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County Government Center
1055 Monterey Street, Room 206
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Submitted online via: https://www.slocounty.ca.gov/Departments/Public-Works/Committees-Programs/Sustainable-Groundwater-Management-Act-(SGMA)/Paso-Robles-Groundwater-Basin/GSP-Development.aspx

Re: Chapters 9-11 of the Paso Robles Subbasin Draft GSP

Dear Angela Ruberto,

The Nature Conservancy (TNC) appreciates the opportunity to comment on Chapters 9-11 of the Paso Robles Subbasin Draft Groundwater Sustainability Plan (GSP) being prepared under the Sustainable Groundwater Management Act (SGMA). Please note that we have previously submitted comments dated 15 April 2019 on Chapters 4-8 and Appendix B of the Paso Robles Subbasin Draft GSP.

TNC is a global, nonprofit organization dedicated to conserving the lands and waters on which all life depends. We seek to achieve our mission through science-based planning and implementation of conservation strategies. For decades, we have dedicated resources to establishing diverse partnerships and developing foundational science products for achieving positive outcomes for people and nature in California. TNC was part of a stakeholder group formed by the Water Foundation in early 2014 to develop recommendations for groundwater reform and actively worked to shape and pass SGMA. We believe that the success of SGMA depends on bringing the best available science to the table, engaging all stakeholders in robust dialog, providing strong incentives for beneficial outcomes and rigorous enforcement by the State of California.

Our specific comments related to Chapters 9-11 of the Draft GSP are provided in detail in **Attachment B** and are in reference to the numbered items in **Attachment A. Attachment C** provides a list of the freshwater species located in the Paso Robles Subbasin. **Attachment D** describes six best practices that GSAs and their consultants can apply when using local groundwater data to confirm a connection to groundwater for DWR's Natural Communities Commonly Associated with Groundwater Dataset[2]. **Attachment E** provides an overview of a new, free online tool that allows GSAs to assess changes in groundwater-dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data.

Thank you for fully considering our comments as you develop your GSP.

Best Regards,

Sandi Matsumoto
Associate Director, California Water Program
The Nature Conservancy

Attachment A
Considering Nature under SGMA: A Checklist

The Nature Conservancy is neither dispensing legal advice nor warranting any outcome that could result from the use of this checklist. Following this checklist does not guarantee approval of a GSP or compliance with SGMA, both of which will be determined by DWR and the State Water Resources Control Board.

GSP Plan Element*		GDE Inclusion in GSPs: Identification and Consideration Elements		Check Box
Admin Info	**2.1.5 Notice & Communication** *23 CCR §354.10*	**Description of the types of environmental beneficial uses of groundwater that exist within GDEs and a description of how environmental stakeholders were engaged throughout the development of the GSP.**		1
Planning Framework	**2.1.2 to 2.1.4 Description of Plan Area** *23 CCR §354.8*	**Description of jurisdictional boundaries, existing land use designations, water use management and monitoring programs; general plans and other land use plans relevant to GDEs and their relationship to the GSP.**		2
		Description of instream flow requirements, threatened and endangered species habitat, critical habitat, and protected areas.		3
		Summary of process for permitting new or replacement wells for the basin, and how the process incorporates protection of GDEs		4
Basin Setting	**2.2.1 Hydrogeologic Conceptual Model** *23 CCR §354.14*	**Basin Bottom Boundary:** Is the bottom of the basin defined as at least as deep as the deepest groundwater extractions?		5
		Principal aquifers and aquitards: Are shallow aquifers adequately described, so that interconnections with surface water and vertical groundwater gradients with other aquifers can be characterized?		6
		Basin cross sections: Do cross-sections illustrate the relationships between GDEs, surface waters and principal aquifers?		7
	2.2.2 Current & Historical Groundwater Conditions *23 CCR §354.16*	**Interconnected surface waters:**		8
		Interconnected surface water maps for the basin with gaining and losing reaches defined (included as a figure in GSP & submitted as a shapefile on SGMA portal).		9
		Estimates of current and historical surface water depletions for interconnected surface waters quantified and described by reach, season, and water year type.		10
		Basin GDE map included (as figure in text & submitted as a shapefile on SGMA Portal).		11
		If NC Dataset *was* used:	Basin GDE map denotes which polygons were kept, removed, and added from NC Dataset (Worksheet 1, can be attached in GSP section 6.0).	12

			The basin's GDE shapefile, which is submitted via the SGMA Portal, includes two new fields in its attribute table denoting: 1) which polygons were kept/removed/added, and 2) the change reason (e.g., why polygons were removed).	13
			GDEs polygons are consolidated into larger units and named for easier identification throughout GSP.	14
		If NC Dataset *was not* used:	Description of why NC dataset was not used, and how an alternative dataset and/or mapping approach used is best available information.	15
		Description of GDEs included:		16
		Historical and current groundwater conditions and variability are described in each GDE unit.		17
		Historical and current ecological condition and variability are described in each GDE unit and adequate to describe baseline as of 2015.		18
		Each GDE unit has been characterized as having high, moderate, or low ecological value.		19
		Inventory of species, habitats, and protected lands for each GDE unit with ecological importance (Worksheet 2, can be attached in GSP section 6.0).		20
	2.2.3 Water Budget *23 CCR §354.18*	Groundwater inputs and outputs (e.g., evapotranspiration) of native vegetation and managed wetlands are included in the basin's historical and current water budget.		21
		Potential impacts to groundwater conditions due to land use changes, climate change, and population growth to GDEs and aquatic ecosystems are considered in the projected water budget.		22
Sustainable Management Criteria	**3.1 Sustainability Goal** *23 CCR §354.24*	**Environmental stakeholders/representatives were consulted.**		23
		Sustainability goal mentions GDEs or species and habitats that are of particular concern or interest.		24
		Sustainability goal mentions whether the intention is to address pre-SGMA impacts, maintain or improve conditions within GDEs or species and habitats that are of particular concern or interest.		25
	3.2 Measurable Objectives *23 CCR §354.30*	**Description of how GDEs were considered and whether the measurable objectives and interim milestones will help achieve the sustainability goal as it pertains to the environment, beneficial uses and managed areas.**		26
	3.3 Minimum Thresholds *23 CCR §354.28*	**Description of how GDEs and environmental uses of surface water were considered when setting minimum thresholds for relevant sustainability indicators:**		27
		Will adverse impacts to GDEs and/or aquatic ecosystems dependent on interconnected surface waters (beneficial user of surface water) be avoided with the selected minimum thresholds?		28
		Are there any differences between the selected minimum threshold and state, federal, or local standards relevant to the species or habitats residing in GDEs or aquatic ecosystems dependent on interconnected surface waters?		29
	3.4 Undesirable Results *23 CCR §354.26*	**For GDEs, hydrological data are compiled and synthesized for each GDE unit:**		30
		If hydrological data *are available* within/nearby the GDE	Hydrological datasets are plotted and provided for each GDE unit (Worksheet 3, can be attached in GSP Section 6.0).	31
			Baseline period in the hydrologic data is defined.	32
			GDE unit is classified as having high, moderate, or low susceptibility to changes in groundwater.	33

			Cause-and-effect relationships between groundwater changes and GDEs are explored.	34
		If hydrological data *are not available* within/nearby the GDE	Data gaps/insufficiencies are described.	35
			Plans to reconcile data gaps in the monitoring network are stated.	36
		For GDEs, biological data are compiled and synthesized for each GDE unit:		37
		Biological datasets are plotted and provided for each GDE unit, and provide baseline conditions for assessment of trends and variability.		38
		Data gaps/insufficiencies are described.		39
		Plans to reconcile data gaps in the monitoring network are stated.		40
		Description of potential effects on GDEs, land uses and property interests:		41
		Cause-and-effect relationships between GDE and groundwater conditions are described.		42
		Impacts to GDEs that are considered to be "significant and unreasonable" are described.		43
		Known hydrological thresholds or triggers (e.g., instream flow criteria, groundwater depths, water quality parameters) for significant impacts to relevant species or ecological communities are reported.		44
		Land uses include and consider recreational uses (e.g., fishing/hunting, hiking, boating).		45
		Property interests include and consider privately and publicly protected conservation lands and opens spaces, including wildlife refuges, parks, and natural preserves.		46
Sustainable Management Criteria	**3.5 Monitoring Network** *23 CCR §354.34*	Description of whether hydrological data are spatially and temporally sufficient to monitor groundwater conditions for each GDE unit.		47
		Description of how hydrological data gaps and insufficiencies will be reconciled in the monitoring network.		48
		Description of how impacts to GDEs and environmental surface water users, as detected by biological responses, will be monitored and which GDE monitoring methods will be used in conjunction with hydrologic data to evaluate cause-and-effect relationships with groundwater conditions.		49
Projects & Mgmt Actions	**4.0. Projects & Mgmt Actions to Achieve Sustainability Goal** *23 CCR §354.44*	Description of how GDEs will benefit from relevant project or management actions.		50
		Description of how projects and management actions will be evaluated to assess whether adverse impacts to the GDE will be mitigated or prevented.		51

* In reference to DWR's GSP annotated outline guidance document, available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf

Attachment B

TNC Evaluation of Chapters 9 - 11 of the Paso Robles Subbasin Draft GSP

This attachment summarizes our comments on Chapters 9-11 of the Paso Robles Subbasin Draft GSP. In this section, we refer to our previous comments, dated 15 April 2019, on Chapters 4-8 and Appendix B of the Draft GSP.

Chapter 9 Management Actions and Projects
[Checklist Items #50-51]:

- As stated in TNC's previous comments in our previous letter on Chapter 8, Sections 8.4 and 8.9, interconnected surface waters (ISWs) *do* exist in the Paso Robles Subbasin, and thus there is a need to establish sustainable management criteria for ISWs in the basin and minimum thresholds for these ISWs. After identifying these minimum thresholds, **please include ISWs as a specific sustainability indicator to be addressed by management actions and projects as described in Chapter 9**. For the management actions and projects already identified, state how ISWs will be benefited or protected. If ISWs will not be adequately protected by those listed, please include and describe additional management actions and projects.
- Page 1 states that the most important sustainability indicator used in development of the management actions and projects is the stabilization of groundwater levels. However, an important data gap already recognized is the lack of publicly available groundwater elevation data in the Alluvial Aquifer. As discussed in TNC's previous comments on Chapter 8, Section 8.4, a scientifically robust methodology must be proposed for establishing the initial minimum thresholds for the Alluvial Aquifer. **In light of the data gap regarding Alluvial Aquifer groundwater data, please be more specific in stating how GDEs and ISWs would benefit from management actions and projects, and how actions and projects will be evaluated to assess whether adverse impacts to GDEs will be mitigated or prevented**:
    - Well Interference Mitigation Program (Page 8): This management action could be expanded to benefit GDEs and ISWs by choosing wells for the rotation or well spacing program that are screened in the alluvial aquifer and located in close proximity to rivers and streams, thus spreading out potential drawdown effects.
    - Promote Stormwater Capture (Page 10): Please describe how recharge from unallocated storm flows will be evaluated to assess benefits to GDEs and ISWs.
    - Mandatory Pumping Reductions (Page 14): Please discuss the data gap for wells screened in the alluvial aquifer and the data gap for vertical gradient between the alluvial aquifer and Paso Robles Formation, since most wells are screened in the Paso Robles aquifer. When these data gaps are resolved, it will become clearer how mandatory pumping reductions could also benefit GDEs and ISWs.

- Agricultural Land and Pumping Allowance Retirement (Page 21): Retirement of agricultural land may include land near rivers and streams, which could impact GDEs and ISWs by decreasing surface runoff and flow, or by decreasing recharge from deep percolation of irrigation water. Conversely, retirement of agricultural land would increase local groundwater levels in the pumped aquifers. The potential benefit or impact of agricultural retirement on GDEs needs to be evaluated.
    - Conceptual Projects (Pages 27-56): Most of the conceptual projects involve in-lieu recharge for the direct use of recycled wastewater. Thus, the recycled water would replace pumped groundwater. Since these conceptual projects are location-specific, please highlight the benefits of these conceptual projects on specific mapped GDEs and ISWs.
    - Substitute Project 4 (Page 73): The capture of 10 cfs of Salinas River flood flows for recharge in a basin should include investigation to see if there is an effect on any instream species, GDEs or wetland habitats located on the Salinas River or hydraulically connected to the river. How this diversion will affect instream flow requirements that are currently being met by dam releases should also be described. **Please state the impact of the diversion of 10 cfs Salinas River flow on freshwater species in the Paso Robles Subbasin (see Attachment C).**
- For more case studies on how to incorporate environmental benefits into groundwater projects, please visit our website: https://groundwaterresourcehub.org/case-studies/recharge-case-studies/

Section 10.2.1.1 Improve Monitoring Network (p. 10-11)
(Checklist item #47-49]:

- **Please further describe the expansion of the monitoring program and specify what types of monitoring will be done to identify impacts to GDEs. Be more specific in describing wells and screened intervals that represent the water levels of both the Alluvial Aquifer and Paso Robles Formation Aquifer.**

Section 10.2.5 Evaluating Interconnected Surface Water (p. 14-15)
[Checklist Item #48]:

- The text states "*As discussed in Chapter 5, the consensus among local groundwater experts is that there is no interconnection between surface water and groundwater in the Subbasin*." (p. 14) This sentence is contradictory to the ISW mapping conducted in Chapter 5 (Figure 5-17). Per TNC's previous comments on Chapter 5, interconnected surface waters *do* exist in the Paso Robles Subbasin (Figure 5-17). Depletions of surface water were also estimated in Section 5.5.1. Therefore, sustainable management criteria and an associated monitoring network for interconnected surface water and groundwater *do* need to be developed in the GSP, as stated in our comments on Chapter 9 above, and depletion of ISWs should be monitored. The Draft GSP states that an initial hydrogeologic investigation will be conducted. **Please provide sufficient detail for the investigation and monitoring program including stream gauges, screened intervals and**

aquifers of the shallow wells and frequency of monitoring, in order to describe monitoring of both the extent of ISWs and the quantity of surface water depletions from ISWs.

- Wells should be selected that are at varying distances from the river to capture vertical gradients from one aquifer to the other and to determine the ISWs and monitor any depletion in ISWs. As stated in TNC's previous comments in our previous letter on Chapter 7, **there is a need to enhance monitoring of stream flow and vertical groundwater gradients by installing more stream gauges and clustered/nested wells near streams, rivers or wetlands.** Ideally, co-locating stream gauges with clustered wells that can monitor groundwater levels in both the Alluvial and Paso Robles Formation aquifers would enhance understanding about where ISWs exist in the basin and whether pumping is causing depletions of surface water or impacts on beneficial users of surface water and groundwater.
- As stated in TNC's previous comments in our previous letter on Chapter 7, the Nature Conservancy recommends identifying beneficial users of surface water, which include environmental users. This is a critical step, as it is impossible to define "significant and unreasonable adverse impacts" without knowing *what* is being impacted, nor is possible to monitor ISWs in a way that can "identify adverse impacts on beneficial uses of surface water". For your convenience, we've provided a list of freshwater species within the boundary of the Paso Robles basin in **Attachment C**. **Please identify appropriate biological indicators that can be used to monitor potential impacts to environmental beneficial users as a current data gap and explain how this data gap will be filled.**

<u>Chapter 11 Notice and Communications (including separate Communications and Engagement Plan)</u>
[Checklist Item #1]:

- Section 3.0 of the Communications and Engagement Plan (Page 6) lists aquatic ecosystems as a beneficial groundwater use. However, no details are given as to the types and locations of environmental uses and habitats supported, or the designated beneficial environmental uses of surface waters that may be affected by groundwater extraction in the subbasin. **To identify environmental users, please refer to the following**:
    - Natural Communities Commonly Associated with Groundwater dataset (NC Dataset) - https://gis.water.ca.gov/app/NCDatasetViewer/
    - The list of freshwater species located in the Paso Robles Subbasin in **Attachment C** of this letter. Please take particular note of the species with protected status.
    - Lands that are protected as open space preserves, habitat reserves, wildlife refuges, etc. or other lands protected in perpetuity and supported by groundwater or ISWs should be identified and acknowledged.

Attachment C

Freshwater Species Located in the Paso Robles Subbasin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result “depletion of interconnected surface waters”, Attachment C provides a list of freshwater species located in the Paso Robles Subbasin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the Paso Robles groundwater basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[1]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife’s BIOS[2] as well as on The Nature Conservancy’s science website[3].

Scientific Name	Common Name	Legally Protected Status		
		Federal	**State**	**Other**
BIRD				
Actitis macularius	Spotted Sandpiper			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	SSC	BSSC - First priority
Aix sponsa	Wood Duck			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya collaris	Ring-necked Duck			
Aythya valisineria	Canvasback		SSC	
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			

[1] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710
[2] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS
[3] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Calidris mauri	Western Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Egretta thula	Snowy Egret			
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Gallinula chloropus	Common Moorhen			
Geothlypis trichas trichas	Common Yellowthroat			
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Icteria virens	Yellow-breasted Chat		SSC	BSSC - Third priority
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius americanus	Long-billed Curlew			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Pandion haliaetus	Osprey		Watch list	
Pelecanus erythrorhynchos	American White Pelican		SSC	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Riparia riparia	Bank Swallow		Threatened	
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa solitaria	Solitary Sandpiper			
Vireo bellii	Bell's Vireo			
Vireo bellii pusillus	Least Bell's Vireo	Endangered	Endangered	

Xanthocephalus xanthocephalus	Yellow-headed Blackbird		SSC	BSSC - Third priority
CRUSTACEAN				
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	SSC	IUCN - Vulnerable
Cyprididae fam.	Cyprididae fam.			
Hyalella spp.	Hyalella spp.			
Pacifastacus spp.	Pacifastacus spp.			
FISH				
Oncorhynchus mykiss - SCCC	South Central California coast steelhead	Threatened	SSC	Vulnerable - Moyle 2013
Catostomus occidentalis mnioltiltus	Monterey sucker			Least Concern - Moyle 2013
Catostomus occidentalis occidentalis	Sacramento sucker			Least Concern - Moyle 2013
Cottus gulosus	Riffle sculpin		SSC	Near-Threatened - Moyle 2013
Entosphenus tridentata ssp. 1	Pacific lamprey		SSC	Near-Threatened - Moyle 2013
Lavinia exilicauda exilicauda	Sacramento hitch		SSC	Near-Threatened - Moyle 2013
Lavinia exilicauda harengeus	Monterey hitch		SSC	Vulnerable - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Orthodon microlepidotus	Sacramento blackfish			Least Concern - Moyle 2013
Ptychocheilus grandis	Sacramento pikeminnow			Least Concern - Moyle 2013
Oncorhynchus mykiss - SCCC	South Central California coast steelhead	Threatened	SSC	Vulnerable - Moyle 2013
HERP				
Actinemys marmorata marmorata	Western Pond Turtle		SSC	ARSSC

Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Anaxyrus boreas halophilus	California Toad			ARSSC
Anaxyrus californicus	Arroyo Toad	Endangered	SSC	ARSSC
Pseudacris cadaverina	California Treefrog			ARSSC
Pseudacris hypochondriaca	Baja California Treefrog			
Pseudacris regilla	Northern Pacific Chorus Frog			
Rana boylii	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	SSC	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	SSC	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	SSC	ARSSC
Taricha torosa	Coast Range Newt		SSC	ARSSC
Thamnophis hammondii hammondii	Two-striped Gartersnake		SSC	ARSSC
Thamnophis sirtalis infernalis	California Red-sided Gartersnake			Not on any status lists
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECT & OTHER INVERT				
Acentrella spp.	Acentrella spp.			
Agabus spp.	Agabus spp.			
Ambrysus mormon	Creeping water bug			Not on any status lists
Antocha spp.	Antocha spp.			
Argia emma	Emma's Dancer			
Argia lugens	Sooty Dancer			
Argia spp.	Argia spp.			
Argia vivida	Vivid Dancer			
Baetidae fam.	Baetidae fam.			
Baetis spp.	Baetis spp.			
Berosus punctatissimus	Water scavenger beetles			Not on any status lists
Berosus spp.	Berosus spp.			
Callibaetis spp.	Callibaetis spp.			

Centroptilum spp.	Centroptilum spp.			
Chaetarthria bicolor	Water Scavenger Beetles			Not on any status lists
Chaetarthria ochra	Water Scavenger Beetles			Not on any status lists
Cheumatopsyche spp.	Cheumatopsyche spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Cladotanytarsus spp.	Cladotanytarsus spp.			
Coenagrionidae fam.	Coenagrionidae fam.			
Corisella spp.	Corisella spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus spp.	Cricotopus spp.			
Dicrotendipes spp.	Dicrotendipes spp.			
Dytiscidae fam.	Dytiscidae fam.			
Enallagma civile	Familiar Bluet			
Enallagma cyathigerum	Common blue damselfly			Not on any status lists
Enochrus carinatus	Water Scavenger Beetles			Not on any status lists
Enochrus cristatus	Water Scavenger Beetles			Not on any status lists
Enochrus piceus	Water Scavenger Beetles			Not on any status lists
Enochrus pygmaeus	Water Scavenger Beetles			Not on any status lists
Enochrus spp.	Enochrus spp.			
Ephemerella spp.	Ephemerella spp.			
Ephemerellidae fam.	Ephemerellidae fam.			
Ephydridae fam.	Ephydridae fam.			
Eukiefferiella spp.	Eukiefferiella spp.			
Fallceon quilleri	A Mayfly			
Graptocorixa spp.	Graptocorixa spp.			
Gyrinus spp.	Gyrinus spp.			
Helichus spp.	Helichus spp.			
Helicopsyche spp.	Helicopsyche spp.			
Hetaerina americana	American Rubyspot			
Hydrochus spp.	Hydrochus spp.			
Hydrophilidae fam.	Hydrophilidae fam.			
Hydroporus spp.	Hydroporus spp.			
Hydropsyche spp.	Hydropsyche spp.			
Hydropsychidae fam.	Hydropsychidae fam.			
Hydroptila spp.	Hydroptila spp.			
Hydryphantidae fam.	Hydryphantidae fam.			
Ischnura spp.	Ischnura spp.			
Laccobius ellipticus	Water scavenger beetles			Not on any status lists
Laccobius spp.	Laccobius spp.			

Laccophilus maculosus	Dingy Diver			Not on any status lists
Lepidostoma spp.	Lepidostoma spp.			
Leptoceridae fam.	Leptoceridae fam.			
Libellula saturata	Flame Skimmer			
Limnophyes spp.	Limnophyes spp.			
Liodessus obscurellus	Predacious Diving Beetle			Not on any status lists
Macromia magnifica	Western River Cruiser			
Malenka spp.	Malenka spp.			
Microcylloepus spp.	Microcylloepus spp.			
Microtendipes spp.	Microtendipes spp.			
Nectopsyche spp.	Nectopsyche spp.			
Ochthebius spp.	Ochthebius spp.			
Ophiogomphus bison	Bison Snaketail			
Optioservus spp.	Optioservus spp.			
Oreodytes spp.	Oreodytes spp.			
Paracloeodes minutus	A Small Minnow Mayfly			
Paracymus spp.	Paracymus spp.			
Paratanytarsus spp.	Paratanytarsus spp.			
Peltodytes spp.	Peltodytes spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Plathemis lydia	Common Whitetail			
Postelichus spp.	Postelichus spp.			
Procladius spp.	Procladius spp.			
Pseudochironomus spp.	Pseudochironomus spp.			
Psychodidae fam.	Psychodidae fam.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Rhyacophila spp.	Rhyacophila spp.			
Sigara mckinstryi	A Water Boatman			Not on any status lists
Sigara spp.	Sigara spp.			
Simuliidae fam.	Simuliidae fam.			
Simulium spp.	Simulium spp.			
Sperchon spp.	Sperchon spp.			
Sperchontidae fam.	Sperchontidae fam.			
Stictotarsus spp.	Stictotarsus spp.			
Sweltsa spp.	Sweltsa spp.			
Tanytarsus spp.	Tanytarsus spp.			
Tipulidae fam.	Tipulidae fam.			
Tramea lacerata	Black Saddlebags			
Tricorythodes spp.	Tricorythodes spp.			
Wormaldia spp.	Wormaldia spp.			
MAMMAL				
Castor canadensis	American Beaver			Not on any status lists

MOLLUSK				
Gyraulus spp.	Gyraulus spp.			
Lymnaea spp.	Lymnaea spp.			
Menetus opercularis	Button Sprite			CS
Physa spp.	Physa spp.			
Pisidium spp.	Pisidium spp.			
Planorbidae fam.	Planorbidae fam.			
PLANT				
Alnus rhombifolia	White Alder			
Ammannia coccinea	Scarlet Ammannia			
Anemopsis californica	Yerba Mansa			
Azolla filiculoides	Mosquito Fern			
Baccharis salicina	Willow Baccharis			Not on any status lists
Bolboschoenus maritimus paludosus	Saltmarsh Bulrush			Not on any status lists
Callitriche heterophylla bolanderi	Large Water-starwort			
Callitriche marginata	Winged Water-starwort			
Castilleja minor minor	Alkali Indian-paintbrush			
Castilleja minor spiralis	Large-flower Annual Indian-paintbrush			
Cotula coronopifolia	Brass Buttons			
Crassula aquatica	Water Pygmyweed			
Crypsis vaginiflora	African Prickle Grass			
Cyperus erythrorhizos	Red-root Flatsedge			
Eleocharis macrostachya	Creeping Spikerush			
Eleocharis parishii	Parish's Spikerush			
Epilobium campestre	Smooth Boisduvalia			Not on any status lists
Epilobium cleistogamum	Cleistogamous Spike-primrose			
Eryngium spinosepalum	Spiny Sepaled Coyote-thistle		SSC	CRPR - 1B.2
Eryngium vaseyi vaseyi	Vasey's Coyote-thistle			Not on any status lists
Euthamia occidentalis	Western Fragrant Goldenrod			
Helenium puberulum	Rosilla			
Hydrocotyle verticillata verticillata	Whorled Marsh-pennywort			
Juncus dubius	Mariposa Rush			
Juncus effusus effusus	Common Bog Rush			
Juncus luciensis	Santa Lucia Dwarf Rush		SSC	CRPR - 1B.2
Juncus macrophyllus	Longleaf Rush			
Juncus xiphioides	Iris-leaf Rush			

Limosella aquatica	Northern Mudwort			
Marsilea vestita vestita	Hairy Waterclover			Not on any status lists
Mimulus guttatus	Common Large Monkeyflower			
Mimulus latidens	Broad-tooth Monkeyflower			
Mimetanthe pilosa	Snouted Monkey Flower			Not on any status lists
Montia fontana fontana	Fountain Miner's-lettuce			
Navarretia prostrata	Prostrate Navarretia		SSC	CRPR - 1B.1
Paspalum distichum	Joint Paspalum			
Persicaria lapathifolia	Common Knotweed			Not on any status lists
Persicaria maculosa	Spotted Ladysthumb			Not on any status lists
Phacelia distans	Common Phacelia			
Pilularia americana	Pillwort			
Plagiobothrys acanthocarpus	Adobe Popcorn-flower			
Plantago elongata elongata	Slender Plantain			
Platanus racemosa	California Sycamore			
Psilocarphus brevissimus brevissimus	Dwarf Woolly-heads			
Ranunculus aquatilis diffusus	Whitewater Crowfoot			Not on any status lists
Rorippa curvisiliqua curvisiliqua	Curve-pod Yellowcress			
Rumex conglomeratus	Green Dock			
Rumex salicifolius salicifolius	Willow Dock			
Salix exigua exigua	Narrowleaf Willow			
Salix laevigata	Polished Willow			
Salix lasiolepis lasiolepis	Arroyo Willow			
Schoenoplectus americanus	Three-square Bulrush			
Schoenoplectus pungens longispicatus	Three-square Bulrush			
Schoenoplectus pungens pungens	Common Threesquare			
Schoenoplectus saximontanus	Rocky Mountain Bulrush			
Typha domingensis	Southern Cattail			
Typha latifolia	Broadleaf Cattail			
Veronica anagallis-aquatica	Water Speedwell			

Veronica catenata	Chain Speedwell			Not on any status lists

Notes:
ARSSC = At-Risk Species of Special Concern
BSSC = Bird Species of Special Concern
CRPR = California Rare Plant Rank
CS = Currently Stable
SSC = Species of Special Concern

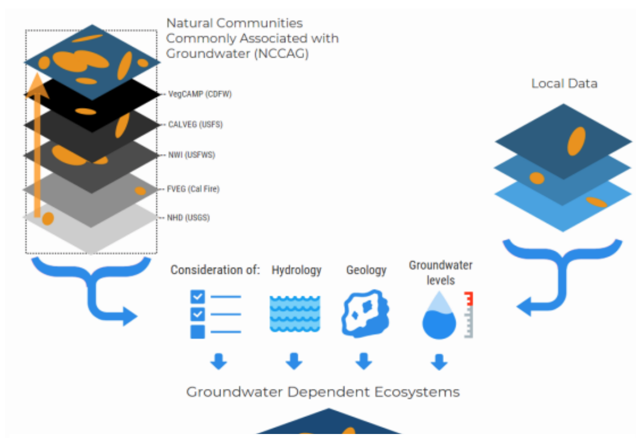
Attachment D

IDENTIFYING GDEs UNDER SGMA

Best Practices for using the NC Dataset

The Sustainable Groundwater Management Act (SGMA) requires that groundwater dependent ecosystems (GDEs) be identified in Groundwater Sustainability Plans (GSPs). As a starting point, the Department of Water Resources (DWR) is providing the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) online[4] to help Groundwater Sustainability Agencies (GSAs), consultants, and stakeholders identify GDEs within individual groundwater basins. To apply information from the NC Dataset to local areas, GSAs should combine it with the best available science on local hydrology, geology, and groundwater levels to verify whether polygons in the NC dataset are likely supported by groundwater in an aquifer (Figure 1)[5]. This document highlights six best practices for using local groundwater data to confirm whether a potential GDE identified in the NC dataset is supported to groundwater.

The NC Dataset identifies vegetation and wetland features that are good indicators of a GDE. The dataset is comprised of 48 publicly available state and federal datasets that map vegetation, wetlands, springs, and seeps commonly associated with groundwater in California[6]. It was developed through a collaboration between DWR, the Department of Fish and Wildlife, and The Nature Conservancy (TNC). TNC has also provided detailed guidance on identifying GDEs from the NC dataset[7] on the Groundwater Resource Hub, a website dedicated to GDEs[8].



[4] *NC Dataset Online Viewer is available at: https://gis.water.ca.gov/app/NCDatasetViewer/*

[5] California Department of Water Resources (DWR). 2018. Summary of the "Natural Communities Commonly Associated with Groundwater" Dataset and Online Web Viewer. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/Natural-Communities-Dataset-Summary-Document.pdf

[6] *For more details on the mapping methods, refer to: Klausmeyer, K., J. Howard, T. Keeler-Wolf, K. Davis-Fadtke, R. Hull, A. Lyons. 2018. Mapping Indicators of Groundwater Dependent Ecosystems in California: Methods Report. San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/iGDE_data_paper_20180423.pdf*

[7] "Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans" is available at https://groundwaterresourcehub.org/gde-tools/gsp-guidance-document/

[8] *The Groundwater Resource Hub is available at: www.GroundwaterResourceHub.org*

BEST PRACTICE #1. Establishing a Connection to Groundwater

Groundwater basins can be comprised of one continuous aquifer (Figure 2A) or multiple aquifers stacked on top of each other (Figure 2B). In unconfined aquifers (Figure 2A), using the depth to groundwater and the rooting depth of the vegetation is a reasonable method to determine groundwater dependence for GDEs. If groundwater is well below the rooting (and capillary) zone of the plants and any wetland features, the ecosystem is considered disconnected and groundwater management is not likely to affect the ecosystem (Figure 2D). However, it is important to consider local conditions (soil type, groundwater flow gradients, and aquifer parameters) and to review groundwater depth data from multiple seasons and water year types (wet and dry) because intermittent periods of high groundwater levels can replenish perched clay lenses that serve as the water source for GDEs (Figure 2C). Maintaining these natural groundwater fluctuations are important to sustaining GDE health.

Basins with a stacked series of aquifers (Figure 2B) may have varying levels of pumping across aquifers in the basin, depending on the production capacity or water quality associated with each aquifer. If pumping is concentrated in deeper aquifers, SGMA still requires GSAs to sustainably manage groundwater resources in shallow aquifers, such as perched aquifers, that support springs, surface water, domestic wells, and groundwater dependent ecosystems (Figure 2). This is because vertical groundwater gradients across aquifers may result in pumping from deeper aquifers to cause adverse impacts onto beneficial users reliant on shallow aquifers or interconnected surface water. The goal of SGMA is to sustainably manage groundwater resources for current and future social, economic, and environmental benefits. While groundwater pumping may not be currently occurring in a shallower aquifer, use of this water may become more appealing and economically viable in future years as pumping restrictions are placed on the deeper production aquifers in the basin to meet the sustainable yield and criteria. Thus, identifying GDEs in the basin should done irrespective to the amount of current pumping occurring in a particular aquifer, so that future impacts on GDEs due to new production can be avoided. A good rule of thumb to follow is: *if groundwater can be pumped from a well - it's an aquifer*.

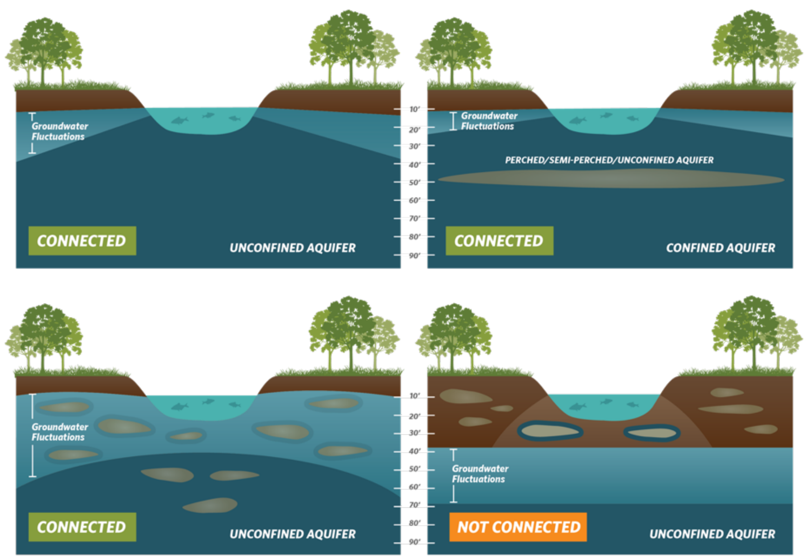


Figure 2. Confirming whether an ecosystem is connected to groundwater in a principal aquifer. Top: (Left) Depth to Groundwater in the aquifer under the ecosystem is an unconfined aquifer with depth to groundwater fluctuating seasonally and interannually within 30 feet from land surface. **(Right)** Depth to Groundwater in the shallow aquifer is connected to overlying ecosystem. Pumping predominately occurs in the confined aquifer, but pumping is possible in the shallow aquifer. **Bottom: (Left)** Depth to groundwater fluctuations are seasonally and interannually large, however, clay layers in the near surface prolong the ecosystem's connection to groundwater. **(Right)** Groundwater is disconnected from surface water, and any water in the vadose (unsaturated) zone is due to direct recharge from precipitation and indirect recharge under surface water feature. These areas typically support species that do not require access to groundwater to survive.

BEST PRACTICE #2. Characterize Seasonal and Interannual Groundwater Conditions

SGMA requires GSAs to describe current and historical groundwater conditions when identifying GDEs [23 CCR §354.16(g)]. Relying solely on the SGMA benchmark date (January 1, 2015) or any other single point in time to characterize groundwater conditions (e.g., depth-to-groundwater) is inadequate because managing groundwater conditions with data from one time point fails to capture the seasonal and interannual variability typical of California's climate. DWR's Best Management Practices document on water budgets[9] recommends using 10 years of water supply and water budget information to describe how historical conditions have impacted the operation of the basin within sustainable yield, implying that a baseline[10] could be determined based on data between 2005 and 2015. Using this or a similar time period, depending on data availability, is recommended for determining the depth-to-groundwater.

GDEs depend on groundwater levels being close enough to the land surface to interconnect with surface water systems or plant rooting networks. The most practical approach[11] for a GSA to assess whether polygons in the NC dataset are connected to groundwater is to rely on groundwater elevation data. As detailed in TNC's GDE guidance document[4], one of the key factors to consider when mapping GDEs is to contour depth-to-groundwater in the aquifer that is supporting the ecosystem (See Best Practice #5).

Groundwater levels fluctuate over time and space due to California's Mediterranean climate (dry summers and wet winters), climate change (flood and drought years), and subsurface heterogeneity in the subsurface (Figure 3). Many of California's GDEs have adapted to dealing with intermittent periods of water stress, however, if these groundwater conditions are prolonged adverse impacts to GDEs can result. While depth-to-groundwater levels within 30 feet[4] are generally accepted as being a proxy for confirming that polygons in the NC dataset are supported by groundwater, it is highly advised that fluctuations in the groundwater regime be characterized to understand the seasonal and interannual groundwater variability in GDEs. Utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs, and inadvertently result in adverse impacts to the GDEs. Time series data on groundwater elevations and depths are available on the SGMA Data Viewer[12]. However, if insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons in the GSP until data gaps are reconciled in the monitoring network (See Best Practice #6).

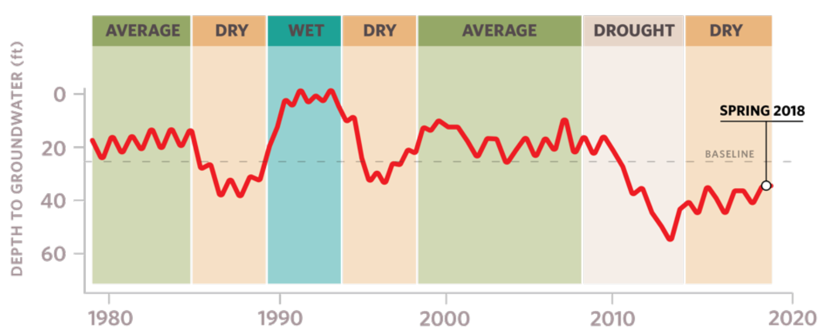


Figure 3. Example seasonality and interannual variability in depth to groundwater over time. Selecting one point in time, such as Spring 2018, to characterize groundwater conditions in GDEs fails to capture what groundwater conditions are necessary to maintain the ecosystem status into the future so adverse impacts are avoided.

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[9] DWR. 2016. Water Budget Best Management Practice. Available at: https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

[10] *Baseline is defined under the GSP regulations as "historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin." [23 CCR §351(e)]*

[11] Groundwater reliance can also be confirmed via stable isotope analysis and geophysical surveys. For more information see The GDE Assessment Toolbox (Appendix IV, GDE Guidance Document for GSPs - link in footnote above).

[12] *SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer*

BEST PRACTICE #3. Ecosystems Often Rely on Both Groundwater and Surface Water

GDEs are plants and animals that rely on groundwater for all or some of its water needs, and thus can be supported by multiple water sources. The presence of non-groundwater sources (e.g., surface water, soil moisture in the vadose zone, applied water, treated wastewater effluent, urban stormwater, irrigated return flow) within and around NC polygons does not preclude the possibility that a connection to groundwater exists. SGMA defines GDEs as "ecological communities and species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" [23 CCR §351(m)]. Hence, depth-to-groundwater data should be used to identify whether NC polygons are supported by groundwater and should be considered GDEs. In addition, SGMA requires that significant and undesirable adverse impacts to beneficial users of surface water be avoided. Beneficial users of surface water include environmental users such as plants or animals[13], which therefore must be considered when developing minimum thresholds for depletions of interconnected surface water.

GSAs are only responsible for impacts to GDEs resulting from groundwater conditions in the basin, so if adverse impacts to GDEs result from the diversion of applied water, treated wastewater, or irrigation return flow away from the GDE, then those impacts will be evaluated by other permitting requirements (e.g., CEQA) and may not be the responsibility of the GSA. However, if adverse impacts occur to the GDE due to changing groundwater conditions resulting from pumping or groundwater management activities, then the GSA would be responsible (Figure 4).

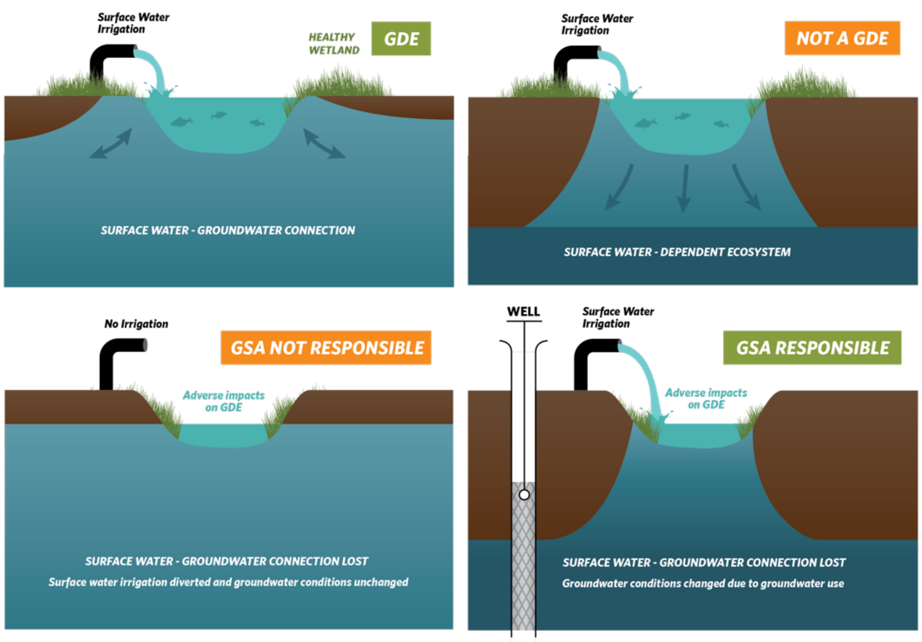


Figure 4. Ecosystems often depend on multiple sources of water. Top: (Left) Surface water and groundwater are interconnected, meaning that the GDE is supported by both groundwater and surface water. **(Right)** Ecosystems that are only reliant on non-groundwater sources are not groundwater-dependent. **Bottom: (Left)** An ecosystem that was once dependent on an interconnected surface water, but loses access to groundwater solely due to surface water diversions may not be the GSA's responsibility. **(Right)** Groundwater dependent ecosystems once dependent on an interconnected surface water system, but loses that access due to groundwater pumping is the GSA's responsibility.

[13] *For a list of environmental beneficial users of surface water by basin, visit: https://groundwaterresourcehub.org/gde-tools/environmental-surface-water-beneficiaries/*

BEST PRACTICE #4. Select Representative Groundwater Wells

Identifying GDEs in a basin requires that groundwater conditions are characterized to confirm whether polygons in the NC dataset are supported by the underlying aquifer. To do this, proximate groundwater wells should be identified to characterize groundwater conditions (Figure 5). When selecting representative wells, it is particularly important to consider the subsurface heterogeneity around NC polygons, especially near surface water features where groundwater and surface water interactions occur around heterogeneous stratigraphic units or aquitards formed by fluvial deposits. The following selection criteria can help ensure groundwater levels are representative of conditions within the GDE area:

- Choose wells that are within 5 kilometers (3.1 miles) of each NC Dataset polygons because they are more likely to reflect the local conditions relevant to the ecosystem. If there are no wells within 5km of the center of a NC dataset polygon, then there is insufficient information to remove the polygon based on groundwater depth. Instead, it should be retained as a potential GDE until there are sufficient data to determine whether or not the NC Dataset polygon is supported by groundwater.

- Choose wells that are screened within the surficial unconfined aquifer and capable of measuring the true water table.

- Avoid relying on wells that have insufficient information on the screened well depth interval for excluding GDEs because they could be providing data on the wrong aquifer. This type of well data should not be used to remove any NC polygons.

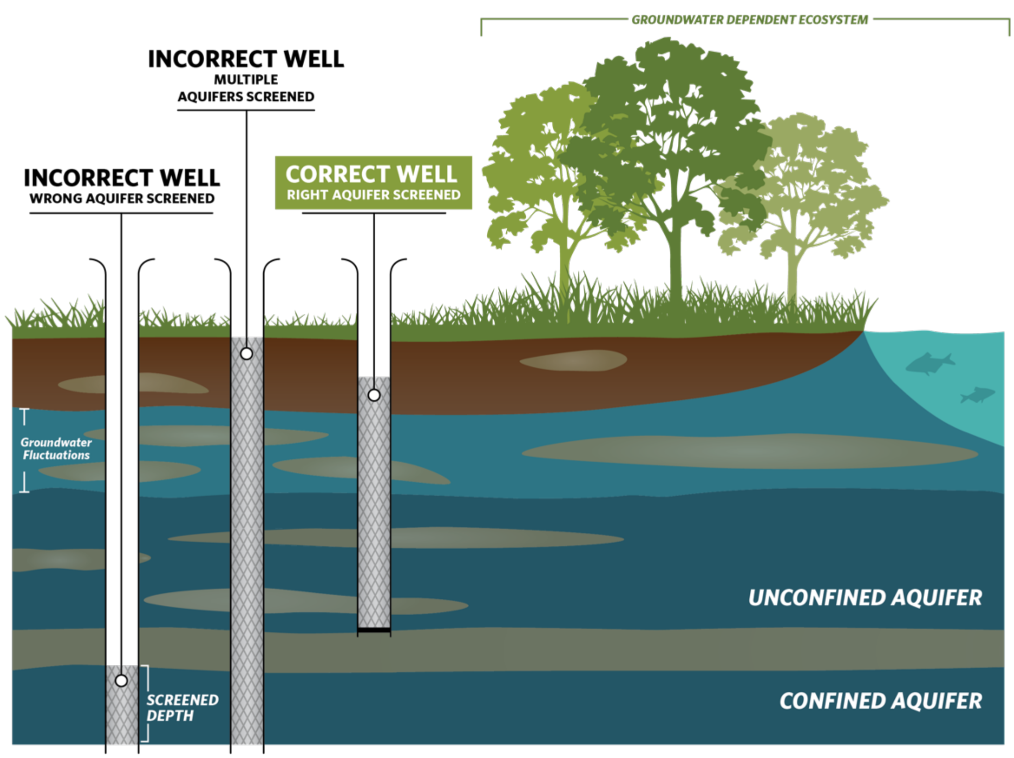


Figure 5. Selecting representative wells to characterize groundwater conditions near GDEs.

BEST PRACTICE #5. Contouring Groundwater Elevations

The common practice to contour depth-to-groundwater over a large area by interpolating measurements at monitoring wells is unsuitable for assessing whether an ecosystem is supported by groundwater. This practice causes errors when the land surface contains features like streams and wetlands depressions because it assumes the land surface is constant across the landscape and depth-to-groundwater is constant below these low-lying areas (Figure 6 - left panel). A more accurate approach is to interpolate **groundwater elevations** at monitoring wells to get an estimate of groundwater elevation across the landscape. This layer can then be subtracted from the land surface elevation from a Digital Elevation Model (DEM)[14] to estimate depth to groundwater contours across the landscape (Figure 6 – right panel; Figure 7). This will provide a much more accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.

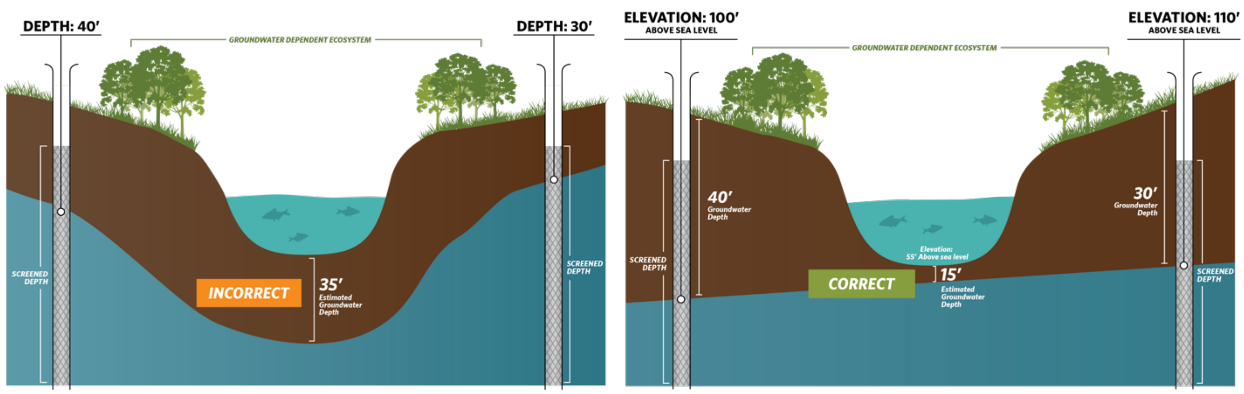


Figure 6. Contouring depth-to-groundwater around surface water features and GDEs. (Left) Groundwater level interpolation using depth-to-groundwater data from monitoring wells. **(Right)** Groundwater level interpolation using groundwater elevation data from monitoring wells and DEM data.

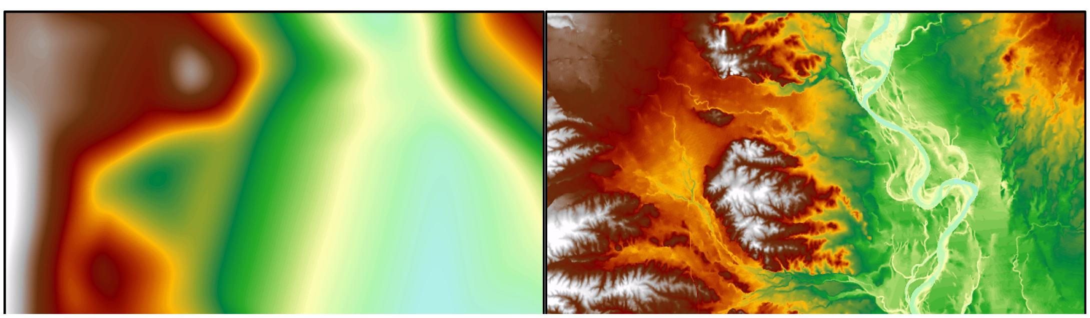


Figure 7. Depth to Groundwater Contours in Northern California. (Left) Contours were interpolated using depth to groundwater measurements determined at each well. **(Right)** Contours were determined by interpolating groundwater elevation measurements at each well and superimposing ground surface elevation from DEM spatial data to generate depth to groundwater contours. The image on the right shows a more accurate depth to groundwater estimate because it takes the local topography and elevation changes into account.

[14] USGS Digital Elevation Model data products are described at: https://www.usgs.gov/core-science-systems/ngp/3dep/about-3dep-products-services and can be downloaded at: https://viewer.nationalmap.gov/basic/

BEST PRACTICE #6. Best Available Science

Adaptive management is embedded within SGMA and provides a process to work toward sustainability over time by beginning with the best available information to make initial decisions, monitoring the results of those decisions, and using the data collected through monitoring to revise decisions in the future. In many situations, the hydrologic connection of NC dataset polygons will not initially be clearly understood if site-specific groundwater monitoring data are not available. If sufficient data are not available in time for the 2020/2022 plan, **The Nature Conservancy strongly advises that questionable polygons from the NC dataset be included in the GSP until data gaps are reconciled in the monitoring network.** Erring on the side of caution will help minimize inadvertent impacts to GDEs as a result of groundwater use and management actions during SGMA implementation.

KEY DEFINITIONS

Groundwater basin is an aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom. *23 CCR §341(g)(1)*

Groundwater dependent ecosystem (GDE) are ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. *23 CCR §351(m)*

Interconnected surface water (ISW) surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. *23 CCR §351(o)*

Principal aquifers are aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems. *23 CCR §351(aa)*

ABOUT US

The Nature Conservancy is a science-based nonprofit organization whose mission is *to conserve the lands and waters on which all life depends*. To support successful SGMA implementation that meets the future needs of people, the economy, and the environment, TNC has developed tools and resources (www.groundwaterresourcehub.org) intended to reduce costs, shorten timelines, and increase benefits for both people and nature.

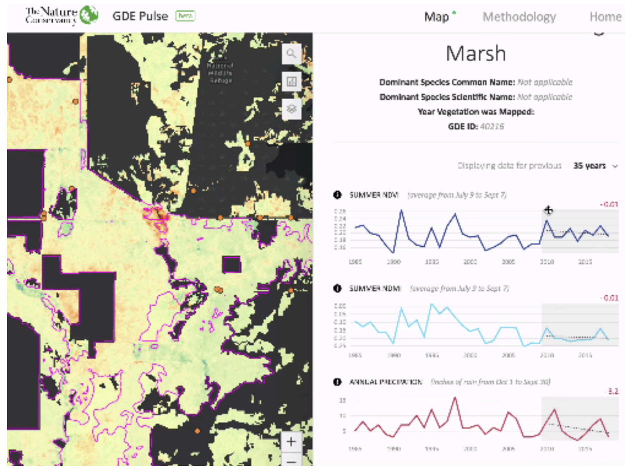
Attachment E

GDE Pulse

A new, free online tool that allows Groundwater Sustainability Agencies to assess changes in groundwater dependent ecosystem (GDE) health using satellite, rainfall, and groundwater data.

The Nature Conservancy
Protecting nature. Preserving life.

Visit
https://gde.codefornature.org/



Remote sensing data from satellites has been used to monitor the health of vegetation all over the planet. GDE pulse has compiled 35 years of satellite imagery from NASA's Landsat mission for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset[15]. The following datasets are included:

Normalized Difference Vegetation Index (NDVI) is a satellite-derived index that represents the greenness of vegetation. Healthy green vegetation tends to have a higher NDVI, while dead leaves have a lower NDVI. We calculated the average NDVI during the driest part of the year (July - Sept) to estimate vegetation health when the plants are most likely dependent on groundwater.

Normalized Difference Moisture Index (NDMI) is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short-Wave Infrared (SWIR) channels. Vegetation with adequate access to water tends to have higher NDMI, while vegetation that is water stressed tends to have lower NDMI. We calculated the average NDVI during the driest part of the year (July–September) to estimate vegetation health when the plants are most likely dependent on groundwater.

Annual Precipitation is the total precipitation for the water year (October 1st – September 30th) from the PRISM dataset[16]. The amount of local precipitation can affect vegetation with more precipitation generally leading to higher NDVI and NDMI.

Depth to Groundwater measurements provide an indication of the groundwater levels and changes over time for the surrounding area. We used groundwater well measurements from nearby (<1km) wells to estimate the depth to groundwater below the GDE based on the average elevation of the GDE (using a digital elevation model) minus the measured groundwater surface elevation.

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[15] *The Natural Communities Commonly Associated with Groundwater Dataset is hosted on the California Department of Water Resources' website: https://gis.water.ca.gov/app/NCDatasetViewer/#*

[16] The PRISM dataset is hosted on Oregon State University's website: http://www.prism.oregonstate.edu/