwater in the Borrego Valley Subbasin has historically been good.[478] However, if groundwater levels drop too far, the water will likely be contaminated by mineral deposits on the bottom of the aquifer, including deposits of sulfur, arsenic, and fluoride.[479] The subbasin has also had some historical problems with high nitrate levels caused by agricultural run-off.[480] The sustainability goal for the Borrego Valley GSP is to maintain the quality of the groundwater extracted from municipal wells so that they continue to meet potable water standards, and to also maintain the quality of groundwater in irrigation wells that is used for non-potable purposes, including agriculture.[481]

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478 *Ibid.,* 2-64.

479 *Ibid*., 2-65.

480 *Ibid*., 2-59.

481 *Ibid.,* ES-4.

- *Seawater Intrusion*

The subbasin is not on the coast, and there is no opportunity for seawater intrusion.[482]

- *Land Subsidence*

Multiple geological surveys concluded that a measurable amount of land subsidence has not occurred in the subbasin.[483]

- *Impacts on Connected Surface Water Systems and GDEs*

While there are a few streams that flow for short distances over the aquifer, such as Coyote Creek, all of these streams are fed by storm runoff and springs that are in the nearby mountains, outside of the Plan Area. The one spring that was connected to the Borrego Valley Subbasin was the Old Borrego Spring, which dried up in 1963. The GSP concluded that "the streams within the Plan Area are predominantly disconnected from the underlying groundwater table" and that the GSP did not need to address damage to connected water systems.[484]

4. Borrego Project and Management Actions

As the Borrego community does not have access to any other water source, its only option to attain sustainability is "aggressive pumping cut-backs".[485] They plan to reduce pumping by over 75% of current levels, to the Subbasin's estimated sustainable yield of 5,700 AFY before 2040. The most important of the Project and Management Actions suggested by the GSP is the Pumping Reduction Program, which allocates water to each user

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482 *Ibid.,* 2-57.

483 *Ibid.,* 2-67.

484 *Ibid.,* 2-69.

485 *Ibid.,* ES-4.

based on historical use, and then gradually reduces the amount of allocated water until the total extraction equals 5,700 AFY.[486] In addition, the Borrego Valley GSP recognizes that agriculture is one of the greatest water users, and they plan to build upon their earlier endeavor[487] to reduce agriculture in the area through a Voluntary Fallowing Program. Through this program, farmers will receive sellable water credits in exchange for fallowing their fields. The Voluntary Fallowing Program works together with a third program, the Water Trading Program, which allows groundwater users to purchase water credits from other historical users.[488] The farmers who fallowed their fields will therefore be able to sell their excess water credits to residents in the municipal areas, whose water allocations will gradually be cut by 75%, even as their water usage does not change.

The Borrego community has realized that it is running out of water. They have determined that there is no point in trying to sustain the agricultural part of their economy because they don't have the water resources to support it. Instead, they are going to fallow their agricultural fields and reduce use so that the municipal residents have enough water to live on. This plan to ration water is a survival tactic to prolong the amount of time that people can live in Borrego. There are only about 2,500 people living there now, with about another 2,500 seasonal residents who come during the winter to escape colder weather.[489] The 5,700 AFY of sustainable recharge should be able to support this population.

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486 *Ibid.,* ES-5.

487 See above section on the Borrego Springs Subbasin.

488 *Ibid.,* ES-4.

489 *Ibid.,* 2-9.

The plan to reach 5,700 AFY of annual groundwater extraction is well-designed. The strict allocation system is made feasible by the programs that allow municipal users to buy water credits from the farmers who fallow their fields. It is therefore likely that this plan will lead to sustainable use of the groundwater in the Borrego Valley Subbasin. However, this plan does not fully consider the effects of closing the agricultural economy. Borrego does not have any big businesses. The main sources of employment for its permanent residents are agriculture and seasonal tourism.[490] Without the agricultural economy, the community may no longer be able to financially sustain itself.

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490 *Ibid.,* 2-10.

Chapter 4: Diagnosis and Prognosis of SGMA

A. The San Joaquin Valley Problem: Almonds and Pistachios

SGMA, as the first state-wide groundwater legislation in California, is in itself an achievement. However, in its current form, it will most likely fail to achieve groundwater sustainability in California by 2040. A pattern clearly emerges from the GSPs: The GSAs for subbasins in the agriculturally rich and politically powerful San Joaquin Valley are not going to take the regulatory actions needed to limit groundwater use and protect the resource. At the same time, GSAs for subbasins outside the San Joaquin Valley, which largely do not have access to other water sources, plan to make a substantial effort to achieve sustainable groundwater use. SGMA will strongly restrict water access in some areas, reigning in economic and agricultural activity to match the availability of the area's water resources. Meanwhile, it will be largely ignored by the farmers of the San Joaquin Valley who will continue to expand the acreage of high-profit and high-water use export crops such as almonds. Unless stricter enforcement mechanisms are added to SGMA, it will serve to consolidate more wealth and power in the San Joaquin Valley as it limits water usage in the rest of California. The Act's underlying principal of local control is not entirely at fault, as it proved effective in areas motivated to achieve groundwater sustainability, such as Oxnard, Borrego Valley, and Paso Robles. However, the combination of local control and lack of enforcement mechanisms will lead to little or no progress toward groundwater sustainability in the San Joaquin Valley, and therefore in California as a whole.

B. Historical Regulation Outside the San Joaquin Valley

Outside the San Joaquin Valley, SGMA resulted in ambitious GSPs that sought to achieve groundwater sustainability by cutting consumption and reorganizing water use priorities within the subbasins. The success of SGMA in these areas is largely due to how well the doctrine of local control works in subbasins with already-established groundwater management practices. Despite the lack of statewide groundwater legislation prior to SGMA, there is actually groundwater regulation in California – it is just local, not state-wide regulation – and it varies widely in terms of scope. A number of subbasins outside the San Joaquin Valley were already being actively regulated by counties, cities, and water management agencies prior to the passing of SGMA – perhaps the most prominent one being the Orange County Water District, which was established by state statute in 1933 and is today viewed as a model for effective groundwater management. Similarly, the Oxnard subbasin is managed by the Fox Canyon Groundwater Management Agency, which was established by state decree in 1982. Both agencies have been charging water pumping fees and issuing pumping restriction ordinances since their inception. The Fox Canyon Groundwater Management Agency even adopted its own drought-related emergency ordinance prior to SGMA in April 2014 that cut users' water allocations by twenty percent.[491]

The Paso Robles Subbasin is managed in part by the County of San Luis Obispo, and the County has been active in trying to prevent increases in groundwater pumping. Specifically, the County in 2015 adopted a Water Demand Offset Ordinance under which they may approve new well permits but only on condition that the applicant either fallow a field or switch to less water-intensive crops.[492] This concept of tying new well permits to fallowing or crop switching is straightforward and could be easily be applied to other

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491 Fox Canyon Groundwater Management Agency, Emergency Ordinance E.

492 Paso Robles GSP, 3-28.

overdrafted subbasins in the state, including those in the San Joaquin Valley. Yet, no GSPs from the San Joaquin Valley mention it or indicate they are even aware of such a program. This fact alone shows one of the weakness of SGMA: Due to its rigid commitment to local control, SGMA does not encourage the various GSAs to investigate the conservation strategies and methods developed by other local groundwater agencies in the state. And because neither DWR nor SWRB play an active role in directing how GSPs are prepared, they have no ability to require GSAs to consider ideas or approaches being used successfully elsewhere.

Like Orange County, Oxnard, and Paso Robles, the Borrego Valley Subbasin has been subject to local regulation prior to SGMA, this time by the Borrego Water District. The Water District has been issuing farmers "Water Credits" for the fallowing of agricultural land since 2004, and the District responded to SGMA by simply accelerating this process.[493] In the case of Borrego Valley, SGMA allowed groundwater regulation to remain under local control and thereby kept the preexisting regulatory powers in place. SGMA merely pushed the Borrego Valley GSA to calculate a sustainability goal and develop an effective plan to reach that goal. It gave focus and direction to communities that were already trying to manage and preserve their groundwater resources. It also provided the GSAs with authority under state law to impose more controls if the GSAs deemed them necessary.

C. No Regulation in the San Joaquin Valley

The problem, however, is that not all "overdraft" areas want to limit and regulate groundwater pumping in order to preserve the resource. While the majority of critically-listed subbasins outside the San Joaquin Valley have been regulated in some way by counties,

[493] Borrego Springs GSP, 2-16

water districts, or other water management agencies, the subbasins underlying the San Joaquin Valley, California's largest agricultural zone, have been largely free of regulation. The San Joaquin Valley, which includes the subbasins of Eastern San Joaquin, Delta-Mendota, and Chowchilla, among others, is controlled by a small number of politically and economically powerful macro-farmers who own extensive amounts of land.

Historically and by law, groundwater in California belongs to the person who owns the land above it, which means that landowners, especially if their landholdings are large and overlie a productive aquifer, have a tremendous amount of power when it comes to how those groundwater resources are used and who gets to use them. In the San Joaquin Valley, there are a few large landowners who are the primary groundwater users. These landowners have successfully fought off any government attempt to regulate their pumping practices. SGMA did not change this. SGMA includes no enforcement mechanisms that would require GSAs to legally mandate pumping limits or restrictions. Given that the GSAs in the San Joaquin Valley are largely controlled by the very same landowners who would be subject to any such pumping restrictions, it is no surprise that none of the San Joaquin Valley GSPs adopted one. In other words, the GSA will only impose pumping regulations if they believe their communities will agree to accept and implement them. In the San Joaquin Valley, there is no interest, economic or environmental, to go down this path. As a result, SGMA provides no means to reshape groundwater consumption or pumping behavior in this part of the state, where the vast majority of groundwater is used.

The GSAs are not entirely at fault for this. Even if a particular GSA in the San Joaquin Valley *wanted* to impose pumping rules or other requirements that would change use patterns and behavior, and even if a majority of users within the subbasin agreed to these rules and requirements, there is a good chance the effort would fail. This is because SGMA still allows individual groundwater users to seek water rights adjudication through the courts, regardless of any rules or programs set forth in the GSP. Thus, the GSA's powers are impeded by an adjudication process that allows water users/land owners with water rights to sue an agency for imposing too-strict regulations and have the court allocate the water. SGMA made no attempt to modify the adjudication of groundwater, and the results of this is felt most strongly in the San Joaquin Valley where land owners have the economic means and economic incentive to challenge the GSA's regulations in court. To avoid this situation, the GSAs of the San Joaquin Valley put little to no regulation in their sustainability plans, and instead hope to find and import additional surface water to their area – a method that will not lead to long-term sustainability, in part because there is no guarantee that this "additional" surface water will even be available for the kind of in-lieu use the GSPs describe.

In fact, history has shown two things to be true when it comes to water use in California: First, increasing imported water supplies only encourages more consumption, which eventually leads to shortages and a new search for more supplies which, if found, results in more over-use. Second, while dry years are always eventually followed by wet years, this cycle does not allow overdrafted groundwater subbasins to recharge to a level of zero net loss. The deficit rises and drops, but it never goes away. It just gets incrementally worse over time. Most climate scientists predict that in the next 50 years, droughts in California will become more frequent, more extreme, and last longer. This change in precipitation patterns will only worsen the groundwater deficit problem; it will also eliminate some of the “additional” surface water that the San Joaquin Valley GSAs hope to import to their region.

Despite the macro-farms in the San Joaquin Valley essentially claiming that they do not need groundwater regulation, the San Joaquin Valley was clearly a target for SGMA. The Department of Water Resources identified 127 subbasins that were in overdraft conditions and required GSPs, of which 21 subbasins were in “critical” overdraft and subject to the early deadline of January 31, 2020. Eleven of these 21 critically over-drafted subbasins were in the San Joaquin Valley. In fact, almost every San Joaquin Valley subbasin south of the Sacramento Bay-Delta was labeled as critical. Despite this, the San Joaquin Valley GSPs unanimously decided to not limit groundwater usage through regulatory action. Instead, they proposed multi-million dollar projects (in many cases upward of $300 million) to bring more surface water to their area, ostensibly to offset groundwater pumping. However, the trend in the San Joaquin Valley over the past 30 years has been for farmers to switch from row crop staples such as broccoli and tomatoes to high-profit export crops such as almonds and pistachios. Almonds and pistachios require an enormous amount of water per unit, largely because the trees they grow on need to be irrigated year-round and cannot be fallowed. For this reason, groundwater depletion in the Central Valley tends to parallel the expansion of almond and pistachio orchards. The amount of Central Valley acreage dedicated to these water-intensive high-profit nuts is expected to increase in the coming years, and bringing more surface water to the area will only speed up this process without reducing groundwater pumping or alleviating overdraft conditions.

D. Economics vs. Resource

Outside the San Joaquin Valley, the most common proposed action to protect groundwater resources is to limit or reduce farming in the area, or at least to alter the manner in which groundwater is used on existing farms. It is the primary management action of the Borrego Springs GSP, which sees drastically cutting agriculture as the only way to keep the area livable for the small community of residents who rely on groundwater for potable uses. The Paso Robles GSA also observed the adverse relationship between groundwater depletion and agricultural expansion, which is why it tied new well permits to land fallowing and/or crop switching. Even Oxnard, whose primary solution to groundwater depletion was artificial recharge with wastewater, mandated the fallowing of land above the areas that suffer from the greatest seawater intrusion. But agriculture is not the only economic consideration in Paso Robles, Borrego, and Oxnard, and the GSAs in these areas are limiting growth in the agricultural sector only because groundwater is depleted to a point where such action is necessary for survival of the resource. In the San Joaquin Valley, agriculture *is* the economy. There are no other economic sectors for the area to fall back on. Furthermore, there is not a shortage of water. The San Joaquin Valley is the direct recipient of CVP and SWP water, programs that are designed to maintain agriculture in the region. Their subbasins are also, on average, much larger and deeper than the other critical subbasins scattered throughout the rest of California, and they don’t feel the urgency of a disappearing resource.

Still, perhaps the most important factor in this area’s refusal to regulate groundwater pumping is that profits tend to increase where there are few regulations. The San Joaquin Valley almond and pistachio farmers have a highly successful business model that relies on large quantities of free or highly-subsidized water. It is natural for them to do everything in their power to protect that business model. However, their unwillingness to alter their consumptive practices frustrates conservation efforts made elsewhere in California. The rest of the state is trying to conserve water by changing their lifestyles and livelihoods, while San Joaquin Valley almond and pistachio farmers, despite complying with SMGA's *procedural* requirements, such as submitting GSPs by the January 31, 2020 deadline, have done little to advance SGMA's *substantive* goal, which is to achieve groundwater sustainability by the second half of the 21st century. The almond and pistachio farmers of the San Joaquin Valley have so much power and leverage over the state they feel like they don't have to change. In fact, rather than taking SGMA as an opportunity to rethink water usage practices in the area, the GSAs in the San Joaquin Valley have used it as a pretext to propose the building of expensive, tax-payer funded infrastructure that will bring more surface water to their farmland from other areas of California. As we have seen from the trends over the last 30 years, more water will only lead to more acreage being converted to almond and pistachio orchards.

However, unlike Borrego Springs and other dryer areas, the San Joaquin Valley does not need to abandon agriculture entirely in order to reduce their water use; they simply need to change their crop mix. The relatively recent switch to water-intensive export crops is the main cause of their unsustainable groundwater use. If California lawmakers want SGMA to be as effective in the San Joaquin Valley as in the rest of the state, they need to put other enforcement mechanisms in place that mandate either pumping limits or crop mix changes.

E. Lack of a Cumulative Impact Assessment

SGMA encourages GSAs to view their respective groundwater subbasins as local resources, with little connection to the larger statewide network of surface water and groundwater supplies. This would not be a problem if DWR or SWRB collected the various GSPs and then conducted its own analysis of the *cumulative* effects of groundwater use in the overdrafted subbasins. This broader analysis could also investigate whether surplus water was, in fact, available to reduce the groundwater deficits as so many of the GSAs assume. It is possible, and in some cases likely, that many of the GSAs, whether they know it or not, are competing for the same "surplus" water, which means most will not receive the water they currently plan to use to offset their groundwater pumping. Without a statewide cumulative assessment, however, it is difficult to see or manage this potentially major problem.

The same goes for the funding of the GSP projects. No individual GSA examines whether the grants and loans they hope to use for water supply infrastructure projects are also being targeted by other GSAs looking for the same financial assistance. Just as much of California's water is over-allocated, it is likely that water project funding could also become over-allocated, and many infrastructure projects will never be built. For example, the three San Joaquin Valley GSPs analyzed in this thesis – the Northern and Central Delta-Mendota, the Chowchilla, and the Eastern San Joaquin – proposed projects with a combined estimated cost of more than $800 million. There are currently no known funding sources to cover this amount. Additionally, many of the other overdrafted subbasins in the San Joaquin Valley, such as Kern and Merced, are looking for grants and low interest loans to fund their large projects as well. Everyone is focused on the same funding sources, but no one is checking to see whether there will be enough money for all the GSAs' projects. SGMA does not require DWR or SWRB to evaluate whether the funding assumptions set forth in the various GSPs are realistic. As a result, there is no way to know whether the projects necessary for groundwater sustainability in these areas will ever be built.

Chapter 5: Conclusion

California has the most elaborate and complex surface water delivery system in the United States, with an intricate network of reservoirs, dams, siphons, aqueducts, pumps, canals, and diversion stations that convey water from one part of the state to another, passing through the jurisdictions of multiple water agencies along its way. Yet, as complicated as California's surface water system may be, the state's groundwater resources are even less understood. Although groundwater serves anywhere from 40% to 60% of California's water needs in any given year, the state government has largely left groundwater basins and subbasins unregulated. In fact, most groundwater wells in California, even the deep ones used for irrigating thousands of acres of crops, are unmetered, which means no one really knows how much groundwater any particular well is extracting on a daily, monthly, or yearly basis.

Uncontrolled and unregulated groundwater pumping has been a problem in California for nearly a century, causing well failure, water quality degradation, loss of riparian habitat, land subsidence, and seawater intrusion. The California legislature has historically taken the position that groundwater is a local issue that is best managed at the local level. In many ways, this is true, given that each groundwater basin is unique in terms of its hydrogeological conditions and the demands that the overlying land owners place upon it. And some local agencies, such as the Orange County Water District, have had success in developing management strategies for ensuring that the groundwater subbasins under their control are not overused to the point of chronic overdraft. For most of the state, however, the local farming interests have resisted anything resembling systematic groundwater regulation, whether imposed by local water agencies or the state. Many of these farming interests, especially those in the San Joaquin Valley, are politically powerful and have successfully blocked attempts by the Legislature to manage California's groundwater resources.

This situation changed in 2014, when an extreme three-year drought caused surface water deliveries to be curtailed, forcing farmers to pump more groundwater than ever before. Groundwater levels dropped sharply, wells went dry, land subsided at an alarming rate, and key infrastructure was damaged. The Legislature responded by passing the Sustainable Groundwater Management Act (SGMA), which promised to finally address the long-standing groundwater overdraft problems in the state. It represented a major shift in California's approach to groundwater management, and put California more in line with Idaho, Nevada, Arizona, Utah, and Colorado. For the first time in the state's history, groundwater monitoring data would be used to develop management strategies that would reverse decades of overdraft and seek to achieve sustainability.

One of the key features of SGMA is that it retained the concept of local control, with the state water agencies having only an oversight or "backstop" role. By delegating groundwater governance and regulation to local agencies, SGMA's sponsors were able to reduce opposition from San Joaquin Valley farmers and get the Act passed. The question, however, is whether local control is an effective approach to managing the state's groundwater resources or merely a political compromise that, in the end, will not result in effective change. There was no way to answer this question until January 31, 2020, when the various local GSAs submitted their Groundwater Sustainability Plans (GSPs) to the Department of Water Resources.

This thesis analyzed a representative sample of the GSPs filed by the January 31, 2020 deadline, and that analysis shows that SGMA has done little to change long-standing attitudes about groundwater conservation, at least among water users in the San Joaquin Valley. In subbasins like Oxnard and Borrego Valley, which have little access to additional or new surface water supplies, the GSAs have built GSPs that genuinely address groundwater sustainability and recommend realistic measures for achieving it. In the subbasins of the San Joaquin Valley, however, the GSPs reject any measure that would require local farmers to reduce groundwater pumping; instead, the GSPs focus almost exclusively on supplementing exiting surface water supplies, much of which is imported through the CVP and SWP. In taking this approach, the GSPs do nothing to curb the expansion of almond and pistachio orchards and the "demand hardening" that tends to come with these two crops.

Based on the information contained in the GSPs, it appears that SGMA will not fundamentally change groundwater management in California, but will instead perpetuate and reinforce the existing power structure that exists between large-scale agribusiness in the San Joaquin Valley and the smaller farming operations that are located beyond the reach of the CVP and SWP. GSAs in subbasins like Oxnard and Borrego have no choice but to radically change how they use groundwater, and that generally means strict restrictions on pumping. GSAs in subbasins like Delta-Mendota and the Eastern San Joaquin, on the other hand, plan to ask for hundreds of millions of dollars, in grants and low interest loans, to fund massive infrastructure projects which, if all goes as planned, will bring more surface water to the region, thereby eliminating the need for long-term conservation measures. In the end, the San Joaquin and the rest of the Central Valley will retain their stronghold on California's water, both above and below ground, as the rest of the state dries up. This is certainly not what the sponsors of SGMA wanted or intended, but unless the statute is amended to give

DWR a more up-front strategic role, complete with extensive enforcement powers, groundwater sustainability in California is not likely to be achieved.

Ultimately, my research has led me to the following five conclusions:

First, much of California's groundwater overdraft problem, especially in the San Joaquin Valley, can be traced to the widespread conversion from annual row crops to perennial orchard crops – primarily almonds and pistachios – that has occurred over the last 25 years. Almonds and pistachio orchards cannot be fallowed and require water all year round, placing significant stress on existing surface and groundwater sources.

Second, SGMA's commitment to local management of groundwater, while consistent with past practices, may cause the statute to fail in its primary mission, as it allows local users to continue non-sustainable pumping behavior so long as they can identify some future, potential source of recharge water, even if that source may already be overallocated.

Third, the GSAs in the San Joaquin Valley have no interest in restricting groundwater pumping or crop conversion to meet their sustainability goals. Instead, they hope to achieve groundwater sustainability by increasing their current supplies of *surface* water, much of which is provided by the CVP and SWP. The projects required to achieve this objective, however, are extremely expensive, and may never be realized.

Fourth, in contrast to the San Joaquin Valley, the GSAs that are outside the reach of the CVP and SWP have few options for increasing water supply and must focus on reducing demand, which means accepting restrictions on groundwater pumping and switching to less water-intensive crops.

Lastly, I conclude that SGMA has the potential to create a two-class system in which the GSAs of the Central Valley (including the San Joaquin Valley) are allowed to continue pumping without limitation, while the GSAs beyond the CVP/SWP distribution system must conserve and fundamentally change behavior. This likely will increase the economic and political power of the Central Valley growers at the expense of everyone else. The only way to prevent this disparity and ensure equity among agricultural interests throughout the state is for DWR to play a more active leadership role in SGMA's implementation, and to view groundwater management from a cumulative, not a local, perspective.

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