Fish & Wildlife Groundwater Planning Considerations

California Department of Fish and Wildlife
GROUNDWATER PROGRAM

contents

preface

In 2014, California passed the Sustainable Groundwater Management Act (SGMA) (AB1739, SB 1168, SB 1319), authorizing local groundwater sustainability agencies (GSAs) to develop groundwater sustainability plans (GSPs) for a subset of California's alluvial aquifers. To comply with SGMA, GSAs must achieve sustainable groundwater management, defined by SGMA as the avoidance of locally-defined undesirable results. To achieve sustainability, GSAs must develop and implement effective groundwater management plans that consider the interests of all beneficial uses and users of groundwater, including environmental users of groundwater. [Water Code § 10723.2.]

In many groundwater basins, fish and wildlife that rely on groundwater are among these beneficial uses and users. Many sensitive species and habitats comprise groundwater dependent ecosystems (GDEs), which are natural communities that rely on groundwater to sustain all or a portion of their water needs. The unsustainable use of groundwater can impact the shallow aquifers and interconnected surface waters on which GDEs depend and may lead to adverse impacts on fish and wildlife.

As trustee for California's fish and wildlife resources, CDFW intends to engage as a stakeholder in groundwater planning processes (where resources are available) to represent the groundwater needs of GDEs and fish and wildlife beneficial uses and users of groundwater. The information provided here is intended to help local groundwater planners, groundwater planning proponents and consultants, and CDFW staff work together to consider the needs of fish and wildlife when developing groundwater management plans and implementing SGMA. The document includes three categories of groundwater planning considerations:

- Scientific Considerations;
- Management Considerations; and
- Legal, Regulatory, and Policy Considerations.

Links to additional guidance and considerations developed by CDFW and other organizations that address the impacts of groundwater pumping on GDEs and depletion of interconnected surface water can be found at the end of this document.

Except to the extent that this document directly references existing statutory or regulatory requirements, use of these groundwater planning considerations is not mandated under law and should not be interpreted as a rule, regulation, order, or standard for local groundwater plans. Practical application of these considerations must be based on the best available information and groundwater basin-specific conditions.

Relevance to CDFW Mission

As trustee for the State's fish and wildlife resources, the California Department of Fish and Wildlife (CDFW) has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species. [FGC §§ 1802 and 711.7(a).] CDFW has an interest in the sustainable management of groundwater, as many sensitive ecosystems and public trust resources depend on groundwater and interconnected surface waters.

Accordingly, CDFW encourages thoughtful groundwater planning that carefully considers fish and wildlife and the habitats on which they depend. This groundwater planning considerations document focuses on impacts to groundwater dependent ecosystems (GDEs) and interconnected surface waters (ISW), both of which may provide habitat for fish and wildlife and are defined under SGMA as:

GROUNDWATER DEPENDENT ECOSYSTEMS: 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:
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).]

SGMA statute and regulations require specific consideration of both GDEs and ISW in the development of a groundwater sustainability plan (GSP). SGMA-governed groundwater plans must:

- Identify GDEs within the basin [23 CCR § 354.16(g)];
- Consider impacts to GDEs [Water Code § 10727.4(l)]; and
- Address six undesirable results, one of which is depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water. [Water Code § 10721(x)(6).]

To encourage GSAs to examine groundwater management impacts on fish and wildlife and the GDE and ISW habitats on which they depend, the CDFW Groundwater Program has catalogued fish and wildlife groundwater planning considerations that address CDFW's key interests.

Key Groundwater Planning Questions

CDFW suggests GSAs consider the following questions during GSP development:

GROUNDWATER DEPENDENT ECOSYSTEMS (GDES)

1. How will groundwater plans identify GDEs and address GDE protection?
2. How will GSAs determine if GDEs are being adversely impacted by groundwater management?
3. If GDEs are adversely impacted, how will groundwater plans facilitate appropriate and timely monitoring and management response actions?

INTERCONNECTED SURFACE WATERS (ISW)

1. How will groundwater plans document the timing, quantity, and location of ISW depletions attributable to groundwater extraction and determine whether these depletions will impact fish and wildlife?
2. How will GSAs determine if fish and wildlife are being adversely impacted by groundwater management impacts on ISW?
3. If adverse impacts to ISW-dependent fish and wildlife are observed, how will GSAs facilitate appropriate and timely monitoring and management response actions?

Groundwater Planning Considerations[1]

CDFW encourages GSAs to think holistically about ecosystem protection and enhancement when designing groundwater plans. The following compilation of fish and wildlife considerations is provided for GSAs to consider during the development of GSPs.

SCIENTIFIC CONSIDERATIONS

The Department of Water Resources GSP Regulations (DWR's Regulations) generally require reliance on 'best available science[2],' consistent with scientific and engineering professional standards of practice. [23 CCR § 351(h).] CDFW relies on ecosystem-based management informed by credible science in all resource management decisions to the extent feasible. [FGC § 703.3.] Accordingly, CDFW expects groundwater plans and supporting documentation to follow 'best available science' practices. Application of the following scientific concepts can improve the likelihood that a groundwater plan will avoid impacts to fish and wildlife beneficial uses and users of groundwater, GDEs, and ISW.

1. Hydrologic Connectivity[3]

Whether terrestrial vegetation can access groundwater and whether surface water is hydrologically connected with groundwater are important determinations in the context of groundwater planning. If hydrologic connectivity exists between a terrestrial or aquatic ecosystem and groundwater, then that ecosystem is a potential GDE and must be identified in a GSP. [23 CCR §354.16 (g).] Aquatic ecosystems reliant on ISW are also specifically relevant to the regulatory requirement to avoid significant and unreasonable adverse impacts to beneficial uses of surface water. [Water Code § 10721 (x)(6).] Hydrologic connectivity between surface water and groundwater, as well as groundwater accessibility to terrestrial vegetation, must therefore be evaluated carefully, and conclusions should be well-supported. Hydrologic connectivity considerations include:

a. *Connected surface waters:* As defined by DWR's Regulations, ISW are surface waters that are 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).] These waters can receive water from the aquifer, or lose water to the aquifer, depending on hydraulic gradients.

b. *Disconnected surface waters:* Disconnected streams occur where surface water is not connected by a continuous saturated zone to an underlying aquifer. In disconnected surface water, lowering the groundwater table does not affect the rate of loss from the surface water to groundwater.

c. *Transition surface waters:* In a transition surface water, the surface waters are hydraulically connected to the underlying aquifer by a capillary fringe[4]. Due to the capillary fringe connection, water table elevation changes can still affect the exchange rate of surface waters[5]. Therefore, in some cases, lowering the groundwater elevation under a streambed without a continuous saturated connection to the underlying aquifer may increase the rate of loss from the surface water body into the underlying aquifer. This potential for increased loss rates during transitional states of connectivity can ultimately increase the area or flow-duration of stream reaches that may be perceived as 'disconnected.'

d. *Terrestrial vegetation:* Many terrestrial plants known as phreatophytes depend on water from shallow aquifers. The depth to which these plants can root and the depth to groundwater collectively determine if the plants can rely on groundwater resources to sustain them. Depth to groundwater fluctuates across seasons and over time, as does plant rooting depth, so connectivity between terrestrial vegetation and shallow groundwater may change over time. Understanding baseline conditions and vegetation groundwater needs across time and species, as well as tolerance for rate of change, can inform groundwater management thresholds.

e. *Geospatial extent of connectivity:* Groundwater interconnectivity with surface water and groundwater accessibility by terrestrial vegetation are impacted by groundwater management regimes that raise or lower the groundwater table. These changes in water table elevation can impact the geospatial extent of connectivity, expanding or decreasing the connected interface. This means gaining and losing stream reaches[6] can grow or shrink in length, and interconnected wetlands and phreatophyte vegetation can grow or shrink in acres of coverage based on changes to groundwater table depth.

f. *Temporal duration of connectivity:* Raising and lowering the groundwater table can also impact the temporal duration of: 1) hydrologic connectivity between the water table and surface waters, and 2) accessibility of groundwater to terrestrial vegetation. Groundwater elevation changes over time can cause transitions from connected/accessible groundwater to disconnected/inaccessible groundwater, and vice versa.

2. Interconnected Surface Water Depletions

ISW depletions attributable to groundwater extraction can occur through two different mechanisms: captured recharge and induced infiltration (described below). Both should be considered when evaluating the possibility of depletions to ISW and establishing ISW sustainability criteria in GSPs. This evaluation is often best accomplished through empirical measurements coupled with numerical modeling.

a. *Captured recharge:* Groundwater withdrawals from aquifers hydrologically connected to surface waters can intercept groundwater travelling downgradient that would otherwise have discharged to surface waters.

b. *Induced infiltration:* Groundwater withdrawal can create a localized cone of depression and induce flow from ISW to groundwater, transforming a previously gaining stream reach to a losing stream reach.

3. Fish and Wildlife Species Water Needs

An evaluation of GDEs and ISW depletions should identify possible impacts to fish and wildlife beneficial uses and users of groundwater and ISW and should consider the following aspects of species water needs across life history phases when defining undesirable results and setting minimum thresholds required by DWR's Regulations.

a. *Temporal Water Needs:* Aquatic and terrestrial species require different quantities and qualities of water at different times and for different durations. There are climate-driven, seasonal variations in water availability to which species are accustomed – for example, migratory water fowl rely on wetlands during fall and spring migrating seasons when surface water was historically available. There are anthropogenic-driven variations in temporal water availability that can compromise species survival – for example, groundwater capture from a stream in summer months caused by irrigation well pumping near a stream can decrease flow, reduce cold groundwater inflows, and increase instream temperatures; thereby degrading cold-water refuge critical to migrating and spawning salmonids. Importantly, groundwater pumping and recharge actions have 'lag' impacts on water availability that are governed by the location and quantity of groundwater extraction as well as aquifer characteristics. Understanding the timing of water availability with respect to species needs across all life history phases will allow groundwater planners to better account for groundwater management impacts to fish and wildlife beneficial uses and users of groundwater and ISW.

b. *Spatial Water Needs:* Similar to temporal water needs, species are sensitive to the location and coverage of ISW and GDE wetland habitat available to them. Wetland geographic coverage dictates associated migratory bird carrying capacities, and specific instream salmonid habitats receiving groundwater inflows can best support spawning and rearing success. Therefore, the location of groundwater extraction and any associated cones of depression can impact GDE and ISW habitats. Wells closer to GDEs and ISW – both

laterally and vertically – may have more influence on the location and coverage of available habitat than wells farther away. These spatial relationships between groundwater extraction, and spatial coverage and location of GDE and ISW habitat are dependent on aquifer and well characteristics.

c. *Hydrologic Variability:* Water availability is naturally variable, and many species rely on a degree of hydrologic variability. This variability can be important to cue animal behavior such as spawning, growth, and migration. Groundwater plans should consider how groundwater management influences the hydrologic variability of ISW quality and quantity and what cascading impacts these variations may have on fish and wildlife species and their habitat.

d. *Water Availability:* At a basic level, water available for fish and wildlife species is subject to the same regulatory paradigms and dynamic climate conditions as water available for municipal and agricultural uses. CDFW expects groundwater budget projections to include fish and wildlife water needs and, when possible, anticipate regulatory and climate impacts on water availability.

e. *Water Quality:* Groundwater quality and ISW quality play a significant role in habitat adequacy. Groundwater pumping can impact many components of water quality including water temperature, dissolved oxygen, salinity, turbidity, and contaminants. Pumping can reverse hydraulic gradients and reduce cold and oxygen-rich inflows to ISW, leach soil constituents such as nitrates, and convey underground point source contamination to ISW. Groundwater plans should demonstrate an understanding of how groundwater management actions will affect water quality.

4. Habitat Value

Groundwater management plans that seek to minimize impacts to GDEs and avoid ISW depletion should consider the following:

a. *Connectivity:* Habitat connectivity is a key ecological attribute of thriving ecosystems. A functional network of connected terrestrial and aquatic habitats is essential to the continued existence of California's diverse species and natural communities. Components of natural and semi-natural landscapes must be large enough and connected enough to meet the needs of all species that use them. In identifying and evaluating groundwater management impacts to beneficial uses and users of groundwater, GDEs, and ISW, habitat connectivity impacts should also be considered.

b. *Heterogeneity:* Habitat heterogeneity, such as vegetation age and diversity, is a key ecological attribute of many functional ecosystems and often a predictor of animal species richness. In identifying and evaluating groundwater management impacts to beneficial uses and users of groundwater, GDEs, and ISW; habitat heterogeneity impacts should be considered.

c. *Groundwater Elevation:* Groundwater-dependent habitats, including ISW, are particularly susceptible to changes in the depth of the groundwater. Lowered water tables that drop beneath root zones can cutoff phreatophyte vegetation from water resources, stressing or ultimately converting vegetated terrestrial habitat. Induced infiltration attributable to groundwater pumping can reverse hydraulic gradients and may cause streams to stop flowing, compromising instream dissolved oxygen and temperature characteristics, and eventually causing streams to go dry. The frequency and duration of exposure to lowered groundwater tables and low-flow or no-flow conditions caused by groundwater pumping, as well as habitat and species resilience, will dictate vulnerability to changes in groundwater elevation. For example, some species rely on perennial instream flow, and any interruption to flow can risk species survival. Impacts caused by changes in groundwater elevation should be considered in the evaluation of groundwater management effects on GDEs and ISW.

5. Monitoring Systems

Effective monitoring methods and systems can aid in understanding groundwater management impacts to GDEs and ISW and informing subsequent action. Groundwater planners are encouraged to design robust monitoring systems with meaningful methods for tracking GDE and ISW conditions over time that account for the following monitoring considerations:

a. *Fundamental Components*: An effective monitoring system to evaluate impacts to GDEs and ISW depletions will ideally provide data that is representative of groundwater-dependent habitat throughout the alluvial basin and will be designed to capture geospatial and temporal variability at a scale meaningful to fish and wildlife beneficial uses and users of groundwater and ISW. GSAs should consider frequency of measurements and observation point density to ensure measurements capture seasonal and operational variability. Monitoring methods should follow accepted technical procedures established by the USGS[7,8], (or equivalently robust methods) and reference DWR's best management practices[9].

b. *Early Recognition*: An effective monitoring system to evaluate impacts to GDEs and ISW depletions will be designed to capture early signs of adverse impacts, so that adaptive management can initiate to avoid undesirable results. Early signs of adverse impacts may manifest as stressed phreatophyte vegetation, increased instream temperature, etc.

c. *Meaningful Baselines*: Where historical baseline information on GDEs and ISW is absent, prompt groundwater information collection is critical to understanding the relationship between climatic variations/water year type and groundwater demand/availability. Monitoring systems can help inform baselines that reflect hydrologic variability and that can be used to measure the impact of management actions on groundwater resources.

d. *Interconnectivity Efficacy*: An effective monitoring system to evaluate impacts to GDEs and ISW depletions will be able to identify and help characterize groundwater-surface water interaction by using appropriate methods including but not limited to paired groundwater and streamflow monitoring; seepage measurements; nested piezometers; geochemical and physical property monitoring; and application of monitoring data to water budget calculations, analytical modeling, and numerical modeling.

e. *Monitoring Characteristics*: A groundwater plan may consider tracking a range of GDE and ISW characteristics to determine groundwater management impacts over time. These characteristics include but are not limited to: geospatial and temporal habitat coverage; changes in groundwater interconnectivity status; habitat connectivity, heterogeneity, or density; habitat 'health' (e.g., application of biological indices, remote sensing/aerial imagery); and species/vegetation presence (e.g., biological surveys).

f. *Scalability*: An effective monitoring system will be designed to improve information gaps over time as resources become available; groundwater plans may choose to identify prioritized monitoring locations and systems that can be implemented in phases based on resource availability.

6. Data Quality

Data quality underscores all components of a groundwater plan and subsequent plan updates. Transparent groundwater plans will clearly identify data used to develop plans and include narratives on data collection methods, equipment calibration, quality assurance checks, data processing steps, and on how data were used to inform plan components. Groundwater plans may also choose to identify available data that were not used and explain why it was excluded from analysis.

SCIENTIFIC CONSIDERATIONS		
	✓	Hydrologic Connectivity
	✓	Interconnected Surface Water Depletion
	✓	Fish and Wildlife Species Water Needs
	✓	Habitat Value
	✓	Monitoring Systems
	✓	Data Quality

MANAGEMENT CONSIDERATIONS

CDFW encourages groundwater planners to detail how management actions will consider fish and wildlife beneficial uses and users of groundwater and what management actions will be initiated on what timeline if adverse impacts to fish and wildlife beneficial uses and users of groundwater, GDEs, or ISW are observed. The following are considerations to inform responsive management.

1. Data Gaps and Conservative Decision-Making Under Uncertain Conditions

Current groundwater management suffers from information gaps, but it is expected that groundwater management agencies (local, state, and federal) will develop or expand groundwater monitoring systems to improve information availability over time. Even with existing data gaps, GSAs must avoid significant and unreasonable adverse impacts to beneficial uses of groundwater and ISW. Information shortages should trigger conservative groundwater management decisions that err on the side of caution when it comes to protecting fish and wildlife and their habitats. For example, in determining the presence of GDEs, if hydrologic connectivity with the water table is uncertain, CDFW recommends including a GDE until hydrologic connectivity can be disproven. The same cautionary principle applies to establishing minimum thresholds for sustainability criteria; conservative thresholds have a higher likelihood of avoiding adverse impacts to fish and wildlife beneficial uses and users of groundwater and ISW. For example, groundwater is a critical cold-water reserve for aquatic inhabitants of ISW, and ISW are expected to increase in water temperature under warming climate conditions. The amount of increase in ISW temperature due to climate change is a data gap and sufficient groundwater elevations to buffer increasing ISW temperatures is important to consider.

2. Adaptive Management

Decision-making with imperfect information requires groundwater managers to be agile and responsive to dynamic circumstances. Groundwater plans should detail how groundwater monitoring and management structures will be designed to adapt to changing resource conditions and information availability. Plans should include discussions on how and on what timeline adverse impacts will be addressed, if observed. Plans should also consider implementation of adaptive management strategies to account for 'lag' impacts wherein groundwater responses to changes in management regimes are delayed due to aquifer characteristics. 'Lag' effects may necessitate conservative aquifer-rebound timeline projections.

3. Prioritized Resource Allocation

With limited resources available, groundwater planners may choose to allocate available monitoring and management resources (e.g., DWR Technical Support Services funding) to prioritized GDEs and ISW. Prioritization may reflect criteria such as habitat value or vulnerability, species dependency, and/or 'indicator' GDEs or ISW.

4. Multi-Benefit Approach

Groundwater planners are encouraged to design project and management actions for multiple-benefit solutions, including habitat improvements. Evaluation of supply augmentation management actions (e.g., managed aquifer recharge) and demand reduction management actions (e.g., limitations on groundwater extraction) may include a quantification of impacts on GDEs and ISW to justify actions that serve multiple beneficial uses and users of groundwater. Planners may also consider marginal cost increases in project and management actions to optimize habitat outcomes, thereby broadening funding opportunities, such as recharge projects that contribute both to aquifers as well as instream flow.

MANAGEMENT CONSIDERATIONS		
	✓	Data Gaps and Conservative Decision-Making Under Uncertain Conditions
	✓	Adaptive Management
	✓	Prioritized Resource Allocation
	✓	Multi-Benefit Approach

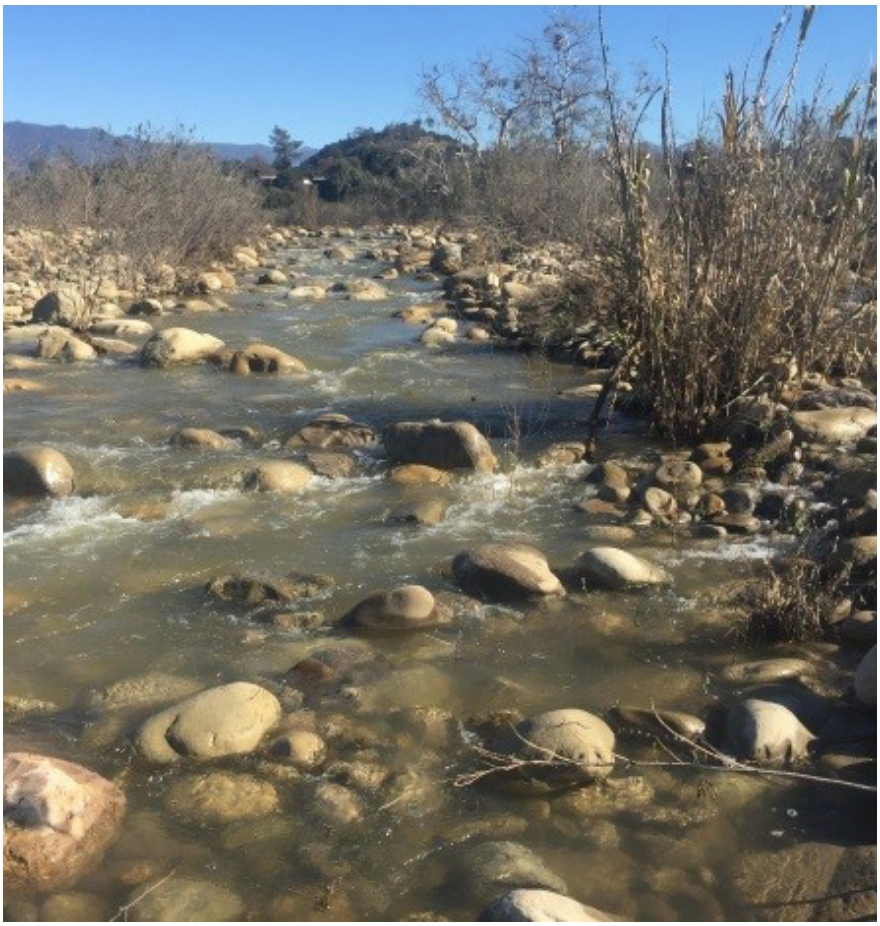
LEGAL, REGULATORY, AND POLICY CONSIDERATIONS

Apart from SGMA requirements, there are numerous laws, regulations, and policies that protect fish and wildlife. The following compilation is provided for GSAs to consider during the development and implementation of groundwater plans. Where applicable and reasonable, GSAs should consider the list below to ensure compliance with existing laws, regulation, and policies. These include but are not limited to:

1. **California Endangered Species Act (CESA), Federal Endangered Species Act (ESA)**
   GDEs and ISW in SGMA-regulated basins contribute to habitat for over 120 federal or State-listed Threatened and Endangered (T&E) species. GDEs and ISW in SGMA-regulated basins also overlap with federally-designated Critical Habitat, areas that contain features essential to the conservation of T&E species. Groundwater management decisions in basins with T&E species and/or Critical Habitat should evaluate groundwater management impacts to species and habitats of concern.[10]

2. **Lake and Streambed Alteration (LSA)**
   The Fish and Game Code requires an entity to notify the Department prior to commencing any activity that may substantially divert or obstruct the natural flow of, or substantially change or use the material from the bed, channel, or bank of any river, stream, or lake, or deposit debris, waste, or other materials where it could pass into any river, stream, or lake. An LSA Agreement is required when the activity may substantially adversely affect existing fish and wildlife resources.

3. **California Environmental Quality Act (CEQA)**
   Groundwater plans developed under SGMA are exempt from CEQA. However, project and management actions needed to achieve basin sustainability are subject to CEQA. CDFW will likely have a CEQA review and permitting nexus with groundwater project and management actions (e.g., Incidental Take Permits, Lake and Streambed Alteration Agreements, etc.). Accordingly, CDFW will expect CEQA lead agencies to thoroughly address proposed groundwater management project impacts (i.e., 'significant effects') to GDEs and ISW.



4. Public Trust Doctrine

Public trust resources entitled to protections under the Public Trust Doctrine include navigable surface waters and fisheries. Tributary waters, including groundwater hydrologically connected to navigable surface waters and surface waters tributary to navigable surface waters, are also subject to the Public Trust Doctrine to the extent that extractions affect or may affect public trust uses. Accordingly, groundwater plans should consider public trust protections for navigable ISW and their tributaries, and ISW that support fisheries, including the level of groundwater contribution to those waters.

5. Clean Water Act and Porter Cologne Act

Water quality degradation, one of the six sustainability indicators required in SGMA groundwater sustainability plans, is also governed by the Clean Water Act and Porter-Cologne Act and has a significant impact on habitat viability. GDEs and ISW are vulnerable to groundwater quality shortcomings. For example, groundwater pollutants can be taken up by phreatophytic vegetation in GDEs or flow into gaining streams. Groundwater extraction can also compound existing ISW water quality impairment designations under the Clean Water Act. For example, reduced streamflow recharge from depleted aquifers can exacerbate temperature and algae Total Maximum Daily Loads. In addition, the preservation and enhancement of fish, wildlife, and other aquatic resources are designated as beneficial uses under the Porter-Cologne Act. Groundwater extraction could cause or exacerbate temperature or other water quality conditions for those uses. Thorough groundwater plans will consider groundwater quality impacts under the Clean Water Act/Porter Cologne Act.

6. State, Federal, Tribal Protected Lands and Waters

Lands and waters governed by state, federal, and tribal governments are held in the protection of the public trust, including CDFW Wildlife Areas, Ecological Reserves, and conservation easements. These lands merit specific consideration and protection in groundwater plans to ensure no adverse impacts occur to the GDEs and ISW on these lands so they can continue to meet their habitat management objectives. This policy consideration applies to groundwater allocations and groundwater fees – public lands providing valuable habitat should be considered for categorical allocations or pricing that allow the lands to continue to serve their public functions successfully.

7. Instream Flow Requirements/Recommendations

The State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCBs) enforce legally-mandated instream flow requirements, such as the instream flow requirements for cannabis compliance gages[11]. CDFW and other environmental organizations develop instream flow recommendations based on field measurements, desktop analyses, and species/habitat needs. Both instream flow requirements and instream flow recommendations can inform development of sustainability criteria (e.g., minimum thresholds) in groundwater plans to help prevent the occurrence of undesirable results. Because flow requirements and/or recommendations represent thresholds beyond which adverse impacts to water rights holders and/or aquatic species are expected to occur, they should be considered in groundwater plans.

8. SWRCB Water Quality Control Plan

The SWRCB adopted a Water Quality Control Plan in December 2018 for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality, which set new regulatory requirements for instream flow. The Lower San Joaquin River flow requirements, as adopted[12], would provide a range of 30 to 50 percent of unimpaired flow from February through June in the Merced, Tuolumne, and Stanislaus Rivers. Groundwater plan water budgets and projections should account for these instream flow regulatory requirements accordingly.

9. California Water Action Plan (WAP)

The California Natural Resources Agency state-wide WAP identifies a list of actions to support reliable water supply in California for all beneficial uses and users and calls for the protection and restoration of important ecosystems. Among priority efforts is ensuring sufficient water for wetlands and waterfowl and enhancing water flows in streams statewide. These statewide priorities should be reflected in groundwater planning for GDEs and ISW.

10. California Biodiversity Initiative[13]

This initiative addressing Executive Order B-54-18 seeks to work across agencies and organizations to secure California's biodiversity benefits for the State's short- and long-term environmental and economic health. Two key groundwater-related facets of this initiative are: 1) improving understanding and protection of the State's native plants, and 2) managing lands and waters to achieve biodiversity goals. This initiative supports CDFW's interest in planning for the conservation of non-listed rare plants and species of concern, in addition to T&E species, and should be reflected in groundwater plan GDE considerations.

LEGAL, REGULATORY AND POLICY CONSIDERATIONS	
✓	California Endangered Species Act, Endangered Species Act
✓	Lake and Streambed Alteration
✓	California Environmental Quality Act
✓	Public Trust Doctrine
✓	Clean Water Act/Porter Cologne Act
✓	State, Federal, Tribal Protected Lands and Waters
✓	SWRCB Water Quality Control Plan
✓	Instream Flow Requirements/Recommendations
✓	California Water Action Plan
✓	California Biodiversity Initiative

Resources

CDFW RESOURCES

The following CDFW resources are publicly available to help identify, prioritize, and protect GDE and ISW habitats and the species therein in the context of groundwater planning processes. These reports, programs, plans, and tools are best used in conjunction with groundwater planning resources from other organizations and agencies (see Additional Resources).

1. California State Wildlife Action Plan (2015 Update; SWAP)
   SWAP identifies priorities for conserving California's aquatic and terrestrial resources and includes habitat conservation targets by geographic area. Among SWAP goals are: *maintain and enhance the integrity of ecosystems by conserving key natural processes and functions, habitat qualities, and sustainable native species population levels*; and *integrate wildlife conservation with working landscapes and environments*. Groundwater is specifically recognized as a critical component of habitat connectivity and water quality, quantity, and availability goals for enhancing ecosystems.

2. CDFW Instream Flow Program
   The CDFW Instream Flow Program conducts instream flow studies and establishes instream flow recommendations pursuant to PRC § 10000. Instream flow studies are carried out based on statewide stream priorities, including Water Action Plan priorities. The studies assess the amount and timing of surface water flow and collect data to recommend flow regimes required to maintain healthy aquatic resources. Groundwater planners are encouraged to cross-reference groundwater plan development (including water budgets and surface water-groundwater models) with CDFW's Instream Flow Program data and recommendations. Specifically, groundwater planners may wish to consider instream flow criteria and recommendations detailed in the program's technical reports to inform surface water depletion undesirable result definitions and monitoring approaches.

3. California National Diversity Database (CNDDB)
   CNDDB inventories narrative and geospatial information on the status and locations of rare plants and animals in California. The CNDDB spatial data can be downloaded as a shapefile or accessed via the Biogeographic Information and Observation System (BIOS) Data Viewer, a system designed to enable the management, visualization, and analysis of biogeographic data. This tool may inform GDE and ISW identification and prioritization for monitoring and protection. Note, CNDDB may not cover all GDEs and ISW, and as a positive detection database, it is not a replacement for on-the-ground surveys. Geographic areas with limited information on CNDDB often signify an absence of survey work. It is therefore inappropriate to imply that rare and endangered plants and animals do not occur in an area due to lack of information in the CNDDB.

4. Areas of Conservation Emphasis (ACE)

   ACE contains geospatial data on native species richness, rarity, endemism, and sensitive habitats for six taxonomic groups: birds, fish, amphibians, plants, mammals, and reptiles. ACE also summarizes information on the location of four sensitive habitat types (i.e., wetlands, riparian habitat, rare upland natural communities, and high-value salmonid habitat) which may inform the identification of GDEs and ISW and integration of habitat protection into groundwater plans.

5. Vegetation Classification and Mapping Program (VegCAMP)

   VegCAMP develops and maintains maps classifying vegetation and habitat in the state to support conservation and management decisions at the local, regional, and state levels. This tool may help identify and prioritize GDEs, as well as provide information regarding their vegetation composition. Note, the tool may not map all GDEs.

6. Natural Community Conservation Plans (NCCP)

   NCCP identify and provide for the regional protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. Not all groundwater basins intersect an approved (n=16) or developing (n=10+) NCCP. Where groundwater basins do intersect an NCCP, the NCCP may be referenced to identify local habitat priorities and protections that may inform GDE and ISW monitoring and management.

7. Regional Conservation Investment Strategies (RCIS)

   RCIS use a science-based approach to identify conservation and enhancement opportunities that, if implemented, will help California's declining and vulnerable species by protecting, creating, restoring, and reconnecting habitat. These opportunities are paired with investment strategies and mitigation credits to incentivize habitat protection. There is potential for groundwater plans to leverage crediting opportunities with project and management actions that optimize GDEs and ISW for habitat value for fish and wildlife beneficial uses and users of groundwater.

ADDITIONAL RESOURCES

The following resources may also be useful in the development of local GSPs that protect GDEs and ISW for fish and wildlife beneficial uses and users of groundwater and ISW. This list is non-exhaustive, and CDFW does not endorse all aspects of these documents; they are included for information purposes only.

1. *Center for Law, Energy & the Environment, UC Berkeley School of Law. 2018.* Navigating Groundwater-Surface Water Interactions under SGMA. A report on legal and institutional questions on groundwater-surface water interactions under SGMA.

2. *Community Water Center. 2019.* Guide to protecting Drinking Water Quality Under the Sustainable Groundwater Management Act. A factsheet to address best management practices for drinking water concerns.

3. *Department of Water Resources. 2018.* Natural Communities Commonly Associated with Groundwater Dataset. A map viewer and data-base allowing viewing and download of Vegetation and Wetland layers that are contained in the Natural Communities Commonly Associated with Groundwater dataset.

4. *Department of Water Resources. 2018.* SGMA Data Viewer. Online mapping tool displaying a variety of datasets related to the SGMA sustainability indicators.

5. *Environmental Defense Fund. 2018.* Addressing Regional Surface Water Depletions in California. A proposed approach for SGMA compliance on the avoidance of depletions of ISW that have significant and unreasonable adverse impacts on beneficial uses of surface water.

6. *Golden Gate University Center on Urban Environmental Law. 2018.* Drafting SGMA Groundwater Plans with Fisheries in Mind. A guidebook for using SGMA to protect fisheries.

7. *Stanford University. 2018.* Guide to Compliance with California's SGMA. A guide on how to avoid the "undesirable result" of "significant and unreasonable adverse impacts on beneficial uses of surface waters."

8. *The Nature Conservancy. 2014.* Groundwater and Stream Interaction in California's Central Valley: Insights for Sustainable Groundwater Management. A report providing technical information on the state of streams and groundwater resources in the Central Valley to illustrate the physical inter-relationship between the surface and groundwater.

9. *The Nature Conservancy. 2018. Considering Nature Under* SGMA: Environmental User Checklist. A checklist to help ensure that groundwater plans adequately address nature as required under SGMA.

10. *The Nature Conservancy. 2018* Groundwater Dependent Ecosystems under SGMA. Guidance for preparing groundwater sustainability plans with careful consideration of GDEs.

11. *The Nature Conservancy. 2018* GDE Rooting Depth Database. A maximum-rooting depth database provides information that can help assess whether groundwater dependent plants are accessing groundwater.

12. *The Nature Conservancy. 2019* GDE Pulse Tool. Compilation of 35 years of satellite imagery for every polygon in the Natural Communities Commonly Associated with Groundwater Dataset to assess changes in GDEs

13. *Union of Concerned Scientists. 2017.* Navigating a Flood of Information. Guidance for evaluating and integrating climate science into California groundwater planning.

Fish & Wildlife Groundwater Planning Considerations Summary

1. CDFW cares about sustainable groundwater management, because groundwater is a critical component of functional ecosystems and habitats, and because it is within CDFW's jurisdiction to conserve, protect, and manage fish, wildlife, native plants and the habitats on which they depend. [FGC § 1802, 711.7(a).] As trustee for California's fish and wildlife resources, CDFW intends to engage in groundwater planning processes (where resources are available) to represent the groundwater needs of GDEs and fish and wildlife beneficial uses and users of groundwater.

2. Groundwater plans should answer key questions about GDEs and ISW including the existence of GDEs and ISW, the determination of adverse impacts attributable to groundwater management, and the identification of appropriate management response actions that minimize or mitigate adverse impacts to GDEs and ISW.

3. GSAs may choose to evaluate and integrate into groundwater plans a range of scientific, management, and legal fish and wildlife planning considerations – complementary to the SGMA statute and regulations – to carefully account for groundwater management impacts to fish and wildlife beneficial uses and users of groundwater.

4. CDFW and other public entities have a variety of publicly available resources that can be used to help identify, prioritize, and protect GDE and ISW habitats and the species therein in the context of groundwater planning processes.

CDFW provides this document only as a consideration in groundwater planning. CDFW is neither dispensing legal advice nor warranting any outcome that could result from the use of these considerations. Following these considerations does not guarantee success of a GSP or compliance with SGMA which will be determined by the Department of Water Resources and the State Water Resources Control Board, or compliance with other applicable laws and regulations. Furthermore, except to the extent that this document directly references existing statutory or regulatory requirements, the information contained herein merely represents considerations, not requirements, that may be considered in light of the individual circumstances of each groundwater plan.

Appendix

FISH & WILDLIFE GROUNDWATER PLANNING CONSIDERATIONS TABLES

The following is a distilled, tabular compilation of fish and wildlife groundwater planning considerations intended to support the development of groundwater sustainability plans (GSPs) that protect fish and wildlife and the groundwater dependent ecosystems (GDEs) on which they depend.

Find the complete Fish and Wildlife Groundwater Planning Considerations Document here: https://www.wildlife.ca.gov/Conservation/Watersheds/Groundwater.

Scientific Considerations

CDFW expects groundwater plans and supporting documentation to follow 'best available science' practices, including careful application of scientific concepts to help avoid adverse impacts to fish and wildlife beneficial uses and users of groundwater.

HYDROLOGIC CONNECTIVITY	Whether terrestrial vegetation can access groundwater and whether surface water is hydrologically connected with groundwater are important determinations in the context of groundwater planning. If hydrologic connectivity exists between a terrestrial or aquatic ecosystem and groundwater, then that ecosystem is a potential GDE and must be identified in a GSP. Changes in geospatial extent and temporal groundwater interconnectivity of these ecosystems can impact their habitat value to fish and wildlife.
SURFACE WATER DEPLETIONS	Interconnected surface water (ISW) depletions attributable to groundwater extraction can occur through two different mechanisms: captured recharge and induced infiltration. Both should be considered when evaluating the possibility of depletions to ISW and establishing ISW sustainability criteria in GSPs.
FISH AND WILDLIFE SPECIES WATER NEEDS	An evaluation of GDEs and ISW depletions should identify possible impacts to fish and wildlife beneficial uses and users of groundwater and should consider a range of species water needs across life history phases including basic spatial and temporal water availability, as wells as sufficient hydrologic variability and water quality.
HABITAT VALUE	GSPs that seek to minimize impacts to GDEs and avoid ISW depletion should contemplate impacts to habitat characteristics including habitat connectivity, heterogeneity, and sensitivity to groundwater elevation changes.
MONITORING SYSTEMS	Effective monitoring methods and systems can aid in understanding groundwater management impacts to GDEs and ISW and inform subsequent action. An effective monitoring system will provide data representative of groundwater-dependent habitats throughout the alluvial basin and will be designed to capture geospatial and temporal variability at a scale meaningful to fish and wildlife beneficial uses and users of groundwater and ISW. Robust monitoring systems will be scalable; and capable of identifying early signs of adverse impacts, informing baselines, and characterizing interconnected surface waters.
DATA QUALITY	Data quality underscores all components of a groundwater plan and subsequent plan updates. Transparent groundwater plans will clearly identify data used to develop plans and include narratives on data collection methods, equipment calibration, quality assurance checks, data processing steps, and on how data was used to inform plan components.

Management Considerations

CDFW encourages groundwater planners to detail how management actions will consider fish and wildlife beneficial uses and users of groundwater and what management actions will be initiated on what timeline if adverse impacts to fish and wildlife beneficial uses and users of groundwater, GDEs, or ISW are observed.

CONSERVATIVE DECISIONS UNDER UNCERTAIN CONDITIONS	Information gaps common to groundwater management should inspire conservative groundwater management decisions that err on the side of caution when it comes to protecting fish and wildlife and their habitats.
ADAPTIVE MANAGEMENT	Decision-making with imperfect information requires groundwater managers to be agile and responsive to dynamic circumstances. GSPs should detail how groundwater monitoring and management will be able to adapt to changing resource conditions and information availability.
PRIORITIZED RESOURCE ALLOCATION	With limited resources available, groundwater planners may choose to allocate available monitoring and management resources to prioritized GDEs and ISWs. Prioritization may reflect criteria such as habitat value or vulnerability, species dependency, and/or 'indicator' GDEs or ISWs.
MULTI-BENEFIT APPROACH	Groundwater planners are encouraged to design project and management actions for multiple-benefit solutions, including habitat improvements. Evaluation of supply augmentation and demand reduction management actions may quantify or describe impacts on GDEs and ISW to justify actions that serve multiple beneficial users of groundwater.

Legal, Regulatory, and Policy Considerations

Apart from SGMA requirements, there are numerous laws, regulations, and policies that protect species and habitat and can inform development and implementation of GSPs.

CALIFORNIA ENDANGERED SPECIES ACT, ENDANGERED SPECIES ACT	GDEs and ISWs in SGMA-regulated basins contribute to habitat for over 120 federal or State-listed Threatened and Endangered (T&E) species. Basins with T&E species should evaluate groundwater management impacts to species and habitats of concern.
LAKE AND STREAMBED ALTERATION (LSA)	The Fish and Game Code requires an entity to notify the Department prior to commencing an activity that may substantially divert/obstruct the natural flow of any river/stream/lake.
CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)	SGMA project and management actions necessary to achieve basin sustainability may be subject to CEQA.
PUBLIC TRUST DOCTRINE	Public trust resources entitled to protections under the Public Trust Doctrine include navigable surface waters and fisheries. Tributary waters, including groundwater hydrologically connected to navigable surface waters and surface waters tributary to navigable surface waters, are also subject to the Public Trust Doctrine to the extent that extractions affect or may affect public trust uses.
CLEAN WATER ACT AND PORTER COLOGNE ACT	Water quality degradation, one of the six sustainability indicators required in GSPs, is also governed by the Clean Water Act and Porter Cologne Act and has a significant impact on habitat viability.
STATE, FEDERAL, TRIBAL PROTECTED LANDS AND WATERS	Lands and waters governed by state, federal, and tribal governments are held in the protection of the public trust, including CDFW Wildlife Areas, Ecological Reserves, and conservation easements. These lands merit specific consideration in GSPs.
INSTREAM FLOW REQUIREMENTS/ RECOMMENDATIONS	The State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards enforce legally-mandated instream flow requirements. CDFW and other environmental organizations develop instream flow recommendations based on field measurements, desktop analyses, and species/habitat needs. These requirements and recommendations can inform GSP sustainability criteria.
SWRCB WATER QUALITY CONTROL PLAN	The SWRCB adopted a Water Quality Control Plan in December 2018 for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality, which set new regulatory requirements for instream flow that inform future water availability.
CALIFORNIA WATER ACTION PLAN (WAP)	The California Natural Resources Agency state-wide WAP identifies a list of actions to support reliable water supply in California for all beneficial users and calls for the protection and restoration of important ecosystems.
CALIFORNIA BIODIVERSITY INITIATIVE	This initiative addressing Executive Order B-54-18 seeks to work across agencies and organizations to secure California's biodiversity benefits for the State's short- and long-term environmental and economic health.

Endnotes

[1] CDFW acknowledges that groundwater knowledge and understanding is imperfect and reserves the right to update these groundwater planning considerations as additional information becomes available and knowledge of groundwater systems in relationship to habitat and species needs improves over time.

[2] 'Best available science' refers to the use of sufficient and credible information and data specific to the decision being made and the time frame available for making that decision. [23 CCR § 351(h).]

[3] SGMA states, "the groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans including surface water users, if there is a hydrologic connection between surface and groundwater bodies." [Water Code § 10723.2(f).] SGMA also defines 'significant depletions of interconnected surface waters' as "reductions in flow or levels of surface water that is hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses of the surface water." [Water Code § 10735.2(d).] These uses of the term hydrologic connectivity in SGMA may differ from other state and federal wetland identification protocols such as the SWRCB Wetland Delineation methods.

[4] The capillary fringe is the area directly above the water table that may hold water in the pores through capillary pressure, a property of surface tension that draws water upward.

[5] Cook, P.G., P. Brunner, C.T. Simmons, and S. Lamontagne. 2010. What is a Disconnected Stream?

[6] A gaining stream is one in which the stream channel bottom is lower than the adjacent groundwater elevation, meaning water moves from the aquifer into the channel. A losing stream is one in which the stream channel bottom is above the groundwater elevation, and water moves from the channel into the surrounding aquifer.

[7] Cunningham, W. L., and C. W. Schalk. 2011. Groundwater Technical Procedures of the U.S. Geological Survey.

[8] Rantz, S.E. 1982. Measurement and Computation of Streamflow: Vol. 1. Measurement of Stage and Discharge.

[9] Department of Water Resources. Best Management Practices for Sustainable Management of Groundwater.

[10] CDFW also seeks protection and preservation of non-T&E species, with specific consideration for Species of Special Concern that directly depend on groundwater for survival.

[11] SWRCB. 2018. Cannabis Compliance Gages (Cannabis Policy, Attachment A, Section 4).

[12] SWRCB. 2018. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

[13] 2018. California Biodiversity Initiative. California Natural Resources Agency, California Department of Food and Agricultures, Governor's Office of Planning and Research.