# Groundwater Sustainability Plan
# Alternative Annual Report
# 2019 Water Year

**(October 1, 2018 to September 30, 2019)**

## Eel River Valley Groundwater Basin
## Humboldt County, California

Prepared for:

## Humboldt County Public Works Department


Prepared by:
**SHN**

In Collaboration with:
**County of Humboldt Public Works Department**


**April 2020**
**016219**

Reference: 016219

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# Eel River Valley Groundwater Basin
# Humboldt County, California

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April 2020

QA/QC:GDS GDS

# Table of Contents



# List of Illustrations

# Abbreviations and Acronyms

| | |
|---|---|
| mg/L | milligrams per liter |
| | |
| Basin | Eel River Valley Groundwater Basin |
| CASGEM | California Statewide Groundwater Elevation Monitoring |
| CCR | California Code of Regulations |
| County | Humboldt Public Works Department |
| CSD | Community Service District |
| DWR | Department of Water Resources |
| g | sourced from groundwater |
| GSA | Groundwater Sustainability Agency |
| GSP Alternative | groundwater sustainability plan alternative |
| HCRCD | Humboldt County Resource Conservation District |
| MW-# | monitoring well-number |
| N/A | not available |
| NAVD88 | North American Vertical Datum, 1988 |
| NR | no reference |
| PECG | Palmer Environmental Consulting Group |
| s | sourced from surface water |
| SGMA | Sustainable Groundwater Management Act |
| SGWP | Sustainable Groundwater Planning |
| USGS | U.S. Geological Survey |
| Working Group | Eel River Valley Groundwater Basin Working Group |
| WY | Water Year |

# Executive Summary

The 2019 Water Year (WY) from October 1, 2018, through September 30, 2019, was a relatively wet year based on total precipitation (57.3 inches) measured at the Scotia Climate Station (048045) and was a wet irrigation season with irrigation beginning around June 1, 2019. The groundwater sustainability plan alternative (GSP Alternative) submitted to the Department of Water Resources (DWR) in December 2016 (SHN, 2016) showed that groundwater levels within the Eel River Valley Groundwater Basin (Basin) (Figure 1 in Appendix 1) have a relatively narrow range of fluctuation and have remained generally stable over time, including during the droughts of 1976-1977, 1987-1992, and the most recent drought of 2013-2015. Groundwater elevation measurements collected over the course of the 2019 WY indicate that water levels are consistent with historical fluctuations observed in wells associated with the California Statewide Groundwater Elevation Monitoring (CASGEM) program. A system of transducers collecting continuous water level data remains in place within select wells and river locations within the Basin.

Groundwater extraction within the Basin continues to be primarily associated with irrigation and municipal use. Studies carried out to support the preparation of the GSP Alternative (HCRCD, 2016; PECG, 2016) indicated that the total volume of groundwater use represents a very small percentage of annual recharge within the Basin. There is very little growth of the agricultural sector or the general population within the Basin. Further, there are no ongoing or anticipated future changes to the conditions of use within the Basin that would significantly change the water balance.

The Eel River Valley Groundwater Basin is a coastal basin and seawater intrusion is a potential undesirable condition. As reported in the GSP Alternative, chloride sampling conducted in Fall 2016 within the lower Basin indicated the position of the seawater/freshwater transition zone in the shallow alluvial aquifer is comparable to the position mapped in 1975 (USGS, 1978). In fall of 2018 and spring of 2019, additional sampling was conducted in selected wells, the results for which indicate no significant changes have occurred.

On November 13, 2019, DWR submitted its final determination that the GSP Alternative was disapproved, triggering the need to establish a Groundwater Sustainability Agency (GSA) and develop a full GSP. The formation of a GSA is in progress at the time of this writing. The County has applied and been approved for grant funding under Proposition 68 for the additional studies necessary to prepare a GSP. The additional studies will improve the understanding of the Basin and provide the framework for the development of sustainable criteria in compliance with the requirements of the Sustainable Groundwater Management Act (SGMA).

# 1.0 Introduction

As a result of Sustainable Groundwater Management Act (SGMA) regulations approved in 2014, the County of Humboldt Public Works Department (County) took the lead role in organizing the local response to SGMA for the Eel River Valley Groundwater Basin (Basin; Figure 1). In October 2015 the Eel River Valley Groundwater Basin Working Group (Working Group) was formed. The Working Group includes stakeholders representing agricultural, municipal, and environmental interests and is instrumental in facilitating compliance with the SGMA. From 2015 through December 2016, the County and Working Group conducted several meetings to discuss compliance and data needs to meet requirements of the SGMA and implemented a groundwater assessment with funding from a Proposition 1 Sustainable Groundwater Planning Grant.

The County submitted to the Department of Water Resources (DWR) a groundwater sustainability plan alternative (GSP Alternative) in December 2016 for the Eel River Valley Groundwater Basin in collaboration with the Working Group. The GSP Alternative was formally disapproved on November 13, 2019, and the process of forming a GSA and the development of a full GSP is ongoing. Proposition 68 Grant funding will be used to install new wells and conduct additional studies. The annual reporting will continue during this process and will include additional data as it is acquired. At this time, the data and analysis provided in this 2019 annual report includes the commitments originally outlined in the 2016 GSP Alternative. The monitoring network and sampling program proposed in the GSP Alternative is shown on Figure 2 and summarized in Table 1.

**Table 1. Monitoring Network and Sampling Program**
**Eel River Valley Groundwater Basin**

| Location | Analysis | Frequency | Responsible Agency |
|---|---|---|---|
| CASGEM[1] Wells | Depth-to-Water (feet) | Bi-annually | DWR[2] |
| USGS River Stations | River Stage (feet) | Continuous | USGS[3] |
| Temporary River Stations | River Stage (feet) | Continuous | County |
| County Monitoring Wells (9 total) | Depth-to-Water (feet) | Bi-annually | County |
| | Chlorides (mg/L)[4] | 1X/5 Years | County |
| MW-2 | Depth-to-Water (feet) | Continuous | County |
| MW-5/MW-7 | Chlorides (mg/L) | Bi-annually | County |

1. CASGEM: California Statewide Groundwater Elevation Monitoring
2. DWR: State of California Department of Water Resources
3. USGS: U.S. Geological Survey
4. mg/L: milligrams per liter

Based on the requirements contained in the California Code of Regulations (CCR), Title 23, §350 et seq. an annual report must be submitted to the DWR by April 1st of each year. This annual report provides a discussion and the results of studies conducted during the 2019 Water Year. Also included is an update on water use and groundwater storage for the preceding water year. This submittal will be processed through the SGMA Portal – Alternative Reporting System monitored by DWR.

# 2.0 2019 Water Year

Precipitation totals for the 2019 water year as measured at the Scotia Climate Station 048045 and reported by the Western Regional Climate Center totaled 57.26 inches (Figure 3), whereas the mean yearly precipitation is 47.98 inches. The wet season started late with significant rains not picking up until mid-November. Rainfall in the months of February (17.62 inches) and May (4.78 inches) were over twice their respective historical averages. There were numerous storm events over the season, including a major flood event at the end of February. River discharge and gage height data for the U.S. Geological Survey (USGS) stations at Scotia (11477000) and Bridgeville (11478500) on the Eel and Van Duzen Rivers, respectively, are provided as Figures 4 and 5.

# 3.0 Groundwater Elevation Data

The principal aquifers within the Basin have been loosely defined based on the primary stratigraphic units of the Basin–the shallow alluvial aquifer and the underlying aquifer associated with the Carlotta Formation.

Groundwater use in the Basin is primarily sourced from the alluvial aquifer, which is on the order of 100 to 200 feet thick. Most wells within the valley have been installed at a depth of less than 100 feet. Due to the scarcity of wells screened within the deeper Carlotta aquifer, and the lack of historical data, the discussion and presentation of groundwater elevation data provided in this report is focused on the shallow alluvial aquifer.

Groundwater elevation data for the 2019 WY included in this annual report (Appendix 2) has been made available from the following sources:

1. Two rounds of groundwater elevation measurements conducted by DWR as part of the California Statewide Groundwater Elevation Monitoring (CASGEM) Program
2. Two groundwater elevation measurement campaigns, one conducted in Fall 2018 and one in Spring 2019
3. A transducer study conducted within selected wells adjacent to the Eel and Van Duzen rivers

## 3.1 CASGEM Program

The seasonal groundwater elevation measurements collected as part of DWR's CASGEM program provide the best opportunity to evaluate long-term groundwater elevation trends. Groundwater elevations were measured by DWR staff in five wells in Fall 2018 and Spring 2019. The groundwater elevations recorded are observed to be consistent with historical values. The locations of the CASGEM wells and their associated hydrographs are shown on Figure 6. Individual hydrographs are also included in Appendix 3.

## 3.2 Groundwater Elevation Contour Maps

In Fall 2018, and again in Spring 2019 groundwater elevations were recorded in wells within the Van Duzen and Eel River valley bottoms in general coordination with the timing of the CASGEM well measurements. There was a total of 9 wells measured, 6 of which consist of shallow/deep well pairs.

Depth-to-water measurements within the county wells were collected by staff from SHN, whereas depth-to-water measurements in the municipal wells were provided by municipal staff. Groundwater elevation contour maps and the locations of the wells used to develop them for the Fall 2018 and Spring 2019 sampling events are shown as Figures 7 and 8, respectively, and details of the monitoring are included in Tables 2-1 and 2-2 (Appendix 2).

Groundwater contours in both Fall 2018 and Spring 2019 indicate that flow is consistently toward the ocean (westward) with gradients and directions mimicking the topography of the valley floors. Flow gradients within the Eel River Valley are generally shallow with Fall elevations ranging from approximately 30 feet along the eastern edge of the valley floor to 5 feet nearest the ocean. A much steeper groundwater gradient is observed within the Van Duzen watershed with elevations ranging from 120 feet within Yager Creek down to 30 feet at the intersection with the Eel River Valley. In general, the elevation changes between the Spring and Fall season were on the order of 4 to 7 feet, except for MW-8 and MW-11, which had elevation changes of ~13 feet and ~9 feet, respectively.

## 3.3 Freshwater-Seawater Transition Zone

The freshwater-seawater transition zone was originally mapped by the USGS in 1975 (USGS, 1978). The 1975 study used a chloride concentration of 100 milligrams per liter (mg/L) as an indicator of the landward edge of the freshwater-seawater transition zone within the shallow alluvial aquifer. In 2016, two wells, MW-5 and MW-7 were installed within the vicinity of the transition zone. The wells were located approximately two to three thousand feet landward of the 100 mg/L line mapped by the USGS and were identified in the GSP Alternative as indicator wells to be used to monitor for changes in the position of the freshwater-seawater transition zone. Each well location consists of two nested wells, each screened at a shallow and a deep interval. Bi-annual sampling and chloride testing are conducted at each of the two wells, including the Fall 2018 and Spring 2019 groundwater elevation measurement campaigns discussed above. The chloride values measured in the shallow zone are consistent with historical data and confirm that the location of the freshwater-seawater as mapped in 1975 remains appropriate.

Historical and recent studies show there is much more variability in the chloride concentrations measured in wells that are screened at depths below 100 feet. This is likely reflective of the stratigraphic complexity of the deeper Eel River Valley deposits. The chloride concentrations within the deep well at the MW-5 location, screened at a depth of 200 to 210 feet, has remained fairly constant with values ranging from 54 to 70 mg/L, while the deep well at the MW-7 location, screened at a depth of 230 to 240 feet, has shown a slight increase in chloride concentration from 240 mg/L in Spring 2017 to 290 mg/L in Spring 2019. The location of the freshwater-seawater transition line mapped by the USGS is shown on Figure 9 along with the 2019 WY test results for MW-5 and MW-7, as well as a wider array of wells tested in Spring 2017.

## 3.4 Surface and Groundwater Monitoring using Pressure Transducers

Pressure transducers have been maintained within wells and river stations in both the Eel and Van Duzen rivers to monitor the surface water and groundwater levels since Fall 2016. There is strong interconnection between the major rivers in the Basin and the underlying alluvial aquifers. The fluctuation of river flows associated with winter storms and its effect on the aquifer is clear in the hydrographs of monitoring wells adjacent to the river system. This observation is consistent with the relatively high hydraulic conductivity of the granular alluvial material that was encountered when installing the wells.

A technical memorandum entitled “Preliminary Analysis of Surface Water/Groundwater Monitoring” was prepared in October 2019 that reviews the surface water/groundwater monitoring from Fall 2016 into 2019 (SHN, 2019).

During the 2019 WY, transducers were maintained within temporary installations at two locations within the major rivers (R-3 and R-4), and two County monitoring wells (MW-2 and MW-9) as shown on Figure 10. Internal memory was exhausted in MW-2d, MW-9d and R-4 in June 2019. MW-2d and MW-9d were cleared and restarted on October 3, 2019. The R-4 installation was abandoned as discussed below in the monitoring section on Van Duzen River. Hydrographs of locations monitored during the 2019 WY are provided in Appendix 3.

### 3.4.1 Eel River Monitoring

The R-3 installation has been maintained through the 2019 WY. Some damage to the R-3 installation during the late February flooding required that it get pulled and reconstructed. There is a gap in the monitoring data between April 4, 2019 and April 24, 2019. The R-3 hydrograph is used alongside the hydrographs from

MW-2 to evaluate the surface water-groundwater interactions. To facilitate this, the R-3 hydrograph is manually adjusted ("tied") to the MW-2 graphs using manual field measurements of the surface water elevations nearest the MW-2 location. Although the R-3 and MW-2 locations are separated by approximately 3,500 feet, the R-3 hydrograph has fit reasonably well with the manual measurements over the course of the monitoring since Fall 2016. The R-3 hydrograph segment between April 24, 2019, and October 3, 2019, however, does not appear to align as well. Although multiple field measurements are not available for that segment to verify, it appears that the surface water elevation near the MW-2 location now has a wider range than it used to, possibly due to river channel changes (such as, incision) near the MW-2. The suitability of the R-3 station location will be evaluated. and a new surface water monitoring location may be necessary.

Consistent with historical data, the water elevations observed in the Eel River and the adjacent aquifer at the location of MW-2 are very closely tied, with peaks in the aquifer very tightly mimicking the peaks in river elevations (see Appendix 3). Rain events and associated rises in the river generally produced losing stream conditions (flow gradients toward the aquifer) and periods between rain events produced gaining stream conditions (flow gradients toward the river).

In general, the surface water and groundwater remain closely tied during the course of the dry season (within a foot of each other) with a gaining stream condition changing to a losing stream condition sometime in mid-summer and remaining that way until the initial storm systems of the wet season begin. A manual measurement of the surface water at the MW-2 location on October 3, 2019, indicated that the surface water and the groundwater were at the same elevation, suggesting that a losing stream condition had yet to develop. The water elevations in both the surface and ground typically equalize at an elevation of approximately 19 feet (near MW-2). There does not appear to be an obvious influence on water levels associated with nearby pumping or the starting and ending of the irrigation season, which generally occurred between June 1 and October 1.

### 3.4.2 Van Duzen River Monitoring

Monitoring of the Van Duzen River and adjacent aquifer has been facilitated with monitoring well MW-9 and the River 4 installation (R-4), situated approximately 1,300 feet apart from each other within the central portion of the Van Duzen valley floor.

It was clear during site visits in the Spring and Summer, once river levels receded, that the high flows and flooding over the 2018/2019 wet season had resulted in a substantial change in the channel morphology of the Van Duzen river near the R-4 location. The banks upstream and across the river showed signs of significant erosion and the channel had migrated toward the south side of the river (away from R-4). The thalweg of the main channel had incised to such an extent that the elevation of the surface water in the summer and fall was below the elevation of the transducer in R-4, leaving it dry. The R-4 installation, which had started silting-in in the fall of 2017, was no longer suitable for monitoring surface water and has subsequently been abandoned. New locations for surface water monitoring in the Van Duzen river will be evaluated as part of the data collection and analysis for the upcoming Proposition 68 grant.

Consistent with historical data, the hydrographs of MW-9 and R-4 indicate that the aquifer gets recharged by the river relatively quickly during the initial peak river flows of the wet season. Water elevations within the aquifer are relatively slow to recede following these peak flows, and result in consistent gradients toward the river in all but the earliest parts of the wet season. Similar to the surface water elevations in the Eel River, the water elevations in the Van Duzen River appear to generally stabilize during the months of

August and September at similar elevations as noted in the 2018 dry season. Data is not available to evaluate the transition from gaining to losing stream conditions as surface water data was not collected beyond June and the station was determined to be unsuitable for surface water monitoring based on changes in the river channel morphology. Similar to previous years, the water levels at the MW-9 location appear to have been affected by nearby pumping during the irrigation season.

Existing transducers will be left in place to continue monitoring water levels, as part of the ongoing monitoring commitments initially outlined in the GSP Alternative. Table 2-3 (Appendix 2) provides details on the locations, including the timeframes for which continuous water level data was being collected over the course of the 2019 WY. The hydrographs from stations monitored during the 2019 WY are provided within Appendix 3. An expanded program for monitoring surface water elevations over the course of the dry season will be implemented as part of the Proposition 68 grant.

# 4.0 Groundwater Use for WY 2019

Groundwater use within the Eel River Valley Groundwater Basin supports agricultural irrigation, municipal distribution, and rural domestic water use. Historically, there has been no comprehensive program for yearly measurement or quantification of total groundwater use in the Basin. In 2016, the Humboldt County Resource Conservation District (HCRCD) carried out an empirical study to estimate irrigated acreage and annual irrigation volume estimates (HCRCD, 2016). The nine municipal entities that extract and distribute water within the Basin coordinated with County staff to provide volumes used over the course of the year. Rural domestic use (private domestic wells) is conservatively estimated at this time. Below, the three primary water use sectors are discussed and the quantification of their extraction volumes for the 2019 WY is provided.

## 4.1 Irrigation Water Use

The GSP Alternative presented a technical memorandum completed by the HCRCD that estimated the irrigation water use rates of irrigated lands within the Basin. The estimated water use for a given year is based on the general start date for irrigation and precipitation received during the irrigation season. Estimated volumes of water use have been developed for each of three “Irrigation Season Types”: dry, normal, and wet (see Table 2).

Based on a review and analysis of the rainfall data collected at the Ferndale Museum, as described in the HCRCD study, the irrigation season can be classified as a “wet” season, largely based on a wet spring and late rains in May. The estimated total acre-feet of groundwater used for irrigation during the 2019 season is, therefore, estimated to be 10,265, with irrigation starting around June 1, 2019. The estimated irrigated acreage for 2019 WY remained the same as that presented in the GSP Alternative and technical memorandum (13,558 acres). Approximately 73% of the irrigated land is situated in the Ferndale area, with the remainder distributed within several geographic areas (Alton, Carlotta, Fortuna, Hydesville, Loleta, Rio Dell, Rohnerville, and Scotia). Figures 11a, 11b, and 11c show the distribution of irrigated acres within the Basin. Table 2 summarizes irrigation water use.

**Table 2. Irrigation Groundwater Use Rate by Water Year (2007-2019)**
**Eel River Valley Groundwater Basin**

| Irrigation Season Type | Water Use Estimate (Acre-Feet) | Associated Years |
|---|---|---|
| Dry Irrigation Season (April 15-October 1) | 16,680 | 2008, 2009, 2013, 2014, 2015 |
| Normal Irrigation Season (May 15-October 1) | 13,600 | 2007, 2012, 2016, 2018 |
| Wet Irrigation Season (June 1-October 1) | 10,265 | 2010, 2011, 2017, 2019 |

## 4.2 Municipal Water Use

There are nine identified municipal users in the Basin. They are made up of community service districts (CSDs), cities/towns, and one tribal nation, all of which collect and distribute water within a larger community. Most extraction is facilitated with source wells, though in the case of the towns of Scotia and Rio Dell, water is primarily sourced from infiltration galleries below the Eel River riverbed, considered to be a surface water source. Del Oro CSD and Riverside CSD both have a combination of wells and shallow collection systems near springs that are collectively considered groundwater. Figure 12 shows the location and service area extent of the municipal water users.

Eight of the nine water suppliers have cooperated in providing extraction volume data covering the past 10 years. A summary of historical (past 10 years) and current municipal water use associated with the eight users is provided in Table 3 below. Record-keeping has varied between entities and not all years were made available. The 2009 to 2015 entries are reported as annual volumes, whereas the 2017, 2018 and 2019 entries are for their respective water years.

The water use reported for Scotia and Rio Dell for the 2018 and 2019 WY includes a breakdown of water derived from infiltration galleries below the Eel River (reported as surface water), whereas years prior to 2018 this distinction was not separated.

Table 3 summarizes municipal water use (domestic, commercial, industrial).

**Table 3. Municipal Water Use, 2009-2019 (Acre-Feet per Year)**
**Eel River Valley Groundwater Basin**

| Supplier | Measuring Device | Accuracy | 2019[1] | 2018[1] | 2017[1] | 2015[2] | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| City of Fortuna | McCrometer flow meter | 99-101 % | 1,292 | 1,252 | 1,262 | 1,445 | 1,595 | 1,654 | 1,540 | 1,333 | 1,399 | 1,423 |
| City of Rio Dell | Electromagnetic flow meter | to 0.5% (±) | 49(g) 252(s) | 7(g) 343(s) | 264 | 254 | 294 | 351 | 315 | 304 | 305 | 327 |
| Town of Scotia | Sparling flow meter | to 2% (±) | 845(s) | 872(s) | 693 | 346 | 363 | 325 | 362 | 422 | 432 | 421 |
| Del Oro Water Co. | Propeller meter | 95% | 177 | 171 | 177 | 46 | 41 | 33 | 29 | 12 | 11 | 19 |

**Table 3. Municipal Water Use, 2009-2019 (Acre-Feet per Year)**
**Eel River Valley Groundwater Basin**

| Supplier | Measuring Device | Accuracy | 2019[1] | 2018[1] | 2017[1] | 2015[2] | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Loleta CSD[3] | Water Specialties mag meter | to 2% (±) | 75 | 93 | 73 | 23 | 23 | 21 | 20 | 20 | 20 | 20 |
| Riverside CSD | Siemens Mag flow meter | to 5% (±) | 29 | 31 | 24 | 24 | N/A | 35 | 32 | 32 | 33 | 32 |
| Palmer Creek CSD | Sensus turbo meter | to 1.5% (±) | 28 | 24 | 23 | 3 | 3 | 3 | 3 | 3 | 3 | 4 |
| Hydesville CSD | Electromagnetic meter | to 1 cubic foot | 113 | 107 | 97 | 97 | 107 | 118 | 124 | 161 | 153 | 126 |
| Bear River | N/A[4] | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| **Total** | **---** | **---** | **2,860** | **2,890** | **2,613** | **2,238** | **2,426** | **2,540** | **2,425** | **2,287** | **2,356** | **2,372** |

1. 2017, 2018 and 2019 are reported in Water Year totals (October of previous year to September of noted year)
2. 2006 to 2015 are reported in annual totals (January to December)
3. CSD: Community Services District
4. N/A: not available

g: sourced from groundwater
s: sourced from surface water

## 4.3 Rural Domestic Water Use

No targeted study for the Basin has been completed to quantify the volume of groundwater extracted by users outside the municipal service areas other than for irrigation purposes. These users would include residential, agricultural, or commercial uses that obtain their water from private wells. For the purposes of capturing the volume of extraction associated with these miscellaneous or otherwise minor uses in the Basin, a conservative estimate is used. An estimate of 1,000 acre-feet was included in the water balance prepared by Palmer Environmental Consulting Group (PECG, 2016), which was included with the GSP Alternative. Until further evaluation of this use sector has been completed, we maintain this value as part of the 2019 WY extraction estimates.

## 4.4 Total Water Use

Agricultural Water Use: ..... **10,265 acre-feet (estimated)**
Municipal Water Use: ..... **2,860 acre-feet (measured)**
Groundwater ..... **1,763 acre-feet**
Surface Water ..... **1,097 acre-feet**
Rural Domestic Water Use: ..... **1,000 acre-feet (estimated)**

**Total Water Use: ..... 14,125 acre-feet**

# 5.0 Changes in Groundwater Storage

Within the Basin, the most reliable long-term data set available to evaluate change in storage over time are the hydrographs for the CASGEM wells. For this reason, our evaluation is focused on the alluvial aquifer of the Lower Eel River Valley. Because use is concentrated in the Lower Eel River Valley, we conclude that the underlying alluvial aquifer is a good proxy for the Basin as a whole.

For the purposes of evaluating trends in the change in groundwater storage, the Eel River Valley was broken into representative polygons based on position within the Basin and general compositional variations in the aquifer material. Each polygon was assigned to a representative CASGEM well within its area. The polygons and their representative CASGEM wells are shown on Figure 13. Sea level was used as a basal boundary to define the storage capacity. This is a practical lower limit as it relates to seawater intrusion and it simplifies the volume calculation. The area within approximately 1.5 miles of the coast was not considered as it is within the intertidal zone, the fluctuation is small, and the water quality is assumed to be poor. The height of the Spring groundwater elevations in each respective well was multiplied by the area of the associated polygon to derive a bulk volume. This volume was then multiplied by a specific yield estimated for each area to develop a quantity of water in storage. Figure 14 shows the change in storage year to year from 1989 to 2019 plotted with the yearly precipitation totals (water year) as measured in Scotia. As expected, the precipitation and storage track very closely with each other. Figure 15 plots the cumulative change over the same period with a net positive shown in 2019.

# 6.0 Plan Implementation Progress–Projects and Management Actions

In 2020, Humboldt County will begin the development of a full GSP, which will be finalized and submitted by January 2022. Proposition 68 grant funding recently awarded to the County will be used to carry out a significant data collection and analysis program, expansion of the monitoring network, and the hydrologic modeling of the surface water-groundwater conditions in the basin. The process of developing the GSP will improve our understanding of the groundwater basin and specific sustainability goals and supporting projects and/or management actions will be defined.

At this time, the monitoring network and program outlined in Section 4.5 of the GSP Alternative remains the primary means for evaluating the basin conditions over time. This network will continue to be used to monitor Basin parameters going into the future. In addition to the monitoring summarized in Table 1, we have also maintained transducers in the paired wells at the MW-7 location (started on August 30, 2018).

# 7.0 References


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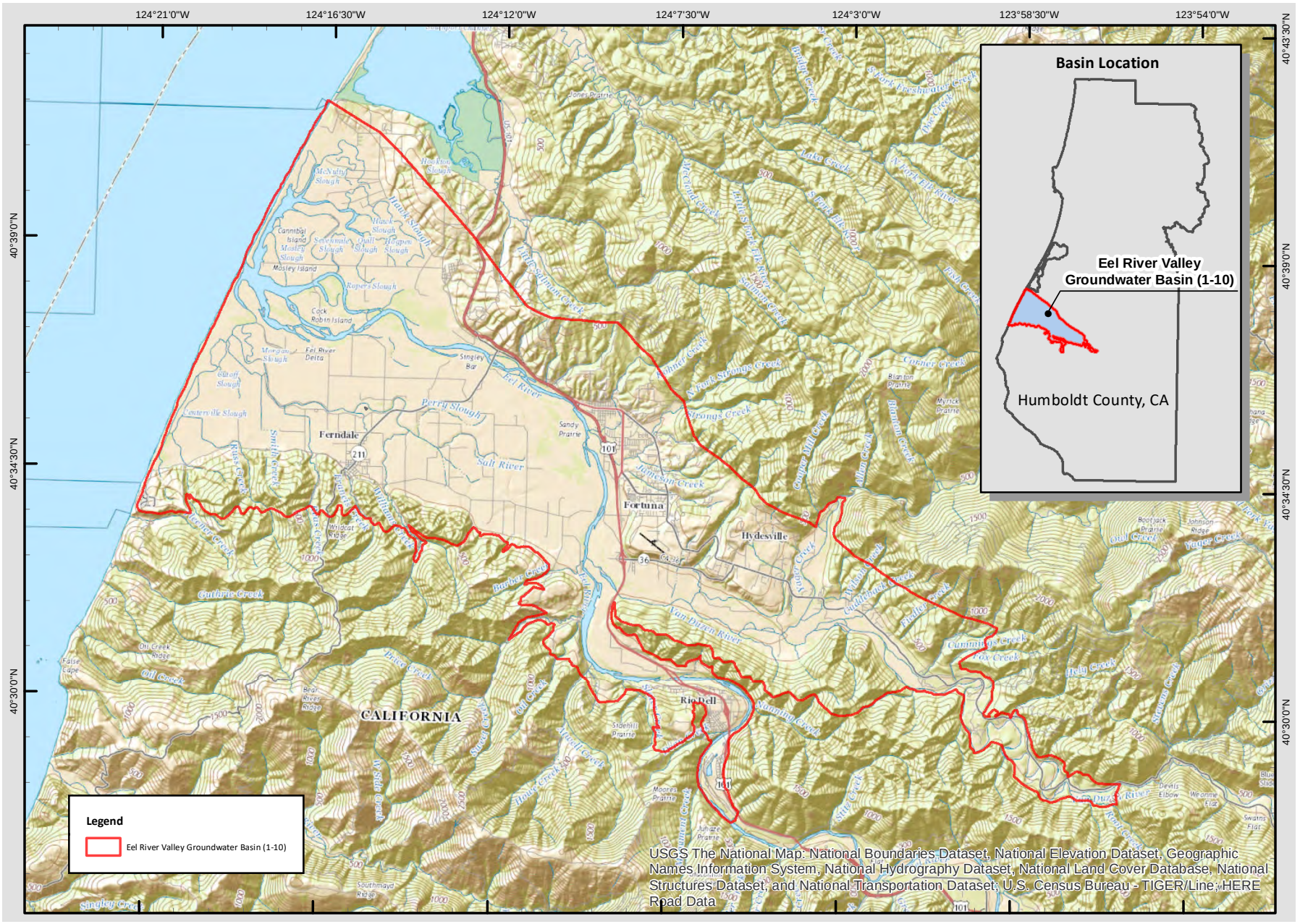
# Figures 1

Path: \\Eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\1_SiteLocationMap.ai

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|---|---|---|---|---|
| ***BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)*** | Consulting Engineers & Geologists, Inc. | Humboldt County Public Works<br>Eel River Groundwater Assessment<br>Humboldt County, California | Site Location Map<br>SHN 016219 | |
| | | March 2020 | 1_SiteLocationMap.ai | Figure 1 |

MW-1 (S/D)
23181
MW-5 (S/D)
23183
MW-7 (S/D)
BI-ANNUAL CHLORIDE SAMPLING IN MW-5 & MW-7
23178
MW-8
36942
36944
TRANSDUCER IN MW-2
MW-2 (S/D)
R3
TEMPORARY RIVER STATION WITH TRANSDUCER
MW-3 (S/D)
MW-9 (S/D)
MW-10
MW-11
USGS BRIDGEVILLE STATION-11478500
USGS SCOTIA STATION-11477000

## EXPLANATION

- RIVER STATION
- CASGEM WELLS
- USGS STREAM GAUGE STATION
- COUNTY MONITORING WELLS
- EEL RIVER GROUNDWATER BASIN

0 8,000
FEET

1"=8,000'

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\2_Monitoring_Network_Locations.mxd

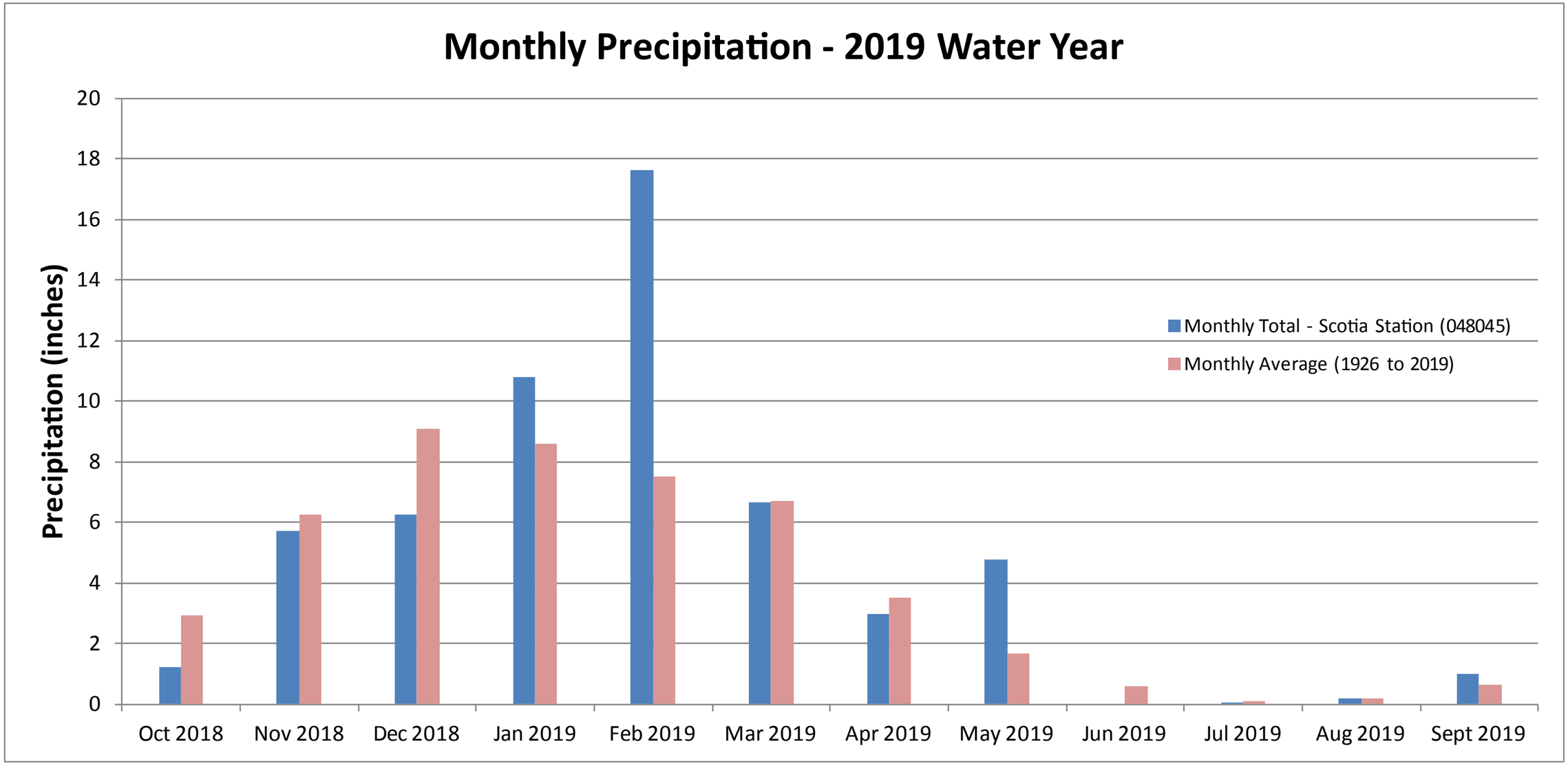
Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Monitoring Network Locations
SHN 016219

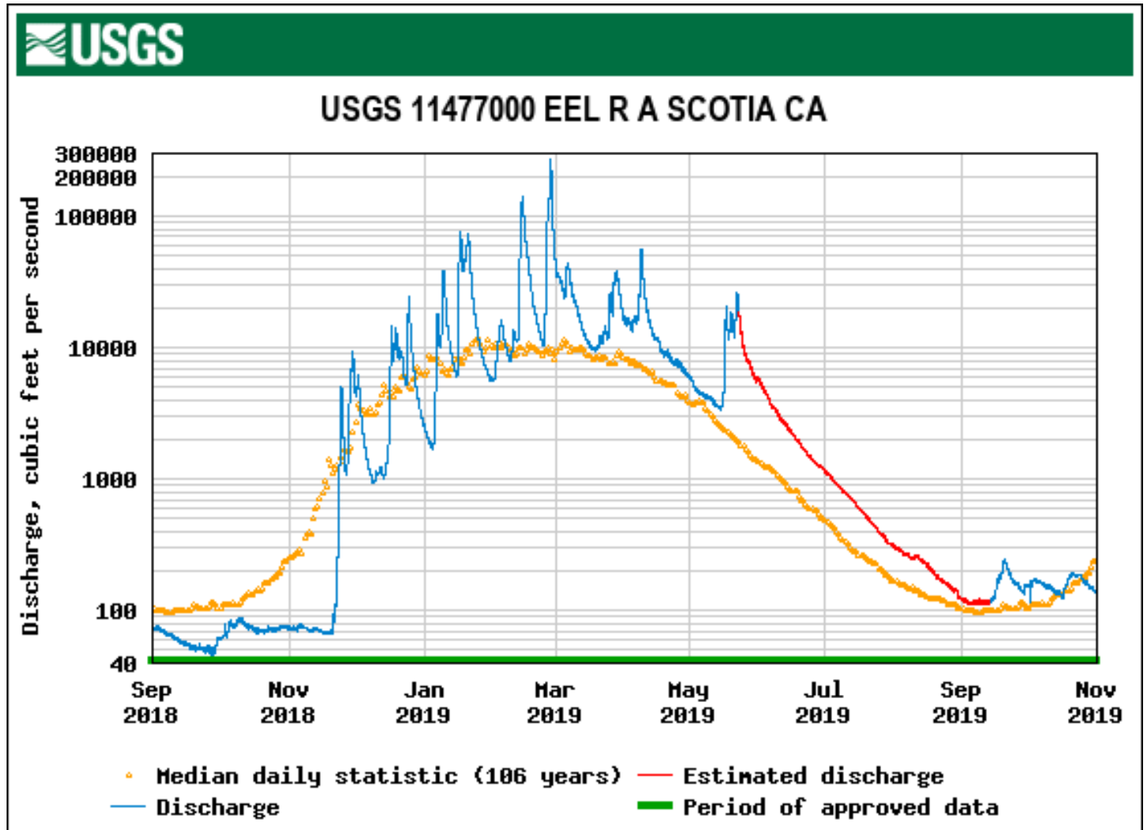
March 2020 | 2_Monitoring_Network_Locations | Figure 2

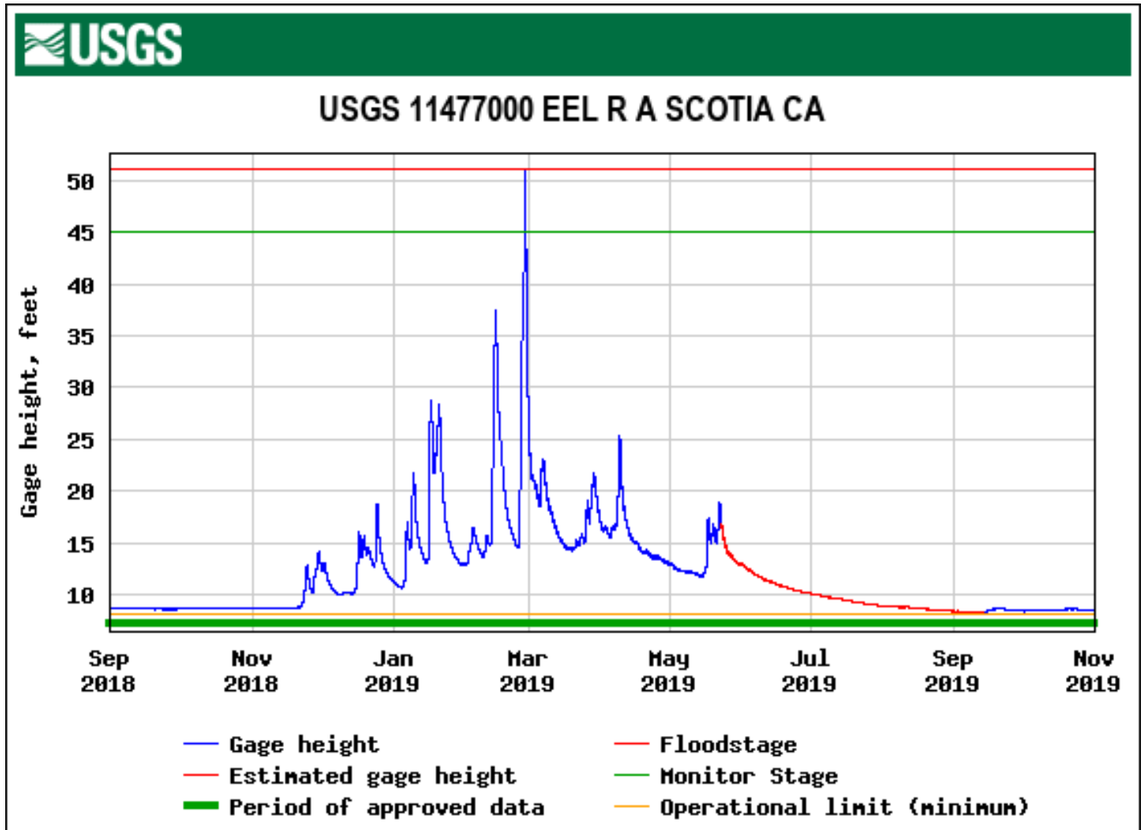
# Monthly Precipitation - 2019 Water Year




Path: \\Eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\3_Precipitation.ai

| | | | |
|---|---|---|---|
| Consulting Engineers & Geologists, Inc. | Humboldt County Public Works<br>Eel River Groundwater Assessment<br>Humboldt County, California | | Monthly Precipitation Totals<br>SHN 016219 |
| | March 2020 | 3_Precipitation.ai | Figure 3 |



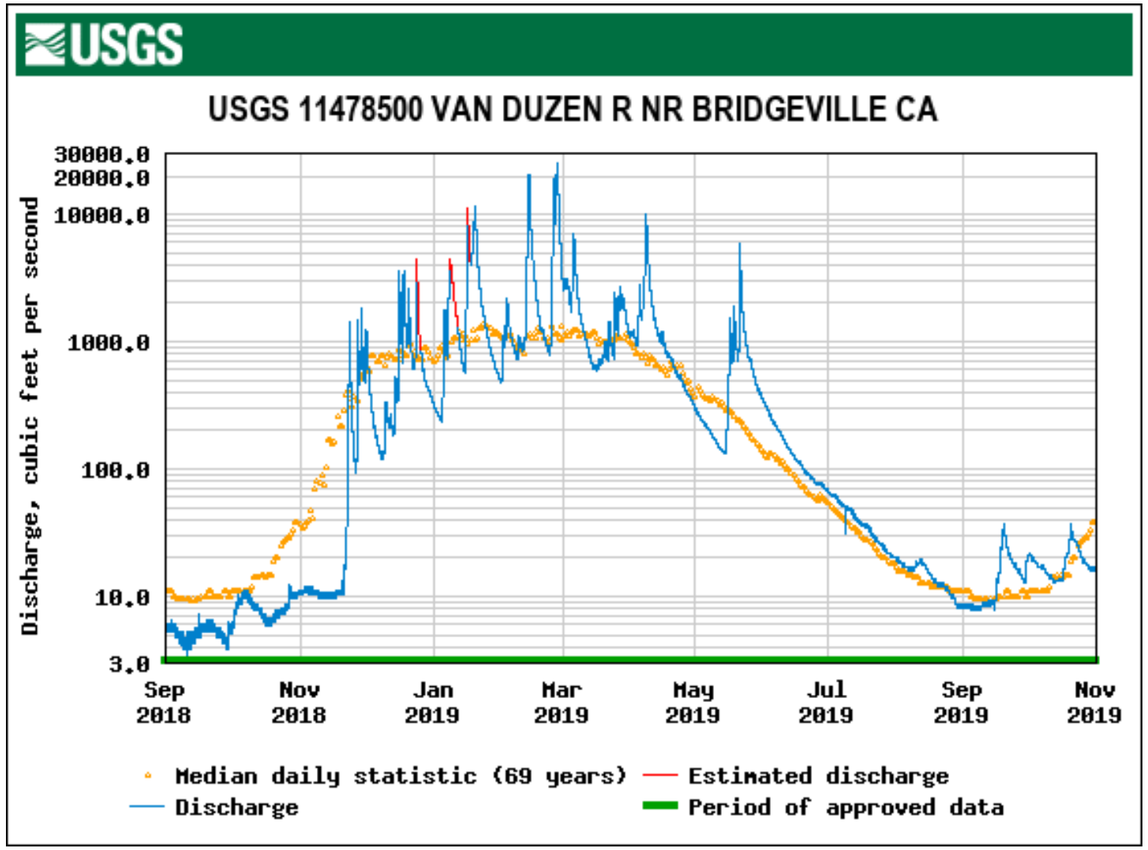

Path: \\Eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\4_ScotiaStationData.ai

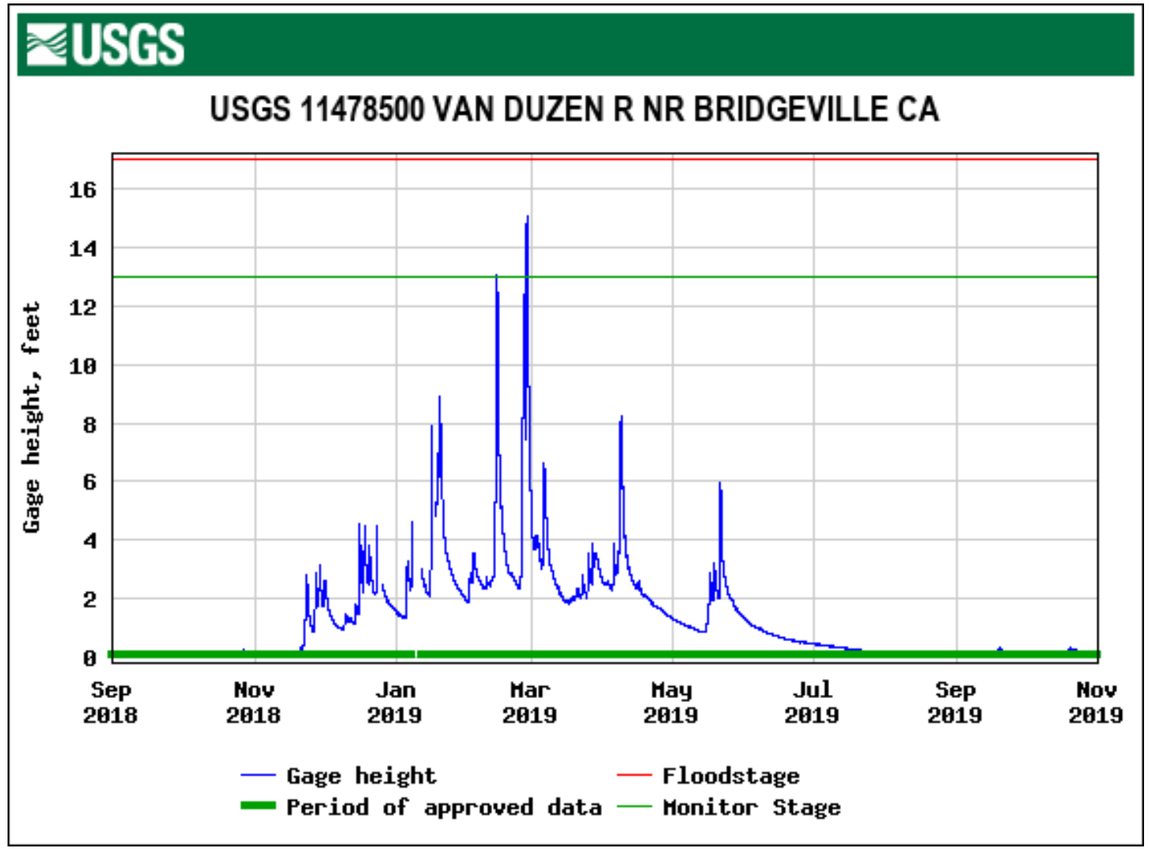
Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Flow and Gage Data
USGS Scotia Station 11477000
SHN 016219

March 2020 | 4_ScotiaStationData.ai | Figure 4




Path: \\Eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\5_BridgevilleStationData.ai

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Flow and Gage Data
USGS Bridgeville Station 11478500
SHN 016219

March 2020 | 5_BridgevilleStationData.ai | Figure 5

WELL DESTROYED IN 2015

NO RECORDS BEYOND 1999

23180

23182

23181

23183

36944

DISCONTINUED IN OCTOBER 2017

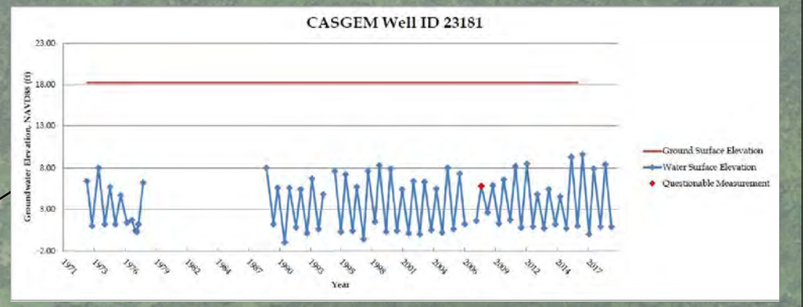
36943

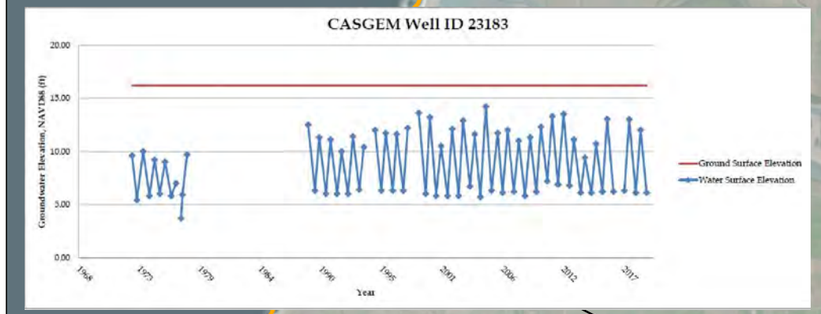
23178

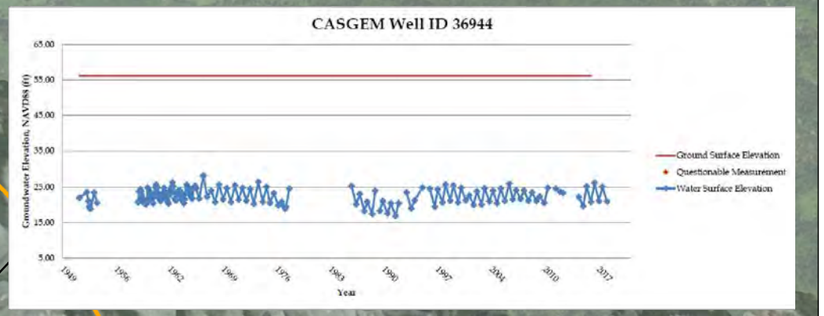
36942

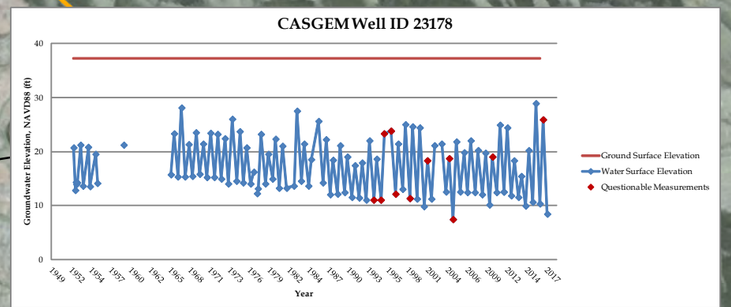
RECORDS ONLY FROM 1986 TO 1994

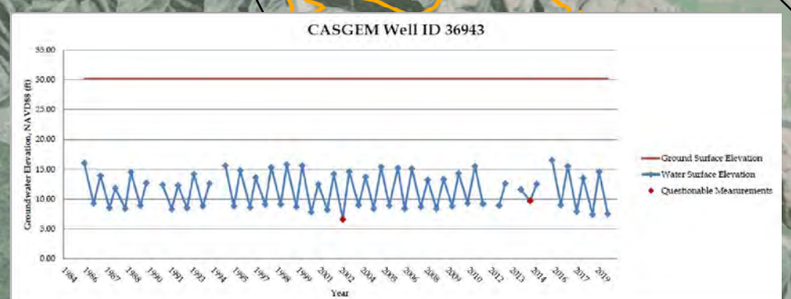
23179

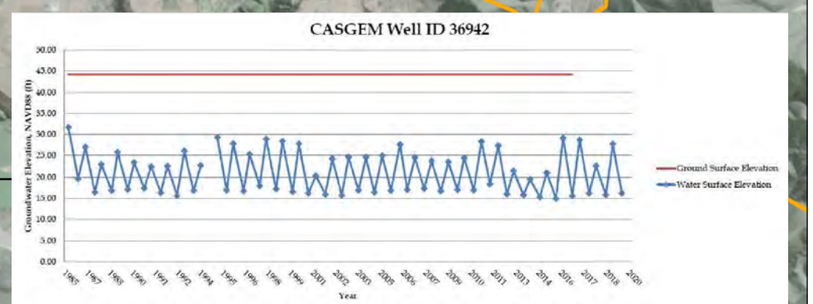



## EXPLANATION

CASGEM WELLS

EEL RIVER GROUNDWATER BASIN

0 1

MILES

1 " = 1 MILES



Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\6_CASGEMWell_Locations.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River GW Assessment
Humboldt County, California

CASGEM Well
Locations and Hydrographs
SHN 016219

March 2020 | 6_CASGEMWell_Locations | Figure 6

FALL 2018 GROUNDWATER CONTOUR MAP

10
10
20
30
40
50
60
40
50
70
80
90
100
120
110

## EXPLANATION

EEL RIVER GROUNDWATER BASIN

WELLS

CASGEM WELLS

COUNTY MONITORING WELLS

N

1"= 10,000'±

0 10,000

FEET



Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\7_GW_Elevations_Fall2018.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River GW Assessment
Humboldt County, California

Groundwater Elevation
Map - Fall 2018
SHN 016219

March 2020 | 7_GW_Elevations_Fall2018 | Figure 7

# SPRING 2019 GROUNDWATER CONTOUR MAP

10
20
30
40
50
60
70
80
90
100
110
120

## EXPLANATION

EEL RIVER GROUNDWATER BASIN

WELLS

CASGEM WELLS

COUNTY MONITORING WELLS

N

1"= 10,000'±

0 10,000

FEET

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\8_GW_Elevations_Spring2019.mxd

Consulting Engineers & Geologists, Inc.

| | | |
|---|---|---|
| Humboldt County Public Works<br>Eel River GW Assessment<br>Humboldt County, California | | Groundwater Elevation<br>Map - Spring 2019<br>SHN 016219 |
| March 2020 | 8_GW_Elevations_Spring2019 | Figure 8 |

## EXPLANATION

100 mg/l LINE OF EQUAL CHLORIDE CONCENTRATION (Johnson, 1975)

CERTAIN

APPROXIMATE

CHLORIDE SAMPLE LOCATIONS

SPRING 2017 CHLORIDE DATA VALUES (mg/L)

INDICATES WELL DEPTH >100 FEET

23/20 INDICATES SHALLOW/DEEP CONCENTRATIONS

N

1"=3,000'±

0 3,000

FEET

1975 CHLORIDE CONCENTRATION 100 MG/L

1600 280 75 120 140 28 4 28 22 62/61 29 40 16/19 30 62 38 2100 97 97 30/240 33 51 290 43 43

| | 11/30/2018 | 4/18/2019 |
|---|---|---|
| MW-5s | 56 mg/L | 45 mg/L |
| MW-5d | 70 mg/L | 54 mg/L |

| | 11/30/2018 | 4/18/2019 |
|---|---|---|
| MW-7s | 22 mg/L | 24 mg/L |
| MW-7d | 280 mg/L | 290 mg/L |

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\9_Chloride_Concentrations.mxd

Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

2019 WY Chloride Concentrations Map
SHN 016219

March 2020 | 9_Chloride_Concentrations | Figure 9

RIVER AND WELL LOCATIONS MONITORED
DURING THE 2019 WATER YEAR

MW-1 (S/D)
MW-5 (S/D)
MW-7 (S/D)
MW-8
MW-2 (S/D)
R-3
MW-3 (S/D)
MW-10
MW-9 (S/D)
R-4
MW-11

## EXPLANATION

- SURFACE WATER TRANSDUCERS

COUNTY MONITORING WELLS

- WITH TRANSDUCER
- WITHOUT TRANSDUCER
- EEL RIVER GROUNDWATER BASIN

0 6,000
FEET

1 "= 6,000 '

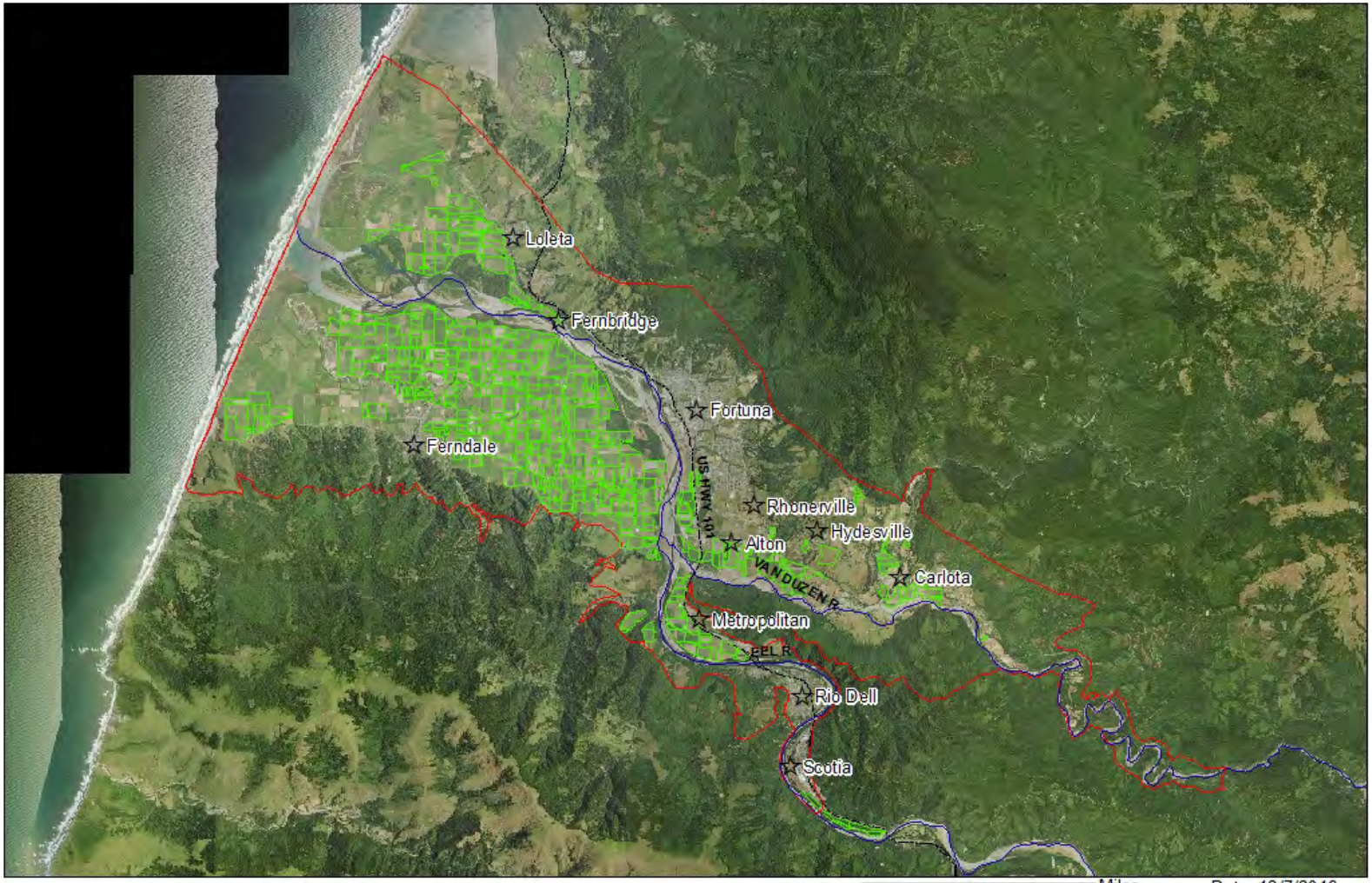
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\10_GWSW_Monitoring_Locations.mxd

SHN Consulting Engineers & Geologists, Inc.

| | | |
|---|---|---|
| Humboldt County Public Works<br>Eel River Groundwater Assessment<br>Humboldt County, California | | Groundwater and Surface Water Monitoring Locations<br>SHN 016219 |
| March 2020 | 10_GWSW_Monitoring_Locations | Figure 10 |

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\IrrigatedAcreages11a.ai




| | | | |
|---|---|---|---|
| *BASEMAP FROM HUMBOLDT COUNTY RESOURCE CONSERVATION DISTRICT ( 2016)* | SHN Consulting Engineers & Geologists, Inc. | Humboldt County Public Works<br>Eel River Groundwater Assessment<br>Humboldt County, California | Irrigated Acreages<br>SHN 016219 |
| | | March 2020 | IrrigatedAcreages11a.ai \| Figure 11a |

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\IrrigatedAcreages11b.ai


**Irrigated Acres**

Irrigated Acres

Eel River Valley Groundwater Basin 1-010

Major Waterways

Highways

☆ City

0 1.5 3 Miles

Date: 12/7/2016

2014 NAIP Imagery

Humboldt County RESOURCE CONSERVATION DISTRICT

Maps are for graphical purposes only. They do not represent a legal survey. While every care has been taken to prepare this map, the HCRCD makes no representations about its accuracy, reliability or completeness for any particular purpose, and thus cannot accept any liability or responsibility of any kind which may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable.

N

***BASEMAP FROM HUMBOLDT COUNTY RESOURCE CONSERVATION DISTRICT ( 2016)***

SHN Consulting Engineers & Geologists, Inc.

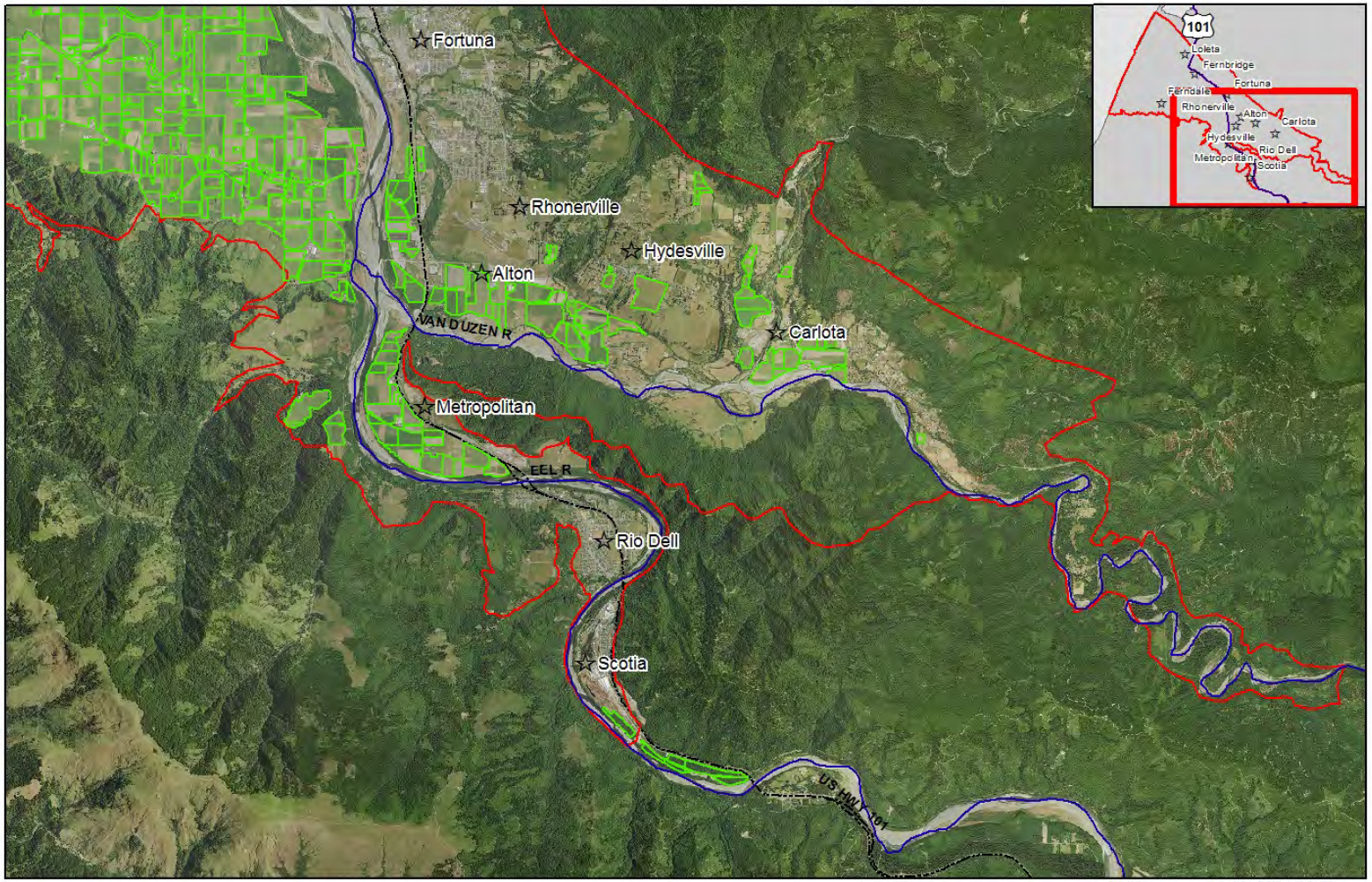
Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Irrigated Acreages

SHN 016219

March 2020 | IrrigatedAcreages11b.ai | Figure 11b

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\IrrigatedAcreages11c.ai




**Irrigated Acres**

Irrigated Acres

Eel River Valley Groundwater Basin 1-010

Major Waterways

Highways

☆ City

Miles

0 1.5 3

Date: 12/7/2016

2014 NAIP Imagery

Humboldt County RESOURCE CONSERVATION DISTRICT

Maps are for graphical purposes only. They do not represent a legal survey. While every care has been taken to prepare this map, the HCRCD makes no representations about its accuracy, reliability or completeness for any particular purpose, and thus cannot accept any liability or responsibility of any kind which may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable.

N

***BASEMAP FROM HUMBOLDT COUNTY RESOURCE CONSERVATION DISTRICT ( 2016)***

SHN Consulting Engineers & Geologists, Inc.

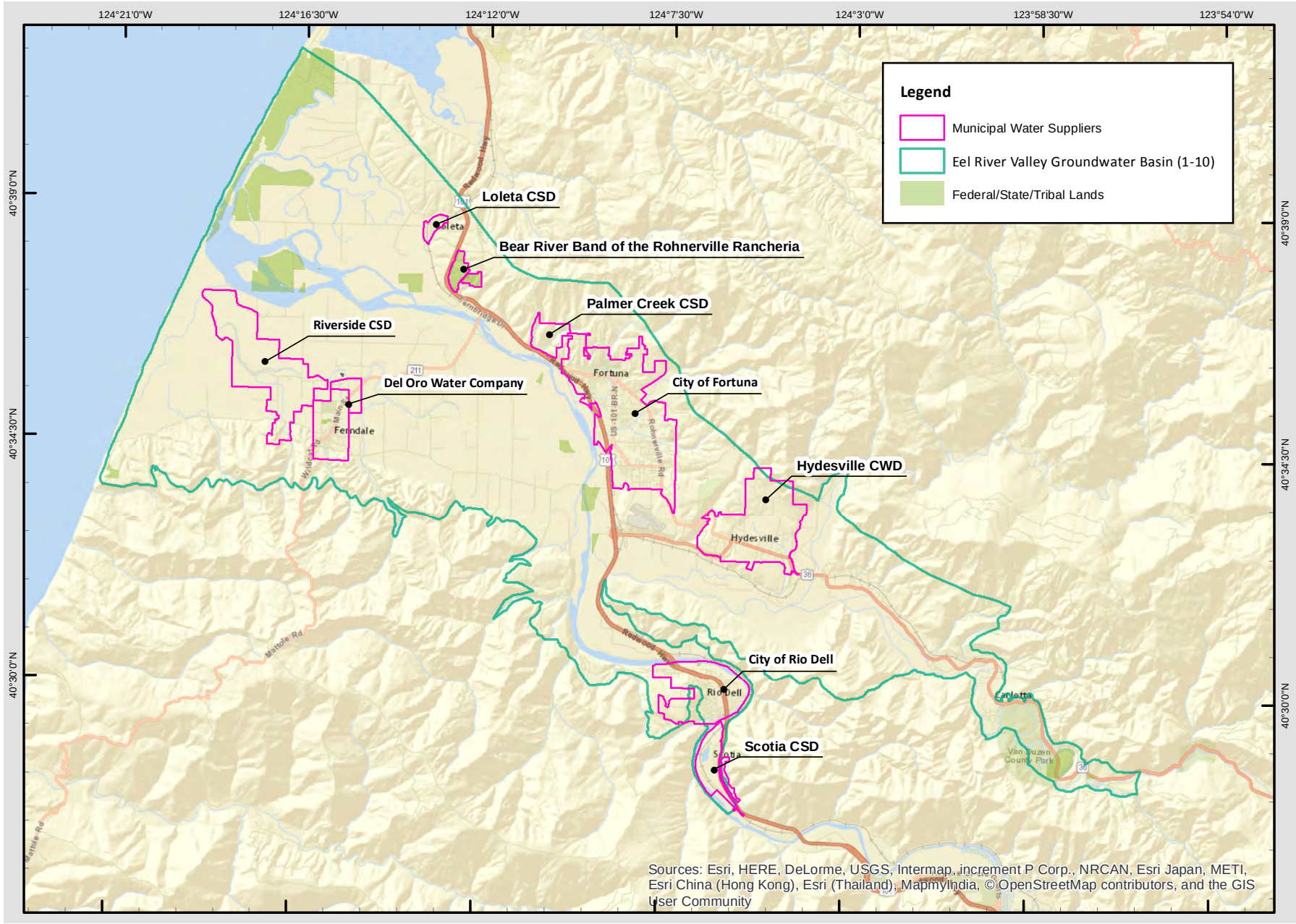
Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Irrigated Acreages

SHN 016219

March 2020 | IrrigatedAcreages11c.ai | Figure 11c

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\12_MunicipalWaterSuppliers.ai




***BASEMAP FROM HUMBOLDT COUNTY PUBLIC WORKS (DECEMBER, 2016)***

SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Municipal Water Suppliers

SHN 016219

March 2020 | 12_MunicipalWaterSuppliers.ai | Figure 12

NO LONGER USED
(WELL DESTROYED)

CASGEM
WELL 23182

CASGEM
WELL 23181

CASGEM
WELL 23183

CASGEM
WELL 36942

## Parameters Used in Analysis of Storage Changes

| CASGEM Well ID# | Area of Associated Polygon (acres) | Estimated Specific Yield |
|---|---|---|
| 23181 | 7019 | 17% |
| 23183 | 7331 | 10% |
| 36942 | 5724 | 22% |

## EXPLANATION

- CASGEM WELLS
- CHANGE IN STORAGE CALCULATION AREAS
- EEL RIVER GROUNDWATER BASIN

0 6,000
FEET

1 "= 6,000 '

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\PROJ_MXD\2020\13_Change_in_Storage_Analysis.mxd

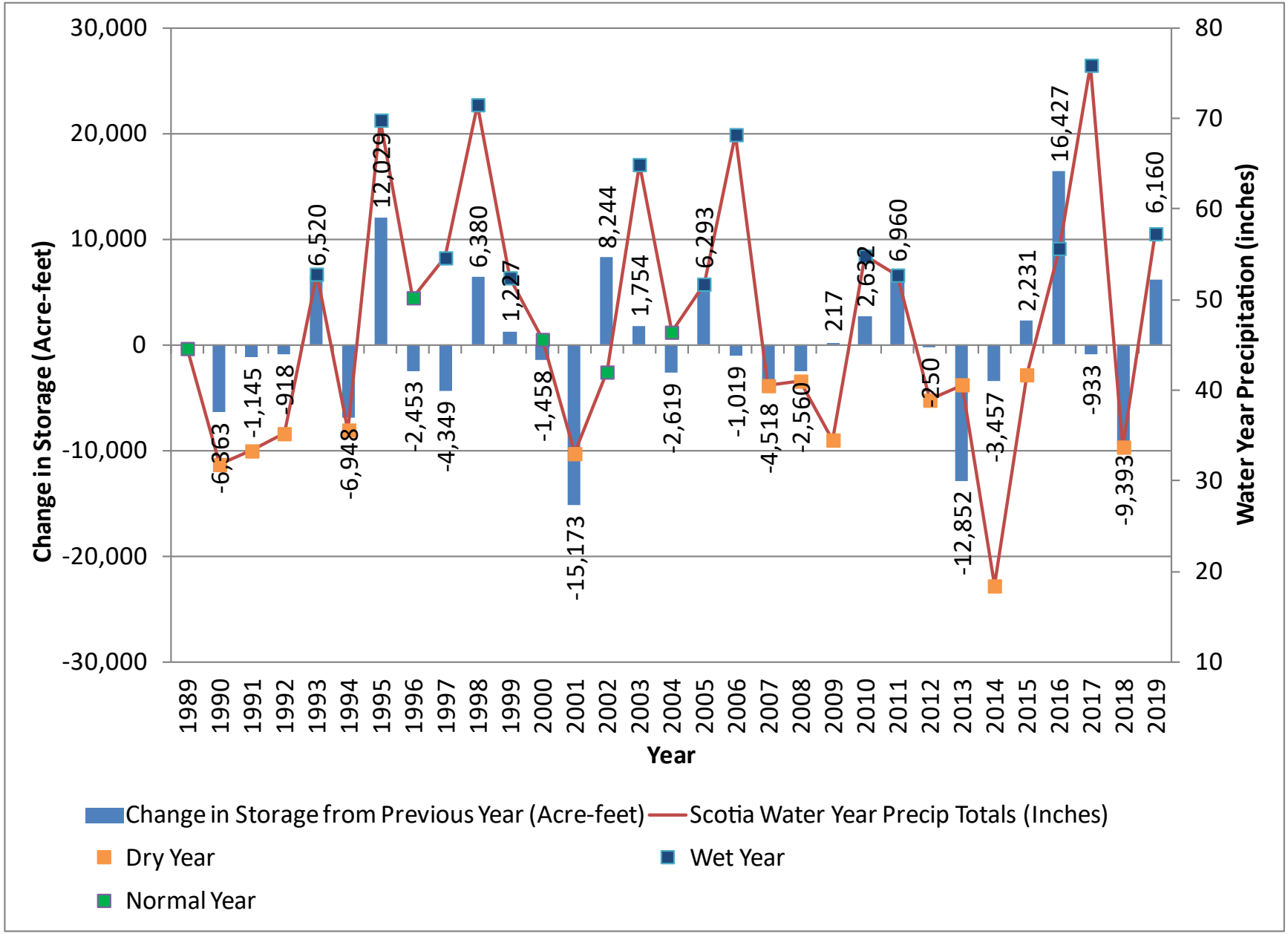
Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

CASGEM Wells and Associated Areas Used in Change in Storage Analysis
SHN 016219

March 2020 | 13_Change_in_Storage_Analysis | Figure 13

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\14_StorageWY.ai




*NOTE: CHANGES IN GROUNDWATER STORAGE WERE CALCULATED USING THE LONG-TERM BI-ANNUAL WATER LEVELS RECORDED BY DWR IN REPRESENTATIVE WELLS (SEE FIGURE 13).*

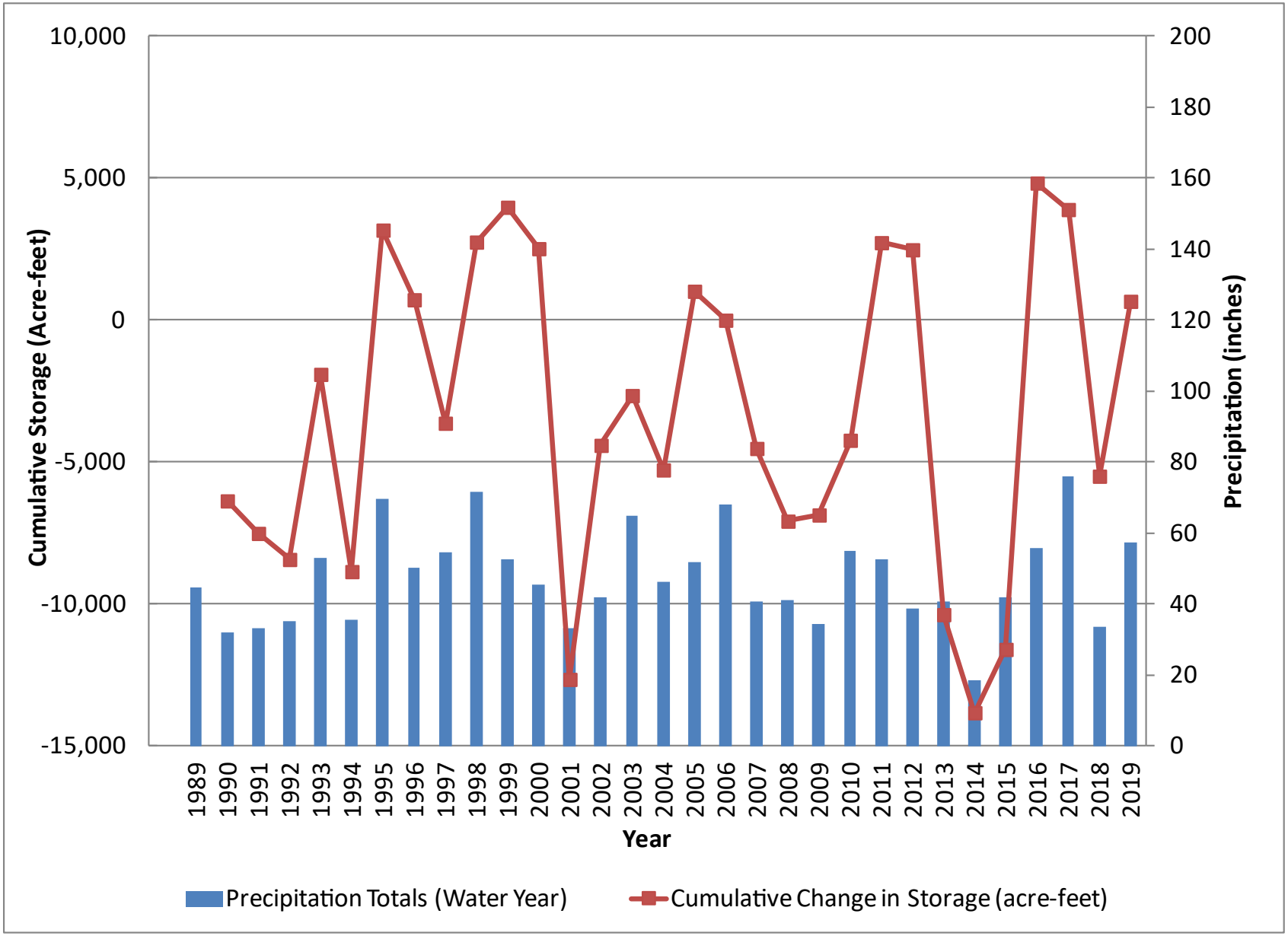
SHN Consulting Engineers & Geologists, Inc.

Humboldt County Public Works
Eel River Groundwater Assessment
Humboldt County, California

Changes in Groundwater Storage
in the Lower Eel River Valley
SHN 016219

March 2020 | 14_StorageWY.ai | Figure 14

Path: \\eureka\Projects\2016\016219-EelRiverGW\GIS\FIGURES\2020\AI\15_CumulativeStorage.ai




| | | | |
|---|---|---|---|
| Consulting Engineers & Geologists, Inc. | Humboldt County Public Works<br>Eel River Groundwater Assessment<br>Humboldt County, California | Cumulative Changes in Storage<br>in the Lower Eel River Valley<br>SHN 016219 | |
| | March 2020 | 15_CumulativeStorage.pdf | Figure 15 |

# Groundwater Elevation Data Tables

# 2

**Table 2-1. Fall 2018 Elevation Monitoring**
**Eel River Valley Groundwater Basin**

| Well Location | Field ID | Depth to Water Measurement Date | GW Elevation (ft, NAVD88)[1] | Well Depth | Analyzed by |
|---|---|---|---|---|---|
| **County Wells** | | | | | |
| 03N01W29Q001H | MW-1s | 10/30/2018 | -0.76 | 35 | SHN |
| 03N01W29Q002H | MW-1d | 10/30/2018 | -0.71 | 60 | SHN |
| 02N01W10R002H | MW-2s | 10/30/2018 | 19.26 | 35 | SHN |
| 02N01W10R002H | MW-2d | 10/30/2018 | 19.30 | 60 | SHN |
| 02N01W22H001H | MW-3d | 10/30/2018 | 25.68 | 60 | SHN |
| 03N02W34A002H | MW-5s | 10/30/2018 | 3.75 | 110 | SHN |
| 03N02W34A002H | MW-5d | 10/30/2018 | 5.95 | 210 | SHN |
| 02N02W03C001H | MW-7s | 10/30/2018 | 13.49 | 40 | SHN |
| 02N02W03C002H | MW-7d | 10/30/2018 | 8.17 | 240 | SHN |
| 02N01W07J001H | MW-8 | 10/30/2018 | 13.34 | 160 | SHN |
| 02N01E19Q001H | MW-9s | 10/30/2018 | 62.22 | 25 | SHN |
| 02N01E19Q001H | MW-9d | 10/30/2018 | 62.31 | 48 | SHN |
| 02N01E16R001H | MW-10 | 10/30/2018 | 126.55 | 29 | SHN |
| 02N01E23N001H | MW-11 | 10/30/2018 | 117.46 | 46 | SHN |
| **CASGEM Wells [5]** | | | | | |
| 03N01W30N001H | 23181 | 10/31/2018 | 0.92 | 50 | DWR |
| 03N02W35M001H | 23183 | 10/31/2018 | 6.11 | 42 | DWR |
| 02N01W09K001H | 36942 | 10/31/2018 | 15.83 | 30 | DWR |
| 03N01W34J001H | 36944 | 10/31/2018 | 20.933 | 496 | DWR |
| 02N02W02G001H | 36943 | 10/31/2018 | 7.42 | 210 | DWR |

1. Groundwater elevation (measured by the foot; North American Vertical Datum of 1988)
2. Chloride concentration measured in milligrams per liter (mg/L)
3. SHN: SHN Engineers & Geologists
4. CASGEM: California Statewide Groundwater Elevation Monitoring (CASGEM) wells
5. DWR: California Department of Water Resources

**Table 2-2. Spring 2019 Elevation Monitoring**
**Eel River Valley Groundwater Basin**

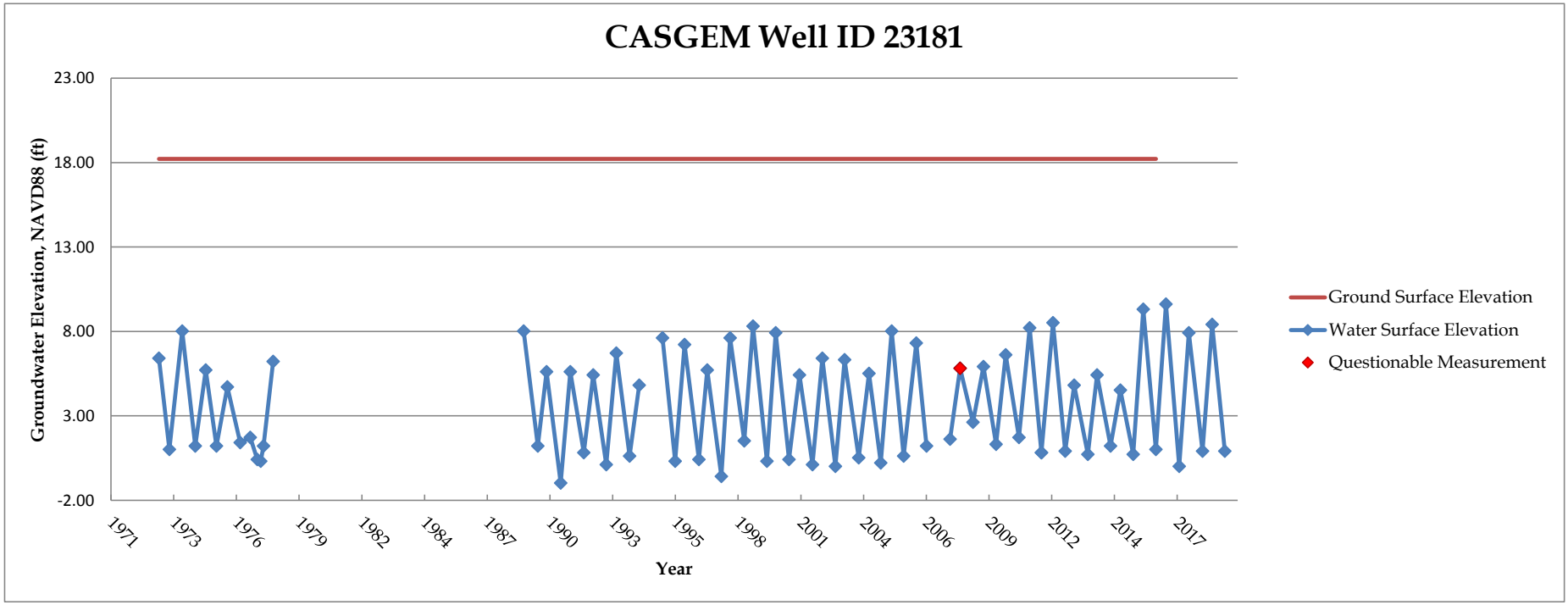
| Well Location | Field ID | Depth to Water Measurement Date | GW Elevation (ft, NAVD88)[1] | Well Depth | Analyzed by |
|---|---|---|---|---|---|
| **County Wells** | | | | | |
| 03N01W29Q001H | MW-1s | 4/24/2019 | 3.99 | 35 | SHN |
| 03N01W29Q002H | MW-1d | 4/24/2019 | 4.05 | 60 | SHN |
| 02N01W10R002H | MW-2s | 4/5/2019 | 26.27 | 35 | SHN |
| 02N01W10R002H | MW-2d | 4/5/2019 | 26.57 | 60 | SHN |
| 02N01W22H001H | MW-3d | 4/5/2019 | 32.75 | 35 | SHN |
| 03N02W34A002H | MW-5s | 4/5/2019 | 7.46 | 110 | SHN |
| 03N02W34A002H | MW-5d | 4/5/2019 | 10.92 | 210 | SHN |
| 02N02W03C001H | MW-7s | 4/5/2019 | 17.14 | 40 | SHN |
| 02N02W03C002H | MW-7d | 4/5/2019 | 12.82 | 240 | SHN |
| 02N01W07J001H | MW-8 | 4/5/2019 | 26.42 | 160 | SHN |
| 02N01E19Q001H | MW-9s | 4/4/2019 | 67.71 | 25 | SHN |
| 02N01E19Q001H | MW-9d | 4/4/2019 | 67.78 | 48 | SHN |
| 02N01E16R001H | MW-10 | 4/4/2019 | 132.63 | 29 | SHN |
| 02N01E23N001H | MW-11 | 4/4/2019 | 126.39 | 46 | SHN |
| **CASGEM Wells [5]** | | | | | |
| 03N01W30N001H | 23181 | 4/4/2019 | 8.42 | 50 | DWR |
| 03N02W35M001H | 23183 | 4/4/2019 | 12.01 | 42 | DWR |
| 02N01W09K001H | 36942 | 4/4/2019 | 27.73 | 30 | DWR |
| 02N02W02G001H | 36943 | 4/4/2019 | 14.62 | 210 | DWR |
| 03N01W34J001H | 36944 | 4/4/2019 | 25.83 | 496 | DWR |
| **Municipal Wells** | | | | | |
| 02N01W11G001H | Fortuna #1 | 3/18/19 | 30.04 | -- | MUNICIP. |
| 02N01W11G002H | Fortuna #4 | 3/18/19 | 27.41 | -- | MUNICIP. |

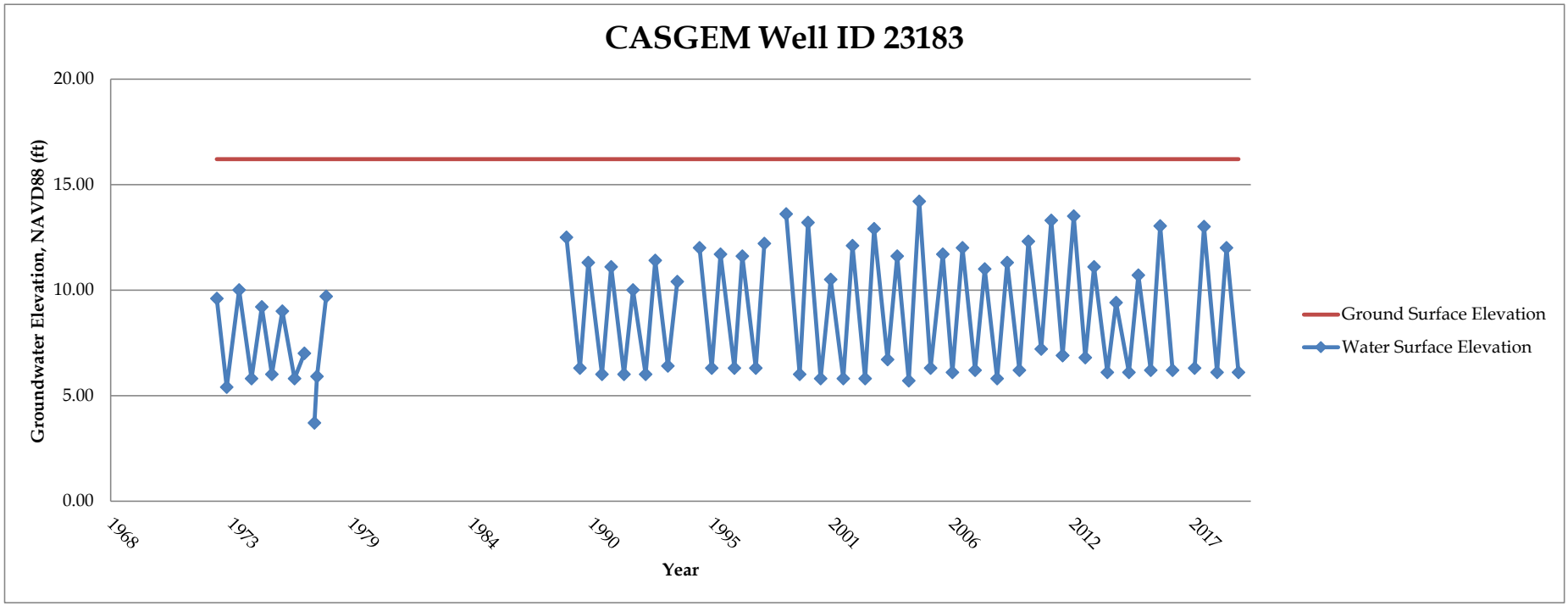
1. Groundwater elevation (measured by the foot; North American Vertical Datum of 1988)
2. Chloride concentration measured in milligrams per liter (mg/L)
3. SHN: SHN Engineers & Geologists
4. CASGEM: California Statewide Groundwater Elevation Monitoring (CASGEM) wells
5. DWR: California Department of Water Resources

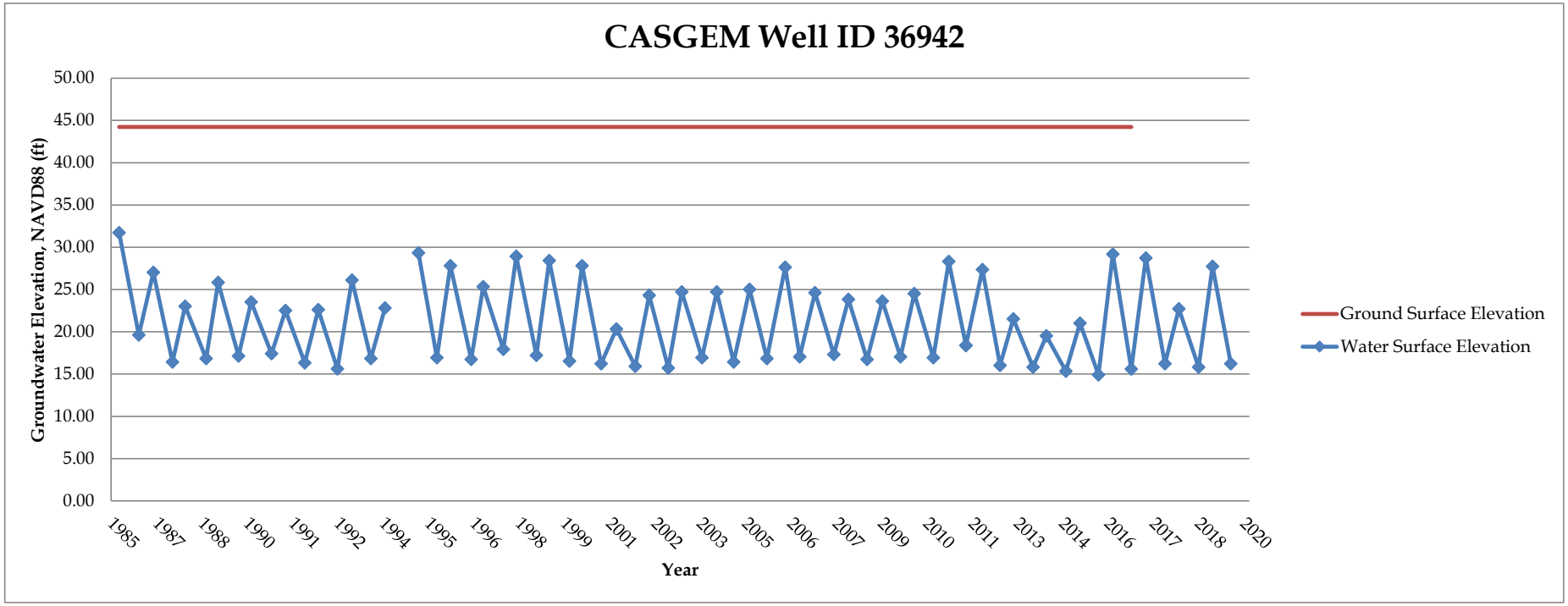
**Table 2-3. River and Groundwater Monitoring Sites**
**Eel River Valley Groundwater Basin**

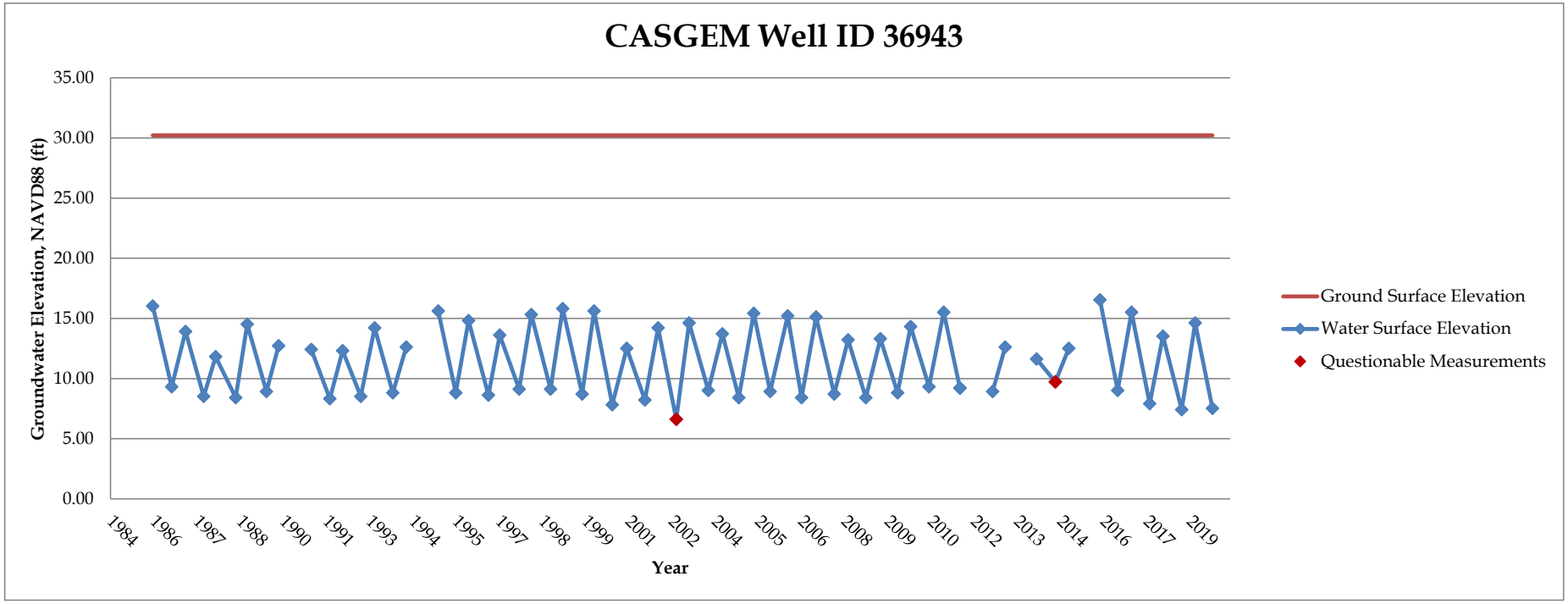
| Location | Field ID | Date(s) Monitored | Well Depth | Notes |
|---|---|---|---|---|
| **River Sites** | | | | |
| Eel River | River 3 | 9/30/16 – 12/10/16 and 7/5/17 – Present<br>Pulled for repair 4/4/19 – 4/24/19 | -- | Destroyed in Jan 2017 Flood (Replaced in July 2017) |
| Van Duzen | River 4 | 9/30/16 – 6/24/19 | -- | River incision dropped below transducer elevation (went dry) |
| **County Monitoring Wells** | | | | |
| 02N01W 10R002H | MW-2s | 10/30/16 – 11/17/17 and 10/31/18 – Present | 35 | Reinstalled on 10/31/18 for 2019 WY monitoring |
| 02N01W 10R002H | MW-2d | 10/30/16 – 6/21/19 and 11/02/19 – Present | 60 | Memory Loss 6/21/19 |
| 02N02W 03C002H | MW-7s | 10/30/16 – 11/16/17 and 8/30/18 – Present | 40 | Reinstalled on 8/30/18 for 2019 WY monitoring |
| 02N02W 03C002H | MW-7d | 10/30/16 – 11/16/17 and 8/30/18 – 6/21/19<br>11/02/19 – Present | 240 | Reinstalled on 8/30/18<br>Memory Loss 6/21/19 |
| 02N01E 19Q001H | MW-9s | 10/30/16 – 11/16/17 and 10/31/18 – Present | 25 | Reinstalled on 10/31/18 for 2019 WY monitoring |
| 02N01E 19Q001H | MW-9d | 10/30/16 –6/21/19 and 11/02/19 – Present | 48 | Memory Loss 6/21/19 |

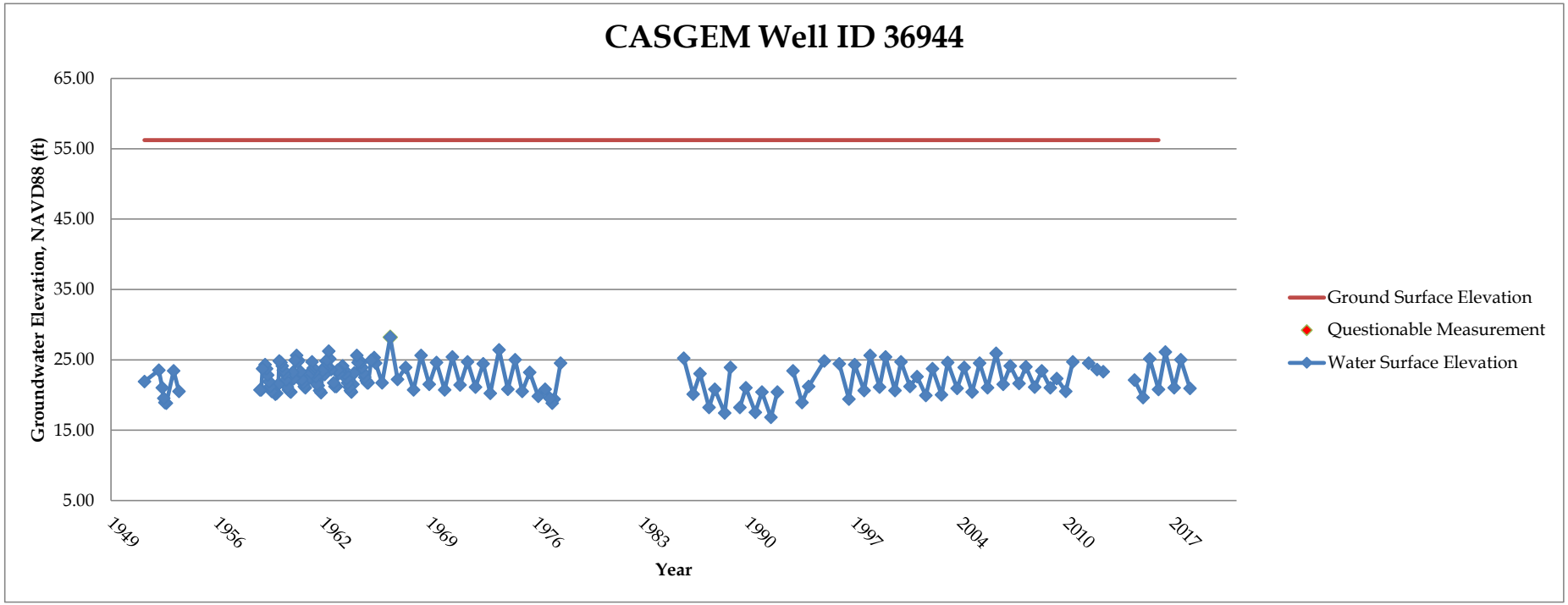
# Hydrographs 3


CASGEM Well ID 23181
Groundwater Elevation, NAVD88 (ft)
23.00
18.00
13.00
8.00
3.00
-2.00
1971
1973
1976
1979
1982
1984
1987
1990
1993
1995
1998
2001
2004
2006
2009
2012
2014
2017
Year
Ground Surface Elevation
Water Surface Elevation
Questionable Measurement


CASGEM Well ID 23183
Groundwater Elevation, NAVD88 (ft)
20.00
15.00
10.00
5.00
0.00
1968
1973
1979
1984
1990
1995
2001
2006
2012
2017
Year
Ground Surface Elevation
Water Surface Elevation

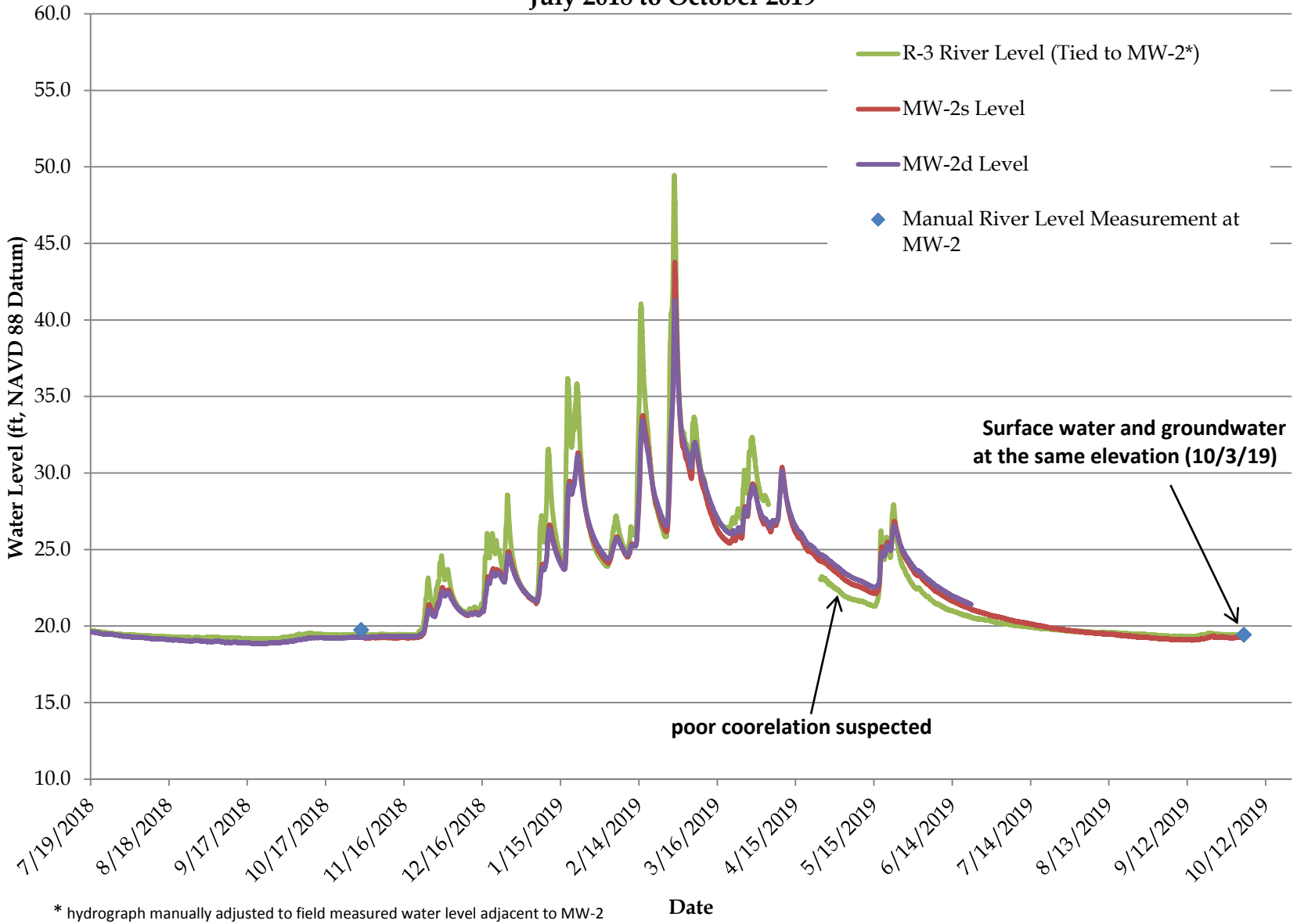

CASGEM Well ID 36942
Groundwater Elevation, NAVD88 (ft)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1985
1987
1988
1990
1991
1992
1994
1995
1996
1998
1999
2001
2002
2003
2005
2006
2007
2009
2010
2011
2013
2014
2016
2017
2018
2020
Year
Ground Surface Elevation
Water Surface Elevation


CASGEM Well ID 36943
Groundwater Elevation, NAVD88 (ft)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1984
1986
1987
1988
1990
1991
1993
1994
1995
1997
1998
1999
2001
2002
2004
2005
2006
2008
2009
2010
2012
2013
2014
2016
2017
2019
Year
Ground Surface Elevation
Water Surface Elevation
Questionable Measurements


CASGEM Well ID 36944
65.00
55.00
45.00
35.00
25.00
15.00
5.00
Groundwater Elevation, NAVD88 (ft)
1949
1956
1962
1969
1976
1983
1990
1997
2004
2010
2017
Year
Ground Surface Elevation
Questionable Measurement
Water Surface Elevation

# MW-2 versus Eel River

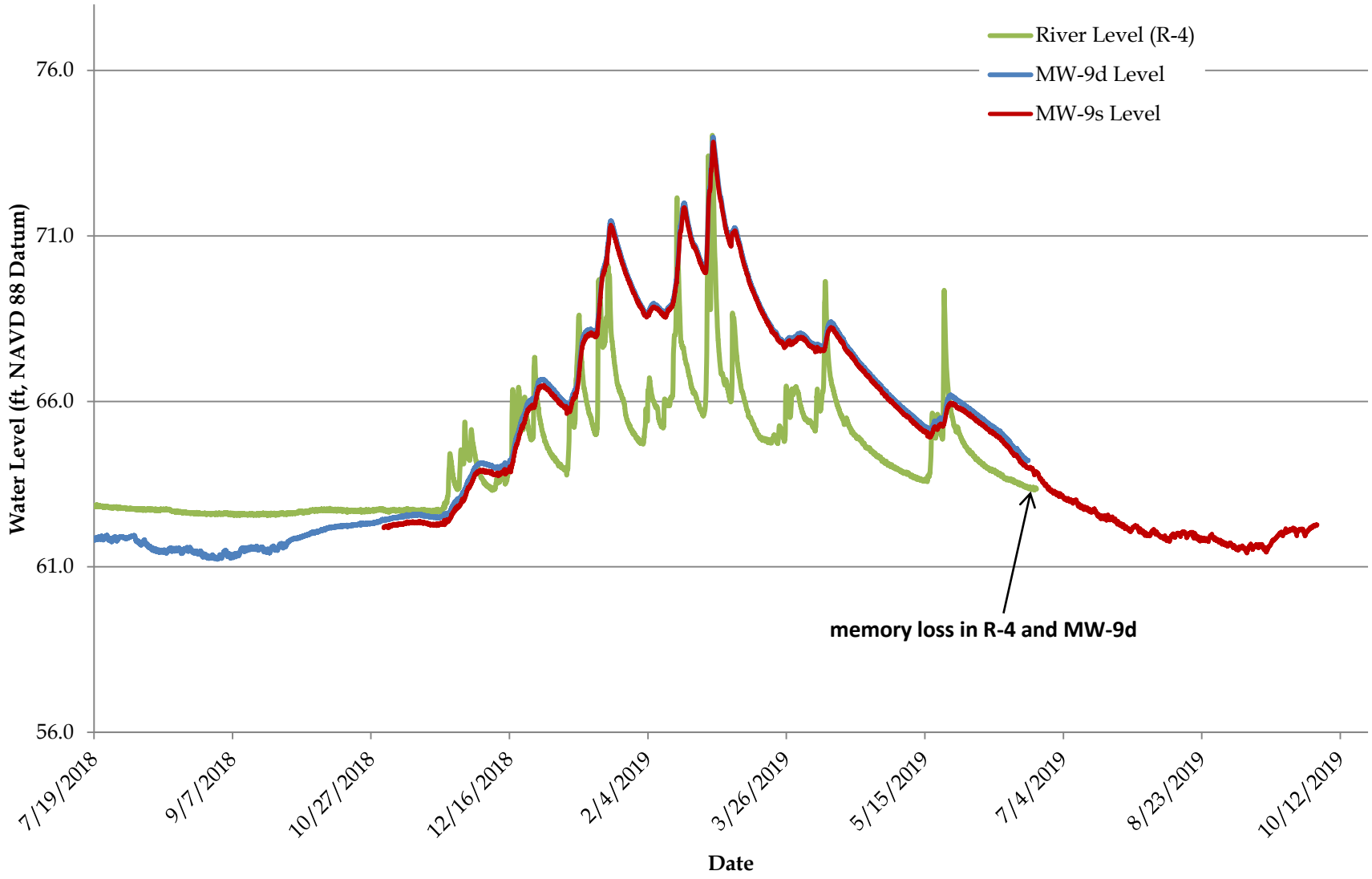
## July 2018 to October 2019




* hydrograph manually adjusted to field measured water level adjacent to MW-2

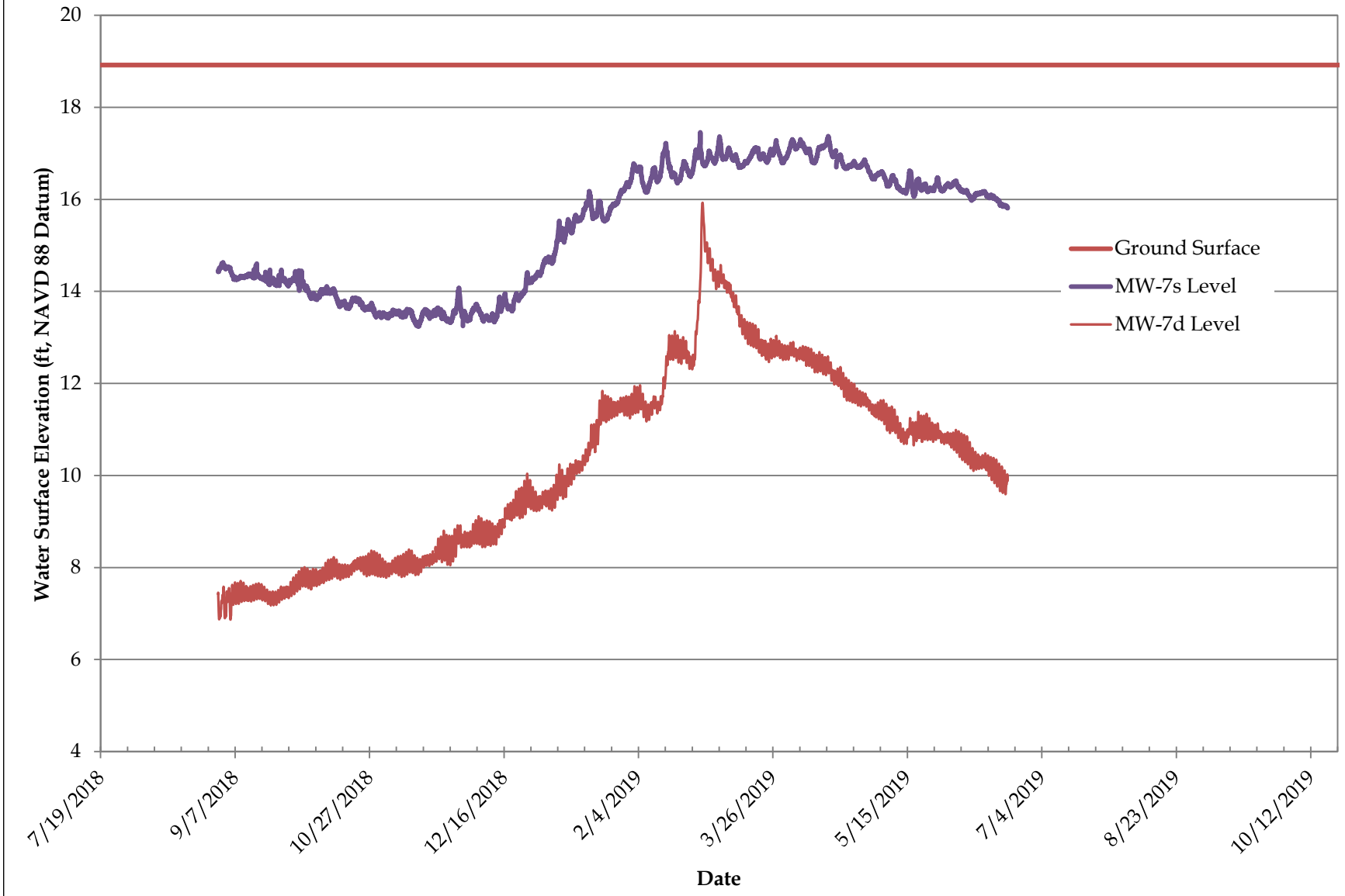
# MW-9 versus Van Duzen River

## July 2018 to October 2019



# MW-7s / MW-7d

## August 2018 to June 2019



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