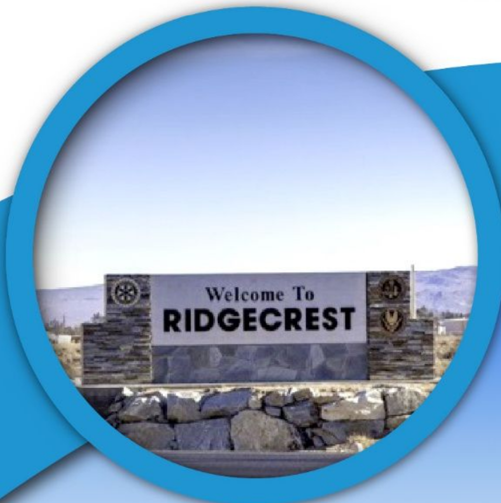
Groundwater Sustainability Plan
for the
Indian Wells Valley Groundwater Basin

Bulletin 118 Basin No. 6-054
Indian Wells Valley Groundwater Authority

IWVGA
INDIAN WELLS VALLEY GROUNDWATER AUTHORITY



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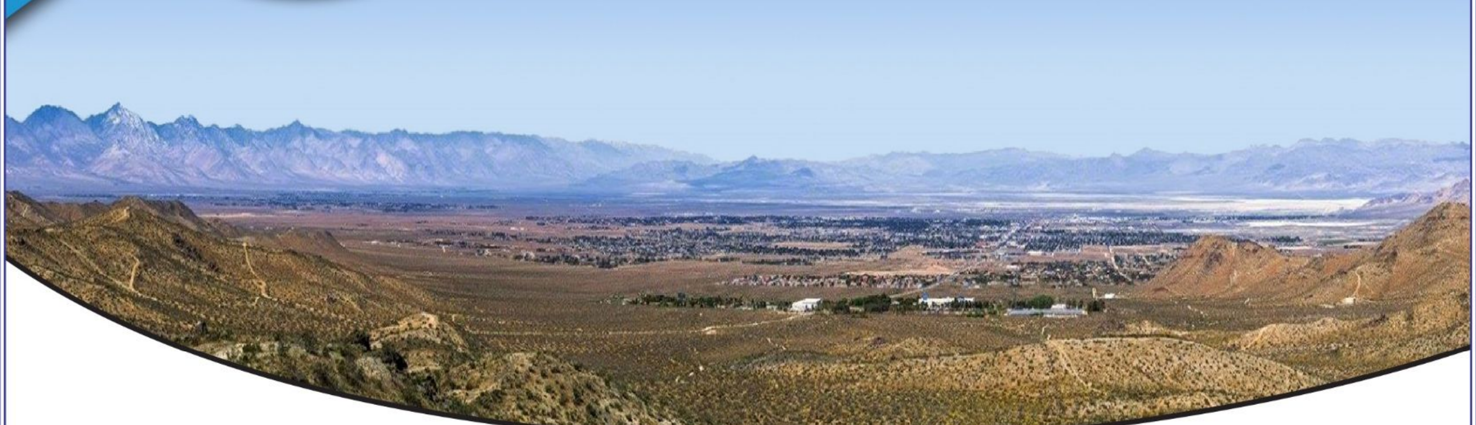

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COVER PHOTOGRAPHS

Front Cover: Ridgecrest City View from College; City of Ridgecrest.

Welcome to Ridgecrest Sign on Inyokern Road; City of Ridgecrest.

Back Cover: Ridgecrest City Hall at Sunset; City of Ridgecrest.

Indian Wells Valley Canyon View; Stetson Engineers Inc.

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INDIAN WELLS VALLEY GROUNDWATER BASIN

Groundwater Sustainability Plan

January 2020

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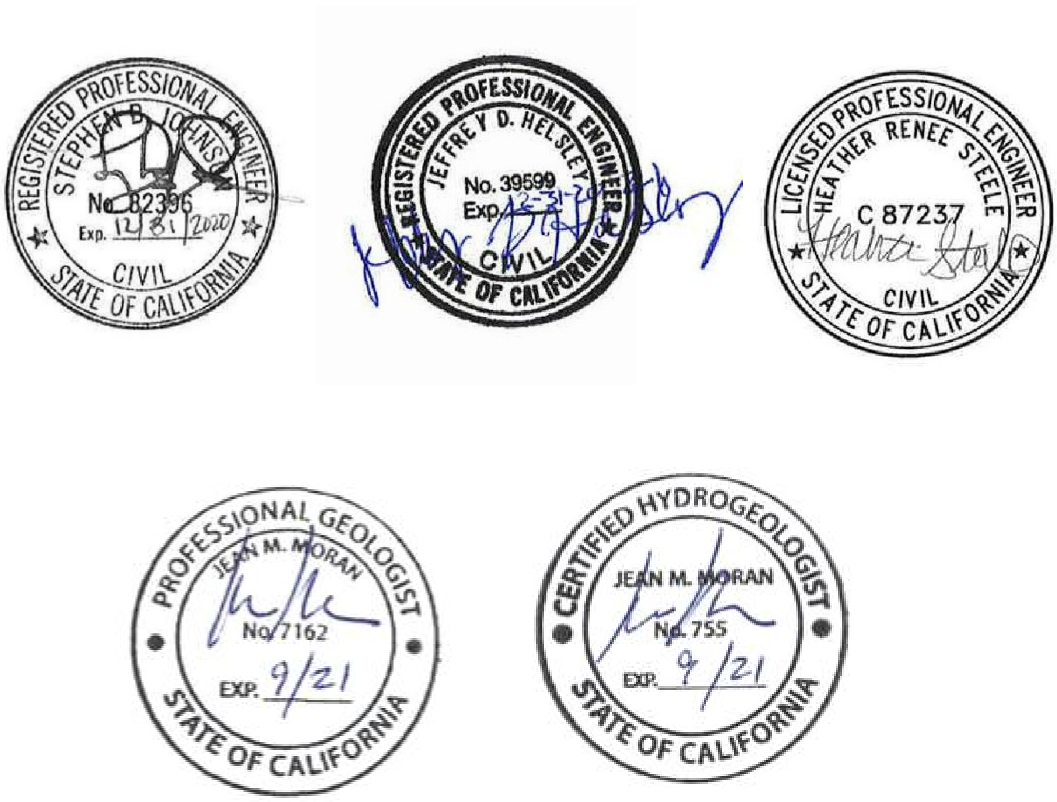
SIGNATURE PAGE

This Groundwater Sustainability Plan for the Indian Wells Valley Groundwater Basin has been prepared under the direction of professional engineers and geologists licensed in the State of California as required per California Code of Regulations, Title 23 Section 354.12 consistent with professional standards of practice.



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ACKNOWLEDGEMENTS

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Appendix 5-C – Recycled Water Technical Memorandum

LIST OF ACRONYMS AND ABBREVIATIONS

AVEK	Antelope Valley – East Kern Water Agency
Basin	Indian Wells Valley Groundwater Basin
BLM	United States Bureau of Land Management
Board	IWVGA Board of Directors
CASGEM	California Statewide Groundwater Elevation Monitoring
CDCA	California Desert Conservation Area
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cerro Coso	Cerro Coso Community College
CGMP	Cooperative Groundwater Management Plan for the Indian Wells Valley
CIMIS	California Irrigation Management Information System
City	City of Ridgecrest
CLUMP	Comprehensive Land Use Management Plan
Cooperative Group	Indian Wells Valley Cooperative Groundwater Management Group
CUP	Conditional Use Permit
CWC	California Water Code
CWSRF	Clean Water State Revolving Fund
DACs	Disadvantaged Communities
DDW	State Water Resources Control Board – Division of Drinking Water
DEHS	Division of Environmental Health Services
DMS	Data Management System
DRP	Direct Potable Reuse
DWR	California Department of Water Resources
DWSRF	Drinking Water State Revolving Fund
ECSZ	Eastern California Shear Zone
EDAs	Economically Distressed Areas
EHD	Environmental Health Department

EKCRCD	East Kern County Resource Conservation District
EPF	El Paso Fault
ET	Evapotranspiration
FRWR	Federal Reserve Water Rights
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDEs	Groundwater Dependent Ecosystems
GRRPs	Groundwater Replenishment Reuse Projects
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
HMP	Habitat Management Plan
ICPC	Inyo County Planning Commission
INRMP	Navy's Integrated Natural Resources Monitoring Plan
INRMP	Integrated Natural Resources Management Plan
InSAR	Interferometric Synthetic Aperture Radar
Inyokern CSD	Inyokern Community Services District
Inyo-Mono IRWMP	Inyo-Mono Integrated Regional Water Management Program
IRP	Installation Restoration Program
IWV	Indian Wells Valley
IWVGA	Indian Wells Valley Groundwater Authority
IWVGB	Indian Wells Valley Groundwater Basin
IWVWD	Indian Wells Valley Water District
KCWA	Kern County Water Agency
Kern County PHSD	Kern County Public Health Services Department
LA Aqueduct	Los Angeles Aqueduct
LADWP	Los Angeles Department of Water and Power
LiDAR	Light Detection and Ranging
LLFZ	Little Lake Fault Zone
LRWQCB	Lahontan Regional Water Quality Control Board
LUST	Leaking Underground Storage Tank
MAE	Mean Absolute Error

MCL	Maximum Contaminant Level
MGD	Million Gallon Per Day
MWA	The Mojave Water Agency
NAWS China Lake	Naval Air Weapons Station China Lake
NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NHD	National Hydrographic Dataset
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
PAC	Policy Advisory Committee
RDAT&E	Research, Development, Acquisition, Test, and Evaluation
REPI	Readiness and Environmental Protection Integration Act
Ridgecrest	City of Ridgecrest
RIFIA	Reclamation Integration Financing and Integration Act
RMPs	Resource Management Plans
Searles	Searles Valley Minerals Inc.
SDACs	Severely Disadvantaged Communities
SDWC	Searles Domestic Water Company
SGMA	Sustainable Groundwater Management Act
SMCL	Secondary Maximum Contaminant Level
SNMP	Salt and Nutrient Management Plan
SNORT	Supersonic Naval Ordnance Research Track
SSURGO	Soil Survey Geographic Database
SVM	Searles Valley Minerals Inc.
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
TSS	Technical Support Services
USBR	U.S. Bureau of Reclamation
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey

UST	Operating Permitted Underground Storage Tanks
Valley	Indian Wells Valley
Water District	Indian Wells Valley Water District
WIFIA	Water Infrastructure Financing and Integration Act
WRDA	Water Resources Development Act
WRM	Water Resources Manager
WWTFs	Wastewater Treatment Facilities
WY	Water Year (October through September)

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION SUMMARY

ES 1.1 Purpose of Groundwater Sustainability Plan

Currently, the groundwater resources in the Indian Wells Valley Groundwater Basin (IWVGB or Basin) are not being sustainably managed. Overdraft conditions have existed for decades as a result of groundwater pumping that exceeds the natural Basin yield (Dutcher and Moyle, 1973). The results of overdraft have manifested themselves through various undesirable results, primarily the chronic lowering of groundwater levels, the degradation of water quality, and the reduction of groundwater in storage throughout the IWVGB. (See Section 3 for a discussion of overdraft conditions in the Basin.)

In compliance with the Sustainable Groundwater Management Act (SGMA), as set forth in California Water Code (CWC) Section 10720.1, this Groundwater Sustainability Plan (GSP) discusses Basin management strategies that will culminate in the absence of undesirable and unsustainable groundwater conditions in the IWVGB. The GSP recommends management actions and projects, and provides measurable sustainability objectives and milestones that are intended to achieve Basin sustainability while considering the unique geologic and hydrogeologic conditions of the IWVGB. The recommendations of this GSP will provide for long-term sustainable groundwater management in the IWVGB within 20 years of GSP implementation.

ES 1.2 Agency Information

In its 2016 Bulletin 118 interim update, the California Department of Water Resources (DWR) identified the IWVGB as a critically overdrafted basin of medium priority[1]. As such, in compliance with SGMA, the associated groundwater sustainability agency (GSA) must submit a GSP by January 31, 2020 to achieve local sustainable management of groundwater resources. The Indian Wells Valley Groundwater Authority

[1] The IWVGB has since been identified as a critically overdrafted basin of **high** priority as of the *Sustainable Groundwater Management Act 2018 Basin Prioritization: Process and Results*, published by DWR in January 2019.

(IWVGA) Board of Directors adopted Resolution No. 02-16 on December 8, 2016, to establish the IWVGA as the exclusive GSA for the entirety of the IWVGB.

The IWVGB underlies portions of the counties of Kern, Inyo, and San Bernardino and is unique in that it is isolated from the urban centers of these three counties. The Indian Wells Valley Water District (IWVWD) serves potable water to the City of Ridgecrest (City or Ridgecrest) and certain areas outside of Ridgecrest's jurisdiction. These five agencies (Kern County, Inyo County, San Bernardino County, Ridgecrest, and the IWVWD) entered into a joint exercise of powers agreement to form the IWVGA and serve as General Members on the IWVGA Board of Directors, which governs the IWVGA as a whole. A significant amount of land overlying the IWVGB comprises either the Naval Air Weapons Station China Lake (NAWS China Lake) or public lands managed by the United States Bureau of Land Management (BLM). The U.S. Navy and BLM serve as Associate Members (non-voting) on the IWVGA Board of Directors.

The IWVGA Board established an eleven-person, voting-member Policy Advisory Committee (PAC) to advise the Board on all policy-related matters of the Board and to develop non-binding proposals on policy matters pertaining to the GSP. The PAC is comprised of voting members from the following constituent groups:

- 2 representatives from Large Agriculture
- 1 representative of Small Agriculture
- 2 representatives from Business Interests
- 2 representatives from Domestic Well Owners
- 2 representatives from residential customers of a public water agency supplier
- 1 representative from the Eastern Kern County Resource Conservation District
- 1 representative from Wholesale and Industrial User

The PAC is also comprised with non-voting members from the following agencies:

- U.S. Navy
- IWVWD
- BLM
- Kern County

The IWVGA Board also established a Technical Advisory Committee (TAC) for the express purpose of giving interested parties a reasonable opportunity to review and conduct a thorough evaluation of each technical element of the GSP prior to its finalization by the Water Resources Manager (WRM). The TAC is comprised of members from the following constituent groups:

- Large Agriculture
- Business Interests
- Residential Customers of a Public Water Agency
- Domestic Well Owners
- Eastern Kern County Resource Conservation District
- Wholesale and Industrial User
- IWVWD (Non-voting member)
- United States Navy (Non-voting member)
- Kern County Water Agency

ES 1.3 Interested Parties and Outreach

During the formation of the IWVGA, a comprehensive listing of interested parties was developed which includes local community residents (including Disadvantaged Communities, Severely Disadvantaged Communities, and Economically Distressed Areas), businesses, large and small-scale agriculture, domestic well owners, academic institutions, relevant State and local agencies, Federal agencies, non-profit organizations, and community organizations. This listing of over 150 stakeholders includes representatives from all types of water users within the IWVGB and was used during the 17-month long GSA formation process for notification of public meetings, notifications, and updates related to discussions on the SGMA.

The regular meetings of the Board, PAC, and TAC are open to members of the public, including representatives of all types of water users. At each meeting, members of the public are allowed time to address the respective Board or committees regarding topics listed and not listed on the meeting agenda. IWVGA documents (such as meeting agendas, minutes, resolutions, ordinances, presentations, meeting packages, etc.) are made available to the public at the following website: https://iwvga.org/

In addition to regular meetings, the IWVGA has hosted public workshops to present IWVGA policies. Additionally, IWVGA Board Members and Staff have met with individual stakeholder groups to provide GSP updates and discuss groundwater pumping and the planned pumping allocation process.

In addition, as part of DWR's requirements for SGMA and the GSP, a publicly-accessible database has been developed to store and present specific supporting elements of the GSP, including monitoring, reporting, management criteria, a water budget, hydrogeologic conceptual model, and other supporting documentation. The database additionally allows the public to review data and other reports related to IWVGB water resources. The database may be reached at the following link: https://www.iwvgsp.com

ES 2.0 PLAN AREA SUMMARY

ES 2.1 General Description and Setting

The IWVGB is located in the northwestern part of the Mojave Desert in southern California, and underlies approximately 382,000 acres or approximately 600 square miles of land area in portions of the Counties of Kern, Inyo, and San Bernardino. The IWVGB is bordered on the west by the Sierra Nevada Mountain Range, on the north by the Coso Range, on the east by the Argus Range, and on the south by the El Paso Mountains. Surface water flow from the surrounding mountain ranges drains to China Lake, a large normally dry lake, or playa, located in the central north-east part of the Basin. U.S. Route 395 and State Route 14 are the major vehicular arteries through the Indian Wells Valley. Overdraft conditions in the IWVGB have existed for since at least the 1960s (Dutcher and Moyle, 1973). DWR Bulletin 118-16 (dated January 2016) indicates the IWVGB is subject to critical conditions of overdraft.

ES 2.2 Jurisdictions

The land overlying the IWVGB encompasses portions of the Counties of Kern, Inyo, and San Bernardino, with the majority (approximately 73%) being in Kern County. Ridgecrest is the only incorporated community in the Indian Wells Valley and covers an area of approximately 20 square miles with a population of approximately 27,000 people. Unincorporated communities in the Indian Wells Valley include the communities of Inyokern in Kern County and Pearsonville in Inyo County, along with other smaller communities.

ES 2.3 Water Supply Source

The IWVGB serves as the sole supply of potable water for the Indian Wells Valley. Residents of the Indian Wells Valley are served groundwater through private domestic wells, small cooperative groups sharing wells, small mutual water companies, the Inyokern Community Services District (Inyokern CSD), and the Water District. The U.S. Navy produces and distributes groundwater for the on-station water uses at the NAWS China Lake. Searles Valley Minerals Inc. produces groundwater from the IWVGB for use in its minerals recovery and processing operations in the Searles Valley (located east of the IWVGB) and for potable use in the small communities of Trona, Westend, Argus, and Pioneer Point in the Searles Valley. In addition, a number of farms located in the Indian Wells Valley rely on the IWVGB's water supplies for their agricultural operations, including Meadowbrook Dairy, Mojave Pistachios, Simmons Ranch, Quist Farms, and other smaller farms. The crops grown in the Indian Wells Valley are primarily alfalfa and pistachios.

ES 2.4 Local Water Agencies

The local water agencies that currently rely on the IWVGB as a water supply source include the IWVWD and the Inyokern CSD. Though not located within the IWVGB boundaries, the Searles Domestic Water Company relies on extracted groundwater imported from the IWVGB to its served communities in the Searles Valley (Trona, Westend, Argus, and Pioneer Point). A number of other water agencies have service areas and/or spheres of influence that extend into the IWVGB but have no water supply infrastructure or water supply services in the IWVGB. These agencies include the Antelope Valley – East Kern Water Agency, the Kern County Water Agency, the Mojave Water Agency, and the Rand Communities Water District.

ES 2.5 Regional Water Management Agencies

The IWVGA is the exclusive Groundwater Sustainability Agency for the IWVGB, Bulletin 118 Basin No. 6-054. There are several other existing regional entities with water supply, management, planning, and/or regulatory authority, whose boundaries encompass all or portions of IWVGB. These entities include the Kern County Water Agency (KCWA), the Lahontan Regional Water Quality Control Board (LRWQCB), the

Inyo-Mono Integrated Regional Water Management Program (Inyo-Mono IRWMP), and the East Kern County Resource Conservation District (EKCRCD).

ES 2.6 Land Use

The lands overlying the IWVGB are governed by the general plans and land use plans of Kern County, Inyo County, San Bernardino County, Ridgecrest, the NAWS China Lake, and the BLM. As mentioned above, approximately 73% of the lands overlying the IWVGB are located within the jurisdiction of Kern County. A majority of the lands overlying the IWVGB within Kern County and Inyo County are zoned for Open Space, while a majority of the lands overlying the IWVGB within San Bernardino County are zoned for Resource Conservation. The City's General Plan discusses the City's goals for land use, community design, open space, and resource conservation, and these goals are consistent with the implementation actions in this GSP.

ES 2.7 Existing Water Resources Monitoring Programs

Multiple entities have been measuring depth to groundwater in the IWVGB since the 1920's. Monitoring programs were first initiated in the IWVGB by the United States Geological Survey (USGS) and have been primarily conducted by KCWA since 1989 with the assistance of the Water District, the United States Bureau of Reclamation (USBR), and NAWS China Lake. Additionally, many of these entities have constructed wells dedicated to monitoring groundwater levels and water quality in the IWVGB.

Prior to formation of the IWVGA, monitoring efforts in the IWVGB were often duplicated due to a lack of communication among interested parties. In 1995, the Indian Wells Valley Cooperative Groundwater Management Group (Cooperative Group) was formed to coordinate monitoring and management efforts, share data, and avoid the redundancy of groundwater data collection and study efforts. As a public data-sharing group consisting of the major water producers, government agencies, and concerned citizens in the IWVGB, the Cooperative Group compiled numerous study and data-gathering efforts in the IWVGB including a basin-wide recharge study, the construction of weather and stream gages, and well monitoring data collected by the Water District, KCWA, and NAWS China Lake for over 100 monitoring wells.

Monitoring efforts in the IWVGB are currently conducted by the KCWA, NAWS China Lake, and the IWVGA (through the California State Groundwater Elevation Monitoring Program (CASGEM)).

ES 2.8 Existing Water Resources Management Programs

It has been well documented that the IWVGB has been in overdraft since at least the 1960s and that current Basin outflows exceed Basin inflows by approximately four times (Dutcher and Moyle, 1973). See Table 3-7. Water resources management programs in the IWVGB have been implemented by a variety of entities to partially address the conditions of Basin overdraft. In many instances, these water resources management programs have resulted in a reduction of historical pumping to reduce the impacts of over-pumping, though additional water resources management programs will be required to bring the IWVGB into sustainable operations. The water resources management programs that have or are currently being implemented in the IWVGB include:

- Adoption of a Salt and Nutrient Management Plan
- Water conservation measures implemented by the IWVWD, the City, and NAWS China Lake
- Beneficial use of recycled water generated at the City's wastewater treatment facility
- Groundwater contamination cleanup performed by the NAWS China Lake
- Well permitting policies established by the Counties of Kern, Inyo, and San Bernardino.

ES 2.9 Data Management System (DMS)

As part of DWR's requirements for SGMA and the GSP, a publicly-accessible database has been developed to store and present specific supporting elements of the GSP, including monitoring, reporting, management criteria, a water budget, hydrogeologic conceptual model, and other supporting documentation. The database allows the public to review data and other reports related to IWVGB water resources. Data obtained through the current water resource monitoring and management programs helped populate the database, and that data was used to develop the projects and management actions recommended in this GSP. Content available on the database includes monitoring locations, groundwater level/pumping data, interactive satellite images of the IWVGB, documented Basin studies, etc.

The database may be reached at the following link: https://www.iwvgsp.com

ES 3.0 BASIN SETTING SUMMARY

ES 3.1 Hydrogeological Conceptual Model

IWV is located in the western edge of the Basin and Range Physiographic Province, characterized by a topography of isolated mountain ranges separated by desert basins (TtEMI, 2003b). IWVGB is bounded by the Sierra Nevada Mountains to the west, the Coso Range to the north, the Argus Range to the east, and the El Paso Mountains and Spangler Hills to the south. The highest elevation in the IWV watershed occurs in the Sierra Nevada reaching 8,452 feet mean sea level (msl) at Owens Peak. Mountain slopes dip steeply to the valley floor that in turn slopes gently to China Lake, which is normally a dry playa, except following significant rainfall. The location map (Figure 3-1) shows the watershed extents, the Basin boundary (also known as the GSA boundary), land ownership, and existing monitoring wells for reference in this discussion. The elevation of the Valley floor ranges from about 2,790 feet msl at the far southwest El Paso area to approximately 2,150 feet msl at China Lake playa (TtEMI, 2003b). The USGS topographic map shown on Figure 3-2 displays how the GSA boundary encompasses the Valley floor and alluvial stream channels of the surrounding mountains.

ES 3.1.1 Geology and Hydrogeology

IWV lies within the northern portion of the Eastern California Shear Zone (ECSZ) or the southern Walker Lane Belt, in a transitional zone of east-west extensional faulting of the Great Basin Province and dominant right-lateral strike-slip faulting common to the Sierra Nevada Mountains (TriEcoTt, 2013). From the Late Miocene (11.6 to 5.3 million years ago) through the Pliocene (5.3 to 2.6 million years ago), IWV was down-faulted along the Sierra Nevada frontal fault resulting in the structural half-graben of present-day (Monastero et. al., 2002; Kunkel & Chase, 1969). Based on historical groundwater levels, the Little Lake fault zone (LLFZ) and El Paso fault (EPF) (mapped by Kunkel and Chase, 1969 and Garner et al., 2017) have been shown to impede movement of groundwater within the Basin. Figures 3-4a and 3-4b show the surficial geology in the IWVGB and Figures 3-5a and 3-5b show two cross-sections through the valley.

There are two principal aquifer units defined by Kunkel and Chase (1969). The shallow aquifer contains coarse sediments near the Sierra Nevada with increased interbedded silts and clays towards the center of the Basin associated with the lacustrine deposits and includes China Lake's playa deposits. The best quality of water is at shallow to medium depths in the southwestern part of the valley, closer to the Sierra Nevada (Dutcher and Moyle, 1973). The deeper aquifer is also composed of gravel, sand, silt and clay. It is strongly connected to the shallow aquifer in the west and southwest of the Basin; and is confined in other parts of the Basin. Existing multi-level CASGEM monitoring wells (USBR, 1993)[2] show semi-confined artesian conditions within the deeper aquifer where it occurs beneath the lacustrine and other fine-grained sediments.

ES 3.1.2 Soils

Limited surface soil data were publicly accessible and available for IWV. The Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) mapped arid to semi-arid soil types occurring in the southwest El Paso area. Soil data for the main area of IWVGB were not present from NRCS, and are considered a data gap requiring further research of non-public databases. Two additional preliminary soil surveys with limited extents were conducted by NRCS but are not digitally available for mapping: (1) Ridgecrest Part, Northeastern Kern Area (USDA-NRCS, 1995); and (2) Portions of China Lake Weapons Center (USDA-SCS, undated).

ES 3.1.3 Hydrology

The IWVGB is part of the Mojave Desert and has an arid, high desert climate characterized by hot summers, cold winters, and irregular and sparse precipitation. The Basin is bounded by mountains to the north, south, and west, which drain internally to the playa. Summer high temperatures on the playa are typically greater than 100 degrees Fahrenheit (°F) and winter lows are typically in the 20s and 30s °F.

[2] Most of the multi-level monitoring wells are being used to support CASGEM reporting. See Figure 3-12 which displays hydrographs that demonstrate the semi-confined artesian conditions.

Precipitation on the valley floor ranges from 2 to 5 inches per year; snowfall, if any, typically occurs in December and January, with an average of less than 1 inch per year (WRCC, 2018c; PRISM, 2012). Mountain areas receive more precipitation than the playa and are the primary source of recharge for the Basin. The average annual precipitation for the IWVGB and mountain areas ranges from about 4 inches per year up to about 20 inches per year (PRISM, 2012)[3].

With high temperatures, high winds, and low humidity the IWVGB has high ET rates. Average annual evaporation from a shallow water body in the playa is about 80 inches per year (Farnsworth et al, 1982). NOAA maps of evaporation (Farnsworth et al 1982) show that, in general, annual evaporation from a free water surface is greater on the valley floor than in mountainous areas of the Basin. For example, in the Sierra Nevada mountains on the west side of the IWVGB, annual evaporation from a free water surface ranges from about 45 in/yr to 65 in/yr (Farnsworth et al, 1982).

Mountain front recharge is believed to be the dominant source of inflow to the Basin. In 2014, Todd Engineers prepared a study that reviewed previous recharge studies and made new estimates of recharge (Todd Engineers, 2014). In 2016, DRI conducted a comprehensive review of recharge estimates for the Basin (McGraw et al, 2016). DRI reviewed fourteen previous studies and then updated the recharge estimates using an empirical relationship between precipitation and groundwater recharge. The average annual recharge developed by DRI is 7,650 AF per year (McGraw et al, 2016; Garner et al, 2017). The total area of recharge is about 770 square miles.

ES 3.1.4 Water Budget and Overdraft Conditions

The current average estimated water budget for IWV is defined as the years 2011 to 2015 and is shown below in Table ES-1.

[3] The spatial data set in Figure 3-8 is from a 30-year climate normal data set prepared by the PRISM Climate Group. These data are based on calendar years and are not available in water year format.

Table ES-1. Current Water Budget (2011 to 2015 Average).

Water Budget Element	Estimated Volume (AFY) [1]
Inflows	
Mountain Front Recharge	7,650
Total Inflow	**7,650**
Outflows	
ET	4,850
Interbasin Subsurface Flow	50
Groundwater Extractions	27,740
Total Outflow	**32,640**
Change of Groundwater in Storage	**-24,990**

[1] The annual calibrated model developed by DRI was provided by the Navy as in-kind services. The calibration model run is based on annual stress periods and water budget numbers are summarized by calendar year (January through December). Future Baseline (no action) and Management Model runs were developed with a monthly stress period, and the water budgets are summarized as water years (October through September).

An IWVGB water budget is defined by the difference between inflows and outflows (see Section 3.3.4). Overdraft occurs when outflows exceed inflows, and there is a loss of groundwater in storage. In the case of the IWV, long-term pumping exceeded local inflow. It is well documented that IWV has been in overdraft since at least the 1960s (Dutcher and Moyle, 1973). Currently (2011 to 2015), outflows are approximately four times the estimated inflows. The magnitude of the overdraft results in an average annual loss of storage of approximately 25,000 AFY.

ES 3.1.5 Sustainable Yield

DWR states that "SGMA requires local agencies to develop and implement GSPs that achieve sustainable groundwater management by implementing projects and management actions intended to ensure the Basin is operated within its sustainable yield by avoiding undesirable results" (DWR, 2016d). Consequently, sustainable yield is a crucial and fundamental element for the development of implementation measures of the GSP. DRI, in coordination with the IWV TAC, has estimated the long-term average natural recharge to the IWVGB is about 7,650 AFY. For the GSP, this is considered the Current Sustainable Yield of the Basin.

ES 3.2 Current and Historical Conditions

ES 3.2.1 Reduction of Groundwater in Storage

The IWVGB is currently in overdraft with a current loss of storage of approximately 25,000 AFY. This significant reduction of groundwater in storage is directly related to the chronic lowering of groundwater levels, water quality degradation, and land subsidence, discussed in the subsection below.

ES 3.2.2 Chronic Lowering of Groundwater Levels

Groundwater levels have been experiencing significant declines in almost all areas of the IWVGB (see Appendix 3-D). Groundwater levels remain stable in some locations within the IWVGB near recharge and discharge zones, as well as in the El Paso area which is separated by a fault from the main IWV aquifer. Declining water levels have historically impacted and are currently impacting shallow production wells, requiring wells to be deepened, re-drilled, or abandoned as a water source. Many shallow wells are located in disadvantaged communities, exacerbating the financial impact of required well modifications and/or replacements.

ES 3.2.3 Seawater Intrusion Conditions

The IWVGB is an inland basin, and as such, is not hydraulically connected to a sea or ocean. The City of Ridgecrest is over 100 miles from both the Pacific Ocean and the Salton Sea. Accordingly, seawater intrusion is not evaluated in this GSP and seawater intrusion will not be considered as a sustainability indicator for establishing sustainable management criteria (see Section 4).

ES 3.2.4 Groundwater Quality Conditions

Currently, substantial groundwater in the IWVGB is of good quality; however, there are regions with poorer water quality due to high concentrations of total dissolved solids (TDS) and/or arsenic. Within the

IWVGB, groundwater moves from the mountains toward the China Lake playa, through coarse-grained alluvial deposits into fine-grained lacustrine deposits. This groundwater movement can cause dissolution of evaporites (caused by high evaporation rates at earlier times), resulting in high TDS concentrations (TriEcoTt, 2013; Berenbrock and Schroeder, 1994). Increased pumping can exacerbate the process described above causing ions to be leached from clay and lacustrine deposits resulting in increased TDS concentrations. TDS samples indicate concentrations have increased over time in some of the northwest area wells where high rates of pumping may have migrated naturally occurring saline water. Historically, some wells sampled within the IWVGB have shown arsenic concentrations in groundwater above California's current arsenic MCL (10 μg/L). The groundwater most strongly affected by arsenic above the MCL occurs in the southeast area of the IWVGB and beneath the Navy Base.

ES 3.2.5 Land Subsidence Conditions

The Basin includes relatively coarse-grained alluvial aquifers with clay and silt interbeds, and low permeability thick clay and silt deposits associated with lacustrine and playa depositional environments. These fine-grained materials are prone to inelastic compaction when the groundwater table is lowered below historical levels. As a result, areas underlain by extensive fine-grained materials have a high to very high susceptibility to land subsidence. The Basin is located within the tectonically active eastern California shear zone, and also subject to direct tectonic changes in ground elevation, as well as soft sediment deformation and compaction of fine-grained units due to seismic activity.

ES 3.2.6 Interconnected Surface Water Systems

There are no significant interconnected surface water systems that interact with groundwater in the IWVGB. Streams in the valley are typically ephemeral and the majority of recharge occurs as mountain front recharge. Additionally, there are multiple natural springs in the mountain and canyon areas surrounding the IWV (see Figure 3-11). One spring located near Highway 14 is used as the water supply source for a restaurant and brewery.

ES 3.2.7 Groundwater Dependent Ecosystems

Groundwater is critical to sustaining springs, wetlands, and perennial flow (baseflow) in streams as well as to sustaining vegetation such as phreatophytes that directly tap groundwater through long and extensive root systems. Mapping of DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset indicates the vast majority of GDEs within the IWV are located on NAWS China Lake, supported by the vertical upward gradient under the China Lake Playa which causes groundwater to discharge to the surface. Smaller and scattered communities of GDEs may be present in the canyons along the Sierra Nevada, in the El Paso area along the ephemeral streams, and in the southwest region of the IWV. GDEs located in the valley floor, including those near the China Lake Playa, are likely more vulnerable due to chronic lowering of groundwater levels, which is supported by U.S. Navy documentation of well-established GDEs near the SNORT facility that are sensitive to changes in groundwater levels (Lancaster, 2019).

ES 3.3 Numerical Model

After peer review of the DRI groundwater flow model, the flow model was modified and recalibrated for suitability for the GSP. The re-calibrated model provides the historical water budgets and are the platform used for the SGMA simulations of baseline conditions and management scenarios. Model assumptions, construction, and performance are detailed in Appendix 3-H. The GSP modeling effort provides tools necessary for estimating the groundwater aquifer's hydrologic water budget, identifying data gaps, assessing groundwater level and quality trends, determining sustainability criteria, and evaluating different strategies to provide long-term sustainable groundwater management for the IWVGB. The model also provides ongoing analysis and support as needed for the annual reports and periodic evaluations that will be required for submittal to DWR.

A three-dimensional solute transport model was developed to address the effects of pumping on groundwater quality over time. The transport model is coupled with the groundwater flow model of IWV, utilizing the same model domain, grid structure, and layers. TDS concentrations are used in the transport model as a surrogate for groundwater salinity to forecast TDS concentrations from the present to the year

2070 by incorporating the volumetric groundwater flow rates simulated by the flow model for the SGMA management scenario.

The numerical model was used to simulate IWVGB baseline conditions with the purpose of understanding future projected conditions if the GSP were not implemented, or under "no action" conditions. The baseline model run was then used as one of the tools to evaluate the proposed projects and management actions.

The numerical model was also used to simulate IWVGB conditions and behavior resulting from implementation of the proposed projects and management actions (Scenario 6.2). This scenario was used further to develop certain sustainable management criteria.

The TAC was instrumental in performing and evaluating the numerical model runs.

ES 3. 4 Existing Monitoring Network and Data Gap Evaluation

As of Fall 2019, 198 monitoring wells, two stream gages, and four weather stations contribute data to the monitoring program. DRI also maintains an eddy covariance station to monitor evapotranspiration/evaporation, and the USGS provides InSAR and earthquake activity data to monitor for land subsidence. Depth to water is measured biannually at 198 monitoring wells during Spring (March) and Fall (October) to observe seasonal changes in groundwater levels. The existing program contains monitoring wells throughout the Basin including 19 multi-level monitoring wells, 60 domestic wells, and 63 wells on the Navy base. Data gaps in the groundwater level monitoring program exist outside of the pumping areas. There are only a few monitoring wells in the El Paso area, mostly open space managed by BLM. Groundwater resources in this area have not been fully characterized or quantified. The largest ephemeral stream system in IWV commences from this area in Freeman and Little Dixie Washes. Additional well drilling to characterize the aquifer structure and properties, and groundwater level monitoring could provide a better understanding of the occurrence and movement of water in this area.

Data gaps for stream flow and mountain front recharge are being addressed initially under DWR Prop 1 Grant funding. A new weather station is being installed at Chimney Peak Fire Station and the Walker Pass

East weather station is being retrofitted to provide high elevation precipitation monitoring at the Sierra Front where most of the recharge is estimated to occur. A new stream gage is being installed within Indian Wells Canyon, and an existing stream gage is being retrofitted in Sand Canyon. Dataloggers are being deployed in six wells within the Sierra stream drainages.

Groundwater pumping data are being collected as part of the GSP process from major pumpers including large and small agriculture, mining, water district, mutual water companies, water cooperatives, and the Navy. Domestic groundwater use is currently estimated. A data gap is quantifying domestic well water use.

Subsurface flows into the Basin from Rose Valley and out of the Basin towards Salt Wells Valley were estimated using the groundwater model. Data gaps for subsurface flow in and out of the Basin are being initially addressed under DWR Prop 1 Grant funding. Dataloggers are being deployed in the northwest, downstream of Little Lake to provide a better estimate of subsurface flow from Rose Valley. The Seabees have drilled monitoring wells near the subsurface outflow towards Salt Wells Valley to develop an understanding of subflow between the two basins.

The existing TDS database has 2,051 water quality data from 1920 to present. Most of the data have been collected during field work that included only a limited number of wells, or a one-time sample when the well was drilled. Under DWR Prop 1 Grant funding, a baseline sampling event is being completed to monitor 30 wells and 10 springs basin-wide to develop a baseline understanding of the distribution of TDS within Indian Wells Valley.

Most of the GDEs are on Federal property within IWV. Data gaps associated with GDEs in IWV include quantifying root extinction depths, better mapping of vegetation types, and correlating depth to groundwater with vegetative health. Dataloggers were purchased under DWR Prop 1 Grant funding to utilize existing wells in the vicinity of GDEs to monitor groundwater levels. Further coordination with the Navy will be required to evaluate vegetation health as groundwater levels are monitored.

Limited aquifer property data was used to calibrate the groundwater model. Data gaps for aquifer properties include the El Paso area, northwest, southwest, and southeast areas of the Basin. In addition, the definable bottom of the Basin is a current data gap. It will be evaluated whether deep drilling or more recent geophysical data will provide the necessary data to fill this data gap.

ES 4.0 SUSTAINABLE MANAGEMENT CRITERIA SUMMARY

ES 4.1 Sustainability Goal

The sustainability goal is to preserve the IWVGB groundwater resource as a sustainable water supply. To the greatest extent possible, the goal is to preserve the character of the community, preserve the quality of life of IWV residents, and sustain the mission at NAWS China Lake. The absence of undesirable results, defined as significant and unreasonable effects of groundwater conditions, throughout the planning horizon will indicate that the sustainability goal has been achieved.

ES 4.2 Undesirable Results

Undesirable results occur when any of the groundwater conditions related to the six sustainability indicators become significant and unreasonable. SGMA requires that groundwater sustainability agencies determine what constitutes significant and unreasonable undesirable results for each groundwater basin.

There are four sustainability indicators in the IWVGB with documented current and/or historical undesirable results: **reduction in groundwater in storage, chronic lowering of groundwater levels, degraded water quality, and land subsidence**. The reduction of groundwater in storage is directly related to the chronic lowering of groundwater levels. Hydrographs of wells taken throughout the IWV demonstrate significant and unreasonable prolonged drawdown causing undesirable results (see Appendix 3-D and Section 3.4.2). TDS samples indicate concentrations have increased over time in areas where high rates of pumping have occurred and indicative of groundwater water quality degradation undesirable results. Land subsidence has historically caused undesirable results to facilities at NAWS China Lake, particularly the SNORT alignment.

There are no known undesirable results and no current data to determine the likelihood of future undesirable results for depletion of interconnected surface water. Streams in the Indian Wells Valley (IWV) are typically ephemeral and contribute to mountain front recharge, but typically do not flow past the mouths of the canyon except in very wet years. Due to the location of the IWVGB, seawater intrusion is not currently applicable to the IWVGB and is not of concern in the future. Consequently, Minimum Thresholds, Measurable Objectives, and Interim Milestones are not established for both the depletion of interconnected surface water and seawater intrusion.

The potential Basin impacts to beneficial uses and users due to undesirable results from reduction in groundwater in storage, chronic lowering of groundwater levels, degraded water quality, and land subsidence include:

- Reduction of buffer from loss of production for deeper wells, both for municipal/domestic use, industrial use, and agriculture use
- Impacts to shallow wells due to lowering of groundwater levels and/or degraded water quality which would require deepening, replacement, well abandonment, or treatment
- Encroachment on mission of NAWS China Lake
- Damage to infrastructure including high value sensitive facilities at NAWS China Lake (For example, the SNORT alignment)
- Jeopardy to beneficial uses due to lowering of groundwater levels and degraded water quality including environmental uses, domestic supplies, industrial supplies, and agriculture supplies which could result in fallowing of agricultural land
- Financial impacts to all groundwater users and well owners for mitigation costs and supplemental supplies (including de minimis groundwater users and members of disadvantaged communities)
- Increase of impacts caused by dust and desertification caused by declining water tables.

ES 4.3 Minimum Thresholds, Measurable Objectives, and Interim Milestones

Minimum thresholds are the quantitative values that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with Minimum

Thresholds at other monitoring sites, may cause an undesirable result(s) in the Basin. Minimum Thresholds for the applicable sustainability indicators are established at monitoring sites that are representative of overall IWVGB conditions. Exceeding a Minimum Threshold at a single monitoring site may not be indicative of an undesirable result, but any Minimum Threshold exceedance will be evaluated to determine the cause and the possible need for corrective action(s). Due to the low quantity of subsurface outflow to other groundwater basins, the Minimum Thresholds selected to address each sustainability indicator are not expected to impact adjacent groundwater basins.

Measurable objectives are the quantitative goals that reflect the Basin's desired groundwater conditions and allow the GSA to achieve the sustainability goal within 20 years. Interim milestones are identified in 5-year increments at each monitoring site to measure the progress towards the Measurable Objectives.

In general, the sustainable management criteria for each sustainability indicator were developed using either simulated estimates from the IWVGA's numerical groundwater model or actual historical data trends. Sustainable management criteria for the chronic lowering of groundwater levels and for degraded water quality were set at representative monitoring sites that provide sufficient spatial distribution throughout the pumping centers in the IWVGB, with additional consideration to IWVGB areas in which pumped groundwater is put to greater beneficial uses. The representative monitoring sites were also selected based on similarity between each site's historical data trends and the simulated data projected by the IWVGA's numerical model. Sustainable management criteria for reduction of groundwater in storage and for land subsidence are set for the entire IWVGB rather than at representative monitoring sites. Monitoring and quantitative measurement of each sustainability indicator will be performed using the Thiessen polygon method (reduction of groundwater in storage), groundwater level measurement (chronic lowering of groundwater levels), TDS sampling (degraded water quality), and level-line surveys (land subsidence).

The Minimum Thresholds, Measurable Objectives, and Interim Milestones for the four sustainability indicators described above are provided in Tables ES4-2, ES4-3, ES4-4, and ES4-5, respectively.

If the planned project and management actions described in this GSP are unable to be realized, or the intended IWVGB benefits are not achieved, sustainable management criteria, including Minimum Thresholds and Measurable Objectives, will be revaluated. Additional or more aggressive projects and management actions may need to be implemented to achieve the intended IWVGB benefits. If necessary, in the future, total annual pumping for the Basin may need be reduced to the Current Sustainable Yield of about 7,650 AFY, which would have significant impacts to the community and NAWS China Lake.

Table ES-2: Sustainable Management Criteria for Reduction of Groundwater in Storage

Sustainable Management Criteria	Value (acre-feet of groundwater removed from storage)
Minimum Threshold	234,821
2025 Interim Milestone	81,952
2030 Interim Milestone	119,661
2035 Interim Milestone	131,896
Measurable Objective	213,474

Table ES-3. Sustainable Management Criteria for Chronic Lowering of Groundwater Levels.

Representative Monitoring Site	Minimum Threshold (ft msl)	2025 Interim Milestone (ft msl)	2030 Interim Milestone (ft msl)	2035 Interim Milestone (ft msl)	Measurable Objective (ft msl)
USBR-01	2,659	2,667	2,667	2,666	2,664
USBR-03	2,139	2,145	2,148	2,151	2,153
USBR-04	2,110	2,118	2,123	2,125	2,126
USBR-05	2,151	2,157	2,156	2,156	2,156
USBR-06	2,166	2,179	2,175	2,173	2,171
MW 32	2,119	2,125	2,131	2,132	2,134
NR-2	2,150	2,157	2,155	2,155	2,155

Representative Monitoring Site	Minimum Threshold (ft msl)	2025 Interim Milestone (ft msl)	2030 Interim Milestone (ft msl)	2035 Interim Milestone (ft msl)	Measurable Objective (ft msl)
Kerr McGee	2,138	2,145	2,144	2,144	2,145
Sandquist Spa	2,162	2,168	2,167	2,167	2,167
Steele 31L01	2,140	2,146	2,148	2,150	2,152

Table ES-4. Sustainable Management Criteria for Degraded Water Quality.

Representative Monitoring Site	Minimum Threshold (mg/l)	2025 Interim Milestone (mg/l)	2030 Interim Milestone (mg/l)	2035 Interim Milestone (mg/l)	Measurable Objective (mg/l)
USBR-01	ND	ND	ND	ND	ND
IWVWD Well 33	500	310	310	310	310
Owens Peak South Well 01	500	300	300	300	300
IWVWD Well 30	500	341	341	341	240
Hometown Water Association Well 01	500	448	448	448	370
IWVWD Well 11	600	546	546	546	530
Sandquist Spa	ND	ND	ND	ND	ND
22B	ND	ND	ND	ND	ND
West Valley Mutual 01	600	511	511	511	500
USBR-06	ND	ND	ND	ND	ND
NR-2	ND	ND	ND	ND	ND

ND = not determined at this time. As baseline TDS sampling data is gathered, these criteria will be established.

Table ES-5. Sustainable Management Criteria for Land Subsidence

Sustainable Management Criteria	Value at SNORT Alignment (inches/year)
Minimum Threshold	0.09 inches/year
2025 Interim Milestone	0.04
2030 Interim Milestone	0.04
2035 Interim Milestone	0.04
Measurable Objective	0.04

ES 4.4 GSP Proposed Monitoring Network

The objective of the GSP proposed monitoring network is to monitor and track Basin conditions and progress towards reaching sustainability. The monitoring network will be reevaluated periodically, as needed, and at least every five years in order to ensure the monitoring network is satisfying SGMA requirements and effectively monitoring for seasonal, short-term, and long-term trends in the Basin.

The existing groundwater level monitoring network will continue throughout the planning horizon. Depth to water is, and will continue to be, measured biannually at 198 wells during Spring (March) and Fall (October) to observe seasonal changes in groundwater levels. Water levels measured at these wells will also be used to determine the change of storage in the Basin annually. Ten representative key wells have been selected specifically to monitor for sustainable management criteria (i.e. addressing chronic lowering of groundwater levels) and used to track progress toward sustainability. Data and information will be provided to the community and stakeholders on the status of and progress toward sustainability.

The currently monitored stream gages, weather stations, and eddy covariance station will continue to be monitored. Newly installed stream gages and weather stations will be incorporated into the GSP monitoring network.

The existing TDS database has water quality data from 1920 to present; however, the dataset includes only a limited number of wells, or a one-time sample when the well was drilled. Baseline sampling at 30 wells and 10 springs basin-wide will be conducted to fill water quality data gaps. Additionally, water quality data from 39 wells that are currently reporting under the GAMA program will continue to be incorporated into the IWV DMS and used to evaluate the changes in TDS within the Basin. The 11 monitoring wells that have been selected to be representative key wells to monitor sustainable management criteria for degraded groundwater quality will be monitored annually and reported as part of the GSP outreach, specifically to track progress toward sustainability.

Land subsidence is not currently monitored in the IWVGB, with the exception of infrequent monitoring conducted by the U.S. Navy at established monuments on NAWS China Lake. The IWVGA will coordinate with the U.S. Navy to obtain data related to land subsidence as monitored. Additionally, the USGS provides InSAR and earthquake activity data to monitor for land subsidence.

ES 5.0 Projects and Management Actions

While it would be beneficial to immediately reduce all pumping to the Current Sustainable Yield of 7,650 AFY, it is not feasible for the Indian Wells Valley community to make such immediate and drastic reductions without extreme lifestyle changes, alteration of the community character, loss of livelihoods, great financial costs, and other significant negative impacts. Water demands in 2015 for municipal and domestic use alone were greater than the Current Sustainable Yield of the IWVGB. A high percentage of the municipal and domestic water demands support the domestic needs of the staff needed to support the mission of NAWS China Lake. Projects and management actions are required to be implemented in order to respond to changing conditions in the groundwater Basin such that undesirable results are avoided and/or mitigated. Implementation of the management actions and projects presented below is intended to bring operation of the IWVGB within its Future Sustainable Yield.

ES 5.1 Management Action No. 1: Implement Annual Pumping Allocation Plan, Transient Pool, and Fallowing Program

The primary initial management action is the establishment of annual groundwater pumping allocations of the safe yield, which is currently estimated to be 7,650 AFY, for each IWVGB pumper after consideration of Federal Reserve Water Rights, California water rights, beneficial uses of groundwater, historical groundwater production (particularly during the Base Period between 2010-2014), and municipal requirements for health and safety. These Annual Pumping Allocations will be used for the purpose of assigning pumping fees ("Augmentation Fees"). The Augmentation Fees will in turn provide the funding for the development of supplemental water supplies and other projects and management actions to achieve sustainability. Accordingly, these Annual Pumping Allocations are not a determination of water rights in that they do not prohibit the pumping of groundwater. Rather, all groundwater pumpers continue to possess the right to produce groundwater provided they pay the Augmentation Fee.

All groundwater pumpers who were producing groundwater during the 2010-2014 Base Period but are not given an Annual Pumping Allocation will be eligible to receive a Transient Pool Allocation, a single use, non-transferable, one-time allocation of water. All groundwater pumpers who are assigned a Transient Pool Allocation may elect to enroll in a Fallowing Program, in which the groundwater pumper may elect to sell their Transient Pool Allocation back to the IWVGA.

In the first year of implementation, it is anticipated that the implementation of this management action will result in the reduction of annual IWVGB groundwater production to approximately 12,000 AFY plus any agricultural pumping as part of the Transient Pool program. Given the amount of overdraft and the cost and scarcity of supplemental water supplies, the IWVGA will allow some reasonable overdraft of the IWVGB due to groundwater production to continue until supplemental water supplies are acquired.

ES 5.2 Project No. 1: Develop Imported Water Supply

The estimated current sustainable yield of 7,650 AFY does not support current groundwater production and current demands. It is infeasible for the community to make immediate reductions in demands to the current sustainable yield without extreme lifestyle changes, alterations to the character of the community, loss of livelihoods, and great financial costs, among other negative impacts. Consequently, the development of an imported water supply is a high-priority project for the IWVGA. Should development of imported water become infeasible, pumping may need to be reduced to 7,650 AFY.

The IWVGA does not currently have access to any water supply from outside of the IWVGB but has identified two potential imported water project options as conceptually feasible:

- Option 1: Direct Use Project with AVEK
    - The IWVGA would purchase SWP Table A Entitlement or potentially a combination of other short and long-term water supplies in coordination with KCWA. The IWVGA would arrange for the purchased water supply to be wheeled through existing AVEK facilities, specifically through existing AVEK surface water treatment facilities and the California City Pipeline. A new pipeline extension would be required.
- Option 2: Groundwater Recharge Project with LADWP
    - The IWVGA would purchase SWP Table A Entitlement or potentially a combination of other short and long-term water supplies in coordination with KCWA. The IWVGA would arrange for the purchased water supply to be delivered to MWD and subsequently provided to LADWP for use in LADWP's service area. In exchange, LADWP would provide Owens Valley water from the LA Aqueduct to the IWVGB for use in a groundwater recharge project. This project may be combined with a LADWP storage and recovery project.

Other imported water projects may be investigated after the GSP is adopted and could be subsequently developed into the final imported water project for implementation.

ES 5.3 Project No. 2: Optimize Use of Recycled Water

The City currently operates an existing 3.6 million gallon per day wastewater treatment facility located on NAWS China Lake, approximately 3.5 miles northeast of the City center. Independent of this GSP, the City is currently planning to upgrade, expand, and potentially relocate the existing City WWTF. The City's plans include the construction of new recycled water treatment, storage, and distribution facilities to provide up to 1.8 million gallons per day (2,016 acre-feet per year) of tertiary-treated recycled water for beneficial use in the IWVGB.

The IWVGA will coordinate with the City to further optimize the use of recycled water in the IWVGB beyond the current scope of the City's project to upgrade, expand, and potentially relocate the existing City WWTF. The optimization of recycled water in the IWVGB will include conversion of additional landscaping from potable groundwater use to recycled water use, as well as a new application of recycled water for groundwater recharge. The IWVGA has identified the following three (3) recycled water subprojects as conceptually feasible for potential implementation in accordance with this GSP.

- Recycled Water Subproject 1: Landscape Irrigation in the City and the NAWS China Lake
    - The IWVGA will replace the groundwater currently used for landscape irrigation within the City with recycled water. While the IWVGA cannot require NAWS China Lake to use recycled water for irrigation, when practical and pending funds availability, NAWS China Lake will implement additional water conservation measures that could include the use of recycled water for irrigation of landscaping beyond that of the golf course.
- Recycled Water Subproject 1a: Landscape Irrigation at Cerro Coso Community College
    - The IWVGA will extend the recycled water distribution system from Recycled Water Subproject 1 to replace existing groundwater use for landscape irrigation at Cerro Coso Community College (Cerro Coso) with recycled water.
- Recycled Water Subproject 2: Groundwater Recharge
    - The IWVGA will further treat the produced recycled water supplies at the City wastewater treatment facility for groundwater recharge through subsurface applications (deep injection).

Other potential beneficial uses of recycled water (including at Searles Valley Minerals Inc.) will be evaluated under Project No. 3 (see below).

ES 5.4 Project No. 3: Basin-Wide Conservation Efforts

The Water District, City, and NAWS China Lake have previously adopted conservation measures within their respective service areas in an effort to mitigate the conditions of overdraft in the IWVGB. An additional project is to coordinate with domestic and municipal groundwater producers and develop additional voluntary and rebate-based conservation efforts for domestic beneficial uses in the IWVGB, and to also promote additional conservation efforts for the other beneficial uses (primarily industrial) that rely on groundwater from the IWVGB.

The results of the IWVGA's Water Conservation Pilot Project (Rebate Program and Water Audit, Leak Detection, and Leak Repair Program) for Severely Disadvantaged Communities will be evaluated for potential implementation on a basin-wide level as well as in the severely disadvantage communities located in Searles Valley that are dependent on the groundwater exported from the IWVGB.

The IWVGA will also coordinate with Searles Valley Minerals Inc. to investigate the potential for and feasibility of accepting recycled water for use in Searles Valley Minerals' industrial water uses.

ES 5.5 Project No. 4: Shallow Well Mitigation Program

The IWVGA will prepare a Shallow Well Mitigation Plan to address the approximately 872 shallow wells in the IWVGB that have been or may later be impacted by the lowering of regional and local groundwater elevations, the reduction of the amount of useable groundwater in storage, the migration of poor-quality groundwater to areas with previously high-quality groundwater, or a combination of these factors. The Shallow Well Mitigation Plan will develop criteria to characterize the level of well impacts as well as an evaluation process to assess the viability of the wells. The Shallow Well Mitigation Plan will also outline the process by which individual well owners can apply and submit wells for evaluation and consideration for mitigation by the IWVGA, including the evaluation and review process that the IWVGA's Water Resources Manager will follow to process the applications and make recommendations to the IWVGA Board.

Following adoption of the Shallow Well Mitigation Plan, shallow wells will be evaluated based on the adopted criteria and categorized into specific areas/zones for development of effective mitigation options. Some wells may be proposed to be abandoned (not mitigated) based on an evaluation of impacts. The wells recommended for mitigation will be placed on an Impacted Shallow Well Priority List and will be scheduled for mitigation. Specific improvements will be identified for impacted shallow wells which may include deepening the well, replacing the well, connecting to existing water systems, or other mitigation measures.

ES 5.6 Project No. 5: Dust Control Mitigation Program

Due to the climate of the Indian Wells Valley, implementation of Management Action No. 1 will potentially result in an increase in windblown dust and sand as a result of decreased agricultural land use, therefore requiring mitigation. Dust Control Mitigation is a critical component of the pumping allocations and voluntary fallowing programs. The IWVGA will prepare a Dust Control Mitigation Plan to (1) identify the location and magnitude of the potential need for dust control, (2) investigate best management practices to address windblown dust and sand, and (3) implement the best management practices on fallowed agricultural land (see Management Action No. 1).

Based on the results of the Dust Control Mitigation Plan and the locations of current IWVGB farms that voluntarily fallow agricultural land as part of Management Action No. 1, critical areas will be identified and prioritized for dust control mitigation. The IWVGA will initially monitor dust issues as agricultural practices continue and are gradually phased out to create a baseline for comparison and evaluation of future necessary mitigation. The IWVGA will continue to monitor the occurrence of windblown dust and sand and implement proactive mitigation measures as identified in the Dust Control Mitigation Plan.

ES 5.7 Project No. 6: Pumping Optimization Project

Some current groundwater pumping may require redistribution to other portions of the IWVGB to reduce the occurrence of localized declining groundwater levels and the corresponding ongoing impacts to shallow domestic wells. It is anticipated that implementation of Management Action No. 1 will greatly reduce groundwater pumping for agricultural uses in the northwestern portion of the IWGWB over time.

The IWVGA's groundwater modeling simulations project that groundwater levels in this area will not only stabilize but will increase as a result of reduced agricultural groundwater pumping. It is also anticipated that groundwater pumping by the Water District west and southwest of the City will continue and that, along with pumping by Searles Valley Minerals Inc. and others, the groundwater levels in these areas may not completely stabilize by 2040 without source redistribution.

The IWVGA will develop a pumping optimization program to potentially relocate some groundwater pumping by the Water District, and by Searles Valley Minerals Inc., to the northwest portion of the IWVGB. The pumping optimization program will include the use of two new wells in the northwest portion of the Basin along Brown Road and approximately nine (9) miles of pipeline to connect the wells to the Water District's existing water system.

ES 5.8 Conceptual Projects Still Under Consideration

ES 5.8.1 Brackish Groundwater Project

There are areas in the IWVGB that have TDS concentrations greater than 1,000 mg/L, particularly in the intermediate and deep aquifer layers. These groundwater areas are considered to be of brackish quality and are the subject of the Brackish Groundwater Feasibility Study currently being prepared by the Brackish Water Resources Partnership, which consists of the IWVWD, the Coso Operating Company, Mojave Pistachios, Searles Valley Minerals Inc, and Meadowbrook Dairy.

Development of the Brackish Groundwater Feasibility Study is an ongoing effort that is currently focusing on brackish water resources located in the northwestern portion of the IWVGB, just south of Pearsonville and north of Brown Road, outside the boundaries of NAWS China Lake. The Brackish Groundwater Feasibility Study is currently evaluating the feasibility of extracting brackish groundwater from the deep aquifer zone in this area of the IWVGB, the available options for treating brackish groundwater, and the opportunities for delivery of all water quality types to the various connection points.

After completion of the Brackish Groundwater Feasibility Study, if brackish groundwater extraction, treatment, and conveyance is found to be feasible and consistent with the GSP, the next steps in the Brackish Groundwater Project would include:

- Conducting a pilot test of brackish groundwater extraction and treatment in the area of interest;
- Designing a full-scale brackish groundwater extraction system with associated treatment plant and conveyance works; and
- Constructing and commissioning the full-scale brackish groundwater extraction, treatment, and conveyance system.

ES 5.8.2 Direct Potable Reuse Project

The State Water Resources Control Board currently has no regulatory criteria for direct potable reuse (DPR) projects in California, though uniform water recycling criteria for DPR through raw water augmentation are required to be adopted by the SWRCB by December 31, 2023, in accordance with California Water Code Section 13561.2. At this time, uniform water recycling criteria for DPR through reservoir water augmentation or treated drinking water augmentation are not anticipated to be adopted.

Because no raw water treatment facilities currently exist in the IWV, a reservoir water augmentation project or treated drinking water augmentation project would currently be the only feasible alternatives for DPR of recycled water in the IWVGB. The IWVGA will evaluate the compatibility of the planned recycled water subprojects (Project No. 2) with a future DPR project as the regulations for DPR projects are developed and adopted. Significant coordination with the SWRCB, DDW, the Lahontan RWQCB, and potentially the USEPA would be required to implement such a project, including conceptual-level planning, treatment evaluations, permit issuance, pilot testing, regulation development, establishing monitoring requirements, etc. Should the IWVGA pursue imported water opportunities that would require construction of new surface water treatment and storage facilities, a raw water or reservoir water augmentation project may be a feasible alternative for a DPR project. Otherwise, the IWVGA will continue researching the feasibility of a potential DPR project through reservoir water augmentation or treated drinking water augmentation over the GSP planning and implementation horizon.

ES 6.0 IMPLEMENTATION SUMMARY

Due to prolonged overdraft conditions in the IWVGB, the community is currently experiencing the undesirable impacts of prolonged overdraft and will continue to experience increasing environmental, social, and economic impacts if sustainability is not achieved. The IWVGB is currently experiencing unreasonable reduction of groundwater in storage, chronic lowering of groundwater levels which result in shallow well performance being impacted or being impacted by poorer water quality, degradation of water quality, and localized land subsidence impacting structures/facilities at NAWS China Lake.

A suite of project and management actions have been evaluated and selected to address current and projected undesirable results with the goal of bringing the IWVGB into sustainable balance (see Section 5). There are currently no reliable sources of supplemental water available to help achieve sustainability. Therefore, the initial priority is on water demand reductions, at least until a reliable supplemental water supply is secured.

In addition to the proposed projects and management actions, GSP implementation requires continual monitoring of the proposed monitoring networks to evaluate IWVGB conditions in relation to the sustainable management criteria, as well as annual and periodic GSP updates to DWR, pursuant to SGMA regulations. Data gaps will continue to be analyzed and monitoring and data management programs will be implemented as necessary.

The IWVGA is taking an adaptive management approach to reach sustainability; therefore, additional projects and management actions not discussed in this GSP will be evaluated and implemented over the planning horizon, as necessary, and the proposed planned projects and management actions may be modified, as necessary.

ES 6.1 Schedule

The IWVGA will start implementation of the GSP after adoption of the GSP by the IWVGA Board. Given the available data and the current conditions of the IWVGB, all of the proposed planned projects and management actions are required to be implemented by 2040 in order to reach sustainability. The anticipated implementation timelines and schedules for the projects and management actions are discussed in Section 5. The anticipated implementation timeline for the projects and management actions range from 2020 to 2035. With this broad range of implementation timelines, there are likewise broad estimates of the project and management action task schedules.

ES 6.2 Costs and Funding

Development of this GSP was funded through the following sources:

- Proposition 1 Sustainable Groundwater Planning Grant
- Pump Fee applicable to all non de minimis pumpers in the IWVGB (with the exception of U.S. Navy pumping to support NAWS China Lake)
- Local Contributions by IWVGA Member Agencies and other local entities
- In-kind Services by IWVGA Member Agencies and other local agencies and entities

GSP implementation costs will require a broad variety of funding sources, from Federal, State, and local sources. Supplemental water supplies, as required for the IWVGB to be sustainable, are extremely costly and limited. Even if supplemental water supplies are available, the IWV community is not financially capable of supporting an imported water supply without significant public funding. As such, the IWVGA will pursue all reasonable funding opportunities to support GSP implementation tasks.

Estimated project costs are provided in Table ES-6.

Table ES-6. Estimated GSP Implementation Costs.

Task	Development/ Engineering Costs	Implementation/ Capital Costs	Total Annual Costs
Projects and Management Actions			
Management Action No. 1: Implement Annual Pumping	$340,000	$9,000,000	$40,000

Task	Development/ Engineering Costs	Implementation/ Capital Costs	Total Annual Costs
Allocation Plan, Transient Pool and Fallowing Program			
Project No. 1: Develop Imported Water Supply			
Option 1:	$28,875,000	$197,490,000	$8,140,000
Option 2:	$8,613,000	$94,823,000	$4,440,000
Project No. 2: Optimize Use of Recycled Water			
Option 1:	$7,005,700	$35,751,500	$395,500
Option 1a:	$1,737,300	$8,445,900	$129,300
Option 2:	$4,936,200	$17,861,800	$480,300
Project No. 3: Basin-wide Conservation Efforts	--	Unknown	$20,000
Project No. 4: Shallow Well Mitigation Program	$70,000	$1,650,000	$20,000
Project No. 5: Dust Control Mitigation Program	$70,000	$19,000,000	$100,000
Project No. 6: Pumping Optimization Project	$3,230,000	$20,170,000	$150,000
GSP Monitoring	--	--	$60,000
Data Gap Projects [1]	--	$270,000	--
Annual GSP Reporting	--	--	$30,000
GSP 5-Year Updates [2]	$360,000	--	--
Data Management System	--	--	$20,000
ESTIMATED TOTALS [3]	$26,362,200 - $46,624,200	$206,972,200 - $309,634,200	$5,884,800 - $9,584,800

[1] Costs for data gap projects are currently funded under Prop 1 grant funding. Additional data gaps will be evaluated periodically to determine if additional projects are required. Estimated costs will be updated as necessary.

[2] Assumes four 5-year updates through 2040.

[3] Estimate total costs show a range of potential estimated costs. The low end of the range assumes Project No. 1 Option 1 will be implemented and the high end of the range assumes Project No. 1 Option 2 will be implemented.

SECTION 1: INTRODUCTION

1.1 PURPOSE OF THE GROUNDWATER SUSTAINABILITY PLAN

The stated purpose of the Sustainable Groundwater Management Act (SGMA), is set forth in California Water Code (CWC) Section 10720.1. More specifically, the express purpose of SGMA is to:

1) provide for the sustainable management[4] of groundwater basins;
2) enhance local management of groundwater consistent with the rights to use or store groundwater and Section 2 of Article X of the California Constitution;
3) preserve the security of water rights in the State to the greatest extent possible consistent with the sustainable management of groundwater;
4) establish minimum standards for sustainable groundwater management;
5) provide local groundwater management agencies with the legal authority along with the technical and financial assistance necessary to sustainably manage groundwater;
6) avoid or minimize subsidence problems;
7) improve the collection of data and the understanding of groundwater resources;
8) increase groundwater storage and remove impediments to recharge;
9) manage groundwater basins through the actions of local governmental agencies to the greatest extent possible while minimizing State intervention; and,
10) provide a more efficient and cost-effective groundwater adjudication process that protects water rights, ensures due process, prevents unnecessary delay, and furthers the objectives of SGMA.

Currently, the groundwater resources in the Indian Wells Valley Groundwater Basin (IWVGB or Basin) are not being sustainably managed. Significant overdraft conditions have existed for decades as a result of groundwater pumping that exceeds the natural Basin yield. The results of overdraft have manifested themselves through various undesirable results, primarily the chronic lowering of groundwater levels, the degradation of water quality, and the reduction of groundwater storage throughout the IWVGB.

[4] SGMA defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results. (CWC Section 10721(v)).

Historically, the Indian Wells Valley (IWV) does not have any water importation infrastructure, and as a result, current and historical water producers have mined the Basin in order to meet water demands. If left unmanaged, such practice will seriously impact groundwater producers' abilities to supply reliable and quality potable water at a reasonable price, if at all. Disadvantaged Communities (DACs), Severely Disadvantaged Communities (SDACs), Economically Distressed Areas (EDAs), mutual water companies, cooperative water systems, and private domestic well owners overlying the IWVGB are particularly susceptible to adverse effects resulting from the chronic lowering of groundwater levels because their wells are typically shallow, and furthermore, they lack the resources to compensate for the continued overdraft. Development of a GSP should therefore consider, as a minimum, the need to supply water for the health and safety of all residents and businesses along with (as stated in CWC Section 106.3) the human right to safe, clean, affordable, and accessible water for human consumption, cooking, and sanitary purposes.

In compliance with SGMA, this Groundwater Sustainability Plan (GSP) discusses Basin management strategies that will culminate in the absence of undesirable and unsustainable groundwater conditions in the IWVGB. The GSP recommends these management strategies and provides measurable sustainability objectives and milestones that are intended to achieve Basin sustainability while considering the unique geologic and hydrogeologic conditions of the IWVGB. The recommendations of this GSP will provide for long-term sustainable groundwater management in the IWVGB within 20 years of GSP implementation. There will be social and economic impacts associated with implementation of the GSP, in order to make the IWVGB sustainable.

The preparation and adoption of the GSP is exempt from Division 13 of the Public Resources Code associated with the California Environmental Quality Act (CEQA) environmental compliance requirements. As a planning document, the GSP provides the high-level planning framework for the implementation of projects and management actions to reach sustainability. The proposed projects and management actions will need to be fully developed and/or designed after adoption of the GSP. These projects and management actions may be required to comply with environmental compliance regulations, including CEQA and/or National Environmental Policy Act (NEPA) reviews before they are implemented.

1.2 SUSTAINABILITY GOAL

As defined in CWC Section 10721, the term “sustainability goal” refers to the existence and the implementation of one or more GSPs that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure the Basin is operated within its sustainable yield. The sustainability goal is not a quantitative measure; it is a statement of a GSP’s objectives and desired conditions, how the Basin will reach the desired conditions, and why the measures recommended in the GSP will achieve these objectives and desired conditions. The sustainability goal is in part defined by the locally-defined minimum thresholds and undesirable results. (These terms are defined and described in detail in Section 4).

The sustainability goal is to manage and preserve the IWVGB groundwater resource as a sustainable water supply. To the greatest extent possible, the goal is to preserve the character of the community, preserve the quality of life of IWV residents, and sustain the mission at Naval Air Weapons Station (NAWS) China Lake. The absence of significant and unreasonable undesirable results throughout the 50-year planning and implementation horizon will indicate that the sustainability goal has been achieved. The detailed sustainability goal, including a description of the development of the goal and an explanation of how the goal is intended to be achieved, is provided in Section 4.

1.3 BENEFICIAL USES AND USERS

According to CWC 10723.2, the IWVGA must consider the interests of all beneficial uses and users in the development and implementation of the GSP. The following beneficial users and uses have been identified in the IWVGB:

- Municipal
- Domestic (De Minimis private wells owners and mutuals/co-ops)
- City/County
- NAWS China Lake
- Industrial
- Agriculture

- Environmental (including wildlife habitat and Groundwater Dependent Ecosystems)

1.4 AGENCY INFORMATION

In its 2016 Bulletin 118 interim update, the California Department of Water Resources (DWR) identified the IWVGB as a critically overdrafted basin of medium priority[5]. As such, in compliance with SGMA, the associated groundwater sustainability agency (GSA) must submit a GSP by January 31, 2020 to enhance the local and sustainable management of groundwater resources. The Indian Wells Valley Groundwater Authority (IWVGA) Board of Directors adopted Resolution No. 02-16 on December 8, 2016, to establish the IWVGA as the exclusive GSA for the entirety of the IWVGB.

The IWVGB underlies portions of the counties of Kern, Inyo, and San Bernardino and is unique in that it is isolated from the urban centers of these three counties. The majority of the Basin's area is set in northeastern Kern County, with smaller portions located in northwestern San Bernardino County and southern Inyo County. The City of Ridgecrest is located in the extreme northeastern portion of Kern County (within the east-central portion of the Basin) and is the only incorporated city in the Basin. The Indian Wells Valley Water District (IWVWD or Water District) serves potable water to the residents of the City of Ridgecrest (City or Ridgecrest) and certain areas outside of the Ridgecrest's jurisdiction.

The five aforementioned agencies (Kern County, Inyo County, San Bernardino County, the Ridgecrest, and the IWVWD) entered into a joint exercise of powers agreement to form the IWVGA. The agreement is attached to this GSP as Appendix 1-A. These five agencies serve as General Members on the IWVGA Board of Directors, which governs the IWVGA as a whole.

A large portion of the lands overlying the northern and northeastern portion of the IWVGB is Federal property owned and managed by the U.S. Navy for NAWS China Lake (see Section 2.2.2). NAWS China Lake consists of two major land areas: the North Range, encompassing 606,926 acres, and the South Range, encompassing 503,510 acres. The North Range lies in portions of Inyo, Kern, and San Bernardino

[5] The IWVGB has since been identified as a critically overdrafted basin of **high** priority as of the *Sustainable Groundwater Management Act 2018 Basin Prioritization: Process and Results*, published by DWR in January 2019.

counties and the South Range is located entirely within San Bernardino County. Mainsite and Headquarters areas, which are in the southern boundary of the North Range, adjoin the City of Ridgecrest on the south. The NAWS China Lake laboratories and ranges support the Navy's Research, Development, Acquisition, Test, and Evaluation (RDAT&E) of cutting-edge weapons systems critical to national defense and create nearly 10,000 direct, indirect, and induced jobs within the region.

SGMA provides that the Federal government, appreciating the shared interest in assuring the sustainability of groundwater resources, may voluntarily agree to participate in the preparation or administration of a groundwater sustainability plan, per CWC Section 10720.3. Recognizing this shared interest, NAWS China Lake has voluntarily engaged in the development of the GSP for the IWVGB by the IWVGA. In addition, NAWS China Lake has provided significant "in-kind" support for this GSP. Likewise, a significant amount of land overlying the southwestern IWVGB is largely undeveloped and managed by the United States Bureau of Land Management (BLM). As such, the BLM also serves a role in the development efforts of the GSP. However, due to their Federal status, the U.S. Navy and BLM serve as Associate Members (non-voting) on the IWVGA Board of Directors.

Additional information on local agencies in the IWVGB as well as their respective jurisdictions is provided in Section 2 (Plan Area).

1.4.1 Organization and Management Structure of the IWVGA[6]

Indian Wells Valley Groundwater Authority

500 W. Ridgecrest Boulevard

Ridgecrest, CA 93555

Main Contact:

Donald Zdeba

don.zdeba@iwvwd.com

[6] The IWVGA has a unique rotating management structure. Names, positions, and contacts are current and valid as of January 1, 2020.

(760) 384-5555

Alternate Contact:

April Nordenstrom—Clerk of the Board of Directors of the IWVGA

apriln@iwvwd.com

(760) 384-5511

Indian Wells Valley Groundwater Authority: General Members

Kern County (Chair)

City of Ridgecrest (Vice-chair)

Indian Wells Valley Water District

Inyo County

San Bernardino County

Indian Wells Valley Groundwater Authority: Associate Members

United States Navy (Non-voting)

United States Bureau of Land Management (Non-voting)

Staff

Acting General Manager

Stetson Engineers Inc.—Water Resources Manager[7]

Board Counsel

Clerk of the Board of Directors

The IWVGA is governed and administered by the aforementioned Board of Directors (Board), which is composed of one voting seat per General Member. Approval of any Board action requires the affirmative

[7] Per IWVGA Agreement No. 02-17, the Water Resources Manager was appointed on August 17, 2017, to prepare, develop, and implement the GSP for the IWVGB.

vote of a majority of the Board. In addition, the Board members representing the County of Kern, the City of Ridgecrest, and the Indian Wells Valley Water District are considered principal voters. That is, no Board action may be approved by the Board unless it receives the affirmative vote from no less than two (2) of the Board members representing the County of Kern, the City of Ridgecrest, and/or the Indian Wells Valley Water District. The U.S. Navy and the BLM hold two Associate Member positions that have a representative non-voting seat on the Board. Although they do not have the power to vote on any Board action or proposal, the Associate Members' position entitles them to full participation in public Board meetings and discussions.

The Board consists of a Chairperson and Vice-Chairperson that preside at all Board meetings and exercise and perform other powers and duties as may be assigned by the Board. Currently, the Chairperson and Vice-Chairperson hold office for a term of one year commencing on January 1st of each and every calendar year. The positions of Chairperson and Vice-Chairperson rotate annually between the Board members representing the County of Kern, the City of Ridgecrest, and the Indian Wells Valley Water District. For example, in calendar year 2017, the Board member representing the County of Kern held the position of Chairperson, followed in order by the Board member representing the City of Ridgecrest and then the member representing the Indian Wells Valley Water District. The Board member representing the City of Ridgecrest held the position of Vice-Chairperson in 2017, followed in order by the Board members representing the Indian Wells Valley Water District and then the member representing the County of Kern.

The joint exercise of power agreement that formed the IWVGA also provided for the adoption of By-Laws. Under Section 8.05 of the agreement, the Board adopted the By-Laws which govern the conduct of meetings and the day-to-day operations of the IWVGA. On March 17, 2017, the By-Laws became effective under IWVGA Resolution No. 03-17. The By-Laws are attached to this GSP as Appendix 1-B.

All IWVGA Board meetings are held in accordance with the Ralph M. Brown Act, set forth in the California Government Code sections 54950, et seq. The IWVGA Board meetings are generally held at 10:00am on the third (3rd) Thursday of each month at Ridgecrest City Chambers, located at 100 West California Avenue, Ridgecrest, CA 93555.

Under Article 3.8 of the IWVGA By-Laws, the IWVGA sought to hire a Water Resources Manager (WRM) with sufficient technical background, expertise, and experience to prepare and implement a GSP for the IWVGB. On August 17, 2017, the IWVGA entered into Agreement No. 02-17 to retain Stetson Engineers Inc. as the WRM responsible for preparing and implementing this GSP. The WRM regularly reports to and coordinates with the IWVGA, the general manager and legal counsel, in relation to GSP preparation and collaborates with the IWVGA's standing committees in relation to the policy and technical aspects of the IWVGB and GSP. In addition, the WRM, along with the TAC chairperson, presents all technical information and reports to the IWVGA.

1.4.2 Legal Authority

As the sole GSA for the IWVGB, the IWVGA has the legal authority to manage local groundwater through SGMA. As such, SGMA grants the IWVGA the legal authority to enter into agreements with private parties that assist or facilitate the implementation of GSPs; impose the requirements of its GSP on other State agencies; oversee the incorporation of its GSP's requirements into a regional water management plan; etc. The general legal authority of GSAs (including the IWVGA) are stated in CWC Sections 10725, 10726, 10730, and 10731, all of which are attached to this GSP as Appendix 3-C.

In addition, the legal authority and powers of the IWVGA are published in Article 4 of the joint exercise of power agreement that formed the IWVGA. These powers include (but are not limited to) the following:

- To collect and monitor all data related and beneficial to the development, adoption, and implementation of the GSP
- To levy assessments, charges, and fees as provided in SGMA
- To regulate and monitor groundwater extractions as permitted by SGMA
- To establish and administer various programs for the benefit of the Basin such as water banking, water recycling, recapture/purification efforts, etc.
- To apply for and accept grants, contributions, donations, and loans under any Federal, State, or local programs for assistance in developing or implementing any of its projects or programs in connection with the GSP

- To acquire by negotiation or condemnation, lease, purchase, construct, hold, manage, maintain, operate, and dispose of any buildings, property, water rights, works, or improvements within and without the respective boundaries of the General Members necessary to accomplish the purposes of the IWVGA
- To cooperate, act in conjunction, and contract with the United States, the State of California or any agency thereof, counties, municipalities, public and private corporations of any kind, and/or individuals for the purposes necessary or convenient for the full exercise of the Authority's powers

1.4.2.1 Policy Advisory Committee (PAC)

Article 5.1 of the IWVGA By-laws provides that the Board may establish standing committees for the purpose of making recommendations to the Board on the various activities of the IWVGA. The Board established an eleven-person, voting-member Policy Advisory Committee (PAC) to advise the Board on all policy-related matters of the Board and to develop non-binding proposals on policy matters pertaining to the GSP. The Board may appoint individuals to the PAC through an adopted resolution.

The PAC is comprised of voting members from the following constituent groups:

- 2 representatives from Large Agriculture
- 1 representative of Small Agriculture
- 2 representatives from Business Interests
- 2 representatives from Domestic Well Owners
- 2 representatives from residential customers of a public water agency supplier
- 1 representative from the Eastern Kern County Resource Conservation District
- 1 representative from Wholesaler and Industrial User

The IWVGA By-Laws require that at least one of the appointed voting PAC members shall also represent Disadvantaged Communities (DACs). On July 20, 2017, the Board approved Resolution No. 08-17 to add a representative of the Inyokern Community Services District as a DAC-representative voting member to the PAC. The PAC also includes non-voting Associate Members that represent the U.S. Navy, the Indian Wells Valley Water District, the Kern County Planning and Natural Resources Department, and the BLM.

To provide for more comprehensive groundwater management planning, these Associate Members provide needed expertise to help the PAC understand the policies of their respective jurisdictions and the impact of proposed Basin management strategies on their agencies' missions, in support of the IWVGA.

To assist the Authority in considering the interest of all beneficial uses and users in the IWVGB, as set forth in CWC Section 10723.2, the PAC's objectives are to (1) provide all water users in the Basin with a meaningful voice and representation on policy matters of the Board associated with SGMA; (2) work collaboratively for the benefit of the IWVGB as a whole; (3) provide input and recommendations to the Board, in collaboration with the WRM, and other committees of the Board, in support of actions that facilitate bringing the IWVGB into compliance with SGMA; and (4) work in good faith to achieve consensus and make unified recommendations to develop a GSP and management actions to achieve groundwater sustainability in accordance with the requirements of SGMA.

All PAC meetings are held in accordance with the Ralph M. Brown Act, set forth in the California Government Code sections 54950, et seq. The By-Laws of the IWVGA provide that the Board shall set regular meeting dates for the PAC by resolution. The PAC meetings are generally held on the first (1st) Thursday of each month at City Council Chambers within City Hall, located at 100 W. California Avenue, Ridgecrest, CA 93555.

1.4.2.2 Technical Advisory Committee (TAC)

The Board also established a Technical Advisory Committee (TAC) for the express purpose of giving interested parties a reasonable opportunity to review and conduct a thorough evaluation of each technical element of the GSP prior to its finalization by the WRM, and adoption by the Authority. As stated in Article 5.12 of the IWVGA By-Laws, TAC members must have a formal education and experience in a groundwater-related field while also maintaining an understanding of the technical aspects of the IWVGB or similar basins in California. The TAC is comprised of individuals representing PAC members, PAC membership categories, and the general interests of landowners and water users in the IWVGB. Each member of the PAC may nominate one member of the TAC for review and possible approval by the Board. To ensure proper stakeholder representation, the Board may also appoint TAC members that are not affiliated with any PAC members.

The TAC is comprised of members from the following constituent groups:

- Large Agriculture
- Business Interests
- Residential Customers of a Public Water Agency
- Domestic Well Owners
- Eastern Kern County Resource Conservation District
- Wholesale and Industrial User
- IWVWD (Non-voting member)
- United States Navy (Non-voting member)
- Kern County Water Agency

In the course of evaluating each draft technical element of the GSP, the TAC strives for consensus in preparing written recommendations to the WRM. These recommendations (along with all related comments) are submitted to the WRM to document all TAC members' input for consideration in the final preparation of each GSP element.

All TAC meetings are held in accordance with the Ralph M. Brown Act, set forth in the California Government Code sections 54950, et seq. The TAC meetings are generally held on the first (1st) Thursday of each month at City Council Chambers within City Hall, located at 100 W. California Avenue, Ridgecrest, CA 93555. The WRM sets the agenda of each TAC meeting so that each technical element of the GSP is presented to the TAC, in draft, to afford the TAC a reasonable opportunity to review and conduct a thorough evaluation of each element.

1.4.2.3 Interested Agencies and Roles

During formation of the IWVGA, a comprehensive listing of interested parties (including name, email, and phone number) was developed. The listing includes local community residents (including Disadvantaged Communities, Severely Disadvantaged Communities, and Economically Distressed Areas), businesses, large and small-scale agriculture, domestic well owners, academic institutions, relevant State and local agencies, Federal agencies, non-profit organizations, and community organizations. This listing of over 150 stakeholders includes representatives from all types of water users and interested parties within the

IWVGB and was used during the 17-month long GSA formation process for notification of public meetings, notifications, and updates related to discussions on the SGMA.

An interested party that wishes to be added to the listing of interested parties is encouraged to contact the IWVGA staff and provide appropriate contact information. The IWVGA will then add the party to the listing for receipt of notifications. No party will be dropped from the listing unless mailings are returned as undeliverable or the party specifically asks for removal from the listing.

The listing of interested agencies and roles is attached to this GSP as Appendix 1-D.

1.4.3 Implementation and Costs

The public will be invited to participate in the implementation of the proposed GSP projects and management actions, monitoring, and data gap projects throughout the GSP planning-horizon. As plans related to implementation of specific projects are developed, the public will be provided opportunity to review and provide comments to the IWVGA Board.

Pursuant to CWC Section 10730, the IWVGA is authorized to fund the costs of groundwater management by imposing fees on the extraction of groundwater from the Basin. On July 19 2018, the IWVGA Board adopted Resolution No. 02-18 to establish a Groundwater Extraction Fee of three dollars ($3.00) per tenth (0.10) of an acre-foot for all groundwater extracted from the IWVGB, with the exception of groundwater extracted by de minimis[8] extractors and Federal entities. The Groundwater Extraction Fee is determined and paid on a monthly basis by all producers with registered groundwater extraction facilities in the IWVGB. Unregistered groundwater extraction facilities that are subject to the groundwater extraction fee are prohibited from extracting groundwater from the Basin until the facility is registered to the satisfaction of the WRM, which oversees the registration of groundwater extraction facilities and reviews producers' self-reported measurements of groundwater extractions.

[8] As defined in CWC Section 10721(e), a De Minimis extractor refers to a person who extracts, for domestic purposes, two acre-feet or less of groundwater per year.

Implementation costs of the proposed projects and management actions required to achieve sustainability are provided in Table 6-1. These costs are anticipated to be funded through Federal and State grants and loans and local pump fees.

1.5 NOTICE AND COMMUNICATION

As stated in California Water Code Sections 10723.2 and 10728, a GSA shall not only consider the interests of all beneficial uses and users of groundwater but also make available to the public and DWR a written statement describing the manner in which interested parties may participate in the development and implementation of the GSP. The IWVGA subsequently adopted Resolution No. 02-18 on April 19, 2018, to adopt a Communication and Engagement Plan (C&E Plan) intended to encourage public and agency participation in GSP development and implementation. The C&E Plan allows each stakeholder and agency in the IWVGB to understand the magnitude of the groundwater overdraft problem, how overdraft will affect stakeholders, and the process for participation in developing a GSP to solve the overdraft problem.

The C&E Plan was developed by the PAC with the intent of providing for open communications and inclusivity between the IWVGA and all interested parties, agencies, and stakeholders in the IWVGB. The C&E Plan's objectives include the following:

- Enhance public understanding about water, groundwater resources, uses, and water balance in the IWVGB by providing accurate and current information
- Provide stakeholders with opportunities to assist in GSP development and learn how the GSP will affect all uses and users of groundwater in the IWVGB
- Promote informed community feedback throughout the GSP preparation and implementation process
- Employ a variety of outreach methods that make public participation easy and accessible while efficiently using the resources of the GSA and local agencies

The C&E Plan is attached to this GSP as Appendix 1-E.

In addition to the C&E Plan, the IWVGA provides advance notice to the public of its regular monthly Board meetings, special meetings, monthly standing committee meetings, and general activities primarily through its website (https://iwvga.org/). Documents and materials relating to open session agenda items that are provided to IWVGA Board members prior to regular meetings are made available for public inspection and copying at the headquarters of the IWVWD (located at 500 Ridgecrest Boulevard, Ridgecrest, CA 93555) or on the IWVGA website.

In accordance with the Ralph M. Brown Act, agenda packages (including technical documents and materials considered for inclusion in this GSP) for upcoming IWVGA Board meetings and committee meetings are posted on the IWVGA's website no later than 72 hours before the Board/committee meeting. During each monthly Board meeting, the IWVGA Board approves meeting minutes for the prior month's Board meeting as well as committee meeting reports for the most recent committee meetings. Meeting minutes and committee meeting reports for the prior month are published in each monthly Board meeting agenda package. Full video streams of IWVGA Board and committee meetings are also uploaded to the website following the end of the meeting.

As published in each Board/committee meeting agenda package, individuals with disabilities or individuals requiring special accommodations to participate in Board/committee meetings are encouraged to contact the Clerk of the Board of Directors of the IWVGA with at least one (1) full business day of notice before the start of the meeting.

A listing of all IWVGA Board, PAC, and TAC meetings are provided in Table 1-1 below. Additional information regarding public IWVGA meetings can be found at https://iwvga.org/.

Table 1-1. List of IWVGA Board Meetings, PAC Meetings, and TAC Meetings (as of January, 2020).

IWVGA Board Meetings	PAC Meetings	TAC Meetings
10/23/15	06/29/17	08/3/17
11/19/15	07/20/17	09/7/17
12/03/15	08/3/17	10/12/17

IWVGA Board Meetings	PAC Meetings	TAC Meetings
12/17/15	09/13/17	11/2/17
01/14/16	10/12/17	12/6/17
02/11/16	11/2/17	01/4/18
02/19/16	12/6/17	02/1/18
03/03/16	01/4/18	03/1/18
03/18/16	02/01/18	04/05/18
04/15/16	03/01/18	05/03/18
05/20/16	03/29/18	05/31/18
06/10/16	05/03/18	07/12/18
06/17/16	05/31/18	08/02/18
07/15/16	07/12/18	09/06/18
08/25/16	08/02/18	10/04/18
09/15/16	09/06/18	11/01/18
10/20/16	10/04/18	12/06/18
11/17/16	11/01/18	01/03/19
12/08/16	12/06/18	02/07/19

IWVGA Board Meetings	PAC Meetings	TAC Meetings
01/19/17	01/03/19	03/07/19
02/16/17	02/07/19	04/04/19
03/16/17	03/07/19	05/02/19
04/20/17	04/04/19	06/06/19
04/26/17	05/02/19	06/27/19
05/18/17	06/06/19	08/01/19
06/15/17	06/27/19	09/05/19
07/20/17	08/01/19	10/03/19
08/10/17	08/07/19	11/07/19
09/21/17	09/05/19	
10/19/17	10/03/19	
11/16/17	11/07/19	
12/13/17		
12/21/17		
02/15/18		
03/15/18		

IWVGA Board Meetings	PAC Meetings	TAC Meetings
04/05/18		
04/19/18		
05/17/18		
06/21/18		
07/19/18		
08/16/18		
09/17/18		
09/20/18		
10/18/18		
11/15/18		
12/20/18		
01/17/19		
02/21/19		
03/21/19		
04/18/19		
05/16/19		

IWVGA Board Meetings	PAC Meetings	TAC Meetings
05/30/19		
06/20/19		
07/18/19		
08/15/19		
09/19/19		
09/19/19		
10/17/19		
11/21/19		
12/19/19		
1/16/20		

To allow for ongoing public engagement, DWR will establish a 60-day comment period following acceptance of this GSP for evaluation, during which any person may provide comments to DWR and the IWVGA regarding this GSP. Interested parties may review this GSP and submit comments (along with the party's name, address, and email) to DWR and the IWVGA during this 60-day comment period. DWR is not required to respond to comments but will consider comments during its evaluation of this GSP. DWR will post all received comments on its website.

For additional information, DWR may be contacted at the mailing address below:

California Department of Water Resources

P.O. Box 942836

Sacramento, CA 94236

(916) 653-5791

1.5.1 Public Outreach

The regular meetings of the Board, PAC, and TAC are open to members of the public, including representatives of all types of water users and interested parties. At each meeting, members of the public are allowed time to address the Board or respective Committee regarding topics listed and not listed on the meeting agenda. IWVGA documents (such as meeting agendas, minutes, resolutions, ordinances, presentations, meeting packages, etc.) are made available to the public at the following website: https://iwvga.org/

In addition to regular meetings, the IWVGA has hosted public workshops to present IWVGA policies and the content of this GSP. Additionally, IWVGA Board Members and Staff have met with individual stakeholder groups to provide GSP updates and discuss groundwater pumping and the allocation process. The following is a partial list of recent meetings, workshops, and outreach events that IWVGA Board members or staff have facilitated with stakeholder groups:

- April 5, 2018: GSP Public Workshop
- October 1, 2018: Stakeholder Meeting with Municipal Pumpers
- October 1, 2018: Stakeholder Meeting with Agricultural Pumpers
- October 1, 2018: Stakeholder Meeting with Federal Pumpers
- October 1, 2018: Stakeholder Meeting with Industrial Pumpers
- March 13, 2019: Outreach Event with Exchange Club
- July 24, 2019: Outreach Event with Rotary Club
- November 14, 2019: Outreach Event with Realtors Association
- December 12, 2019: GPS Public Workshop

In addition, as part of DWR's requirements for SGMA and the GSP, a publicly-accessible database (see Section 2.8) has been developed to store and present specific supporting elements of the GSP, including monitoring, reporting, management criteria, a water budget, hydrogeologic conceptual model, and other supporting documentation. The database allows the public to review data and other reports related to IWVGB water resources. The database may be reached at the following link: https://www.iwvgsp.com

1.5.2 Public Comments

The IWVGA distributed a public review draft of the GSP in order to solicit comments from members of the public. Additionally, a public hearing was held on January 16, 2020 prior to the IWVGA Board considering adoption of the Final Draft GSP. Written comments received on the public review draft GSP, as well as a comment and response matrix table with IWVGA responses to comments, are provided in Appendix 1-F. Verbal comments were also received by the public at the public hearing. To the extent required, verbal comments received at the public hearing were responded to by IWVGA staff at the public hearing. The public hearing can be viewed from the following link: https://www.youtube.com/watch?v=eYPkrmrOzTo.

1.6 GSP ORGANIZATION

This GSP is organized into the following sections, which generally follow DWR's GSP guidelines and suggested elements as applicable to the IWVGA and IWVGB:

- Section 1 – Introduction
    - Provides information on the purpose of the GSP along with regulatory and agency background
- Section 2 – Plan Area
    - Presents background information on the IWVGB area with respect to overlying water management agencies, land use, Basin beneficial uses, water quality objectives, production wells, and other planning efforts undertaken in the IWVGB
- Section 3 – Basin Setting
    - Presents a summary description of Basin geology, hydrogeology, groundwater conditions, groundwater quality, groundwater-dependent ecosystems, and water budget

- Section 4 – Sustainable Management Criteria
  - Summarizes the Basin's existing undesirable results due to overdraft and the Basin management objectives, milestones, and monitoring network that will track the overall progress toward basin-wide sustainability
- Section 5 – Projects and Management Actions
  - Describes the potential projects and water management strategies intended to achieve the goals and objectives of the GSP
- Section 6 – Plan Implementation
  - Discusses the work plan, schedule, and costs for implementation of the GSP as well as the requirements for annual reporting to DWR

1.6.1 Checklist for GSP Submittal

DWR has prepared a number of guidance documents for the sustainable management of groundwater, including a *Preparation Checklist for GSP Submittal* dated December 2016. The Preparation Checklist suggests general GSP content requirements for the purpose of verifying that a GSP is complete and ready for submission to DWR. In particular, the Preparation Checklist serves as a guide so that the reader of this GSP may find the relevant sections and page numbers that discuss specific groundwater management topics. The Preparation Checklist is attached to this GSP as Appendix 1-G.

1.7 REFERENCES

California Water Code; SB1168, AB1739, and SB1319. Sustainable Groundwater Management Act.

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SECTION 2: PLAN AREA

2.1 INTRODUCTION

This section provides background and discussion of 1) geographic area and jurisdictions; 2) management agencies; 3) land use; 4) existing monitoring and management programs; and 5) the data management system, as required in the GSP Emergency Regulations (§354.8).

2.2 GENERAL DESCRIPTION

2.2.1 Setting

The IWVGB is located in the northwestern part of the Mojave Desert in southern California, as shown on Figure 2-1, and underlies approximately 382,000 acres or approximately 600 square miles of land area in portions of the Counties of Kern, Inyo, and San Bernardino. The IWVGB is bordered on the west by the Sierra Nevada Mountain Range, on the north by the Coso Range, on the east by the Argus Range, and on the south by the El Paso Mountains. Surface water flow from the surrounding mountain ranges drains to China Lake, a large dry lake, or playa, located in the central north-east part of the Basin. U.S. Route 395 and State Route 14 are the major vehicular arteries through the Indian Wells Valley. The IWVGB is in the vicinity of other Bulletin-118 groundwater basins including the Fremont Valley, Salt Wells Valley, Searles Valley, Coso Valley, Rose Valley, and Kern River Valley groundwater basins (see Figure 2-2).

The IWVGB is designated Basin Number 6-054 by DWR and is included in DWR Bulletin No. 118 entitled "California's Ground Water", dated September 1975. Bulletin 118 noted that recharge in the IWVGB averaged about 10,000 acre-feet per year (AFY) while extractions (as of 1968) were about 12,500 AFY, implying that overdraft conditions have existed since at least the 1960s. DWR Bulletin 118 was updated in January 1980 and designated Bulletin 118-80. Table 8 of Bulletin 118-80 noted that there is evidence of groundwater overdraft in the IWVGB. Table 1 of Bulletin 118-16 (dated January 2016) indicates the IWVGB is subject to critical conditions of overdraft.

2.2.2 Jurisdictions

The Indian Wells Valley land overlying the IWVGB encompasses portions of the Counties of Kern, Inyo, and San Bernardino, with the majority (approximately 73%) being in Kern County as shown in Table 2-1. The City of Ridgecrest is the only incorporated community in the Indian Wells Valley and covers an area of approximately 20 square miles with a population of approximately 27,000 people. Unincorporated communities in the Indian Wells Valley include the communities of Inyokern in Kern County and Pearsonville in Inyo County, along with other smaller communities.

Table 2-2. IWVGB: Distribution of Overlying Land, by County

County Name	Overlying Land (acres)	Overlying Land (%)
Kern County	277,204	73%
Inyo County	66,519	17%
San Bernardino County	37,985	10%
Total	**381,708**	**100%**

As shown in Tables 2-2 and 2-3, approximately 302,000 acres of land overlying the IWVGB are Federal property managed by either the NAWS China Lake or the BLM. The non-federal lands overlying the IWVGB consist of the incorporated City of Ridgecrest and unincorporated lands in the counties of Kern, Inyo, and San Bernardino (see Section 2.4). A map showing general jurisdictions and boundaries is provided in Figure 2-3.

Table 2-3. IWVGB: Distribution of Federal and Non-Federal Overlying Lands, by Entity

Entity	Overlying Land (acres)	Overlying Land (%)
U.S. Department of the Interior (Bureau of Land Management)	140,184	37%
U.S. Navy (Naval Air Weapons Station China Lake)	161,911	42%
Non-Federal Entities	79,613	21%
Total	**381,708**	**100%**

Table 2-4. IWVGB: Distribution of Federal and Non-Federal Overlying Lands, by County

Entity	Overlying Land (acres)				Overlying Land (%)			
	NAWS China Lake	BLM	Non-Federal	Subtotal	NAWS China Lake	BLM	Non-Federal	Subtotal
Kern County	71,971	129,032	76,201	277,204	26%	47%	27%	100%
Inyo County	57,413	6,448	2,658	66,519	86%	10%	4%	100%
San Bernardino County	32,527	4,704	754	37,985	86%	12%	2%	100%
Total	**161,911**	**140,184**	**79,613**	**381,708**	**-**	**-**	**-**	**-**

2.2.3 Classification

In accordance with SGMA, DWR is required to classify groundwater basins by priority for achieving long-term sustainable groundwater management. DWR has published the "Sustainable Groundwater Management Act, 2018 Basin Prioritization Process and Results" document, dated January 2019, which provides the process, components, and rationale to develop the prioritization of California groundwater basins. In this document, DWR identifies and prioritizes 517 groundwater basins and subbasins as either "High", "Medium", "Low," or "Very Low". DWR considered the following eight components when prioritizing the groundwater basins:

1) The population overlying the basin or subbasin.
2) The rate of current and projected growth of the population overlying the basin or subbasin.
3) The number of public supply wells that draw from the basin or subbasin.
4) The total number of wells that draw from the basin or subbasin.
5) The irrigated acreage overlying the basin or subbasin.
6) The degree to which persons overlying the basin or subbasin rely on groundwater as their primary source of water.
7) Any documented impacts on the groundwater within the basin or subbasin, including overdraft, subsidence, saline intrusion, and other water quality degradation.
8) Any other information determined to be relevant by the department, *including adverse impacts on local habitat and local streamflows*.

In addition to the IWVGB's designation as a basin subject to critical conditions of overdraft, the 2018 Basin Prioritization Report rates the IWVGB as a "High" Priority basin. Consequently, the IWVGA is required to submit this GSP by January 31, 2020 pursuant to SGMA.

2.2.4 Water Supply Source

In general, streams and other surface waters in the IWVGB are ephemeral due to low annual precipitation in the Indian Wells Valley, and Basin recharge occurs as mountain block recharge. Consequently, although natural channels for surface water exist in the IWVGB (see Figure 2-4), surface water resources in the IWVGB are limited. Surface water supplies are not available for substantial groundwater recharge as in-lieu use. Further discussion on surface water systems in the IWVGB is provided in Section 3.3.3.2.

The IWVGB serves as the sole supply of potable water for the Indian Wells Valley. Residents of the Indian Wells Valley are served groundwater through private domestic wells, small cooperative groups sharing wells, small mutual water companies, the Inyokern Community Services District (Inyokern CSD), and the Water District. The Navy produces and distributes groundwater for the on-station water uses at the NAWS China Lake. However, more recently, the majority of Navy-affiliated staff reside off-station, and the water supply needs of the off-station Navy-affiliated staff and their dependents are supplied by either the Water District, Inyokern CSD, or by privately-owned domestic wells. Searles Valley Minerals Inc. (SVM) produces groundwater from the IWVGB for use in its minerals recovery and processing operations in the Searles Valley (located east of the IWVGB) and for potable use in the small communities of Trona, Westend, Argus, and Pioneer Point in the Searles Valley. In addition, a number of farms located in the Indian Wells Valley rely on the IWVGB's water supplies for their agricultural operations, including Meadowbrook Dairy, Mojave Pistachios, Simmons Ranch, Quist Farms, and other smaller farms. The crops grown in the Indian Wells Valley are primarily alfalfa and pistachios.

The Kern County Public Health Services Department has provided the IWVGA with spatial data on wells located in the Kern County portion of the IWVGB. The data included well information such as approximate well location, point of contact, driller, and permit number. As of July 2018, the data provided such information (where available) for a total of 546 wells located in the Kern County portion of the IWVGB. The IWVGA has incorporated this spatial data into the development of this GSP.

The Desert Research Institute (DRI) has developed a groundwater pumping database for the IWVGB to represent historical pumping conditions and develop future pumping projections. The groundwater pumping database contains a compiled list of active wells in the IWVGB as well as their respective uses of groundwater and approximate well locations, which have been cross-referenced using published existing databases and aerial photographs (see Section 3.3.4.1). As shown on Figure 2-5, there are 932 estimated groundwater production wells located in the IWVGB with an average well density of approximately 1.6

wells per square mile. A summary of groundwater production wells by type of use is provided in Table 2-4. The NAWS China Lake's groundwater production wells for on-station water uses are not included on Figure 2-5.

Approximately 90% of all groundwater production wells in the IWVGB support domestic/private uses. It is estimated that approximately 832 domestic/private wells in the IWVGB produced approximately 800 acre-feet (AF) in 2015, or approximately 3% of total groundwater production in 2015. To confirm the number of domestic/private wells in the IWVGB, the IWVGA has implemented a well registration process to obtain information from all users and owners of groundwater extraction facilities in the IWVGB and properly adopt, implement, and administer this GSP. The well registration process has assisted in verifying well existence and location, but there remains some uncertainty in the existence and locations of all domestic/private wells due to a lack of compliance with well registration. This uncertainty will be reduced through future data gap analysis and groundwater allocation verification, both of which will be conducted as GSP implementation actions.

Table 2-5. Summary of Groundwater Production Wells in the IWVGB

Well Use	Number of Wells
Domestic/Private	832
Dust Control	1
Industrial	5
Landscape Irrigation	5
Large Agriculture	18
Municipal	51
Small Agriculture	20
Total	**932**

2.3 LOCAL WATER AGENCIES

2.3.1 Background

The local water agencies within the IWVGB are shown on Figure 2-6 and are briefly summarized below. Additional information on the local water agencies and total current groundwater pumping is provided in Section 3.3.4.1.

2.3.2 Indian Wells Valley Water District

The Water District was formed in 1955 as the Ridgecrest County Water District by consolidating several smaller water companies serving the Ridgecrest area with domestic water. On January 19, 1970, the Board of Directors voted to change the name from the Ridgecrest County Water District to the Indian Wells Valley County Water District, reflecting its service area which covers areas beyond the City of Ridgecrest. In 1980, the Board of Directors formally dropped the word "County" from the name of the District. Since that date, it has been known as the "Indian Wells Valley Water District".

The Water District serves approximately 30,000 customers through approximately 12,000 connections and encompasses an area of approximately 37.7 square miles within the eastern portion of the IWVGB. The Water District operates facilities (groundwater production wells, treatment systems, booster stations, storage tanks, and distribution pipelines) to provide potable groundwater from the IWVGB to its customers. Accordingly, the protection, conservation, and replenishment of groundwater supplies is of critical importance to the Water District.

2.3.3 Inyokern Community Services District

The Inyokern CSD, established in 1983, provides water, wastewater, and street lighting services to the community of Inyokern, located approximately 7 miles west of Ridgecrest. The Inyokern CSD operates service facilities including approximately 265 water service connections, 4 groundwater production wells, distribution pipelines, and a wastewater treatment plant. The Inyokern CSD serves a primarily residential population of approximately 1,000 and an estimated 420 residential households (Alpert et al., 2014).

2.3.4 Antelope Valley – East Kern Water Agency

The Antelope Valley – East Kern Water Agency (AVEK) is a wholesale water agency serving nearly 2,400 square miles in northern Los Angeles and eastern Kern Counties, as well as a small portion of Ventura County. AVEK produces groundwater from the Antelope Valley groundwater basin and also obtains imported water from Northern California through a long-term contract with the State Water Project (SWP). As shown on Figure 2-6, the AVEK service area extends into the largely undeveloped land in the southernmost portion of the IWVGB, but no AVEK water infrastructure or water supply services exist in that portion of the IWVGB. The AVEK water transmission lines closest to the IWVGB are located in California City, located approximately 15 miles south of the IWVGB boundaries and 50 miles south of Ridgecrest.

2.3.5 Kern County Water Agency

The Kern County Water Agency (KCWA) is a public agency providing wholesale water services to its 13 member units along with water resources management and monitoring services throughout Kern County. As shown on Figure 2-6, the KCWA service area encompasses all portions of the IWVGB within Kern County, except for that portion of the IWVGB in the AVEK service area. KCWA obtains imported water from Northern California through a long-term contract with the SWP. At this time, no water agencies in the IWVGB serve as member units to KCWA, and no KCWA water infrastructure exists within the IWVGB boundaries.

Additional information on KCWA's water resources monitoring efforts in the IWVGB is provided in Section 2.6.2.

2.3.6 Mojave Water Agency

The Mojave Water Agency (MWA) is a wholesale water agency serving 4,900 square miles of the High Desert in San Bernardino County. MWA produces groundwater from the Mojave Basin Area, a series of Bulletin 118 groundwater basins and subbasins located along the Mojave River. MWA also obtains imported water from Northern California through a long-term contract with the SWP. As shown on Figure 2-6, the MWA service area extends into the easternmost portion of the IWVGB, but no MWA water infrastructure or water supply services exist in that portion of the IWVGB. The MWA water transmission lines closest to the IWVGB are located in Barstow, located approximately 60 miles southeast of the IWVGB boundaries and Ridgecrest.

2.3.7 Searles Domestic Water Company

The Searles Domestic Water Company (SDWC) serves potable water to over 850 households in the communities of Trona, Westend, Pioneer Point, and Argus in the Searles Valley, which is located outside of the IWVGB boundaries approximately 20 miles northeast of the City of Ridgecrest. The SDWC is provided with groundwater pumped from the IWVGB by SVM which operates five (5) groundwater wells in Ridgecrest and west of the Ridgecrest city limits.

2.3.8 Rand Communities Water District

Encompassing approximately 314 square miles (200,900 acres) in unincorporated Kern County and northwestern San Bernardino County, the Rand Communities Water District provides potable water service to the communities of Randsburg, Johannesburg, Atolia, and Red Mountain, all of which are located southeast of the IWVGB boundaries. The Rand Communities Water District operates two groundwater production wells located in the Fremont Valley and conveys produced groundwater to approximately 260 active water services. As shown on Figure 2-6, the Rand Communities Water District service area encompasses a small portion of the IWVGB, but no Rand Communities Water District water infrastructure or water supply services exist in that portion of the IWVGB.

2.4 REGIONAL WATER MANAGEMENT AGENCIES

2.4.1 Background

The IWVGA is the exclusive Groundwater Sustainability Agency for the IWVGB, Bulletin 118 Basin No. 6-054. There are several other existing regional entities with water supply, management, planning, and/or regulatory authority whose boundaries encompass all or portions of IWVGB. These entities include the Kern County Water Agency (KCWA), the Lahontan Regional Water Quality Control Board (LRWQCB), the Inyo-Mono Integrated Regional Water Management Program (Inyo-Mono IRWMP), and the East Kern County Resource Conservation District (EKCRCD). The following is a brief overview of these entities and their role in water supply management within the IWVGB.

2.4.2 Kern County Water Agency

The Kern County Water Agency (KCWA) was created in 1961 by a special act of the California State Legislature and is the contracting entity in Kern County for the SWP. The KCWA participates in various water management activities including water quality control, flood control, and groundwater banking to preserve and enhance Kern County's water supply.

The KCWA is the second largest participant in the SWP, a water storage and delivery system for water supplies from Northern California. The KCWA has contracts with 13 local water districts, referred to by KCWA as Member Units for SWP water. Since 1968, about 33 million acre-feet of SWP water has been delivered to Kern County using SWP facilities. The KCWA does not have a contract with a local water agency in the IWVGB; therefore, the KCWA does not currently provide SWP water to the IWVGB.

Due to low rainfall in a semi-arid region, surface water supplies in Kern County must be augmented by groundwater supplies. The KCWA works to improve groundwater levels and to monitor groundwater quality throughout Kern County, especially in the areas surrounding groundwater banking projects.

The KCWA collects, interprets, and distributes groundwater data for the IWVGB. Since 1989, the KCWA has measured depth to groundwater in the IWVGB biannually during March (before peak pumping demands) and October (after peak pumping demands). KCWA analyzes the resulting measurements to generate maps of groundwater elevation and depth to groundwater throughout the IWVGB. The KCWA was also a participant in the Indian Wells Valley Cooperative Groundwater Management Group (see Section 2.4.6).

2.4.3 East Kern County Resource Conservation District

The EKCRCD is a California Special District that assists local landowners and interested citizens in voluntary, cooperative, incentive-based approaches to solve natural resource concerns (including water resources) in eastern Kern County. The EKCRCD's jurisdiction covers approximately 1.2 million acres in eastern Kern County, including all portions of the IWVGB's overlying lands within Kern County. EKCRCD's services in water resources management include distributing information on and offering assistance in water conservation practices such as installing efficient irrigation systems; watering plants, trees, and crops during droughts; and choosing vegetation with low water demands.

Historically, the EKCRCD has actively participated in the study and sustainable management of the IWVGB. Since the 1990s, the EKCRCD has engaged in a continuous educational effort in water conservation practices in the IWVGB through events such as poster contests. The EKCRCD has hosted and continues to host Xeriscape seminars in the IWVGB and encourages water-efficient landscaping by selling drought-tolerant plants to IWVGB residents. In 2003, the EKCRCD secured a Local Groundwater Assistance Fund Grant (AB 303) to conduct studies characterizing groundwater resources and hydrostratigraphic conditions in the IWVGB, and to carry out groundwater monitoring activities in accordance with the Groundwater Management Plan of the Indian Wells Valley Cooperative Groundwater Management Group (Cooperative Group) (see Section 2.4.6). More recently, the EKCRCD secured a partial grant for installation of a California Irrigation Management Information System (CIMIS) station at the NAWS China Lake golf course to monitor local evaporation trends.

2.4.4 Lahontan Regional Water Quality Control Board

The Lahontan Regional Water Quality Control Board (LRWQCB) is a seven-member decision-making body appointed by the Governor of California for the purpose of protecting the water quality and ensuring the proper allocation and efficient use of water resources in the Lahontan Region. The Lahontan Region is divided into the North and South Lahontan Basins and includes over 700 lakes, 3,170 miles of streams, and 1,581 square miles of groundwater basins. The IWVGB is located within the South Lahontan Basin, which includes three major surface water systems (Mono Lake, Owens River, and the Mojave River watersheds) and multiple separated groundwater basins. A map of the LRWQCB boundaries is provided in Figure 2-7.

The LRWQCB's general duties include approving Water Quality Control Plans and Salt and Nutrient Management Plans; setting regional water quality standards; issuing waste discharge requirements; determining compliance with those standards and requirements; and taking appropriate enforcement actions. The LRWQCB has established the "Water Quality Control Plan for the Lahontan Region, North and South Basins" (Basin Plan) as the regulatory document that sets forth water quality standards and control measures for surface water and groundwater in the Lahontan Region (including the IWVGB). The LRWQCB has also approved the IWVGB Salt and Nutrient Management Plan in 2018 (see Section 2.7.2 for additional information).

2.4.5 Inyo-Mono Integrated Regional Water Management Program

The Inyo-Mono Integrated Regional Water Management Program (Inyo-Mono IRWMP) is a regional water resource planning organization which formed in 2008 as part of the statewide Integrated Regional Water Management collaborative effort. Over 30 organizations are members of the Inyo-Mono IRWMP, including the County of Kern, the County of Inyo, the Inyokern CSD, the Water District, the BLM, and the EKCRCD. The Inyo-Mono IRWMP has obtained more than $2.5 million through DWR grants made available through Proposition 84 funding to assist essential water management projects and research efforts for Inyo, Mono, and Kern Counties, including the IWVGB. A map of the area included in the Inyo-Mono IRWMP is provided in Figure 2-8.

The "Inyo-Mono Integrated Regional Water Management Plan" dated October 2014 states:

> "The purpose of the Inyo-Mono IRWM Program is to foster coordination, collaboration, and communication among water-related stakeholders in the region for the purpose of developing water management strategies and projects that will benefit multiple entities and enhance water supply, water quality, and watershed health."

2.4.6 Indian Wells Valley Cooperative Groundwater Management Group

The Cooperative Group was created in 1995 as a public water data-sharing group to consolidate and coordinate voluntary water management efforts in the Indian Wells Valley. The Cooperative Group collected and shared information regarding groundwater resources and uses of groundwater in the IWVGB. At various times, members of the Cooperative Group included the NAWS China Lake, Searles Valley Minerals Inc., the Water District, the BLM, the City of Ridgecrest, KCWA, Kern County, Inyokern CSD, EKCRCD, Meadowbrook Dairy, Mojave Pistachio, and Inyokern Airport District. These members provided materials and services as in-kind contributions to support the Cooperative Group's goals. In addition to in-kind services, the Cooperative Group received state funding from DWR for groundwater Basin studies.

The Cooperative Group developed a "Cooperative Groundwater Management Plan for the Indian Wells Valley" (CGMP), dated March 2006, that established planning objectives to address conditions of overdraft and the resulting consequences for stakeholders in the Indian Wells Valley. The CGMP was not intended to alter or affect any existing water rights, but rather served as a set of guidelines to encourage participation in voluntary water management efforts among the Cooperative Group members. The water management efforts listed in the CGMP included:

- Working towards and encouraging limitation of additional large-scale pumping in areas that appear to be adversely impacted;
- Distributing new groundwater extractions within the Indian Wells Valley in a manner that will minimize adverse effects to existing groundwater conditions (levels and quality), and maximize the long-term supply within the Indian Wells Valley;
- Aggressively pursuing the development and implementation of water conservation policy and education programs;
- Encouraging the use of treated water, reclaimed water, recycled, gray, and lower quality water where appropriate and economically feasible;
- Exploring the potential for other types of water management programs that are beneficial to the Indian Wells Valley;

- Continuing cooperative efforts to develop information and data which contributes to further defining and better understanding the groundwater resources in the Indian Wells Valley;
- Developing an interagency management framework to implement and enforce the objectives of the CGMP.

The Cooperative Group is no longer a functional entity due to the withdrawal of members of time. The IWVGA has since assumed responsibilities for data collection and exchange as well as water resources management in the IWVGB.

2.5 LAND USE

2.5.1 Background

California Government Code Section 65040.2 requires cities and counties to establish a General Plan as a guideline to determine growth patterns, land use, land development, etc. A municipal General Plan addresses the following elements for its city or county: land use, circulation, housing, conservation, open space, noise, safety, environmental justice, and other optional topics of local interest. The General Plan elements of greatest relevance to this GSP and the IWVGA's water supply issues are land use, housing, conservation, and open space.

Implementation of this GSP may impact the water supply and water demand assumptions of existing General/land use Plans presiding over the IWVGB due to changes in the quantities and locations of groundwater extractions. Specifically, through the proposed recycled water projects (see Section 5.3.2) and basin-wide conservation measures (see Section 5.3.3), implementation of this GSP will result in decreased local water demands that rely on the IWVGB for water supplies. Also, though the proposed pumping optimization project (see Section 5.3.6), implementation of this GSP will result in relocating the pumping centers of major producers in the IWVGB to prevent future undesirable results. The land use plans of the counties of Kern, Inyo, and San Bernardino, the City of Ridgecrest, the BLM, and the U.S. Navy will be considered and incorporated during GSP implementation. The IWVGA will coordinate with the relevant local land use and planning agencies presiding over the IWVGB during GSP implementation to discuss the GSP projects and management actions and their potential impacts to the water supply and water demand assumptions of those land use plans.

Implementation of land use plans presiding over areas outside of the IWVGB may affect implementation of this GSP, specifically the IWVGA's goal of procuring and developing imported water supplies (see Section 5.3.1). Implementation of this GSP will establish a local reliance on new external water supplies to meet IWVGB domestic water demands. It is unknown at this time which external water supplies may be procured, and therefore unknown which land use plans will be affected. When external water supplies are identified and secured, the IWVGA will coordinate with the land use and planning agencies associated with the IWVGA's imported water supplies and imported water project, and subsequently provide updates as appropriate in the IWVGA's 5-Year GSP Updates (see Section 6) . Should it be determined that imported water supplies become unavailable or infeasible to obtain due to existing land use policies and/or other constraints, the IWVGA will consider modifications to this GSP. These modifications may include potentially revisiting Management Action No. 1 (see Section 5.3.1) and modifying the Annual Pumping Allocations such that the IWVGB may achieve sustainability without imported water supplies.

2.5.2 Summary of General Plans and Other Land Use Plans

2.5.2.1 *Kern County*

The majority of land overlying the IWVGB is within Kern County. The Kern County General Plan, adopted September 22, 2009, is a policy document that, along with its amendments, guides the development and/or preservation of the county's natural resources not directly managed by the Federal government. The Kern County General Plan was prepared by the Kern County Planning and Community Development Department.

Page viii of the Introduction to the Kern County General Plan states:

> "This planning document recognizes that the relationship between water supply and land use planning is important to promoting future growth and a strong economy for Kern County's future.

Recent State laws require local governments to ensure that development approvals occur with substantive, realistic assessments of the availability of a reliable water supply. The new laws require the verification of sufficient water supplies as a condition for approving certain developments and compel urban water suppliers to provide more information on the reliability of groundwater for a long-term time frame. Long-term water supply planning is important to ensuring that rural and urban economic growth can be accommodated into the future."

The Kern County General Plan acknowledges that water supply is a critical issue for Kern County's residents and economy. For this reason, the Kern County General Plan requires that General Plan amendments subject to environmental review and not otherwise subject to CWC Section 10910 demonstrate through a water supply assessment that a long-term water supply for a 20-year timeframe is available. Additionally, all development proposals are required to be reviewed by County staff to ensure that adequate water supplies are available to accommodate projected growth. To sustain long-term economic stability in Kern County, Chapters 1.9 and 1.10.6 of the Kern County General Plan encourage effective groundwater resource management through the following actions:

- Promoting groundwater recharge activities in various zone districts;
- Supporting the development of Urban Water Management Plans and promoting Department of Water Resources grant funding for all water providers;
- Supporting the development of groundwater management plans;
- Supporting the development of future sources of additional surface water and groundwater including conjunctive use, recycled water, conservation, additional storage of surface water and groundwater, and desalination;
- Requiring water-conserving design and equipment in new construction;
- Encouraging water-conserving landscaping and irrigation methods;
- Encouraging the retrofitting of existing development with water-conserving devices.

A total of 277,204 acres of land overlying the IWVGB is located within Kern County. 201,003 acres (73%) of the overlying land within Kern County is Federal land managed by the BLM (129,032 acres, or 47%), or controlled by the NAWS China Lake (71,971 acres, or 26%). Most of the BLM-managed land in the IWVGB is open space managed for natural and economic resources, including mineral resources and rights-of-way for powerlines and pipelines (Todd Engineers, 2014). The land controlled by the NAWS China Lake is used for weapons research, development, acquisition, testing, and evaluation for the U.S. Navy.

Zoning in the Kern County portion of the IWVGB (including definitions of each Kern County zoning district and the permitted land uses in each zoning district) is regulated by Title 19 of the Kern County Municipal Code. Near the westerly and southeasterly City of Ridgecrest boundaries, the permitted zoning consists of residential zoning generally with a minimum lot size at 2.5 acres per dwelling unit, light industrial zoning, open space zoning, etc. The area between the City of Ridgecrest boundaries and the community of Inyokern contains primarily residential zoning districts with varying densities, while the areas northwest of Inyokern are residential and resource (primarily agriculture) zoning districts. Zoning in the southwest portion of the IWVGB, commonly referred to as the El Paso area, consists primarily of open space, recreation (forestry), limited agriculture, and mobile home districts. Lands in the El Paso area are largely uninhabited and are managed by BLM. As a result, significant groundwater extraction does not occur in the El Paso area due to the lack of local water demands in that area. In addition, the limited quantity of mountain-front recharge to the El Paso area limits the potential for groundwater extraction in the El Paso area except through unsustainable Basin mining (see Section 3.3.3.1).

A breakdown of the Kern County lands overlying the IWVGB and their associated land use designations is provided in Table 2-5 and is shown in Figure 2-9.

Table 2-6. Zoning Districts in the Kern County lands overlying the IWVGB

Zoning District	Area (acres)	Area (%)
Estate District 0.25 Acre (E(1/4))	344	0.13%
Estate District 0.5 Acre (E(1/2))	608	0.23%
Estate District 1 Acre (E(1))	1,190	0.46%
Estate District 2.5 Acre (E(2 ½))	9,420	3.63%

Zoning District	Area (acres)	Area (%)
Estate District 5 Acre (E(5))	5,493	2.12%
Estate District 10 Acre (E(10))	3,754	1.45%
Estate District 20 Acre (E(20))	14,056	5.41%
Estate District 40 Acre (E(40))	952	0.37%
Estate District 80 Acre (E(80))	922	0.36%
Limited Agriculture (A-1)	72,353	27.86%
Exclusive Agriculture (A)	452	0.17%
General Commercial (C-2)	283	0.11%
Neighborhood Commercial (C-1)	1	< 0.10%
Highway Commercial (CH)	294	0.11%
Light Industrial (M-1)	1,955	0.75%
Medium Industrial (M-2)	1,321	0.51%
Low-Density Residential (R-1)	136	< 0.10%
Medium-Density Residential (R-2)	14	< 0.10%
Mobilehome Park (MP)	31	< 0.10%
Mobilehome Subdivision (MS)	29	< 0.10%
Floodplain Primary (FPP)	19	< 0.10%
Open Space (OS)	105,462	40.61%
Recreation Forestry (RF)	11,841	4.56%
Other (China Lake)	28,749	11.07%
Other	4	< 0.10%
Total	**259,683[9]**	**100%**

[9] Kern County zoning data was obtained from the County of Kern Geodat Open Data Portal. Updated as of September 24, 2019. Note that the City of Ridgecrest (located within the Kern County portion of the IWVGB) is not under the zoning jurisdiction of Kern County.

Section 1.6 of the Kern County General Plan projects that the population of Kern County will continue to grow at a rate of less than 2 percent annually over the 20 years after publication in 2009. This population growth is attributed to a continuing influx of new residents from outside the County, as well as the natural increase of the population in the County. The City of Ridgecrest General Plan provides the growth trends for the City, which indicate that population growth in the City is anticipated to be lower than that of Kern County. The water demands of the Indian Wells Valley Water District are projected to increase at a rate of 1.0% percent annually (ESA, 2009) over the planning and implementation horizon of this GSP, to account for population growth in the IWVGB.

2.5.2.2 *Inyo County*

The Inyo County General Plan was approved by the Inyo County Board of Supervisors in 2001. In accordance with the 2001 General Plan, the Inyo County Planning Department is currently updating its Zoning Code and has subsequently released draft General Plan updates associated with the proposed updates to the Zoning Code. The Inyo County General Plan Update dated May 2013 was used to complete this GSP, which will be appropriately updated in accordance with all updates to the Inyo County General Plan.

Section 8.5 of the 2001 Inyo County General Plan provides planning goals related to water resources including:

- Providing an adequate and high-quality water supply to all users within the County;
- Protecting and preserving water resources for the maintenance, enhancement, and restoration of environmental resources; and
- Protecting and restoring environmental resources from the effects of export and withdrawal of water resources.

In October 2017, the Inyo County Planning Department updated Section 18.67 of the Inyo County Code to create a non-groundwater neutral agricultural use overlay district that requires agricultural uses within the district that will adversely impact the underlying groundwater Basin to have a conditional use permit.

The community of Pearsonville is the primary community in the Inyo County portion of the IWVGB to which this update applies. The conditional use permit process is discretionary, allowing Inyo County (through the Inyo County Planning Commission) to prohibit agricultural uses that would be detrimental to Inyo County's interests and to the groundwater Basin in general, while still allowing agricultural uses that can be shown to be sustainable and have minimal impacts to the groundwater Basin.

The vast majority of land in Inyo County is owned by either the Federal government (~92%), the City of Los Angeles (~4%), and the State of California (~2.5%) (Inyo County Planning Department, 2013). Approximately 96% of the Inyo County land overlying the IWVGB is either owned by the US Navy as part of NAWS China Lake, or managed by the BLM (see Table 2-3 above). Approximately 98% of the Inyo County land overlying the IWVGB is zoned as open space (see Table 2-6 below). The community of Pearsonville, occupying approximately four-square miles, is zoned for various residential densities as well as some commercial and industrial zoning to compliment the community's highway-oriented businesses.

A breakdown of the Inyo County lands overlying the IWVGB and their associated zoning is provided in Table 2-6 and shown in Figure 2-10.

Table 2-7. Zoning Districts in the Inyo County lands overlying the IWVGB

Zoning District	Area (acres)	Area (%)
Commercial Recreation	5	< 0.1%
General Industrial and Extractive	167	0.3%
Heavy Commercial	15	< 0.1%
Highway Services and Tourist Commercial	25	< 0.1%
Light Industrial	29	< 0.1%
Multi-Family Residential	23	< 0.1%
Open Space	65,038	98.2%
Public	65	0.1%
Rural Residential	848	1.3%

Zoning District	Area (acres)	Area (%)
Total	**66,215**[10]	**100%**

2.5.2.3 *San Bernardino County*

The General Plan for San Bernardino County was last updated in 2007 and is currently in the process of being revised. The land just adjacent to the City of Ridgecrest's eastern boundary is designated as Rural Living, allowing for a maximum of one dwelling unit per 2.5 acre lot. This area contains less than one square mile of residential lots. Areas with a Resource/Land Management designation span over several miles to the east of China Lake and south of the Inyo County line. A majority of the land overlying the IWVGB within San Bernardino County is within the NAWS China Lake boundaries, as shown above in Table 2-3.

A breakdown of the San Bernardino County lands overlying the IWVGB and their associated zoning is provided in Table 2-7 and shown in Figure 2-11.

Table 2-8. Zoning Districts in the San Bernardino County lands overlying the IWVGB

Zoning District	Area (acres)	Area (%)
Resource Conservation	37,411	98.5%
Rural Living	574	1.5%
Total	**37,985**[11]	**100%**

[10] Inyo County zoning data was obtained from the County of Inyo Public Geographic Information Systems Page. Updated as of January 31, 2019. Note that not all Inyo County lands overlying the IWVGB were given zoning district categories in the dataset.
[11] San Bernardino County zoning data was obtained from the ArcGIS Hub – Open Data, in conjunction with the San Bernardino County Land Services Department. Updated as of May 3, 2018.

2.5.2.4 *City of Ridgecrest*

The City of Ridgecrest has direct land use jurisdiction within its city limits with the exception of the small northern portion of the City within NAWS China Lake. The community within and surrounding the City of Ridgecrest is strongly linked to supporting NAWS China Lake by providing housing and services for personnel and contractors working at NAWS China Lake; accordingly, the City of Ridgecrest General Plan emphasizes both achieving growth and sustainably supporting the military installation.

The City of Ridgecrest's General Plan was last updated in 2009. The City's General Plan discusses the City's goals for a number of elements, including public facilities and public services. The following Land Use (LU), Community Design (CD), and Open Space and Conservation (OSC) goals stated in the City's General Plan are related to and in alignment with the implementation of this GSP:

- Goal LU-10.13: Ensure that all General Plan updates, specific plans, and planned developments in the City consider impacts to water availability and quality;
- Goal CD-2.11: Develop a long-range plan for the distribution of reclaimed waste water to be used in place of fresh water where applicable.
- Goal OSC-4.2: Develop programs to encourage water conservation in conjunction with the Indian Wells Valley Water District and other interested agencies.
- Goal OSC-6.1: Require a construction plan prior to groundbreaking that uses site design and grading techniques to reduce the amount of impervious surface and runoff for all new urban commercial or residential developments proposed projects.
- Goal OSC-6.2: Require the disposition of solid and liquid wastes in a manner consistent with State and Federal regulations to prevent aquifer contamination.
- Goal OSC-6.3: Work in partnership with the Indian Wells Water Valley Water to establish a reasonable population limit for the City and Indian Wells Valley in order to reflect the Basin's capacity for sustainable yield of groundwater.

- Goal OSC-6.4: Investigate methods of expanded reuse or tertiary treatment of wastewater for groundwater recharge, industrial use and landscape irrigation, and implement effective methods where feasible.
- Goal OSC-6.5: Discourage further increases in groundwater extraction for water intensive uses such as non-native landscaping and water-intensive agricultural crops.
- Goal OSC-6.6: Encourage water conservation on a city-wide basis.
- Goal OSC-6.7: Investigate and implement water efficient devices for existing and future municipal buildings.
- Goal OSC-6.8 Evaluate, define, and correct water losses on City property that are detrimental to conservation efforts.
- Goal OSC-6.9: Encourage using water efficient landscaping practices, where possible, for all City landscaping.
- Goal OSC-6.10: Update the building code to encourage the use of recycled or grey water for landscaping.
- Goal OSC-6.11: Support and adopt the goals of the Indian Wells Valley Water District Urban Water Management Plan.
- Goal OSC-6.12: Support efforts to more accurately determine the groundwater dynamics of the Indian Wells Valley groundwater basin.
- Goal OSC-6.13: Support the IWVWD and NAWS efforts to identify and secure alternative sources of water supply.
- Goal OSC-6.14: Support efforts by the IWVWD, NAWS and other water purveyors to develop sound pumping patterns through well field redesign, and, where possible, consolidate systems.
- Goal OSC-6.15: Support the efforts of the Indian Wells Valley Water District toward consideration of the creation of a valley wide water policy to control the exportation of water from the Indian Wells Valley.
- Goal OSC-6.16: Identify flood plains, aquifer recharge areas and natural drainage courses, where possible, as open space to aid groundwater recharge.

- Goal OSC-11.5: Develop park areas utilizing xeriscape practices, wastewater reuse and other water conserving measures as a demonstration and educational opportunity for residents to learn water conservation practices.

2.5.2.5 *Federal Lands*

The BLM prepares Resource Management Plans (RMPs) that serve as land management blueprints. The majority of southern California, including the Indian Wells Valley, is within the California Desert Conservation Area (CDCA). The CDCA comprehensive land-use management plan was completed in 1980 and revised in 1999. Additionally, the Indian Wells Valley is within the BLM's West Mojave Plan area which established a Habitat Conservation Plan for sensitive plants and species in the region.

The US Department of Interior has assigned land management responsibility of NAWS China Lake to the U.S. Navy. Consequently, the U.S. Navy has developed a Comprehensive Land Use Management Plan (CLUMP) for land use management and environmental resources management for NAWS China Lake.

2.5.3 Agricultural Land Use

There are approximately 3,086 acres of actively farmed land overlying the IWVGB[12]. Typically, each farm has its own well system and water delivery system for its respective crops. The primary crops grown in the Indian Wells Valley are pistachios (2,027 acres) and alfalfa (985 acres), with other miscellaneous crops (74 acres) such as miscellaneous grain and hay constituting a minority of production. A map of actively farmed land overlying the IWVGB is provided in Figure 2-12.

2.5.4 Industrial Land Use

There are no large-scale industrial land uses in the Indian Wells Valley. Since the 1920's, Searles Valley Minerals Inc. (SVM) has exported groundwater from five (5) wells located in Ridgecrest and west of the

[12] Actively farmed land in the IWVGB was determined using the California Department of Water Resources' Crop Mapping 2014 GIS dataset. Updated as of March 13, 2018.

Ridgecrest city limits to Searles Valley (located outside of the IWVGB) to support both its industrial operations and the domestic needs of the unincorporated communities of Trona, Westend, Argus, and Pioneer Point. Section V.C of the San Bernardino County General Plan maintains a countywide goal of promoting conservation of water and maximizing the use of existing water resources by promoting activities and measures that facilitate the reclamation and reuse of water and wastewater, including for industrial uses.

2.6 EXISTING WATER RESOURCES MONITORING PROGRAMS

2.6.1 Background

Multiple entities have been measuring depth to groundwater in the IWVGB since the 1920's. Monitoring programs were first initiated in the IWVGB by the United States Geological Survey (USGS) and have been primarily conducted by KCWA since 1989 with the assistance of the Water District, the United States Bureau of Reclamation (USBR), and the NAWS China Lake. Additionally, many of these entities have constructed wells dedicated to monitoring groundwater levels and water quality in the IWVGB. Many private entities and well owners monitor their own wells for groundwater levels and water quality.

Prior to formation of the IWVGA, monitoring efforts in the IWVGB were often duplicated due to a lack of communication among interested parties. In 1995, the Cooperative Group was formed to coordinate monitoring and management efforts, share data, and avoid the redundancy of groundwater study efforts. As a public data-sharing group consisting of the major water producers, government agencies, and concerned citizens in the IWVGB, the Cooperative Group compiled numerous study and data-gathering efforts in the IWVGB including a basin-wide recharge study and well monitoring data collected by the Water District, KCWA, and the U.S. Navy for over 100 monitoring wells. The Cooperative Group also oversaw the construction of weather and stream gages throughout the IWVGB and compiled data collected at these weather and stream gages. The Cooperative Group published its compiled monitoring data, including historical reported pumping and Basin studies, on its website:

http://iwvgroundwater.org/

The Cooperative Group was designated as the California Statewide Groundwater Elevation Monitoring (CASGEM) monitoring entity for the IWVGB per a DWR letter dated November 18, 2011. With the formation of the IWVGA and the subsequent withdrawal of several key signatories from the Cooperative Group, the status of CASGEM monitoring entity was transferred to the IWVGA in January 2018 as part of the IWVGA's initial SGMA compliance efforts.

The following sections summarize the existing water resources monitoring programs that are on-going within the IWVGB. These programs are conducted by a variety of agencies and are now being incorporated into the SGMA compliance efforts overseen and managed by the IWVGA. Data obtained through the existing water resource monitoring programs helped populate the IWVGA's Data Management System (see Section 2.8), and the data was used to develop alternative groundwater Basin management strategies (see Section 5).

2.6.2 KCWA Groundwater Monitoring Programs

The KCWA measures depth to groundwater in over 200 monitoring wells in the IWVGB consisting of a network of private and public water production wells and monitoring wells. Field measurements of water levels are conducted semiannually in March and October, before and after peak pumping demands. The water level data is collected, analyzed, and plotted onto contour maps to depict groundwater depths, groundwater elevations, and changes in groundwater elevation over time. The contour maps portray how the IWVGB spatially reacts to groundwater extractions across the Indian Wells Valley. The contour maps and hydrographs are updated annually by KCWA and can be viewed at the IWVGA's Data Management System (see Section 2.8), which can be accessed at www.iwvgsp.com.

KCWA also collects water quality samples at monitoring wells for analysis. The water quality results can then be plotted on contour maps and a variety of other types of diagrams and graphs.

The data collected from monitoring groundwater levels and water quality are archived in the IWVGA's Data Management System, which contains groundwater level data dating back to 1946 and water quality data dating back to 1952.

The locations of the KCWA monitoring wells and other monitoring wells in the IWVGB are provided in Figure 2-13.

2.6.3 California Statewide Groundwater Elevation Monitoring

A subset of the data from 20 of the over 200 wells monitored throughout the IWVGB are submitted to DWR as part of their California Statewide Groundwater Elevation Monitoring (CASGEM) program. CASGEM requires each individual groundwater basin to develop a representative groundwater level monitoring program to assist with tracking change in groundwater levels, and consequently changes in the volume of water stored in the groundwater basin. The CASGEM program aides in identifying the seasonal and long-term trends in the IWVGB. The locations of the IWVGB CASGEM wells are provided in Figure 2-13. A selection of these CASGEM wells served as representative monitoring sites while evaluating impacts and management actions and subsequently served as the locations where sustainability criteria were set (see Section 5).

2.6.4 NAWS China Lake Monitoring Program

The Navy currently implements a comprehensive Basewide Groundwater Monitoring Program (BGMP) to provide groundwater quality and water level data to support the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process at Installation Restoration Sites and Operable Units located throughout Naval Air Weapons Station China Lake. The BGMP includes basewide collection and analysis of groundwater quality samples, quarterly downloads of continuous hourly groundwater level measurements, and semi-annual reporting.

2.7 EXISTING WATER RESOURCES MANAGEMENT PROGRAMS

2.7.1 Background

It has been well documented that the IWVGB has been in overdraft since at least the 1960s and that current Basin outflows exceed Basin inflows by approximately four times (see Section 3.3.4.4). Water resources management programs in the IWVGB have been implemented by a variety of entities to partially address the conditions of Basin overdraft. In many instances, these water resources management programs have resulted in a reduction of historical pumping to reduce the impacts of over-pumping, though additional water resources management programs will be required to bring the IWVGB into sustainable operations (see Section 5). The water resources management programs that are **not** currently practiced in the IWVGB include replenishment of groundwater extractions; conjunctive use and underground storage; and diversions to storage.

The following section summarizes the existing and on-going water resources management programs administered in the IWVGB. Proposed water resources projects and management actions that will be primarily managed by the IWVGA are discussed in Section 5.

2.7.2 Salt and Nutrient Management Plan

A Salt and Nutrient Management Plan (SNMP) for the IWVGB was finalized in March 2018 and accepted by the LRWQCB. The SNMP (RMC, et al., 2018) was prepared as a high-level planning document to inform the monitoring and implementation elements being developed for this GSP. The SNMP was also prepared in compliance with the requirements of the State Water Resources Control Board 2009 Recycled Water Policy, including addressing the National Pollutant Discharge Elimination System (NPDES) permitting for the existing City WWTF. The SNMP provides an overview of Basin characteristics, groundwater conditions, historical groundwater production, and existing groundwater quality. In addition, the SNMP:

- Tentatively identifies sources of additions/withdrawals of both salts (Total Dissolved Solids) and nutrients (such as nitrate);
- Analyzes current assimilative capacity for salts and nutrients;
- Projects trends in water quality and loading;
- Analyzes water quality conditions against the water quality objectives described in the Basin Plan;
- Discusses existing and potential water resources practices that do and may impact Basin water quality; and
- Provides a proposed preliminary water quality monitoring program for inclusion in the GSP groundwater monitoring program.

The SNMP estimated salt and nutrient loading in the IWVGB as a whole, using a GIS-based model incorporating land use, irrigation water, septic systems, and wastewater discharge. Findings from the SNMP indicate that there is assimilative capacity for salts (Total Dissolved Solids) and nitrate for the IWVGB as a whole, though localized salinity issues in portions of the IWVGB were not addressed. Although no new implementation measures or Best Management Practices are recommended by the SNMP, the SNMP does recommend an adaptive management strategy through continuation of existing groundwater quality measures and practices (including Best Management Practices for wastewater treatment, recycled water management, agricultural irrigation, and septic system management) to monitor and manage groundwater quality in the IWVGB. To further understand salt and nutrient stabilization in the IWVGB, the SNMP also recommends additional salinity monitoring and evaluation of the Brackish Groundwater Project (see Section 5.4.1). As GSP implementation proceeds, consideration will be given to compliance with the SNMP. In addition, the SNMP will be periodically updated.

2.7.3 Conservation Programs

2.7.3.1 *Water District Demand Management Measures*

The Water District has implemented a number of successful water conservation programs in an attempt to reduce annual groundwater extractions and in response to state-mandated conservation goals. The Water District has achieved a 30% reduction in total water demand as a result of implementing a four-tier water rate structure along with various water conservation Ordinances issued by the Water District. The current Water District Ordinances that are in effect include:

- Water District Ordinances 98 and 99 (adopted in 2015)
  - Implementation of an Approved Plant List for landscaping
  - Mandated use of low volume irrigation systems, high efficiency sprinkler heads, pressure regulators, and master shut-off valves
    - Subsurface drip irrigation required on areas less than 10 feet wide
- Water District Ordinance 101 (adopted in 2017)
  - Implementation of the 2017 Water Shortage Contingency Plan

        - Actions for two stages of local water shortages and a drought state of emergency
- Water District Ordinance 103 (adopted in 2017)
    - Irrigation limited to 3 days per week during all months
    - No water user shall waste water; prohibits washing down hard or paved surfaces for strictly aesthetic purposes
    - Prohibit vehicle washing except by use of a hand-held bucket or hand-held nose equipped with a shut-off nozzle or device
    - Irrigation limited to 3 days per week based on addresses
    - Restaurants shall only serve water on request
    - Turf or ornamental landscapes shall not be irrigated within 48 hours after measurable precipitation
    - Hotel/motel operators shall provide guests the option of choosing not to have towels and linens laundered daily
    - Prohibits recreational fountains or decorative water features

The Water District has hosted community outreach events (e.g. school education programs) to raise awareness of water conservation practices, such as the use of appropriate desert landscaping. At these and other local events, the Water District has distributed water conservation fixtures including 3,746 low-flow showerheads; 5,256 low-flow hose nozzles; 880 shower timers; 2,480 faucet aerators; 3,514 water tumblers; and 2,339 moisture meters. The Water District's "Cash for Grass" Rebate Incentive Program offers rebates to property owners who elect to replace lawns with eligible low water-use landscaping. To supplement its ongoing conservation practices, the Water District manages a digital customer engagement portal that allows the Water District and its customers to track and analyze customer water use, conservation practices, ordinance violations, leakage incidents, etc.

2.7.3.2 *City of Ridgecrest Demand Management Measures*

Similar to the Water District, the City of Ridgecrest has adopted water conservation Ordinances to reduce demands. The Ordinances include:

- City of Ridgecrest Ordinance 09-05 (adopted in 2009)
    - Similar irrigation restrictions to Water District Ordinance 100
- City of Ridgecrest Ordinance 16-01 (adopted in 2016; supersedes Ordinance 09-05)
    - Water-efficient landscaping and irrigation scheduling
    - Promoted use of recycled water and greywater
    - Promoted stormwater management practices

2.7.3.3 *Navy Water Use*

The Cooperative Group's recorded production data indicates that the Navy has historically been a major pumper in the IWVGB. The Navy has since reduced its historic groundwater pumping through a combination of instituted conservation measures and a shift from on-base housing of Navy personnel to off-base housing within the Ridgecrest area.

While a member of the Cooperative Group, the NAWS China Lake committed to explore the potential for water resources management programs that would benefit the IWVGB, including water conservation efforts. In its "Water Conservation Public Advisory" dated June 2008, the Cooperative Group (including the Navy) developed strategies to reduce unnecessary and/or excessive water uses to support the sustainable management of the IWVGB.

The NAWS China Lake's Integrated Natural Resources Management Plan (INRMP) dated June 2014 describes the Navy's implementation of natural resources programs at NAWS China Lake, including water resources management. In its 2014 INRMP, the Navy emphasizes a water conservation program focused on xeriscaping, a landscaping method based on the use of native or drought-resistant plants, in addition to efficient irrigation practices that require less water. Principles of xeriscaping include using gravel or plastic/rubber-based products to preclude weed growth and enhance water retention; using ground cover to prevent blowing dust and soil erosion; watering using automatically controlled cycles during low evaporation periods; and using drip irrigation whenever possible. The 2014 INRMP discourages the addition of new lawn areas except where functionally essential (i.e. in areas used for ceremonies, family housing, recreation fields, and children's playgrounds).

Per CWC Section 10720.3(d), SGMA recognizes that federally reserved water rights to groundwater must be respected in full and that Federal law shall prevail in the case of any conflict between Federal and State law. NAWS China Lake considers groundwater resources (or lack thereof) to be the number one encroachment concern with the potential to impact missions enabled on and around the NAWS China Lake. NAWS China Lake has agreed to voluntarily participate in the preparation and administration of this GSP, which considers the interests of all beneficial uses and users of groundwater—including the Federal government, military, and managers of Federal lands—in accordance with CWC Section 10723.2. In October2018, the Navy estimated its short-term future water needs on the installation to be approximately 2,041 AFY, which includes a 25% increase in current water use. This estimation is **not** indicative of the Navy's federally reserved water right, which has yet to be quantified and is not subject to the provisions of SGMA.

2.7.3.4 *Opportunities for Additional Conservation*

Opportunities for implementation of additional conservation measures are discussed in Section 5.

2.7.4 Efficient Water Management Practices

The Water District prepared its "2015 Urban Water Management Plan" (2015 UWMP), dated June 2016, which includes a discussion of efficient water management practices in Section 6.B.7 "Prohibitions, Penalties, and Consumption Reduction Methods". The following is a brief summary of these efficient water management practices.

2.7.4.1 *Mandatory Prohibitions on Wasting Water*

The Water District has adopted Ordinance No. 103 implementing emergency water conservation through mandatory restrictions. The City of Ridgecrest adopted a Water Efficient Landscape Ordinance (Ordinance No. 16-01). These ordinances have common requirements, including but not limited to:

- Prohibiting runoff from landscape irrigation;

- Prohibiting wash down of hard or paved surfaces;
- Prohibiting water leaks;
- Prohibiting use of a hose without a shut-off nozzle;
- Prohibiting landscape irrigation, except for hand watering or the use of a drip irrigation system, between the hours of 8:00 P.M. and 8:00 A.M. during the months of May, June, July, August, September, and October, unless a special permit is issued to accommodate newly planted material;
- Requiring new plumbing fixtures to conform to requirements of law as to flow capacity.

2.7.4.2 *Water Efficient Landscaping*

The Water District has implemented numerous water-efficient landscape requirements for customers within its service area, including:

- Prohibiting turf in the front yard;
- Limiting plants in front yards to those provided in a Water District-approved list;
- Prohibiting front yard irrigation systems that are not low-volume;
- Requiring use of high-efficiency irrigation sprinkler heads;
- Prohibiting irrigation runoff.

2.7.4.3 *Excessive Use Penalties*

Based on the actual cost to produce and distribute water, the Water District has adopted a tiered water rate structure which rewards customers that conserve water through lower water rates. Customers that consistently waste water may be subject to having flow restrictions placed on their meters.

2.7.5 Recycled Water Use

CWC Section 13050(n) defines “recycled water” as water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. There are currently two wastewater treatment facilities (WWTFs) within the IWVGB: The City of Ridgecrest WWTF[13], and the Inyokern CSD WWTF. IWVGB residents that do not contribute flow to either of these WWTFs use household septic tanks to dispose of wastewater.

Prior to 1974, the City of Ridgecrest Sanitation District operated a small WWTF in the eastern portion of the City, near the eastern City limits. At that time, the Navy operated its own separate WWTF on the NAWS China Lake. To address capacity problems, the City abandoned its old WWTF and consolidated the two treatment facilities to treat combined flow from the City and from the NAWS at a common plant. The City has since operated the existing 3.6 million gallon per day (MGD) WWTF located on the NAWS base, approximately 3.5 miles northeast of the City center. Annual average day flows at the WWTF were approximately 2.44 MGD (2,739 AFY) in 2017. The City WWTF provides primary wastewater treatment through a series of headworks and sedimentation tanks. Secondary treatment occurs in a series of on-site facultative ponds with clay linings.

The City of Ridgecrest's WWTF is currently the only facility which generates a recycled water supply for direct beneficial or controlled use within the IWVGB. The City WWTF produces recycled water that is applied at a City site for alfalfa irrigation and at the NAWS China Lake for golf course irrigation. The remaining treated wastewater generated at the City WWTF is discharged to evaporation/percolation ponds at the City WWTF site.

Independent of this GSP, the City is currently planning to upgrade, expand, and potentially relocate the existing City WWTF. The City plans to abandon and demolish the existing City WWTF for construction of a new oxidation ditch secondary treatment plant with new evaporation/percolation ponds and new solids handling facilities (Provost & Pritchard, 2015). The City has evaluated constructing new recycled water facilities including tertiary treatment trains (filtration and disinfection) at the new WWTF, a recycled water storage tank, a recycled water pump station, and a purple pipe distribution system. The new recycled

[13] A Memorandum of Agreement dated April 1, 1993, between the Navy and the City states that the City owns and operates the WWTF, though there is a general lack of consensus among the IWVGB stakeholders regarding the ownership and operations of the WWTF. The term "City WWTF" is used in this GSP for the sole purpose of distinguishing between the two existing WWTFs in the IWVGB.

water facilities would provide up to 1.8 MGD (2,016 AFY) of recycled water for City use in landscape irrigation and/or groundwater recharge (Provost & Pritchard, 2015). The City is considering two (2) potential sites for the new WWTF: (1) the existing WWTF site, or (2) the old City WWTF site. The new WWTF location will depend on ongoing easement and land use negotiations between the City and the Navy.

The Inyokern CSD also operates a small WWTF with an approximate capacity of 0.035 MGD to treat wastewater from residents within its service area. The final effluent generated at the Inyokern WWTF is currently not of sufficient quality for any beneficial uses of recycled water and is instead disposed of through evaporation/percolation ponds located at the Inyokern WWTF site.

2.7.5.1 *Alfalfa Irrigation*

Approximately 220 AFY of recycled water (secondary-treated wastewater) from the City WWTF has been historically used to irrigate 30 acres of alfalfa located at the old City WWTF site. The alfalfa is commonly sold by the City for use in cattle feed. The July 2019 Salt Wells Valley earthquakes caused disruptions to the City WWTF and prevented the City from irrigating its alfalfa for the 2019 growing season. The City plans to continue its alfalfa irrigation with recycled water until the new WWTF with recycled water facilities is constructed, at which point the City plans to instead apply recycled water (tertiary-treated wastewater) for landscape irrigation in place of potable groundwater supplies and/or groundwater recharge.

2.7.5.2 *NAWS China Lake Golf Course*

The Navy receives secondary-treated effluent from the City WWTF and provides additional treatment for beneficial use on a golf course. The Navy uses a chlorine contact basin to provide additional treatment of the effluent. A Negotiated Sewer Service Contract between the City and the Navy reserves up to 750 AFY of treated wastewater from the City WWTF for irrigation of the golf course located at the NAWS China Lake. However, it has been noted that the golf course only uses approximately 500 AFY of water (Provost & Pritchard 2015).

2.7.5.3 *Evaporation/Percolation Ponds*

The City WWTF site contains four (4) evaporation/percolation ponds which may receive secondary-treated effluent that is not supplied for alfalfa irrigation or golf course irrigation. Wastewater stored in these ponds evaporates or percolates into either the underlying shallow groundwater aquifer or the Mohave Tui Chub habitat located north of the City WWTF.

The Mohave Tui Chub are an endangered species of fish native to the Mohave River. Due to numerous alterations to its native habitat in the Mojave River, a small population of the Tui Chub were relocated to the NAWS China Lake during the 1970s. The current Tui Chub habitat at China Lake consists of two seeps, referred to as Lark Seep and G-1 Seep. The two seeps are connected through a series of man-made channels, which were originally constructed during the 1950s and 1960s to divert seeping groundwater away from nearby roads and facilities. The habitat inflows include seepage from the City WWTF ponds, irrigation percolation from the China Lake golf course, and various contributions from the City of Ridgecrest area (e.g. irrigation percolation, wash-down, commercial water discharge, and transmission line leaks) (ERS 1991).

The Navy prepared a preliminary habitat management plan (HMP) for the Mohave Tui Chub (ERS, 1991) in response to a Biological Opinion issued by the U.S. Fish and Wildlife Service. The HMP proposed actions to protect and maintain the Mohave Tui Chub habitat, including construction of a water delivery system to discharge water to the existing seeps and channels in the habitat. No additional steps have been taken to implement any potential protection or maintenance plans for the Tui Chub habitat, although it has been proposed that an evaluation be conducted on potentially relocating the Tui Chub in the near future to potentially increase the amount of recycled water available in the IWVGB. The United States Fish and Wildlife Service (U.S. Fish and Wildlife) and the U.S. Navy have taken initial steps to further evaluate the Tui Chub habitat, including an updated quantification of the habitat's water demands and an effort to improve the habitat's water supply conditions. Per discussions with U.S. Fish and Wildlife staff, a potential long-term goal for the Tui Chub includes relocation to a more stable location/environment, which may occur within 5-10 years after IWVGA adoption of this GSP. Recycled water that would become available as a result of Tui Chub relocation may be used to either meet existing water demands to reduce groundwater extractions or serve as a new source of groundwater recharge for the IWVGB.

SGMA requires that all beneficial uses and users, including Groundwater Dependent Ecosystems (GDEs), be considered in the development and implementation of GSPs. GDE identification must be included in the GSP to determine whether groundwater conditions are having potential effects on any and all beneficial uses and users within the Basin. Additionally, GDE management must be incorporated into the sustainable management criteria established as part of the GSP. Although the Tui Chub are not native to their current habitat at the NAWS China Lake, the location of the Tui Chub habitat coincides with GDEs identified in DWR's Natural Communities Commonly Associated with Groundwater (NCCAG) dataset. Further definition of and discussion on GDEs in the IWVGB is provided in Section 3.4.7 and in Section 4.

2.7.6 Groundwater Contamination Cleanup

The United States Department of Defense initiated the Installation Restoration Program (IRP) in 1980 to identify, investigate, and remediate or control the release of hazardous substances that resulted from past waste disposal operations and hazardous material spills at military facilities. Per the Navy's 2014 INRMP, NAWS China Lake is assessing and remediating areas of past contamination on its ranges through the IRP, including sites of possible and confirmed groundwater contamination. A list of these sites along with their cause of contamination and remediation status is provided in Appendix 2-A.

Sites of possible and confirmed groundwater contamination are also made publicly available on GeoTracker, the State Water Resources Control Board's (SWRCB's) data management system for sites that impact, or have the potential to impact, water quality in California. The data available on GeoTracker includes site characteristics (e.g. case number, site location, cleanup status, responsible parties, affected water resources) as well as site actions (e.g. project activities, compliance responses, milestone tracking, land use controls, risk to water quality assessments). GeoTracker also provides public records such as regulatory communication and decision documents for each site. GeoTracker may be accessed at the following link: https://geotracker.waterboards.ca.gov/

Figure 2-14 shows the sites of possible and confirmed groundwater contamination located in the IWVGB as published on GeoTracker, including:

- Sites that require cleanup
  - Leaking Underground Storage Tank (LUST) sites
  - Military Cleanup Sites
  - Cleanup Program Sites
- Permitted facilities
  - Operating Permitted Underground Storage Tanks (USTs)
  - Military UST Sites
  - Land Disposal Sites

2.7.7 Well Permitting Policies and Procedures

2.7.7.1 *Kern County*

Nearly all water supply wells in the IWVGB are located within the jurisdiction of Kern County. Well standards for both water supply and monitoring wells within Kern County are provided in Title 14, Chapter 14.08, Article III of the Kern County Municipal Code. Per Kern County Municipal Code Section 14.08.210, the standards for the construction, repair, reconstruction, or destruction of wells within Kern County are set forth in DWR Bulletin 74-81 "Water Well Standards, State of California" and all subsequent supplements and revisions. The construction, reconstruction, deepening, or destruction of any well requires filing a valid application for a permit with the Kern County Public Health Services Department (Kern County PHSD), and subsequent approval of the application. All abandoned wells within Kern County are to be destroyed within ninety (90) days of abandonment.

In July 2017, the Kern County Board of Supervisors approved an ordinance adding Sections 14.08.113 and 14.08.285 and amending Section 14.08.290 of Title 14, Chapter 14.08 of the Kern County Municipal Code. The ordinance requires that all new private domestic, public domestic, industrial, agricultural, and any reconstructed or upgraded wells be installed with water flow meters or equivalent devices/methods for water measurement.

The Kern County PHSD administers a "Water Wells Program" to manage the permitting and compliance requirements for groundwater wells (both monitoring wells and drinking water wells) in the Kern County portion of the IWVGB. The Water Wells Program ensures that the public receives water that is safe to drink and that the quantity of water supplied is adequate to meet the community's needs. The Water Wells Program is responsible for processing applications and issuing permits for the following:

- Monitoring Wells
- Drinking Water Wells
- Well Destruction
- Well Driller Registration
- Water Supply Certification

Guidance and information are provided on the Water Wells Program website (https://kernpublichealth.com/water-wells/) including information on the following:

- Agriculture Well Permit Guidelines
- Domestic Well Permit Guidelines
- Well Destruction Procedures
- Disinfection Procedures, Laboratories, and Sampling
- List of Approved Drillers and Sealing Material
- Water Well Site Location Requirements

The Kern County PHSD maintains a listing of well information collected through administration of the Water Wells Program.

The Kern County PHSD also administers a Small Water Systems Program aimed at ensuring the quality and quantity of water supplied to meet user demands in State Small Water Systems (between 5 and 14 service connections) and Non-Public Water Systems (between 2-4 service connections). The Small Water Systems Program assists small water systems by monitoring water quality, processing permits and inspections, and managing system maintenance.

Guidance and information are provided on the Small Water Systems Program website (https://kernpublichealth.com/water-wells-small-water-systems/) including information on the following:

- Water Supply Certification Application
- Permitting Process for State Small Water Systems and Non-Public Water Systems
- Intended Use Statements
- Laboratories and Sampling Services

2.7.7.2 *Inyo County*

The Inyo County Environmental Health Department (EHD) oversees well permitting policies in Inyo County. Section 7.52.020 of the Inyo County Code states that it is unlawful for any person or entity to operate a small water system or to construct or abandon a well unless that person or entity has applied for and obtained a permit from the Inyo County EHD. The appropriate permit fees specified in Sections 7.52.070 ("Fees Related to Water Wells") and 7.52.090 ("Fees Related to Small Water Systems") must also be paid to the Inyo County EHD. Each groundwater extractor in Inyo County shall allow the Inyo County Water Department to collect and analyze water quality samples taken from the extractor's wells. Each groundwater extractor must submit monthly reports to the Inyo County Water Department providing actual extraction quantities, projected extraction quantities, and the use and location of use of extracted groundwater. Owners of monitoring wells in Inyo County must also submit monthly reports to the Inyo County Water Department providing water level measurements taken in the preceding month for all monitoring wells owned.

The Inyo County EHD administers a Small Water System Program to manage the permitting and compliance requirements of 105 active public and state small water systems throughout Inyo County, including:

- 30 Community systems with between 25 and 199 residential service connections or 25 or more yearlong residents;
- 11 Non-transient Non-community systems such as schools, institutions, and places of employment;
- 47 Transient Non-community systems such as restaurants and campgrounds, and resorts; and
- 16 State Small systems that serve between 5 and 14 residential service connections but less than 25 yearlong residents.

Guidance and information on permit applications for new systems are provided on the Small Water Systems Program website (https://www.inyocounty.us/EnvironmentalHealth/drinking_water.html). The Inyo County EHD maintains a database of well information collected through administration of the Small Water System Program.

2.7.7.3 *San Bernardino County*

The San Bernardino County Division of Environmental Health Services (DEHS) oversees well permitting policies in San Bernardino County. Section 33.0613 of the San Bernardino County Code of Ordinances states that no person or entity shall furnish or supply water to a user for domestic purposes from any source of water supply without first applying for, receiving, and retaining a permit to do so from the San Bernardino County DEHS. Well construction or destruction activities on all wells in San Bernardino County require the filing of a written application to the San Bernardino County DEHS, followed by approval and permit issuance. Groundwater extractors (either individuals or entities) in San Bernardino County are responsible for providing and paying for approved analyses of groundwater supplies to the San Bernardino County DEHS.

The San Bernardino County DEHS administers a “Safe Drinking Water Program” and “Small Drinking Water Systems Program” which, in part, manages the permitting and compliance requirements for groundwater wells and 272 existing small drinking water systems. The Safe Drinking Water Program is responsible for processing applications and issuing permits for the following:

- Well Permits
- Well Drillers Registration

Guidance and information are provided on the Safe Drinking Water Program website (http://wp.sbcounty.gov/dph/programs/ehs/safe-drinking-water/) including information on the following:

- Well Abandonment
- Private Domestic Well Owners
- Typical Well Requirements
- Well Sharing

The San Bernardino County DEHS maintains a database of well information collected through administration of the Safe Drinking Water Program and Small Drinking Water Systems Program.

2.7.7.4 *IWVGA Policies*

The IWVGA adopted a groundwater extraction fee on July 19, 2018 (Ordinance No. 02-18) under the authority granted by CWC Section 10730. In addition to authorizing the collection of fees, CWC Section 10725(a) authorizes the IWVGA to “perform any act necessary or proper to carry out the purposes of this part [SGMA]”. In order to implement the groundwater extraction fee, the IWVGA required that all wells subject to the fee register their wells with the IWVGA. All groundwater pumpers in the IWVGB are subject to the current groundwater extraction fee except for the following:

- Federal entities (U.S. Navy and United States Department of Interior, Bureau of Land Management); and
- Small pumpers defined as "de minimis extractors" or those who extract, for domestic purposes, two acre-feet or less per year (CWC Section 10721(e)).

As part of the preparation of this GSP, the IWVGA oversaw a basin-wide well registration process to formally document the existence and operation of wells subject to the groundwater extraction fee (i.e. all wells in the IWVGB except those owned by Federal entities or by de minimis extractors). During the well registration process, well owners were required to provide the IWVGA's Water Resources Manager (WRM) with registration information including the following:

- Name and contact address of the well owner;
- Point of contact of the well operator;
- Well location;
- Name and address of the owner of land upon which the well is located;
- Description of the method used by the well owner and operator to measure groundwater extractions from the well;
- A statement describing whether the extracted groundwater is used for residential, commercial, industrial, or agricultural purposes, or a combination thereof; and
- Any other information that the IWVGA's General Manager deems necessary to achieve the legal purposes of the IWVGA.

The fee is determined and paid on a monthly basis by all producers with registered groundwater extraction facilities in the IWVGB. Unregistered groundwater extraction facilities that are subject to the groundwater extraction fee are prohibited from extracting groundwater from the Basin until the facility is registered to the satisfaction of the WRM, which oversees the registration of groundwater extraction facilities and reviews producers' self-reported measurements of groundwater extractions.

The IWVGA adopted Ordinance 01-19 in August 2019 in an effort to identify and register all non-federal groundwater extraction facilities in the IWVGB (including de minimis extractors). Well registration pursuant to Ordinance 01-19 is ongoing and will continue following adoption of this GSP.

2.8 DATA MANAGEMENT SYSTEM (DMS)

This chapter presents an overview of the Indian Wells Valley Data Management System (DMS). It describes how the DMS works and summarizes the data used in the DMS. The Indian Wells Valley DMS has public access available through the web application at https://iwvgsp.com.

2.8.1 Purpose and Development

As part of on-going groundwater management activities, the DMS has been used to develop and organize data collected for the development of this GSP and results from analysis conducted in support of the GSP. The specific data sets to be developed as part of SGMA are provided for in CWC Sections 10727-10728. These data sets include monitoring, reporting, and management criteria. Other elements supporting the GSP are also stored in the DMS, including a water budget, hydrogeologic conceptual model, and supporting documentation.

Data obtained through the current water resource monitoring and management programs helped populate the DMS, and that data was used to develop alternative groundwater Basin management strategies (see Section 5).

The DMS provides the public with access to data that would be infeasible to deliver through more traditional printed report format. These types of data sets and information include the following:

- Searchable electronic library of reports regarding Indian Wells Valley water resources;
- Access to a copy of the full database of well information (including well logs if available) covering the Basin, including information on all known well sites; and
- Data for the Groundwater Monitoring Plan.

2.8.2 DMS Contents Overview

The DMS is built with several components for various types of data: a database, map server to provide access to complex geospatial data, and various other indexed files. The web application itself is a set of scripts that ensures access controls, facilitate queries to the database and files, and organizes and presents the results.

Particular software components use open source software which allows for flexibility, and all components with the exceptions of a few reference map layers, are contained on the same server to ensure long term reliability.

2.8.2.1 *Database Data*

The primary use of the database is to host primarily indexed data which can contain the following types of data:

- Time-invariant location data for indexing and describing locations such as wells and surface sites such as stream gages.
- Time-variant data such as groundwater levels, pumping data, or streamflow. Generally, this data consists of a location index, a measurement time, a measurement type identifier, a value, and a value qualifier.
- General information used in the interpretation of the above data types. This includes tables such as the USGS parameter code list, various set regulatory tables, etc. Each well has corresponding database fields containing the well ID data, site information, construction details, and well screen information.
- Metadata about key documents regarding conditions within the Basin. Metadata fields include publication data, author, alternative DOI or URL location, and geographic extents; not all documents will have all metadata fields.
- Data related to the access of the web application including web users and web user roles. This would include items such as the web user contact information, specific access-granted roles, and

encrypted copies of web user passwords. Other data included here would be access logs which track usage of the web application, including information such as web user, IP addresses, login times, and browser details.

2.8.2.2 *Geospatial Data Types*

In addition to the geospatial data that is being included in the database, there are other geospatial data sets that are included as part of the DMS. These include both vector and raster datasets. A summary of these geospatial data types are as follows:

- Geographic vector data sets that are relatively simple in terms of styling and small in terms of file size are generally saved in as GeoJSON format. This format is a structured version of the JSON (JavaScript Object Notation), a JavaScript data-interchange format, specifically for geospatial data. Additionally, the DMS may have programming (JavaScript) that adds interactivity based on the fields contained in the file.
- For large or complex vector data sets or raster data, the data are stored in the original format such as "ESRI" shapefile and made accessible through the mapserver following the Web Map Service (WMS) protocol. When data are requested by the user the mapserver renders the GIS format data into image tiles which are then sent to the user.
- For some large or complex data sets, data may be pre-rendered and stored as a series of image tiles.

The selection of the method of storing and transmitting a geospatial data set depends on the details of the data set and needed output, as well as on constraints, such as available computing resources.

In addition to the key geospatial data which are hosted on the DMS server, the DMS may link to external geospatial data hosted by third parties. Currently these linked external third-party geospatial data are primarily from Federal and State of California servers, and include various aerial imagery, supplemental topographic data, and geological maps with copyright restrictions. Third party data by nature is not controlled or managed by the DMS, so availability may be subject to change. To increase response time and security of the users, some of this data are cached on the DMS server.

2.8.2.3 *Organized Files (Other Data)*

There are several sets of data which are indexed by the database but not contained within. Generally, these include particular data structures which are not suitable for inclusion in a data table. Examples of these are as follows:

- Digital copies of published and unpublished documents regarding conditions within the Basin. These are saved in the standard portable document format (PDF). These are provided and saved using unique identifiers, and the metadata is stored in the database.
- Photographs of the wells and surface sites are expected to be stored outside of the database in a JPEG format.

2.8.3 User Access and Privileges

2.8.3.1 *Public Access*

The IWVGA decided to enable public access to the DMS web application. The DMS has a pre-programmed default username and password so that any general user may easily access the DMS. To access the DMS, the general public may visit the URL https://iwvgsp.com and click the "Log In" button and subsequent "log on" button. Doing so will direct the user to the DMS homepage at the public user level using the default username and password. A sample screenshot of the DMS login page is shown on Figure 2-15.

2.8.3.2 *Data Privilege Model*

The Indian Wells Valley DMS web application primarily uses a user group privilege model to control access to particular data sets and options. Access to most resources requires a login in order to determine the appropriate level of access to provide.

For example, the general public has a public user level, meaning that the general public is limited to either viewing GSP data or viewing/downloading GSP reports. The general public cannot manage, edit, or upload any data on the DMS. Furthermore, the general public does not have access to confidential documents.

Other web users are allowed various other privileges based upon their group membership, including access to administrative tools which allows for managing, editing, or uploading specific data sets.

2.8.4 Data Visualizations and Analysis

The DMS web application provides a set of tools for the users to browse the data that has been collected and prepared as part of the groundwater sustainability plan. All the graphing functions described include a data export function to allow for use in other programs. The DMS visualization tools currently consist of several primary parts.

2.8.4.1 *Map Interface*

This is an interactive map that displays key site information, relevant geospatial data sets, and other geospatial reference information. Particular features on the map can be interacted with to provide additional information and links to other pages. A sample screenshot of the DMS map page with most of the layers hidden is shown on Figure 2-16.

Examples of the various types of features provided are as follows:

- Site geospatial information
    - Wells
    - Surface sites, such as stream flow gages and weather stations
- Relevant Geospatial Data
    - Extents of the Groundwater Basin
    - Extents of the Watershed
    - Historical Groundwater Surface Contours

- Surface Elevation Contours
- Hydrography such as streams and lakes
- Elevation data, such as the Digital Elevation Model (DEM) and Elevation Contours

- Reference geospatial information
  - Roads, Railroads
  - Jurisdictional Boundaries: Military, County, and Municipal
  - Public Land Survey grids

2.8.4.2 *Site Information*

This provides a summary of the information about a particular site of interest. Depending on availability, this includes a photo of the site, a graph of the key data collected, and for wells a copy of the well log.

Because this is for a known site, graphs for water level wells include some specific information:

- Elevation of water Level and depth to water (from measuring point) for that well
- Location of perforations
- Land surface elevation
- Option to add in water levels from nested wells

2.8.4.3 *Multi-Data Graph*

This is an interface that allows for selecting and graphing of the time series data, not based around a specific site. This allows the user to compare multiple site and data types.

2.8.5 Data Import and Entry

Data are submitted to the IWVGA. The IWVGA reviews and validates it before putting it into the DMS at the database level. Currently the IWVGA has not moved forward with including telemetry directly into the DMS.

2.9 REFERENCES

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SECTION 3: BASIN SETTING

3.1 INTRODUCTION

GSP Emergency Regulations §351 (g) define the Basin Setting as the "physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget…". Furthermore, the GSP Emergency Regulations Guide "GSP Guide" (DWR 2016a) calls for development of a Basin Setting that includes a description of the physical characteristics of the IWVGB, the occurrence and movement of groundwater, and the overall water budget for the basin. The descriptive hydrogeologic conceptual model (HCM) of the IWV presented herein will be used to describe Basin setting and elements of the water budget. The HCM will provide stakeholders with an "understanding of the basin's physical characteristics related to hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards…" (DWR 2016b). The HCM will also provide an understanding of how "aquifers react to hydrologic stresses over time, and the interaction of surface water and groundwater systems within the basin" (DWR 2016a). The intent is for the HCM to be used as an informational tool to facilitate a shared understanding among all parties regarding groundwater behavior and cause and effect relationships of actions affecting the IWV, such as the implementation of projects and management actions.

The GSP Guide (DWR 2016a) also states that dynamic groundwater conditions should be described by historical and present-day groundwater conditions *related to undesirable results*, and that the GSP should include a description for conditions as of January 1, 2015. Data gaps and data uncertainty that limit Basin understanding or evaluation of GSP performance must be noted (DWR, 2016a).

In addition to the HCM, the Basin Setting should also include a quantitative water budget that accounts for inflows and outflows. Groundwater basins subject to critical overdraft, such as the IWVGB, must quantify the amount of overdraft. Baseline conditions related to supply, demand, hydrology, and surface water supply reliability are established for the purpose of understanding future projected conditions and for development of management actions and projects.

Consistent with requirements in the GSP Guide, this section provides background and discussion of: 1) the HCM; 2) the historical water budget and sustainable yield; 3) the current and historical groundwater conditions and hydrology; 4) the numerical groundwater model of the IWVGB; and 5) the existing monitoring network and data gap evaluation.

3.2 HISTORY OF WATER USE IN THE INDIAN WELLS VALLEY

The first water use in the IWV corresponds with the first habitation of the valley by Native Americans more than 10,000 years ago (Giambastiani, 2017). Evidence of prehistoric village sites in the IWV suggest a stable, long term resident population. The region during that time was different than it is today, characterized by a cooler and wetter climate with numerous springs, lakes, and streams. The valley was surrounded by conifer forests similar to the forests seen today along the Sierra Crest, in areas above the elevation at Walker Pass (Harris, 2013).

Approximately 7,000 years ago, the region's climate started to warm and dry, causing the gradual appearance of the present-day Mojave Desert landscape (Bacon, 2006 and Bacon, 2014). Research indicates the creosote bush, which is prevalent in the IWV today, had arrived around that time.

The first Europeans arrived in the valley in the first half of the 1800s, consisting of trappers, adventurers and explorers. Joseph Walker passed through in the early 1830s, and then returned with the Fremont party in 1845, which included famous explorers Kit Carson, Richard Owens, and Ed Kern. These early European arrivals in the IWV were transient, with many of these parties making use of the perennial Indian Wells Spring, where the restaurant and brewery along Highway 14 are today, as they passed through the IWV. (See Figure 2-2 for the location of IWV landmarks.) Travelers during the California Gold Rush, the infamous Death Valley 49'ers Parties, and the Whitney Geological Party are all thought to have utilized perennial springs during their travels (Farquhar, 1946).

The second half of the 19th century brought more permanent settlements along the Eastern Sierra with the development of mining operations. Given the arid climate, fresh water was a valuable commodity and exclusively came from surface flows at springs and streams. Sites such as Coyote Holes near Freeman

Junction, Indian Wells, and Little Lake became noted water stops. Borax and soda deposits were mined along Searles Lake and China Lake, gold and silver in the Panamint and Coso Ranges, creating additional freight and stagecoach routes running between water sources. Basque sheepherders also arrived in the IWV during the late 1800's, and drove their sheep though the valley every year in route to their summer ranges north of Bishop (Harris, 2013).

The composition of the community and water landscape changed toward the end of the 1800s when a large gold discovery in Randsburg attracted thousands of people into regions surrounding the IWV. Additional mines were developed in the Rademacher Hills at the south edge of the IWV, and many operations required ground or spring water to supply the milling needs. The infrastructure became part of the support for the future construction of the Los Angeles Aqueduct that supplies water from the Owens Valley to the City of Los Angeles. The "Jawbone" branch of the Southern Pacific Railway was constructed in 1910 partly to aid in the construction of the LA Aqueduct (Complete Report on the Construction of the Los Angeles Aqueduct, 1916). These projects and operations encouraged an influx of miners, farmers and teamsters into the valley for work, which led to land and farming promotions that fostered the establishment of the communities of Inyokern and Brown.

The beginning of the 20th century saw an even greater migration of people into the IWV to homestead and farm. As a significant number of government land titles were issued, agriculture land use increased, which resulted in an estimated 1,000 acre-feet (AF) of groundwater use to support local farms by 1912 (Lee, 1912). Typically, alfalfa and oats were grown in the IWV for dairy cattle and for horses and mules for the extensive freighting operations.

Industrial groundwater use also increased during the first decades of the 20th century. Westend Chemical Company (previously Pacific Coast Borax Company) began transporting water from the IWV in the 1920's. A pipeline was built in 1930 to transport water from a well at the Windy Acres Ranch location to Searles Valley. In 1942, an additional pipeline was constructed by American Potash and Chemical Company (previously known as American Trona Corporation) to transport water from its wells in the IWV to Searles Valley. After multiple acquisitions, the mining company in Trona became Searles Valley Minerals

Incorporated in 2004, as it is known today. Searles Valley Minerals Inc continues to be the largest industrial user and only exporter of water from the IWVGB.

World War II brought permanent changes to the IWV by introducing the U.S. Navy into the region. In 1943, the U.S. Navy began development of the Naval Ordnance Test Station, which included construction of hundreds of industrial and residential buildings, roads, runways, and other necessary infrastructure. As development by the U.S. Navy continued, more groundwater wells were drilled to supply the increased water demands. Most of the IWV's new permanent residents were associated with the naval operations and lived on Navy property during the 1940s and into the 1970s. The growth of the naval operations led to the incorporation of the City of Ridgecrest in 1963. In the 1970s and 1980s, Navy personnel began shifting to off-Base housing in the City of Ridgecrest, which transferred water demands from the U.S. Navy service area to the Indian Wells Valley Water District.

Water use in the IWV over the past 70 years has been documented, first by the U.S. Geological Survey (USGS) with U.S. Navy participation and then by the U.S. Bureau of Reclamation (USBR). For a period of about 20 years starting in the mid 1990's the annual production tally was maintained by the IWV Cooperative Group. Water use data from 1975 records show total groundwater production of 15,980 AF, with the U.S. Navy accounting for 31% of pumping (Table 3-1). Data from the Cooperative Group (see Appendix 3-A) estimated that historical groundwater pumping exceeded 29,000 AF during four years: 1984 (29,521 AF), 1985 (29,730 AF), 2006 (29,316 AF), and 2007 (29,433 AF). Between 2007 and 2015 (9 years), conservation efforts, primarily by the Navy (43%), the IWVWD (23%) , and Meadowbrook Dairy (30%) have reduced groundwater production in the IWV. Some of this water savings has been diminished by an increase in irrigation of orchards during this same time period. Since 2007, net groundwater production in the IWV has been reduced to approximately 25,300 AF in 2015. The water use category distribution in 2015 had changed significantly from 1975 as shown by the following tabulated distribution.

Table 3-1 Historical Pumping Distribution by Water Use (Calendar Year)

Water Use	1975 15,980 AF	1985 29,730	2007 29,433 AF	2015 25,285 AF
Agriculture, Irrigation	22%	48%	42%	52%
Industrial	17%	8%	9%	10%
Municipal/Domestic 2	29%	31%	41%	33%
U.S. Navy	31%	9%	9%	6%

Note: individual percentages have been rounded to the nearest 1%, and the sum of the numbers may not equal 100% due to this summation rounding error.
1. Agriculture, Irrigation includes Meadowbrook Farms, Simons Ranch, City of Ridgecrest, Neal Ranch, Quist Farms, S. Leroy, and other Orchards estimated on the Cooperative Group's Pumping Table included in Appendix 3-A.
2. City/Municipal/Domestic includes China Lake Acres, IWVWD, Inyokern CSD, Private Wells and R/C Heights estimated on the Cooperative Group's Pumping Table included in Appendix 3-A

3.3 HYDROGEOLOGIC CONCEPTUAL MODEL[14]

In accordance with GSP Emergency Regulations §354.14, the HCM "characterizes the physical components and interaction of the surface water and groundwater systems in the basin". The geology and hydrogeology of the IWVGB have been studied since the early 1900's. The California Conservation Commission (Lee, 1912) wrote one of the first reports to estimate available groundwater resources within the IWVGB. The USGS and DWR completed multiple studies of the IWVGB to delineate the geologic and hydraulic features (Moyle, 1963; Kunkel and Chase, 1969; Dutcher and Moyle, 1973; Berenbrock, 1987). Further geologic work was completed by the USBR in 1993 including the first deep fully characterized Basin borings and installation of multi-level wells. Important recharge investigations[15] were undertaken by the EKCRCD[16] (Tetra Tech EM, 2003b) and Cooperative Group[17] (2008) with AB303 grant funding. In 2014, a comprehensive survey of existing IWV Basin groundwater research and yearly documented water

[14] CCR §354.14 Hydrogeologic Conceptual Model that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.

[15] USBR (1993) recommended the recharge study completed by EKCRCD, 2013 study was

[16] EKCRCD, Eastern Kern County Resources Conservation District managed the AB303 grant in 2003 from State of California Water Resources Department.

[17] IWVCWMG, IWV Cooperative Water Management Group managed the second phase of an AB303 grant in 2008.

production was undertaken with Kern County funding (Todd, 2014). In 2016 and 2017, the Navy funded a groundwater flow model update[18], performed by the Desert Research Institute (DRI), that is providing key technical support including groundwater level predictions for pumping scenarios identified in this GSP (DRI: McGraw et al., 2016; Garner et al, 2017). More recently a SkyTEM (Transient Electro-Magnetic,) geophysical survey was completed and analyzed (Thorn, et al., 2019) to develop a detailed hydrogeologic conceptual model for the Basin[19]. In May 2019, detailed geomorphic landforms were mapped for the Navy[20]. Following is a general description of the HCM that has been a foundation for the numerical groundwater model and development of the GSP water budget analysis.

IWV is located in the western edge of the Basin and Range Physiographic Province, characterized by a topography of isolated mountain ranges separated by desert basins (TtEMI, 2003b). IWVGB is bounded by the Sierra Nevada Mountains to the west, the Coso Range to the north, the Argus Range to the east, and the El Paso Mountains and Spangler Hills to the south. The highest elevation in the IWV watershed occurs in the Sierra Nevada reaching 8,452 feet mean sea level (msl) at Owens Peak. Mountain slopes dip steeply to the valley floor that in turn slopes gently to China Lake, which is usually a dry playa, except following significant rainfall. The location map (Figure 3-1) shows the watershed extents, the Basin boundary (also known as the GSA boundary), land ownership, and existing monitoring wells for reference in this discussion. The elevation of the Valley floor ranges from about 2,790 feet msl at the far southwest El Paso area to approximately 2,150 feet msl at China Lake playa (TtEMI, 2003b). The USGS topographic map shown on Figure 3-2 displays how the GSA boundary encompasses the Valley floor and alluvial stream channels of the surrounding mountains.

The HCM shown in Figure 3-3 provides an illustration of the general structure of the Basin with the primary recharge in and discharge out of the groundwater aquifer. Natural recharge occurs along the mountain-

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[18] DRI updated model structure and input data and re-calibrated the numerical MODFLOW model developed by Brown and Caldwell (2009) for IWVWD.

[19] Thorn et. al., March 2019. This document was draft at the time of initially writing the GSP, and was finalized in the same timeframe this document was being written. SkyTEM data was calibrated to existing lithologic logs to develop subsurface cross sections and a three-dimensional HCM of the IWVGB. Some of the initial findings have been incorporated into this GSP. Data and analysis from the SkyTEM study will be evaluated and incorporated into the 5-year plan review and model update for this GSP, as appropriate.

[20] Bullard et. al, May 2019.

front areas and as subflow from Rose Valley. The main discharge of groundwater occurs from pumping wells, evapotranspiration (ET) at the playa, and estimated (small) subflow to Salt Wells Valley. The general flow direction of the groundwater system is from the mountains (recharge area) towards the playa (discharge area). This section describes the soils, geology, hydrogeology, and hydrology of the Basin, followed by a description of the historical water budget and current understanding of the sustainable yield for the IWVGB.

3.3.1 Geology and Hydrogeology

Indian Wells Valley lies within the northern portion of the Eastern California Shear Zone (ECSZ) or the southern Walker Lane Belt, in a transitional zone of east-west extensional faulting of the Great Basin Province and dominant right-lateral strike-slip faulting common to the Sierra Nevada Mountains (TriEcoTt, 2013). From the Late Miocene (11.6 to 5.3 million years ago) through the Pliocene (5.3 to 2.6 million years ago), IWV was down-faulted along the Sierra Nevada frontal fault resulting in the structural half-graben of present-day (Monastero et. al., 2002; Kunkel & Chase, 1969). Based on historical groundwater levels, the Little Lake fault zone (LLFZ) and El Paso fault (EPF) (mapped by Kunkel and Chase, 1969 and Garner et al., 2017) have been shown to impede movement of groundwater within the Basin. Figures 3-4a and 3-4b show the surficial geology in the IWVGB and Figures 3-5a and 3-5b show two cross-sections through the valley. More recent geophysical studies, including SkyTEM data, will be evaluated for inclusion in the GSP at the time of the next update, including additional cross-sections of the IWVGB.

During the Pleistocene epoch (2.6 million to 12,000 years ago), the region was much wetter and surrounding basins were all connected via the ancestral Owens River (Bacon, 2006; Bullard et.al., 2019). Active alluvial fan movement from the Sierra Nevada Mountains, deposition of finer material from Owens Valley and subsequent reworking of Basin sediments by the Owens River and mountain streams resulted in a complex distribution of well sorted to poorly sorted deposits within the IWV Basin (Dutcher and Moyle, 1973). Deposition of lacustrine sediments developed in lakes connected by the ancestral Owens River. Dryer conditions developed following the Pleistocene and into recent time. Previously connected basins evolved into isolated basins through decreased precipitation and streamflow, subsequent faulting, and volcanic activity.

Because of the low permeability bedrock of surrounding mountain ranges, IWVGB receives no significant recharge from beyond the topographic divides of the watershed boundary, except for subflow from Rose Valley. Large alluvial fan complexes stemming primarily from the Sierra Nevada, and to a lesser degree from other mountain ranges, allow groundwater flow into the Basin as mountain block recharge (Dutcher and Moyle, 1973). Dutcher and Moyle (1973) estimated the depth of water-bearing alluvial deposits could locally reach to 2,000-feet. These sediments consist mainly of gravel and sand in alluvial fans near the mountains and grade to silt and clay beneath the playa. There is significant irregular cemented and relatively impervious shallow zones at different locations within the IWVGB.

Lithologic units were taken from Berenbrock and Martin (1991) who based their work on units mapped by Von Huene (1960), Zbur (1963), and Kunkel and Chase (1969). The geologic units include consolidated bedrock and unconsolidated sediments (Figures 3-5a and 3-5b). Bedrock is typically low in permeability and porosity, and may yield some water to wells completed in fractures. These rocks include Mesozoic igneous and metamorphic rocks in the surrounding mountains, as well as Miocene basalts near the El Paso Mountains.

For the GSP, the groundwater depletion that is of concern in the IWVGB is from the water in unconsolidated alluvial deposits. These water-bearing sediments store and transmit water, and are divided into the following hydrostratigraphic features that are important for analyzing sustainability criteria and groundwater budgets. Unconsolidated units are mapped across the project site as alluvium, lacustrine, and playa. Berenbrock and Martin (1991) describe these units as follows:

- Alluvium consists of moderately to well-sorted gravel, sand, silt, and clay of Pleistocene and Holocene age (12,000 years to present) and is considered to have a high permeability. The percentage of silt and clay tends to increase toward the central portion of the IWVGB, which reduces permeability in most areas. These deposits include both older and younger alluvial deposits, alluvial fans, and elevated pediment veneers and stream terrace deposits. Alluvium extends across the entire IWV and is thickest along the western and southern edges of the Basin (Figures 3-5a and 3-5b).

- Lacustrine deposits were described by Kunkel and Chase (1969) as containing silt and silty clay of Pleistocene age and exhibiting low permeability. This unit is interbedded with the alluvial deposits in the southeast, western and central portion of the Basin.
- Playa deposits of low permeability are of Holocene and Pleistocene age and contain silt and clay with an occasional sand lens. In the northwest area, an unusually thick and extensive deposit of organic clay and silt of Pleistocene age occurs as a continuous unit.

There are two principal aquifer units defined by Kunkel and Chase (1969). The shallow aquifer contains coarse sediments near the Sierra Nevada with increased interbedded silts and clays towards the center of the Basin associated with the lacustrine and includes China Lake's playa deposits. The best quality of water is at shallow to medium depths in the southwestern part of the valley, closer to the Sierra Nevada (Dutcher and Moyle, 1973). The deeper aquifer is also composed of gravel, sand, silt and clay. It is strongly connected to the shallow aquifer in the west and southwest of the Basin; and is confined in other parts of the Basin. Existing multi-level monitoring wells (USBR, 1993)[21] show semi-confined artesian conditions within the deeper aquifer where it occurs beneath the lacustrine and other fine-grained sediments.

Historical well drilling and aquifer testing results were reviewed and compiled for background hydraulic conductivity data throughout the IWVGB. Hydraulic conductivity has been determined to range from < 5 feet per day (ft/day) to > 50 ft/day based on slug and aquifer testing. The distribution of measured hydraulic conductivity values throughout the IWVGB is shown in Figure 3-6 and testing results are shown in Appendix 3-B. In general, the shallow and deep aquifer zones are associated with higher hydraulic conductivity. USBR (1993) slug test data[22] show lower hydraulic conductivity that impedes flow within the lacustrine/playa deposits.

[21] Most of the multi-level monitoring wells are being used to support CASGEM reporting. See Figure 3-12 which displays hydrographs that demonstrate the semi-confined artesian conditions.
[22] USBR (1993) noted that that poor well development could have affected some of the slug test results (page A25).

3.3.2 Soils

Limited surface soil data were publicly accessible and available for IWV. The Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) mapped arid to semi-arid soil types occurring in the southwest El Paso area (Figure 3-7). Soil data for the main area of IWVGB were not present from NRCS, and are considered a data gap requiring further research of non-public databases. Two additional preliminary soil surveys with limited extents were conducted by NRCS but are not digitally available for mapping: (1) Ridgecrest Part, Northeastern Kern Area (USDA-NRCS, 1995); and (2) Portions of China Lake Weapons Center (USDA-SCS, undated).

Desert soils found in arid[23] regions cover most of the undisturbed land on the valley surface. Arid soils are stabilized by a biological soil crust formed as a veneer on the surface that is important for reducing wind and rain erosion of underlying sediments. This soil crust also increases water retention during sporadic heavy rainfall events. The desert crust can be damaged when disturbed, resulting in clay, silt, and sand being mobilized by wind. One of the minor water uses in IWV is for dust suppression. The IWV natural desert environment also includes active and inactive (vegetated) sand dunes and playa deposits. The Basin's primary discharge area is the China Lake playa, where surface water collects at the lowest elevation in the Basin and evaporates, developing a salt pan. The Navy recently completed a detailed geomorphic survey of surface landforms (Bullard et al, 2019) that provides an indication of soil types that occur on Base. Predominant landforms include alluvial fan, eolian, fluvial, deltaic, lacustrine, and playa features. Other landform features from this study include bedrock and developed land.

Soil data available for the southwest El Paso region of IWV (Figure 3-7, USDA, 2019) include aridisols on the valley floor, entisols on the steeper sloped alluvial fans and canyons west of the valley floor, and mollisols at higher elevations near the watershed divide. Aridisols are the desert soils of 'arid' regions with only enough natural recharge to support adapted desert plants. Entisols occur in environments where erosion or deposition rates are faster than soil development rates and typically occur on dunes,

[23] Arid regions typically average less than 10 inches/year of precipitation.

steep slopes, and flood plains (USDA NRCA, 2019). Mollisols occur in semi-arid[24] mountain valleys where detritus from vegetation and organisms (worms, ants) help to develop a rich soil profile. These three soil types develop under different conditions – (1) the valley floor is relatively flat with very limited rainfall (average 4 inches/year) forming a desert soil crust, (2) the steep canyons are reworked unconsolidated sediments/rock that have a very limited to no soil profile, and (3) higher elevations with more rainfall allow for development of vegetation and a limited soil profile.

3.3.3 Hydrology

3.3.3.1 *Climate and Precipitation*

The IWVGB is part of the Mojave Desert and has an arid, high desert climate characterized by hot summers, cold winters, and irregular and sparse precipitation. The Basin is bounded by mountains to the north, south, and west, which drain internally to the playa. Summer high temperatures on the playa are typically greater than 100 degrees Fahrenheit (°F) and winter lows are typically in the 20s and 30s °F.

Precipitation on the valley floor ranges from 2 to 5 inches per year; snowfall, if any, typically occurs in December and January, with an average of less than 1 inch per year (WRCC, 2018c; PRISM, 2012). Mountain areas receive more precipitation than the playa and are the primary source of recharge for the Basin. The average annual precipitation for the IWVGB and mountain areas ranges from about 4 inches per year up to about 20 inches per year (PRISM, 2012)[25] (Figure 3-8). The annual precipitation by water year[26] and cumulative departure from mean at two stations near the IWV are shown in Figure 3-9.

With high temperatures, high winds, and low humidity the IWVGB has high ET rates. Average annual evaporation from a shallow water body in the playa is about 80 inches per year (Farnsworth et al, 1982). NOAA maps of evaporation (Farnsworth et al 1982) show that, in general, annual evaporation from a free water surface is greater on the valley floor than in mountainous areas of the Basin. For example, in the

[24] Semi-arid regions typically receive between 10 inches/year and 20 inches/year of precipitation.

[25] The spatial data set in Figure 3-8 is from a 30-year climate normal data set prepared by the PRISM Climate Group. These data are based on calendar years and are not available in water year format.

[26] Water years ranges from October 1st through September 30th.

Sierra Nevada mountains on the west side of the IWVGB, annual evaporation from a free water surface ranges from about 45 in/yr to 65 in/yr (Farnsworth et al, 1982).

3.3.3.2 *Streamflow and Mountain-Front Recharge*

Streamflow gaging stations in and near the IWVGB are shown on the map in Figure 3-8. The USGS historically collected data at three Sierra canyon streams. The stations were active starting in the 1960's and 1970's and have more than twenty years of observations. The daily hydrograph at Ninemile Creek (USGS gage 10264878), which drains a 10.4-square mile area of the Sierra Nevada, is shown in Figure 3-10. The discharge record for Ninemile Creek is characterized by sharp peaks with little to zero discharge in between storm events. The largest peaks occurred during winter months, with negligible discharge in the summer. During two calendar years, 1964 and 1968, there was no significant discharge measured at this gage for the entire year.

Streamflow observations at Sand Canyon and Grapevine Canyon have been collected through a monitoring effort by the EKRCD (Ribble and Haslebacher, 2000; Haslebacher, 2016). Sand Canyon has a drainage area of about 18 square miles. Flow is measured with a compound rectangular weir and datalogger, with recent records dating back to 1999. The annual gaged streamflow at Sand Canyon is given in Table 3-2 and ranges from dry during drought conditions to 3,783 AFY. The average annual streamflow is 647 AFY and the median is 209 AFY. Grapevine Canyon, with a drainage area of about 10 square miles, is gaged with a v-notch weir and datalogger, with recent records dating back to 1997. As shown in Table 3-2, annual flows at Grapevine Canyon range from 4 AF to 2,275 AF, with average annual streamflow of 237 AFY and a median of 90 AFY. At both gages, flow during wet years, i.e. 1998 and 2005, skews the average toward high flows.

Table 3-2. Annual Gaged Streamflow at Sand Canyon and Grapevine Canyon.

Calendar Year	Sand Canyon Gaged Streamflow (AF)	Grapevine Canyon Gaged Streamflow (AF)
1997	--[1]	49

Calendar Year	Sand Canyon Gaged Streamflow (AF)	Grapevine Canyon Gaged Streamflow (AF)
1998	--[1]	2,275
1999	200	394
2000	217	95
2001	150	43
2002	69	19
2003	329	16
2004	102	4
2005	3,783	1,160
2006	585	193
2007	171	35
2008	--[2]	--[2]
2009	--[2]	--[2]
2010	--[2]	--[2]
2011	184	--[2]
2012	286	90
2013	--[2]	--[2]
2014	--[2]	--[2]
2015	--[2]	--[2]
2016	--[2]	--[2]
2017	1,683	563
2018*	86	32
Complete Years	12	13
Average	647	237
Median	209	90

Source: Haslebacher, 2018

1. No data available; gage not yet active.

2. No data available; measurements were not reported for these years.

**Total through March 2018; value for 2018 not included in statistics.*

Mountain front recharge is the dominant source of inflow to the Basin. In 2014, Todd Engineers prepared a study that reviewed previous recharge studies and made new estimates (Todd Engineers, 2014). In 2016, DRI conducted a comprehensive review of recharge estimates for the Basin (McGraw et al, 2016). DRI reviewed fourteen previous studies and then updated the recharge estimates using an empirical relationship between precipitation and groundwater recharge. The average annual recharge developed by DRI is 7,650 AF per year (McGraw et al, 2016; Garner et al, 2017). The recharge zones identified by DRI are shown in Figure 3-11. The total area of recharge is about 770 square miles. The area and estimated annual recharge in each zone are shown in Table 3-3.

Table 3-3. Recharge Zones and Estimated Annual Recharge.

Recharge Zone	Area (sq miles)	Annual Recharge[1] (AFY)
Rose Valley	193	2,400
Sierra Nevada N	116	2,100
Sierra Nevada S	101	1,500
El Paso	56	50
Argus and Coso	302	1,600
Total	768	7,650

[1] *Recharge areas and annual volumes as developed by DRI (McGraw et al, 2016; Garner et al, 2017)*

There are no significant interconnected surface water systems which interact with groundwater in IWVGB. Streams in the valley are ephemeral and recharge occurs as mountain block recharge. Surface water in Little Lake, located in the Rose Valley recharge area, is thought to infiltrate into groundwater and then contribute as subflow into the Basin. Estimates of losses from Little Lake are included in the annual recharge amount in Table 3-3 (McGraw et al, 2016). The IWVGB has many natural springs, shown in Figure 3-11, generally located in the mountain areas, that contribute to the ephemeral streams and mountain block recharge. Each point represents a spring or seep as mapped by the USGS in the National Hydrographic Dataset (NHD) (USGS, 2019). Springs in the IWVGB have historically been used for human water supply, cattle, and wildlife. Spring water quality and geochemistry have been studied previously

(Stoner et al, 1995; Houghton HydroGeo-Logic, 1996). The water quality of the spring/surface water samples collected is relatively good. Although TDS concentrations range from 199 mg/L to 1,300 mg/L, the average TDS concentration for these samples is 533 mg/L. The majority of samples collected from springs/surface water sources fall within the recommended TDS Secondary maximum contaminant level (MCL) and the upper TDS Secondary MCL for potable water, 500 mg/l and 1,000 mg/L, respectively. Data are included in Appendix 3-C.

3.3.4 Water Budget and Overdraft Conditions

A water budget is an accounting tool that quantifies inflows (sources) and outflows (sinks) occurring within a groundwater basin (or specified management area) using the following equation:

Inflows – Outflows = Change in Storage

Water budgets are similar to a bank account in that there are inflows, outflows, and a change in the bank account balance (or storage). Inflows and outflows in the hydrologic system are largely driven by processes occurring on the land surface. Within the basin the outflow (pumping) is dominated by land use. The water budget is a key component of overall understanding of the IWVGB and contributes to developing the following GSP elements:

- Identifying data gaps
- Evaluating monitoring requirements
- Evaluating potential projects and management actions
- Estimating the sustainable yield
- Evaluating undesirable impacts
- Informing water management decision-making

3.3.4.1 *Water Budget Elements*

The elements contributing to the IWVGB water budget include recharge, groundwater pumping, ET, and interbasin flow (inflow and outflow).

Recharge

Mountain front recharge, predominantly from the Sierra Nevada Mountains, is the primary inflow into the IWVGB. The Coso Range, Argus Range, and the El Paso Mountains contribute to the natural recharge to a lesser degree. Numerous Basin studies have been prepared to estimate natural recharge to the IWVGB with various methods and with varying results. The methodology used in selected previous studies is described in McGraw et al. (2016). The historical natural recharge estimates from selected previous recharge studies are shown below in Table 3-4. In addition, the USGS is currently revising an existing Basin Characterization Model to refine the recharge estimates in the IWV.

Table 3-4. Natural Recharge Estimates from Selected Recharge Studies (AFY).

Recharge Study	Natural Recharge Estimate (AFY)
Brown and Caldwell (2009)	8,900
Epstein et al. (2010)	5,800 to 12,000
Todd Engineers (2014) [1]	6,100 to 8,900
USGS Basin Characterization Model (Draft, 2018)[27]	8,680 (1981-2010) 5,980 (2000-2013)
Desert Research Institute (McGraw et al. 2016)	7,650

1 Excludes estimates of recharge from excess irrigation and distribution system leakage.

[27] https://www.usgs.gov/centers/ca-water/science/using-basin-characterization-model-bcm-estimate-natural-recharge-indian?qt-science_center_objects=0#qt-science_center_objects

Studies by Austin (1988), Ostdick (1997) and Thyne et al (1999) estimated a total recharge volume from three to four times the quantity estimated by the natural recharge used in this study. These studies suggested that IWVGB was an "open basin" with a large recharge component coming through the Sierra Nevada batholith from a neighboring watershed (to the west of the watershed divide, possibly through fractures). At that time, there were limited data to explain large groundwater gradients from the west and southwest into the IWVGB, and limited laboratory methods to quantify isotope data. With AB303 funding, Cooperative Group[28] (2008) drilled and fully characterized nine borings in T27S/R38E, installed eight monitoring wells, and collected 27 isotope samples[29] throughout the Basin to re-analyze these higher recharge estimates. Further re-analysis was completed by Todd Groundwater[30] (2014). Newer lithologic, water quality, and groundwater level data refuted the "open basin" recharge estimates. More recently, some of the data gaps from these earlier studies have been addressed by the Navy's (Garner et al, 2017) fault zone mapping that explain observed groundwater gradients, and KCWA's measured groundwater level trends since 1995 (Section 3.5).

Groundwater Pumping

DRI developed a groundwater pumping database to represent historical pumping and to assist with making future pumping projections (McGraw et al., 2016). The database contains pumping from 1920 to 2013. The USGS and the USBR provided pumping estimates from 1920 to 1995 and the Cooperative Group provided pumping estimates from 1995 to 2016. Pumping wells were assigned to one of the following water use categories:

- Private domestic
- Municipal
- City of Ridgecrest

[28] See referenced report, Section 5 for a more detailed discussion of intermountain recharge and re-calculation of Ostdick's (1997) and Thyne's (1999) methodologies.

[29] The isotope samples included the same wells that Ostdick and Thyne et al based their analysis on. The repeated sampling did not reproduce the earlier results.

[30] See Todd, 2014, Appendix A.5 Additional Recharge: the Open Basin Hypothesis.

- Industrial (Searles Valley Minerals)
- U.S Navy (NAWS China Lake)
- Agriculture

Well locations and water use were cross-referenced and verified using published existing databases and aerial photographs. In situations where historical data for individual wells were not available, pumping rates were evenly distributed among appropriate wells within each water use category (McGraw et al., 2016).

The Cooperative Group has assembled annual production data dating back to 1975, organized by large users and primary categories. Groundwater production estimates from 1975 through 2016 as compiled by the Cooperative Group are provided in Appendix 3-A. The location of all groundwater production wells in the IWV is shown in Figure 2-5.

Approximately 800 private domestic wells exist in the IWV outside of the City of Ridgecrest and community of Inyokern. These wells serve individual residences and typically pump around 1 AF per year with an approximate water use of 800 AF in 2015. Additionally, many private residences have formed small mutual water companies and co-ops with a single well serving multiple residences. Water use by these mutuals and co-ops was approximately 300 AF in 2015[31].

Since 1975, the IWVWD's service area and population have expanded, resulting in corresponding increases in groundwater extractions; however, the Water District has implemented several demand management programs and conservation measures to bring their water use down to 7,050 AF in 2015, from a peak of approximately 9,200 AF in 2007. (See Section 2.7.3 for discussion of Water District conservation). The Inyokern Community Services District produced approximately 91 AF in 2015. The City

[31] Appendix 3-A lists a category of water users called "Private Wells". "Private Wells" in this context also includes water use from mutual water companies and co-ops; therefore, the combined total of private domestic wells and mutual water companies and co-ops is 1,100 AF in 2015.

of Ridgecrest, which irrigates recreational parks and sports complexes, produced approximately 427 AF in 2015. Total domestic, municipal water and City use was 7,568 AF in 2015.

Since 1975, the reported industrial water use within the IWV by Searles Valley Minerals has remained fairly constant at approximately 2,600 AFY on average. Water uses at Searles Valley Minerals include potable water for office buildings, laboratories and industrial processes, primarily boiler feed water for the power generation. Additionally, Searles Valley Minerals provides potable water to the SDWC which services the communities of Trona, South Trona, Westend, Argus and Pioneer Point, including schools and government buildings.

Water reliability is critical to military sustainability and resiliency. The U.S. Navy operates production wells in the IWVGB that supply water needs on-Station. Production wells operated and maintained by the IWVWD and domestic wells in unincorporated areas of the IWV provide water to Navy affiliated staff (made up of scientists, engineers, technicians, and professionals) and their dependents that reside off-Station. These personnel are critical to supporting the mission at NAWS China Lake. Water uses on NAWS China Lake include potable water for office buildings, laboratories, residences, and schools. In 1970, the U.S. Navy reported their highest groundwater use at 7,988 AF. Over decades, as base personnel increasingly moved to off-base housing in Ridgecrest and after implementation of aggressive water conservation programs beginning in 2007, the U.S. Navy reduced their water use to 1,595 AF in 2015.

Total agricultural water use has increased significantly in recent decades from 8,500 AFY in 2000 to 13,100 AFY in 2015 as new ranches, orchards, and farms have been developed in the IWV. Alfalfa and pistachios are the largest crops by volume grown in the IWV, with the production of olives, tomatoes, and other crops significantly less. Pistachios typically require a water application rate of approximately 5 feet per year (AF/acre/year), while alfalfa requires a higher rate of 7 feet per year or more (Todd, 2014; McGraw et al., 2016). Total agriculture water use, as reported by the Cooperative Group, was approximately 13,100 AF in 2015, comprising approximately 52% of the total reported water use that year. Individual farms have reduced water use and developed water-saving irrigation systems (see Section 3.2; Appendix 3-A), but overall agricultural water use within the basin has increased 53% from 2000 to 2015. Unless restricted, by either mandatory or voluntary means, agricultural use is expected to increase significantly based on future pumping projections provided by Basin agriculture stakeholders.

Evapotranspiration

The ET that occurs at the China Lake Playa and nearby phreatophytic area is the primary natural discharge for the IWVGB. Prior to development of well fields around the 1920s, ET from the China Lake Playa was the predominant outflow from the IWVGB. Todd Engineers (2014) noted that estimates of ET have decreased over time; "[some] of the decrease is attributable to revised estimates of recharge based on model calibration, but most of it reflects the interception of playa outflow by wells." Declines in water levels alter and reduce phreatophyte vegetation, reducing transpiration, and reduce bare surface evaporation rates. Vegetation changes have been assessed by comparing maps of the current vegetation distribution to the pre-development vegetation map of Lee (1912). The major difference is the addition of greasewood in areas north and east of the playa, and also in a small area to the southwest, where pickleweed and saltgrass occurred previously (McGraw et al., 2016). The pickleweed and saltgrass vegetation zone is associated with a shallower water table with a maximum ET rate of 5.7 ft/yr, and ET effectively terminates when the water table is greater than 10 ft bgs. The greasewood unit that develops as water levels decline has a maximum ET rate of 2.4 ft/yr and a maximum rooting depth of 33 ft. Current bare playa evaporation rates have been estimated from data from an eddy covariance station at the south end of China Lake playa and suggest annual ET of 4.5 inches for the adjacent bare playa area (McGraw et al., 2016). This measurement removes rainy days from the calculation, but bare playa groundwater ET could be as low as 2.4 inches per year, if ET is included after significant precipitation events. Current overall ET loss from the IWVGB is estimated at 4,850 AFY.

Interbasin Flow

Previous studies on the IWVGB have primarily considered the IWVGB to be a closed basin with little to no subsurface outflow to Salt Wells Valley. Nonetheless, DRI concluded "the absence of a large accumulation of salinity in Indian Wells Valley suggests that the basin may not be hydrologically closed" (McGraw et al., 2016). Furthermore, DRI noted that water levels within IWV "are higher than in Salt Wells Valley, which indicates that interbasin groundwater flow is a possibility given large enough transmissivities" (McGraw et al., 2016). DRI performed a hydraulic analysis of the Salt Wells Valley and concluded that it is possible that currently approximately 50 AFY of the groundwater flow in the Salt Wells Valley originates as underflow from the IWV as distinguished from mountain front recharge from the Argus Range.

3.3.4.2 *Historical Water Budgets*

As discussed previously in Section 3.2, groundwater extractions began around the 1910s (Lee ,1913) when farmers and industrial users began large scale operations in the IWV. Prior to the development of well fields, it is assumed the IWVGB was in hydraulic equilibrium, with inflows in balance with outflows. Table 3-5 provides the estimated water budget during pre-development conditions[32] (i.e. prior to the 1920s), summarizing the inflow and outflow of water within the basin. Pre-development conditions were also used to establish steady state conditions for model calibration discussed in Appendix 3-H.

Table 3-5. Steady-State Water Budget (Pre-Development Conditions).

Water Budget Element	Estimated Volume (AFY) [1]
Inflows	
Mountain Front Recharge1 2	
Sierra Nevada, North	2,100
Sierra Nevada, South	1,500
Rose Valley	2,400
Coso/Argus Ranges	1,600
El Paso	50
Total Inflow	**7,650**
Outflows	
ET	7,450
Interbasin Subsurface Flow	200
Groundwater Extractions	0

[32] Originally developed by DRI (McGraw et al., 2016), and confirmed during recalibration for the IWVGA. Recharge estimates were discussed and confirmed by the IWV TAC Model Ad Hoc Group.

Water Budget Element	Estimated Volume (AFY) [1]
Total Outflow	**7,650**
Change of Groundwater in Storage	**0**

Source: IWV Groundwater Model (Model Documentation Appendix, Pohlmann, et al.; DRI, 2019).

[1] The annual calibrated model developed by DRI was provided by the Navy as in-kind services. The calibration model run is based on annual stress periods and water budget numbers are summarized by calendar year (January through December). Future Baseline (no action) and Management Model runs were developed with a monthly stress period, and the water budgets are summarized as water years (October through September).

[2] Recharge Areas are shown on Figure 3-11

As industrial, agricultural, and residential development expanded beginning in the 1920s, groundwater extractions increased which reduced the ET occurring at China Lake Playa and reduced subsurface flow to the Salt Wells Valley. The historical average post 1920 estimated water budget since IWV was developed is shown below in Table 3-6.

Table 3-6. Historical Water Budget (1922 to 2016)

Water Budget Element	Estimated Volume (AFY) [1]
Inflows	
Mountain Front Recharge	7,650
Total Inflow	**7,650**
Outflows	
ET	6,580
Interbasin Subsurface Flow	60
Groundwater Extractions	15,240
Total Outflow	**21,880**
Change of Groundwater in Storage	**-14,230**

Source: IWV Groundwater Model (Model Documentation Appendix, Pohlmann, et al.; DRI, 2019).

[1] The annual calibrated model developed by DRI was provided by the Navy as in-kind services. The calibration model run is based on annual stress periods and water budget numbers are summarized by calendar year (January through December). Future Baseline (no action) and Management Model runs were developed with a monthly stress period, and the water budgets are summarized as water years (October through September).

3.3.4.3 *Current Water Budget*

In more recent years, agricultural water demands have increased resulting in higher groundwater extractions compared to the long-term average. Reductions in the ET occurring at China Lake Playa and subsurface flow to the Salt Wells Valley also require water balance adjustments. The current average estimated water budget for IWV is defined as the years 2011 to 2015 and is shown below in Table 3-7.

Table 3-7. Current Water Budget (2011 to 2015 Average).

Water Budget Element	Estimated Volume (AFY) [1]
Inflows	
Mountain Front Recharge	7,650
Total Inflow	**7,650**
Outflows	
ET	4,850
Interbasin Subsurface Flow	50
Groundwater Extractions	27,740
Total Outflow	**32,640**
Change of Groundwater in Storage	**-24,990**

Source: IWV Groundwater Model (Pohlmann, et al.; DRI, 2019).

[1] The annual calibrated model developed by DRI was provided by the Navy as in-kind services. The calibration model run is based on annual stress periods and water budget numbers are summarized by calendar year (January through December). Future Baseline (no action) and Management Model runs were developed with a monthly stress period, and the water budgets are summarized as water years (October through September).

3.3.4.4 *Overdraft Conditions*

An IWVGB water budget is defined by the difference between inflows and outflows (see Section 3.3.4). Overdraft occurs when outflows exceed inflows, and there is a loss of groundwater in storage. In the case of the IWV, long-term pumping exceeded local inflow. It is well documented that IWV has been in overdraft since at least the 1960s (Dutcher and Moyle, 1973). Currently (2011 to 2015), outflows are approximately four times the estimated inflows. The magnitude of the overdraft results in an average annual loss of storage of approximately 25,000 AFY (See Table 3-7 Current Water Budget).

This loss of storage equates to the measured decline of groundwater levels near pumping centers at a rate of approximately 1.0 to 2.5[33] feet per year. Todd (2014) characterized the evidence of overdraft in the IWV by stating "[the] ubiquitous, long term and ongoing decline in water levels is the most definitive evidence of groundwater overdraft." Hydrographs of eleven CASGEM wells displayed on Figure 3-12 show historical groundwater level trends throughout the IWVGB. Eight of these CASGEM wells (NR-1, Sandquist Spa, USBR-02, -03, -05, -06, MW 32, and 27S/40E-01K02) demonstrate significant prolonged groundwater level declines near pumping centers. Other CASGEM well hydrographs show little or no decline of groundwater levels in the El Paso area (USBR-01, southwest of a fault), and in the upper northwest (USBR-10, near the Rose Valley subflow into the Basin). Groundwater elevation data, including selected well hydrographs from wells distributed throughout the IWV, are provided in Appendix 3-D.

According to California Water Code Section 12924, DWR is required to investigate groundwater extractions and recharge patterns within California's groundwater basins and identify groundwater basins in critical conditions of overdraft. DWR has determined the IWVGB meets their definition of critical overdraft defined in DWR Bulletin 118-80 (1980) as when "continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

Consequences of prolonged overdraft, beyond the loss of groundwater in storage, include chronic lowering of groundwater levels, increased pumping costs, loss of well yields[34], water quality degradation, and land subsidence. These consequences of overdraft, characterized as significant and unreasonable, will

[33] Shallow well impact analysis (Appendix 3-E) compared 2010 and 2015 groundwater level contours to develop a map of average annual historical changes to groundwater levels for these pumping conditions.

[34] Loss of well yields includes the need to re-drill or deepen a well to produce water (i.e. shallow well impact).

be addressed and mitigated as applicable through implementation of this GSP in order to prevent further environmental, social, and economic impacts.

Groundwater storage capacity is essentially the reservoir space contained in a given volume of aquifer. It consists of the estimated amount of water stored in the saturated zone and the estimated amount of recoverable water stored in the unsaturated zone of an aquifer. The storage capacity for the IWVGB has been estimated by both USGS and USBR on separate occasions, as noted below.

The USGS has made two estimates of groundwater in storage for the IWVGB (or portions thereof): Kunkel and Chase (1969) and Dutcher and Moyle (1973). Kunkel and Chase (1969) estimated there were 720,000 AF of groundwater in storage underlying 64,000 acres of IWV. There was the assumption of storage estimated to a depth of 100 feet below the water level of March 1954. The Kunkel and Chase (1969) estimate divided the IWVGB into two storage units with different specific yields. Dutcher and Moyle (1973) estimated that there were 2,200,000 AF of groundwater in storage underlying 70,800 acres of the IWV as of 1921. This estimate was based on an assumption of usable water in the 200 feet of saturated aquifer below groundwater contour levels, with the IWVGB divided into three storage units.

USBR (1993) estimated that there were anywhere from 1,020,000 AF to 3,020,000 AF[35] of groundwater in storage underlying 92.5 square miles (59,200 acres) of the IWV. This estimate was based on an assumption of usable water in the 100 to 300 feet of saturated aquifer below groundwater contour levels. The specific yield was assumed to be uniform with the IWVGB divided into three storage units. USBR (1993) stated that "200 feet of dewatering will be considered the realistic value of dewatering depth." This drawing down of the water table corresponds to mining approximately 2,370,000 AF of groundwater from 1992 conditions[36].

[35] USBR, 1993, Appendix C, Page C7 provided estimates for 100-ft dewatering (1,184,000 acre-feet), 200-ft dewatering (2,368,000 acre-feet), and 300-ft dewatering (3,033,600 acre-feet). They described the northwest area as limited to 200 feet of dewatering given the extensive clay in that area.
[36] Ibid.

The IWV Model was used to calculate annual changes of groundwater in storage based on historical pumping from 1922 through 2017 (Model Documentation Appendix 3-H). From 1922 conditions, the historical model run estimates a cumulative change of groundwater in storage of approximately 1,366,000 AF (ranging from 1,200 AF/year in the 1920s to 25,400 AF/year from 2010-2017). The historical model run simulates a cumulative change of 620,000 AF of groundwater in storage since 1992 (ranging from 20,100 AF/year in 1992 to 27,200 AF/year in 2017). Using USBR (1993) estimates of 2,370,000 AF of available groundwater in storage[37], this would imply that the amount of available groundwater in storage in 2017 was 1,750,000 AF (2,370,000 AF – 620,000 AF = 1,750,000 AF). This may be up to an additional 60 years of available groundwater storage (assuming 2017 pumping rates and a 200-foot drop in groundwater levels from 1992 conditions). Note, the USBR (1993) estimate was calculated before SGMA was passed, and the impacts from lowering groundwater levels were not fully characterized.

There are a number of limitations and sources of uncertainty with these estimates:

- The historical estimates assume aquifer heterogeneity and do not account for interbedded layers of find-grained sediments that do not yield water.
- There were insufficient number of wells in some areas to adequately characterize aquifer characteristics or groundwater levels.
- Major faults exist causing different groundwater levels in different areas within the Basin
- The selection of a specific saturated aquifer is a subjective judgment based on assumptions that drawing water from deeper would induce counter migration of saline water, contaminating water quality.
- The estimates do not account for the negative impacts of compaction of clay layers when dewatered.

[37] USBR (1993) groundwater in storage estimates include a uniform Sy of 0.20, 200 feet of dewatering, applied to an areal extent of 59,200 acres.

3.3.5 Sustainable Yield

DWR states that "SGMA requires local agencies to develop and implement GSPs that achieve sustainable groundwater management by implementing projects and management actions intended to ensure the Basin is operated within its sustainable yield by avoiding undesirable results" (DWR, 2016d). Consequently, sustainable yield is a crucial and fundamental element for the development of implementation measures of the GSP. As discussed in Section 3.3.3.2 and Section 3.3.4.1, DRI, in coordination with the IWV TAC[38], has estimated the long-term average natural recharge to the IWVGB is about 7,650 AFY. For the GSP, this is considered the Current Sustainable Yield of the Basin.

The natural recharge to the IWVGB, which is the basis for the Current Sustainable Yield, will be augmented with the implementation of projects and management actions that will increase the effective recharge to the IWVGB resulting in a greater IWVGB sustainable yield than the Current Sustainable Yield. The proposed projects and management actions (see Section 5) were included in Modeling Scenario 6.2 which showed these actions resulted in no undesirable results when the actions are fully implemented, expected to be by the year 2035 (see Section 4 for the descriptions of undesirable results established for the IWVGB). See Section 3.5.5 for a description of Model Scenario 6.2. Scenario 6.2 results are included in Appendix 3-H.

The estimated sustainable yield of the Basin in 2035, with the implementation of the proposed management actions and projects, is 11,150 AFY. The estimated future water budgets for the sustainable yields in 2035 (year when projects and management actions are fully implemented, 2040 (year when sustainability must be achieved), and 2070 (end of planning horizon) are shown in Table 3-8. The Future Sustainable Yields assume an average increase in IWVWD groundwater pumping of 1% per year with a corresponding average increase in imported water recharge to the Basin[39].

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[38] TAC Model Ad Hoc workshop August 29, 2018 to determine calibration model assumptions.
[39] The modeled increased IWVWD groundwater pumping rates represent growth for the entire community is not intended to suggest growth can only occur within the IWVWD's service area.

Table 3-8. Predicted Water Budget with Projects and Management Actions Implemented (Scenario 6.2).

Water Budget Element[1]	WY 2035 Estimated Volume (AF)	WY 2040 Estimated Volume (AF)	WY 2070 Estimated Volume (AF)
Inflows			
Mountain Front Recharge[2]	7,650	7,650	7,650
Artificial Recharge	3,500[3]	3,590	6,340
Total Inflow (Estimated Sustainable Yield)	**11,150**	**11,240**	**13,990**
Outflows			
ET	2,120	1,950	1,330
Interbasin Subsurface Flow	50	40	20
Groundwater Extractions	11,140	11,240	13,990
Total Outflow	**13,310**	**13,230**	**15,340**
Change of Groundwater in Storage	**-2,160**	**-1,980**	**1,350**

[1] Annual acre-feet per water year (October – September) based on monthly groundwater model values.

[2] Long-term average recharge.

[3] 2035 Artificial Recharge is the proposed average initial calendar year annual imported water and recycled water recharge for the project due to timing and schedule of recycled water injections and deliveries of imported water.

The projects and management actions presented in Section 5 result in balancing groundwater pumping with the natural and supplemental recharge to the IWVGB through both increasing supplies and decreasing demands; however, the water balances in Table 3-8 show that groundwater outflows exceed inflows in an amount approximately equal to the evapotranspiration outflows. The IWVGB numerical model (see Section 3.5) was used to evaluate the ability of the projects to mitigate losses of groundwater to evapotranspiration by increasing imported water recharge to the Basin. The modeling results for increased imported water recharge to offset evapotranspiration outflows didn't show any noticeable increases in groundwater levels or any noticeable benefit in avoiding undesirable results or meeting the sustainable management criteria presented in Section 4. DWR's Water Budget BMP Guidance Document, December 2018, page 9 states "The GSP water budget requirements are not intended to be a direct measure of groundwater sustainability …" SGMA defines sustainable yield as the maximum quantity of water, calculated over a base period representative of long-term conditions in the Basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing undesirable results. Accordingly, estimated Future Sustainable Yields, which modeling Scenario 6.2 shows do not result in undesirable results over the 50-year planning horizon modeled, include small continuing losses of groundwater from storage.

3.4 CURRENT AND HISTORICAL GROUNDWATER CONDITIONS AND HYDROLOGY

SGMA defines a "sustainability indicator" as an "effect caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, cause undesirable results" (GSP 2016). SGMA further identifies the following six sustainability indicators as those required to be addressed in a GSP:

- Reduction of Groundwater Storage
- Chronic Lowering of Groundwater Levels
- Seawater Intrusion
- Degraded Water Quality
- Land Subsidence
- Depletion of Interconnected Surface Water

These sustainability indicators are discussed in the subsections below in the context of identifying the presence of these current conditions in the IWVGB that are causing undesirable results. See also Section 4.3 for the discussion on undesirable results. SGMA requires Groundwater Dependent Ecosystems (GDEs) to be evaluated. While not a specific sustainability indicator, GDEs are discussed in Section 3.4.7 below along with the sustainability indicators because they could be impacted by chronic lowering of groundwater levels and depletions of interconnected surface water. The understanding of current conditions existing in the IWV will support evaluation of the sustainability indicators and will inform Basin management decisions such as implementation of projects and management actions and establishment of criteria to track goals for achieving sustainability (See Section 4 and Section 5).

3.4.1 Reduction of Groundwater in Storage

As discussed in Section 3.3.4.4, the IWVGB is currently in overdraft with a current loss of storage of approximately 25,000 AFY (see Table 3-7). This significant reduction of groundwater in storage is directly related to the chronic lowering of groundwater levels, water quality degradation, and land subsidence, discussed in the subsection below.

3.4.2 Chronic Lowering of Groundwater Levels

As discussed in Section 3.3.4.4, groundwater levels have been experiencing significant declines in almost all areas of the IWVGB (see Appendix 3-D and Figure 3-12). Groundwater levels remain stable in some locations within the IWVGB near recharge and discharge zones, as well as in the El Paso area which is separated by a fault from the main IWV aquifer. Declining water levels have historically impacted and are currently impacting shallow production wells, requiring wells to be deepened, re-drilled, or abandoned as a water source. Many shallow wells are located in disadvantaged communities, exacerbating the financial impact of required well modifications and/or replacements. Appendix 3-E (Figure 6) shows the average rate of groundwater level declines by section within IWV based on groundwater level contour maps developed from 2010 and 2015 measured data at over 150 monitoring wells. This figure also shows the limited areas where groundwater levels have not declined (blue).

The impacts lowering of groundwater levels have on shallow wells are discussed in Appendix 3-E. The technical memorandum summarizes the methodology developed to estimate historical impacts, and potential future impacts, to shallow wells due to changes in groundwater levels from groundwater management within the Basin. The results of this shallow well analysis approximate 97 shallow wells have been impacted from declining groundwater levels between 1980 and 2018.

3.4.3 Seawater Intrusion Conditions

The IWVGB is an inland basin, and as such, is not hydraulically connected to a sea or ocean. The City of Ridgecrest is over 100 miles from both the Pacific Ocean and the Salton Sea. Accordingly, seawater intrusion is not evaluated in this GSP and seawater intrusion will not be considered as a sustainability indicator for establishing sustainable management criteria (see Section 4).

3.4.4 Groundwater Quality Conditions

Currently, substantial groundwater in the IWVGB is of good quality; however, there are regions with poorer water quality due to high concentrations of total dissolved solids (TDS) and/or arsenic. These constituents and resulting water quality conditions are discussed in the subsection below.

3.4.4.1 *Total Dissolved Solids*

Total Dissolved Solids (TDS) is a measure of all dissolved solids in water including organic and inorganic components. Sources of TDS in groundwater include interaction of groundwater with the minerals that comprise the aquifer matrix material. Over time, TDS will increase as more minerals in contact with groundwater dissolve. In desert basins, evaporative enrichment is known to naturally increase TDS in groundwater. This process also occurs in plants, both in agricultural and natural systems. Anthropogenic sources include synthetic fertilizers, manure, wastewater treatment facilities, and septic effluent. Repeated irrigation is also a known cause of elevated TDS, as minerals concentrate in the soil column with repeated evaporation. These increased concentrations can then, under certain conditions, be mobilized into the underlying groundwater table. The concentration of TDS in groundwater within the IWVGB has been studied and documented for many decades. For most locations in the Basin, cementation in surface soils and deeper fine alluvium prevents migration of surface waters to the aquifer itself. The California Water Board regulates TDS as a Secondary Maximum Contaminant Level (SMCL), as a contaminant potentially affecting the taste and odor of drinking water (CA Water Boards 2019). There is no Primary MCL for TDS. The Lahontan Regional Water Board adheres to the State Water Board's recommended and upper TDS Limits (SMCL of 500 mg/L and 1,000 mg/L, respectively (CA Water Boards, 2018; CA Regional Water Quality Control Board Lahontan Region, 2016)).

Within the IWVGB, groundwater moves from the mountains toward the China Lake playa, through coarse-grained alluvial deposits into fine-grained lacustrine deposits. This groundwater movement can cause dissolution of evaporites (caused by high evaporation rates at earlier times), resulting in high TDS concentrations (TriEcoTt, 2013; Berenbrock and Schroeder, 1994). Increased pumping can exacerbate the process described above causing ions to be leached from clay and lacustrine deposits resulting in increased TDS concentrations.

TDS trends for a number of wells sampled throughout the Basin are shown in Figure 3-13. TDS samples indicate concentrations have increased over time in some of the northwest area wells where high rates of pumping may have migrated naturally occurring saline water. The most recent TDS concentrations for wells sampled in the IWVGB are shown in Figure 3-14. Lab results for a number of wells sampled in the U.S. Navy/China Lake and northwestern areas show TDS concentrations considerably above the SMCL (ranging from 1,001 mg/L to >5,000 mg/L). Groundwater below the SMCL occurs in the southern area of the Basin. Degraded water quality has caused groundwater producers in the Basin to relocate pumping to areas with higher water quality. IWV TDS data are provided in Appendix 3-C.

3.4.4.2 *Arsenic*

In semi-arid and arid groundwater basins, groundwater recharge is limited due to low precipitation and high residence time of groundwater in the Basin. The long residence time of groundwater in the Basin allows for more interaction between groundwater and minerals that comprise the aquifer matrix material. With time, naturally occurring arsenic desorbs from sediments and enters groundwater.

Historically, some wells sampled within the IWVGB have shown arsenic concentrations in groundwater above California's current arsenic MCL (10 µg/L). Existing arsenic data were assembled from earlier field and Basin studies (TriEcoTt, 2013; Tetra Tech EM Inc., 2003; Houghton HydroGeo-Logic, 1996; USBR, 1993; Berenbrock, 1987), and DWR's GAMA program. Figure 3-15 displays the most recent groundwater quality measurements for arsenic at 209 wells with laboratory data. The groundwater most strongly affected by arsenic above the MCL (shown as red dots on Figure 3-15 map) occurs in the southeast area of the IWVGB and beneath the Navy Base. The arsenic database included as Appendix 3-F incorporates GAMA data from production wells monitored by IWVWD, Navy, Searles Valley Minerals, mutual water companies, and the

Inyokern CSD. Where arsenic occurs above the MCL of 10 µg/L, potable water is treated by water suppliers before it is distributed.

3.4.5 Land Subsidence Conditions

The Basin includes relatively coarse-grained alluvial aquifers with clay and silt interbeds, and low permeability thick clay and silt deposits associated with lacustrine and playa depositional environments. These fine-grained materials are prone to inelastic compaction when the groundwater table is lowered below historical levels. As a result, areas underlain by extensive fine-grained materials have a high to very high susceptibility to land subsidence. Differential land subsidence across the valley is expected given the variability in the distribution of the fine-grained units and the presence of faults. The Basin is located within the tectonically active eastern California shear zone, and also subject to direct tectonic changes in ground elevation, as well as soft sediment deformation and compaction of fine-grained units due to seismic activity.

Geologic and hydrogeologic information, high-resolution level-line surveys of the Supersonic Naval Ordnance Research Track (SNORT) alignment within Naval Air Weapons Station China Lake, and satellite-based Interferometric Synthetic Aperture Radar (InSAR) remote sensing data are evaluated to assess subsidence in IWV. Comparison of the SNORT and InSAR data found comparable results, providing confidence in both types of measurements. The data identify cyclic elevation changes caused by tectonic stress buildup and subsequent release associated with earthquakes. Uplift and subsidence changes of 40 to 50 mm have been measured over a 34-year period at SNORT and can be attributed to tectonic processes. InSAR recorded positive and negative elevation changes ranging from 38 to 64 mm (1.5 to 2.52 inches) for an 8-year period. The higher rate of change found with InSAR reflects the effect of both tectonic and non-tectonic subsidence, as well as a wider area of subsidence, in comparison to the SNORT analysis.

A northern subsidence zone identified by InSAR is coincident with the 1995 Ridgecrest earthquake and attributed primarily to tectonic effects. An area in the southern valley experienced subsidence during an InSAR measurement period coinciding with low tectonic activity. The southern subsidence area experienced 25 mm (0.98 inches) of subsidence in the 8 years between 1992 and 2000, for a rate of 3.1

mm/year (0.12 inches/year). The same area for the five years from 2005-2010 had 15 mm (0.59 inches) of subsidence (3.0 mm/year or 0.12 inches/year). The subsidence rate over the entire 18-year period of InSAR data is up to 2.2 mm/year (0.09 inches/year). Analysis of groundwater drawdown at pumping wells and land-surface changes detected by InSAR demonstrates a temporal correspondence between the magnitude of drawdown calculated at the wells and the observed land-surface changes. Subsidence rates calculated for the well sites range from 0.3 to 1.1 mm/year (0.01 to 0.04 inches/year).

Data for IWV indicate that the valley has aquifer materials susceptible to compaction as groundwater levels decline, but that compaction and other mechanisms of land elevation change also occur in the valley due to tectonic processes. For the period through 2010, the relative magnitude of subsidence observed due to tectonic processes is roughly equivalent to that observed from groundwater withdrawals in various parts of the valley, and is on the order of 1 to 2 mm/year (0.04 to 0.08 inches/year).

Testing and laboratory facilities on NAWS China Lake are finely calibrated and thus are particularly susceptible to undesirable results due to land subsidence, even at relatively small land subsidence rates as compared to what would typically be acceptable for other infrastructure. In particular, the SNORT alignment on NAWS China Lake, located within the southern subsidence area, has been impacted and has experienced undesirable results due to land subsidence caused by declining groundwater levels. The extent of land subsidence from southern subsidence area radiates northward and westward and can impact areas in Ridgecrest and into the neighboring unincorporated communities, especially if groundwater levels continue to decline.

See Appendix 3-G for additional land subsidence analysis.

3.4.6 Interconnected Surface Water Systems

As discussed previously in Section 3.3.3.2, there are no significant interconnected surface water systems that interact with groundwater in the IWVGB. Streams in the valley are typically ephemeral and the majority of recharge occurs as mountain front recharge. Additionally, there are multiple natural springs in the mountain and canyon areas surrounding the IWV (see Figure 3-11). One spring located near Highway 14 is used as the water supply source for a restaurant and brewery.

3.4.7 Groundwater-Dependent Ecosystems (GDEs)

SGMA defines GDEs as “ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface” (GSP, 2016). Groundwater is critical to sustaining springs, wetlands, and perennial flow (baseflow) in streams as well as to sustaining vegetation such as phreatophytes that directly tap groundwater through long and extensive root systems. Mapping of DWR’s Natural Communities Commonly Associated with Groundwater (NCCAG) dataset indicates the vast majority of GDEs within the IWV are located on NAWS China Lake, supported by the vertical upward gradient under the China Lake Playa which causes groundwater to discharge to the surface. Smaller and scattered communities of GDEs may be present in the canyons along the Sierra Nevada, in the El Paso area along the ephemeral streams, and in the southwest region of the IWV. A map of the different vegetative species comprising the GDEs within the IWV is shown in Figure 3-16. Although phreatophytes are not mapped by DWR, they are present in the surrounding mountain canyons. The U.S. Navy has mapping of GDEs on NAWS China Lake with variations to the NCCAG dataset; however, the spatial extent of GDEs is similar to the extent mapped by the NCCAG. A field visit on November 1, 2018 verified the significant presence of GDEs in the China Lake Playa region on the NAWS China Lake. The Nature Conservancy’s web-based GDE Pulse application provides tools to view long-term trends of moisture and photosynthetic chlorophyll present in vegetation based on satellite data. This information serves as an indicator of vegetative health for GDEs. The GDE Pulse maps show little or no change in vegetative moisture or photosynthetic chlorophyll present from 1985 to 2018. GDEs located in the mountain canyons are not considered vulnerable because they are supported by mountain block recharge. Likewise, GDEs located in the El Paso region are not considered vulnerable due to the lack of groundwater pumping in the area and the resulting stable groundwater levels. However, the GDEs located in the valley floor, including those near the China Lake Playa, are likely more vulnerable due to chronic lowering of groundwater levels, which is supported by U.S. Navy documentation of well-established GDEs near the SNORT facility that are sensitive to changes in groundwater levels (Lancaster, 2019). Vegetation loss due to the chronic lowering of groundwater levels has been documented on NAWS China Lake east of the LLFZ

(Lancaster, 2019). These GDE communities, which currently stabilize sand dunes, are vulnerable to destabilization if groundwater level declines continue to occur.

Historical impacts to GDEs have already occurred and will continue if groundwater levels continue to decline. The details of the relationship between groundwater levels and vegetation health, such as the extinction root depth for the vegetation in the vicinity of the China Lake Playa, is currently unknown and is a data gap to be evaluated once data is available. See Section 3.6.1.4 for additional discussion of the GDE data gaps.

3.5 NUMERICAL GROUNDWATER MODEL

3.5.1 Initial Model Development

The groundwater flow model of the IWV, used to evaluate SGMA compliance, was developed on a foundation of decades of hydrogeologic investigations of the Basin. The first numerical model of the valley's groundwater focused on the Ridgecrest and Inyokern areas and used a simplified aquifer geometry (Bloyd and Robson, 1971). Berenbrock and Martin (1991) used a more sophisticated representation of aquifer geometry in a subsequent model, but the system was simulated only in a quasi-three-dimensional manner. These models provide a comprehensive catalog of hydraulic properties, although Basin recharge, playa discharge, and predevelopment groundwater use are outdated based on more recent data. The USBR (1993) updated the conceptual model of the IWVGB and increased knowledge of the hydrogeology of IWV through the drilling, testing, and analysis of 10 deep wells (2,000 feet) on the western side of the valley. These wells were specifically sited to explore mountain front recharge. Additional drilling and testing are reported by Tetra Tech EM, Inc. (2003a, b), including extensive data and analysis regarding groundwater quality and isotopic composition especially near the Basin sink at the playa.

The current DRI groundwater flow model can be traced to the Brown and Caldwell model published in 2009. The Brown and Caldwell model successfully replicated some of the regional hydrogeologic features and was used to explore overdraft conditions. The major limitation of the 2009 model is that it did not accurately reproduce drawdown rates. The model underpredicts drawdown within the City of Ridgecrest and in the southwest, but overpredicts drawdown northeast of Ridgecrest, indicating a spatial bias. The model errors also generally increase over time. Recharge and ET values were revised again for this 2009 model, and other conceptual model features were added. These updates include a fine-grained sediment plug in the western valley, a gravel zone, and a high gradient zone between the El Paso Subbasin and IWV. An update of the Brown and Caldwell model occurred in 2011 with Layne Hydrologic (2011) refining the grid spacing, changing the solver configuration, and modifying initial conditions and pumping rates.

In 2016, DRI developed a significantly improved groundwater flow model (McGraw et al., 2016) for the U.S. Navy to support planning for NAWS China Lake in response to declining groundwater levels and concerns about water quality degradation and subsidence. Starting with the Brown and Caldwell (2009) platform, mountain front recharge and playa evaporation rates were refined, the grid resolution was increased in the horizontal and vertical directions, model layering was refined to better represent aquifer units, boundary conditions were modified to allow flow to Salt Wells Valley and a pilot-point hydraulic parameterization was performed to improve calibration to water levels and, importantly, to drawdown rates. A solute transport model and subsidence model were linked to the flow model to allow simulations of the impact of pumping on groundwater quality and land subsidence. Alternative conceptual models were analyzed, as were alternative future conditions. During 2017, DRI revised the model for the Navy by incorporating regional faults as groundwater barriers (Garner et al., 2017). This change corrected under-prediction of water levels in El Paso sub-basin by including the informally named EPF in the southwestern sector of the valley. The LLFZ was similarly added as a horizontal flow barrier trending northwesterly across the middle of the IWV.

Following peer review[40], the Navy retained DRI to update the existing models (McGraw et al., 2016 and Garner et al., 2017), address SGMA concerns, and recalibrate to historical 1922-2017 conditions. The TAC provided a model ad hoc group to participate in two model workshops and multiple conference calls for model review and comments during the GA model's historical calibration. The re-calibrated model provides the historical water budgets and are the platform used for the SGMA simulations of baseline

[40] See Section 3.5.2.1 for a discussion on the model review for suitability for the GSP.

conditions and management scenarios. Model assumptions, construction, and performance are detailed in Appendix 3-H. The GSP modeling effort provides tools necessary for estimating the groundwater aquifer's hydrologic water budget, identifying data gaps, assessing groundwater level and quality trends, determining sustainability criteria, and evaluating different strategies to provide long-term sustainable groundwater management for the IWVGB. The model also provides ongoing analysis and support as needed for the annual reports and periodic evaluations that will be required for submittal to DWR.

3.5.2 Flow Model Review and Recalibration

3.5.2.1 *Model Review*

The IWVGA reviewed the DRI groundwater flow model to assess suitability for the GSP. A peer review was conducted by technical staff of the Water Resources Manager and approved by the IWV TAC. This review included evaluating model assumptions and documentation (McGraw et al., 2016; Garner et al., 2017), meetings with DRI modelers and Navy personnel, a hydrogeologic site visit, and assessment of model output files. Guidelines used to evaluate the model included GSP Emergency Regulations), DWR best management practices for modeling (DWR, 2016c), and USGS's recommendations for evaluating groundwater models (Reilly and Harbaugh, 2004). The DRI groundwater flow model was reviewed to 1) evaluate its accuracy in describing the groundwater Basin structure, hydrogeologic characteristics, and inflows/outflows, and 2) determine its suitability for supporting the implementation of the IWVGA's GSP through 2040.

The Water Resources Manager staff, and TAC members reviewed existing hydrogeologic reports and monitoring data to understand elements of the conceptual model that were being simulated by the numerical model. A groundwater model review checklist was developed based on the USGS guidelines (Reilley and Harbaugh, 2004), GSP Emergency Regulations (GSP, 2016), and DWR modeling best management practices (DWR, 2016c).

The model review evaluated the hydrogeologic representation of available historical data and conceptual model, model construction, boundary conditions, aquifer properties, and fluxes (recharge, pumping, ET).

The model output file was assessed by technical staff of the Water Resources Manager and TAC for water budget consistency and numerical convergence criteria. Steady state and transient model calibration were evaluated based on the Hydrogeologic Conceptual Basin Model.

This review prompted additional changes to the flow model and a full recalibration. Changes to the flow model include incorporating additional hydraulic conductivity data, revision of the conceptual model in several areas including the northwest and southwest, and sensitivity analyses for recharge, hydraulic conductivity, specific storage and specific yield. Conceptual model changes include representation of a zone of low hydraulic conductivity in the northern Brown Road area, extension of the zone of low hydraulic conductivity playa sediments southward, and increased vertical variability in hydraulic properties. The transport model was also updated to include a revised salinity database and revised boundary conditions for the recharge salinity.

3.5.2.2 *Model Calibration*

The IWV SGMA model was calibrated in three phases. The general approach has been to adjust the values of selected hydrogeologic parameters using manual and automated calibration processes until the model's simulated results are consistent with observed historic trends in IWV and the El Paso sub-basin. The flow model was calibrated in two stages, steady state and transient, with comparisons made to observed water levels and water budgets in both cases. The calibration methods and results were reviewed and approved by the IWV TAC and its Model Ad-Hoc Committee during a series of meetings held in 2018 and 2019.

The steady-state groundwater flow model represents hydrologic conditions before large-scale groundwater pumping began in 1921. This model is calibrated to steady-state water levels measured in 132 wells in IWV in 1920 and four wells in the El Paso sub-basin. Pre-development water levels are not available in El Paso sub-basin, so recent stable water levels are used instead. During calibration, the values of two model parameters were varied: (1) horizontal hydraulic conductivity of the six model layers and (2) hydraulic characteristics (fault transmissivity divided by barrier width) of the two major faults included in the model. These parameters were chosen because in general they have significant effects on simulated water levels and because measurements of their values in IWV are limited and therefore are considered more uncertain than other parameters. Ranges of hydraulic conductivity were developed for the four primary subsurface hydrogeologic units in the valley by Brown and Caldwell (2009). The ranges of the parameters used for the DRI model calibration and their calibrated values are described in Appendix 3-H. The results of calibration show that the steady-state flow model provides a good simulation of observed water levels in IWV (Figure 3-17). The mean absolute error (MAE) between simulated and observed water levels is 6 feet. The relative error in water levels, which is the MAE divided by the range in observed water levels, is 0.84 percent, which is far below the 10-percent threshold that is generally considered an acceptable maximum relative error for predictive models.

Groundwater conditions during the period 1921 through 2016 are simulated by the transient flow model. This model is calibrated to water budget terms and historic water-level trends and water levels observed in 36 wells (Figure 3-18) by adjusting values of the transient storage parameters specific storage and specific yield. The values of the hydraulic conductivity and fault hydraulic characteristic parameters determined during calibration of the steady-state model were adopted unchanged in the transient model. Model results were found to be insensitive to specific storage so this parameter was assigned a constant value of 3x10-7 ft^{-1} for all confined model layers. The transient model uses observed rates of water-level drawdown that resulted from groundwater pumping as a calibration metric to supplement the MAE of water level elevations. This approach was taken because the rate of drawdown is the critical factor for simulating the effect of overdraft conditions.

The water-level elevation is generally controlled by hydraulic conductivity and recharge, parameters that were determined in the steady-state model, while drawdown rates are strongly affected by storage parameters. This approach minimizes errors in the transient calibration that might result from the model attempting to resolve offsets in water level elevations simulated by the steady-state model. A robust regression slope-fitting approach was used to remove observation outliers and compute the differences in slope of the simulated and observed water-level trends at the 36 observation locations. An example of the slope-fitting approach is shown in Figure 3-19. The results of both calibration metrics as they relate to specific yield values are shown in Figure 3-20. The optimal solution using drawdown slope as the metric is obtained for a specific yield value of 0.225, whereas an optimum specific yield of 0.25 results when using MAE of water levels as the metric. Although these values are very close in magnitude, the value of 0.225 was selected because the drawdown-slope approach more accurately represents how the model is applied for predictive pumping scenarios. The transient model was also calibrated to water budget terms and demonstrated excellent agreement with measured ET rates.

3.5.3 Transport Model

Saline groundwater that underlies several areas of Indian Wells Valley may reduce water quality in production wells if this poorer-quality groundwater is drawn toward pumping centers. Solutes in groundwater within Indian Wells Valley are conceptualized as originating from recharge from surrounding mountain ranges, groundwater subflow from Rose Valley, mixing with remnant evaporative brines and geothermal fluids, and concentration by evaporation. Solutes are removed from the groundwater system by precipitation of minerals and discharge to Salt Wells Valley to the east. McGraw et al. (2016) summarized historical studies that together identify areas of generally higher salinity groundwater to the east near China Lake Playa, to the northwest toward Rose Valley, around eastern Ridgecrest, and in other locations associated with clay horizons or geothermal zones. Evidence of increasing salinity in wells in the Ridgecrest area have been documented by Berenbrock and Schroeder (1994) and Todd Engineers (2014).

A three-dimensional solute transport model was developed to address the effects of pumping on groundwater quality over time. The transport model is coupled with the groundwater flow model of IWV, utilizing the same model domain, grid structure, and layers. TDS concentrations are used in the transport model as a surrogate for groundwater salinity to forecast TDS concentrations from the present to the year 2070 by incorporating the volumetric groundwater flow rates simulated by the flow model for the SGMA management scenario. The results are presented as time-series plots showing forecasted TDS concentrations at selected locations of interest, maps showing the spatial distribution of forecasted TDS concentrations for selected times, and maps showing rates of change of TDS concentration as selected times.

The TDS initial conditions for the transport model were developed from historical groundwater TDS measurements as described in Appendix 3-C. From the Groundwater Ambient Monitoring and Assessment Program (GAMA) database (California Water Board, 2018), publications by the USGS (such as Moyle, 1963; Berenbrock, 1987, and Berenbrock and Schroeder, 1994), and a database by the Kern County Water Agency (2018). The resultant database includes 563 locations with data collected over a 70-year period, though only wells with known depths were utilized for the model. The most-recent TDS concentration for each location (if multiple values were available) provided the framework for interpolation to a continuous TDS distribution over all model cells.

The transport model was vertically partitioned into three TDS zones to represent the TDS distributions at shallow, intermediate, and deep depth intervals as indicated by the measurements. The Shallow TDS zone includes measurements within the depth range of flow model layer 1, the Intermediate TDS zone corresponds to flow model layers 2 and 3, and the Deep TDS zone includes measurements within the depth ranges of flow model layers 4, 5, and 6. The deeper flow model layers were combined for the transport model because the TDS data are sparse (Figure 3-21). For cases where measurements at multiple depths at a single well location occur in the same TDS zone, their average TDS value was used, resulting in an initial condition dataset of 391 TDS data points. The measured data were supplemented by manually assigned control points in regions of sparse data to ensure that the interpolated TDS distributions were consistent with conceptualized TDS distributions. The initial TDS concentrations (both measured and control points) for the three TDS zones are shown in Figure 3-21.

A quantitative calibration of the transport model was not performed because the initial TDS distribution integrates available measurements that span many decades; thus, a single historic simulation period could not be developed for calibration. Instead, a qualitative calibration compared the forecasts of TDS trends simulated by the transport model to general historic trends and spatial distributions represented by the conceptual model of groundwater salinity. The values of transport parameters (e.g. dispersivity and porosity) were based on those used in DRI's groundwater transport model for the Navy (McGraw et al., 2016) and were adjusted as needed during model calibration. TDS concentrations of recharge at the model boundaries were also revised from the DRI groundwater transport model. Detailed descriptions of the assumptions, configuration, and results of the Indian Wells Valley transport model are contained in the Model Documentation Appendix 3-H.

3.5.4 Baseline Conditions

California Code of Regulations § 351 (e) define “Baseline” or “baseline conditions” 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.”

The numerical model was used to simulate IWVGB baseline conditions with the purpose of understanding future projected conditions if the GSP were not implemented, or under “no action” conditions. The baseline model run was then used as one of the tools to evaluate the proposed projects and management actions.

To develop the baseline conditions to be simulated, a balanced hydrologic period and mountain-front recharge distribution was developed. These hydrologic conditions were also applied for simulated runs of planned future projects and management actions.

Precipitation data and streamflow data were considered for assessing long-term hydrologic trends; however, streamflow data in the IWV is currently limited, so precipitation data was prioritized for assessing trends. Cumulative departure from mean curves were prepared and 26-year period from 1990-2015 was selected as a balanced hydrologic period, to be repeated to complete the 51-year future modeling period of 2020-2070. The 51-year future period will use hydrology from 1990-2015, then 1990-2014. When examining hydrologic trends, a more recent balanced period was selected to take advantage of recent precipitation data available at stations within the recharge zones. A monthly precipitation index was computed for three recharge zones for the corresponding balanced hydrologic period of 1990 to 2015. The precipitation index was used to scale the average annual recharge for the groundwater model (7,650 AFY) using a linear relationship between the precipitation index and recharge.

Historical groundwater extractions were evaluated for establishing future baseline pumping conditions. The most recent pumping data were used for the majority of groundwater producers. Through stakeholder outreach efforts during the development of the baseline conditions, some agriculture representatives provided estimates to use for future conditions that reflected their projected water demands. Pumping was distributed monthly throughout each year with the peak months in the summer when irrigation needs are the greatest. The upper graph in Figure 3-22 shows the annual and cumulative pumping assumptions used for the baseline pumping.

Table 3-9. Baseline Pumping Distribution by Water Use

Water Use	**2020** 34,900 AF	**2040** 36,700 AF	**2070** 38,100 AF
Agriculture	62%	62%	59%
Industrial	8%	8%	8%
City/Municipal/Domestic	24%	25%	28%
U.S. Navy	6%	6%	5%

The simulated water budget representing baseline conditions are provided in Table 3-9. Under "no action" conditions, overdraft conditions will continue to exist due to significant and increasing groundwater extractions. The total loss of groundwater in storage from 2020 through 2070, which is related to the other sustainability indicators, is approximately 1.6 million acre-feet, as shown in Figure 3-22. Baseline condition model results are provided in Appendix 3-H.

Table 3-10. Baseline Conditions Water Budget. (2020 through 2070 WY averages)

Water Budget Element[1]	**Estimated Volume (AFY)**
Inflows	
Mountain Front Recharge[2]	7,650
Total Inflow	**7,650**

Water Budget Element[1]	Estimated Volume (AFY)
Outflows	
ET	1,620
Interbasin Subsurface Flow	40
Groundwater Extractions	36,870
Total Outflow	**38,530**
Change of Groundwater in Storage	**-30,880**

[1] Annual acre-feet per water year (October – September) based on monthly groundwater model values.

[2] Long-term average recharge.

3.5.5 Numerical Model Scenario 6.2

The TAC was instrumental in performing and evaluating the numerical model runs. The numerical model was used to simulate IWVGB conditions and behavior resulting from implementation of the proposed projects and management actions (Scenario 6.2). See Section 5.2 and 5.3 for the descriptions of the proposed projects and management actions. A summary of the assumptions for Scenario 6.2 are provided below.

- Natural Recharge:
    - The same natural recharge pattern as was developed for the baseline conditions was used in Scenario 6.2 (see Section 3.5.4)
- Management Action No. 1: Pumping Allocations
    - Pumping: Allocations were assumed to begin February 2020 and were based on pumping history and the highest beneficial uses of groundwater. Groundwater producers who did not continuously pump groundwater from 2010 to 2014 were assumed to cease pumping. Domestic and municipal pumpers were assigned an allocation equivalent to their highest continuous annual pumping from 2010 to 2014.

  - Pool Allocations: A pool of water was allocated for agricultural and industrial use. Portions of the pool were allocated to agriculture and industrial groundwater producers based on historical irrigated acres and historical water use. Although these allocations could be used at the discretion of the groundwater producer, for modeling purposes, it was assumed that current pumping rates continued until the individual pool allocations were exhausted.
- Lease Market:
  - A lease market for unused groundwater allocations was assumed to be created driven by the relative economic value of the water to the users for modeling purposes, it was assumed possible sellers include some large agriculture, the IWVWD, and the City of Ridgecrest; possible buyers include some large agriculture and industrial users.
- Project No. 1: Imported Water
  - Imported water used for groundwater replenishment is assumed to begin in 2035. Imported water is used to offset pumping over the sustainable yield of the IWVGB.
- Project No. 2: Recycled Water
  - Recycled water for direct non potable use and for injection is assumed to begin in 2025. Recycled water is assumed to be used by the City of Ridgecrest and Searles.
- Project No. 6: Pumping Optimization
  - Pumping was optimized to prevent additional lowering of groundwater levels near pumping depressions by redistributing pumping from the Southwest and Southeast regions of the IWVGB to the Northwest region where less pumping is anticipated over time. For the purposes of modeling, it was assumed that some of the IWVWD and Searles Valley Minerals pumping would be relocated.
- Growth:
  - IWVWD groundwater pumping was assumed to increase by 1% annually. This increase represented overall increase in pumping in the IWVGB due to growth in domestic and municipal sectors, and is not intended to imply growth is limited to the IWVWD service area only.

- Projects No. 3, 4, and 5 would have limited or no impact on the assumed groundwater production and were therefore not incorporated into Scenario 6.2.

Table 3-11 below describes the pumping distribution by water use.

Table 3-11. Management Scenario 6.2 Pumping Distribution by Water Use.

Water Use	**2020** 20,800 AF	**2040** 11,200 AF	**2070** 14,000 AF
Agriculture	40%	0%	0%
Industrial	10%	3%	3%
City/Municipal/Domestic	40%	79%	83%
U.S. Navy	10%	18%	15%

Table 3-12 provides the simulated 50-year water budget under the conditions modeled in Scenario 6.2 for the period 2020 through 2070. Additional Scenario 6.2 water budgets at specific years are provided in Table 3-8. The total loss of groundwater in storage from 2020 through 2070, which is related to the other sustainability indicators, is approximately 0.2 million AF, as shown in the lower graph of Figure 3-22.

Table 3-12. Scenario 6.2 Water Budget (2020 through 2070 WY averages)

Water Budget Element[1]	Estimated Volume (AFY)
Inflows	
Mountain Front Recharge[2]	7,650
Artificial Recharge (Imported and Recycled Water)	3,690
Total Inflow	**11,340**
Outflows	
ET	1,880
Interbasin Subsurface Flow	40

Water Budget Element[1]	Estimated Volume (AFY)
Groundwater Extractions	13,320
Total Outflow	**15,240**
Change of Groundwater in Storage	**-3,900**

[1] *Annual acre-feet per water year (October – September) based on monthly groundwater model values.*

[2] *Long-term average recharge.*

Scenario 6.2 results supported development of sustainable management criteria (Section 4). Management Scenario 6.2 model results are also provided as an attachment to the Model Documentation Appendix (Appendix 3-H) of this report. Scenario 6.2 includes many uncertainties as to the timeline of when planned projects and management actions will come online. Consequently, the numerical model may be used in the future to simulate additional scenarios with updated pumping information and project and management actions timelines.

3.5.6 Climate Change

DRI (McGraw et al, 2016) examined the predicted precipitation quantities for several published IPCC climate models and documented conflicting results; i.e., some models predicted decreases and some predicted increases in precipitation in the future with the assumed driver of CO_2 increase. This GSP does not incorporate any precipitation change in model simulations into the future other than annual fluctuations similar to those that have been observed in the past record.

3.6 EXISTING MONITORING NETWORK AND EVALUATION

The existing basin-wide groundwater monitoring program was established by the KCWA in 1995, and operated until the IWVGA accepted the monitoring program's responsibility in the summer of 2018. The Cooperative Group, consisting of major water producers, and local, county, and Federal agencies, assisted the monitoring efforts of local regulatory agencies by coordinating water resource data sharing, performing Basin water supply studies, and applying for State legislation and grant programs. These members continue to participate on the GA Board of Directors, in the IWVGA TAC and through public participation for GSP development. The Cooperative Group developed a website and compiled historical reports and documents to post for public access. Technical members wrote articles for public outreach with respect to IWV's water use history, available water resources, and state of the alluvial Basin

KCWA has maintained a semi-annual groundwater monitoring program within the Basin since 1995. These data provide a strong foundation for understanding the trends and state of water resources within the Basin. As of Fall 2019, 198 monitoring wells, two stream gages, and four weather stations (Figure 3-1) contribute data to the monitoring program. DRI also maintains an eddy covariance station to monitor evapotranspiration/evaporation; and the USGS provides InSAR and earthquake activity data to monitor for land subsidence.

Depth to water is measured biannually at 198 monitoring wells during Spring (March) and Fall (October) to observe seasonal changes in groundwater levels. The existing program contains monitoring wells throughout the Basin including 19 multi-level monitoring wells, 60 domestic wells, and 63 wells on the Navy base.

The wells in the existing monitoring program have varying supporting data, with limited well log and construction data. Table 3-13 summarizes existing wells monitored for groundwater levels by different areas within the IWVGB.

Table 3-13. Existing Groundwater Level Monitoring Well Program.

BASIN AREAS	NUMBER OF MONITORING WELLS	NUMBER OF MONITORING WELL LOGS	NUMBER OF DWR CASGEM WELLS
Northwest	47	29	12
Southwest	17	7	0
Southeast	53	33	8
Navy	63	15	5

BASIN AREAS		NUMBER OF MONITORING WELLS	NUMBER OF MONITORING WELL LOGS	NUMBER OF DWR CASGEM WELLS
El Paso		18	13	8
	TOTAL:	198	97	33

KCWA provides field staff to measure depths to groundwater at the monitoring wells, and a geologist to manage the field and reporting program. KCWA's geologist compiles the field data and develops groundwater level/depth contour maps. KCWA also reports data from 33 active monitoring wells to DWR's CASGEM (Figure 3-1) program[41]. The most recent monitoring event was completed in March 2019.

3.6.1 Data Gap Evaluation of the Existing Monitoring Network

The GSP Emergency Regulations §351 specifies that "data gaps" *refer to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation, and could limit the ability to assess whether a basin is being sustainably managed*. The existing hydrogeologic data and monitoring network was evaluated for its support of the GSP, including the HCM, components of the water budget, changes to groundwater in storage, potential impact to shallow wells, and groundwater quality. The existing monitoring program has been used to develop the HCM (Section 3.3) and the IWV Model (Section 3.5). Both the monitoring program and the IWV Model were used jointly to develop criteria and performance measurements to meet the GSP's objectives for sustainable (quantity and quality) water resources for IWV.

Data to be monitored and managed for assessing sustainability under the GSP include physical datasets that describe aquifer structure and characteristics, inflows and outflows of the IWV groundwater budget, and changes in quantity and quality of groundwater in storage. Driller's logs were compiled to understand aquifer structure and occurrence of clay units associated with poorer water quality. Limited aquifer test

[41] https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM/

data (Figure 3-6) provided hydraulic conductivity and storage parameters near pumping areas within the Basin.

3.6.1.1 *Groundwater Levels and Changes to Groundwater in Storage*

The existing groundwater level monitoring network is very robust for establishing changes in groundwater levels over time throughout the Basin. Many of the wells have been monitored for over 20 years, and some for over 50 years. The monitoring network shows groundwater level declines from 0.5 to 2.5 feet per year near pumping areas in the main Basin, and no change or slight increase in other areas of the Basin (Section 3.4.2). Ten multi-level monitoring wells[42] provide vertical gradients of groundwater flow, identifying some of the recharge and discharge areas within the Basin.

Data gaps in the groundwater level monitoring program exist outside of the pumping areas. There are only a few monitoring wells in the El Paso area, mostly open space managed by BLM. Groundwater resources in this area have not been fully characterized or quantified. The largest ephemeral stream system in IWV commences from this area in Freeman and Little Dixie Washes. Additional well drilling to characterize the aquifer structure and properties, and groundwater level monitoring could provide a better understanding of the occurrence and movement of water in this area. Outreach to include existing well owners from this region into the existing monitoring program would be beneficial for evaluating groundwater levels on the southwest side of the fault. The GA has submitted a Technical Support Services (TSS) application with DWR for funding of a multi-level monitoring well in the El Paso sub-basin to address this data gap.

3.6.1.2 *Water Budget*

IWV water budget includes mountain front recharge, groundwater pumping, evapotranspiration, and subsurface flow from Rose Valley and to Salt Wells Valley. Environmental parameters measured to

[42] These ten multi-Level monitoring wells are included in the CASGEM database. Construction details are documented in USBR, 1993.

quantify these budget terms include: precipitation, surface flow, groundwater levels, groundwater pumping, and evaporation.

Data gaps for stream flow and mountain front recharge are being addressed initially under DWR Prop 1 Grant funding. A new weather station is being installed at Chimney Peak Fire Station and the Walker Pass East weather station is being retrofitted to provide high elevation precipitation monitoring at the Sierra Front where most of the recharge is estimated to occur. A new stream gage is being installed within Indian Wells Canyon, and an existing stream gage is being retrofitted in Sand Canyon. Dataloggers are being deployed in six wells within the Sierra stream drainages. More frequent groundwater levels provided by these dataloggers will be used to 1) estimate the rate of drainage within tributary alluvium and fan deposits, and 2) to determine gradients toward the Basin's alluvial aquifer. While observations of these environmental parameters are not expected to change in the future, the location of where these parameters are measured will be refined or expanded as more knowledge is obtained during development and future implementation of the GSP. Data gaps will be re-evaluated at the 5-year progress report following installation, collection, and assessment of these new data for measuring components that contribute to the recharge of the Basin.

Groundwater pumping data are being collected as part of the GSP process from major pumpers including large and small agriculture, mining, water district, mutual water companies, water cooperatives, and the Navy. Domestic groundwater use is currently estimated. A data gap is quantifying domestic well water use. This study has built on previous studies[43] to estimate the number and location of domestic wells. This GSP has refined the domestic users by accounting for municipal and cooperative wells supplying some of the water to rural domestic homes based on aerial photography and nearest location to wells. Ground-truthing domestic well estimates and confirming well construction history would provide a better management tool for assessing shallow well impacts.

Subsurface flows into the Basin from Rose Valley and out of the Basin towards Salt Wells Valley were estimated using the groundwater model. Data gaps for subsurface flow in and out of the Basin are being

[43] Todd Engineers, 2004. Desert Research Institute, 2016.

initially addressed under DWR Prop 1 Grant funding. Dataloggers are being deployed in the northwest downstream of Little Lake to provide a better estimate of subsurface flow from Rose Valley. The Seabees have drilled monitoring wells near the subsurface outflow towards Salt Wells Valley to develop an understanding of subflow between the two basins.

3.6.1.3 *Groundwater Quality Monitoring*

The predominant water quality concern is TDS in the drinking water. Sulfate is also a concern in some domestic wells requiring well head treatment. The existing TDS database has 2051 water quality data from 1920 to present. Most of the data have been collected during field work that included only a limited number of wells, or a one-time sample when the well was drilled. Under DWR Prop 1 Grant funding, a baseline sampling event is being completed in Fall 2019 to monitor 30 wells and 10 springs basin-wide to develop a baseline understanding of the distribution of TDS within Indian Wells Valley. In addition, there are 39 drinking water wells that supply TDS data to the GAMA program within the Basin. These data will be analyzed to support the GA’s management of groundwater resources. Ongoing water quality measurements will be required to verify that salinity is managed within the Basin. Wells that have been selected to be representative monitoring sites (see Section 4.4.3.6) will continue to be evaluated for suitability based on factors including access, well conditions, and others.

3.6.1.4 *Other Data Gaps*

Evapotranspiration at the playa is the largest natural discharge of groundwater within the Basin. DRI installed an eddy covariance station in September 2014 at the south end of China Lake playa to obtain measured data for ET estimates. These data have been incorporated into the IWV Model and no further expansion of ET stations are being planned at this time.

As discussed in Section 3.4.7, most of the GDEs are on Federal property within IWV. The Navy’s Integrated Natural Resources Monitoring Plan (INRMP) inventories and monitors phreatophytic vegetation that relies on groundwater to maintain its ecosystem. Data gaps associated with GDEs in IWV include quantifying root extinction depths, better mapping of vegetation types, and correlating depth to groundwater with vegetative health. Dataloggers were purchased under Prop 1 Grant funding to utilize existing wells in the vicinity of GDEs to monitor groundwater levels. Further coordination with the Navy will be required to evaluate vegetation health as groundwater levels are monitored. Data will start to be collected and analyzed under the Prop 1 Grant funding. These data gaps will be re-evaluated for the 5-year progress report to develop a correlation between measured data and vegetation health.

Limited aquifer property data was used to calibrate the groundwater model. Data gaps for aquifer properties include the El Paso area, northwest, southwest, and southeast areas of the Basin. Prop 1 Grant funding will be used to fill in some of these data gaps using existing production wells in these areas. In addition, the definable bottom of the Basin is a current data gap. It will be evaluated whether deep drilling or more recent geophysical data will provide the necessary data to fill this data gap.

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SECTION 4: SUSTAINABLE MANAGEMENT CRITERIA

4.1 INTRODUCTION

Sustainable Groundwater Management is defined as the "…management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results…" (CWC 10721 (v)). The GSP regulations collectively include four GSP requirements for Sustainable Management Criteria which include: 1) **Sustainability Goal** (see Section 4.2); 2) **Undesirable Results** (see Section 4.3); 3) **Minimum Thresholds** (see Section 4.4); and 4) **Measurable Objectives** (see Section 4.5).

The development of these criteria relies upon information about the IWVGB developed in the hydrogeologic conceptual model, the description of current and historical groundwater conditions, and the water budget. The impacts and estimated changes to future IWVGB conditions from the projects and management actions proposed in Section 5 were considered when developing the sustainable management criteria for the IWVGB. As discussed in Section 3, the IWVGB has been in overdraft for decades and the resulting reduction of useable groundwater in storage, chronic lowering of groundwater levels resulting in wells going dry, and water quality degradation in some wells continue to threaten the long-term viability of the IWVGB. In addition, although the amount of land subsidence due to declining groundwater levels in the IWVGB is relatively small, the SNORT facility at NAWS China Lake, which is a significant asset, has been impacted by subsidence due to both reduction of groundwater levels and tectonic activity. The sustainable management criteria are used to establish thresholds and objectives to ensure the IWVGB does not experience undesirable results in the future.

4.1.1 Sustainability Indicators

SGMA has identified six sustainability indicators which refer to effects caused by groundwater conditions occurring throughout a basin that, when significant and unreasonable, cause undesirable results (Water Code Section 10721(x)). Basin sustainability, and the effectiveness of the proposed plans and programs will be judged by the ability to eliminate the undesirable results and conditions represented by the six sustainability indicators, as applicable to the IWVGB:

- Reduction of Groundwater in Storage
- Chronic Lowering of Groundwater Levels
- Seawater Intrusion
- Degraded Water Quality
- Land Subsidence
- Depletion of Interconnected Surface Water

4.1.2 Representative Monitoring Sites

The IWVGA has selected representative monitoring sites to be used to specifically measure and monitor groundwater conditions caused by the sustainability indicators applicable to the IWVGB and to evaluate the efficacy of the proposed Projects and Management Actions achieving sustainability. These sites were selected based on evaluation of the best available data. As more data becomes available through monitoring and data collection, the representative sites will be reevaluated for effectiveness at representing basin-wide conditions. Data from these sites, along with measured and verified groundwater production, will be used as the basis for confirming the proposed projects and management actions are having the desired effect on IWVGB management. Data from wells that are not designated as representative monitoring sites will continue to be monitored as part of the complete monitoring network as they provide valuable data and information regarding overall Basin conditions.

4.2 SUSTAINABILITY GOAL

4.2.1 Background

DWR states that "SGMA requires local agencies to develop and implement GSPs that achieve sustainable groundwater management by implementing projects and management actions intended to ensure that the basin is operated within its sustainable yield by avoiding undesirable results" (DWR, 2016). As discussed in Section 3.3.5, the sustainable yield is a crucial and fundamental element of GSP development, including establishing sustainable management criteria. The importance of the IWVGB sustainable yield is magnified by the fact that groundwater is the sole source of potable water in the IWV. The results of the water balance analysis indicate the natural long-term average recharge of 7,650 AFY is the current estimated sustainable yield.

As discussed in Section 3.3.4.4, it is well documented that IWV has been in overdraft since at least the 1960s (Dutcher and Moyle, 1973). Current IWVGB outflows are approximately four times the inflows (see Section 3.3.4). The IWV community is currently experiencing the consequences of prolonged overdraft and will continue to experience increasing environmental, social, and economic impacts if sustainability is not achieved (see Section 4.3).

Water reliability is critical to sustain the community and the diverse interests that operate in the IWV. It is also critical to military sustainability and resiliency at NAWS China Lake. The current overdraft conditions indicate groundwater resources in the IWVGB are not currently sustainably managed and water supply and demand management projects must be implemented in order to preserve the water resource and maintain the community.

4.2.2 Description of Sustainability Goal

The sustainability goal is to manage and preserve the IWVGB groundwater resource as a sustainable water supply. To the greatest extent possible, the goal is to preserve the character of the community, preserve the quality of life of IWV residents, and sustain the mission at NAWS China Lake. The absence of undesirable results, defined as significant and unreasonable effects of groundwater conditions, throughout the planning horizon will indicate that the sustainability goal has been achieved. The sustainability goal will be accomplished by achieving the following objectives:

- Operate the IWVGB groundwater resource within the sustainable yield.
- Implement projects and management actions to reduce IWVGB groundwater demands, increase reuse of current supplies, obtain supplemental water supplies, and mitigate undesirable results.

- Monitor the IWVGB actively and thoroughly and adaptively manage the projects and management actions to ensure the GSP is effective and undesirable results are avoided.

4.2.3 Sustainability Measures

The IWVGA is developing a series of projects and management actions that will reduce demands and increase supplies, helping achieve the sustainability goal. These projects are briefly summarized below and described in greater detail in Section 5. If one or more of the planned measures to achieve the sustainability goal are not able to be realized, the proposed projects and management actions may need to be modified, including potential additional measures to reduce groundwater production to reach sustainability.

- Implement Annual Pumping Allocation Plan, Transient Pool and Voluntary Fallowing Program. A Pumping Allocation Plan, Transient Pool Allocation, and Voluntary Fallowing Program will be implemented in 2020. Pumping allocations will be assigned to qualified pumpers and implemented consistent with existing groundwater rights and priorities including health and safety, municipal and industrial, and the Federal reserve of water necessary for military purposes.
- Optimize recycled water use. The City's current recycled water supplies will be optimized for direct and indirect reuse to reduce groundwater demands. The expanded recycled water project is anticipated to be online in 2025.
- Continue emphasis on water conservation. Conservation pilot projects in severely disadvantaged communities will be implemented in 2020. In addition, the IWVGA and beneficial users of groundwater in the IWV will continue to evaluate and implement additional measures to reduce groundwater demands.
- Obtain an imported water supply. After all projects and management actions that increase IWVGB water supplies or reduce water demands are fully implemented (Pumping Limitations, Recycled Water Project, and Conservation), it is anticipated groundwater demands will continue to be greater than the current sustainable yield. Accordingly, the IWVGA will continue to develop a firm imported water supply to be available by no later than 2040 to ensure groundwater pumping

equals sustainable yield (including imported water replenishment.) The goal is to have the imported water project online by 2035.

- Pumping Optimization. Pumping will be optimized throughout the IWVGB by moving pumping from areas with high volumes of pumping to areas with lesser pumping in order to mitigate undesirable results caused by pumping depressions and chronic lowering of groundwater levels by 2025.
- Shallow Well Mitigation. Shallow wells impacted by degraded water quality and/or lowering of groundwater levels will be mitigated on an ongoing basis.
- Dust Control Mitigation. Potential undesirable results caused by potential increased windblown dust and sand resulting from agriculture fallowing will be mitigated on an ongoing basis.

4.2.4 Explanation of How Goal will be Achieved

The sustainability goal is described in Section 4.2.2 with the specific measures to achieve the goal listed in Section 4.2.3 above. The following is a summary of how those measures will collectively achieve the sustainability goal by 2040. (See Section 5.2 and Section 6.3 for additional information including discussion on project costs, funding, and schedule.)

- Implement Annual Pumping Allocation Plan, Transient Pool and Fallowing Program. This management action will have a direct impact in achieving sustainability by reducing overdraft conditions and will be directly quantified through reported groundwater production and verified through groundwater elevation measurements. There is a direct relationship between reduced extractions and a decrease in the rate of decline of groundwater levels in the IWVGB. Furthermore, reduced groundwater pumping will mitigate undesirable results by reducing or eliminating localized pumping depressions, minimizing impacts to shallow wells, reducing annual overdraft, minimizing or eliminating adverse impacts to groundwater water quality (which will be quantified through groundwater quality sampling), and minimizing land subsidence caused by excessive groundwater extraction.
- Optimize recycled water use. A recycled water project to optimize reuse of the City's recycled water supply will be implemented by 2025. This project will have a direct impact in achieving

sustainability through reduced groundwater demands and reduced overdraft which will be directly quantified through reported groundwater production and metered use of recycled water use and verified through groundwater elevation measurements.

- Continue emphasis on water conservation. As discussed previously, the U.S. Navy, IWVWD, and others have already implemented successful conservation measures. Conservation will have a direct impact toward achieving sustainability through reduced groundwater demands which will be quantified directly through reported groundwater pumping and indirectly through groundwater elevation measurements. Individual groundwater savings resulting from the conservation programs will be measured and documented.
- Obtain an imported water supply. It is anticipated that the IWVGA will have an imported water supply by 2035. The addition of imported water for either direct use and/or groundwater replenishment will have a quantifiable benefit by reducing overdraft conditions which will be identified through reported groundwater pumping, groundwater level measurement, and metered use or delivery of imported water. Furthermore, increased use of imported water to offset pumping of water from the IWVGB will mitigate undesirable results by reducing or eliminating localized pumping depressions, reducing impacts to shallow wells, reducing annual overdraft, reducing or eliminating adverse impacts to groundwater water quality (which will be quantified through groundwater quality sampling), and minimizing land subsidence caused by excessive groundwater extraction.
- Pumping Optimization. The pumping optimization project will be implemented by 2025. It will directly contribute to mitigation of undesirable results caused by chronic lowering of groundwater levels and results will be verified by groundwater level measurements.
- Shallow Well Mitigation. The Shallow Well Mitigation Program will directly contribute to mitigating undesirable results caused by reduction of groundwater in storage, chronic lowering of groundwater levels, and degraded water quality.
- Dust Control Mitigation. The Dust Control Mitigation Program will directly contribute to mitigating secondary undesirable results and environmental impacts caused by the fallowing of agriculture lands.