Kern County Subbasin Coordination Agreement

THIS COORDINATION AGREEMENT (the "Agreement") is made effective as of JANUARY 20, 2020 by and among the Groundwater Sustainability Agencies ("GSA") within the Kern County Subbasin that are developing a Groundwater Sustainability Plan ("GSP") (each a "Party" and collectively the "Parties"), each of which is identified in Appendix 1 and is made with reference to the following facts:

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act ("SGMA"); and

WHEREAS, SGMA requires all groundwater basins designated as high or medium priority by the Department of Water Resources ("DWR") to manage groundwater in a sustainable manner; and

WHEREAS, the Kern County Subbasin (Basin Number 5-22. 14, DWR Bulletin 118) ("Basin") within the San Joaquin Valley Groundwater Basin, has been designated as a high-priority basin by DWR; and

WHEREAS, the Basin includes eleven (11) GSAs that are managing the Basin through five (5) different GSPs; and

WHEREAS, SGMA allows local agencies to engage in the sustainable management of groundwater, but requires GSAs intending to develop and implement multiple GSPs within a basin to enter into a coordination agreement;

WHEREAS, the Agreement does not prevent any Party from providing comments on a GSP, or otherwise coordinating among parties with regard to specific items in a GSP outside this Agreement, on issues including but not limited to specific border conditions between GSP's and/or the timing and/or effect of projects and management actions contained within another GSP; and

WHEREAS, nothing in this Agreement represents or should be construed as the determination of any claim or assertion of a groundwater right; specifically, the coordinated water budget information or data does not amount to an allocation, or otherwise represent a determination, validation, or denial of any claimed or asserted groundwater right.

THEREFORE, in consideration of the facts recited above and of the covenants, terms and conditions set forth herein, the Parties agree as follows:

SECTION 1 – PURPOSE

The purpose of this Agreement is to comply with SGMA coordination agreement requirements and ensure that the multiple GSPs within the Basin are developed and implemented utilizing the same methodologies and assumptions as required under SGMA and Title 23 of the California Code of Regulations, and that the elements of the GSPs are appropriately coordinated to support sustainable management.

The Parties intend that this Agreement be a description of how the multiple GSPs, developed by the individual GSAs, are implemented together to satisfy the requirements of SGMA. The Parties intend this Agreement to be incorporated as part of each individual GSP developed by the Parties.

SECTION 2 – GENERAL GUIDELINES

2.1 Responsibilities of the Parties

The Parties shall work collaboratively to comply with SGMA and this Agreement. Each Party to this Agreement is a GSA and acknowledges it is bound by the terms of the Agreement. This Agreement does not otherwise affect each Party's responsibility to implement the terms of their respective GSP. Rather, this Agreement is the mechanism through which the Parties will coordinate portions of the multiple GSPs to ensure such GSP coordination complies with SGMA.

2.2 No Adjudication or Alternative Plans in the Basin

As of the date of this Agreement, there are no portions of the Basin that have been adjudicated or have submitted for DWR approval an alternative to a GSP pursuant to Water Code Section 10733.6.

SECTION 3 – GOVERNANCE

3.1 Basin Coordination Committee

The Basin Coordination Committee (BCC) will oversee the activities described in section 3.1.5 of this Agreement. The Basin Coordination Committee will consist of one representative appointed from each GSP.

3.1.1 Each Basin Coordination Committee member's compensation for service on the Basin Coordination Committee, if any, is the responsibility of the appointing Party.

3.1.2 Each Basin Coordination Committee member shall serve at the pleasure of the appointing GSP and may be removed or substituted from the Basin Coordination Committee by the appointing GSP at any time.

3.1.3 The Basin Coordination Committee will meet periodically as it deems necessary to carry out the activities described in this Agreement

3.1.4 The Basin Coordination Committee may suggest subcommittees, workgroups, or otherwise request staff of the Parties to develop technical data, supporting information and/or recommendations.

3.1.5 The purposes of the Basin Coordination Committee are to (1) recommend to their respective GSAs the appointment of a Plan Manager who will act in accordance with this Agreement, and (2) provide a forum wherein the Parties may discuss basin coordination activities, which may include the development, planning, financing, environmental review, permitting, implementation, and long-term monitoring of the multiple GSPs in the Basin, pursuant to SMGA requirements ("Coordination Activities").

3.2 Plan Manager

The Plan Manager shall be appointed by unanimous agreement by the Parties for a term of one calendar year, and annually thereafter, and may be removed by unanimous agreement of the Parties with or without cause. The Plan Manager shall serve as the point of contact for DWR as specified in 23 CCR § 357.4, subd. (b)(1). The Plan Manager shall submit or assist with the submittal of all GSPs, plan amendments, supporting information, monitoring data and other pertinent information, Annual Reports, and periodic evaluations to DWR when required. The Plan Manager has no authority to take any action or represent the Basin Coordination Committee or a particular GSA without the specific direction and authority of the Basin Coordination Committee or the particular GSA, respectively. The Plan Manager is obligated to immediately disclose all communications he/she receives in his/her capacity as Plan Manager to the Basin Coordination Committee and the affected GSA, as appropriate under the circumstances.

SECTION 4 – EXCHANGE OF DATA AND INFORMATION

4.1 Procedure for Exchange of Information

4.1.1 The Parties may exchange information through collaboration and/or informal requests made at the Basin Coordination Committee level or through subcommittees suggested by the Basin Coordination Committee. However, to the extent it is necessary to make a written request for information to another Party, each Party shall designate a representative to respond to information requests and provide the name and contact information of the designee to the Basin Coordination Committee. Requests may be communicated in writing and transmitted in person or by mail, facsimile machine or other electronic means to the appropriate representative as named in this agreement.

4.1.2 Nothing in this Agreement shall be construed to prohibit any Party from voluntarily exchanging information with any other Party by any other mechanism separate from the Basin Coordination Committee.

4.2 Non-Disclosure of Confidential Information

Pursuant to Section 4.1 of this Agreement, a Party may provide one or more of the other Parties with confidential information. To ensure the protection of such confidential information and in consideration of the agreement to exchange said information, appropriate arrangements may be made to restrict or prevent further disclosure.

SECTION 5 – METHODOLOGIES & ASSUMPTIONS

Pursuant to California Water Code section 10727.6 and 23 CCR, § 357.4, the Parties will meet and agree upon the methodologies used in their respective GSPs with respect to utilizing the same data and methodologies for the following assumptions: 1) groundwater elevation data; 2) groundwater extraction data; 3) surface water supply; 4) total water use; 5) change in groundwater storage; 6) water budget; and 7) sustainable yield, and that such methodologies and assumptions will continue to be used in the future development and implementation of such GSPs, except to the extent modified by the Parties in the future. Information regarding the agreed upon Basin methodologies and assumptions shall be attached as Appendix 2 to this Agreement when approved by all Parties.

SECTION 6 – MONITORING NETWORK

6.1 The Parties shall develop a monitoring network and monitoring network objectives for the Basin in accordance 23 CCR, §§ 354.32 – 354.40. Each network shall facilitate the collection of data in order to characterize groundwater and related surface water conditions in the Basin and evaluate changing conditions that occur from implementation of the individual GSPs. The individual GSPs shall include monitoring objectives, protocols, and data reporting requirements as necessary under SGMA and SGMA Regulations.

6.2 The monitoring network(s) will demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions. Each Party's GSP will describe the monitoring network's objectives for the Basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface water conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of GSP implementation. The Parties shall implement the monitoring network objectives to accomplish the following: a) demonstrate progress toward achieving measurable objectives described in the GSPs; b) monitor impacts to the beneficial uses or users of groundwater; c) monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds; and d) quantify annual changes in water budget components. Information regarding the agreed upon Basin monitoring network shall be attached as Appendix 3 to this Agreement when approved by all Parties.

6.3 The Parties shall design a monitoring network that will achieve the following for the enumerated sustainability indicators:

6.3.1 Chronic Lowering of Groundwater Levels:

The network shall collect information sufficient to demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods: a) density of monitoring wells to collect measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer; and b) take static groundwater elevation measurements, at least two times a year, representing seasonal low and high conditions.

6.3.2 Change in Groundwater Storage:

The network will provide sufficient data for the GSAs to estimate the change in annual groundwater in storage.

6.3.3 Degraded Water Quality:

The network will collect sufficient spatial and temporal data from each GSA to determine groundwater quality trends for water quality indicators, as determined by the GSA, to address known water quality issues.

6.3.4 Land Subsidence:

The network will identify the location, rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or any other appropriate method.

6.3.5 Seawater Intrusion/Depletion of Interconnected Surface Water:

The network will not be designed to monitor Seawater Intrusion and/or Depletion of Interconnected Surface Water because these issues are not applicable to the Basin.

6.4 The Parties shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors: a) the amount of current and projected groundwater use; b) aquifer characteristics, including confined or unconfined aquifer conditions or other physical characteristics that affect groundwater flow; c) impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal; d) whether individual GSAs have adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

6.5 Parties may designate a subset of monitoring sites as representative of conditions in the Basin or a portion of the Basin.

6.6 The Parties shall identify data gaps where the Basin does not contain sufficient monitoring sites, where the frequency of monitoring is insufficient, or sites are unreliable. If such gaps are identified, the Parties shall describe the reason for the gap and describe actions that may be taken to remedy such gaps.

6.7 The Parties shall share information necessary to create a Basin map displaying the location and type of each monitoring site within the Basin, and a report in tabular format, including information regarding the monitoring site type, frequency of measurement, and purpose for which the monitoring site is being used.

SECTION 7 – COORDINATED WATER BUDGET

7.1 In accordance with 23 CCR, § 357.4 subd. (b) the Parties shall prepare a coordinated water budget for the Basin as described in this sub-section, as required by 23 CCR, § 354.18. The water budget will provide an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the Basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored. Information regarding the agreed upon coordinated water budget shall be attached as Appendix 4 to this Agreement when approved by all Parties.

7.2 Each Party for its respective GSP shall endeavor to provide the information required by 23 CCR, § 356.2 to the Basin Coordination Committee by March 1 for the preceding calendar year.

7.3 The Parties shall use the projected water budgets to estimate future baseline conditions of supply, demand, and aquifer response to their GSP implementation, and to identify the uncertainties of these projected water budget components. The Parties shall use the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon for the projected water budget.

7.3.1 To the extent available, use 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

7.3.2 Projected water demand shall utilize the most recent reliable land use, population growth, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

7.3.3 Projected surface water supply shall utilize the most recent reliable water supply information as the baseline condition for estimating future surface water supply. The projected surface supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply as identified in the historical water budget and the projected changes in local land use planning, population growth, and climate.

SECTION 8 – COORDINATED DATA MANAGEMENT SYSTEM

The Parties will develop and will maintain a data management system that is capable of storing and reporting information relevant to the development and/or implementation of the GSPs and monitoring network of the Basin as required by SGMA and the SGMA Regulations. Information regarding the agreed upon coordinated data management system shall be attached as Appendix 5 to this Agreement when approved by all Parties.

SECTION 9 – ADOPTION AND USE OF THE COORDINATION AGREEMENT

9.1 Cooperative Implementation of GSPs

The Parties intend that their individual GSPs will be implemented together in order to satisfy the requirements of SGMA. The collective GSPs in a coordinated manner will utilize the groundwater models, a description of the physical setting and characteristics of the separate aquifer systems within the Basin, the methodologies and assumptions as specified in Water Code section 10727.6, a description of the undesirable results, the minimum thresholds, the measurable objectives, and monitoring protocols that together provide a description of the sustainable yield of the Basin(s) as a whole, and how it will be sustainably managed.

9.2 GSP and Coordination Agreement Submission

The Parties shall submit their respective GSPs to DWR through the Plan Manager in accordance with SGMA and SGMA Regulations. The Parties intend that this Agreement suffice to fulfill the requirements of providing an explanation of how the GSPs implemented together satisfy Water Code sections 10727.2, 10727.4 and 10727.6 for the entire Basin.

9.3 In Event Entire Basin Not Covered by GSP

In the event it appears that the entire Basin may not be covered by one or more GSPs as of January 31, 2020, each Party may take such action as deemed necessary or appropriate by such Party with respect to filing its GSP and/or other documents with DWR.

9.4 Duration of Coordination Agreement

This Coordination Agreement shall be reopened for amendment at the at the submission of the next round of GSP's covering the Kern Subbasin (no later than 5 years from January 31, 2020). Unless amended at that time, the Coordination Agreement shall be automatically renewed every 5 years. The parties may agree to unanimously amend this Coordination Agreement at any time.

SECTION 10 – Modification and Termination of the Agreement

10.1 Modification

This Agreement shall be reviewed as part of each five year assessment and may be supplemented, amended, or modified only by the written agreement of all the Parties. No supplement, amendment, or modification of this Agreement shall be binding unless it is in writing and signed by all Parties.

10.2 Withdrawal, Termination, Adding Parties

10.2.1 A Party may unilaterally withdraw from this Agreement without causing or requiring termination of this Agreement, effective upon 30 days' notice to the other Parties.

10.2.2 A new GSA or group of GSA's may be added as a Party to this Agreement if such entity or entities is submitting a GSP within the Basin.

10.2.3 This Agreement may be rescinded by unanimous written consent of all the Parties. Nothing in this Agreement shall prevent the Parties from entering into another coordination agreement.

SECTION 11 – Dispute Resolution

11.1 Procedures for Resolving Conflicts

In the event that any dispute arises among the Parties relating to the rights and obligations arising from this Agreement, the aggrieved Party or Parties shall provide written notice to the other Parties of the dispute. Within thirty (30) days after such written notice, the Parties shall attempt in good faith to resolve the dispute through informal means. If the Parties cannot agree upon a resolution of the dispute within thirty (30) days from the providing of written notice specified above, the dispute will be elevated to the BCC for consideration, along with the notice of dispute and any other relevant supporting documentation produced and shared by the disputing parties pursuant to their informal meet and confer process. The BCC may issue a recommendation concerning resolution of the dispute. If the Parties cannot agree upon a resolution of the dispute following the input of the BCC, the disputing Parties will meet and confer to determine if other alternative dispute resolution methods are agreeable, including voluntary non-binding mediation, which may include the Department of Water Resources dispute resolution process, arbitration, or appointment of a panel of technical experts prior to commencement of any legal action. The cost of alternative dispute resolution shall be paid in equal proportion among the Parties to the dispute, otherwise the Parties shall bear their own costs. Upon completion of alternative dispute resolution, if any, and if the controversy has not been resolved, any Party may exercise any and all rights to bring a legal action relating to the dispute.

11.2 Litigation

In the event a dispute or claim is not resolved by a mutually agreeable settlement through informal negotiation or voluntary mediation, the aggrieved Party may file suit in a County Superior Court with jurisdiction to provide a binding decision on the matter.

[signature] - PRESIDENT
Henry Miller Water District
Print Name, Position

1-10-20
Date

[signature]
Kern Groundwater Authority
Jason Selvidge, Vice Chair

12-18-19
Date

[signature] - John Vidovich
Buena Vista Water Storage District
Print Name, Position

20 January 2020
Date

[signature]
Kern River Groundwater Sustainability Agency
Print Name, Position

1-15-20
Date

Olcese Water District Groundwater Sustainability Agency
Print Name, Position

Date

In the event that any dispute arises among the Parties relating to the rights and obligations arising from this Agreement, the aggrieved Party or Parties shall provide written notice to the other Parties of the dispute. Within thirty (30) days after such written notice, the Parties shall attempt in good faith to resolve the dispute through informal means. If the Parties cannot agree upon a resolution of the dispute within thirty (30) days from the providing of written notice specified above, the dispute will be elevated to the BCC for consideration, along with the notice of dispute and any other relevant supporting documentation produced and shared by the disputing parties pursuant to their informal meet and confer process. The BCC may issue a recommendation concerning resolution of the dispute. If the Parties cannot agree upon a resolution of the dispute following the input of the BCC, the disputing Parties will meet and confer to determine if other alternative dispute resolution methods are agreeable, including voluntary non-binding mediation, which may include the Department of Water Resources dispute resolution process, arbitration, or appointment of a panel of technical experts prior to commencement of any legal action. The cost of alternative dispute resolution shall be paid in equal proportion among the Parties to the dispute, otherwise the Parties shall bear their own costs. Upon completion of alternative dispute resolution, if any, and if the controversy has not been resolved, any Party may exercise any and all rights to bring a legal action relating to the dispute.

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______________________ Henry Miller Water District Print Name, Position	______________ Date
______________________ Kern Groundwater Authority Jason Selvidge, Vice Chair	______________ Date
______________________ Buena Vista Water Storage District Print Name, Position	______________ Date
______________________ Kern River Groundwater Sustainability Agency Print Name, Position	______________ Date
______________________ Olcese Water District Groundwater Sustainability Agency Print Name, Position James L. Nickel, President	1/13/2020 Date

GROUNDWATER SUSTAINABILITY AGENCIES NOT SUBMITTING A GROUNDWATER SUSTAINABILITY PLAN

Greenfield County Water District

____
Print Name, Position,

____
MacFarland County Water District

____
Print Name, Position,

____
Cawelo Water District /GSA

Keith Watkins - President
Print Name, Position,

APPENDICES

APPENDIX 1

APPENDIX 1

Buena Vista Water Storage District

Henry Miller Water District

Kern Groundwater Authority Groundwater Sustainability Agency

Kern River Groundwater Sustainability Agency

Olcese Water District Groundwater Sustainability Agency

APPENDICES
2 & 4

TODD GROUNDWATER

January 7, 2020

MEMORANDUM

To: Mark Mulkay, Kern River GSA
Patty Poire, Kern Groundwater Authority GSA

From: Michael Maley, Todd Groundwater
Charles Brush, Hydrolytics LLC

Re: **SGMA Water Budget Development using C2VSimFG-Kern in support of the Kern County Subbasin Groundwater Sustainability Plans (GSPs)**

1. INTRODUCTION

In compliance with the Sustainable Groundwater Management Act (SGMA), the multiple Groundwater Sustainability Agencies (GSAs) of the Kern County Subbasin (**Figure 1**) have successfully coordinated on the development of Groundwater Sustainability Plans (GSPs). The Kern County Subbasin, the largest in the State, was designated as critically-overdrafted by the California Department of Water Resources (DWR). Water management in the Kern County Subbasin is complex. It involves more than 30 water districts/systems, contains large groundwater banking projects of State-wide importance, and provides large quantities of groundwater to support both large urban centers and one of the top agricultural-producing areas in the country. In addition, most agencies are involved in conjunctive management of local surface water, imported state and federal water, and groundwater.

Within this complex water management setting, GSAs recognized that a numerical modeling tool would be needed to meet GSP regulations for assessment of historical, current, and future projected water budgets that are developed on a Subbasin-wide basis (§357.4(b)(3)). The California Central Valley Groundwater-Surface Water Simulation Model (C2VSim) is anticipated to be DWR's primary tool for evaluating water management in the Central Valley and is specifically referenced in the GSP regulations for application to GSP water budgets (§354.18(f)); therefore, C2VSim was selected by the GSAs for GSP compliance.

This technical memorandum describes the process and approach for selection, revisions, and application of the C2VSim to the Kern County Subbasin. The memorandum documents the development of Subbasin water budgets and presents the results. This document is being prepared as an attachment to Subbasin GSPs and as an attachment to the Kern County Subbasin GSAs' coordination agreement.

1.1 Background

During late 2016 and 2017, Subbasin GSAs held a series of meetings and workshops to evaluate potential modeling tools for GSP application. Although numerous existing models had been developed by various entities in the Subbasin over time, none of those models covered the entire Subbasin or incorporated all of the local water budget components necessary to meet GSP requirements.

During the time that the Subbasin was evaluating various modeling alternatives, DWR was in the process of updating the regional C2VSim model through water year (WY) 2015. In particular, the GSP regulations stated that DWR would provide the C2VSim model "for use by Agencies in developing the water budget." Todd Groundwater developed an approach for review, revisions, and application of the C2VSim model to the Kern County Subbasin. In March 2017, the Kern River GSA (KRGSA), on behalf of the Subbasin GSAs, entered into a contract with Todd Groundwater to conduct the proposed scope of work. The Kern Groundwater Authority (KGA), on behalf of the Subbasin GSAs, also retained Woodard & Curran to conduct a peer review of the Todd Groundwater C2VSim model revisions and application for the Kern County Subbasin.

DWR released the C2VSim Fine Grid Public Beta model (C2VSimFG-Beta) on May 18, 2018 (CNRA, 2018). An initial model review indicated that the C2VSimFG-Beta generally had good historical precipitation, streamflow, land use and crop acreage for the entire Central Valley. Historical water supply and demand data were also generally good in the Sacramento Valley and San Joaquin River hydrologic regions; however, data were considered less reliable in the Tulare Lake hydrologic region including Kern County. To address this concern, Todd Groundwater – working with all Subbasin GSAs –revised the Kern County portion of C2VSimFG-Beta for WY1985 to WY2015. This revised version of C2VSim for the Kern County Subbasin, referred to herein as the C2VSimFG-Kern model, was used to develop historical, current and projected-future water budgets in accordance with the requirements in the GSP regulations.

The Central Valley portion of Kern County contains two groundwater subbasins, the Kern County Subbasin (5-022.14) and the White Wolf Subbasin (5-22.18) based on DWR Bulletin 118 (DWR, 2016A). All of the agencies that deliver water in White Wolf Subbasin also deliver water in the Kern County Subbasin and participated in the C2VSim revision. The White Wolf Subbasin portion of C2VSimFG-Beta model was included in this update to ensure coordination of groundwater conditions between the two subbasins. These are considered separate groundwater basins under SGMA with the Kern County Subbasin listed by DWR as critically-overdrafted with a GSP deadline of January 30, 2020, whereas the White Wolf Subbasin is listed as medium priority with a GSP deadline of January 30, 2022. Therefore, only the model results for the Kern County Subbasin are evaluated and reported here.

1.2 General Approach

The current C2VSim model has a detailed finite element mesh that closely follows local hydrologic features. As a regional model, the C2VSimFG-Beta may over-generalize local conditions within the Kern County Subbasin so as to be inconsistent with local site-specific data and knowledge. To address this concern, the managed water supply and demand inputs were updated to better represent the local water balance. To do this, the more general assumptions in C2VSimFG-Beta were replaced with local data and knowledge that are regionally or locally significant over the WY1995 to WY2015 Hydrology Period. Local managed water supply input data (e.g., surface water deliveries, land use, irrigation demand, return flows, and groundwater banking) were collected and applied to C2VSim. Improvement of Kern County data focused on incorporating:

- Surface water delivery volumes, application areas and use by water district,
- Groundwater banking recharge, recovery and application of recovered water,
- Irrigation demand from recent analyses of remote sensing data of evapotranspiration in the Kern County Subbasin based (ITRC, 2017),
- Urban demand for the Subbasin focusing on Metropolitan Bakersfield, and
- Data on other water sources and demands of local significance to individual districts/GSAs.

Compiling the data needed for the model revision required a coordinated effort from the Subbasin GSAs (**Figure 1**) to provide locally derived data on managed water supply and demand that was used to revise the C2VSimFG-Beta for the Kern County Subbasin. The Subbasin GSAs also coordinated on selection of consistent study periods for the C2VSimFG-Kern water budget analyses. Based on technical considerations and a review of regional data, the following study periods were selected:

- Historical Water Budget - WY1995 through WY2014 (Section 3.2), and
- Current Water Budget - WY2015 (Section 3.2),
- Projected Water Budget - WY2021 through WY2070 using 50 years of hydrologic data based on historical data (Section 6.1).

Todd Groundwater also coordinated data collection and model revision efforts with a Technical Peer Review Team and local agencies to ensure input data were accurately represented in the model. Tabulated input data, model files and model-derived water budgets were provided to the Technical Peer Review Team for review of accuracy and appropriateness. Model input data and results were also provided to Kern County Subbasin water districts and local water purveyors for their review. Comments and data issues were reconciled and incorporated into the revised C2VSimFG-Kern model.

1.3 Acknowledgements

These regional model revisions were enhanced by the participation of the many agencies that provided local water budget input data. Todd Groundwater worked with the member agencies, and their consultants, including the Kern River GSA, Kern Groundwater Authority GSA, Henry Miller Water District GSA, Olcese Water District GSA, and Buena Vista GSA to coordinate acquisition of input data from other agencies in formats that could be easily incorporated into the C2VSim model. On-going review of interim model results by these agencies, including local zonal water budgets, groundwater hydrographs and other model results, helped ensure that the revised model reproduced local mass balance estimates across the Subbasin.

Woodard & Curran conducted an on-going peer review of model input files at the request of the GSAs in the Kern County Subbasin. Todd Groundwater worked with Woodard & Curran throughout the historical model revision process. The C2VSimFG-Kern input files for the Kern County Subbasin revised historical simulation were provided to DWR for incorporation into future C2VSim public releases.

Dr. Charles Brush of Hydrolytics LLC was added to the Todd Groundwater modeling team. As an early developer of C2VSim for DWR, he provided his experience and expertise with the C2VSim. This collaborative effort provided further assurance that the significant model revisions could be managed in an efficient manner to meet the expedited schedule for water budget development.

2. C2VSIM

C2VSim uses DWR's modeling code *Integrated Water Flow Model* (IWFM) and covers the entire California Central Valley. Kern County is located at the far southern end of the Central Valley (**Figure 2**). C2VSim simulates the full hydrologic cycle, calculating water demands and tracking water movement through surface water and groundwater systems, and is therefore well suited to support GSP development.

2.1 C2VSim Background

DWR developed C2VSim to simulate water demands and supplies in the Central Valley. C2VSim is an application of DWR's IWFM software. IWFM is an integrated hydrologic model that simulates water flows on the linked land surface, unsaturated zone, groundwater, and surface water flow systems. A key feature of IWFM is DWR's agricultural and urban water supply and demand management module that dynamically simulates the delivery of both surface water and groundwater supplies based on both water availability and calculated water demands, as affected by usage and climatic conditions.

The C2VSim is derived from a series of Central Valley hydrologic models developed by DWR and other agencies beginning in the early 1990s. Each model in this series has incorporated significant improvements over the previous version (Brush, Dogrul and Kadir, 2013). The groundwater flow system is modeled in IWFM using the finite element method and uses a highly efficient solver developed at UC Davis. The IWFM Demand Calculator (IDC) and land surface simulation process were developed with input from California irrigation management professionals. Given DWR's emphasis on water management, detailed water budgets produced by C2VSim provide strong representations of the surface water and groundwater flow systems and make it a preferred platform for developing water budgets.

2.2 C2VSImFG-Beta Model

DWR's 2018 release of C2VSimFG-Beta includes historical input data for WY1922 to WY2015. C2VSimFG-Beta includes historical precipitation, stream inflow, land use and crop acreage for the entire Central Valley. These data include monthly precipitation and annual land use for each model element and estimated monthly evapotranspiration for each modeled land use type and agricultural crop. Historical surface water data include monthly surface water inflow for each river entering the model boundary and monthly surface water diversions and deliveries.

The C2VSimFG-Beta finite element grid divides the Central Valley into 32,537 model elements (**Figure 2**). Element areas are small near streams and in developed areas and expand to larger sizes in undeveloped areas. Element sizes average 407 acres and range from 4 to 1,770 acres. Central Valley rivers and streams are represented with a network of 110 stream reaches. Surface water and groundwater inflows from uplands along the model boundary are simulated with 1,033 small watersheds. Within the Kern County Subbasin, the land surface elevation varies from 208 feet above mean sea level (msl) in the north to 3,922 feet above msl in the foothills.

The groundwater aquifer system is represented with four aquifer layers and one regional confining layer. The aquifer thickness in the Kern County Subbasin varies from 857 to 9,054 feet and the deepest aquifer location is 8,752 feet below msl. The Central Valley aquifer is simulated with the following hydrostratigraphic layers, listed from top to bottom:

- Shallow, unconfined aquifer,
- Regional confining layer,
- Active confined aquifer (contains high level of pumping),
- Inactive confined aquifer (contains limited pumping), and
- Saline confined aquifer.

C2VSimFG-Beta includes annual land use and crop acreages and monthly precipitation, evapotranspiration, stream inflows, surface water deliveries and specified groundwater pumping rates for WY1922 to WY2015. C2VSimFG-Beta uses IDC to dynamically calculate distributed monthly water demands, allocate available water supplies to meet these demands, and calculate unmetered groundwater pumping necessary to satisfy unmet demands. C2VSimFG-Beta produces detailed monthly water budgets for arbitrary sets of elements grouped into zones.

Water demands are calculated dynamically for each model element using the IWFM Demand Calculator (IDC) for agricultural, urban, native and riparian land use types. Agricultural demand is calculated based on annual crop type distribution mapping and user-specified evapotranspiration rates for 20 irrigated crop types and managed seasonal wetlands at the Kern National Wildlife Refuge. Agricultural water demand is determined based on a soil moisture balance that uses local soil properties to assess the amount of applied water (precipitation and specified surface water applications) available to meet the crop demand. If water demands in an element are not satisfied from these sources, the C2VSim model calculates the groundwater pumping needed to eliminate any deficit.

Urban demands are calculated based on population and per-capita water demands. Water demands for native, undeveloped, fallow or riparian settings are calculated from monthly evapotranspiration rates and the amount of precipitation. If water demands in an element are not satisfied, no applied water is provided to these areas, and the vegetation is assumed to be in a stressed state. Runoff of precipitation in developed and undeveloped areas within the Subbasin and surrounding small watersheds is calculated using methodology included in IWFM that is based on the Soil Conservation Service Curve Method (NRCS, 2004).

C2VSimFG-Beta was released after a preliminary model calibration. The distribution of aquifer parameters was based on a texture analysis of lithologic well logs compiled by the US Geological Survey (USGS, 2009) from Well Completion Reports submitted to DWR by well drillers. The texture analysis interpolated the percentage of coarse-grained material at each well location and depth of the C2VSimFG-Beta mesh. Aquifer parameters were then calculated for the model mesh based on the percentage of coarse-grained material and estimated properties for pure coarse- and fine-grained materials. Transmissivities were estimated using specific capacity tests, where available. Soil properties for each model element were derived from digitized soil maps published by the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS, 2018).

3. KERN COUNTY REVISIONS

C2VSimFG-Beta input files were revised to incorporate locally-derived managed water supply and demand data to better represent the local water budgets for the Kern County Subbasin. Additional revisions were made to C2VSimFG-Beta model to address issues that were identified with the physical representation of the Kern County Subbasin. The result of these Kern County specific modifications is a local version of C2VSimFG-Beta that is referred to here as C2VSimFG-Kern. The following provides a summary of the model modifications.

3.1 C2VSimFG-Kern Model

C2VSimFG-Kern input files incorporate locally-derived historical data for the Kern County and White Wolf subbasins to better represent local water conditions. These are two separate groundwater subbasins in the Kern County portion of the San Joaquin Groundwater Basin. The Kern County Subbasin is listed as critically-overdrafted by DWR with a GSP deadline of January 30, 2020, whereas the White Wolf Subbasin is listed as medium priority by DWR with a GSP deadline of January 30, 2022. C2VSimFG-Kern was not changed for areas outside of the Kern County Subbasin.

Historical surface water diversion, water bank recharge and water bank withdrawal information were collected from local GSAs, management areas, water agencies and purveyors. Urban land use was restricted to developed areas, and urban populations and per-capita water demands were updated. Model structure (elements, streams, stratigraphy, etc.) was not modified. Model parameters were not calibrated, although some model parameters were adjusted to improve model performance in specific geographic areas.

3.2 Simulation Time Period

GSP requirements indicate a need to identify an average hydrologic study period for purposes of the groundwater analyses in the basin-wide water budgets. In order to select a consistent study period, the Kern County Subbasin GSAs agreed upon an historical hydrologic study period covering WY1995 through WY2014 (October 1, 1994 through September 30, 2014). The selection of the historical hydrologic study period was based on a variety of technical criteria including:

- Covers at least 10 years consistent with GSP regulations (§354.18(c)(2)(B)),
- Contains 10 years characterized as above normal or wet years based on precipitation; also contains 10 years of below normal or dry years, including four critically dry years,
- 100 percent of the long-term average streamflow conditions on the Kern River, as indicated by an average annual Kern River Index of 100 percent (**Figure 4**),
- About 104 percent of long-term average precipitation (NOAA Bakersfield Meadows Field Airport Station),
- Widely-available high-quality data available across the Subbasin,
- Time period with current water management practices, intensive groundwater banking operations, and more recent land use patterns,
- Begins in a time of relatively stable water levels (October 1994), and
- Overlaps a time period with consistently developed basin-wide contour maps by Kern County Water Agency (KCWA).

For the historical water budget, it is desirable to define a base period when natural hydrology represents average conditions. C2VSimFG-Kern incorporates this 20-year base period of WY1995 through WY2014 with a 10-year spin-up period (WY1985 to WY1994).

Kern County water agencies provided locally-derived water budget data for WY1993 to WY2015 for this study so that data input extended beyond the historical base period. Additional water budget data prior to WY1993 were also collected where available and input into the model.

The simulation period for C2VSimFG-Kern was set to WY1986 to WY2015 (October 1, 1985 through September 30, 2015), allowing a 10-year spin-before the start of the historical base period. The C2VSimFG-Beta simulation period ran from October 1973 through September 2015 (WY1974 to WY2015). The period from October 1973 to September 1985 was not included in the simulation due to concerns about lack of comparable data from these earlier periods.

3.3 Data Compilation

Participating agencies compiled water budget input data sets (using their staff, consultants or other resources) and provided them to Todd Groundwater. Where appropriate, Todd Groundwater developed data templates that conformed to IWFM model data needs and used them to facilitate obtaining input data from local agencies. This included monthly data for the following:

- Surface water imports and diversions (inflows and outflows) by source, conveyance and application area,
- Groundwater banking and managed aquifer recharge by water district or agency,
- Groundwater recovery pumping of groundwater bank recharge for export from the basin,
- Groundwater recovery pumping of managed aquifer recharge for local use,
- Urban area population and per capita water use, and
- Crop evapotranspiration (ET) rates based an analysis of satellite data (ITRC, 2017).

In addition, groundwater banking data were compiled for the large Kern Fan banking projects. Recently developed crop ET rates derived from remote sensing data were used to develop monthly crop ET rates for agricultural crops. Urban land use was restricted to developed areas, urban populations and per-capita water demands were updated, and urban wastewater recharge operations were added.

3.4 Surface Water

Kern County surface water diversions in C2VSimFG-Beta were grouped by project or water source, and some surface water deliveries were applied to large regions rather than to individual districts. In addition, some local surface water deliveries were missing from C2VSimFG-Beta. For C2VSimFG-Kern, the 43 Kern County surface water diversions from C2VSimFG-Beta were replaced with 113 surface water diversions developed with data provided by local agencies.

The Arvin-Edison WSD, Wheeler Ridge-Maricopa WSD and Tejon-Castaic WD overlie both the Kern County and White Wolf subbasins. Surface water deliveries for these districts were apportioned to either the Kern County and White Wolf subbasins, based on data provided by Arvin-Edison WSD and Wheeler Ridge-Maricopa WSD, so that surface water deliveries to those areas could be tracked separately for the water budgets.

3.4.1 River and Stream Inflow

Inflows to the Kern River and Poso Creek at the Subbasin boundary are based on historical gauge data. Kern River inflows at the First Point gauge and downstream gauges were verified and updated based on the annual Kern River Hydrographic Reports produced by the City of Bakersfield (COB, 1985-2015). C2VSimFG-Beta contained Poso Creek inflows for WY1961 to WY1986. Poso Creek inflows for WY1987 to WY2015, based from flow records for the Coffee Canyon and Trenton stream gauges, were added to C2VSimFG-Kern based on data provided by the local agencies.

3.4.2 Surface Water Diversions

Monthly surface water diversion data for WY1995 to WY2015 were collected for 21 agencies and recharge projects in Kern County. The data from each water district or agency included monthly surface water inflow by source and monthly surface water outflow by destination.

The monthly surface water inflow and outflow data collected for this study did not have sufficient detail to track this water and create an accurate historical water budget for each canal for each month. The data did provide sufficient information to identify monthly surface water diversions from each source and deliveries to each end use. Therefore,

- All diversions from the Kern River were exported from the model and treated as imports at delivery locations,
- Diversions from Poso Creek and the Kern River Flood Channel (or Main Drain) were diverted from the appropriate stream nodes, and
- All other surface water deliveries (State Water Project (SWP), Central Valley Project (CVP), oil field recovery water, etc.) were treated as imports.

Each C2VSim surface water diversion is linked to two groups of model elements: the elements of the end use and the elements receiving the recoverable losses. A single set of elements was used for both purposes in C2VSimFG-Kern. Model elements for agricultural, urban and refuge deliveries were selected by overlaying the model grid on delivery areas maps. Model elements for recharge diversions were selected by overlaying the model grid on recharge basin maps.

Monthly water delivery data for the SWP, CVP and Kern River were also provided by the agencies. Monthly turnout-level deliveries for the SWP were also compiled from the monthly SWP Report of Operations published by DWR. Monthly CVP deliveries were compiled from the USBR Report of Operations. Monthly Kern River flow and diversions were compiled from Kern River Hydrographic Reports. Water agencies in the Kern County Subbasin trade and wheel water in real time to maximize water utilization, minimize waste and energy consumption, and meet immediate water needs. Water delivery reports from water suppliers (such as the CVP and SWP) generally identify the owner of delivered water, not where it was actually delivered.

Some surface water conveyances discharge water into stream or river channels for re-diversion downstream. A key part of the surface water system in Kern County is the Kern River. Kern River operations data were reviewed for calendar years 1970 to 2015. While **Table 1** summarizes surface water deliveries, **Table 2** summarizes Kern River diversions by turnout location as applied in C2VSimFG-Kern.

3.4.3 Surface Water Deliveries

Water flow through the Kern River and its associated canal system is very complex. Water is diverted from the Kern River into a parallel canal system at several locations, with some diverted water flowing back to the river. Some water from the CVP and SWP are discharged into the Kern River for diversion downstream. Some water agencies are served from multiple diversion points along the Kern River. Several canals that receive water diverted from the Kern River also exchange water with other canals and receive some water from groundwater pump-in, so deliveries from many canals cannot be attributed to a single source. **Figure 5** shows the locations of the primary streams, regional surface water canals, and groundwater recharge locations in the Kern County Subbasin.

Each surface water diversion in C2VSim is allocated to a specified destination and water use. Five water use types are simulated in C2VSimFG-Kern: agricultural, urban, refuge, recharge and export. Agricultural and refuge diversions are applied to a group of model elements that corresponds to a surface water service area within a specific water agency or refuge. Urban diversions are allocated to an urban service area. Groundwater recharge diversions are allocated to the model element or elements where the receiving recharge basin is located. Three delivery fractions apportion each surface water diversion to application, loss to groundwater (recoverable loss), and loss to evaporation (non-recoverable loss). **Table 1** summarizes the annual surface water deliveries for agricultural use by water district in Kern County. **Table 3** summarizes surface water diversions for urban use, wastewater land disposal and wildlife refuge management in Kern County.

3.5 Groundwater Banking and Managed Aquifer Recharge Operations

In our preliminary discussions with the C2VSim developers at DWR, it was revealed that significant model uncertainty was related to incomplete data regarding groundwater banking and other managed aquifer recharge (MAR) operations in the Kern County Subbasin. Recognizing the importance of these groundwater banking projects for simulating groundwater conditions, the groundwater banking and MAR operations data was updated using the earliest available records.

3.5.1 Recharge and Recovery Data

A monthly time-series of recharge rates was determined for each recharge project. Recharge rates were allocated to individual recharge basins using the initial data whenever possible or were shared proportionally between basins based on historical rates. All Kern County recharge basin surface water deliveries were simulated as imports.

Recharge basin locations and recovery well locations were provided by each agency or project (**Figure 6**). The C2VSim finite element grid was overlaid onto a map of recharge basins to determine the model elements for each recharge location. Well location coordinates were added to C2VSimFG-Kern.

Monthly volumes for recharge at groundwater banking and managed aquifer recharge facilities were compiled for 16 agencies and projects (**Table 4**). This information originated from multiple sources, and included data provided by agencies, compiled from agency reports, and compiled from Kern River Hydrographic Reports. The data includes monthly recharge for years prior to 1995 for many projects. Several agencies and projects provided data for multiple recharge basins. Some groundwater wells used for recovery of banked water are also used for other purposes such as supplementing agricultural or urban surface water deliveries.

Recognizing that several of the large groundwater banking projects (especially those on the Kern Fan) pre-date the 20-year base period, and that future studies might simulate periods prior to 1985, all available historical data for groundwater banking operations was reviewed and updated. This included incorporating pre-1985 data for banking operations at

- Arvin-Edison WSD (1966-2015),
- Berrenda Mesa Project (1977-2015),
- Buena Vista WSD (1963-2015),
- City of Bakersfield 2800 Recharge Facilities (1973-2015),
- North Kern WSD (1956-2017), and
- Rosedale-Rio Bravo WSD (1980-2015).

3.5.2 Groundwater Recovery

Two types of recovery wells were added to the C2VSimFG-Kern. These include district-operated water wells that were used for out-of-district transfers or out-of-basin exports of groundwater, and wells used for recovering banked groundwater and distributing the pumped groundwater via the district's water conveyance system to provide water supply, typically for agricultural use, within the district. The locations of the specified groundwater recovery wells are shown on **Figure 6**. The specified groundwater recovery pumping input into C2VSimFG-Kern is summarized as follows:

- 229 time series for Kern County groundwater banking withdrawals were added,
- 313 simulated pumping wells and 225 pumping time series for local groundwater pumping by district-operated recovery wells were added, and
- Elemental agricultural, refuge and urban pumping was eliminated in areas where it has not historically occurred.

Recharge and withdrawal data for the Kern Fan banking projects, including the Kern Water Bank, Berrenda Mesa Project, Pioneer Project, and the City of Bakersfield 2800 Recharge Facilities were shared with the local banking authorities for verification. Banking data for district-specific groundwater banking projects were provided by these districts. A summary of the data input for groundwater recovery pumpage added to C2VSimFG-Kern is provided in **Table 5**.

3.5.3 Model Application

A separate diversion was created to deliver surface water to each recharge basin or set of geographically close jointly managed basins. A diversion time series of monthly application rates was then created for each recharge diversion from the available data. Each recharge diversion delivers water to the model elements coinciding with the receiving recharge basin(s). Recharge basins were simulated in C2VSimFG-Kern by setting the application delivery fraction to zero, the recoverable loss fraction to 94% and the evaporation loss to 6%.

Monthly groundwater recovery was generally provided by well field and destination (e.g., agriculture, urban, canal pump-in, or export). This information was used to develop a pumping time series for each well field and destination. Groundwater pumped for export from the Kern County Subbasin is summarized in **Table 6**. Recovery well locations and screen intervals were used to enter each recovery well into C2VSimFG-Kern. Recovery pumping time series were then allocated equally to all of the wells in each field.

Some well fields supply water to two different end uses, for example supplementing surface water deliveries within the district in some months and exporting water from the district in other months. This is handled in C2VSimFG-Kern by entering the well two times. Each entry is associated with a separate time series of pumping rates and delivery destination.

3.5.4 Groundwater Banking Obligations

The general operation of groundwater banking facilities is to recharge excess available surface water supplies during wet years by recharging to the groundwater and recovering this water by pumping in dry years when surface water supplies are limited. Groundwater banking programs store water in the Kern County Subbasin for use by local agencies and for export to out-of-basin entities.

For evaluating the groundwater sustainability, any water stored in the Kern County Subbasin that is contractually obligated to an out-of-basin entity does not contribute to the long-term groundwater sustainability because the owner of that water could call for its return at any time. However, this can be difficult to track because a common practice is to recover groundwater for local use to replace imported surface water that was sent to the out-of-basin entity.

C2VSimFG-Kern does not have a mechanism to track these complex contractual exchanges, so the tracking is done as a post processing step by assigning the portion of the groundwater recharge as an out-of-basin banking obligation.

The Kern County Subbasin GSAs provided the total out-of-basin banking obligation for their operations as of September 2014 for the historical assessment. As of September 2014, the out-of-basin banking obligation for the Kern County Subbasin totaled of 1,719,307 acre-feet, which, when averaged over the 20-year period, was 85,965 acre-feet per year (AFY). The 85,965 AFY is applied during post-processing of C2VSimFG-Kern historical water budget results.

3.6 Urban Water Demand

C2VSim calculates urban water demands for specified urban delivery zones, allocates specified surface water and groundwater supplies to meet these demands, and can optionally pump additional groundwater to satisfy unmet urban demands in each zone. Urban demands were represented with nine urban zones in C2VSimFG-Beta. These zones were reconfigured, and a tenth urban zone was added representing Metropolitan Bakersfield in C2VSimFG-Kern. Historical urban populations and per capita water use rates were reviewed and updated.

3.6.1 Urban Zones

C2VSimFG-Kern dynamically calculates urban water demands for urban zones using time-series data of urban populations and monthly per capita water use. The urban delivery zones of C2VSimFG-Beta were modified to better represent Kern County population centers, jurisdictional boundaries and urban water sources. Although Kern County urban water delivery systems are operated by many diverse entities, their water generally comes from two sources: surface water deliveries and agency-operated groundwater wells.

The nine Kern County urban zones in C2VSimFG-Beta for Kern County were numbered 97-105. The Urban Zone boundaries were adjusted, as shown on **Figure 7**, as follows:

- Portions of Urban Zones 97, 99, 100, and 102 in C2VSimFG-Beta were used to create Urban Zone 106 representing the Metropolitan Bakersfield area,
- Urban Zone 98 was extended southeast to near the Stockdale Highway to include unincorporated urban areas,
- The boundary of Urban Zone 99 was extended eastward to California State Route 65 to include small communities in this area, removing them from Urban Zone 100, and

- The northern boundary of Urban Zone 104 was moved north to correspond to the West Kern WD service area.

3.6.2 Urban Population and Per Capita Use

Historical annual urban populations for the urban zones were estimated using United States Census total population data from 1990, 2000 and 2010 (US Department of Commerce, 2018). Tabular historical census data and census block shapefiles were obtained from the IPUMS National Historical Geographic Information System Database (IPUMS 2018). These data were combined to produce maps of the geographic distributions of populations within Kern County. The historical populations for each Urban Zone were estimated by mapping census block centroids to the ten Urban Zones using ArcGIS. The 1990, 2000 and 2010 populations of each Urban Zone were then estimated as the sum of the populations of the associated census blocks. Populations for other years were estimated using interpolation and extrapolation. The population values by Urban Zone used for C2VSimFG-Kern are listed in **Table 7**.

3.6.3 Urban Water Use Specifications

Monthly historical urban water demands for Urban Zone 106 were calculated using water delivery data from the water purveyors in the Metropolitan Bakersfield area. Monthly historical urban water demands for the other urban zones in the Kern County Subbasin were estimated using available water use data from published urban water management plans for the communities served in those zones. The historical monthly water use in each zone was then divided by the historical population to obtain the monthly per capita urban water demand. Monthly historical per capita water demands for zones without urban water management data were estimated using the per capita water demand from zones with similar demographics.

The urban water use specifications indicate the portion of total urban water that is used indoors. In C2VSimFG-Kern, the portion used indoors becomes urban return flow, and the remainder is added to the urban root zone where it contributes to evapotranspiration and deep percolation. C2VSimFG-Beta included monthly urban water use specifications for each model subregion. The urban per capita water use was based on local water supply data and urban water management plans. **Table 8** lists the per capita water use data used for C2VSimFG-Kern.

3.6.4 Urban Wastewater

Urban wastewater for the Metropolitan Bakersfield area is treated at local wastewater treatment plants; however, wastewater disposal is primarily evaporation ponds or land disposal at locations outside of the Metropolitan Bakersfield area. C2VSimFG-Beta does not have a direct means to redirect wastewater to an outside location. Urban wastewater, based as the indoor use, is applied uniformly within the urban zone. To get around this limitation, application of wastewater for the Metropolitan Bakersfield area was turned off in C2VSimFG-Kern. The wastewater deliveries to evaporation ponds and land disposal areas from the wastewater treatment plants was assigned to the appropriate location using data provided by the plants. This conserved the water balance by not double counting wastewater, and it was applied at the appropriate locations for evaluating groundwater levels.

3.6.5 Model Application

Historical annual urban population estimates were placed in the C2VSimFG-Kern urban population input file. Historical monthly urban per capita water demand estimates for each urban zone were placed in the C2VSimFG-Kern urban per capita water use file. Urban demand was calculated by C2VSimFG-Kern and the water supply to meet these demands was met first by specified surface water and groundwater pumping deliveries for urban use. The remaining water demand in each model element was met with groundwater pumped from the aquifer portion of that element.

3.7 Agricultural Crop Water Demand

C2VSim dynamically calculates agricultural crop water demands and allocates supplies to meet these demands for each model element. Agricultural demands are calculated for 20 crops using historical crop acreage data and crop evapotranspiration (ETc) rates. Crop water demands in each model element are first met with stored soil moisture, surface water deliveries and specified groundwater deliveries. If the agricultural demands are not satisfied, the model can optionally calculate the additional groundwater pumping required to satisfy the unmet demands and extract that water from the groundwater component of the model element.

C2VSimFG-Beta contained one set of monthly ETc rates for each model subregion that were applied to all years despite climatic variation. New monthly ETc rates for three model subregions (northeast, northwest, south) in Kern County were calculated for 1993-2015 using monthly remote sensing imagery and detailed annual crop maps. ETc for 1974-1992 were estimated from 1993-2015 values by using the values for similar water year types based on the San Joaquin Index. Satellite data were not available for 2012, so ITRC was unable to provide METRIC data for 2012. In C2VSimFG-Kern, 2013 was applied as an appropriate proxy for ETc data in 2012 because of their hydrologic similarity.

A remote sensing study of historical ETc rates across the entire Kern County Subbasin by the Irrigation and Training Research Center (ITRC, 2017) provided detailed basin-wide agricultural demands that corresponded to the WY1995 to WY2014 base period. These data were used to develop monthly ETc rates for the Kern County portion of the model.

3.7.1 ET Rates

The Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo, has developed a procedure to use remote sensing imagery from Landsat satellites to calculate historic ETc rates (ITRC, 2017). The Mapping of Evapotranspiration with Internal Calibration (METRIC) method was originally developed by Richard Allen of the University of Idaho. ITRC made several modifications to the original METRIC method to better match California data and conditions (named the ITRC-METRIC method). These modifications include using grass for reference evapotranspiration (ETo), incorporating a semi-automated calibration procedure and spatially interpolating ETo rates. An example of the METRIC ET data for the total annual ET in 2013 is provided in **Figure 8**.

ITRC used Landsat imagery for 1994-2015 (except 2012 when no imagery was available) and the ITRC-METRIC method to develop monthly raster maps of ETc at 30 x 30-meter resolution for the Kern County portion of the Central Valley (ITRC, 2017). The monthly ETc raster maps were used with annual DWR crop maps to calculate the average ETc by crop type for the three Kern County C2VSim subregions. ITRC-METRIC raster data were used to determine the exact areas of applied irrigation and total annual ETc. A raster pixel was assumed to be irrigated if the total annual ETc was greater than 20 inches.

The following data processing steps were used to determine monthly ETc rates for each crop and C2VSim subregion:

- Create irrigation coverages – ITRC-METRIC monthly ETc raster data were summed to calculate total annual ETc for each year for each raster location. The ArcGIS Reclassify tool was then used on each annual ETc raster to create a binary polygon coverage for each year for 1994-2015 (except 2012), setting the attribute "IRR" to 1 if total annual ETc was over 20 in/year, and to 0 if total annual ETc was equal to or less than 20 in/year.

- Create land use coverages – Annual DWR land use rasters were converted to polygon coverages with the attribute "Crop" set to the corresponding integer crop value used in C2VSimFG-Kern. The land use rasters were checked against GIS maps produced by the Kern County Agricultural Commissioner and errors in the DWR land use rasters were corrected. DWR land use maps for 1994-1997 were missing large areas of data, so the 1998 land use map was used to approximate the land use for 1994-1997.
- Create monthly zone maps – One zone shapefile was created for each month by using the ArcGIS Union tool to combine a shapefile of the three C2VSim subregions with the irrigation coverage (produced in step 1) and the land use coverage (produced in step 2). Each monthly zone polygon shapefile has three attributes: C2VSim subregion, binary irrigation indicator, and a land use crop value. The dissolve function was used to combine zones with identical parameters.
- Calculate average monthly ETc for each zone – The ArcGIS Zonal Statistics by Table tool was used to calculate the average ETc value for each zone for each month. The individual pixels in each monthly ETc raster were averaged within each zone (produced in step 3). ITRC-METRIC data for 2013 were used in place of missing data for 2012.
- Combine tables – The MS Access Append function was used to combine the monthly ETc tables into a master table of monthly ETc by crop and C2VSim subregion.
- Output data – Data from the Access database was exported in a form consistent with the C2VSimFG-Kern input files. The output was also summarized to show the average monthly ETc for the irrigated area of each crop type in each model subregion.

The monthly ETc rates for the three Kern County subregions for WY 1993-2015 were then replaced with the monthly ETc rates calculated using ITRC-METRIC data. The annual ETc rates applied to C2VSimFG-Kern by crop are listed in **Table 9**.

3.7.2 Irrigation Periods

The C2VSim Irrigation Periods file contains monthly parameters for each crop and subregion that indicate whether or not the crop is irrigated in that month. C2VSimFG-Beta irrigation periods for the three Kern County subregions were adjusted to match crop irrigation practices from ITRC-METRIC water usage. Refuge irrigation periods for the three Kern County subregions were also adjusted to match Kern NWR practices. Simulated irrigation water usage for the C2VSimFG-Kern better reflects observed irrigation practices.

3.8 Model Modifications

In general, the scope of work was to revise the managed water supply and demand for the Kern County Subbasin. During the course of this revision, several issues were identified with the hydrogeological conceptual model and simulation parameters that affected the historical water budget. The following summarizes modifications made in C2VSimFG-Kern to improve the model performance. Other issues identified regarding the hydrogeological conceptual model, model setup and simulation parameters that were not addressed in C2VSimFG-Kern but are recommended to be modified for future model updates, are listed in Section 8.5. A summary of the changes that were made in C2VSimFG-Kern are provided below.

3.8.1 Streambed Parameters

In the Kern County Subbasin, the Kern River and Poso Creek are the two largest streams. Both have multiple stream gauges along their courses including ones near where they enter the Kern County Subbasin from the Sierra Nevada. These are the only two streams that are simulated in the model using the IWFM stream module. Both are predominantly losing streams where surface water recharges groundwater, except during limited periods near the major groundwater banking operations west of Bakersfield when multi-year periods of recharge operations produce high groundwater levels.

As a part of the C2VSimFG-Kern update, the simulated recharge from the Kern River and Poso Creek were compared to changes in stream gauge measurements and estimated streambed losses to evaluate how well the model was simulating streambed seepage. For much of the Kern River, the amount of streambed seepage is estimated based on daily weir information and is documented in the annual Kern River Hydrographic Reports. The streambed parameters used in C2VSimFG-Beta were not providing a comparable volume and distribution of seepage along the Kern River streambed. In dry years, streamflow as not getting far enough downstream whereas in wet years the seepage was too low. Similarly, the Poso Creek streambed seepage showed similar issues based on comparisons to differences in stream gauge data along its course.

To address this, the Kern River and Poso Creek streambed parameters were manually modified until a reasonable approximation of the measured streambed seepage was achieved by C2VSimFG-Kern. In general, the streambed conductance was lowered whereas the stream wetted perimeter was increased. This provided the best balance in matching the measured dry, average and wet years flows in both streams.

Part of this issue is that C2VSimFG-Beta uses a simple form of the stream module in the simulation. This approach appears to work sufficiently well for the continuously flowing streams in the northern parts of the Central Valley but is not sufficient for simulating the highly variable flows that occur on the Kern River and Poso Creek. It is recommended that future revisions to C2VSimFG-Kern further evaluate issues in simulating streamflow and seepage in the Kern River and Poso Creek (see Section 8.5). This may include incorporating more advanced streamflow simulation features that are available in IWFM but that have not been utilized in C2VSimFG.

3.8.2 Small Watershed Runoff

In reviewing the small watershed contributions, it was determined that the runoff was not representing the variable nature of runoff in an arid region. Although this was not part of the originally planned model revisions, it affected the model results. Todd Groundwater revised the corresponding model parameters to be more representative of the local arid conditions in Kern County.

Runoff of precipitation from the surrounding small watersheds was calculated within C2VSimFG-Kern using methodology included in IWFM that is based on the SCS Curve Method (NRCS, 2004). The C2VSimFG-Beta results showed a steady baseflow that contributed water to the Kern County Subbasin continuously and did not show the appropriate variation in runoff expected between wet, average and dry years in the arid environment.

Two major issues were identified and revised. First, the SCS curve number was changed to allow a higher percentage of runoff in wet years to capture the flashy nature of runoff from these watersheds during differing climatic conditions. Second, IWFM uses a localized soil moisture water budget; however, soil, ET and other parameters were set that allowed for the continuous outflow from the basins. These were changed to more appropriate values that limited baseflow from the very small watersheds while allowing baseflow from the larger watersheds. Parameters were varied to better match estimated watershed runoff from a local USGS study (Nady and Larragueta, 1983).

3.8.3 Root Zone Parameters

Areas of overly high root zone hydraulic parameters led to high volumes of deep percolation that required additional groundwater pumping to meet the overall water demand for irrigation. This issue was noted by local water district staff who recognized that the groundwater pumping and deep percolation from preliminary model results were significantly higher than what was found in practice. A review found areas of overlying hydraulic conductivity and other hydraulic parameters that caused this high percolation rate. Two types of issues were found. First, very high parameters were found in parts of the basin that were not consistent with local soil data. Second, the root zone parameters for lakebed and other heavy clay soil areas were too high. These areas were manually adjusted to be more in line with observed conditions. A more rigorous development of root zone parameters should be considered in the future as this issue demonstrates that it is a sensitive parameter.

3.8.4 Land Use Modifications

The agricultural land use and crop type distribution in the model for early period (1974-1990 and 1992-1996) from C2VSimFG-Beta used a regional distribution and did not accurately represent historical practices. This resulted in agricultural water use being distributed across the entire Kern County Subbasin including areas that did not have irrigated agriculture. To correct for this, land use and crop type data were modified to conform with irrigated agricultural areas in the early 1990s. The crop types were adjusted to be consistent with the Kern County Agricultural Commissioner reports for these years. This included capturing the appropriate crop types present in the Kern County Subbasin in the periods from 1974 through 1996. For example, there was a higher percentage of cotton produced during that period and a lower percentage of nut trees, which became one of the major crop types in the 2010s.

3.8.5 Westside Pumping Limits

Western Kern County contains large areas with poor groundwater quality. As a result, little or no agricultural or urban groundwater pumping occurs in this area. To simulate this, groundwater pumping was turned off in C2VSim-Kern in most of the area with poor groundwater quality. However, in the Westside District Water Authority Management Area, limited groundwater pumping does occur. The poor-quality water is mixed with surface water to supplement the imported water supply. To simulate this condition, the groundwater pumping rate in the Westside District Water Authority Management Area was estimated to be 10% of the surface water deliveries, and the automated groundwater pumping adjustment in C2VSimFG-Kern was turned off for these areas.

Subsequent to the completion of the historical model, GSP developers in the Westside area refined their estimate of pumping used to mix with delivered surface water to about 3,000 AFY, which is considerably lower than that used in the historical model. The Westside GSP developers included a management action to further refine the estimated groundwater use in the Westside GSP water districts. Therefore, the original assumption was left in this version of the historical model. The Westside District Water Authority Management Area GSP identifies a management action to further evaluate the groundwater pumping in their area. The results of their evaluation will be included in in future model updates.

3.8.6 Kern Wildlife Refuge pumping

C2VSimFG-Beta enabled groundwater pumping in the model elements representing the Kern National Wildlife Refuge. The Kern National Wildlife Refuge Water Management Plan (USBR, 2011) indicates that during the simulation time period, the refuge was sustained entirely on imported surface water and occasional diversions of Poso Creek flood waters. No groundwater was pumped at the refuge during the simulation period 1985-2015. Groundwater pumping was used at some time in the past. Groundwater pumping and automated groundwater pumping adjustment were turned off for all model elements in the Kern National Wildlife Refuge.

In addition to the Kern National Wildlife Refuge, former rice fields and other areas are currently used for sustaining ponds at private duck hunting clubs in the northwestern portion of the Kern County Subbasin. Water use data for these operations were not available during the development of the historical model. This water includes a combination of surface water and groundwater, and this volume is considered to be very small relative to the overall basin water use. GSP developers included a management action to further refine the estimated water use for these facilities that will be addressed in future updates.

3.9 C2VSimFG-Beta Modifications

Minor changes were made to the C2VSimFG-Kern hydrogeological conceptual model and natural water budget components and are listed in **Table 10**. The architecture of the model including layering, discretization, boundary conditions, and aquifer properties was not revised. Aquifer parameters were adjusted in several areas to better match observed historical conditions, especially in areas with high historic recharge volumes such as the Kern Fan. Extremely high soil hydraulic conductivities in a small set of elements were reduced to more reasonable values. Stream-bed conductance values were modified in some stream reaches to better match simulated stream gains and losses to observed values. Minor adjustments to small watershed parameters were also made to match surface runoff to observed values.

Due to the number of modifications that were identified with the hydrogeological conceptual model and aquifer parameters during the C2VSimFG-Kern update, it is recommended that a more rigorous model update be conducted that will update the hydrogeological conceptual model and aquifer parameters to be consistent with that presented in the Kern County Subbasin GSPs. In addition, further calibration of C2VSimFG-Kern is recommended to update aquifer parameters in the Kern County Subbasin. Future calibration is further discussed in Section 8.5.

4. HISTORICAL AND CURRENT WATER BUDGETS FROM C2VSIMFG-KERN

C2VSimFG-Kern was used to develop historical (WY1995 to WY2014) and current (WY2015) water budgets for the Kern County Subbasin. The following summarizes the simulated water budgets from C2VSimFG-Kern. A summary of these results is provided below.

4.1 Historical and Current Water Budget

The simulated historical and current water budgets based on C2VSimFG-Kern are presented in **Tables 11A** and **11B** and are presented graphically on **Figures 9**. **Figure 10** presents the average annual historical water budget for the Kern County Subbasin. The results for the historical water budget are summarized under the following categories that are defined as:

- **Deep Percolation** – Precipitation and applied water that reaches the groundwater after simulated transport across the unsaturated zone. The simulated historical 20-year average is a net inflow of 669,398 AFY.
- **Managed Recharge and Canal Seepage**- Combined groundwater recharge from managed aquifer recharge operations, groundwater banking, and seepage from canals and other conveyance. The simulated historical 20-year average for Managed Recharge and Canal Seepage is a net inflow of 583,598 AFY. On Figure 10, this total is subdivided between out-of-basin groundwater banking obligations (85,965 AFY) and the remaining local recharge of 497,633 AFY.
- **Net Groundwater-Surface Water (GW/SW) Interactions** - Net volumetric exchange of surface water and groundwater between the aquifer and streams: Positive represents a net groundwater recharge, and negative represents a net groundwater discharge to the stream. The simulated historical 20-year average is a net inflow of 98,606 AFY.
- **Small Watershed Inflow** – Runoff, small stream inflow and subsurface inflow from the small watersheds and areas surrounding the groundwater basin. The simulated historical 20-year average is a net inflow of 48,760 AFY.
- **Groundwater (GW) Pumping** - Total groundwater pumping by wells. Groundwater banking recovery pumping is specified as fixed input values and agricultural and municipal pumping is calculated by C2VSimFG-Kern based on demand minus surface water diversions. The simulated historical 20-year average is a net outflow of 1,590,373 AFY.
- **Subsurface Flow with Adjacent Groundwater (GW) Basins** - Net subsurface groundwater flow to and from the Kern County Subbasin with adjoining groundwater basins: negative is a net flow out of the Subbasin and positive is a net flow into the Subbasin. The simulated historical 20-year average is a net outflow of 87,102 AFY.
- **Change in Groundwater Storage** - Sum of the inflow components (positive numbers) plus the outflow components (negative numbers): positive is an increase in storage typified by a rise in groundwater levels whereas a negative is a decrease in storage typified by a decline in groundwater levels. The simulated historical 20-year average is a decline in groundwater storage of 277,114 AFY.

The simulated change in groundwater storage varies over the 20-year historical period and is closely related to climatic conditions and surface water supply availability (**Figure 11**). During the periods

WY1995 to WY1999, WY2005 to WY2006 and WY2011, the groundwater storage volume was stable to increasing and correlates to the above average rainfall and surface water availability during these times. During the periods WY2000 to WY2004, WY2007 to WY2010 and Y2012 to WY2015, groundwater storage volume decreased, correlated to periods of drought and low surface water availability. The simulated historical groundwater recharge also reflects this climatic pattern with high deep percolation to groundwater and steep increases in managed aquifer recharge and canal seepage during the above average rainfall periods and lower groundwater recharge during the drought years (**Figure 12**).

Groundwater pumping for agriculture shows a general increasing trend from WY1995 to WY2014; however, groundwater pumping is lower in above average rainfall years and higher during droughts (**Figure 13)**. This general increasing trend follows a comparable decreasing trend in surface water deliveries over this same period. As shown on **Figure 14**, surface water deliveries show a general decreasing trend from WY1995 to WY2014; however, the surface water deliveries are higher in the above average rainfall years and lower during the droughts.

4.2 Sustainable Yield

Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). 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 an undesirable result."

SGMA does not incorporate sustainable yield estimates directly into sustainable management criteria. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results. Basinwide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the six sustainability indicators.

4.2.1 Determination of Sustainable Yield

To determine the sustainable yield for the Kern County Subbasin, the results of the C2VSimFG-Kern model were used with two methods to estimate the amount of groundwater pumping that would avoid the undesirable result of a reduction in groundwater storage over the historical base period 1995 to 2014. The results are shown in **Table 12** and are summarized below:

- **Sustainable Yield from Groundwater Pumping –** The model results produced an average annual groundwater pumping in the Kern County Subbasin of 1,590,373 AFY with a decline in groundwater storage of 277,114 AFY. Subtracting the groundwater storage decline from groundwater pumping produced a sustainable yield of approximately 1,313,000 AFY.

- **Sustainable Yield from Groundwater Recharge –** The model results produced an average annual groundwater recharge in the Kern County Subbasin of 1,400,362 AFY. The subsurface outflow from the GSA was estimated to be 87,102 AFY. Subtracting these outflow losses from the groundwater recharge produced a sustainable yield of approximately 1,313,000 AFY.

Sustainable yield estimates are part of SGMA's required basinwide water budget. In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. This sustainable yield estimate can be helpful for evaluating the projects and programs needed to achieve sustainability. Although the SGMA regulations require a single value of sustainable yield calculated basinwide, it should be noted that the sustainable yield can be changed by implementation of recharge projects, variations in climate, or changes in stream flow conditions.

Using WY1995 to WY2014 as the base period, C2VSimFG-Kern results show declining groundwater levels and long-term reduction of groundwater storage. During this period, average annual inflow to the aquifer is 1,400,362 AFY, and outflow is 1,677,476 AFY (**Table 11A**). This yields an average annual deficit of 277,114 AFY. Based on these historical C2VSimFG-Kern results, the sustainable yield of the basin is approximately 1,313,000 AFY, with an estimated level of uncertainty on the order of plus or minus 10% to 20%.

4.2.2 Native Yield

Although not a SGMA requirement, the native yield is being used by Kern County GSAs for determining a portion of the groundwater allocation within the basin. The native yield is comparable to the sustainable yield except that the only recharge that is included in the calculation is the natural, unallocated portion of the groundwater recharge. For the Kern County Subbasin, this includes the groundwater recharge derived from precipitation and runoff from unallocated streams. The Kern River and Poso Creek, however, are allocated streams where specific agencies or parties have rights to specific volumes of flow.

The C2VSimFG-Kern model results over the historical base period WY1995 to WY2014 was again used for estimation of native yield. The model results were used to determine the amount of precipitation recharge over irrigated agricultural areas and the native/urban/undeveloped areas. The total and average annual volume of precipitation that percolates to groundwater during the WY1995 to WY2014 base period are listed in **Table 13**. The basinwide contribution is the relative proportion of the runoff along the basin margins from small, unallocated watersheds and inflow from the surrounding basin margin (from areas not defined as DWR groundwater basins). The results of this assessment based on the C2VSimFG-Kern results are shown in **Table 13** and are summarized below:

- The volume of precipitation that recharges the groundwater in the irrigated agricultural areas is 77,780 AFY.
- The volume of precipitation that recharges groundwater in the other areas is 132,981 AFY.
- The volume of inflow from unallocated small watersheds that recharges the groundwater in the irrigated agricultural areas is 48,760 AFY.

Totaling these inputs results in a native yield for the Kern County Subbasin of 259,520 AFY. The annual contribution per acre of approximately 0.144 acre-feet per acre is estimated by dividing the average annual contribution by the total area of the Kern County Subbasin (**Table 13**).

Similar to the sustainable yield, the native yield at this time is based on the available data. However, as data gaps are eliminated and management actions/plans are implemented, the native yield could change, and any changes to native yield will be included in future GSP amendments.

4.2.3 Application of Sustainable and Native Yield

In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. The native yield is comparable to the sustainable yield except that the only recharge that is included in the calculation is the natural, unallocated portion of the groundwater recharge. The following estimates of the Kern County Subbasin sustainable and native yields are derived from the C2VSimFG-Kern historical model results for the purpose of supporting GSP assessment of the types and magnitude of projects and programs needed to achieve sustainability.

The C2VSimFG-Kern estimates of sustainable and native yield presented here are based on available data and the current level of model calibration. Therefore, these estimates are considered appropriate as guides to SGMA planning. However, the C2VSimFG-Kern sustainable and native yield estimates are initial water budget estimates that are not intended for determination of individual landowner allocations or groundwater rights. Additional technical and legal analysis, along with stakeholder involvement, is necessary to fully quantify the sustainable and native yields.

5. APPROACH FOR PROJECTED FUTURE WATER BUDGETS

Projected future Baseline water budgets for the Kern County Subbasin were developed using the C2VSimFG-Kern. These projected water budgets establish expected Baseline conditions to evaluate the impacts of GSP implementation. Three predictive scenarios were developed for the Kern County Subbasin, each representing a different expected future hydrologic condition, by adapting C2VSimFG-Kern as follows:

- Future Baseline Conditions: Repeat historical hydrology with expected future water supply,
- 2030 Climate Conditions: Adjust historical hydrology for 2030 climatic conditions and expected water supply, and
- 2070 Climate Conditions: Adjust historical hydrology for 2070 climatic conditions and expected water supply.

Projected future water budgets were developed for Baseline conditions and expected 2030 Climate Conditions and 2070 Climate Conditions over a 50-year planning and implementation horizon. These scenario models provide a basis of comparison for evaluating proposed sustainability management actions and projects over the SGMA planning and implementation horizon.

5.1 Assumptions

C2VSimFG-Kern was modified to incorporate projected future hydrology and land use using analog data from the historical C2VSimFG-Kern model. This approach meets GSP requirements using:

- A 50-year time-series of historical precipitation, evapotranspiration and stream flow information as the future Baseline hydrology conditions,
- The most recent land use, METRIC-based evapotranspiration, crop coefficient and urban population growth information as the Baseline condition for estimating future water demands,
- The most recent water supply projections as the Baseline condition for estimating future surface water supply,

- DWR Climate Change Guidance and Data Sets to incorporate estimated climate change conditions for the Kern County Subbasin,
- Specialized analysis of the Kern River watershed and estimated runoff volumes under climate change conditions,
- Specialized analysis of CVP deliveries to Kern County under climate change conditions incorporating implementation of the San Joaquin River Restoration Program, and
- Specialized analysis of SWP deliveries to Kern County under climate change conditions incorporating implementation of the OCAP Biological Opinion and recent changes in Table A and Article 21 allocations.

5.2 Projected Future SGMA Projects

Projected water budgets for the Kern County Subbasin were developed using the C2VSimFG-Kern to evaluate the performance of proposed management actions with respect to achieving groundwater sustainability. Participating agencies provided a list of projected future management actions to be implemented between WY2021 and WY2040. These projects were simulated under Baseline conditions, 2030 Climate Conditions and 2070 Climate Conditions through WY2070 using the C2VSimFG-Kern.

Proposed future projects and management actions were provided by GSAs. The types of proposed SGMA projects and management actions are summarized as follows:

- Demand Reduction is the volume of water reduced by changing the land use; these include:
  - Agricultural demand reduction projects through incentives or actions to reduce crop water use,
  - Fallowing of agricultural land and conversion of agricultural land to recharge basins, and
  - Conversion of agricultural land to urban land.
- New Supply groups together planned increases in imported water supplies; these include:
  - Increased surface water imports generally resulting from projected water purchases,
  - New water conveyance facilities including pipelines and reservoirs to increase flexibility, and
  - Expansion of surface water delivery areas to reduce groundwater usage.
- Other Supply groups together proposed projects to increase local water supplies; these include:
  - Recharging treated waste waters derived from both urban areas and oil production operations; increased recharge occurs in both existing and new locations,
  - Increased stream flow diversions; these include exercising riparian water rights and diverting flood flows,
  - Reallocation of water; generally reducing sales of surface water and banked groundwater and using this water within the agency, and
  - Brackish groundwater in areas not currently overdrafted will be treated and mixed with surface water to augment surface water supplies.

Some management actions are implemented gradually over many years, with savings increasing each year over the implementation period. Some management actions are implemented only in certain years (wet years, for example). The anticipated average-annual water supply benefit of the proposed SGMA projects and management actions steadily increases over the 20-year period from WY2021 to WY2040 to represent the implementation of the Kern County Subbasin GSPs. This increasing trend, as shown as the average-annual water supply benefit over five-year increments on **Figure 15**, is summarized as follows:

- about 116,000 AFY over the first five-year period (WY2021-WY2025),
- about 216,000 AFY over the second five-year period (WY2026-WY2030),
- about 343,000 AFY over the third five-year period (WY2031-WY2035), and
- about 361,000 AFY over the fourth five-year period (WY2036-WY2040).

The anticipated water supply benefit of the proposed SGMA projects and management actions included in the C2VSimFG-Kern projected future simulations is 422,000 AFY over the period from WY2041 to WY2070. Benefits of implementing these projects and management actions over the 20-year implementation period are summarized in **Figure 15**.

6. PROJECTED FUTURE BASELINE DEVELOPMENT

Projected water budgets are required by GSP regulations to represent future conditions over a 50-year GSP planning and implementation horizon. A Baseline condition was developed that projects water supply, demand and operations based on current land use and expected water supply availability over 50 years. The Baseline then serves as a basis of comparison for evaluating proposed sustainability management actions and projects for achieving sustainability over the planning and implementation horizon. Each predictive scenario model simulates the 50-year planning and implementation period WY2021 to WY2070. Development of the projected future Baseline conditions is summarized below.

6.1 Projected Future Time Period Development

WY1995 to WY2014 was chosen as a historical hydrology period because detailed demand and supply data are available for this period, and most Subbasin water delivery infrastructure was fully developed by the middle of this period. The average Kern River inflow for this period is also very close to the long-term average Kern River inflow.

The projected future simulation period is based on repeating the WY1995 to WY2014 historical study period. This period is only 20 years long, so a 50-year sequence of historical hydrology was developed by repeating data from this period in the sequence as shown in **Table 14**. The development of this sequence is summarized as follows:

- Simulation period WY2021 to WY2032 used the historical period WY2003 to WY2014,
- Simulation period WY2033 to WY2052 used the historical period WY1995 to WY2014, and
- Simulation period WY2053 to WY2070 used the historical period WY1995 to WY2012.

This sequence was developed to match long-term average flows on the Kern River, and to ensure that the Baseline does not end in an extreme drought or extreme wet year. By starting the projected future simulation time sequence with WY2003, the 50-year hydrology period has approximately 100 percent of the long-term average streamflow conditions on the Kern River, as indicated by an average annual Kern River Index of 100 percent. The sequence includes the appropriate range of hydrologic conditions including extremely wet years and extended periods of drought.

C2VSimFG-Kern simulation results for the last timestep of the historical simulation (September 30, 2015) were used as initial conditions for all projected future simulations, including initial conditions for the root zone, saturated and unsaturated aquifer zones, and small watersheds. Since the historical C2VSimFG-Kern simulation period ends with WY2015, all projected future scenarios also include estimated hydrology for WY2016 to WY2020. Model input data for WY2016 to WY2020 was developed by repeating model input data for recent years based on correlation with the San Joaquin Index (DWR, 2019).

6.2 Development of Key Baseline Data Sets

Key required components for the Projected Future Baseline, as summarized in the DWR *Water Budget Best Management Practices* guidance document (DWR, 2016B) include the following:

- The projected Baseline hydrology conditions were developed using 50-years of historical precipitation and streamflow following the sequence outlined in Section 6.1.
- Surface water supplies are based on available information from DWR and others to project future water imports from the SWP, CVC - Friant-Kern Canal (FKC) and Kern River diversions. For the Kern River, recent diversion practices based on entitlements were used to develop water use consistent with the Baseline hydrology.
- WY2013 land use was used as current land use for all scenarios as drought conditions likely reduced agricultural production in WY2014 and WY2015.
- Consumptive use for agriculture and undeveloped lands was based on the recent land use and METRIC-based evapotranspiration. Following DWR guidance, METRIC data over the Baseline period was varied according to varying hydrologic conditions (e.g., water year type).
- Urban water demand was based on projections from recent urban water management plans to meet regulations for future water use. Urban demand was estimated in the model based on projected urban population growth and per capita water demand information (including recent regulatory guidance).
- Small watershed inflows used the same parameters as the historical C2VSimFG-Kern model; however, volumes varied based on changes in the precipitation and ET under the 2030 and 2070 climate change conditions.

Time-series input data were first developed for the Baseline scenario model for WY2021 to WY2070. Development of this time-series input data generally involved repeating time-series data from the historical C2VSimFG-Kern in the appropriate sequence. The following time-series data were developed for each scenario:

- Precipitation rates,
- Evapotranspiration rates,
- Surface water inflow rates,
- Surface water diversion and delivery rates, and
- Specified groundwater pumping rates.

Baseline scenario model time-series data files were then modified following DWR guidelines to produce time-series input data for the 2030 Climate Conditions and 2070 Climate Conditions scenario models. C2VSim input data were modified only in Kern County. C2VSim input data for areas outside of Kern County were not modified.

The baseline data sets were incorporated into the model files to develop the projected future water demand and supply under Baseline, 2030 Climate and 2070 Climate conditions. A summary of the development of the projected future water demand and supply is discussed below.

6.3 Projected Future Water Demand

The projected future water demand was developed using fixed WY2013 land use areas with historical evapotranspiration rates for the Baseline and modified evapotranspiration rates for the 2030 and 2070 climate scenarios and increasing urban populations.

6.3.1 Agricultural Water Demand

Evapotranspiration rates for the Baseline scenario model were developed by repeating input evapotranspiration rates from C2VSimFG-Kern in the appropriate sequence. DWR provided monthly change factors for ETo values under 2030 and 2070 central tendency climatic conditions on a 6 km x 6 km VIC grid for calendar years 1915 through 2011. The VIC grid IDs for each C2VSim subregion in the Kern County Subbasin Zone of Interest were identified and area weighted monthly ETo change factors were calculated for each subregion. Baseline scenario ETc rates for each subregion were then multiplied by the appropriate area-weighted ETo change factors to produce time-series ETc rates for the 2030 Climate Conditions and 2070 Climate Conditions scenarios. Factors for calendar years 1959-1961 were used as analogs for calendar years 2012-2014.

6.3.2 Urban Water Demand

Urban water demand calculations include an indoor component and an outdoor component. Indoor urban water demands are based on the urban population and monthly per capita water demand. Future urban populations for Kern County urban areas were estimated using California Department of Finance population projections. Future per capita urban water demands were estimated using projections from urban water management plans and California urban water conservation regulations, including SB 606 and AB 1668. Future outdoor urban water demands are based on ETc rates, which were modified as described in the Agricultural Water Demand section above.

6.3.3 Groundwater Banking Recovery

Future groundwater banking recovery rates were developed by repeating historical recovery rates in the appropriate sequence. No adjustments were made to Baseline rates or to rates for 2030 and 2070 climatic conditions.

6.4 Projected Future Water Supply

Projected future precipitation, stream inflow and surface water import time series were developed following DWR guidelines. Baseline future water supplies were developed by repeating historical values in the appropriate sequence. Surface water diversions were then adjusted to account for operational changes. Baseline water supplies were then modified to simulate 2030 and 2070 central tendency climatic conditions.

6.4.1 Precipitation Rates

Precipitation rates for the Baseline scenario model were developed by repeating input precipitation rates from C2VSimFG-Kern in the appropriate sequence. DWR provided monthly change factors for precipitation under 2030 and 2070 central tendency climatic conditions on a 6 km x 6 km VIC grid for calendar years 1915 through 2011. The VIC grid ID for each C2VSim element in the Kern County Subbasin Zone of Interest was identified and the Baseline scenario precipitation rates were multiplied by the appropriate factors to produce time-series precipitation rates for the 2030 Climate Conditions and 2070 Climate Conditions scenarios. Factors for calendar years 1959-1961 were used as analogs for calendar years 2012-2014.

6.4.2 Surface Water Inflow Rates

Surface water inflow rates for Poso Creek and White River for the Baseline scenario model were developed by repeating input inflow rates from C2VSimFG-Kern in the appropriate sequence. DWR provided unimpaired streamflow change factor datasets for Central Valley streams, and an Excel spreadsheet tool to modify basin unimpaired streamflow using these change factors. The unimpaired streamflow change factors and spreadsheet were used to modify Baseline inflows to produce 2030 Climate Conditions and 2070 Climate Conditions scenario time series inflows for Poso Creek and White River.

Surface water inflow rates for Kern River at First Point for the Baseline scenario model were developed by repeating historical inflow rates from C2VSimFG-Kern in the appropriate sequence. Flows on the Kern River are regulated, so the unimpaired streamflow method was not appropriate for estimating future flows under 2030 and 2070 climatic conditions. Projected Kern River flows at First Point under 2030 and 2070 central tendency conditions were estimated by GEI (2018) for calendar years 1956-2010 hydrology. This analysis considered the impacts of changed runoff in each sub-watershed contributing to the Kern River to develop revised streamflow estimates for Kern River at First Point. Future scenario Kern River at First Point flows for calendar years 2011-2014 were estimated using flows for analog years with similar annual flows and monthly flow pattern. Analog years 1986, 1991, 1990 and 1961 respectively were used for 2011-2014 in the future scenarios.

6.4.3 Surface Water Deliveries

Surface water delivery rates for the Baseline scenario model were developed by first repeating input surface water delivery rates from the C2VSimFG-Kern in the appropriate sequence, and then modifying selected data sets. Surface water deliveries from in-basin sources such as Oil Field Recovery were held constant at WY2015 rates for all future scenarios.

The Kern County Subbasin is served by both the CVP and the SWP. Recent changes in CVP and SWP operations and their impacts on future surface water supplies are reflected in surface water diversion rates for the three scenarios. Future CVP deliveries will be affected by implementation of the San Joaquin River Restoration Program (SJRRP) that included the 2008 U.S. Fish & Wildlife Service biological opinion (BO) on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the CVP and SWP. Future SWP deliveries will be affected by operational changes implemented between 2004 and 2008 including the OCAP BO, reduced Table A contract amounts and reduced Article 21 deliveries. DWR provided projected future deliveries from the CVP and SWP for WY1922 to WY2003, derived from CalSim-II modeling conducted for the Water Supply Investment Program (WSIP) (California Water Commission, 2016). DWR's CVP projections as provided do not fully incorporate these SJRRP operational changes. DWR's SWP delivery projections do not include the OCAP BO operational constraints, the reduced Table A amounts and reduced Article 21 water.

Future CVP delivery projections developed by the Friant Water Authority (FWUA) were used in place of DWR's CVP projections. FWUA (2018) used CalSim-II to develop projected surface water deliveries with SJRRP implementation under hydrological conditions representing the Current Baseline, 2030 and 2070 climate conditions by delivery class for WY1922 to WY2003, and estimated allocations to each CVP contractor. The 2015.c data set was used for Baseline scenario CVP deliveries, the 2030.c data set was used for 2030 Climate Conditions scenario CVP deliveries, and the 2070.c data set was used for the 2070 Climate Conditions scenario CVP deliveries. CVP deliveries for WY2004 to WY2014 were estimated using deliveries for analog years WY1951 to WY1961; these analog years have a similar distribution of water availability.

The SWP projections provided by DWR for WY1995 to WY2003 and historical deliveries for WY2004 to WY2014 were modified to incorporate the impacts of SWP operational changes in the three scenarios. 2019 SWP Table A contract amounts were used to allocate these SWP deliveries to individual districts. In summary:

- Baseline Hydrologic Conditions
    - WY1995 to WY2003 conditions are based on 2030-Level CALSIM increased by 3.03 %,
    - WY2004 to WY2007 conditions are based on historical data adjusted for OCAP BO, and
    - WY2008 to WY2014 conditions are based on historical data with the assumption that OCAP BO adjustments are already factored into the data.
- 2030 Climate Change Hydrologic Conditions
    - WY1995 to WY2003 conditions are based on the 2030-Level CALSIM Projection,
    - WY2004 to WY2007 conditions are based on OCAP BO adjustment reduced by 3.03 %, and
    - WY2008 to WY2014 conditions are based on historical data reduced by 3.03%.
- 2070 Climate Change Hydrologic Conditions
    - WY1995 to WY2003 conditions are based on the 2070-Level CALSIM Projection,
    - WY2004 to WY2007 conditions are based on OCAP BO adjustment reduced by 8.09%, and
    - WY2008 to WY2014 conditions are based on historical data reduced by 8.09%.

Within the Kern County Subbasin, water users engage in complex real-time water trading and wheeling activities to maximize water utilization, minimize waste and energy consumption, and meet immediate water needs. It would be difficult to project future surface water deliveries in the Kern County Subbasin without the use of a surface water allocation model that simulates these water trading and wheeling activities. Therefore, for this modeling effort, monthly future scenario agricultural, urban and recharge deliveries from sources originating outside the basin were estimated by adjusting historical deliveries by the ratio of (total scenario inflows)/(total historical inflows) for each month, where total inflows are the sum of CVP deliveries, SWP deliveries and Kern River at First Point. In addition, Kern River at First Point flows above historical flows under the 2030 Climate Conditions and 2070 Climate Conditions scenarios were proportionally added to selected recharge deliveries. This method is deemed adequate for subbasin-level future scenario analyses.

Some future scenario data sets did not cover the entire period from October 1994 through September 2014. In these cases, data from an analog historical period with similar water availability was used to fill in the missing data. The analog years for each data type are summarized as:

- For CVP deliveries (CalSim-II data), WY1951 to WY1961 were used as analogs for missing WY2004 to WY2014 data; these analog years have a similar distribution of water availability.
- Projected future Kern River at First Point flows for calendar years 1986, 1991, 1990 and 1961 were used as analogs to missing calendar years 2011 through 2014; each of these analog years had a similar historical annual flow volume and monthly distribution.

- For climatic data adjustment factors, calendar years 1959-1961 were used as analogs to missing calendar years 2012-2014.

6.5 Development of Climate Change Conditions

Input data for the C2VSimFG-Kern were modified to simulate three future climatic scenarios. Historical precipitation, evapotranspiration, land use, population, surface water inflow and surface water delivery rates were replaced with projected future values for WY2016 to WY2070 for Future Baseline Conditions. The Future Baseline Conditions for WY2021 to WY2070 were then modified to simulate 2030 Climate Conditions and 2070 Climate Conditions. Water management agencies in the Kern County Subbasin provided a broad suite of proposed water management and conservation projects to increase water supplies and reduce water management demands. These projects are added to the C2VSimFG-Kern to assess the long-term impacts of these projects under the Baseline, 2030 Climate Conditions and 2070 Climate Conditions scenarios.

Projected water budgets under Future Baseline Conditions, 2030 and 2070 Climate conditions are used to evaluate the potential effects of future Baseline and extended dry conditions with respect to achieving sustainability. DWR published a *Modeling Best Management Practices* Guidance Document (DWR, 2016B) that outlines DWR recommendations for developing and running predictive scenarios. The C2VSimFG-Kern was modified following these recommendations to develop the Baseline scenario model. DWR also issued the *Guidance for Climate Change Data Use During Sustainability Plan Development* Guidance Document (DWR 2018A) that outlines how DWR recommends that climate change be addressed under SGMA. Baseline scenario data sets were modified using DWR climate change data sets for Kern County following procedures outlined in the guidance documents to develop the 2030 Climate Conditions and 2070 Climate Conditions scenario models. The adjustment factors for Baseline, 2030 Climate Change and 2070 Climate Change for SWP deliveries were developed based on consistent CalSim operations studies at current, 2030 and 2070 climate levels developed for Bay Delta Conservation Plan evaluation and provided by DWR Bay Delta Office staff. The WSIP studies provided on DWR's SGMA web site were not used due to the unavailability of a Baseline study with assumptions consistent with the 2030 and 2070 climate change studies.

6.6 Groundwater Banking Assumptions

Groundwater banking operations are simulated in the C2VSimFG-Kern with surface water diversions to recharge basins and specified pumping rates for groundwater extractions. All surface water deliveries were adjusted under the Baseline, 2030 Climate Conditions and 2070 Climate Conditions scenarios. Surface water deliveries to recharge basins were first adjusted by the same ratio as other surface water deliveries, then increased if Kern River flows were greater than historical flows. Specified pumping rates for groundwater extraction were not modified.

The out-of-basin banking obligations were assumed to follow a similar pattern where groundwater banking recharge would be affected by the limitation on surface water deliveries, but that banking recovery would remain similar to historical volumes. Therefore, the historical groundwater banking obligations were adjusted under the Baseline, 2030 Climate Conditions and 2070 Climate Conditions scenarios by the same percentage as the surface water deliveries; however, the groundwater banking recovery was assumed to remain the same. Based on the historical banking obligations and using that as a foundation going forward, no banking partner has ever requested the full amount of the water banked at any particular time even in the most recent drought years. All the banking obligation agreements require limitations on amounts to be requested and delivered as well as "leave in" amounts that remain in the Kern County Subbasin. This historical management of banking obligations provides the Kern County Subbasin more flexibility for use of water as well as delivery of the obligations. For the projected future scenarios, the out-of-basin banking obligations were calculated as follows:

- For the Baseline scenarios, the out-of-basin banking obligations were calculated as 69,632 AFY based on surface water deliveries of about 81% of historical deliveries.
- For the 2030 Climate scenarios, the out-of-basin banking obligations were calculated as 67,913 AFY based on surface water deliveries of about 79% of historical deliveries.
- For the 2070 Climate scenarios, the out-of-basin banking obligations were calculated as 64,474 AFY based on surface water deliveries of about 75% of historical deliveries.

Tracking of banked groundwater obligations was done using the same post processing process as applied to the historical groundwater assessment by assigning the portion of the groundwater recharge as an out-of-basin banking obligation.

7. PROJECTED FUTURE C2VSIMFG-KERN SIMULATION RESULTS

The C2VSimFG-Kern was run for three scenarios that estimate hydrologic conditions of Baseline, 2030 Climate Conditions and 2070 Climate Conditions scenarios both with and without the proposed SGMA projects and management actions for a total of six projected future scenarios.

7.1 Projected Future Water Budgets

C2VSimFG-Kern calculates water budget components each month of the simulation period for each future scenario. Projected future water budgets developed based on the C2VSImFG-Kern simulation results with the proposed SGMA management actions were then compared to results for the future scenarios without the management actions to assess how these changes enhance groundwater sustainability within the Kern County Subbasin.

The average annual value of each water budget component summarizes the impacts over 50 years with current water demands. The water budget results for the six Projected Future Scenarios are presented in **Tables 16 through 21**, and include averages over three different periods, which include:

- **WY2021 to WY2040** – Implementation Period representing the 20-year period required by the SGMA regulations to implement projects and management actions to achieve sustainability.
- **WY2041 to WY2070** – Sustainability Period representing the 30-year hydrologic period following the Implementation Period to assess the long-term sustainability of the proposed projects and management actions with variable climatic conditions including periods with above average rainfall and extended droughts.
- **WY2021 to WY2070** – Simulation Period representing the entire 50-year projected future hydrologic conditions.

Changes to surface water diversions under the proposed projects and management actions included monthly increases or reductions to 37 model diversions and the addition of 7 new diversions. Ten new groundwater pumping wells were added to simulate a new groundwater pumping program. Agricultural land use was converted to native vegetation in ten management areas, and to urban land use in three management areas. The projects and management actions included in the C2VSimFG-Kern scenarios with SGMA projects are described in the individual GSPs and management area plans. These changes were applied to a series of six C2VSimFG-Kern scenarios for Baseline, 2030 Climate Conditions and 2070 Climate Conditions both with and without SGMA projects. The results of these simulations are summarized in **Table 15** below.

Baseline simulation results indicate that the Kern County Subbasin has an average annual overdraft of 324,326 AFY. By implementing the proposed projects and management actions, the Subbasin is forecasted to achieve sustainability by 2040 with an estimated 42,144 AFY of annual surplus. With adjustments to account for limitations in the simulation (discussed in Section 7.2.1), the adjusted change in storage increases to 85,578 AFY.

Collectively, the C2VSimFG-Kern simulation results indicate that the currently proposed SGMA projects and management actions, once fully implemented, provide a reasonable approach to achieve sustainable management of the groundwater basin and can be adaptively managed to meet future challenges as necessary. A brief summary of each of the six projected future water budgets from C2VSimFG-Kern is provided below.

Table 15: Summary of Simulated Change in Groundwater Storage Results over the 2041 to 2070 Sustainability Period

C2VSimFG-Kern Model Scenario	Change in Groundwater Storage (AFY)	
	C2VSimFG-Kern Model Results	Adjusted Model Results
Historic	-277,114	-277,114
Baseline	-324,326	-324,326
Baseline with Projects	42,144	85,578
2030 Climate Change	-380,900	-372,120
2030 Climate with Projects	-12,861	46,829
2070 Climate Change	-489,828	-472,336
2070 Climate with Projects	-118,273	-45,969

7.1.1 Baseline Condition Water Budgets

The Baseline Scenarios simulate how the Kern County Subbasin aquifer would respond if the recent hydrology were repeated with current expected surface water availability and current land use. The Baseline Scenarios were run both with and without SGMA projects.

For the Baseline Scenario without SGMA Projects, the groundwater budget for WY2021 to WY2040 (**Table 16**) repeats the 20-year historical hydrologic period so it provides a direct comparison of the differences between the projected future Baseline without SGMA Projects and the historical condition. The primary difference between historical conditions and the projected future Baseline is a nearly 20% decrease in imported surface water deliveries primarily from the SWP due to the OCAP Biological

Opinion. This is replaced with additional groundwater pumping. As a result, total net aquifer outflows increase by about 20,200 AFY and total net aquifer inflows decrease by about 76,500 AFY. This is mostly because of increased groundwater pumping and decreased managed aquifer recharge due to a decline in imported SWP water. Over this period, the average groundwater pumping is 1,581,000 AFY, which includes agricultural pumping, urban pumping and exported water. This results in an additional loss of groundwater storage of about 56,300 AFY over the 50-year projected future Baseline period.

The Baseline Scenario with SGMA Projects simulates the proposed SGMA projects and management actions (Section 5.2) applied to the Baseline Scenario. No other changes were made except for the addition of the SGMA projects to provide a direct comparison of the relative benefits of about 422,000 AFY of proposed SGMA projects and management actions. The groundwater budget for the Baseline Scenario with SGMA Projects is provided in **Table 17**. Comparing the groundwater budget for WY2041 to WY2070 (**Table 17**) with the same period from the Baseline Scenario (**Table 16**) provides an evaluation of groundwater conditions after the SGMA projects and management actions have been fully implemented. As a result, total net aquifer inflows increase about 135,400 AFY due to increased managed aquifer recharge and deep percolation. The total net aquifer outflows decrease about 231,100 AFY due mostly to decreased groundwater pumping with agricultural demand reduction management actions.

The change in groundwater storage for the Baseline Scenario with SGMA Projects improves by about 366,500 AFY compared to the Baseline Scenario without SGMA Projects. This change results in a net gain in groundwater in aquifer storage over the WY2041 to WY2070 sustainability period of about 42,100 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is presented in **Figure 16**. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070.

A comparison of the average annual water budget components for the two different Baseline Scenarios is presented in **Figure 17**. Over the WY2041 to WY2070 period, the average groundwater pumping of 1,354,000 AFY for the Baseline Scenario with SGMA Projects (which includes agricultural pumping, urban pumping and exported water) is over 270,000 AFY less than in the Baseline Scenario.

7.1.2 2030 Climate Change Water Budgets

The 2030 Scenarios simulate how the Kern County Subbasin aquifer would respond assuming hydrologic conditions representing a potentially drier climate and are based on the DWR Climate Change Guidance and Resource Guide (DWR, 2018A and 2018B). The 2030 DWR climate change factors were applied to the Baseline Scenario conditions. Additional adjustments were made to the imported surface water supplies from the SWP, CVP and Kern River, accounting for about an additional 2% decrease from the Baseline Conditions. The 2030 Climate Change Scenarios were run both with and without SGMA projects. Results for climate change budgets are illustrated in **Figures 18, 19, and 20**.

The groundwater budget for the 2030 Climate Scenario without SGMA Projects for WY2041 to WY2070 (**Table 18**) is compared the same period for the Baseline Scenario without SGMA Projects to assess the relative change due to the climate change assumptions. The results show a net increase in aquifer inflows of about 44,700 AFY, however, the aquifer net outflows increase by about 101,200 AFY. This is mostly attributed to the climate shift to earlier rainfall making more surface water available for managed aquifer recharge during the winter but less available for irrigation in the summer, resulting in higher groundwater pumping. The net change in groundwater storage is an additional decline of about 56,600 AFY due to the climate change impacts.

The 2030 Climate Scenario with SGMA Projects simulates the proposed SGMA projects and management actions (Section 5.2) applied to the 2030 climate change conditions. No other changes were made to this scenario. The groundwater budget for the 2030 Climate Scenario with SGMA Projects is provided in **Table 19**. Comparing the groundwater budget for WY2041 to WY2070 (**Table 18**) between the two 2030 Climate Scenarios, the total net aquifer inflows increase about 118,700 AFY due to increased managed aquifer recharge and deep percolation. The total net aquifer outflows decrease about 249,300 AFY due mostly to decreased groundwater pumping with agricultural demand reduction management actions.

The change in groundwater storage for the 2030 Climate Scenario with SGMA Projects improves by about 368,000 AFY. This change results in a net decline in groundwater in aquifer storage over WY2041 to WY2070 of about 12,900 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is presented in **Figure 20**. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070, but at a level below the results for the Baseline Scenario with SGMA Projects.

A comparison of the average annual water budget components for the two 2030 Climate Scenarios is presented in **Figure 18**. Over this period, the average groundwater pumping of 1,444,000 AFY for the 2030 Climate Scenario with SGMA Projects, which includes agricultural pumping, urban pumping and exported water, is over 290,000 AFY less than in the 2030 Climate Scenario without SGMA Projects.

7.1.3 2070 Climate Change Water Budgets

The 2070 Scenarios simulate how the Kern County Subbasin aquifer would respond assuming hydrologic conditions representing a potentially very dry climate and are based on the DWR Climate Change Guidance (DWR, 2018A and 2018B). The 2070 DWR climate change factors were applied to the Baseline Scenario Conditions. Additional adjustments were made to the imported surface water supplies from the SWP, CVP and Kern River, and these accounted for an additional 6% decrease from the Baseline Conditions. The 2070 Climate Change Scenarios were run both with and without SGMA Projects.

The groundwater budget for the 2070 Climate Scenario without SGMA Projects over WY2041 to WY2070 (**Table 20**) is compared the same period for the Baseline Scenario without SGMA Projects to assess the relative change due to the climate change assumptions. The results show a net increase in aquifer inflows of about 66,100 AFY, however, the net aquifer outflows increase by about 231,600 AFY. This is mostly attributed to an even greater climate shift to earlier rainfall making more surface water available for managed aquifer recharge during the winter but less available for irrigation in the summer resulting in higher groundwater pumping. The net change in groundwater storage is an additional decline of about 165,500 AFY due to the climate change assumptions.

The 2070 Climate Scenario with SGMA Projects simulates the proposed SGMA projects and management actions (Section 5.2) applied to the 2070 climate change conditions. No other changes were made to this scenario. The groundwater budget for the 2070 Climate Scenario with SGMA Projects is provided in **Table 21**. Comparing the groundwater budget for WY2041 to WY2070 (**Table 20**) between the two 2070 Climate Scenarios, the total net aquifer inflows increase about 106,300 AFY due to increased managed aquifer recharge and deep percolation. The total net aquifer outflows decrease about 265,300 AFY due mostly to decreased groundwater pumping due to agricultural demand reduction management actions.

The change in groundwater storage for 2070 Climate Scenario with SGMA Projects improves by about 371,600 AFY. This change results in a net decline of groundwater in aquifer storage over WY2041 to WY2070 of about 118,300 AFY. A comparison of the annual change in groundwater storage over the 50-year hydrologic period is presented in **Figure 20**. The time series shows that change in groundwater storage has stabilized to slightly increasing over the period from WY2041 to WY2070, but at a level below the results for the Baseline and 2030 Scenarios with SGMA Projects.

A comparison of the average annual water budget components for the two different 2070 Climate Scenarios is presented in **Figure 19**. Over this period, the average groundwater pumping of 1,559,000 AFY for the 2070 Climate Scenario with SGMA Projects, which includes agricultural pumping, urban pumping and exported water, is over 307,000 AFY less than in the 2070 Climate Scenario without SGMA Projects.

7.2 Projected Future Sustainability Assessment

To assess the sustainability of the proposed GSP plans, the C2VSimFG-Kern model future scenario input files were modified to incorporate all the proposed SGMA projects and management actions.

7.2.1 Change in groundwater storage

Groundwater sustainability for the Kern County Subbasin was assessed using annual changes in groundwater storage. As discussed in Section 7.1, the decline in groundwater storage of the three future Baseline scenarios is significantly mitigated by the implementation of the proposed SGMA projects and management actions. An assessment of the projected future groundwater storage change for the six projected future scenarios is summarized in **Table 22**.

The Change in Groundwater Storage presented in **Table 22** provides the net difference in aquifer inflows and outflows without consideration of subsurface flow to and from adjacent groundwater basins. This provides a measure of the natural and managed water supply within the groundwater basin without being influenced either positively or negatively by the subsurface flow. For the Kern County Subbasin, the net operational flow differs from the change in groundwater storage by about 50,000 to 75,000 AFY for the scenarios without SGMA projects, indicating that most of the groundwater storage change is due to conditions within the basin.

The Adjustments to Groundwater (GW) Storage Change are made to account for limitations in either the underlying conceptual model of C2VSimFG-Kern or the setup of the projected future scenarios. The two adjustments made to the projected future water budgets include:

- **Adjustment for Excess Basin Outflows** is the difference in simulated basin outflow that is attributed to addition of SGMA projects in Kern County without comparable SGMA projects added to adjacent basins. Adjustment assumes that this difference is due to limitation of the simulation, and that this difference would remain in Kern County Subbasin when SGMA projects from adjacent basins are included in the simulation.
- **Adjustment for Excess Kern River Outflow** is the increase in simulated groundwater outflows to the Kern River relative to Baseline condition that are attributed to SGMA projects and climate change. The model is not optimized for river management. Because the Kern River is a highly managed system, the assumption is that in practice this water would be recovered for beneficial use and not allowed to flow from the basin.

These adjustments resulted in an overall improvement in the change in groundwater storage for the projected future water budgets. For the scenarios that include the SGMA Projects, the change in groundwater storage improves by 43,400 AFY (Baseline), 59,700 AFY (2030 Climate Change), and 72,300 AFY (2070 Climate Change). As a result of these adjustments, the adjusted change in groundwater storage for the three scenarios with SGMA Projects varied as follows:

- the Baseline Scenario with SGMA Projects changes from an increase of 42,100 AFY to an increase of 85,600 AFY.
- the 2030 Climate Scenario with SGMA Projects changes from a decline of 12,900 AFY to an increase of 46,800 AFY.
- the 2070 Climate Scenario with SGMA Projects changes from a decline of 118,000 AFY to a decline of 46,000 AFY.

These adjustments indicate areas of improvement for C2VSimFG-Kern. Future updates to the model will address how to better simulate these conditions directly to limit the use of post-simulation adjustments.

7.2.2 Sustainability Assessment

As defined by SGMA, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Although the SGMA regulations require that a single value of sustainable yield must be calculated basinwide, it should be noted that the sustainable yield can be changed with implementation of recharge projects, variations in climate, or changes in stream flow conditions. For the projected future scenarios, both the climate and the managed water supply operations are significantly affected which would lead to a change in the sustainable yield for the basin.

For the sustainability assessment, the sustainable yield was recalculated using the method described in Section 4.2, and the results are presented in **Table 23**. Without the SGMA projects and management actions, the percentage of the Average Annual Difference to the total groundwater pumping provides context to compare the significance of the level of groundwater pumping for the basin. For the scenarios without SGMA projects and management actions, the groundwater pumping exceeds the sustainable yield on the order of 25% to 34% (**Table 23**). However, with the proposed SGMA projects and management actions, the groundwater pumping is less than the sustainable yield of the Subbasin for the Baseline and 2030 climate scenarios and is within 3% of the sustainable yield for the 2070 climate scenario (**Table 23**). This assessment indicates that the proposed SGMA projects and management actions for the Kern County Subbasin are of sufficient magnitude that, if fully implemented, would lead to groundwater sustainability for the Kern County Subbasin after WY2040.

7.2.3 Minimum Thresholds and Measurable Objectives

Another requirement of SGMA is for groundwater levels not to cross their minimum thresholds to the extent that undesirable results would occur in the basin, and moreover, that proposed SGMA projects and management actions would lead to meeting the measurable objectives. The Kern County Subbasin GSAs have defined 186 representative monitoring well (RMW) locations spread across the Kern County Subbasin. A minimum threshold and measurable objective have been assigned each of the 186 locations, and the hydrographs for all 186 locations are provided in **Attachment A**. The RMW locations are shown on **Figure 21**.

The C2VSimFG-Kern results were used to assess whether the simulated groundwater levels would meet the minimum threshold and measurable objective for each monitoring well. Because C2VSimFG-Kern is not fully calibrated, the results are presented as relative change (which does not require calibration) instead of simulated groundwater levels using the superposition method. Future change in groundwater level was determined for each of the 186 locations for each of the six projected future simulations. The change was calculated from the simulated March 2015 groundwater levels from the model. The change in groundwater level was then applied to the measured March 2015 groundwater level at the monitoring location. The result was to superimpose the simulated change in groundwater levels from the projected future C2VSimFG-Kern scenarios relative to the measured March 2015 groundwater level.

Figure 22 provides four representative examples of the simulated hydrographs using this method. Hydrographs of the simulated groundwater levels relative to the minimum thresholds and measurable objectives for all 186 locations were provided to the various GSAs and water districts for inclusion in their respective GSPs. In general, across most areas of the basin, groundwater levels fall near or below the minimum thresholds without the SGMA projects but are typically above the minimum threshold for the simulations that include the SGMA projects.

The groundwater hydrographs for some locations, especially along the eastern and western basin margins, show an unusual pattern that is likely influenced by issues with the hydrogeological conceptual model incorporated into C2VSimFG-Kern for these locations. The hydrographs for these areas are not considered to be representative of actual conditions that would physically occur. This is a limitation to the model. It is recommended that a more rigorous model update be conducted to revise the hydrogeological conceptual model to be consistent with that presented in the Kern County Subbasin GSPs. In addition, further calibration of C2VSimFG-Kern is recommended to update aquifer parameters in the Kern County Subbasin. The recommendations for revisions to the hydrogeological conceptual model and additional calibration are further discussed in Section 8.5.

8. VALIDATION OF C2VSIMFG-KERN PERFORMANCE

The C2VSimFG-Kern performs well within the central part the Kern County Subbasin. The model does not perform as well east of the Friant-Kern Canal or west of the California Aqueduct. The geologic and hydrogeologic conceptual models within the central part of the Kern County Subbasin appear to be generally realistic. The geologic and hydrogeologic conceptual models appear to be very poor in the areas where the model does not perform well.

8.1 C2VSimFG-Kern Validation

One of the concerns for the modeling is the overall calibration of C2VSimFG-Beta in Kern County. As discussed above, the assumption is that C2VSimFG-Beta was developed using reasonable care in developing the geologic framework and developing a consistent regional methodology for determining aquifer properties. An identified weakness of the C2VSimFG-Beta is the quality of data used in developing the overall water balance such as the extent of the groundwater banking operations in Kern County. The issues with the water balance are considered the primary contributing factor affecting the calibration of the C2VSimFG-Beta; the hydrogeologic conceptualization is reasonably accurate for a regional planning analysis.

To address these concerns, a validation analysis was performed for C2VSimFG-Kern by comparing simulations results to field measured groundwater level data collected during the Study Period and comparing those to a similar set of residuals from the C2VSimFG-Beta model. The statistical results of this analysis should be comparable, if not better, for C2VSimFG-Kern compared to the C2VSimFG-Beta results.

The analysis used 42,058 groundwater levels measurements collected from 558 monitoring wells in the Kern County Subbasin. The data were collected by Kern County Water Agency, the Kern Fan Monitoring Committee, the DWR Water Data Library, and local agencies. For each location, the residual was calculated as the simulated groundwater level minus the measured groundwater level based on the well measurement data. A brief summary of the statistical measures used to evaluate the calibration results (shown on **Table 24**) is provided below:

- The residual mean is computed by dividing the sum of the residuals by the number of residual data values. The closer this value is to zero, the better the calibration especially as related to the water balance and estimating the change in aquifer storage. The residual mean of 17.3 feet for C2VSimFG-Kern is an improvement of 47% over the 32.6 feet from C2VSimFG-Beta.
- The absolute residual mean is the arithmetic average for the absolute value of the residual, so it provides a measure of the overall error in the model. The absolute residual mean of 37.4 feet for C2VSimFG-Kern is an improvement of 34% over the 56.8 feet from C2VSimFG-Beta.
- The residual standard deviation evaluates the scatter of the data. A lower standard deviation indicates a closer fit between the simulated and observed data. The standard deviation is 45.5 feet for C2VSimFG-Kern, which is an improvement of 16% over the 54.0 feet from C2VSimFG-Beta.
- The Root Mean Square (RMS) Error is the square root of the arithmetic mean of the squares of the residuals and provides another measure of the overall error in the model. The RMS Error is 50.0 feet for C2VSimFG-Kern, which is an improvement of 32% over the 73.5 feet from C2VSimFG-Beta.
- The correlation coefficient ranges from 0 to 1 and is a measure of the closeness of fit of the data to a 1 to 1 correlation. A correlation of 1 is a perfect correlation. The correlation coefficient of 0.76 for C2VSimFG-Kern is an improvement of 47% over the 0.52 from C2VSimFG-Beta.
- Another statistical measure is the ratio of the standard deviation of the mean error divided by the range of observed groundwater elevations. This ratio shows how the model error relates to the overall hydraulic gradient across the model. The ratio for C2VSimFG-Kern is 0.061 feet, which is an improvement of 34% over the 0.092 from C2VSimFG-Beta.

Considering these results in context with the overall range of measurements of 616 feet, the residual mean of 17.3 feet represents a relative percentage difference of less than 3%. For the absolute residual mean of 37.4 feet, the relative percentage difference is about 6%. Despite this improvement in model performance, the model is not considered fully calibrated. However, C2VSimFG-Kern is reasonably validated for assessing groundwater level changes on the subbasin scale for the purposes of SGMA planning.

8.2 Sensitivity Analysis

The C2VSimFG-Kern model was not formally calibrated. Some physical parameters were adjusted to improve model performance in specific areas. A sensitivity analysis was conducted on the adjusted model to understand how variations in model parameters affect model results. Eight physical parameter sets were systematically varied, and model results compared to the base model for a selected group of groundwater hydrographs. C2VSimFG-Kern parameter sensitivities evaluated for Kern County Subbasin include:

- Horizontal hydraulic conductivity of aquifer (Kh)
- Vertical hydraulic conductivity of aquifer (Kv)
- Vertical hydraulic conductivity of Corcoran Clay aquitard (Kcorc)
- Streambed conductance of Kern River (Cstm)
- Specific storage of aquifer (Ss)
- Specific yield of aquifer (Sy)
- Soil hydraulic conductivity in root zone (Ksoil)
- Soil pore size distribution index in root zone (λ)

The Root Mean Squared Error between observed and simulated values was calculated for the original parameter set and after varying each parameter set upward and downward by a set factor. Results are presented in **Figure 23**. This sensitivity analysis shows that the hydrologic parameter values in the C2VSimFG-Kern model are generally within an acceptable range. A full model calibration would likely improve model performance.

8.3 Peer Review Process

Todd Groundwater worked with Woodard and Curran (W&C) throughout the model development process as W&C conducted an on-going peer review of model input files. W&C staff have developed several IWFM-based models and worked with DWR to develop C2VSimFG-Beta. Their reviews helped ensure that the model update used best practices when incorporating new data. The peer review process was documented in a series of meeting summaries to the KGA and KRGSA. The updated C2VSimFG-Kern input files for the Kern County Subbasin were shared with DWR for incorporation into future C2VSim public releases.

The more general assumptions in C2VSimFG-Beta were replaced with local data and knowledge that are regionally or locally significant for WY1995 to WY2015. This update employed a phased approach with regular peer reviews.

1) Phase 1 revisions address components of Regional Significance that require significant changes to the overall model input file structure. These include:
    a) Surface water delivery volumes, application areas and use by water district,
    b) Groundwater banking recharge, recovery and application of recovered water,
    c) Evapotranspiration rates and irrigation demand based on ITRC METRIC data (ITRC 2017),
    d) Urban population and per capita demand, including addition of an urban zone for Metropolitan Bakersfield, and
    e) Addition of groundwater extraction wells for groundwater banking projects.
2) Interim Review
    a) The Woodard & Curran Peer Review Team
    b) Kern County Subbasin water districts and purveyor's local data review
    c) Stakeholder input
3) Phase 2 revisions address components of Local Significance that generally require modifications of input data and parameters within the existing C2VSim model input file structure. These include:

a) Local water sources and demands of significance to individual Districts/GSAs,
b) District pumping for in-district delivery via surface water canals where significant,
c) District recharge operations utilizing canals, stream channels, and basins,
d) Wastewater disposal and land application, and
e) Review and limited adjustment of model parameters.

4) Interim Review by same reviewers listed in item 2

5) Phase 3 revisions include addressing comments and incorporating new data from the Interim Reviews

6) Interim Review by same reviewers listed in item 2

7) Tabulate model-derived water budgets for Peer-Review and GSP Use

In each update phase, historical and current water budgets for zones representing water agency service areas were produced with the revised C2VSimFG-Kern model incorporating corrected local data. These water budgets were shared with participating agencies for review, to ensure that C2VSimFG-Kern correctly represented local water balances. Where necessary, participating agencies provided additional data which was incorporated into C2VSimFG-Kern.

8.4 Internal Review Process

Todd Groundwater and Hydrolytics LLC worked collaboratively on this model revision, water budget development and the projected future scenarios. Throughout this work, efforts were applied to improve data management to develop a systematic process for generating model input files. Using this approach, internal review could be conducted with each firm reviewing the contributions from the other. The goal was to accurately represent the data provided by the Kern County agencies in the model.

Due to schedule constraints, a thorough internal review of the projected future model scenarios was not completed prior to the submission of the Public Review Draft of the model results in August 30, 2019. A thorough review of all input for the projected future scenarios was conducted in September and October 2019. During this review, several issues were identified and corrected. As a result, the results in this report vary from those provided in the August 2019 Public Review Draft. Although the numbers changed, the overall conclusions from the C2VSimFG-Kern simulations remained essentially the same.

8.5 Recommendations for Future Improvements to C2VSimFG-Kern

The C2VSimFG-Kern performs well in the Kern County Subbasin, producing simulated water budget components that generally match historical values compiled by local agencies. C2VSimFG-Kern simulated groundwater levels provide a reasonable approximation of observed groundwater levels in the central part of the Kern County Subbasin. The model is well suited for estimating the impacts of management actions on the Subbasin groundwater storage and is also well suited as a planning tool in meeting compliance of SGMA.

During the model update, several outstanding issues were identified that should be addressed in future updates to C2VSimFG-Kern. The following actions and model improvements are recommended:

- **Improve streamflow simulations of the Kern River and Poso Creek.** Flows in the Kern River channel, including local stream-groundwater interactions, are not well replicated and surface water diversions are not dynamically simulated. Some rejected recharge occurs in the Kern Fan area in very wet years, with significant outflow of groundwater to the Kern River especially in the Kern Fan banking area (i.e., rejected recharge). This has been an ongoing issue and needs to be addressed for the projected future water budgets so that banking recharge volumes can be better matched in the model. It is recommended that future revisions to C2VSimFG-Kern further evaluate issues in simulating streamflow and seepage in the Kern River and Poso Creek (see Section 8.5). This may include incorporating more advanced streamflow simulation features that are available in IWFM but that have not been previously utilized in developing C2VSim models by DWR. Changing the stream simulation feature may require development of a local Kern County Subbasin model.

- **Improve the geologic and hydrogeologic conceptual model of the Kern County portion of the Central Valley.** A hydrogeologic conceptual model is a framework for understanding where groundwater exists, where it flows, and how groundwater interacts with surface water bodies and the land surface. A geologic conceptual model provides a framework for understanding the geologic features that control groundwater movement. Quantitative analysis of Kern County Subbasin groundwater flow is severely hampered by the lack of detailed geologic and hydrogeologic conceptual models of the areas outside the central alluvial basin. Geologic and hydrogeologic conceptual models will provide a foundation for the quantitative analysis of the groundwater flow system, and the framework for modeling the system. Key steps are:
    - Develop detailed geologic and hydrogeologic conceptual models of the Kern County Subbasin.
    - Differentiate the four Principal Aquifers that have been identified in the Kern County Subbasin based on definitions from local management area GSPs.
    - Identify the locations and characteristics of natural features that affect groundwater recharge and movement (faults, ridges, clays).
    - Understand water occurrence and movement in areas outside the central Kern County Subbasin.
    - Develop water quality maps (natural constituents and anthropogenic constituents).
    - Modify the Kern County Subbasin model to conform to the updated conceptual models.
- **Simulation of deep percolation and small watersheds.** Unreasonably high deep percolation (return flows) of the applied water in some areas has led to unreasonably elevated pumping rates to compensate. One problem is high root zone hydraulic parameter values in certain areas that were identified and corrected to better reflect local soil conditions. Because the excess pumping was returning to groundwater, the change has little effect on the basin change in storage, but the pumping and deep percolation are now more in line with local estimates. Root zone hydraulic parameters should be redeveloped throughout the subbasin to assure model values are representative of actual values.
- **Root Zone Parameters,** Areas of overly high root zone hydraulic parameters led to high volumes of deep percolation that required additional groundwater pumping to meet the overall water demand for irrigation. A review found areas of overlying high soil hydraulic conductivity and other soil parameters produced percolation rate that were too high. These areas were manually adjusted to be more in line with observed conditions. A more rigorous development of root zone parameters should be considered in the future as this issue demonstrates that it is a sensitive parameter.

- **Investigate development of a stand-alone Kern County Subbasin model.** The C2VSim model provided by DWR and updated with local data is adequate for GSP preparation. However, this model may not meet all of the groundwater modeling needs of Kern County Subbasin stakeholders. In addition, running a full Central Valley simulation model imposes longer model run times and reduces model flexibility. Stakeholders should undertake a comprehensive study to develop a list of their integrated (groundwater and surface water) modeling needs, and then decide whether further improving C2VSimFG-Kern or developing a new integrated hydrologic model is the best way to address the Subbasin modeling needs. This decision should be made before the end of 2020 to allow sufficient time to develop a new model or improve C2VSimFG-Kern in time for use in development of the 2025 GSP.
- **Adjust the finite element grid to honor water management boundaries.** The C2VSimFG-Kern model grid is a randomly generated grid that does not conform to any local features other than natural surface water channels. This limits the spatial accuracy of model inputs and the precision and flexibility of water budget outputs. Adjusting the grid to match district and agency boundaries, historical delivery areas, water management units within districts, and geologic and hydrologic features would greatly enhance model capabilities.
- **Quantify boundary flows.** Significant uncertainty exists regarding the rates and timing of groundwater flows into the Kern County Subbasin from surrounding watersheds, and groundwater flows from the Kern County Subbasin to Kings and Tulare counties to the north. Reliable estimates of boundary flows will improve model performance in boundary areas.
- **Kern County Subbasin Boundary.** The GSAs in the basin should consider when DWR updates the Bulletin 118 in 2020 to investigate the "actual" Kern County Subbasin and to remove those peripheral lands where aquifer connectivity does not exist.
- **Utilize more complex water management features of IWFM.** The Kern Update process modified information within the existing C2VSimFG-Beta model structure to improve model performance within the Kern County Subbasin. The IWFM application has several features that could be further utilized to improve model performance.
    - Adjust the agricultural crops to better match the Kern County crop mix (for example, create separate crop categories for carrots, young and mature almonds, young and mature pistachios, etc.).
    - Implement multi-cropping with semiannual or quarterly land use.
    - Some C2VSim data are organized by DWR subregions, which represent heterogeneous areas with homogeneous data. Developing Kern County Subbasin subregions and organizing model input data by these subregions may provide a better representation of local hydrologic conditions.
- **Calibrate the improved model for the Kern County Subbasin**. DWR did not fully calibrate the Kern County portion of the C2VSim model, owing to both poor historical input data and a lack of calibration data sets. The Kern Update process significantly improved the historical data in the model, developed some calibration data sets, and included limited adjustment of model parameters. The updated model performs adequately in the central part of the Kern County Subbasin and poorly in areas outside the central part of the basin. Once the above improvements are completed, the Kern County portion of the resulting model should be fully calibrated to ensure that it performs well throughout the Kern County Subbasin.

9. CONCLUSIONS

This brief summary provides an overview of the findings and conclusions of the modeling results for the Kern County Subbasin using C2VSimFG-Kern.

9.1 Findings of the C2VSimFG-Kern Application and Results

The subbasin-wide update of C2VSimFG-Kern incorporated data from many local agencies. Each participating agency provided data for their jurisdiction for use in improving the model. This included managed water supply data (e.g., surface water deliveries, land use, irrigation demand, return flows, and groundwater banking), stream and groundwater monitoring data, geologic data, and other relevant data. This information was compiled and used to improve C2VSimFG-Kern performance in the Kern County Subbasin.

The historical water budget analysis indicates that the Kern County Subbasin was in a state of overdraft equivalent to the long-term decline in groundwater storage from WY1995 to WY2014 of 277,144 AFY. Projected Future simulations indicate that the proposed SGMA projects and management actions in the Kern County GSPs are sufficient for the Kern County Subbasin to achieve sustainability under Baseline and 2030 Climate Change conditions.

C2VSimFG-Kern was used to evaluate the change in groundwater in storage for projected future conditions using a baseline condition that projects current water supply, water demand and land use over a 50-year period based on historical hydrology. The baseline was adapted following DWR climate change guidance to develop 2030 and 2070 climate change simulations. The proposed SGMA projects and management actions were compiled from all of the Kern County Subbasin GSAs and management areas. The total projects total about 421,000 AFY after implementation. This assessment indicates that the proposed SGMA projects and management actions for the Kern County Subbasin are of sufficient magnitude that, if fully implemented, would lead to groundwater sustainability for the Kern County Subbasin after WY2040.

The historical C2VSimFG-Kern performs well in the Kern County Subbasin, producing simulated water budget components and groundwater levels that generally match historical values compiled by local agencies. C2VSimFG-Kern simulated groundwater levels provide a reasonable statistical approximation of observed groundwater levels in the Kern County Subbasin that show significant improvement relative to C2VSimFG-Beta. Therefore, C2VSimFG-Kern is well suited as a planning tool to estimate the impacts of the proposed SGMA projects and management actions on groundwater conditions in the Kern County Subbasin.

The C2VSimFG-Kern model development and the water budget analysis were designed to fulfill the GSP requirement for a coordinated subbasin-wide water budget analysis, while also providing information required to fulfill other GSP requirements. The C2VSimFG-Kern was provided to DWR so the Kern County Subbasin revisions can be incorporated into their master version of the C2VSim model.

9.2 C2VSimFG-Kern Compliance with Coordination Agreement Requirements

Subbasin GSAs coordinated on the development and application of the C2VSimFG-Kern to ensure that the model was incorporating comparable data sets and the best available information; as such, the model meets numerous technical requirements for Subbasin-wide coordination, including for

Coordination Agreements in §357.4. As demonstrated throughout this memorandum, the C2VSimFG-Kern model documents the use of "the same data and methodologies" for water budget development.

Specifically, groundwater extraction data were coordinated through the use of ET METRIC data for all irrigated lands over the entire Subbasin to estimate private irrigation pumping. Monthly metered data from District, municipal, and banking pumping were incorporated as available. Surface water supply data were provided in similar units and formats using consistent templates for data collection and management in the model. Total water use and change in groundwater in storage were developed through consistent methodologies as applied in the C2VSimFG-Kern model. Calibration targets also incorporated consistent data sets for groundwater elevation data throughout the Subbasin as compiled in the DWR Water Data Library, KCWA water level database, and supplemented with local data, as needed. This memorandum documents coordination efforts in subsequent sections that demonstrates compliance with GSP requirements in §354.18, §357.4, and other portions of the regulations.

9.3 Limitations and Uncertainty of C2VSimFG-Kern

The C2VSimFG-Kern performs well in the Kern County Subbasin, producing simulated water budget components that generally match historical values compiled by local agencies. C2VSimFG-Kern simulated groundwater levels provide a reasonable approximation of observed groundwater levels in the central part of the Kern County Subbasin. The model is well suited to estimating the impacts of management actions on subbasin groundwater storage.

The C2VSimFG-Kern update was limited in scope, and some model components do not perform well. These components do not reduce model capabilities with respect to GSP development but limit the usefulness of the model for other types of studies. Flows in the Kern River channel, including local stream-groundwater interactions, are not well replicated and surface water diversions are not dynamically simulated. The Kern County Subbasin portion of the C2VSimFG-Kern is not calibrated, and although the land surface water budget components are generally accurate, groundwater conditions and stream flows are poorly simulated in much of the Subbasin. Some rejected recharge occurs in the Kern Fan area in very wet years, but this is not significant as it is a very small volume.

The C2VSimFG-Kern is a reliable and defensible tool to support planning future groundwater conditions and estimating the potential hydrological impacts of future climate conditions and management actions at the subbasin level. It is currently the best available quantitative tool for assessing projected future groundwater conditions under SGMA. DWR recommends updating and refining models used in GSPs to incorporate new data including that in annual GSP updates. Refining Kern County Subbasin hydrologic modelling tools to replicate district-level historical conditions will provide a reliable means of assessing future effects of management actions at the district level for future GSP development.

9.4 Applicability of C2VSimFG-Kern Simulation Results

Based on the model validation, C2VSimFG-Kern provides a useful planning tool to evaluate potential future trends in groundwater in the Kern County Subbasin. The model validation demonstrated the capability of C2VSimFG-Kern to reasonably simulate the groundwater elevations and trends during the period from WY1995 through WY2015 based on the comparison to measured data.

The ability to reasonably simulate historical conditions provides confidence that C2VSimFG-Kern can be used to simulate potential future conditions. The model has the capability to simulate the most beneficial application of water projects that would provide the long-term benefit to the area. For the future case scenarios, the general practice is to evaluate model results with respect to long-term trends. Therefore, as a planning tool, it is most beneficial to run the model in relation to a base case and to evaluate the relative difference between the model scenario and the base case. The base case would assume a selected set of climatic, hydrologic and pumping conditions. Commonly, the calibration base period is assumed to repeat; however, any number of variations can be constructed.

It is important to note that in some cases the model results may vary from those measured in individual wells due to the geologic complexity of the Kern County Subbasin. However, the model is capable of evaluating the impacts of changes in pumping and water use practices in the Kern County Subbasin that are useful for SMGA planning purposes.

The conclusions and recommendations presented herein are professional opinions based on the C2VSimFG-Kern revisions and simulations as described herein. The findings and professional opinions presented in this letter are presented within the limits prescribed by the client contract, in accordance with generally accepted professional engineering, geologic and modeling practices, to support development of GSPs within the Kern County Subbasin. There is no other warranty, either expressed or implied, regarding the conclusions, recommendations, and opinions presented in this report.

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TABLES

TABLE 1 - Summary of data input for surface water diversion to agriculture by water district applied to C2VSimFG-Kern Historical Simulation

Water Year	Arvin-Edison WSD	Belridge WSD	Berrenda Mesa WSD	Buena Vista WSD	Cawelo WD	Kern River Canal Co.	Henry Miller WD	Kern Delta WD	Kern-Tulare WD	Lost Hills WD	North Kern WSD	Rosedale Rio Brave WSD	Semi-tropic WSD	Shafter-Wasco ID	So. San Joaquin MUD	Wheeler Ridge - Maricopa WSD	Olcese WD	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	144,722	106,293	90,909	162,444	78,084	14,994	43,242	183,471	27,131	103,268	198,865	0	74,487	149,252	112,888	177,348	1,493	1,668,891
1987	127,333	106,293	90,909	142,274	89,117	12,113	43,242	137,458	27,131	123,981	112,432	0	53,753	172,161	76,193	161,949	1,493	1,477,832
1988	114,321	106,293	90,909	141,152	77,106	4,203	43,242	135,078	27,131	111,872	81,580	0	47,071	164,192	71,243	154,030	1,417	1,370,840
1989	114,591	106,293	90,909	150,341	85,190	11,096	43,242	140,360	27,131	122,044	61,797	0	50,495	190,990	94,729	178,129	1,480	1,468,817
1990	70,816	106,293	90,909	124,845	67,867	14,757	43,242	114,531	27,131	88,963	51,926	0	34,381	49,992	73,000	170,693	1,480	1,130,826
1991	40,698	106,293	90,909	100,517	50,621	10,416	43,242	117,287	27,131	9,553	28,931	0	40,595	7,926	11,683	31,030	1,480	718,312
1992	52,839	106,293	90,909	108,874	54,406	9,909	43,242	118,190	27,131	52,853	34,291	0	45,851	94,467	65,310	96,514	1,480	1,002,559
1993	137,479	93,344	85,549	151,653	75,490	11,596	43,973	174,003	26,034	77,793	181,920	5,040	72,120	226,462	108,767	137,221	1,425	1,609,869
1994	171,856	110,017	93,092	125,084	62,968	13,862	53,471	132,865	28,017	87,636	117,580	2,362	47,111	110,951	83,680	151,368	1,685	1,393,606
1995	134,559	110,993	78,521	189,797	73,155	6,600	29,047	159,595	27,333	85,963	174,020	5,591	62,105	235,347	108,778	153,783	1,425	1,636,611
1996	166,288	112,412	115,132	184,597	90,229	11,591	39,539	179,052	28,749	145,349	202,199	5,722	72,231	313,420	128,865	189,454	1,987	1,986,816
1997	185,820	143,146	97,233	197,871	88,202	11,134	50,584	179,388	29,998	122,140	191,871	4,563	67,407	313,717	124,456	188,455	1,778	1,997,763
1998	120,808	79,387	85,885	152,455	69,758	4,959	30,260	124,464	24,422	80,845	153,662	4,756	53,064	240,072	89,373	148,174	849	1,463,194
1999	152,909	101,786	93,199	142,271	86,667	10,085	53,858	141,626	28,093	108,563	146,395	4,679	57,625	307,686	110,686	166,018	1,248	1,713,394
2000	158,008	111,057	87,200	135,689	87,894	12,833	44,302	152,338	29,948	119,828	133,872	3,920	61,358	315,833	119,597	179,278	1,382	1,754,337
2001	158,432	91,642	65,734	76,718	70,873	10,048	31,379	113,044	30,109	68,302	74,725	0	48,772	70,879	98,104	136,390	1,588	1,146,739
2002	158,197	107,617	63,705	78,735	75,042	9,058	31,724	116,181	25,443	67,574	62,006	0	55,121	165,448	103,849	133,652	1,702	1,255,054
2003	139,412	103,724	64,267	96,601	75,749	8,371	33,941	161,162	24,120	62,007	106,436	1,000	55,511	265,110	106,779	120,733	2,041	1,426,964
2004	155,531	118,543	68,902	86,119	78,558	9,383	39,101	138,664	25,541	67,607	99,610	1,739	58,351	174,605	106,537	138,771	1,637	1,369,199
2005	136,887	105,523	69,372	125,522	78,101	6,037	39,248	169,747	21,445	60,844	207,612	2,784	58,711	294,595	109,716	127,846	1,939	1,615,929
2006	140,411	115,146	84,869	149,851	96,249	5,317	46,538	172,882	22,525	73,422	199,626	0	68,468	332,115	120,106	150,416	2,048	1,779,988
2007	158,526	118,036	102,971	91,196	70,811	4,574	48,482	112,341	23,348	83,116	89,195	552	37,391	146,826	75,642	164,924	1,496	1,329,426
2008	157,604	114,525	86,217	70,032	62,437	4,380	18,156	145,633	22,788	74,554	86,051	0	47,623	29,675	87,776	168,211	1,700	1,177,361
2009	145,184	113,385	86,439	73,530	67,340	4,340	12,129	126,039	21,803	83,740	84,727	0	44,265	30,808	116,967	159,502	1,781	1,171,979
2010	132,462	117,589	88,556	102,109	76,351	3,604	29,694	166,787	19,272	88,191	171,744	1,543	65,238	168,870	120,394	159,162	1,756	1,513,322
2011	130,306	121,808	87,344	121,329	88,617	4,617	39,642	192,069	20,213	92,149	173,305	4,466	74,413	337,724	124,678	156,216	1,530	1,770,425
2012	148,146	130,559	87,953	96,407	89,745	3,988	41,553	195,763	21,682	91,720	81,584	1,329	35,369	227,901	81,602	168,753	1,783	1,505,837
2013	159,887	138,131	93,311	33,558	49,978	3,585	18,533	94,682	22,252	93,322	23,343	0	26,194	81,279	58,923	170,033	1,966	1,068,977
2014	144,605	123,390	82,731	410	41,223	2,645	2,246	70,367	14,067	82,546	11,290	0	8,303	5,748	14,249	152,372	1,238	757,429
2015	114,350	117,357	81,535	134	38,195	2,663	0	68,228	10,274	80,631	9,901	0	0	12,226	3,020	145,842	1,462	685,817

TABLE 2 - Summary of data input for surface water diversion from Kern River at different diversion and turnouts applied to C2VSimFG-Kern Historical Simulation

Water Year	Kern River to Beardsley Canal	Kern River to Carrier Canal at Rocky Point	Kern River to Carrier Canal at Calloway Weir	Kern River to CVC at Turnout #4	Kern River to River Canal	Kern River to Rio Vista at River Walk	Kern River to Rosedale Channel	Kern River to North Lake	Kern River to Pioneer Canal	Kern River to Berrenda Mesa WSD	Kern River to Pioneer Project	Kern River to Kern Water Bank	Kern River to Kern Water Bank Canal	Kern River to 2800 Acre Facility	Kern River to Buena Vista WSD BSA	Kern River to Aqueduct at Intertie	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	291,715	199,035	238,877	181,392	0	0	65,684	0	63,232	0	0	0	0	97,866	86,736	0	1,224,537
1987	190,539	76,888	179,876	58,811	0	0	19,893	0	756	0	0	0	0	21,592	86,736	0	635,091
1988	111,679	25,813	163,938	21,851	0	0	345	0	0	0	0	0	0	0	86,736	0	410,362
1989	98,796	28,696	168,926	23,291	0	0	0	0	0	0	0	0	0	0	86,736	0	406,445
1990	77,389	5,373	128,753	6,577	0	0	0	0	0	0	0	0	0	0	86,736	0	304,828
1991	69,736	180,189	56,331	13,944	0	0	5,869	0	0	0	0	0	0	0	86,736	0	412,805
1992	71,521	194,315	690	11,008	0	0	3,598	0	0	0	0	0	0	0	86,736	0	367,868
1993	213,099	241,104	43,555	59,099	50,897	0	54,936	0	27,803	0	0	0	0	64,852	64,488	0	819,833
1994	187,380	213,631	18,103	26,829	67	0	0	0	0	9,882	0	0	0	28,046	38,745	0	522,683
1995	256,234	248,113	65,360	144,230	136,516	0	91,721	0	40,366	23,822	45,284	0	0	60,476	103,429	11,850	1,227,401
1996	315,988	255,792	105,845	108,405	119,999	0	78,824	0	14,286	17,382	55,074	0	0	24,037	92,768	0	1,188,400
1997	288,746	280,471	123,771	130,336	123,333	0	62,841	0	23,271	14,977	45,600	0	0	27,212	134,320	52,848	1,307,726
1998	312,857	244,337	143,422	131,398	23,346	0	95,706	0	51,802	18,483	69,637	0	0	95,160	115,019	188,048	1,489,215
1999	214,847	180,856	71,974	46,274	58,082	0	33,938	0	839	6,915	21,343	0	0	17,891	77,220	0	730,179
2000	175,718	169,844	38,793	31,596	38,147	0	20,213	0	0	1,396	15,929	0	0	30,660	47,882	0	570,178
2001	130,052	188,404	23,762	14,050	4,631	0	3,177	0	2,179	0	0	0	0	0	32,686	0	398,941
2002	91,980	203,010	4,149	23,609	7,878	0	581	0	199	431	871	0	0	0	29,404	0	362,112
2003	164,112	206,448	15,893	14,088	31,451	0	12,306	0	0	1,045	0	0	0	0	38,307	0	483,650
2004	153,148	198,769	29,338	18,247	2,301	589	1,503	165	0	2,545	2,005	0	0	0	39,412	0	448,022
2005	236,776	228,885	73,215	62,146	60,019	0	141,022	1,442	1,942	39,702	102,111	21,548	23,125	77,127	72,865	0	1,141,925
2006	257,590	247,806	53,872	122,931	33,872	3,942	87,318	1,442	9,962	24,636	116,108	25,165	34,358	42,587	97,955	0	1,159,544
2007	135,525	189,169	1,049	10,483	7,752	2,746	0	0	0	13,099	17,809	7,507	0	4,568	47,914	0	437,621
2008	137,813	229,304	53,824	22,700	0	544	0	0	0	0	0	0	0	0	34,549	0	478,734
2009	139,246	238,103	31,342	28,635	115	712	109	0	0	0	0	0	0	0	18,418	0	456,680
2010	196,135	241,876	70,315	68,944	60,087	820	10,816	776	1,775	1,165	0	0	0	13,748	66,441	0	732,898
2011	298,003	266,684	75,784	160,243	90,048	1,752	101,209	787	20,479	26,223	121,857	23,951	47,187	84,876	98,416	0	1,417,499
2012	148,513	241,953	20,495	55,303	409	1,001	10,998	0	0	7,594	20,162	582	0	7,871	45,173	0	560,054
2013	45,141	153,474	706	25,758	0	247	0	0	0	3,529	0	0	0	155	0	0	229,010
2014	26,041	122,044	0	8,356	0	283	0	0	0	0	0	0	0	0	0	0	156,724
2015	16,883	104,841	0	0	0	195	0	0	0	0	0	0	0	0	0	0	121,919

TABLE 3 - Summary of data input for surface water diversions for various purposes applied to C2VSimFG-Kern Historical Simulation

Water Year	Metro Bakersfield Urban Surface Water Supply	Metro Bakersfield Wastewater Land Disposal	Kern Nat'l Wildlife Refuge SWP Supply	Kern Nat'l Wildlife Refuge Surface Water Inflows from Poso Creek	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	24,416	29,235	0	1,611	30,846
1987	25,298	30,832	0	247	31,079
1988	28,563	32,304	0	65	32,369
1989	27,818	33,785	0	136	33,921
1990	27,426	35,756	0	0	35,756
1991	20,959	36,837	0	123	36,960
1992	25,867	37,801	0	10	37,811
1993	30,261	38,774	120	852	39,746
1994	29,111	39,684	16,861	95	56,640
1995	27,248	40,709	12,097	896	53,702
1996	28,261	41,667	12,776	4,536	58,979
1997	19,216	40,832	7,964	13,811	62,607
1998	11,036	40,355	12,268	90,926	143,549
1999	26,996	39,629	14,827	1,876	56,332
2000	30,963	41,497	7,489	58	49,044
2001	28,611	41,559	13,179	0	54,738
2002	30,185	42,043	19,299	1	61,343
2003	32,206	42,962	20,945	22	63,929
2004	56,861	43,735	23,461	0	67,196
2005	43,727	44,021	23,310	9,025	76,356
2006	40,294	44,614	21,829	11,734	78,177
2007	55,334	44,643	21,607	2,440	68,690
2008	56,335	44,936	17,728	18	62,682
2009	58,834	45,416	19,494	9	64,919
2010	61,314	45,527	21,808	536	67,871
2011	64,388	46,429	26,599	7,691	80,719
2012	68,013	46,666	18,451	9	65,126
2013	66,998	45,513	23,701	0	69,214
2014	55,692	44,645	13,877	0	58,522
2015	44,981	43,256	9,203	0	52,459

TABLE 4 - Summary of data input for surface water diversion to groundwater banking and managed aquifer recharge for different facilities applied to C2VSimFG-Kern Historical Simulation

Water Year	Arvin-Edison WSD	Berrenda Mesa Project	Buena Vista WSD	Cawelo WD	Kern Delta WD	Kern River GSA	North Kern WSD	Rosedale-Rio Bravo WSD	Semi-tropic WSD	West Kern WD	City of Bakers-field	Pioneer Project	Kern Water Bank	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	63,708	0	28,948	0	0	107,936	115,498	103,384	0	25,559	164,861	0	0	609,894
1987	18,800	0	7,487	0	0	62,084	47,206	47,731	0	23,249	50,585	0	0	257,142
1988	1,434	0	227	0	0	49,926	11,171	19,026	0	24,594	18,294	0	0	124,672
1989	3,358	0	3,532	0	0	58,640	804	27,984	0	28,604	14,148	0	0	137,070
1990	4,660	0	0	0	0	35,825	0	11,530	0	22,368	9,564	0	0	83,947
1991	2,404	0	0	0	0	54,577	1,224	5,931	0	14,754	19,768	0	0	98,658
1992	3,886	0	799	0	0	48,497	10,236	11,880	0	10,368	23,482	0	0	109,148
1993	99,714	0	19,229	0	0	83,472	25,220	88,065	0	24,420	126,544	0	0	466,664
1994	28,968	0	11,485	0	0	60,217	12,333	26,016	0	29,233	67,418	0	0	235,670
1995	87,910	17,808	49,623	0	0	98,122	149,948	119,339	0	28,201	143,019	62,274	121,465	877,709
1996	69,472	23,398	18,253	0	0	102,034	103,277	116,704	0	37,351	75,468	51,330	232,355	829,642
1997	58,069	9,801	38,015	7,524	0	103,578	102,050	108,711	0	18,555	53,470	38,169	132,457	670,399
1998	97,098	9,493	63,868	9,136	0	90,233	196,469	136,250	0	23,133	149,426	57,357	236,320	1,068,783
1999	81,398	11,489	8,904	6,110	0	83,858	69,080	78,941	0	29,249	41,516	21,884	116,663	549,092
2000	95,786	1,027	238	3,446	0	74,926	163	44,501	0	23,082	51,444	22,032	36,551	353,196
2001	38,774	0	99	2,683	0	59,411	0	5,653	0	8,747	22,005	1,253	10,029	148,654
2002	4,437	0	1,065	2,596	0	63,427	0	1,404	0	19,467	11,840	0	13,439	117,675
2003	44,030	0	424	3,314	4,177	73,362	367	27,154	0	17,766	20,133	0	5,369	196,096
2004	7,160	3,172	0	5,172	1,380	65,335	3,039	9,626	0	3,513	22,480	10,768	53,070	184,715
2005	100,311	19,663	33,153	7,882	7,274	98,474	74,241	151,136	0	29,552	164,991	93,466	308,092	1,088,235
2006	90,722	28,268	22,966	4,219	1,224	95,246	138,698	174,051	0	14,385	113,166	64,388	308,877	1,056,210
2007	20,012	15,292	0	5,241	488	51,678	80,467	20,348	0	4,209	31,534	19,386	70,553	319,208
2008	4,409	0	0	5,069	0	53,118	0	0	92	0	8,787	0	0	71,475
2009	34,000	0	3,000	5,239	0	48,217	2,596	2,354	0	5,075	18,730	0	0	119,211
2010	101,606	323	19,127	6,252	11,038	97,829	18,377	76,399	0	10,419	40,113	0	8,272	389,755
2011	99,559	19,373	73,880	29,630	46,690	158,694	147,576	227,775	17,276	24,880	144,869	132,320	397,029	1,519,551
2012	27,799	20,055	0	7,162	54,573	83,460	60,613	88,019	1,865	30,166	37,046	27,293	83,991	522,042
2013	3,947	5,750	0	9,345	14,726	46,298	5,078	5,622	22	2,500	11,518	0	0	104,806
2014	3,518	0	0	2,102	0	46,654	0	0	0	0	9,176	0	0	61,450
2015	401	0	0	5,893	0	40,368	4,768	0	22	0	18,840	0	0	70,292

TABLE 5 - Summary of data input for groundwater recovery pumping for local water supply by water district applied to C2VSimFG-Kern Historical Simulation

Water Year	Arvin-Edison WSD	Berrenda Mesa Project	Buena Vista WSD	City of Bakers-field	Cawelo WD	KCWA ID4	Kern Delta WD	Kern Water Bank	Lost Hills UD	North Kern WSD	Olcese WD	Pioneer Project	Rosedale Rio Brave WSD	Semi-tropic WSD	West Kern WD	Wheeler Ridge - Maricopa WSD	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	1,955	0	0	0	0	0	0	0	274	0	101	0	0	0	12,073	0	14,403
1987	21,660	0	0	0	0	0	0	0	278	41,963	101	0	0	0	12,195	0	76,196
1988	27,486	0	960	0	0	0	0	0	281	67,609	138	0	0	0	12,316	0	108,790
1989	38,231	0	2,507	0	0	0	0	0	285	79,674	132	0	0	0	12,438	0	133,266
1990	78,769	0	2,605	0	957	0	0	0	292	73,635	132	0	0	0	12,560	0	168,949
1991	82,566	0	2,511	0	4,666	0	0	0	307	80,432	132	0	0	0	12,546	0	183,160
1992	94,444	0	4,146	0	7,124	0	0	0	306	72,926	132	0	0	0	12,533	5,419	197,029
1993	21,035	0	222	0	3,469	0	0	0	308	3,950	66	0	0	0	12,530	150	41,730
1994	67,679	0	1,732	0	7,805	0	0	0	321	37,251	123	0	0	0	12,078	2,705	129,693
1995	14,191	0	73	0	4,628	0	0	0	322	4,176	66	0	0	0	11,638	0	35,094
1996	1,095	0	175	0	2,475	0	0	0	322	4,726	143	0	0	2,373	13,642	0	24,950
1997	0	0	0	0	2,406	0	0	0	322	4,261	112	0	0	5,824	13,962	0	26,887
1998	245	0	0	0	1,008	0	0	0	307	318	232	0	0	1,499	13,404	76	17,089
1999	915	0	0	0	2,099	0	0	0	333	773	105	0	0	1,241	14,692	2,806	22,963
2000	2,119	0	855	0	6,406	0	0	0	336	15,864	81	0	0	689	17,125	0	43,475
2001	100,492	19,482	6,115	13,950	8,533	0	0	86,404	350	61,988	103	52,034	0	0	15,714	6,507	371,673
2002	86,809	3,436	4,453	13,972	10,047	0	0	24,664	360	70,804	94	9,578	0	2,082	16,247	0	242,545
2003	30,906	0	1,619	3,211	5,484	1,892	0	53,591	364	21,811	56	16,181	0	2,828	17,733	24	155,699
2004	75,399	0	3,848	7,147	8,920	3,345	0	27,736	393	49,888	120	1,985	0	2,879	20,809	41	202,510
2005	25,104	589	430	0	3,563	0	0	21,553	400	6,121	111	12,951	0	2,145	20,843	0	93,809
2006	174	0	228	0	4,202	0	0	0	416	2,645	77	0	0	156	22,108	0	30,007
2007	101,515	23,022	5,858	10,000	11,039	6,220	0	167,291	419	88,841	149	54,150	2,302	0	23,107	0	493,914
2008	141,081	27,850	6,066	13,400	12,222	9,478	9,744	246,249	423	100,465	115	77,533	7,470	0	22,340	0	674,436
2009	128,043	29,745	5,315	9,086	742	5,582	15,117	166,703	389	111,798	144	78,033	6,001	449	21,629	0	578,777
2010	37,081	15,117	841	3,896	2,078	1,886	4,466	97,576	362	20,897	112	41,021	0	375	21,334	0	247,041
2011	445	0	290	0	146	0	0	0	378	683	115	0	0	500	20,801	1,037	24,395
2012	43,589	6,362	1,835	3,960	2,058	1,319	3,148	94,381	393	103,236	107	14,257	0	0	21,107	14,579	310,330
2013	123,971	1,379	4,261	5,571	20,994	2,252	19,809	171,627	373	146,543	118	41,743	14,231	0	19,494	16,518	588,883
2014	146,319	23,891	3,269	7,997	18,120	30,884	34,160	183,235	359	133,769	472	78,603	21,604	0	33,129	16,020	731,830
2015	123,618	26,298	1,267	3,516	24,146	38,294	32,918	154,687	358	118,342	109	56,634	17,237	0	20,344	13,857	631,624

TABLE 6 - Summary of data input for groundwater pumping for basin export by water district applied to C2VSimFG-Kern Historical Simulation

Water Year	Arvin-Edison WSD to Aqueduct	DWR to Aqueduct	North Kern WSD to Friant-Kern Canal	Rosedale Rio Brave WSD to CVC	Semi-tropic WSD to Aqueduct	Wheeler Ridge - Maricopa WSD to Aqueduct	County of Kern to BVARA	TOTAL
	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1986	0	0	0	0	0	0	0	2,056
1987	0	0	0	0	0	0	673	63,724
1988	0	0	0	0	0	0	6,301	96,193
1989	0	0	0	0	0	0	5,879	120,544
1990	0	0	0	0	0	0	8,836	156,097
1991	0	0	0	0	0	0	22,114	170,307
1992	0	0	0	0	0	0	25,025	184,191
1993	0	0	0	0	0	0	7,521	28,892
1994	0	0	0	0	0	0		117,295
1995	0	2,319	0	0	0	0	4,748	23,134
1996	0	0	0	0	0	0	0	10,986
1997	0	0	0	0	0	0	0	12,603
1998	0	0	0	0	0	0	0	3,378
1999	0	0	0	0	0	0	0	7,938
2000	0	0	0	0	0	0	56	26,013
2001	0	0	0	0	1,457	638	10,024	355,608
2002	0	0	0	0	21,819	0	22,402	225,938
2003	12,380	0	0	0	0	0	9,886	137,602
2004	11,573	0	0	0	8,965	0	13,643	181,308
2005	13,939	0	0	0	19,103	0	6,071	72,567
2006	0	0	0		0	0	0	7,482
2007	7,609	0	7,276	0	6,282	0	10,437	470,388
2008	42,615	0	4,612	0	92,169	0	17,351	651,673
2009	43,080	0	5,880	0	86,194	7,243	7,786	556,758
2010	56,229	0	73	0	37,995	12,404	7,019	225,345
2011	16,065	0	0	0	0	0	369	3,217
2012	10,010	0	6,803	0	0	1,340	1,889	288,831
2013	15,111	0	7,471	12,116	5,610	3,815	9,786	569,016
2014	45,195	0	12,071	28,818	95,611	18,236	21,567	698,342
2015	67,142	0	9,752	26,314	89,453	26,943	23,330	610,923

TABLE 7 - Summary of population data input by urban zone applied to C2VSimFG-Kern Historical Simulation

Water Year	Urban Zone 97	Urban Zone 98	Urban Zone 99	Urban Zone 100	Urban Zone 102	Urban Zone 103	Urban Zone 104	Urban Zone 105	Urban Zone 106	Total	Annual Growth Rate
	Population	Population	Population	Population	Population	Population	Population	Population	Population	Population	percent
1985	18,266	4,545	54,766	199	11,589	1,845	15,756	443	229,085	336,493	
1986	18,506	4,565	56,021	184	11,631	1,868	16,127	443	245,095	354,441	5.3%
1987	18,747	4,586	57,277	170	11,673	1,892	16,498	443	261,105	372,389	5.1%
1988	18,987	4,607	58,532	155	11,715	1,915	16,869	442	277,114	390,337	4.8%
1989	19,227	4,627	59,788	141	11,758	1,939	17,240	442	293,124	408,285	4.6%
1990	19,467	4,648	61,043	126	11,800	1,962	17,611	442	309,134	426,233	4.4%
1991	19,808	4,662	64,110	132	12,190	2,023	17,570	475	316,532	437,502	2.6%
1992	20,150	4,676	67,178	138	12,581	2,084	17,528	507	323,930	448,771	2.6%
1993	20,491	4,690	70,245	144	12,971	2,145	17,487	540	331,328	460,041	2.5%
1994	20,832	4,704	73,313	150	13,362	2,206	17,445	572	338,726	471,310	2.4%
1995	21,174	4,718	76,380	156	13,752	2,268	17,404	605	346,124	482,579	2.4%
1996	21,515	4,732	79,447	161	14,142	2,329	17,363	637	353,522	493,848	2.3%
1997	21,856	4,746	82,515	167	14,533	2,390	17,321	670	360,920	505,117	2.3%
1998	22,197	4,760	85,582	173	14,923	2,451	17,280	702	368,318	516,387	2.2%
1999	22,539	4,774	88,650	179	15,314	2,512	17,238	735	375,716	527,656	2.2%
2000	22,880	4,788	91,717	185	15,704	2,573	17,197	767	383,114	538,925	2.1%
2001	23,154	4,887	94,141	193	16,313	2,601	17,609	742	395,409	555,047	3.0%
2002	23,429	4,985	96,564	200	16,922	2,628	18,020	717	407,703	571,169	2.9%
2003	23,703	5,084	98,988	208	17,532	2,656	18,432	692	419,998	587,291	2.8%
2004	23,977	5,182	101,412	215	18,141	2,683	18,844	667	432,292	603,413	2.7%
2005	24,252	5,281	103,836	223	18,750	2,711	19,256	643	444,587	619,536	2.7%
2006	24,526	5,379	106,259	230	19,359	2,738	19,667	618	456,882	635,658	2.6%
2007	24,800	5,478	108,683	238	19,968	2,766	20,079	593	469,176	651,780	2.5%
2008	25,074	5,576	111,107	245	20,578	2,793	20,491	568	481,471	667,902	2.5%
2009	25,349	5,675	113,530	253	21,187	2,821	20,902	543	493,765	684,024	2.4%
2010	25,623	5,773	115,954	260	21,796	2,848	21,314	518	506,060	700,146	2.4%
2011	25,815	5,802	117,403	261	21,959	2,862	21,474	519	512,386	708,482	1.2%
2012	26,009	5,831	118,871	261	22,124	2,877	21,635	521	518,791	716,919	1.2%
2013	26,204	5,860	120,357	262	22,290	2,891	21,797	522	525,275	725,458	1.2%
2014	26,400	5,889	121,861	263	22,457	2,905	21,961	523	531,841	734,102	1.2%
2015	26,598	5,919	123,385	263	22,626	2,920	22,125	525	538,489	742,850	1.2%

TABLE 8 - Summary of data input of per-capita water use by urban zone applied to C2VSimFG-Kern Historical simulation

Water Year	Urban Zone 97	Urban Zone 98	Urban Zone 99	Urban Zone 100	Urban Zone 102	Urban Zone 103	Urban Zone 104	Urban Zone 105	Urban Zone 106
	gdpc	gdpc	gdpc	gdpc	gdpc	gdpc	gdpc	gdpc	gdpc
1985	228	196	245	159	180	159	293	159	508
1986	228	196	245	159	180	159	293	159	480
1987	228	196	245	159	180	159	293	159	450
1988	228	196	245	159	180	159	293	159	439
1989	228	196	245	159	180	159	293	159	419
1990	228	196	245	159	180	159	293	159	438
1991	228	196	245	159	180	159	293	159	409
1992	228	196	245	159	180	159	293	159	417
1993	228	196	245	159	180	159	293	159	414
1994	228	196	245	159	180	159	293	159	421
1995	228	196	245	159	180	159	293	159	381
1996	228	196	245	159	180	159	293	159	401
1997	228	196	245	159	180	159	293	159	348
1998	228	196	245	159	180	159	293	159	304
1999	228	196	248	159	159	159	237	159	388
2000	228	196	248	159	159	159	237	159	367
2001	228	196	248	159	159	159	237	159	364
2002	228	196	248	159	159	159	237	159	362
2003	228	196	248	159	159	159	237	159	358
2004	228	196	248	159	159	159	237	159	386
2005	228	196	248	159	159	159	237	159	314
2006	228	196	248	159	159	159	237	159	338
2007	228	196	248	159	159	159	237	159	375
2008	228	196	248	159	159	159	237	159	367
2009	228	196	248	159	159	159	237	159	344
2010	228	196	248	159	159	159	237	159	328
2011	228	196	248	159	159	159	237	159	351
2012	228	196	248	159	159	159	237	159	378
2013	228	196	248	159	159	159	237	159	330
2014	228	196	248	159	159	159	237	159	314
2015	228	196	248	159	159	159	237	159	261

TABLE 9 - Summary of data input for crop evapotranspiration (ET) by crop type based on METRIC satellite data applied to C2VSimFG-Kern Historical Simulation

Water Year	Grain	Cotton	Sugar Beets	Cotton	Dry Beans	Saf-flower	Other Field Crops	Alfalfa	Pasture	Tomoto-Processed	Tomato-Fresh	Curcubits	Onions & Garlic	Potatoes	Other Truck	Almonds & Pistachios	Orchards	Citrus	Vineyards	Idle	Rice	Refuge	Urban	Native
Units	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr	in/yr
1985	30.0	31.6	34.6	35.4	30.8	28.0	27.9	38.9	35.8	28.8	27.3	24.9	28.7	27.6	29.3	31.6	29.7	36.5	25.0	27.4	35.8	31.6	28.1	27.5
1986	28.2	28.9	36.4	32.8	28.0	26.2	29.2	39.3	35.5	29.8	28.8	27.7	26.5	26.2	27.9	35.1	33.6	36.8	26.9	27.1	39.3	36.2	27.8	26.8
1987	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
1988	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
1989	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
1990	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
1991	30.0	31.6	34.6	35.4	30.8	28.0	27.9	38.9	35.8	28.8	27.3	24.9	28.7	27.6	29.3	31.6	29.7	36.5	25.0	27.4	35.8	31.6	28.1	27.5
1992	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
1993	28.2	28.9	36.4	32.8	28.0	26.2	29.2	39.3	35.5	29.8	28.8	27.7	26.5	26.2	27.9	35.1	33.6	36.8	26.9	27.1	39.3	36.2	27.8	26.8
1994	29.5	34.0	36.9	37.0	31.9	24.0	36.5	37.6	31.4	32.4	27.3	27.4	34.1	28.7	31.6	37.2	37.5	38.7	29.1	33.3	26.6	23.9	27.0	27.3
1995	30.1	32.4	35.8	34.4	30.7	26.6	30.7	36.6	32.6	29.4	29.0	28.1	33.1	27.4	30.2	35.8	35.5	35.8	28.7	32.2	31.6	36.3	27.5	29.6
1996	35.0	37.1	39.7	39.2	38.2	32.6	35.8	42.3	38.7	36.1	32.7	28.7	35.3	30.4	33.0	39.3	40.1	39.4	32.1	32.8	34.1	36.4	30.2	31.0
1997	31.3	35.5	39.1	37.7	33.9	29.3	37.2	43.5	36.0	33.2	28.1	28.8	29.7	28.8	30.1	33.7	34.0	38.1	26.1	30.6	34.1	34.0	28.1	31.1
1998	28.2	28.9	36.4	32.8	28.0	26.2	29.2	39.3	35.5	29.8	28.8	27.7	26.5	26.2	27.9	35.1	33.6	36.8	26.9	27.1	39.3	36.2	27.8	26.8
1999	30.0	31.6	34.6	35.4	30.8	28.0	27.9	38.9	35.8	28.8	27.3	24.9	28.7	27.6	29.3	31.6	29.7	36.5	25.0	27.4	35.8	31.6	28.1	27.5
2000	31.1	34.6	36.0	33.2	29.4	28.7	33.8	44.0	38.6	32.2	32.3	27.3	30.5	29.4	29.5	37.0	34.6	41.0	28.9	27.6	41.2	31.4	32.3	33.0
2001	31.9	33.4	36.3	32.0	29.3	27.2	32.1	44.5	33.8	30.2	29.9	26.5	28.8	28.1	28.8	39.9	36.0	40.7	29.7	28.0	41.7	30.8	30.5	31.6
2002	33.8	35.2	39.5	33.3	31.0	26.3	31.4	44.5	33.2	34.2	28.3	27.2	31.3	30.9	31.2	41.4	37.1	43.4	32.1	30.6	40.7	32.2	32.3	33.0
2003	33.0	35.5	35.6	33.2	33.5	28.0	31.7	42.9	30.6	31.0	26.2	27.8	29.7	27.2	28.4	39.6	32.8	38.8	30.4	29.7	37.0	32.1	28.5	30.4
2004	34.5	36.6	37.3	33.5	33.3	32.8	35.6	46.4	36.1	33.1	26.4	26.1	32.4	30.3	33.1	44.2	36.7	40.0	33.1	35.5	39.0	31.5	30.1	32.4
2005	31.8	35.4	40.6	30.5	31.8	27.8	33.0	40.7	32.3	28.4	23.7	26.8	29.6	28.4	28.0	35.1	30.2	34.8	28.0	29.6	37.3	34.1	28.2	30.0
2006	30.9	33.7	33.7	31.4	31.3	24.9	31.1	41.4	33.2	25.4	26.9	29.5	26.9	31.9	28.2	33.9	28.6	35.0	27.6	27.3	39.6	39.3	27.9	29.0
2007	34.3	36.5	33.9	36.1	31.6	28.9	35.3	44.1	35.3	29.4	24.4	26.7	29.1	27.8	32.5	34.5	29.6	37.6	29.6	29.7	38.0	34.0	27.7	31.5
2008	35.2	34.1	30.6	35.3	29.7	25.1	36.0	43.8	37.2	28.0	25.1	25.7	29.7	29.1	31.3	33.2	31.5	37.9	29.6	26.9	34.2	29.9	28.3	31.4
2009	35.3	34.1	25.1	34.2	32.4	32.6	33.9	42.2	30.9	26.5	24.4	24.9	27.1	29.3	29.6	34.5	31.9	37.8	30.4	28.9	35.8	30.5	27.9	32.0
2010	31.6	28.9	25.8	30.2	28.5	23.7	29.8	38.7	26.8	23.2	23.4	26.2	25.4	26.5	27.0	37.3	31.0	35.5	32.3	28.3	33.7	30.8	27.1	30.2
2011	30.1	28.2	23.9	28.3	27.0	21.8	29.6	36.0	25.1	22.6	27.0	24.4	25.5	25.8	25.2	36.2	32.0	33.6	30.9	26.6	38.1	33.6	26.9	32.7
2012	30.2	27.3	22.5	28.7	26.3	23.0	31.0	35.8	26.1	22.6	28.1	24.3	25.8	26.1	26.1	36.6	31.7	33.9	31.2	26.0	38.4	33.8	27.5	33.0
2013	35.7	35.5	28.0	34.7	32.7	33.2	36.4	44.0	33.1	27.2	30.7	29.1	32.4	30.1	30.1	43.6	35.5	39.9	38.6	29.5	36.3	36.8	29.1	35.2
2014	33.9	33.6	25.2	32.9	28.4	28.8	36.0	40.4	28.8	25.2	28.2	28.3	28.6	28.7	29.8	42.5	33.0	37.8	34.1	28.5	36.0	35.8	29.2	34.2
2015	33.4	34.2	28.3	36.3	31.9	33.9	37.0	43.2	29.0	24.0	26.4	27.1	34.8	27.5	30.7	38.8	31.8	38.3	31.0	28.1	29.6	32.2	27.9	32.4
Average	**32.4**	**33.4**	**33.0**	**33.4**	**30.9**	**27.8**	**32.9**	**41.5**	**33.0**	**28.8**	**27.5**	**26.9**	**29.3**	**28.5**	**29.5**	**37.3**	**33.3**	**37.7**	**30.3**	**29.1**	**37.1**	**33.6**	**28.8**	**31.3**
BETA	**21.6**	**39.8**	**39.2**	**32.3**	**31.1**	**34.9**	**36.4**	**48.0**	**50.4**	**31.6**	**40.6**	**32.0**	**36.5**	**35.4**	**31.6**	**48.1**	**45.9**	**42.5**	**42.0**	**57.1**	**50.2**	**76.1**	**52.0**	**57.1**
Difference	**10.8**	**-6.4**	**-6.3**	**1.1**	**-0.2**	**-7.2**	**-3.5**	**-6.5**	**-17.4**	**-2.8**	**-13.0**	**-5.0**	**-7.2**	**-6.9**	**-2.1**	**-10.9**	**-12.6**	**-4.8**	**-11.7**	**-28.0**	**-13.1**	**-42.6**	**-23.2**	**-25.8**

TABLE 10 - Summary of C2VSimFG-Beta modifications in the Kern County Revision applied to C2VSimFG-Kern by IWFM model input file

File Name	Change to Model Input File
C2VSimFG.in	
*	Change simulation starting time to 09/30/1985_24:00
C2VSimFG_Unsat.dat	
*	Replaced initial condition values with more representative values for revised starting
C2VSimFG_SWatersheds.dat	
*	Modified parameters to improve stream discharge match to historical values
C2VSimFG_Groundwater1985.dat	
*	Added hydrologic flow barrier at White Wolf Fault
*	Set Corcoran Clay thickness to 0 ft in areas where it is not present
*	New 10/1/1985 initial condition
*	Modified hydraulic conductivity and specific storage in Layer 1 in the Kern Water Bank
*	Kern County observation wells
C2VSimFG_ElemPump.dat	
*	FRACSK and DSTSK modified for Kern County elements with limited pumping
C2VSimFG_WellSpec.dat	
*	Added Kern County groundwater water bank recovery wells
*	Added Kern County In-District and Urban wells
C2VSimFG_PumpRates.dat	
*	Added Kern County groundwater water bank recovery pumping
*	Added Kern County In-District and Urban pumping
C2VSimFG_StreamInflow.dat	
*	Exteneded Poso Creek inflow through WY2015
C2VSimFG_DiverionSpec.dat	
*	Removed all Kern County diversions and renumbered remaining diversions to 1-371
*	Added Kern County diersions 372-484
C2VSimFG_Diverions.dat	
*	Removed all Kern County diversions and renumbered remaining diversions to 1-371
*	Added Kern County diersions 372-484
*	Updated diversion data for all diversions to Kern County
C2VSimFG_BypassSpecs.dat	
*	Removed bypass #17
C2VSimFG_RootZone.dat	
*	Native return flow is sent to either nearby stream nodes as runoff or out-of-model as ET
C2VSimFG_IrrPeriod.dat	
*	Adjusted Kern County irrigation periods
C2VSimFG_ReturnFlowFrac.dat	
*	Modified Kern County Ag return flow fraction
C2VSimFG_Urban.dat	
*	Added zone 106 for Metro Bakersfield and adjusted other Kern County zone areas
*	Applied estimated September 1985 initial condition

TABLE 10 - Summary of C2VSimFG-Beta modifications in the Kern County Revision applied to C2VSimFG-Kern by IWFM model input file

File Name	Change to Model Input File
C2VSimFG_Urban_Area.dat	
*	Changed Kern County oil fields from urban to native vegetation
C2VSimFG_Urban_PerCapWaterUse.dat	
*	Updated population for Kern County Urban Zones based on 1990, 2000, 2010 Census
*	Developed demands from historical data and water management plans
C2VSimFG_Urban_Population.dat	
*	Updated population for Kern County Urban Zones based on 1990, 2000, 2010 Census
C2VSimFG_Urban_WaterUseSpecs.dat	
*	Set fractions for SRs 19-21 based on local info
C2VSimFG_NonPondedCrop.dat	
*	Return flow = 0 for Kern County
C2VSimFG_NonPondedCrop_Area.dat	
*	Revided crop distributions to match historical distribution
C2VSimFG_PondedCrop_Area.dat	
*	Modified distribution of rice to be limited to areas in northwest Kern County with
C2VSimFG_NativeVeg_Area.dat	
*	Rebalanced native veg distribution after redistribution of non-ponded crop area to

Table 11A - Historical Groundwater Budget for the Kern County Subbasin for Water Years 1995 to 2014 based on the C2VSimFG-Kern Historical Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	GW Pumping	Small Watershed Inflow	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1995	880,480	944,800	185,777	-946,782	122,287	-75,299	1,111,263
1996	801,572	926,537	106,692	-1,247,471	41,190	-84,675	543,845
1997	766,667	771,510	126,405	-1,068,169	50,548	-87,372	559,587
1998	1,034,867	1,097,180	121,413	-884,593	155,312	-87,515	1,436,665
1999	755,674	633,676	39,704	-1,109,310	32,155	-85,211	266,692
2000	617,018	462,522	91,454	-1,375,733	25,956	-83,759	-262,541
2001	551,880	222,131	66,647	-1,839,000	24,633	-81,896	-1,055,605
2002	466,463	202,687	76,147	-1,760,186	18,882	-83,943	-1,079,950
2003	502,831	297,019	118,149	-1,492,816	34,003	-85,638	-626,452
2004	488,327	284,862	83,294	-1,860,344	27,959	-89,250	-1,065,153
2005	799,614	1,147,287	132,785	-1,108,382	93,557	-89,912	974,946
2006	839,390	1,125,277	44,657	-1,149,877	40,846	-96,591	803,702
2007	560,860	403,611	26,260	-2,099,953	17,882	-91,566	-1,182,908
2008	463,721	146,763	78,841	-2,341,780	36,058	-86,260	-1,702,659
2009	485,234	186,548	73,848	-2,206,377	21,586	-85,764	-1,524,923
2010	599,434	467,683	141,715	-1,470,205	58,145	-94,664	-297,892
2011	1,073,963	1,530,123	259,404	-984,968	118,303	-94,981	1,901,842
2012	713,826	580,590	88,581	-1,583,369	19,020	-93,041	-274,395
2013	538,356	156,704	59,483	-2,447,479	19,043	-83,619	-1,757,511
2014	447,782	84,456	50,857	-2,830,674	17,832	-81,081	-2,310,831
Total	**13,387,959**	**11,671,966**	**1,972,113**	**-31,807,470**	**975,198**	**-1,742,039**	**-5,542,280**
Average	**669,398**	**583,598**	**98,606**	**-1,590,373**	**48,760**	**-87,102**	**-277,114**

Table 11B - Current Groundwater Budget for the Kern County Subbasin for Water Year 2015 based on the C2VSimFG-Kern Historical Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	GW Pumping	Subsurface Flow within GW Basin	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
2015	429,983	89,744	46,344	-2,740,237	0	-51,201	-2,225,366

NOTES:

Deep Percolation	Precipitation and applied water that reaches the groundwater after simulated transport across the unsaturated zone
Managed Recharge and Canal Seepage	Combined groundwater recharge from managed aquifer recharge operations, groundwater banking, and seepage from canals and other conveyance
Net GW/SW Interactions	Net volumetric exchange of surface water and groundwater from streams: Positive represents a net groundwater recharge, and negative represents a net groundwater discharge to the stream
GW Pumping	Total groundwater pumping by wells. Groundwater banking recovery pumping is specified input whereas agricultural and municipal pumping is calculated by C2VSim based on demand
Subsurface Flow within GW Basin	Net subsurface groundwater flow into a neighboring water district or area within the Kern County Subbasin: negative is a net flow out of the district and positive is a net flow into the district
Subsurface Flow with Adjacent GW Basins	Net subsurface groundwater flow from the Kern County Subbasin with an adjoining groundwater basin: negative is a net flow out of the Basin and positive is a net flow into the Basin
Change in Groundwater Storage	Sum of the inflow components (positive numbers) plus the outflow components (negative numbers): positive is an increase in storage typified by a rise in GW levels whereas a negative is a decrease in storage typified by a decline in GW levels

TABLE 12: Estimated sustainable yield for Kern County Subbasin for WY1995 to WY2014 Base Period based on C2VSimFG-Kern Historical Simulation

Water Year	Total Average Annual Volume	Agricultural Average Annual Volume	Agricultural Average Annual Volume per Ag Acre	Urban Average Annual Volume
Units	Acre-ft	Acre-ft	ft/acre	Acre-ft
	Sustainable Yield from Groundwater Pumping			
Groundwater Pumping	1,590,373	1,239,931	1.59	176,146
Percentage of Pumping		78%		11%
Change in Groundwater in Storage	-277,114	-216,051	-0.28	-30,692
Percentage of Pumping		-17%		-17%
Sustainable Yield	**1,313,259**	**1,023,880**	**1.31**	**145,453**
Average Annual Difference	**-277,114**	**-216,051**	**-0.28**	**-30,693**
Percent Difference	**-21%**	**-21%**	**-21%**	**-21%**
	Sutainable Yield from Basin Recharge and Outflow			
Groundwater Recharge	1,400,362	1,091,789	1.40	155,101
Subsurface Outflow	-87,102	-67,909	-0.09	-9,647
Sustainable Yield	**1,313,260**	**1,023,880**	**1.31**	**145,453**
Average Annual Difference	**-277,114**	**-216,051**	**0**	**-30,692**
Percent Difference	**0**	**0**	**0**	**0**

NOTES:

Sustainable Yield from Groundwater Pumping	Approach assumes that adjusting total groundwater pumping by the change in storage provides an reasonable approximation of the Basin Sustainable
Sutainable Yield from Basin Recharge and Outflow	Approach assumes that the Basin Sustainable Yield can be reasonably approximated by adding up the different recharge components and non-

TABLE 13: Estimate of potential native yield for Kern County Subbasin for WY1995 to WY2014 based on C2VSimFG-Kern Historical Simulation

	Ag Precipitation Recharge			Other Area Precipitation Recharge			Small Watershed Inflows			
Water Year	Precipitation in Agricultural Area	Precipitation to ET Demand	Precipitation to Groundwater in Agricultural Area	Precipitation in Other Areas	Precipitation to ET Demand	Precipitation to Groundwater in Other Areas	Small Watershed Subsurface Inflow	Small Watershed Runoff Percolation	Small Watershed Recharge to Groundwater	Native Yield
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
1995	702,794	521,974	180,820	1,108,386	824,558	283,828	17,540	104,746	122,287	586,934
1996	381,496	351,540	29,956	526,809	422,541	104,268	17,512	23,679	41,190	175,414
1997	482,117	356,589	125,528	637,266	487,128	150,138	17,524	33,024	50,548	326,214
1998	966,485	663,632	302,853	1,492,576	1,024,918	467,658	17,840	137,472	155,312	925,823
1999	433,456	400,669	32,786	589,454	464,061	125,393	17,812	14,343	32,155	190,334
2000	384,158	357,496	26,661	476,308	398,994	77,315	17,757	8,200	25,956	129,933
2001	431,757	353,840	77,917	579,440	488,081	91,358	17,722	6,911	24,633	193,908
2002	255,111	227,877	27,234	382,463	317,069	65,394	17,679	1,203	18,882	111,510
2003	400,953	331,300	69,653	599,314	506,451	92,863	17,683	16,320	34,003	196,519
2004	301,023	275,258	25,765	422,514	339,652	82,862	17,661	10,298	27,959	136,586
2005	653,833	486,132	167,701	964,382	785,465	178,917	17,808	75,750	93,557	440,175
2006	499,756	447,319	52,437	657,647	546,950	110,697	17,783	23,063	40,846	203,981
2007	216,658	227,752	-11,095	292,814	241,483	51,331	17,725	157	17,882	58,119
2008	189,035	170,649	18,385	305,703	248,514	57,189	17,697	18,361	36,058	111,633
2009	268,010	221,348	46,663	405,160	336,116	69,044	17,674	3,913	21,586	137,293
2010	457,031	346,082	110,949	683,456	543,580	139,876	17,731	40,414	58,145	308,969
2011	649,878	441,717	208,161	1,023,701	692,781	330,919	17,932	100,370	118,303	657,382
2012	335,227	299,191	36,036	446,686	372,675	74,012	17,851	1,169	19,020	129,067
2013	214,951	203,005	11,946	303,560	246,644	56,916	17,787	1,257	19,043	87,906
2014	167,800	152,566	15,234	263,824	214,181	49,642	17,713	120	17,832	82,708
Total	**8,391,529**	**6,835,938**	**1,555,591**	**12,161,462**	**9,501,842**	**2,659,620**	**354,429**	**620,769**	**975,198**	**5,190,409**
Average	**419,576**	**341,797**	**77,780**	**608,073**	**475,092**	**132,981**	**17,721**	**31,038**	**48,760**	**259,520**
Use (ft/acre)	**0.54**	**0.44**	**0.10**	**0.59**	**0.46**	**0.13**	**0.01**	**0.02**	**0.03**	**0.144**

NOTES:

Simulation of Recharge	IWFM applies two processes to simulate the movement of water from the surface to the groundwater. The root zone simulates calculates the volume of water that will percolate below the root zone based on local soil properties. This water bases to the unsaturated zone that applies a 1-D vadose zone flow that simulates the rate that water will reach the groundwater based on subsurface properties and soil moisture content.
Percolation from Agricultural Area	Total volume of rainfall and applied water calculated to meet the total agricultural demand that percolates below the root zone in irrigated agricultural areas based on C2VSim simulation.
Percolation from Urban Area	Total volume of rainfall and applied water calculated to meet urban outdoor use that percolates below the root zone in urban areas based on C2VSim simulation.
Percolation from Native, Undeveloped or Fallow Areas	Total volume of rainfall and applied water that percolates below the root zone in native, undeveloped and fallow areas based on C2VSim simulation.
Percolation to Unsaturated Zone	Total volume of rainfall and applied water that percolates below the root zone from all areas based on C2VSim simulation.
GW Recharge from Unsaturated Zone	Volume of water going from the unsaturated zone to groundwater
GW Banking, Managed Recharge and Canal Seepage	Managed aquifer recharge and groundwater banking is simulated in C2VSim by applying a high recoverable loss factor for surface water diversions. For Kern County, these operations generally assumes that 88% to 94% of surface water deliveries physically recharge groundwater. This recharge is applied directly to the groundwater without passing through the unsaturated zone.
Net GW/SW Interactions	Net volumetric exchange between surface water in Kern River or Poso Creek and the groundwater. A positive number is surface water to groundwater, and a negative is groundwater discharge to the stream. This recharge is applied directly to the groundwater without passing through the unsaturated zone.
Total GW Recharge	Total volume to water reaching the groundwater as recharge

Table 14 - Hydrologic year correlation with relevant river indices for projected-future simulation period

Project Year	Hydrology Year	Annual Kern River Index	San Joaquin River Index
2021	**2003**	71	Below Normal
2022	**2004**	56	Dry
2023	**2005**	159	Wet
2024	**2006**	147	Wet
2025	**2007**	35	Critical
2026	**2008**	71	Critical
2027	**2009**	65	Below Normal
2028	**2010**	126	Above Normal
2029	**2011**	201	Wet
2030	**2012**	45	Dry
2031	**2013**	28	Critical
2032	**2014**	24	Critical
2033	**1995**	191	Wet
2034	**1996**	136	Wet
2035	**1997**	162	Wet
2036	**1998**	236	Wet
2037	**1999**	60	Above Normal
2038	**2000**	66	Above Normal
2039	**2001**	54	Dry
2040	**2002**	58	Dry
2041	**2003**	71	Below Normal
2042	**2004**	56	Dry
2043	**2005**	159	Wet
2044	**2006**	147	Wet
2045	**2007**	35	Critical
2046	**2008**	71	Critical
2047	**2009**	65	Below Normal
2048	**2010**	126	Above Normal
2049	**2011**	201	Wet
2050	**2012**	45	Dry
2051	**2013**	28	Critical
2052	**2014**	24	Critical
2053	**1995**	191	Wet
2054	**1996**	136	Wet
2055	**1997**	162	Wet
2056	**1998**	236	Wet
2057	**1999**	60	Above Normal
2058	**2000**	66	Above Normal
2059	**2001**	54	Dry
2060	**2002**	58	Dry
2061	**2003**	71	Below Normal
2062	**2004**	56	Dry
2063	**2005**	159	Wet
2064	**2006**	147	Wet
2065	**2007**	35	Critical
2066	**2008**	71	Critical
2067	**2009**	65	Below Normal
2068	**2010**	126	Above Normal
2069	**2011**	201	Wet
2070	**2012**	45	Dry

Table 16 - Projected Future Groundwater Budget for Kern County Subbasin under Baseline Conditions with NO SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net Stream GW/SW Interaction	Net Small Watershed Recharge	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	31,276,668	27,591,218	6,284,636	2,457,805	-80,359,227	-3,647,996	**-16,396,918**
Average	625,533	551,824	125,693	49,156	-1,607,185	-72,960	**-327,938**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	12,059,157	10,900,930	2,570,048	948,239	-31,618,403	-1,527,102	**-6,667,151**
Average	602,958	545,046	128,502	47,412	-1,580,920	-76,355	**-333,358**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	19,217,510	16,690,288	3,714,588	1,509,566	-48,740,823	-2,120,894	**-9,729,767**
Average	640,584	556,343	123,820	50,319	-1,624,694	-70,696	**-324,326**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	421,248	253,922	124,080	38,770	-1,605,058	-83,845	-850,883
2022	466,065	311,661	80,807	28,596	-1,881,001	-79,540	-1,073,415
2023	670,267	894,337	186,631	97,803	-1,082,942	-77,289	688,801
2024	782,933	971,636	250,700	67,141	-1,004,008	-81,747	986,650
2025	487,829	334,264	74,696	18,060	-1,956,094	-78,483	-1,119,730
2026	440,342	154,936	78,551	36,473	-2,258,997	-69,511	-1,618,207
2027	522,430	255,426	73,629	21,942	-1,995,091	-69,397	-1,191,063
2028	569,509	496,227	141,957	35,496	-1,490,383	-70,383	-317,575
2029	1,025,597	1,528,921	110,823	119,558	-891,968	-80,187	1,812,744
2030	692,430	587,522	63,468	19,157	-1,382,783	-79,634	-99,841
2031	550,146	164,041	109,295	19,161	-2,366,434	-73,780	-1,597,574
2032	459,496	111,528	66,581	18,134	-2,763,485	-65,268	-2,173,015
2033	742,600	875,129	188,075	126,420	-1,059,514	-71,675	801,034
2034	617,059	786,754	201,477	42,156	-1,422,316	-78,762	146,370
2035	691,055	727,363	294,732	52,652	-1,120,121	-82,586	563,094
2036	848,018	1,151,100	175,108	103,683	-890,760	-84,597	1,302,552
2037	617,636	539,499	102,463	32,114	-1,230,808	-82,549	-21,645
2038	517,060	379,550	106,226	26,241	-1,390,747	-77,398	-439,070
2039	495,144	190,829	65,868	25,370	-1,883,912	-72,405	-1,179,106
2040	442,293	186,285	74,884	19,311	-1,941,979	-68,067	-1,287,273
2041	466,980	254,002	124,912	34,980	-1,621,935	-66,834	-807,894
2042	519,154	311,722	81,095	28,467	-1,928,066	-66,378	-1,054,007
2043	723,193	894,377	183,602	100,835	-1,131,893	-66,724	703,389
2044	829,429	971,656	217,998	68,630	-1,055,212	-73,234	959,267
2045	520,072	334,263	67,722	18,136	-2,005,971	-71,742	-1,137,519
2046	465,742	154,936	78,954	36,599	-2,308,492	-64,094	-1,636,355
2047	542,433	255,426	73,991	22,117	-2,044,767	-65,020	-1,215,821
2048	587,534	496,227	142,442	35,645	-1,539,937	-66,665	-344,754
2049	1,038,285	1,528,924	111,871	121,871	-940,873	-77,190	1,782,886
2050	704,906	587,522	63,577	19,216	-1,430,758	-77,175	-132,713
2051	567,160	164,041	109,977	19,218	-2,411,967	-71,447	-1,623,019
2052	480,958	111,528	66,775	18,007	-2,776,754	-63,069	-2,162,556
2053	756,460	875,129	189,903	127,393	-1,105,182	-69,591	774,112
2054	629,422	786,754	203,667	42,236	-1,466,597	-76,937	118,546
2055	697,412	727,363	297,238	52,738	-1,163,909	-81,081	529,760
2056	955,260	1,151,202	186,248	169,221	-887,932	-83,323	1,490,676
2057	663,489	539,499	104,143	33,376	-1,272,005	-81,579	-13,077
2058	543,714	379,550	107,428	26,454	-1,432,264	-76,504	-451,623
2059	516,904	190,829	65,982	25,586	-1,924,204	-71,122	-1,196,025
2060	461,832	186,285	75,033	19,353	-1,923,734	-66,838	-1,248,069
2061	483,873	254,002	125,183	34,990	-1,662,322	-65,509	-829,782
2062	535,495	311,722	81,199	28,658	-1,968,451	-64,883	-1,076,261
2063	747,374	894,377	185,862	103,344	-1,173,248	-65,287	692,423
2064	797,596	971,656	227,478	42,092	-1,131,322	-72,135	835,365
2065	518,644	334,263	69,814	18,276	-2,046,917	-70,907	-1,176,825
2066	472,700	154,936	79,262	36,483	-2,350,004	-63,321	-1,669,944
2067	550,095	255,426	74,266	22,151	-2,087,215	-64,426	-1,249,703
2068	654,126	496,227	142,653	60,396	-1,488,744	-65,173	-200,515
2069	1,067,944	1,528,924	112,385	123,705	-984,856	-76,302	1,771,799
2070	719,324	587,522	63,930	19,394	-1,475,294	-76,404	-161,529

Table 17 - Projected Future Groundwater Budget for Kern County Subbasin under Baseline Conditions WITH SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	Small Watershed Inflow	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	33,771,527	32,630,931	5,233,643	2,457,805	-69,157,708	-5,025,601	**-89,422**
Average	675,431	652,619	104,673	49,156	-1,383,154	-100,512	**-1,788**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	13,100,548	12,612,730	2,239,160	948,239	-28,535,055	-1,719,340	**-1,353,732**
Average	655,027	630,637	111,958	47,412	-1,426,753	-85,967	**-67,687**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	20,670,979	20,018,200	2,994,483	1,509,566	-40,622,653	-3,306,261	**1,264,311**
Average	689,033	667,273	99,816	50,319	-1,354,088	-110,209	**42,144**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	430,153	302,373	123,650	38,770	-1,594,606	-83,189	-782,849
2022	475,303	349,553	80,614	28,596	-1,862,120	-78,565	-1,006,617
2023	770,374	1,002,929	168,647	97,803	-1,009,264	-78,404	952,085
2024	855,058	1,086,448	198,849	67,141	-944,665	-84,319	1,178,512
2025	503,643	350,298	70,663	18,060	-1,861,303	-81,925	-1,000,565
2026	440,243	214,542	77,894	36,473	-2,187,564	-73,190	-1,491,603
2027	518,989	316,584	73,092	21,942	-1,919,158	-73,183	-1,061,733
2028	578,749	623,230	137,529	35,496	-1,407,567	-75,335	-107,901
2029	1,194,895	1,696,947	83,255	119,558	-744,743	-87,273	2,262,638
2030	750,668	608,048	58,365	19,157	-1,257,759	-87,531	90,947
2031	555,404	180,833	107,613	19,161	-2,187,295	-83,584	-1,407,869
2032	453,293	125,476	66,634	18,134	-2,567,449	-76,460	-1,980,378
2033	824,902	1,059,059	172,274	126,420	-840,738	-84,135	1,257,782
2034	653,828	917,135	178,991	42,156	-1,197,621	-93,181	501,309
2035	827,370	931,556	238,868	52,652	-872,560	-98,679	1,079,205
2036	1,116,969	1,381,739	113,563	103,683	-633,072	-102,650	1,980,231
2037	725,584	594,384	63,749	32,114	-1,023,020	-100,141	292,669
2038	511,919	433,966	84,887	26,241	-1,154,051	-95,834	-192,873
2039	489,540	224,450	65,153	25,370	-1,627,860	-92,035	-915,382
2040	423,665	213,184	74,871	19,311	-1,642,642	-89,729	-1,001,340
2041	445,485	305,376	122,807	34,980	-1,354,885	-89,185	-535,423
2042	498,858	354,364	80,832	28,467	-1,639,112	-89,772	-766,363
2043	812,155	1,090,304	140,266	100,835	-882,848	-92,437	1,168,274
2044	892,628	1,153,766	138,151	68,630	-836,920	-100,949	1,315,306
2045	524,833	355,672	49,525	18,136	-1,730,147	-100,070	-882,051
2046	454,216	218,616	78,021	36,599	-2,055,875	-92,126	-1,360,549
2047	532,454	320,562	73,425	22,117	-1,809,154	-93,438	-954,033
2048	593,653	668,774	137,874	35,645	-1,324,186	-97,255	14,505
2049	1,234,198	1,750,812	79,492	121,871	-710,054	-110,080	2,366,239
2050	768,780	619,092	54,500	19,216	-1,197,582	-110,438	153,567
2051	578,825	192,400	107,098	19,218	-2,110,155	-106,461	-1,319,074
2052	479,637	135,929	66,695	18,007	-2,470,952	-99,536	-1,870,221
2053	850,038	1,095,469	170,484	127,393	-813,603	-107,867	1,321,915
2054	682,383	948,274	168,655	42,236	-1,143,633	-117,748	580,168
2055	858,469	966,141	223,989	52,738	-849,900	-123,451	1,127,986
2056	1,291,577	1,415,721	105,108	169,221	-638,704	-126,824	2,216,098
2057	807,949	600,599	52,465	33,376	-1,027,113	-123,865	343,411
2058	541,774	439,164	78,391	26,454	-1,146,168	-119,115	-179,499
2059	503,264	229,194	64,724	25,586	-1,627,673	-114,273	-919,179
2060	435,869	217,320	75,042	19,353	-1,597,610	-111,590	-961,617
2061	449,783	308,906	122,761	34,990	-1,363,117	-110,530	-557,207
2062	501,922	357,723	80,757	28,658	-1,643,414	-110,538	-784,892
2063	820,754	1,111,099	135,039	103,344	-898,437	-113,406	1,158,393
2064	871,279	1,174,447	124,818	42,092	-868,913	-122,551	1,221,172
2065	511,277	358,753	43,942	18,276	-1,750,481	-120,972	-939,204
2066	454,845	222,078	77,969	36,483	-2,077,330	-112,479	-1,398,433
2067	531,138	323,961	73,264	22,151	-1,832,363	-113,339	-995,189
2068	672,372	689,792	138,150	60,396	-1,265,870	-116,258	178,583
2069	1,286,647	1,771,462	77,455	123,705	-733,283	-129,909	2,396,076
2070	783,917	622,428	52,784	19,394	-1,223,170	-129,799	125,553

Table 18 - Projected Future Groundwater Budget for Kern County Subbasin under 2030 Climate Conditions with NO SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	Small Watershed Inflow	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	30,885,159	30,404,998	6,083,382	2,517,393	-85,792,996	-3,318,618	**-19,220,714**
Average	617,703	608,100	121,668	50,348	-1,715,860	-66,372	**-384,414**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	11,956,360	12,006,382	2,488,942	967,011	-33,772,959	-1,439,420	**-7,793,706**
Average	597,818	600,319	124,447	48,351	-1,688,648	-71,971	**-389,685**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	18,928,799	18,398,617	3,594,440	1,550,382	-52,020,037	-1,879,198	**-11,427,008**
Average	630,960	613,287	119,815	51,679	-1,734,001	-62,640	**-380,900**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	422,205	264,773	147,393	42,134	-1,686,375	-82,161	-892,031
2022	486,382	352,708	97,994	31,229	-1,966,104	-77,718	-1,075,519
2023	670,731	968,807	192,300	100,122	-1,194,263	-75,163	662,531
2024	724,438	1,015,022	177,313	64,551	-1,153,552	-78,823	748,944
2025	451,579	327,176	67,822	18,068	-2,002,002	-75,206	-1,212,569
2026	443,127	213,524	132,483	37,800	-2,325,127	-67,041	-1,565,234
2027	508,495	246,268	115,977	23,732	-2,151,549	-65,434	-1,322,507
2028	572,490	566,005	191,408	39,445	-1,651,430	-65,956	-348,038
2029	1,218,648	1,901,727	112,842	122,295	-1,104,305	-76,600	2,174,607
2030	553,673	532,639	51,185	19,641	-1,476,524	-74,857	-394,243
2031	521,194	199,452	76,829	18,143	-2,339,207	-68,717	-1,592,305
2032	453,699	143,631	46,557	17,968	-2,788,464	-60,558	-2,187,167
2033	743,629	915,198	182,822	122,210	-1,190,116	-67,058	706,686
2034	615,276	872,000	147,377	45,764	-1,543,359	-73,439	63,619
2035	736,533	843,258	281,587	55,297	-1,297,450	-77,197	542,029
2036	863,933	1,264,065	123,884	102,926	-1,044,324	-79,069	1,231,416
2037	542,139	510,531	72,919	32,384	-1,342,279	-75,848	-260,154
2038	507,189	428,732	81,591	27,413	-1,503,202	-70,781	-529,059
2039	482,914	213,280	87,387	26,084	-2,017,703	-65,709	-1,273,748
2040	438,087	227,586	101,273	19,804	-1,995,626	-62,086	-1,270,964
2041	462,417	263,946	147,623	39,151	-1,702,404	-60,765	-850,032
2042	532,326	354,460	98,221	31,228	-2,012,621	-59,960	-1,056,345
2043	717,292	967,381	179,212	103,193	-1,243,088	-59,869	664,119
2044	766,402	1,015,346	117,742	65,724	-1,204,632	-65,643	694,939
2045	477,463	326,770	51,863	18,138	-2,051,621	-63,896	-1,241,282
2046	465,642	213,337	132,843	37,870	-2,374,509	-57,074	-1,581,891
2047	526,192	246,482	116,132	23,946	-2,201,023	-56,606	-1,344,877
2048	584,963	564,936	191,656	39,636	-1,700,745	-57,895	-377,449
2049	1,218,687	1,904,385	99,805	124,949	-1,152,654	-69,447	2,125,726
2050	560,761	533,577	47,140	19,693	-1,524,426	-68,362	-431,617
2051	531,733	199,452	76,920	18,193	-2,385,216	-62,565	-1,621,483
2052	469,853	139,904	46,651	17,931	-2,807,543	-54,827	-2,188,030
2053	748,982	916,702	183,503	123,682	-1,235,658	-61,582	675,628
2054	618,472	870,588	145,806	45,880	-1,587,472	-68,329	24,946
2055	736,517	843,485	279,382	55,392	-1,341,090	-72,519	501,167
2056	954,438	1,263,249	134,078	169,164	-1,037,331	-74,710	1,408,888
2057	579,927	508,121	73,014	33,640	-1,384,414	-71,487	-261,199
2058	532,403	431,547	81,726	27,628	-1,544,662	-66,368	-537,727
2059	503,820	214,669	87,386	26,299	-2,057,978	-61,126	-1,286,930
2060	456,299	228,154	101,178	19,792	-1,984,645	-57,872	-1,237,094
2061	478,968	264,126	147,695	39,158	-1,742,970	-56,708	-869,739
2062	546,856	353,554	98,263	31,426	-2,052,889	-55,984	-1,078,775
2063	740,448	969,075	181,599	104,939	-1,284,313	-56,141	655,606
2064	735,683	1,013,851	124,774	41,649	-1,277,235	-62,203	576,518
2065	478,349	327,088	54,630	18,289	-2,092,701	-60,730	-1,275,076
2066	473,836	213,074	132,845	37,782	-2,406,519	-57,164	-1,606,144
2067	537,374	246,454	116,277	23,923	-2,231,035	-58,641	-1,365,648
2068	660,267	565,258	192,661	65,542	-1,647,974	-59,014	-223,263
2069	1,254,195	1,903,367	104,892	126,664	-1,191,285	-71,013	2,126,821
2070	578,235	536,275	48,924	19,883	-1,559,383	-70,699	-446,765

Table 19 - Projected Future Groundwater Budget for Kern County Subbasin under 2030 Climate Conditions WITH SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	Small Watershed Inflow	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	32,838,979	35,447,299	4,941,607	2,517,393	-73,869,518	-4,735,936	**-2,860,202**
Average	656,780	708,946	98,832	50,348	-1,477,390	-94,719	**-57,204**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	12,873,160	13,719,306	2,153,021	967,011	-30,545,188	-1,641,666	**-2,474,378**
Average	643,658	685,965	107,651	48,351	-1,527,259	-82,083	**-123,719**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	19,965,818	21,727,994	2,788,586	1,550,382	-43,324,331	-3,094,271	**-385,823**
Average	665,527	724,266	92,953	51,679	-1,444,144	-103,142	**-12,861**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	436,607	313,191	146,335	42,134	-1,676,044	-81,420	-819,196
2022	495,680	391,450	97,863	31,229	-1,947,388	-76,701	-1,007,874
2023	777,040	1,077,709	179,601	100,122	-1,117,722	-76,444	940,302
2024	808,215	1,130,101	141,980	64,551	-1,088,738	-81,861	974,238
2025	462,701	343,315	61,517	18,068	-1,906,220	-78,953	-1,099,574
2026	439,400	273,084	131,767	37,800	-2,253,887	-70,713	-1,442,550
2027	504,308	306,757	115,891	23,732	-2,068,551	-69,760	-1,187,619
2028	576,402	692,833	189,187	39,445	-1,565,005	-71,313	-138,447
2029	1,371,389	2,070,178	67,647	122,295	-932,879	-84,094	2,614,536
2030	584,511	553,212	37,888	19,641	-1,345,295	-83,321	-233,371
2031	528,715	216,234	76,879	18,143	-2,159,236	-78,674	-1,397,939
2032	447,278	157,578	46,694	17,968	-2,586,970	-72,132	-1,989,585
2033	822,633	1,099,092	179,078	122,210	-954,120	-79,949	1,188,943
2034	642,235	1,002,883	120,224	45,764	-1,314,339	-88,379	408,386
2035	882,067	1,046,864	225,239	55,297	-1,036,291	-94,244	1,078,932
2036	1,079,981	1,496,375	67,732	102,926	-748,234	-98,400	1,900,379
2037	618,298	565,459	31,639	32,384	-1,137,009	-94,427	16,344
2038	503,029	481,733	53,082	27,413	-1,262,856	-89,986	-287,584
2039	473,864	246,867	81,296	26,084	-1,751,020	-86,330	-1,009,239
2040	418,807	254,393	101,481	19,804	-1,693,383	-84,564	-983,462
2041	444,811	315,197	147,563	39,151	-1,429,438	-83,810	-566,526
2042	514,255	397,576	97,317	31,228	-1,723,016	-83,907	-766,546
2043	816,698	1,163,940	134,478	103,193	-969,015	-86,356	1,162,938
2044	847,571	1,197,675	50,668	65,724	-949,162	-94,611	1,117,864
2045	471,125	348,281	32,446	18,138	-1,769,470	-93,309	-992,789
2046	446,314	276,979	132,424	37,870	-2,116,321	-86,037	-1,308,771
2047	507,943	310,952	116,190	23,946	-1,951,408	-86,246	-1,078,625
2048	570,746	737,315	190,434	39,636	-1,454,664	-89,846	-6,380
2049	1,365,299	2,126,760	34,358	124,949	-846,645	-103,976	2,700,745
2050	579,883	565,192	23,802	19,693	-1,287,166	-103,007	-201,604
2051	538,250	227,799	76,822	18,193	-2,083,539	-98,472	-1,320,948
2052	464,011	164,305	46,977	17,931	-2,493,990	-92,183	-1,892,949
2053	839,476	1,136,728	177,834	123,682	-921,588	-100,638	1,255,494
2054	659,537	1,032,674	98,253	45,880	-1,258,249	-110,065	468,030
2055	903,882	1,081,677	208,421	55,392	-1,002,340	-116,311	1,130,721
2056	1,216,310	1,529,332	56,914	169,164	-718,274	-120,237	2,133,209
2057	673,501	569,268	16,245	33,640	-1,122,622	-115,686	54,346
2058	522,020	489,739	44,186	27,628	-1,253,276	-110,474	-280,179
2059	481,112	252,996	77,161	26,299	-1,749,204	-105,946	-1,017,581
2060	429,670	259,054	101,488	19,792	-1,652,713	-103,828	-946,537
2061	447,419	318,905	147,790	39,158	-1,437,034	-102,731	-586,494
2062	515,397	400,090	96,110	31,426	-1,726,653	-102,439	-786,068
2063	822,203	1,186,122	125,545	104,939	-982,407	-105,263	1,151,138
2064	812,383	1,217,000	39,194	41,649	-986,296	-114,017	1,009,913
2065	461,447	351,690	27,964	18,289	-1,789,318	-112,105	-1,042,033
2066	449,867	280,211	132,607	37,782	-2,125,316	-106,826	-1,331,675
2067	511,035	314,307	116,486	23,923	-1,960,796	-107,878	-1,102,923
2068	651,081	758,626	191,836	65,542	-1,393,447	-109,878	163,759
2069	1,417,188	2,146,388	28,009	126,664	-861,456	-124,760	2,732,032
2070	585,382	571,217	19,064	19,883	-1,309,505	-123,427	-237,386

Table 20 - Projected Future Groundwater Budget for Kern County Subbasin under 2070 Climate Conditions with NO SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	Small Watershed Inflow	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	30,266,907	32,824,218	5,541,096	2,495,122	-92,372,522	-3,271,463	**-24,516,680**
Average	605,338	656,484	110,822	49,902	-1,847,450	-65,429	**-490,334**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	11,792,918	12,994,527	2,263,192	960,586	-36,385,358	-1,447,672	**-9,821,843**
Average	589,646	649,726	113,160	48,029	-1,819,268	-72,384	**-491,092**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	18,473,988	19,829,691	3,277,904	1,534,536	-55,987,164	-1,823,791	**-14,694,837**
Average	615,800	660,990	109,263	51,151	-1,866,239	-60,793	**-489,828**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	408,652	250,550	140,163	38,275	-1,842,475	-83,663	-1,088,499
2022	472,102	369,832	95,673	30,903	-2,096,387	-78,608	-1,206,496
2023	673,989	1,058,910	189,890	97,206	-1,367,109	-76,560	576,325
2024	744,177	1,122,749	154,523	64,640	-1,269,966	-81,123	734,995
2025	434,940	339,216	62,383	18,095	-2,093,637	-77,242	-1,316,253
2026	469,752	316,670	142,130	42,165	-2,392,400	-68,542	-1,490,227
2027	468,805	219,342	111,136	22,713	-2,302,101	-66,245	-1,546,351
2028	565,266	622,490	194,932	37,491	-1,777,664	-66,172	-423,661
2029	1,232,895	2,021,954	94,628	120,391	-1,272,882	-75,969	2,121,016
2030	512,383	510,545	46,067	18,406	-1,606,048	-73,952	-592,602
2031	514,885	217,243	80,080	18,510	-2,404,879	-69,108	-1,643,271
2032	420,919	109,243	41,157	17,864	-2,961,316	-59,737	-2,431,871
2033	717,704	983,283	185,465	124,666	-1,366,638	-66,770	577,711
2034	636,472	1,011,310	124,135	48,403	-1,629,020	-73,691	117,609
2035	742,442	926,830	240,059	52,829	-1,506,120	-76,785	379,255
2036	840,589	1,369,821	66,325	95,355	-1,236,377	-78,889	1,056,824
2037	511,349	550,855	51,377	33,462	-1,460,435	-75,693	-389,084
2038	525,422	516,749	68,512	30,839	-1,615,455	-70,944	-544,878
2039	486,185	261,453	84,925	29,526	-2,078,540	-66,064	-1,282,515
2040	413,990	215,482	89,632	18,846	-2,105,907	-61,915	-1,429,871
2041	434,872	249,759	141,456	34,801	-1,861,023	-59,685	-1,059,819
2042	506,082	371,490	95,431	30,811	-2,143,228	-58,424	-1,197,837
2043	701,042	1,057,536	164,332	99,819	-1,415,545	-58,898	548,287
2044	765,882	1,123,035	84,872	65,709	-1,321,033	-65,596	652,868
2045	457,199	338,796	43,022	18,140	-2,143,265	-63,760	-1,349,868
2046	491,322	316,422	142,576	42,210	-2,441,728	-56,475	-1,505,673
2047	486,516	219,663	111,300	22,758	-2,350,989	-55,383	-1,566,136
2048	575,922	621,390	195,292	37,553	-1,826,869	-56,367	-453,078
2049	1,207,108	2,024,646	76,576	122,702	-1,321,171	-67,189	2,042,673
2050	516,604	511,479	41,647	18,437	-1,653,603	-66,049	-631,485
2051	524,249	217,243	80,184	18,541	-2,450,881	-61,709	-1,672,374
2052	436,390	105,521	41,256	17,846	-2,980,914	-52,973	-2,432,875
2053	721,385	984,833	185,983	125,947	-1,412,037	-60,560	545,551
2054	637,035	1,010,015	122,314	48,546	-1,673,215	-67,888	76,808
2055	739,029	926,775	240,837	53,236	-1,549,608	-71,550	338,718
2056	916,865	1,369,239	78,789	163,750	-1,223,884	-73,970	1,230,789
2057	542,683	548,446	53,332	34,610	-1,503,509	-70,686	-395,124
2058	550,193	519,512	70,081	31,051	-1,656,729	-65,944	-551,837
2059	506,313	262,783	85,481	29,722	-2,118,584	-60,956	-1,295,243
2060	434,143	216,084	89,721	18,987	-2,098,596	-57,233	-1,396,893
2061	453,048	249,994	141,478	34,761	-1,901,319	-55,229	-1,077,267
2062	522,814	370,621	95,685	30,984	-2,183,537	-54,157	-1,217,590
2063	725,002	1,059,135	169,499	100,139	-1,456,460	-54,936	542,379
2064	737,845	1,121,596	96,738	41,720	-1,390,161	-62,039	545,700
2065	456,525	339,078	47,370	18,277	-2,183,880	-60,597	-1,383,226
2066	498,361	316,005	142,585	41,907	-2,483,011	-53,520	-1,537,673
2067	496,804	219,419	111,431	22,808	-2,393,461	-52,693	-1,595,690
2068	655,939	621,712	196,418	66,128	-1,787,044	-52,309	-299,157
2069	1,243,827	2,023,476	87,110	124,017	-1,364,360	-64,030	2,050,039
2070	532,988	513,990	45,107	18,619	-1,697,522	-62,987	-649,805

Table 21 - Projected Future Groundwater Budget for Kern County Subbasin under 2070 Climate Conditions WITH SGMA Projects based on C2VSimFG-Kern Simulation

Water Year	Deep Percolation	Managed Recharge and Canal Seepage	Net GW/SW Interactions	Small Watershed Inflow	GW Pumping	Subsurface Flow with Adjacent GW Basins	Change in Groundwater Storage
Units	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft	Acre-ft
SUMMARY: WY2021 to WY2070 Simulatation Period							
Total	31,799,129	37,863,262	4,293,932	2,495,122	-79,755,674	-4,729,641	**-8,033,910**
Average	635,983	757,265	85,879	49,902	-1,595,113	-94,593	**-160,678**
SUMMARY: WY2021 to WY2040 Implementation Period							
Total	12,589,633	14,705,737	1,891,043	960,586	-32,975,395	-1,657,287	**-4,485,720**
Average	629,482	735,287	94,552	48,029	-1,648,770	-82,864	**-224,286**
SUMMARY: WY2041 to WY2070 Sustainability Period							
Total	19,209,496	23,157,525	2,402,889	1,534,536	-46,780,279	-3,072,354	**-3,548,190**
Average	640,317	771,917	80,096	51,151	-1,559,343	-102,412	**-118,273**
Annual Simulation Results for WY2021 to WY2070 Simulation Period							
2021	416,859	299,174	140,033	38,275	-1,829,917	-83,068	-1,018,646
2022	482,771	408,716	95,545	30,903	-2,075,055	-77,724	-1,134,857
2023	778,119	1,167,829	176,974	97,206	-1,283,726	-78,065	858,337
2024	824,224	1,237,834	116,452	64,640	-1,201,267	-84,296	957,582
2025	444,081	355,471	55,004	18,095	-1,995,258	-81,218	-1,203,834
2026	466,475	376,346	141,087	42,165	-2,313,156	-72,774	-1,359,861
2027	464,976	279,425	111,024	22,713	-2,213,764	-70,681	-1,406,307
2028	569,538	749,332	192,740	37,491	-1,685,558	-71,949	-208,410
2029	1,366,993	2,190,420	41,284	120,391	-1,077,423	-84,620	2,557,045
2030	534,178	531,150	29,555	18,406	-1,464,690	-82,917	-434,320
2031	519,704	234,003	79,675	18,510	-2,224,205	-79,250	-1,451,562
2032	415,122	123,188	41,020	17,864	-2,750,519	-71,829	-2,225,156
2033	783,412	1,166,531	179,799	124,666	-1,109,329	-80,416	1,064,663
2034	658,731	1,142,196	88,031	48,403	-1,395,221	-89,128	453,011
2035	863,103	1,130,070	184,994	52,829	-1,232,204	-94,328	904,464
2036	1,029,800	1,602,138	12,470	95,355	-917,373	-98,485	1,723,905
2037	570,198	605,678	8,505	33,462	-1,243,785	-94,402	-120,345
2038	523,835	569,446	34,689	30,839	-1,363,512	-90,407	-295,110
2039	479,164	294,676	72,792	29,526	-1,805,973	-86,949	-1,016,764
2040	398,352	242,115	89,372	18,846	-1,793,459	-84,780	-1,129,554
2041	414,818	301,192	141,646	34,801	-1,568,913	-83,592	-760,049
2042	491,990	414,742	93,845	30,811	-1,840,528	-83,323	-892,462
2043	790,613	1,254,107	115,429	99,819	-1,116,588	-86,323	1,057,057
2044	836,403	1,305,369	17,905	65,709	-1,045,824	-95,401	1,084,162
2045	449,154	360,429	22,817	18,140	-1,852,116	-93,998	-1,095,574
2046	471,989	380,169	142,402	42,210	-2,176,184	-86,568	-1,225,983
2047	471,984	283,737	111,550	22,758	-2,085,163	-85,737	-1,280,870
2048	554,428	793,776	194,145	37,553	-1,568,985	-88,857	-77,939
2049	1,321,092	2,246,987	3,572	122,702	-987,606	-102,881	2,603,867
2050	524,857	543,145	12,030	18,437	-1,398,511	-101,367	-401,409
2051	526,155	245,563	79,307	18,541	-2,147,741	-98,008	-1,376,184
2052	430,658	129,919	41,236	17,846	-2,649,533	-91,211	-2,121,085
2053	792,109	1,204,216	177,747	125,947	-1,064,253	-100,431	1,135,335
2054	668,348	1,172,104	66,220	48,546	-1,336,993	-110,282	507,943
2055	860,469	1,164,599	170,576	53,236	-1,194,626	-115,992	938,261
2056	1,144,616	1,635,346	2,390	163,750	-873,811	-120,178	1,952,112
2057	610,598	609,490	-6,003	34,610	-1,226,393	-115,425	-93,124
2058	546,965	577,365	26,400	31,051	-1,353,145	-110,712	-282,076
2059	486,798	300,706	68,354	29,722	-1,802,615	-106,347	-1,023,382
2060	409,456	246,809	89,277	18,987	-1,751,495	-103,792	-1,090,757
2061	418,628	304,951	141,821	34,761	-1,574,579	-102,407	-776,824
2062	495,173	417,295	92,534	30,984	-1,842,095	-101,824	-907,934
2063	793,354	1,276,196	108,214	100,139	-1,128,328	-105,241	1,044,334
2064	805,281	1,324,749	9,903	41,720	-1,082,528	-114,909	984,217
2065	440,536	363,793	19,730	18,277	-1,870,357	-113,021	-1,141,042
2066	471,618	383,251	141,837	41,907	-2,193,139	-104,993	-1,259,519
2067	473,770	286,942	111,773	22,808	-2,105,041	-103,867	-1,313,616
2068	625,100	815,113	195,615	66,128	-1,516,065	-105,894	79,999
2069	1,353,276	2,266,438	1,701	124,017	-1,005,088	-121,015	2,619,328
2070	529,258	549,028	8,916	18,619	-1,422,036	-118,758	-434,973

TABLE 22: Assessment of change in groundwater storage from C2VSimFG-Kern model results for historical and future scenarios for the Kern County Subbasin

Scenario	Model Results 2041-2070 Sustainability Period		Adjustments to GW Storage Change 2041-2070 Sustainability Period		
	Change in Groundwater Storage	**Change in Net Operational Budget**	**Adjustment for Excess Basin Outflows**	**Adjustment for Excess Kern River Outflow**	**Adjusted Change in GW Storage**
units	**AFY**	**AFY**	AFY	AFY	**AFY**
Historic	**-277,114**	**-190,012**	0	0	**-277,114**
Baseline	**-324,326**	**-253,629**	0	0	**-324,326**
Base Projects	**42,144**	**152,353**	26,327	17,108	**85,578**
2030 Climate	**-380,900**	**-318,260**	0	8,780	**-372,120**
2030 Projects	**-12,861**	**90,282**	27,056	32,634	**46,829**
2070 Climate	**-489,828**	**-429,035**	0	17,492	**-472,336**
2070 Projects	**-118,273**	**-15,861**	28,077	44,227	**-45,969**

NOTE:

"Change in *Groundwater Storage* " DOES include subsurface flow with adjacent basins

"*Operational Storage* " DOES NOT include subsurface flow with adjacent basins

"Adjustment for *Excess Basin Outflows* " is the difference in simulated basin outflow that is attributed to addition of SGMA projects in Kern County without comparable SGMA projects added to adjacent basins**.** Adjustment assumes that this difference is due to limitation of simulation, and that this difference would remain in Kern County when SGMA projects from adjacent basin are included in simulation.

"Adjustment for *Excess Kern River Outflow* " is the increase in simulated groundwater outflows to Kern River relative to Baseline condition that are attributed to SGMA Projects and Climate Change. Model is not optimized for river management. Since the Kern River is a highly managed system, the assumption is that in practice this water would be recovered for beneficial use rather than be a loss of water from the basin.

"*Adjusted Change in GW Storage* " Change in GW Storage plus modifications listed as adjustments to provide a more realistic Change in GW Storage estimate for the simulation.

TABLE 23: Evaluation of Sustainable Yield for Projected-Future scenarios based on C2VSimFG-Kern Model Results for Kern County Subbasin

Scenario	C2VSimFG-Kern Model Results 2041-2070 Sustainability Period					
	Groundwater Pumping	Change in Groundwater in Storage	GW Storage Adjustments	Sustainable Yield	Average Annual Difference of Pumping to Yield	Percent Difference of Pumping to Sustainable Yield
units	**AFY**	**AFY**	**AFY**	**AFY**	**AFY**	**AFY**
Historic	**1,590,373**	**-277,114**	**0**	**1,313,259**	**-277,114**	**-21%**
Baseline	**1,624,694**	**-324,326**	**0**	**1,300,369**	**-324,326**	**-25%**
Baseline Projects	**1,354,088**	**42,144**	**43,434**	**1,439,666**	**85,578**	**6%**
2030 Climate	**1,734,001**	**-380,900**	**8,780**	**1,361,881**	**-372,120**	**-27%**
2030 Projects	**1,444,144**	**-12,861**	**59,690**	**1,490,974**	**46,829**	**3%**
2070 Climate	**1,866,239**	**-489,828**	**17,492**	**1,393,902**	**-472,336**	**-34%**
2070 Projects	**1,559,343**	**-118,273**	**72,304**	**1,513,373**	**-45,969**	**-3%**

NOTES:

Groundwater Pumping	Total groundwater pumping by wells. Groundwater banking recovery pumping is specified input whereas agricultural and municipal pumping is calculated by C2VSim based on demand
Change in Groundwater in Storage	Sum of the inflow components (positive numbers) plus the outflow components (negative numbers): positive is an increase in storage typified by a rise in GW levels whereas a negative is a decrease in storage typified by a decline in GW levels
Adjusted Banking	Adjustment that assumes that recharge operations are affected by reductions in imported water sources, but
GW Storage Adjustments	Adjustment to GW Storage that reflect artifacts of the simulation. For Kern County, adjustments made to reflect no SGMA projects simulated north of Kern County, and that Kern River operations are not optimized to
Sutainable Yield	Sustainable yield is defined is the amount of pumping that can be sustained in the groundwater basin without the undesirable effect of a decline in groundwater storage that serves as a proxy for other undesirable effects
Average Annual Difference	The difference between the sustainable yield and the simulated groundwater pumping. A negative value is pumping in excess of the sustainable yield
Percent Difference	The percentage of the Average Annual Difference to the total groundwater pumping to provide context and a method to compare the significance of the difference in the pumping copmared to the sustainable yield.

TABLE 24: Summary of Statistical Analysis for Validation of C2VSimFG-Kern Historical Simulation

Validation Measure	C2VSimFG-Kern	C2VSimFG-Beta	Percent Change
Units	Feet	Feet	Percent
Residual Mean	17.3 ft	32.6 ft	47%
Residual Standard Deviation	45.5 ft	54.0 ft	16%
Absolute Residual Mean	37.4 ft	56.8 ft	34%
Root Mean Square (RMS) Error	50 ft	73.5 ft	32%
Scaled Absolute Residual Mean	0.061	0.092	34%
Correlation Coefficient	0.76	0.52	47%
Number of Monitor Wells	558	558	same
Number of Observations	42,075	42,075	same

Notes

Observation Point	Location in the model where measured data from well is compared to simulated model results
Residual	Difference between measured and simulated groundwater elevations at an observation point
Residual Mean	Statistical measure of fit of simulated to measured data using sum of the residuals divided by the number of residual data values
Residual Standard Deviation	Statistical evaluation of the scatter of the data by calculating standard deviation of residuals
Absolute Residual Mean	Statistical measure of fit of simulated to measured data using sum of the absolute value residuals divided by the number of residual data values
Root Mean Square (RMS) Error	Statistical measure of fit of simulated to measured data using square root of the quotient of sum of squares of residuals by the number of observations
Scaled Absolute Residual Mean	Statisical measure to provide scale of validation using ratio of the absolute residual mean divided by the range of observed groundwater elevations
Correlation Coefficient	Scaled measure of the closeness of fit of simulated to measured data from -1 to 1 correlation with 1.0 a perfect correlation
Number of Monitor Wells	Number of wells where measured groundwater level data was compared to C2VSimFG-Kern simulation results for model validation
Number of Observations	Number of groundwater level measurements that were compared to C2VSimFG-Kern simulation results for model validation

FIGURES

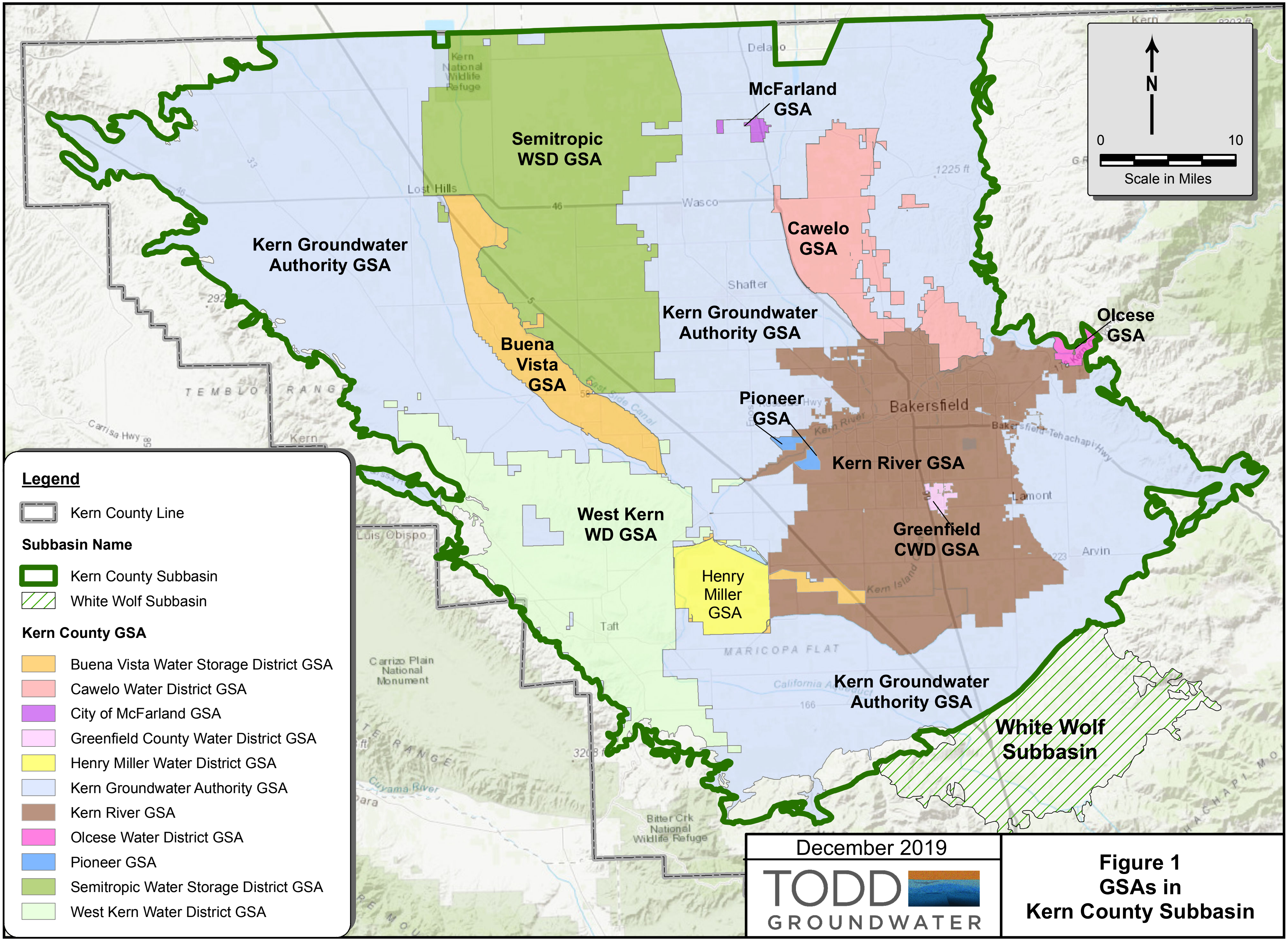
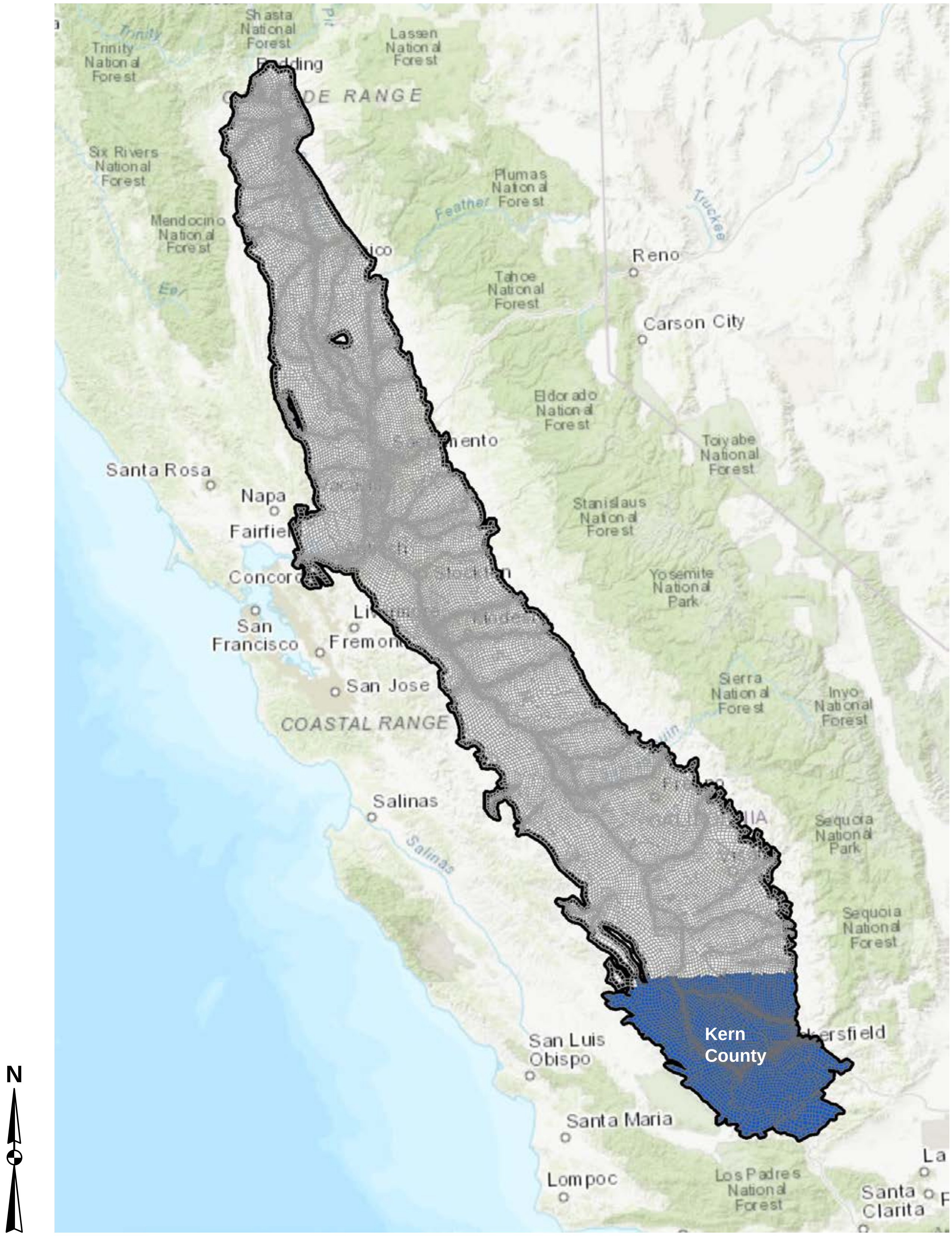
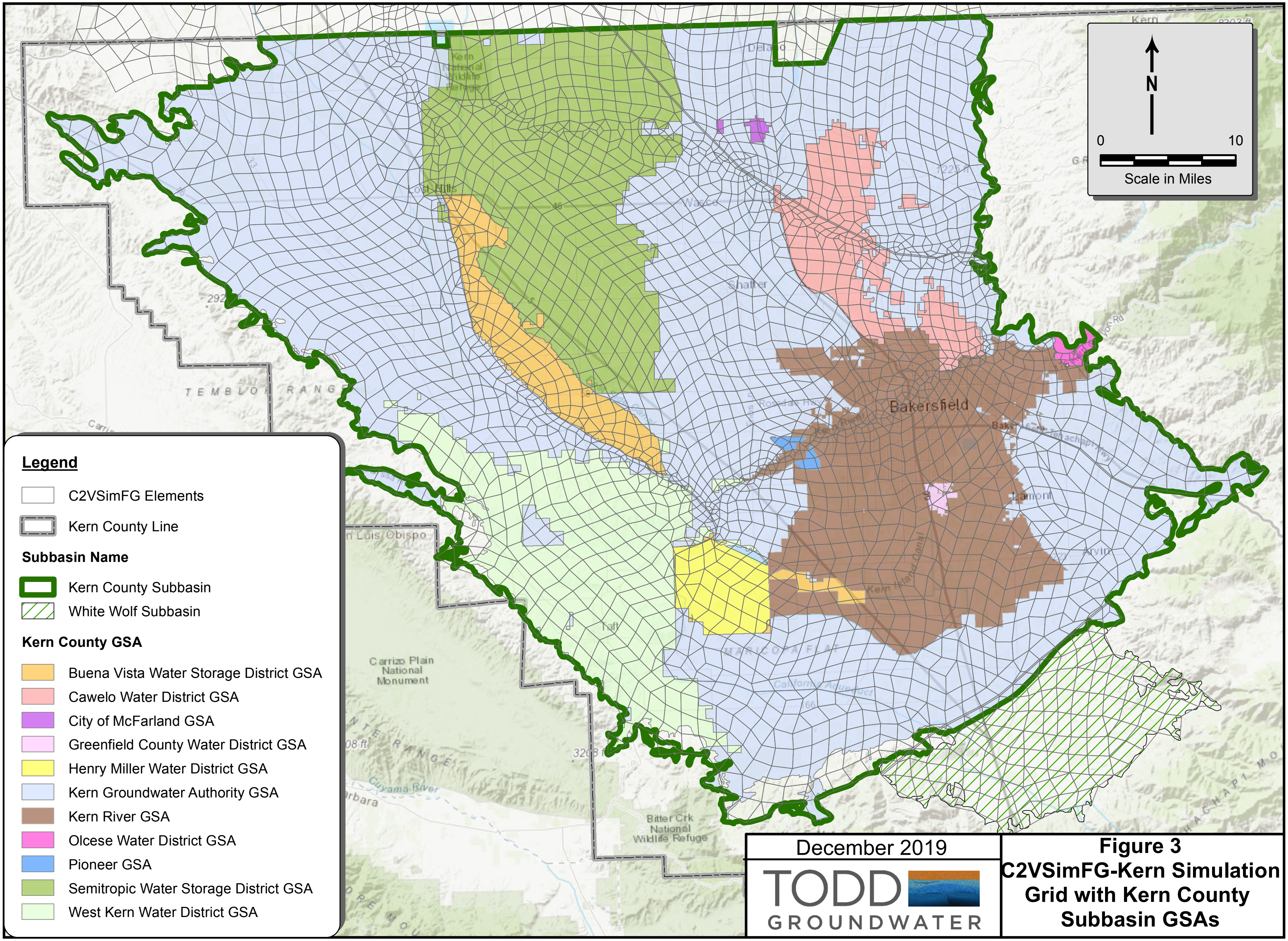


Figure 1
GSAs in Kern County Subbasin



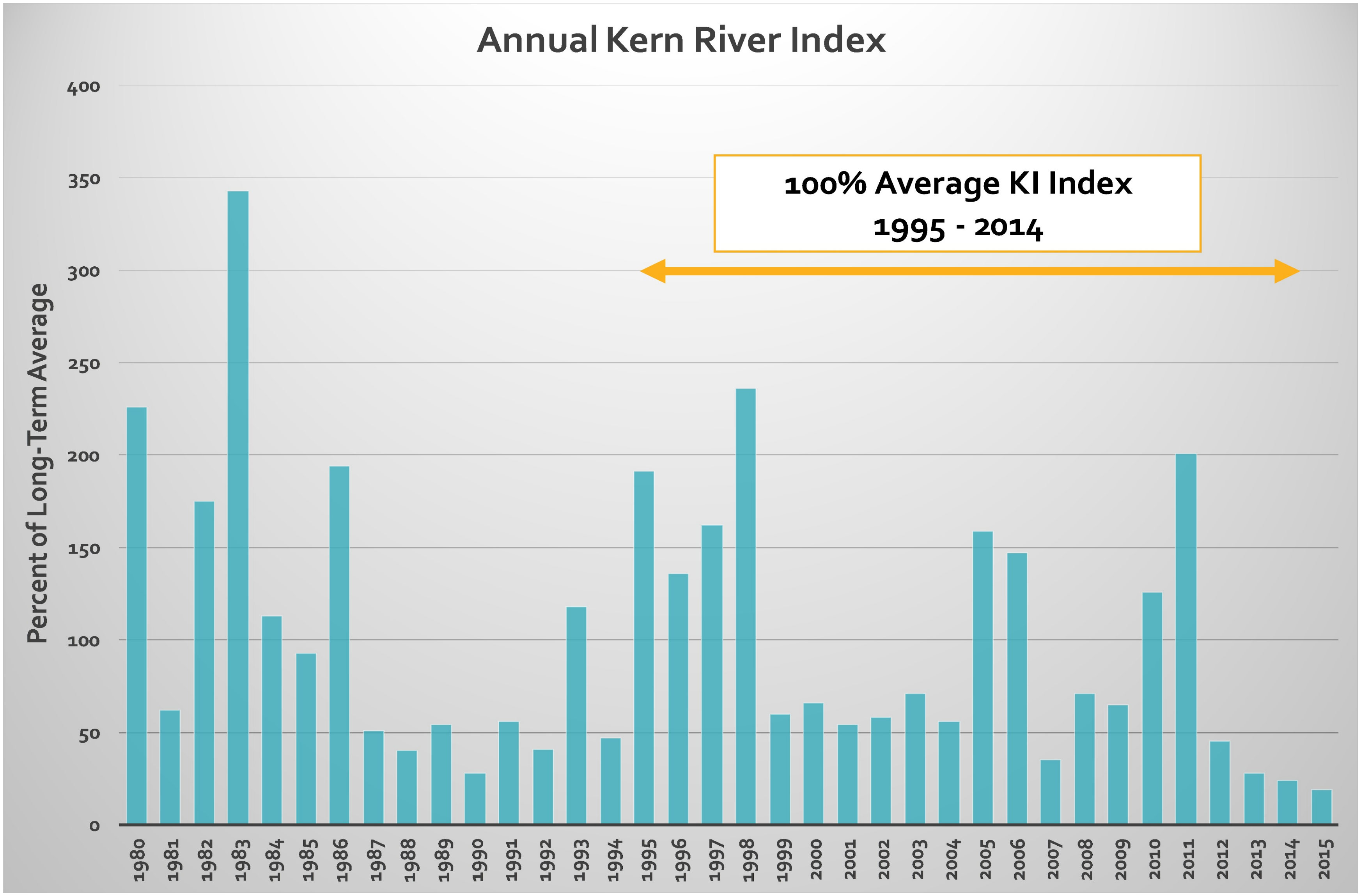
December 2019	Figure 2 C2VSimFG Simulation Grid for Central Valley Showing Kern County Subbasin
TODD GROUNDWATER	



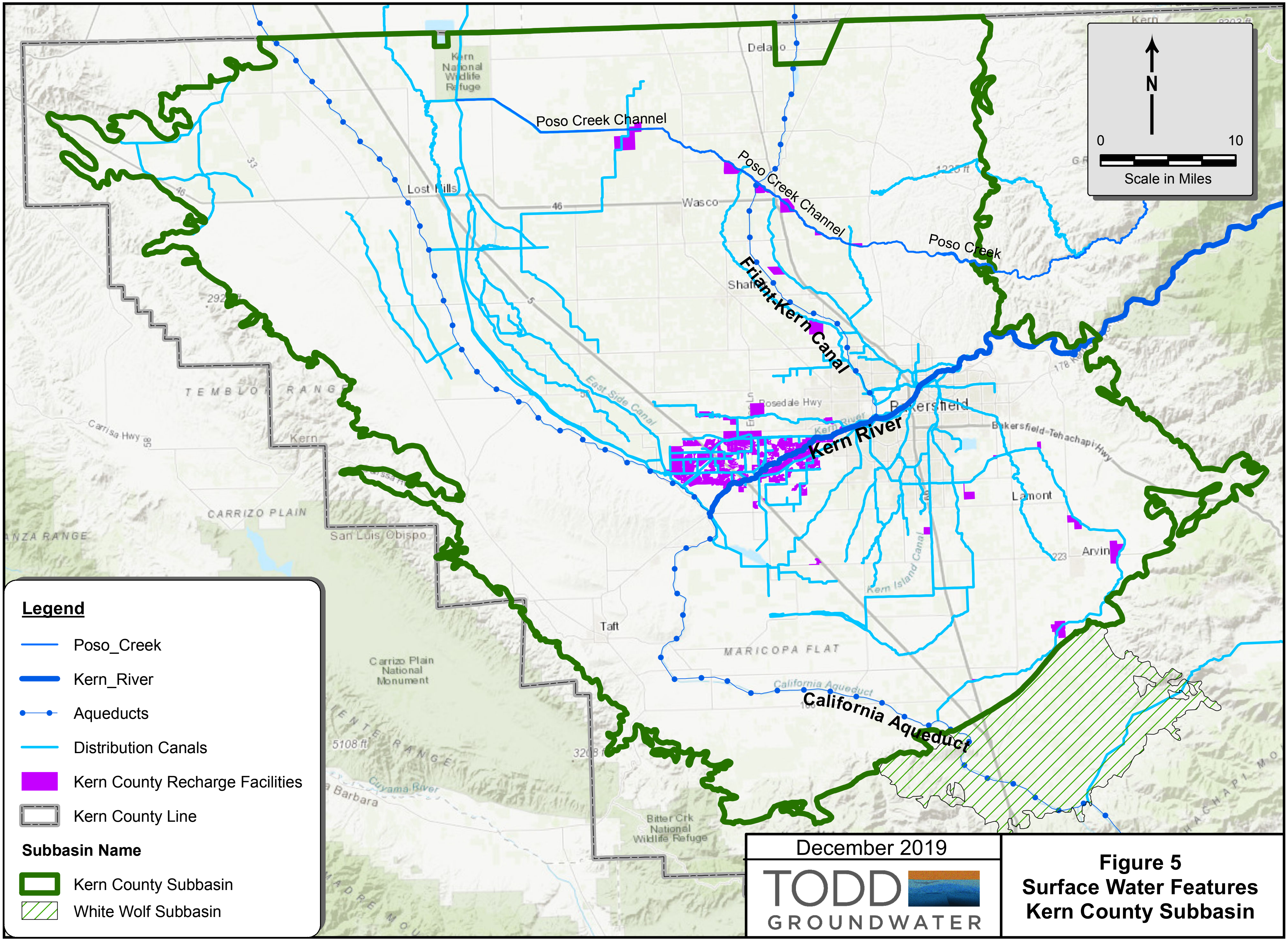
December 2019

TODD GROUNDWATER

Figure 3
C2VSimFG-Kern Simulation Grid with Kern County Subbasin GSAs



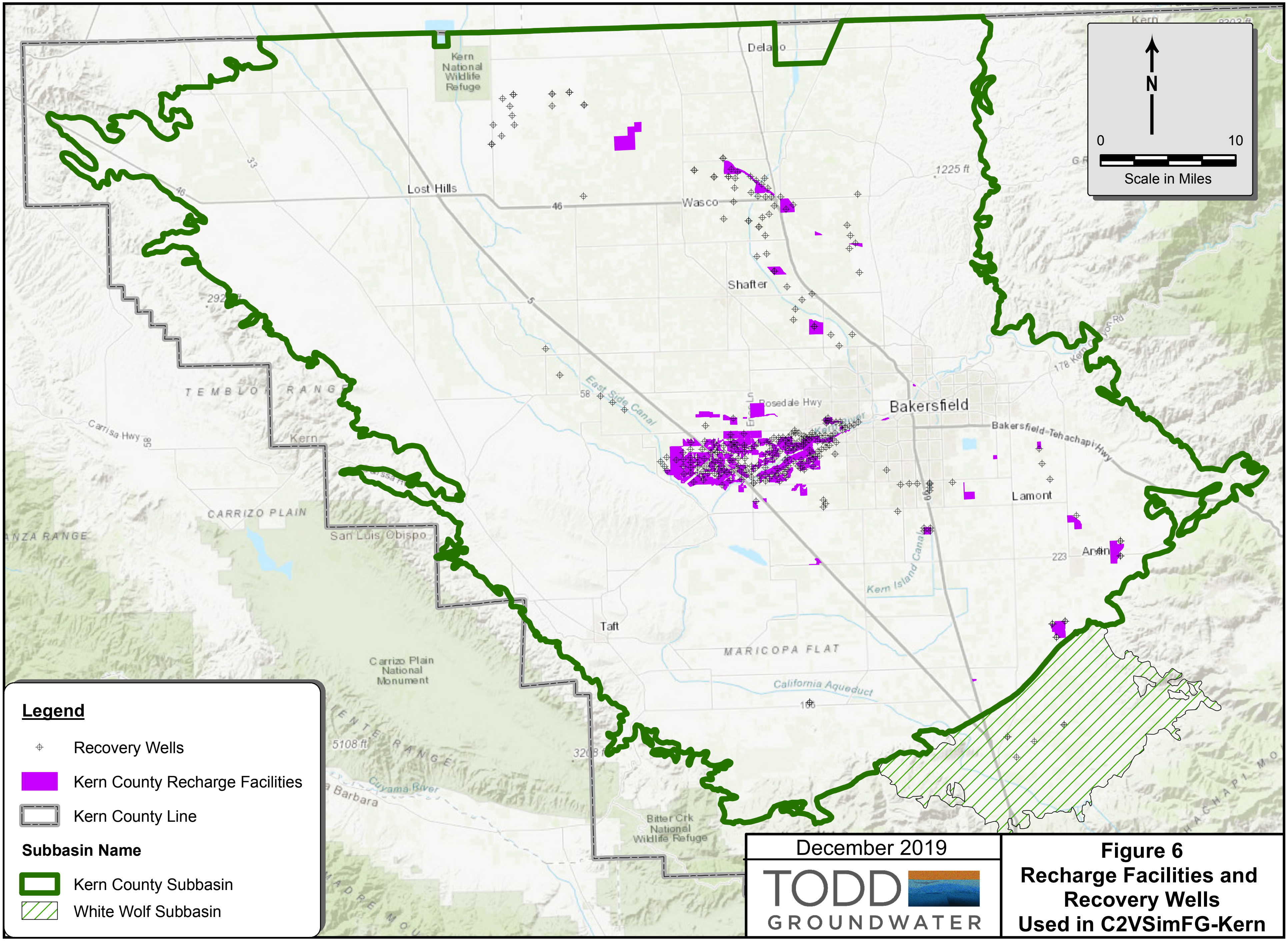
December 2019	Figure 4 Annual Kern River Index used to Define 20-Year Historical Study Period
TODD GROUNDWATER	



December 2019

TODD GROUNDWATER

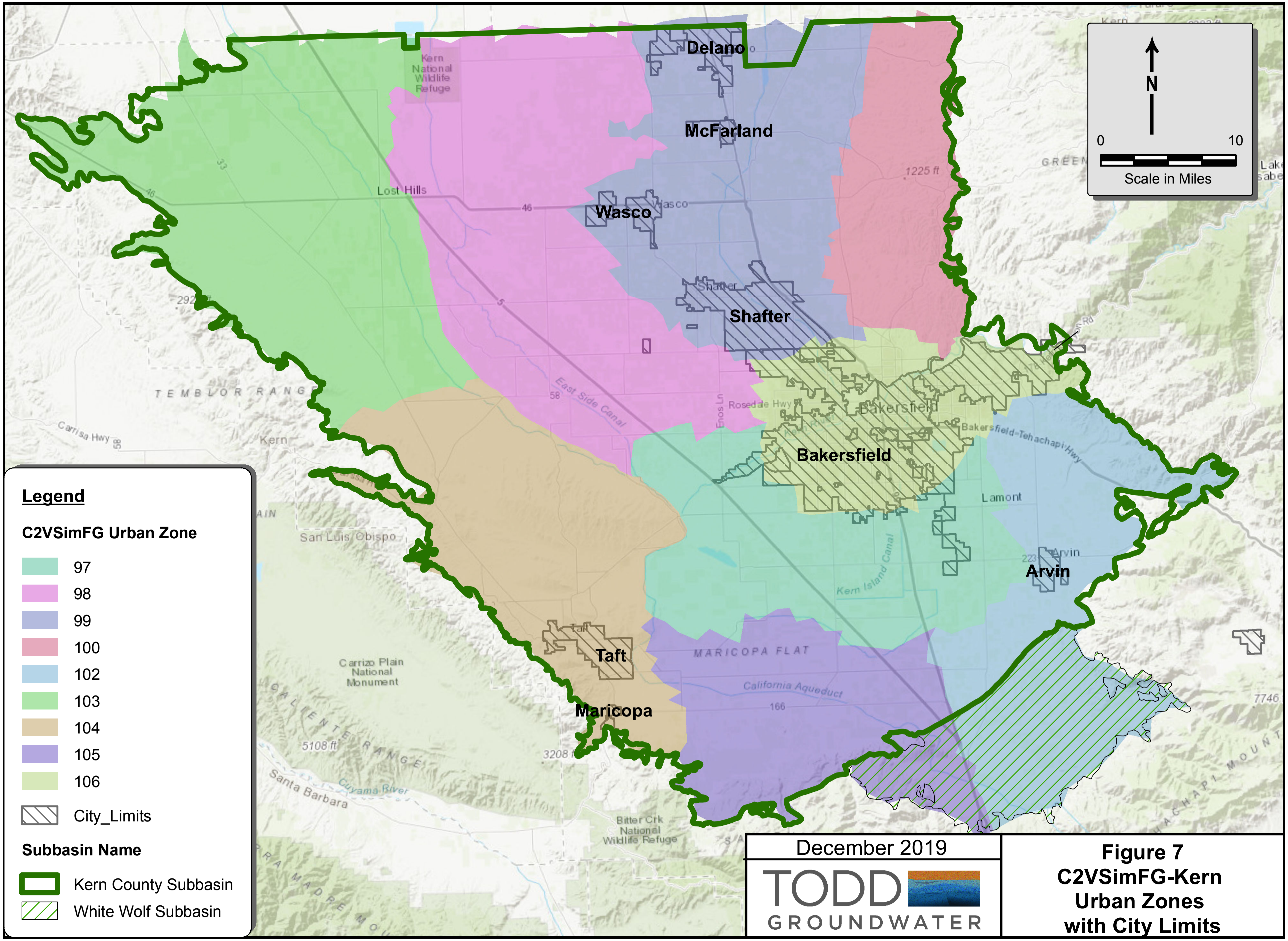
Figure 5
Surface Water Features
Kern County Subbasin



December 2019

TODD GROUNDWATER

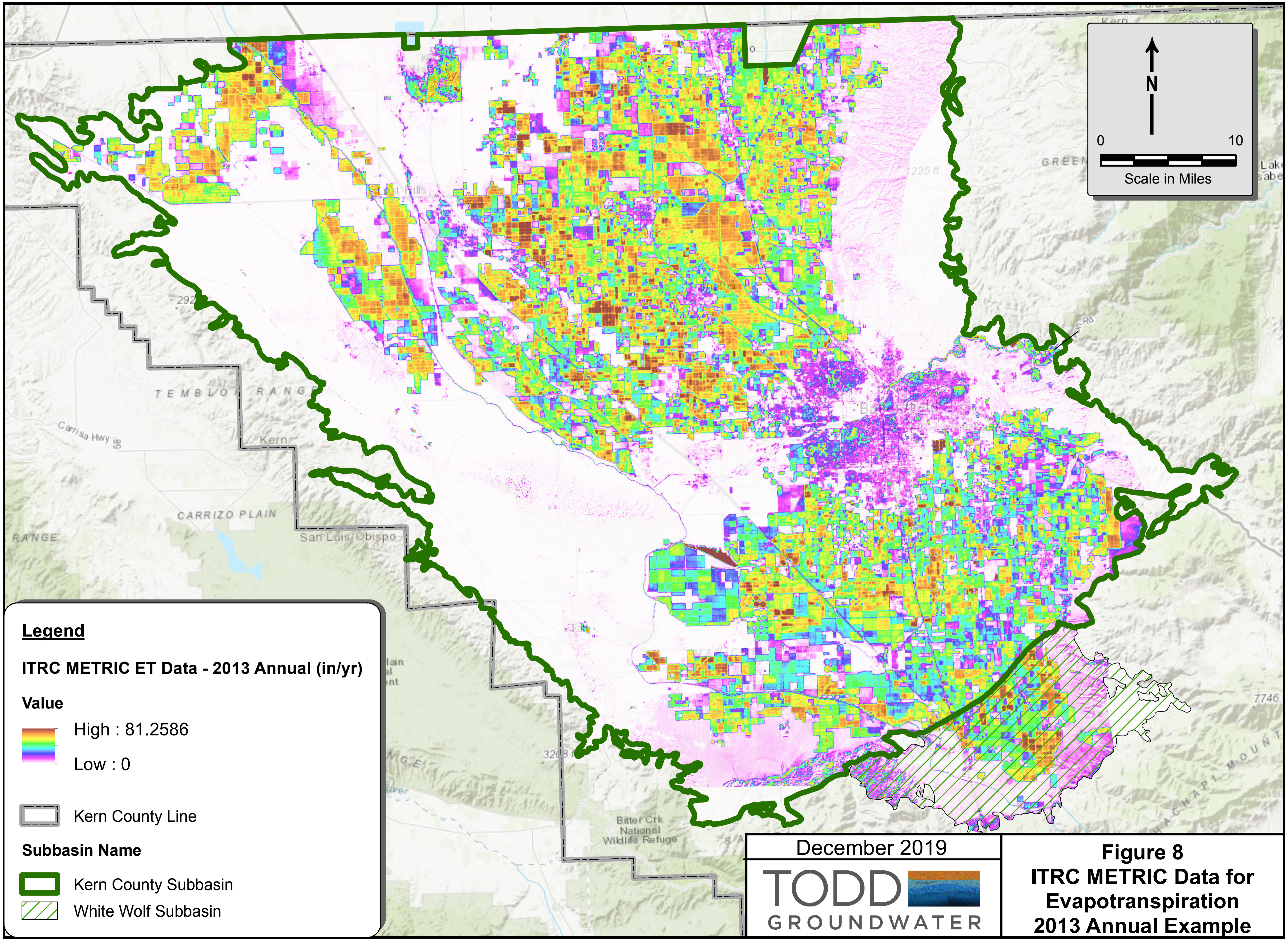
Figure 6
Recharge Facilities and Recovery Wells Used in C2VSimFG-Kern



December 2019

TODD GROUNDWATER

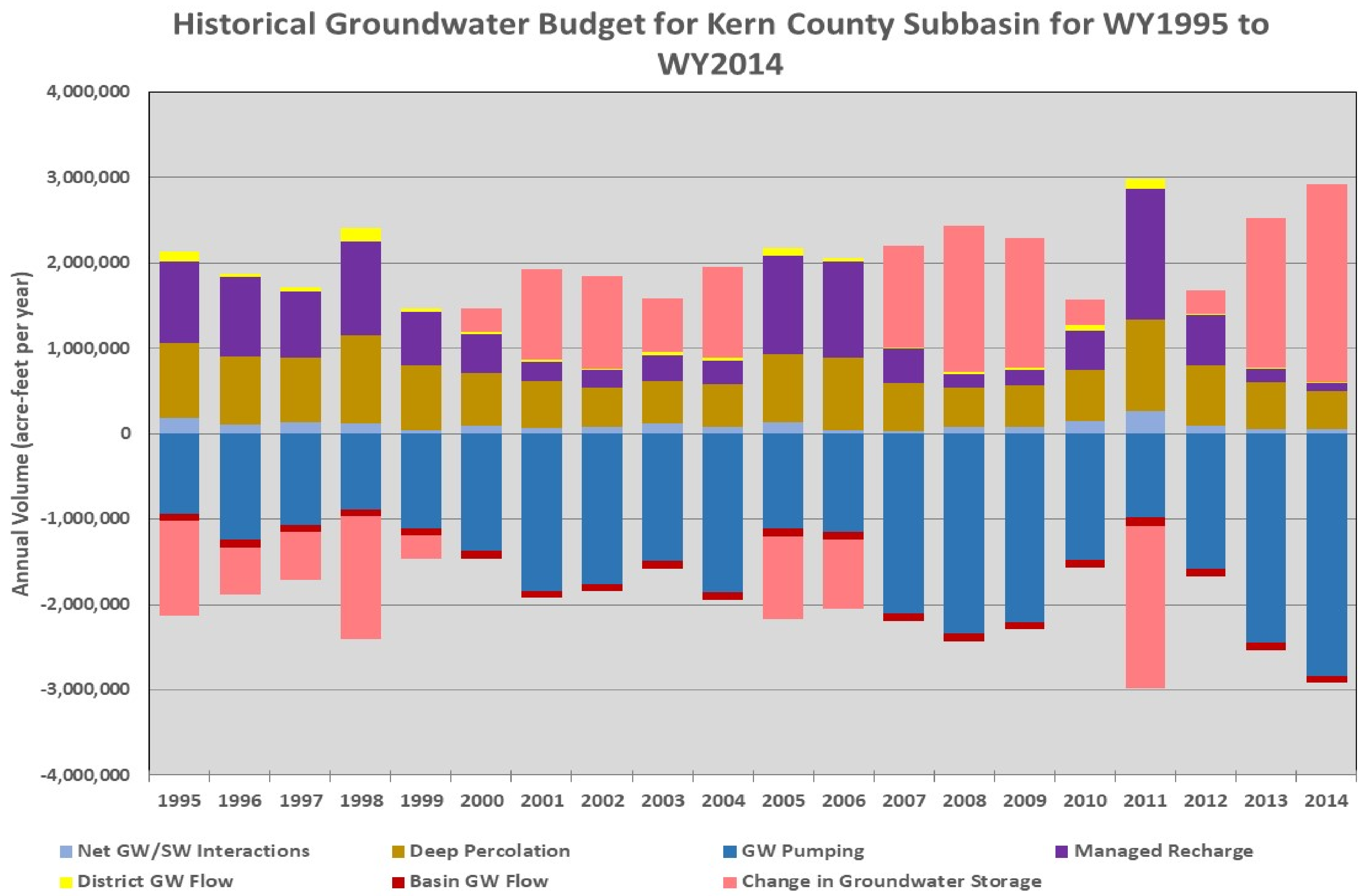
Figure 7
C2VSimFG-Kern Urban Zones with City Limits



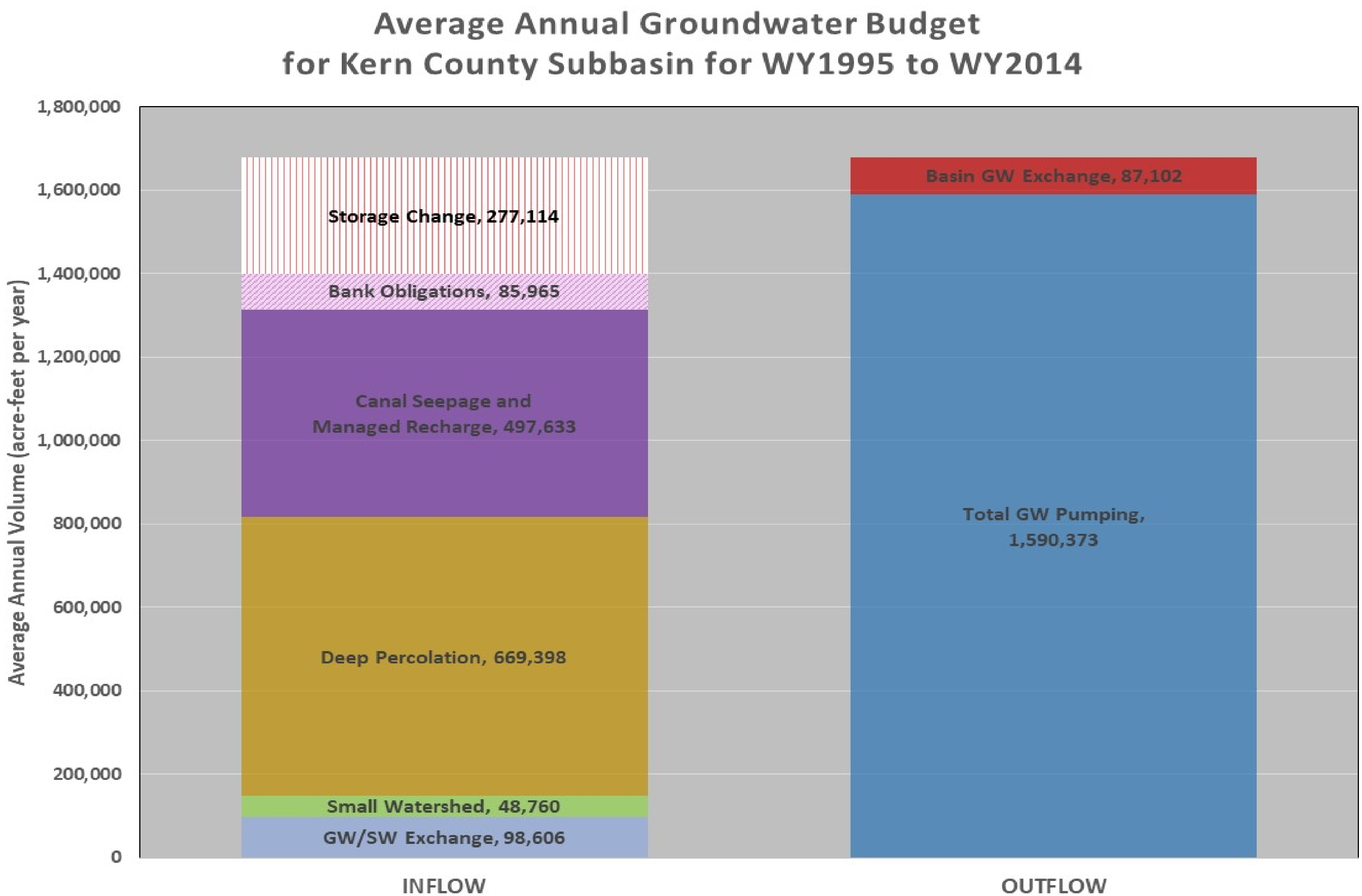
December 2019

TODD GROUNDWATER

Figure 8
ITRC METRIC Data for Evapotranspiration 2013 Annual Example



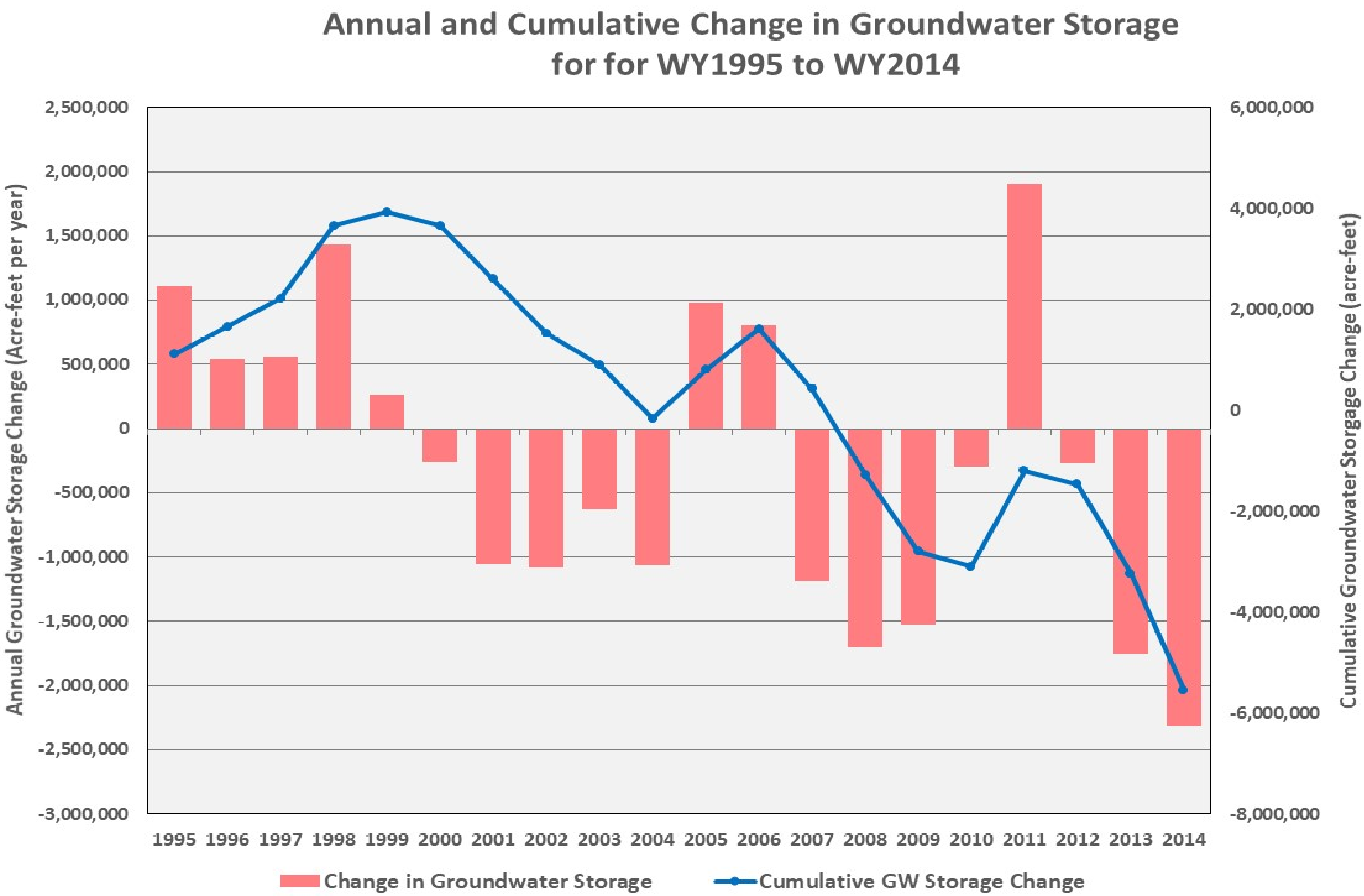
December 2019	Figure 9 C2VSimFG-Kern Historical Groundwater Budget for Kern County Subbasin
TODD GROUNDWATER	



December 2019

TODD GROUNDWATER

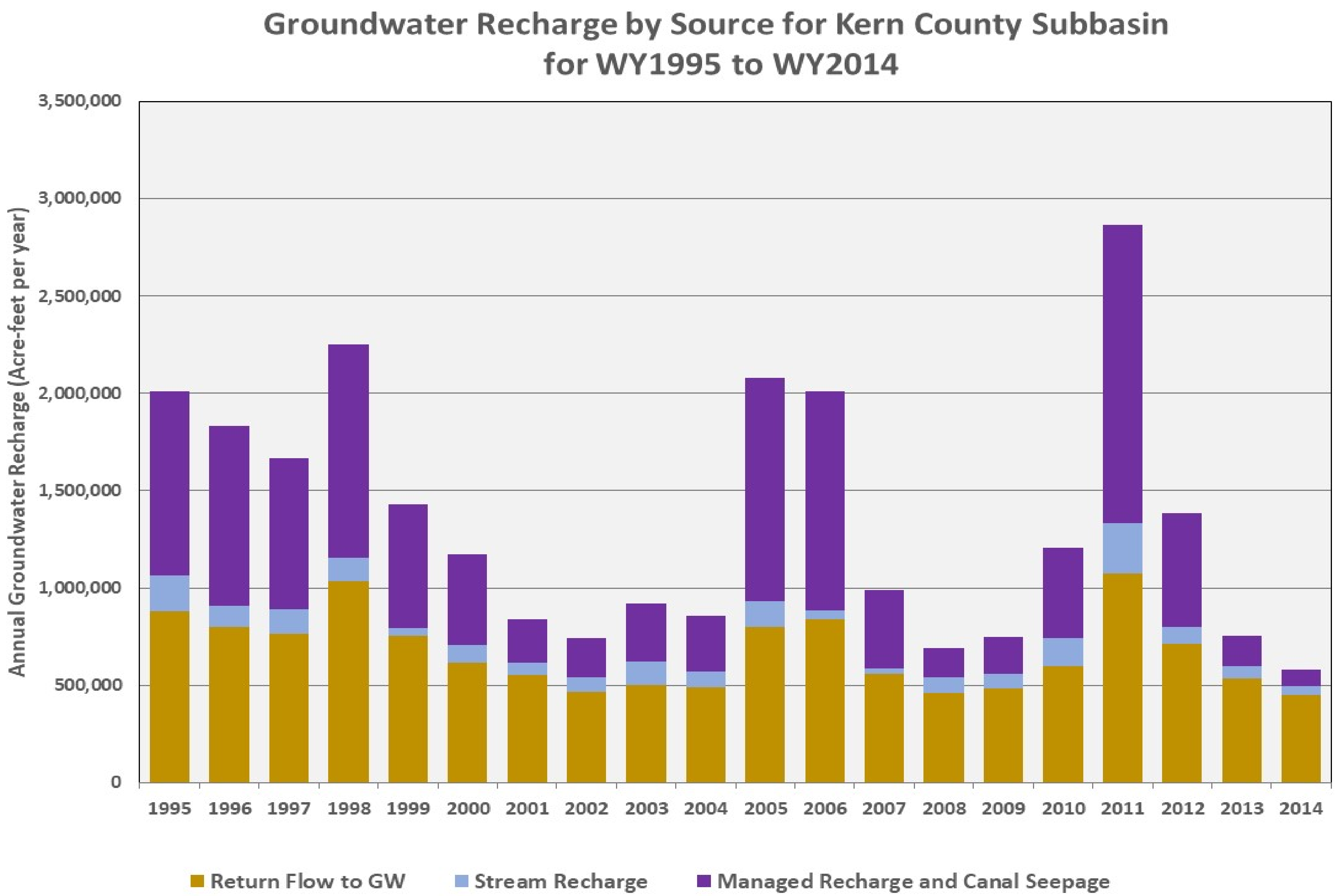
Figure 10
C2VSimFG-Kern Average
Annual Water Budget
for Kern County Subbasin



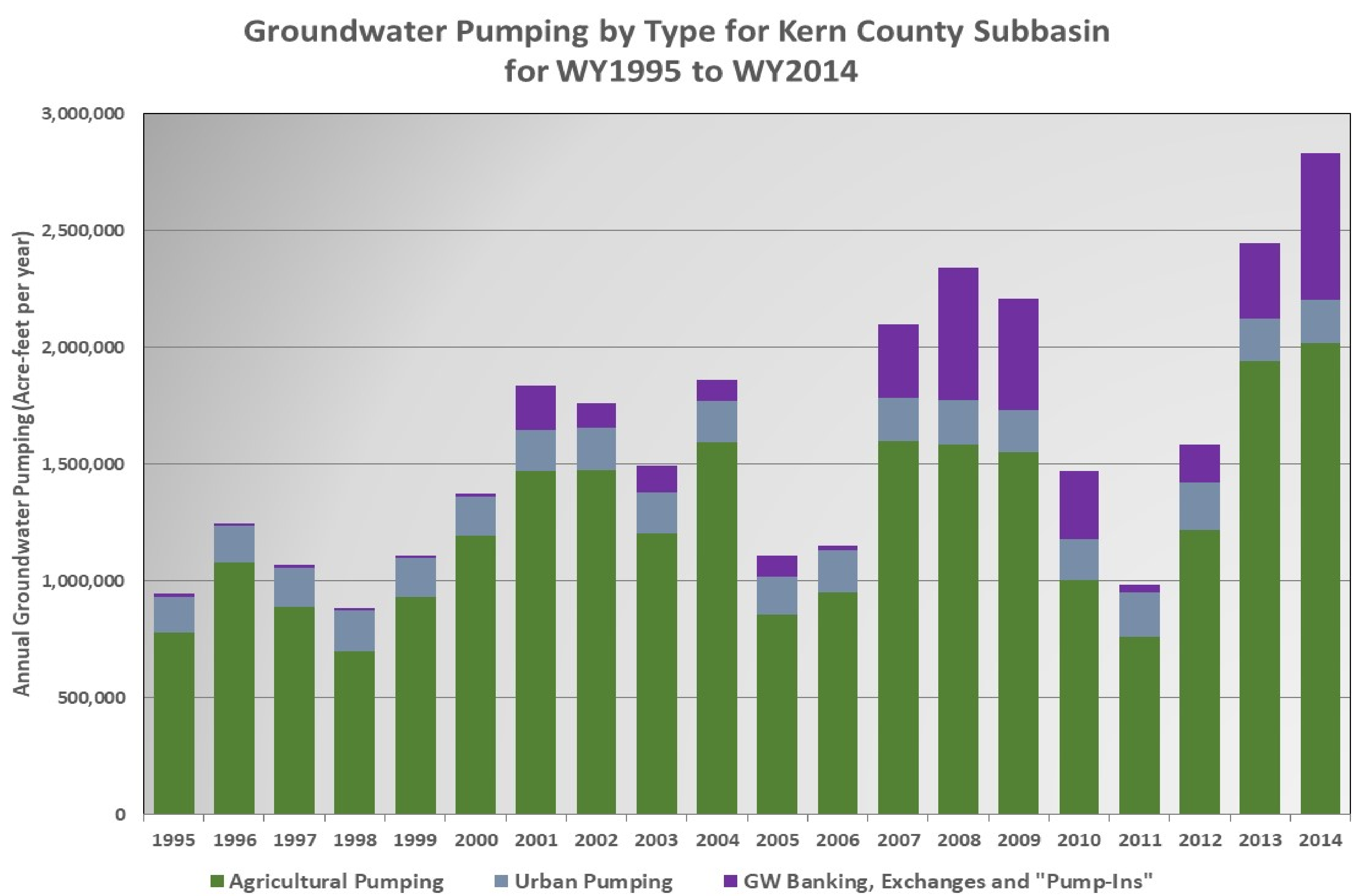
December 2019

TODD GROUNDWATER

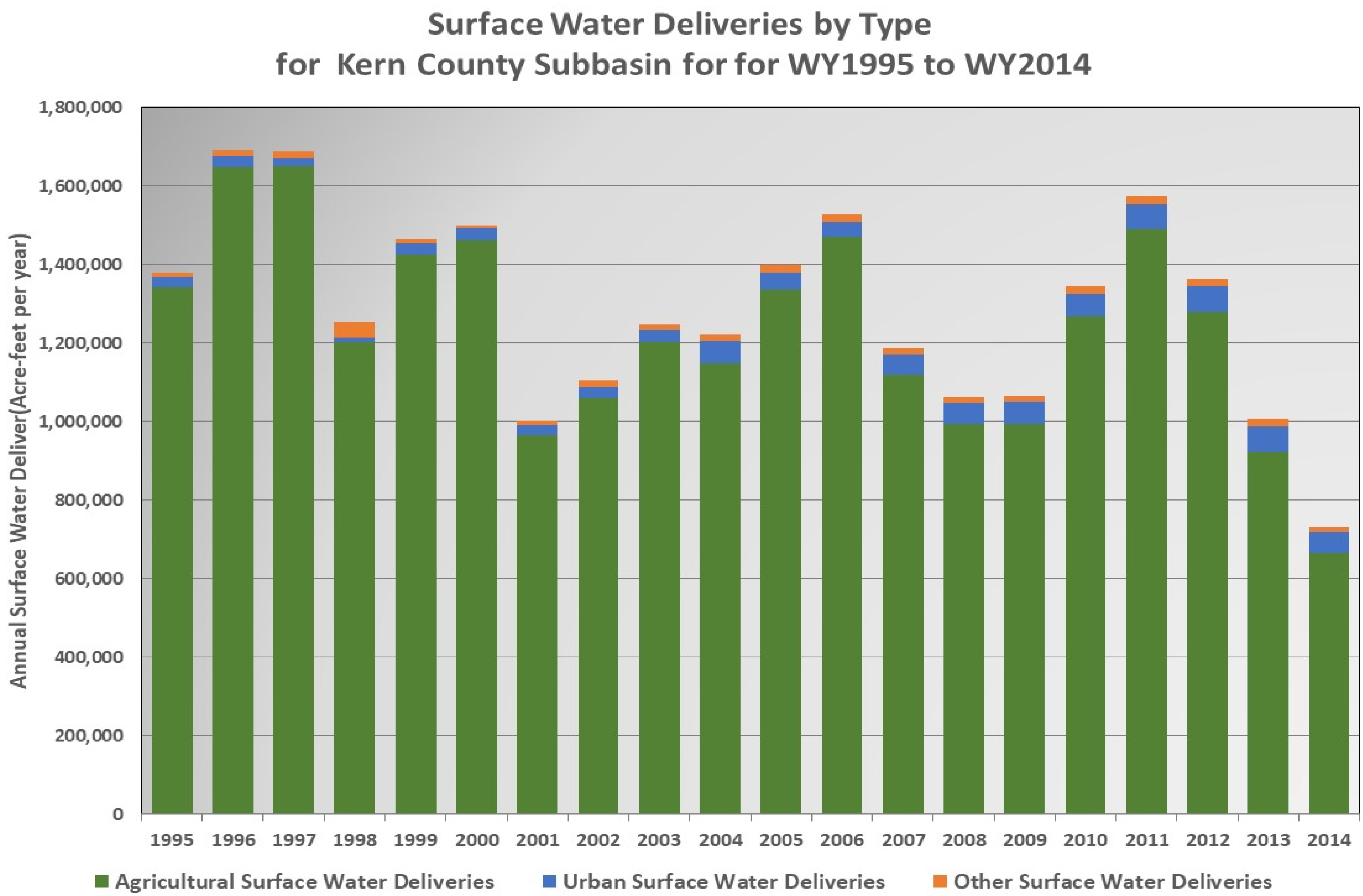
Figure 11
Simulated Historical Change in Groundwater Storage for Kern County Subbasin



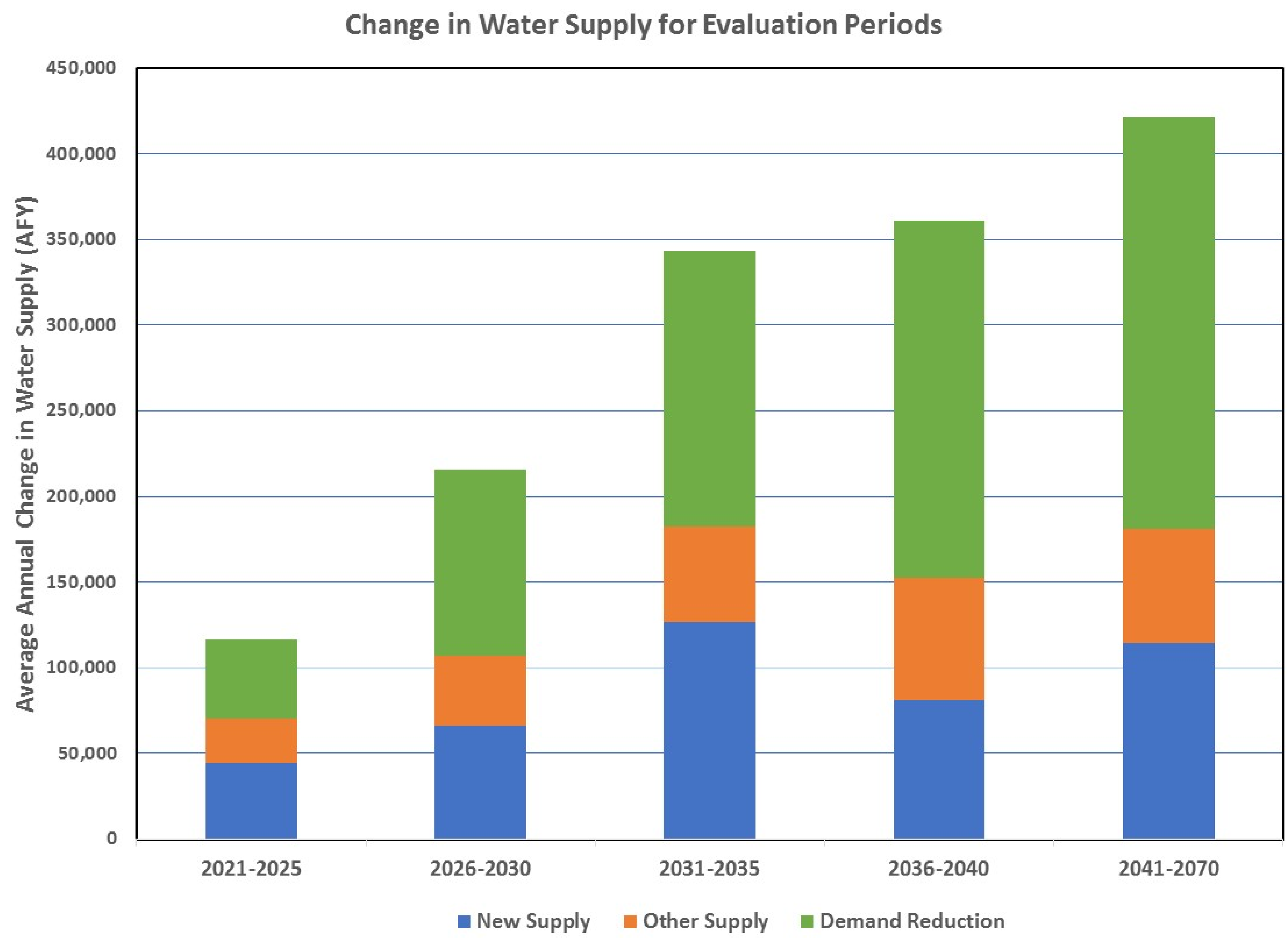
December 2019	Figure 12 Simulated Historical Recharge Operations for Kern County Subbasin
TODD GROUNDWATER	



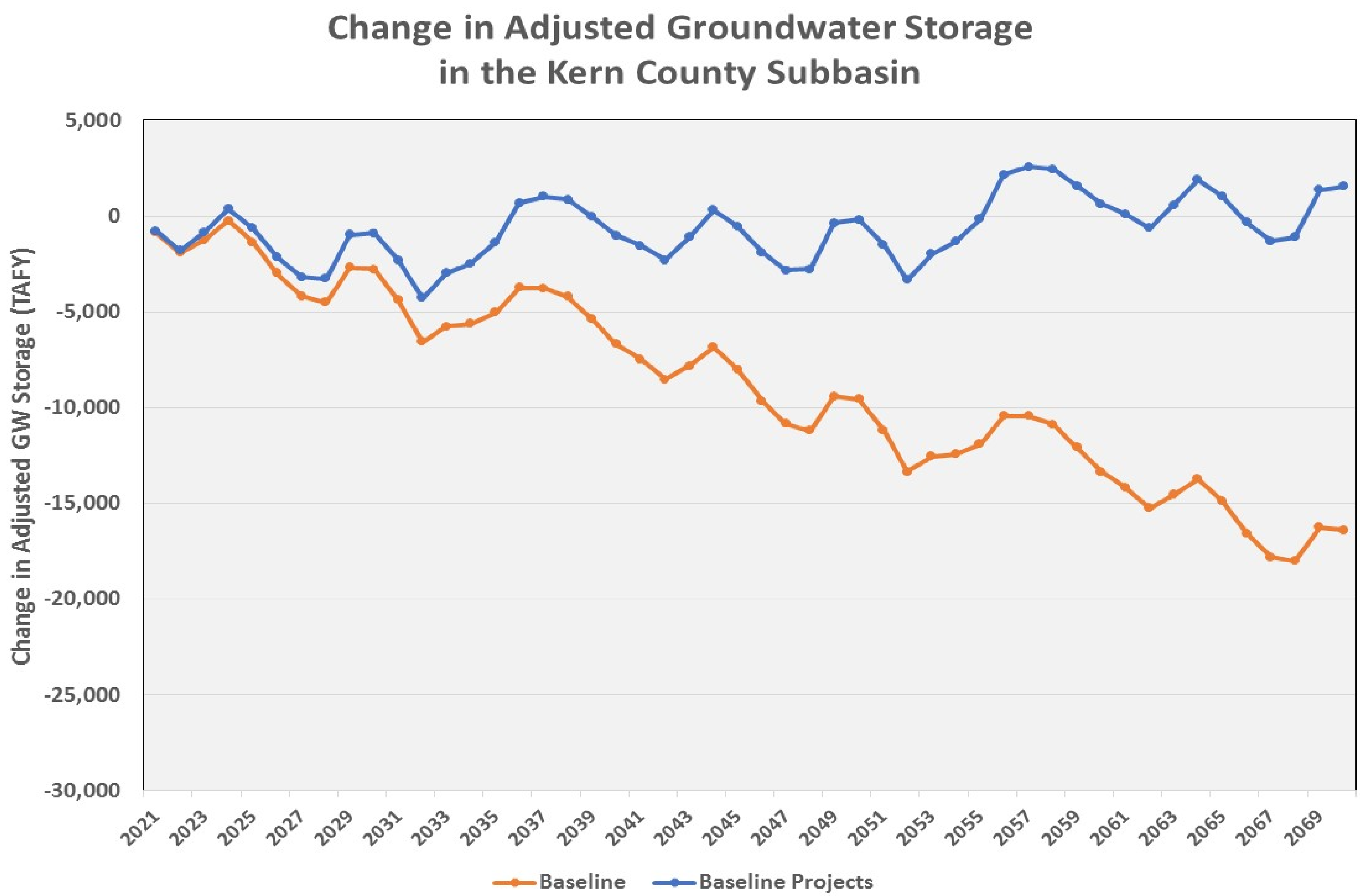
December 2019	Figure 13 Simulated Historical Groundwater Pumping for Kern County Subbasin
TODD GROUNDWATER	



December 2019	Figure 14 Simulated Historical Surface Water Deliveries for Kern County Subbasin
TODD GROUNDWATER	



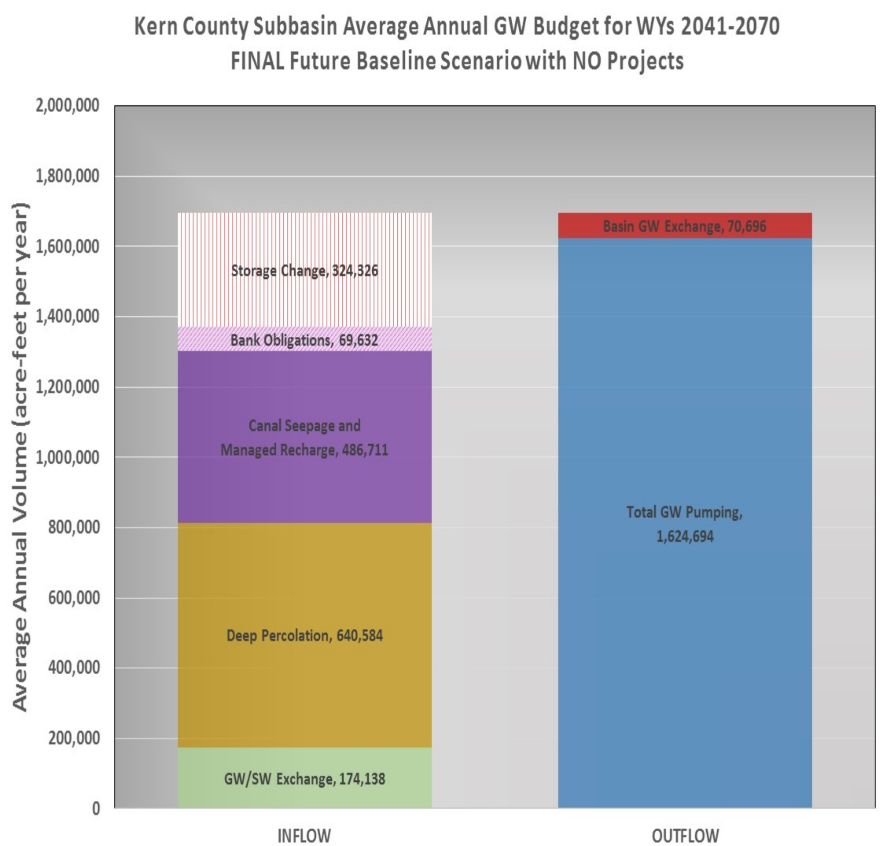
December 2019	Figure 15 Average Annual Benefit of Proposed SGMA Projects and Management Actions
TODD GROUNDWATER	

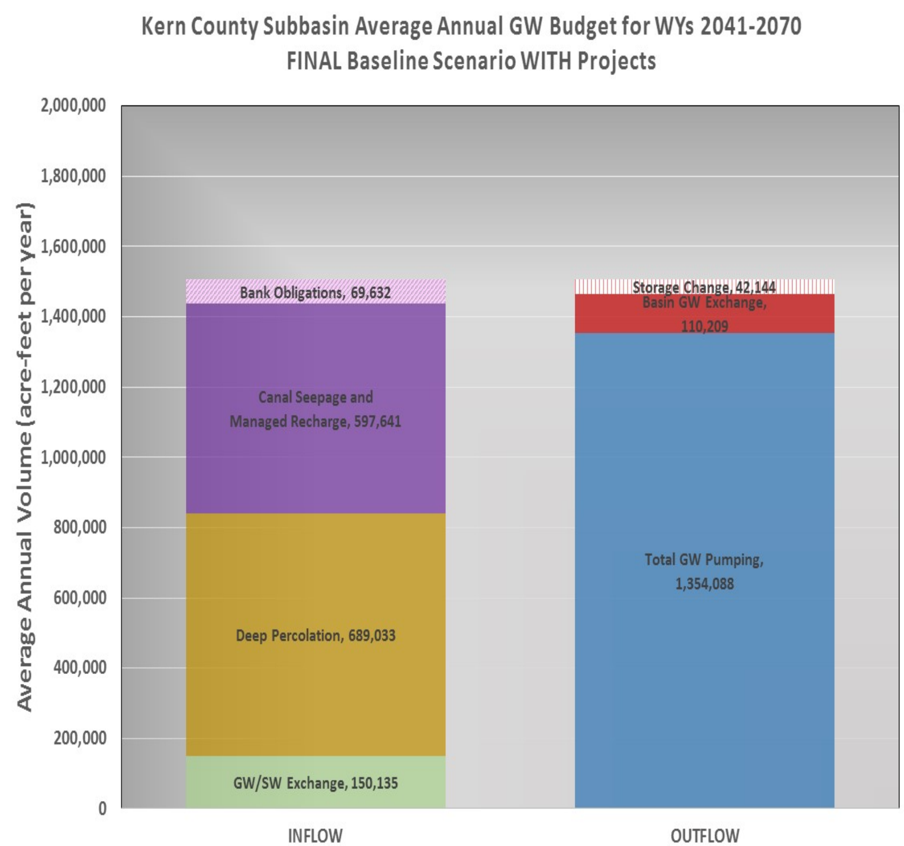


December 2019

TODD GROUNDWATER

Figure 16
Projected Future Change in Groundwater Storage for Baseline Conditions

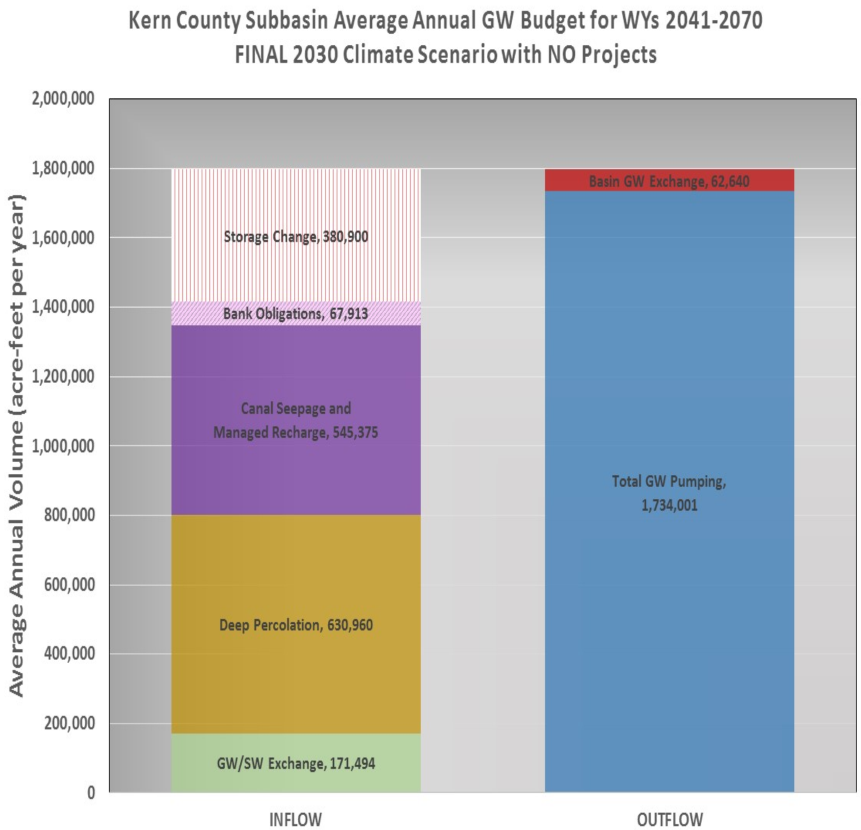


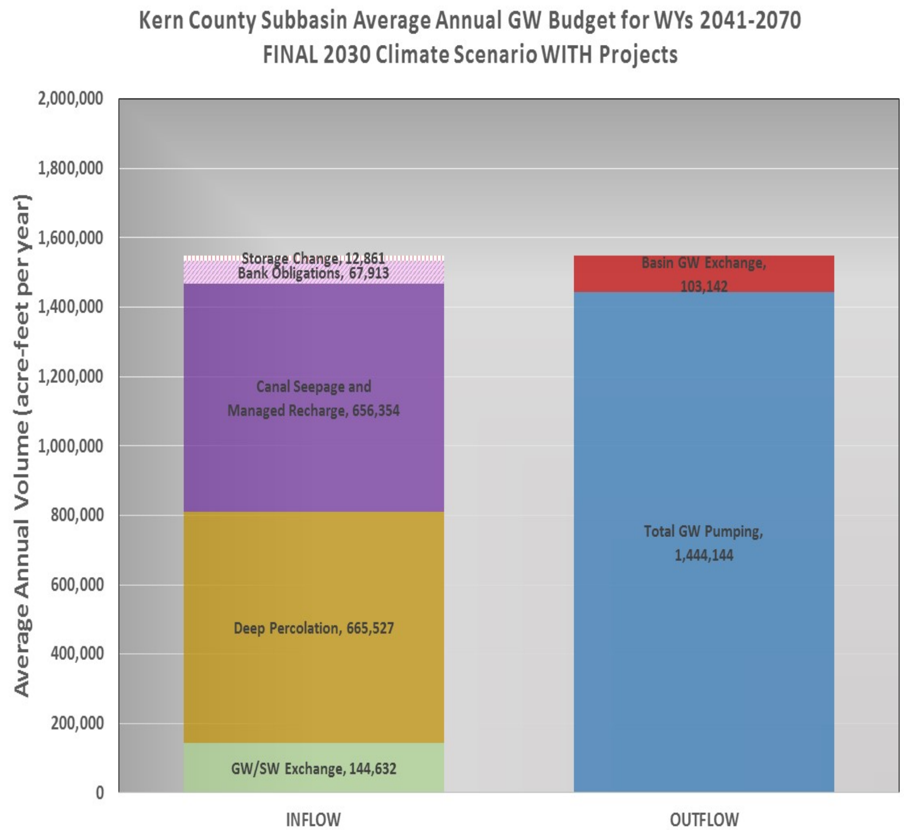


December 2019

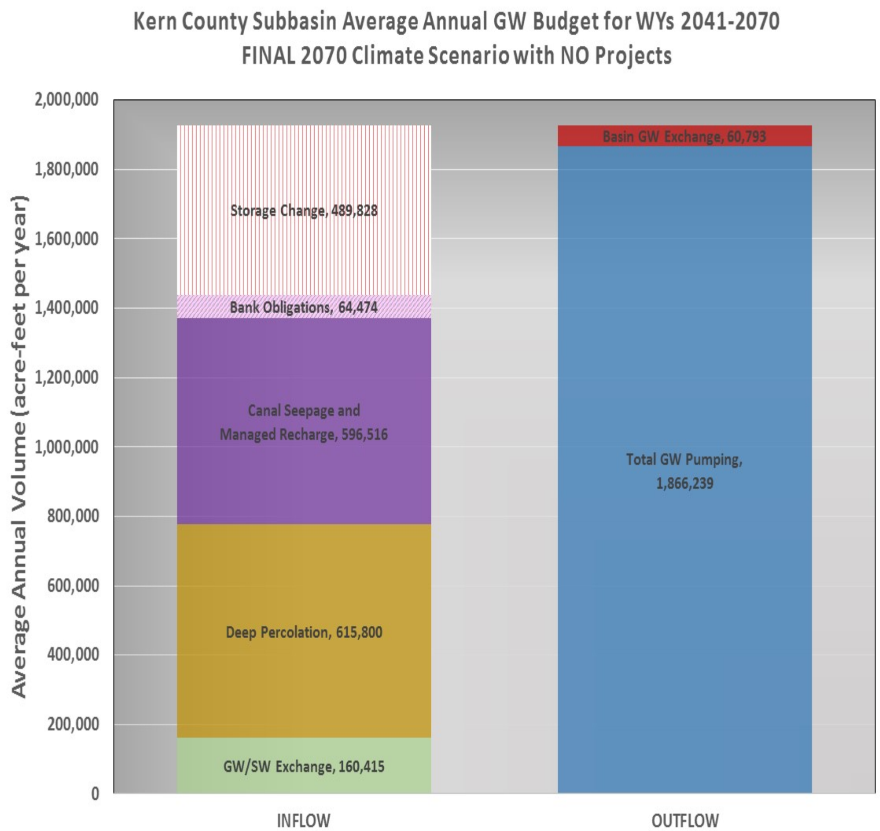
TODD GROUNDWATER

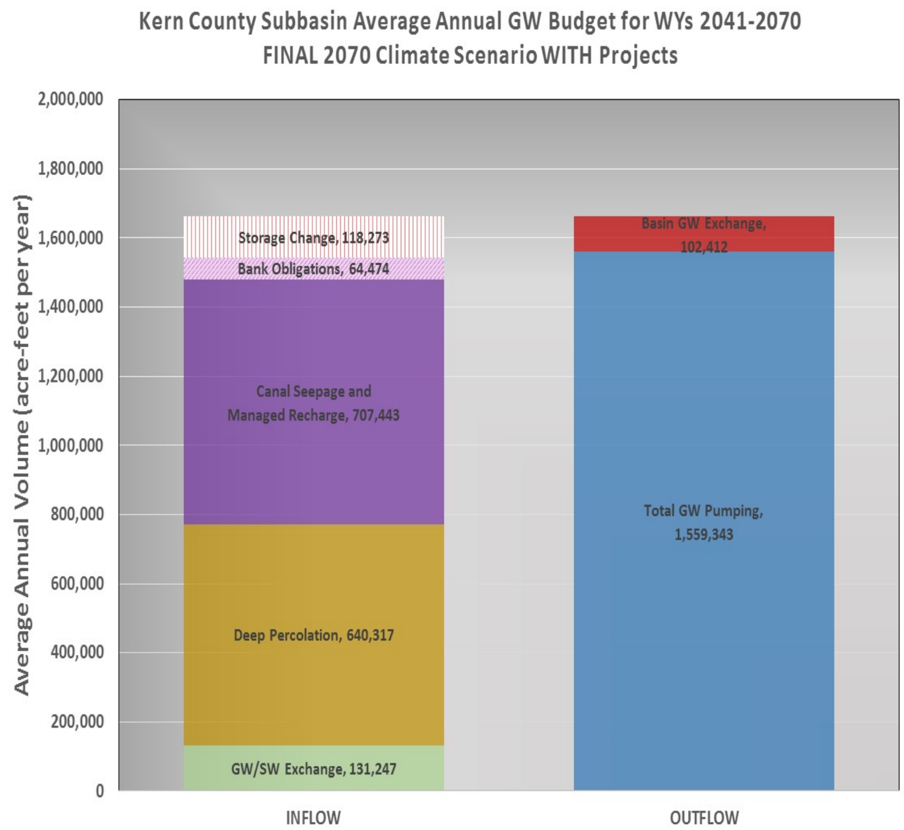
Figure 17
Baseline Projected Future Average Annual Groundwater Budget for WY2041-2070



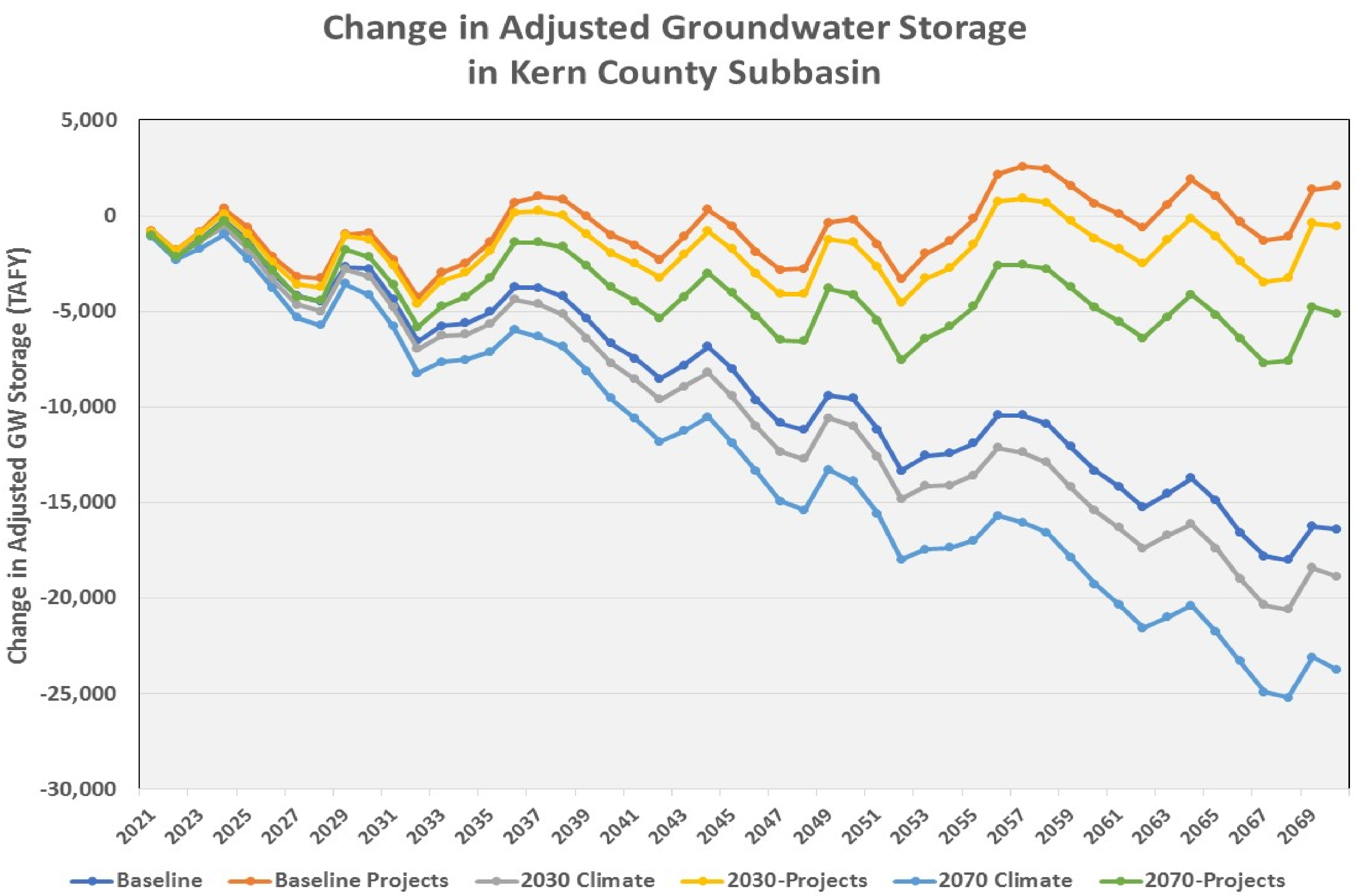


December 2019	Figure 18
TODD GROUNDWATER	2030 Climate Projected Future Average Annual Groundwater Budget for WY2041-2070

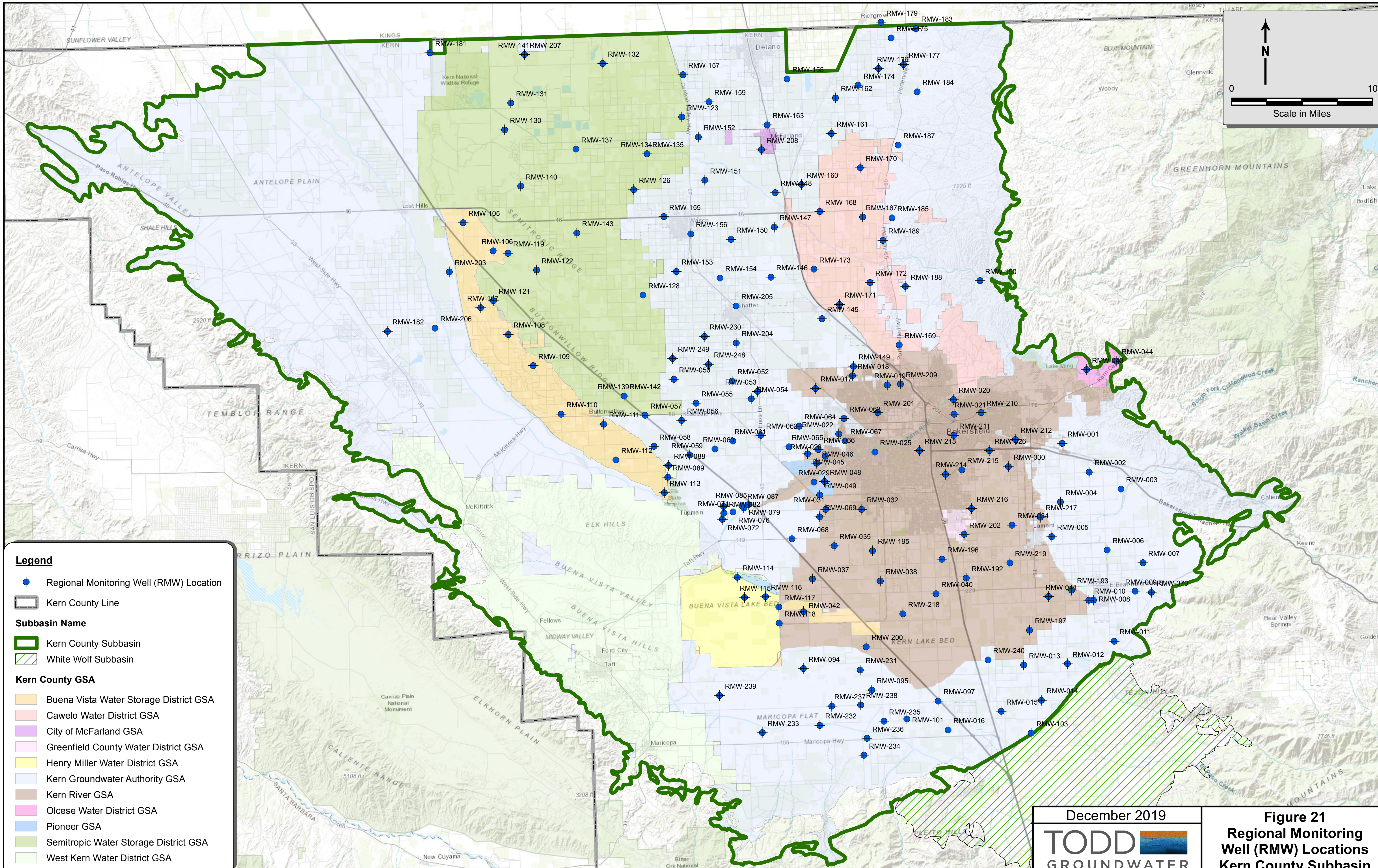




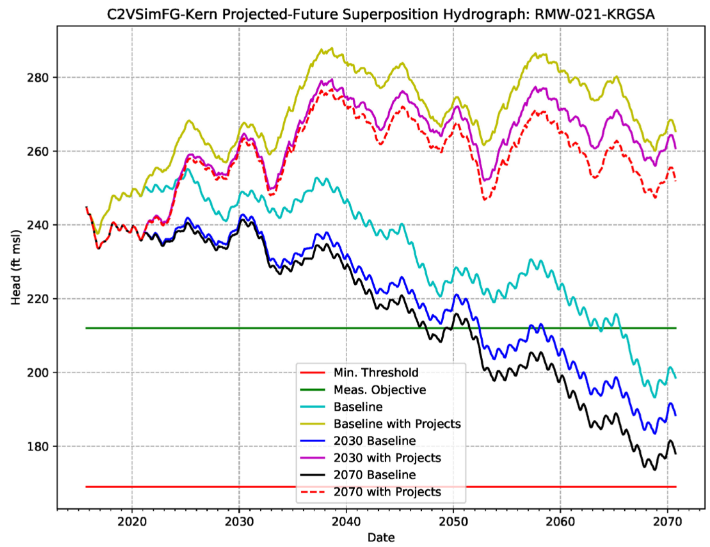
December 2019	Figure 19
TODD GROUNDWATER	2070 Climate Projected Future Average Annual Groundwater Budget for WY2041-2070

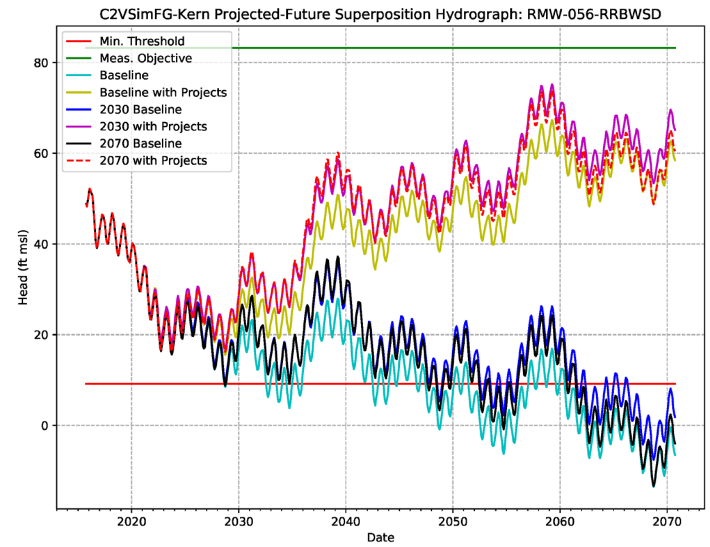


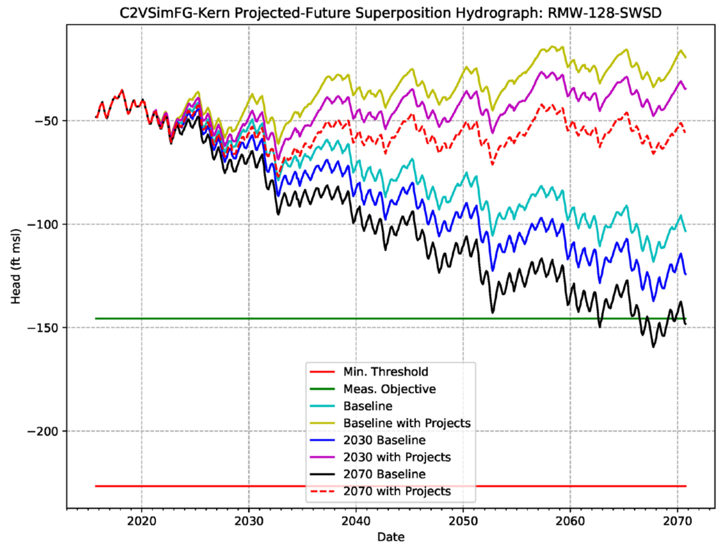
December 2019	Figure 20 Projected Future Change in Groundwater Storage for All Conditions
TODD GROUNDWATER	

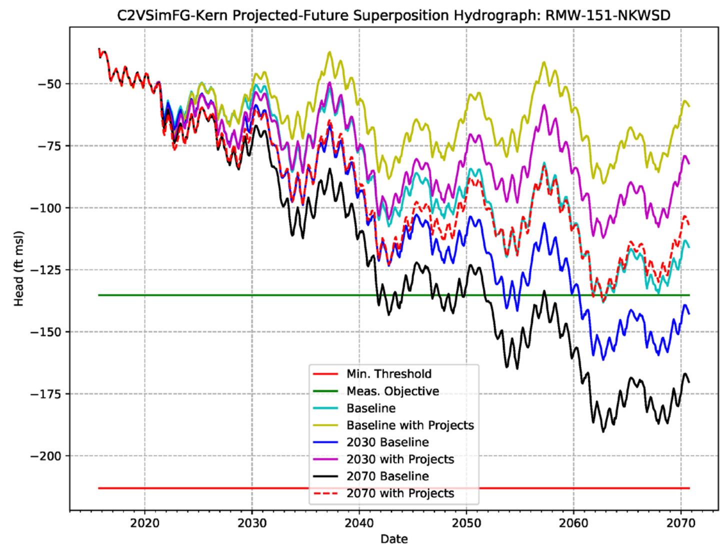


Legend
Regional Monitoring Well (RMW) Location
Kern County Line
Subbasin Name
Kern County Subbasin
White Wolf Subbasin
Kern County GSA
Buena Vista Water Storage District GSA
Cawelo Water District GSA
City of McFarland GSA
Greenfield County Water District GSA
Henry Miller Water District GSA
Kern Groundwater Authority GSA
Kern River GSA
Olcese Water District GSA
Pioneer GSA
Semitropic Water Storage District GSA
West Kern Water District GSA
N
0
10
Scale in Miles
December 2019
TODD
GROUNDWATER
Figure 21
Regional Monitoring Well (RMW) Locations
Kern County Subbasin

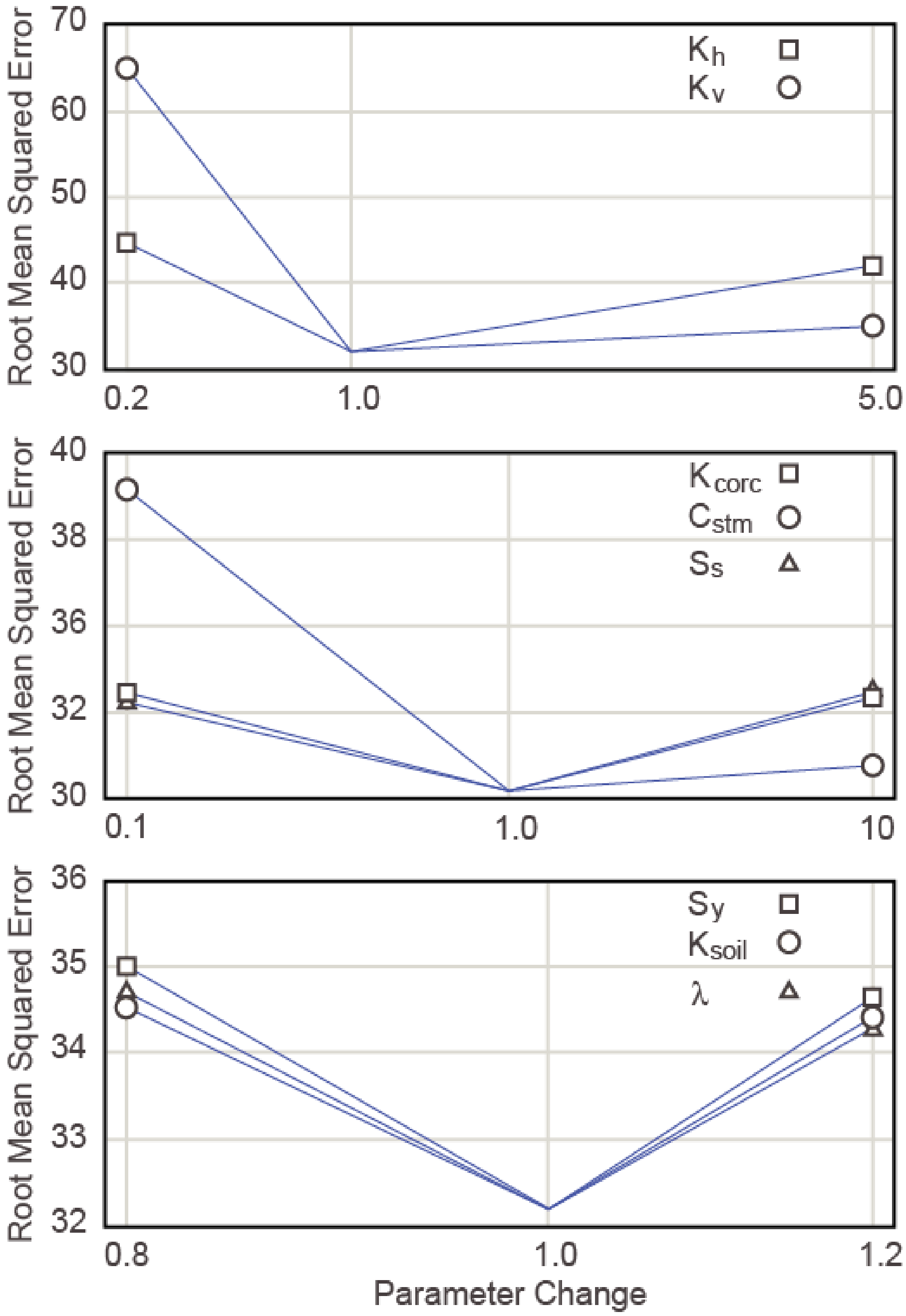








December 2019	Figure 22 Hydrographs for all Projected Future Conditions with SGMA Sustainability Criteria
TODD GROUNDWATER	



Notes:
Sensitivity parameters modified and evaluated for Kern County Subbasin
Kh – horizontal hydraulic conductivity of aquifer
Kv – vertical hydraulic conductivity of aquifer

Kcorc - horizontal hydraulic conductivity of Corcoran Clay aquitard or equivalent
Cstm – streambed conductance of Kern River and Poso Creek
Ss – specific storage of aquifer

Sy – specific yield of aquifer
Ksoil –soil hydraulic conductivity in root zone
Λ –soil pore size distribution index in root zone

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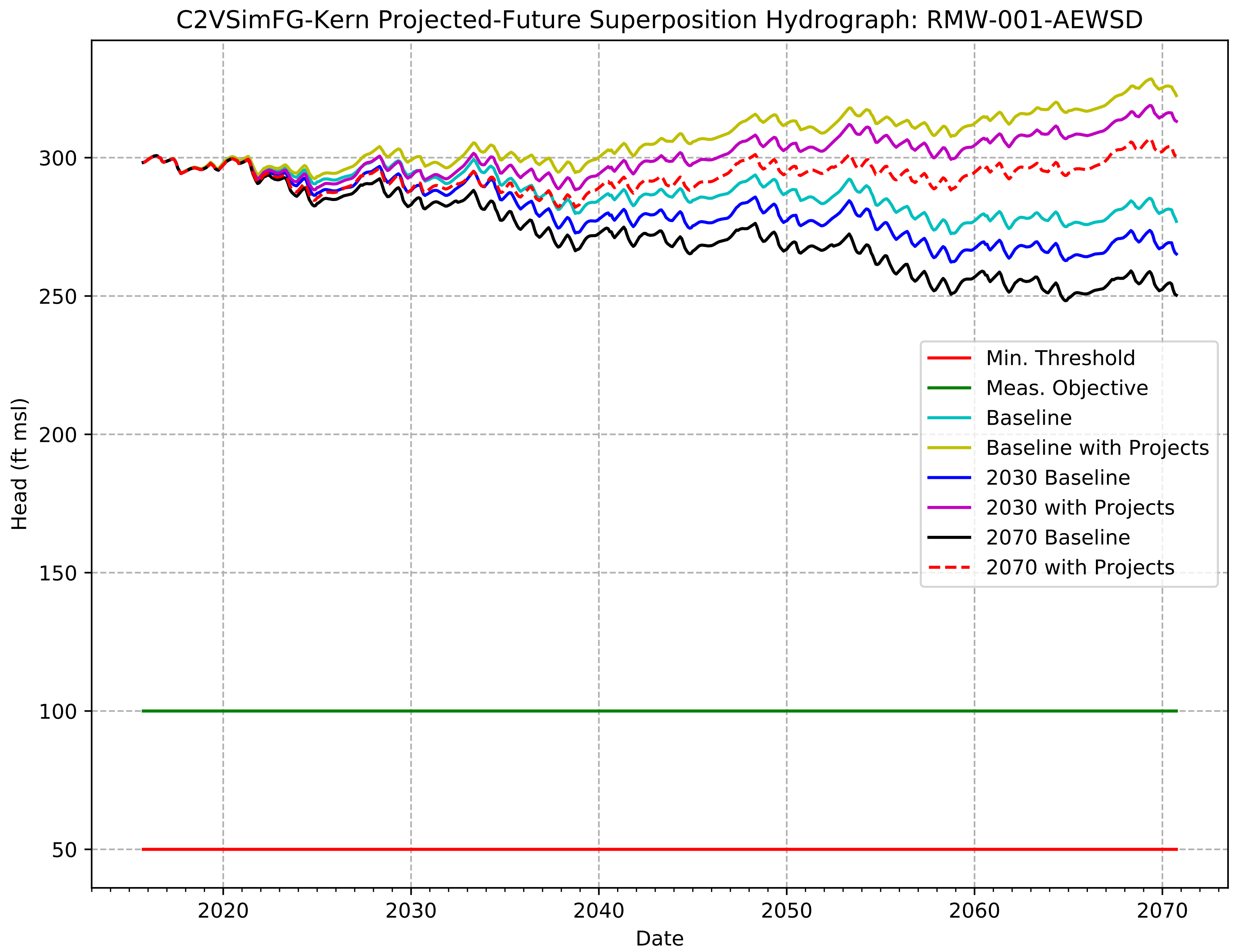
TODD GROUNDWATER

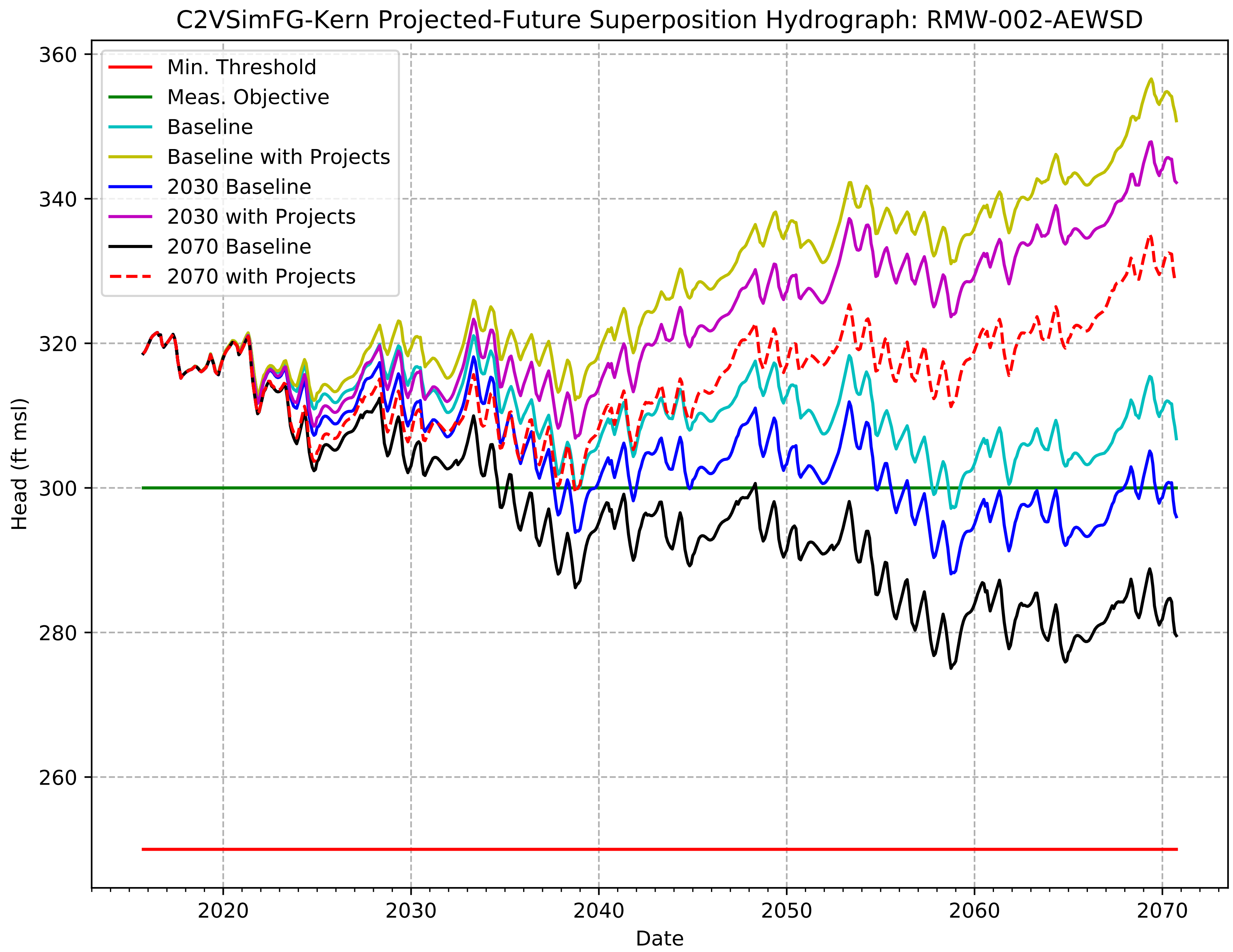
Figure 23
C2VSimFG-Kern Sensitivity Analysis Results

ATTACHMENT

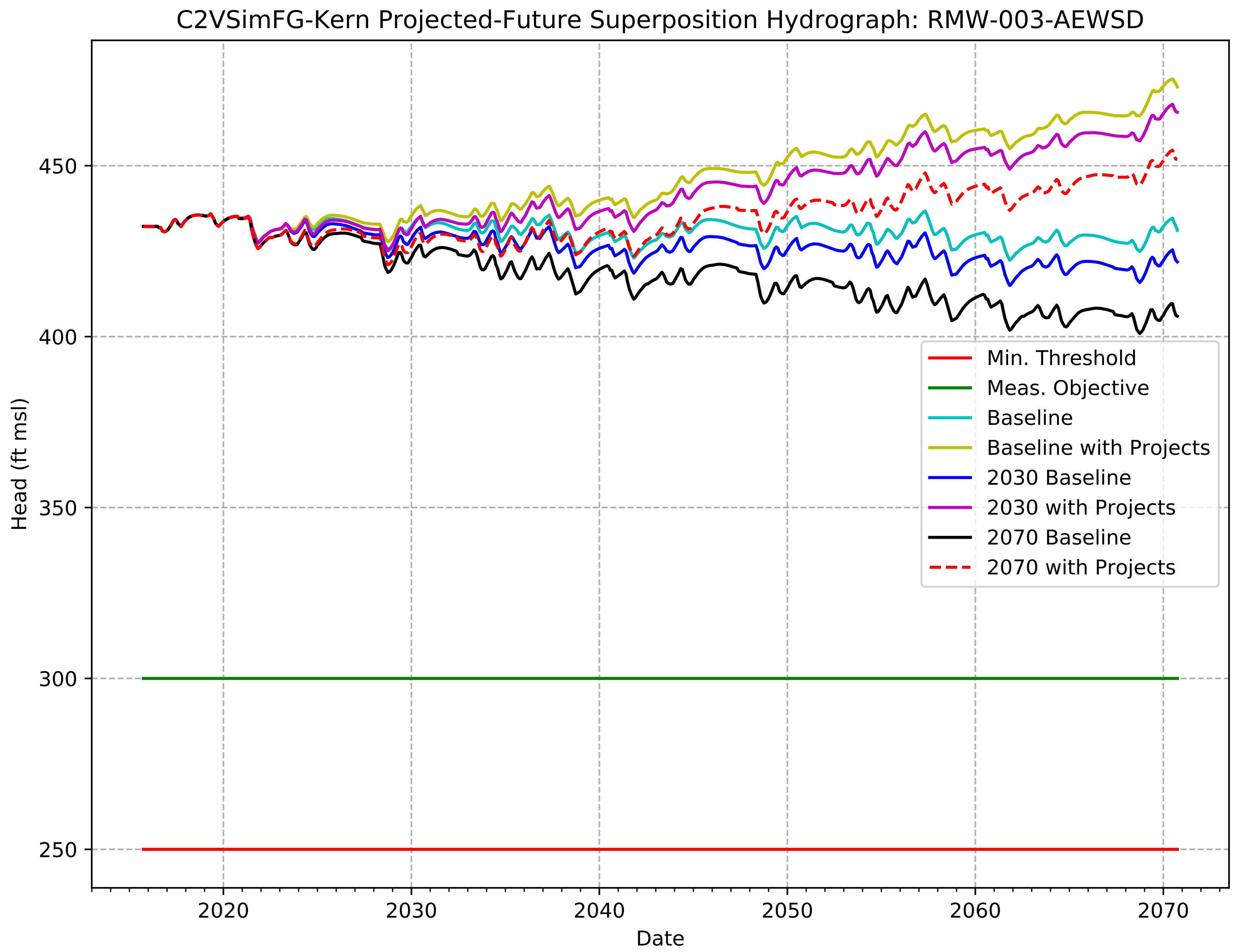
C2VSimFG-Kern Hydrographs at Regional Monitoring Wells in Kern County Subbasin for Projected Future Water Budget Simulations

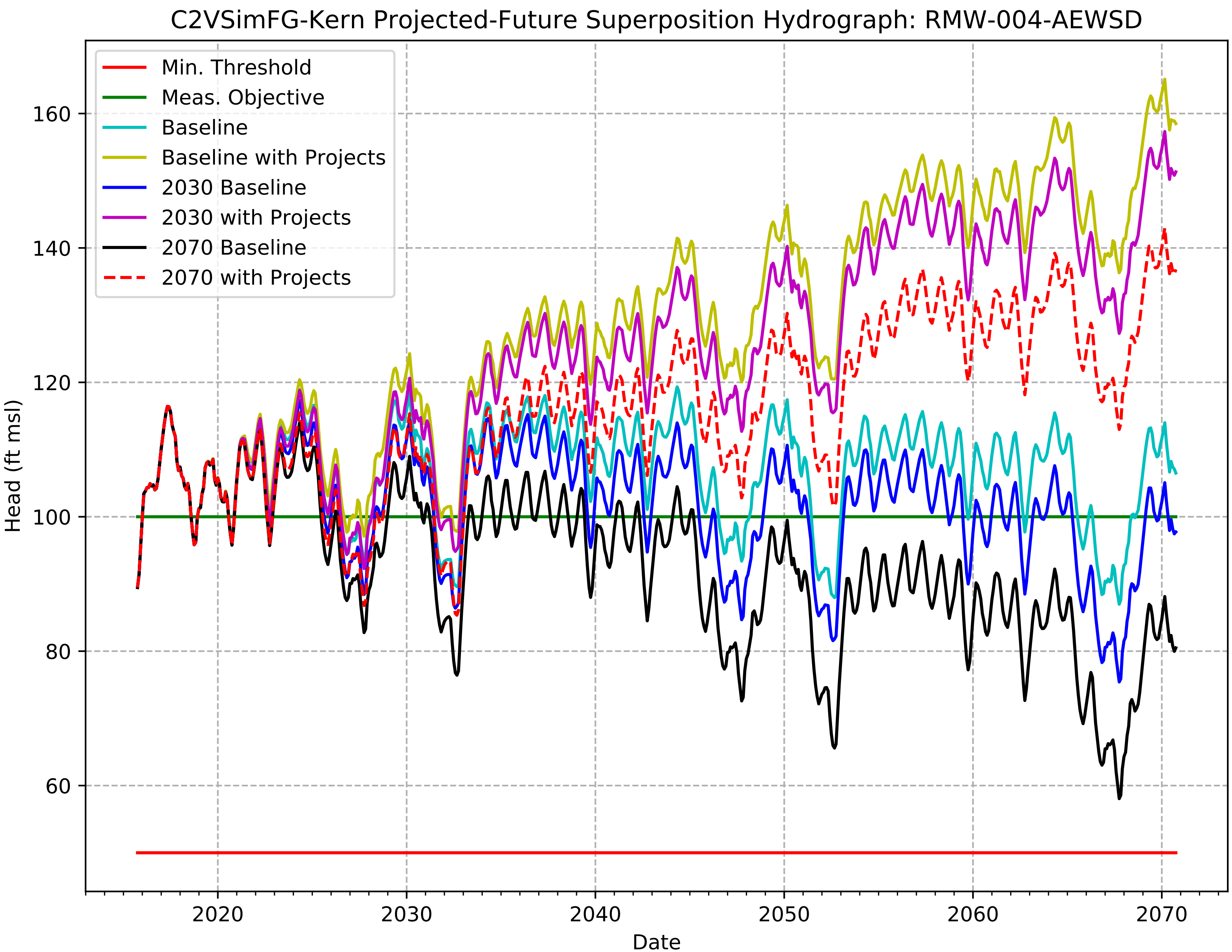


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-001-AEWSD
Head (ft msl)
300
250
200
150
100
50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

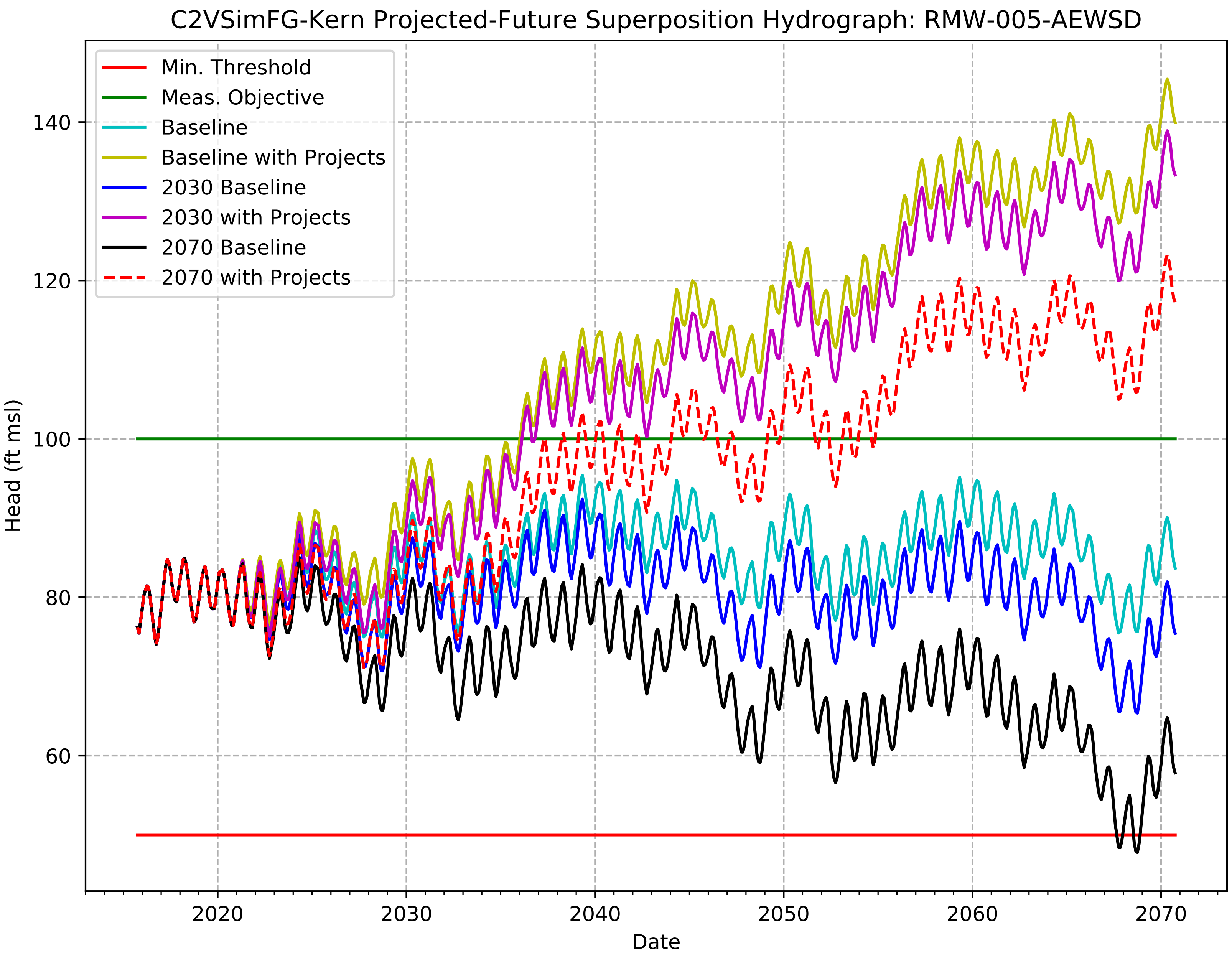


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-002-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
360
340
320
300
280
260
Date
2020
2030
2040
2050
2060
2070

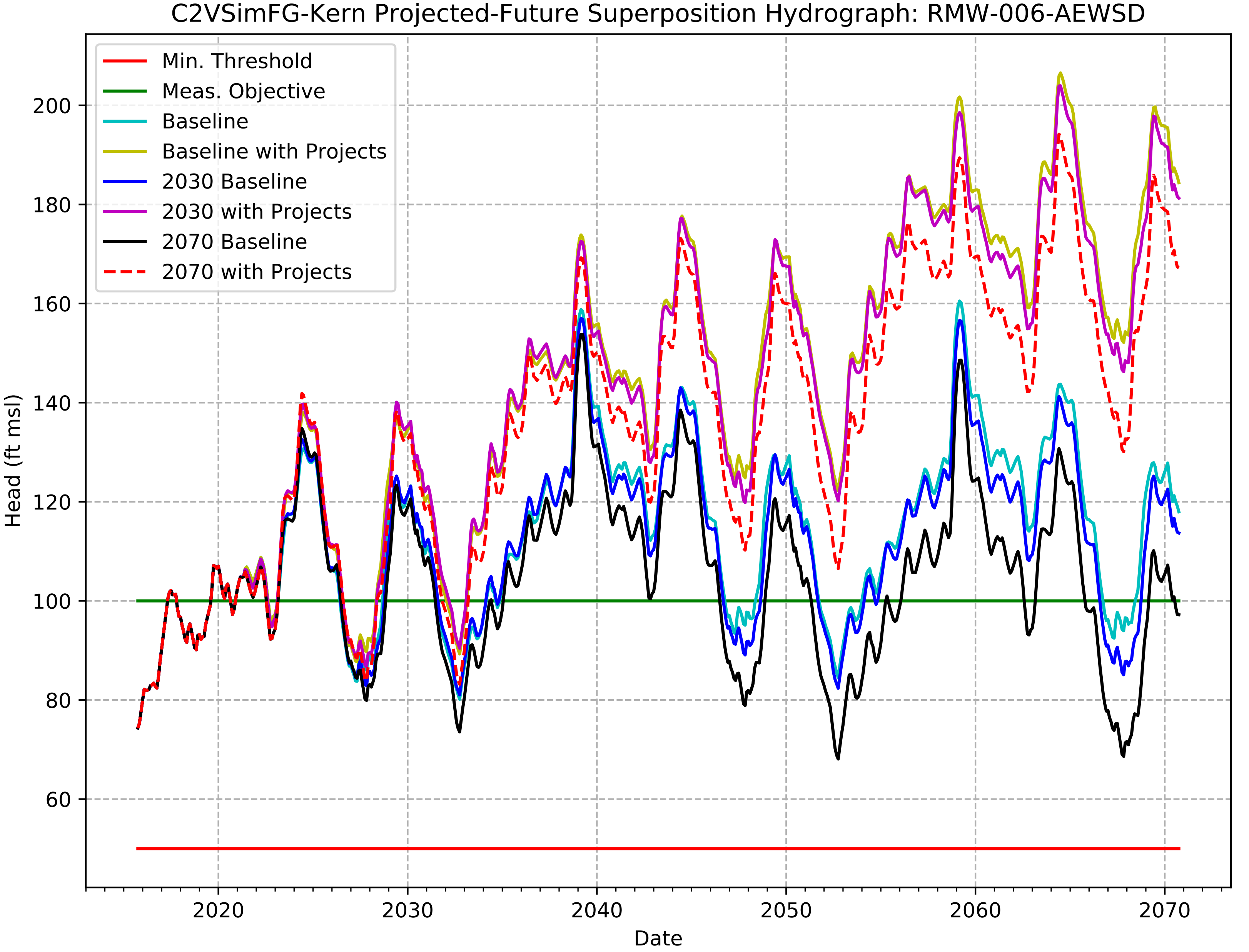

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-003-AEWSD
Head (ft msl)
450
400
350
300
250
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



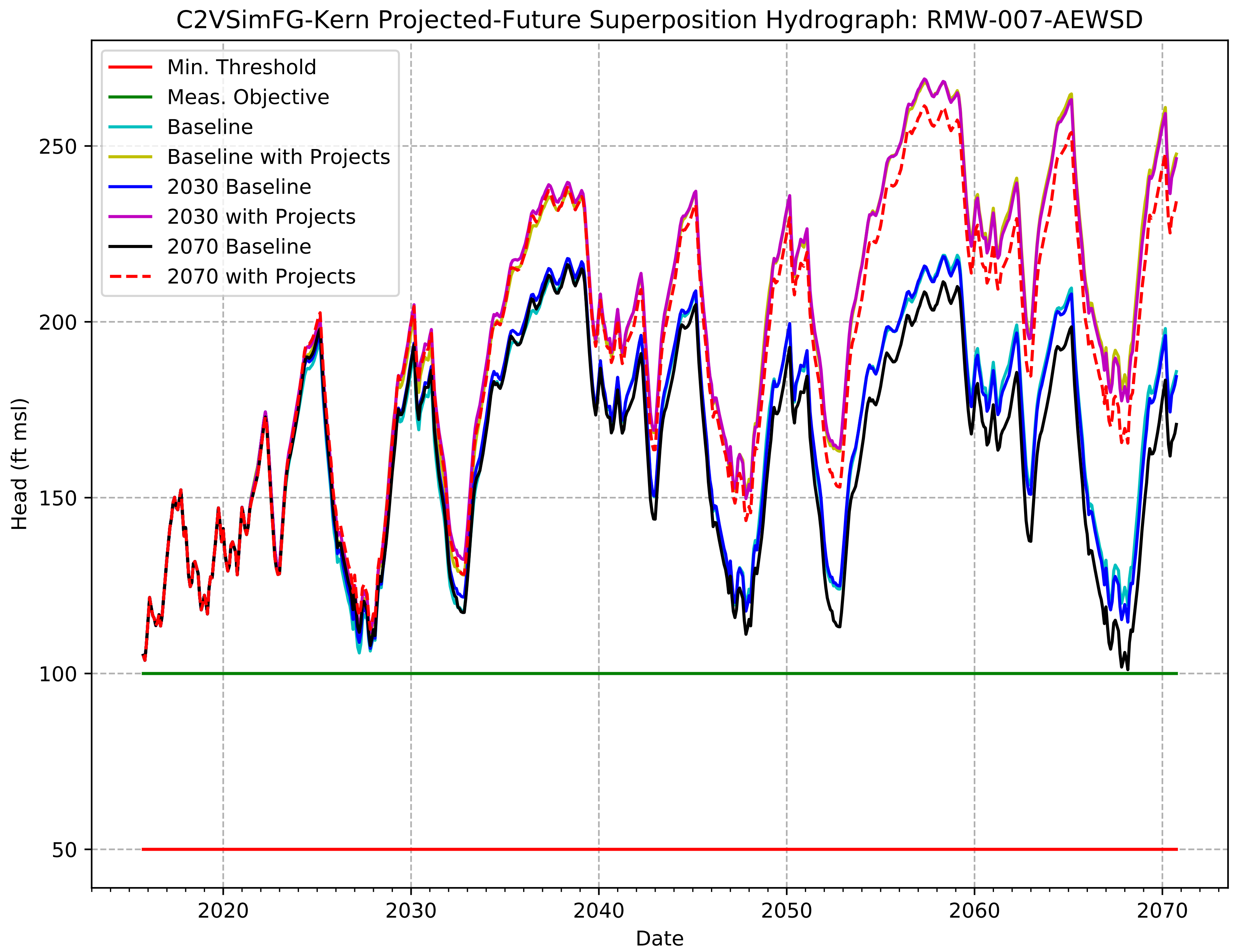
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-004-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date

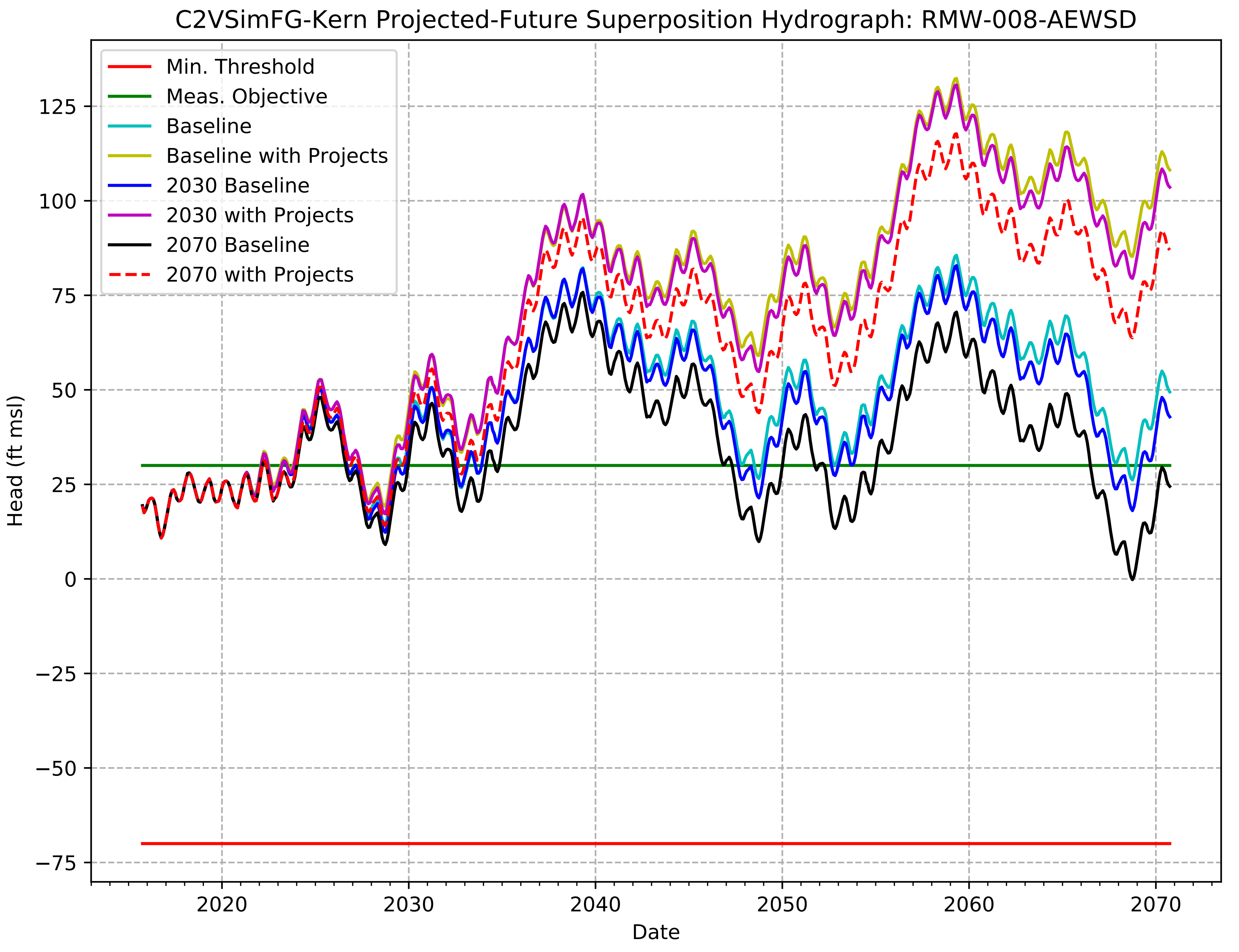


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-005-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date

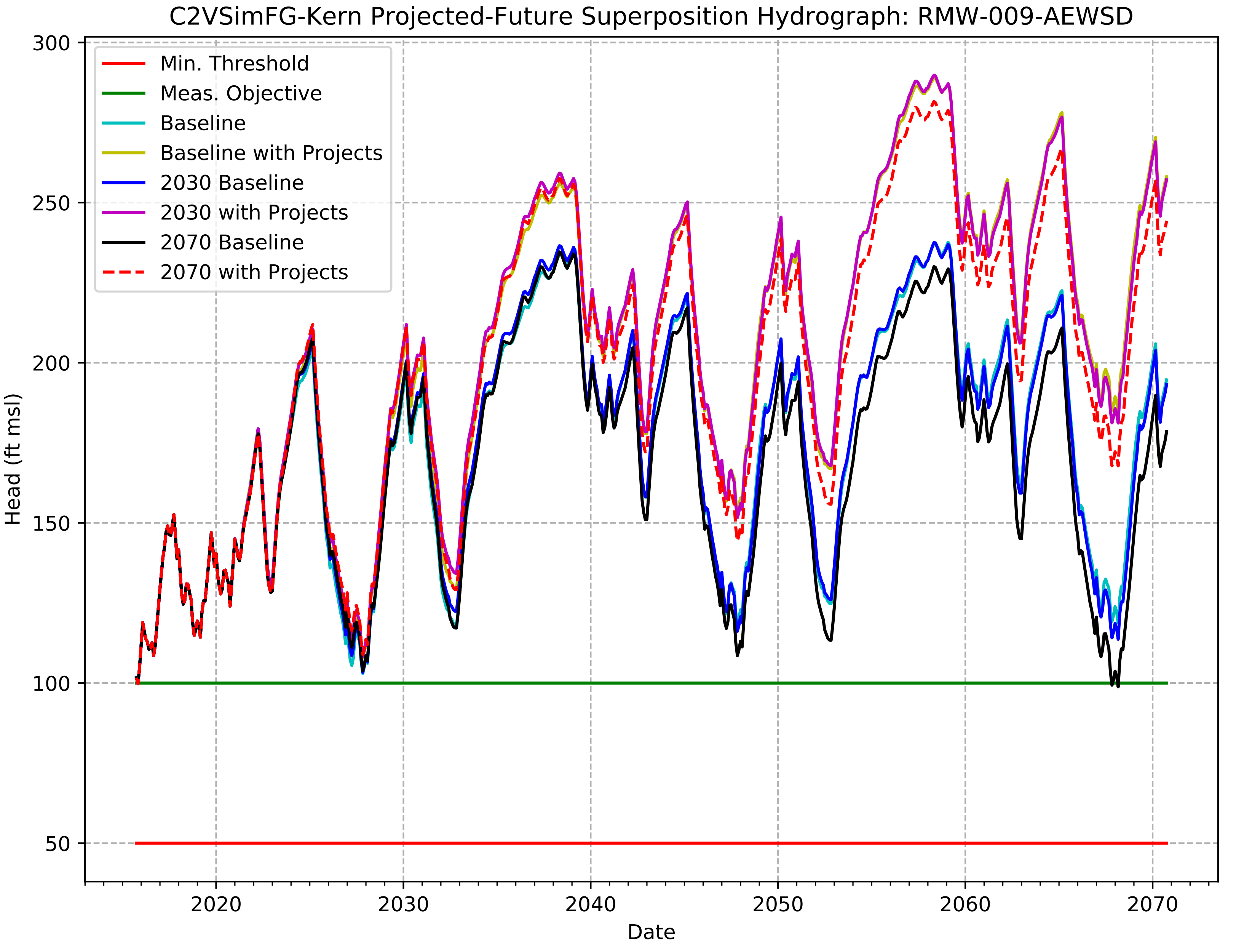


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-006-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date

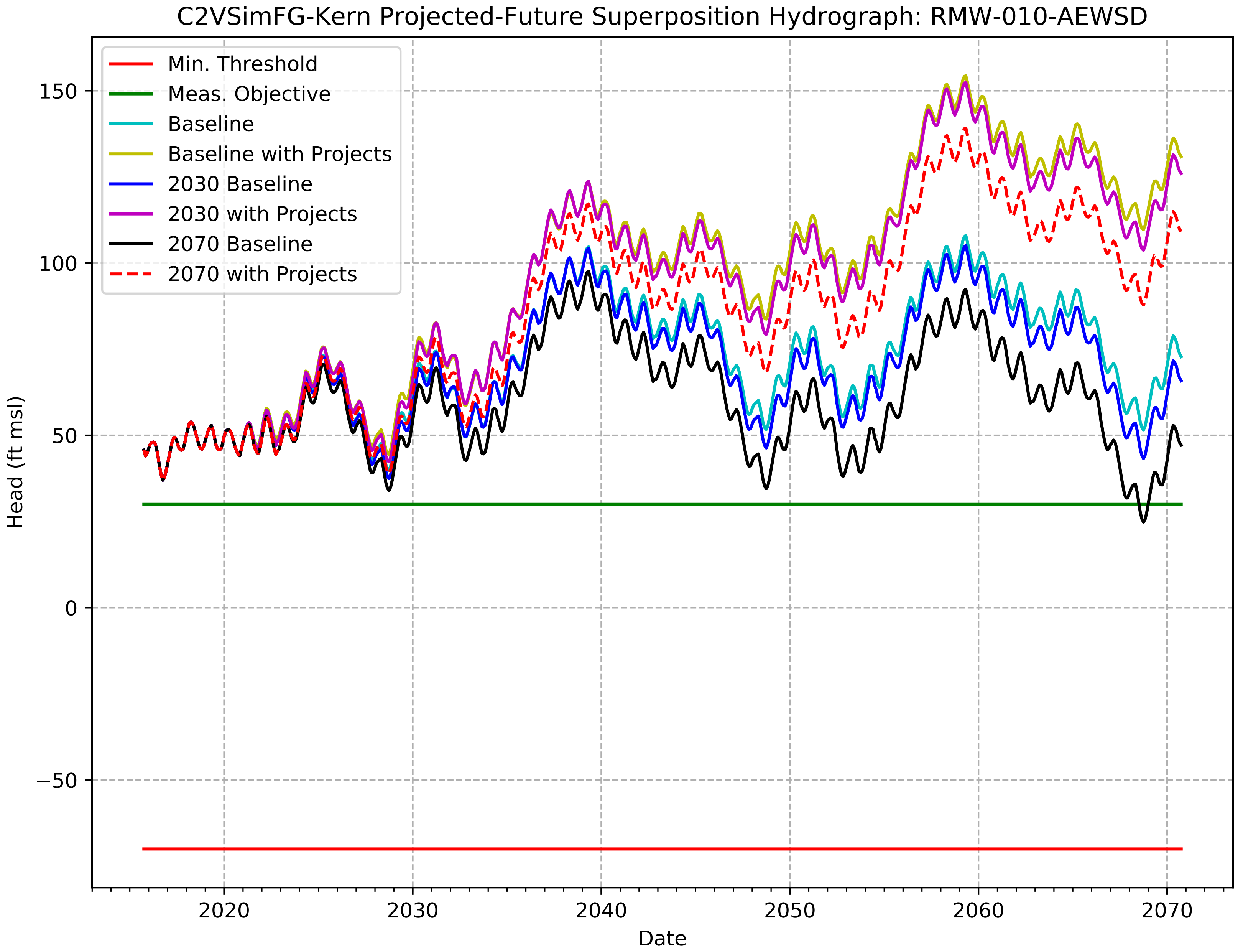

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-007-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
250
200
150
100
50
2020
2030
2040
2050
2060
2070
Date



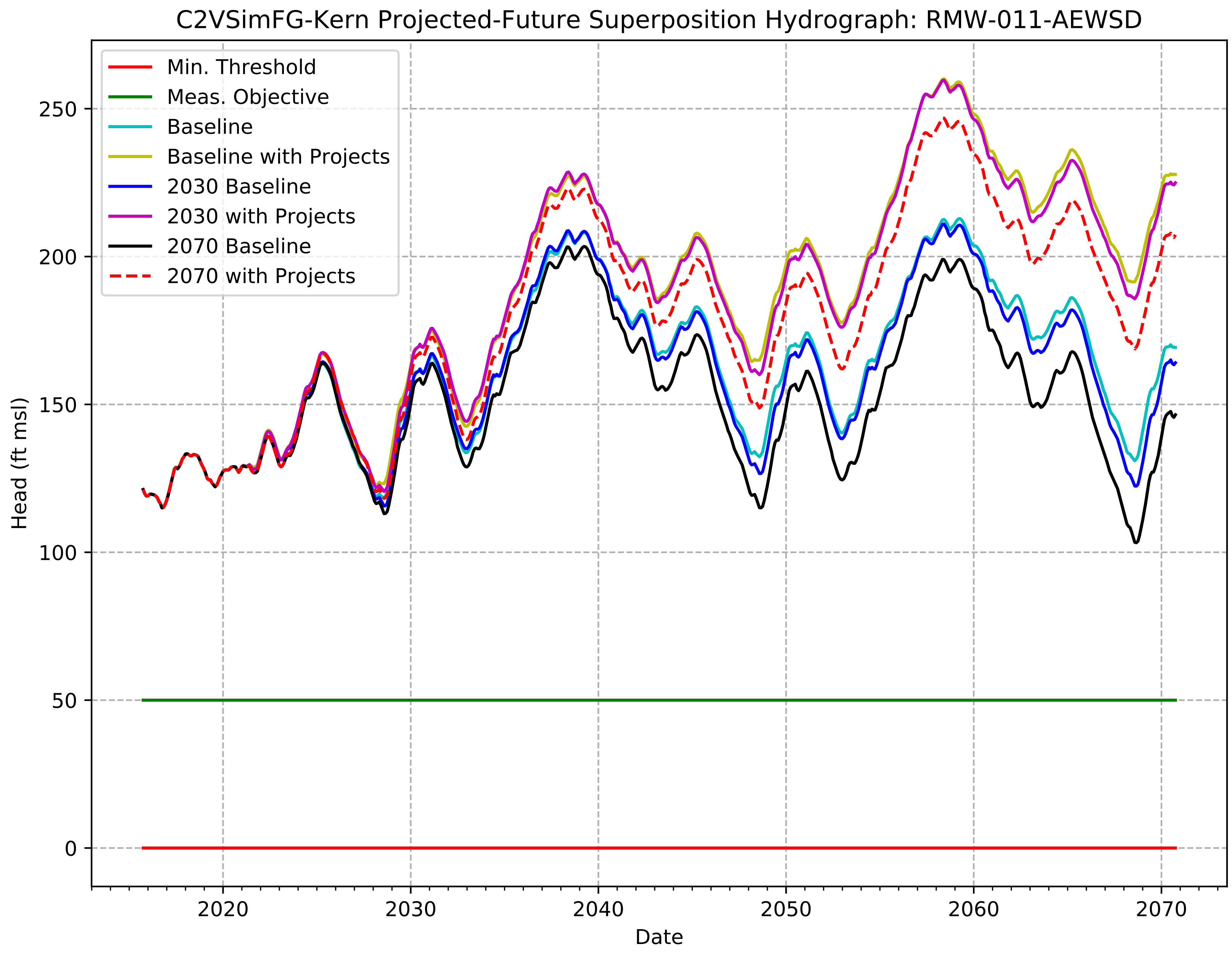
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-008-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
125
100
75
50
25
0
−25
−50
−75
2020
2030
2040
2050
2060
2070
Date



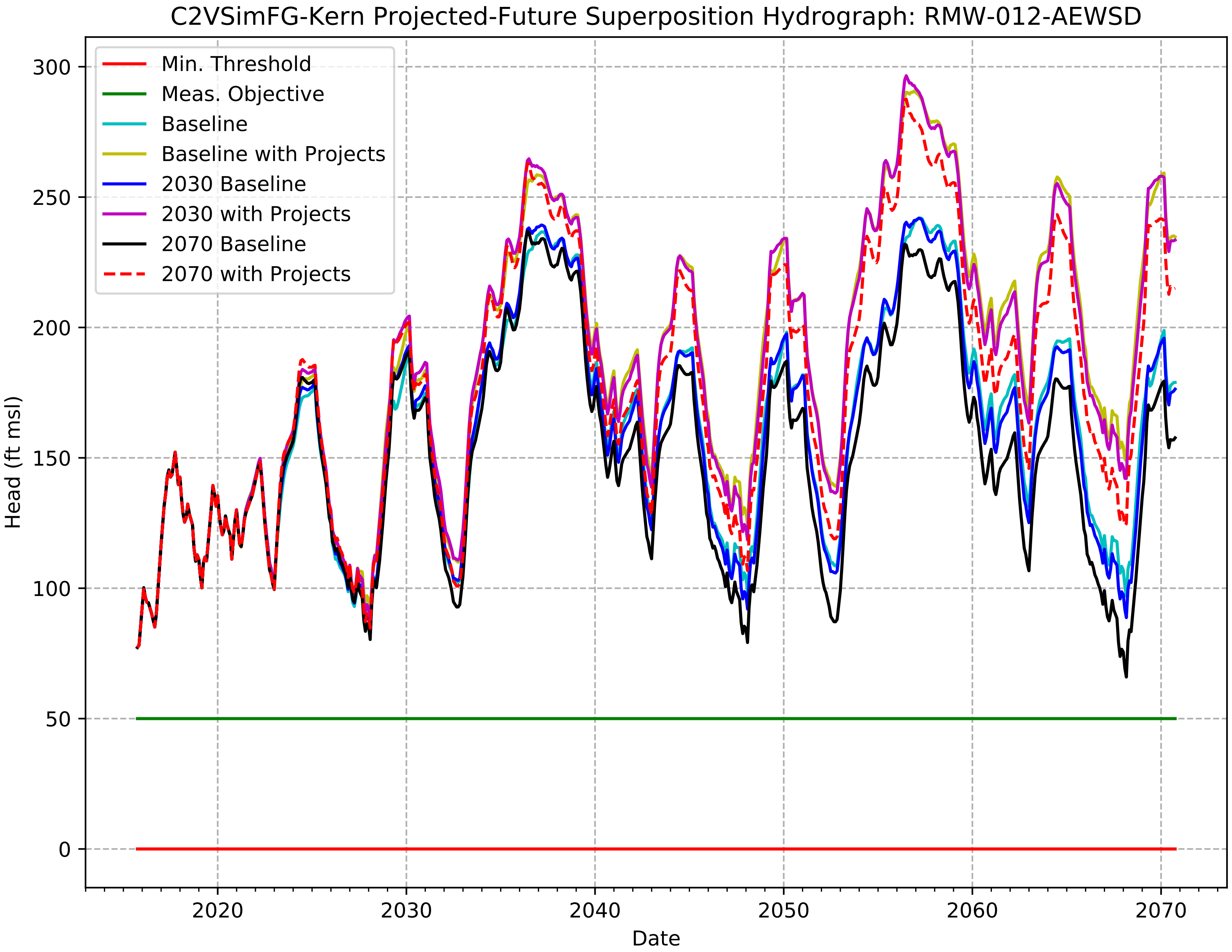
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-009-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
300
250
200
150
100
50
2020
2030
2040
2050
2060
2070
Date

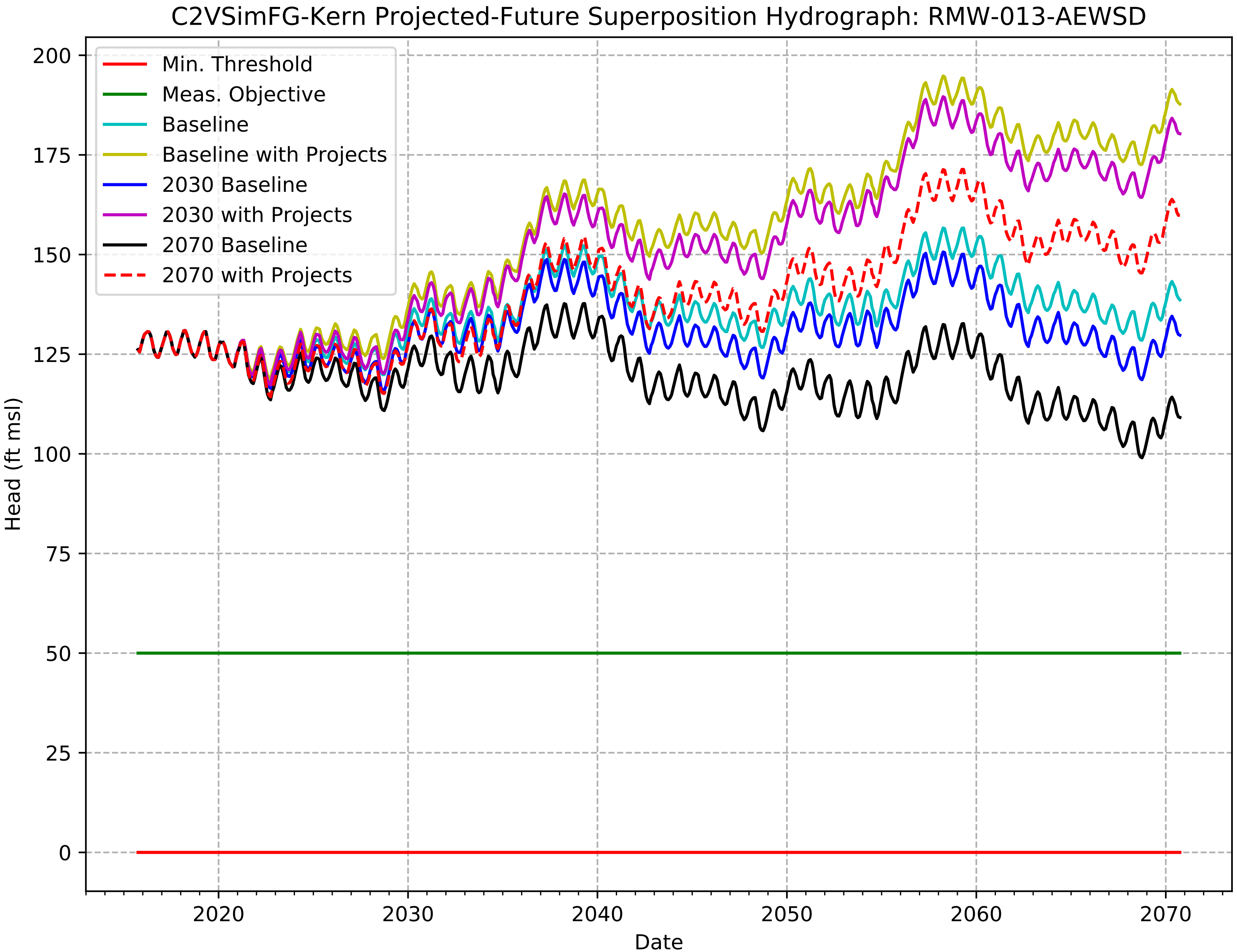


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-010-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-011-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-012-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
300
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-013-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
175
150
125
100
75
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25
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2030
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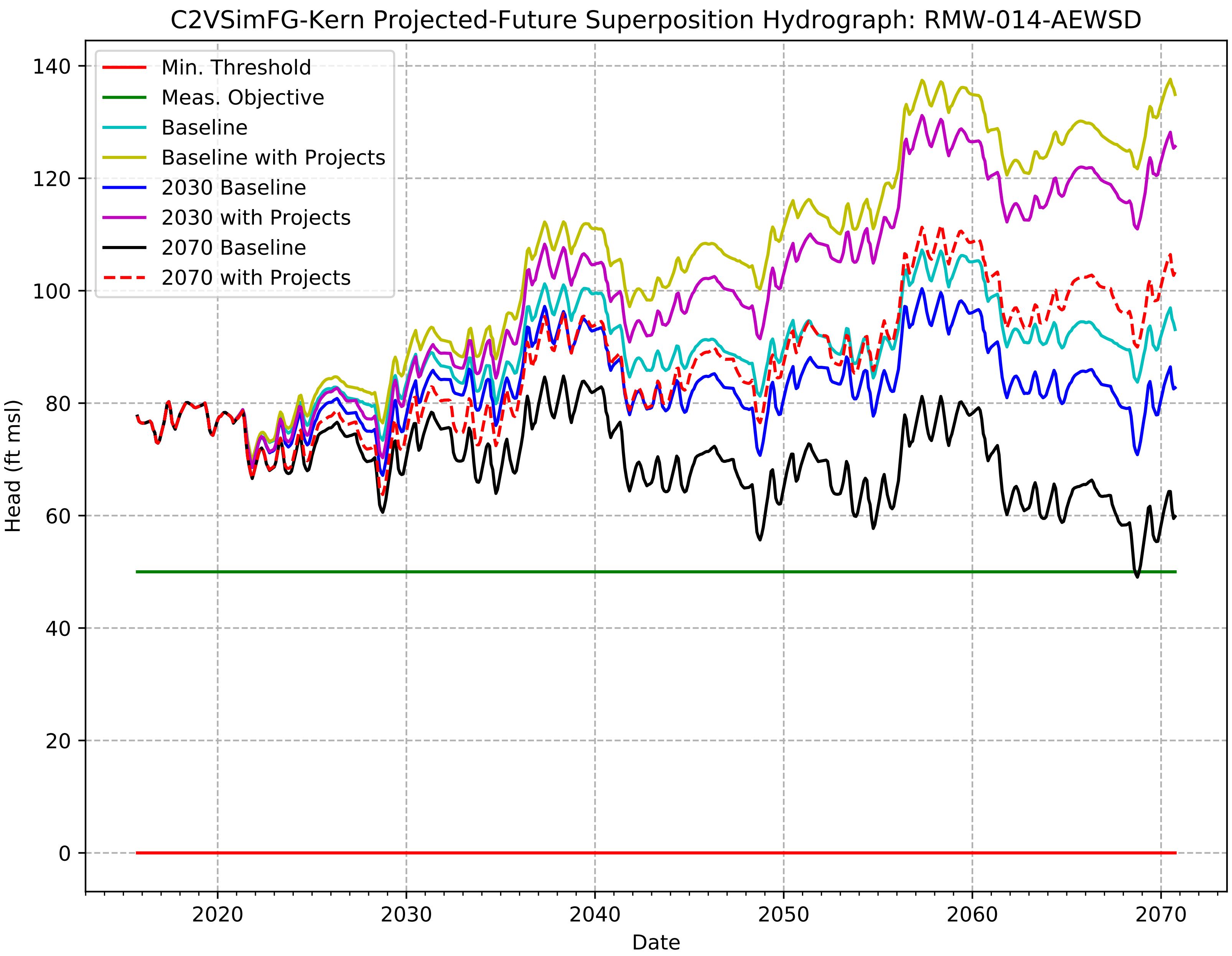
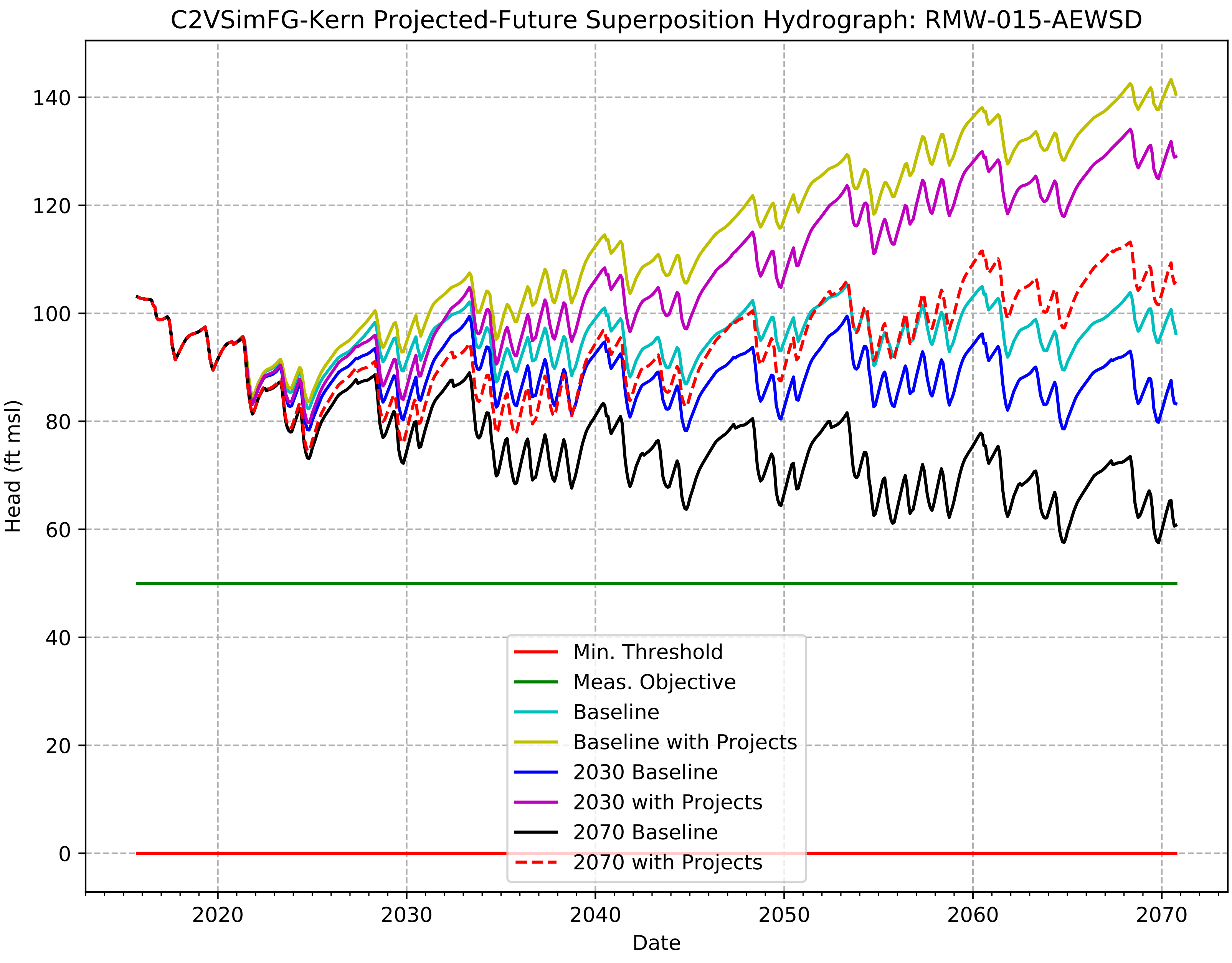
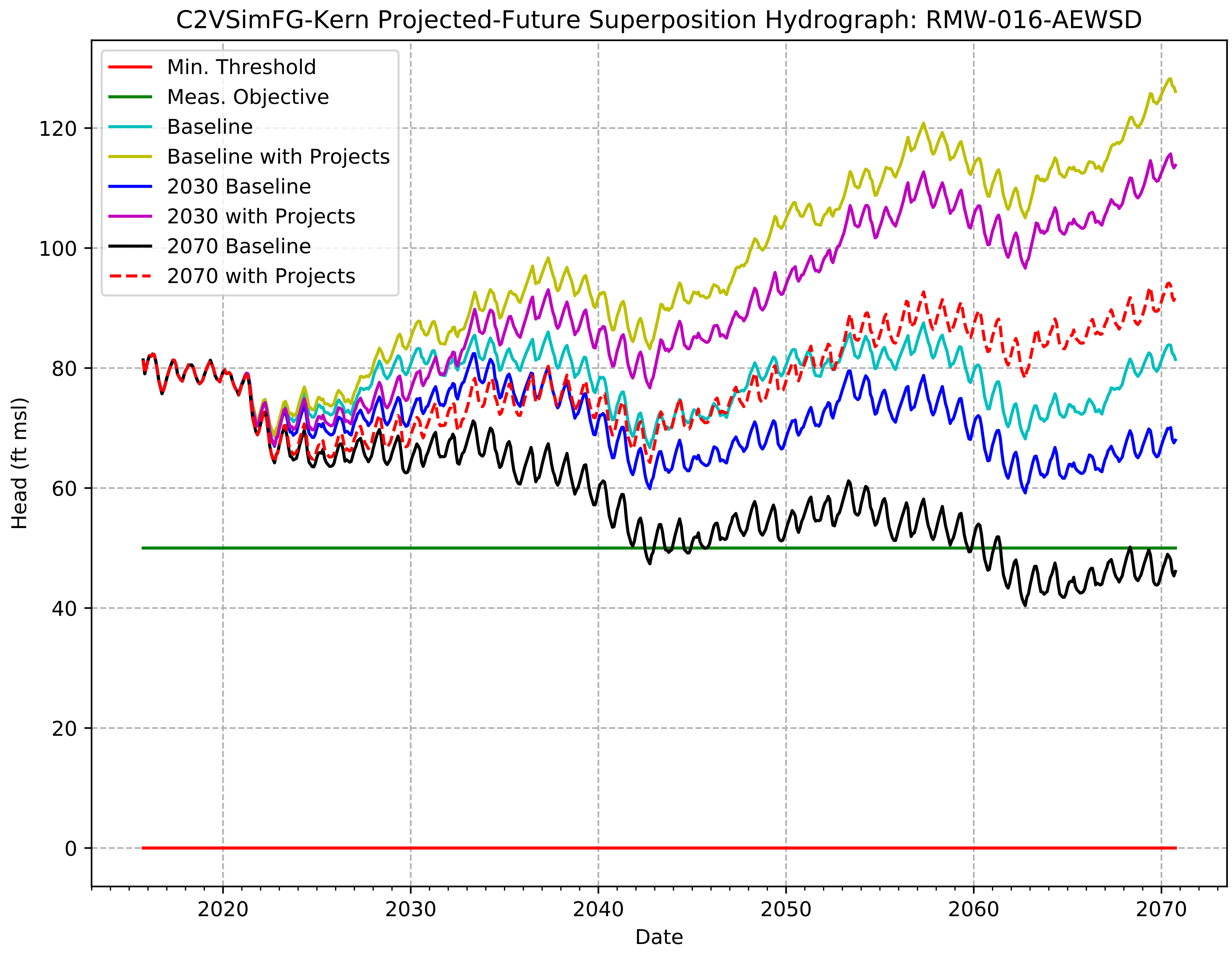
2050
2060
2070
Date

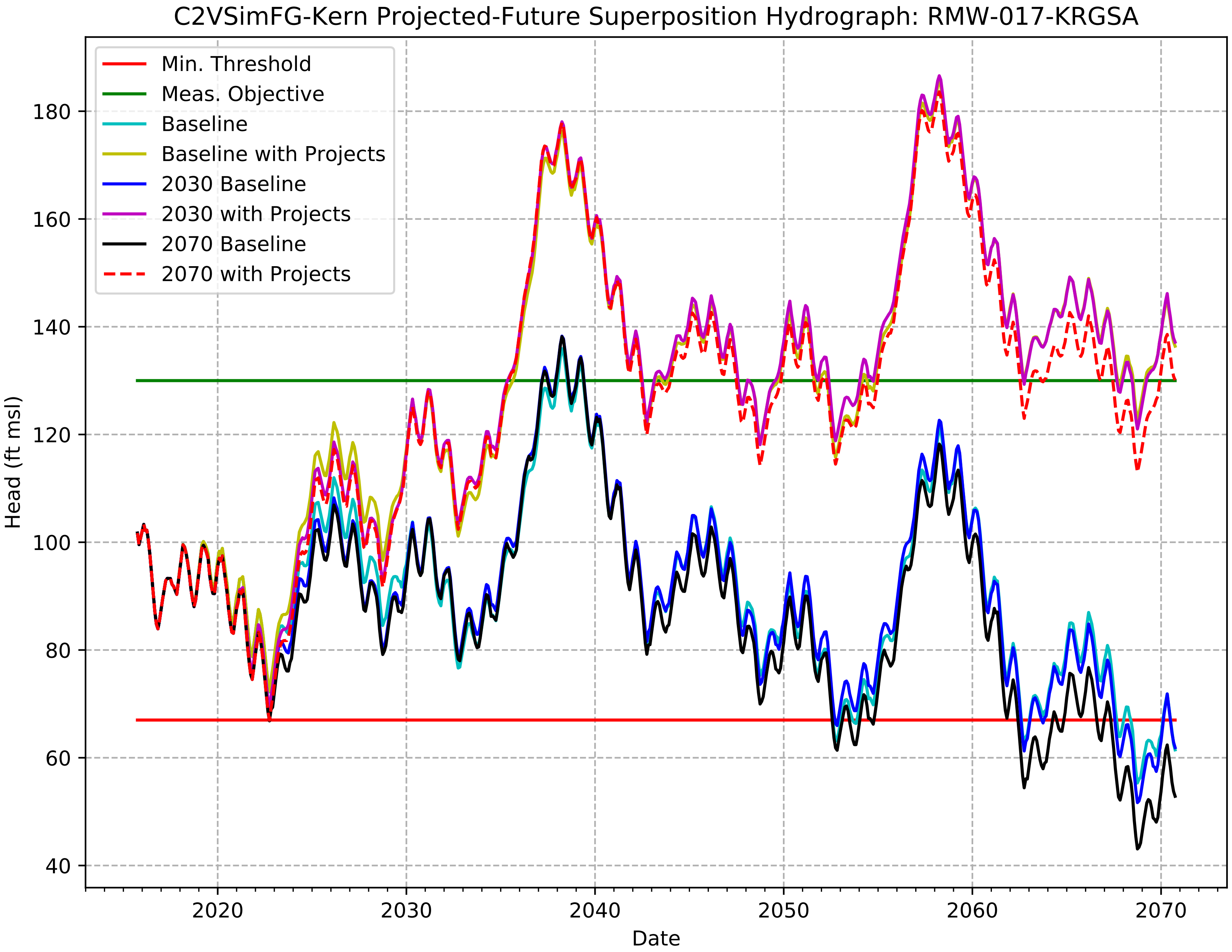


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-014-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
140
120
100
80
60
40
20
0
2020
2030
2040
2050
2060
2070
Date

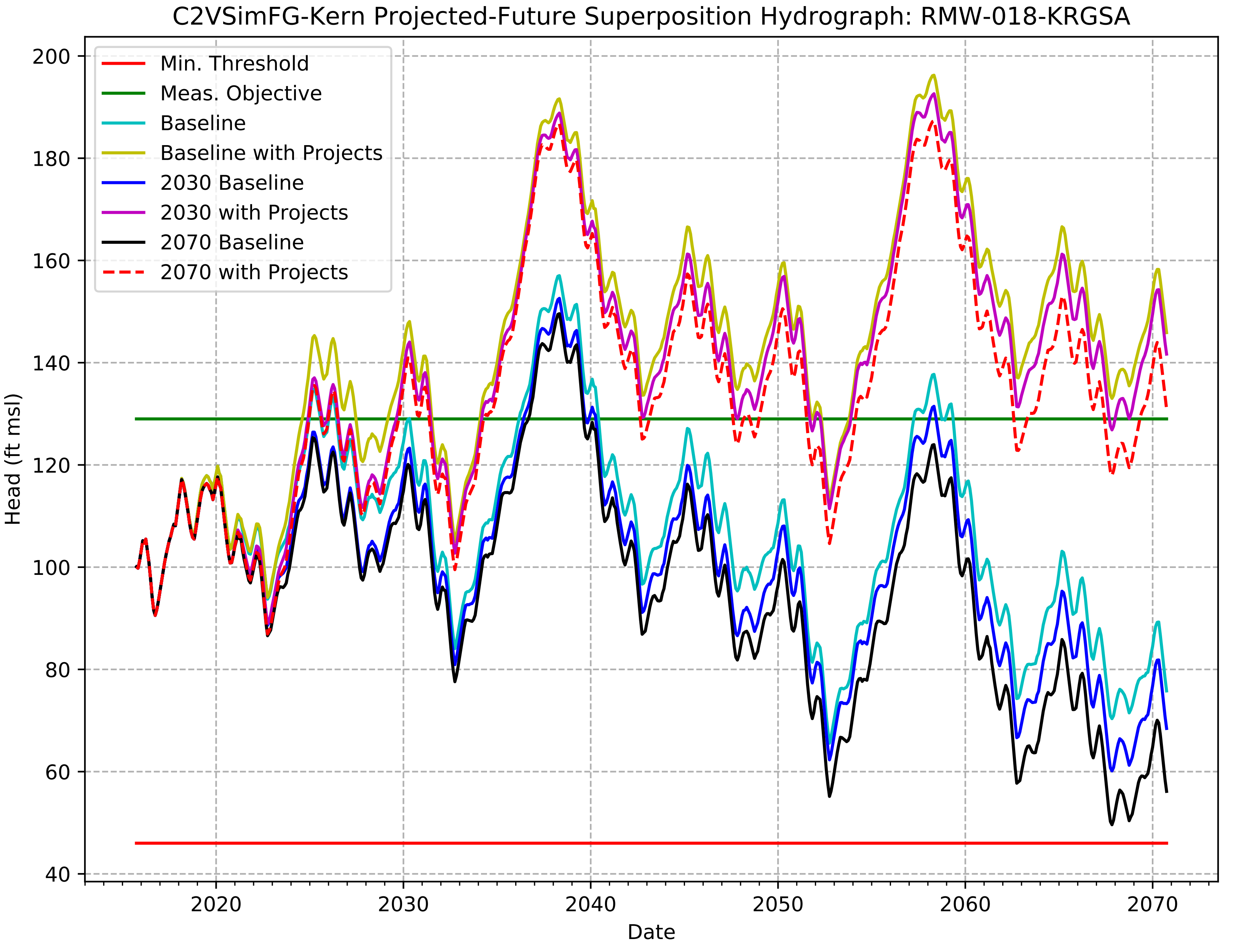


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-015-AEWSD
Head (ft msl)
140
120
100
80
60
40
20
0
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-016-AEWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
0
20
40
60
80
100
120
2020
2030
2040
2050
2060
2070



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-017-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
180
160
140
120
100
80
60
40
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-018-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
60
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2020
2030
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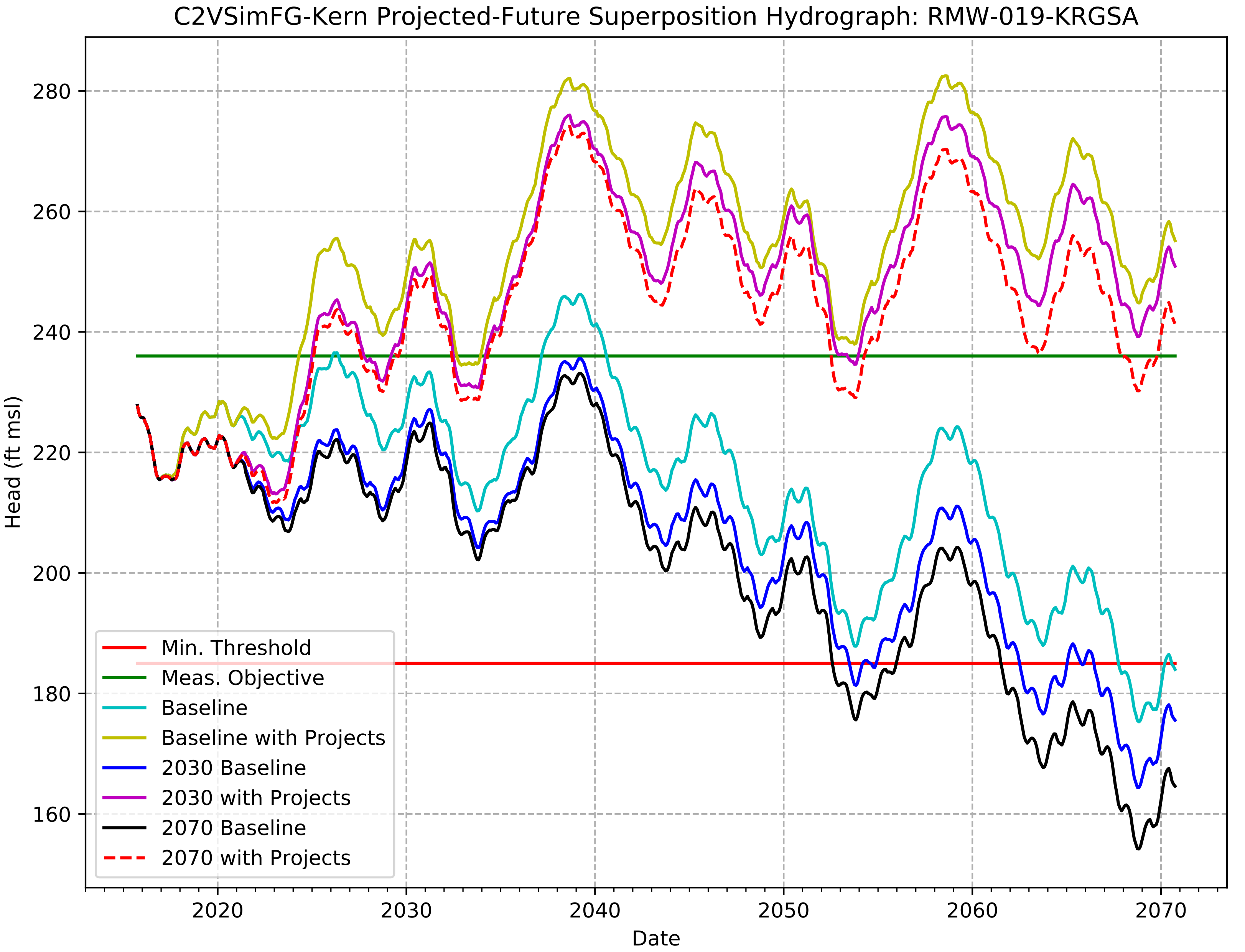
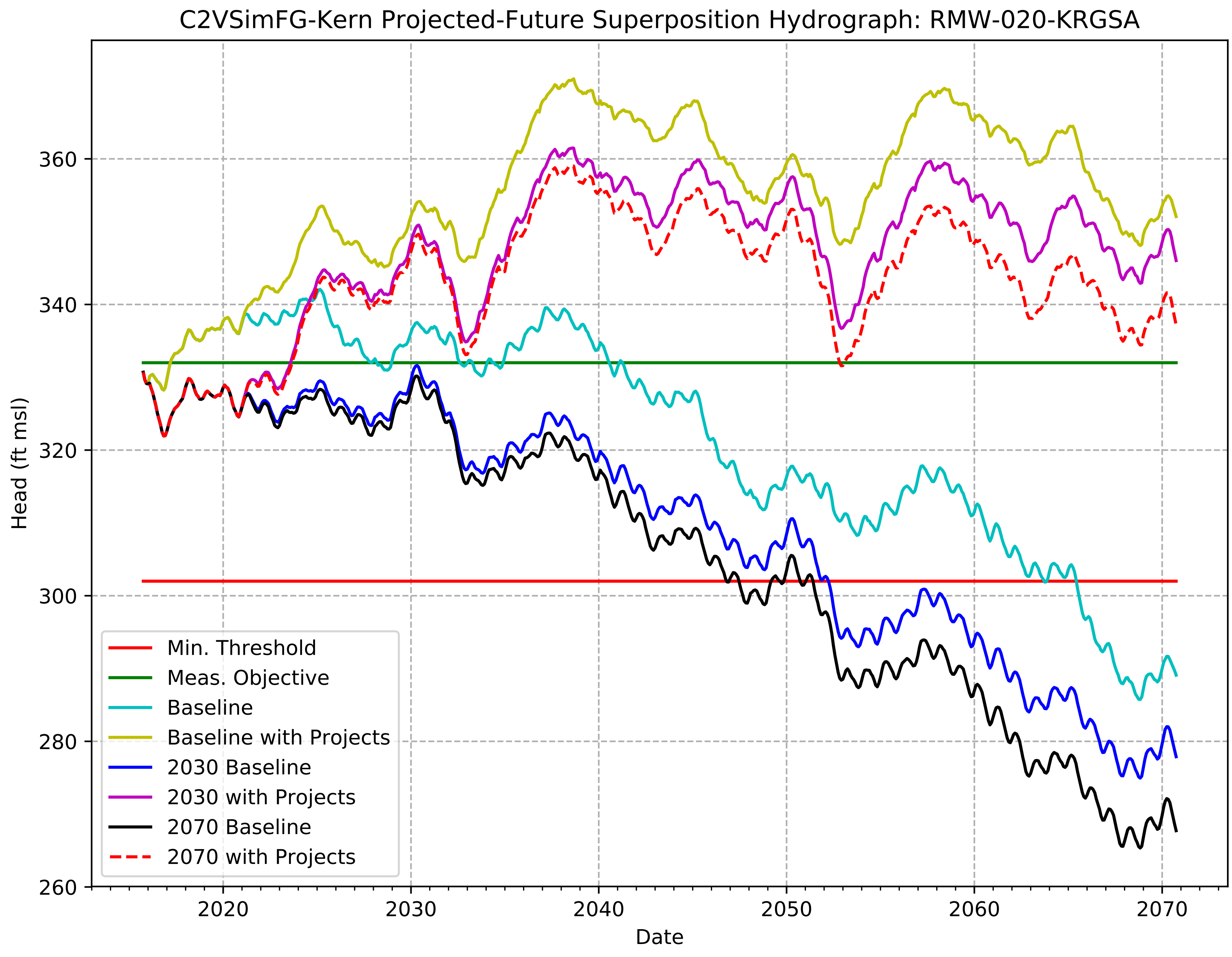
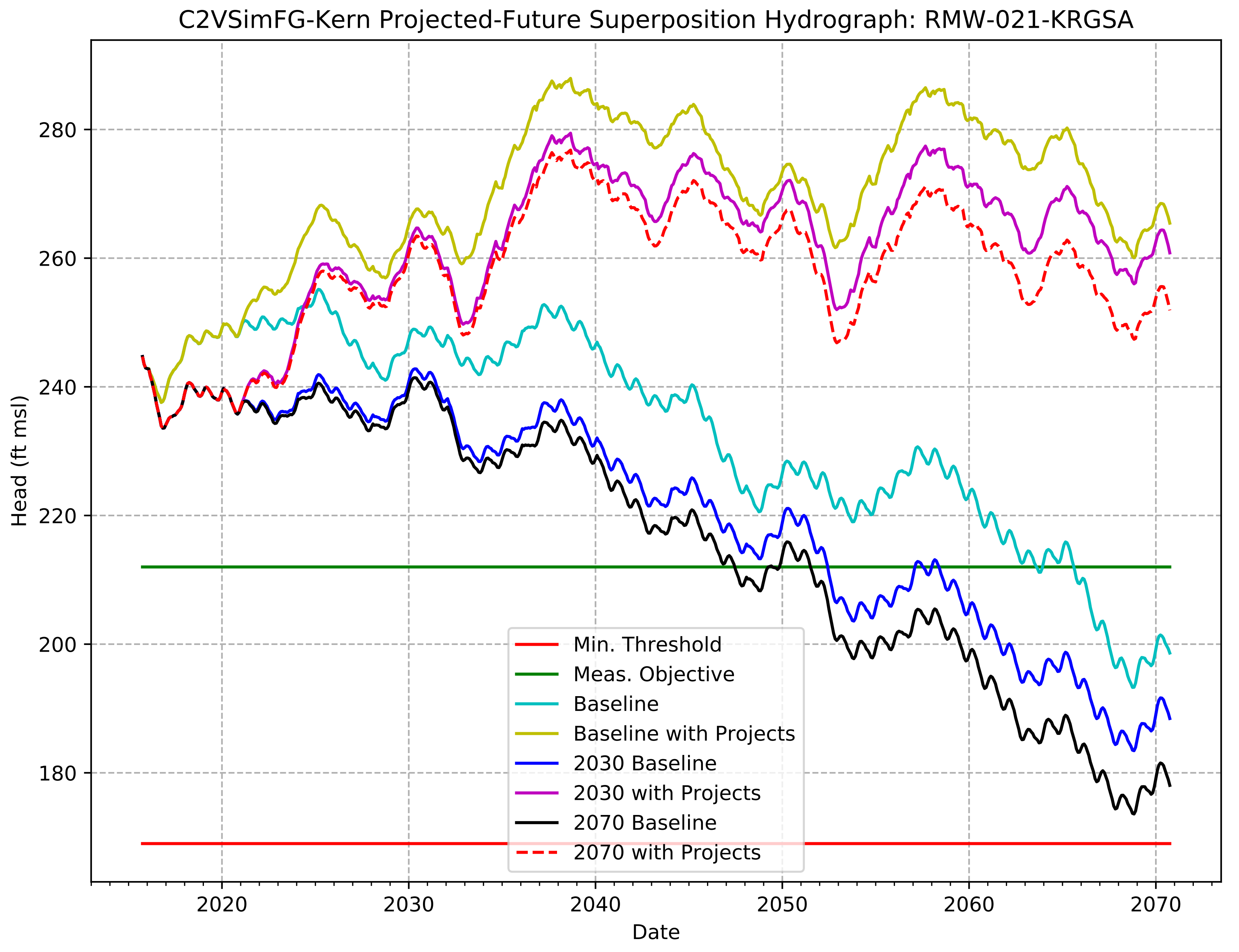
2050
2060
2070
Date



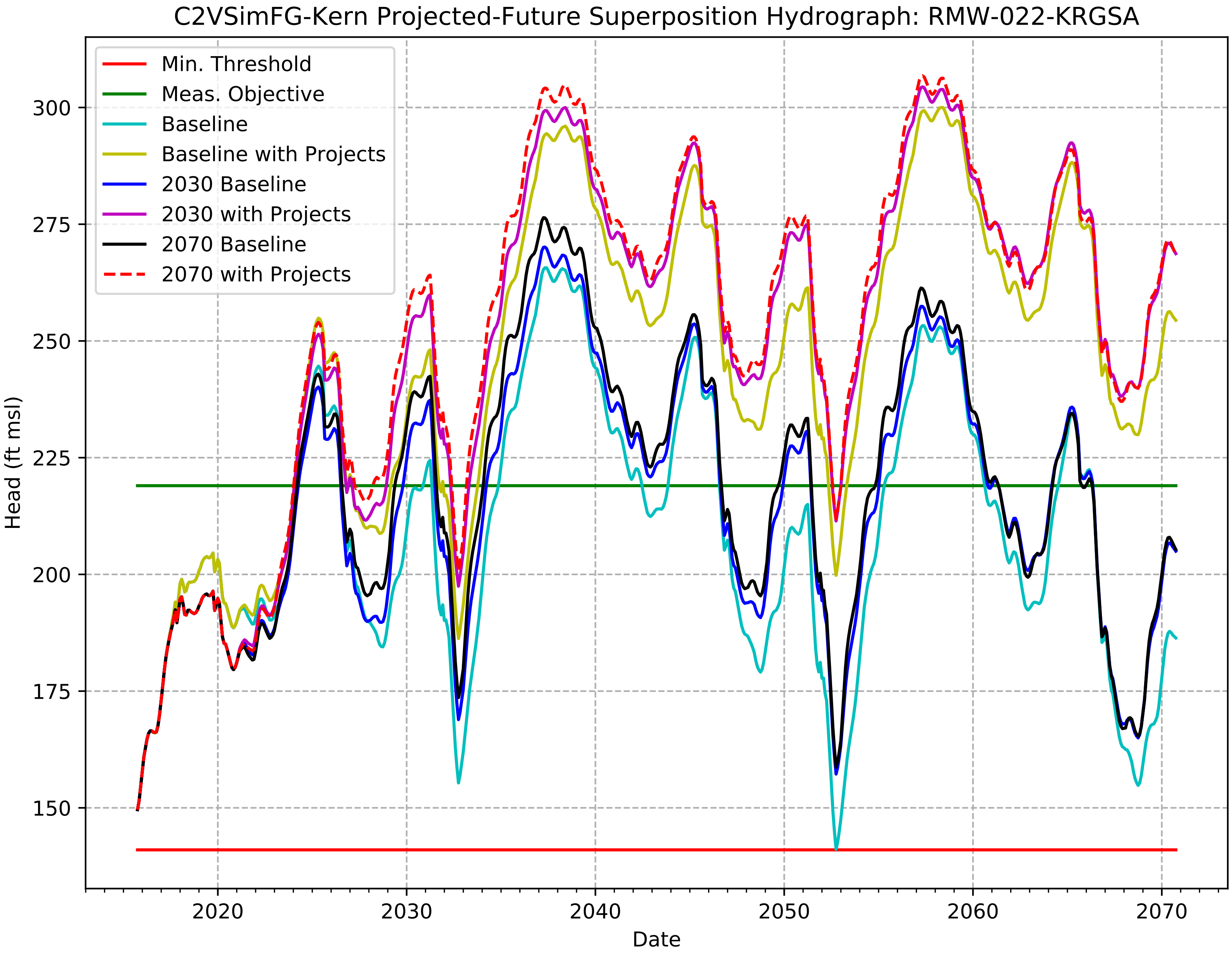
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-019-KRGSA
Head (ft msl)
Date
280
260
240
220
200
180
160
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



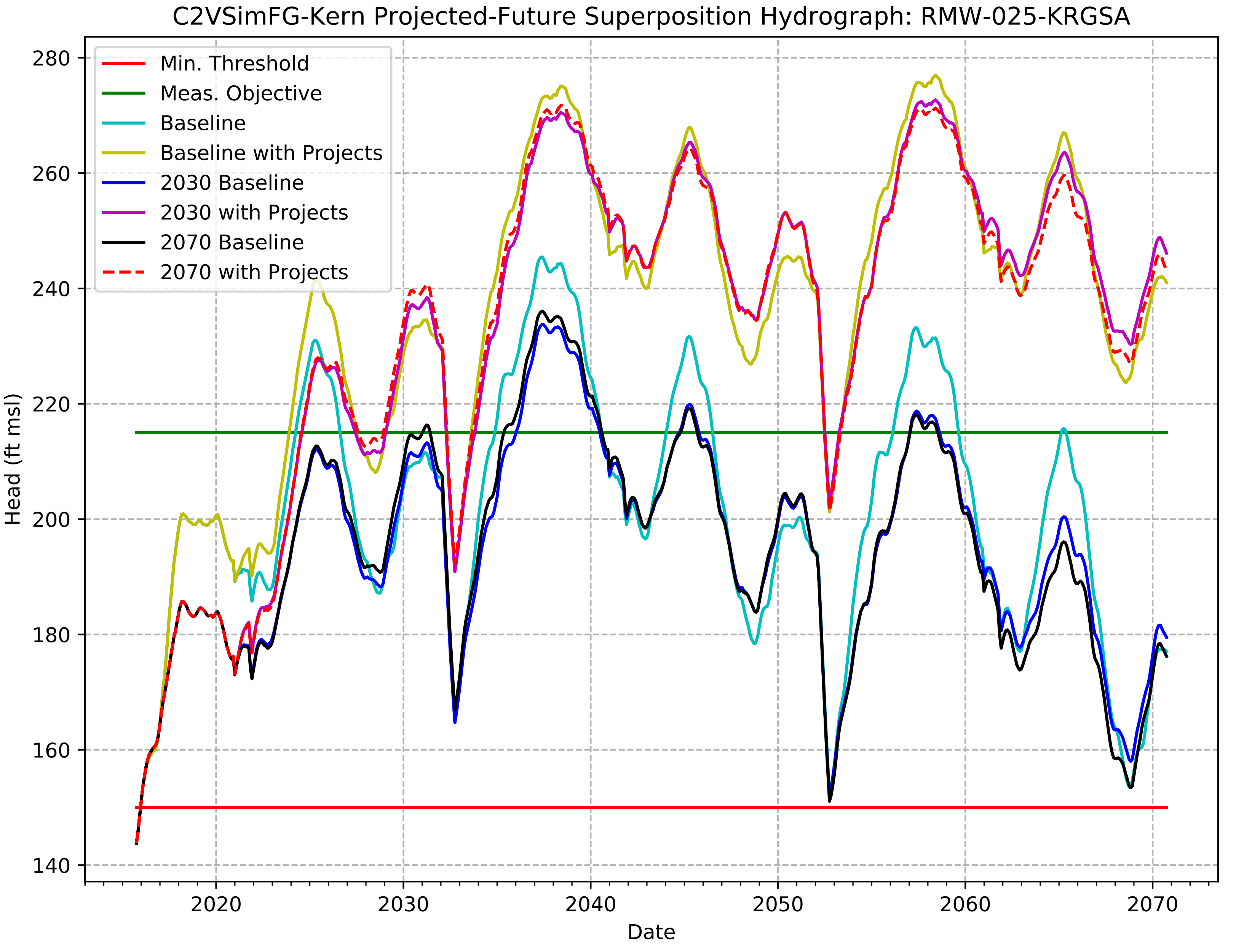
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-020-KRGSA
Head (ft msl)
260
280
300
320
340
360
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



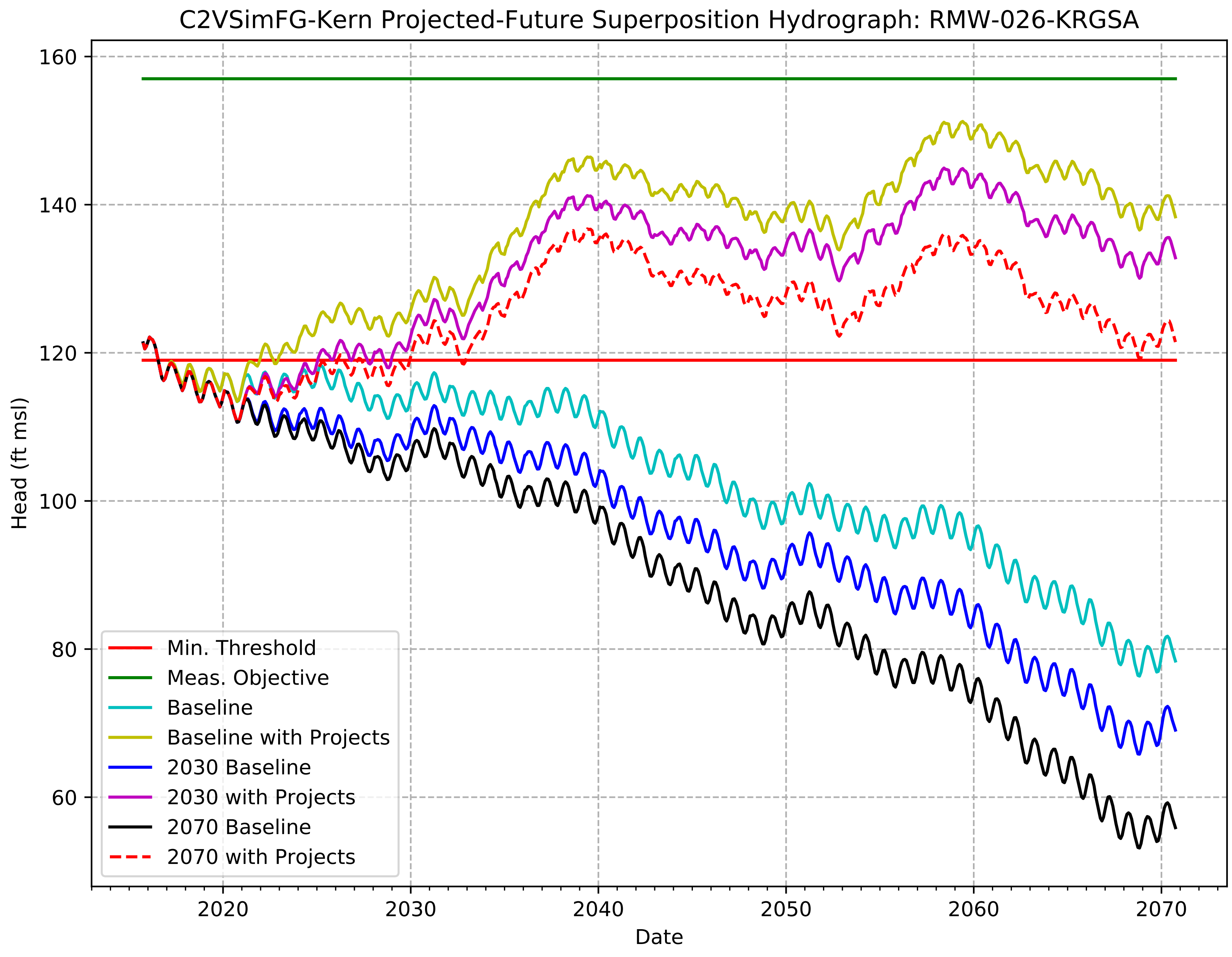
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-021-KRGSA
Head (ft msl)
Date
280
260
240
220
200
180
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



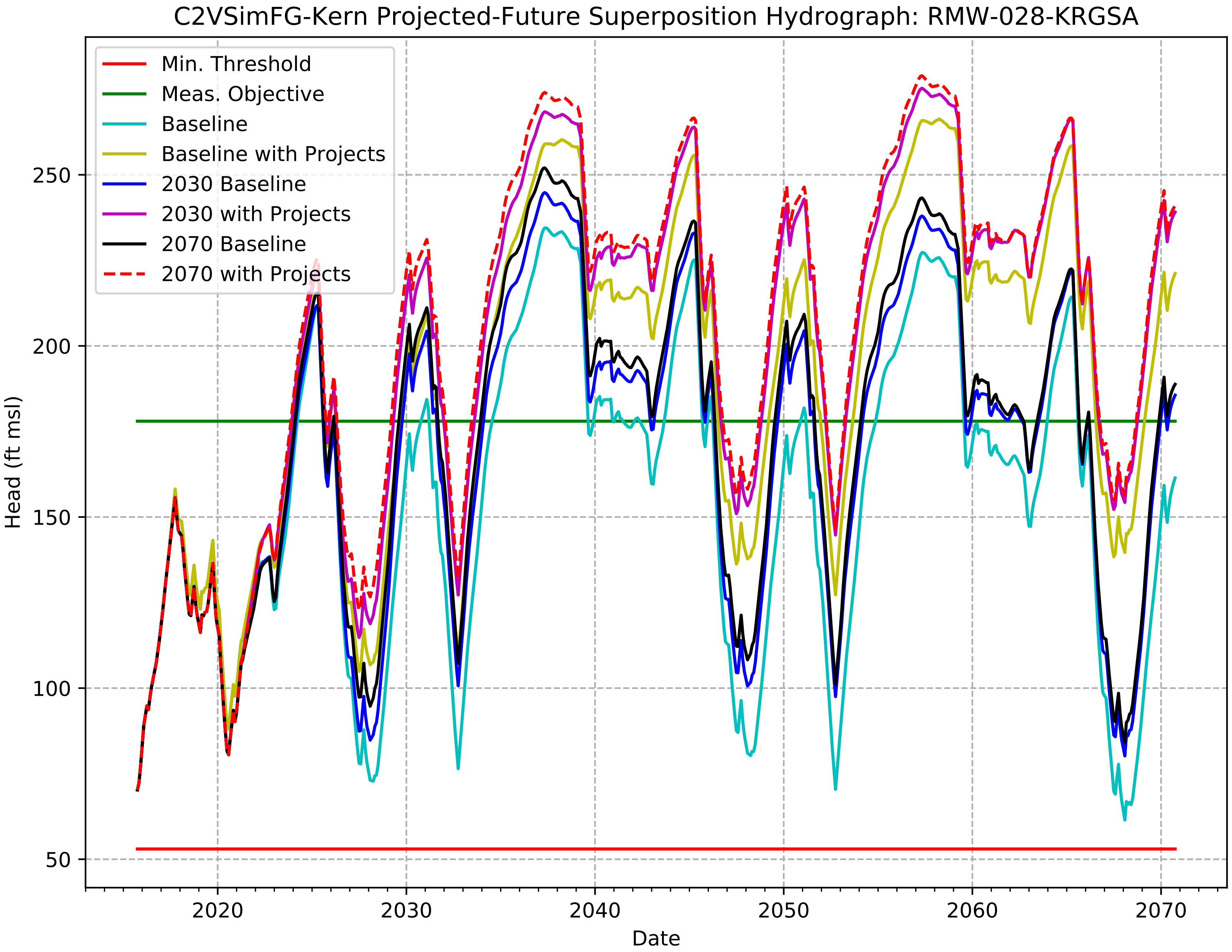
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-022-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
300
275
250
225
200
175
150
2020
2030
2040
2050
2060
2070
Date



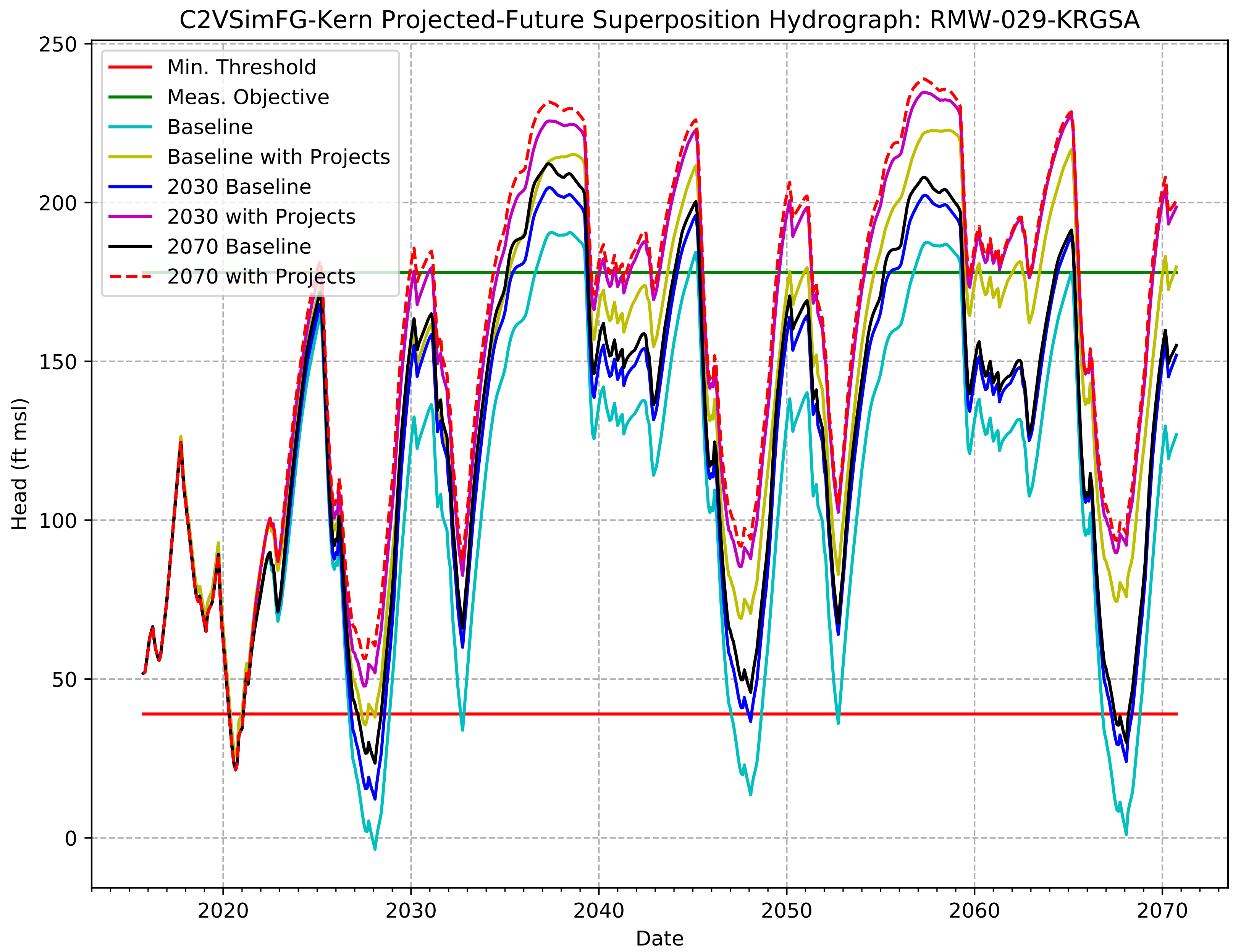
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-025-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
280
260
240
220
200
180
160
140
2020
2030
2040
2050
2060
2070
Date



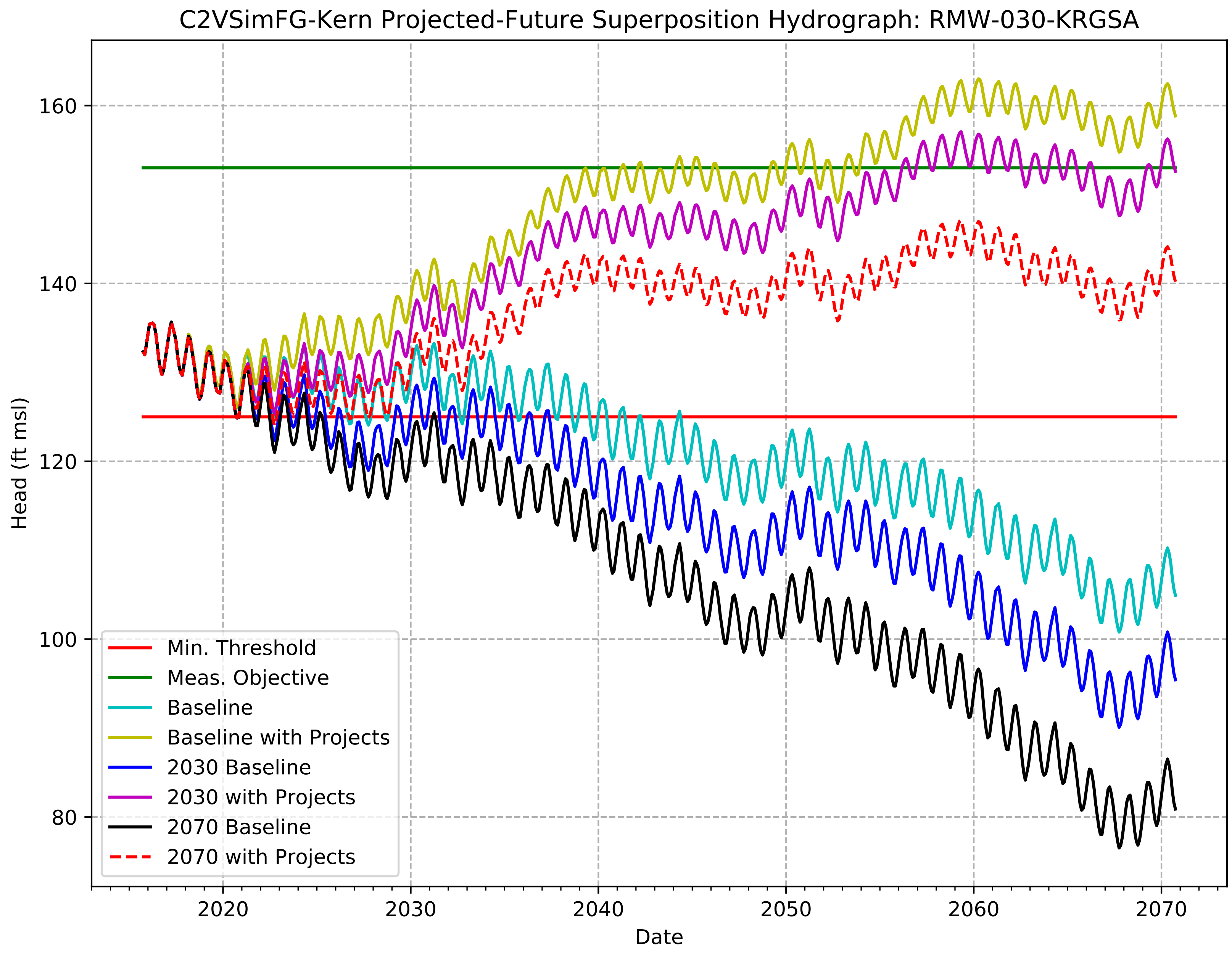
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-026-KRGSA
Head (ft msl)
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

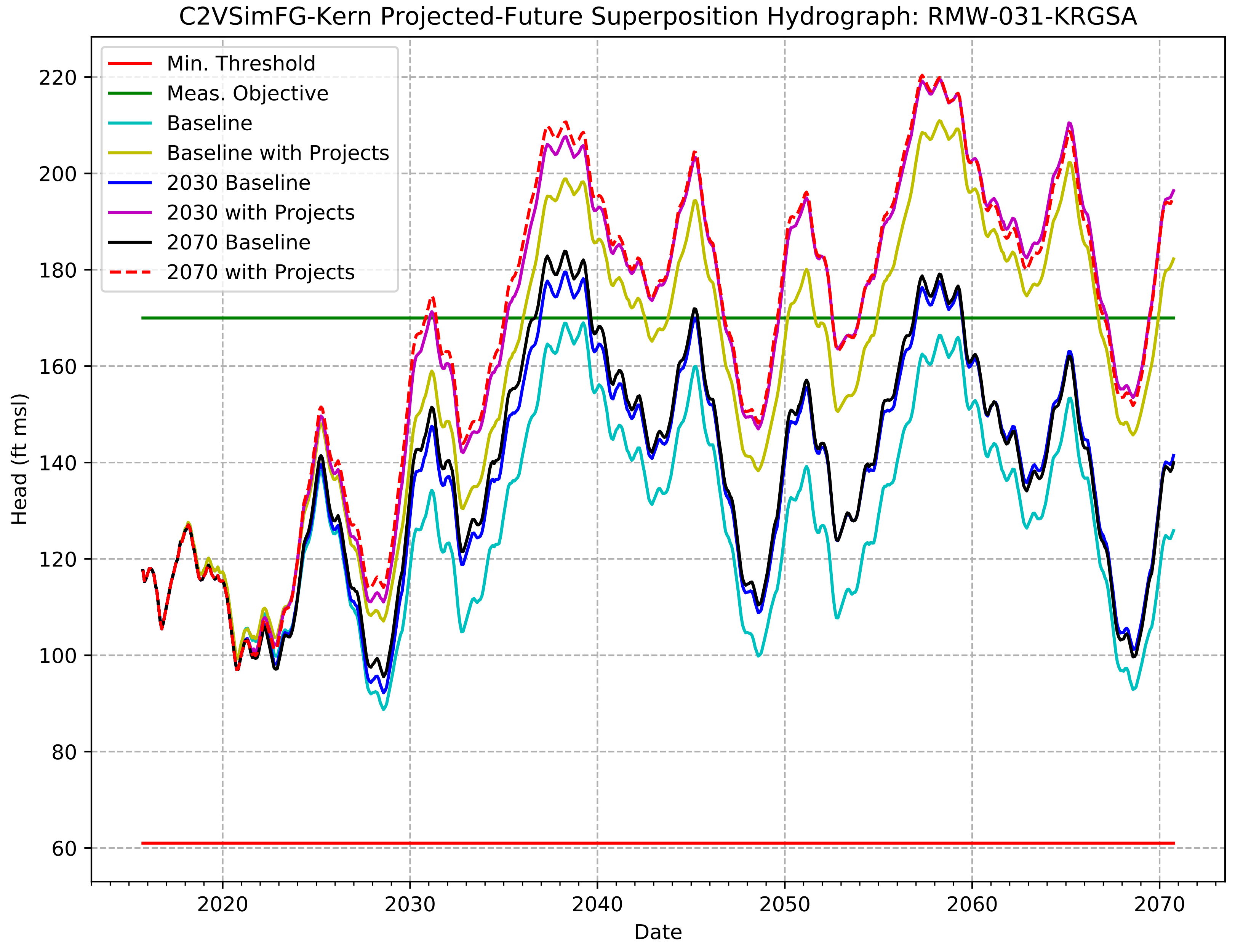


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-028-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
250
200
150
100
50
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-029-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-030-KRGSA
Head (ft msl)
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-031-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
220
200
180
160
140
120
100
80
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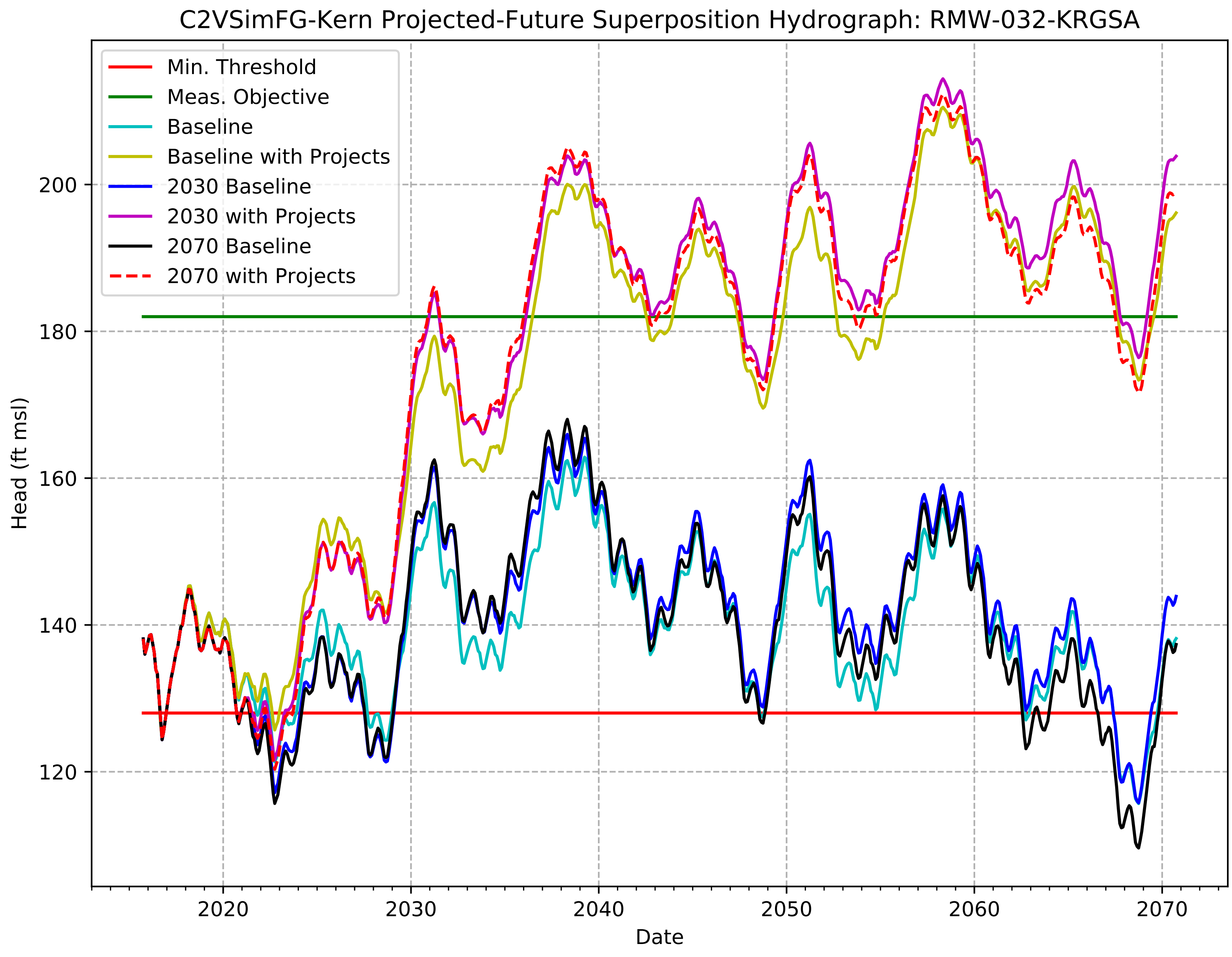
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-032-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
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140
120
2020
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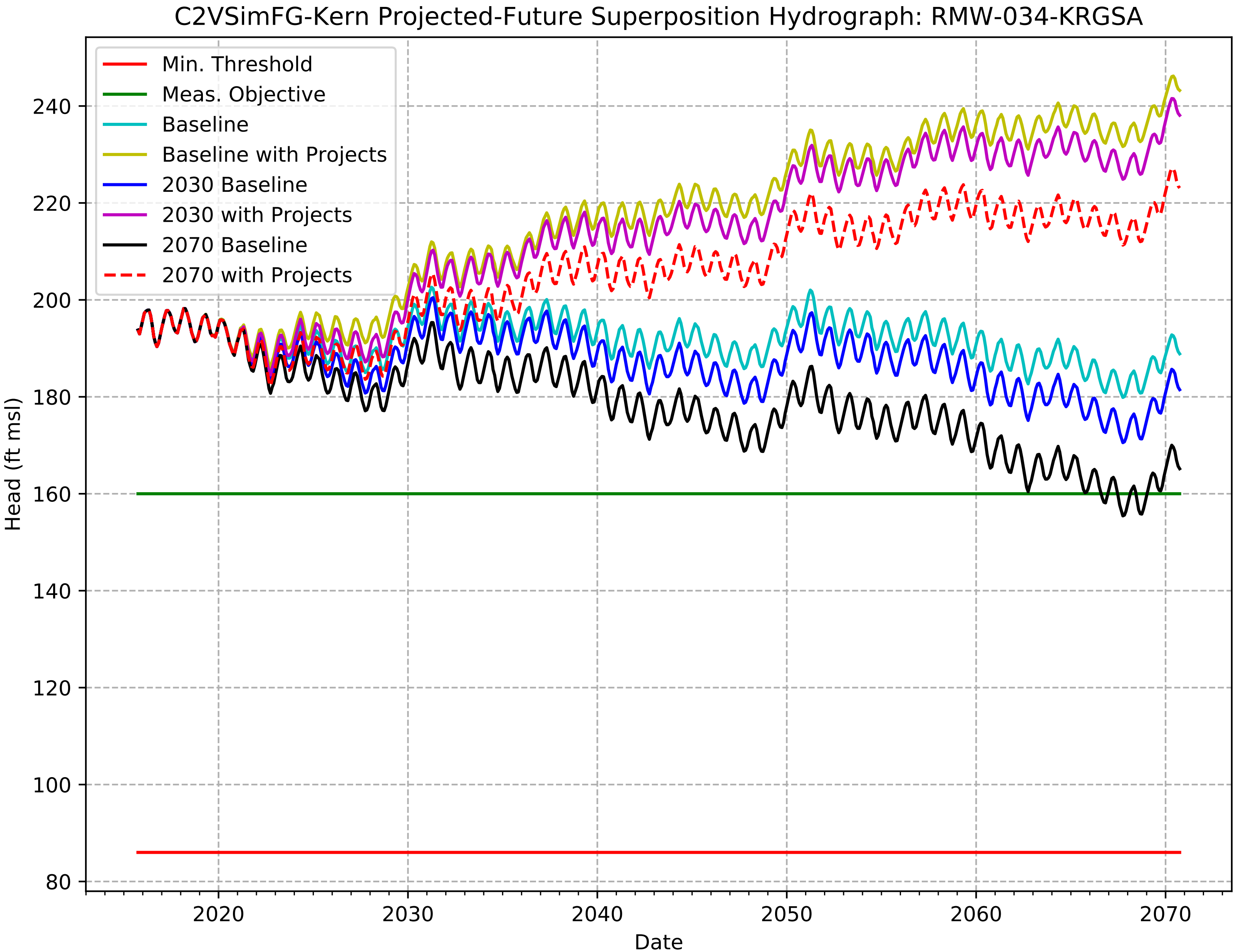
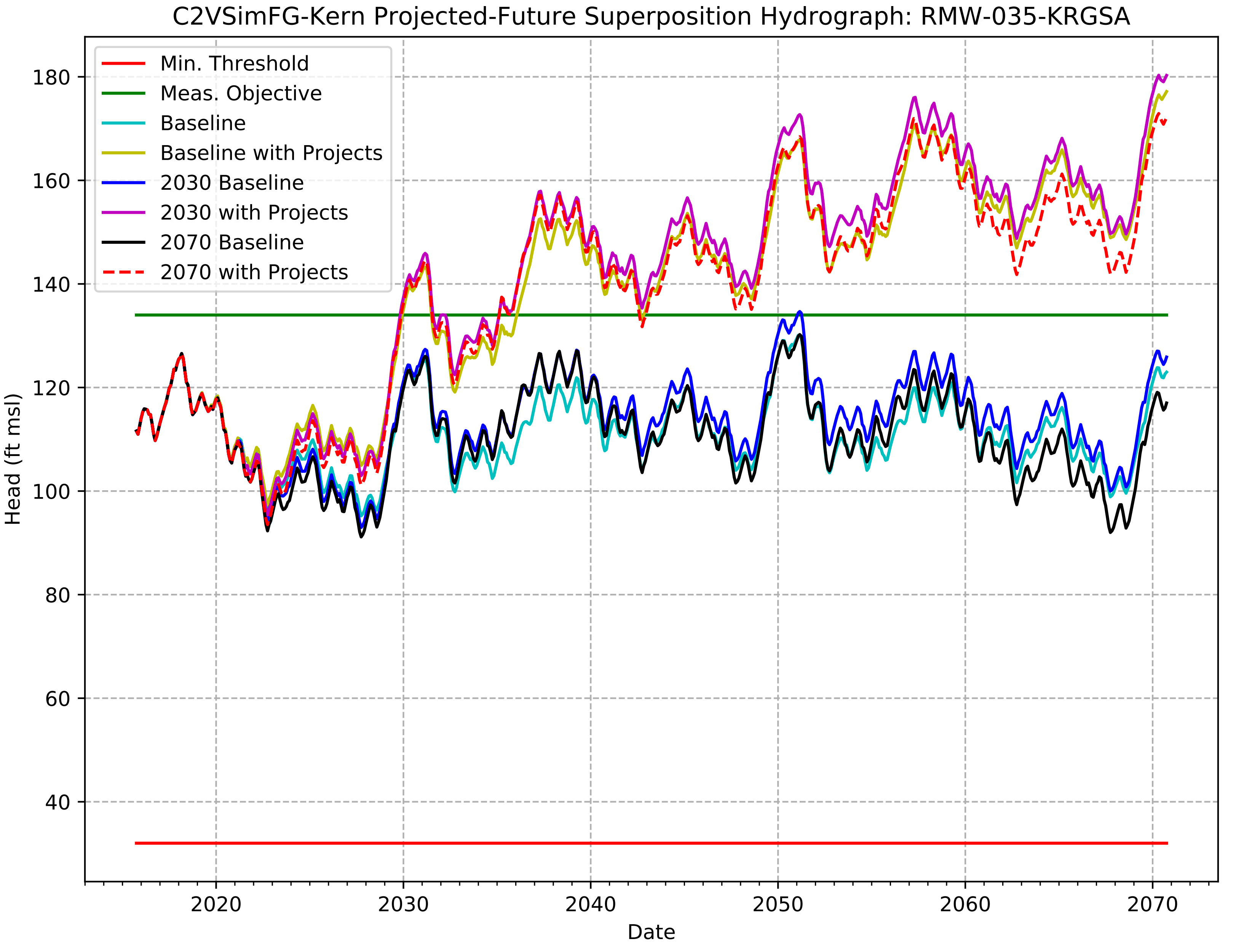
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-034-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
240
220
200
180
160
140
120
100
80
Date
2020
2030
2040
2050
2060
2070



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-035-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
180
160
140
120
100
80
60
40
2020
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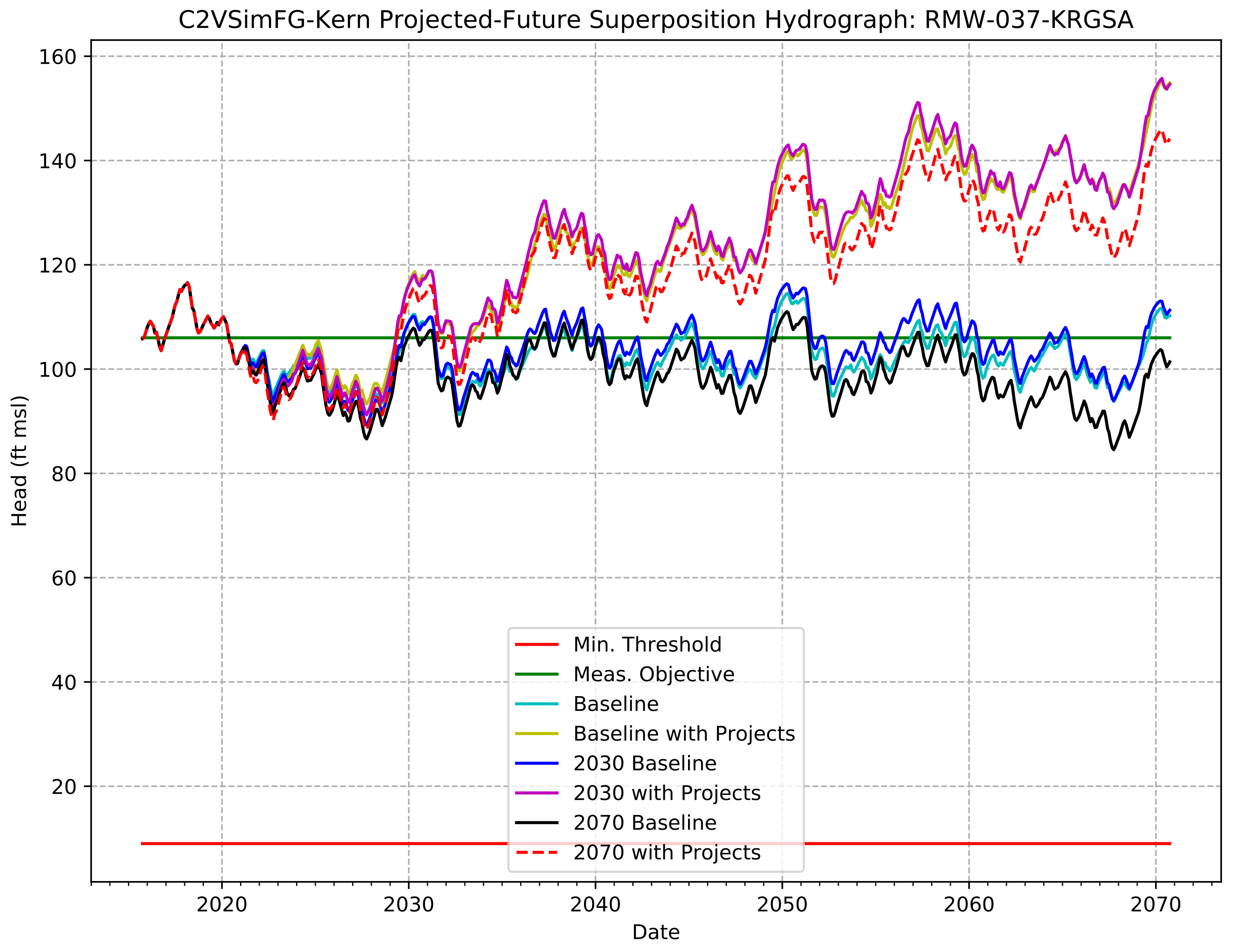
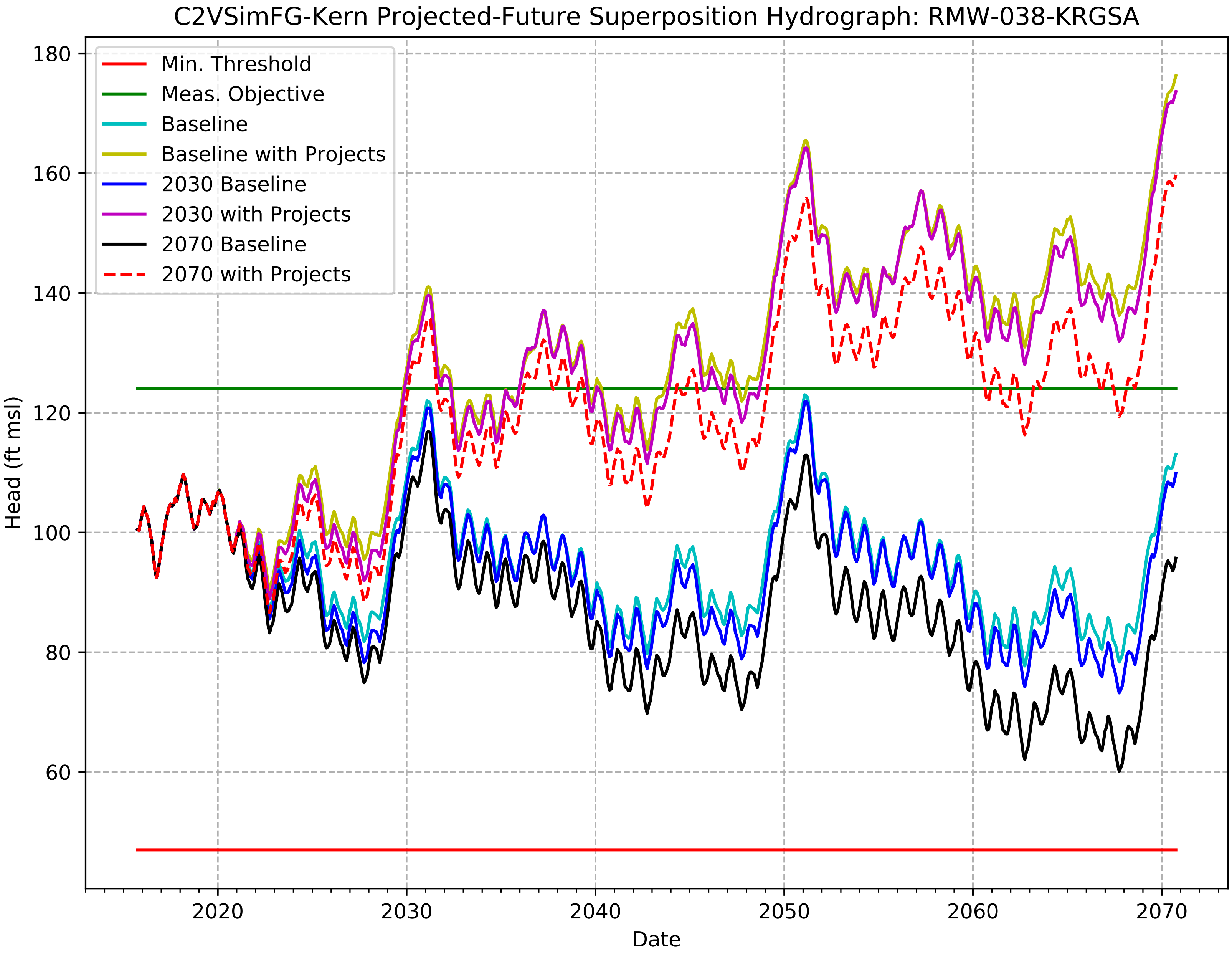
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-037-KRGSA
Head (ft msl)
Date
160
140
120
100
80
60
40
20
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-038-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
180
160
140
120
100
80
60
2020
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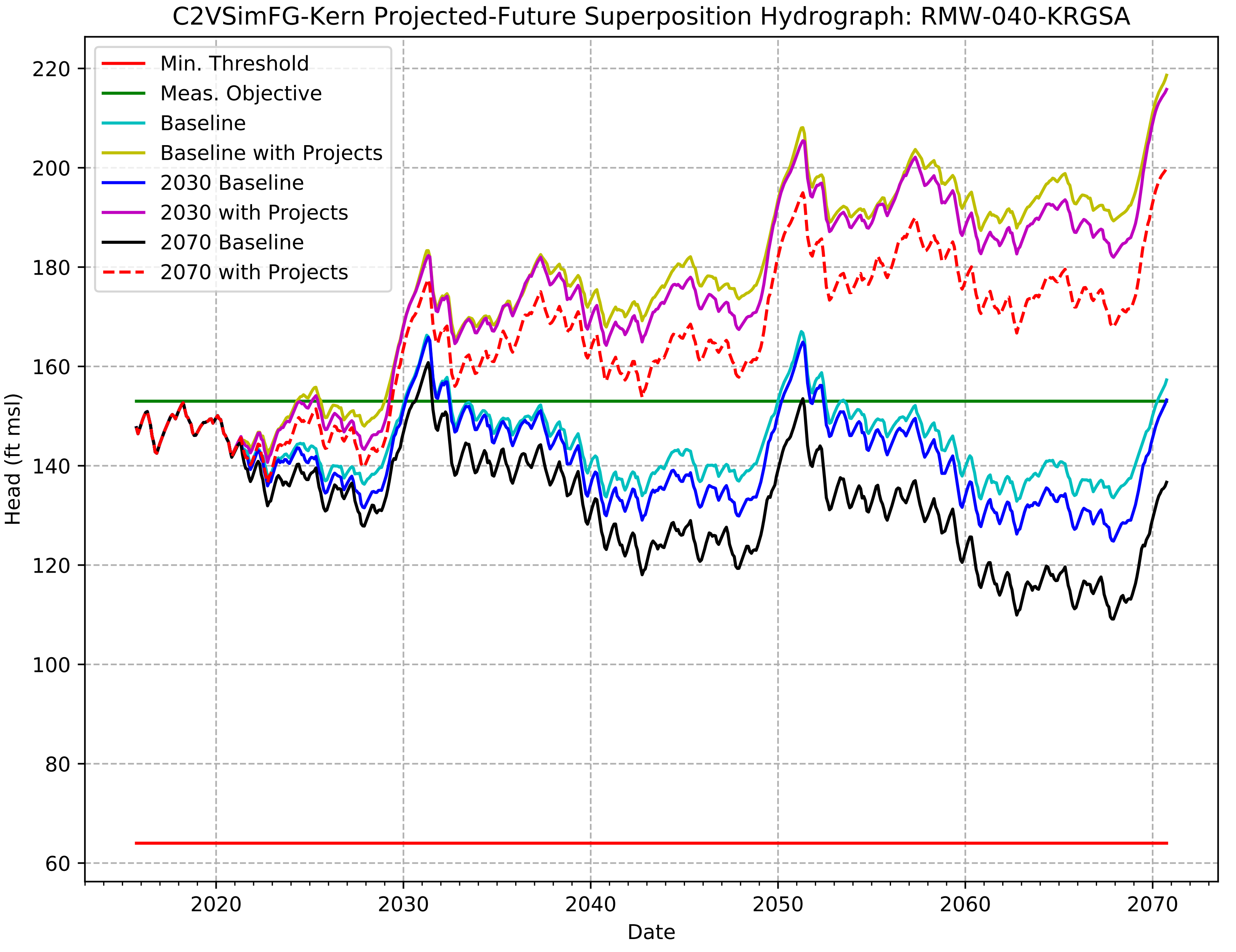
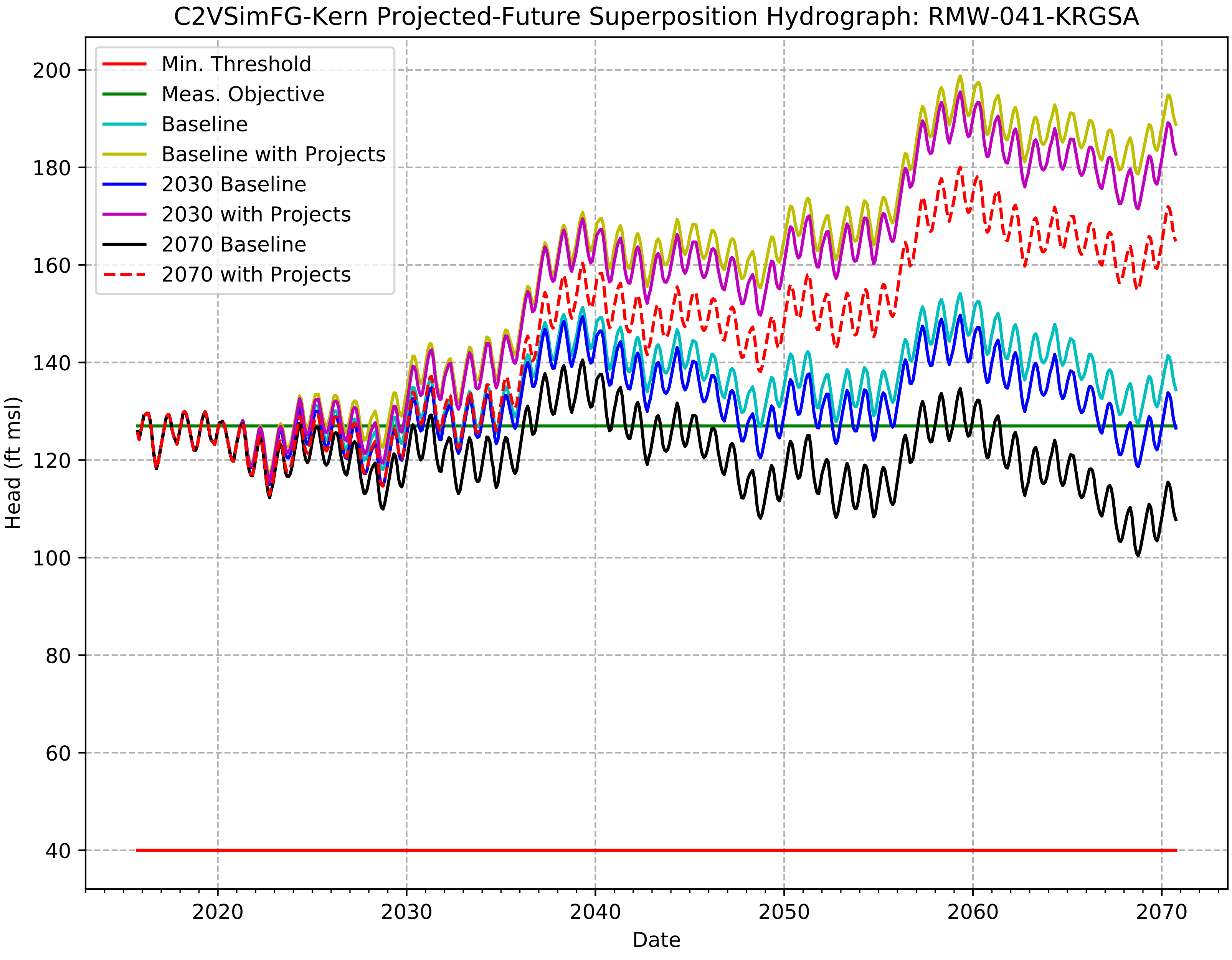
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-040-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
220
200
180
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-041-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
60
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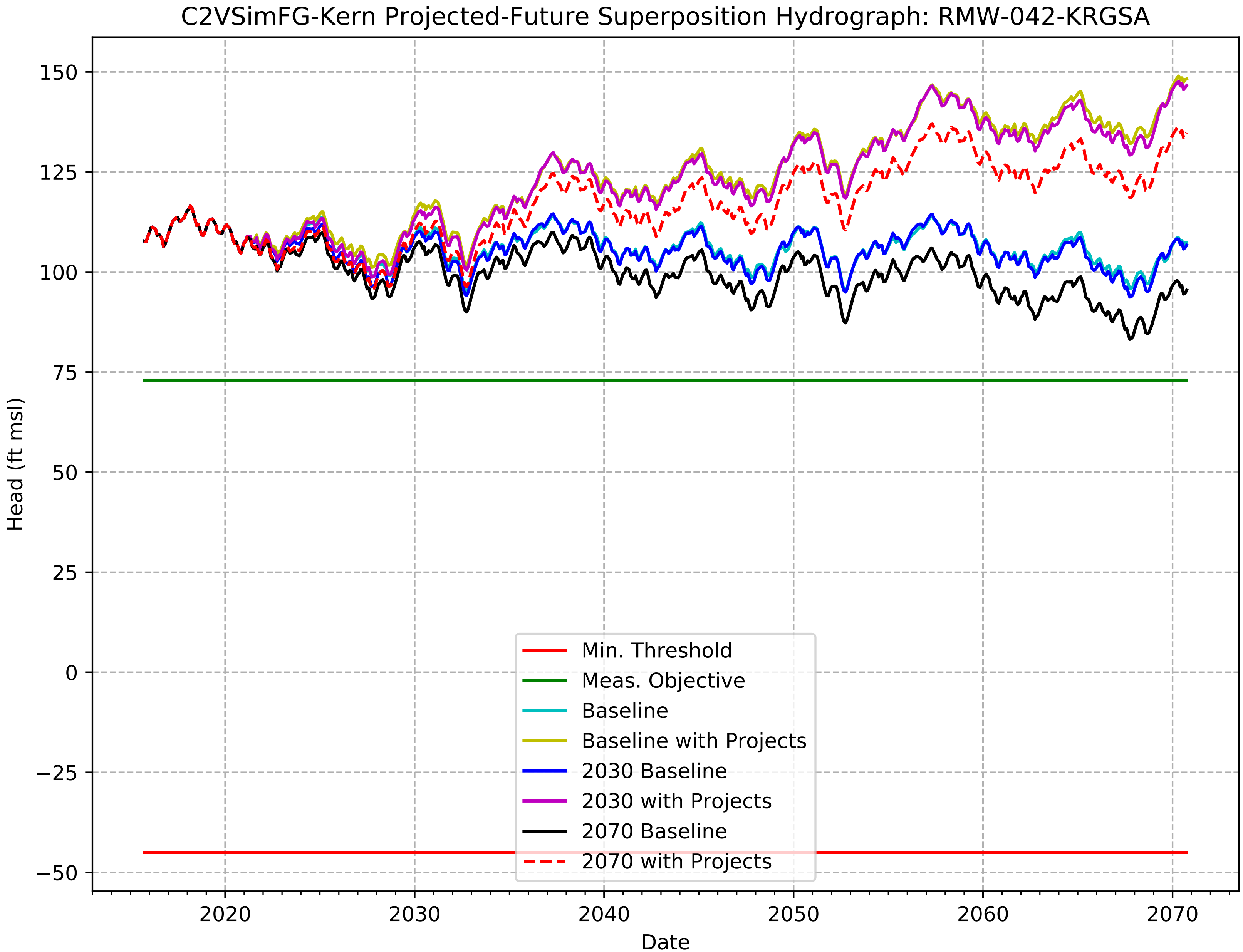
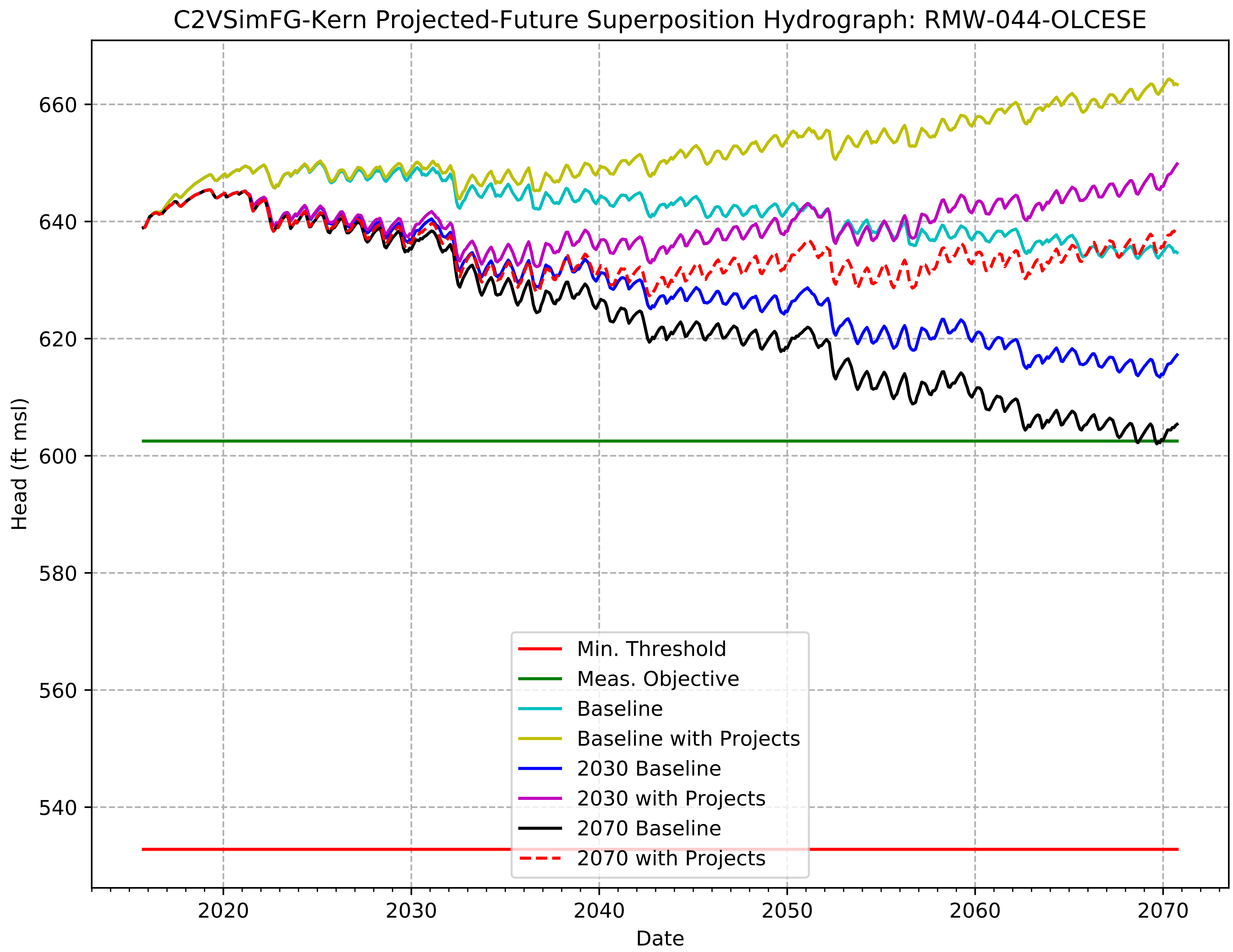
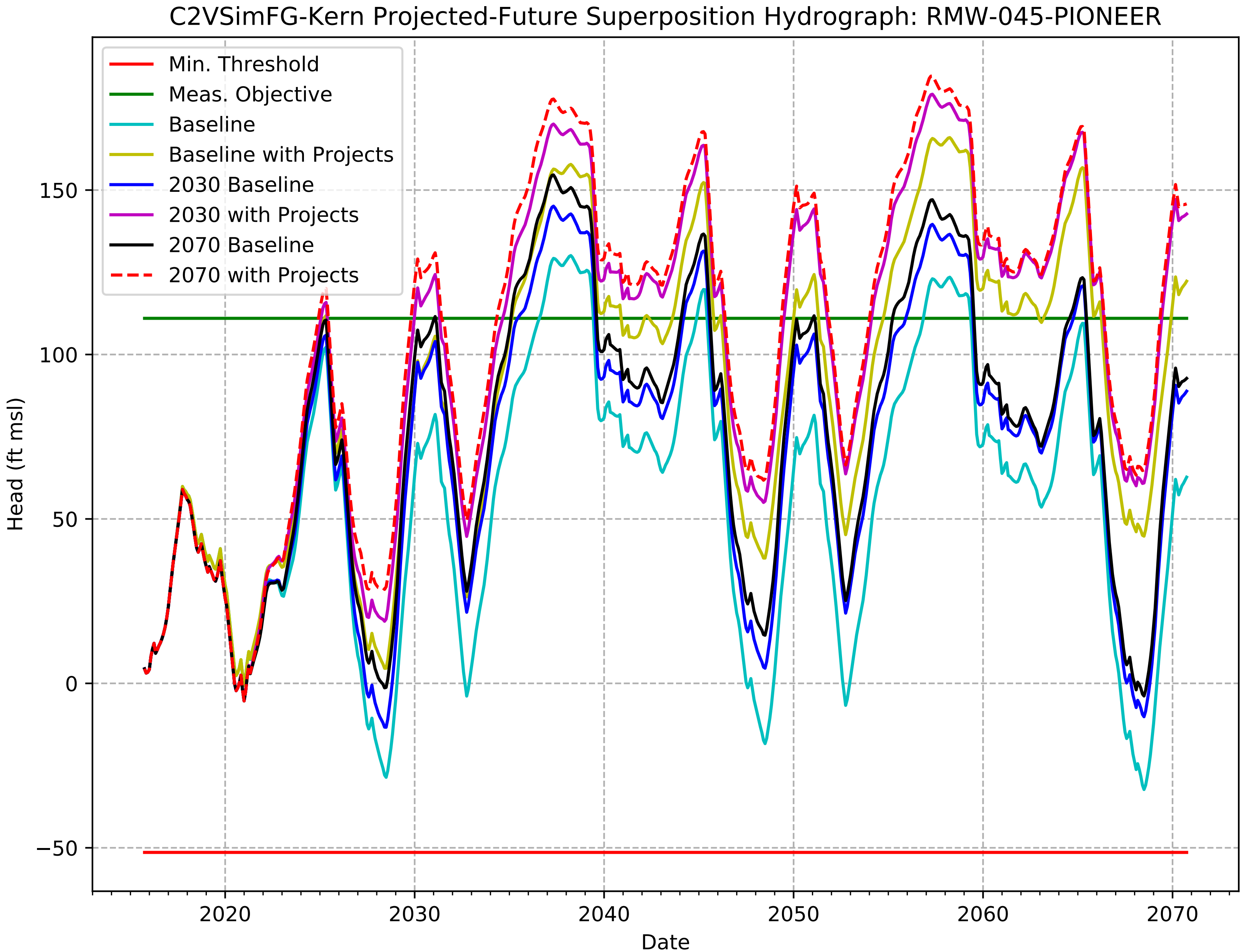
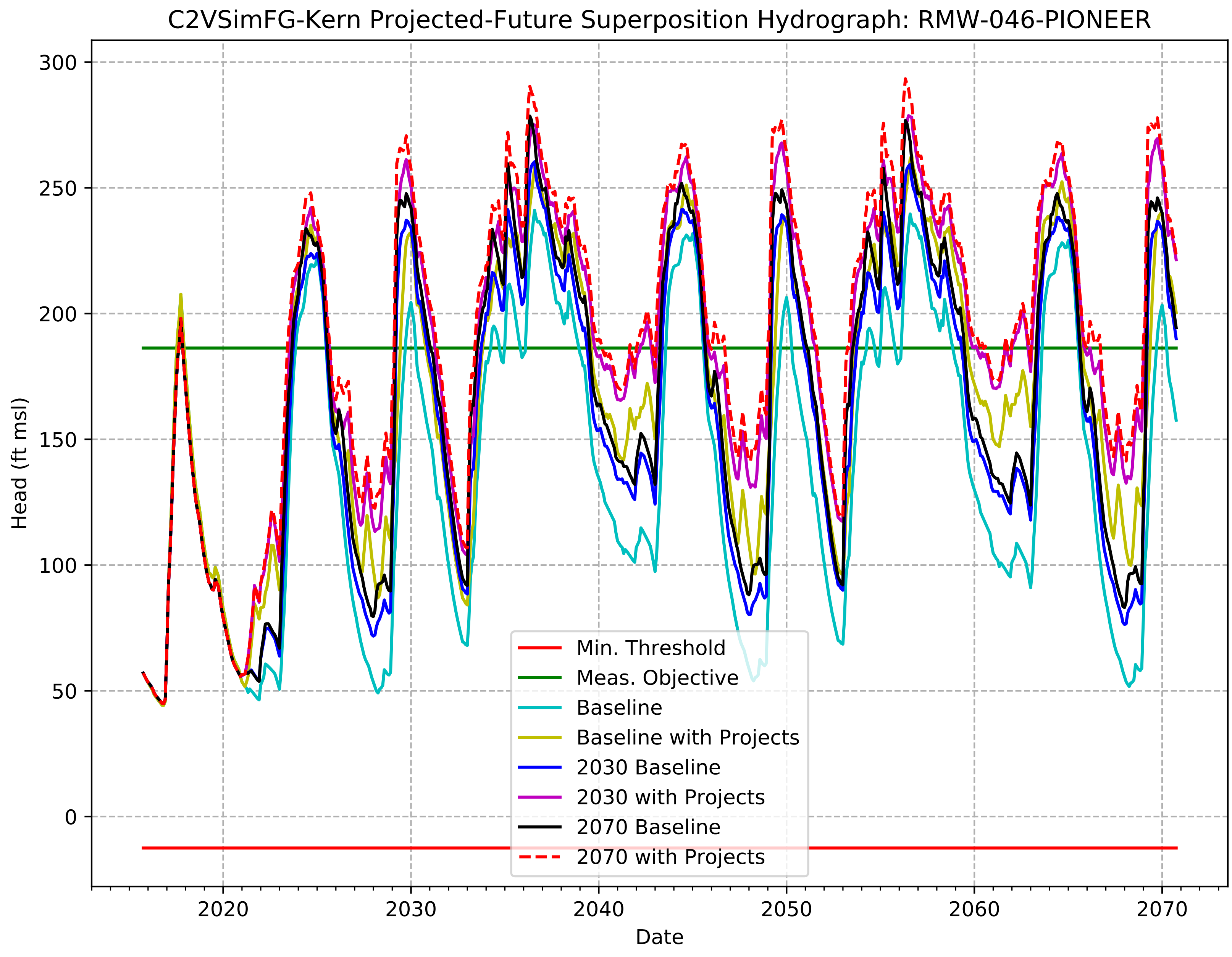
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-042-KRGSA
Head (ft msl)
Date
150
125
100
75
50
25
0
−25
−50
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

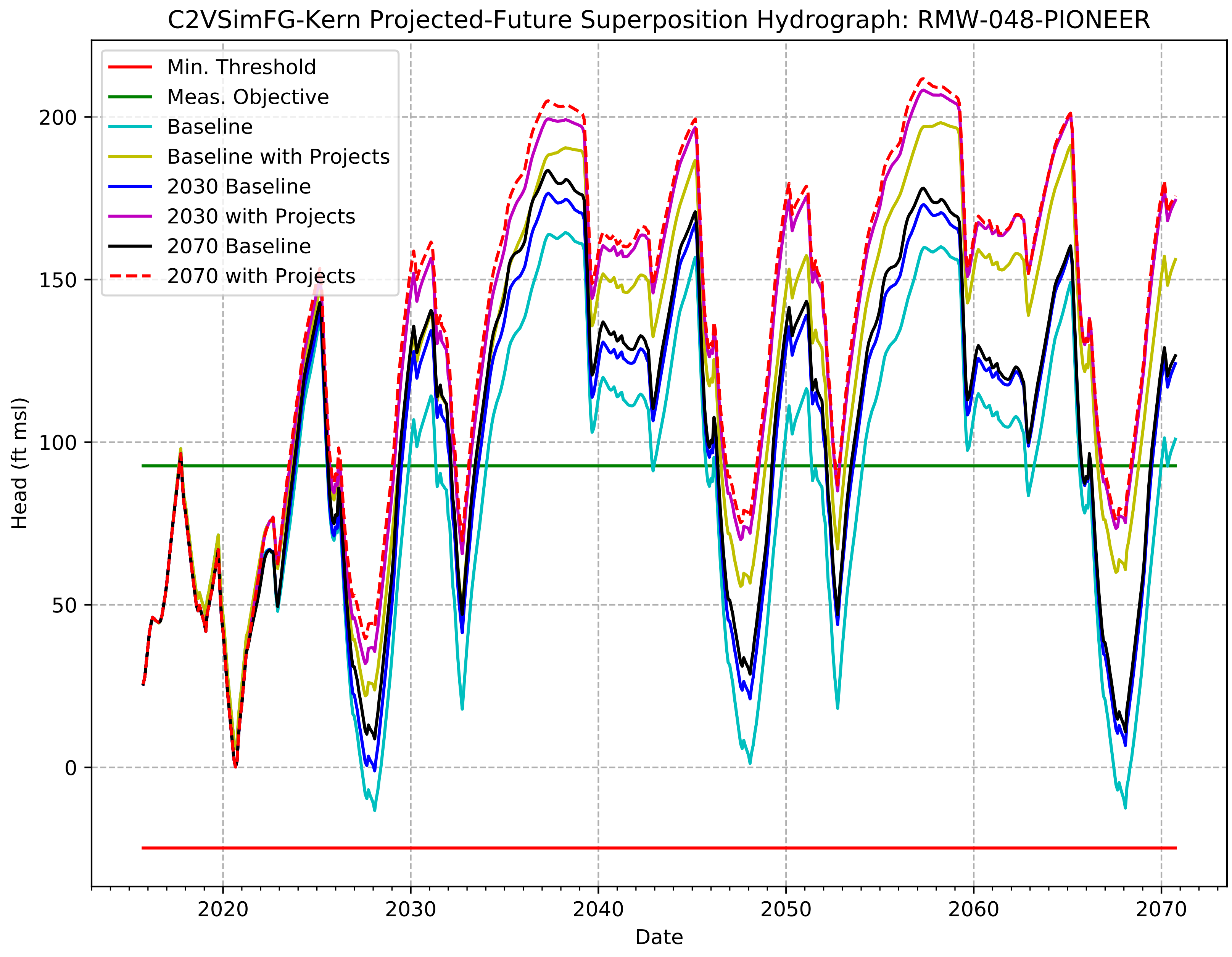

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-044-OLCESE
Head (ft msl)
660
640
620
600
580
560
540
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

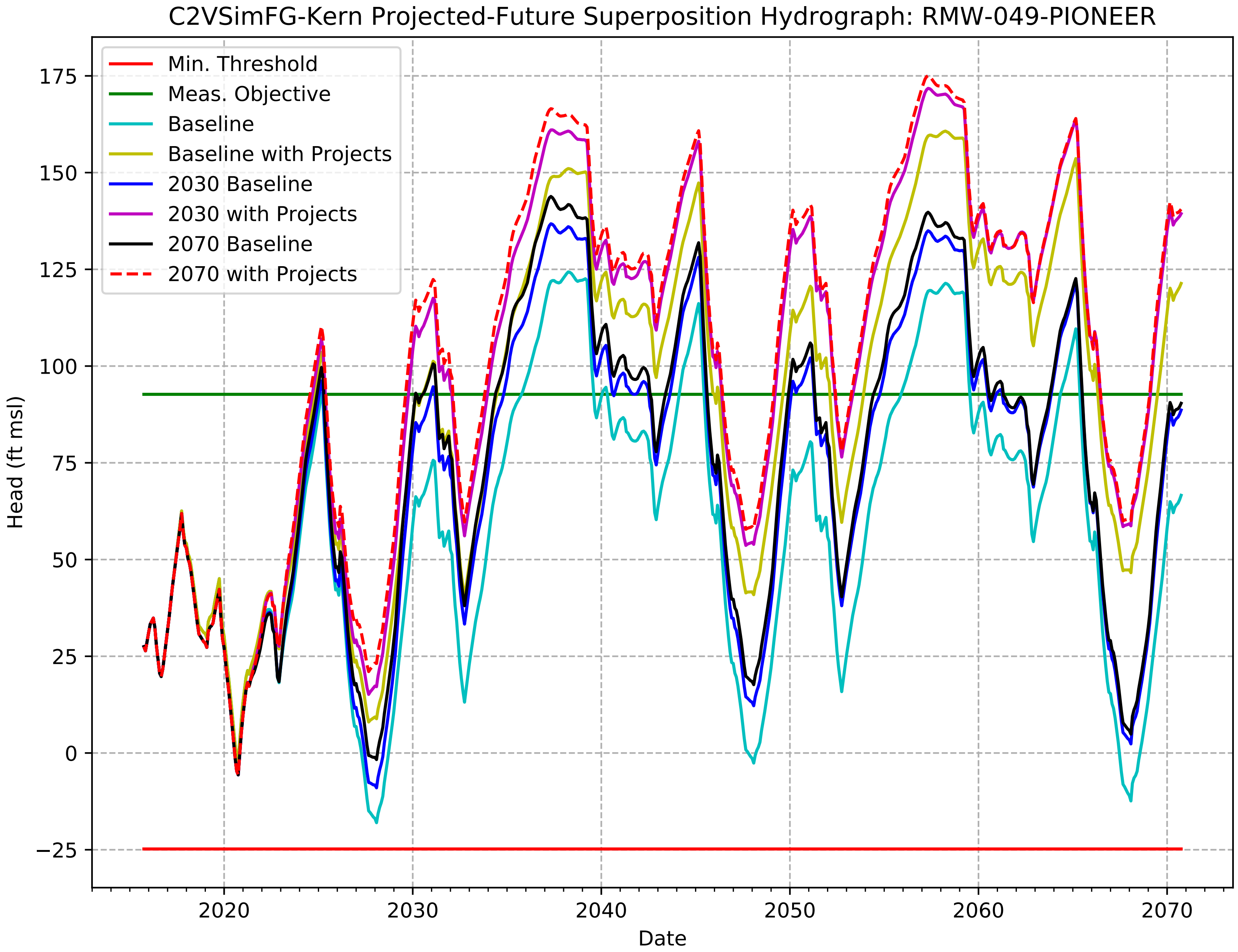


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-045-PIONEER
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date

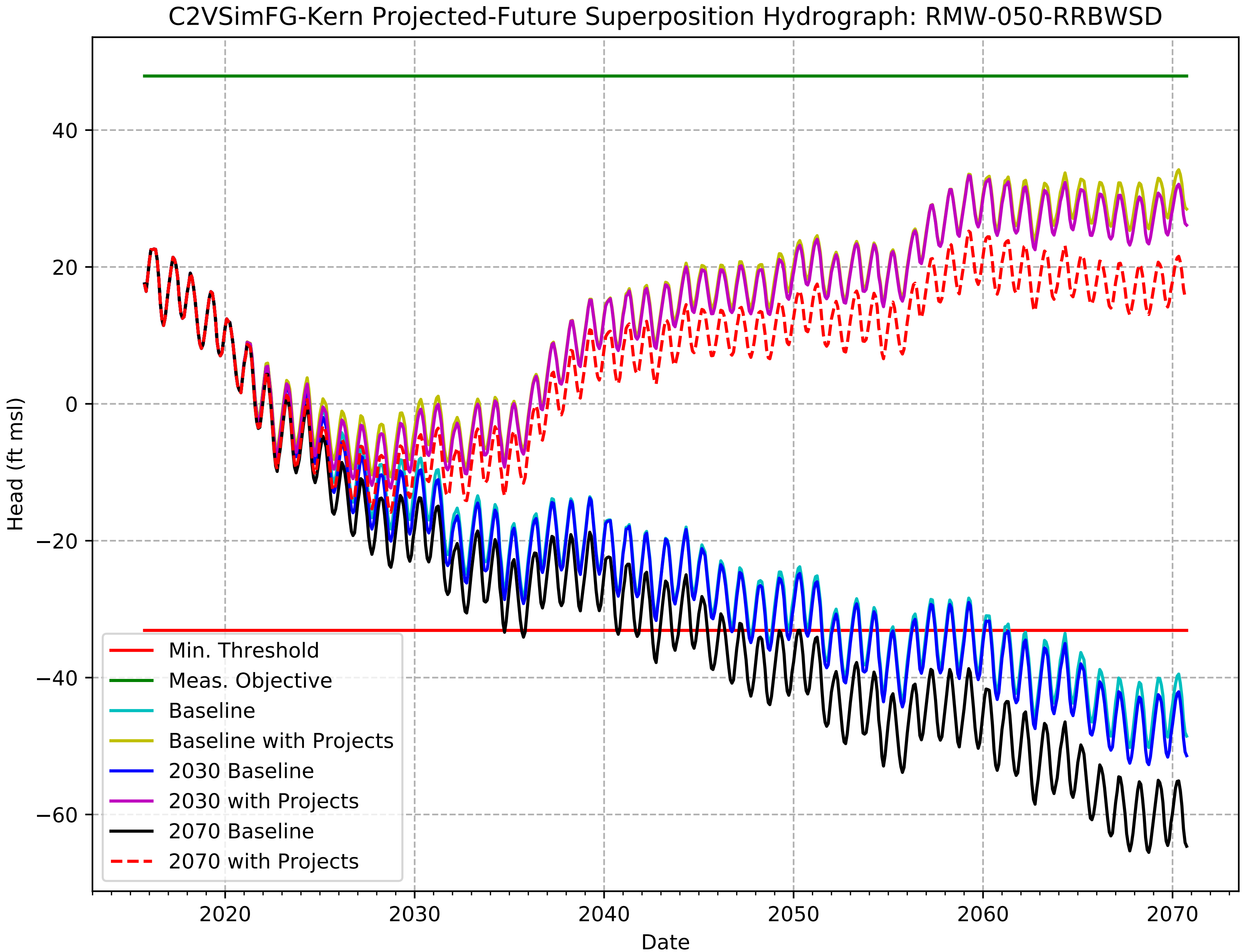


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-046-PIONEER
Head (ft msl)
Date
300
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

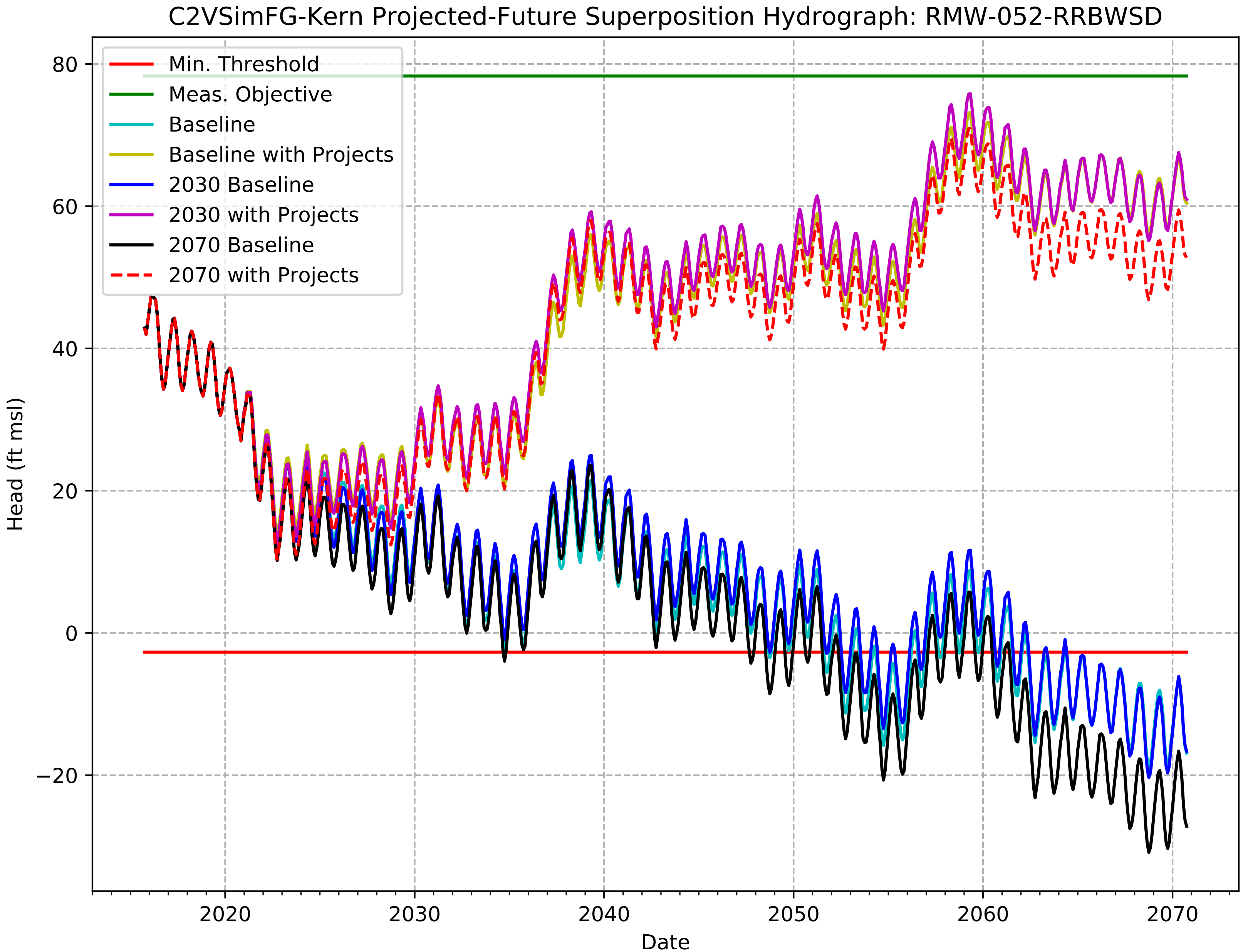

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-048-PIONEER
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-049-PIONEER
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
175
150
125
100
75
50
25
0
−25
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-050-RRBWSD
Head (ft msl)
40
20
0
−20
−40
−60
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-052-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
80
60
40
20
0
−20
2020
2030
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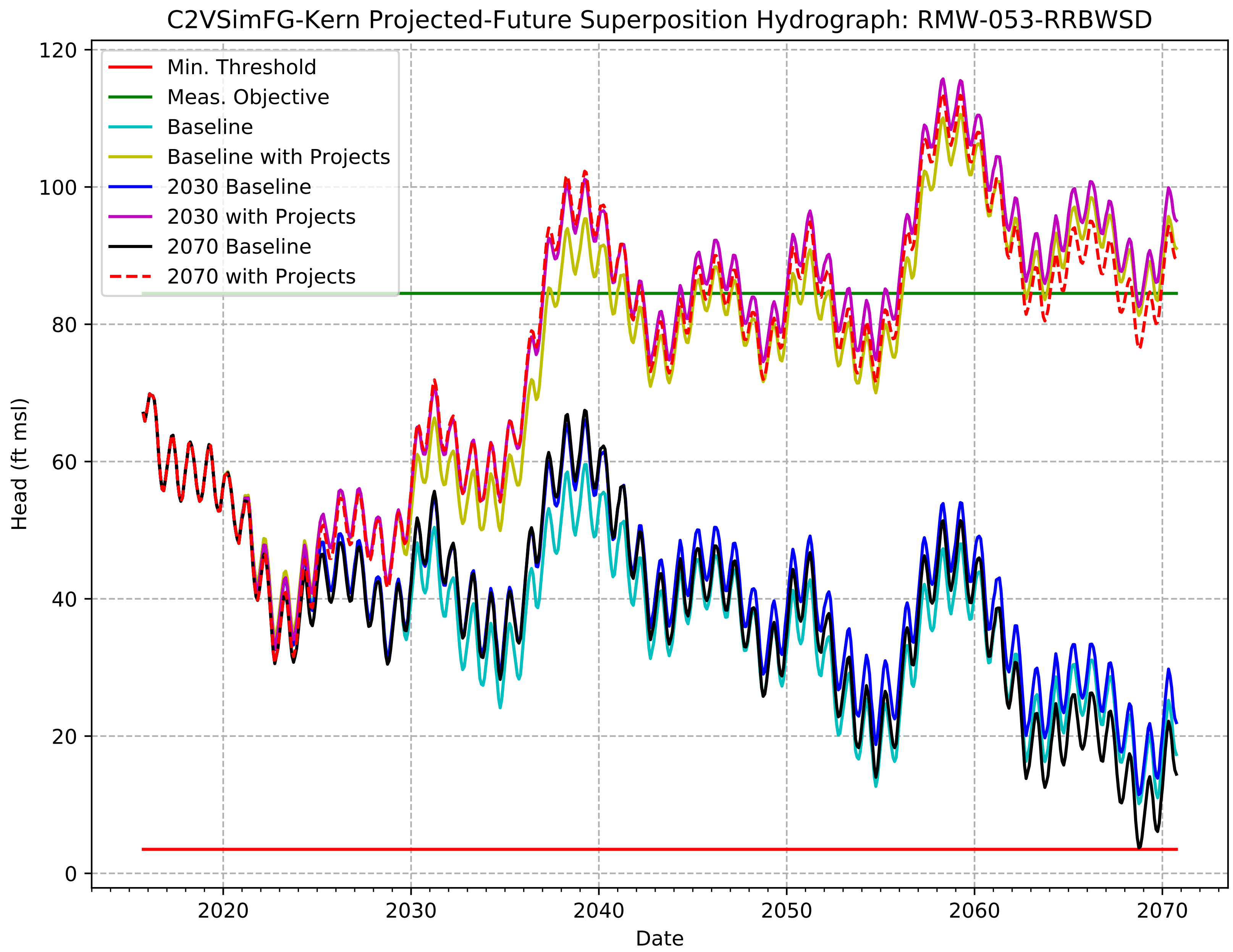
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-053-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
0
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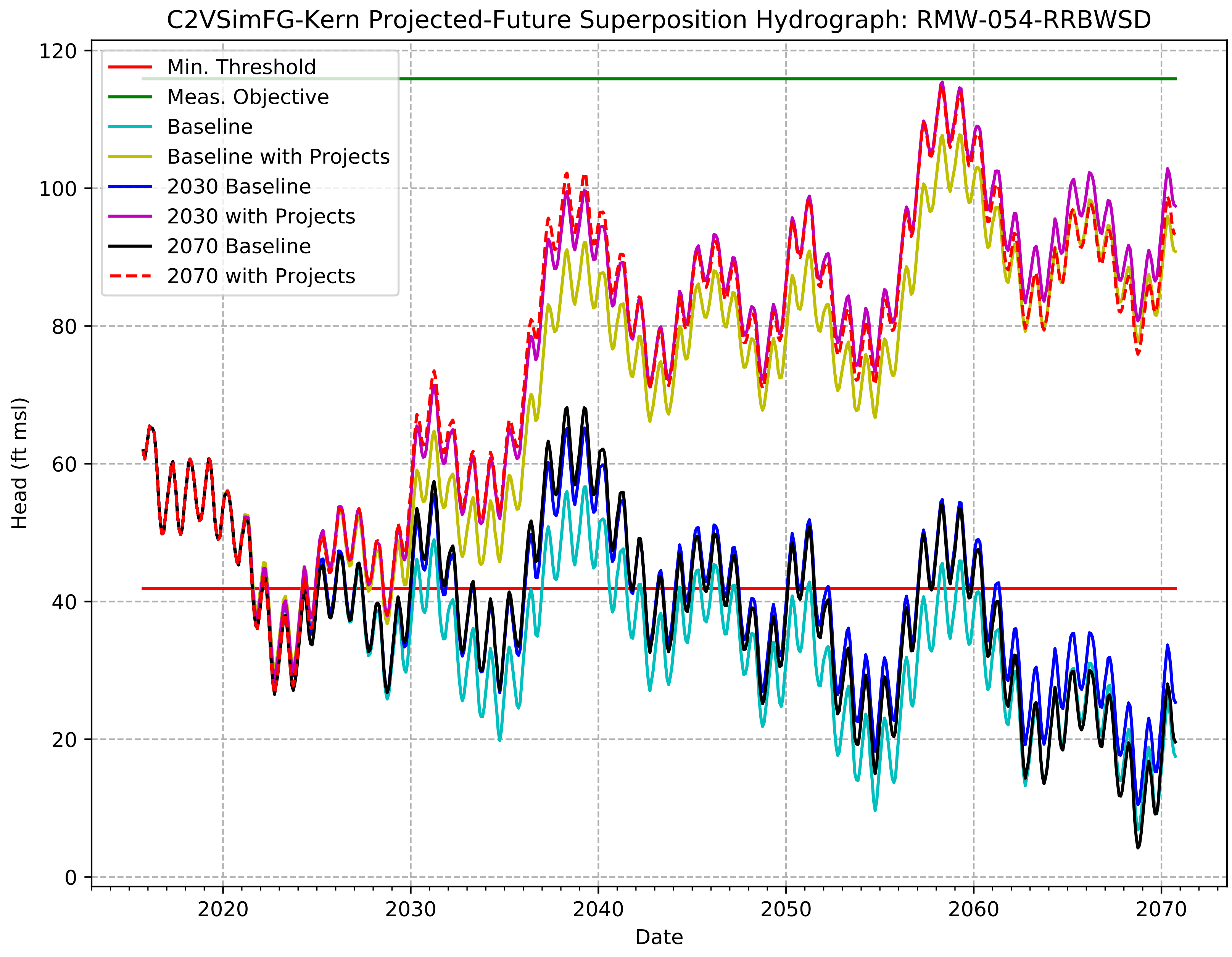
2040
2050
2060
2070



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-054-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
0
20
40
60
80
100
120
2020
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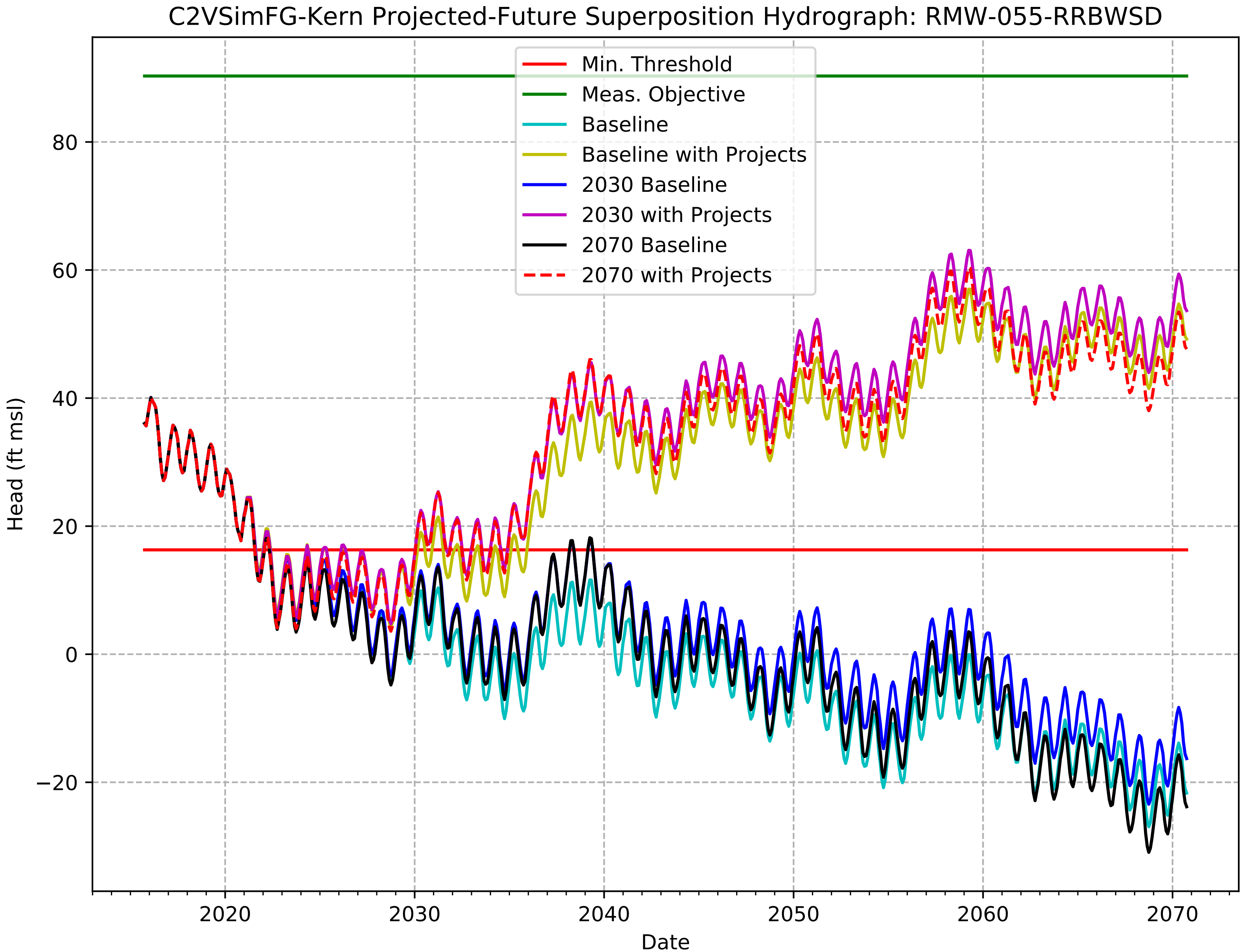
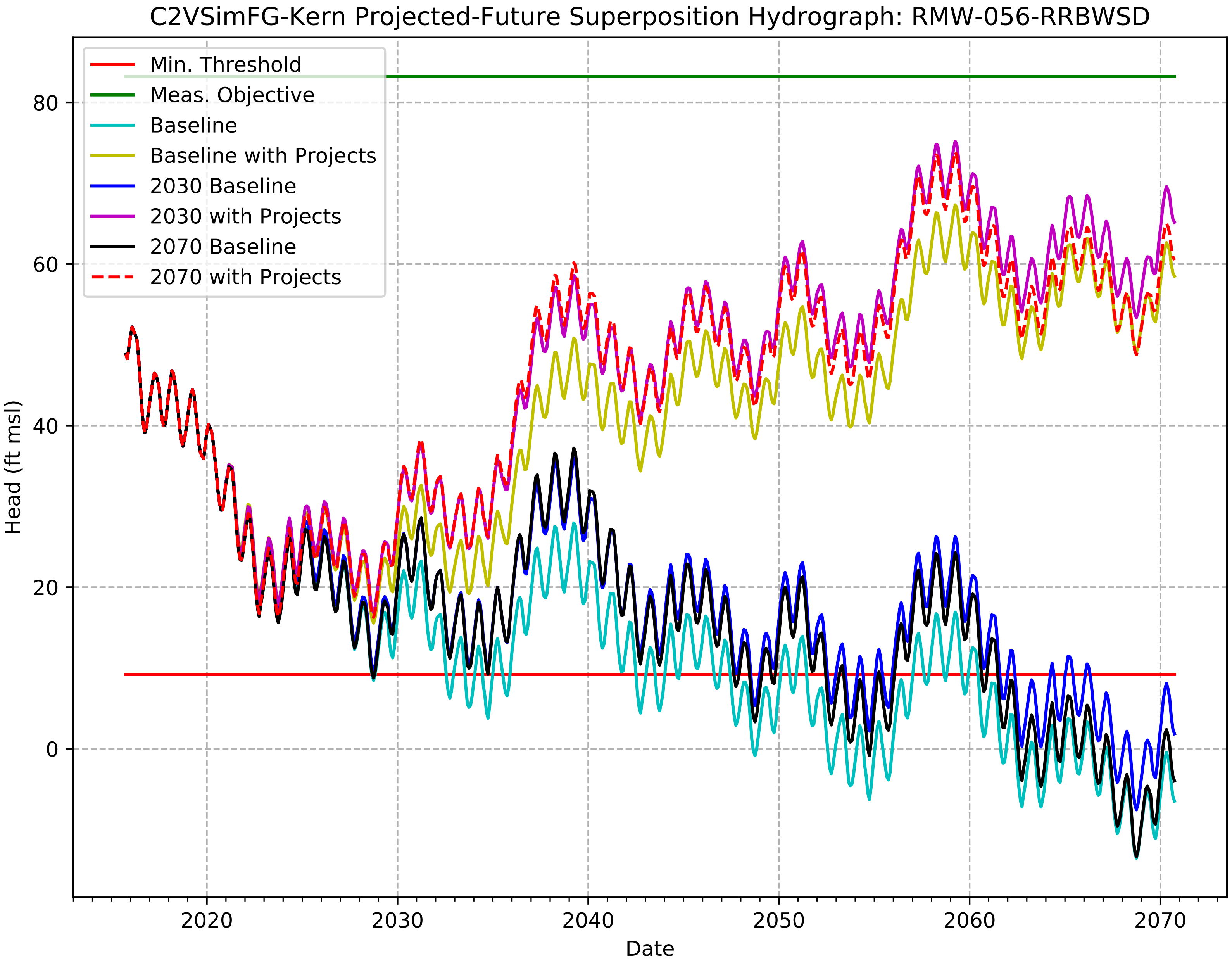
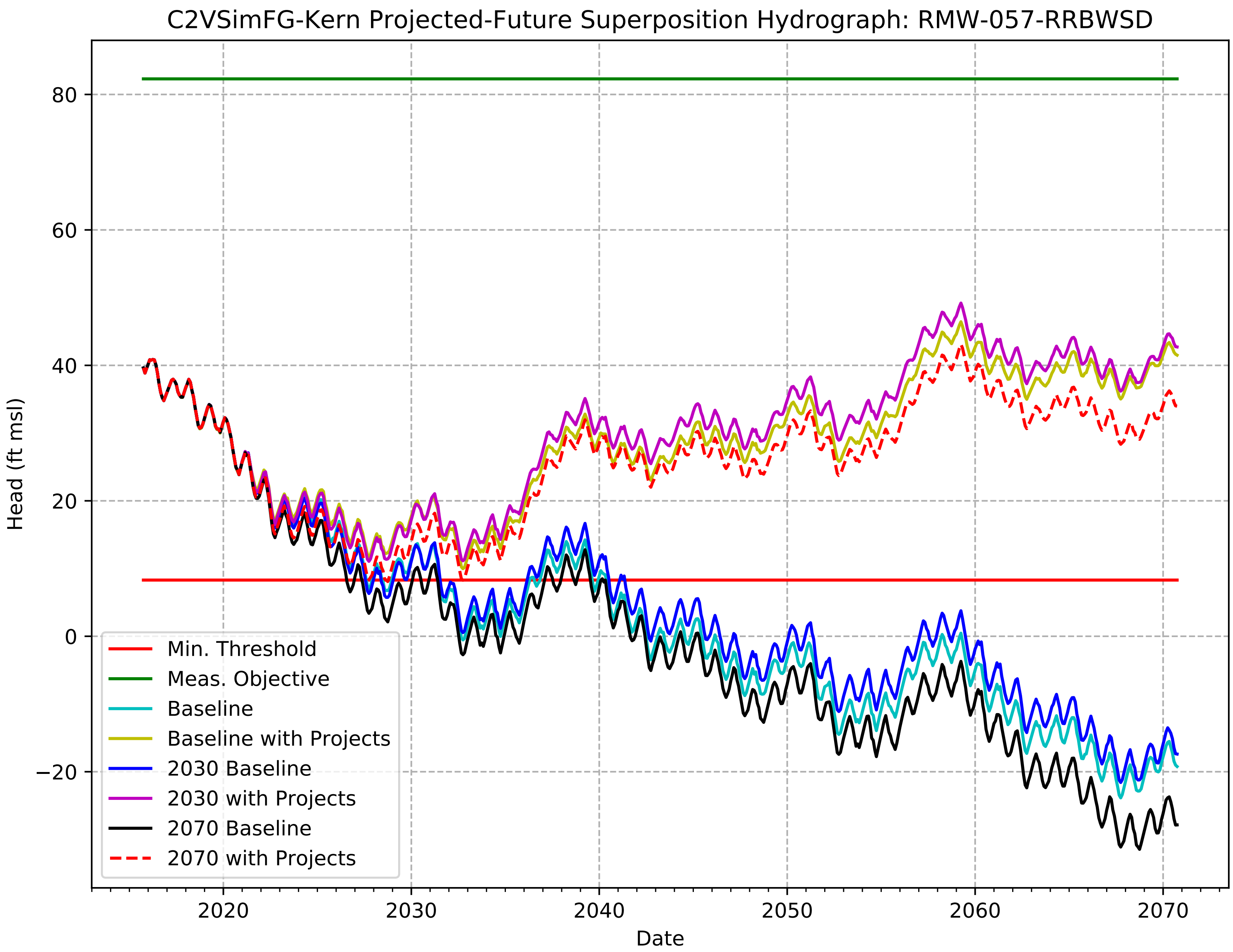
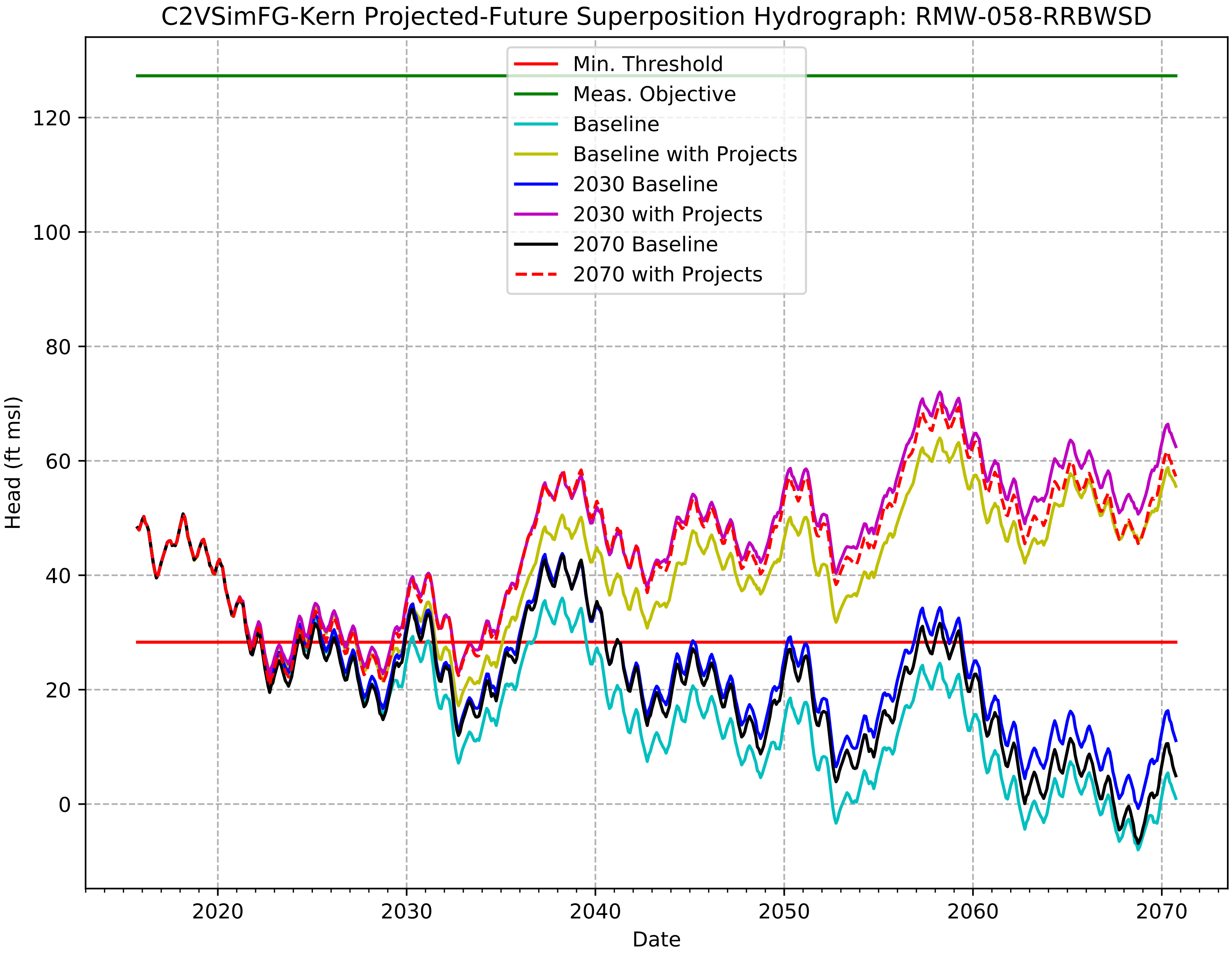
2050
2060
2070
Date



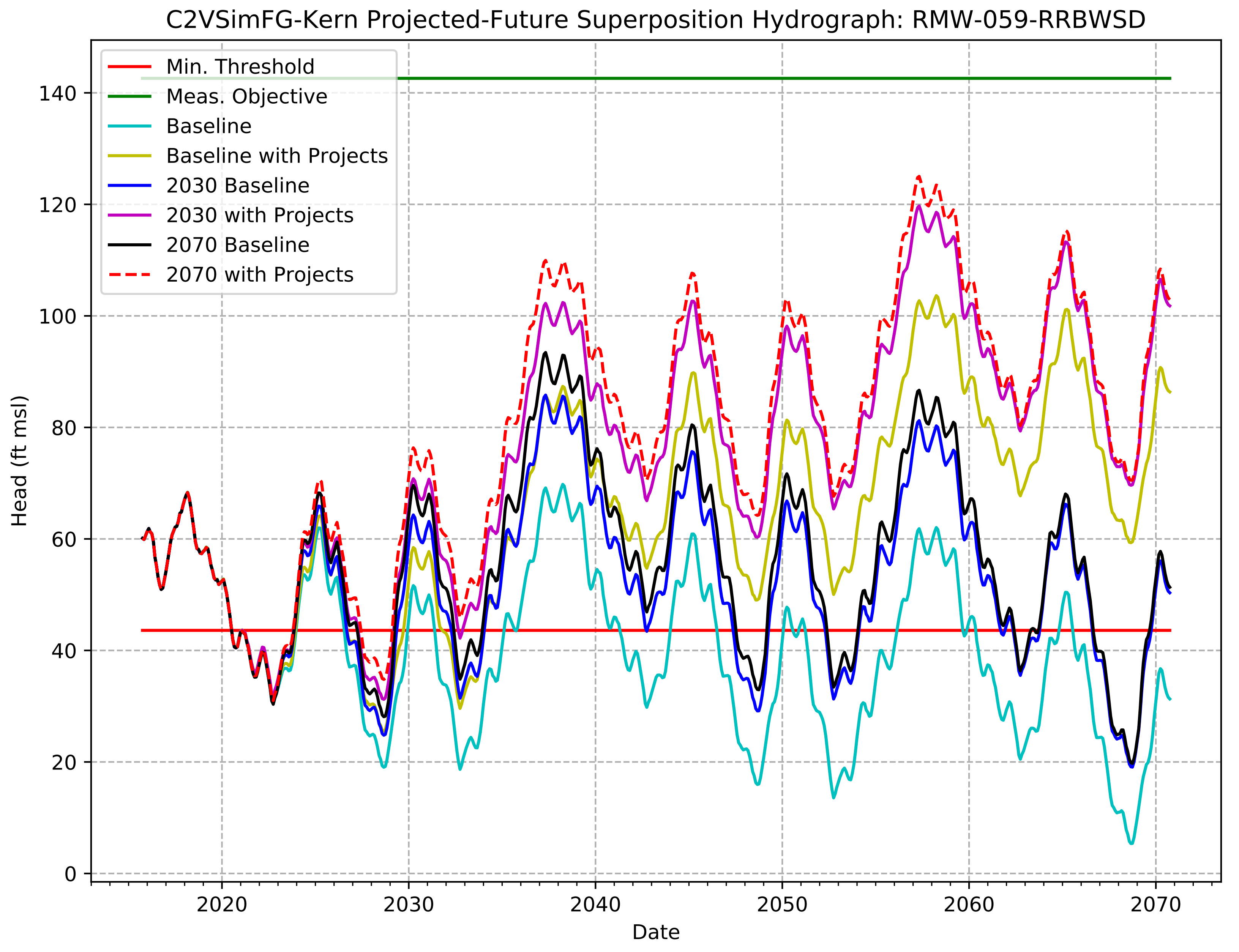
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-055-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
80
60
40
20
0
−20
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-056-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
80
60
40
20
0
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-057-RRBWSD
Head (ft msl)
80
60
40
20
0
−20
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-058-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
120
100
80
60
40
20
0
2020
2030
2040
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-059-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
0
20
40
60
80
100
120
140
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2030
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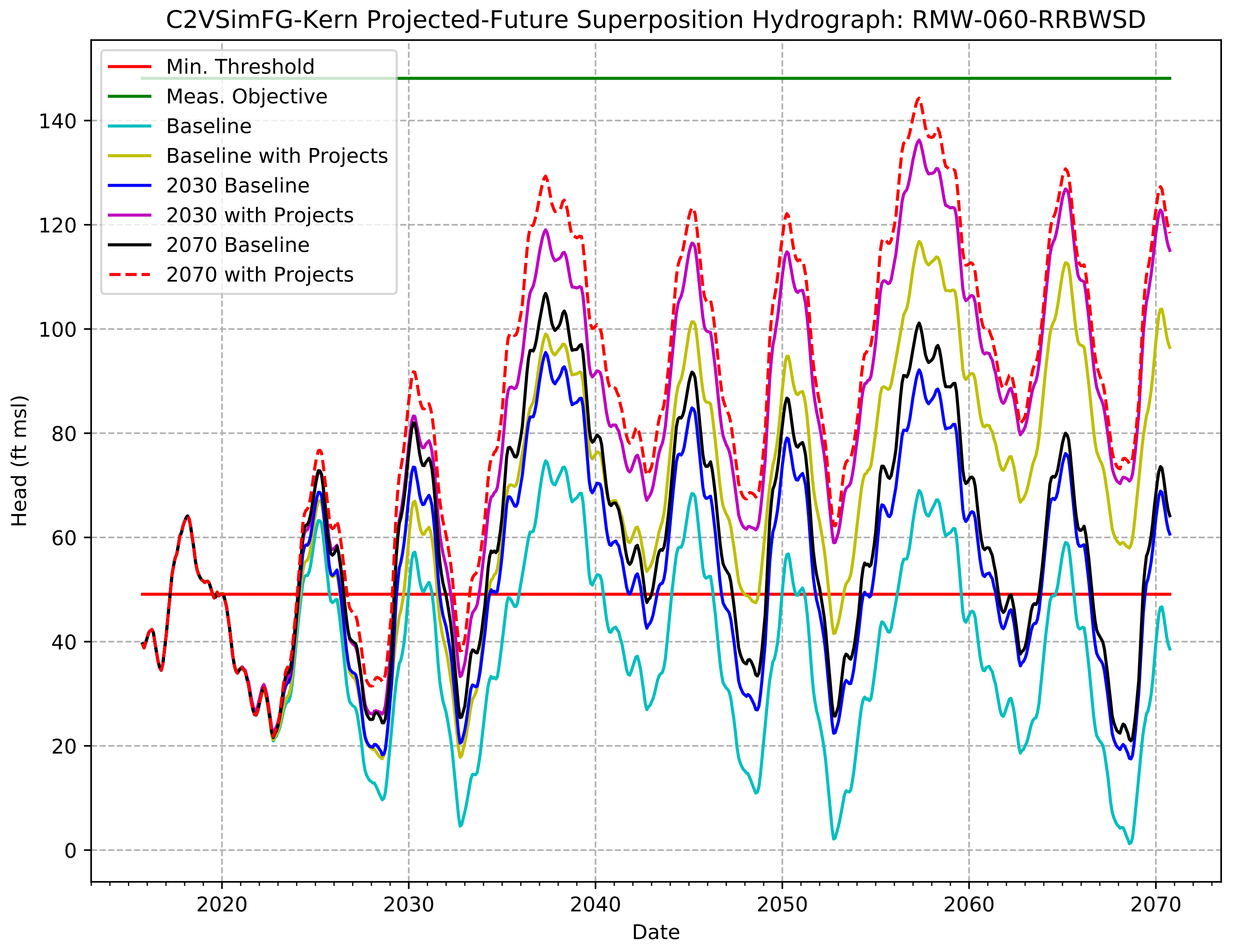
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-060-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
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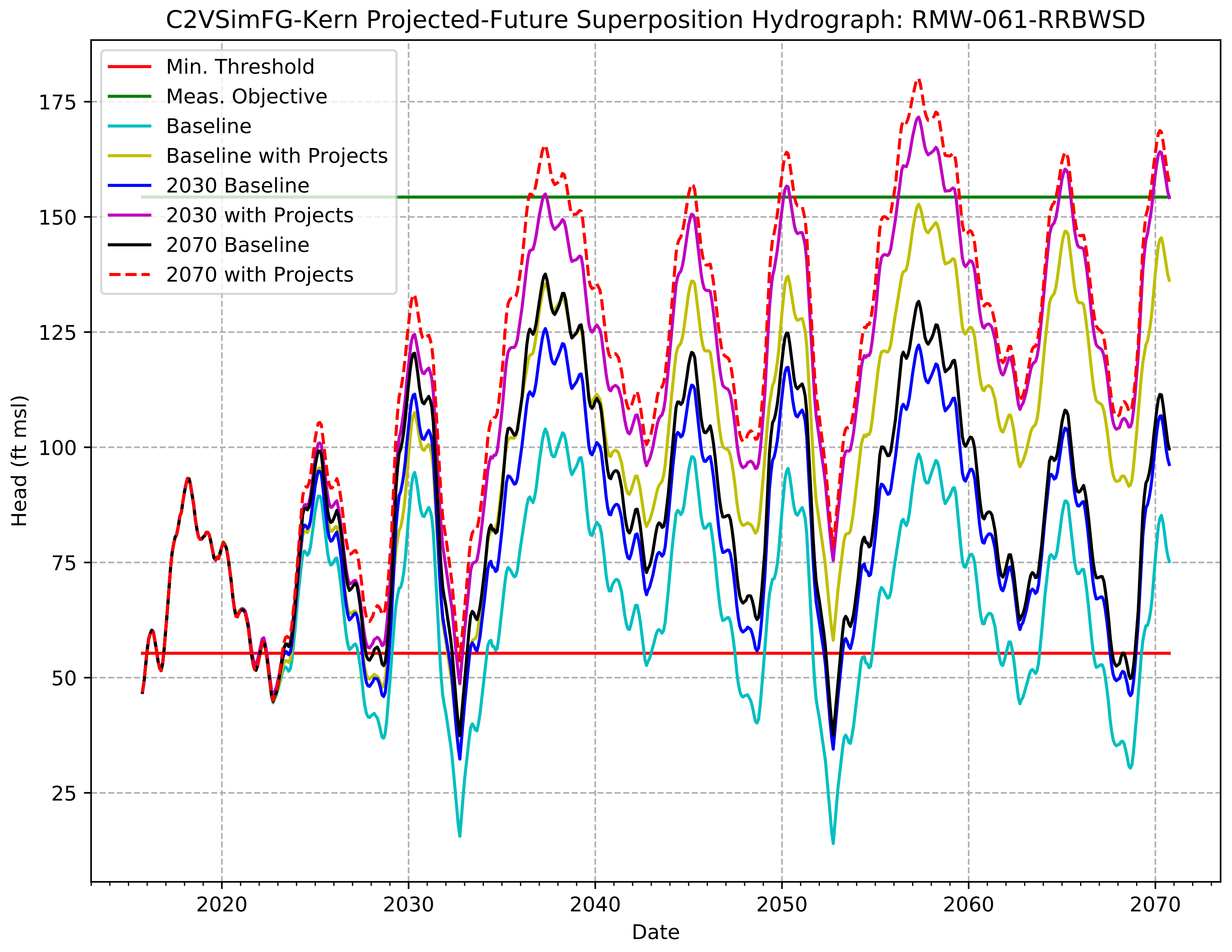
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-061-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
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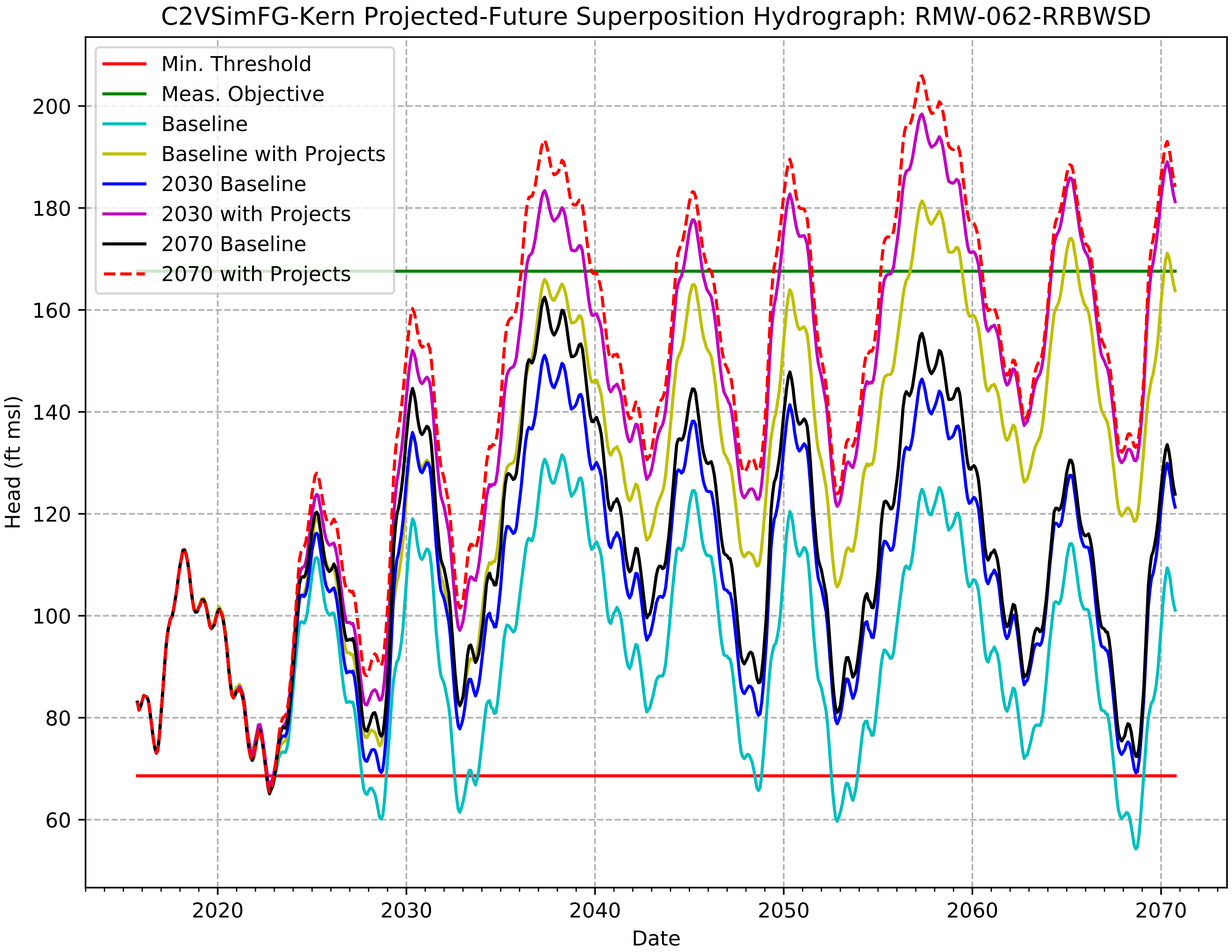
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-062-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
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160
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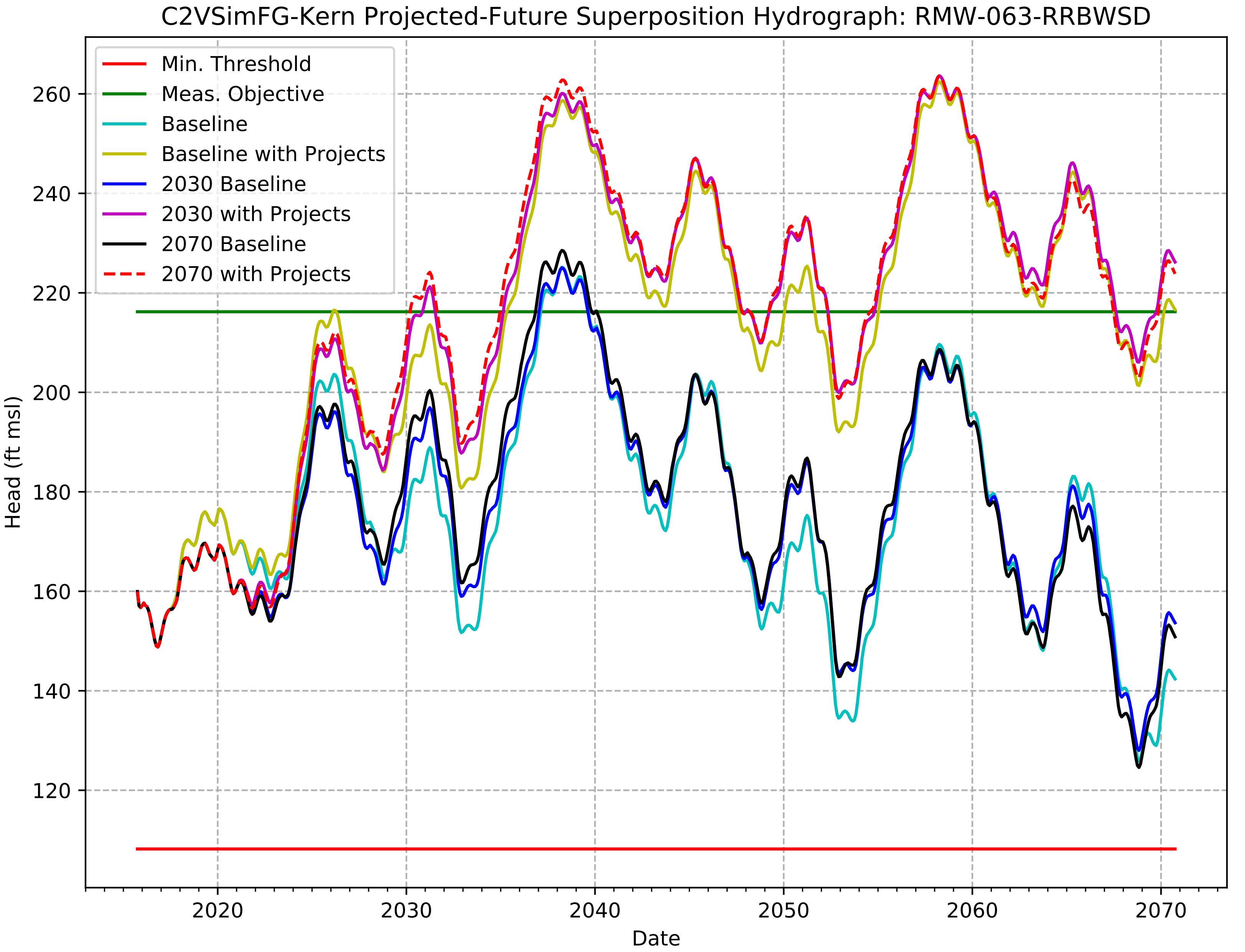
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-063-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
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240
220
200
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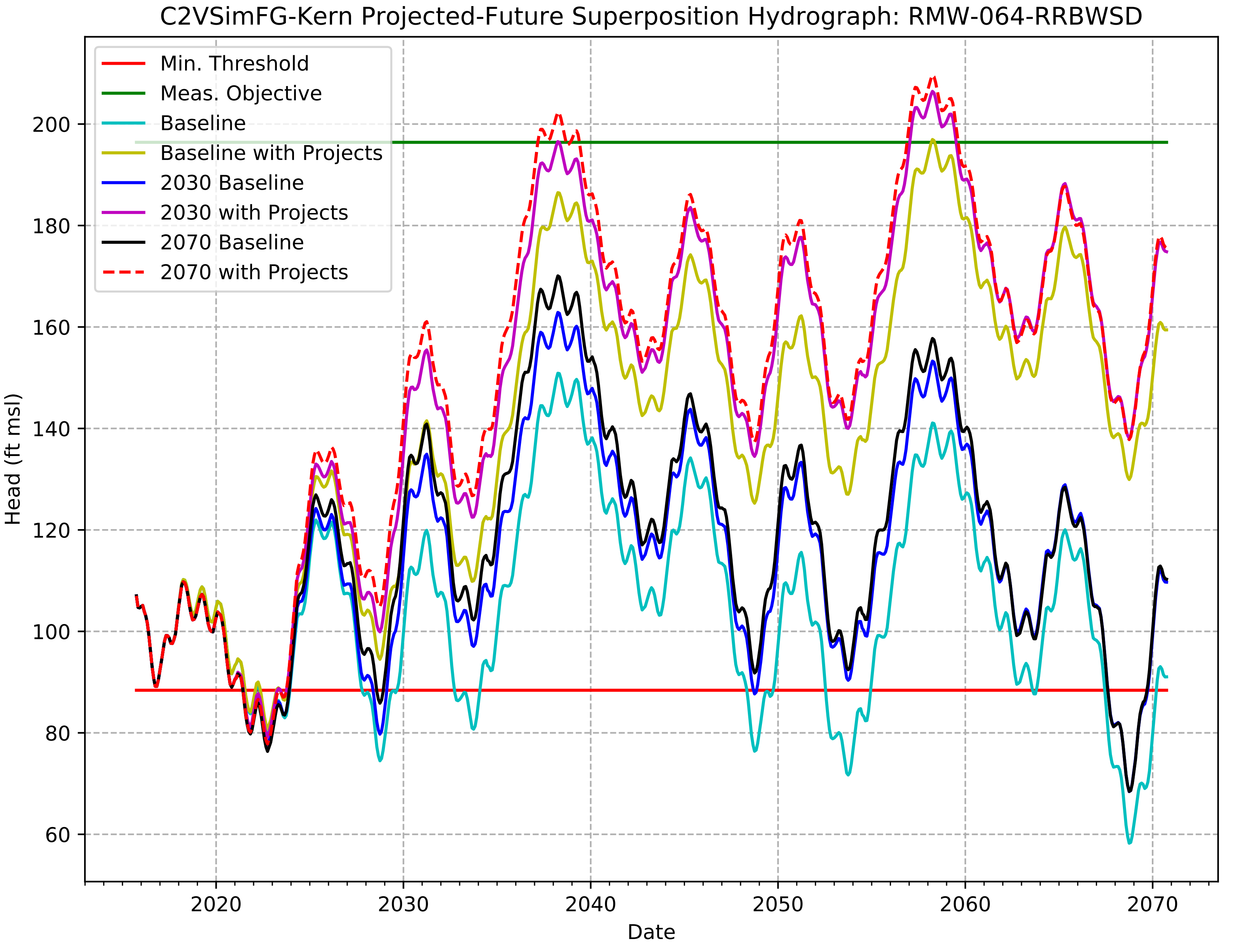
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-064-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
60
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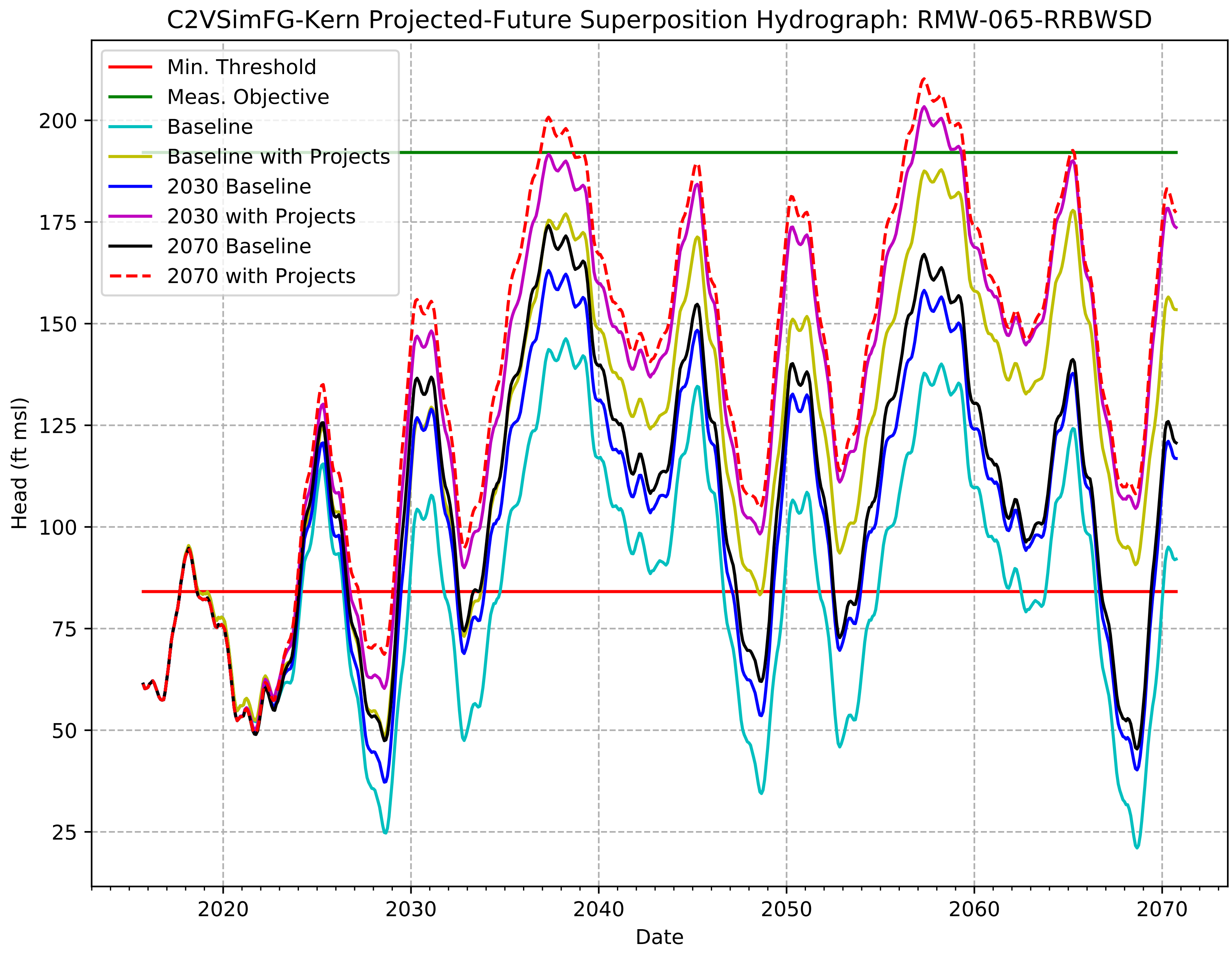
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-065-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
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150
125
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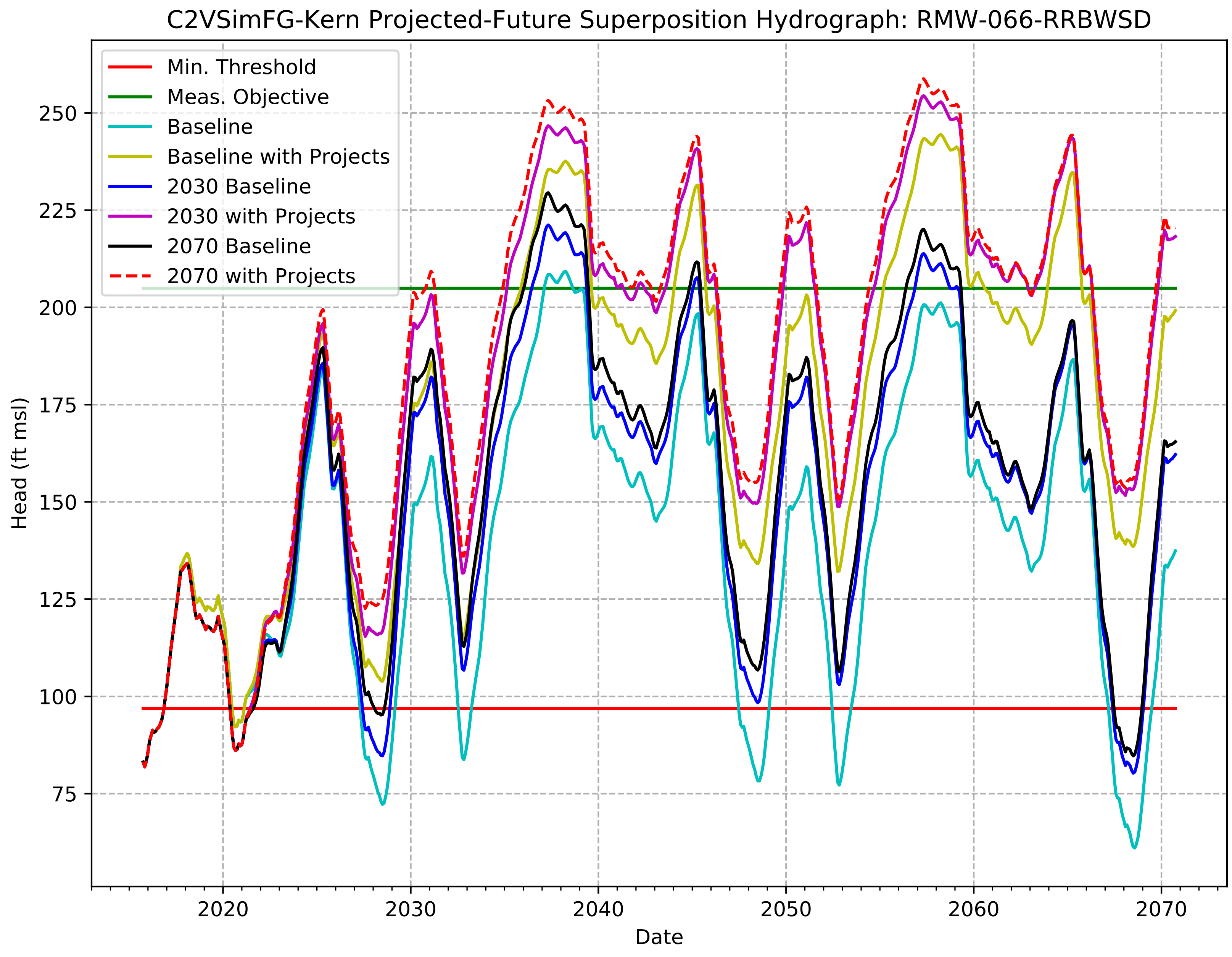
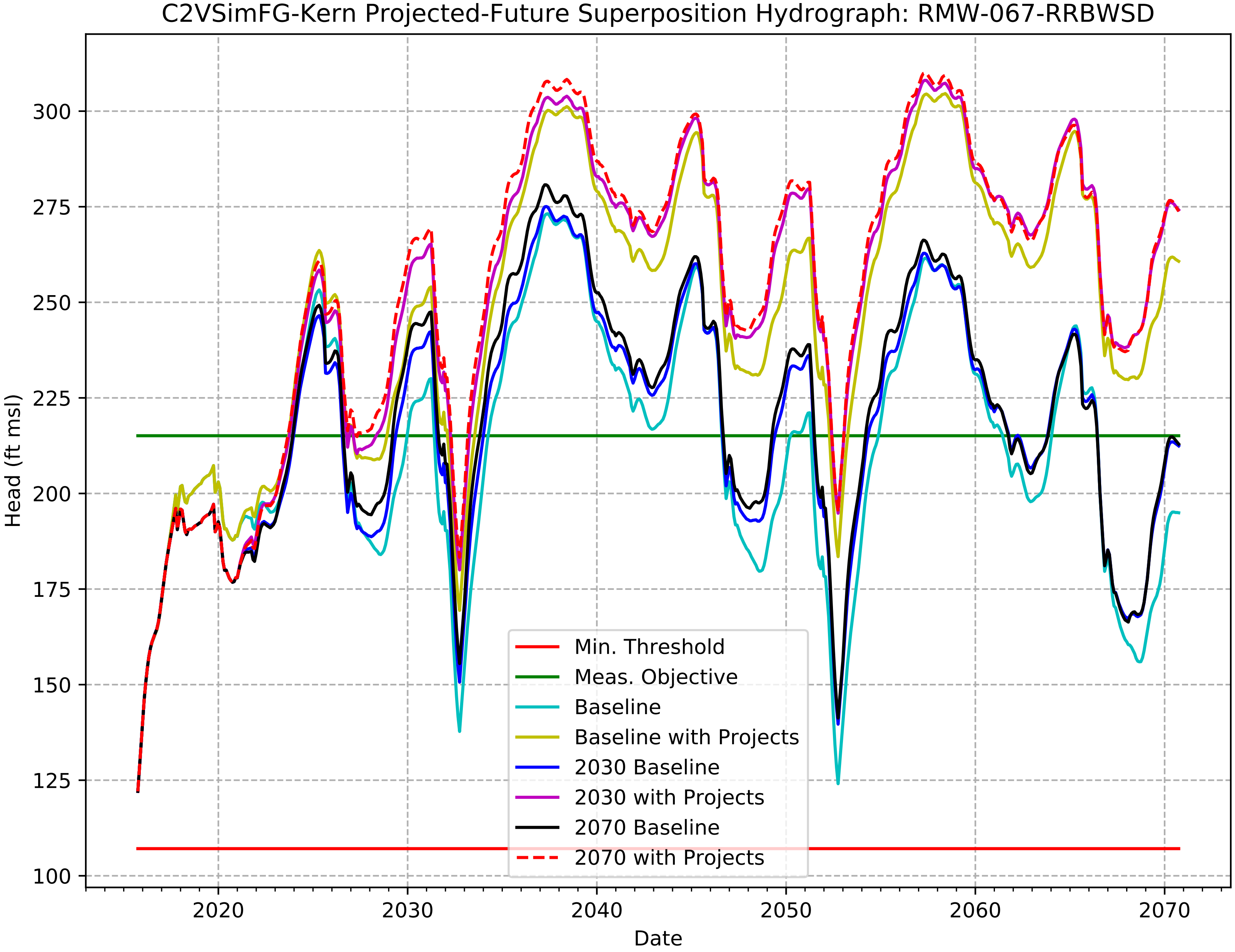
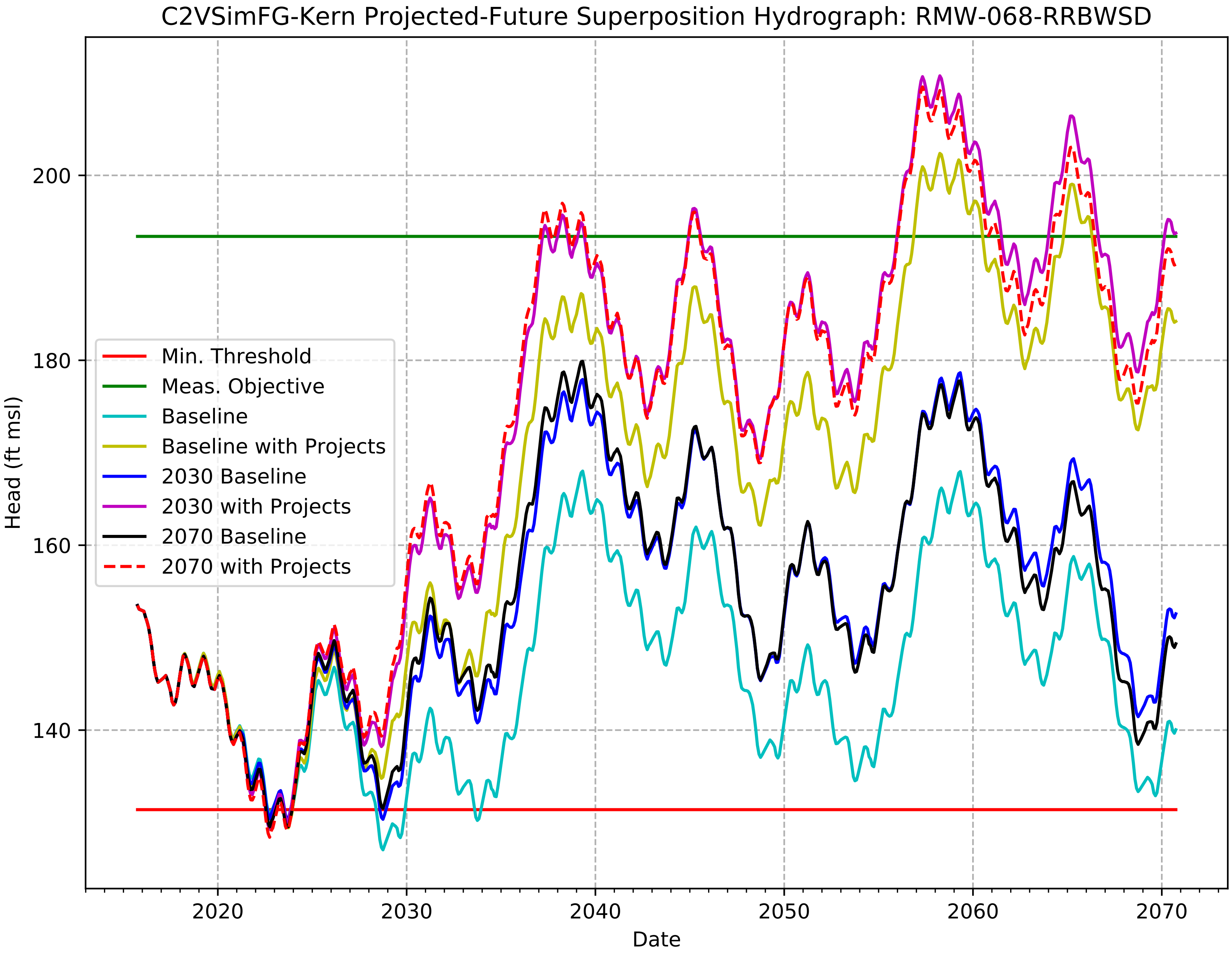
2050
2060
2070
Date

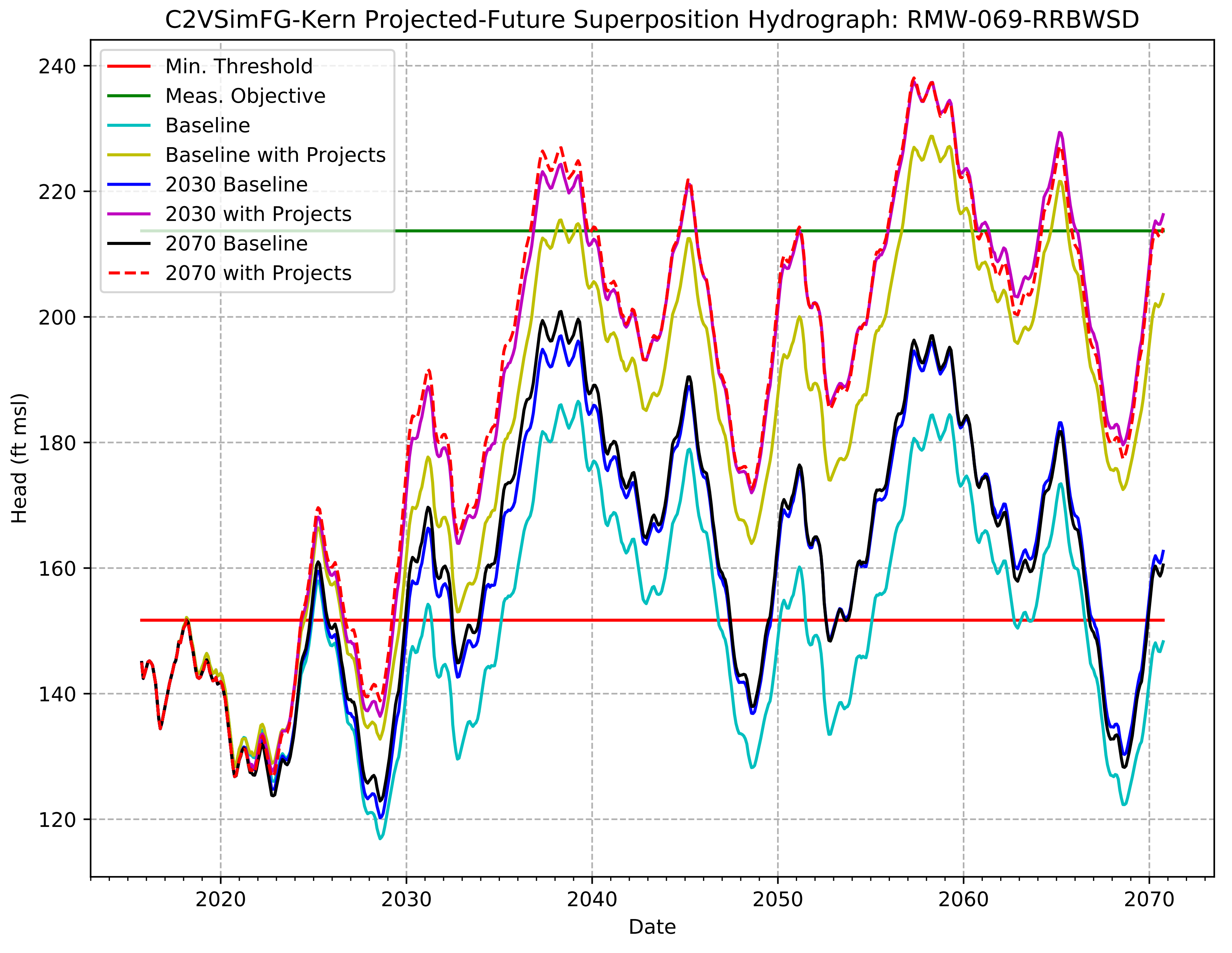

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-066-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
250
225
200
175
150
125
100
75
2020
2030
2040
2050
2060
2070



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-067-RRBWSD
Head (ft msl)
300
275
250
225
200
175
150
125
100
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-068-RRBWSD
Head (ft msl)
Date
200
180
160
140
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-069-RRBWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
240
220
200
180
160
140
120
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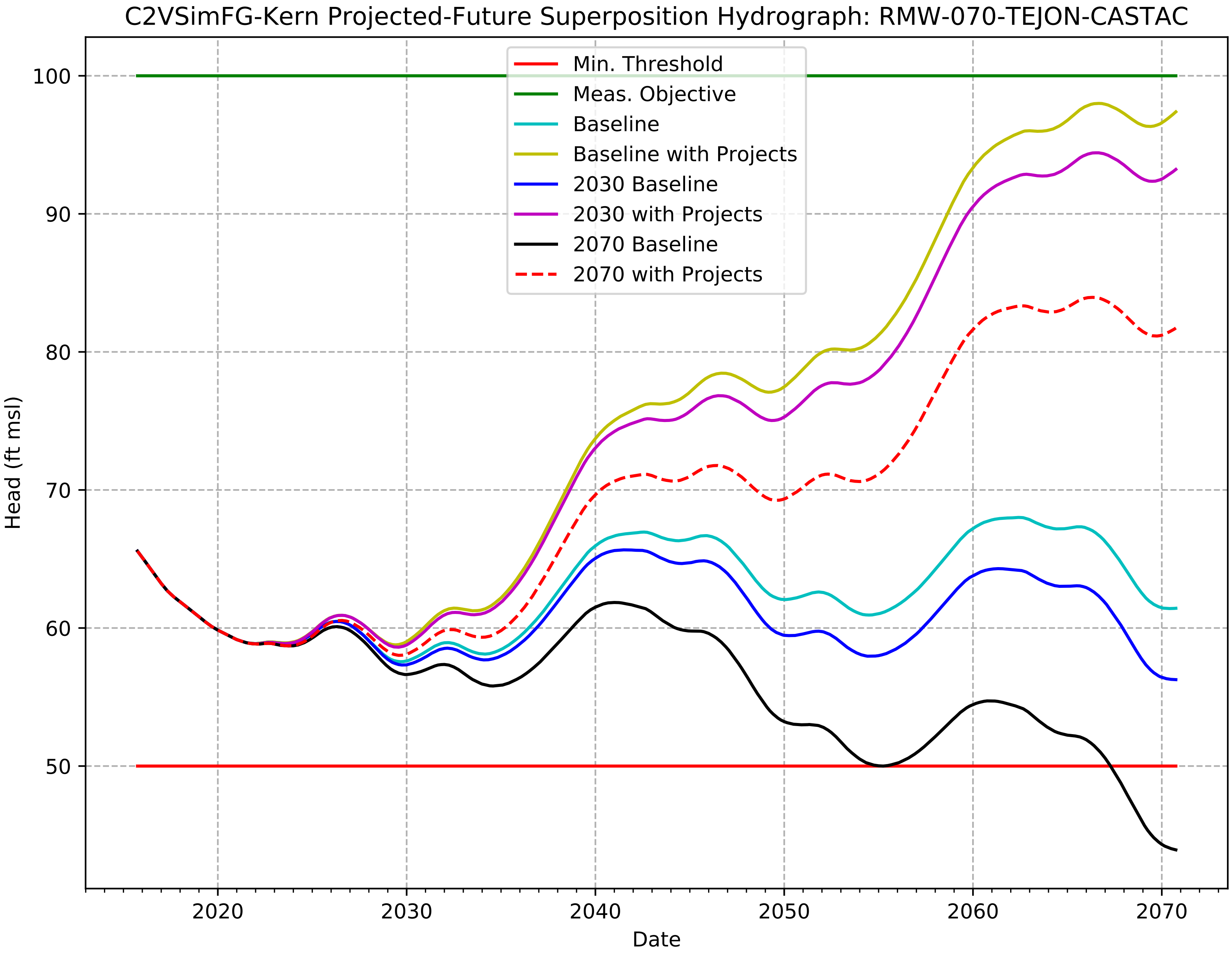
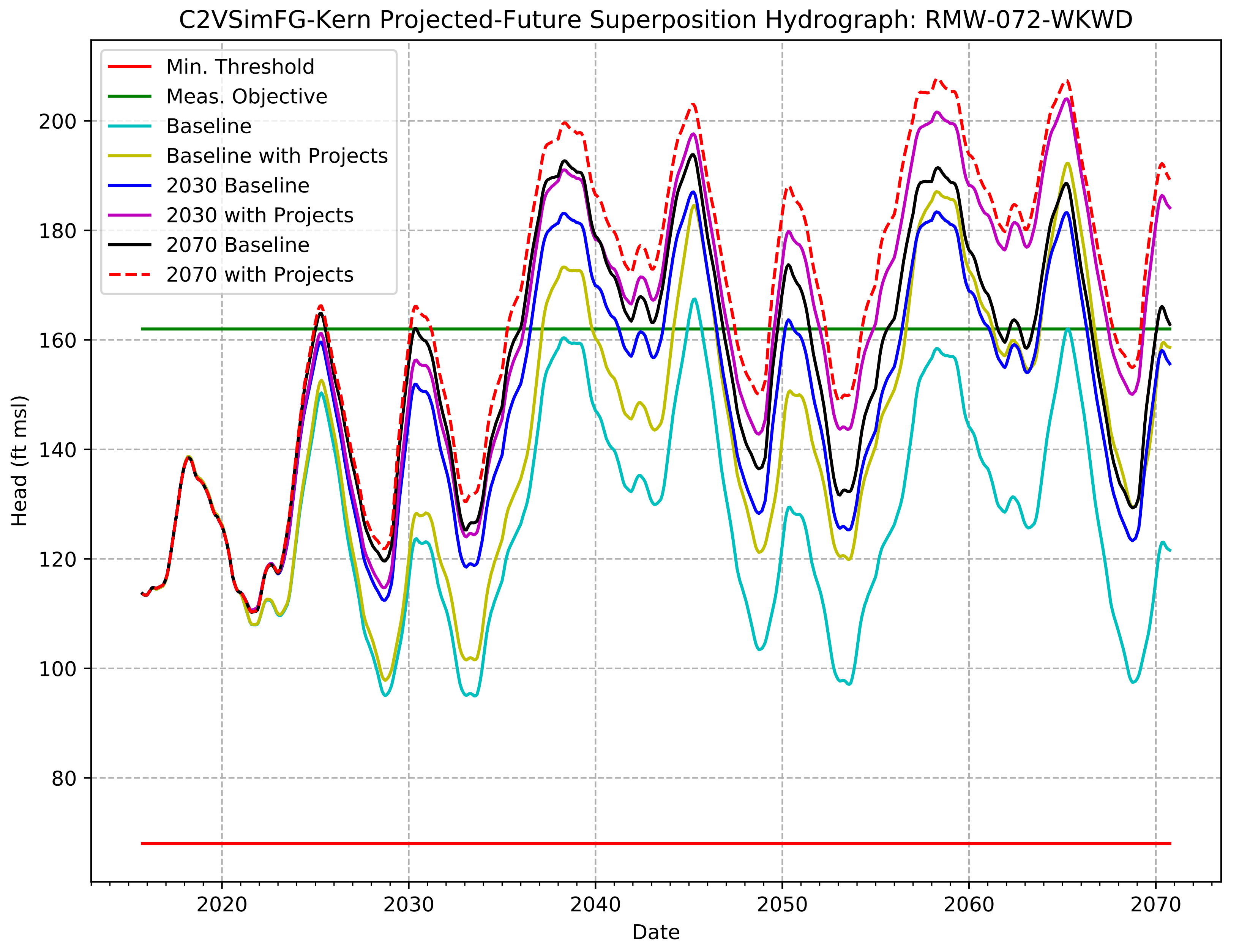
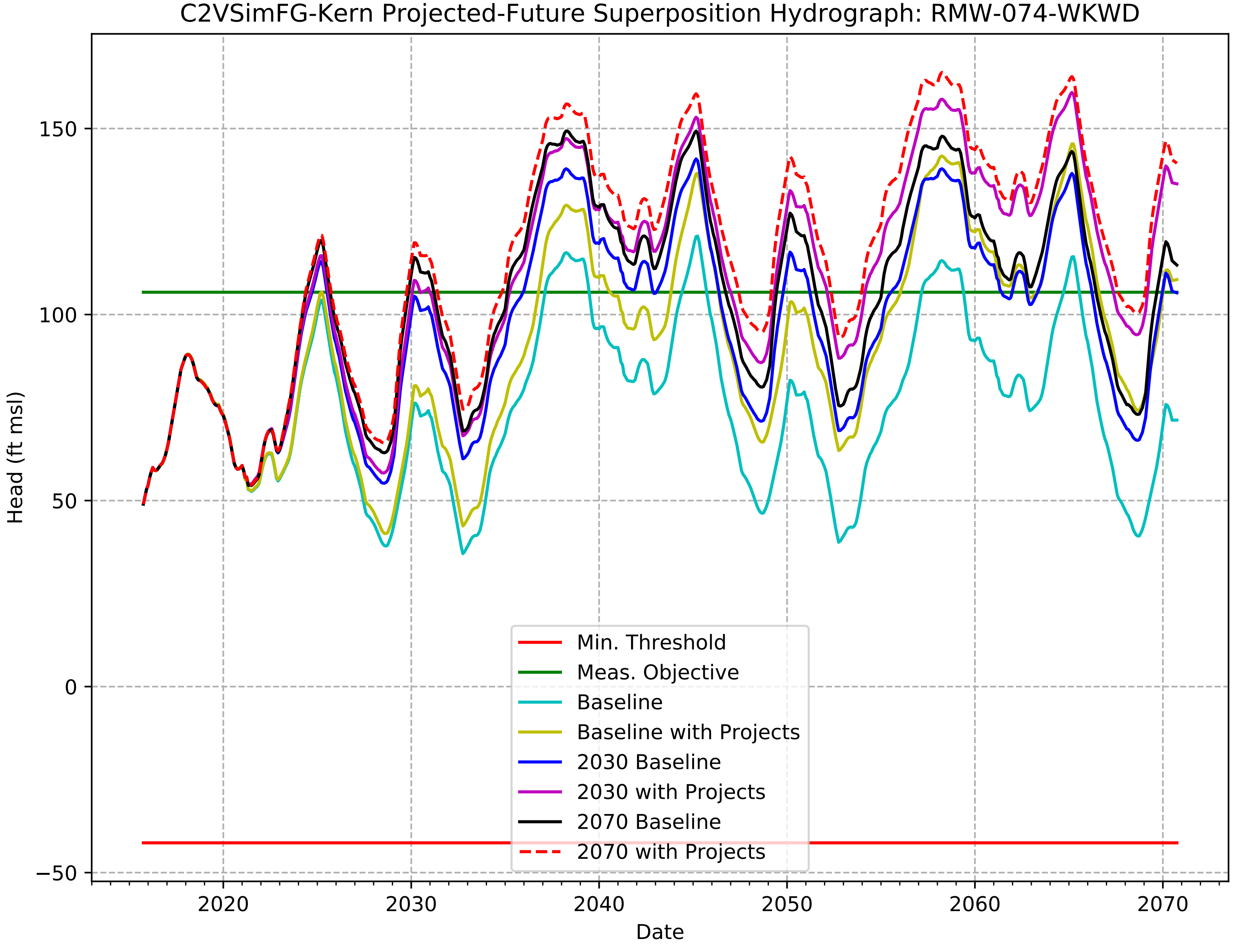
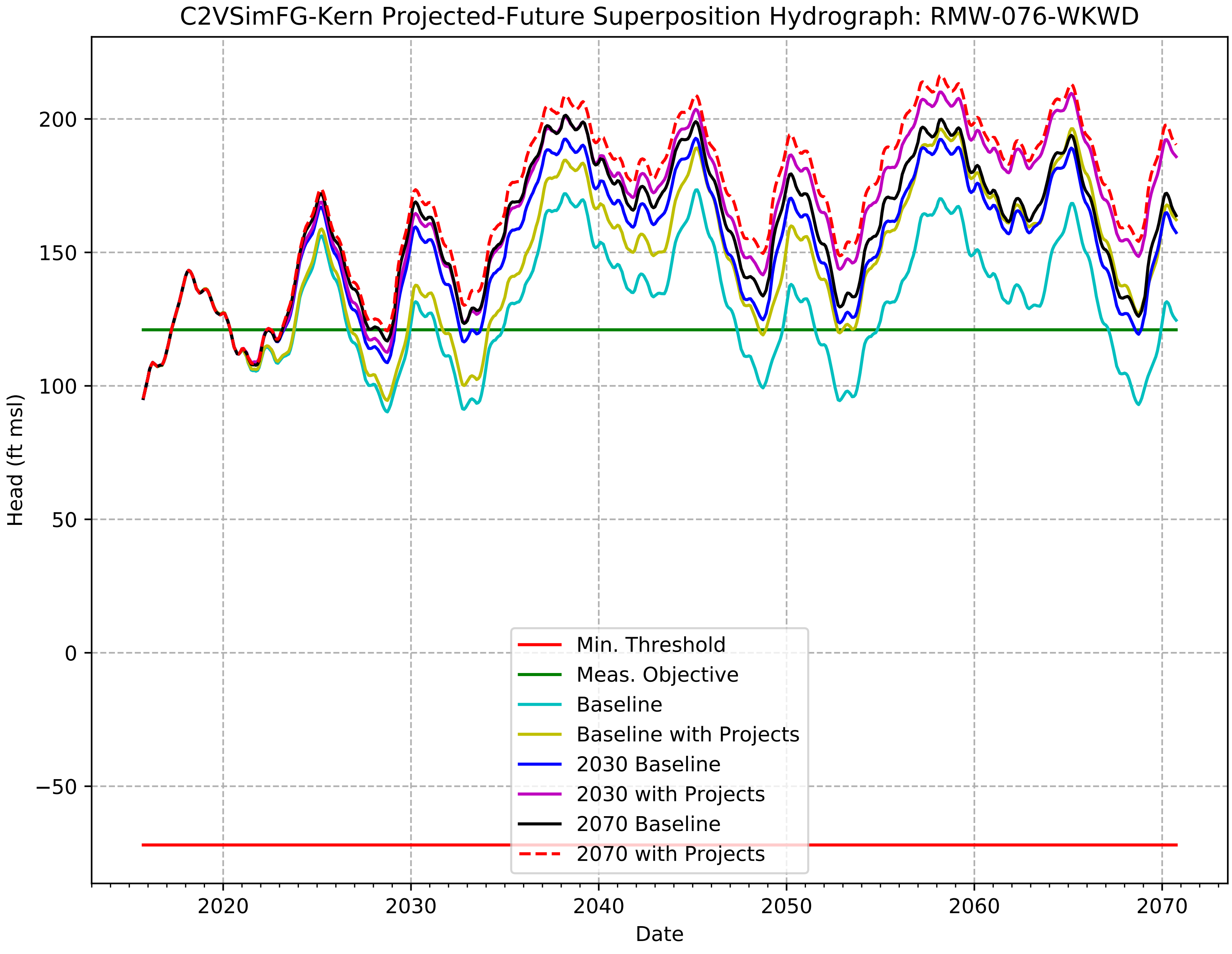
2040
2050
2060
2070

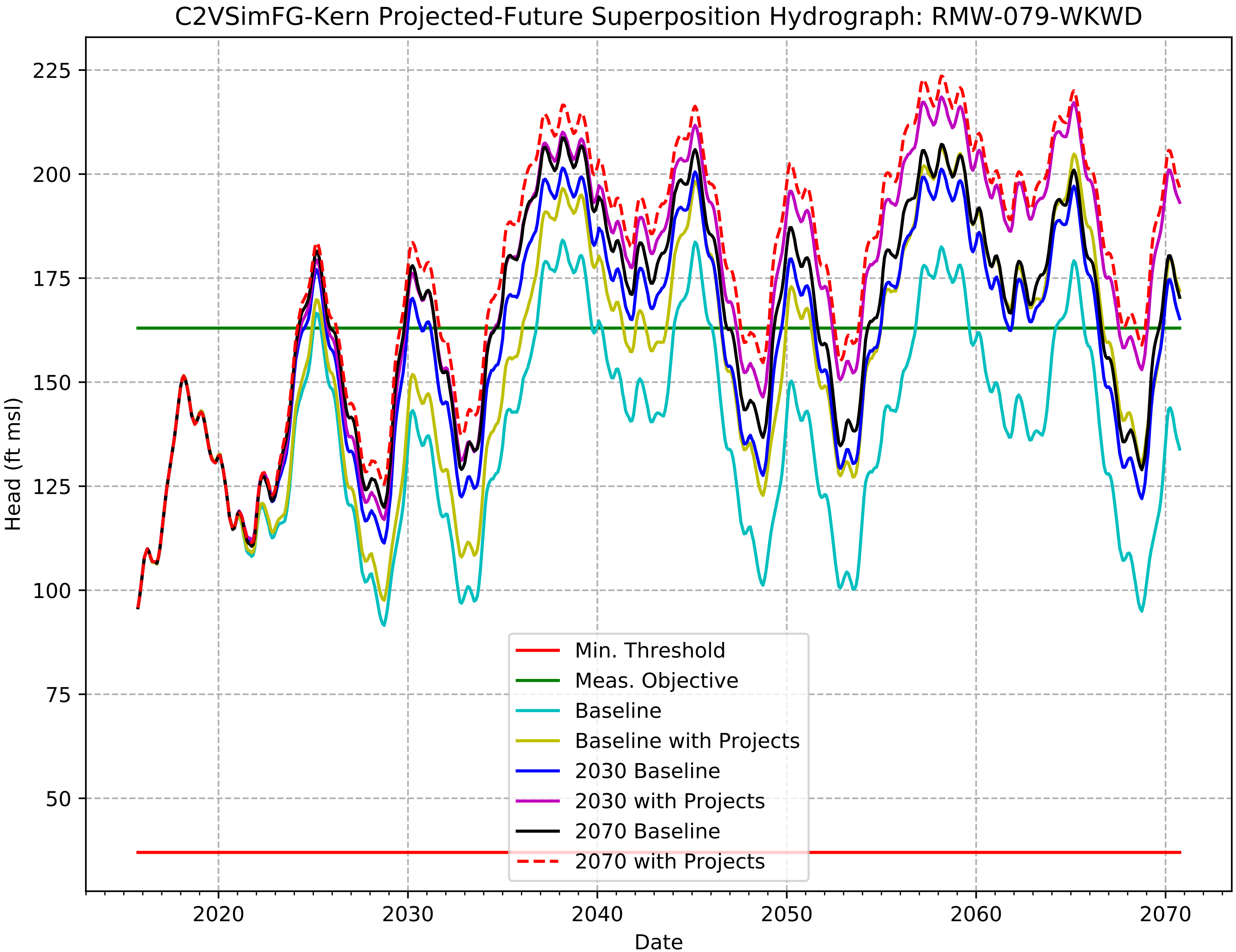

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-070-TEJON-CASTAC
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
100
90
80
70
60
50
Date
2020
2030
2040
2050
2060
2070



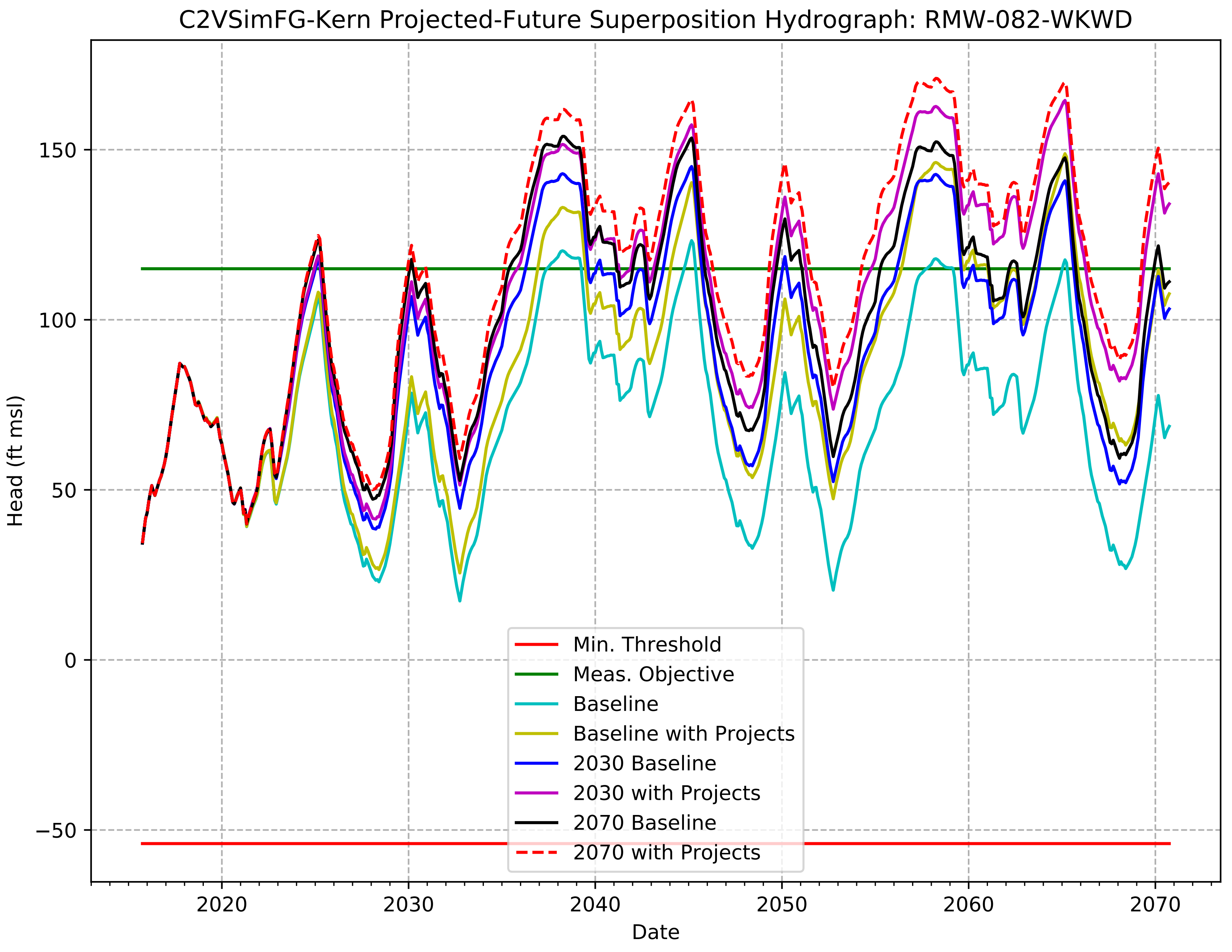
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-072-WKWD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-074-WKWD
Head (ft msl)
Date
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

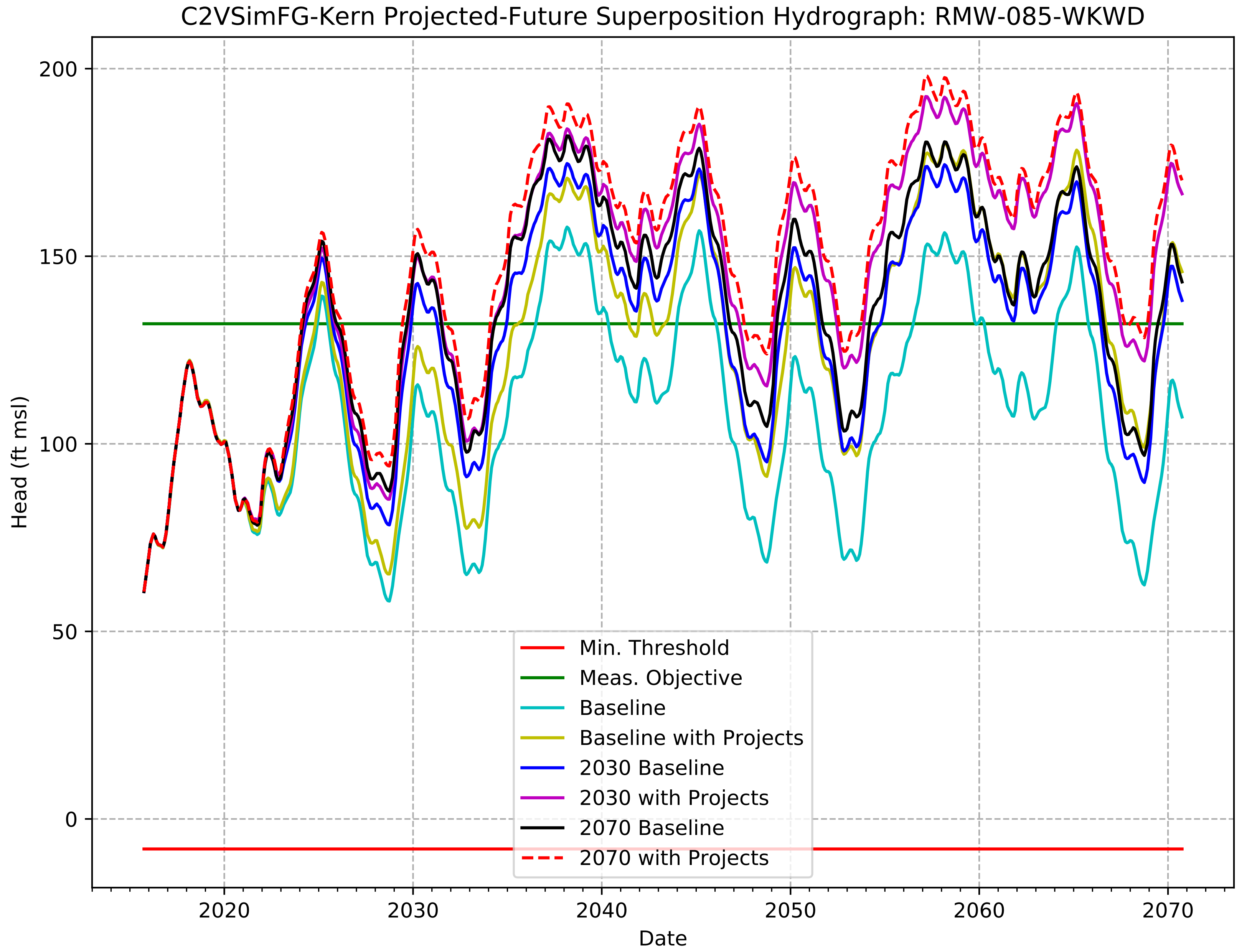

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-076-WKWD
Head (ft msl)
200
150
100
50
0
−50
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



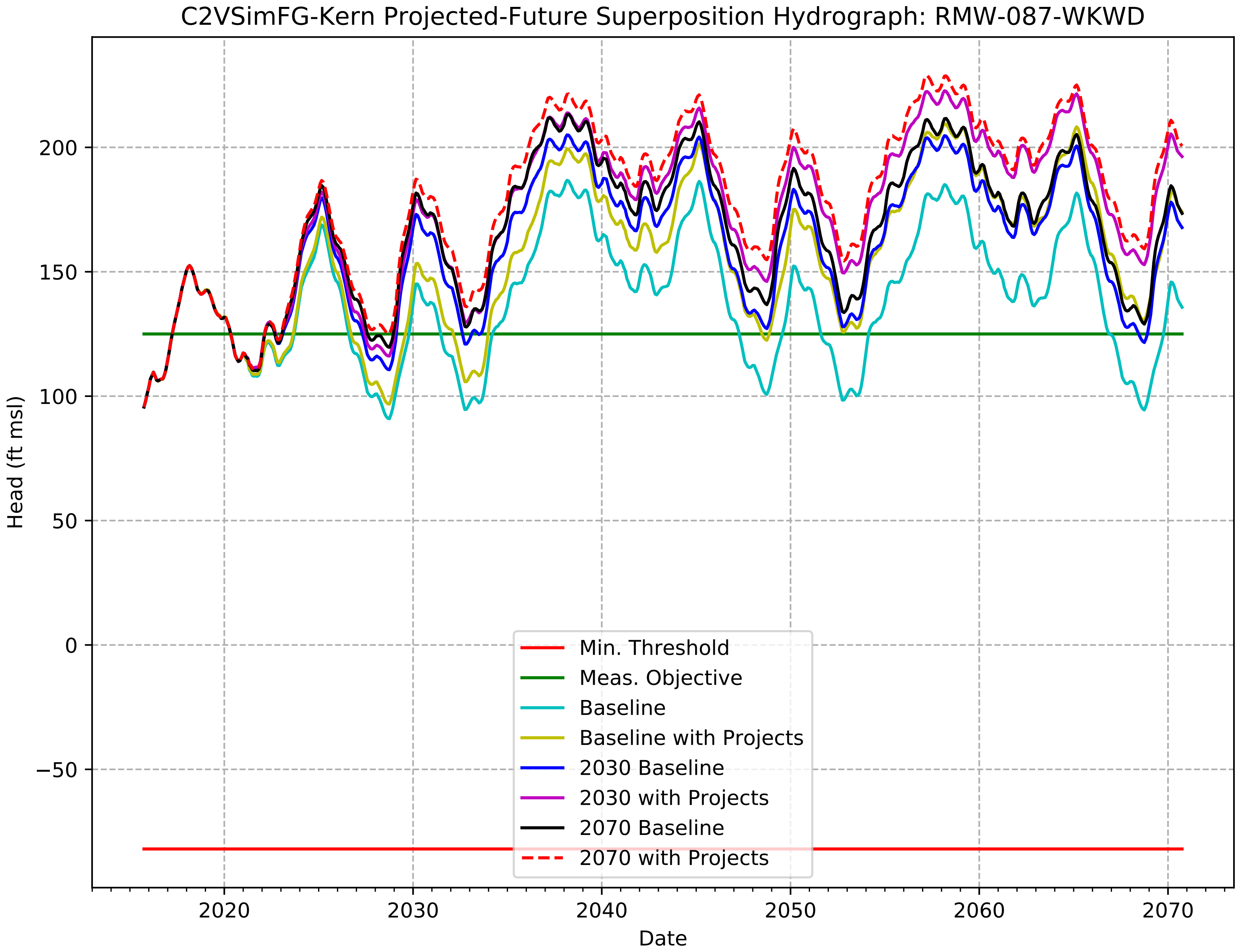
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-079-WKWD
Head (ft msl)
225
200
175
150
125
100
75
50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



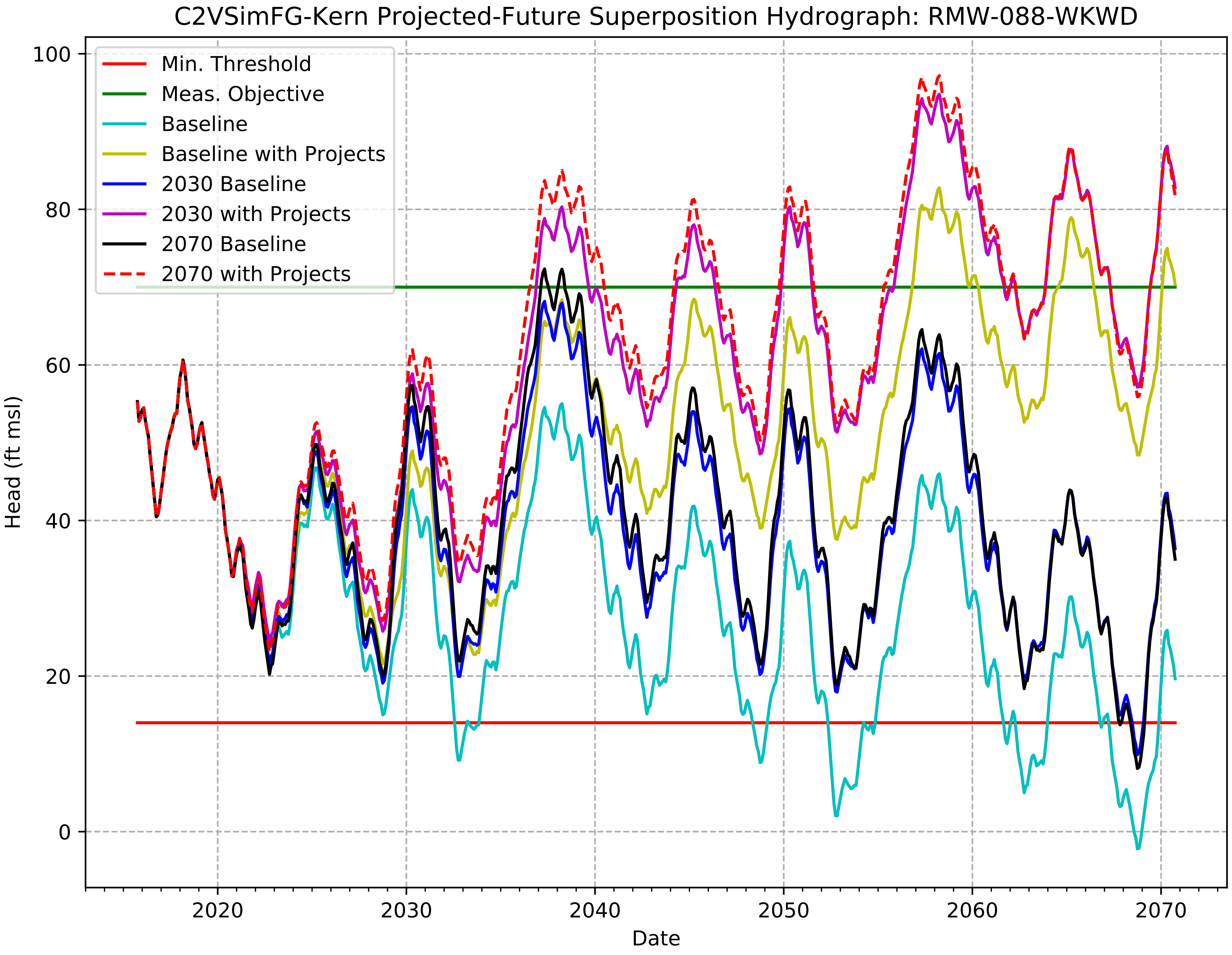
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-082-WKWD
Head (ft msl)
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-085-WKWD
Head (ft msl)
Date
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-087-WKWD
Head (ft msl)
200
150
100
50
0
−50
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-088-WKWD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
100
80
60
40
20
0
2020
2030
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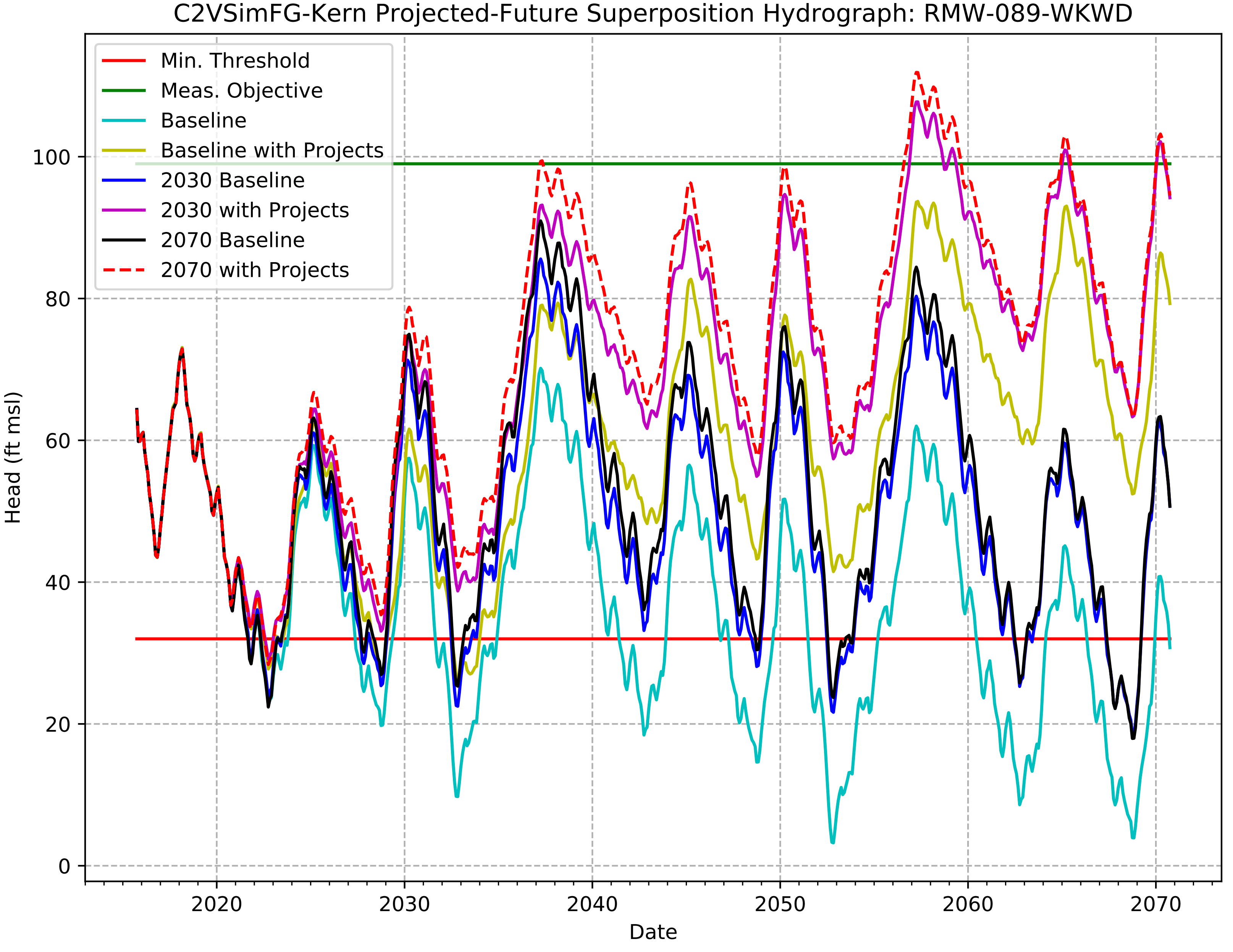
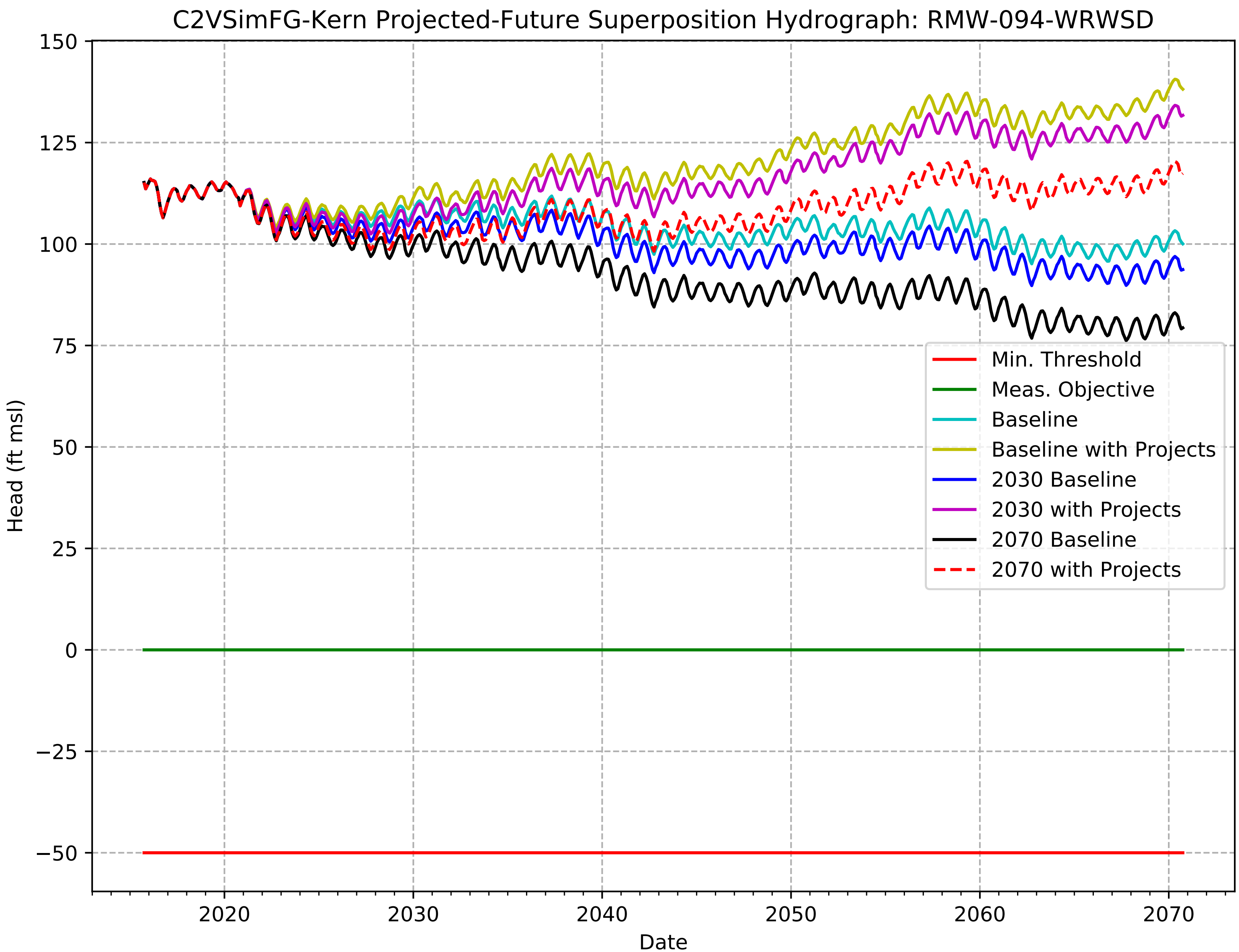
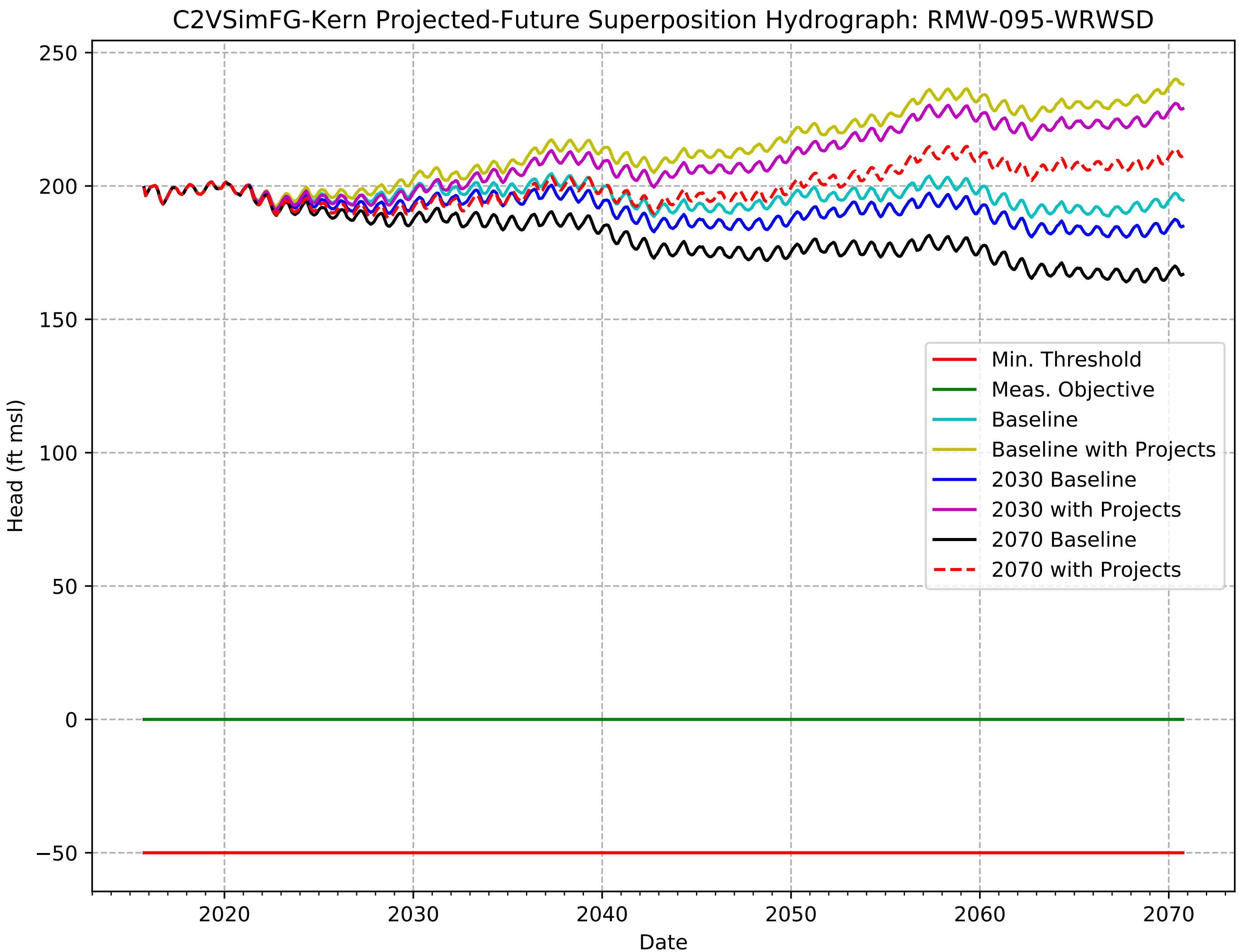
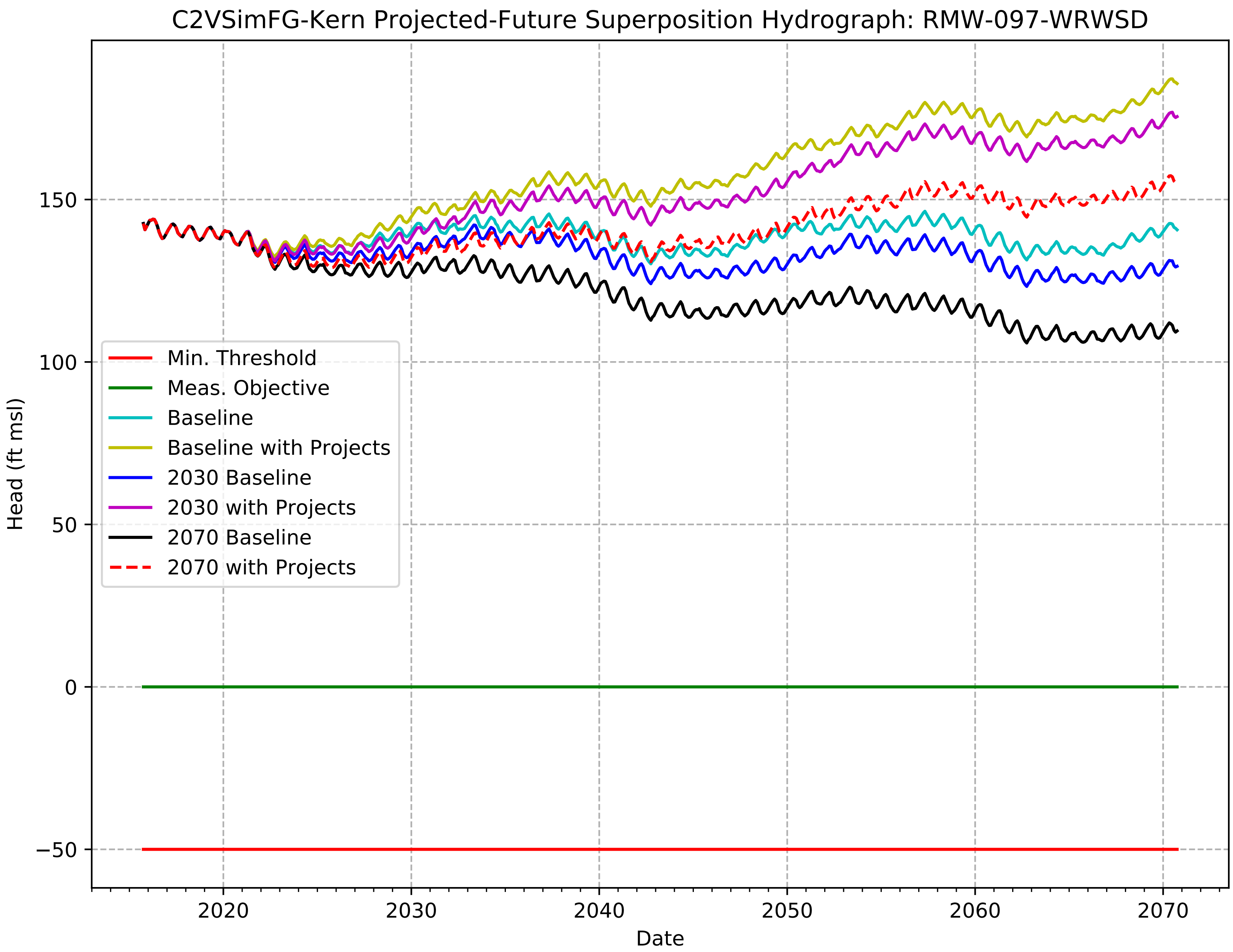
2050
2060
2070
Date


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-089-WKWD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
0
20
40
60
80
100
2020
2030
2040
2050
2060
2070

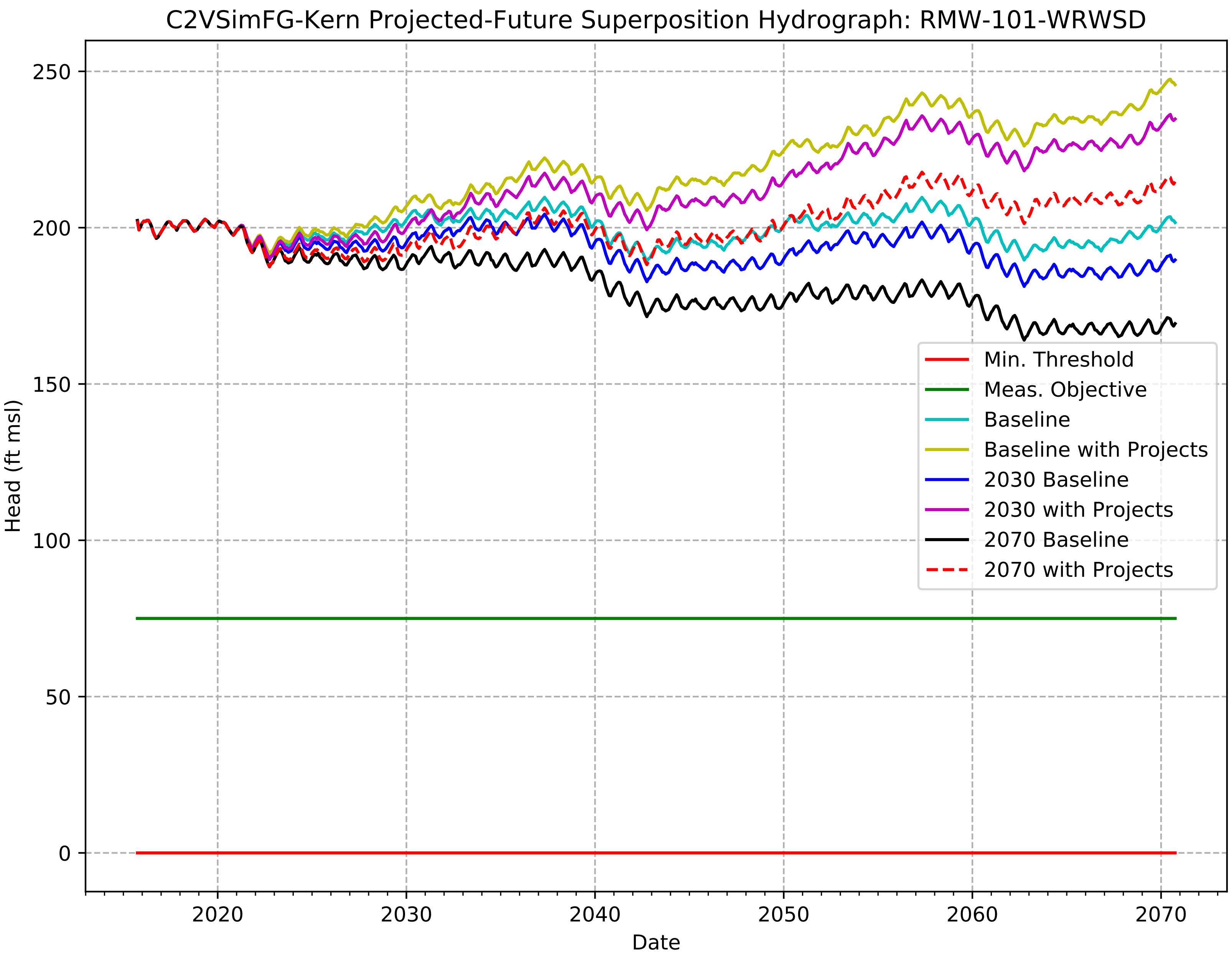


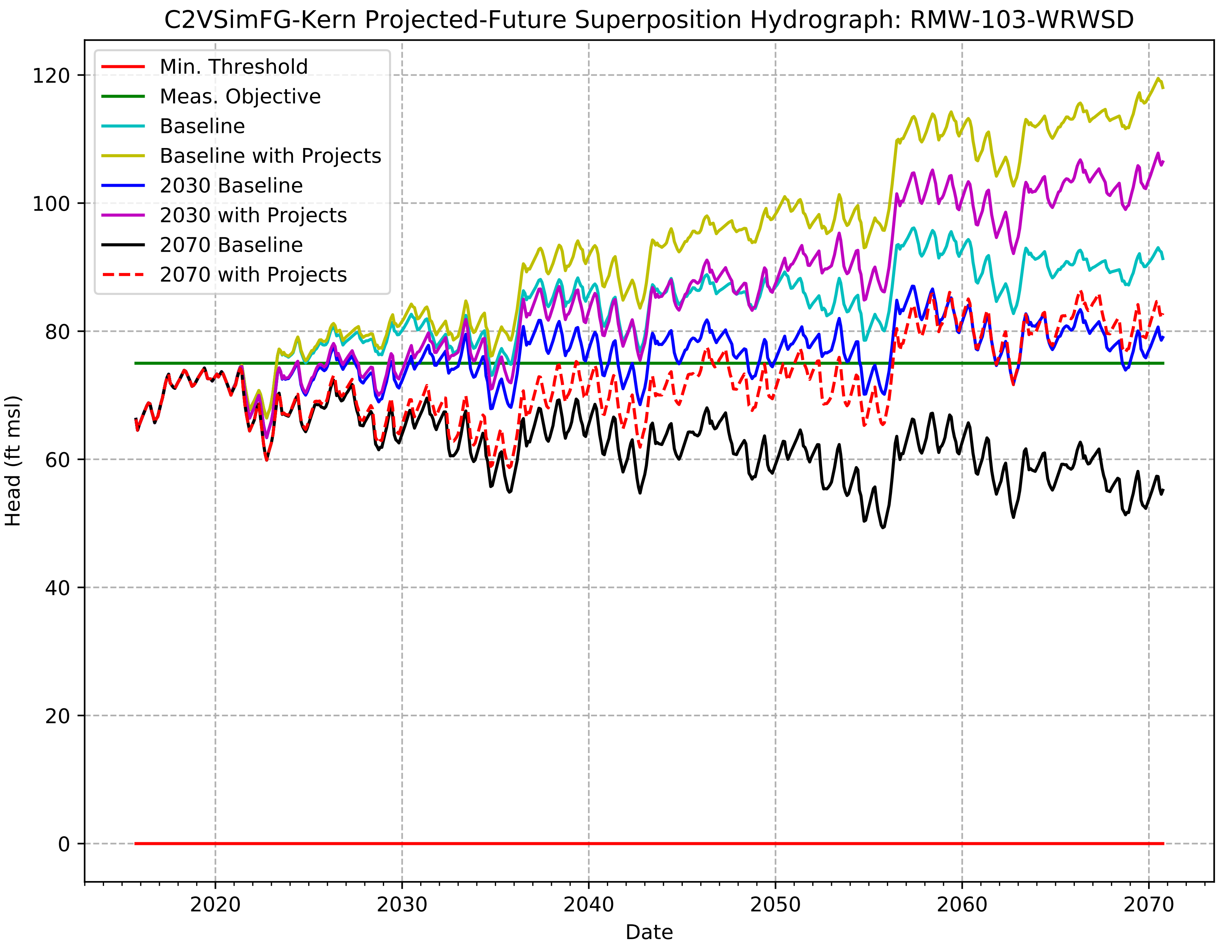
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-094-WRWSD
Head (ft msl)
150
125
100
75
50
25
0
−25
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-095-WRWSD
Head (ft msl)
250
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-097-WRWSD
Head (ft msl)
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-101-WRWSD
Head (ft msl)
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-103-WRWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
120
100
80
60
40
20
0
2020
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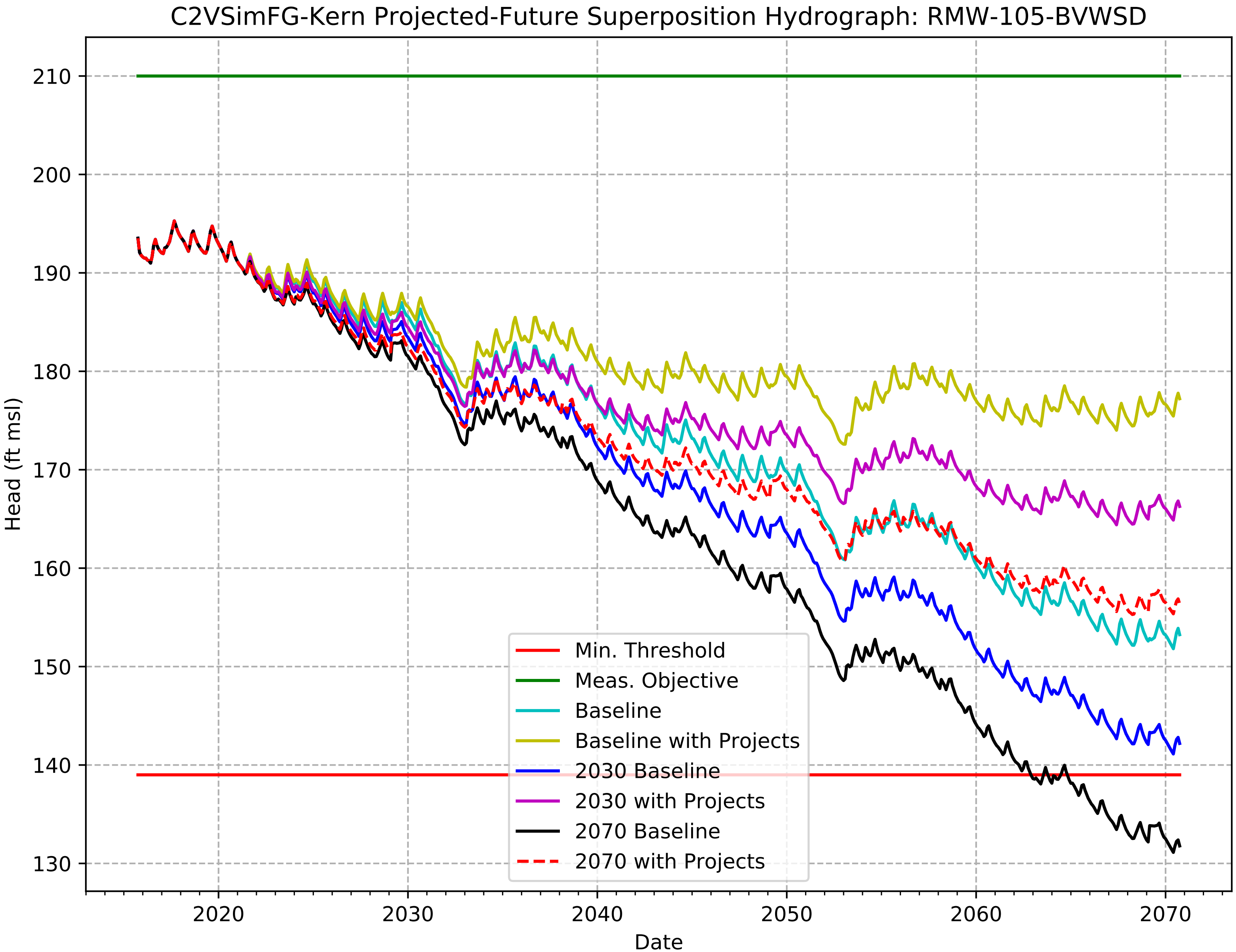
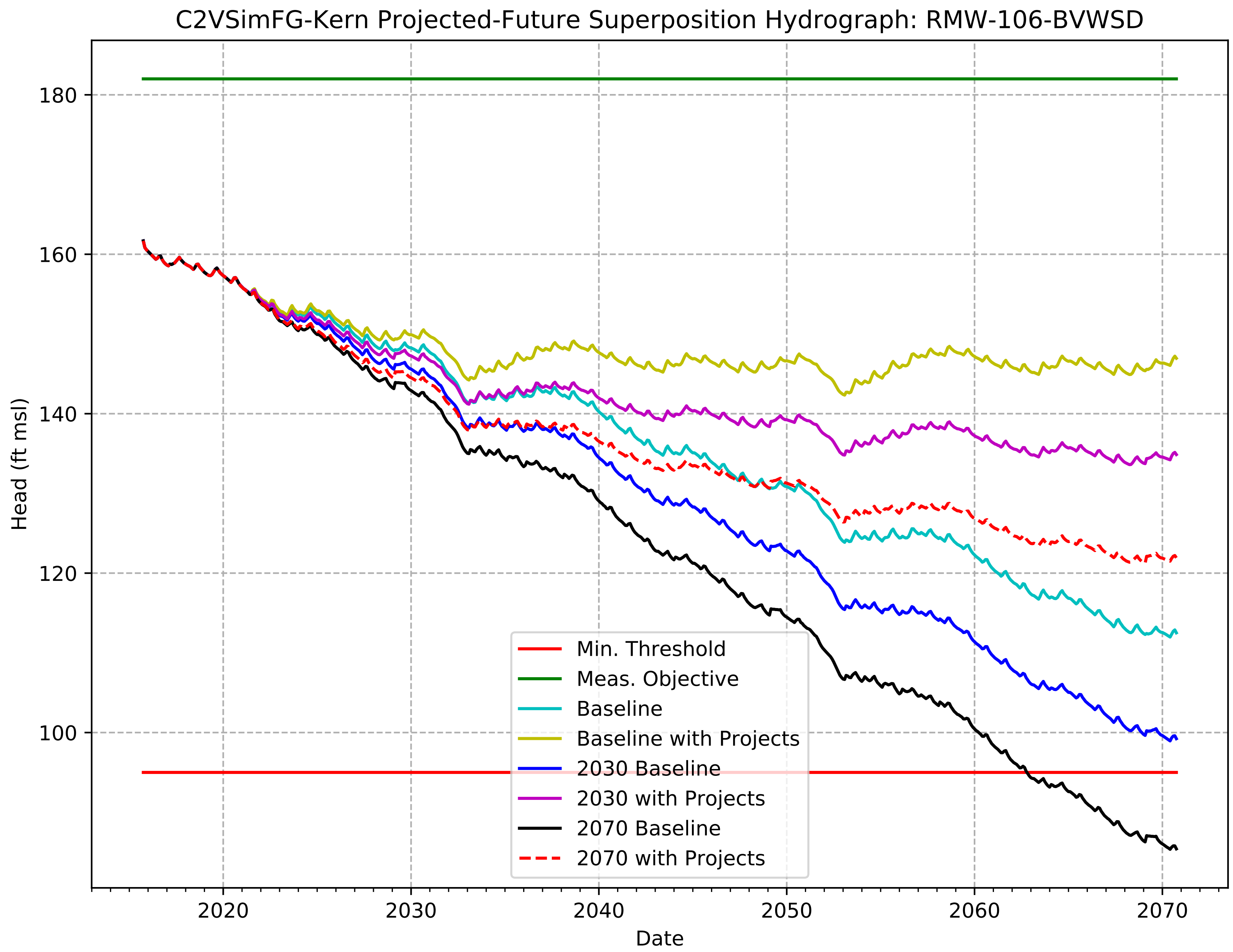
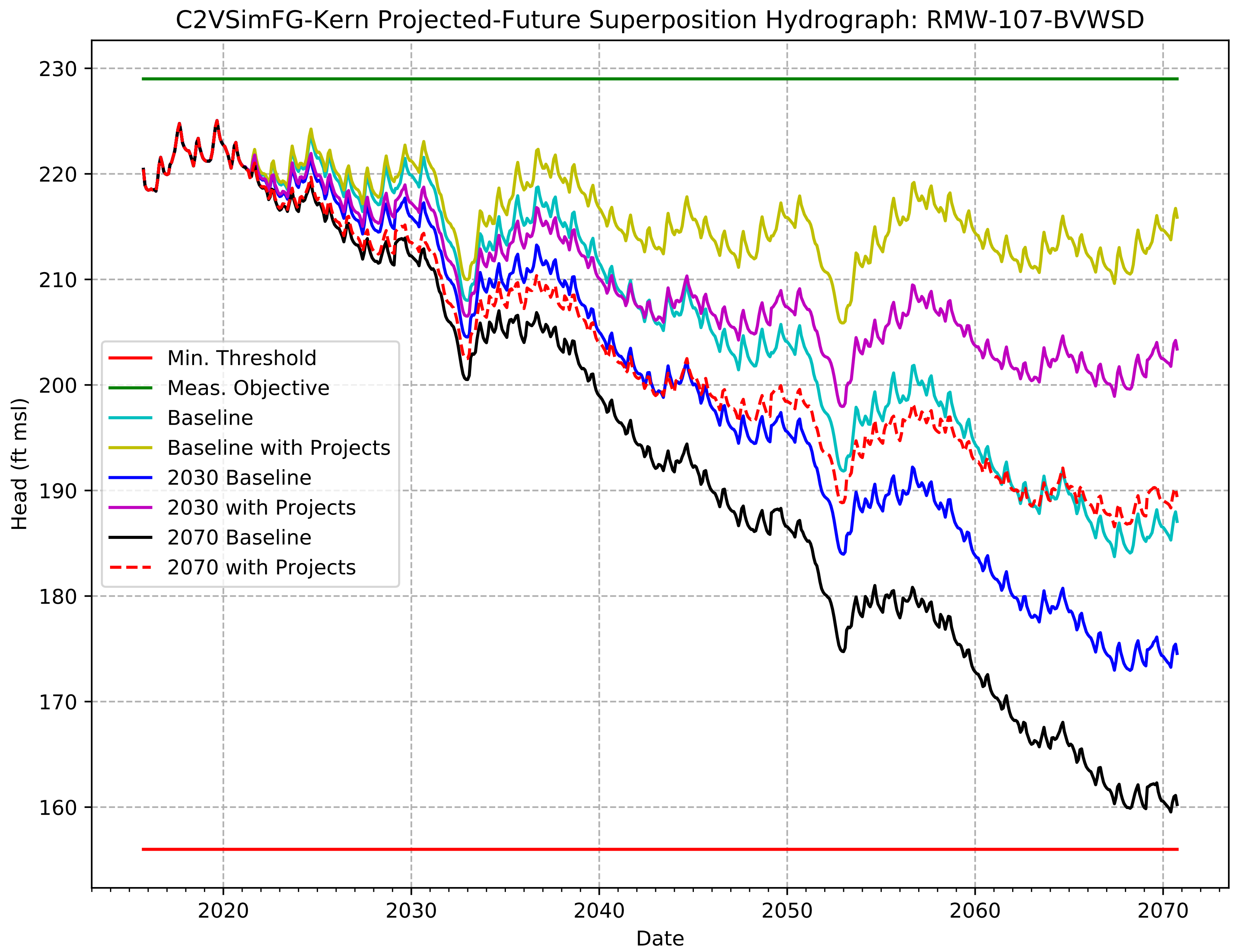
2050
2060
2070
Date

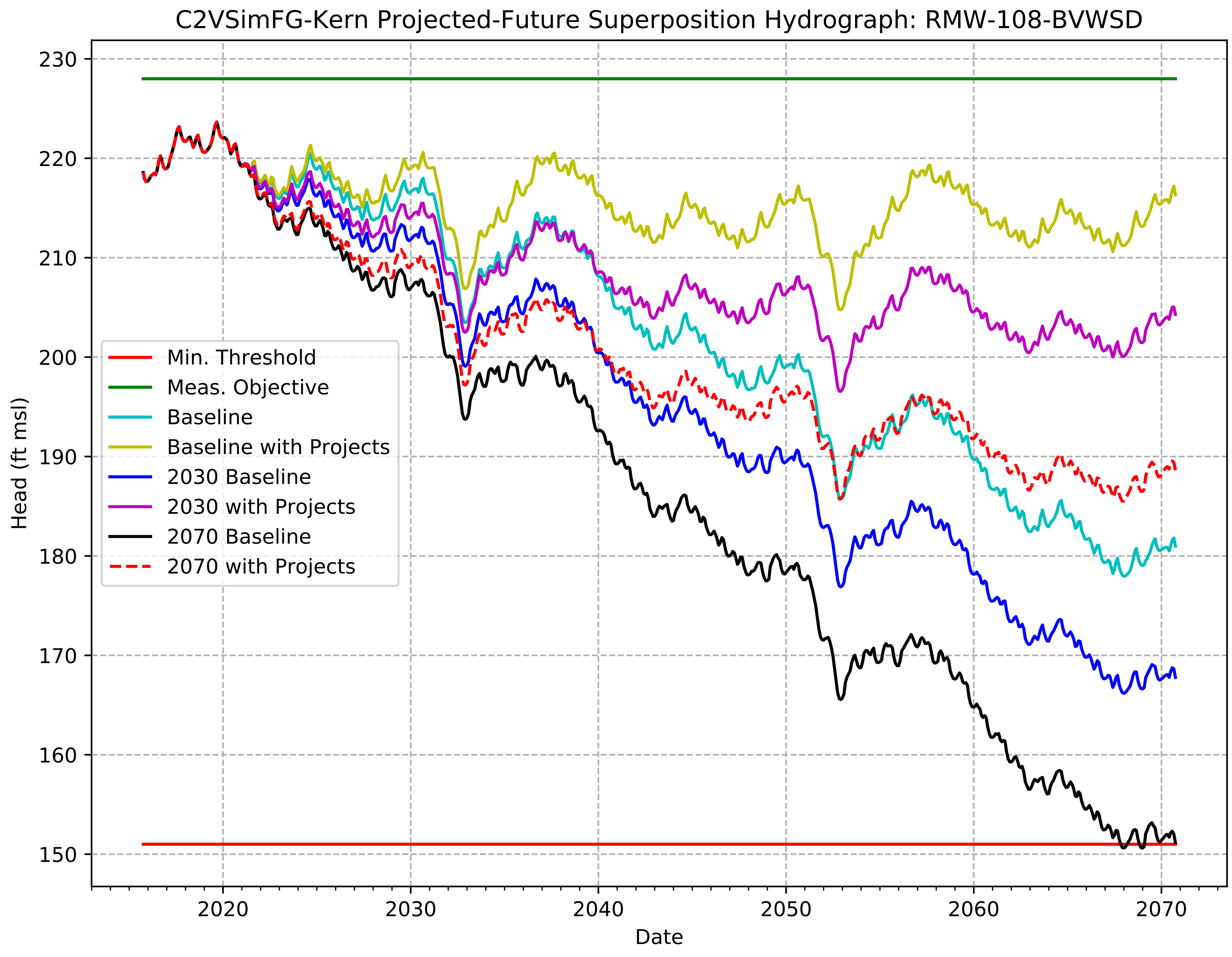

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-105-BVWSD
Head (ft msl)
210
200
190
180
170
160
150
140
130
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



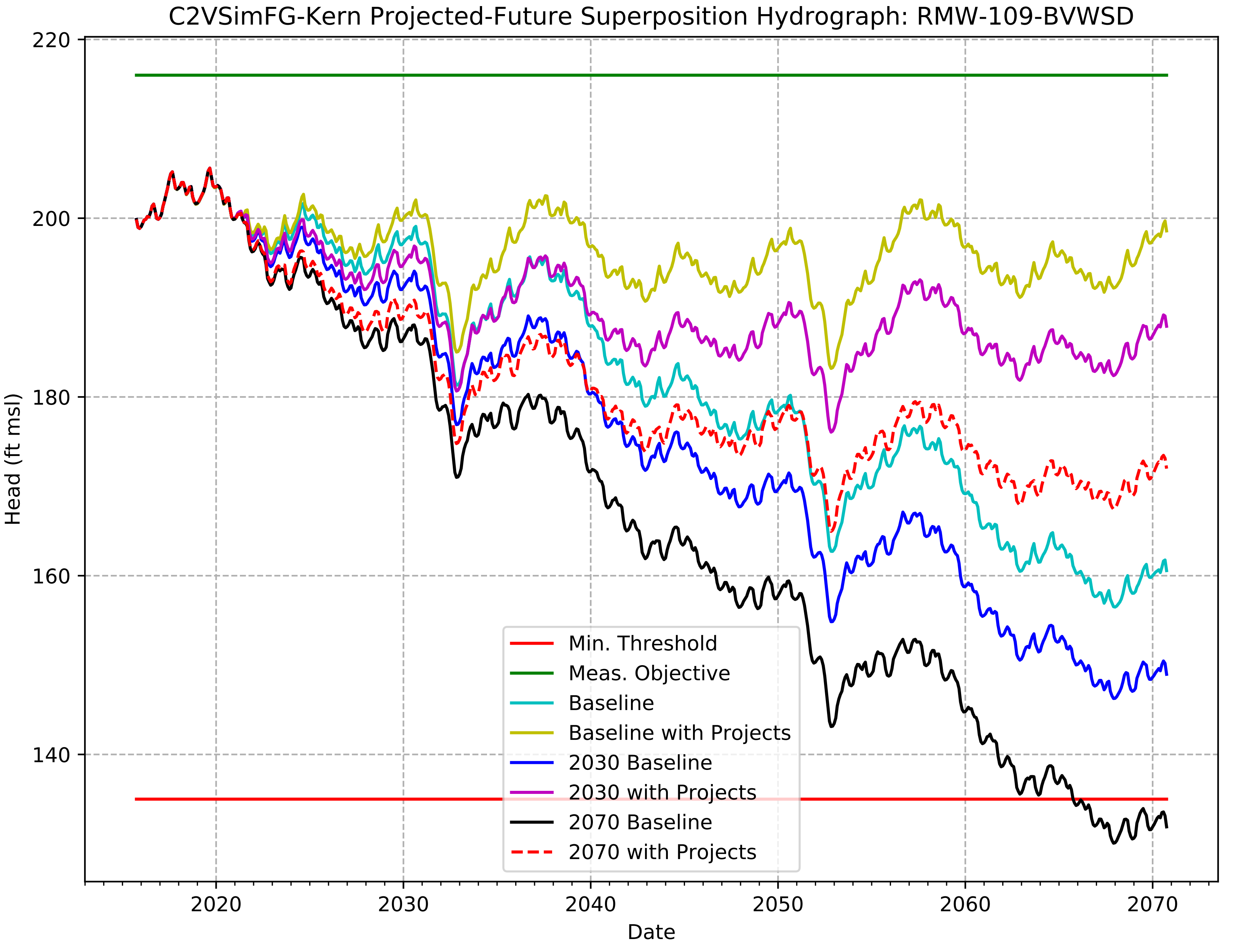
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-106-BVWSD
Head (ft msl)
180
160
140
120
100
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

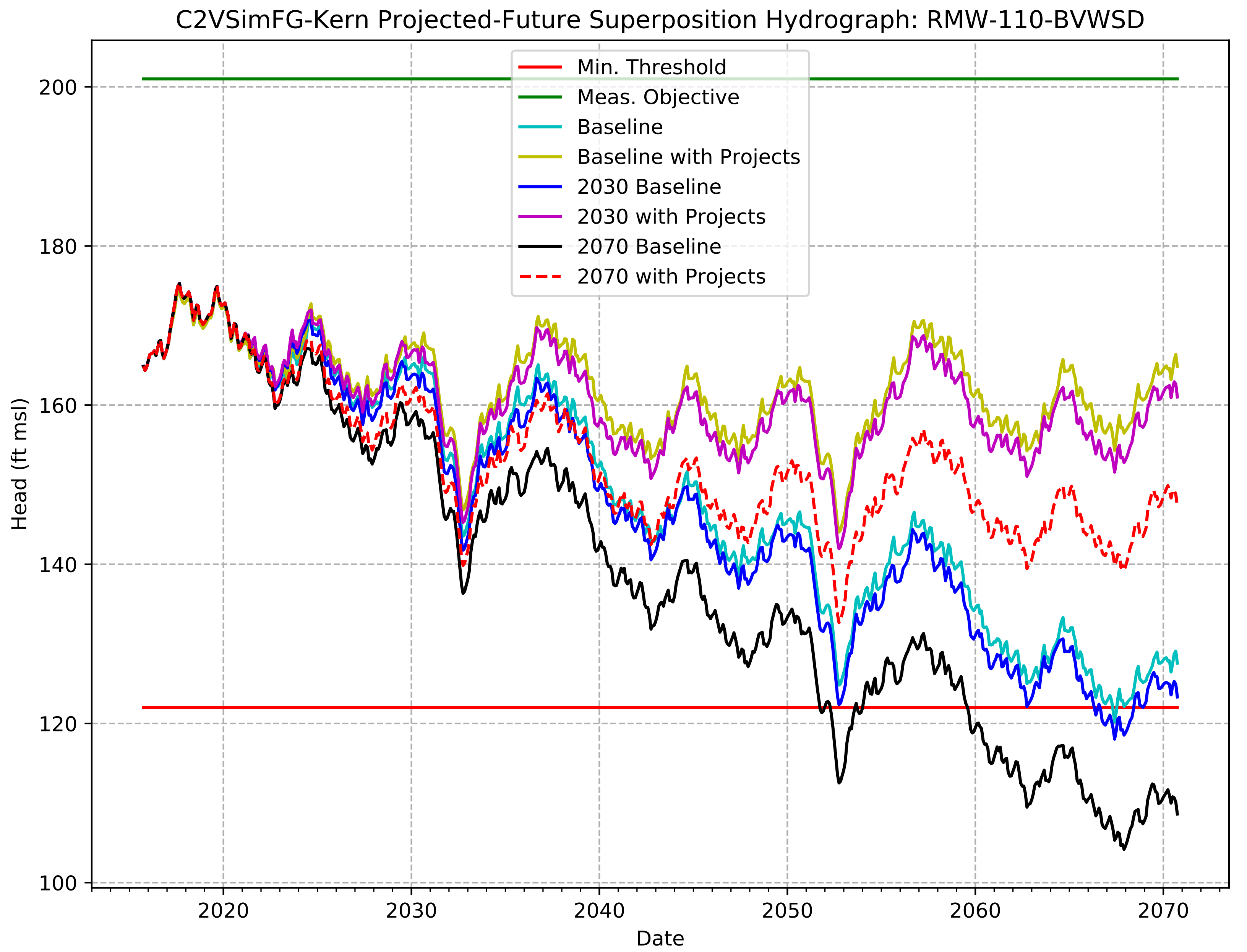


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-107-BVWSD
Head (ft msl)
230
220
210
200
190
180
170
160
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-108-BVWSD
Head (ft msl)
Date
230
220
210
200
190
180
170
160
150
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-109-BVWSD
Head (ft msl)
220
200
180
160
140
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-110-BVWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
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2020
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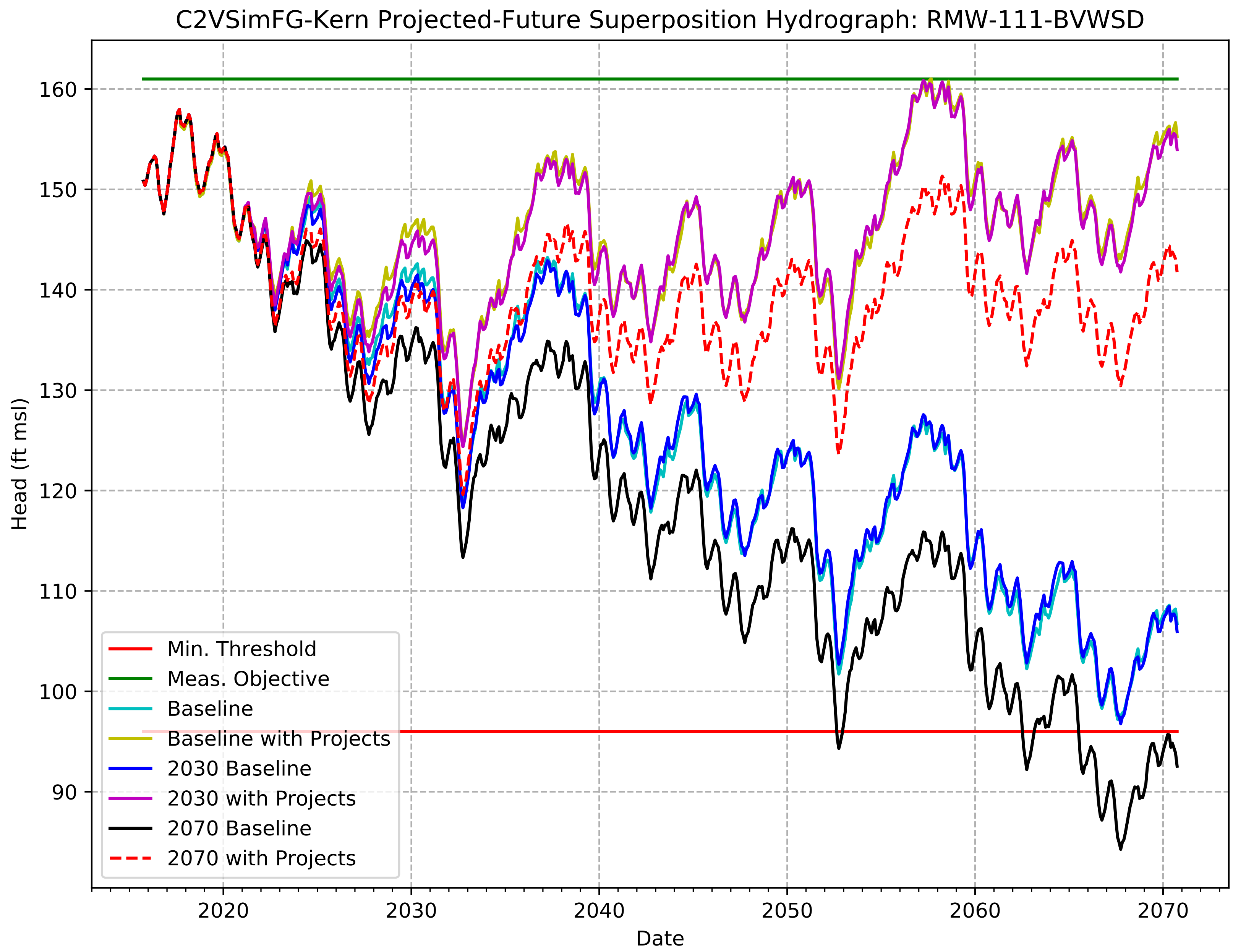
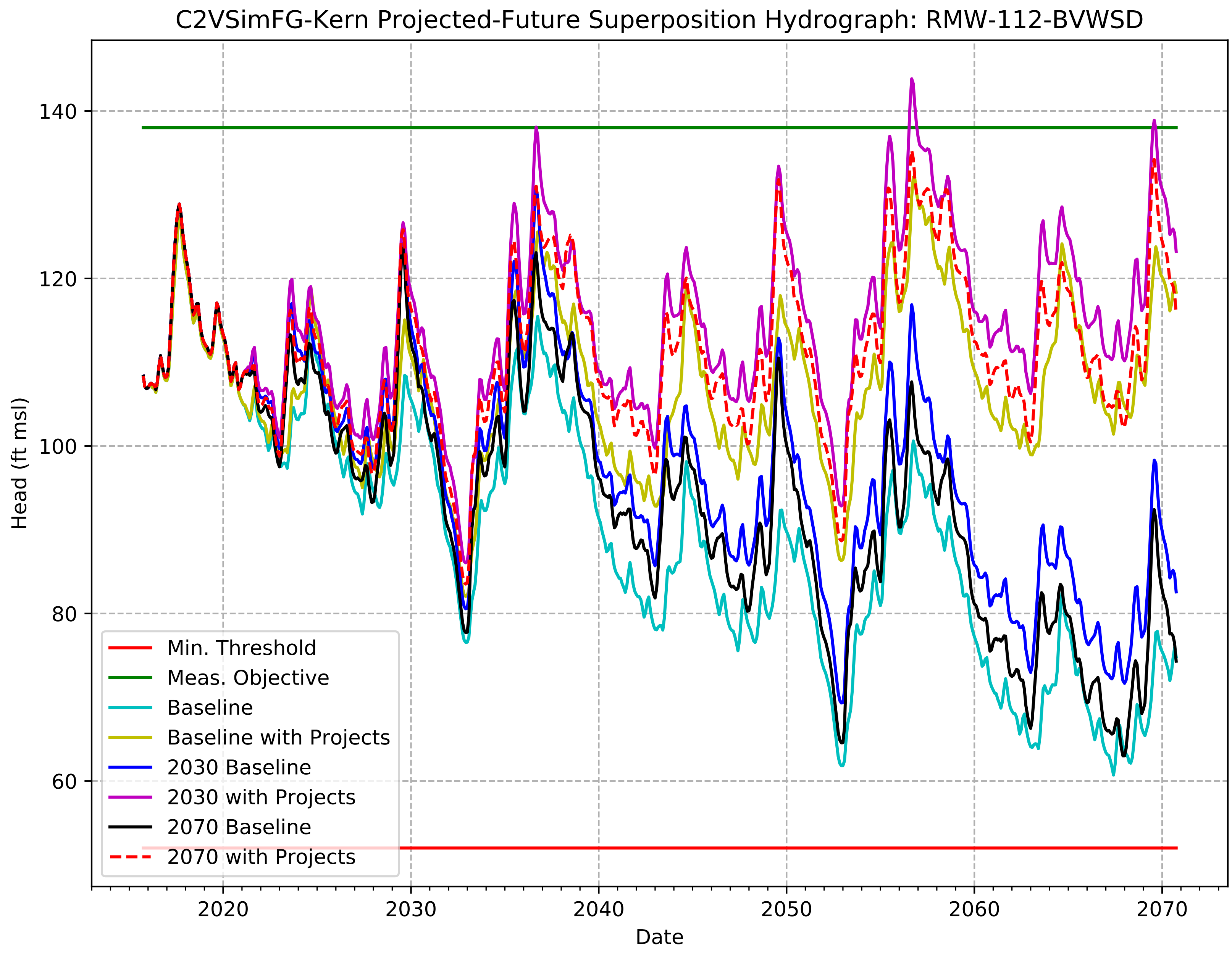
2050
2060
2070
Date



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-111-BVWSD
Head (ft msl)
160
150
140
130
120
110
100
90
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-112-BVWSD
Head (ft msl)
Date
140
120
100
80
60
2020
2030
2040
2050
2060
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Min. Threshold
Meas. Objective
Baseline
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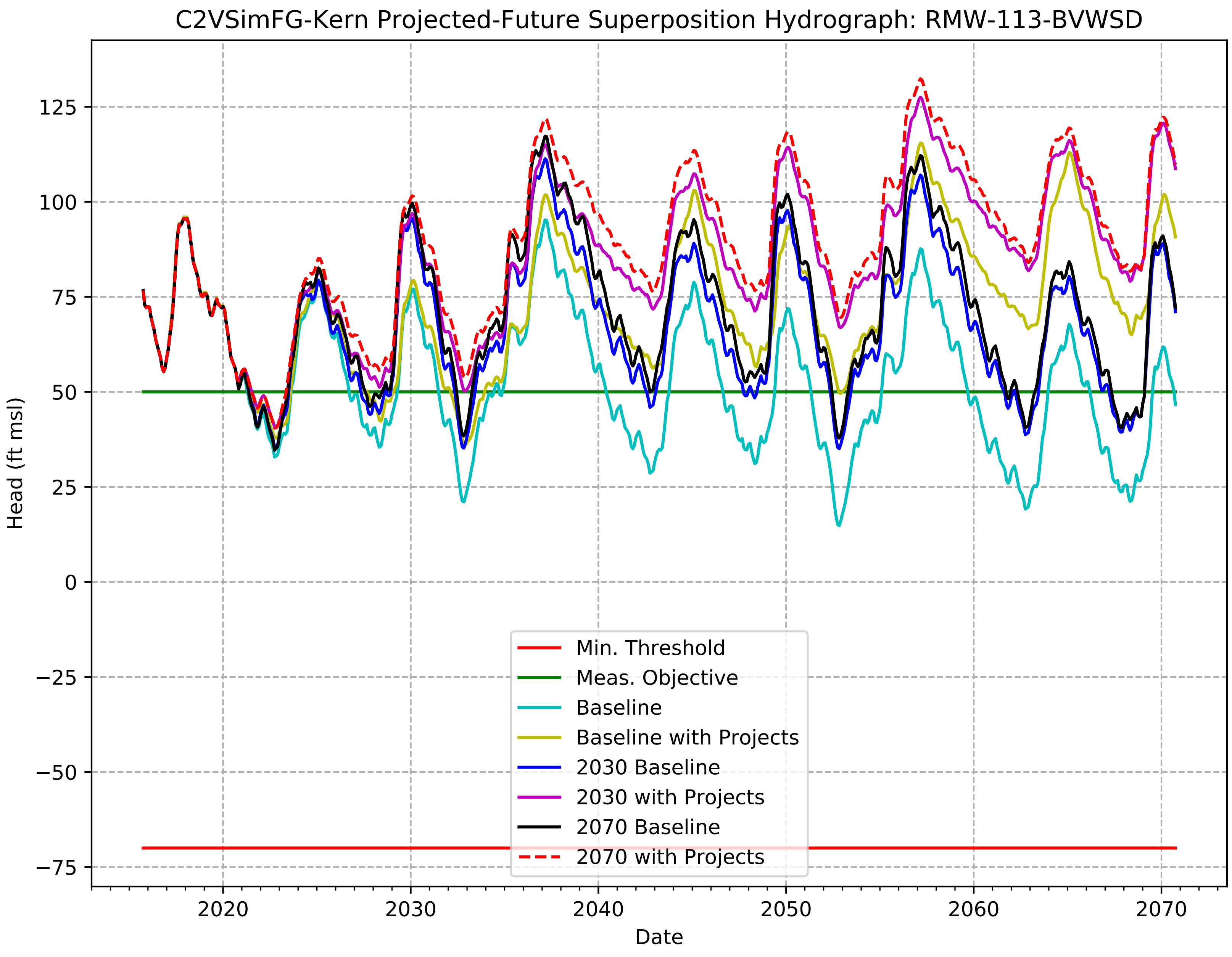
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-113-BVWSD
Head (ft msl)
125
100
75
50
25
0
−25
−50
−75
2020
2030
2040
2050
2060
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Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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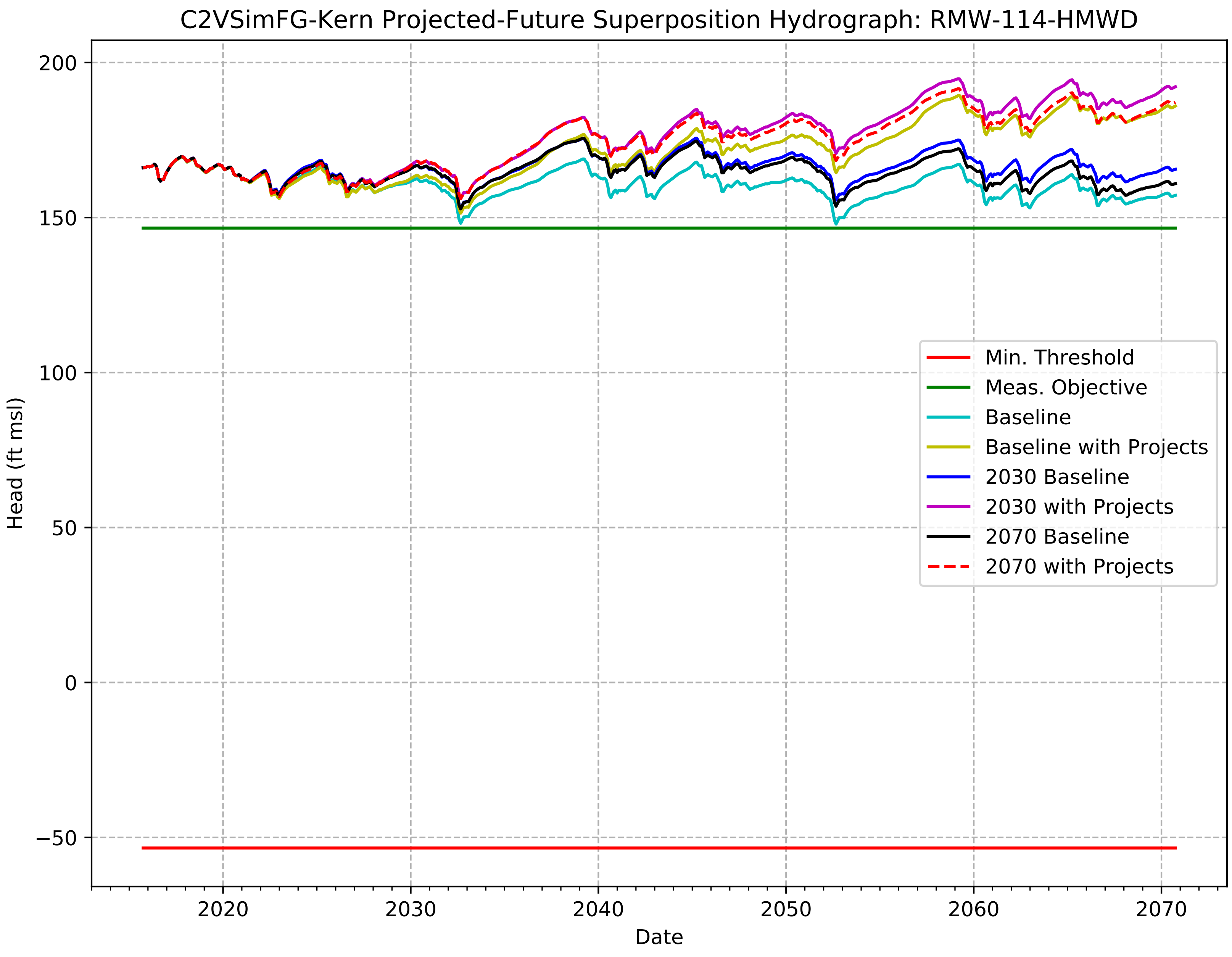

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-114-HMWD
Head (ft msl)
Date
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
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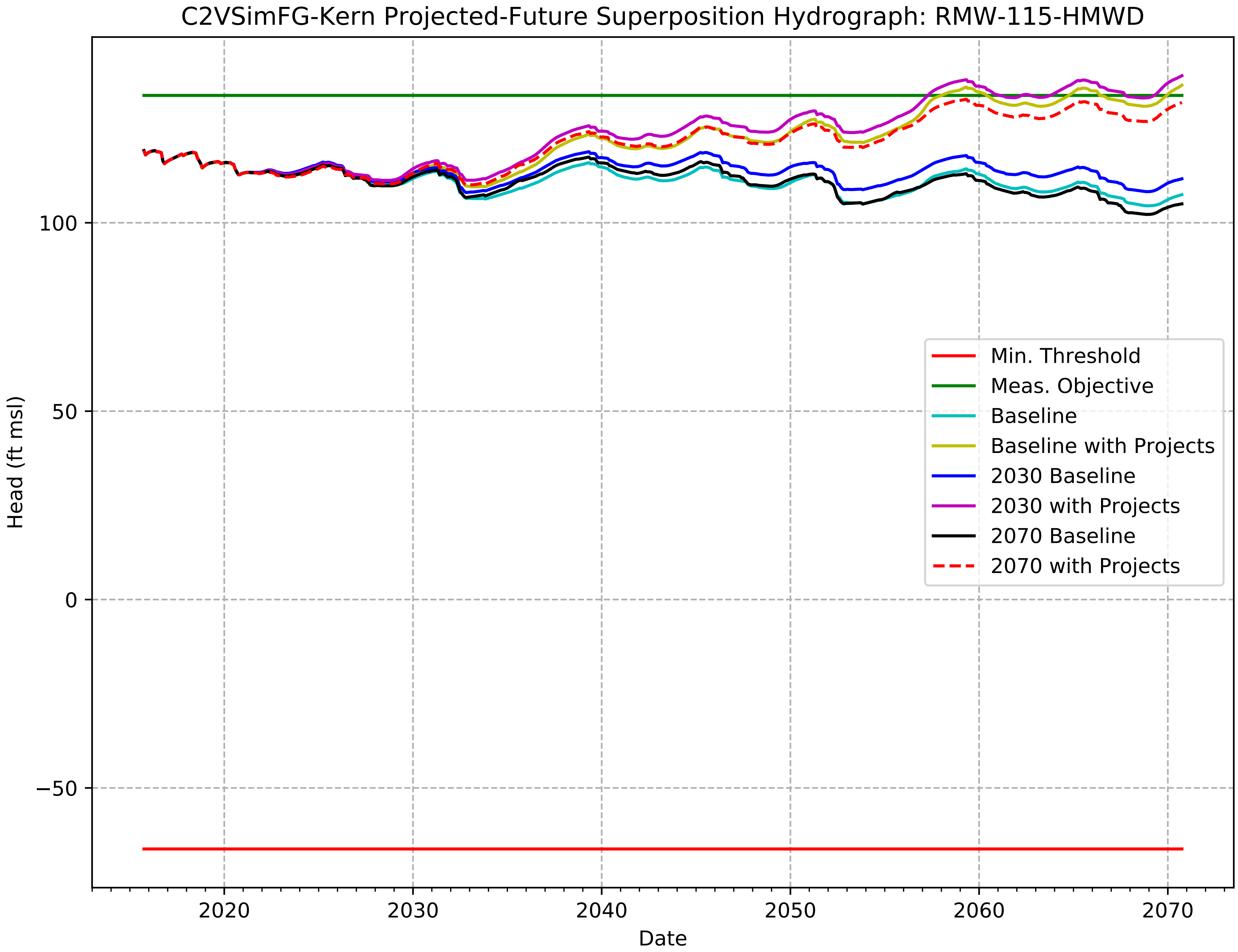
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-115-HMWD
Head (ft msl)
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
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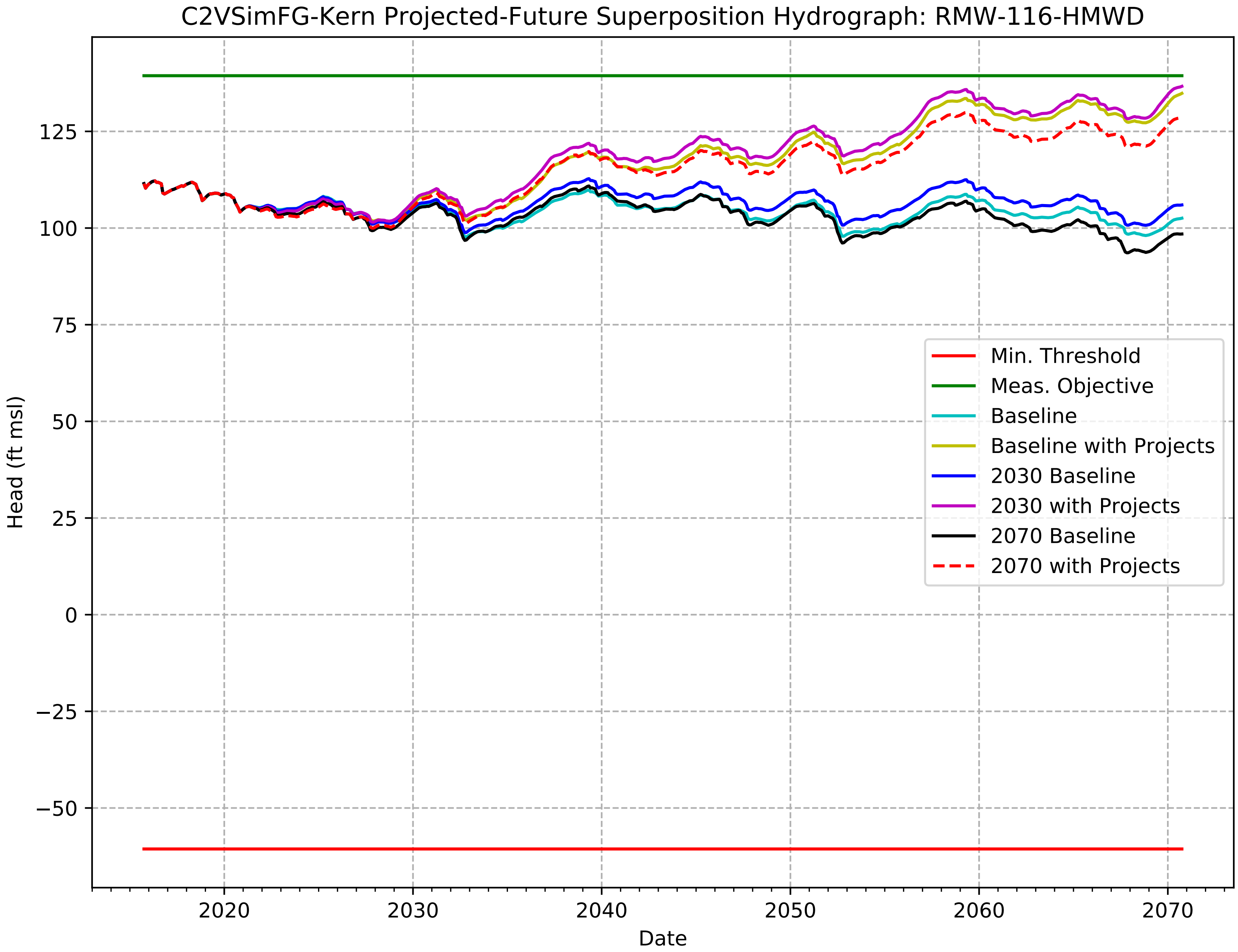

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-116-HMWD
Head (ft msl)
125
100
75
50
25
0
−25
−50
2020
2030
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Date
Min. Threshold
Meas. Objective
Baseline
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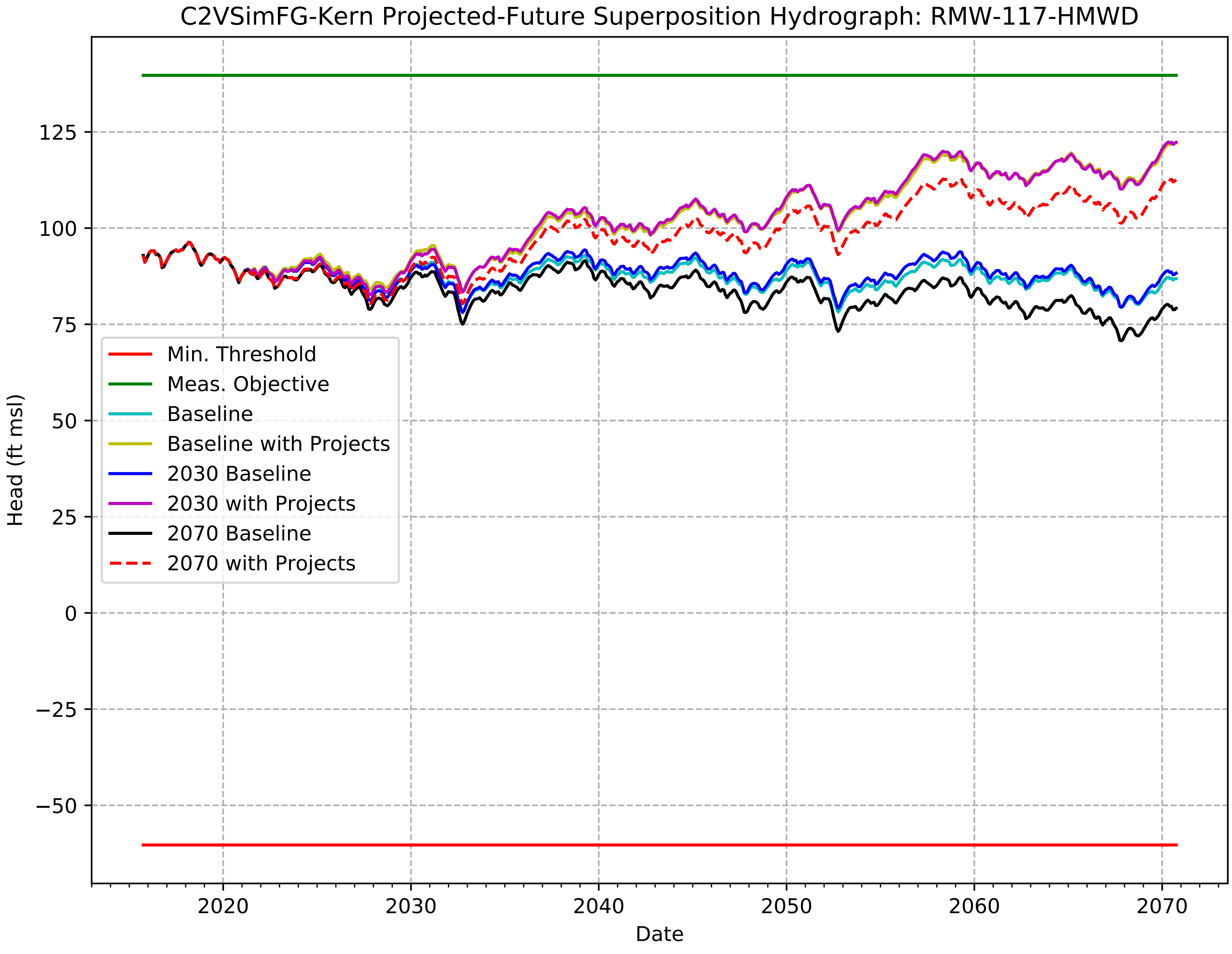
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-117-HMWD
Head (ft msl)
Date
125
100
75
50
25
0
−25
−50
2020
2030
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2060
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Min. Threshold
Meas. Objective
Baseline
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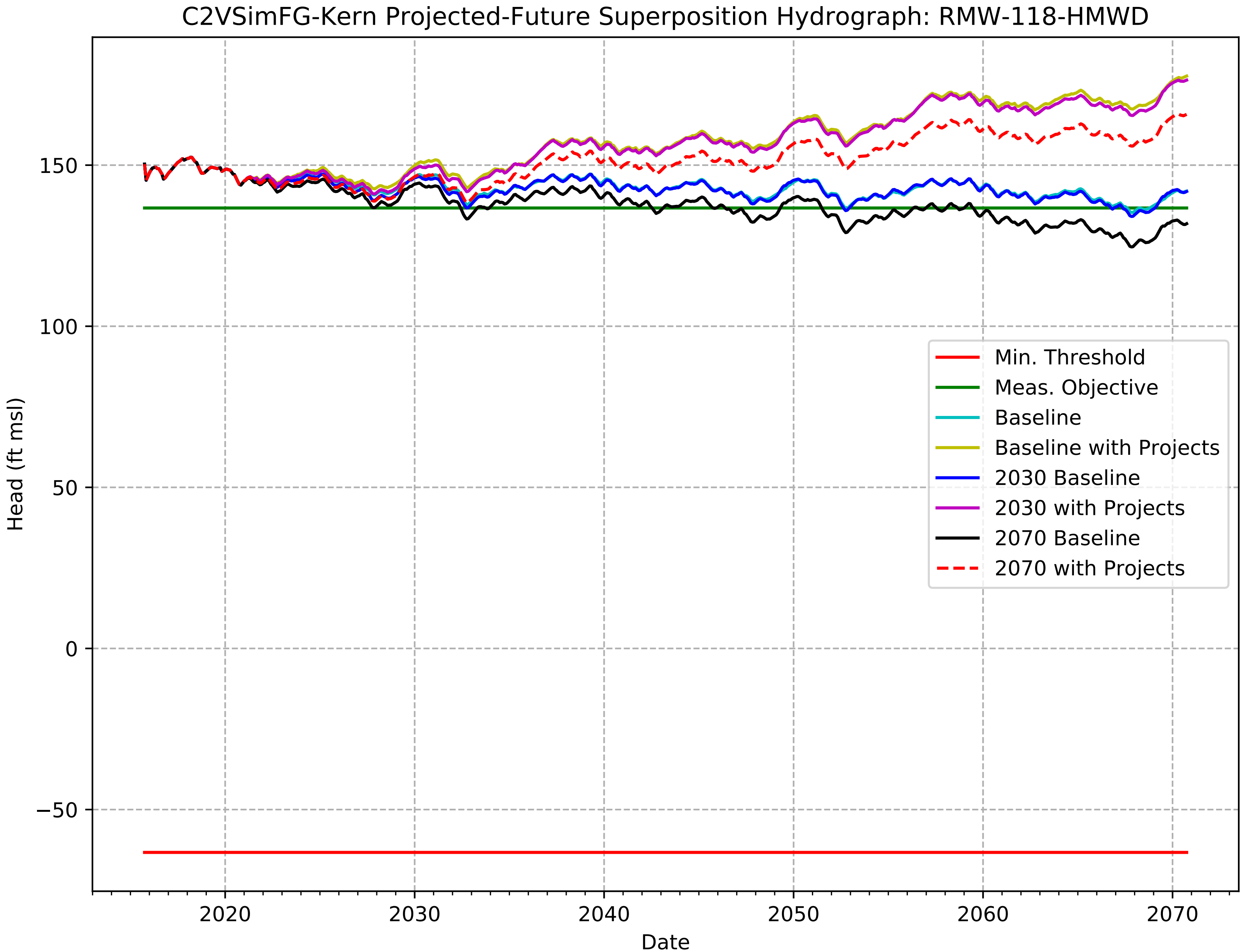

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-118-HMWD
Head (ft msl)
150
100
50
0
−50
2020
2030
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2050
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Date
Min. Threshold
Meas. Objective
Baseline
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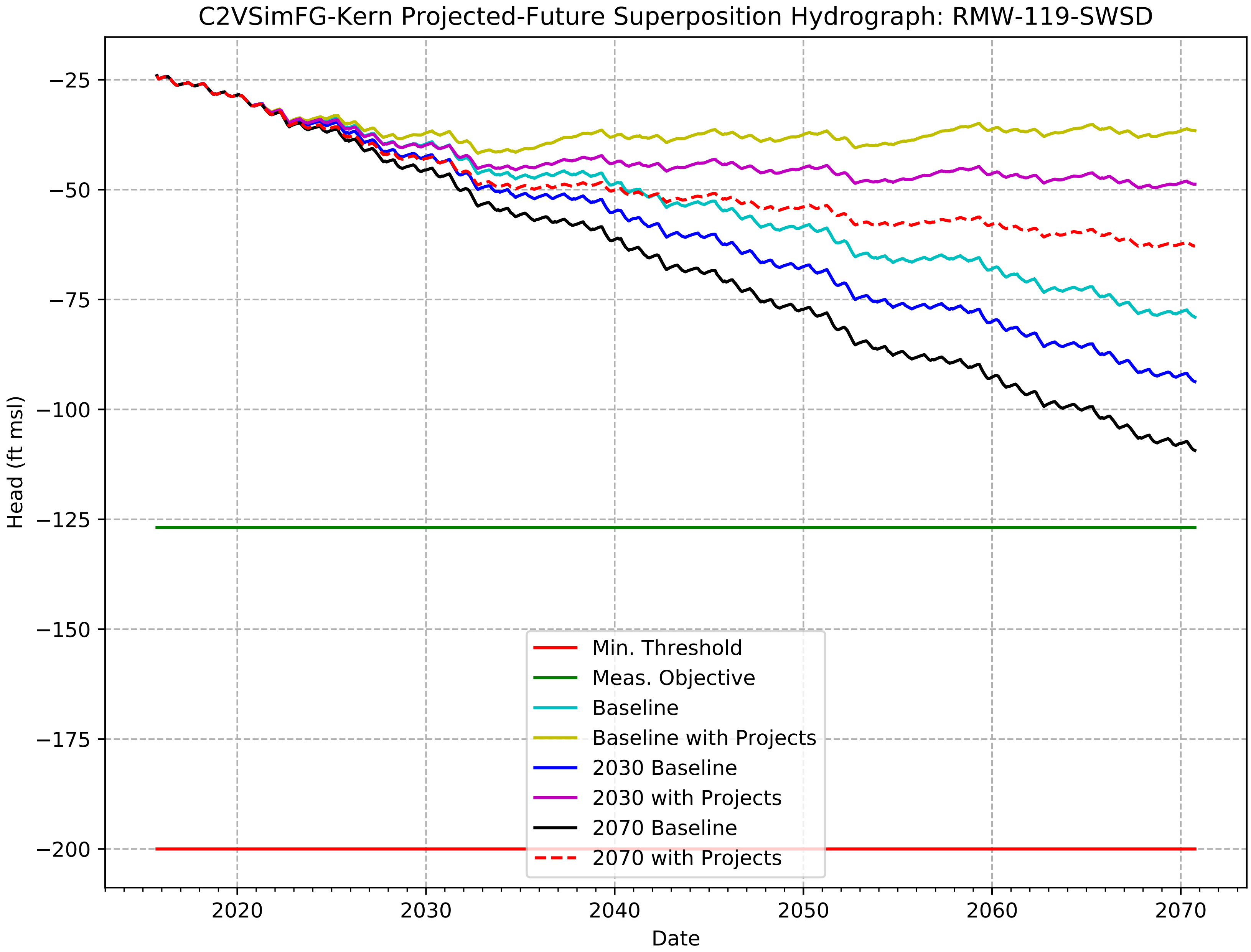
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-119-SWSD
Head (ft msl)
−25
−50
−75
−100
−125
−150
−175
−200
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
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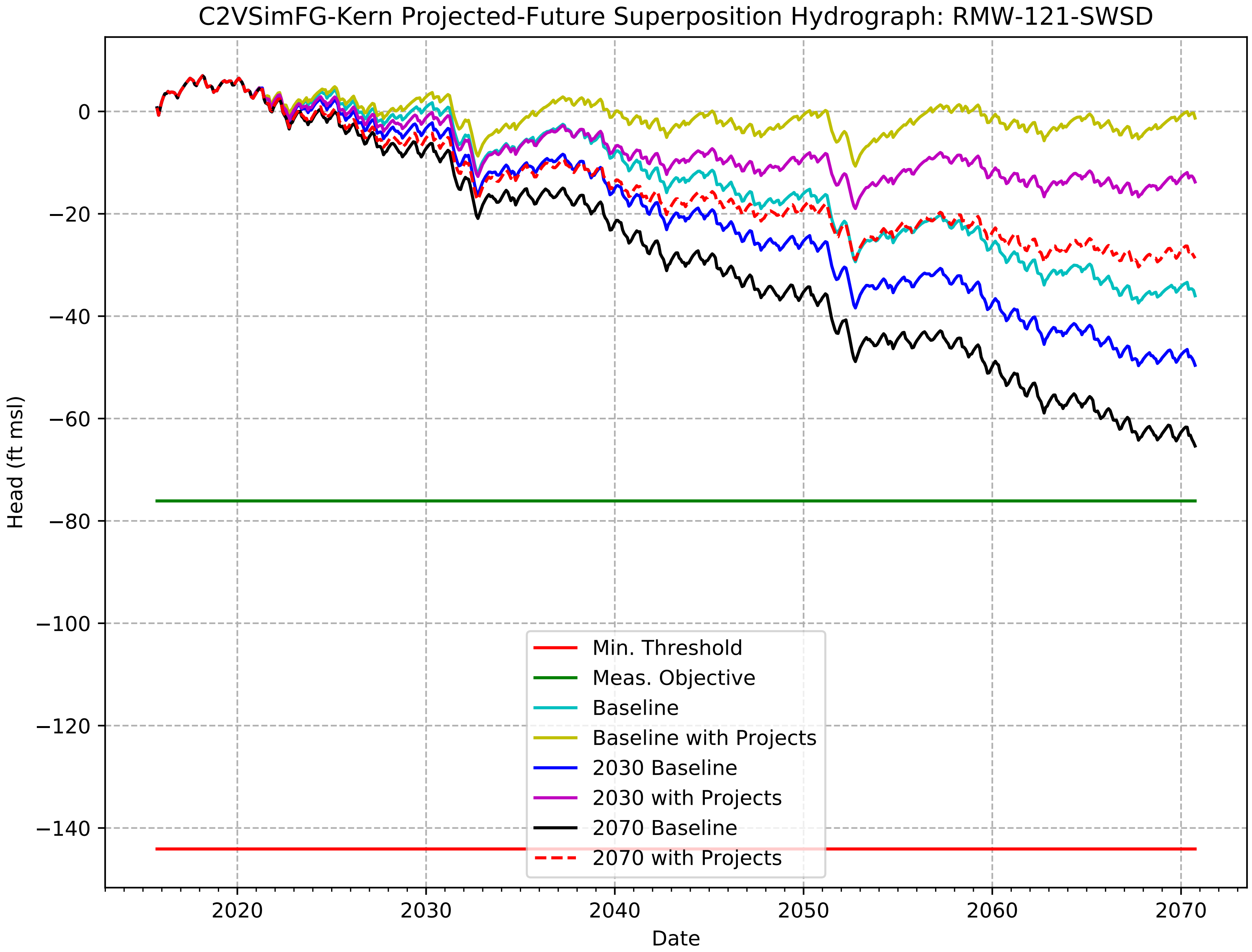
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-121-SWSD
Head (ft msl)
0
−20
−40
−60
−80
−100
−120
−140
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
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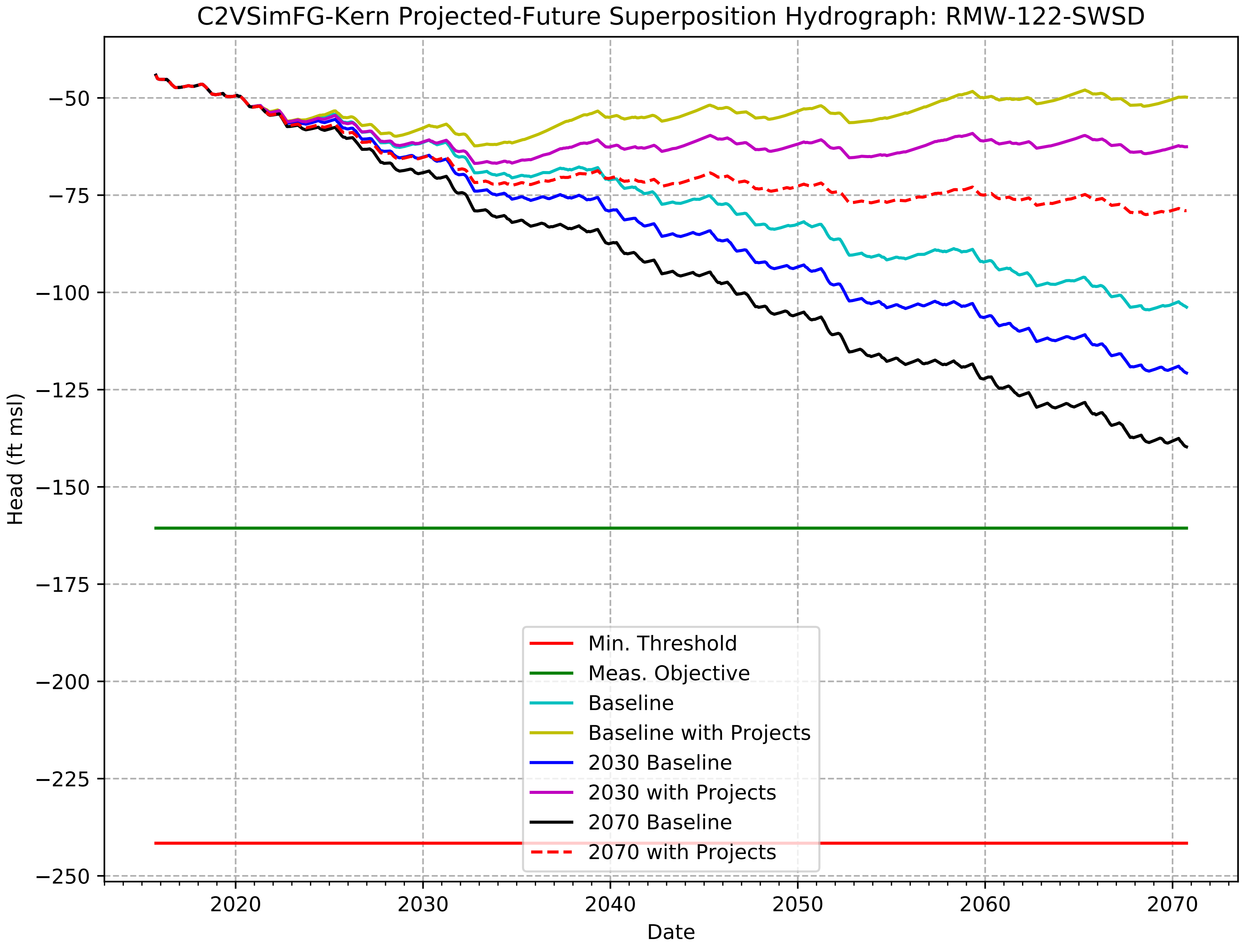
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-122-SWSD
Head (ft msl)
−50
−75
−100
−125
−150
−175
−200
−225
−250
2020
2030
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2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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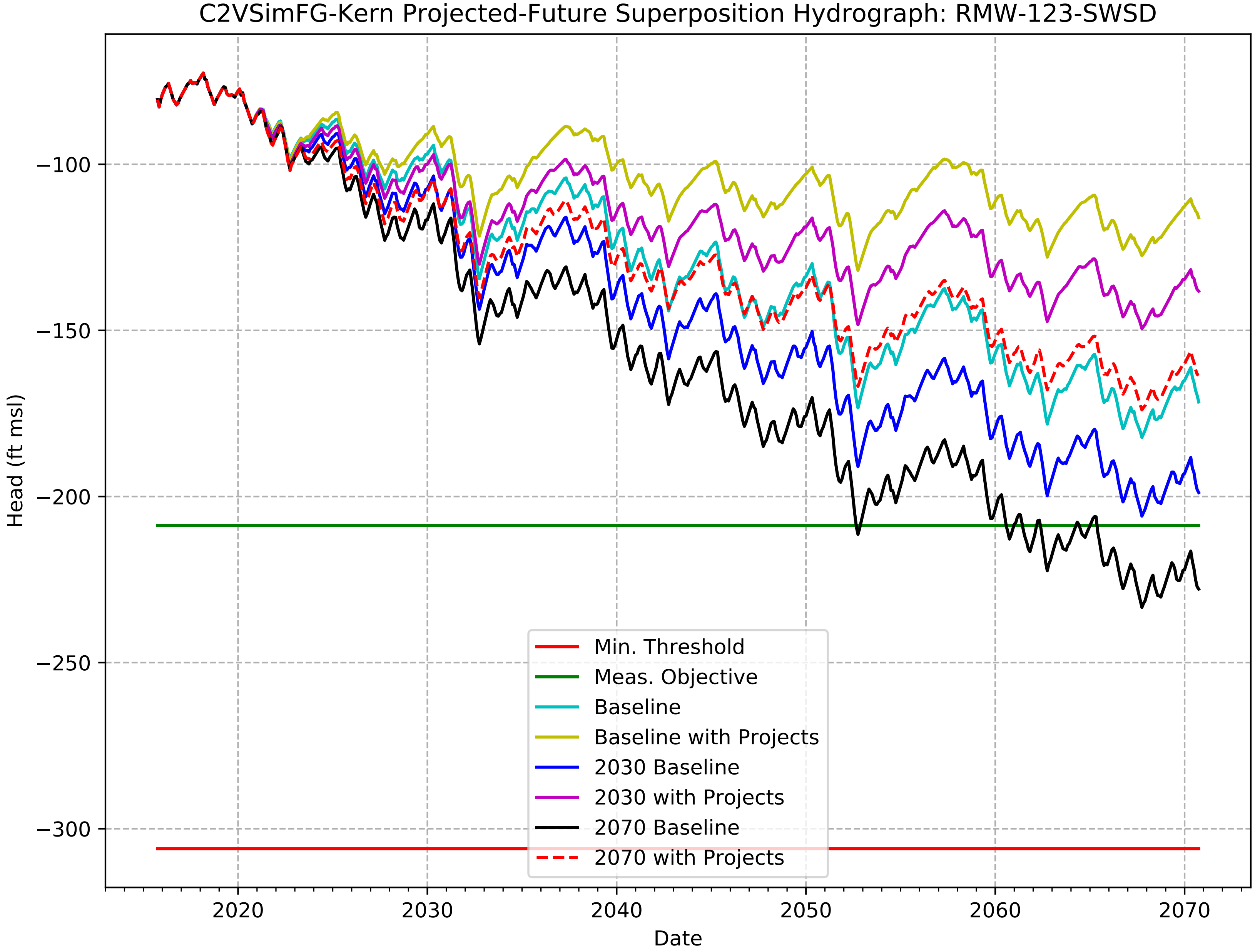
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-123-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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2030 with Projects
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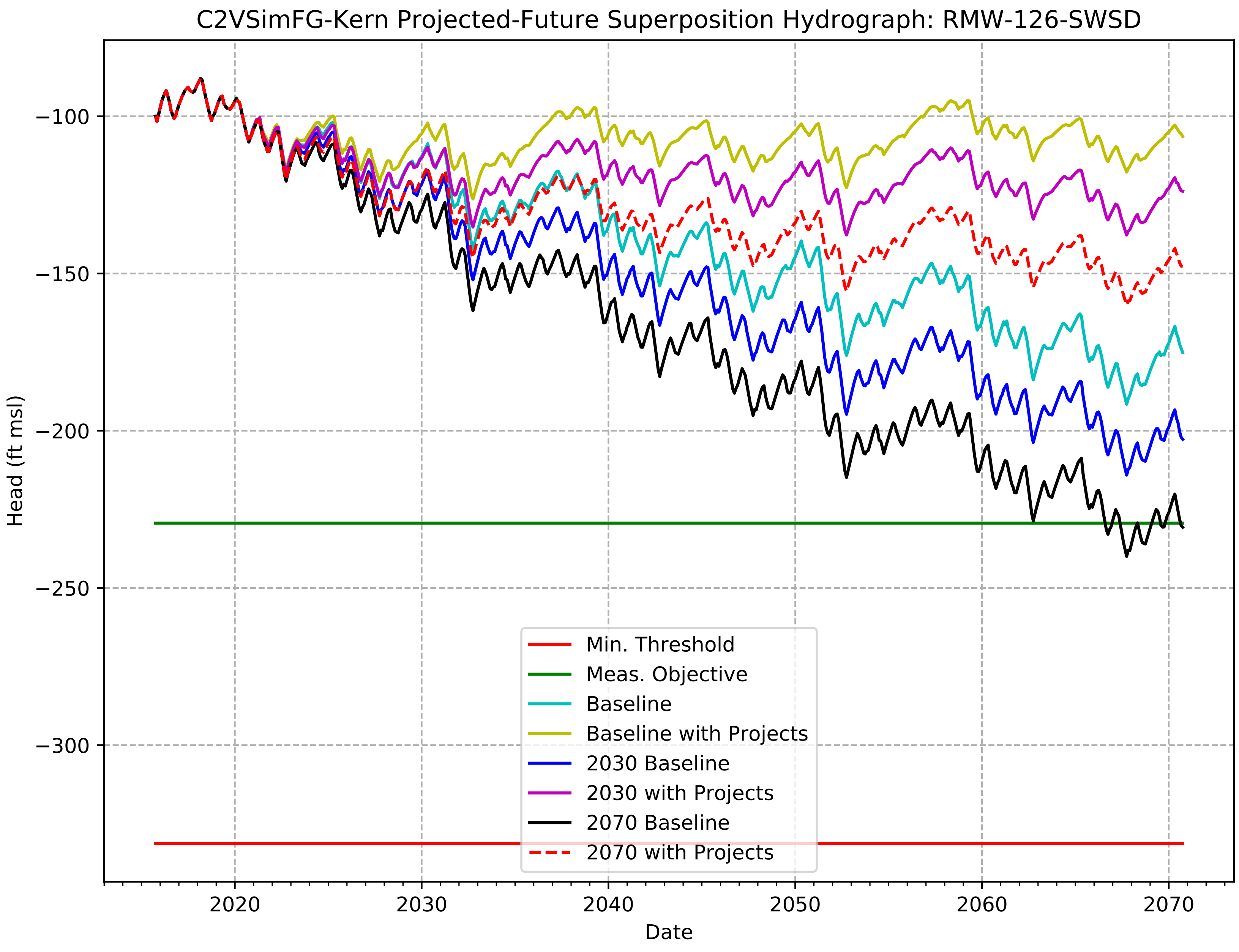
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-126-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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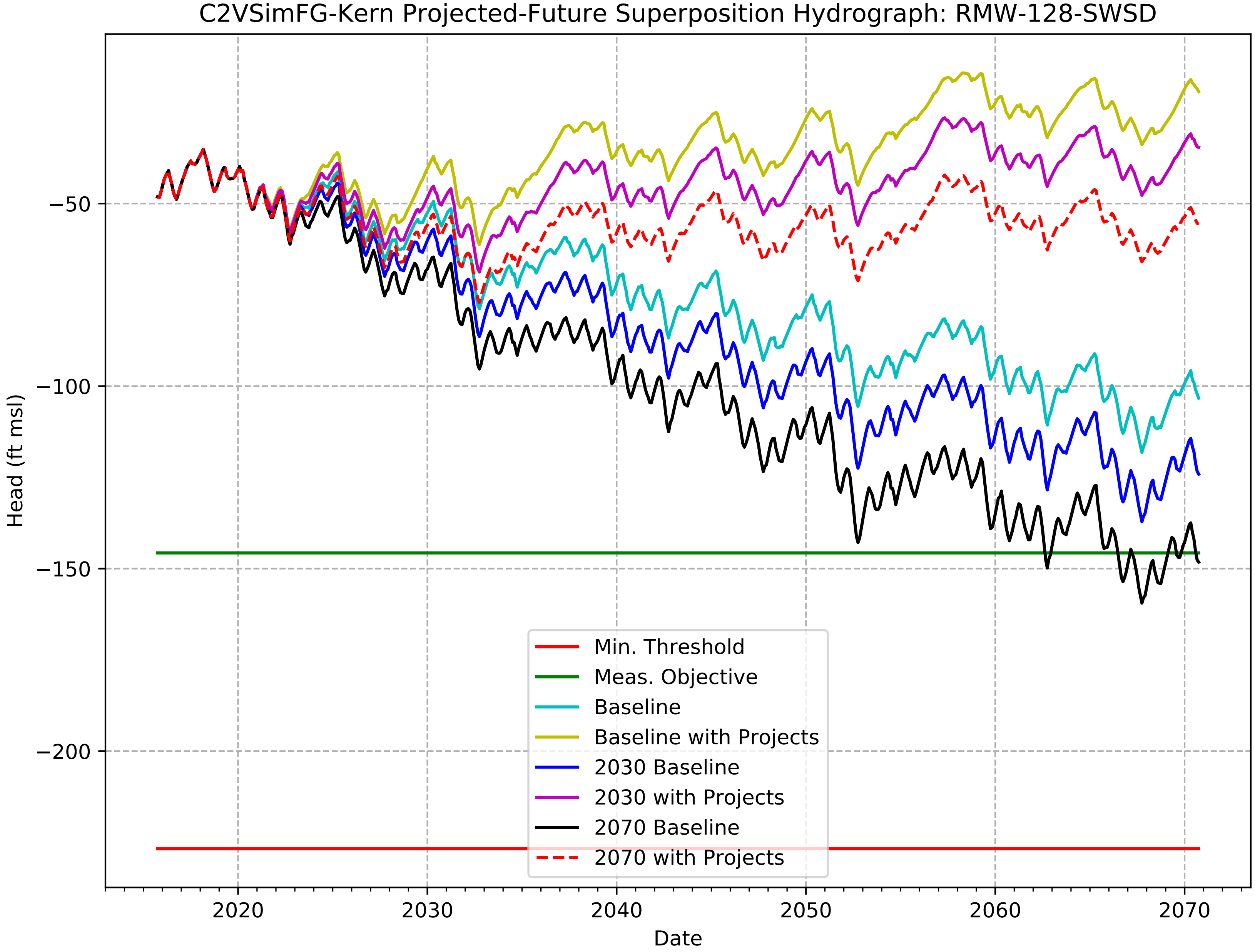
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-128-SWSD
Head (ft msl)
−50
−100
−150
−200
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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2030 with Projects
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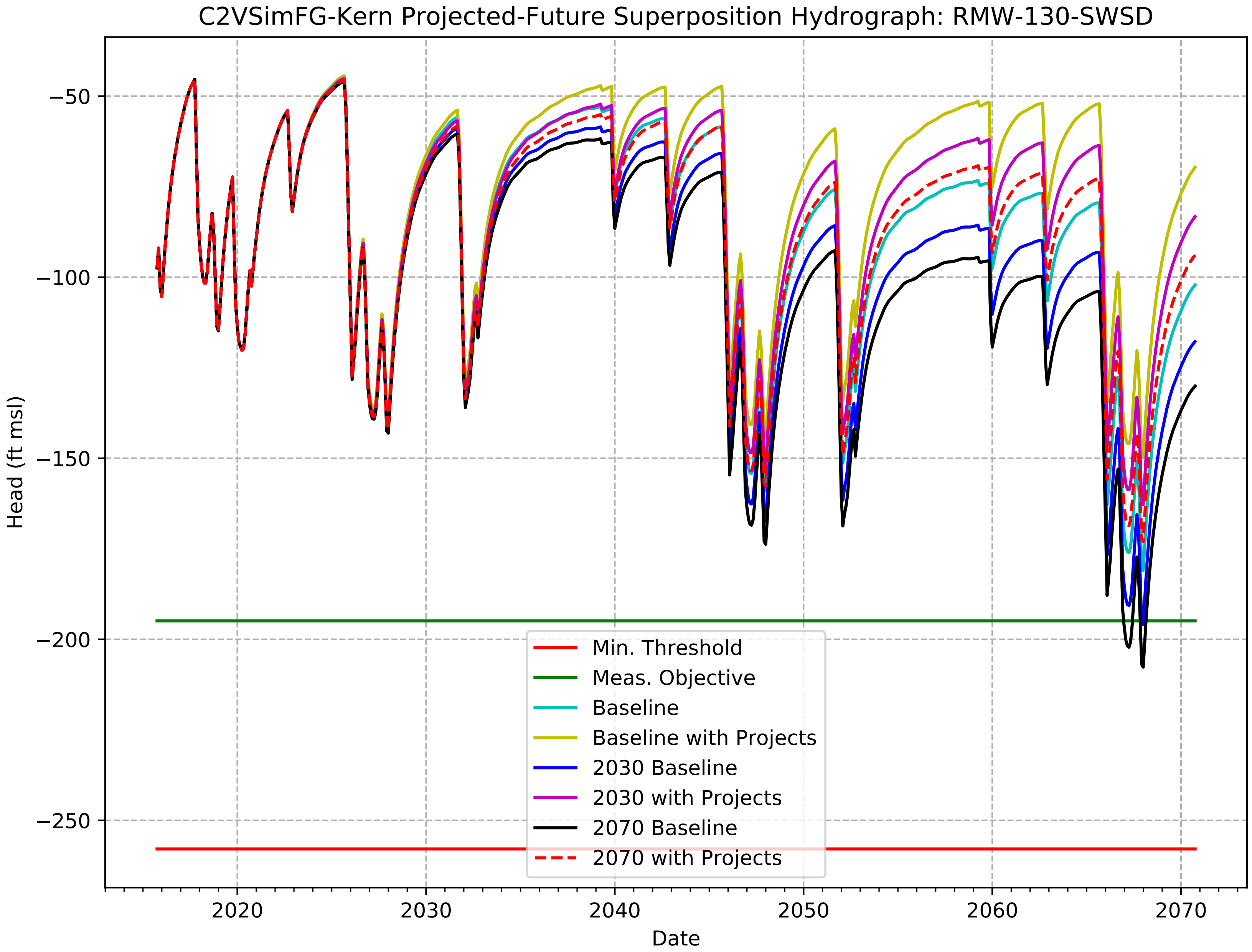
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-130-SWSD
Head (ft msl)
−50
−100
−150
−200
−250
Date
2020
2030
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2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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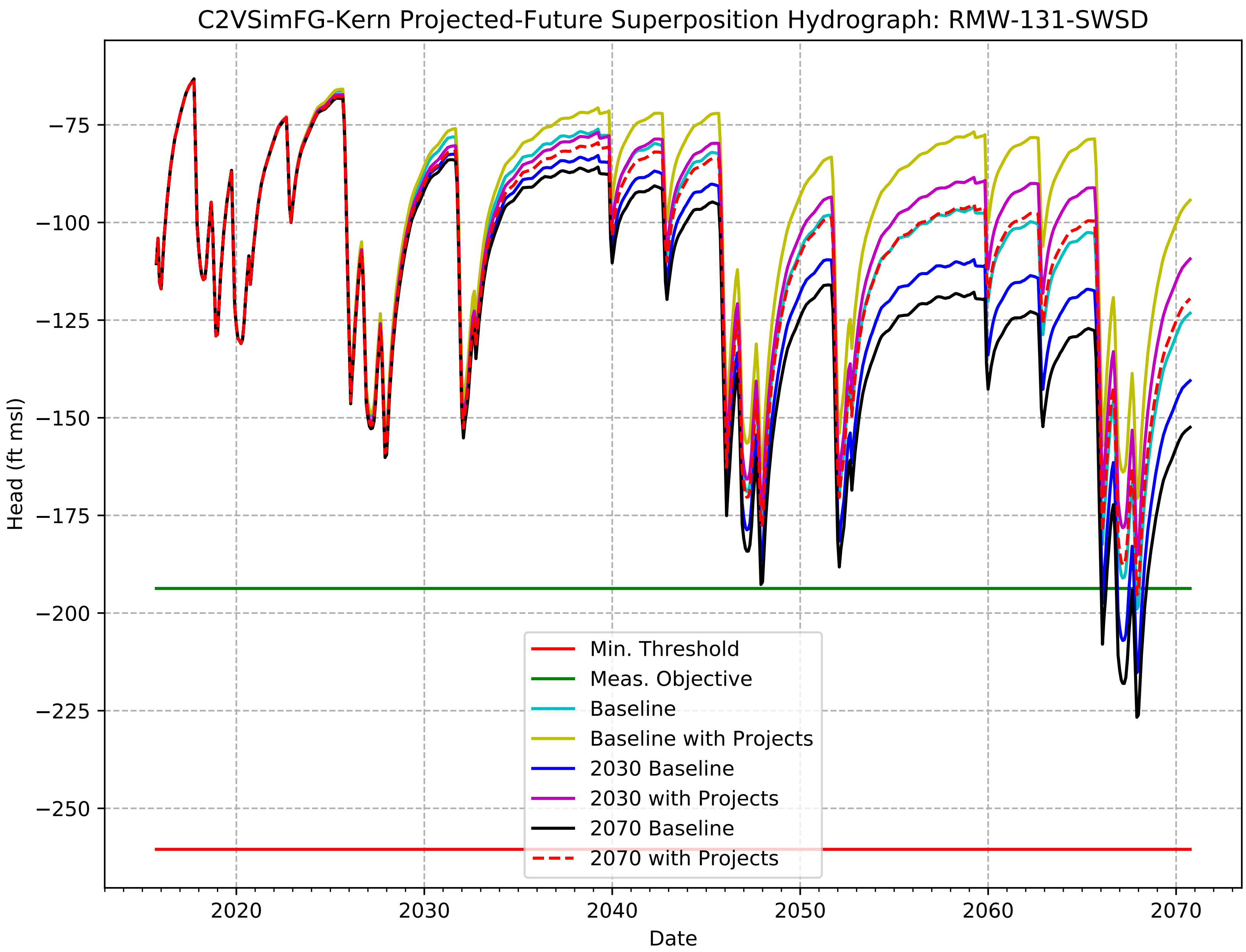
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-131-SWSD
Head (ft msl)
−75
−100
−125
−150
−175
−200
−225
−250
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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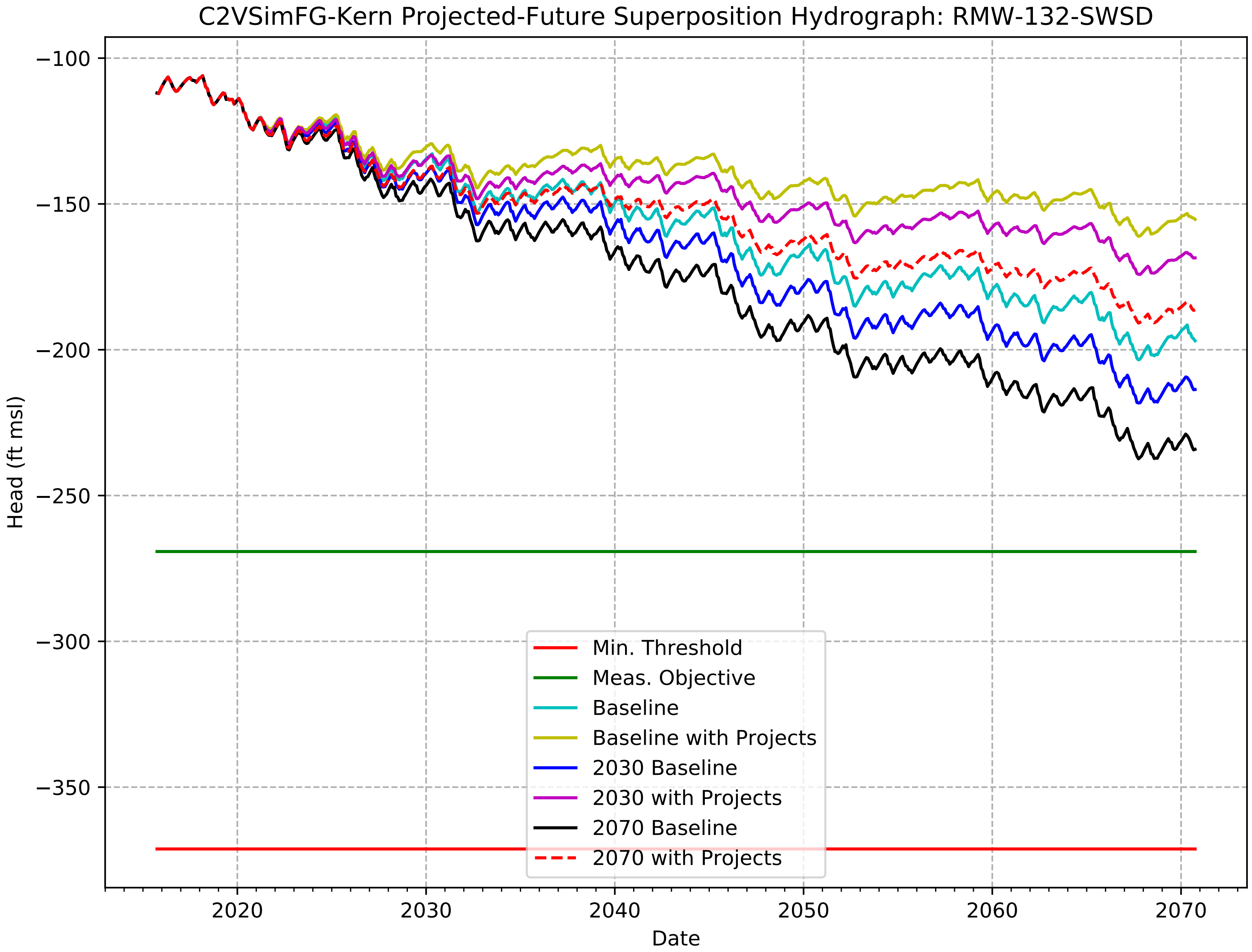
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-132-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
−350
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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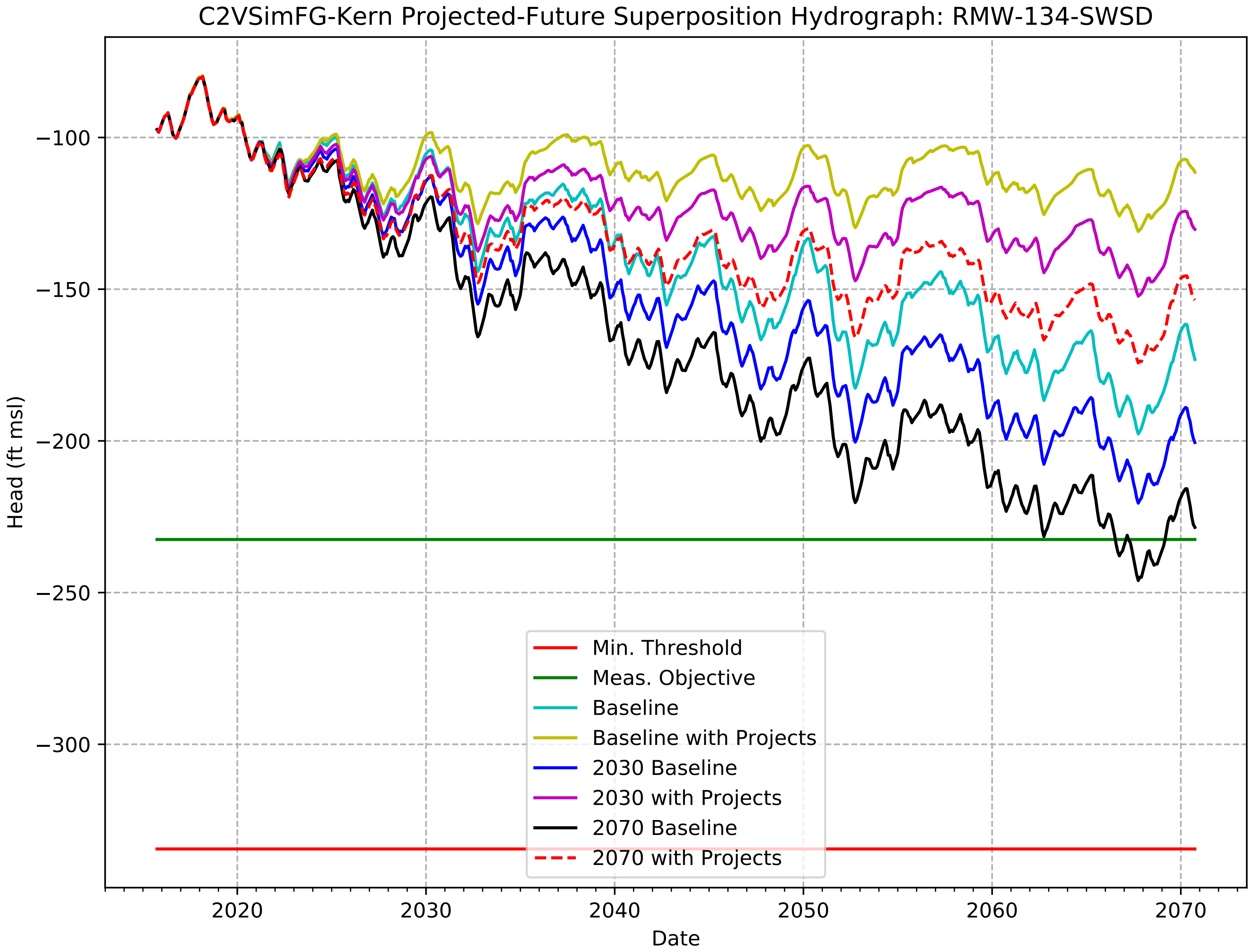

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-134-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
2020
2030
2040
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2070
Date
Min. Threshold
Meas. Objective
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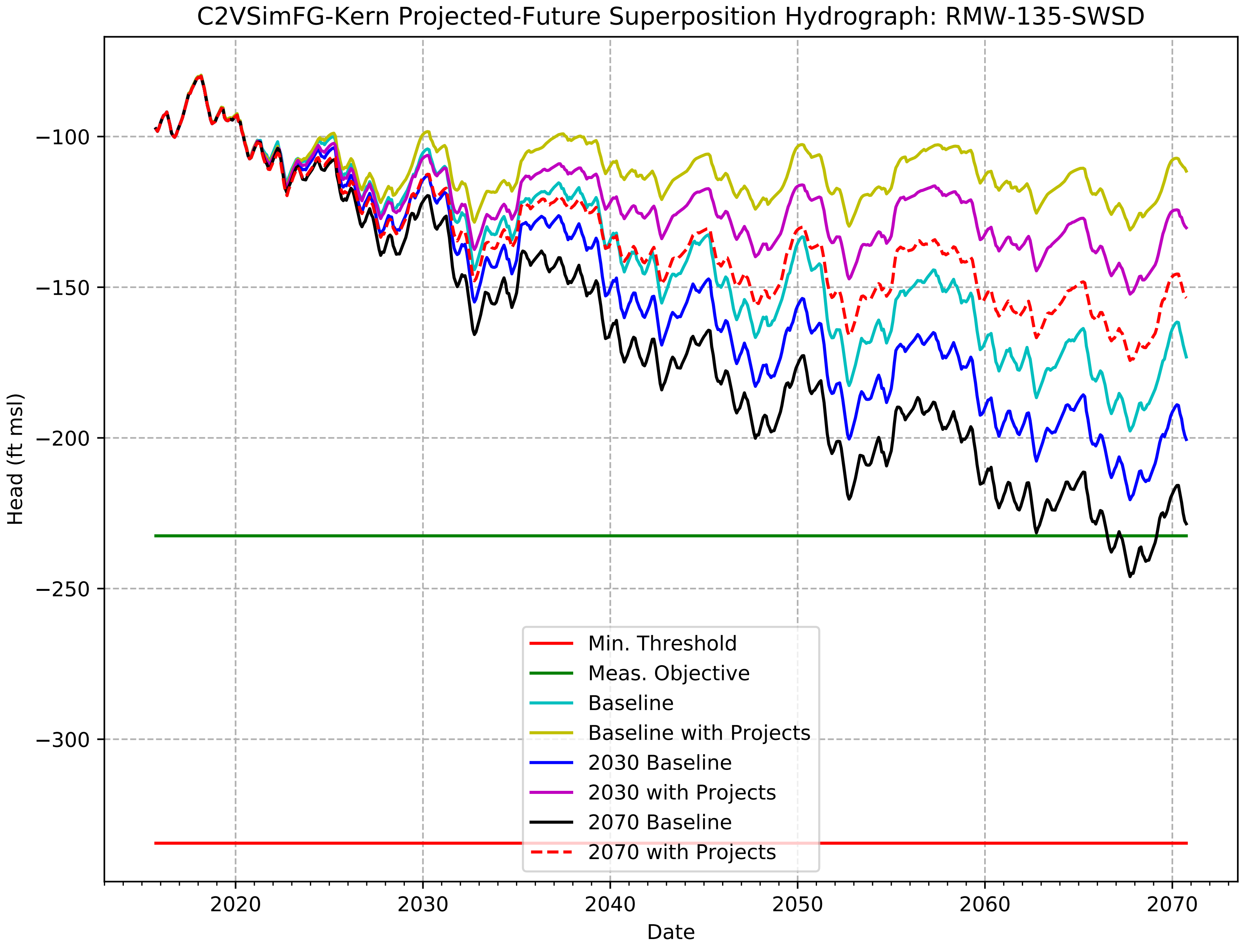
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-135-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
2020
2030
2040
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2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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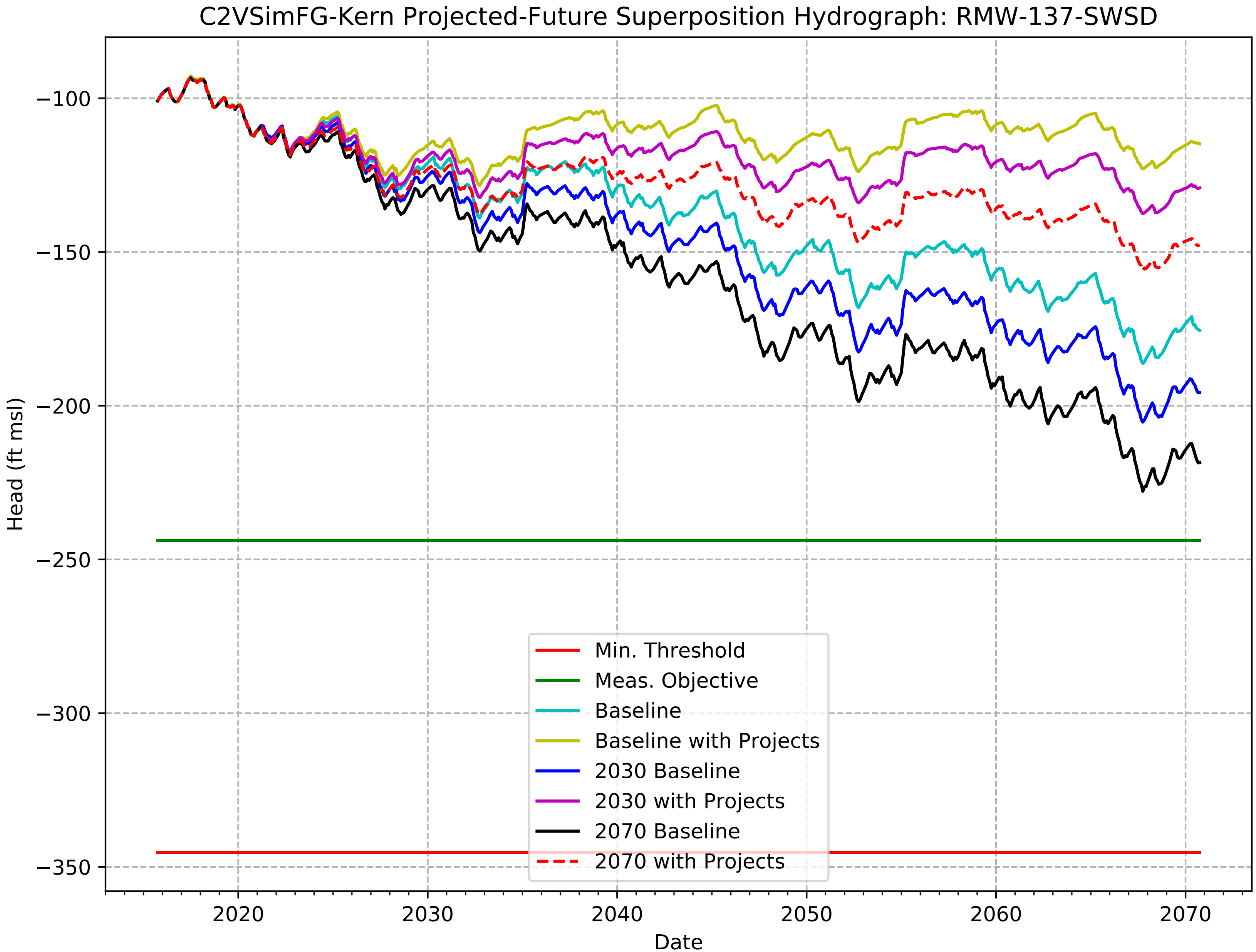
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-137-SWSD
Head (ft msl)
−100
−150
−200
−250
−300
−350
Date
2020
2030
2040
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2060
2070
Min. Threshold
Meas. Objective
Baseline
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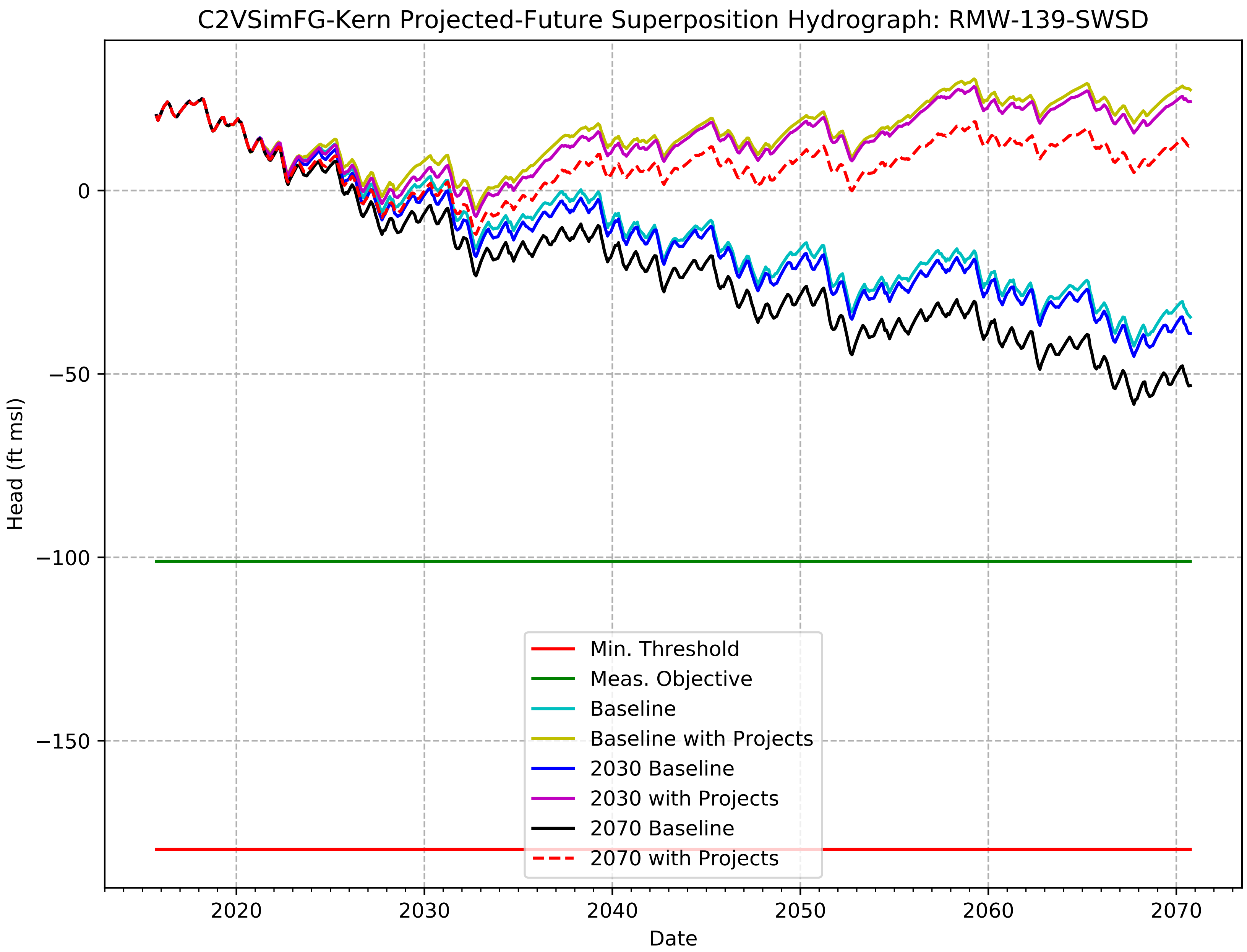
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-139-SWSD
Head (ft msl)
0
−50
−100
−150
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
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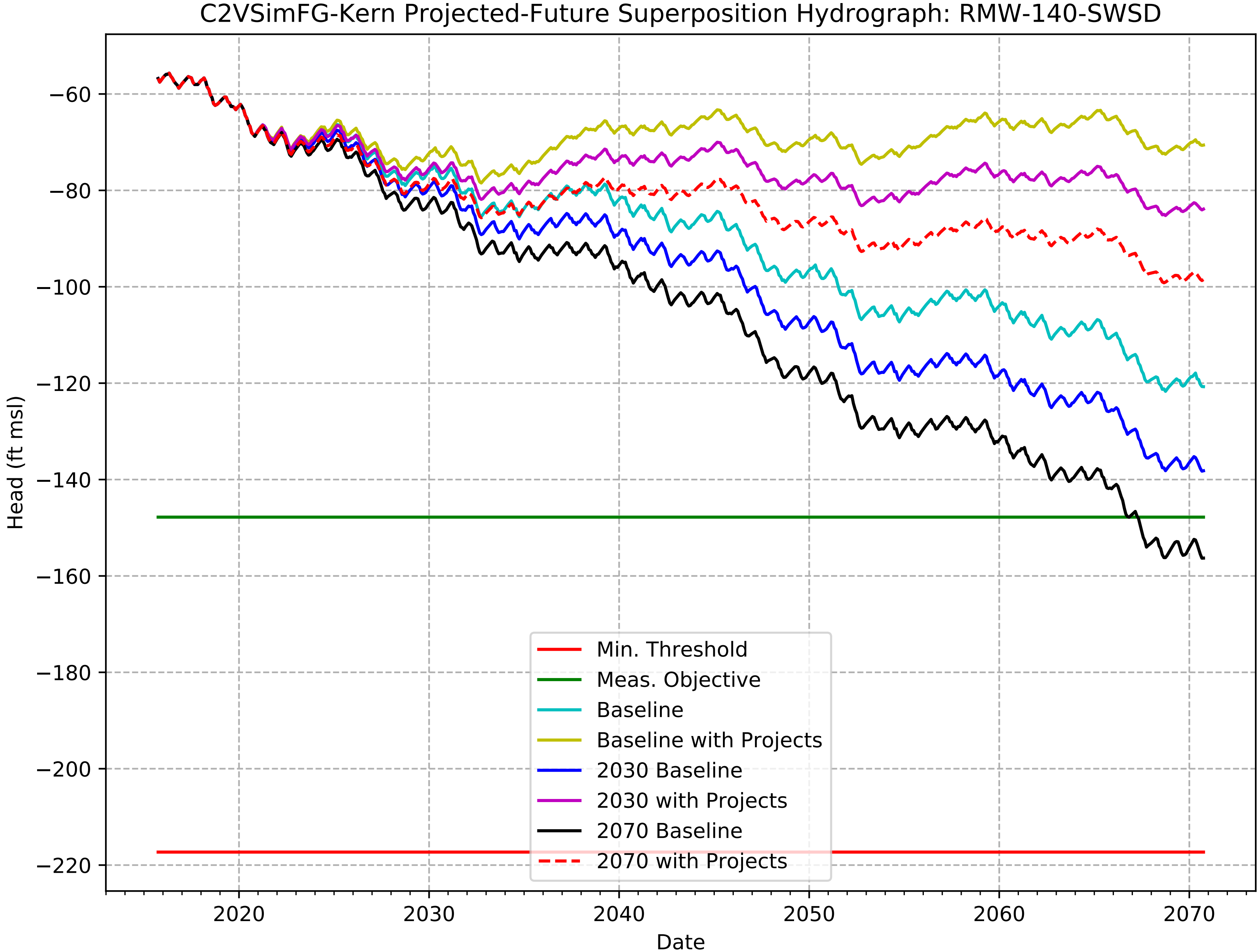
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-140-SWSD
Head (ft msl)
−60
−80
−100
−120
−140
−160
−180
−200
−220
2020
2030
2040
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Date
Min. Threshold
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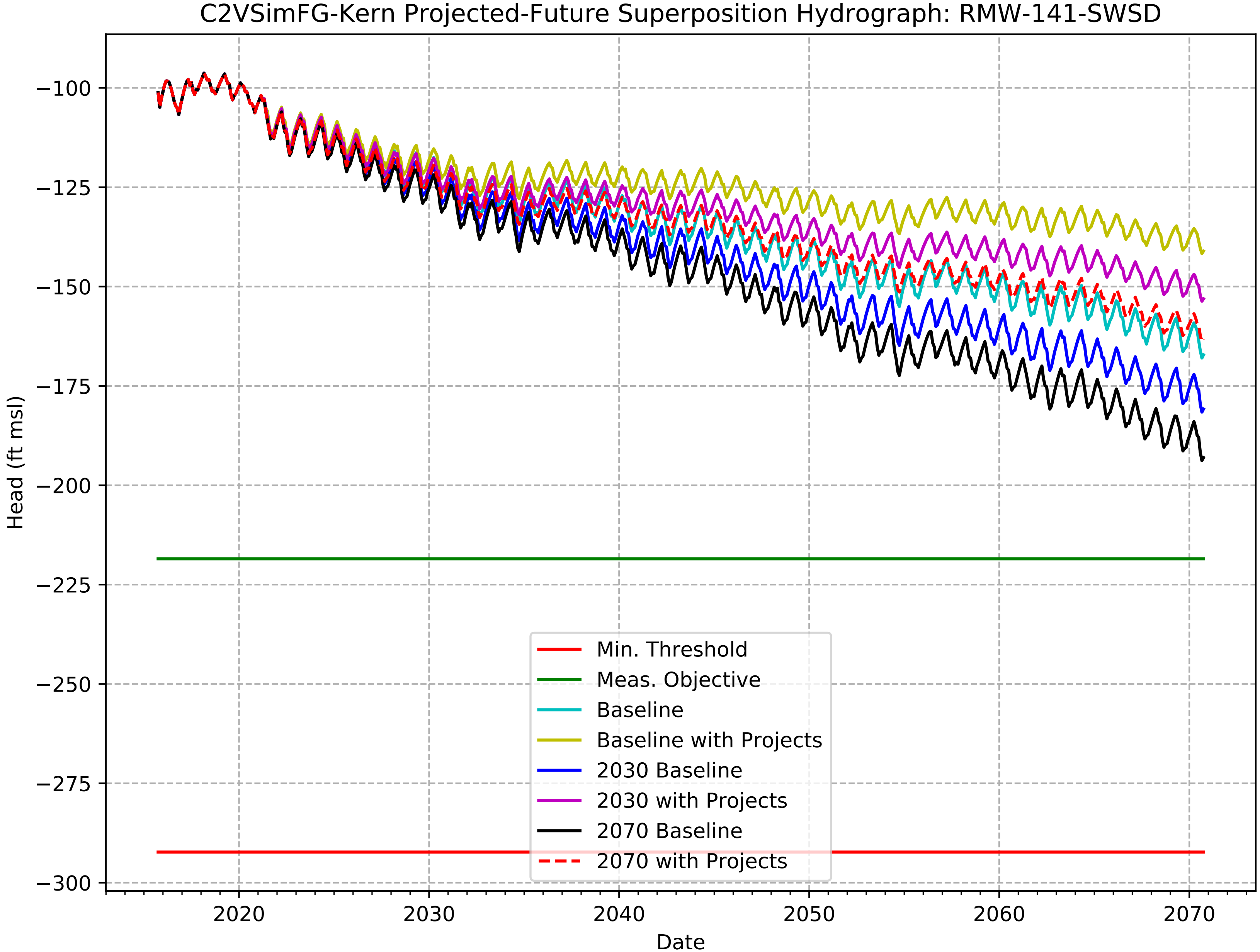

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-141-SWSD
Head (ft msl)
−100
−125
−150
−175
−200
−225
−250
−275
−300
Date
2020
2030
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Min. Threshold
Meas. Objective
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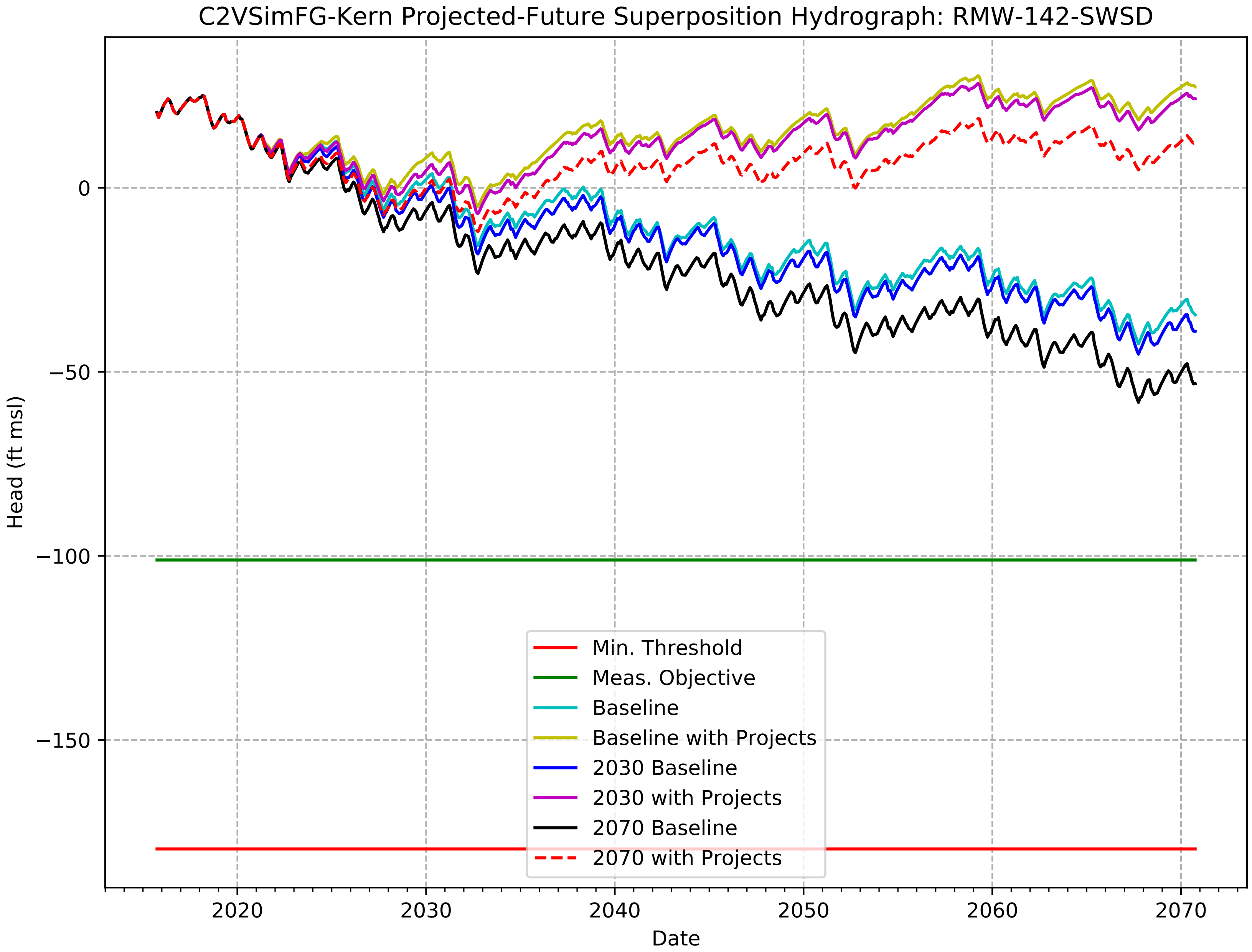
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-142-SWSD
Head (ft msl)
0
−50
−100
−150
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
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2030 with Projects
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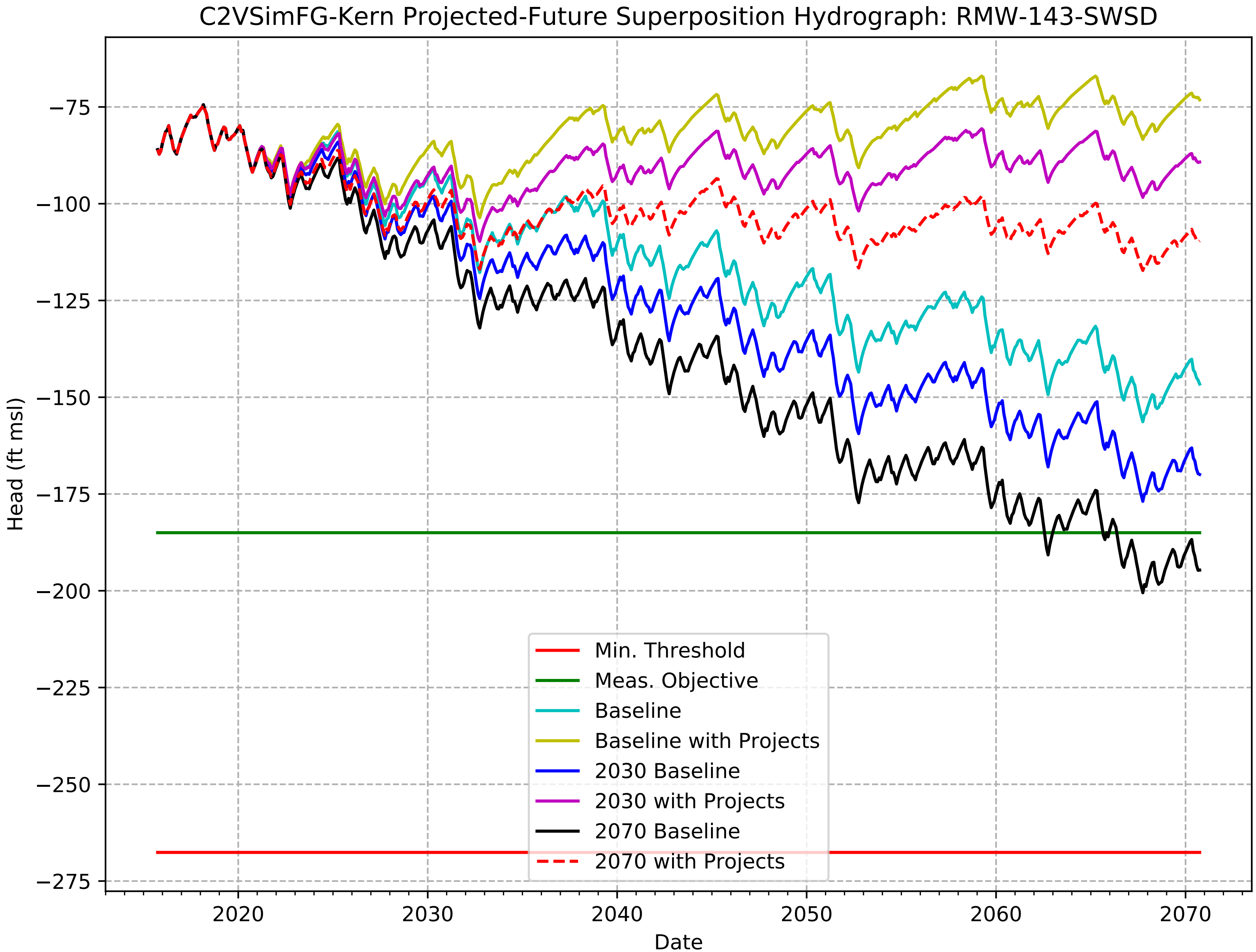
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-143-SWSD
Head (ft msl)
−75
−100
−125
−150
−175
−200
−225
−250
−275
Date
2020
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Min. Threshold
Meas. Objective
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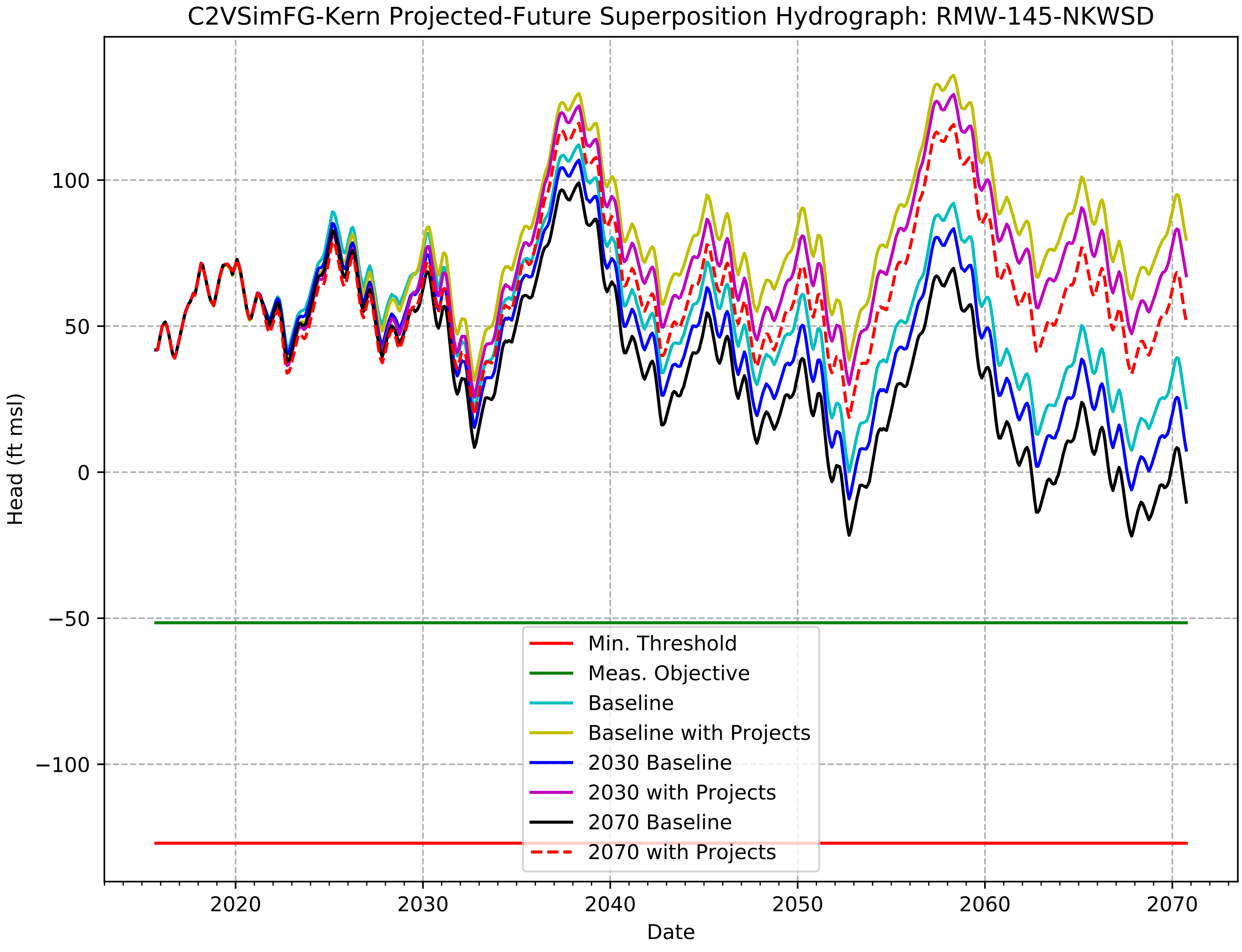

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-145-NKWSD
Head (ft msl)
100
50
0
−50
−100
2020
2030
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2070
Date
Min. Threshold
Meas. Objective
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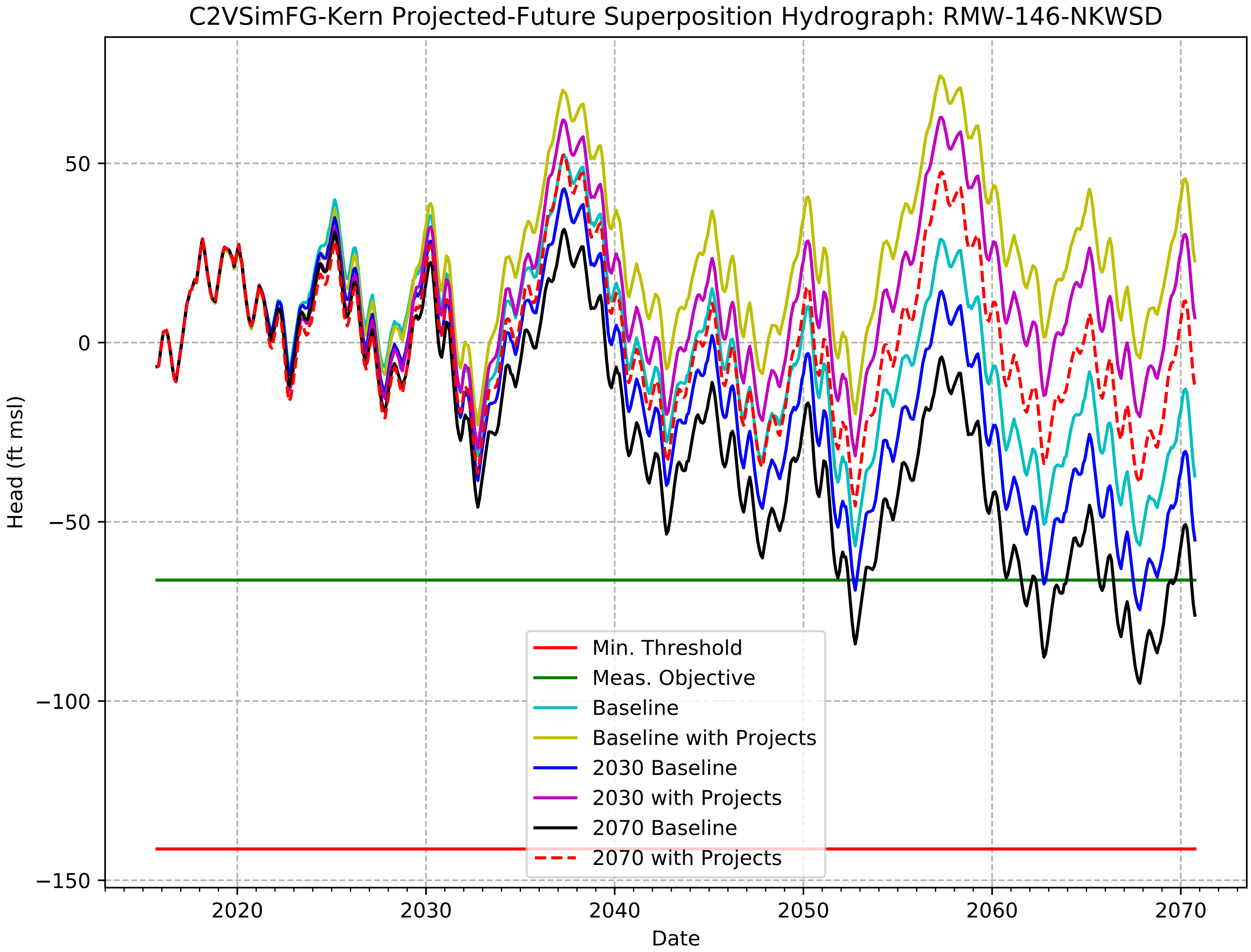
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-146-NKWSD
Head (ft msl)
50
0
−50
−100
−150
2020
2030
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Date
Min. Threshold
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Baseline
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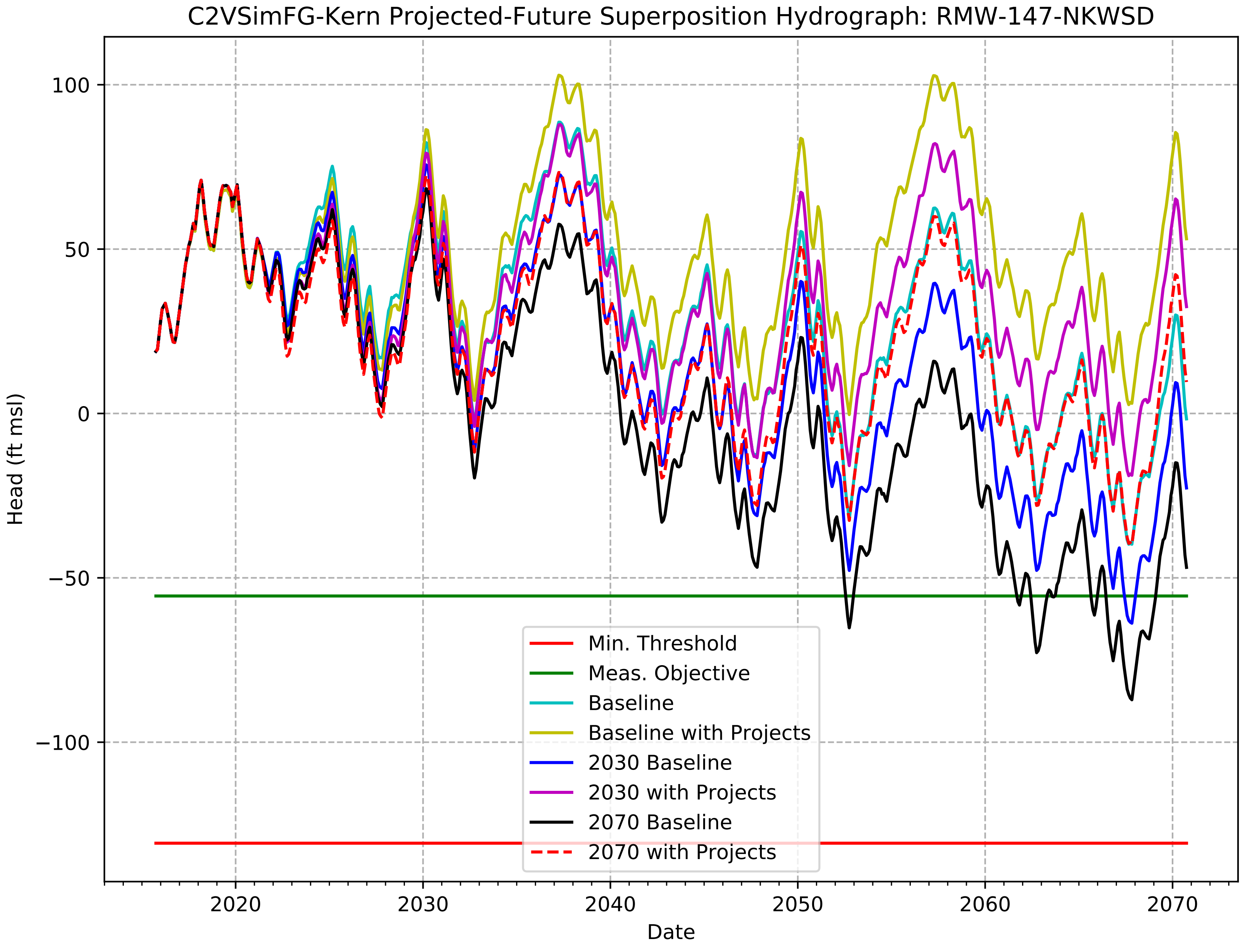
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-147-NKWSD
Head (ft msl)
100
50
0
−50
−100
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
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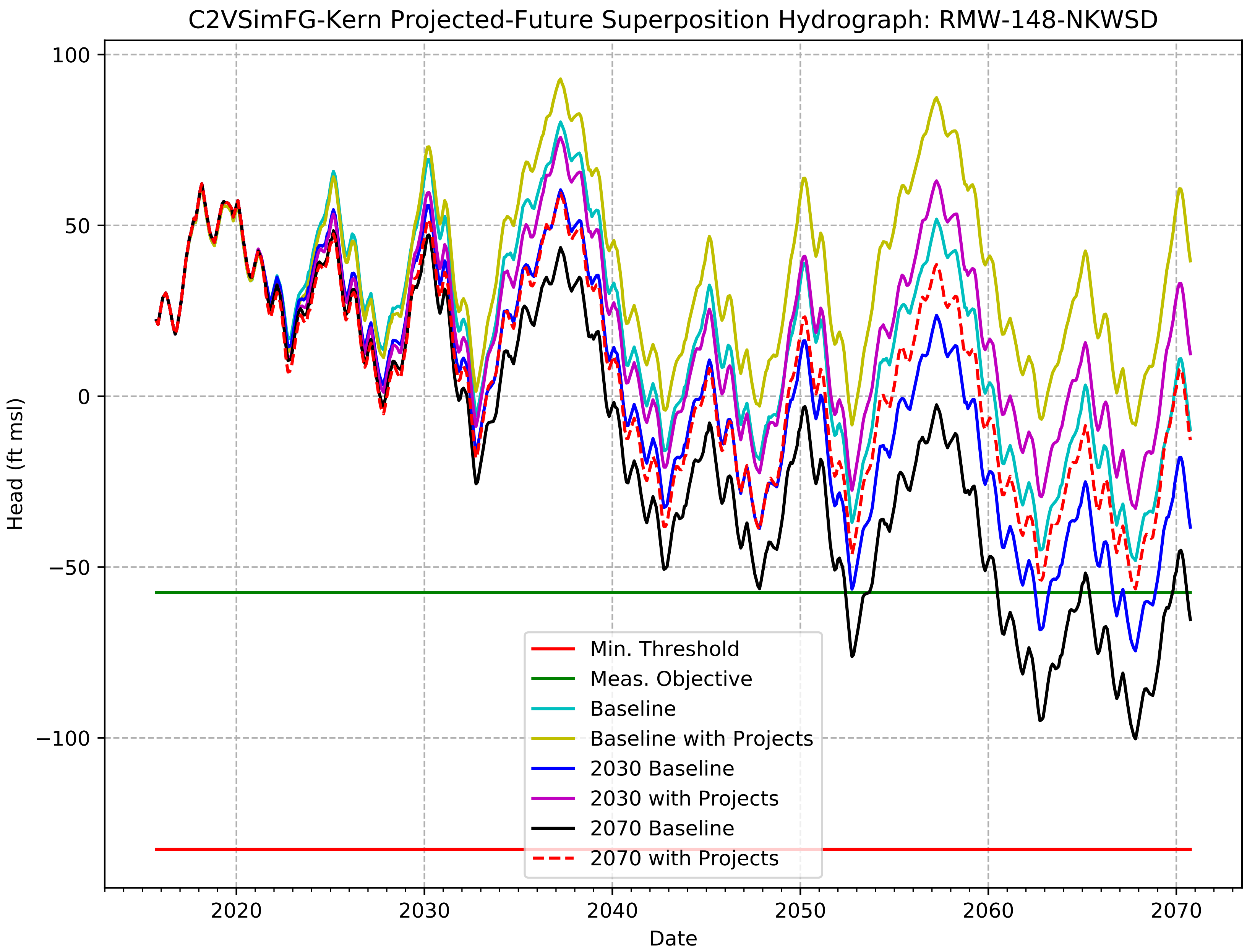
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-148-NKWSD
Head (ft msl)
100
50
0
−50
−100
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
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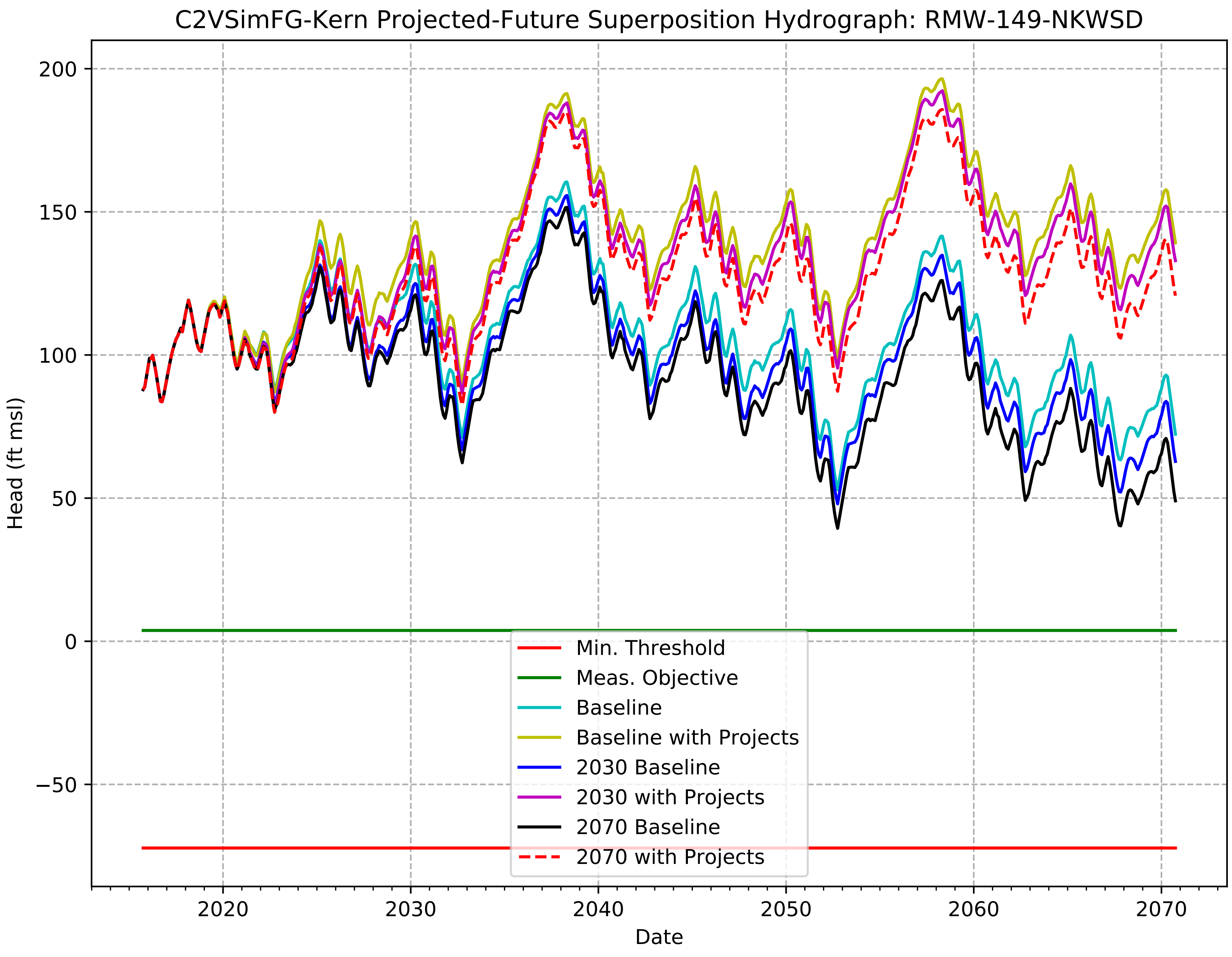
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-149-NKWSD
Head (ft msl)
200
150
100
50
0
−50
Date
2020
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2050
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Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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2030 with Projects
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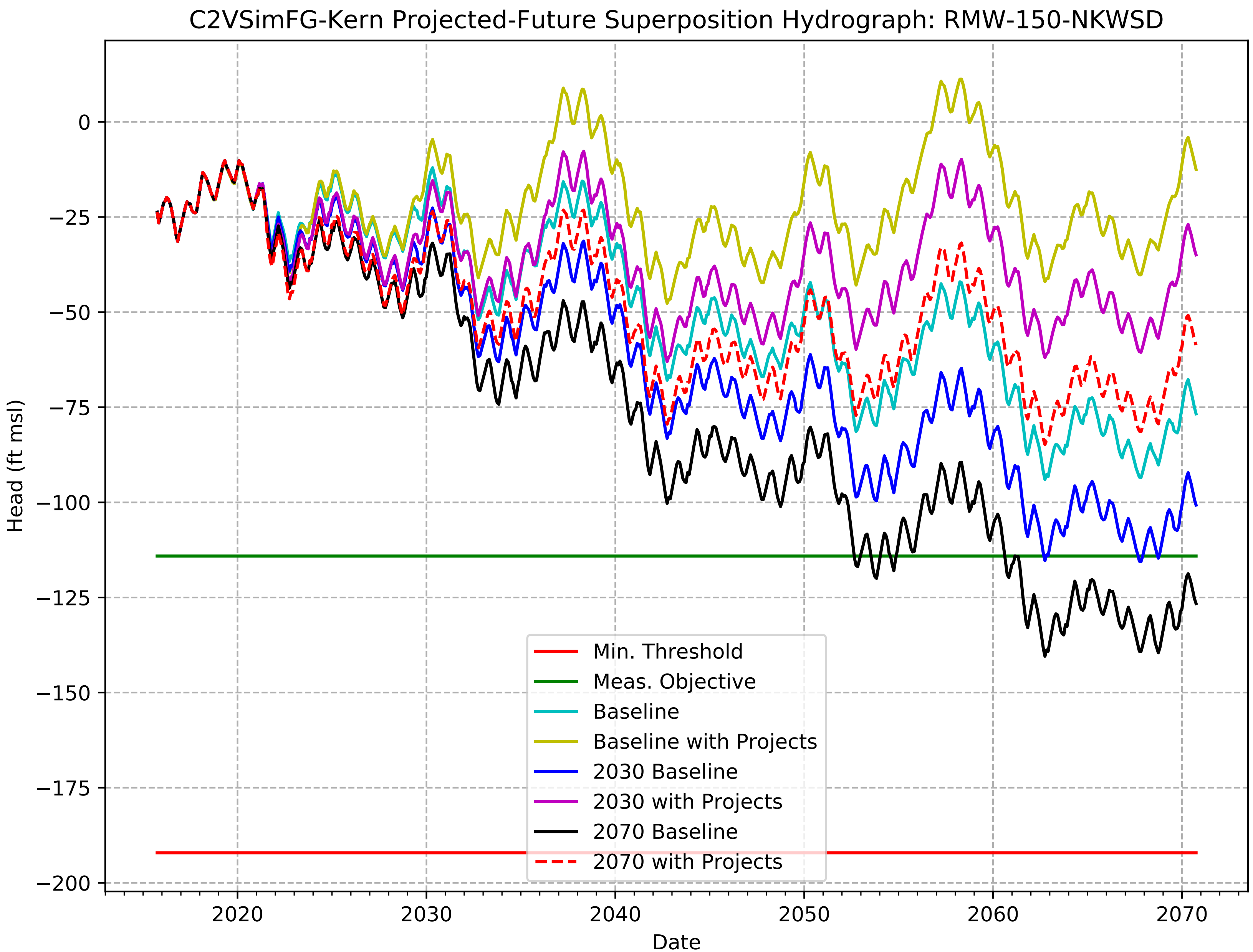
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-150-NKWSD
Head (ft msl)
0
−25
−50
−75
−100
−125
−150
−175
−200
2020
2030
2040
2050
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2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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2030 with Projects
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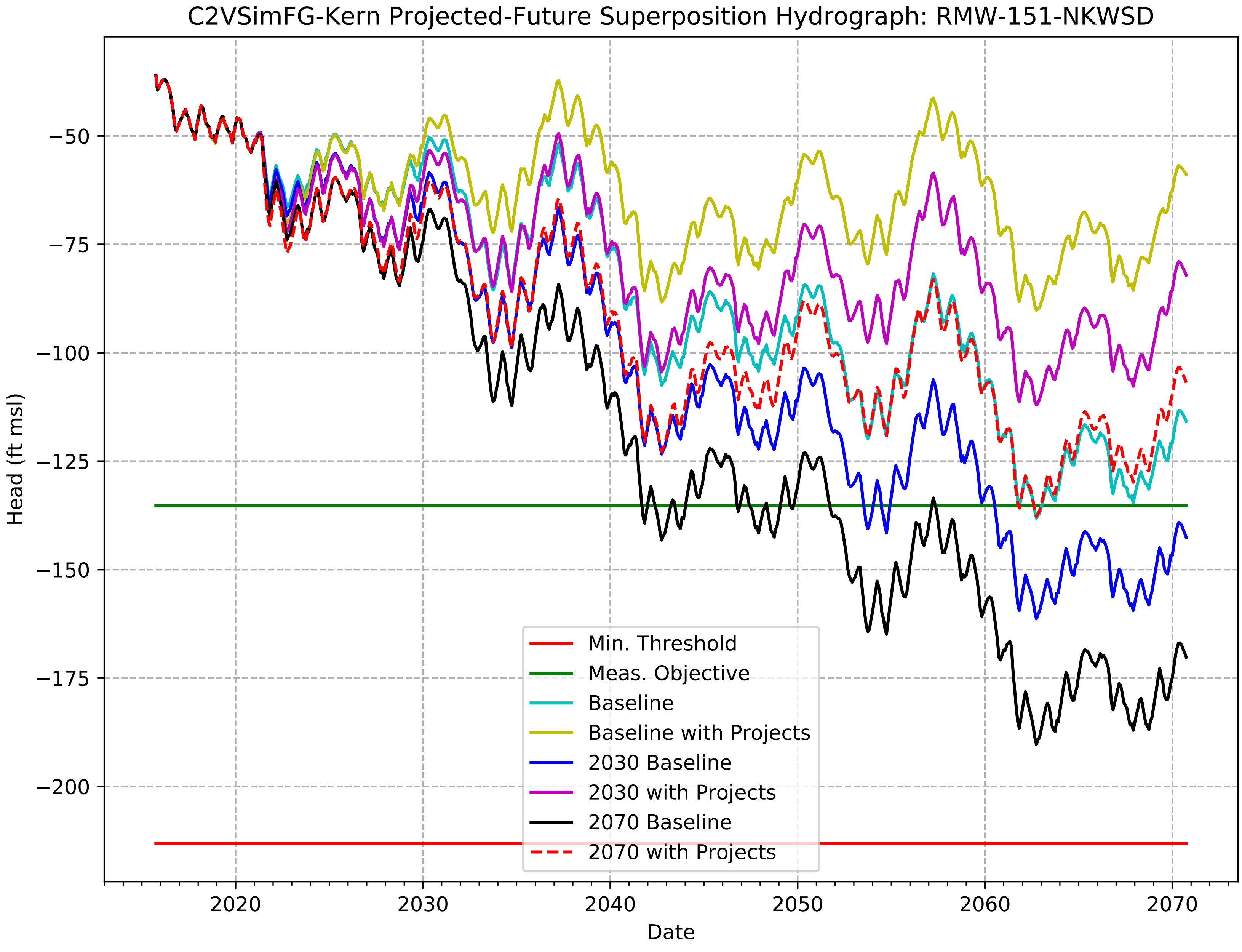
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-151-NKWSD
Head (ft msl)
−50
−75
−100
−125
−150
−175
−200
2020
2030
2040
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2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
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2030 with Projects
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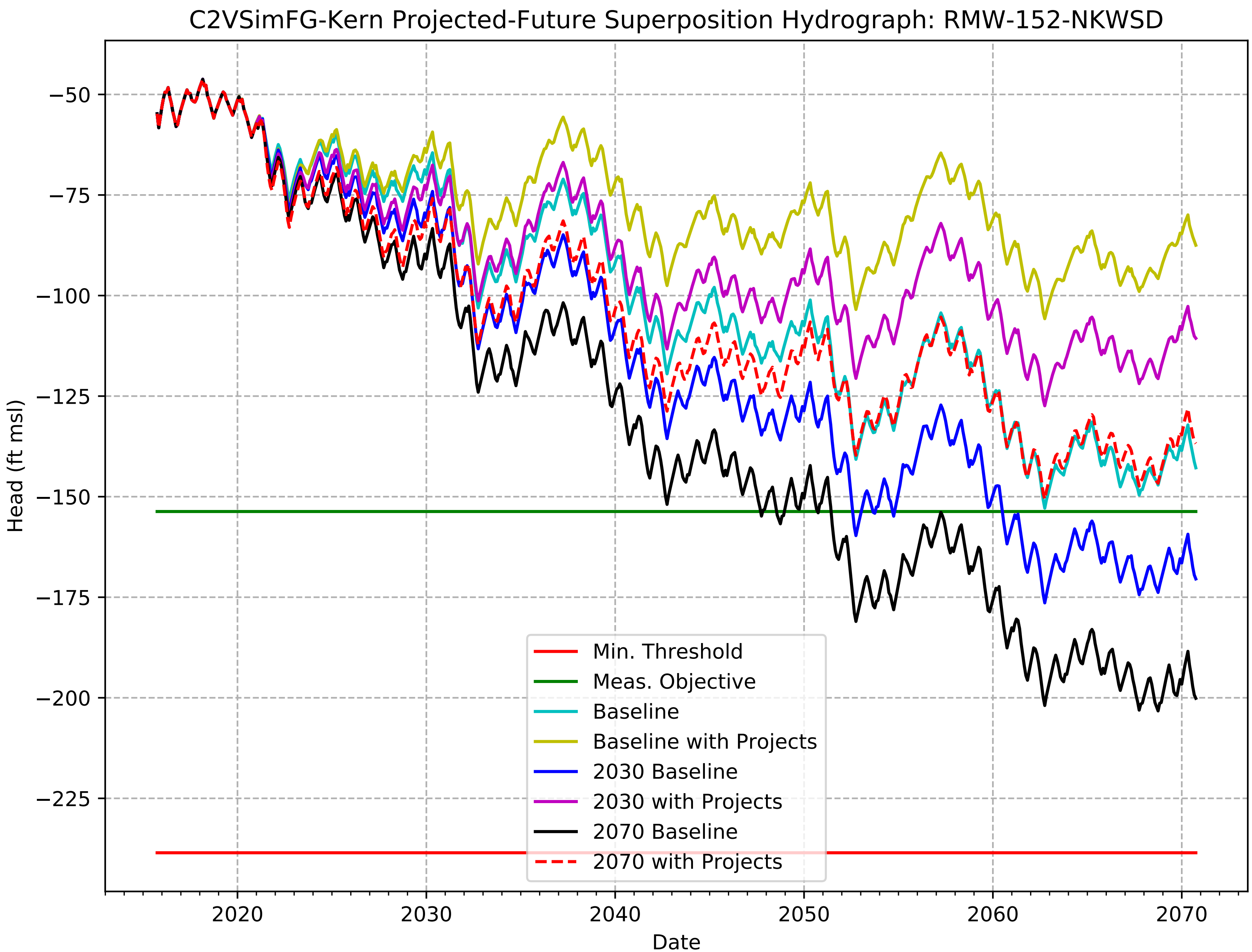
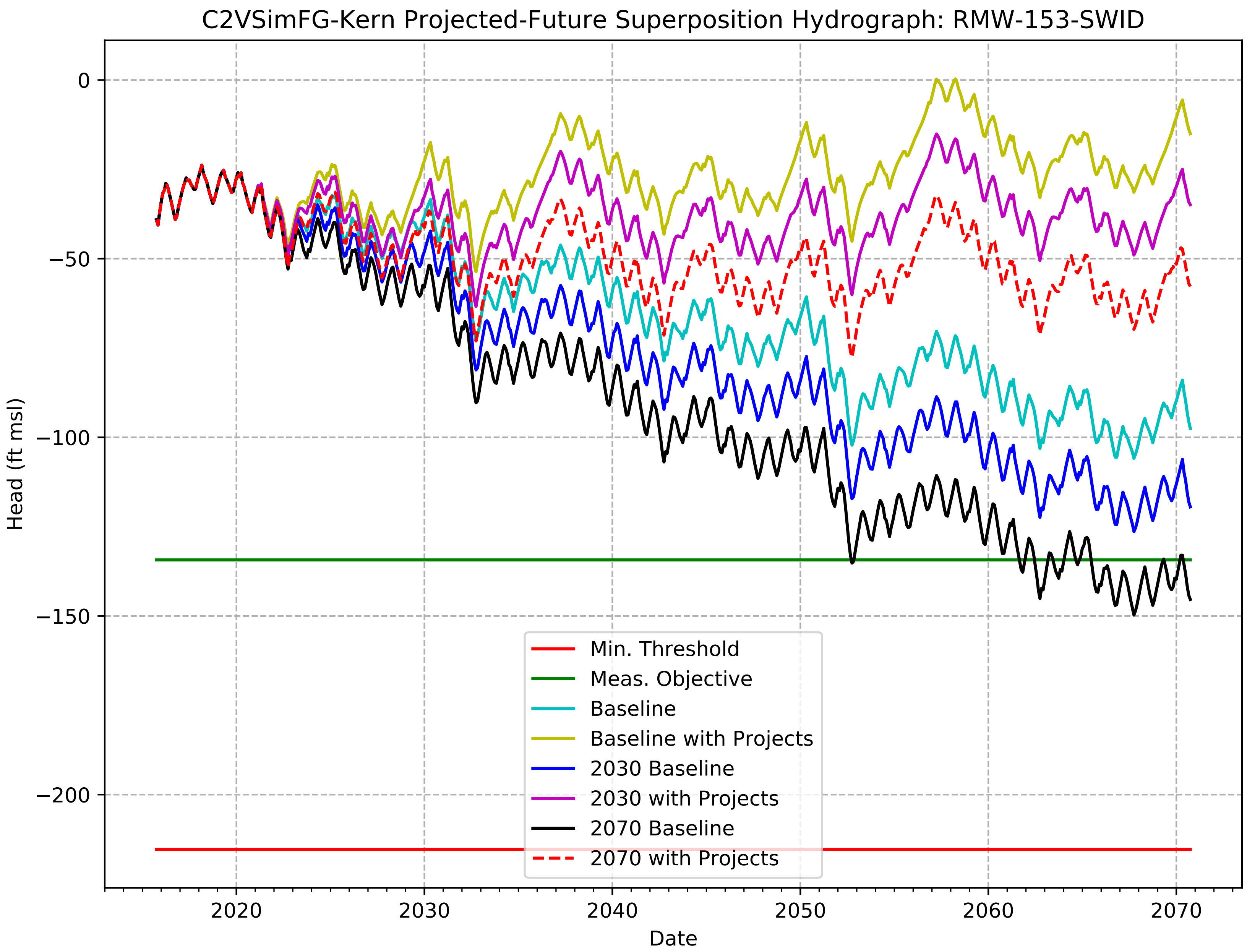
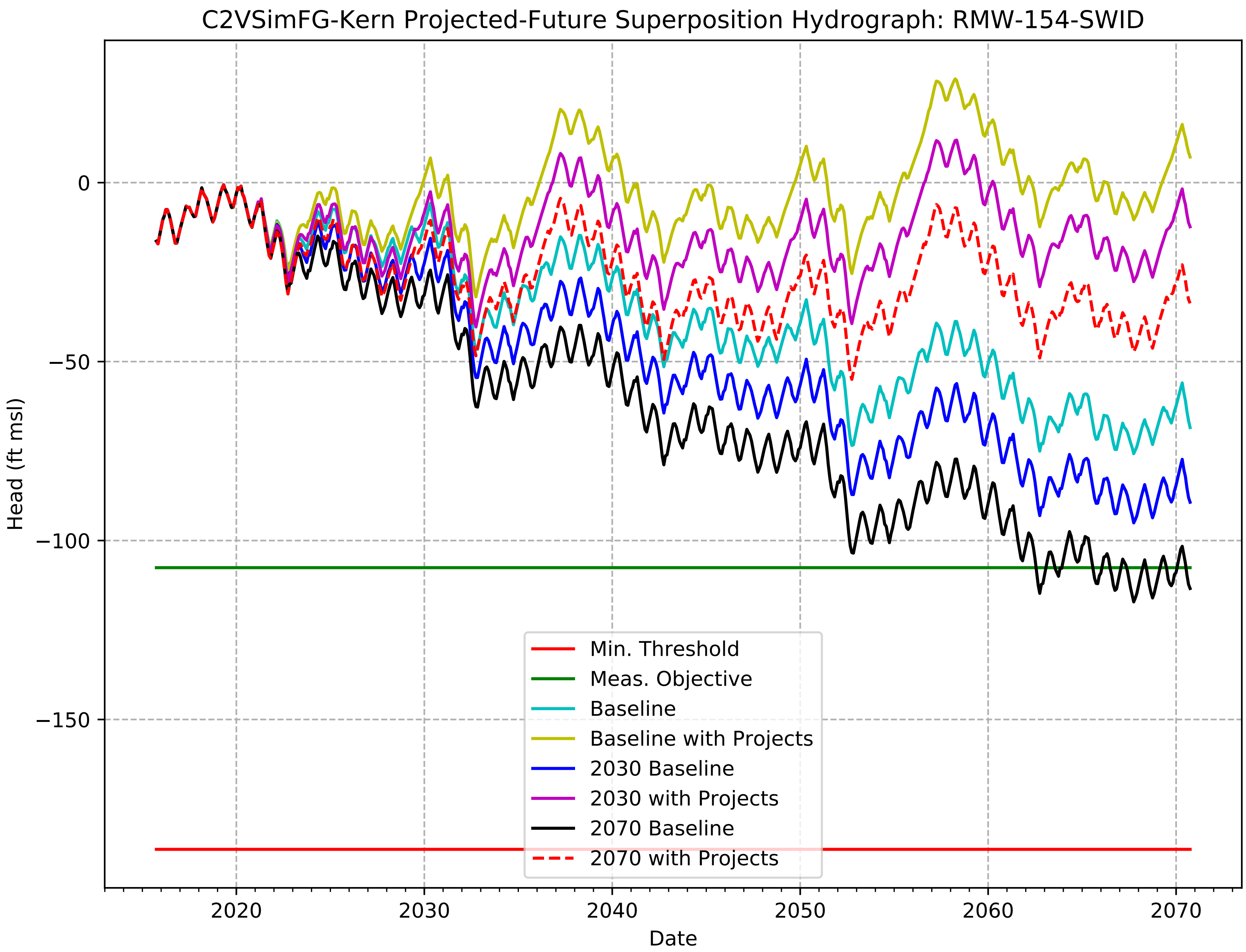
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-152-NKWSD
Head (ft msl)
−50
−75
−100
−125
−150
−175
−200
−225
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-153-SWID
Head (ft msl)
0
−50
−100
−150
−200
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-154-SWID
Head (ft msl)
0
−50
−100
−150
Date
2020
2030
2040
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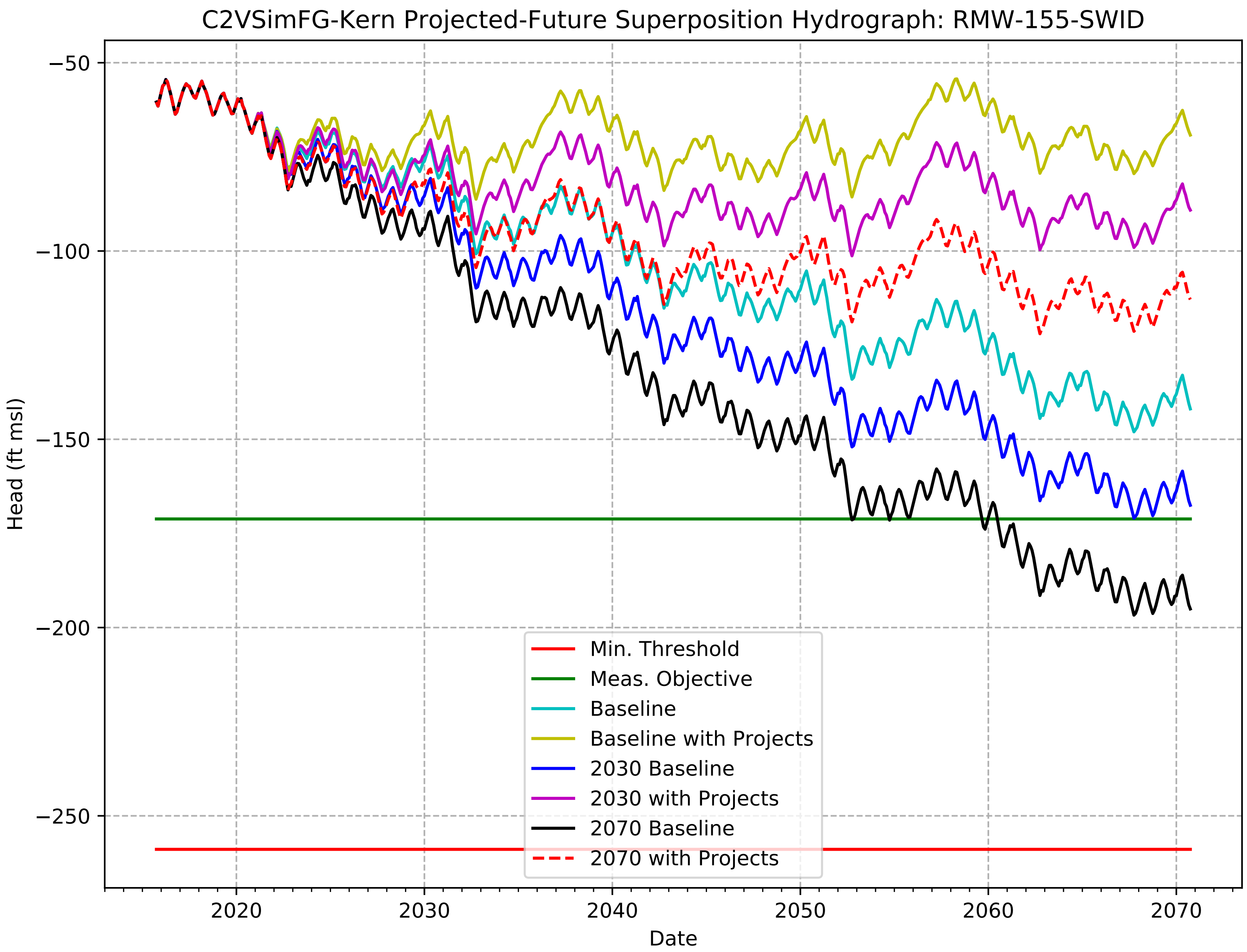
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-155-SWID
Head (ft msl)
−50
−100
−150
−200
−250
2020
2030
2040
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Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
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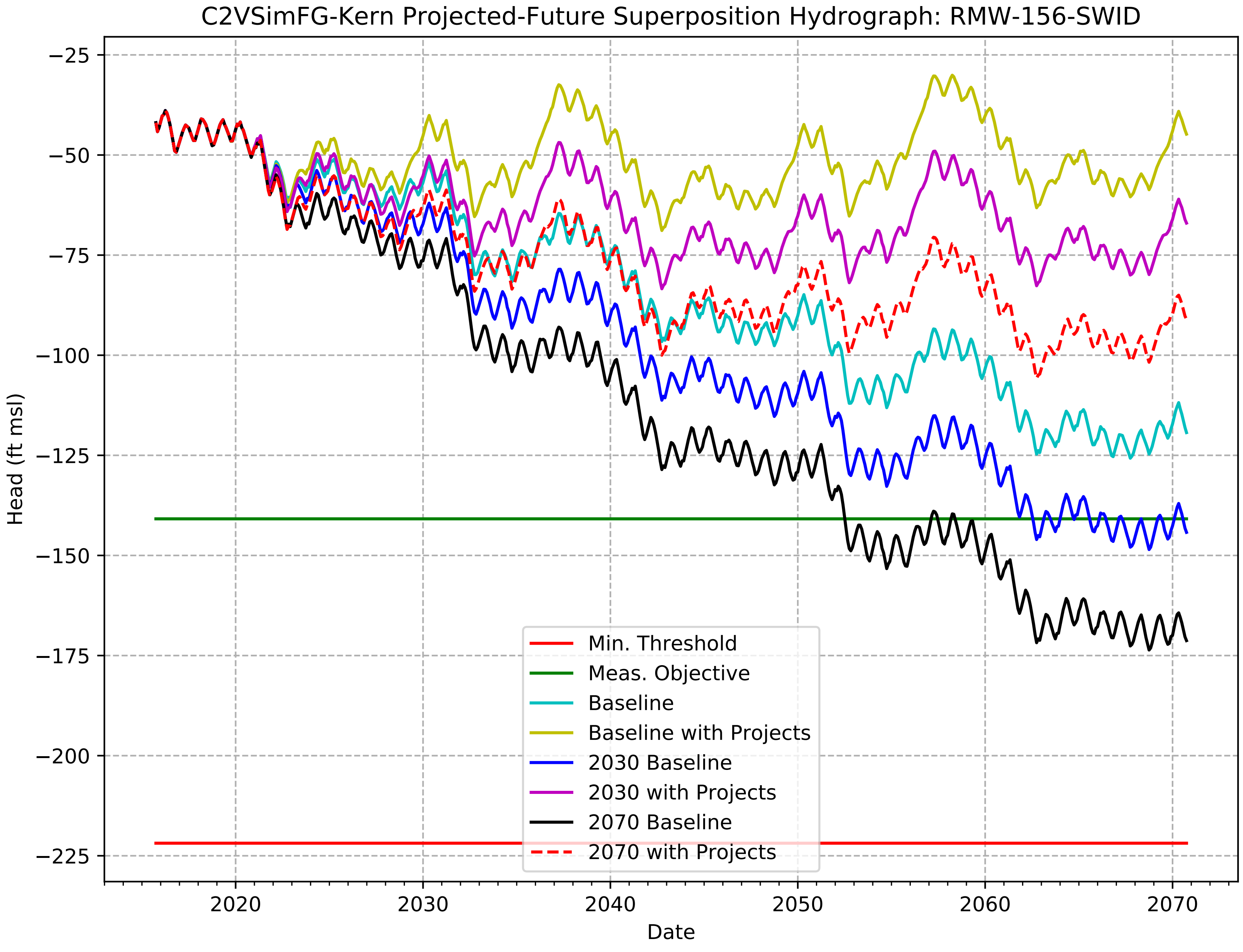
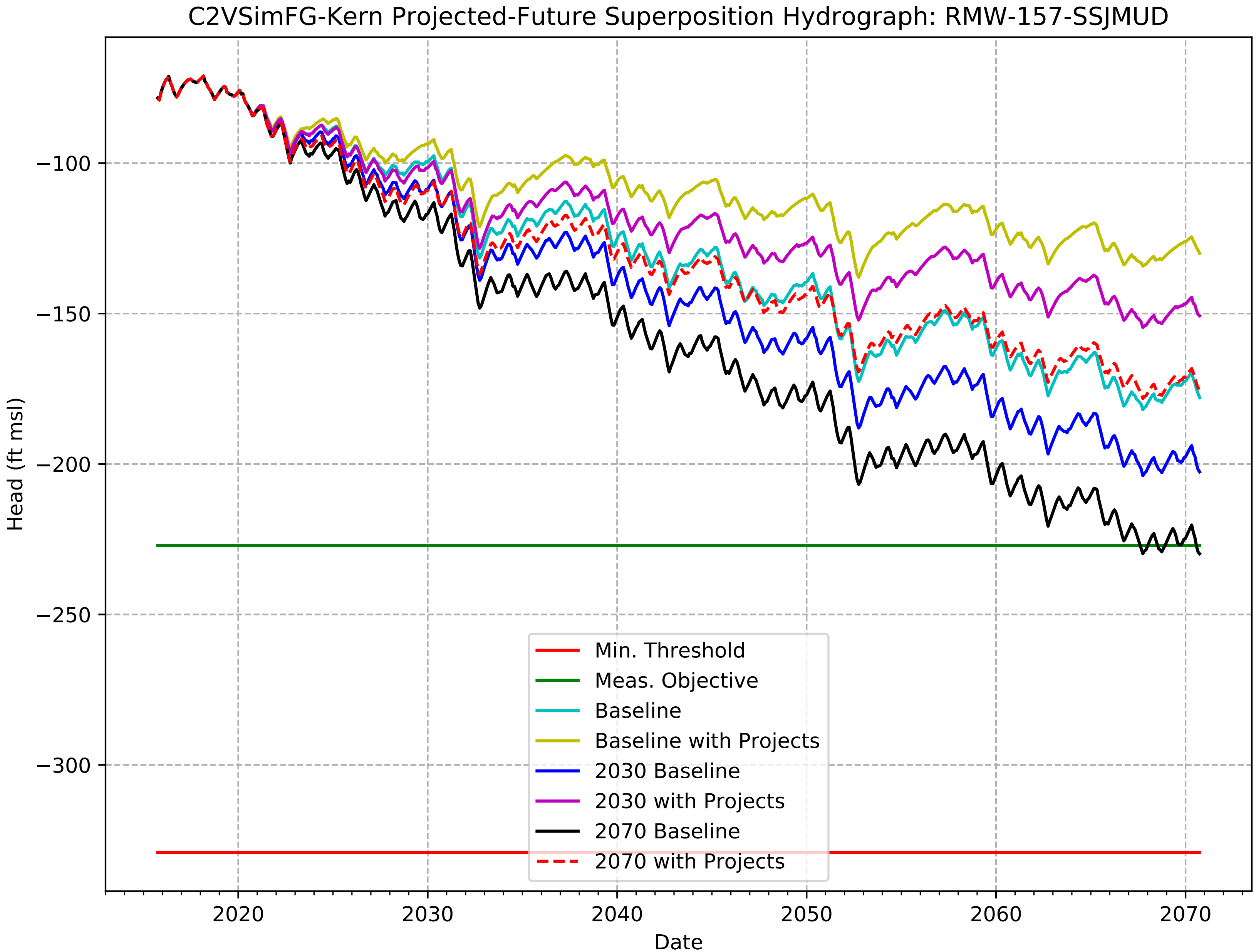
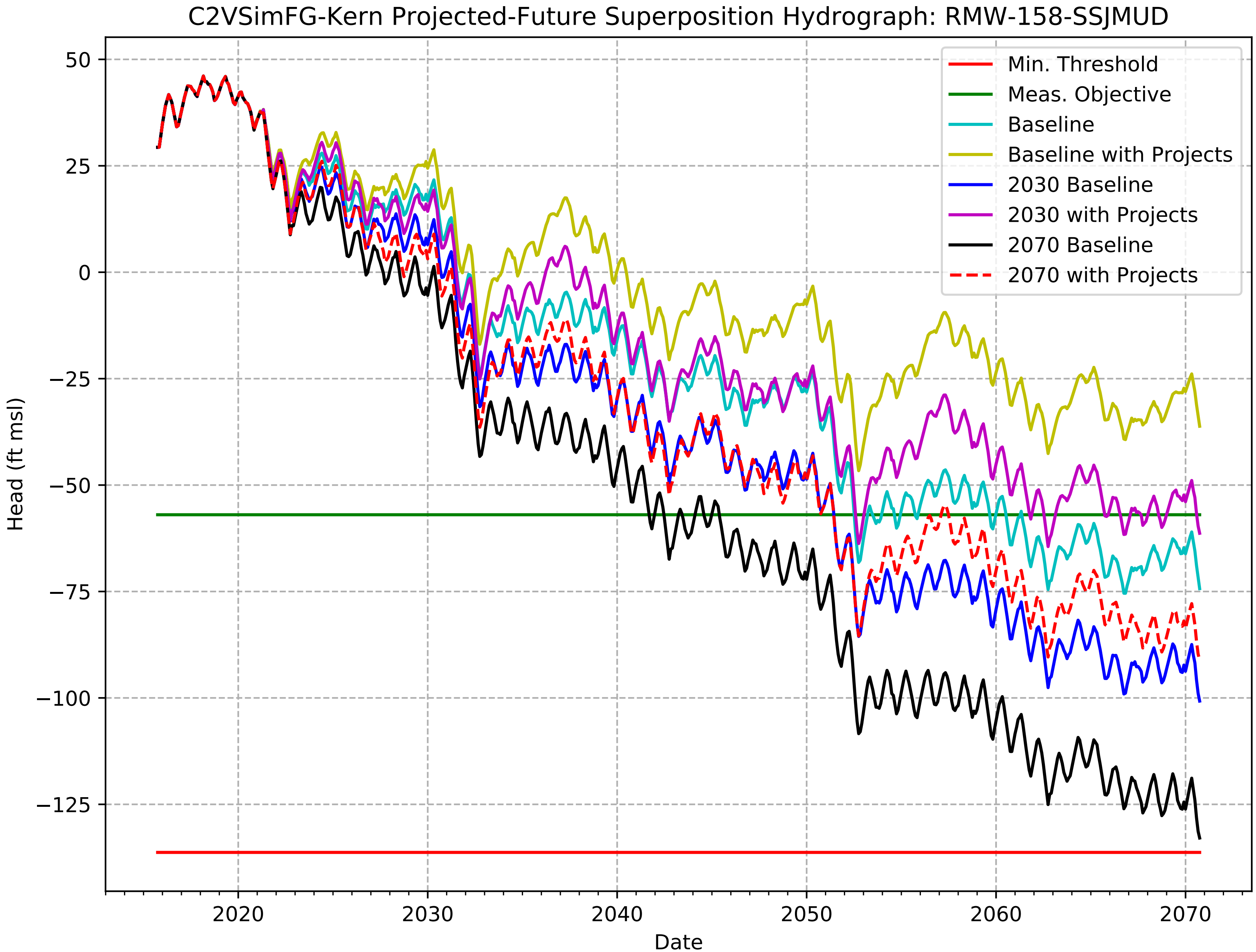
2070 with Projects

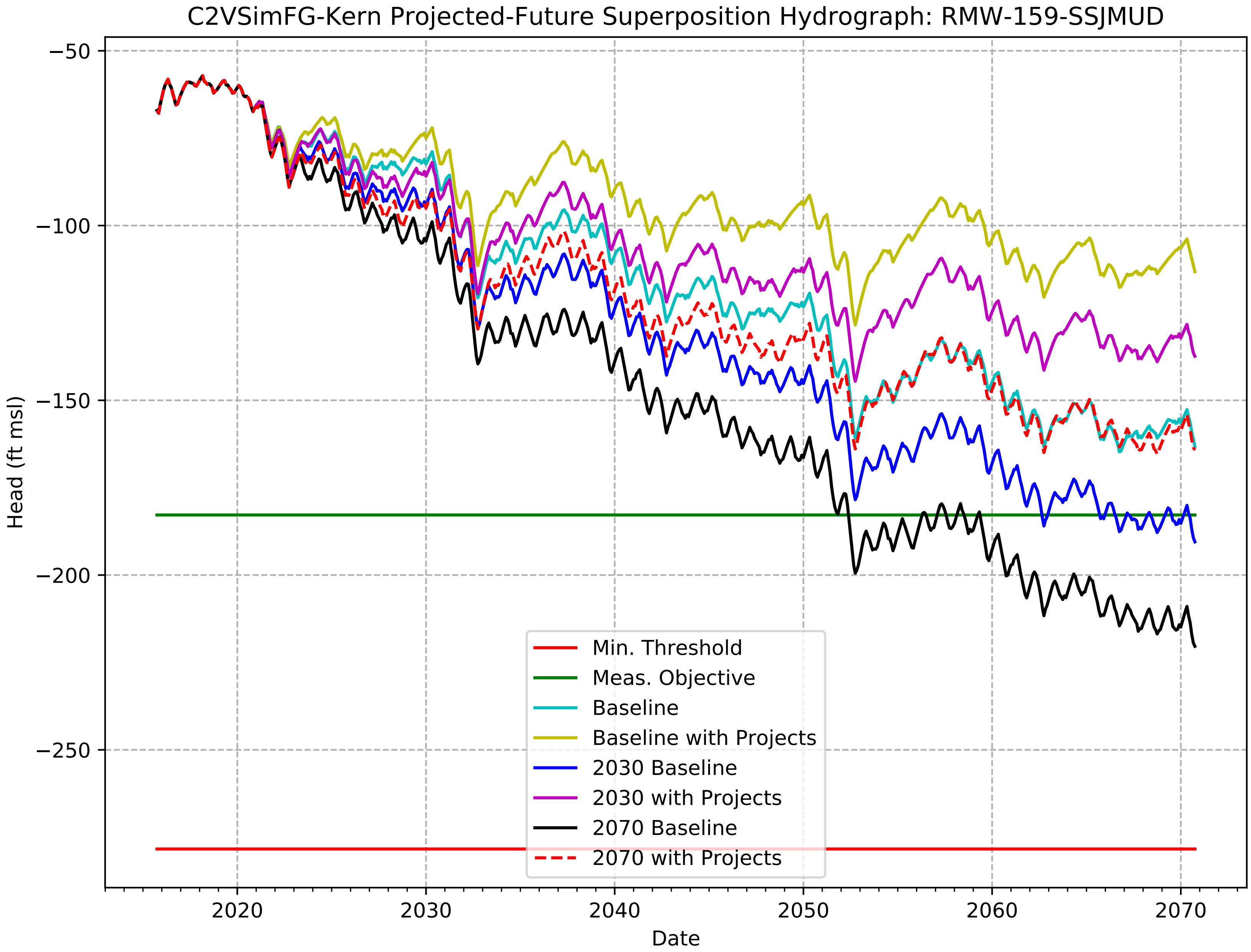

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-156-SWID
Head (ft msl)
−25
−50
−75
−100
−125
−150
−175
−200
−225
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



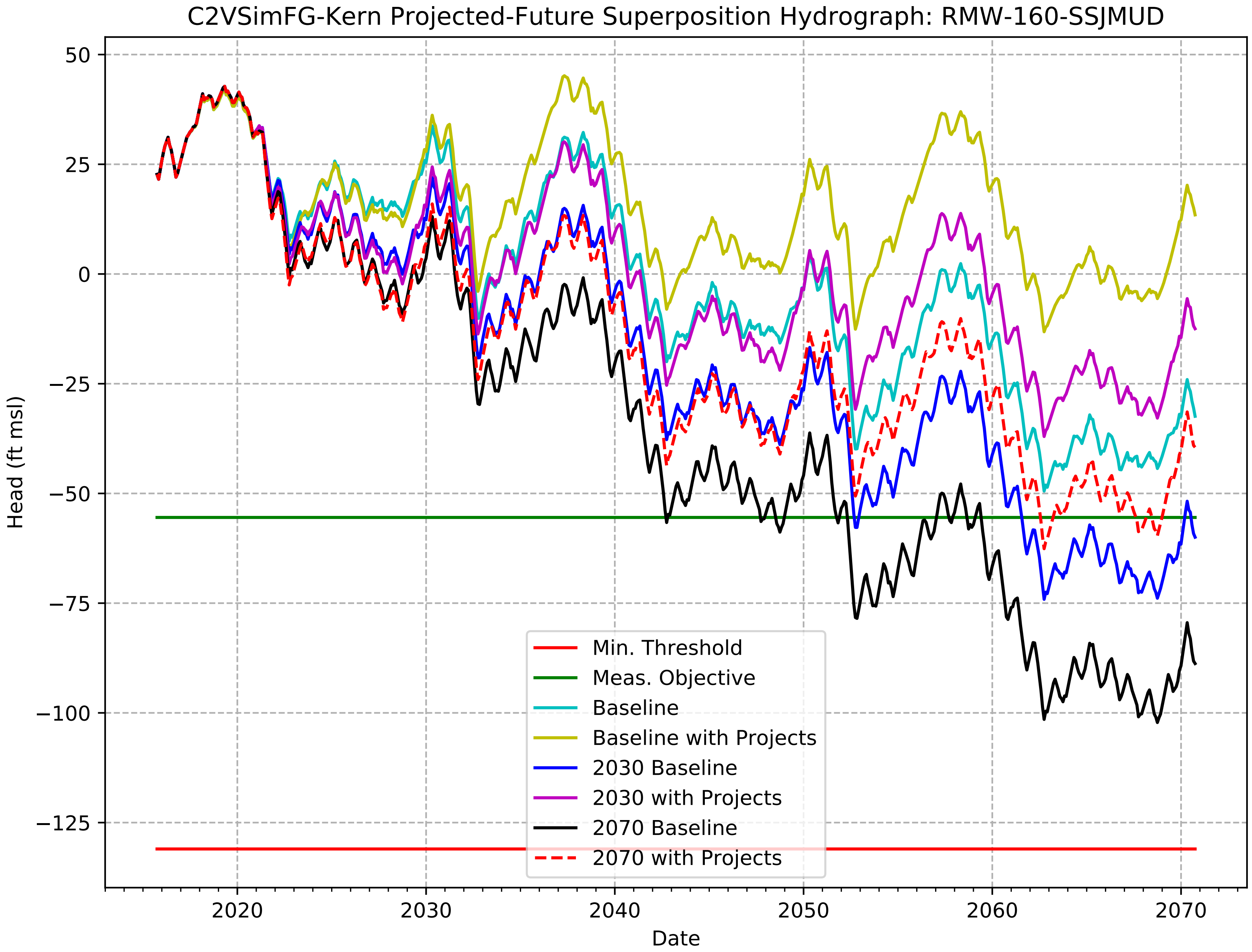
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-157-SSJMUD
Head (ft msl)
−100
−150
−200
−250
−300
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



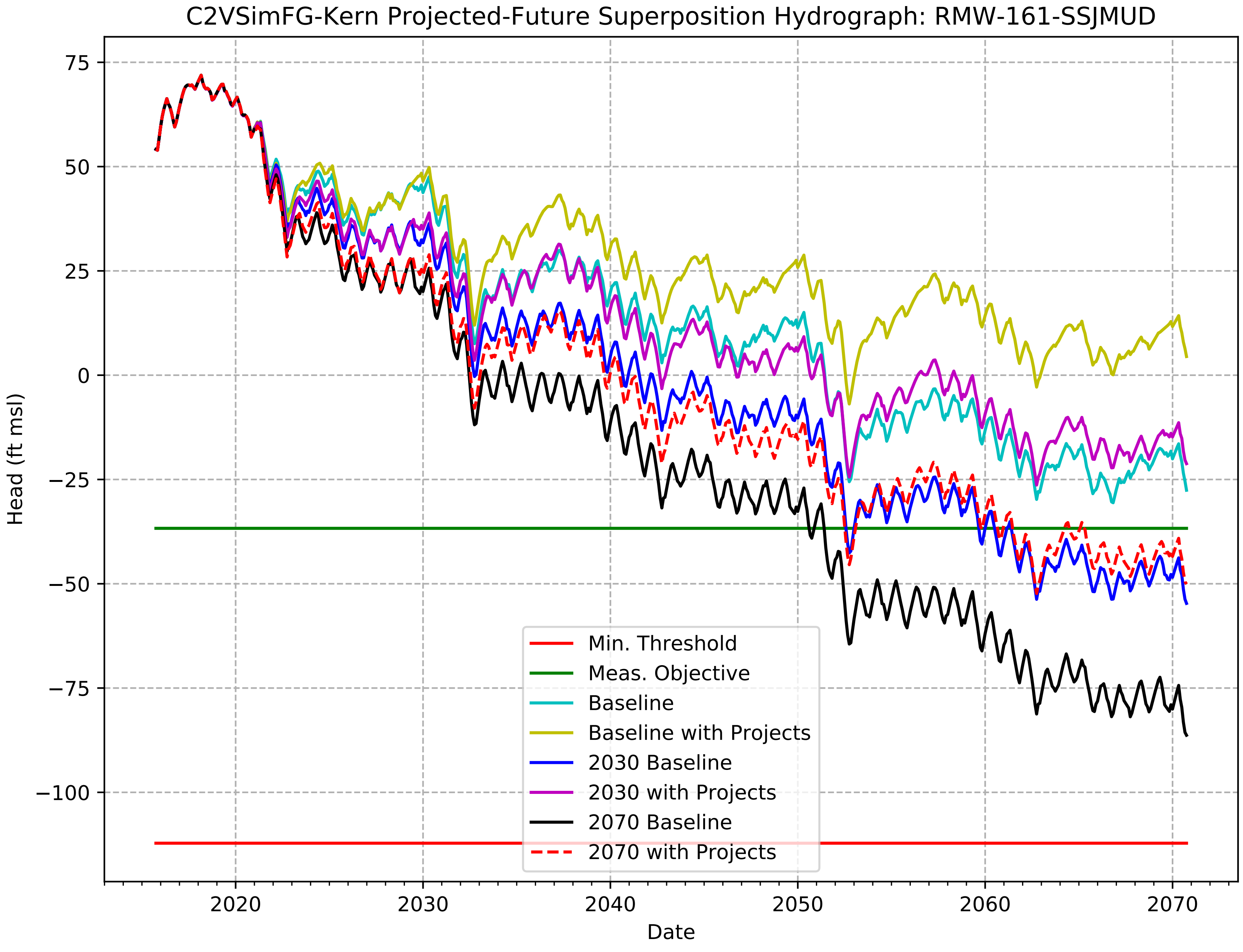
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-158-SSJMUD
Head (ft msl)
Date
50
25
0
−25
−50
−75
−100
−125
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



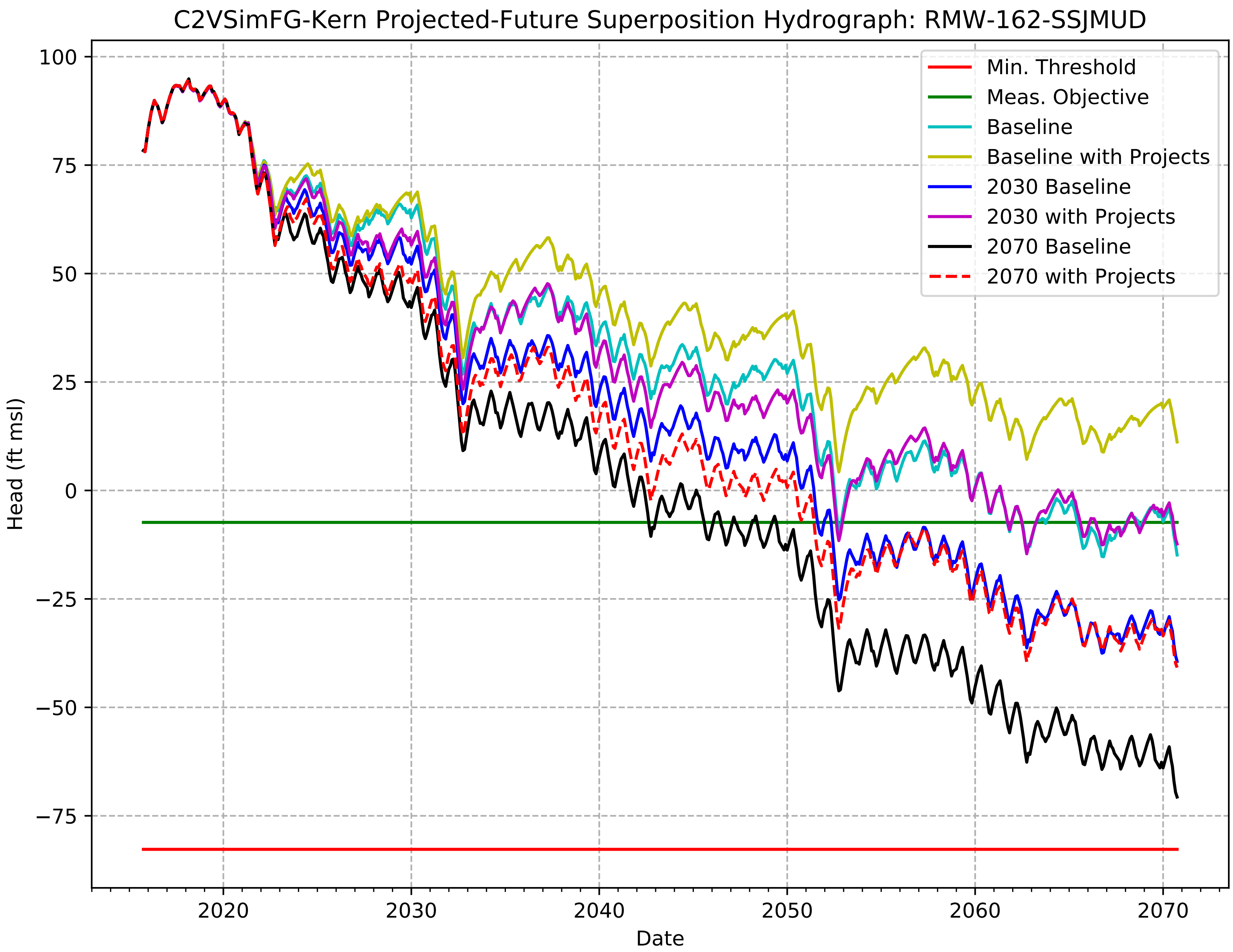
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-159-SSJMUD
Head (ft msl)
−50
−100
−150
−200
−250
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

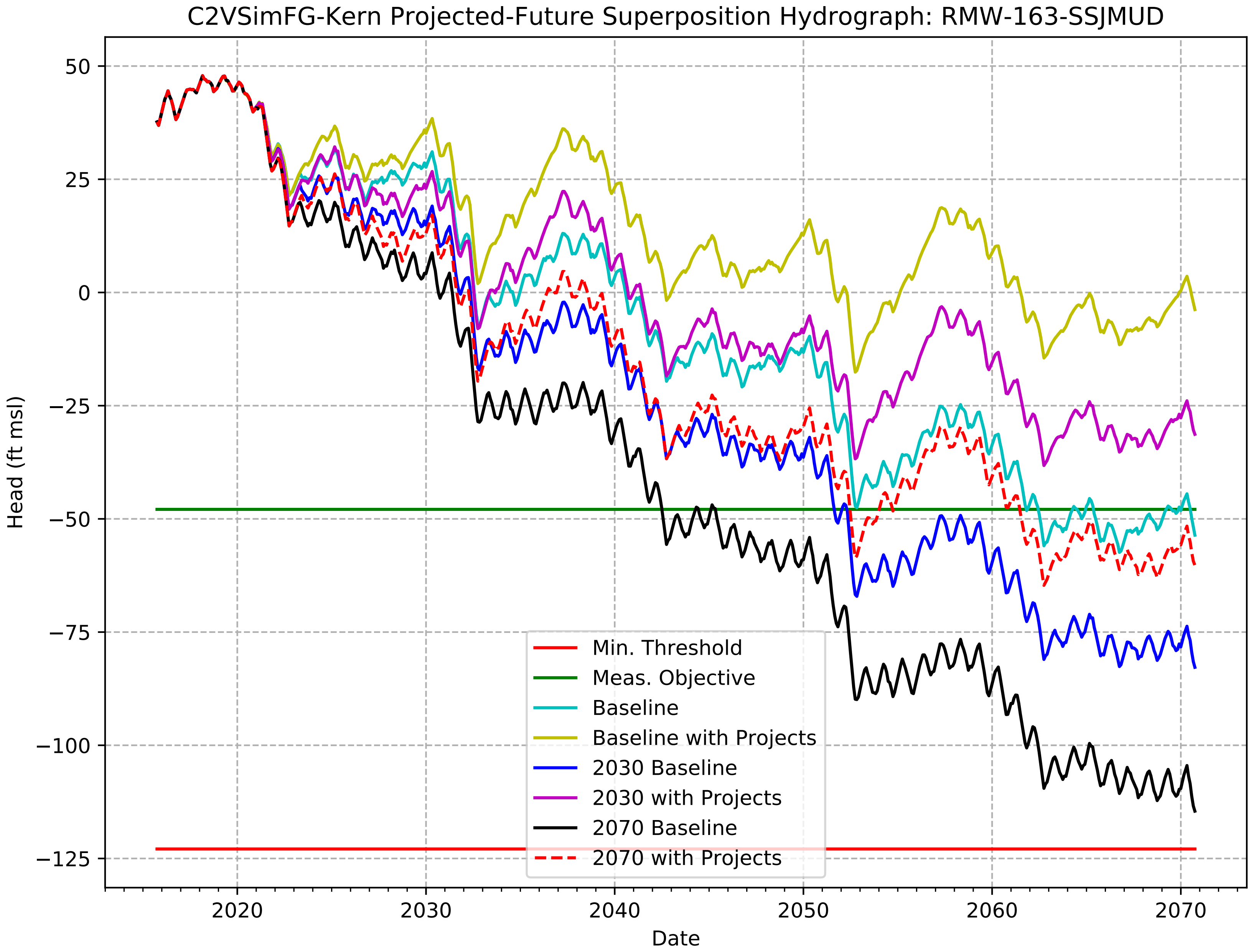


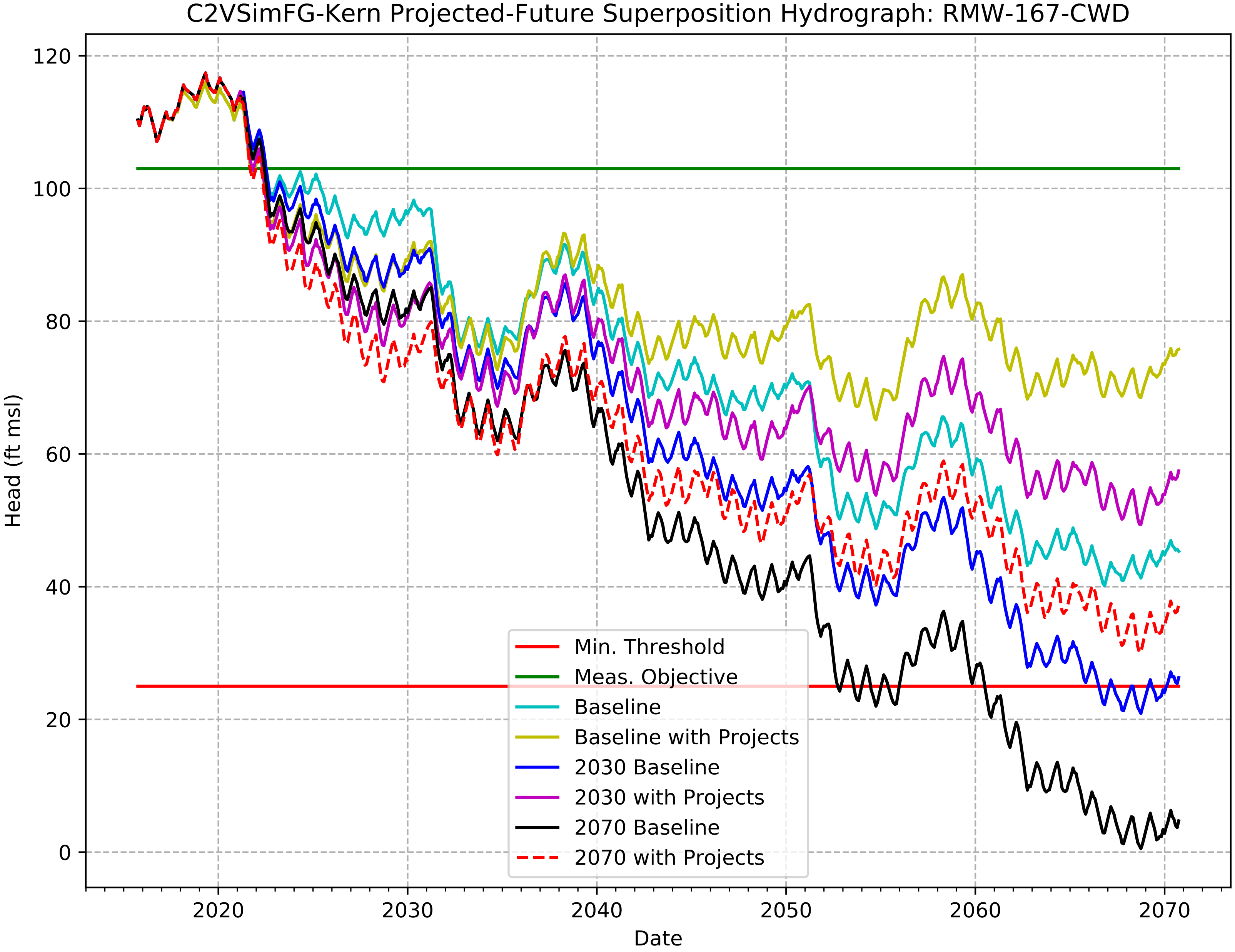
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-160-SSJMUD
Head (ft msl)
50
25
0
−25
−50
−75
−100
−125
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



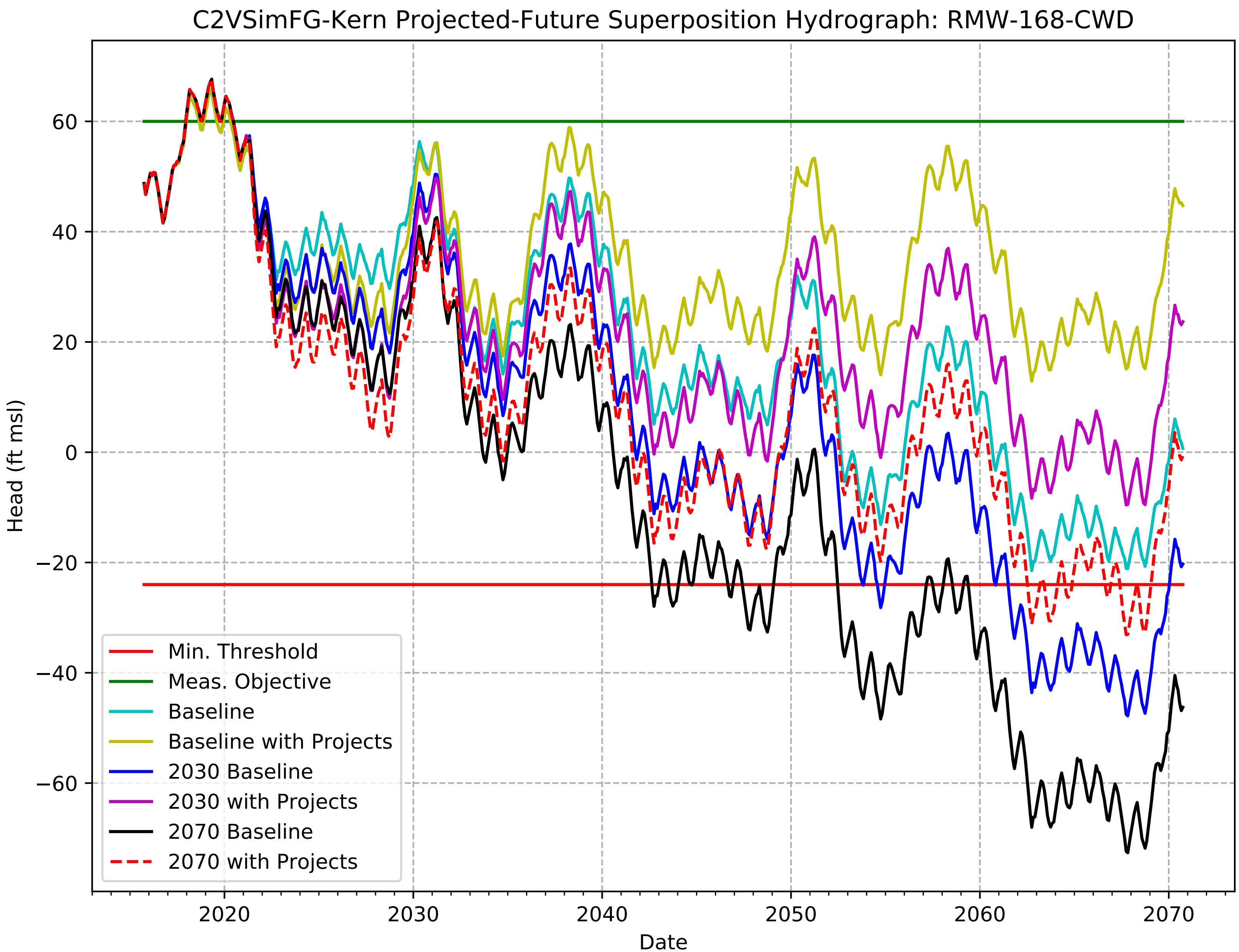
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-161-SSJMUD
75
50
25
0
−25
−50
−75
−100
Head (ft msl)
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-162-SSJMUD
Head (ft msl)
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
100
75
50
25
0
−25
−50
−75
2020
2030
2040
2050
2060
2070

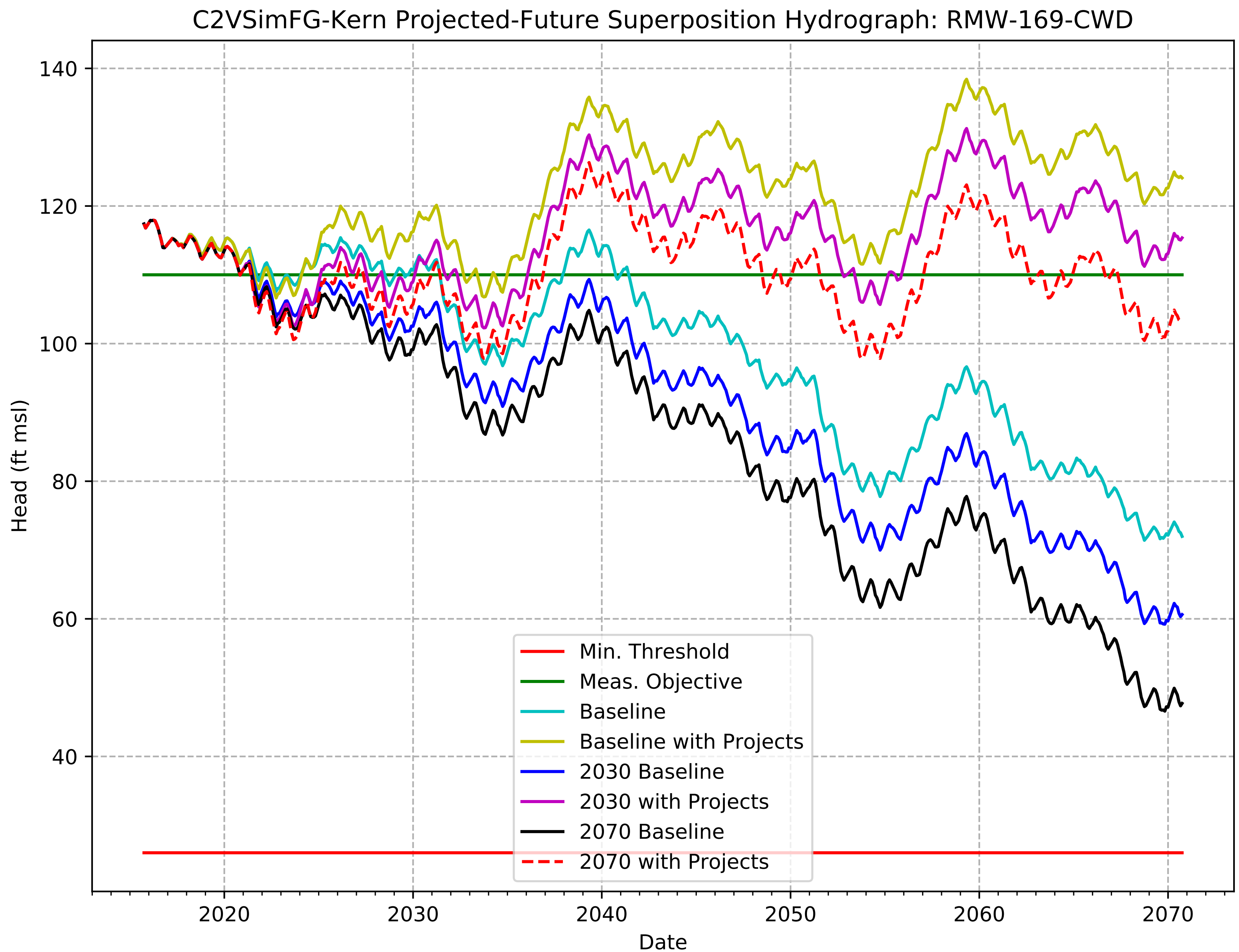

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-163-SSJMUD
Head (ft msl)
50
25
0
−25
−50
−75
−100
−125
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



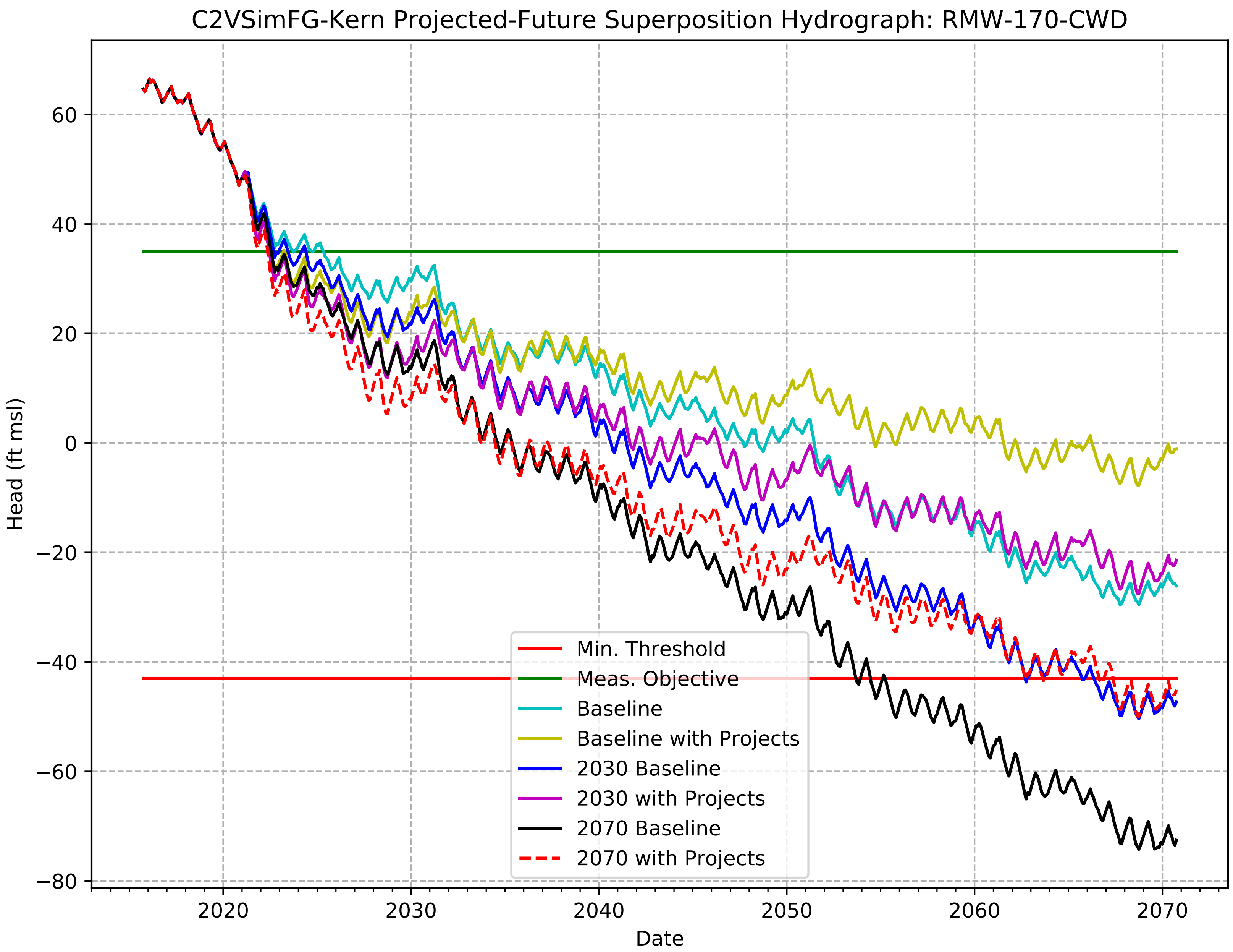
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-167-CWD
Head (ft msl)
120
100
80
60
40
20
0
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



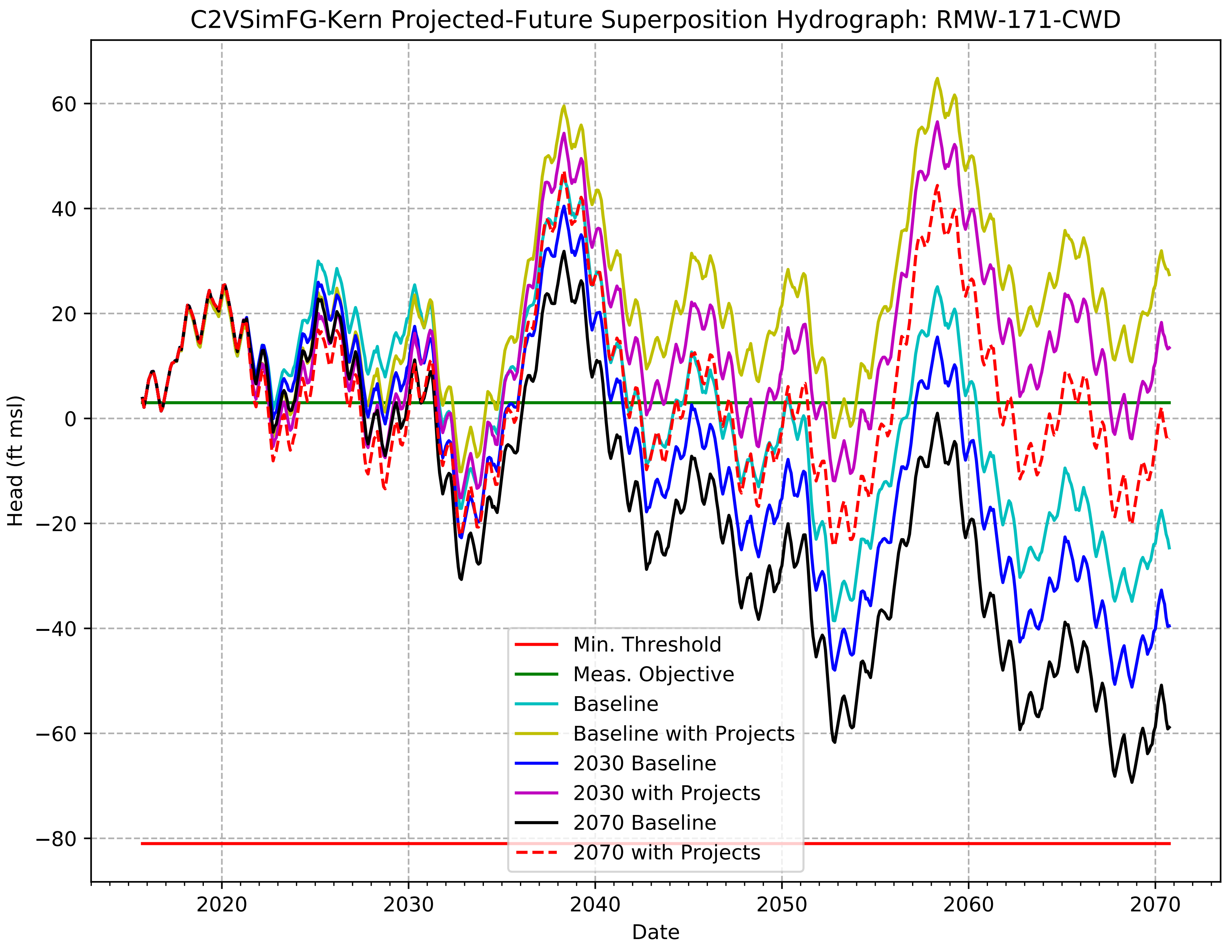
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-168-CWD
Head (ft msl)
Date
60
40
20
0
−20
−40
−60
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

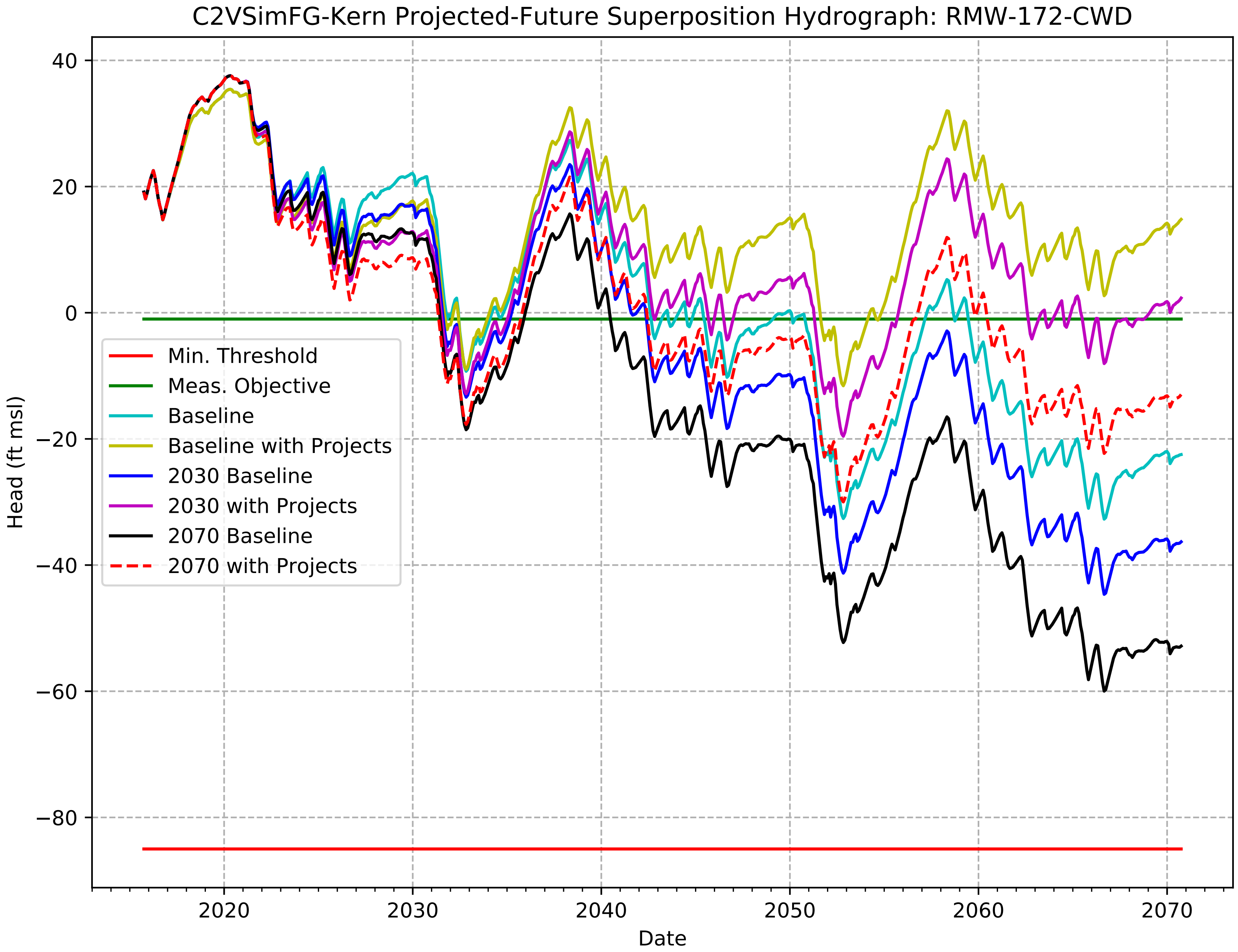


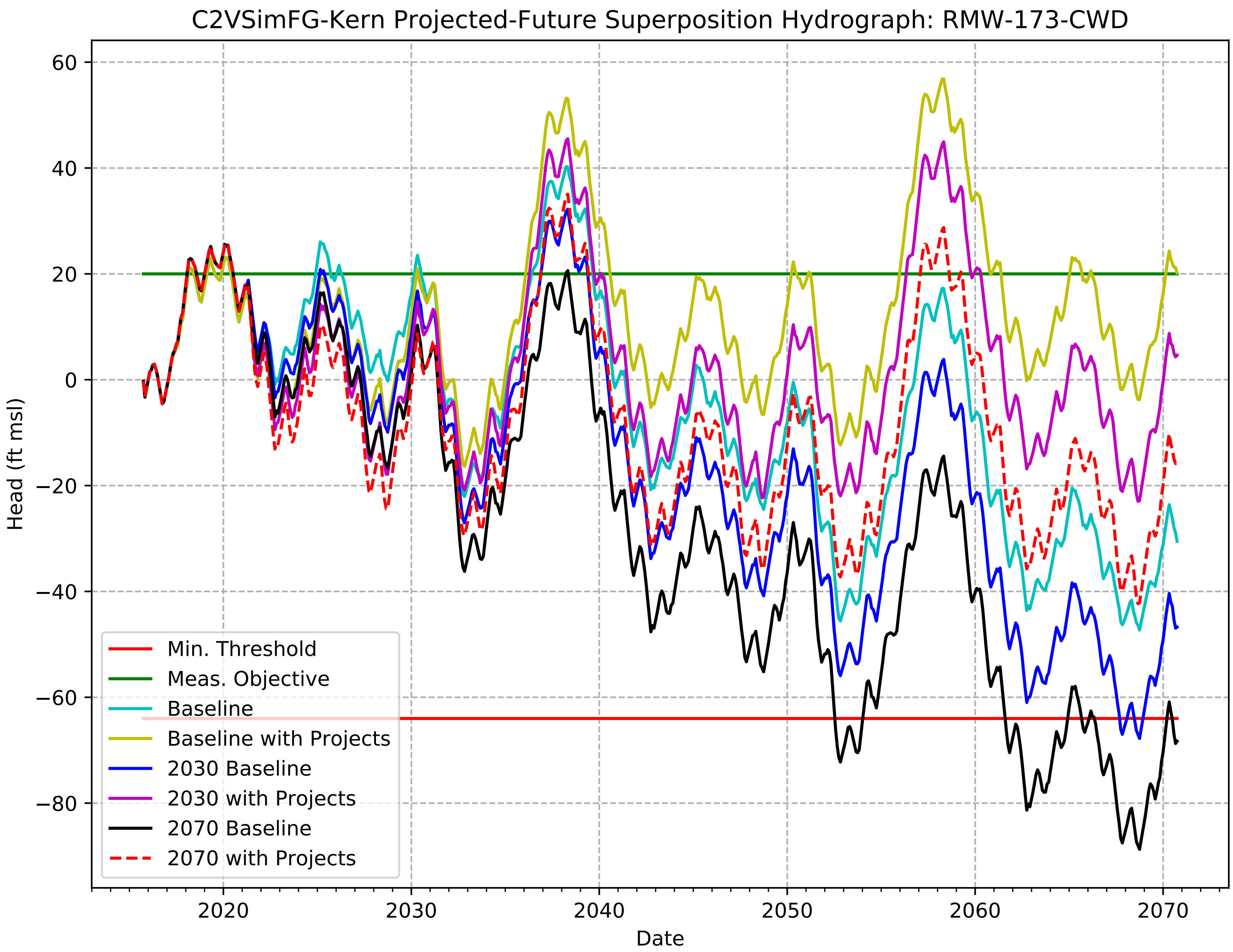
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-169-CWD
Head (ft msl)
140
120
100
80
60
40
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

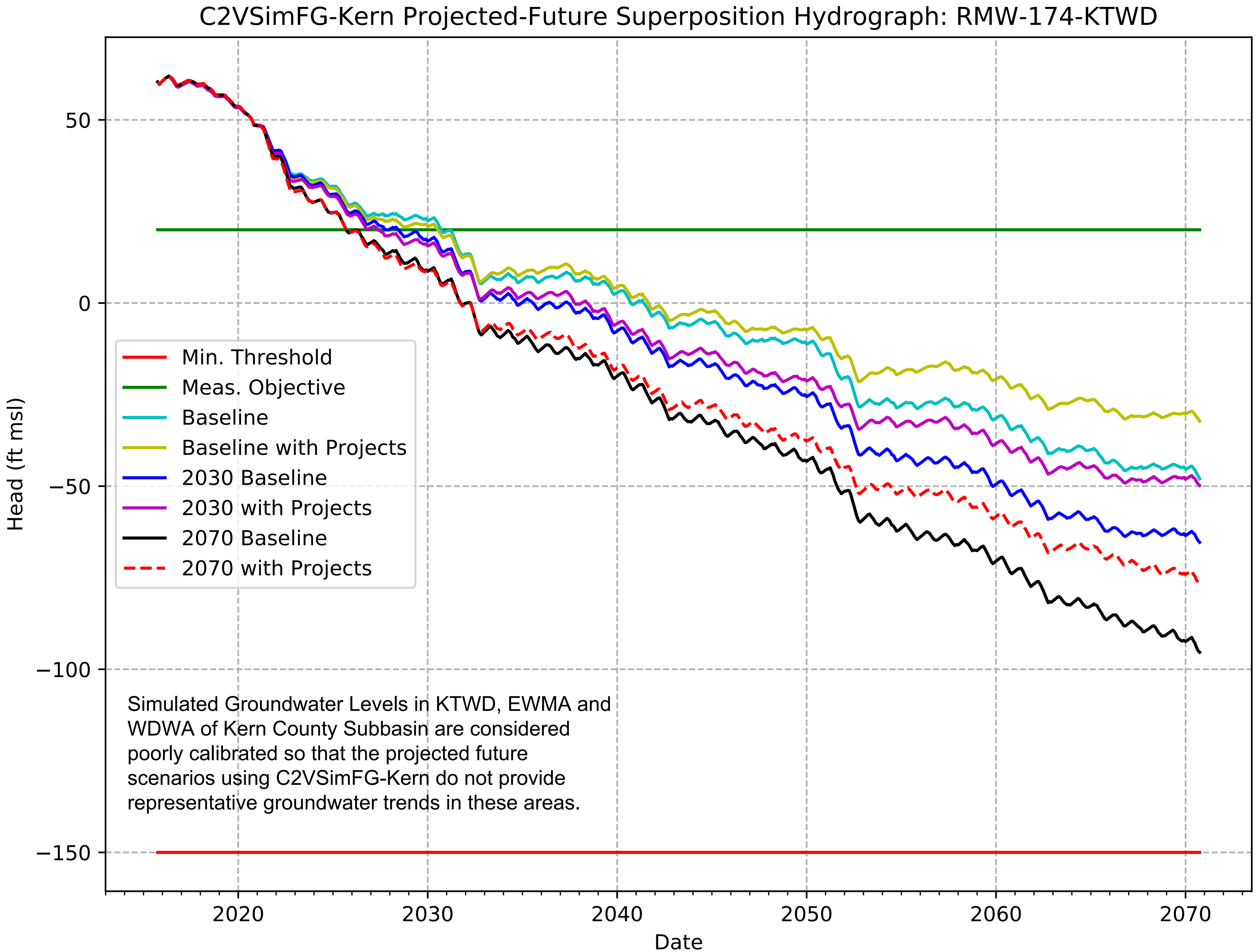


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-170-CWD
Head (ft msl)
Date
60
40
20
0
−20
−40
−60
−80
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

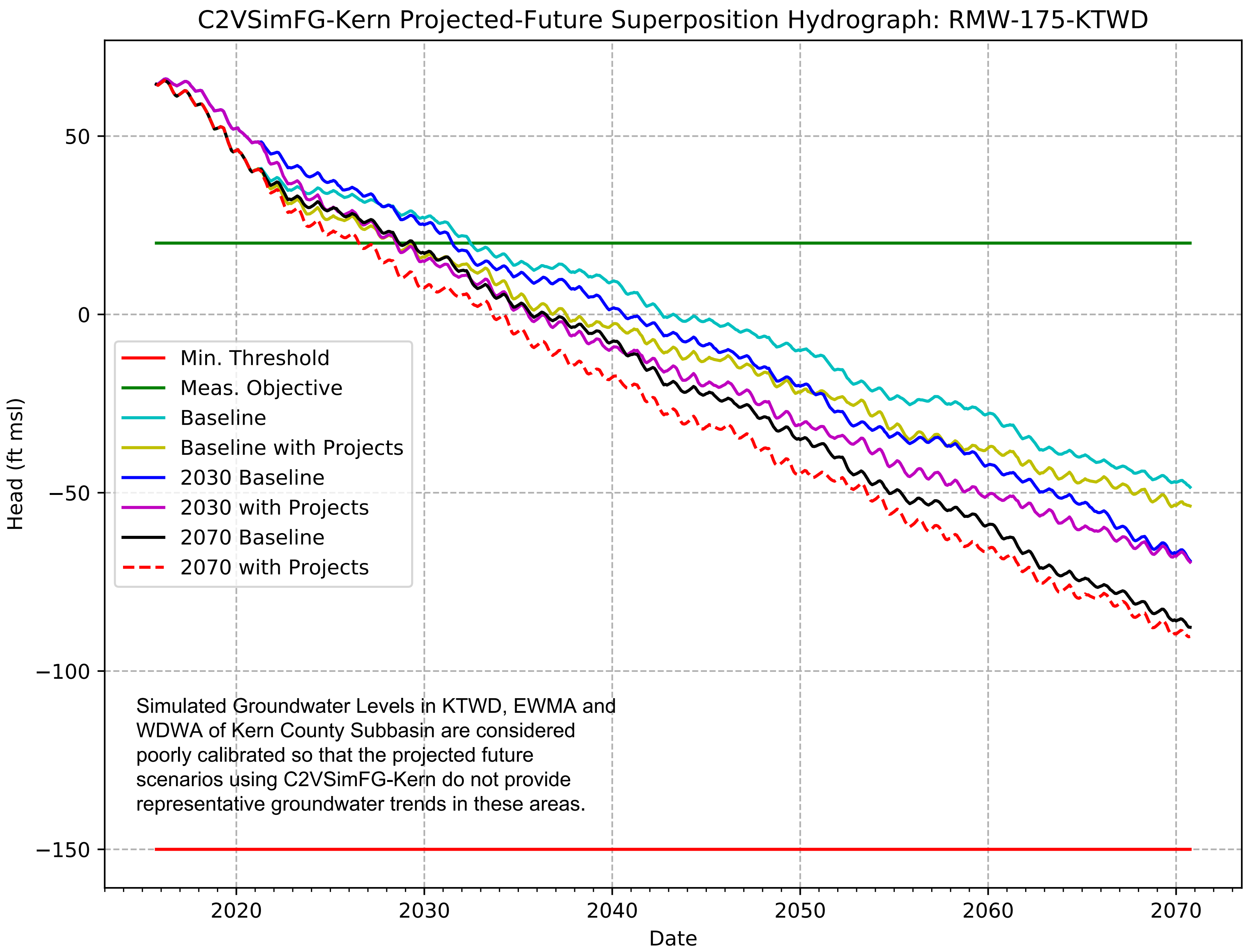

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-171-CWD
Head (ft msl)
60
40
20
0
−20
−40
−60
−80
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

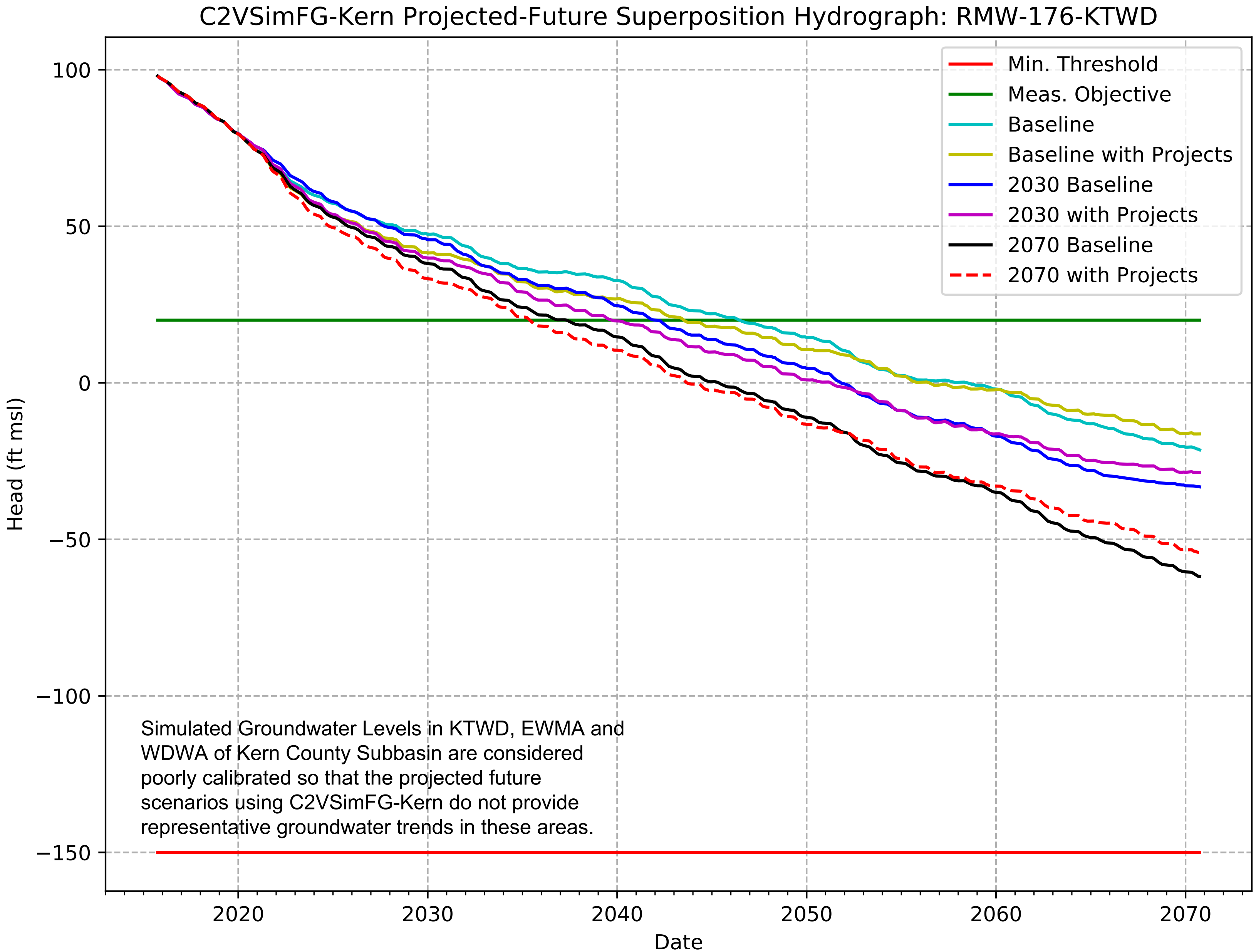

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-172-CWD
Head (ft msl)
Date
40
20
0
−20
−40
−60
−80
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-173-CWD
Head (ft msl)
60
40
20
0
−20
−40
−60
−80
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

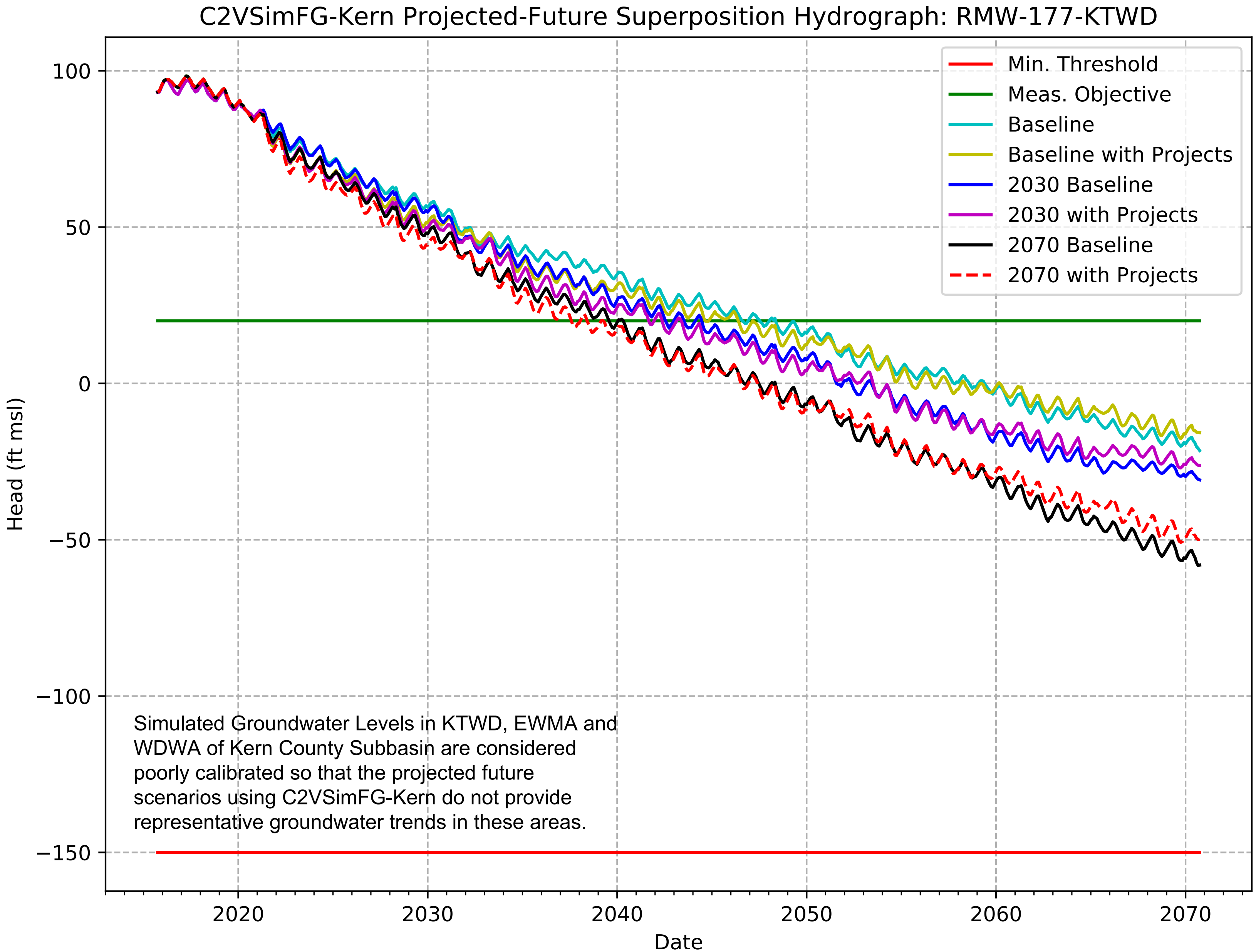


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-174-KTWD
Head (ft msl)
Date
50
0
−50
−100
−150
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.

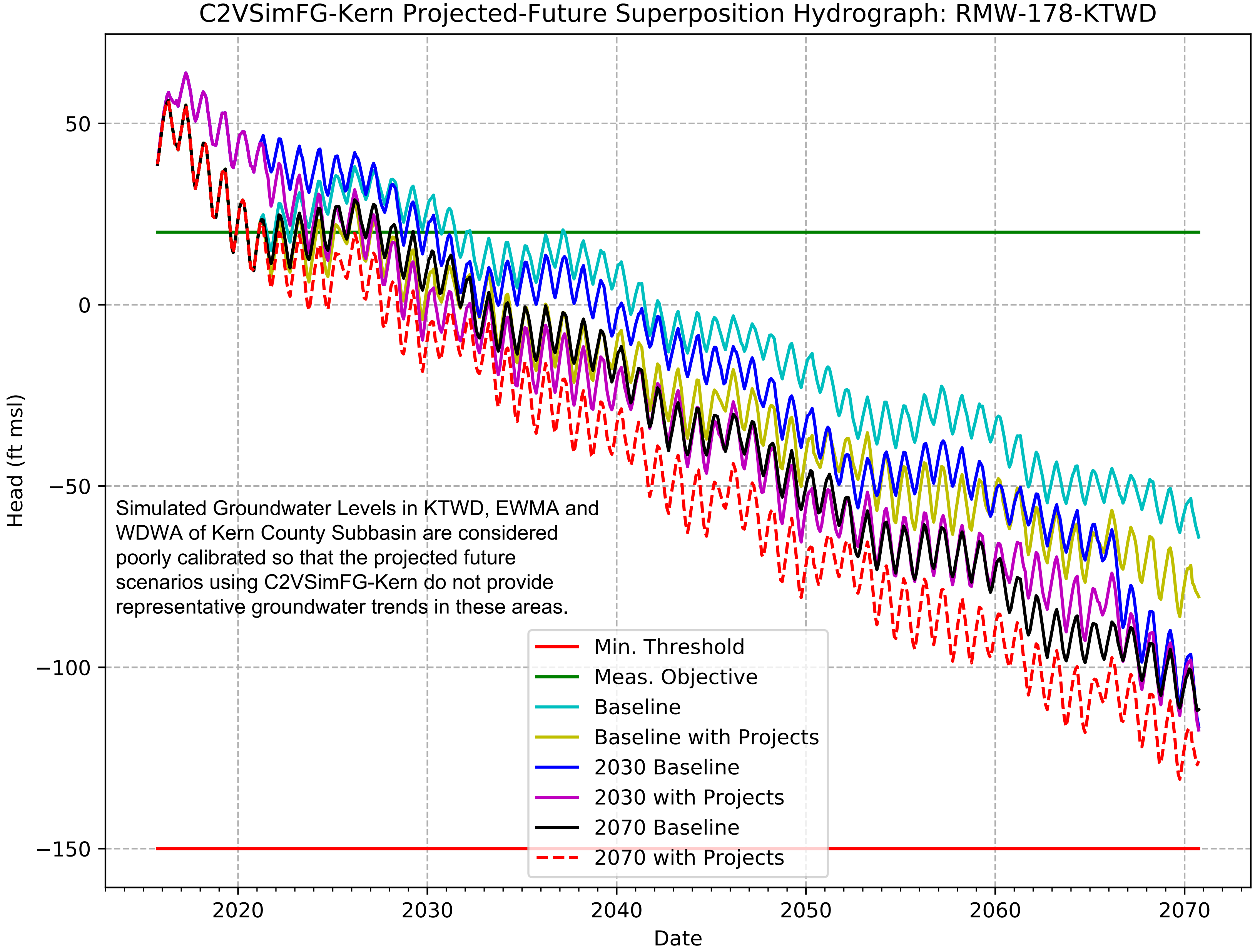

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-175-KTWD
Head (ft msl)
50
0
−50
−100
−150
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.



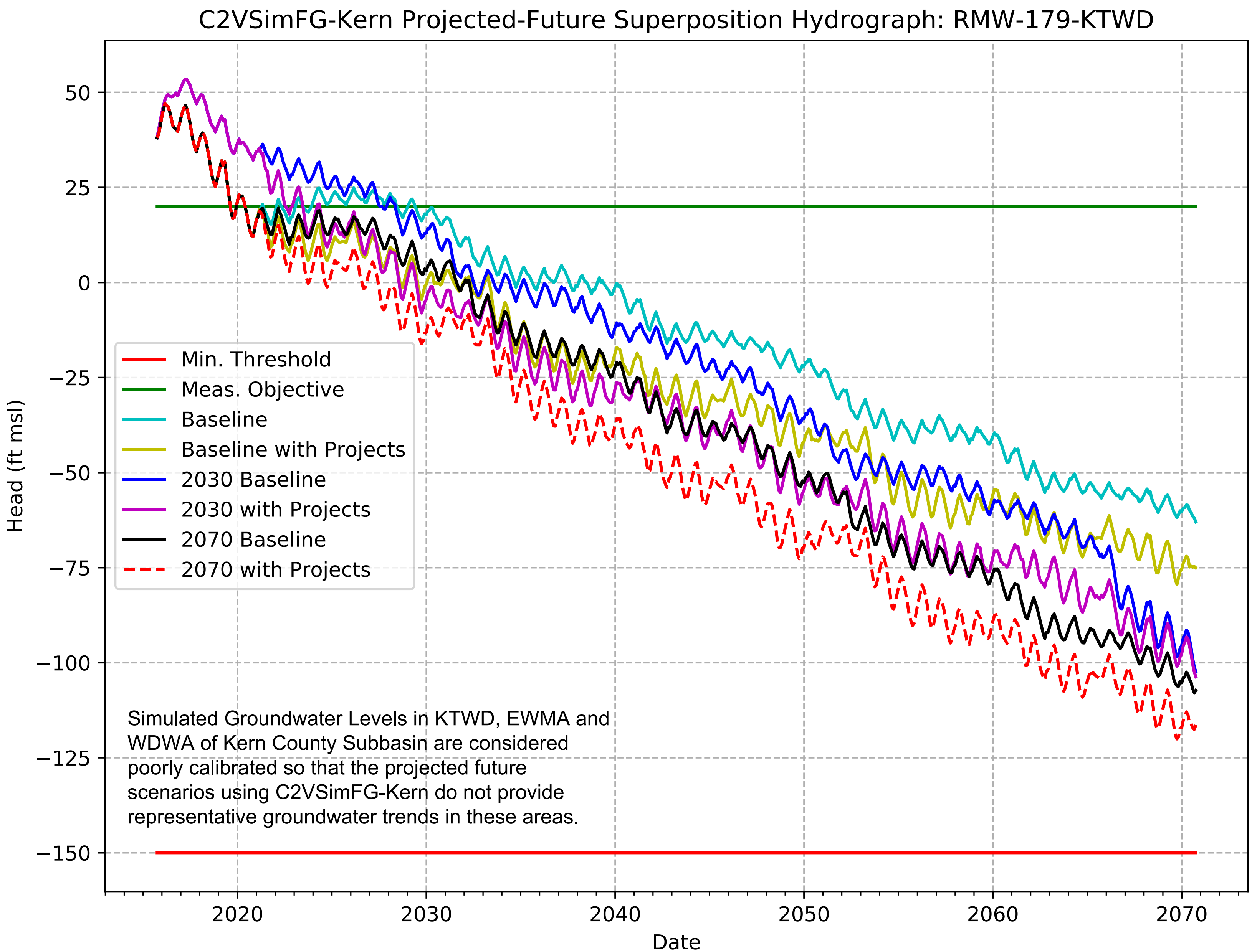
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-176-KTWD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
100
50
0
−50
−100
−150
Head (ft msl)
2020
2030
2040
2050
2060
2070
Date
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.



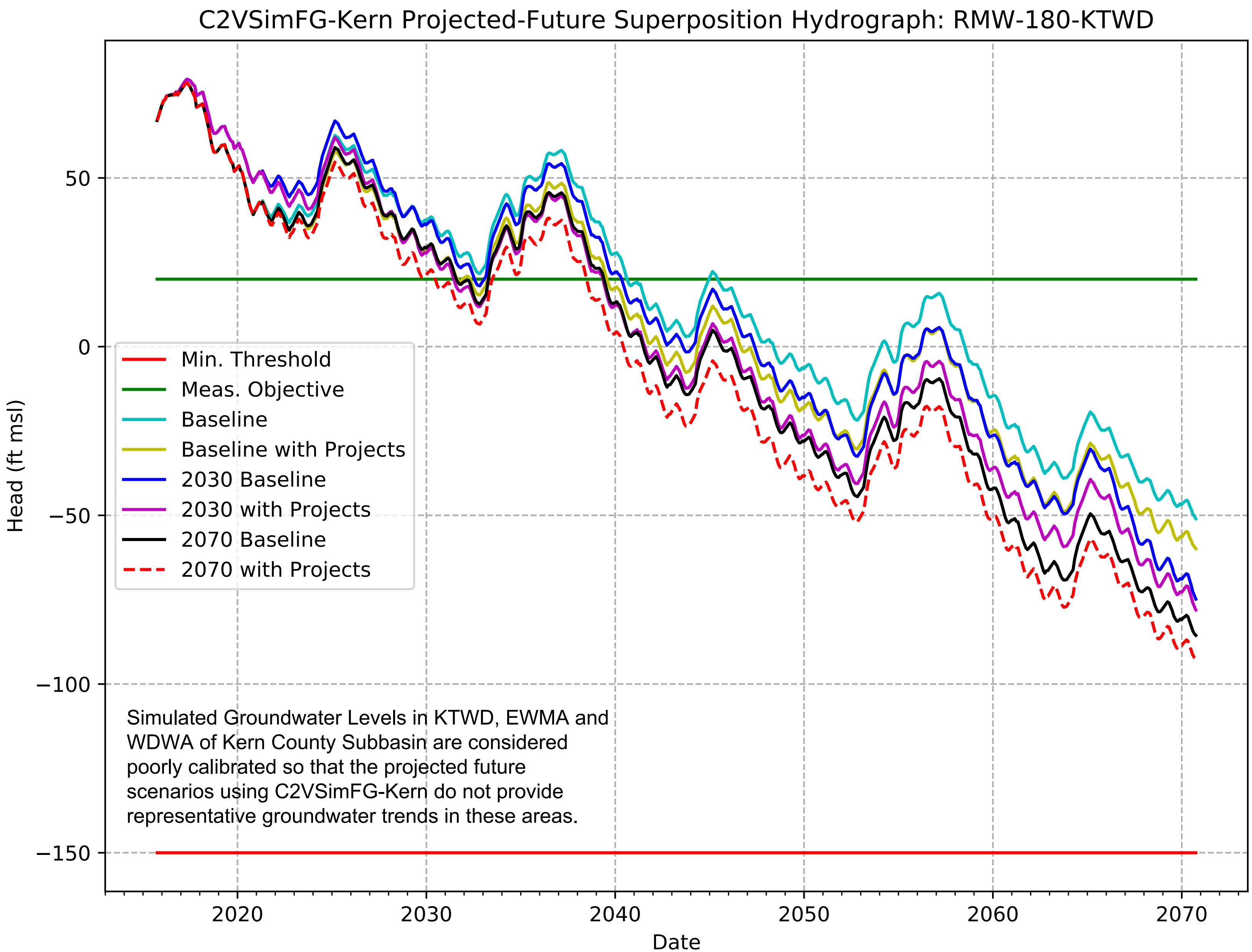
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-177-KTWD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
100
50
0
−50
−100
−150
Date
2020
2030
2040
2050
2060
2070
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.



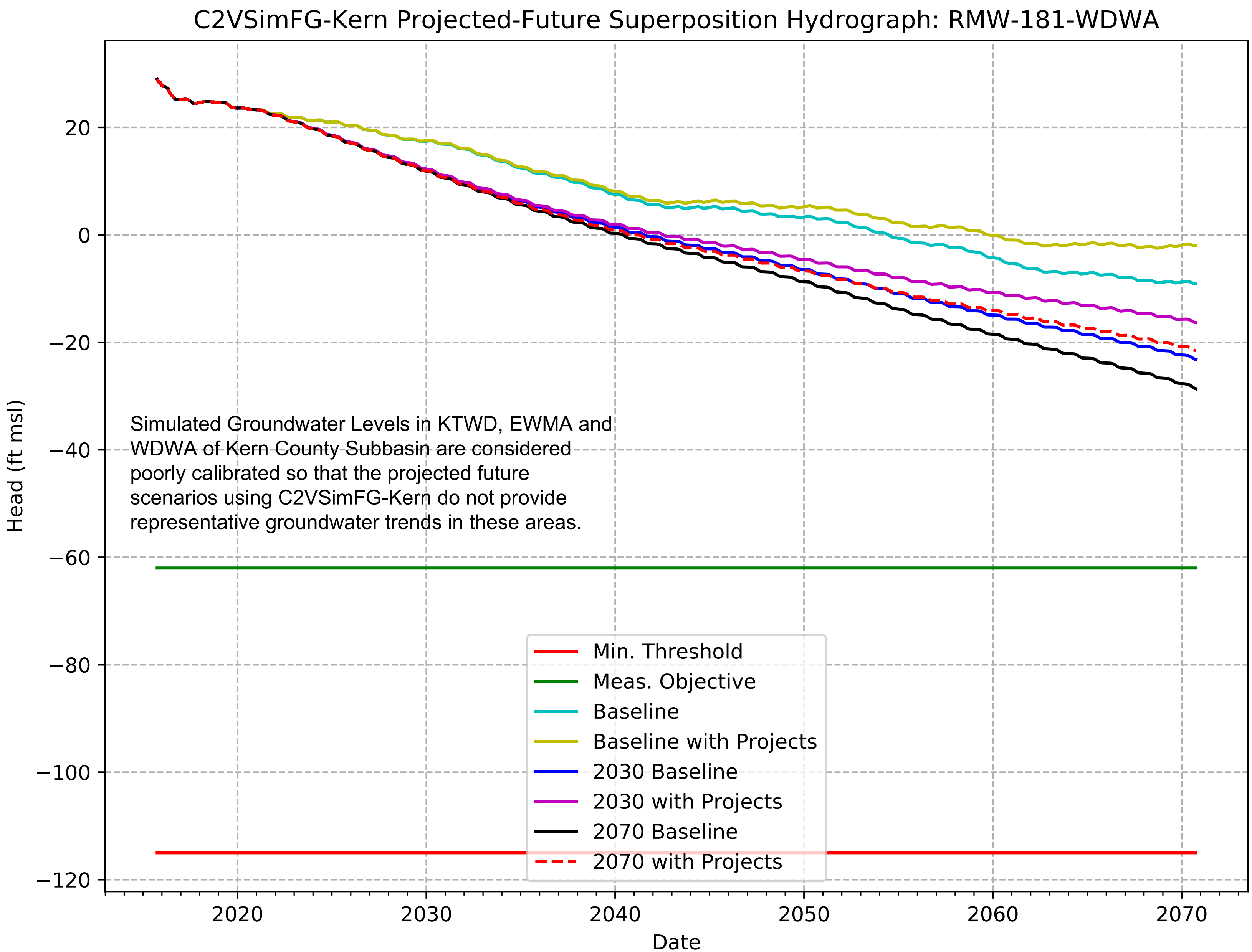
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-178-KTWD
Head (ft msl)
Date
50
0
−50
−100
−150
2020
2030
2040
2050
2060
2070
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



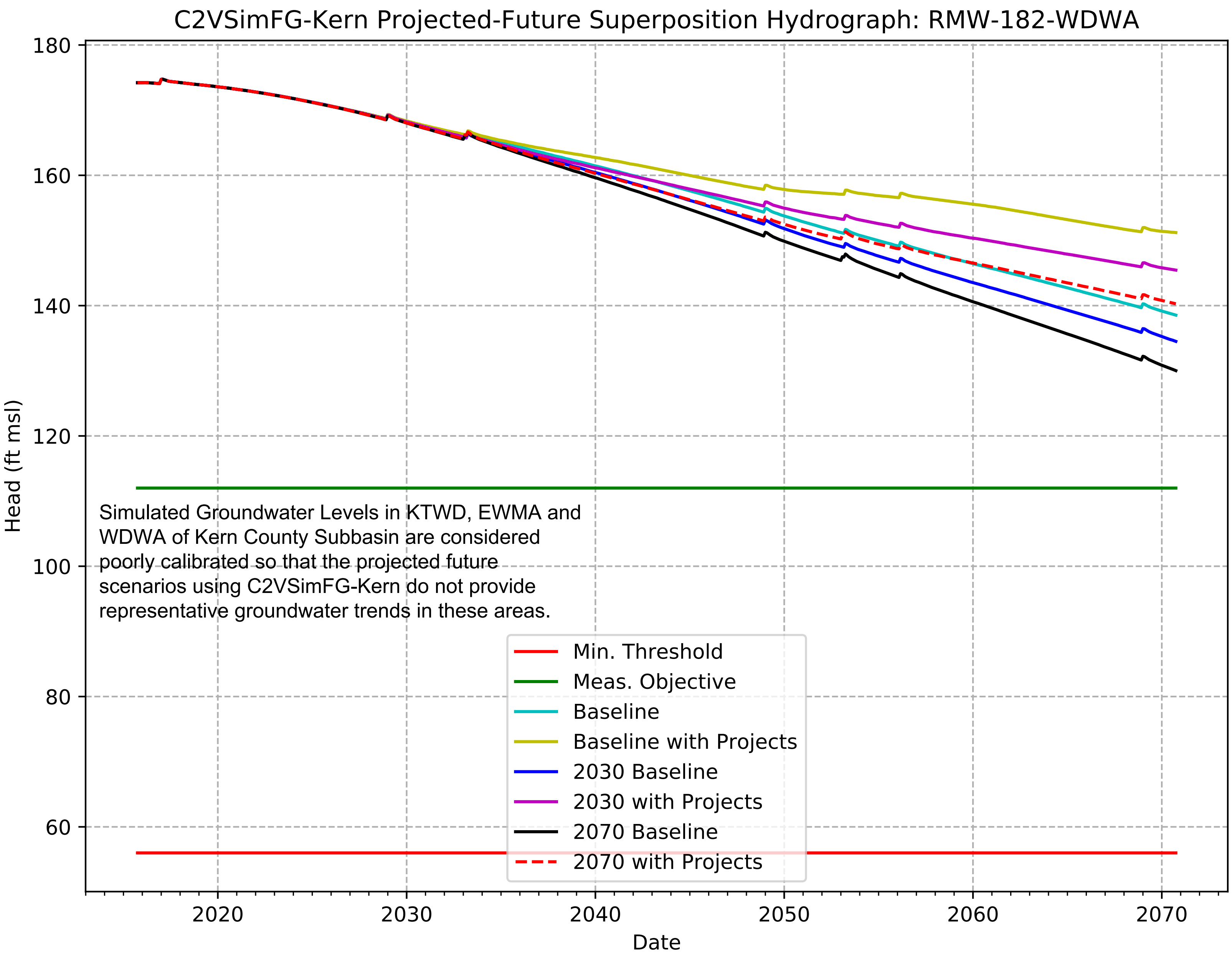
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-179-KTWD
Head (ft msl)
50
25
0
−25
−50
−75
−100
−125
−150
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.



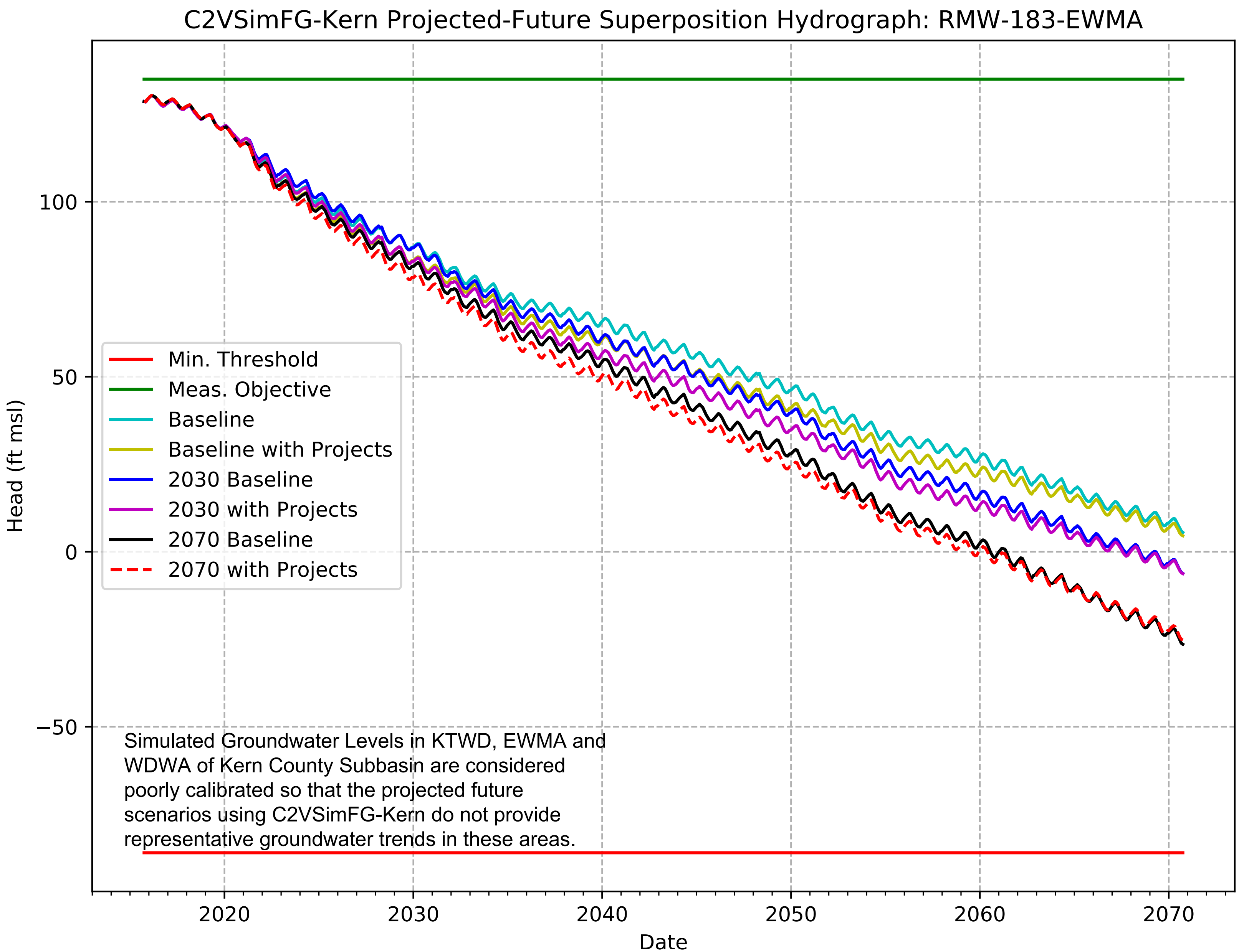
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-180-KTWD
Head (ft msl)
Date
50
0
−50
−100
−150
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and
WDWA of Kern County Subbasin are considered
poorly calibrated so that the projected future
scenarios using C2VSimFG-Kern do not provide
representative groundwater trends in these areas.



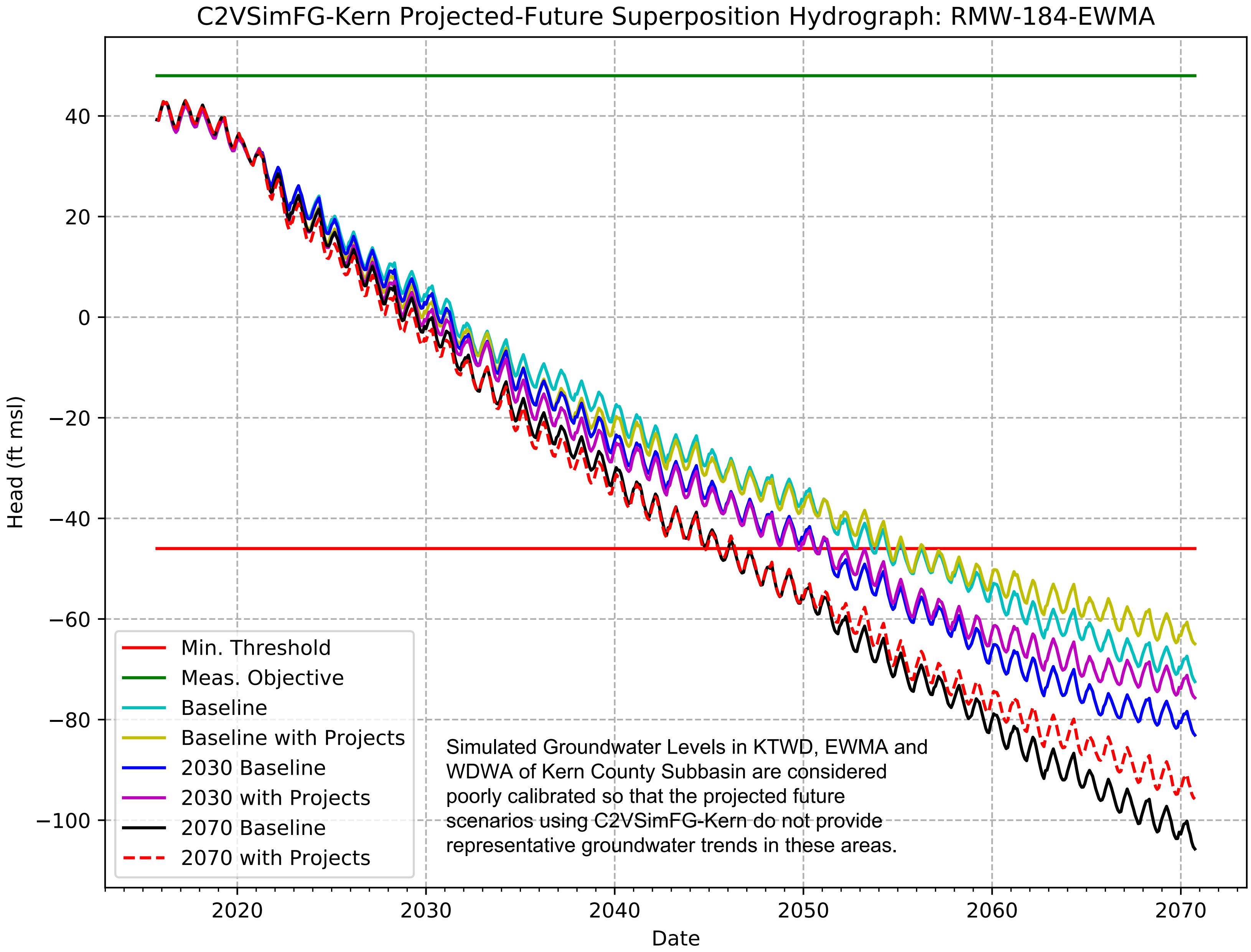
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-181-WDWA
Head (ft msl)
Date
20
0
−20
−40
−60
−80
−100
−120
2020
2030
2040
2050
2060
2070
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

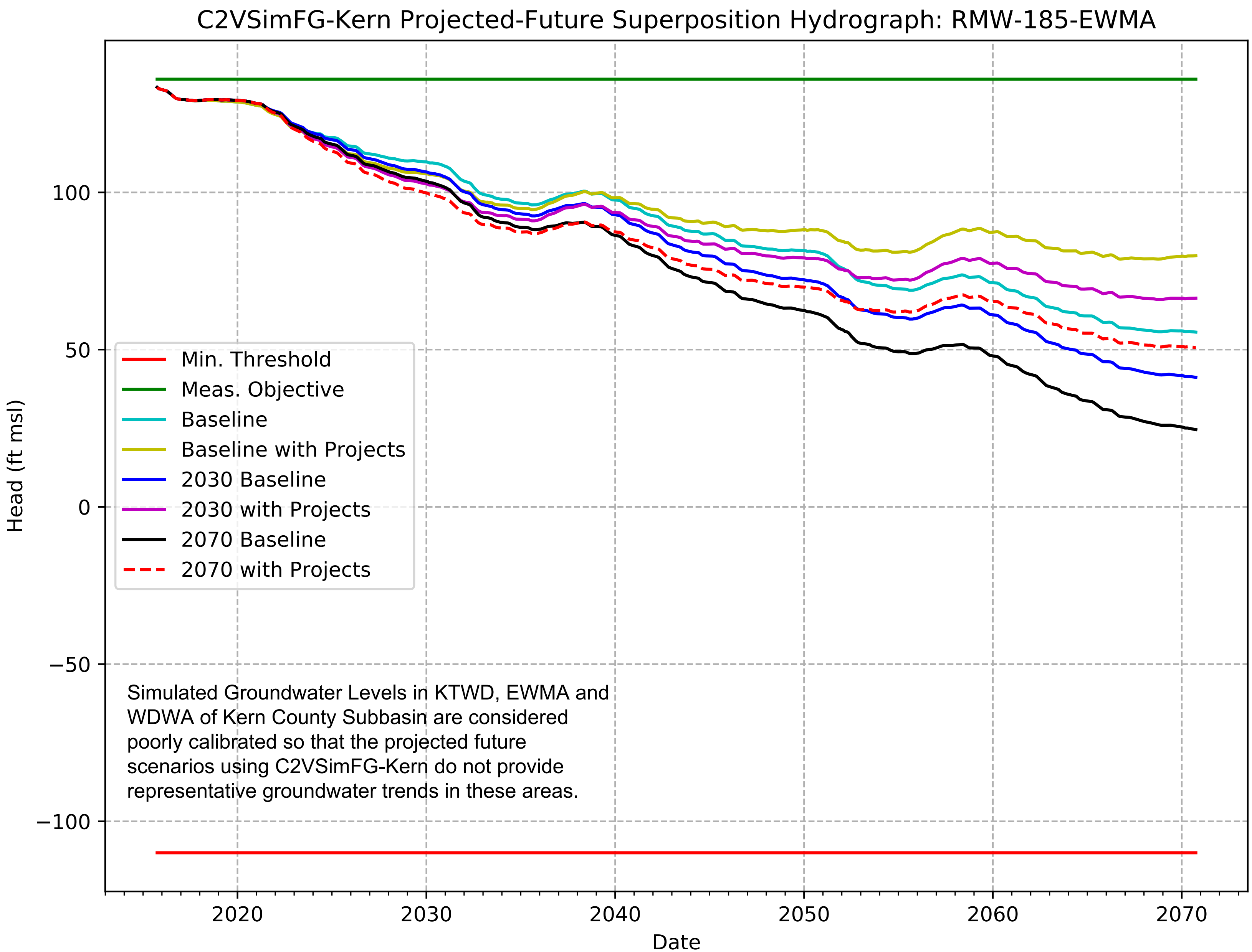


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-182-WDWA
Head (ft msl)
180
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

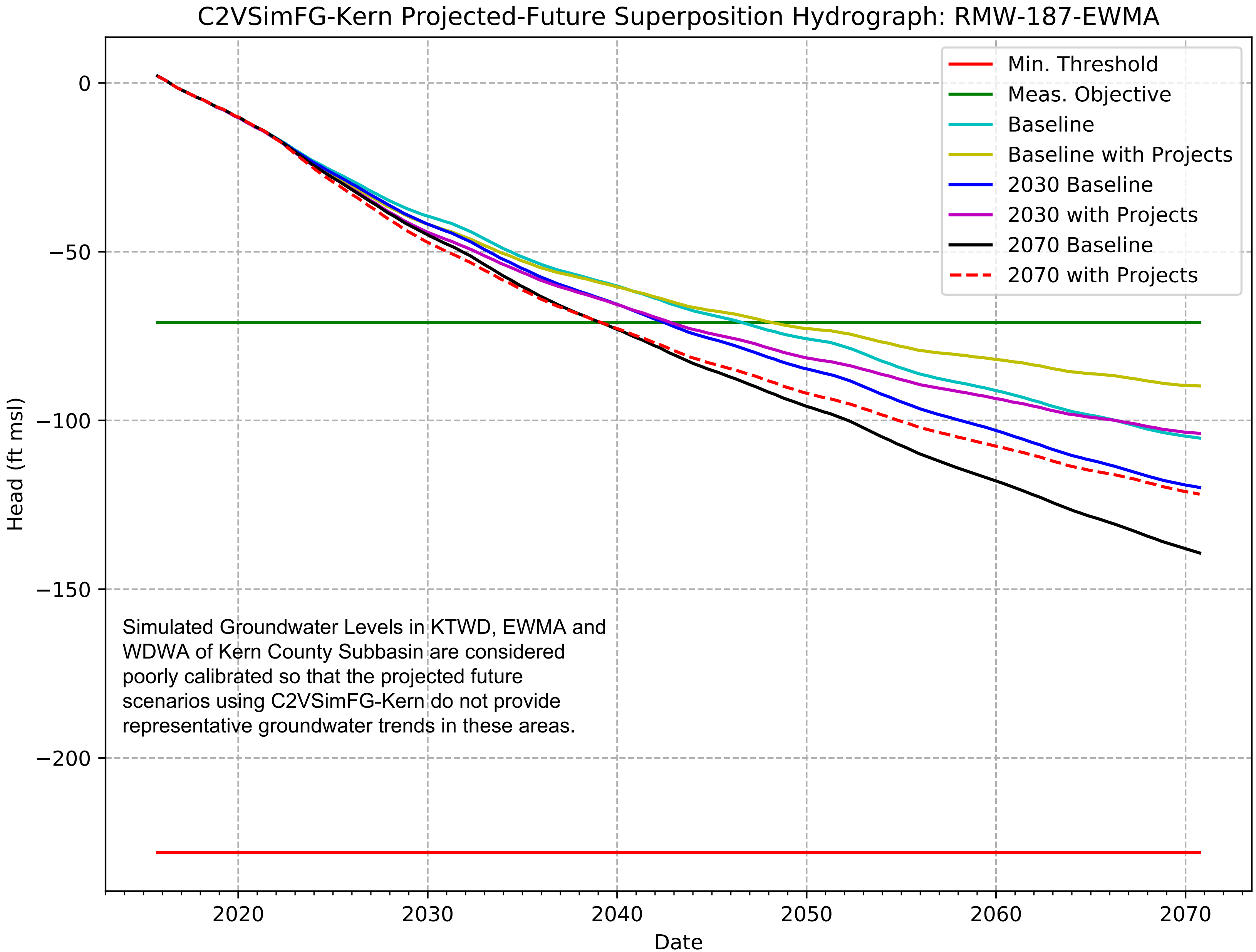


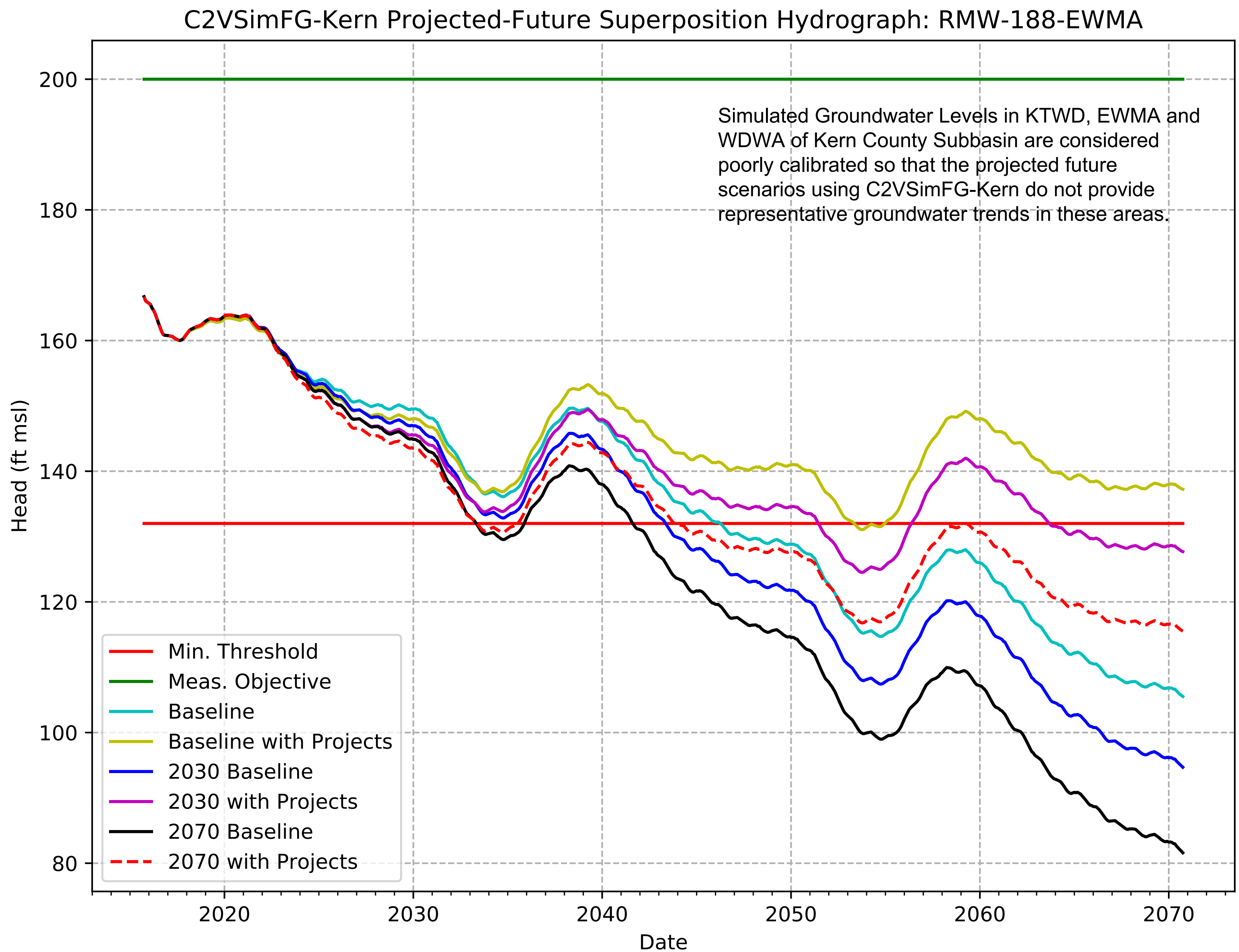
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-183-EWMA
Head (ft msl)
100
50
0
−50
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.

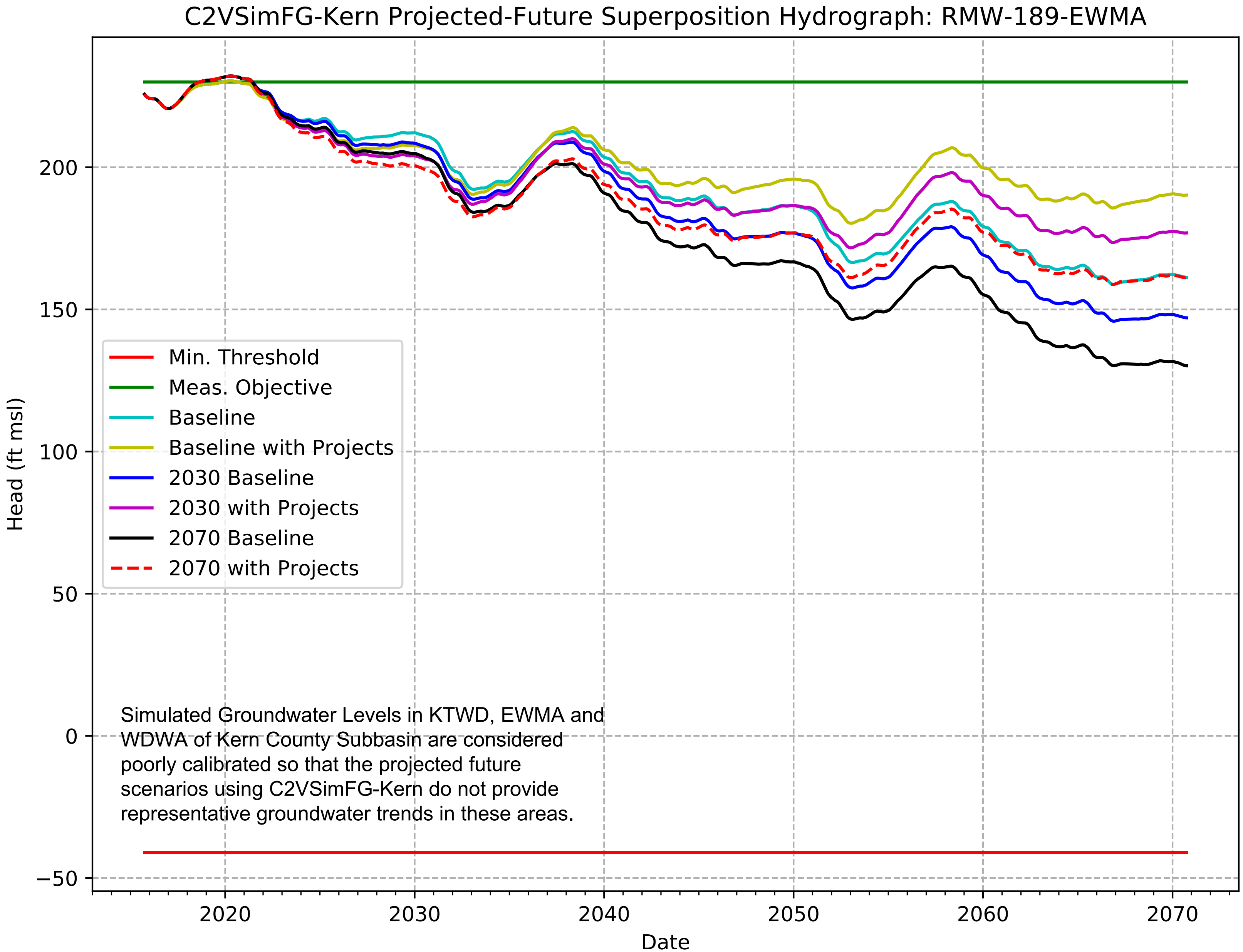

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-184-EWMA
Head (ft msl)
40
20
0
−20
−40
−60
−80
−100
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.

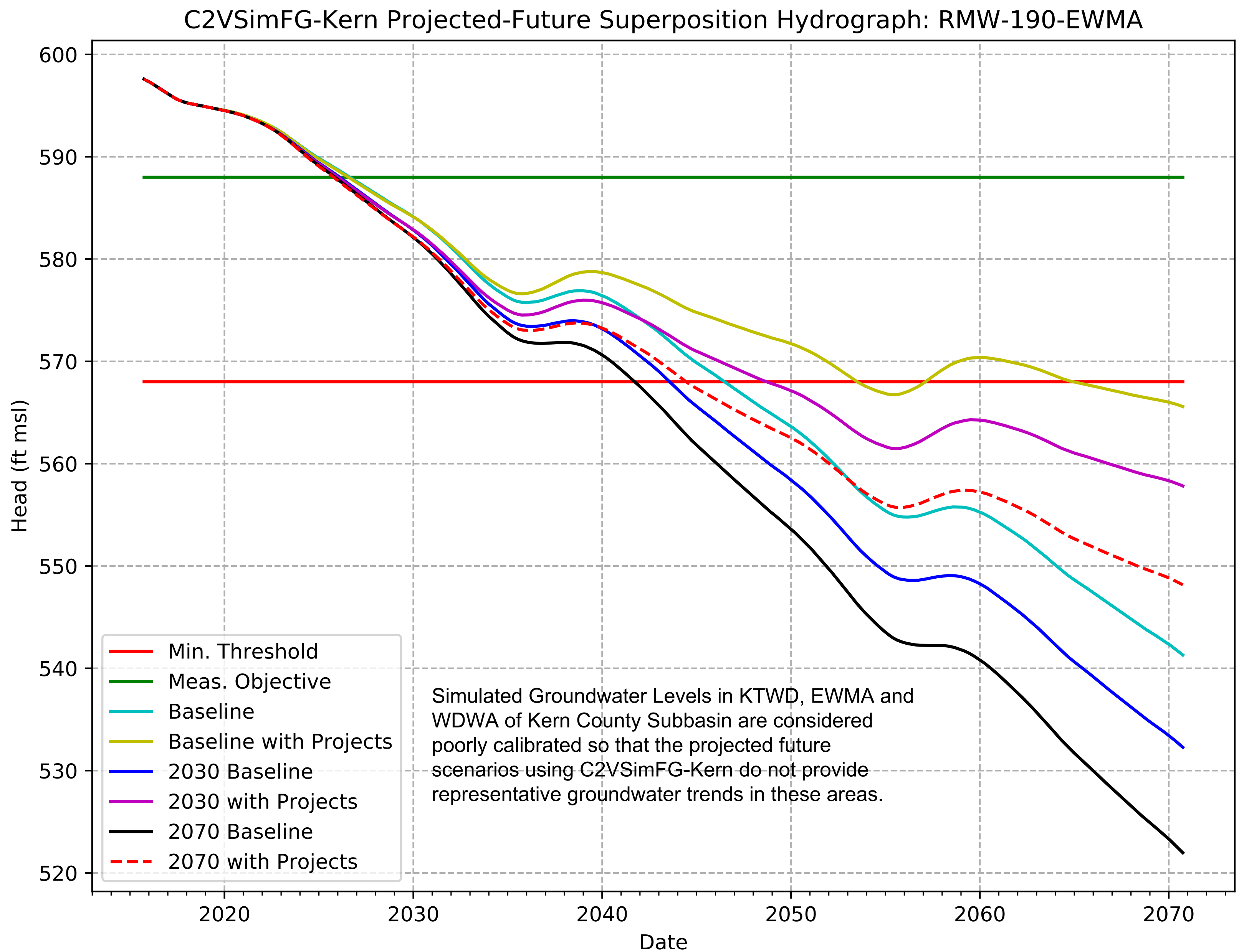


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-185-EWMA
Head (ft msl)
100
50
0
−50
−100
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.

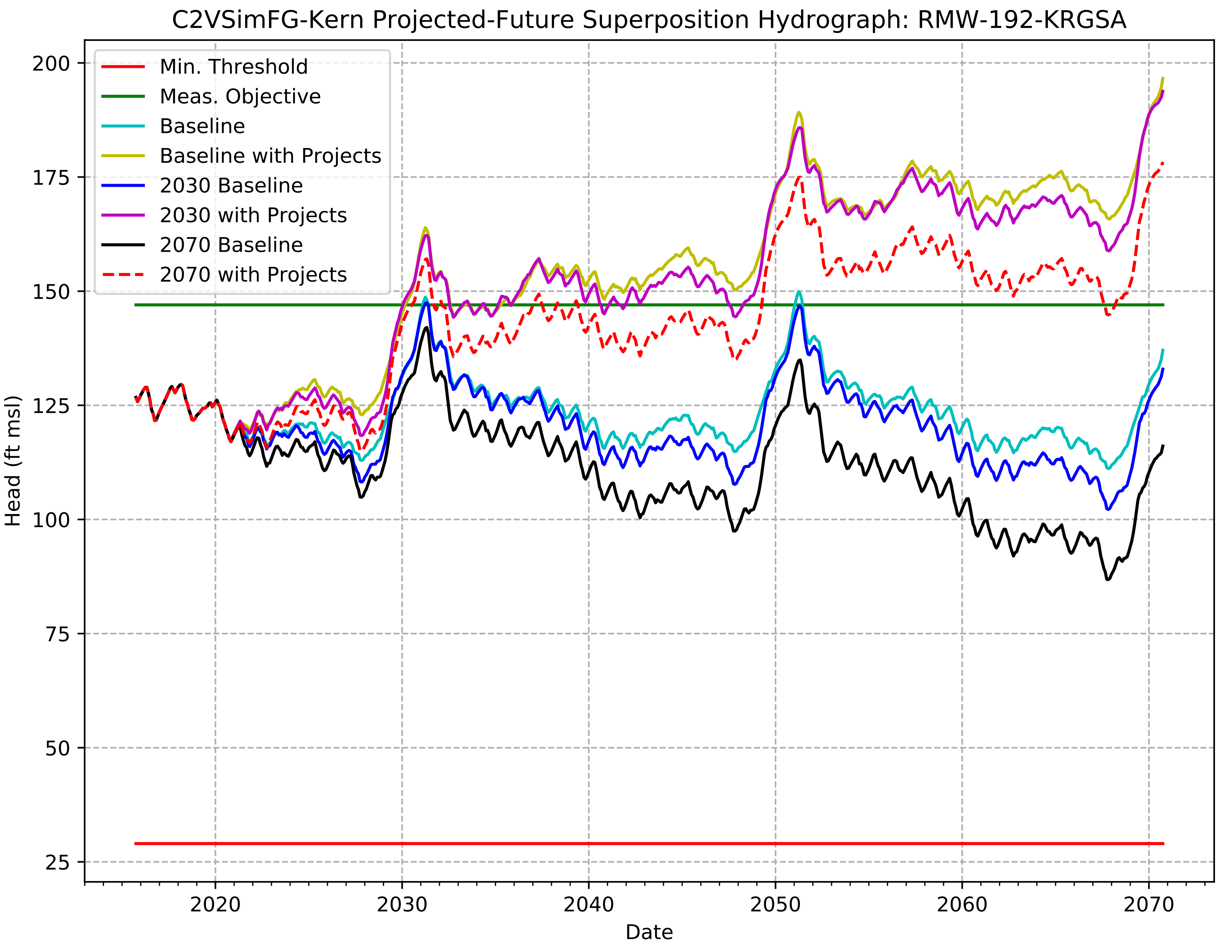

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-187-EWMA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
0
−50
−100
−150
−200
Head (ft msl)
2020
2030
2040
2050
2060
2070
Date
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.

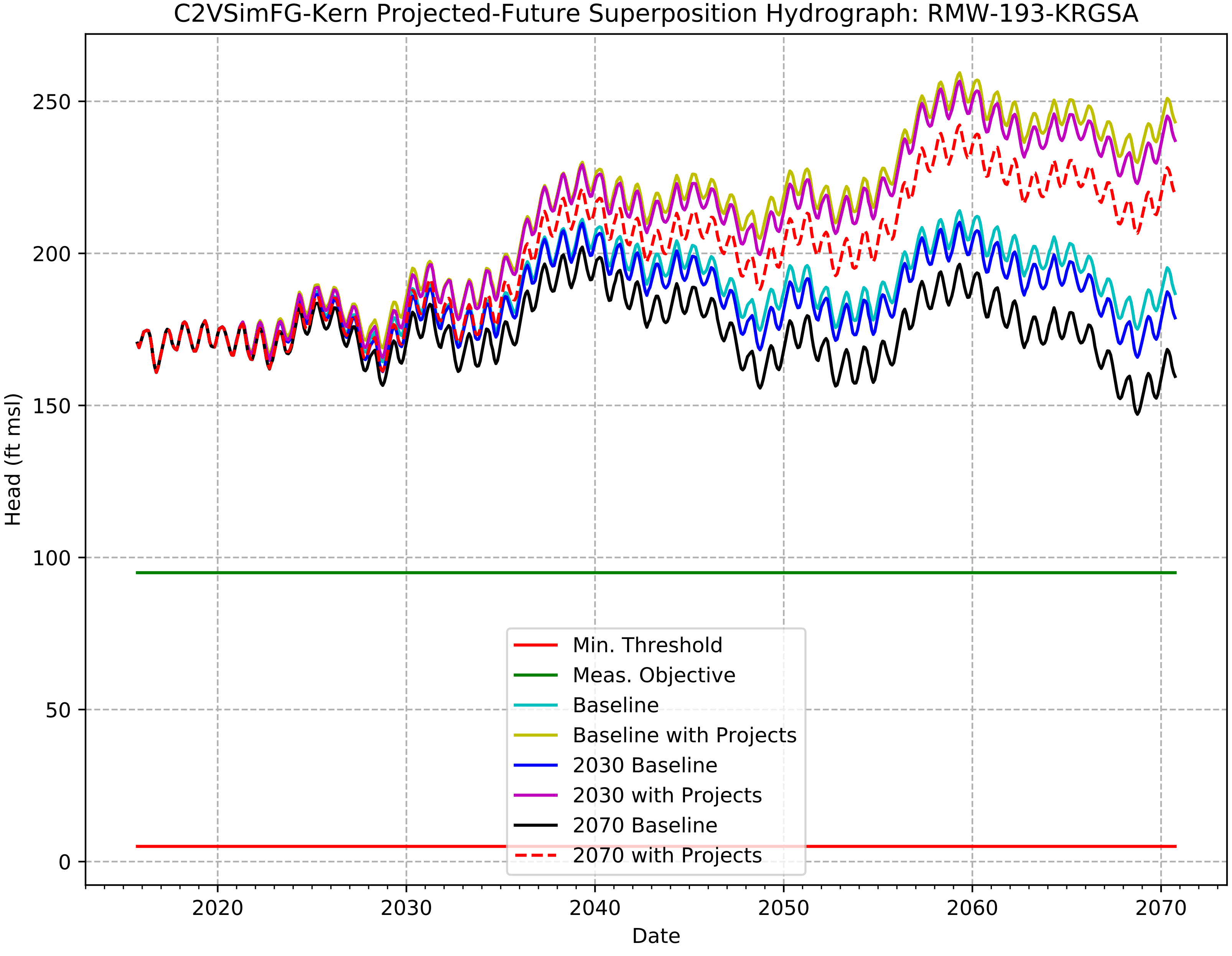

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-188-EWMA
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Head (ft msl)
Date
200
180
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

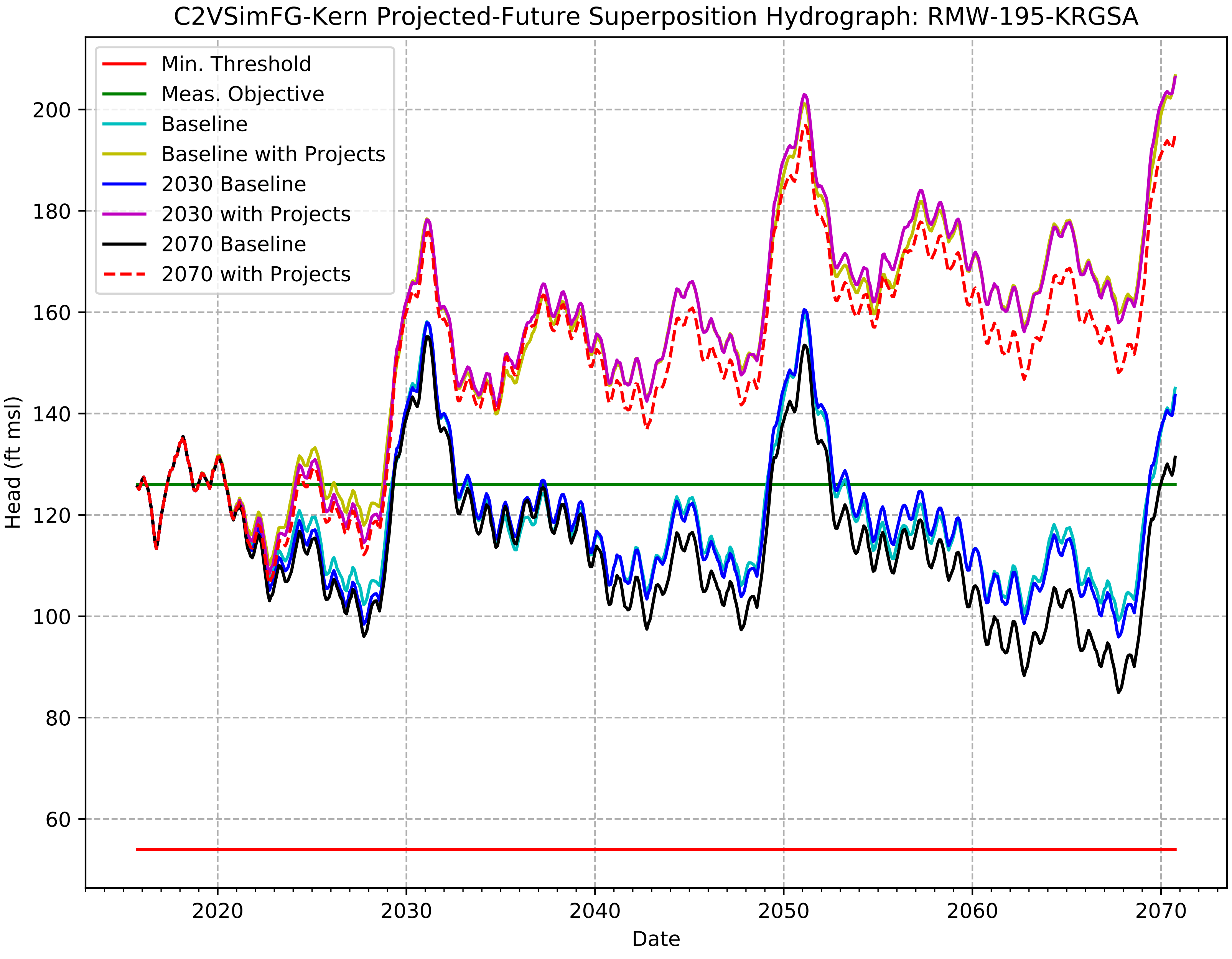

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-189-EWMA
Head (ft msl)
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.



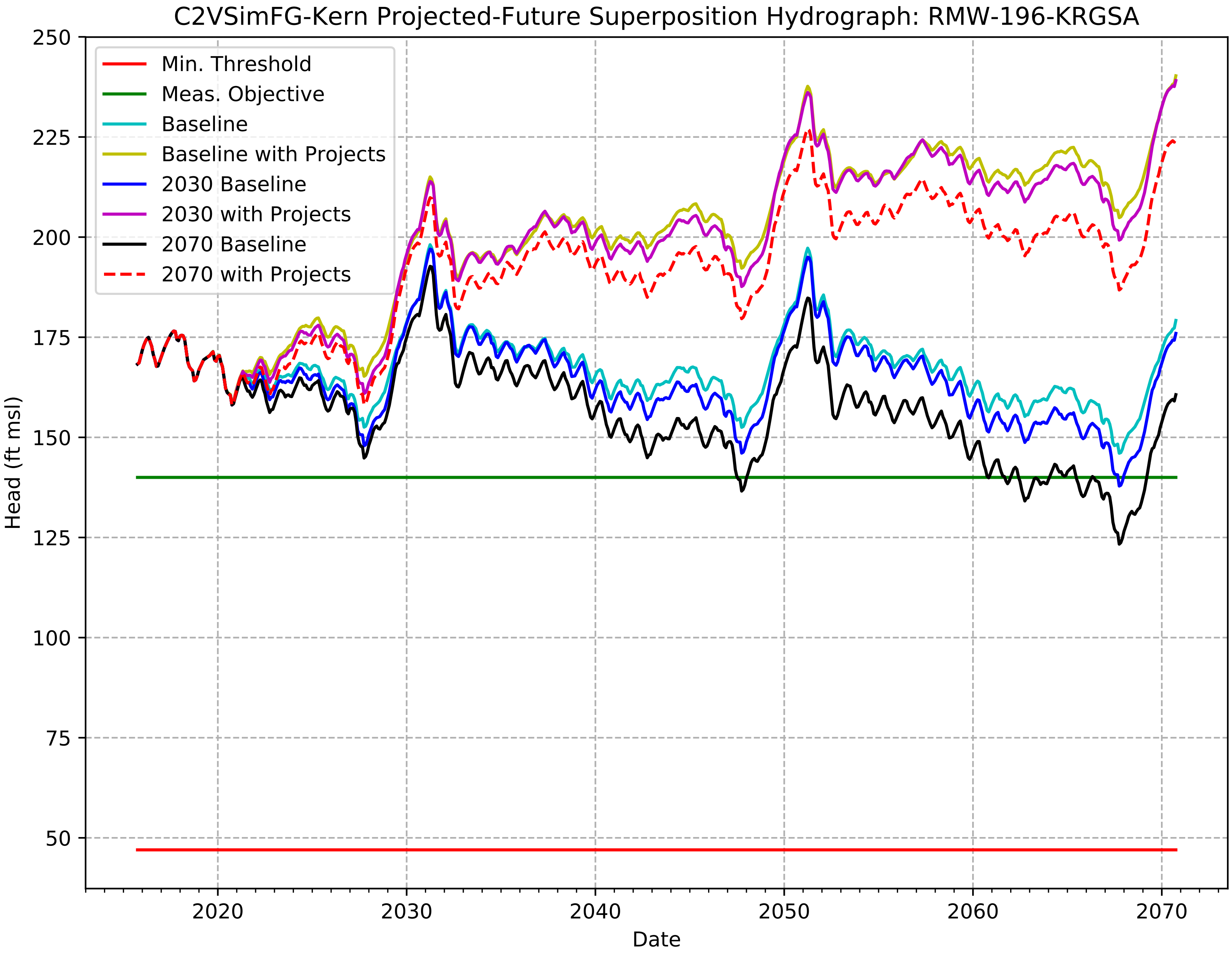
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-190-EWMA
Head (ft msl)
Date
600
590
580
570
560
550
540
530
520
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-192-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
175
150
125
100
75
50
25
2020
2030
2040
2050
2060
2070
Date

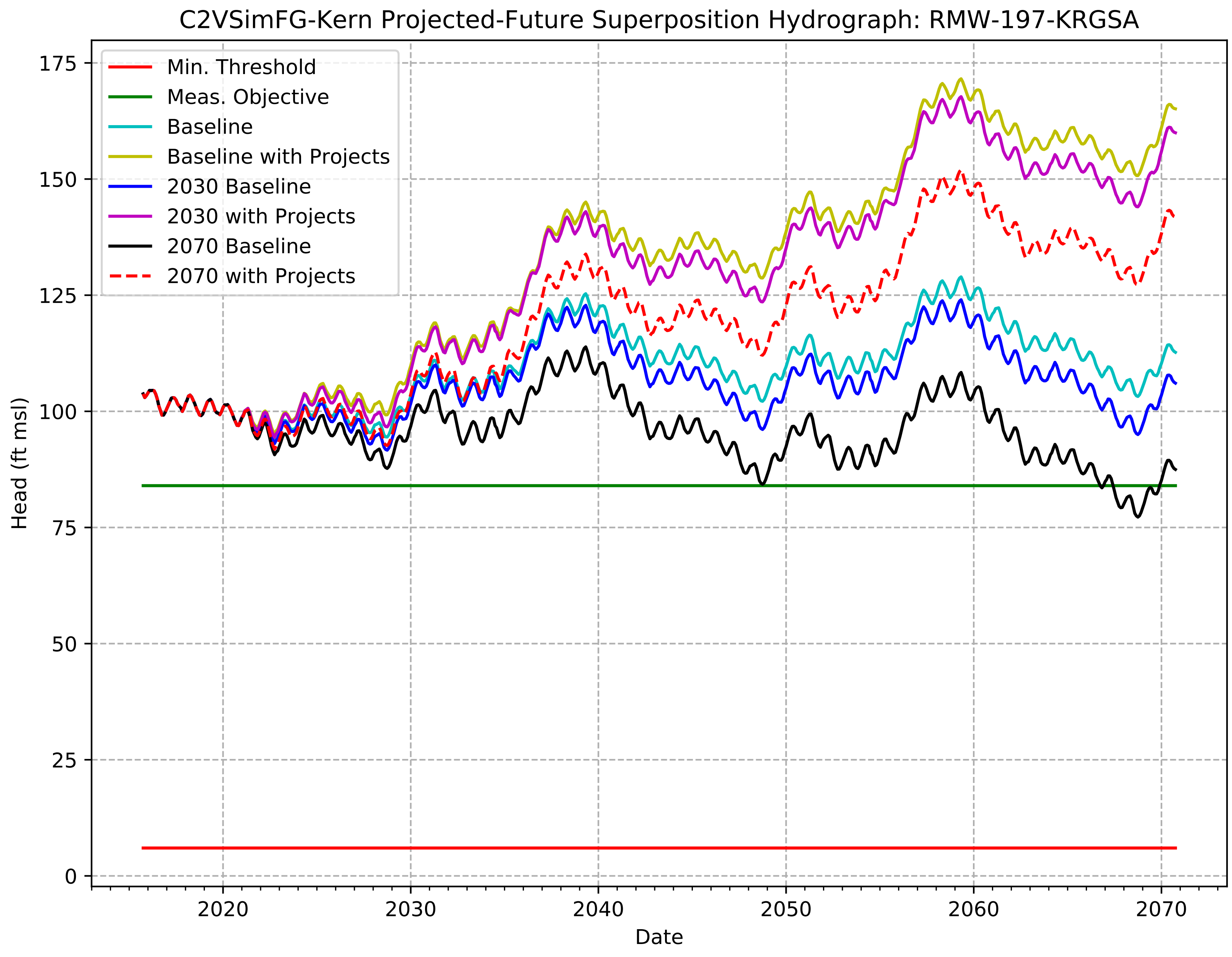

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-193-KRGSA
Head (ft msl)
250
200
150
100
50
0
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

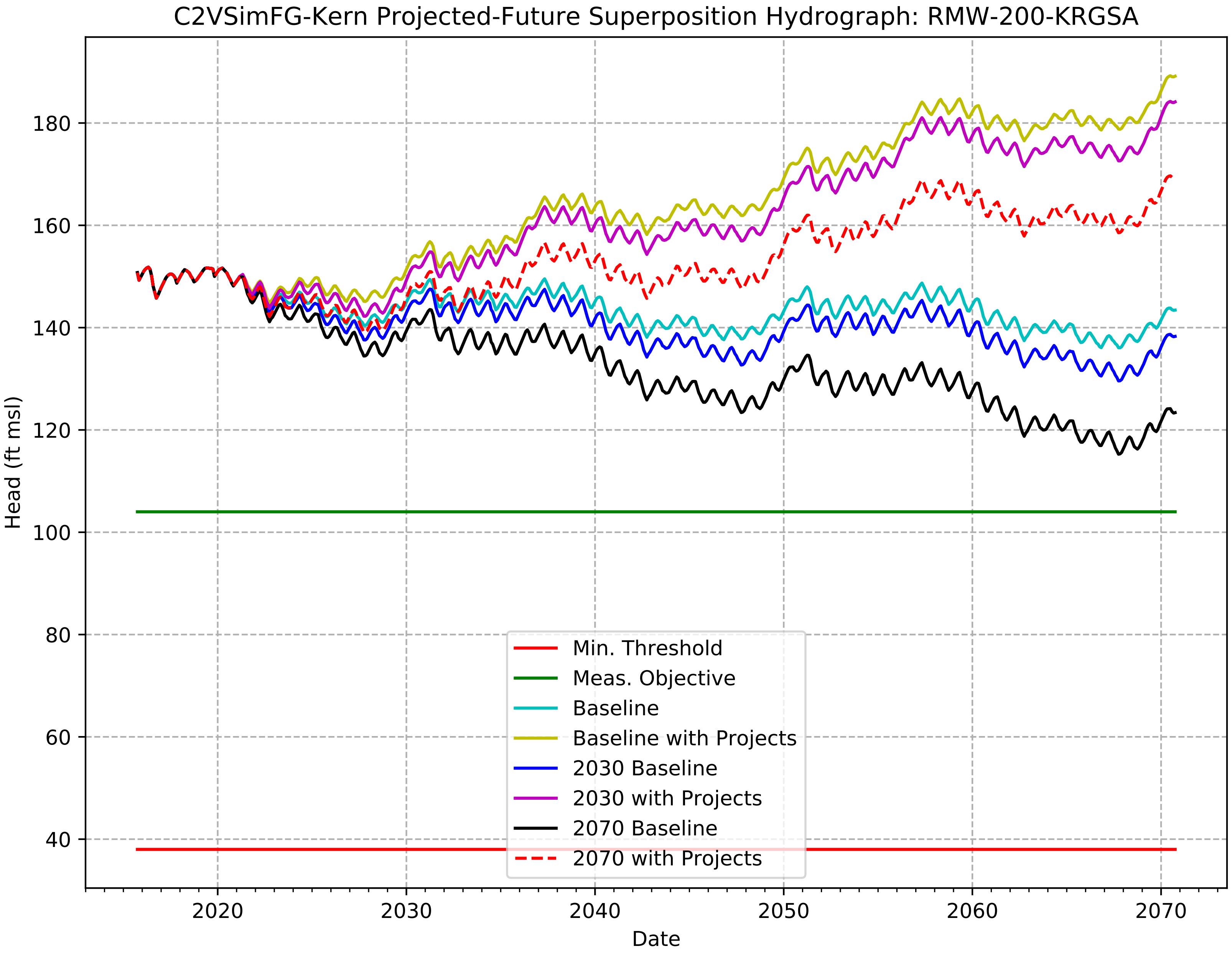


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-195-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
200
180
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date

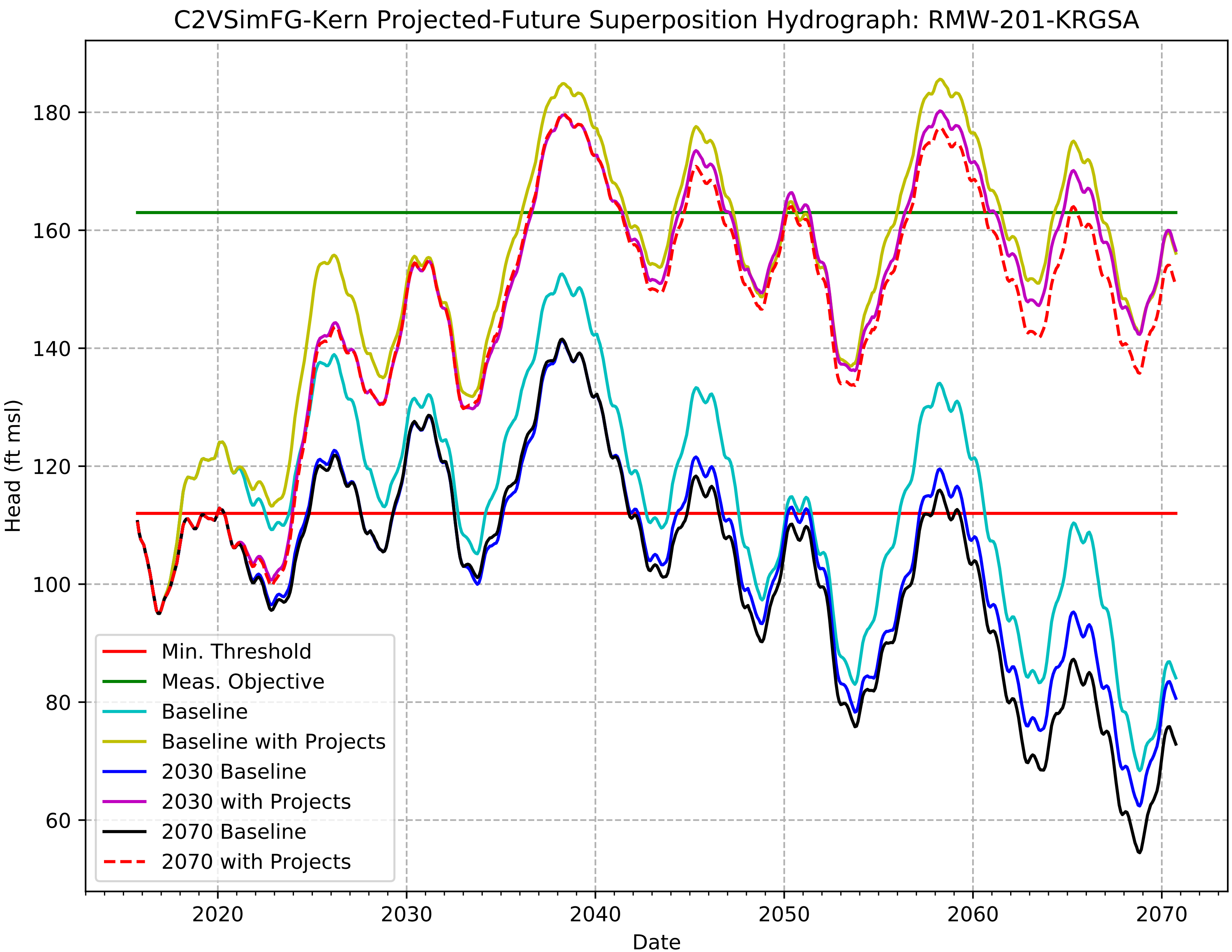


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-196-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
250
225
200
175
150
125
100
75
50
2020
2030
2040
2050
2060
2070

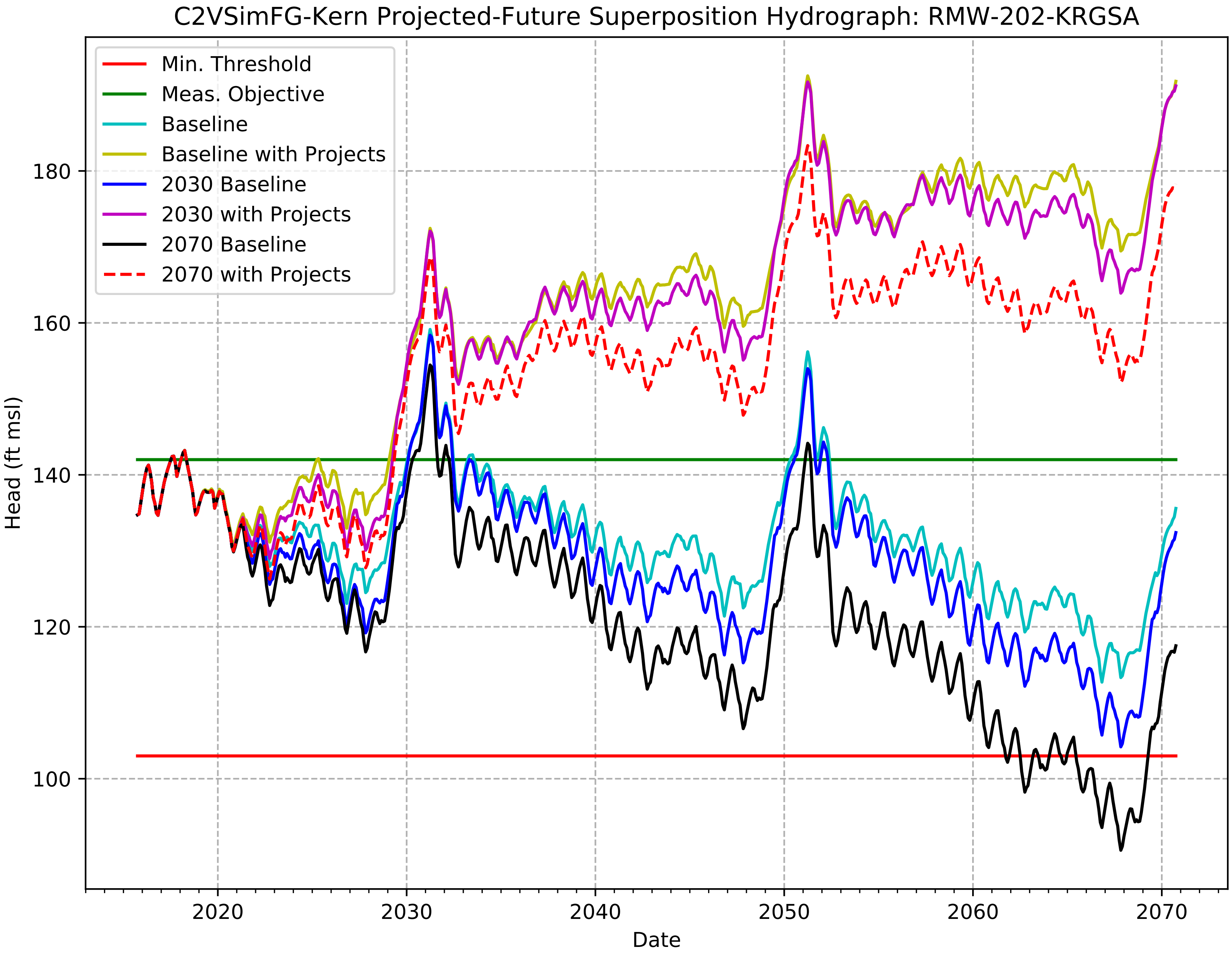

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-197-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
175
150
125
100
75
50
25
0
2020
2030
2040
2050
2060
2070
Date

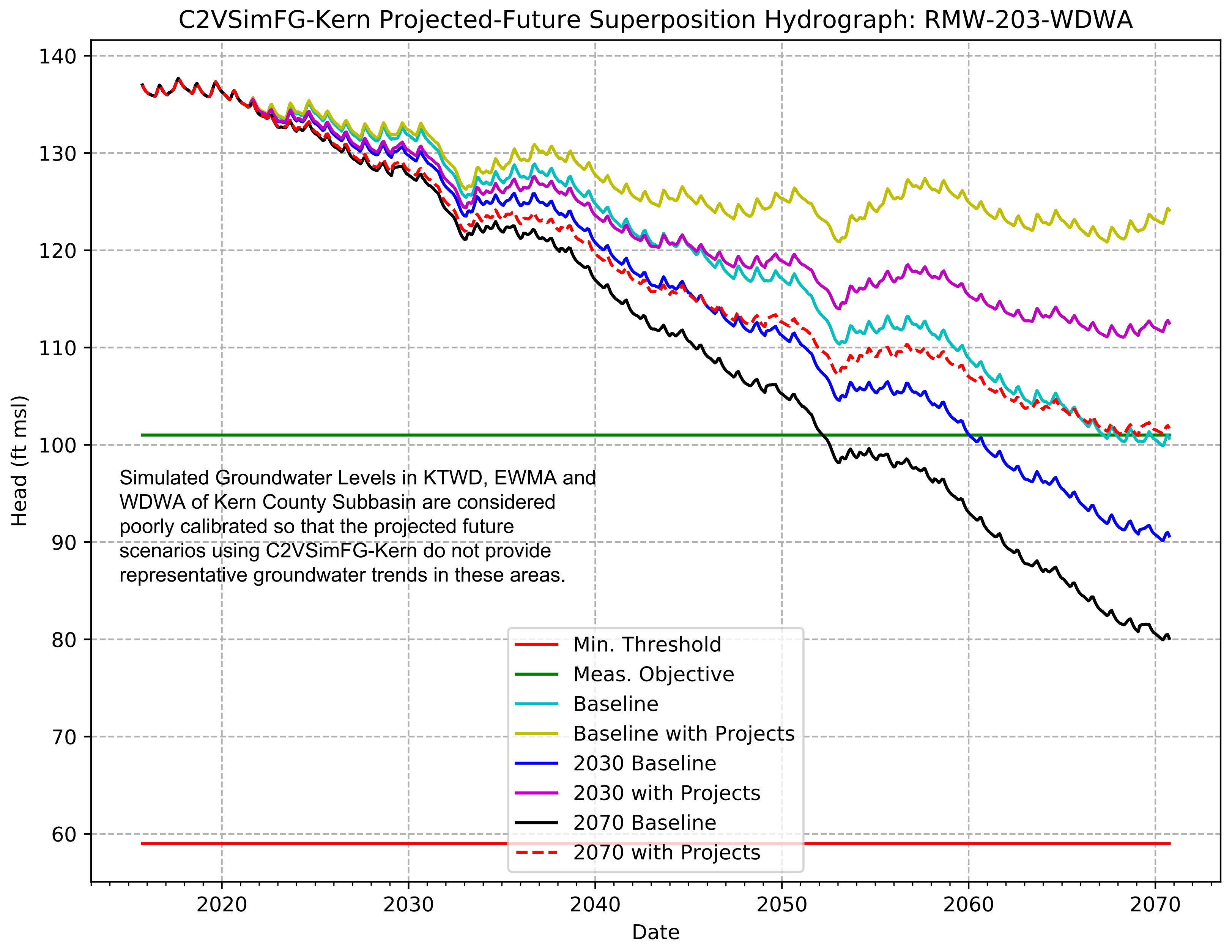


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-200-KRGSA
Head (ft msl)
Date
180
160
140
120
100
80
60
40
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

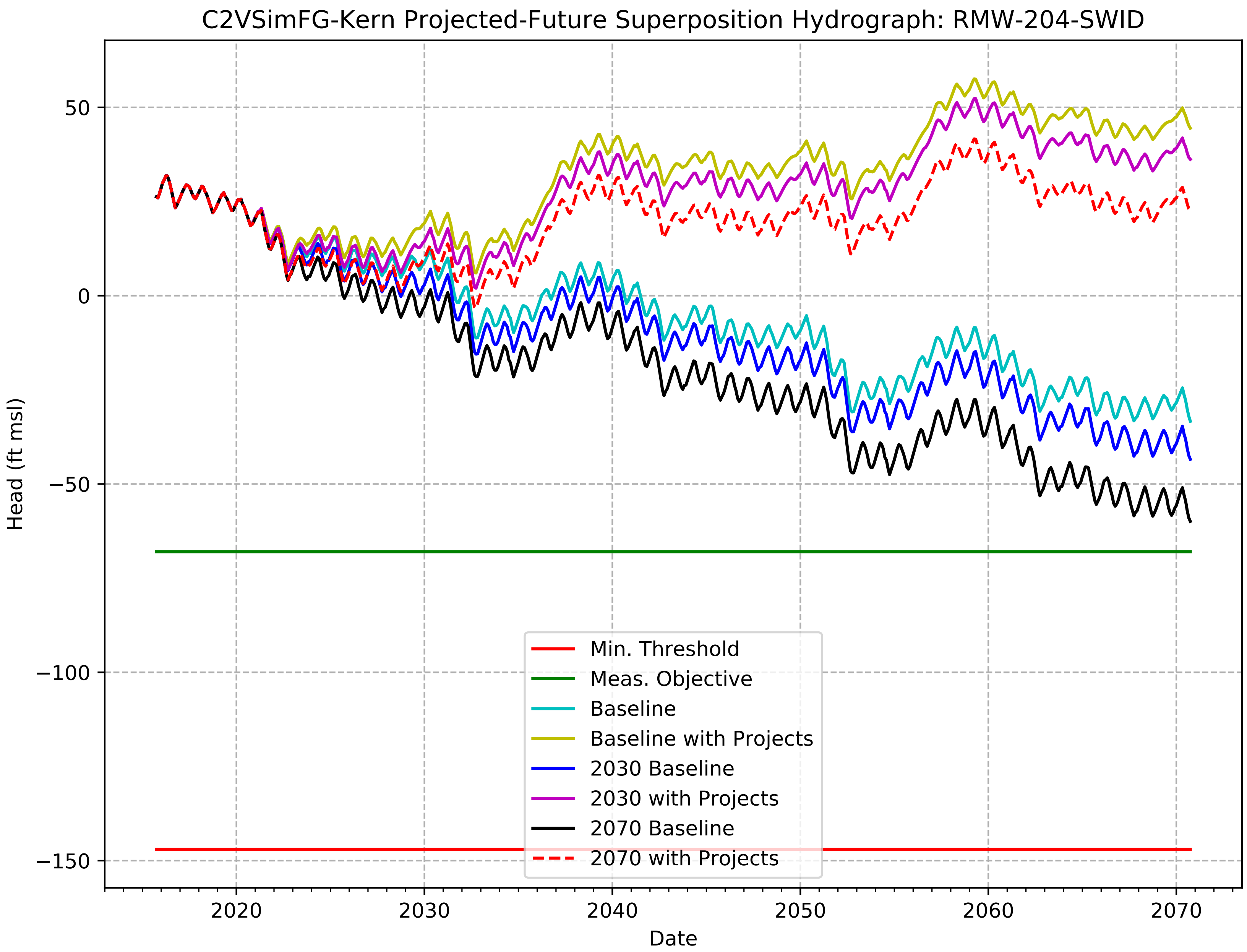


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-201-KRGSA
Head (ft msl)
Date
180
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

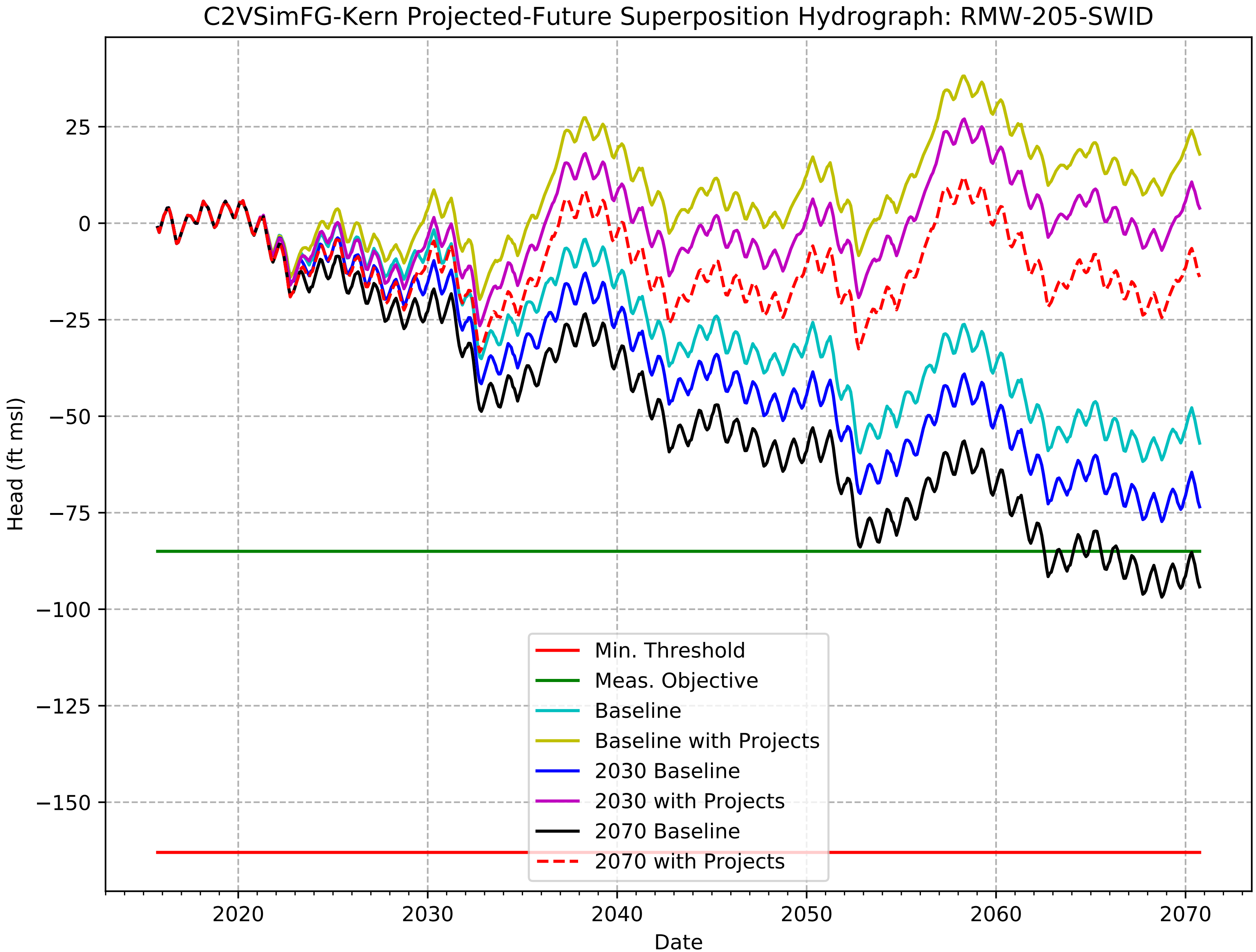

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-202-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
100
120
140
160
180
2020
2030
2040
2050
2060
2070
Date

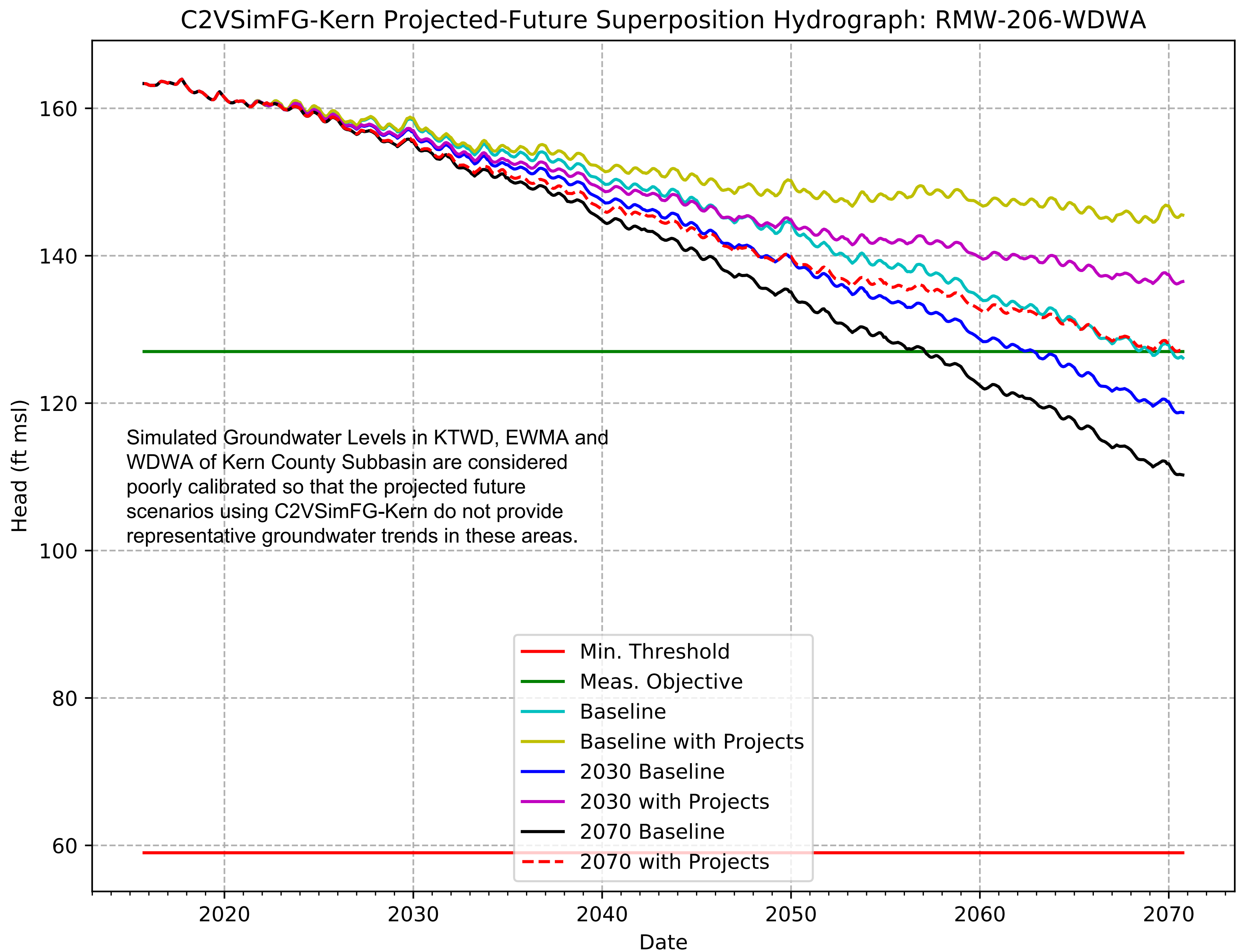


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-203-WDWA
Head (ft msl)
140
130
120
110
100
90
80
70
60
2020
2030
2040
2050
2060
2070
Date
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

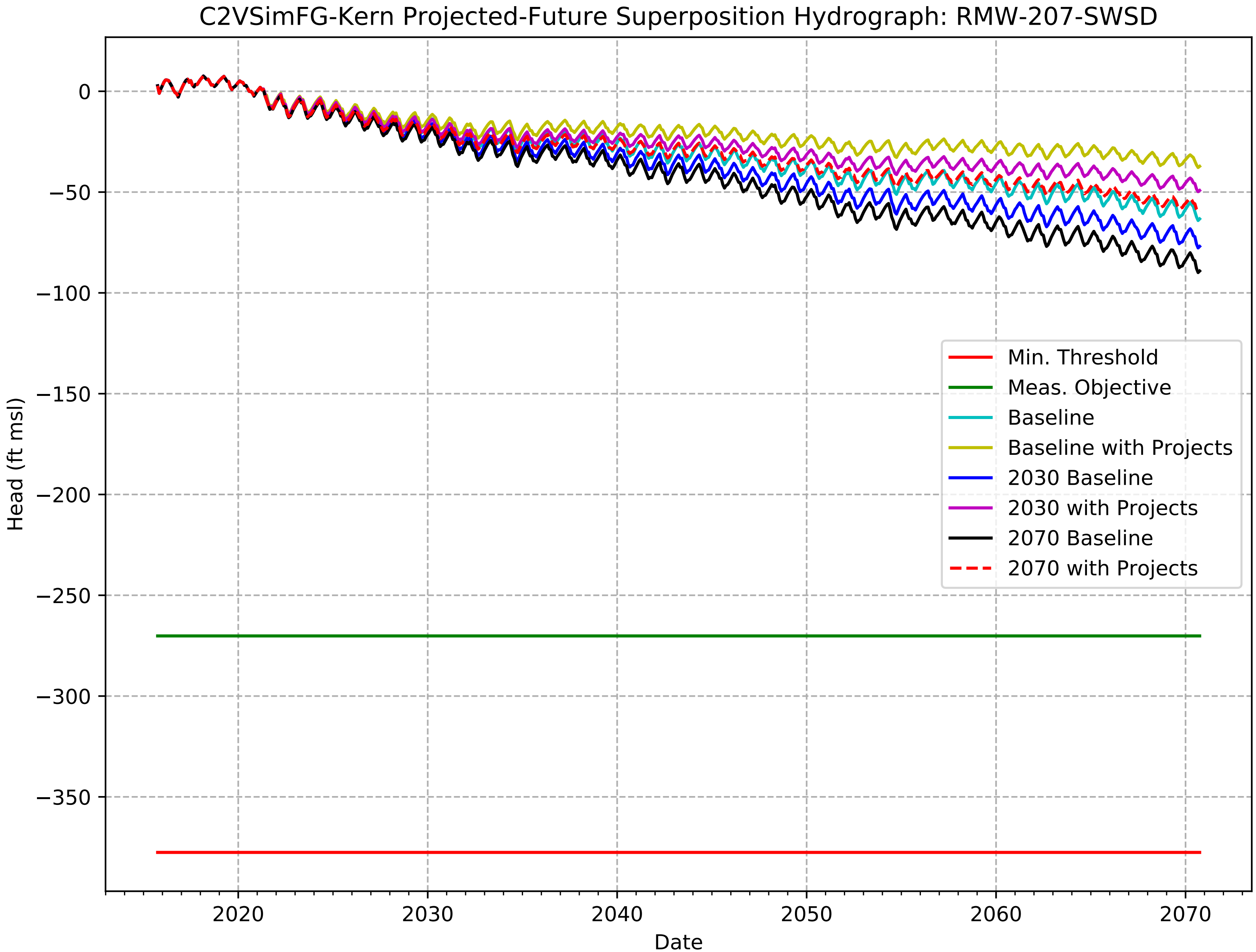


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-204-SWID
Head (ft msl)
50
0
−50
−100
−150
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

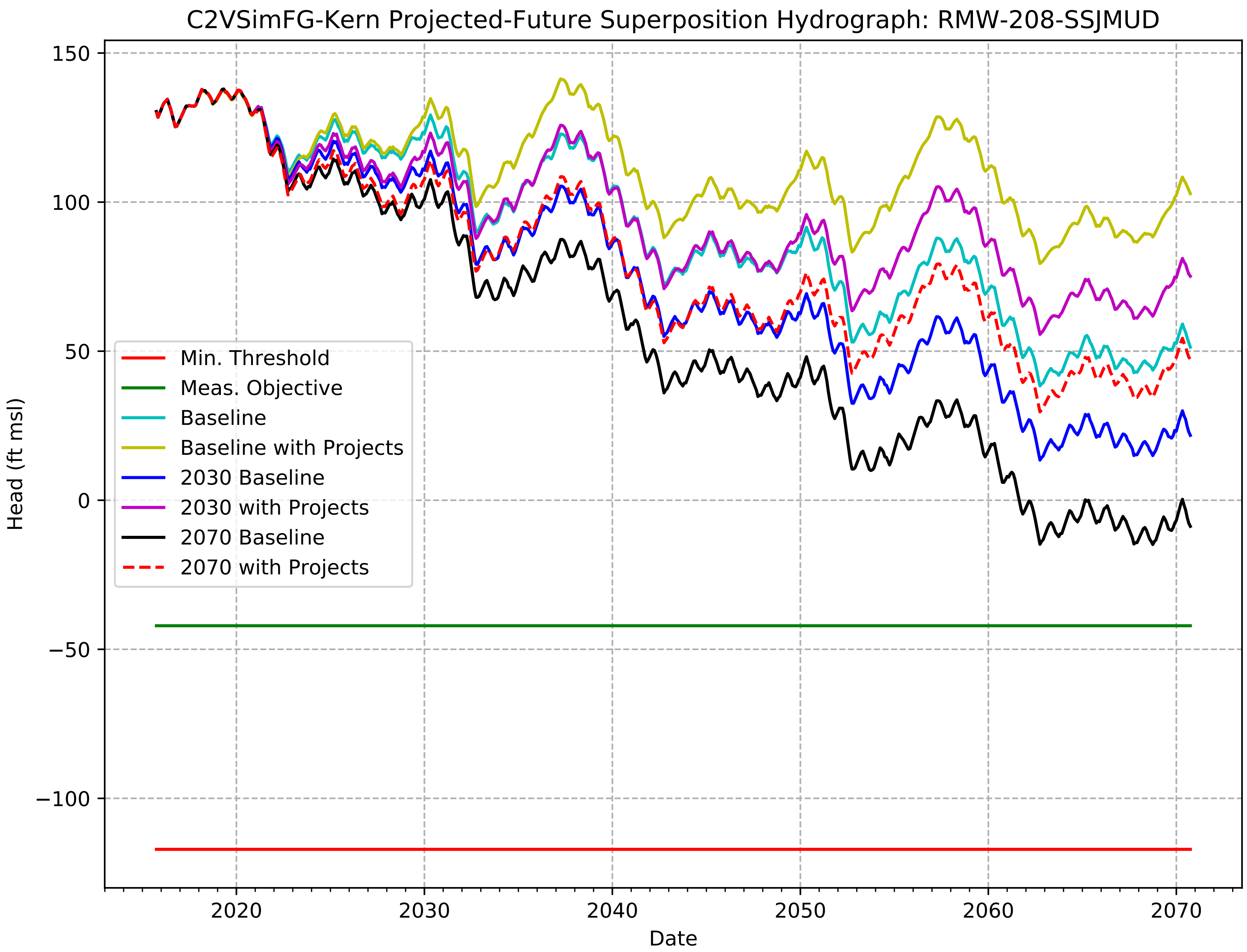

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-205-SWID
Head (ft msl)
25
0
−25
−50
−75
−100
−125
−150
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



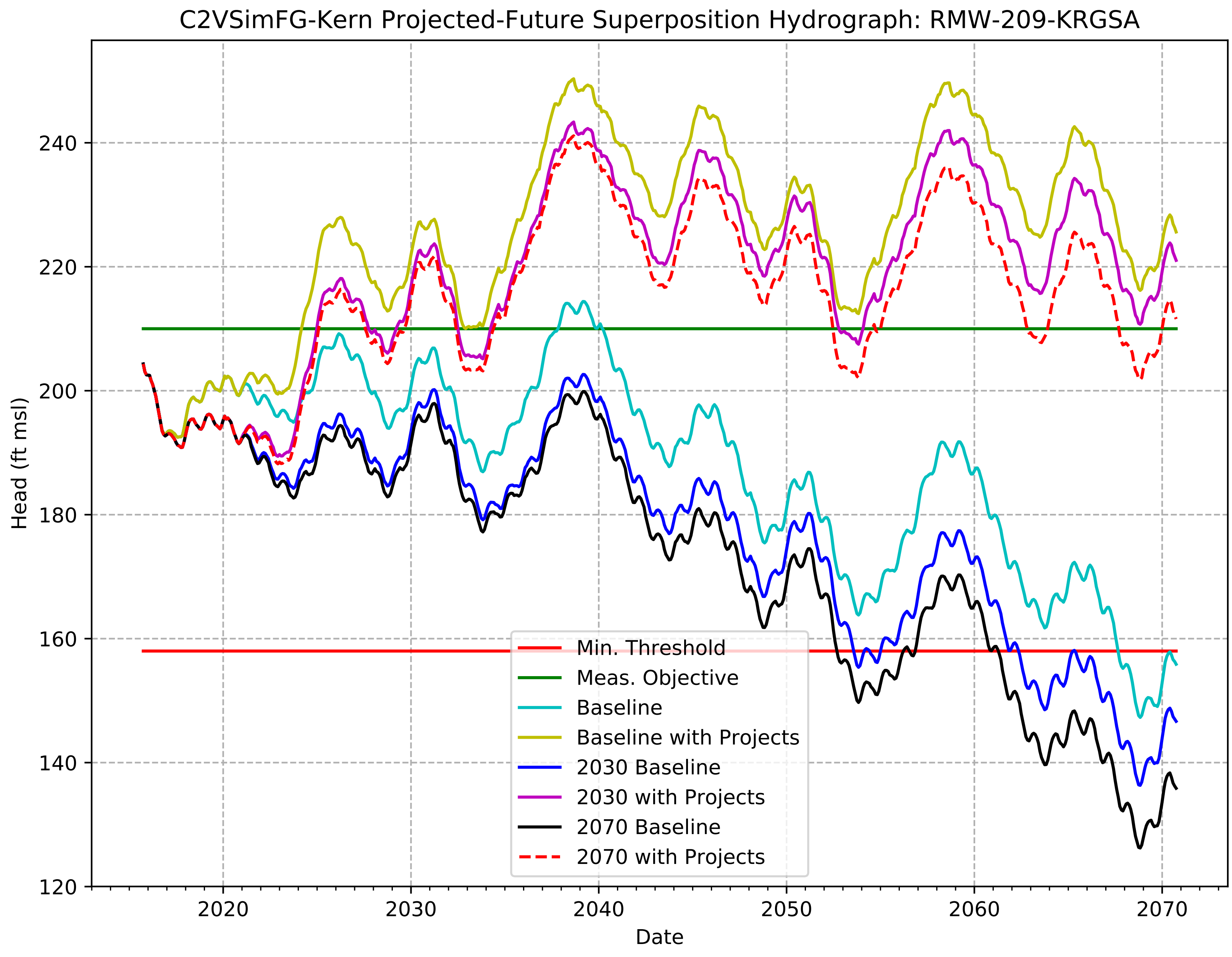
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-206-WDWA
Head (ft msl)
160
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date
Simulated Groundwater Levels in KTWD, EWMA and WDWA of Kern County Subbasin are considered poorly calibrated so that the projected future scenarios using C2VSimFG-Kern do not provide representative groundwater trends in these areas.
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



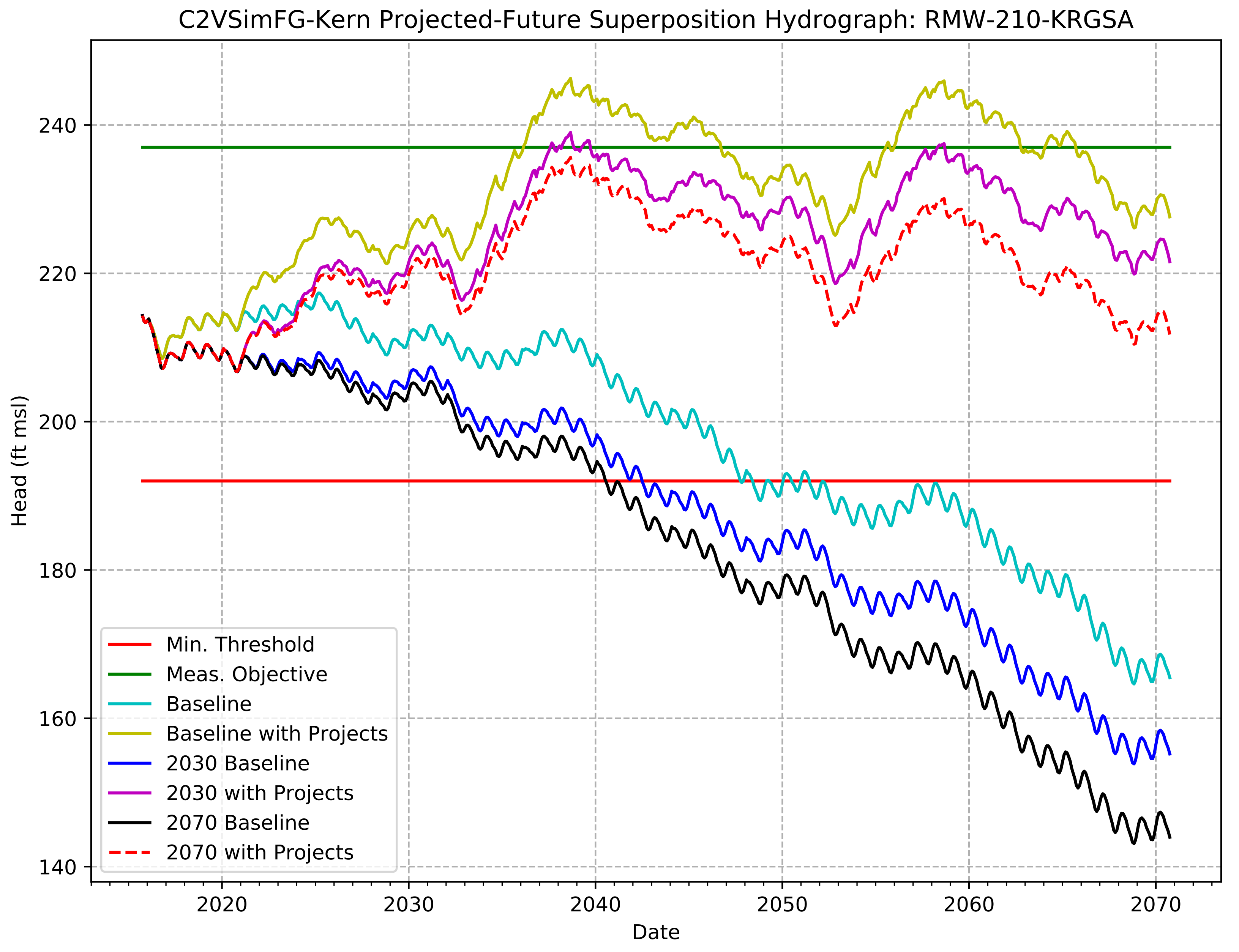
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-207-SWSD
Head (ft msl)
0
−50
−100
−150
−200
−250
−300
−350
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



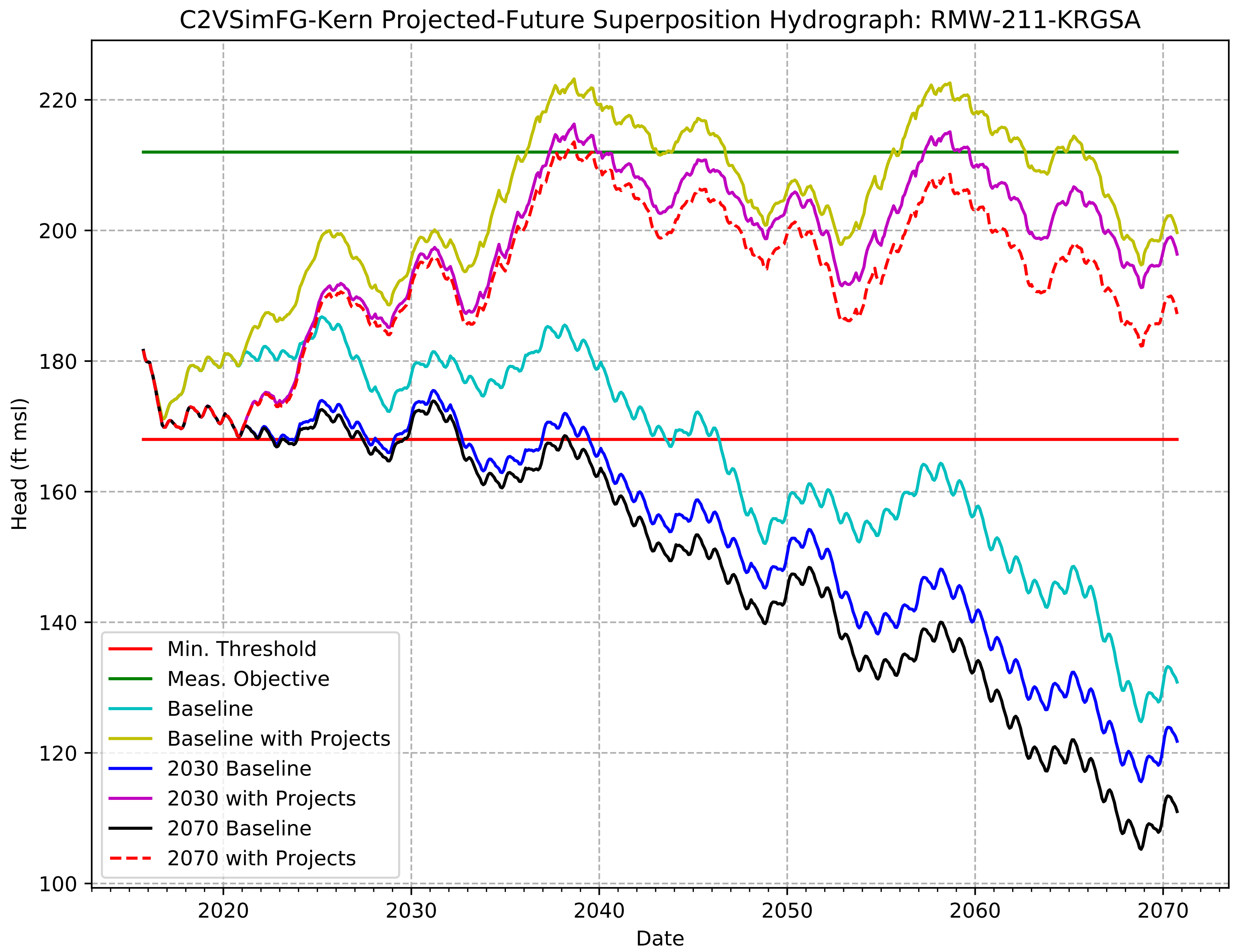
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-208-SSJMUD
Head (ft msl)
150
100
50
0
−50
−100
Date
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

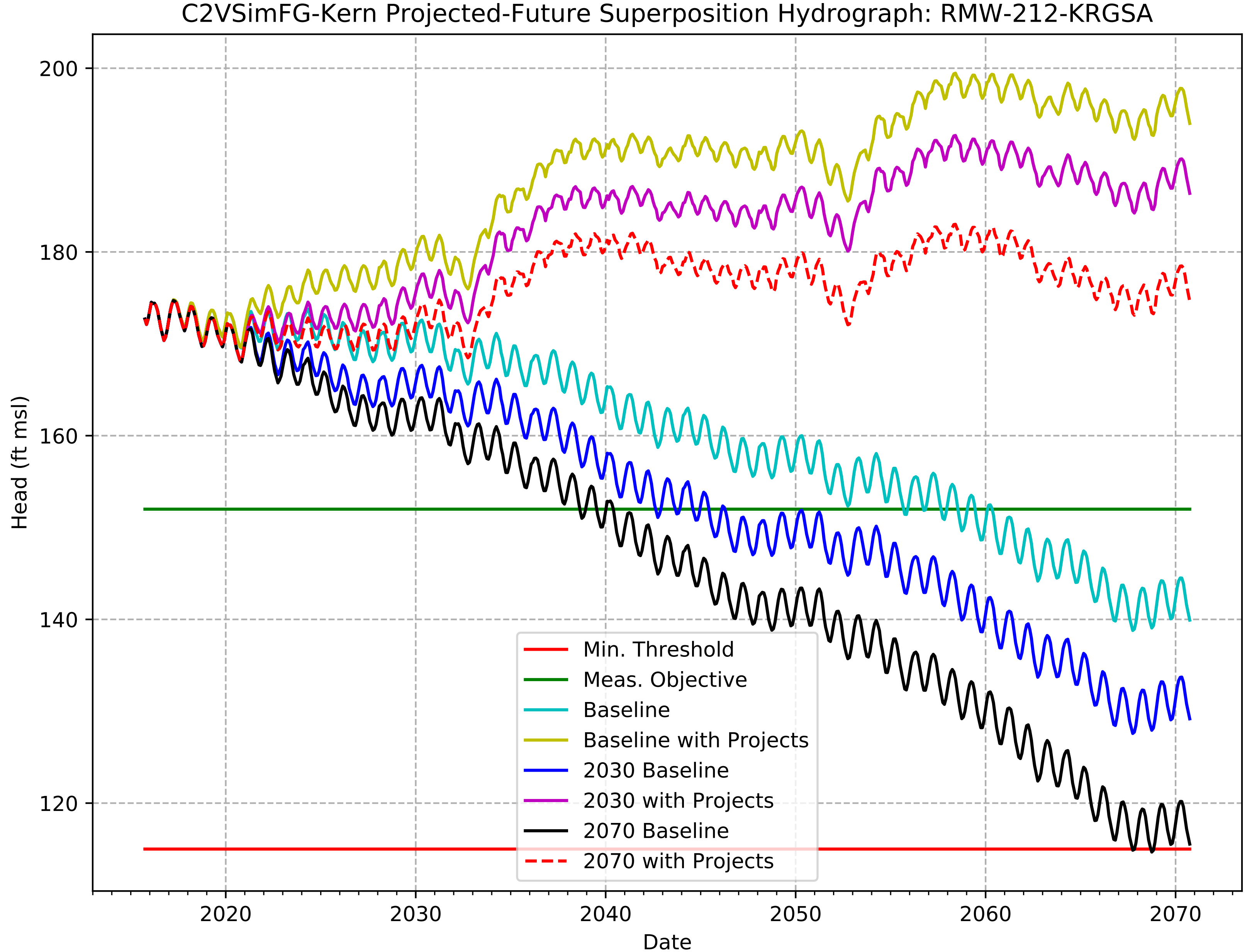


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-209-KRGSA
Head (ft msl)
Date
120
140
160
180
200
220
240
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

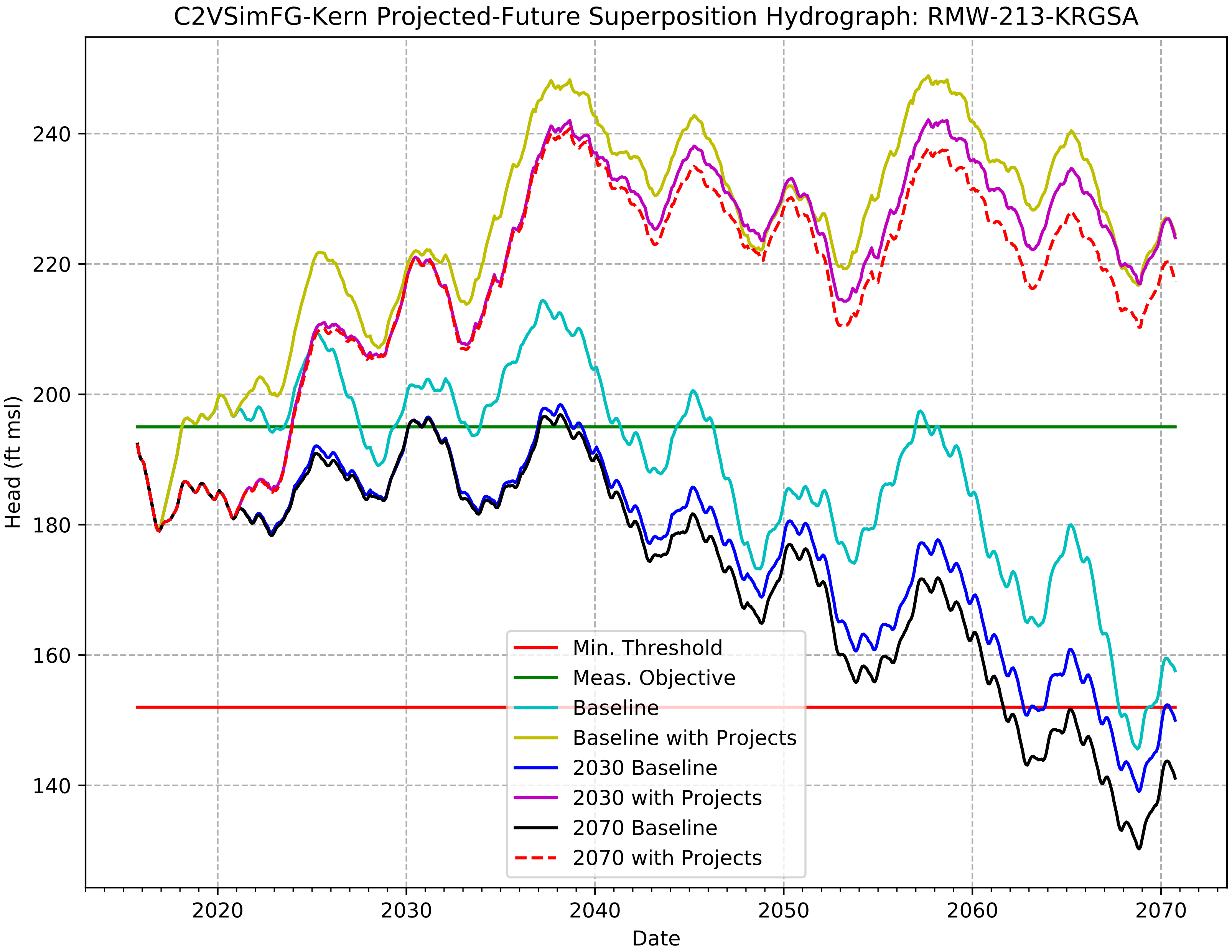


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-210-KRGSA
Head (ft msl)
Date
240
220
200
180
160
140
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

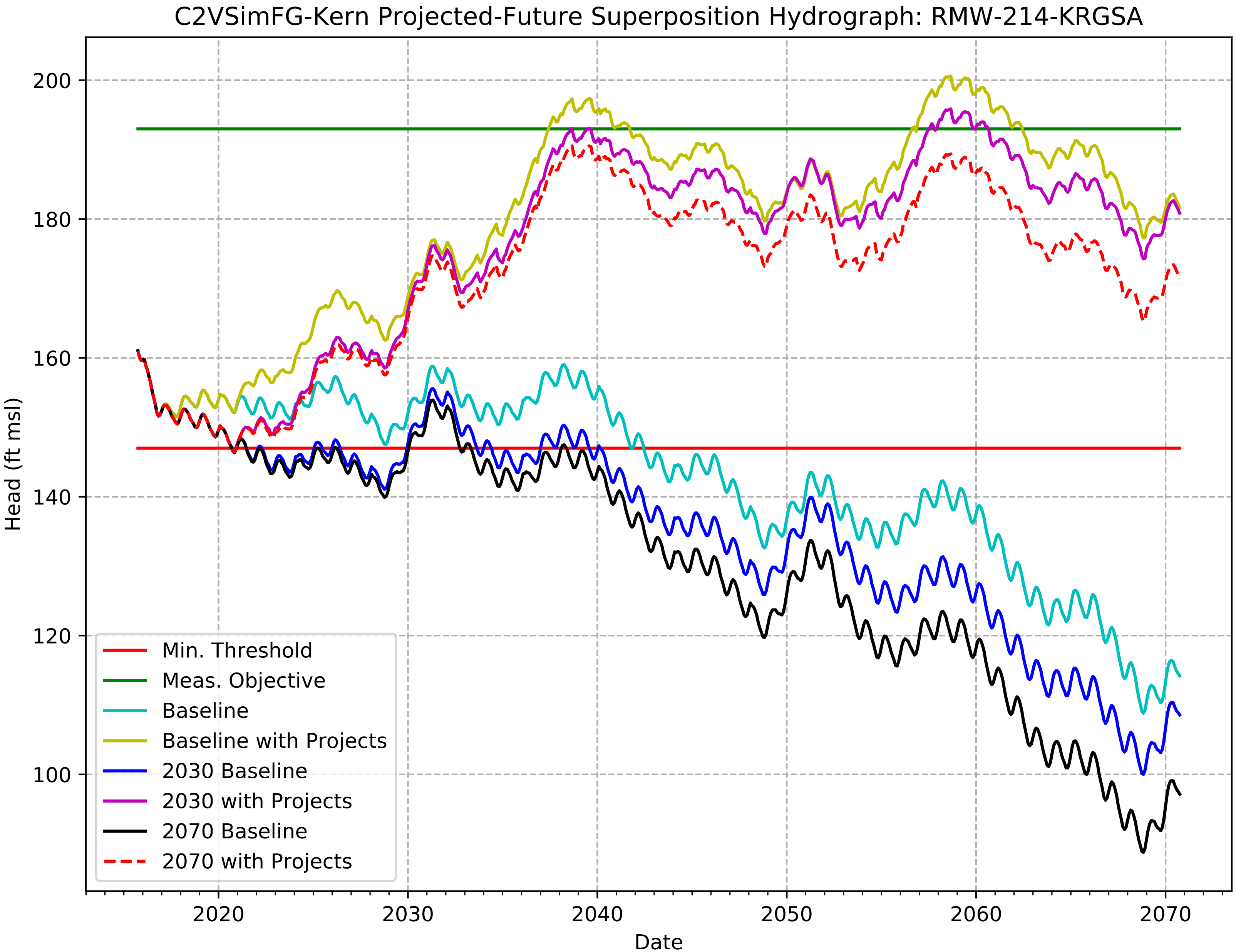

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-211-KRGSA
Head (ft msl)
Date
220
200
180
160
140
120
100
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

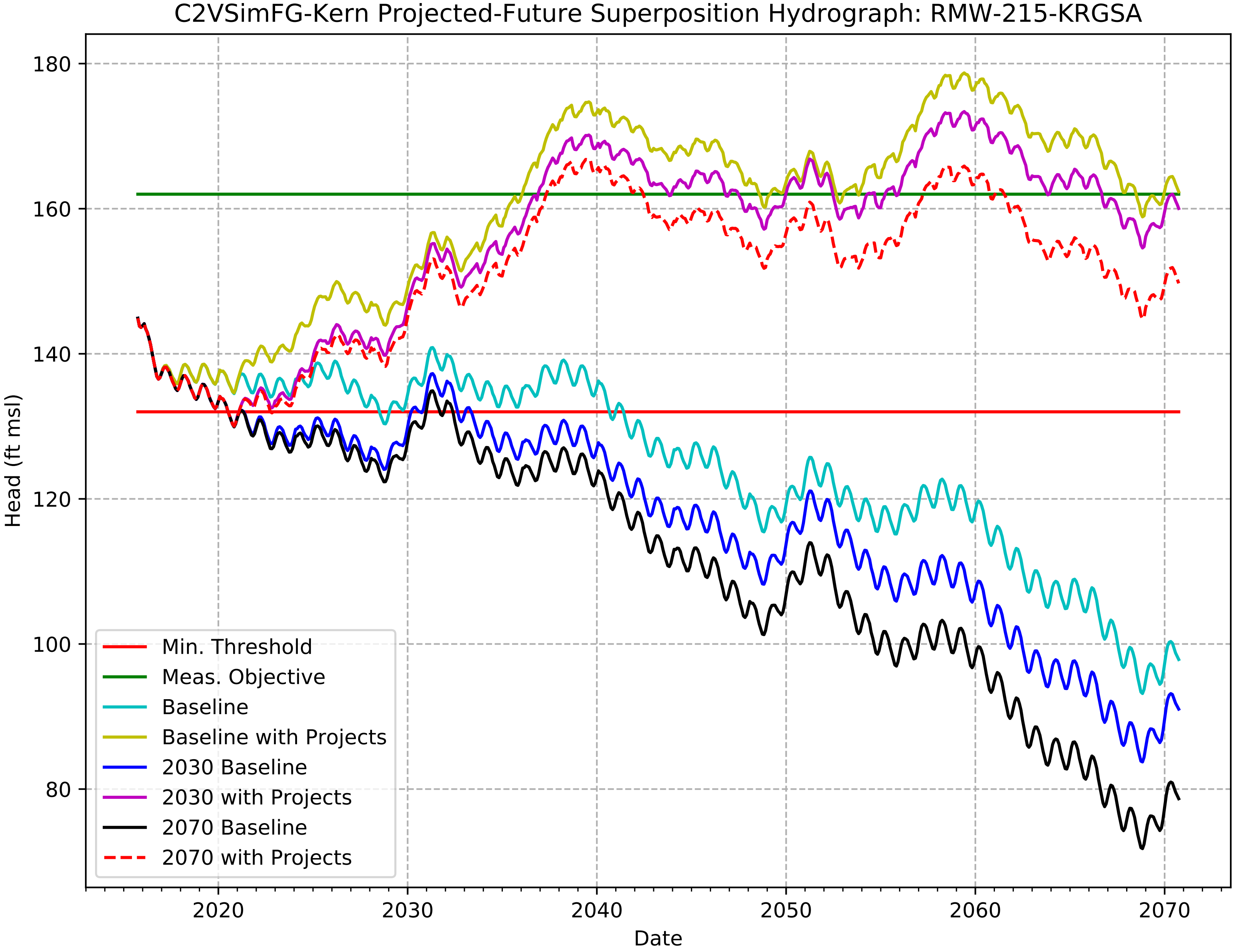


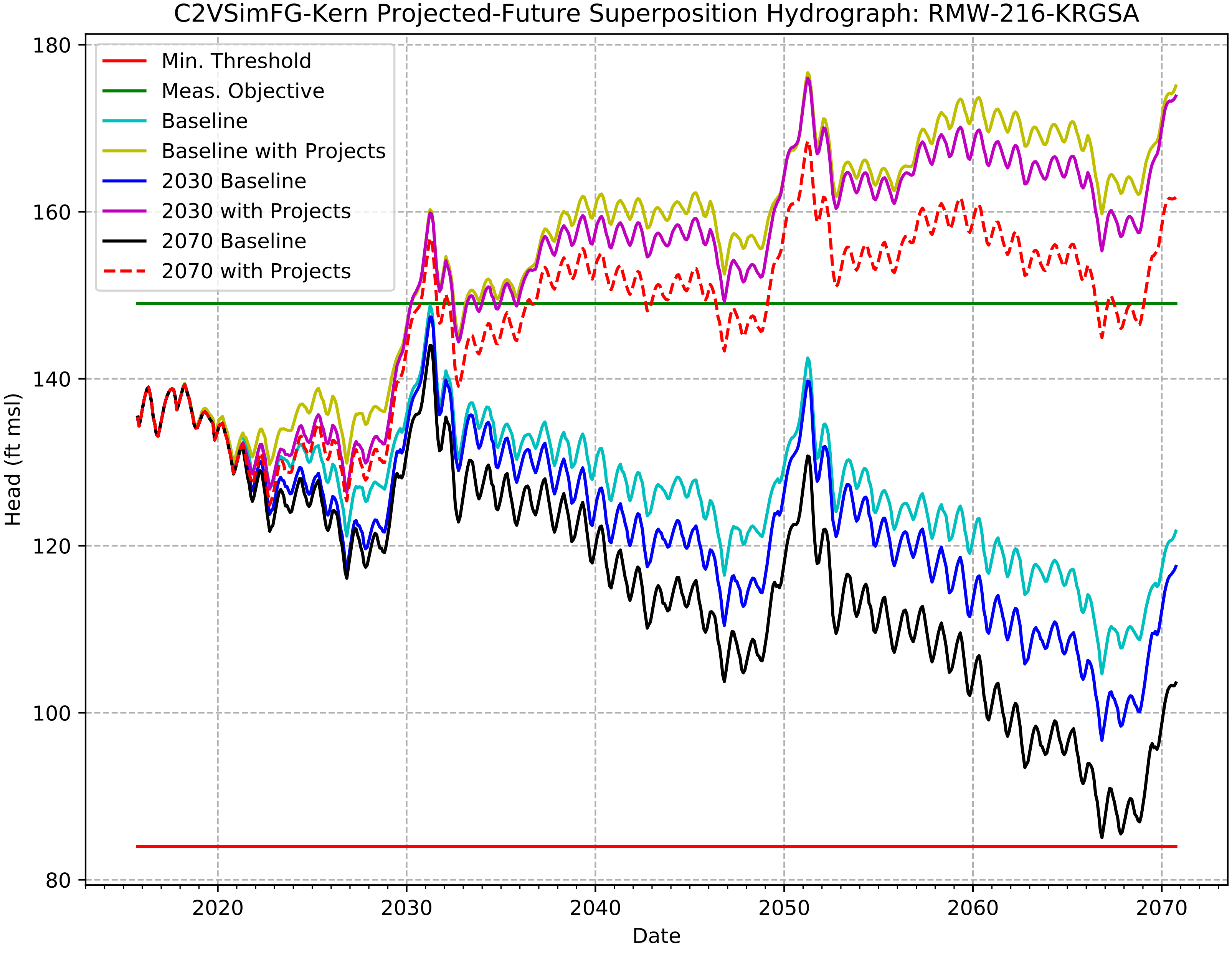
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-212-KRGSA
Head (ft msl)
Date
200
180
160
140
120
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



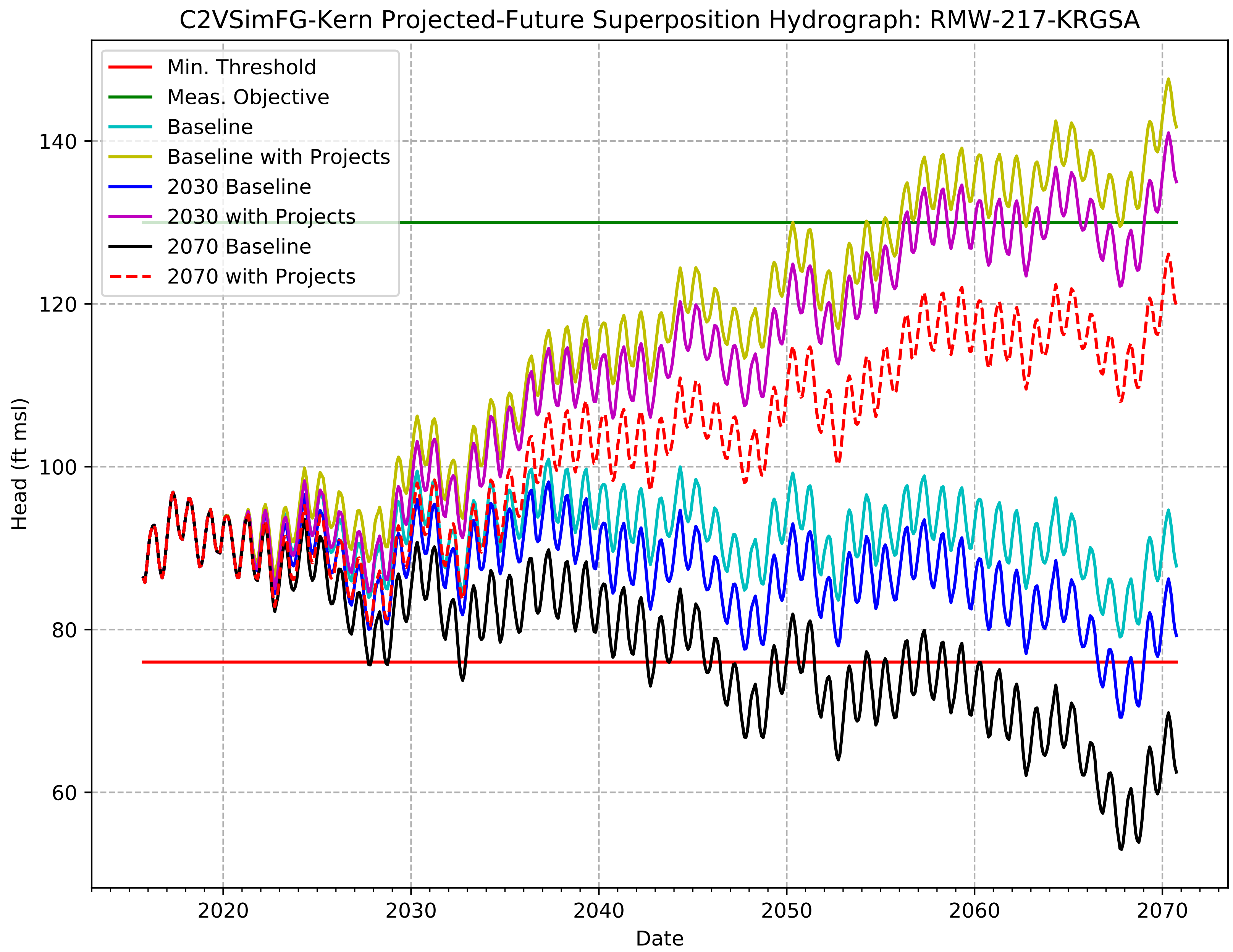
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-213-KRGSA
Head (ft msl)
240
220
200
180
160
140
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

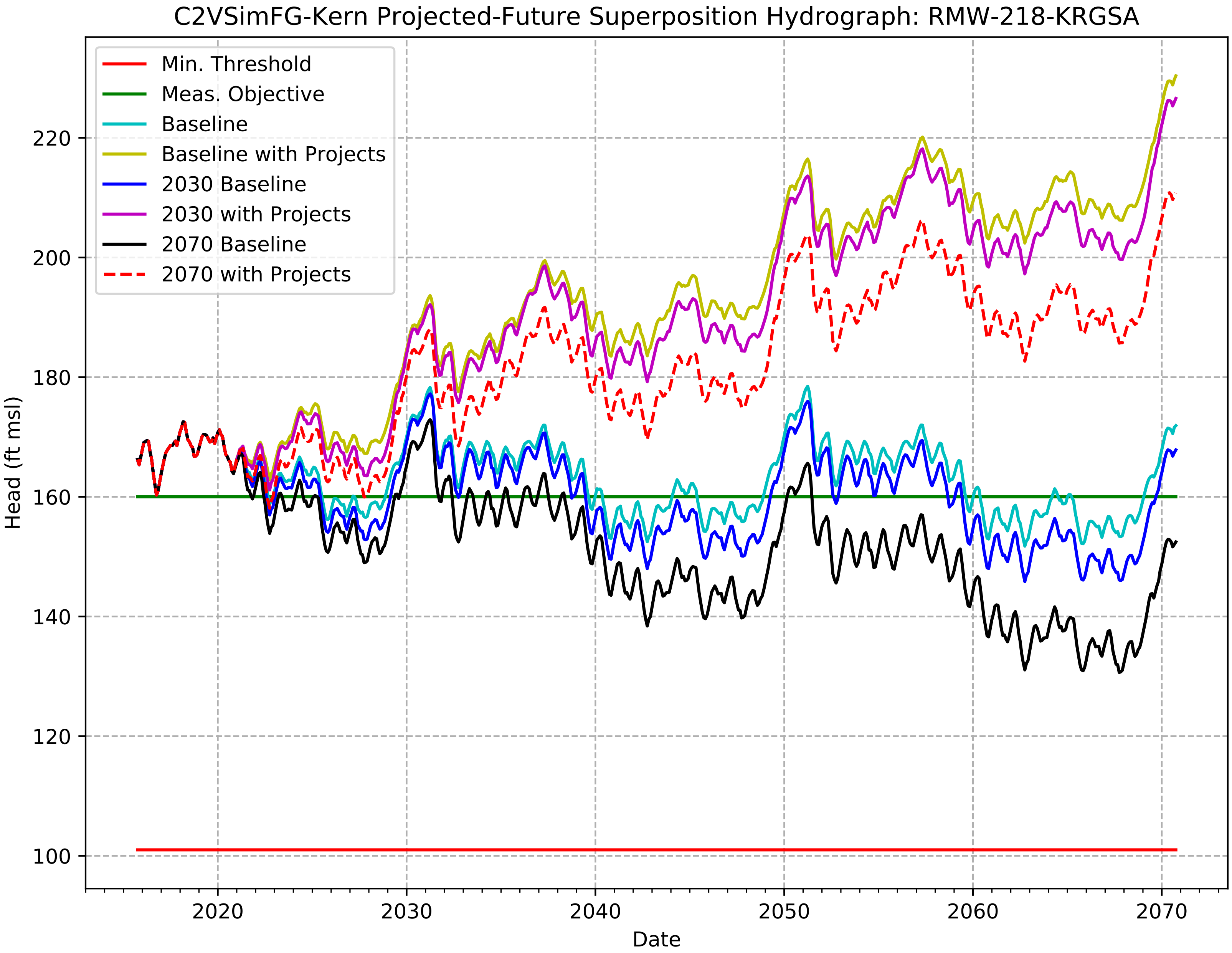

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-214-KRGSA
Head (ft msl)
200
180
160
140
120
100
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-215-KRGSA
Head (ft msl)
180
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

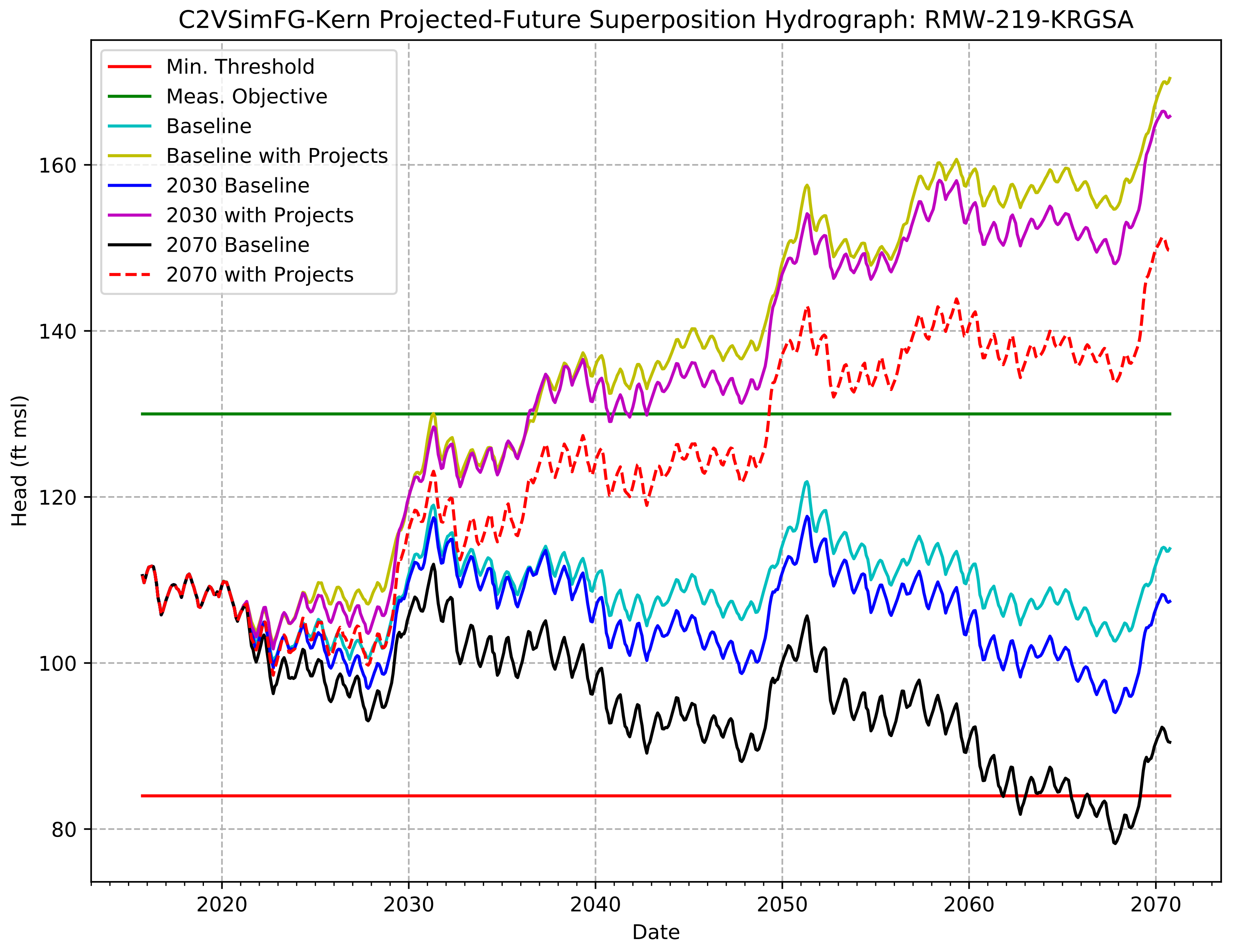


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-216-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
180
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Date

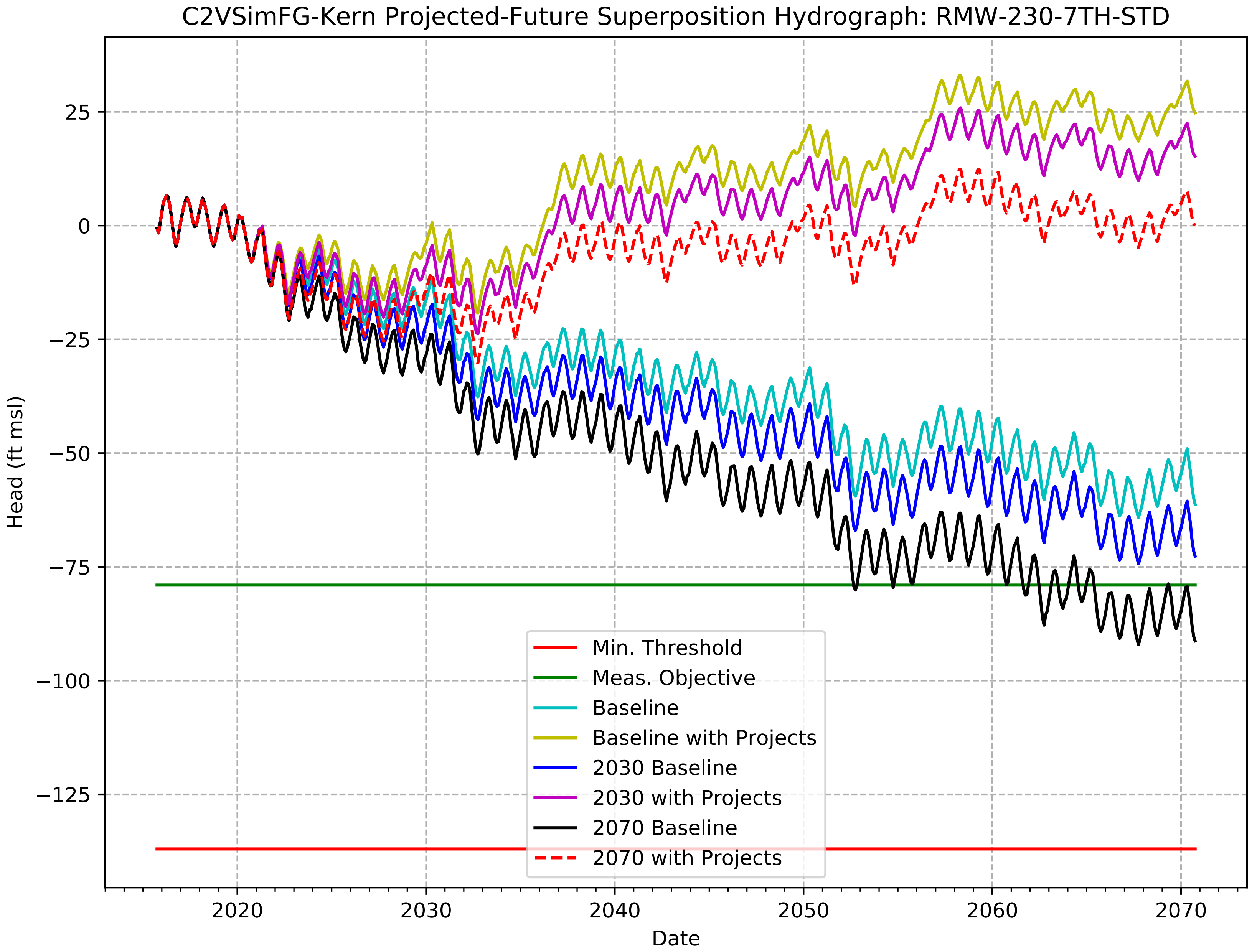

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-217-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
140
120
100
80
60
2020
2030
2040
2050
2060
2070
Date



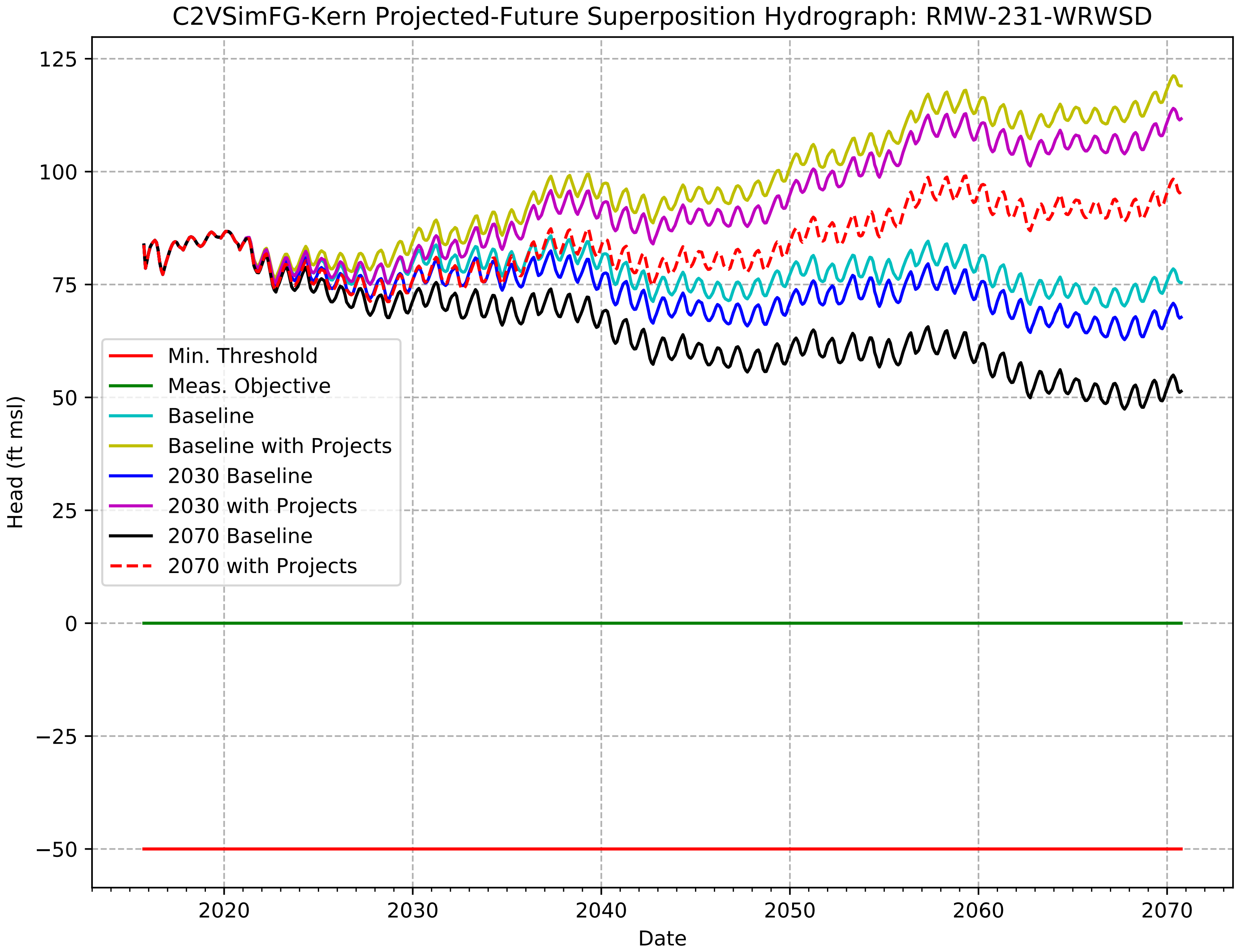
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-218-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
100
120
140
160
180
200
220
2020
2030
2040
2050
2060
2070



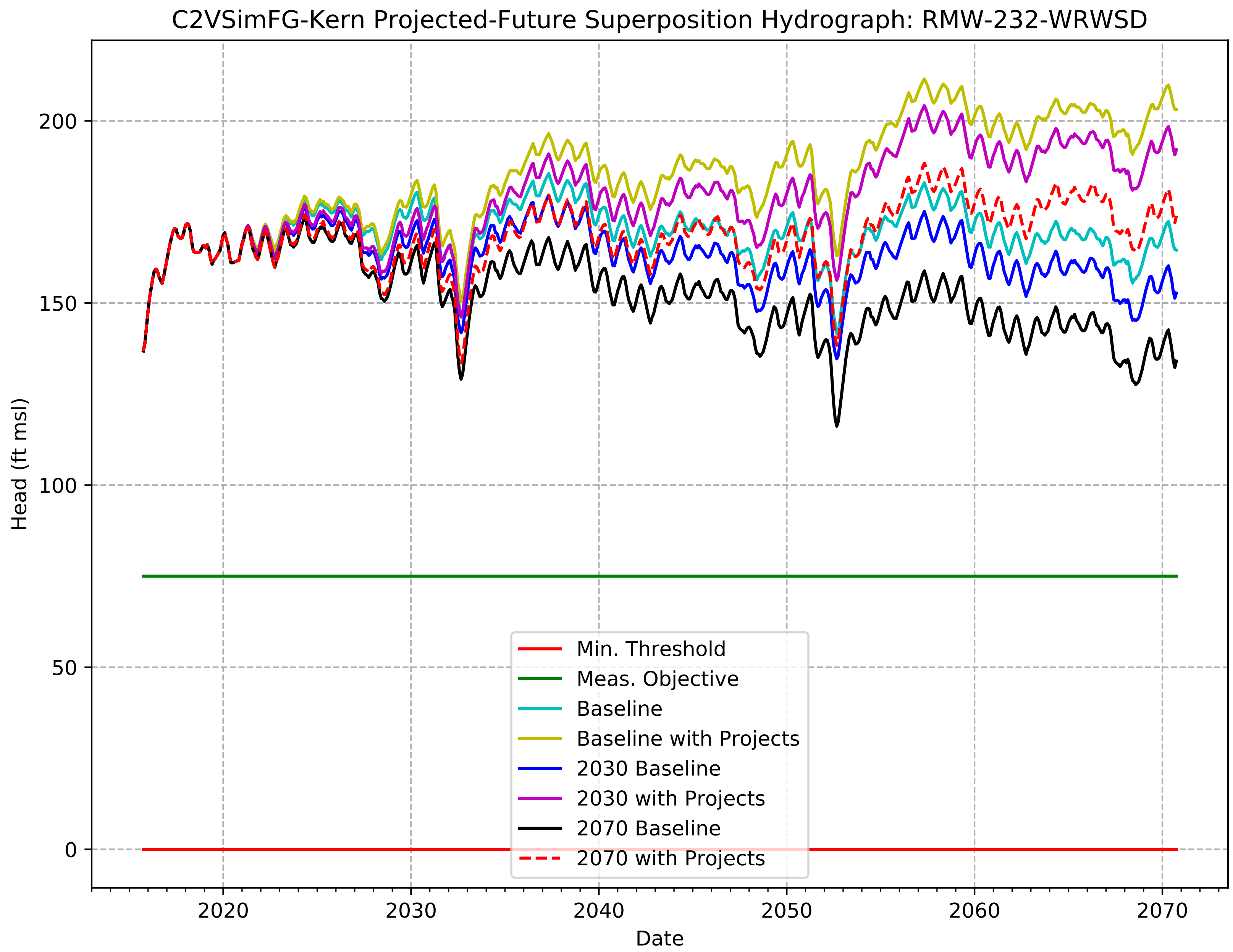
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-219-KRGSA
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
160
140
120
100
80
2020
2030
2040
2050
2060
2070
Date

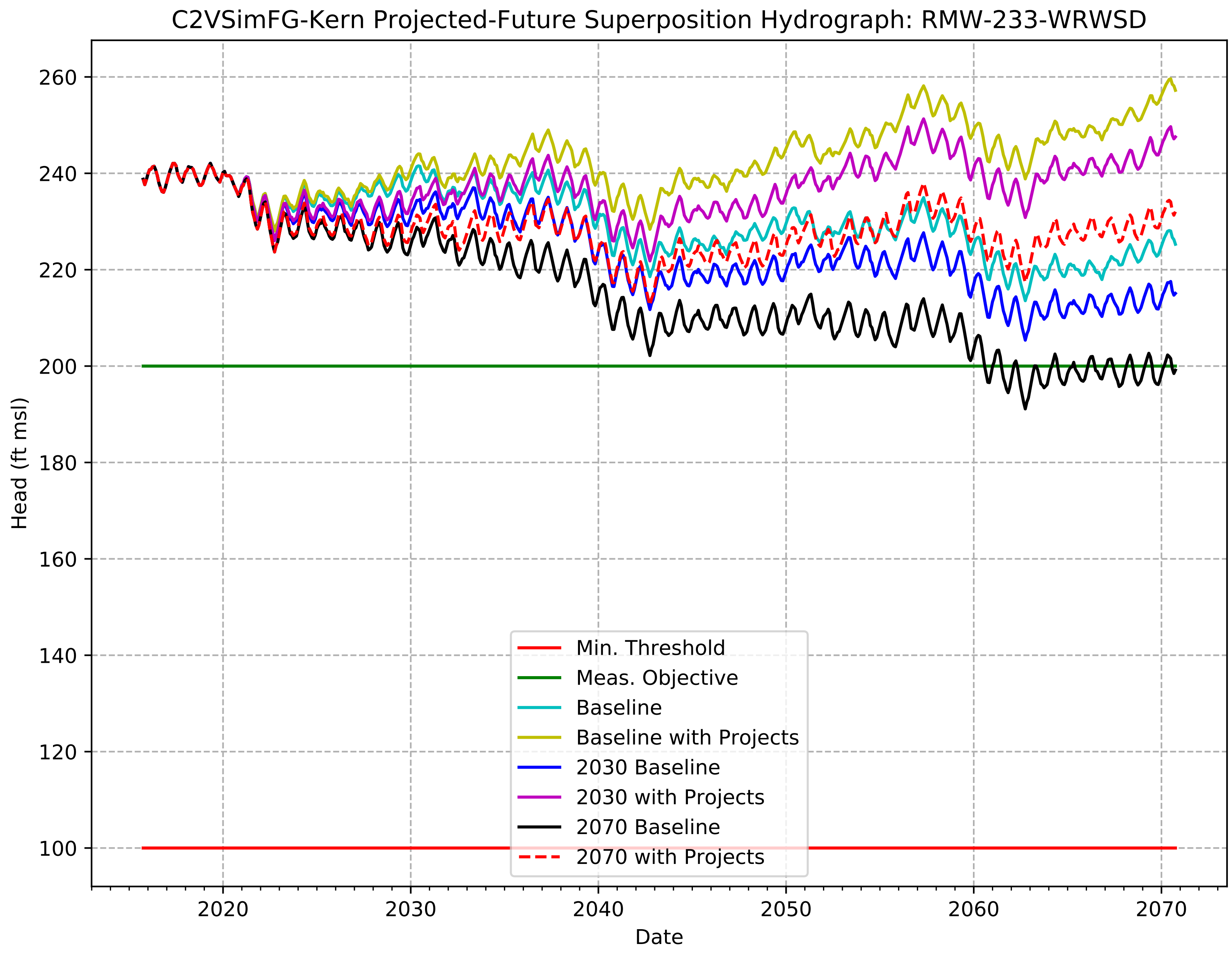


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-230-7TH-STD
Head (ft msl)
25
0
−25
−50
−75
−100
−125
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

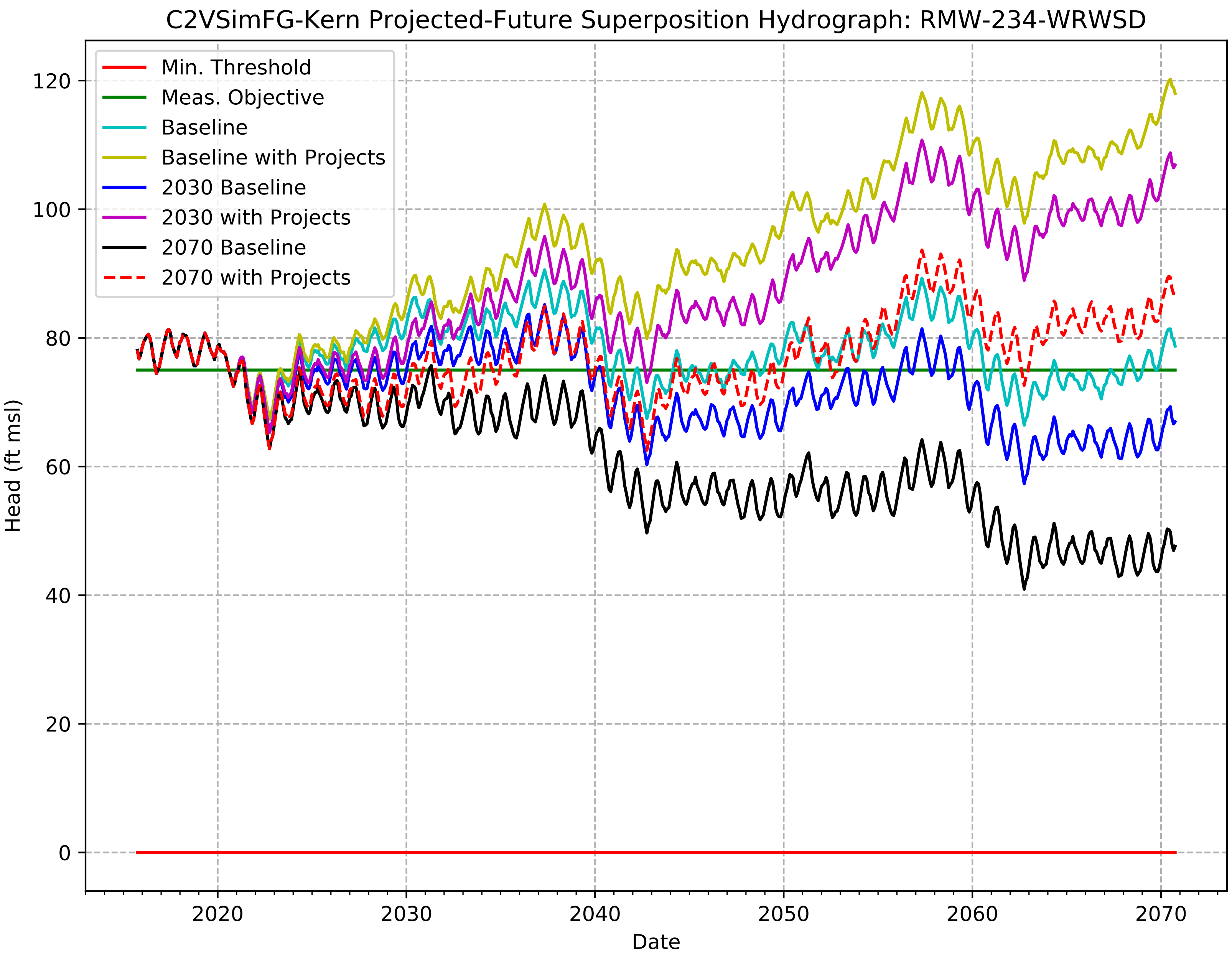


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-231-WRWSD
Head (ft msl)
Date
125
100
75
50
25
0
−25
−50
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

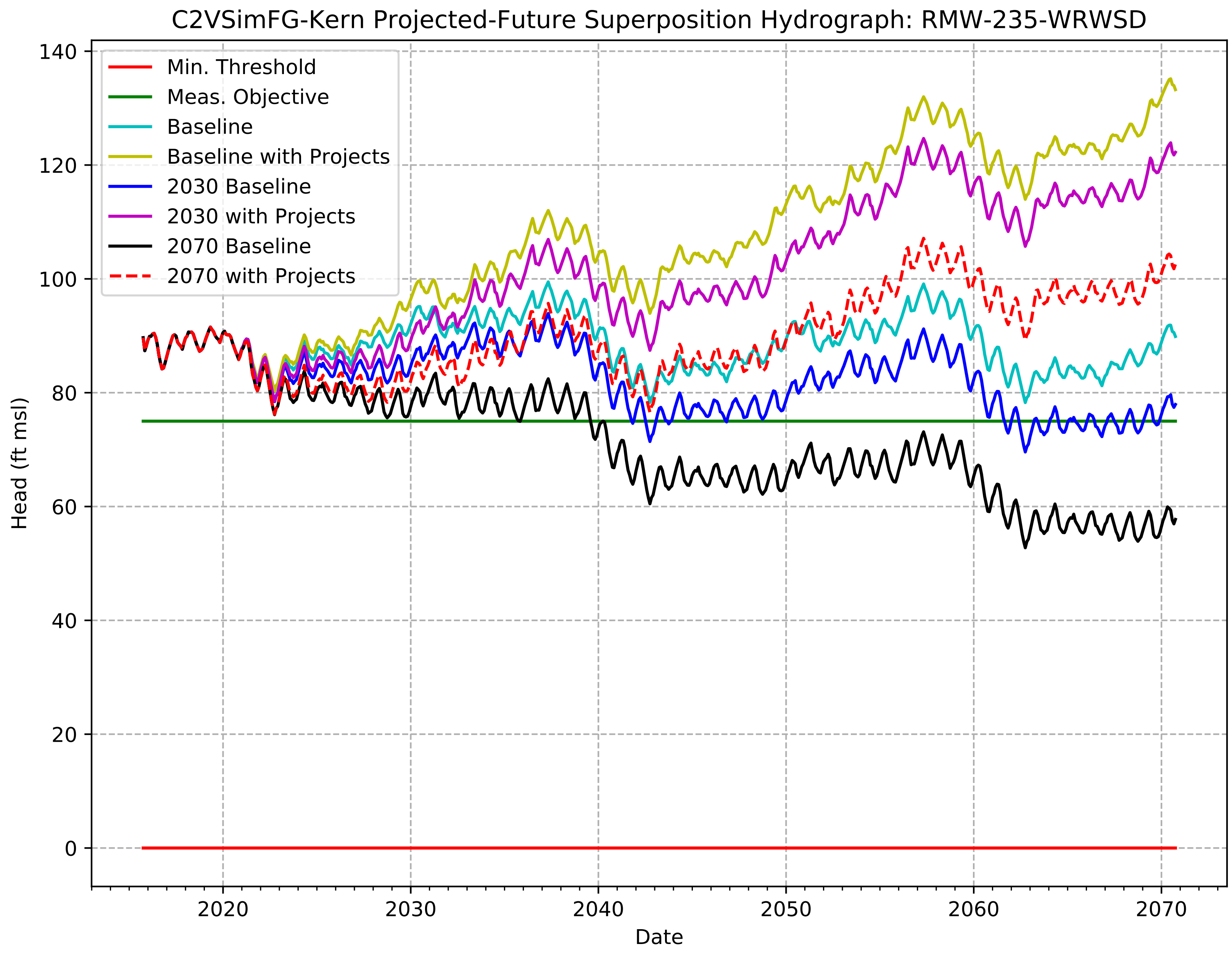

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-232-WRWSD
Head (ft msl)
Date
0
50
100
150
200
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



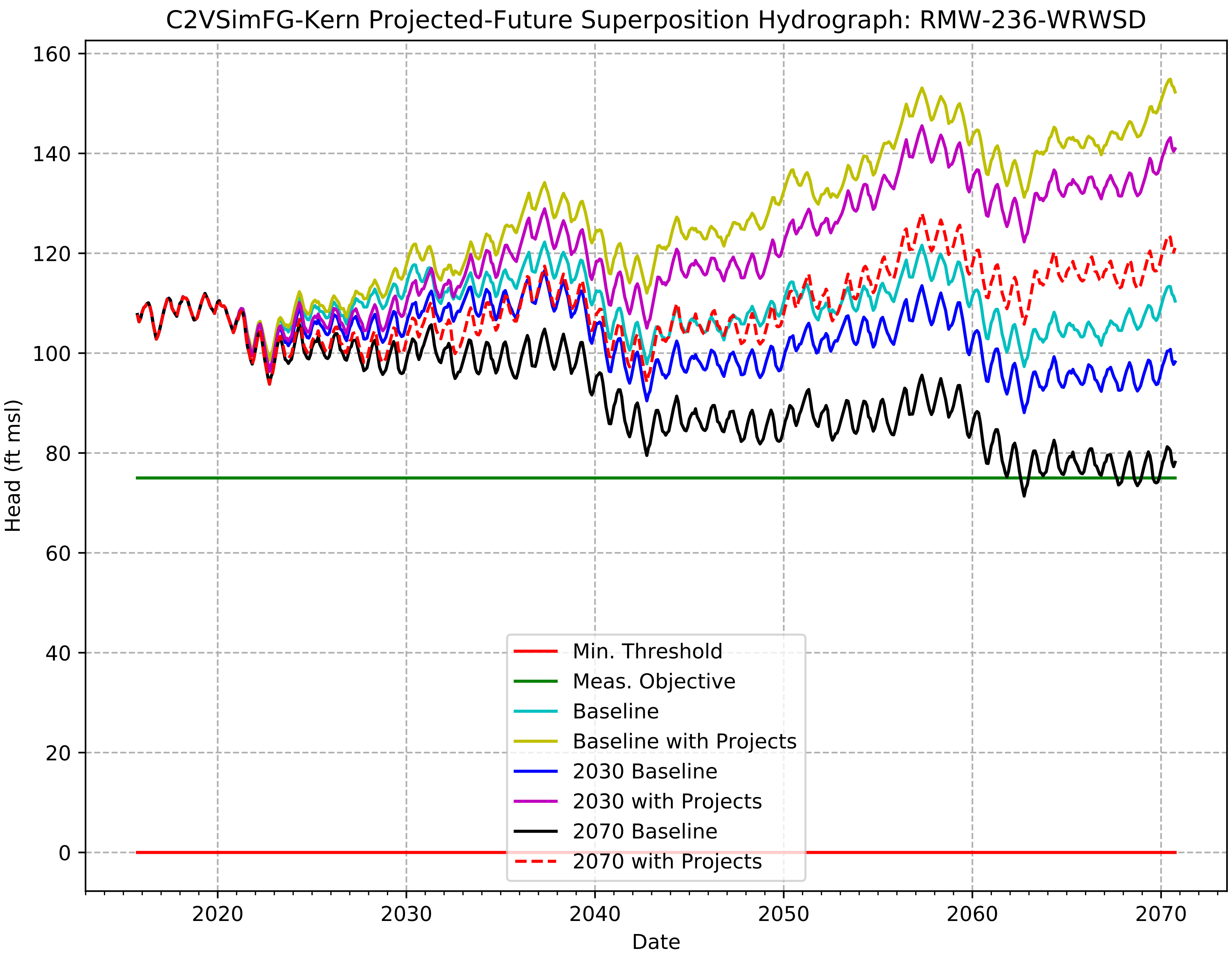
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-233-WRWSD
Head (ft msl)
Date
260
240
220
200
180
160
140
120
100
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



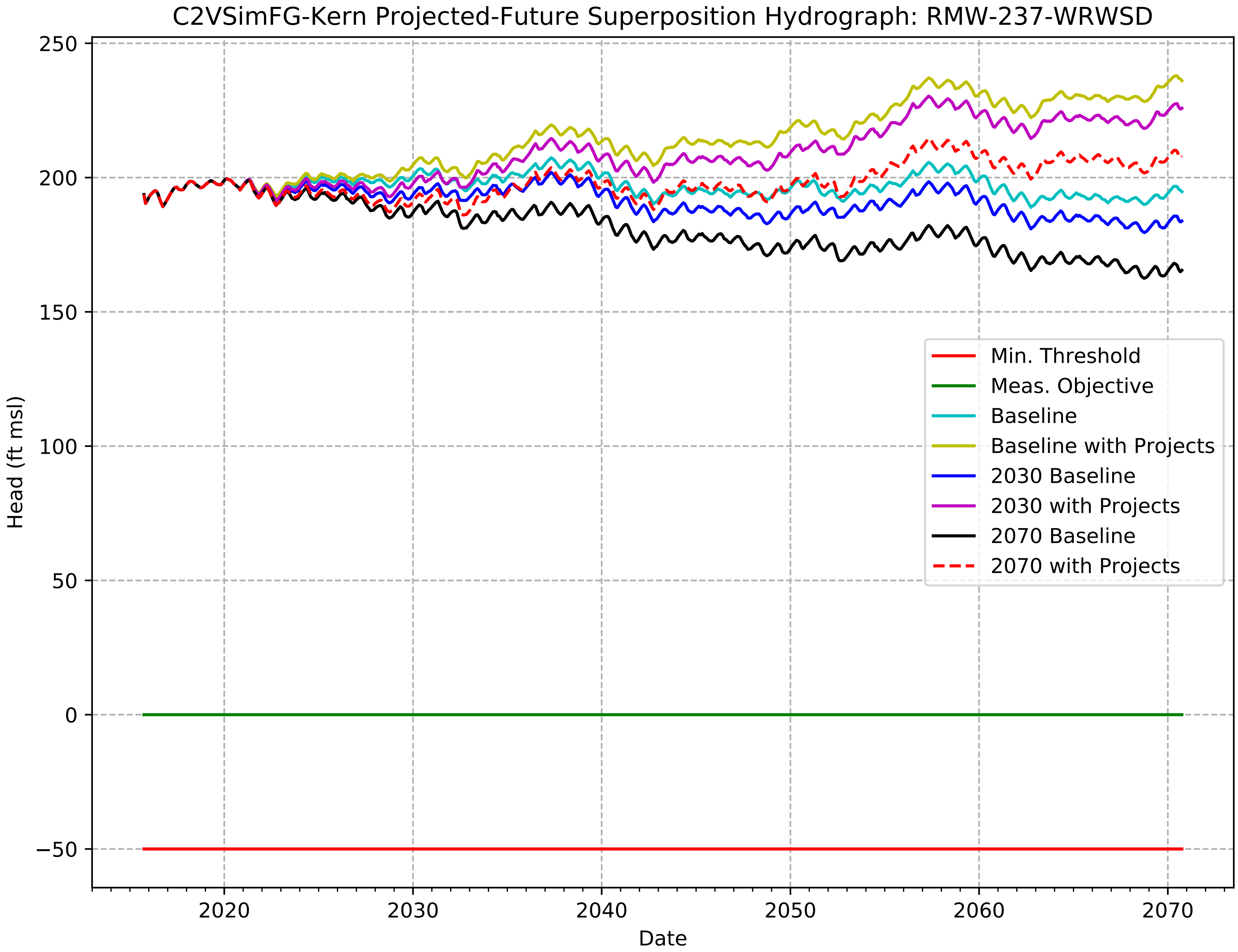
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-234-WRWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
0
20
40
60
80
100
120
2020
2030
2040
2050
2060
2070



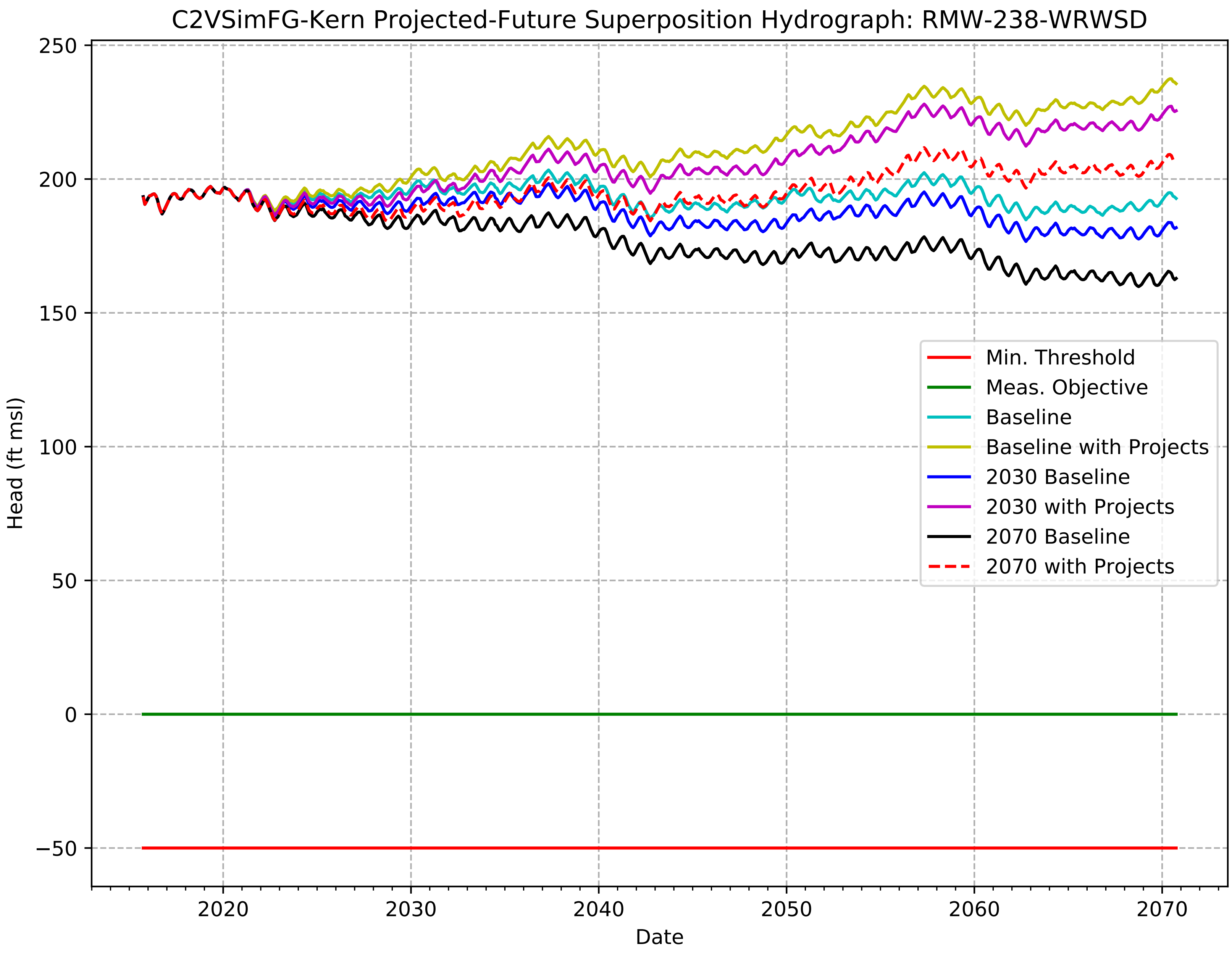
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-235-WRWSD
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects
Head (ft msl)
Date
140
120
100
80
60
40
20
0
2020
2030
2040
2050
2060
2070

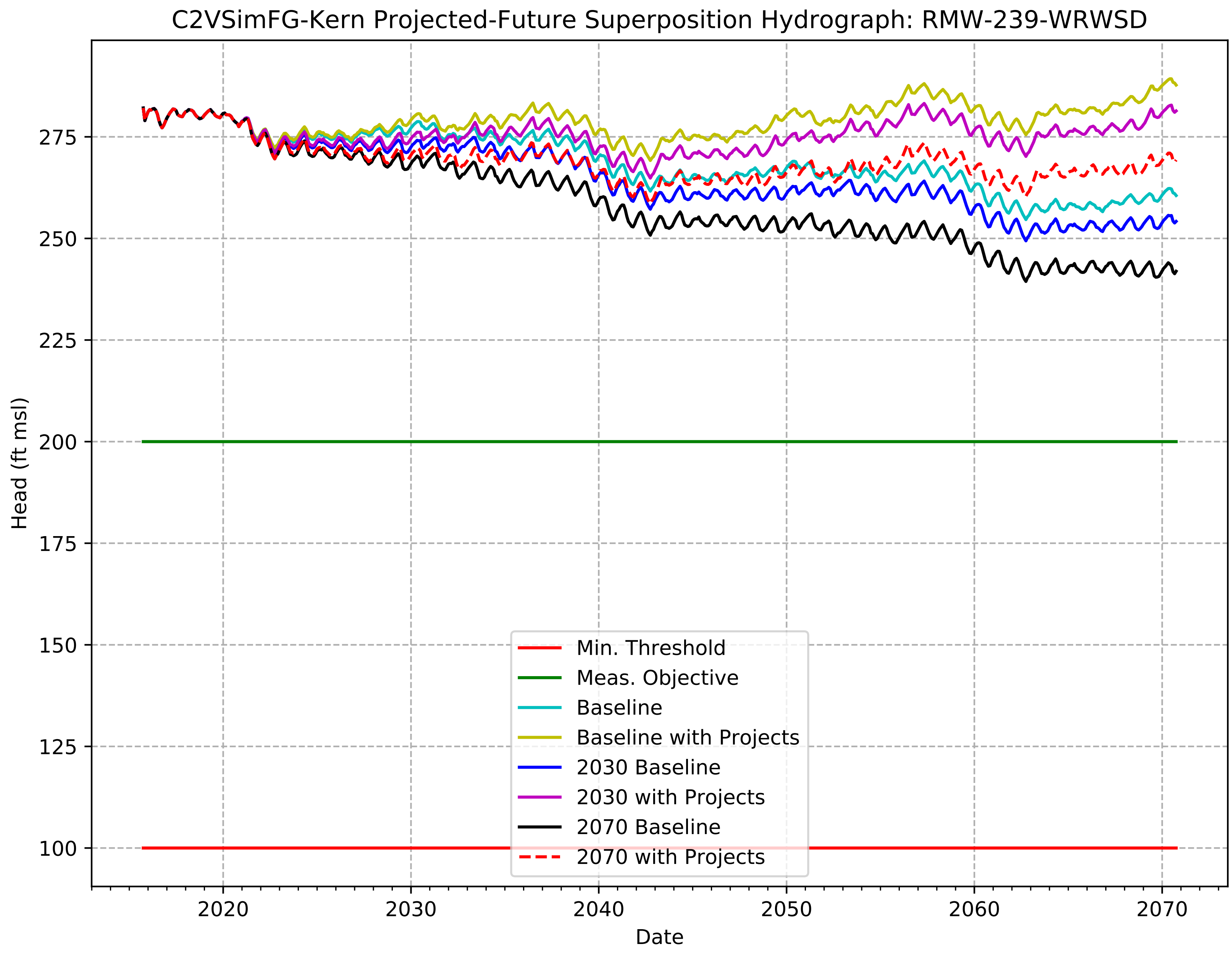


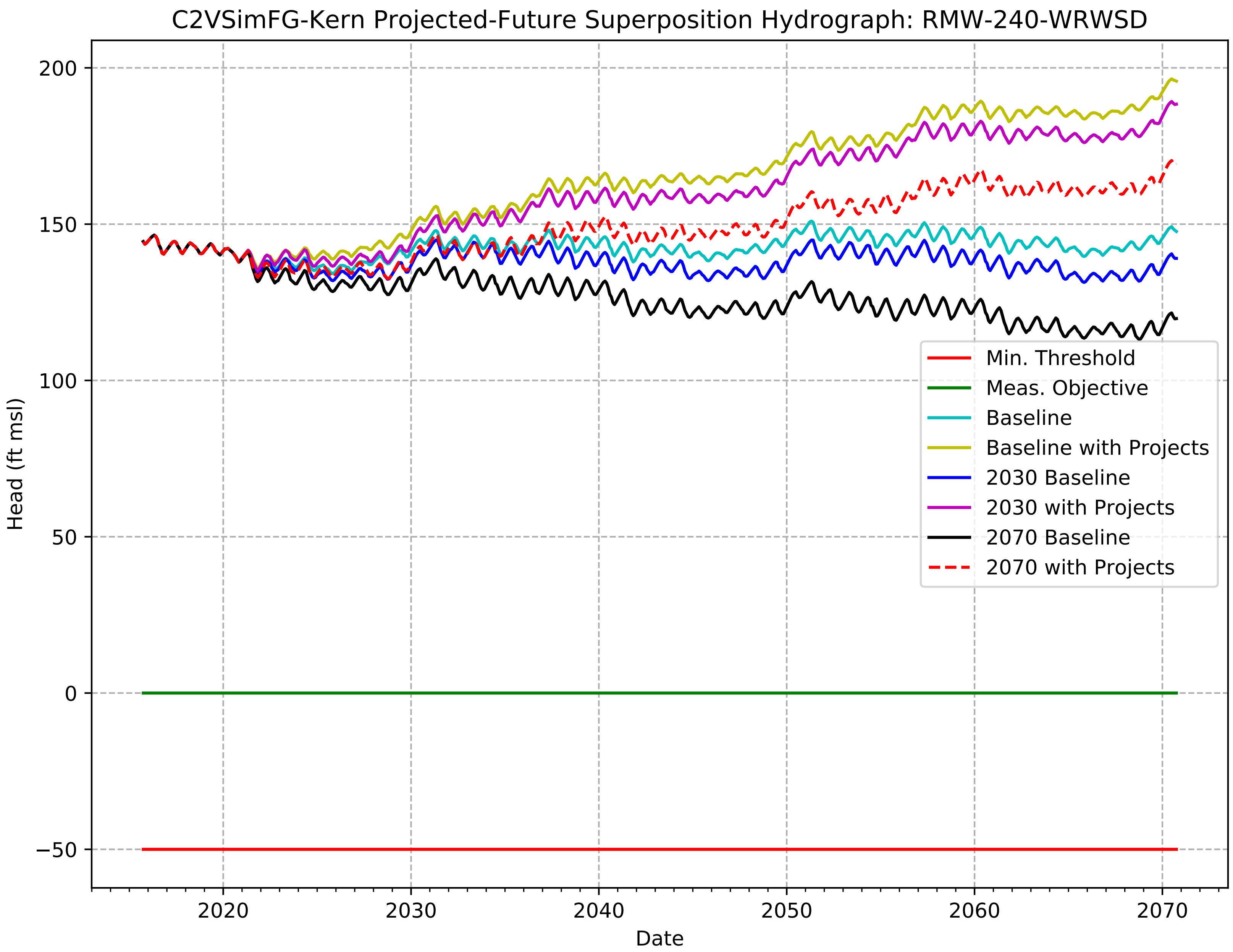
C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-236-WRWSD
Head (ft msl)
Date
0
20
40
60
80
100
120
140
160
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

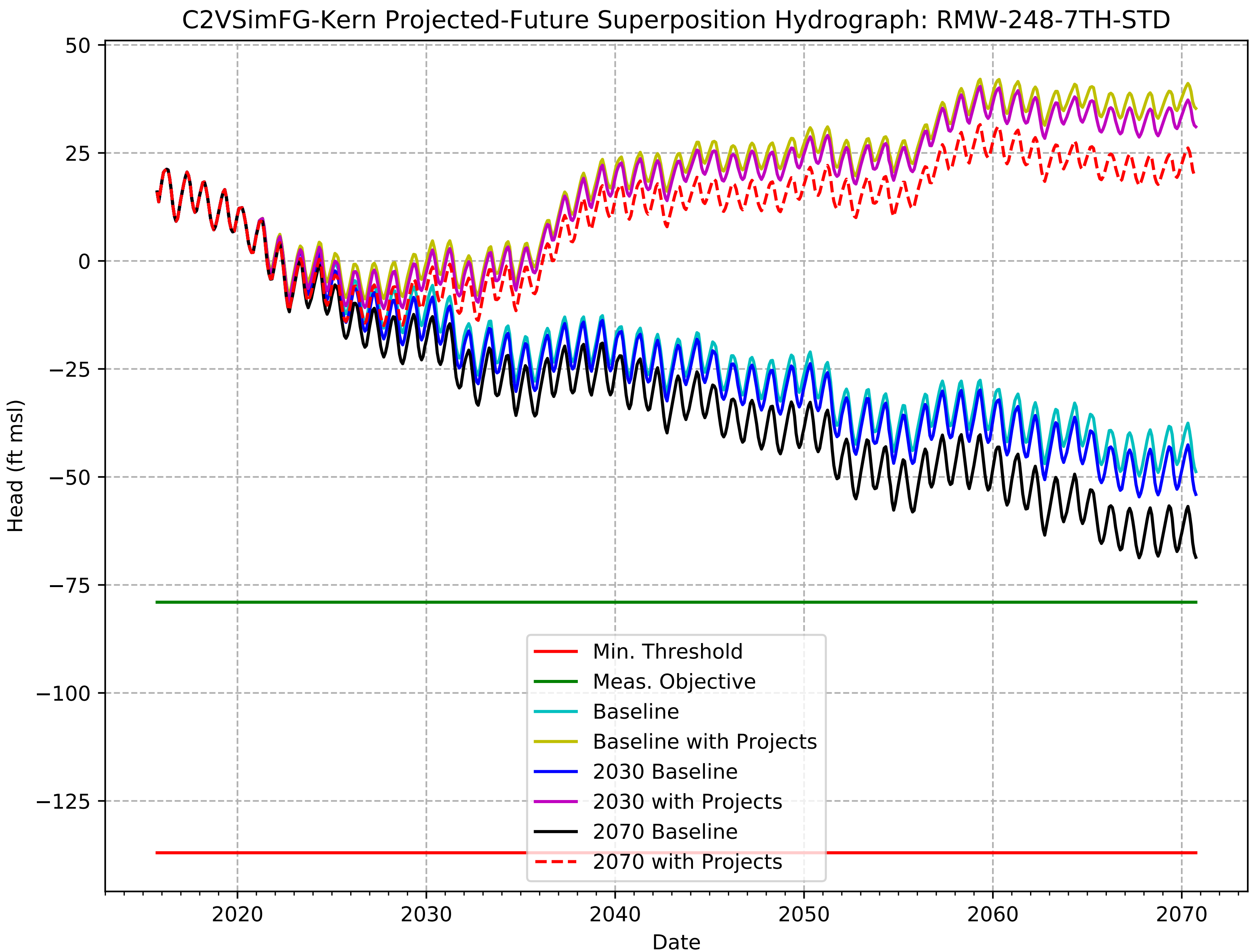


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-237-WRWSD
Head (ft msl)
250
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

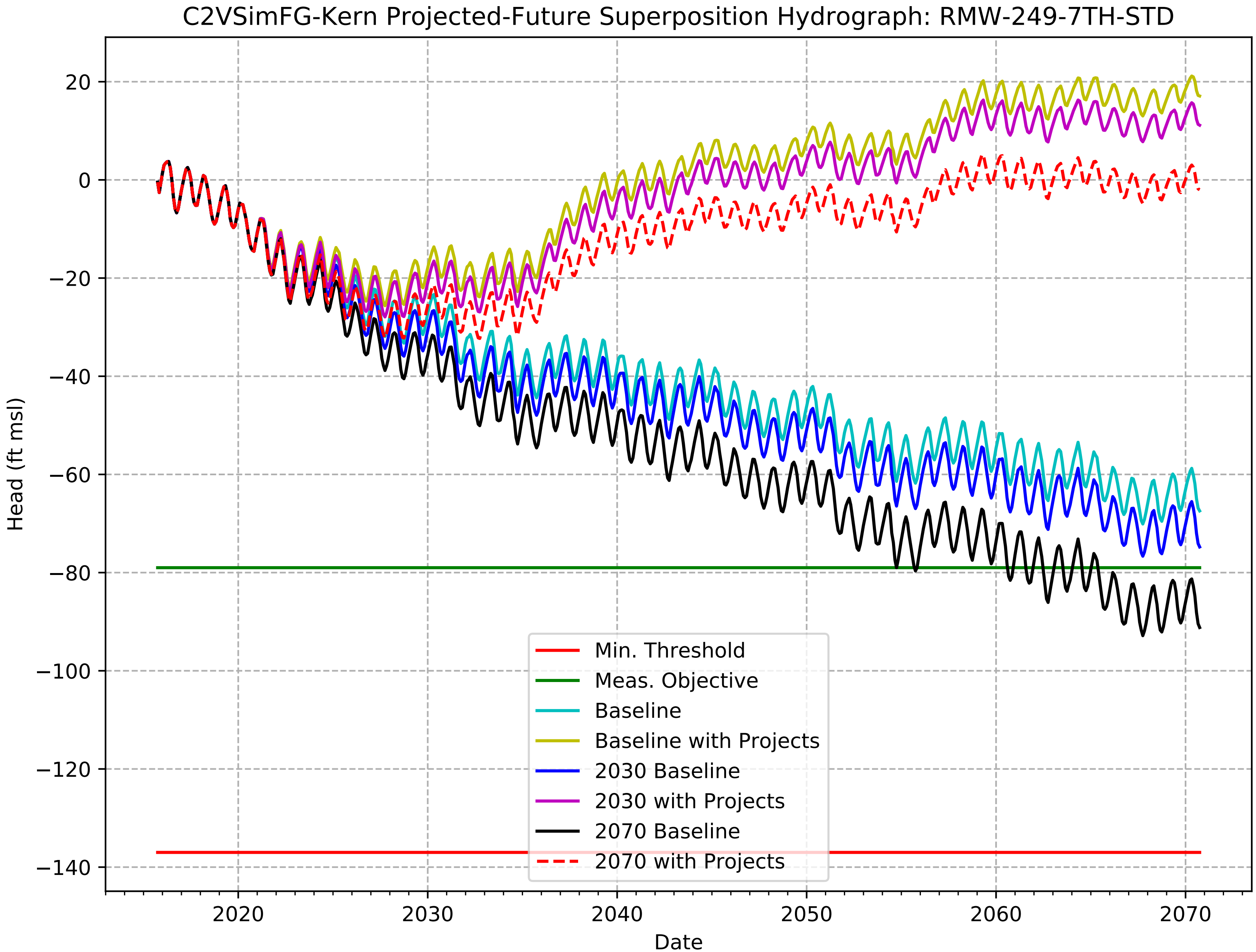

C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-238-WRWSD
Head (ft msl)
250
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-239-WRWSD
Head (ft msl)
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects


C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-240-WRWSD
Head (ft msl)
Date
200
150
100
50
0
−50
2020
2030
2040
2050
2060
2070
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-248-7TH-STD
50
25
0
−25
−50
−75
−100
−125
Head (ft msl)
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects



C2VSimFG-Kern Projected-Future Superposition Hydrograph: RMW-249-7TH-STD
Head (ft msl)
20
0
−20
−40
−60
−80
−100
−120
−140
2020
2030
2040
2050
2060
2070
Date
Min. Threshold
Meas. Objective
Baseline
Baseline with Projects
2030 Baseline
2030 with Projects
2070 Baseline
2070 with Projects

BASELINE CONDITIONS

ENTITY	TOTAL DEMAND	TOTAL WATER SUPPLY	NET WATER BUDGET
Kern Groundwater Authority	1,939,409	1,683,128	-256,281
Henry Miller GSA	40,884	35,791	-5,093
Olcese Water District GSA	2,650	3,202	552
Kern River GSA	305,310	276,157	-29,153
Kern River GSA - App. K Properties	1,308		-1,308
Buena Vista GSA	103,950	126,936	22,986
Non-districted lands*	18,013		-18,013
Totals	2,411,524	2,125,214	**-286,310**

Todd Groundwater Modeling Result for Baseline Condition: -324,326

Todd Groundwater Modeling Result for Historical Change in Groundwater in Storage: -277,114

***Most of the irrigated non-districted lands are now being managed/covered under SGMA by the GSAs**

The Kern County Subbasin GSAs have collaboratively developed the above water budget table to present an inventory of supply and demand using a "checkbook approach". The checkbook approach provides a mechanism for coordinated water accounting among the GSAs and does not include subsurface flows. The table was used to examine local water budget conditions and to prevent double-counting of water supplies. Although developed separately from the C2VSimFG-Kern model, the sum of the water budget deficits compares relatively well with model results; model deficits shown at the bottom of the table are larger due to inclusion of Subbasin subsurface outflows, which are not included in the checkbook approach.

APPENDIX 3

Undesirable Results Definitions

Introduction:

- **Management areas shall be identified by the basin and shown on exhibit "A".**
- **Representative Monitoring Locations shall mean the locations within the basin which are identified and designated by the GSA's for purposes of monitoring sustainability indicators.**
- **Critical Infrastructure shall mean facilities which are utilized to provide public services such as water, utilities, and or transportation service for a region.**
- **Prolonged Drought – The undesirable results herein take into account the accommodation of a prolonged drought as defined in DWR's BMP.**

Chronic Lowering of Water Levels –
The point at which significant and unreasonable impacts over the planning and implementation horizon, as determined by depth/elevation of water, affect the reasonable and beneficial use of, and access to, groundwater by overlying users.

This is determined when the minimum threshold for groundwater levels are exceeded in at least three(3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by each Management Area). Minimum thresholds shall be set by each of the management areas through their respective Groundwater Sustainability Plans.

Groundwater Storage –
The point at which significant and unreasonable impacts, as determined by the amount of groundwater in the basin, affect the reasonable and beneficial use of, and access to, groundwater by overlying users over an extended drought period. (10-years?)

This is determined when the volume of storage (above the groundwater level minimum thresholds) is depleted to an elevation lower than the groundwater level minimum threshold in at least three(3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the subbasin (as measured by the acreage of each Management Area).

Minimum thresholds shall be set by each of the management areas through their respective Groundwater Sustainability Plans.

Degraded Water Quality Trends –
The point at which significant and unreasonable impacts over the planning and implementation horizon, as caused by water management actions, that affect the reasonable and beneficial use of, and access to, groundwater by overlying users.

This is determined when the minimum threshold for a groundwater quality constituent of concern is exceeded in at least three(3) adjacent management areas that represent at least 15% of the subbasin or greater than 30% of the designated monitoring points within the basin. Minimum thresholds shall be set by each of the management areas through their respective Groundwater Sustainability Plans.

Land Subsidence Trends –
The point at which significant and unreasonable impacts, as determined by a subsidence rate and extent in the basin, that affects the surface land uses or critical infrastructure.

This is determined when subsidence results in significant and unreasonable impacts to critical infrastructure as indicated by monitoring points established by a basin wide coordinated GSP subsidence monitoring plan.

Monitoring Network & Protocols

Monitoring Network shall be developed to be capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

1) Demonstrate progress toward achieving measurable objectives described in the Plan
2) Monitor impacts to the beneficial uses and users of groundwater
3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
4) Quantify annual changes in water budget components

Monitoring Network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area. To the extent possible, the use of existing monitoring data and infrastructure should be utilized to meet the needs for characterization, historical record documentation and continued monitoring requirements.

Monitoring Network shall describe the scientific rationale for the monitoring site selection and for each sustainability indicator, the quantitative values for the minimum threshold, measurable objective and interim milestones shall be indicated at each monitoring site.

Monitoring Protocols developed shall include a description of technical standards, data collection methods, and other procedures or protocols for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies. There is no definitive rule for the density of groundwater monitoring points needed in a basin. The table below provides guidance for the density of monitoring wells per hundred square miles. One important item to consider is how the definitions of undesirable results will be impacted to provide the necessary information to indicate compliance.

Reference	Monitoring Well Density (wells per 100 miles2)
Heath (1976)	0.2 - 10
Sophocleous (1983)	6.3
Basins pumping more than 10,000 acrefeet/year per 100 miles	4.0
Basins pumping between 1,000 and 10,000 acre-feet/year per 100 miles	2.0
Basins pumping between 250 and 1,000 acre-feet/year per 100 miles	1.0
Basins pumping between 100 and 250 acre-feet/year per 100 miles	0.7

Measuring Groundwater Levels

Given the significant variations in groundwater elevations throughout the Kern subbasin which are due to variations in hydrologic conditions, no single groundwater elevation surface should be considered a representation of groundwater flow directions in this basin.

Requirements for well selections:

- A long-term access agreement that includes year-round site access to allow for increased monitoring frequency
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact, type of information to be collected, latitude, longitude and elevation
- Monitoring location should also track all modifications to the site in a modification log

The following data collection protocols are to be followed within the Kern subbasin:

- Groundwater level data shall be sufficient to produce seasonal maps of potentiometric surfaces or water table surfaces throughout the basin that clearly identify changes in groundwater flow direction and gradient.
- Use the Well Data form provided (see attached)
- Groundwater level data shall be collected from each principal aquifer in the basin
- Collection of data between the approved time frames only
  - January 15th to March 30th
  - September 15th to November 15th
- A weighted water level meter or other CASGEM approved measuring device will be used to measure the depth to groundwater
- Depth to groundwater must be measured relative to an established Reference Point on the well casing. If no mark or reference point is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing
- The elevation of the Reference Point of the well must be referenced to the North American Vertical Datum of 1988. The accuracy of the reference point should be consistent with CASGEM established guidelines.
- Each well's Reference Point will be cataloged to ensure identical procedures are followed for subsequent measurements.
- The data collector should remove the appropriate cap, lid or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate.
- Depth to groundwater must be measured to the accuracy associated with the approved monitoring method or device.
- The water level meter shall be decontaminated after measuring each well.
- The data collector shall calculate the groundwater elevation as:
  - GWE = RPE – DTW
  - GWE = Groundwater Elevation

  - RPE = Reference Point Elevation
  - DTW = Depth to Water
- The data collector must ensure that all measurements are consistent units of feet, tenths of feet or hundredths of feet. Measurements and Reference Point Elevations should not be recorded in feet and inches.

Groundwater Quality

Groundwater quality monitoring networks shall be designed to demonstrate that the degraded water quality sustainability indicator is being observed for the purpose of meeting the definition of the sustainability goal.

Requirements for well selections:

- A long-term access agreement that includes year-round site access to allow for increased monitoring frequency
- A unique identifier that includes a general written description of the site location, date established, access instructions and point of contact, type of information to be collected, latitude, longitude and elevation
- Monitoring location should also track all modifications to the site in a modification log
- The use of existing water quality data within the basin should be done to the greatest extent possible
- Monitoring network should consist largely as a supplemental monitoring locations where known groundwater contamination plumes are under existing regulatory management

The following data collection protocols are to be followed within the Kern subbasin:

- Monitor groundwater quality data from each principal aquifer in the basin
- Data should be sufficient for mapping movement of degraded water quality
- Data should be sufficient to assess groundwater quality impacts to beneficial uses and users
- Data should be sufficient to evaluate whether management activities are contributing to water quality degradation.
- All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program
- Samples will be collected according to the standards listed in the Standard Methods for the Examination of Water and Wastewater, USGS National Field Manual for the Collection of Water Quality Data
- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sampler containers, and clarify any sample holding times or sample preservation requirements
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples are not to be taken/collected from storage tanks, at the end of long pipe runs or after any water treatment infrastructure

- Samples will be taken/collected only after the appropriate volume of water has been purged from the casing and field parameters have stabilized
- Sampler will clean the sampling port and/or sampling equipment. The sampling port and/or sampling equipment must be free of any contaminants
- Groundwater elevation in the well should be measured following the protocols described in the groundwater level measuring protocols
- Field parameters of pH, electrical conductivity and temperature should be collected for each sample. Lab pH analysis are typically unachievable due to short hold times.
- All field instruments should be calibrated daily and evaluated for drift throughout the day
- Sample containers should be labeled prior to sample collection. The sample label must include:
    - Sample ID (well ID)
    - Sample date and time
    - Sample personnel
    - Sample location
    - Preservative used
    - Analytes and analytical method
- Samples shall be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection
- Samples requiring preservation must be preserved as soon as practically possible
- Samples to be analyzed for metals should be field-filtered prior to preservation. Do not collect an unfiltered sample in a preserved container
- Samples will be chilled and maintained at 4 C to prevent degradation of the sample
- Samples will be shipped under a chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions
- Custody Seal will be used by the field technician if a third-party transportation service is used
- A Field Sampling Log will include:
    - Sampler's identification
    - Well identification
    - Climatic conditions
    - Depth to water prior to purging
    - Type of purging and sampling device
    - Purging rate and volume
    - Relative well yield volume
    - Field parameter measurements (pH, temperature, EC, DO)
    - Type and number of samples collected
    - Date and time collected

Change in Groundwater Storage

Since the groundwater storage is not a directly measurable condition, it does rely heavily on the collection of accurate groundwater levels. The changes in groundwater levels reflect changes in storage and can thus be estimated with assumptions of thickness of units, porosity, and connectivity. These observations will be essential for use in calculating the water budget.

A water budget is a foundational tool used to compile water flows (supplies) and outflows (demands). It is an accounting of the total groundwater and surface water entering and leaving a basin or user-defined area. The difference between flows and outflows is a change in the amount of water stored.

Coordination of Water Budget Data to comply with groundwater storage:

- Surface water supply
- Total water use
- Water budget
- Sustainable yield

The change in the annual volume of groundwater storage between seasonal high conditions shall be quantified in the water budget.

Land Subsidence

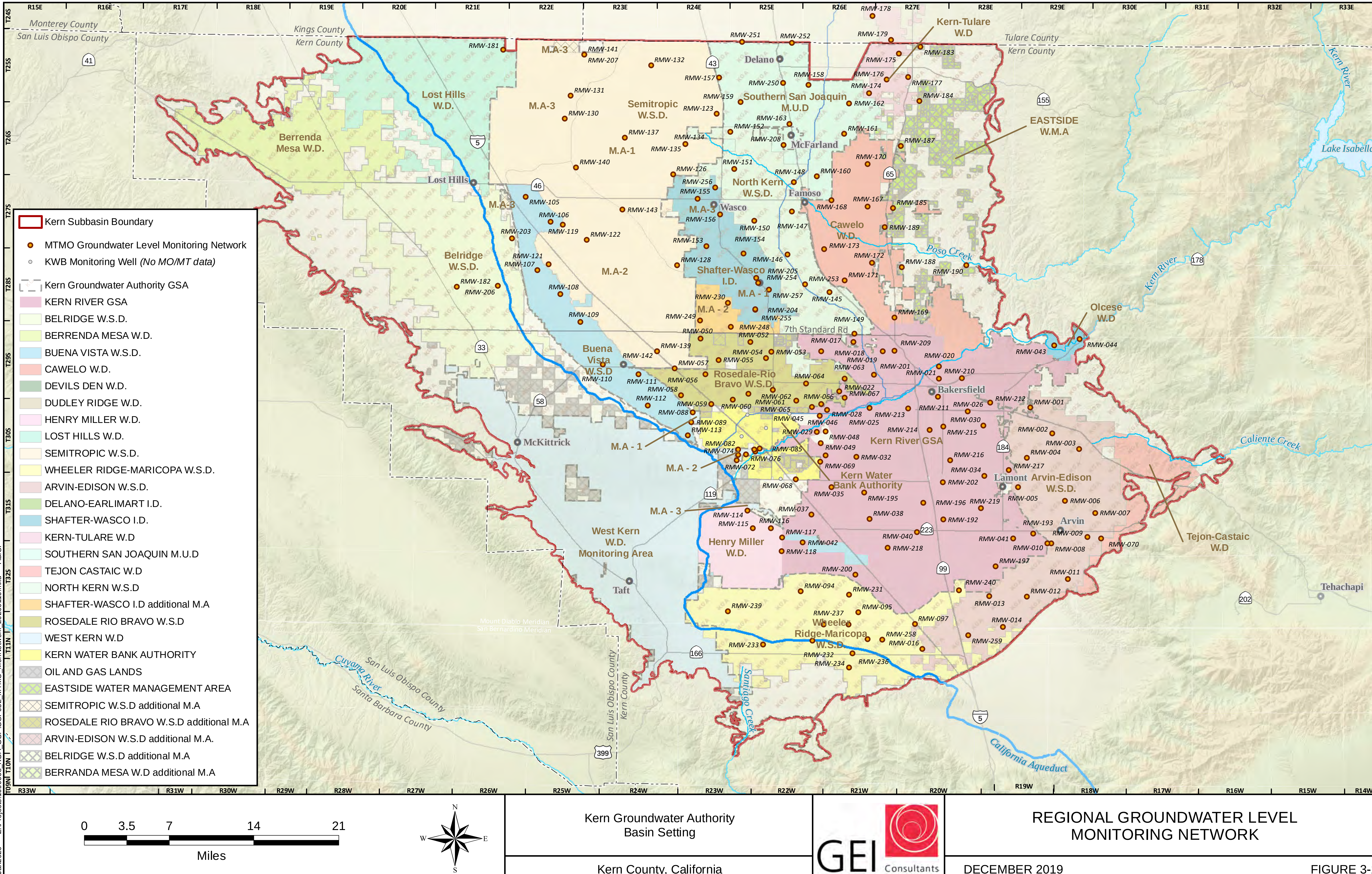
Land subsidence protocols are to be set up to identify the rate and extent of land subsidence, which maybe measured by extensometers, surveying, remote sensing technology, or other appropriate method. To the extent possible, the use of existing data should be utilized.

Prior to development of a specific subsidence monitoring network a screening level analysis should be conducted. The screening of subsidence occurrence should include:

- Review of the HCM and understanding of grain-size distributions and potential for subsidence to occur
- Review of any known regional or correlative geologic conditions where subsidence has been observed.
- Review of historic range of groundwater levels in the principal aquifers of the basin
- Review of historic records of infrastructure impacts, including but not limited to damage to pipelines, canals, roadways or bridges or well collapse potentially associated with land surface elevation changes
- Review of remote sending results such as InSAR or other land surface monitoring data
- Review of existing CGPS surveys

This basin has decided to work together on this protocol with a consultant to obtain the required data.

See the attached for the coordinated effort by all the GSAs in the Kern Subbasin pertaining to Land Subsidence.



Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

REGIONAL GROUNDWATER LEVEL MONITORING NETWORK

DECEMBER 2019

FIGURE 3-1

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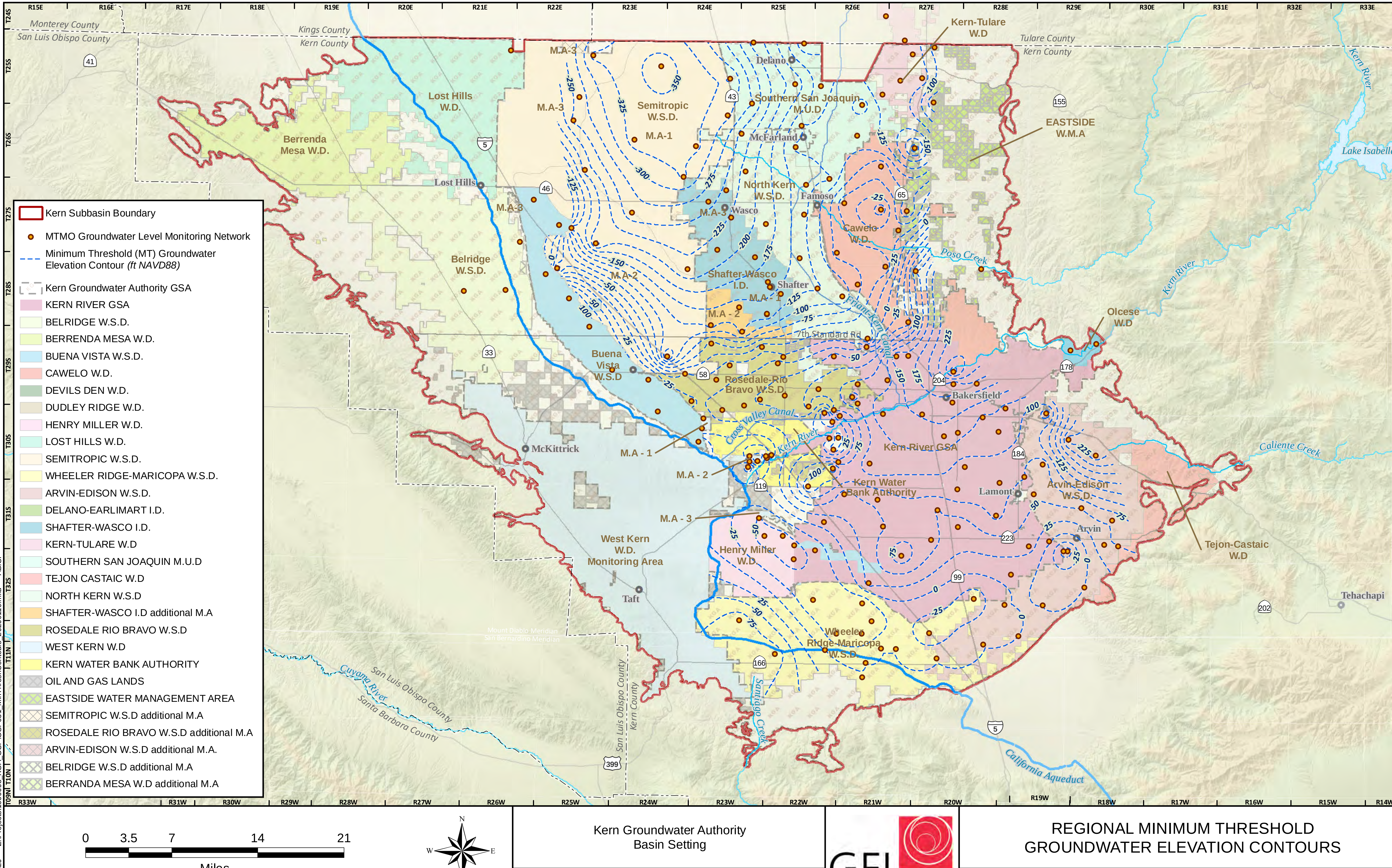


Kern Groundwater Authority
Basin Setting

Kern County, California

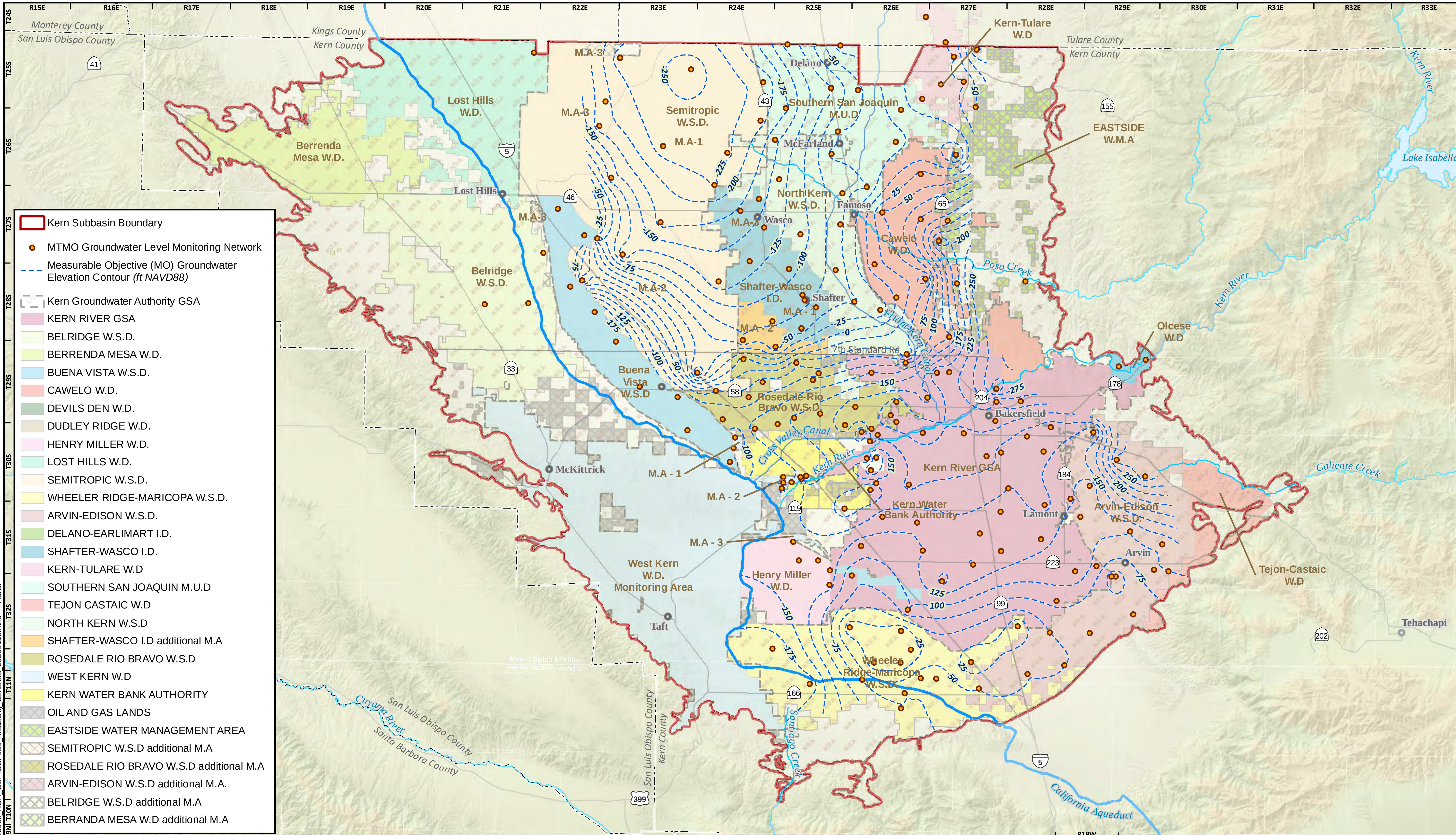
GEI Consultants

REGIONAL MINIMUM THRESHOLD GROUNDWATER ELEVATION CONTOURS

DECEMBER 2019

FIGURE 3-2

10Jan2020 Z:\Projects\1900668_KGA_GSP\GSP031_MinThreshContours_20200110.mxd AB/SI



0 3.5 7 14 21

Miles

Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

REGIONAL MEASURABLE OBJECTIVE GROUNDWATER ELEVATION CONTOURS

DECEMBER 2019

FIGURE 3-3

10Jan2020 Z:\Projects\1900668_KGA_GSP\GSP030_MeasObj_Contours_20200110.mxd AB/SI

Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

REGIONAL GROUNDWATER QUALITY MONITORING NETWORK

DECEMBER 2019

FIGURE 3-4

Z:\Projects\1900668_KGA_GSP\GSP040_MTMO_WQ_MonNetwork_20200110.mxd AB/SI 10Jan2020

TECHNICAL MEMORANDUM

TO: Kern County Subbasin GSAs

FROM: GEI Consultants, Inc.

DATE: October 25, 2019

RE: IMPROVEMENTS TO REGIONAL SUBSIDENCE MONITORING IN THE KERN COUNTY SUBBASIN

This memorandum was prepared, in coordination with the Kern County Subbasin GSAs, to fill data gaps in the Kern County Subbasin subsidence monitoring network. It prioritizes areas of interest, at a subbasin-level, that require additional subsidence monitoring. It also includes the design approach and parameters to be monitored, and references DWR guidelines regarding subsidence monitoring design.

Background and Purpose

The development of a network to monitor sustainability indicators, including subsidence, is one of the requirements of the Groundwater Sustainability Plans (GSPs) to be submitted to the Department of Water Resources (DWR) for compliance with the Sustainable Groundwater Management Act (SGMA).

To achieve and comply with the requirements of SGMA as it pertains to subsidence and knowing that in the Kern County Subbasin there lacks sufficient data, this memo was generated for the benefit of the entire Kern Subbasin GSAs as a coordinated effort. In each individual GSPs of the Kern Subbasin, existing land surface elevation and land subsidence monitoring is identified, along with data gaps within the existing network. This memo describes the process and rationale for identifying subsidence areas of interest (AOIs) to address data gaps, the current monitoring network, and the location of future monitoring points. The memo includes the following objectives for monitoring, which are applicable to land subsidence:

1. Demonstrate progress toward achieving measurable objectives described in the management area and throughout the Subbasin;
2. Monitor impacts to the beneficial uses and users of groundwater, surface land uses, and critical infrastructure; and
3. Monitor changes in groundwater conditions (or land subsidence) relative to measurable objectives and minimum thresholds.

The monitoring network is designed to monitor impacts to surface land uses or critical infrastructure as stated in the Subbasin-wide definition of undesirable results for land subsidence (KGA, 2019 emphasis added):

> *The point at which significant and unreasonable impacts, as determined by a subsidence rate and extent in the basin, that affects the surface land uses or critical infrastructure.*
>
> *This is determined when subsidence results in significant and unreasonable impacts to critical infrastructure as indicated by monitoring points established by a basin wide coordinated GSP subsidence monitoring plan.*

One of the purposes for improving the subsidence monitoring network is to collect additional data at each AOI to fill data gaps so that sustainable management criteria (SMCs) can be set. As more data are gathered for the AOIs, Kern County Subbasin GSAs and stakeholders can establish SMCs to avoid undesirable results stemming from subsidence.

AOI Screening and Monitoring Approach

The first step in the subsidence monitoring approach is to identify AOIs based on the presence of critical infrastructure or other surface land uses. These AOIs can then be evaluated based on the decision-making criteria listed below to determine if monitoring is required. This process is illustrated in Figure 1.

An AOI requires monitoring if the following three criteria apply:

1. Infrastructure or surface land uses are susceptible to land subsidence.
2. Significant land subsidence has been observed in screening from Interferometric Synthetic-Aperture Radar (InSAR) or other remote sensing techniques.
3. The subsidence is caused by groundwater extraction.

Where data gaps exist in evaluating the criteria, additional investigation may be necessary. For example, further investigation at AOI-2 is necessary to evaluate if groundwater extraction is causing subsidence.

Monitoring Parameters

If the area is identified as an AOI that requires monitoring, then the following actions should be taken:

A. Groundwater level monitoring near the AOI,

B. Ground-truthing of subsidence detected by InSAR (CGPS, extensometer, or level surveying), and

C. Monitoring of the critical infrastructure.

As depicted in Figure 1, the process for establishing monitoring points includes locations with susceptible critical infrastructure where InSAR and/or other historical and recent monitoring has detected recent subsidence that is likely caused by groundwater extraction.

Regional Coordination

Regional coordination of monitoring is key to the design of the network in the subbasin because regional groundwater extraction is a main driver of subsidence. In addition, many of the critical infrastructure are regional and may require coordination for access within the vicinity and data sharing.

Subsidence associated with oil and gas activities may also occur in the subbasin. However, any subsidence potentially associated with oil and gas activities is regulated by the California Division of Oil, Gas, and Geothermal Resources (DOGGR) under the California Public Resources Code and is therefore separate from SGMA requirements. Coordination between groundwater and oil and gas stakeholders may be needed where there is potential for both activities to cause subsidence that impacts critical infrastructure.

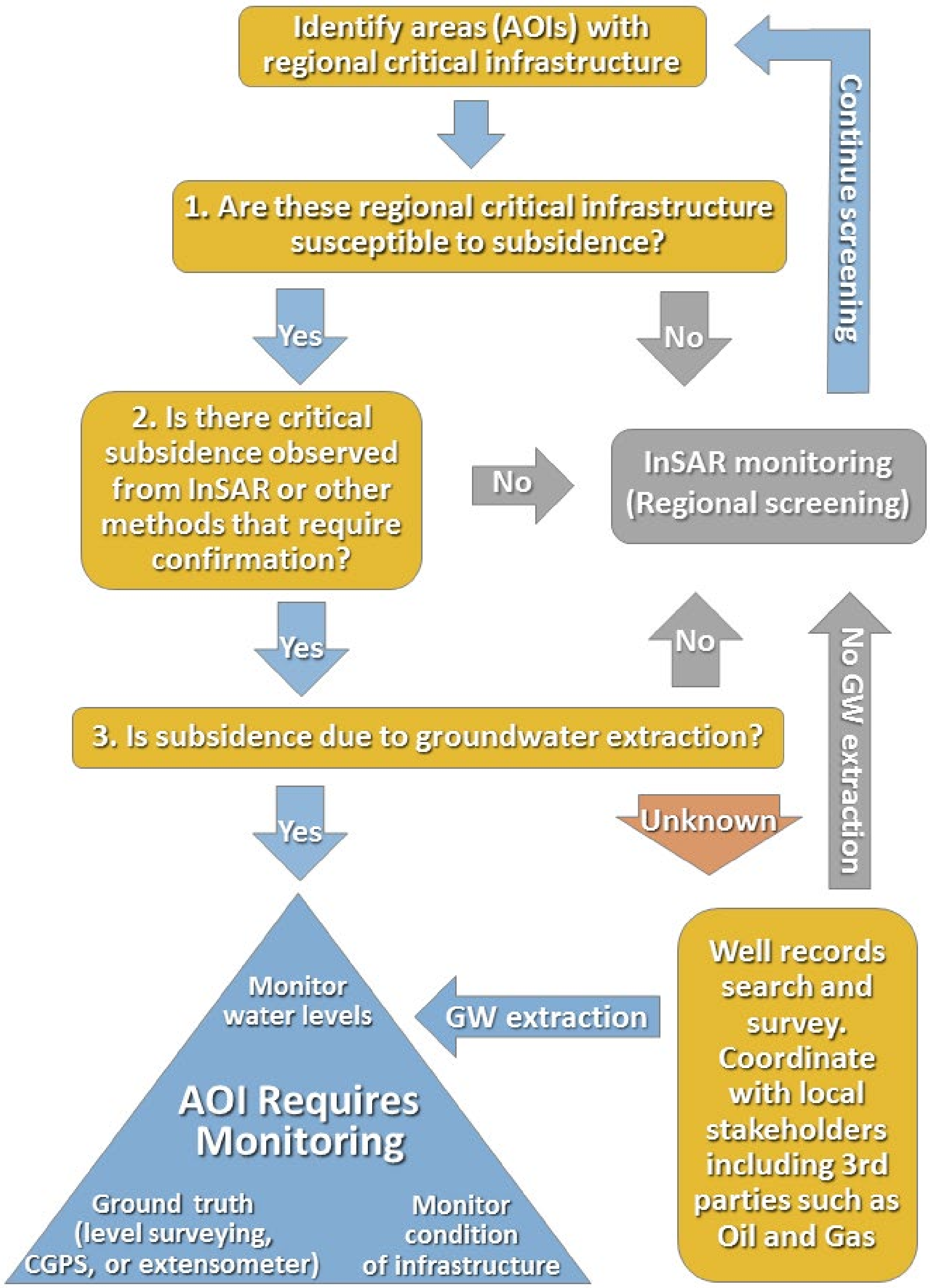


Figure 1. Subsidence Monitoring Decision Making Process and Criteria.

Improvements to Monitoring Network

Timeline and Approach

Five AOIs were identified, in order of priority, to improve the subbasin monitoring network (AOI-1 to AOI-5). Two of these areas are located along the Friant-Kern Canal (FKC), two are along the California Aqueduct, and one area is for monitoring changes in land surface elevation along the northern boundary of the subbasin where a significant amount of subsidence has been reported in the InSAR data.

It is anticipated that these sites will be evaluated in order of priority and may take up to several years to design and implement monitoring points.

Each monitoring site design will consider the following:

1. Confirm groundwater extraction is the cause of subsidence (if necessary),
2. Land siting and ownership,
3. Site access,
4. Monitoring design (CGPS or extensometer),
5. Confirmation that data for all three monitoring parameters can be collected (a. groundwater elevations, b. subsidence, and c. condition of infrastructure), and
6. Connection to the monitoring network and data sharing.

The subsidence monitoring network AOIs are presented on Figure 2. AOI-1 was selected to monitor along the FKC where subsidence has been detected near the northern boundary of the subbasin. AOI-2 was selected where the California Aqueduct has had historical impacts partially attributed to subsidence. AOI-3 along the FKC south of Poso Creek has had subsidence detected and reported by the North Kern WSD. AOI-4 along the California Aqueduct has had subsidence reported by DWR Division of Engineering (DOE) and InSAR, and AOI-5 along the northern boundary of the subbasin is not associated with critical infrastructure but is the location of high cumulative subsidence at the boundary of the subbasin and may be indicative of conditions in the neighboring subbasins which have the potential to impact the conditions of the Kern County Subbasin.

Groundwater Elevations

A key parameter in evaluating subsidence as a sustainability indicator for groundwater management is understanding groundwater level changes with respect to subsidence, particularly regional changes in water level. Figure 3 presents the regional water level monitoring points (RMWs) from the draft GSP with respect to the five AOIs for subsidence monitoring. The following are observations of RMWs within AOI vicinity:

- AOI-1 has a few surrounding RMWs; however, none are within 1 mile of the FKC.
- AOI-2 has one RMW within a mile of the Aqueduct and the AOI.
- AOI-3 has one RMW in the central portion about 1 mile from FKC.
- AOI-4 has two RMWs within the vicinity of the Aqueduct.
- AOI-5 has no RMWs within 1 mile.

Recommendation

Where possible, subsidence monitoring stations should be installed within 1 mile of a reliable RMW. If necessary, a new RMW may be installed to provide a point at which groundwater level may be collected in proximity to the land surface elevation monitoring point.

AOIs listed on subsequent pages

AOI-1. FKC Milepost 120 to 130

This high priority area is located along the FKC between Mileposts 120 to 130 (Figure 2), east-northeast of the City of McFarland. The purpose of this AOI is to monitor subsidence along the FKC and its related infrastructure. At times, InSAR monitoring has reported up to 5 inches per year of subsidence in areas surrounding this segment of the FKC. At present, no significant impacts to the FKC have been reported along this portion of the canal's alignment. According to leveling survey data from Friant Water Authority (FWA, 2019), the FKC invert may have subsided from 2 ft to 3 ft below original as-built elevations between Mileposts 120 to 135. Continued lowering of the canal invert can decrease freeboard from the original as-built conditions, which may contribute to reduction in emergency storage capabilities and delivery options of the Canal.

In contrast, beyond the subbasin's northern boundary, subsidence has caused significant impacts to the FKC conveyance capabilities between Mileposts 101 to 108.

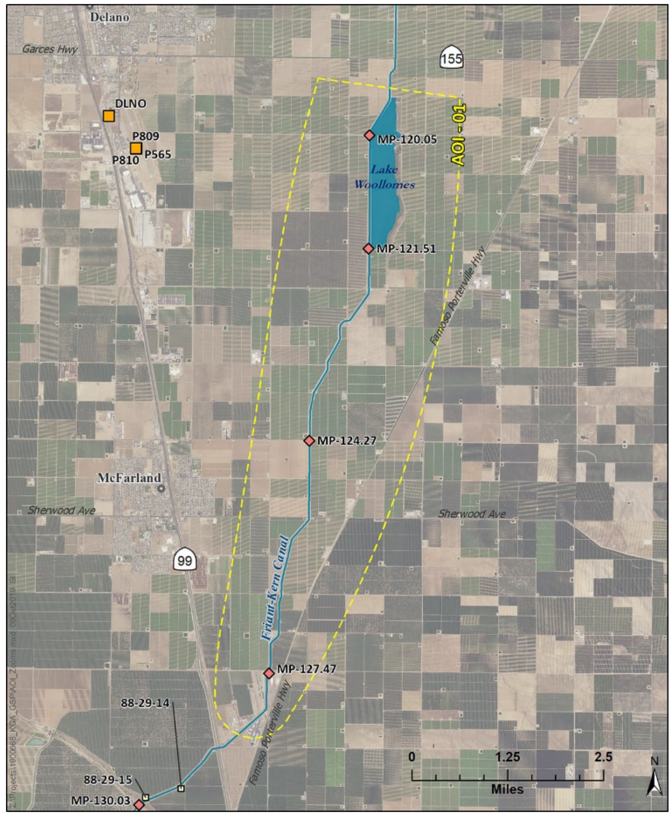


Figure 4. AOI-1. FKC Milepost 120 to 130
(symbol legend on Figure 2)

Existing Monitoring

Currently, this area is screened by InSAR, and previous level surveying was performed by FWA at the mileposts labeled on Figures 2 and 4. There are no other active monitoring points except for InSAR along this stretch.

New Monitoring Approach

A new CGPS station that monitors at the ground surface any subsurface subsidence, regardless of the depth interval, is recommended because the only known cause of subsidence in this area is attributed to groundwater extraction. This CGPS data will complement any manual level surveys that may incorporate the FWA reported measuring points. CGPS data may also provide on-demand data as needed.

Coordination of Monitoring

Subsidence monitoring along the FKC benefits local stakeholders, CVP contractors, and the FWA. It is anticipated that this monitoring can be coordinated with FWA to share data as well as potentially share resources and cost.

Any level surveying along the canal from the United States Bureau of Reclamation (USBR) Friant-Kern benchmarks (Figure 2) will require coordination with the FWA.

AOI-2. California Aqueduct Milepost 196 to 215

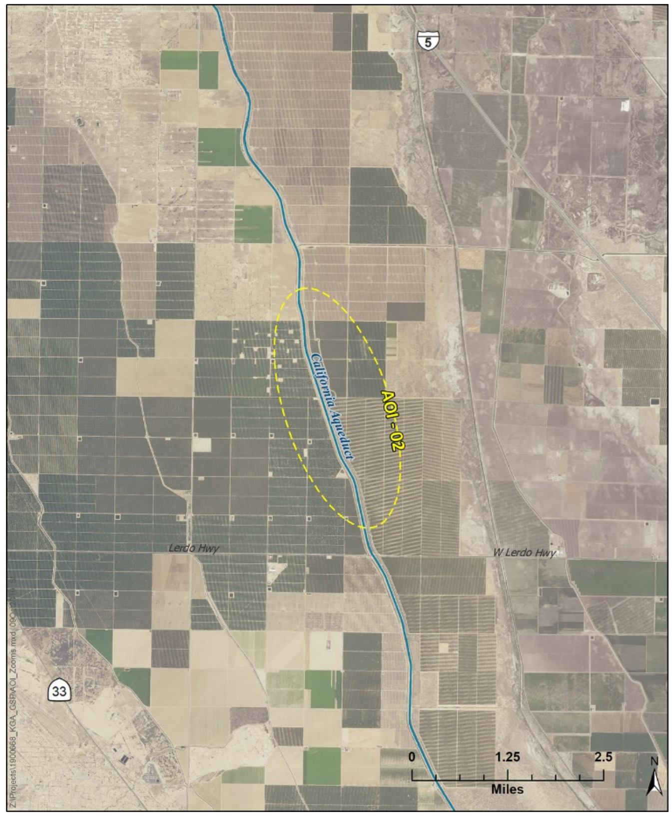


Figure 5. AOI-2. CA Aqueduct Milepost 196 to 215
(symbol legend on Figure 2)

This high priority area is the segment of the California Aqueduct where an embankment failure occurred at Milepost 208 in June 2011 (DWR, 2017). This failure is partially attributed to subsidence. The cause of this subsidence is unknown and is therefore a subject of monitoring at this location. This area is along the Aqueduct between Mileposts 196 to 215 in the western central subbasin (Figure 2). In addition to embankment failure, other consequences of subsidence include loss in freeboard in the Aqueduct. This area has experienced at least 2 feet of subsidence since the Aqueduct was constructed.

Existing Monitoring

Currently, this area is screened by InSAR and is monitored with level surveys every three to seven years by the DWR's DOE. There are no other active monitoring points along this stretch.

New Monitoring Approach

The source of subsidence, either by groundwater extraction activities or other activities, will be investigated by performing well records searches from DWR well completion records, the Kern County Public Health Department well permit records, and the DOGGR's databases. If necessary, a field well survey may be performed. Coordination may be needed with local stakeholders to confirm the magnitude of groundwater extracted within 1 mile of this portion of the Aqueduct's alignment and the volume of fluids extracted and injected by oil and gas activities within 1 mile of this alignment. A third potential source for subsidence in this area could be hydrocompaction, which was identified during the initial design and construction of the Aqueduct. Pre-consolidation of soil was performed during initial construction so hydrocompaction is likely not significant, however, it cannot be ruled out at this time.

If it is determined that groundwater extraction is playing a role in subsidence for this area, a monitoring point should be installed away from the footprint of the Aqueduct to avoid potential signatures of hydrocompaction if any exist. If there is question of whether some of the subsidence is related to nearby oil and gas activities, then an extensometer should be installed in the interval where groundwater production occurs. An extensometer will provide data of subsidence pertaining to intervals with groundwater production, whereas a CGPS would capture any subsidence regardless of the depth interval.

Coordination of Monitoring

Subsidence monitoring along the Aqueduct benefits local stakeholders, State Water Project (SWP) contractors, and the DWR's DOE. It is anticipated that this monitoring can be coordinated with DWR to share data as well as potentially share resources and cost.

AOI-3. FKC Milepost 130 to 137

This medium priority area is located along the FKC between Mileposts 130 to 137 (Figure 2), southwest of Famoso and Poso Creek. The purpose of this AOI is to monitor subsidence along the FKC infrastructure where InSAR and local stakeholders have reported subsidence in the surrounding area. As with AOI-1, no significant impacts to the FKC have been reported along this stretch. According to leveling survey data from the FWA (2019), the FKC invert may have subsided from 2 ft to 3 ft below original as-built elevation between Mileposts 120 to 135. Continued lowering of the canal invert can decrease freeboard from the original as-built conditions, which may contribute to reduction in emergency storage capabilities and delivery options of the Canal.

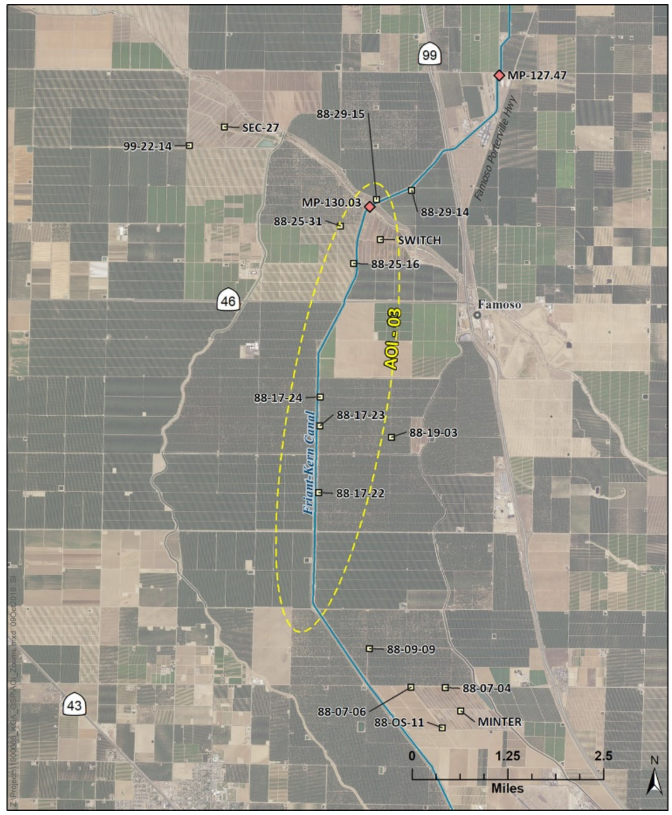


Figure 6. AOI-3. FKC Milepost 130 to 137
(symbol legend on Figure 2)

Existing Monitoring

Currently, this area is screened by InSAR, and previous level surveying was performed by the FWA at Mileposts labeled on Figure 2. Local districts monitor this stretch regularly as labeled on Figures 2 and 6. Currently there are no continuous monitoring points along this stretch.

New Monitoring Approach

A CGPS station that monitors from the ground surface, any subsurface subsidence regardless of the depth interval, is recommended because the only known cause of subsidence in this area is attributed to groundwater extraction. This CGPS data will complement manual level surveys from local district surveys. CGPS data will also provide nearly on-demand data as needed.

Where possible, this station should be tied in to benchmark surveys performed by local districts.

Coordination of Monitoring

Subsidence monitoring along the FKC benefits local stakeholders, CVP contractors, and the FWA. It is anticipated that this monitoring can be coordinated with FWA to share data as well as potentially share resources and cost.

Any level surveying along the canal from USBR Friant-Kern benchmarks (Figures 2 and 6) will require coordination with the FWA.

AOI-4. California Aqueduct Milepost 267 to 271

This medium priority area is located along the Aqueduct between Milepost 267 to 271 near Old River Road. InSAR data report subsidence southwest and along I-5 and southwest toward the Aqueduct along Old River Road. A former CGPS station (BKR1/2) located about 5 miles north of the Aqueduct along Old River Road also reported significant subsidence; however, this station has since been decommissioned (2016).

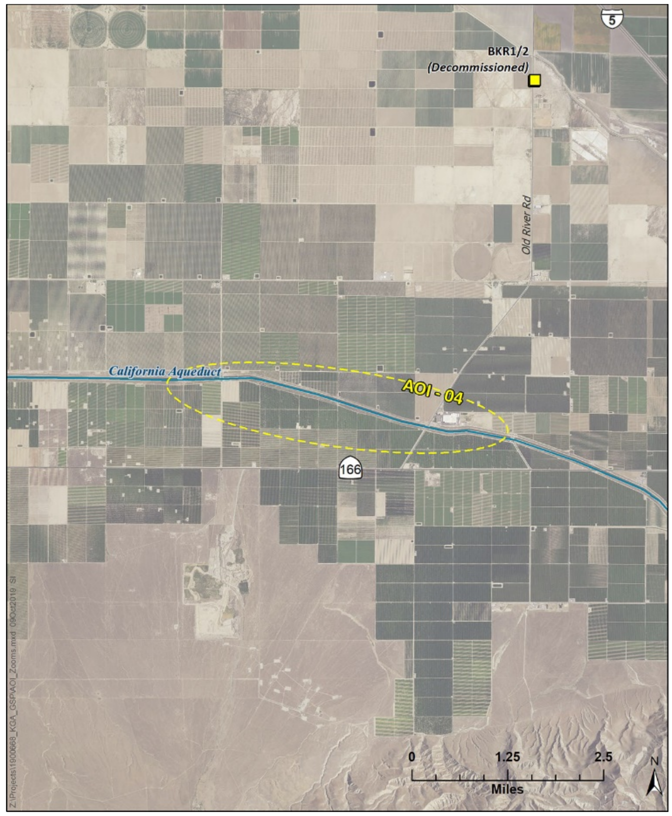


Figure 7. AOI-4. CA Aqueduct Milepost 267 to 271
(symbol legend on Figure 2)

Existing Monitoring

Currently, this area is screened by InSAR, and is monitored by level surveying every three to seven years by the DWR's DOE. There are no other active monitoring points along this stretch.

New Monitoring Approach

Groundwater extraction is potentially the source of subsidence, so a continuous monitoring station such as a CGPS or extensometer will be installed. Other potential sources could be oil and gas extraction and hydrocompaction. A DOGGR records search may provide sufficient information to understand the extent of oil and gas extraction in this area. Although hydrocompaction may not be significant because of pre-consolidation practices during Aqueduct construction, nonetheless, in order to avoid potential signatures of hydrocompaction, a monitoring point should be installed away from the footprint of the Aqueduct. If feasible during the siting study, the site location may be selected to the north between the Aqueduct and former BKR1/2.

Where possible, this station should be tied in to benchmark surveys performed by local districts.

Coordination of Monitoring

Subsidence monitoring along the Aqueduct benefits local stakeholders, SWP contractors, and the DWR's DOE. It is anticipated that this monitoring can be coordinated with DWR to share data as well as potentially share resources and cost.

AOI-5. Central-Northern Boundary of Subbasin

This medium priority area is in the northern quarter of T25S-R24E and T25S-R25E. Currently, this AOI does not have recognized susceptible critical infrastructure. It has significant subsidence reported both historically (USGS level surveys) and recently (InSAR). A CGPS station in this area will provide a needed ground truthing point to confirm InSAR readings and will act as a useful monitoring point to gauge progress of groundwater management along the border of the subbasin in relation to neighboring subbasins to the north.

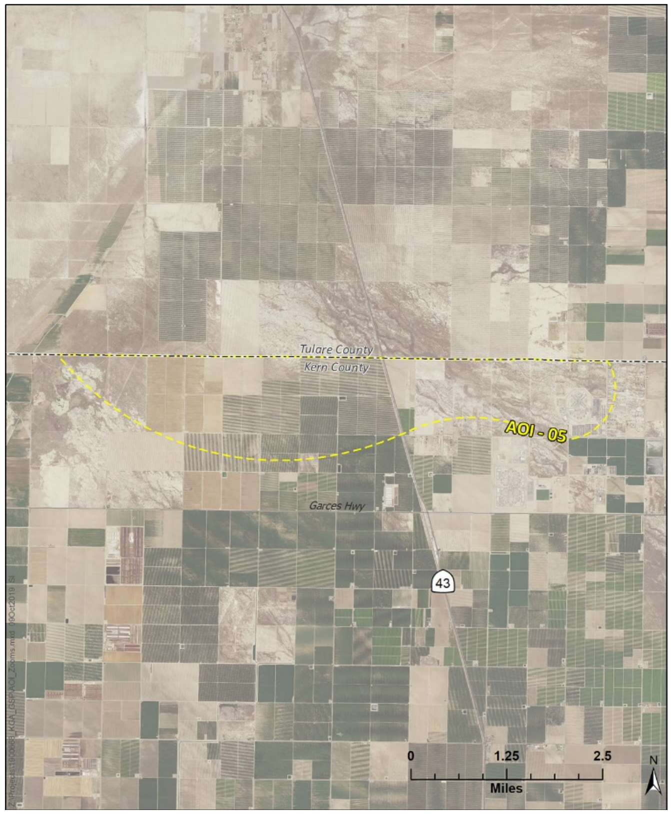


Figure 8. AOI-5 Central-Northern Boundary of Subbasin (symbol legend on Figure 2)

Existing Monitoring

Currently, this area is screened by InSAR. There are no other active monitoring points along this stretch.

New Monitoring Approach

Groundwater extraction is potentially the source of subsidence, so a CGPS or extensometer monitoring station should be installed. Where possible, this station should be tied in to benchmark surveys performed by local districts.

Coordination of Monitoring

Subsidence monitoring along the subbasin boundary benefits local stakeholders in Kern County subbasin and adjacent subbasins. In the future, data may be shared with neighboring GSAs for coordination.

Monitoring and Design Guidelines

According to the BMP (DWR, 2016), Leveling surveys and CGPS surveys must follow, at a minimum, guidelines in the *CalTrans Survey Manual*: https://dot.ca.gov/programs/right-of-way/surveys-manual-and-interim-guidelines. Extensometer resources from USGS are also listed in the BMP (DWR, 2016).

In addition to CalTrans guidance, UNAVCO has provided many CGPS design specifications on their website. UNAVCO offers a robust CGPS monument design (deep drill based monument [DDBM] that minimizes interference in data recording from soil expansion and temperature effects. Attachments 1 and 2 include example specifications for CGPS stations from CalTrans and UNAVCO, respectively. Attachment 3 includes sample extensometer designs for reference.

Rough Costs to Consider

For subbasin-wide monitoring to be implemented with the recommended AOIs in this memorandum, Kern Subbasin stakeholders will coordinate how the work will be implemented. Below is a brief summary of rough costs expected for the installation of each monitoring solution. Costs do not include ongoing management and maintenance of the stations. Actual costing will be confirmed during procurement and the planning process.

Level Surveying and Benchmarks (not proposed in this memo, but is an alternative approach).

- Install benchmarks where none available along linear features every 1/8 to 1/4 mile in area of interest.
- Each ~$500 to $2500 installation
- Initial Survey (5 to 8 monuments per day). ~$1500-$2500 per day (includes reporting).
- Subsequent Surveys (8 to 10 monuments per day). ~$1500-$2500 per day (includes reporting).

CORS CGPS Station

- ~$30k to $100k depending on equipment (purchase and installation). This may not include programming and digital network setup.
- DWR may be able to provide technical assistance, and at a minimum, review design specifications if DWR concurrence is wanted. DWR has not at this time offered any current specifications or assistance in developing designs.
- Optional outside consulting may be recommended for design and programming.

Extensometer

Drilling and installation costs ~$200k to $300k (design and operation not included).

Conclusions

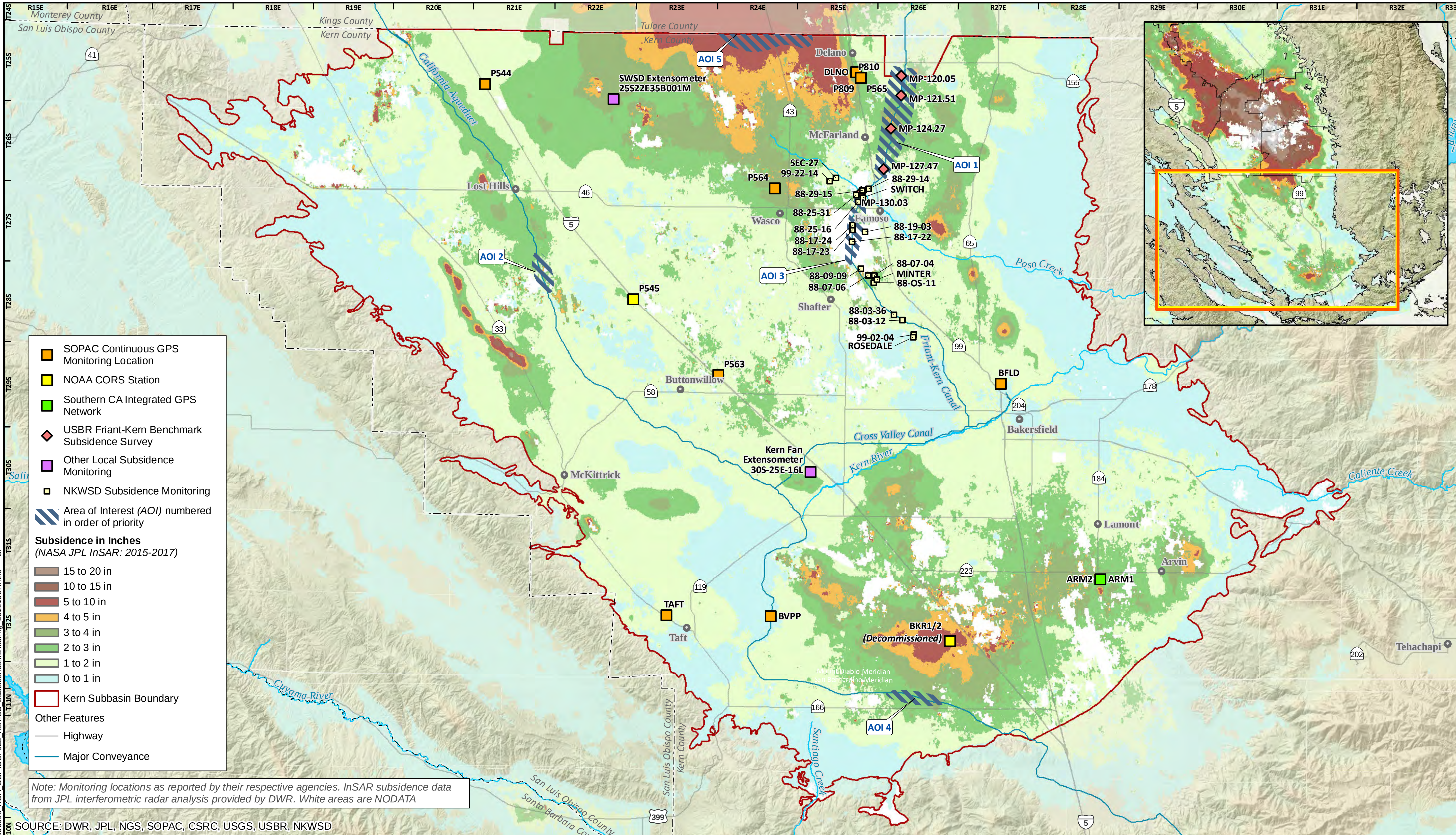
This memorandum was prepared, in coordination with subbasin stakeholders, to improve the Kern County Subbasin subsidence monitoring network. It prioritizes areas of interest, at a subbasin-level, that require additional subsidence monitoring. Figures 2 and 3 present the AOIs for future monitoring points and associated water level monitoring wells (RMWs). AOIs are listed in order of highest priority for investigation and monitoring installation. Figures 4 to 8 present aerial images of these areas. In AOIs where groundwater extractions and oil and gas activities may be contributing to subsidence, extensometers will be installed in lieu of CGPS points in order to monitor the depth interval of groundwater extractions. Where subsidence monitoring is required, monitoring water levels and the condition of infrastructure is necessary. Where groundwater extraction is not causing subsidence, the AOI can be screened by the region-wide InSAR subsidence monitoring network.

References

DWR. 2016. Monitoring Networks and Identification of Data Gaps. Best Management Practices (BMP) for the Sustainable Management of Groundwater. December.

DWR. 2017. California Aqueduct Subsidence Study. San Luis Field Division. San Joaquin Field Division. June.

Kern Groundwater Authority (KGA). 2019. Groundwater Sustainability Plan of Kern County Subbasin. Public Draft. August.



0 3.5 7 14 21
Miles

Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

REGIONAL SUBSIDENCE MONITORING NETWORK

OCTOBER 2019 | DRAFT | FIGURE 2

Z:\Projects\1900668_KGA_GSP\GSP025_KernSB_SubsidenceMonitoring_20191007.mxd SI
07-Oct-2019

Kern Groundwater Authority
Basin Setting

Kern County, California

GEI Consultants

REGIONAL GROUNDWATER QUALITY MONITORING NETWORK

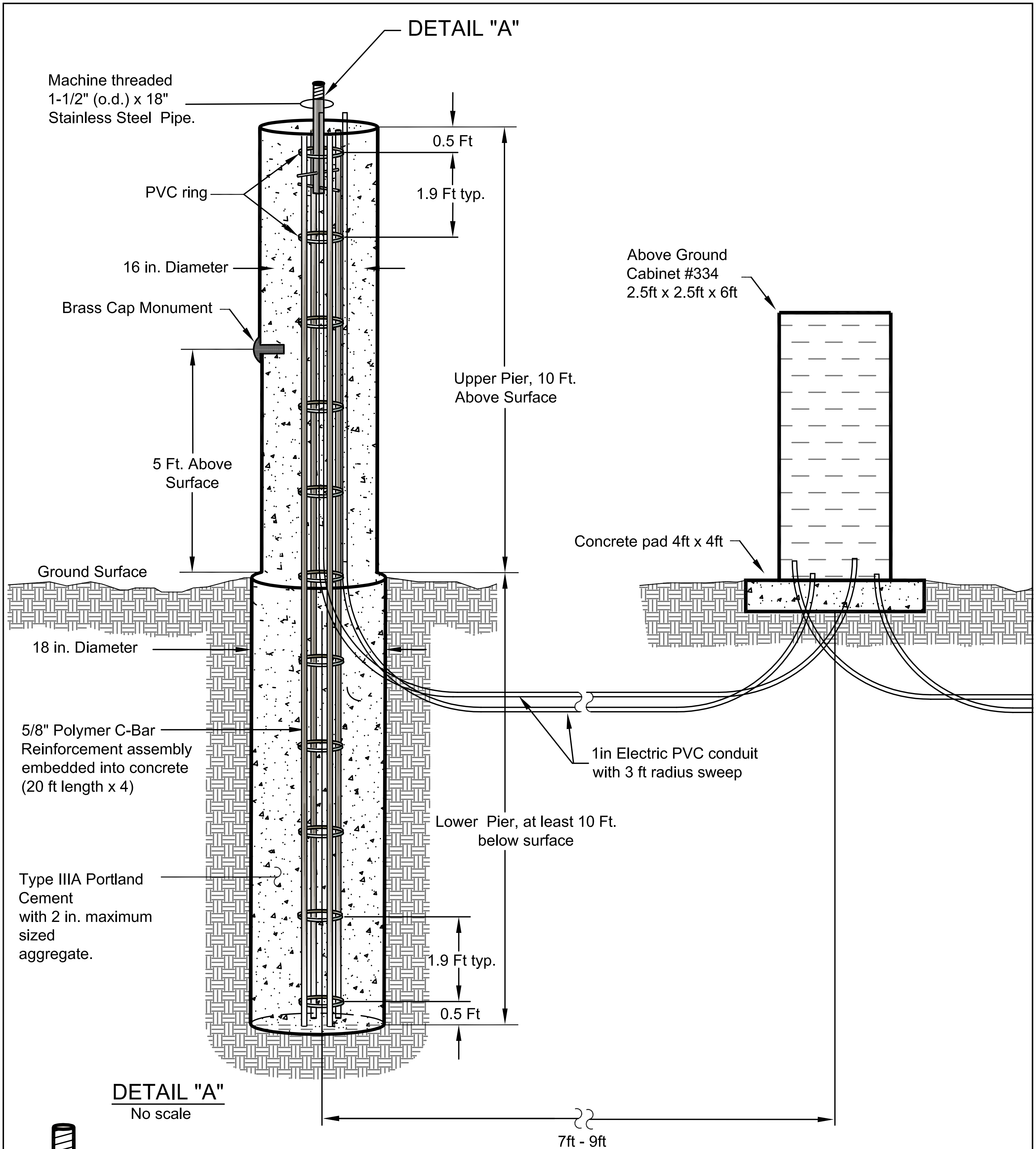
DECEMBER 2019

DRAFT

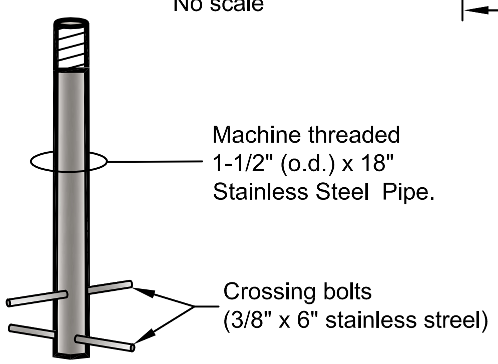
FIGURE 3

10Jan2020 Z:\Projects\1900668_KGA_GSP\GSP040_MTMO_WQ_MonNetwork_20200110.mxd AB/SI

Attachment 1. CGPS CDOT Design



DETAIL "A"
No scale



Caltrans 855 M Street, Suite 200, Fresno, CA 92721	Monument CVSRN		TAFT MS Station Name
	CENTRAL VALLEY SPATIAL REFERENCE NETWORK C V S R N	Design By: GC	Revision: Feb 20, 2007
		Drawn By: PNP	Scale: None
		File: Monument TAFT	
		Date:Feb 20, 2007	Sheet 1 of 1

Attachment 2. CGPS UNAVCO Design and Resources

Deep Drilled Braced Monument Overview

Article ID: 300 | Rating: Unrated | Last Updated: Wed, Oct 26, 2011 at 6:49 PM

Deep Drilled Braced Monument

Back to comparison table	Mount Commonly Used	Stability	Cost	Install Time	Labor	Substrate	Site Impact
	 SCIGN mount	high	$7,500-15,000	2-4 d	3-4	BR, U	high

The deep drilled braced monument (UNAVCO DDBM*) provides for a high degree of stability and longevity and can be anchored in bedrock or unconsolidated material. It is in the form of a tripod, each leg extending into the ground up to about 40 feet and welded at the top with gusset reinforcements. If site access is an issue and bedrock is available, the short drilled braced monument is the next best alternative to this type. The UNAVCO DDBM is used throughout the PBO network. It is based on the SCIGN design used at older installations in the SCIGN, BARGEN, PBO and PANGA networks.

* Modified from the original SCIGN DDBM design of Duncan Agnew and Frank Wyatt.

Site ASHM of the BARGEN network, Nevada, Utah, and California.

Pros

- high stability
- longevity
- can be installed in either bedrock or unconsolidated materials

Cons

- labor and tool intensive (requires a drilling rig and crew)
- expensive (can be $7,500 to $15,000, depending on drilling)
- time intensive (requires 2-4 days)
- may not be able to install in some remote locations... depends upon ease of site access
- large construction disturbance footprint

Design and Construction

A drilling contractor is required to install this monument. The cost of installation can typically range between $6,000 and $10,000 depending upon factors such as the type of drilling rig used, distance the drill rig and crew need to travel to site (mobilization/de-mobilization), foundation material (ground) being drilled, etc.

- Driller's Instructions (.pdf)

Documents

- Deep Drilled Braced Monument Technical Drawings in .pdf format:
  - Full
  - Above Surface
  - Top
  - Construction
  - Site Layout
  - Sub-surface
- Deep Drilled Braced Monument Alignment Tool Diagrams in .pdf format:
  - sign-01-01-010.pdf
  - sign-01-01-020.pdf
  - sign-01-01-030.pdf
  - sign-01-02-010.pdf
  - sign-01-02-020.pdf
  - sign-01-02-030.pdf

Installation Photos

- Construction Photos

Approximate Cost

$7,500-15,000 depending principally on drilling (substrate, distance drill rig needs to travel to and from the site)

This cost is for the monumentation only; the antenna mount (e.g. SCIGN mount) is not included.

Materials

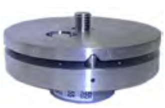
- 21-foot 1.25" diameter schedule 40 stainless steel pipe, threaded (5 per site)

- 10-foot 1.25" diameter schedule 40 stainless steel pipe, threaded (5 per site)
- 1.25" schedule 40 stainless steel threaded adapters (5 per site)
- 3 weld gussets
- threaded adapter (if using the SCIGN antenna mount; see below)
- 2.5" diameter schedule 40 PVC (for each leg and for center post)
- foam wrapper (for each leg and for center post)
- rebar (for each leg and for center post)
- duct tape (for foam)
- concrete (provided by drillers)
- water (provided by drillers)
- welding rod
- gas for the generator (if there is no AC hookup)
- string, paint, nails, and wood stakes (for marking legs)

Tools

- generator (if there is no AC hookup)
- compass
- reel measuring tape (30m/100ft)
- leg alignment tool
- mallet
- large vice grips (2 or more)
- grinder
- vertical and angle level(s)
- welder
- file, pick, brush, gloves, helmet, long-sleeved shirt, hat (for welding)

Mount Commonly Used



The SCIGN mountis the antenna mount most commonly used with the deep drilled braced monument, although it is only required when using the SCIGN radome. Otherwise, any other leveling mount, such as the SECO 2072-series antenna mount, is acceptable.

GPS Deep Drilled Braced Monument Installation
Driller Instructions

Overview

The deep drilled braced GPS monument (DDBM) is designed to create a highly rigid and immobile structure isolated from surface soil movement and cemented in place at depth. The monument consists of 5 legs (stainless steel pipes) placed into drilled holes, and welded together above the surface to create a "tripod" frame. Of the 5 legs, the center leg is vertical and the 4 other legs are installed at angles to brace the vertical leg.

The Plate Boundary Observatory (PBO) project will require the installation of at least 600 of these DDBM monuments throughout the Western US and Alaska. We hope to locate a small number of highly skilled contractors throughout the Western US and Alaska to install these monuments during the next five years. This scope of work is for a one-time installation project consisting of a small number (1-5) of these installations. This will allow us to evaluate the contractor for possible future work within PBO. Please provide a quote for services based upon the scope of work outlined below.

Material

Contractor to supply to the following material:

1) A sufficient amount of grout to fill 5-35 foot deep holes (4.5"-6" diameter) will be used. Contractor will assure the following:

   a) Type I, II Portland cement and Class F Flyash shall be used for grout materials.
   b) Flyash shall replace 10-15% of the volume of Portland cement.
   c) Grout shall be proportioned to have a water to cementitious material ratio of 0.50.
   d) If using pre-packaged grout, grout shall be 1118 Grout supplied by Surecrete, Seattle, WA, or an approved equal meeting these specifications. Grout 1119 should be used for applications when water is present in the hole.

2) Water sufficient to mix grout. Final mix should be consistency of a milk shake.

All other material will be supplied by UNAVCO.

Construction Procedure

Drilling/Casing/Pipe Placement

1) Drill rig type and size selection shall be determined by contractor such that equipment used is most suited to site geology and hole precision requirements.

2) UNAVCO shall provide to the contractor a summary of expected site conditions such as surface topography and subsurface material.

3) Contractor shall drill 5 holes of 4.5” diameter to minimum depths of 35 ft.

a) Center hole shall be drilled at vertical orientation plus/minus 2 degrees.
b) Four angled holes shall be drilled at 35 degrees from vertical plus/minus 2.5 degrees.

4) Holes drilled at precise locations specified by UNAVCO engineering staff. Frequent measurement of hole inclination during drilling shall be made to ensure holes are drilled to exact specifications. The centerlines of all 5 holes shall intersect at a single point plus/minus 3”. This point of intersection shall be located 62” above the surface, at the center leg. On level ground, each of the 4 angled legs will enter the ground at 43.5” from the center leg.

5) All holes shall be drilled straight enough so that PVC casing can be installed in the top 15.5 ft of each hole, and that the steel pipe can be freely lowered, not forced, for its entire 35 ft length.

6) Hole depth is to be determined by actual measurement after drilling. If necessary, loose material may need to be removed from the bottom of the holes to achieve required depth.

7) 2.5” PVC casing (wrapped with insulation) shall be installed in upper 15.5 ft of each hole immediately after drilling. It may be necessary to use drill rig to push casing into hole.

8) Contractor shall assist UNAVCO staff in placement of steel piping immediately after drilling and casing installation. 1.25” schedule 40 steel pipe shall be installed inside casing in each hole to a depth of 32-38 ft.

9) A single 5 foot vertical hole shall be drilled for the equipment enclosure.

10) UNAVCO is responsible for siting and alignment.

11) Contractor shall assist in the clearing of cuttings from the hole, during the drilling operation.

Grout Installation

1) Contractor shall provide grouting material and water for mixing.

2) All five legs are to be cemented in place with expansive grout.

3) Contractor shall prepare the pumpable grout to a “milkshake” consistency. Jobsite conditions may affect actual quantities of water needed.

4) Following steel pipe installation, contractor shall pump grout down steel pipes until grout fills pipe and pipe-casing annulus, and is seen emerging from top of annulus. Due to small clearances within pipe and at pipe-casing annulus, high pressures may be encountered during grout placement.

5) Contractor shall place grout such that no air bubbles are introduced. Ensuring a continuous flow of grout through pipe and back up through annulus requires proper grout handling, mixing, and pumping equipment and procedures.

6) Contractor shall neatly finish grout at surface of casing such that water will not puddle around monument legs.

Site Documentation and Cleanup

Contractor shall assist UNAVCO personnel in compiling site documentation including:

1) Depths of holes. All drilling documentation including drilled, measured, tamped, and shimmed pipe depths shall be recorded by contractor.

2) Grout information. Time of day, grout sack ID#, grout amount sifted, mixed, pumped, and lost shall all be monitored by contractor and reported to UNAVCO engineer for recording.

3) Contractor shall be responsible for removal of hazardous materials (i.e. hydraulic fluid, diesel fuel and/or contaminated soil) and debris. Site shall be left in suitable condition.

4) Contractor shall be responsible for containing and disposing of excess grouting material and debris such as cement bags, trash, and cigarette butts.

5) Contractor shall be responsible for leveling and raking of areas that were disturbed by drill rig and support vehicles at the site.

Miscellaneous

1) Contractor is responsible for hotel and per diem for the drilling crew.

2) Contractor shall assist UNAVCO personnel in any tasks related to GPS site installation such as pipe/coupling preparation, installation of pipe and insulation piping.

3) UNAVCO will mark for Underground Services Alert.

4) UNAVCO will provide maps, directions and relevant access information for drilling access.

5) Contractor’s equipment and tools are the sole responsibility of the contractor. UNAVCO will not reimburse the contractor for any lost or damaged equipment.

All work shall be done to highest professional standards.

GPS/GNSS Receiver Comparison Table

	Receiver	Multi-GNSS ?	Available as special buy	Available on loan	Serviceable at UNAVCO	File Size (24 hr, 15 s	Memory	Time lasts recording at 15 s	Power draw w/ antenna	Time lasts on 18amphr battery
	Alert Geomatics/XEOS Resolute Polar	Y	Y	Y	N	4.2MB	8GB	5.2 years	1.2 - 2W	1 Week
	Ashtech ProFlex 500 CORS	Y	Y	N	Y	N/A	8MB + Ext. USB	N/A	<5W	>1.5 days
	Javad Sigma	Y	N	N	N	N/A	up to 2 GB	N/A	4 W	1.9 days
	Leica GR25	Y	Y	N	N	1.6 MB 1.2 MB (zip)	up to 32 GB SD card	54 years on an 32 GB card	N/A	N/A
	Leica GR10	Y	Y	N	N	1.6 MB 1.2 MB (zip)	up to 32 GB SD card	54 years on an 32 GB card	3.5 W	2.5 days

	Septentrio PolaRx5	Y	Y	N	N	N/A	up to 32 GB	N/A	2-4 W	4.5 days
	Septentrio PolaRx4	Y	Y	N	N	N/A	up to 7.4 GB	N/A	6.1W	1.25 days
	Septentrio AsteRx3 HDC	Y	Y	N	N	N/A	N/A	N/A	N/A	N/A
	Septentrio AsteRx2el HDC	N	Y	N	N	N/A	N/A	N/A	N/A	N/A
	Topcon NetG5	Y	Y	N	Y	6.8 MB (default messages)	up to 32 GB	~10 years	4 W	1.9 days
	Topcon Net-G3 and Net-G3A	Y	Y	N	Y	6.8 MB (default messages)	up to 8 GB CF card	3.2 years	4 W	1.9 days
	Topcon GB-1000	Y	N	Y	Y	4.6 MB	1 GB internal, 1 GB CF card	1.2 years	3.9+ W	1.9 days

	Trimble NetR9	Y	Y	Y	Y	0.9 MB	8 GB Internal + External USB	24 years at 8 GB	3.8 W	2.4 days
	Trimble NetR8	Y	N	Y	Y	0.9 MB	4 GB	12 years	4.3 W	1.8 days
	Trimble NetR5	Y	N	N	Y	1.4 MB	256 MB	6 months	4.8 W	1.6 days
	Trimble NetRS	N	N	Y	Y	800 kb	1 GB	3.5 years	3.4 W	2.25 days
	Trimble R7	N	N	Y	Y	1 MB	up to 2 GB CF card	- 4 mo.- 5.5 years*or* 512 files	3.7 W	2 days
	Trimble 5700	N	N	Y	Y	1 MB	up to 2 GB CF card	- 4 mo. - 5.5 years*or* 512 files	3 W	2.5 days

	Trimble 4800/5800/R8	N	N	N	N	-	0 MB	requires external data collection	varies: 6+ W - 2.5 W	1.25 - 3 days
No longer supported	**Receiver**	**GNSS ?**	**Available as special buy**	**Available on loan**	**Serviceable at UNAVCO**	**File Size (24 hr, 15 s)**	**Memory**	**Time lasts recording at 15 s**	**Power Draw**	**Time lasts on 18amphr battery**
	Allen Osborne TurboRogue	N	N	N	N	2.2 MB turbo binary 900 kb conan binary	low	low	high	low
	Ashtech Z-12	N	N	N	N	1.8 MB	32 MB or less	18 days or less	12 W	15 hrs
	Ashtech MicroZ & ICGRS	N	N	N	Y	3.8 MB	- 32-128 MB	8 days - 1 month	8 W	23 hrs
	Canadian Marconi AllStar	N	N	N	N		0 MB	requires external data collection		
	Trimble 4000	N	N	N	N	1.8 MB	10 MB or less	5 days	10 W	18 hrs

	Trimble 4700	N	N	N	N		0 MB	requires external data collection	4.5 W	1.7 days

Available as special buy: Special pricing is available to UNAVCO members and associate members on select equipment. For more information see the GNSS Equipment Purchase Information page.
Available on loan: UNAVCO maintains a large pool of GPS and related equipment, available on loan to member and associate member institutions and NSF-funded programs. To submit a request, fill out the Online Support Request Form .
Serviceable at UNAVCO: UNAVCO is licensed to repair select GNSS receivers and antennas. For more information see the Equipment Repairs page.
File size (24 hr, 15 s): File size for a 24 hour-long file collected at a 15 second sample rate. File size is approximate and varies based on # of satellites tracked and frequencies recorded. File sizes shown here were taken from site data in the UNAVCO data archive.
Memory: Memory for receivers from the dealer may vary; values are given for UNAVCO-owned receivers.
Time last recording at 15 s: Estimated length of time the receiver can record at its given internal memory at a sample rate of 15 seconds.
Power draw: Estimated power draw in Watts. The power draw varies depending on the other equipment e.g. antenna(s) connected to the receiver.
Time lasts on 18 amphr battery: Estimated length of time the receiver can operate on the 12 volt, 18 amphr battery standard for UNAVCO campaign systems, without a solar panel. Time will vary based on temperature and battery health.

UNAVCO Resources: GNSS Antennas

Dual frequency (L1/L2) Choke Ring Antennas provide geodetic-quality GNSS measurements for surveying, map
Typical dual-frequency choke ring antennas maintain a stable phase center that has less than 1 mm of drift. T
on the geodetic research standard and features aluminum choke rings and a Dorne Margolin antenna elemen
have a low power consumption, and have excellent multipath rejection characteristics. Less-expensive but also
available as well. The UNAVCO Facility currently supports the following GNSS antennas.

GPS/GNSS Antennas Used by UNAVCO

MENU

	Trimble Choke Ring	• NGS antenna calibration (Trimble GNSS Choke Ring, TRM59800.00 SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=TRM59800.00_SCIT.atx) • NGS antenna calibration (TRM29659.00 SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=TRM29659.00_SCIT.atx) • Note: Trimble GNSS Choke Ring TRM59800.80 is a TRM29659.00 reworked with a wide-band low noise amplifier (LNA) for GNSS. The TRM59800.00 and TRM59800.80 elements are identical in construction, the two antenna types are assumed to show similar phase center corrections. The TRM59800.80 calibrations are copies of the TRM59800.00 calibrations.
	Ashtech Choke Ring	• NGS antenna calibration (ASH701945G_M SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ASH701945G_M_SCIT.atx) • NGS antenna calibration (ASH701945E_M SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ASH701945E_M_SCIT.atx) • NGS antenna calibration (ASH701945C_M SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ASH701945C_M_SCIT.atx) • NGS antenna calibration (ASH701945B_M SCIT) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ASH701945B_M_SCIT.atx) • NGS antenna calibration (ASH700936D_M NONE) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=ASH700936D_M_NONE.atx) • Preliminary Report on Data Quality with a Trimble 5700 GPS Receiver and an Ashtech Choke Ring Antenna (2002) (http://kb.unavco.org/kb/article.php?id=237)

MENU

	Trimble Zephyr Geodetic	• NGS antenna calibration (TRM41249.00 NONE) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=TRM41249.00_NONE.atx) • NGS antenna calibration (TRM57971.00_NONE) (http://www.ngs.noaa.gov/ANTCAL/LoadFile?file=TRM57971.00_NONE.atx) • Trimble Zephyr Geodetic - Dimensions (from Trimble) (http://kb.unavco.org/kb/article.php?id=240) • The Design and Performance of the Zephyr Geodetic Antenna (Trimble publication) (http://kb.unavco.org/kb/article.php?id=241)
	Trimble Zephyr	• NGS antenna calibration (TRM39105.00) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM39105.00)
	Topcon PG-A1	• NGS antenna calibration (TPSPG_A1+GP) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TPS&Antenna=TPSPG_A1,GP) • Topcon PG-A1 Antenna Dimensions (.pdf) (http://kb.unavco.org/kb/assets/102/TPSPG_A1GP.pdf)
no photo available	AOA TurboRogue SNR-800	• NGS antenna calibration (AOAD/M_T) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=AOA&Antenna=AOAD/M_T)
no photo available	Trimble L1/L2 microcentered geodetic with groundplane	• NGS antenna calibration (TRM33429.20+GP) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM33429.20,GP)
no photo available	Trimble Permanent L1/L2	• NGS antenna calibration (TRM23903.00) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM23903.00)
no photo available	Trimble Geodetic Compact L1/L2	• NGS antenna calibration (w/ ground plane) (TRM22020.00+GP) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM22020.00,GP) • NGS antenna calibration (w/o ground plane) (TRM22020.00-GP) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM22020.00-GP)

no photo available	Trimble 4000SST L1/L2 Geodetic	• NGS antenna calibration (TRM14532.00) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM14532.00)
no photo available	Trimble 4000SSE Kinematic L1/L2	• NGS antenna calibration (TRM14532.10) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=TRM&Antenna=TRM14532.10)
	UNAVCO/Micro Pulse L1	• NGS antenna calibration (MPL1370W) (http://www.ngs.noaa.gov/cgi-bin/query_cal_antennas.prl?Model=MPL&Antenna=MPL1370W) • UNAVCO/Micro Pulse L1 - How to make UNAVCO's L1 antenna (http://kb.unavco.org/kb/article.php?id=635)

MENU

Setting up GPS/GNSS Antennas

- Introduction to GNSS Antenna Set-up Methods for Campaigns (http://kb.unavco.org/kb/article.php?id=71)
  An introduction for inexperienced surveyors including antenna height measurement methods and g
- How to use declination to align the GNSS antenna to true north (http://kb.unavco.org/kb/article.php?id=61)
  Antennas are typically aligned to true north to keep measurements both within and between campa
  that the location of the antenna phase center is modeled correctly.
- Geographic Magnetic Calculator (http://www.resurgentsoftware.com/GeoMag.html)
  Link to software you can download and use to calculate the declination in your study area.

Development and Testing of GPS/GNSS Antennas

- Choke Ring Antenna Calibrations (http://kb.unavco.org/kb/article.php?id=311)
- Equipment Power Usage Testing (http://kb.unavco.org/kb/article.php?id=235)
- Antenna Phase Center Plots (.pdf) (http://kb.unavco.org/kb/assets/242/phaseplots.pdf) (L1 and L2 phase center p
  Trimble Zephyr Geodetic, Trimble Zephyr, and Leica Choke Ring antennas)
- Iridium & GPS Antenna Interference Test (2008) (http://kb.unavco.org/kb/article.php?id=110)
- Assessing the Impact of the SCIGN Radome on Geodetic Parameter Estimates (2007) (http://kb.unavco.or
- Development of an antenna and multipath calibration system for Global Positioning System sites (2
  (http://kb.unavco.org/kb/article.php?id=254)
- UNAVCO 2004 GPS Campaign System Testing in Support of the Plate Boundary Observatory (PBO) (2
  (http://kb.unavco.org/kb/article.php?id=5)
- UNAVCO 2003 GPS Receiver and Antenna Testing in Support of the Plate Boundary Observatory (PB
  (http://kb.unavco.org/kb/article.php?id=15)
- Multipath characteristics of GPS signals as determined from the Antenna and Multipath Calibration
  (http://kb.unavco.org/kb/article.php?id=253)
- Preliminary report on data quality with a Trimble 5700 GPS receiver and an Ashtech Choke Ring Ant
  (http://kb.unavco.org/kb/article.php?id=237)

UNAVCO Resources: Permanent GNSS Station Enclosures

Article ID: 381 | Rating: 1/5 from 2 votes | Last Updated: Wed, Aug 24, 2016 at 8:36 PM

UNAVCO Resources: Permanent GNSS Station Enclosures

UNAVCO has installed and supports a large variety of equipment enclosures for both AC and DC GNSS sites, from enclosures specifically designed for solar systems (the SunWize battery enclosure) to simple storage containers modified to accommodate cable pass-throughs. We can work to find the most suitable enclosure given the budget and the location of each permanent or semi-permanent GNSS installation. Below is a list of enclosures used within the last several years in UNAVCO-supported projects; click on the photographs to see sample content lists and more photos of actual installations. For standard UNAVCO campaign enclosures, check out UNAVCO Campaign GNSS Systems .

	SunWize Premium F-Series Battery Enclosure	The SunWize F-Series 4-battery enclosure is used throughout the Plate Boundary Observatory network, as well as in several other permanent GPS station networks in the US. Benefits include reasonable strength (the enclosure is made of aluminum), security (two key locks secure the enclosure), both internal and external knockouts for passing wires and cables, weatherproof seals, and a generous amount of space. Drawbacks include cost ($700-$1000 as of February 2009), size (if on-site space is limited or if equipment must be shipped), and mounting requirements (enclosure is designed to be mounted on a post, which must be cemented into the ground and strong enough to support batteries).
	Hardigg Case	Hardigg (now owned by Pelican Products) makes rugged, well-sealed plastic enclosures which are stackable, easy to handle, and UV resistant. Connectors are recessed within the ribs of the case to reduce the risk of damage during shipping.

	JOBOX	JOBOX chests, made by Delta Consolidated Industries, Inc. , are durable, weatherproof metal enclosures that UNAVCO has used in several long-term installations, including the EarthScope-sponsored Rio Grande Rift network. Chests are secured with key locks. The major drawback of the JOBOX is weight; boxes are heavy and cumbersome, thus not ideal for shipping and for transporting by foot over long distances. Cost of the box shown here is approximately $300-400 (as of February 2009).
	Pelican Case (large)	The Pelican case is easily portable, can be used to transport equipment, and is weatherproof. The case shown here, as deployed in the EarthScope-sponsored Rio Grande network, contains 2 100 amphr batteries in addition to the GPS receiver. The case is difficult to destroy and can be locked with padlocks. Cost is approximately $250-$300 (February 2009). Smaller cases are available (see below), and have been used in networks with year-round, reliable sunlight where large battery banks are not required.
	Pelican Case (small)	Like the larger Pelican cases (above), the smaller Pelican case is weatherproof and can be used to transport equipment. A smaller case is ideal if space is not an issue--specifically, if the requirement for amount of power stored is small (e.g. in a year-round sunny environment, as is common near the equator). The case is difficult to destroy and can be locked with padlocks. Networks utilizing small Pelican cases include Afar, Ethiopia, and Sierra Negra, Galapagos. Cost for the case shown here is approximately $125 (February 2009).
	Commercial Electrical Enclosure	Electrical boxes can be often purchased 'locally,' in major cities, rather than being shipped. Boxes may include knock-outs for passing cables through and locking options, like the box shown here. Electrical boxes are often sturdy, made of either strong plastic or of metal, and may or may not be weatherproof. Networks utilizing local electrical enclosures include Calabria, Italy and Bangladesh. Typical price range is about $100-$300.

	Storage Container	A heavy-duty storage container, such as the Contico Tuff Box, designed for the back of a truck or other outdoor use may work well for an equipment enclosure. They are generally low cost (about $70 for the container shown here, as of February 2009), available in most US cities, rugged, and lockable with padlocks. The case shown here fits four sealed 100 Amphr batteries along with the GPS and communications equipment. Used as enclosures in the Peatland Bog, Minnesota network.

Cellular Modem Summary

Article ID: 357 | Rating: Unrated | Last Updated: Wed, Oct 28, 2009 at 3:12 PM

Cellular Modem Summary

Cellular modems need to be very robust as the inherent disadvantages of the analog cellular phone system become especially evident with high speed data transfers. Cellular coverage could be of a quality not compatible with high speed data transfers and handshaking protocols. Often more than one cellular provider offers coverage in an area and it is worthwhile to investigate several options. A good voice communication does not translate into an acceptable data communication. Your choice of cellular modem and cellular phone should be able to run off 12VDC, even if AC power is available, to facilitate DC (battery) backup.

Suggested Minimum Requirements

- 12 VDC power
- V.32, V.32bis communication protocols
- V.42, MNP error correction/data compression
- RTS/CTS hardware flow control
- High speed baud rates (2.4-19.2 kbps)
- Compatible with CCITT and Bell standards
- Support industry-standard AT command set
- Compatible with RS-232 Control Signals

Information on radio modems used by UNAVCO

Proxicast LANCell Gateway

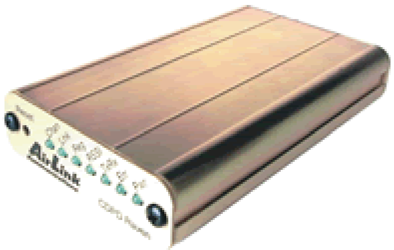
Used throughout the Plate Boundary Observatory (PBO) network, Western U.S.

- UNAVCO summary of Proxicast cellular modems and networking

ZyXEL U-1496P

- ZyXEL U-1496P Portable Cellular Modem Summary Page

Raven II CDPD



- How to use the Raven II CDPD modem with the Lantronix MSS100 serial-to-ethernet device

Attachment 3. Extensometer Design

SAMPLE DESIGN
FOR REFERENCE

PAGE No.	DRAWING No.	DRAWING TITLE
1	100	TITLE SHEET
2	300	TYPICAL RAT HOLE
3	301	GRADING AND FOUNDATION PAD
4	302	EXTENSOMETER UNIT
5	303	BUILDING
6	304	SCHEMATIC DIAGRAM OF EXTENSOMETER

REV	DATE	DESCRIPTION	SUB	APP'D

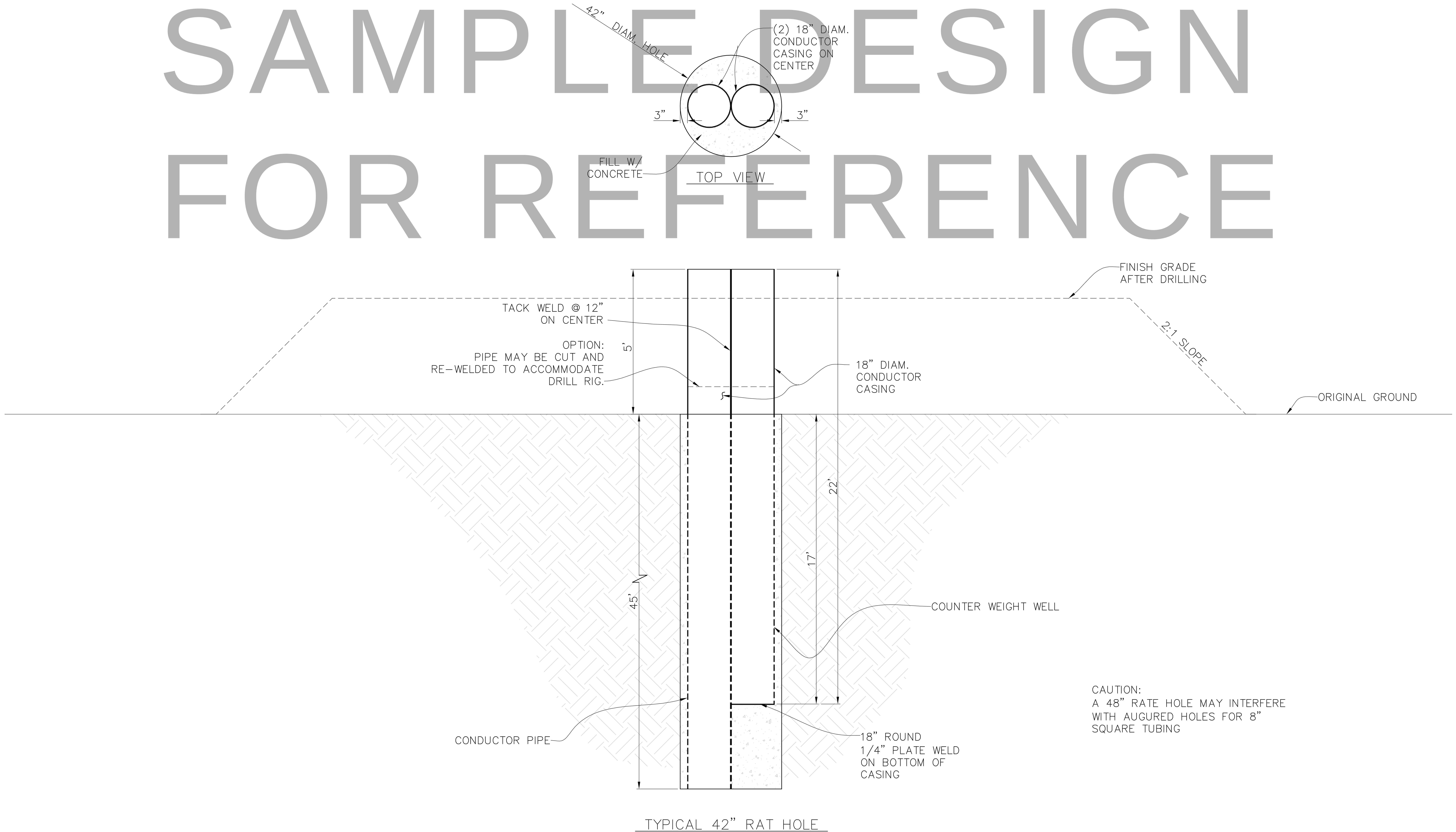
APPROVED BY: __________ DATE: __________

APPROVED

EXTENSOMETER CONSTRUCTION
TITLE SHEET

DATE

DRAWING NUMBER
100



CAUTION:
A 48" RATE HOLE MAY INTERFERE WITH AUGURED HOLES FOR 8" SQUARE TUBING

REV	DATE	DESCRIPTION	SUB	APP'D

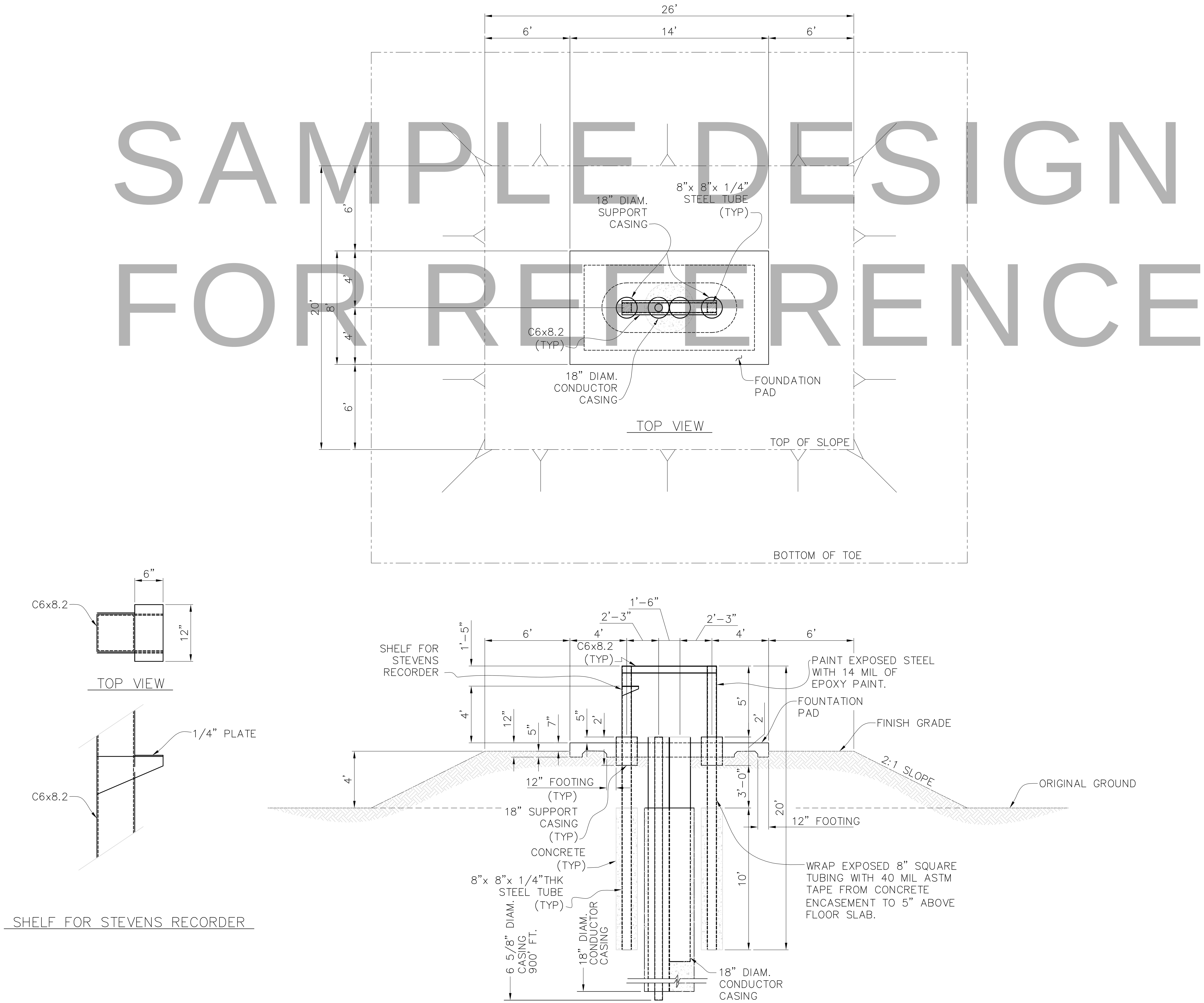
APPROVED BY: DATE:

APPROVED

EXTENSOMETER CONSTRUCTION
TYPICAL RAT HOLE

DATE

DRAWING NUMBER
300



REV	DATE	DESCRIPTION	SUB	APP'D

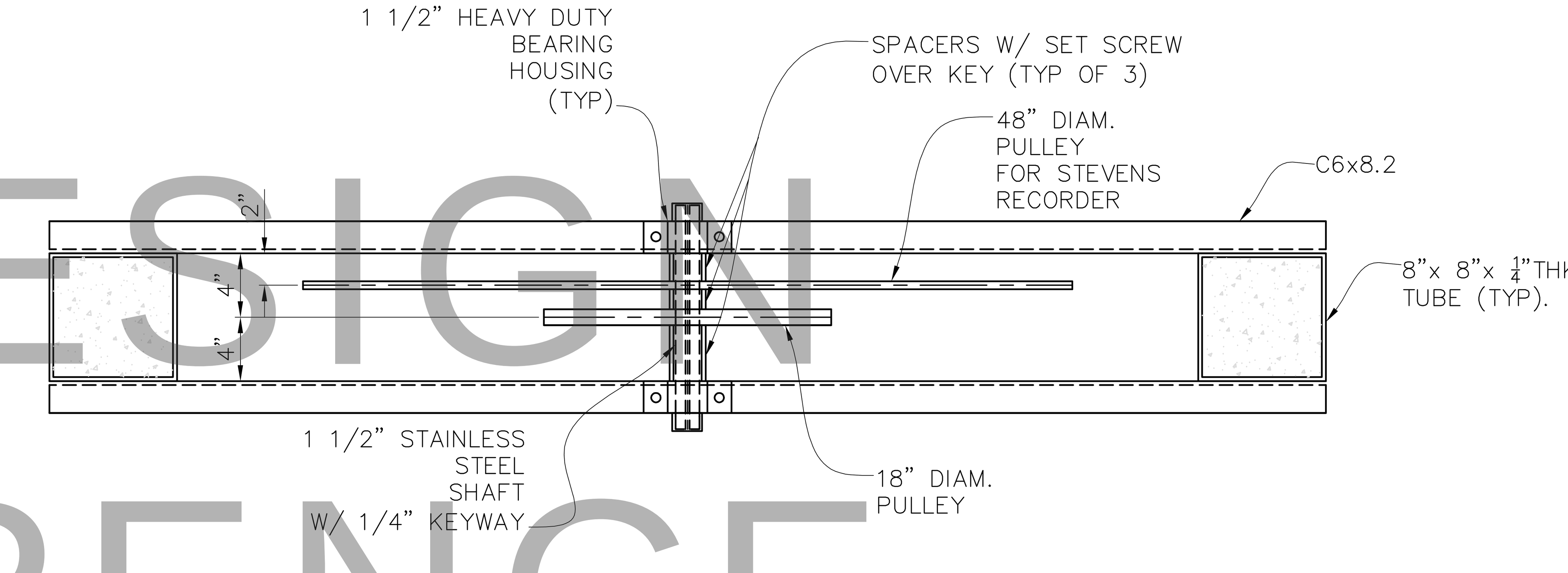
APPROVED BY: ____________ DATE: ____________

APPROVED

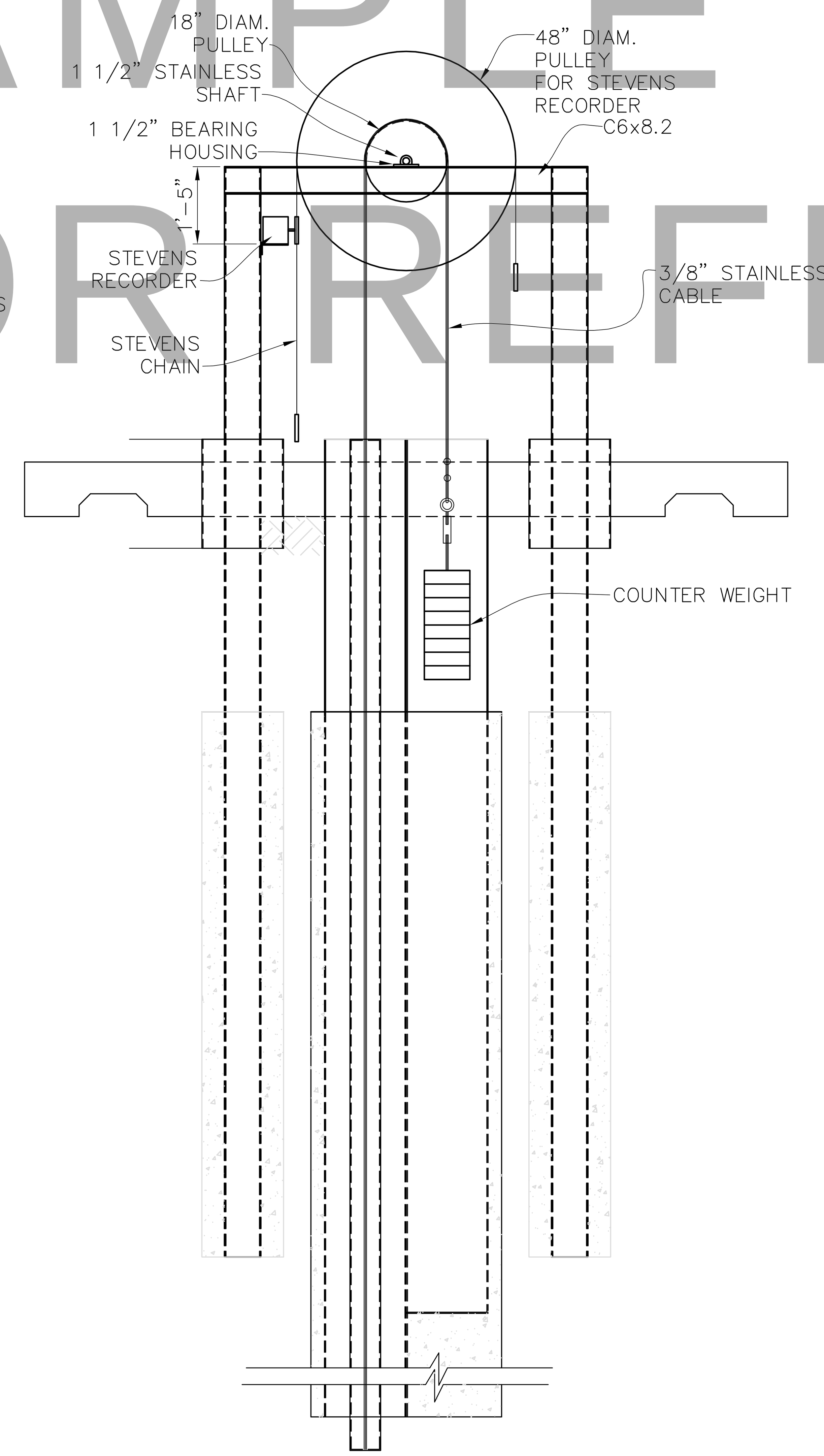
EXTENSOMETER CONSTRUCTION
GRADING AND FOUNDATION PAD

DATE

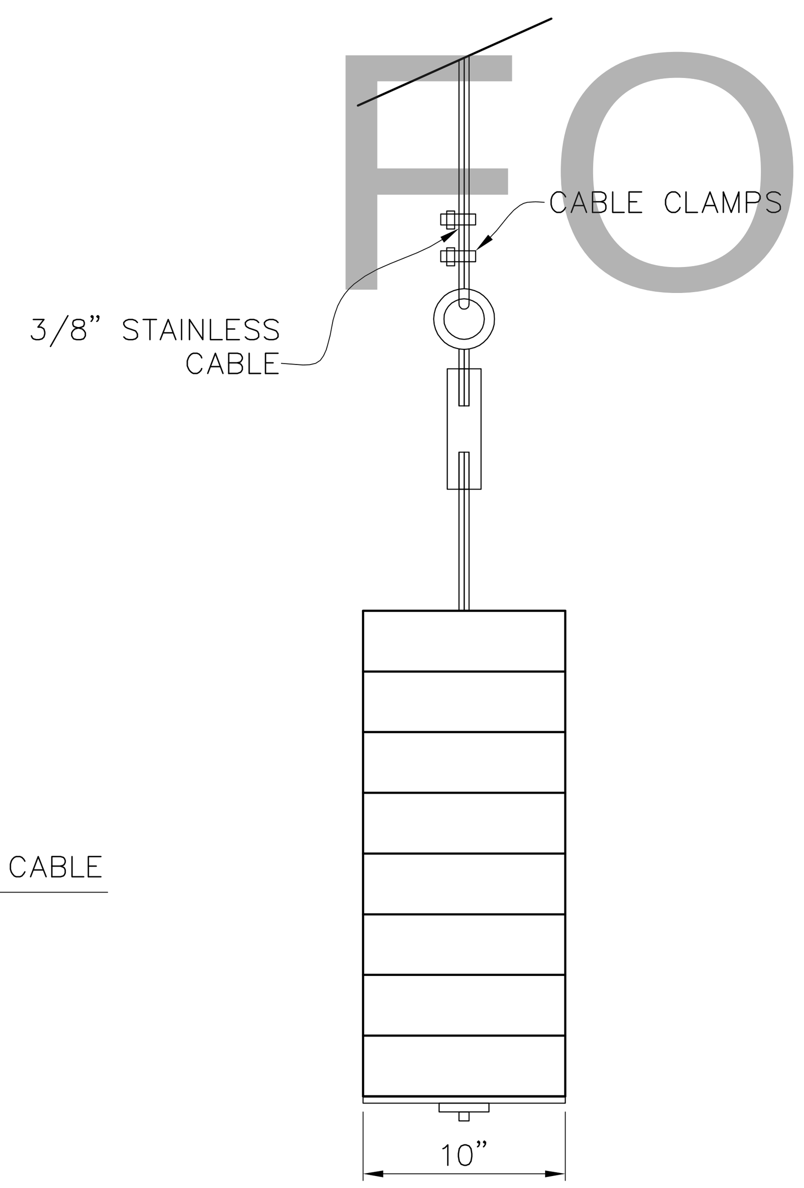
DRAWING NUMBER
301



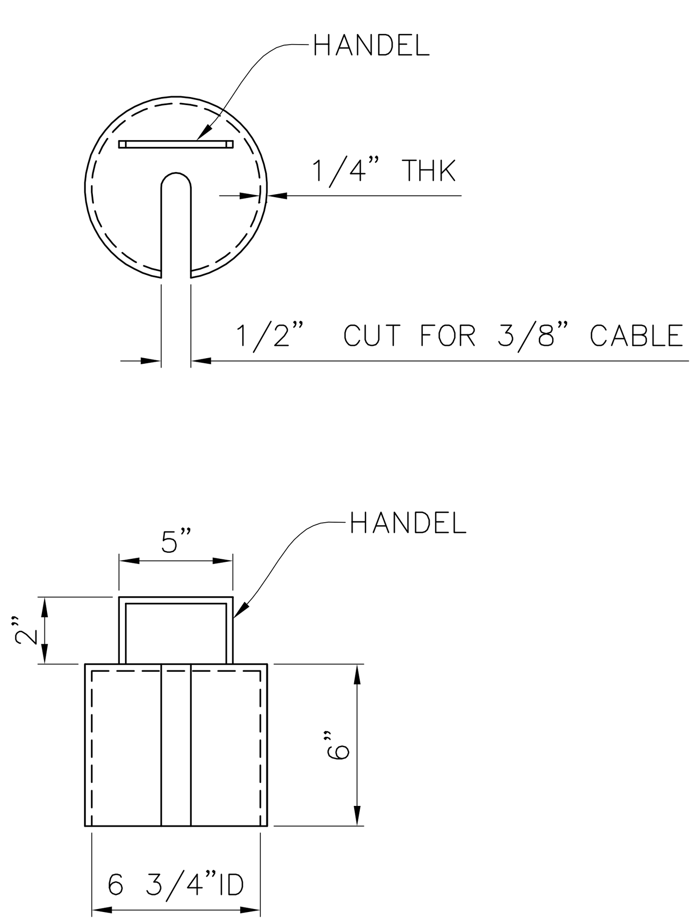
TOP VIEW



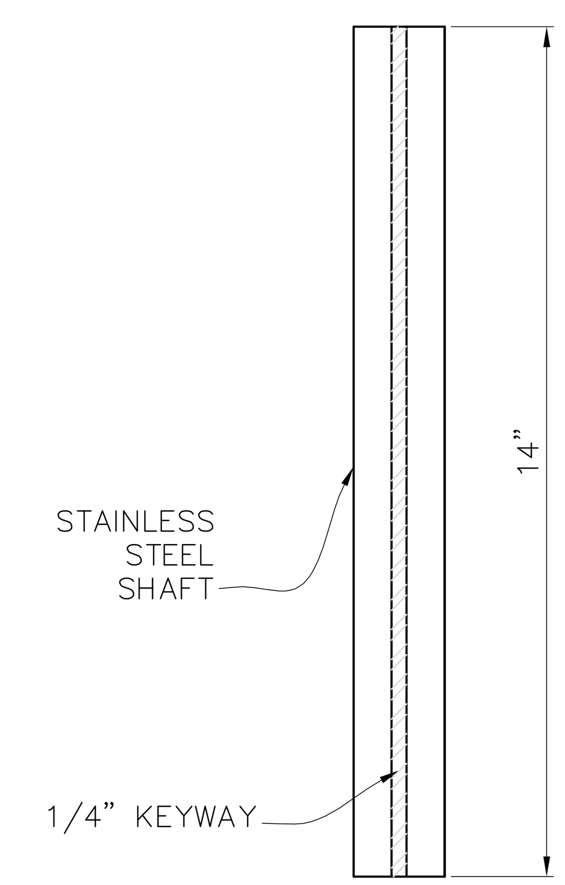
PULLEY ASSEMBLY

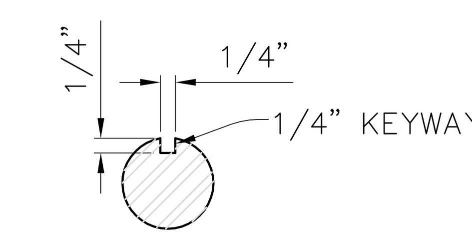


540 lbs
COUNTER WEIGHT



CASING CAP





1 1/2" SHAFT

REV	DATE	DESCRIPTION	SUB	APP'D

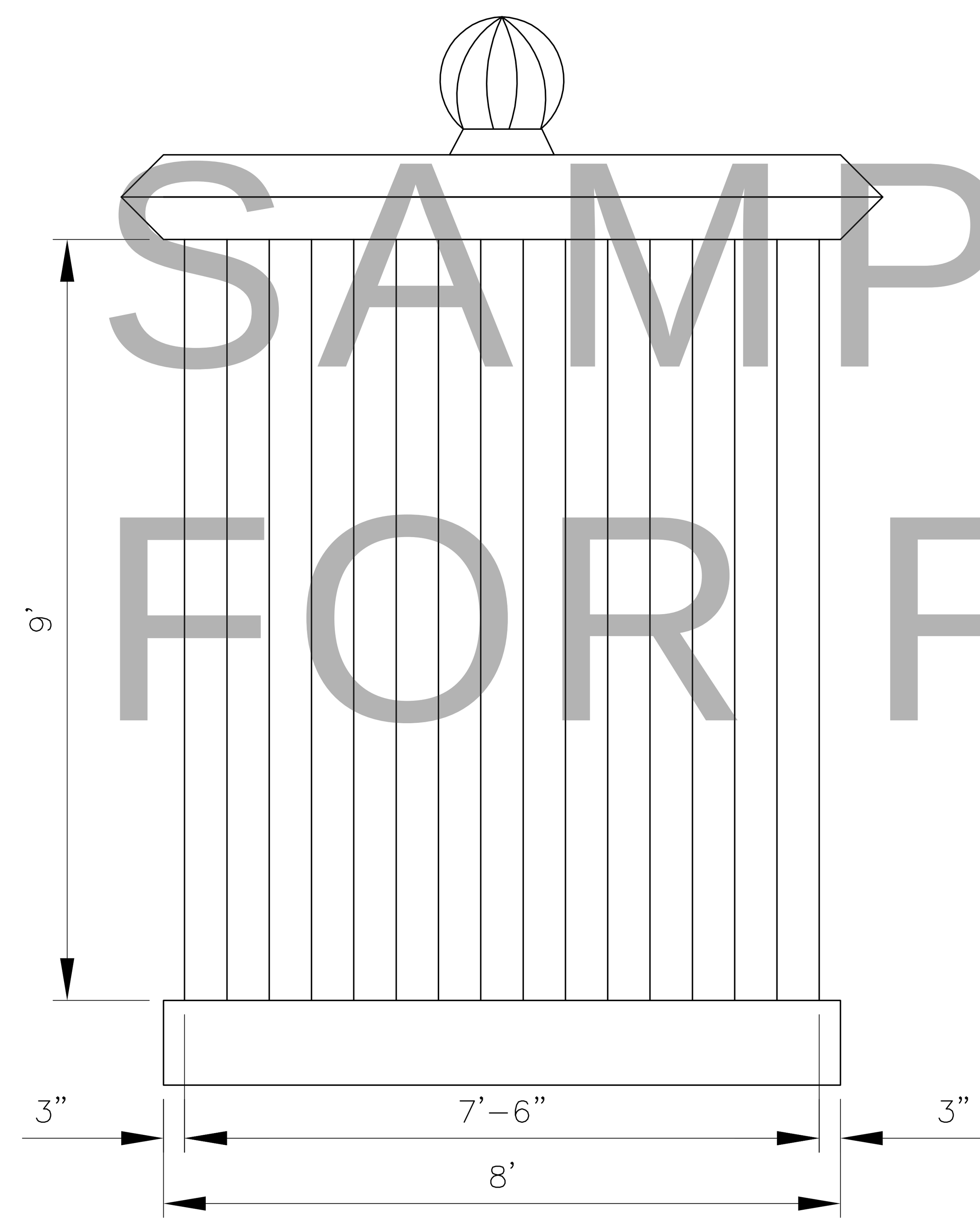
APPROVED BY: ____________ DATE: ____________

APPROVED

EXTENSOMETER UNIT

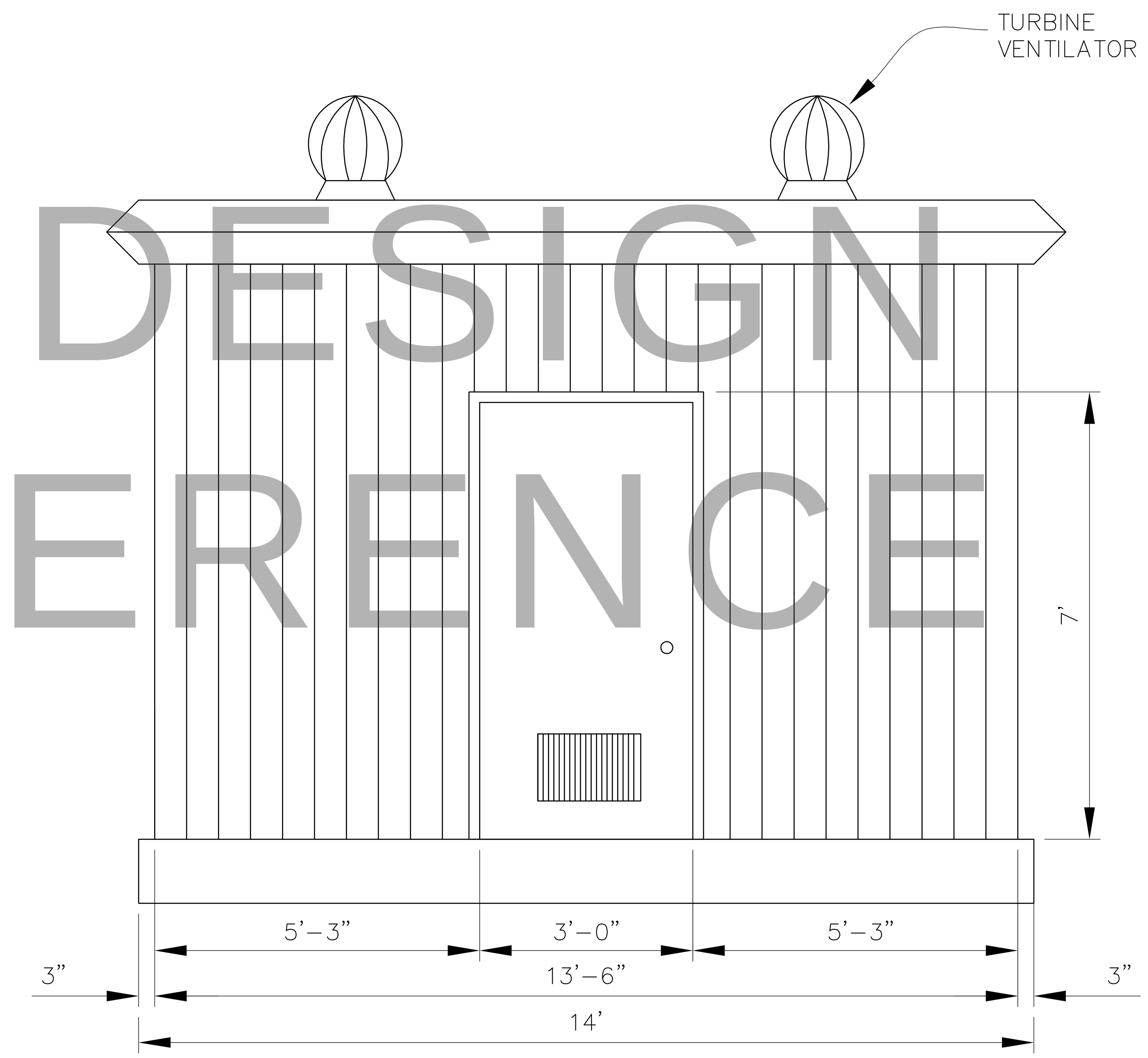
DATE

DRAWING NUMBER
302

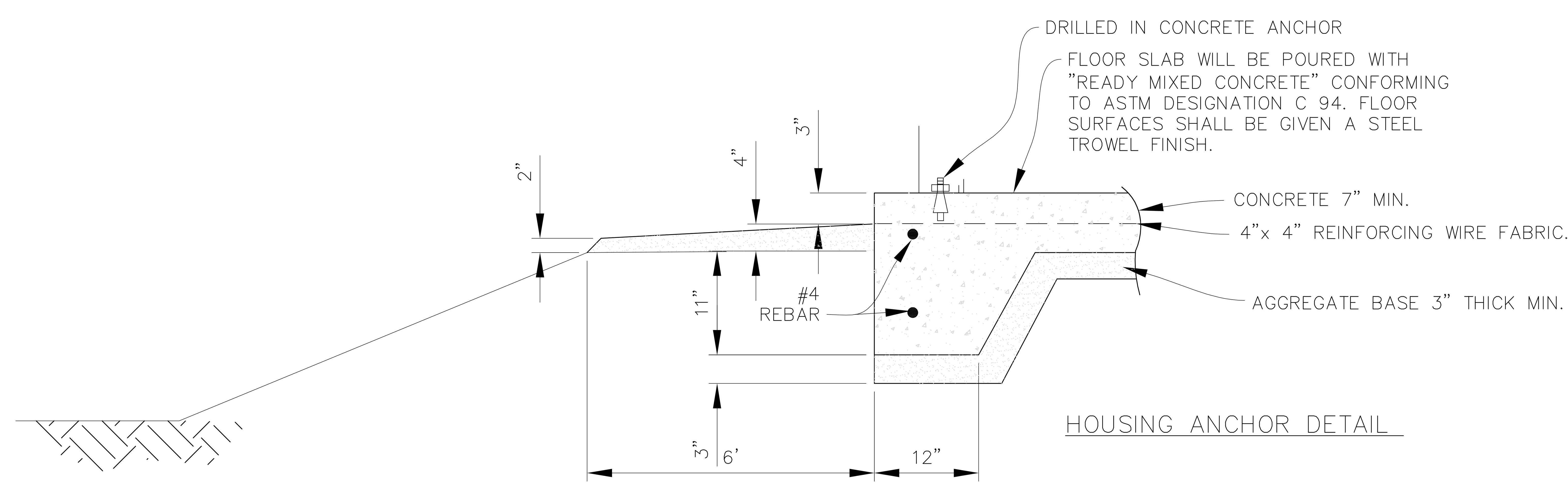


ENDWALL

ARMCO STEELOX BUILDING SYSTEMS TEC-LINE
1 BUILDING OR EQUIVALENT



SIDE VIEW



HOUSING ANCHOR DETAIL

REV	DATE	DESCRIPTION	SUB	APP'D

APPROVED BY:

DATE:

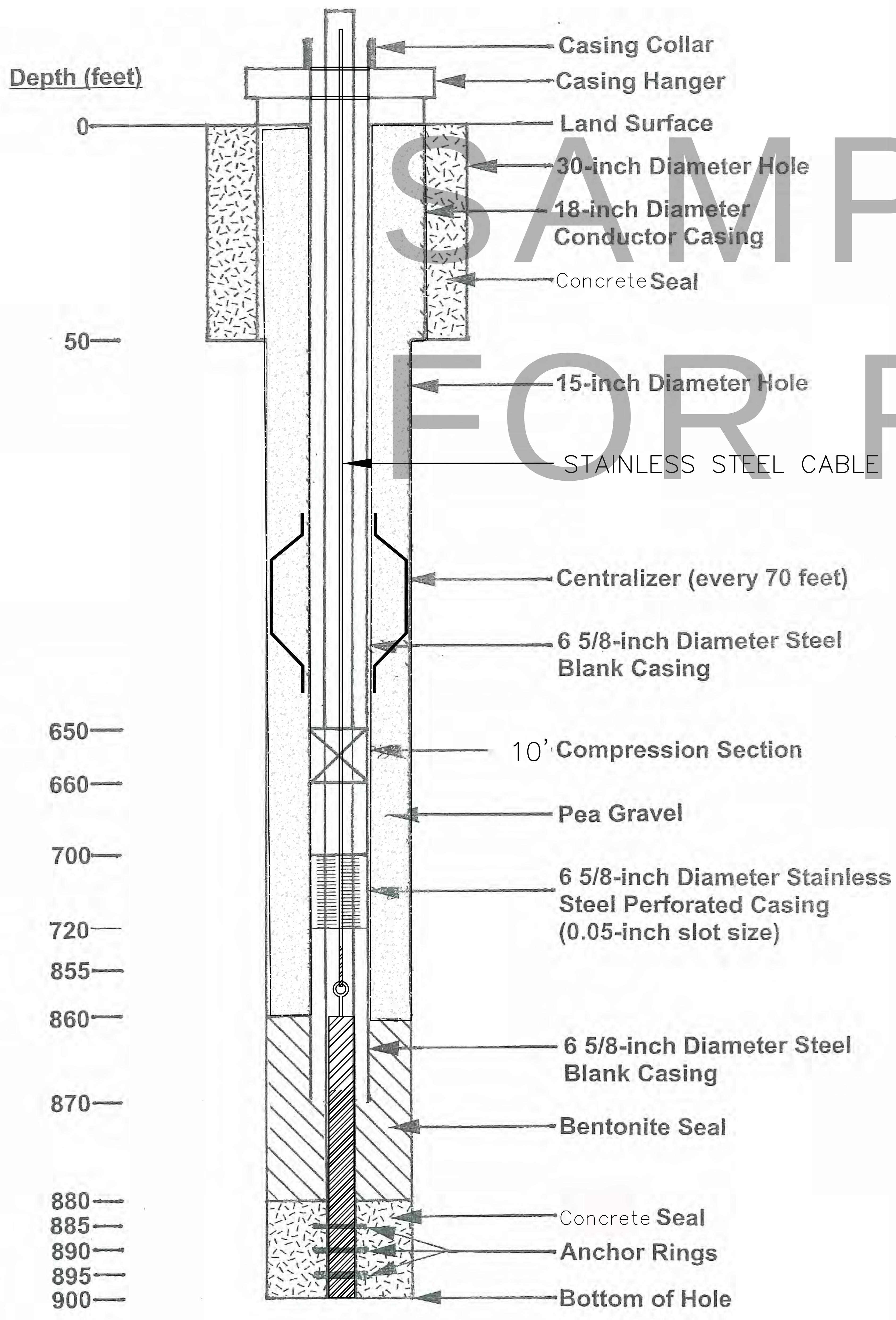
APPROVED

EXTENSOMETER CONSTRUCTION
BUILDING

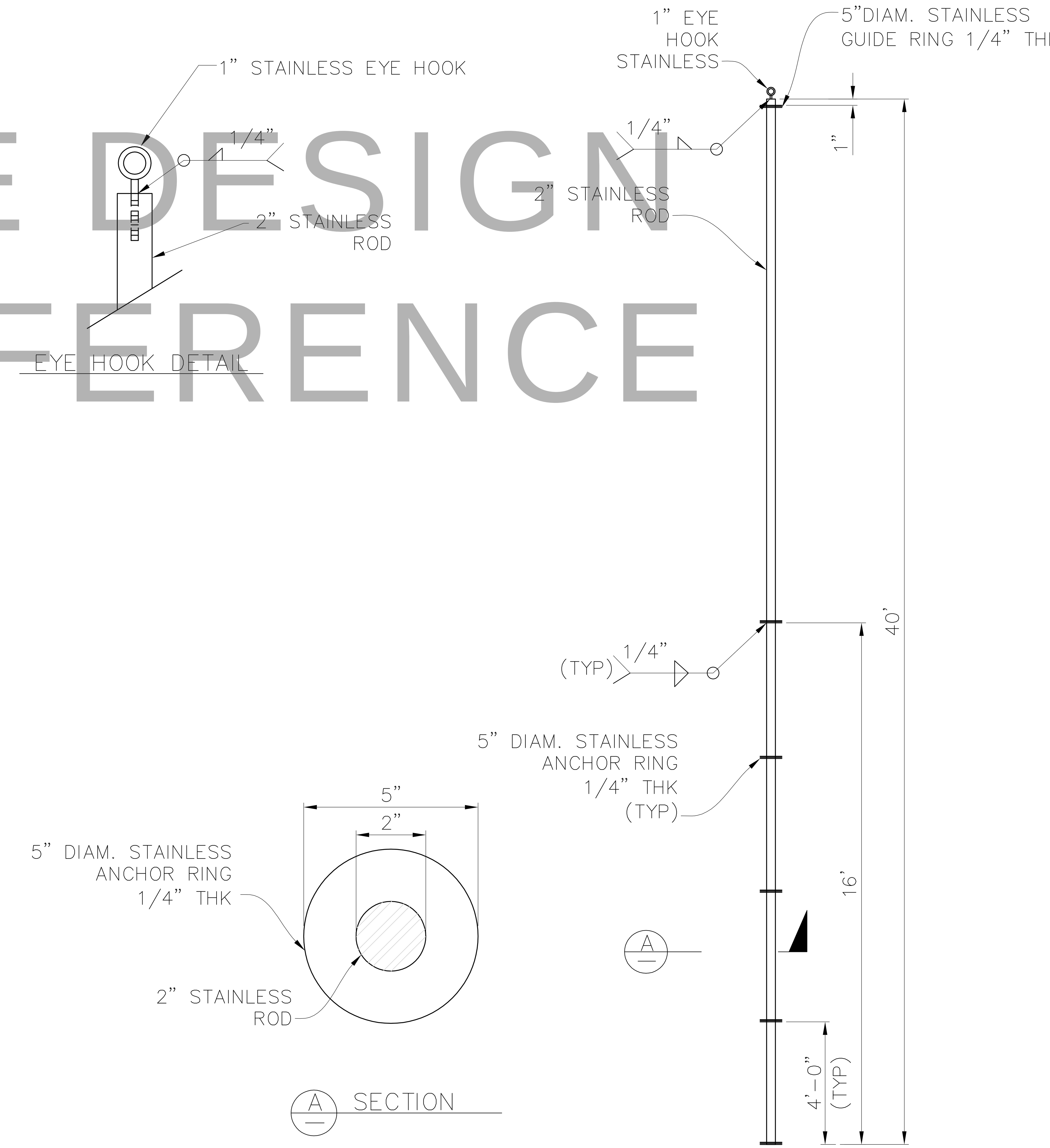
DATE

DRAWING NUMBER

303



SCHEMATIC DIAGRAM OF EXTENSOMETER



REV	DATE	DESCRIPTION	SUB	APP'D

APPROVED BY: ____________ DATE: ____________

APPROVED

EXTENSOMETER CONSTRUCTION
SCHEMATIC DIAGRAM OF EXTENSOMETER

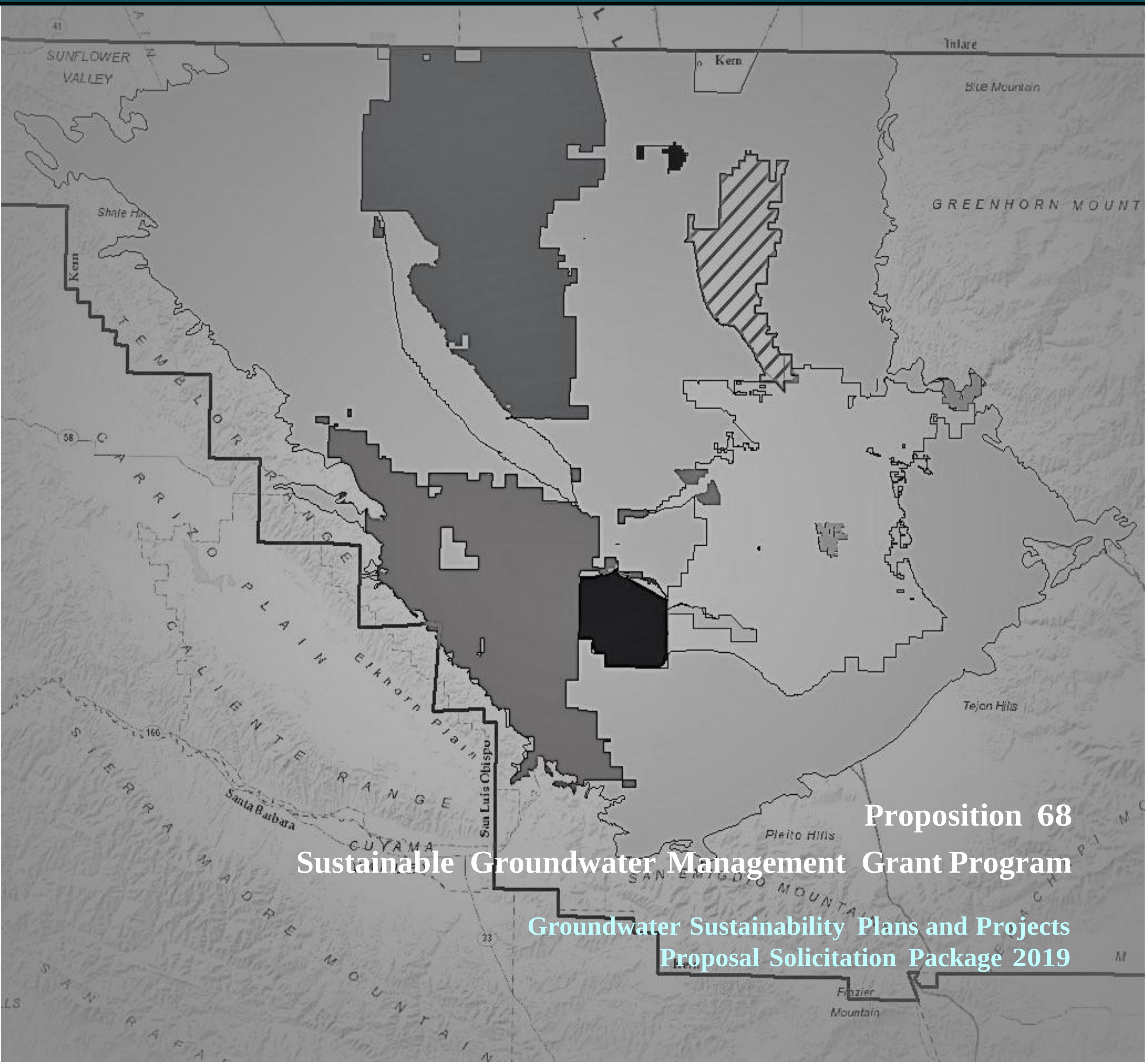
DATE

DRAWING NUMBER 304

APPENDIX 5

At this time, the Kern subbasin is working on the development of a basin-wide coordinated Data Management System. Please see the following documents related to that development of an application to DWR Prop 68 Grant requesting funds for the development. For the current year of annual reporting, see the following document related to a coordinated basin-wide cost share agreement.

Kern County Subbasin
Groundwater Sustainability Plan Support
2019 Grant Application



Proposition 68

Sustainable Groundwater Management Grant Program

Groundwater Sustainability Plans and Projects
Proposal Solicitation Package 2019

Proposal Full View

Applicant Information				
Organization Name*	Kern River GSA			
Point Of Contact	First Name:*	Kristin	Last Name:*	Pittack
	Email:*	kpittack@bakersfieldcity.us		
	Division Name:	City of Bakersfield	Phone:*	(661) 3263646 Ext:
	Address Line 1:*	1600 Truxtun Avenue	Address Line 2:	
	City:*	Bakersfield	State:*	California
	Zip:*	93301		
Point Of Contact Position Title*	Water Resources Planner			
Proposal Name*	Kern County Subbasin Groundwater Sustainability Plan Support - Phase II			
Proposal Objective*	The Kern County Subbasin is a critically overdrafted groundwater basin of high priority, located in the Southern San Joaquin Valley. The Proposal covers the entire Kern County Subbasin and is submitted by the Applicant, the Kern River Groundwater Sustainability Agency (KRGSA), on behalf of all the GSAs and participating entities in the Subbasin. The overarching goal of the proposed Subbasin Data Management System (DMS) Development project is to initiate the key steps to develop and build a Subbasin DMS. This DMS will ultimately support SGMA compliance by Subbasin GSAs by providing (1) improved coordination of groundwater monitoring and management actions and (2) the ability to meet the reporting and implementation requirements of SGMA for the Kern County Subbasin. To meet this goal, the project objectives are to retain a contractor to develop, manage, and coordinate use of the DMS with the GSAs and participating agencies; identify the data types that would be required to monitor GSP implementation and Subbasin progress toward sustainability; and investigate, select, and procure a commercially available or custom-designed DMS with an appropriate configuration that combines technical rigor, flexibility, ease of use, and expansion capabilities to store data in text, spreadsheet, graphical, and map-based formats. Some aspects of the DMS project, such as development of a User's Manual and DMS review and assessment, will be funded by the grant but may also be subject to GSA funding if needed. These tasks are included in the project Work Plan to provide context for the work to be completed under this Round 3 Planning funding request.			

Budget Information	
Other Contribution	$0.00
Local Contribution	$0.00
Federal Contribution	$0.00
Inkind Contribution	$0.00
Amount Requested*	$500,000.00
Total Proposal Cost*	$500,000.00

Geographic Information						
Latitude*	DD(+/-):	35	MM:	25	SS:	39
Longitude*	DD(+/-):	119	MM:	19	SS:	37
Longitude/Latitude Clarification	Location of the approximate center of the Kern County Subbasin.					
Location	The Kern County Subbasin is located in the center of the southern end of the San Joaquin Valley.					
County*	Kern					
Ground Water Basin	5-022.14 San Joaquin Valley-Kern County					
Hydrologic Region	Tulare Lake					
Watershed	115 7557 South Valley Floor; 116 7558 South Valley Floor					

Legislative Information	
Assembly District*	32nd Assembly District, 34th Assembly District
Senate District*	16th Senate District, 18th Senate District
US Congressional District*	District 21 (CA), District 23 (CA)

Project Information

Project Name: Subbasin Data Management System Development Project	
Implementing Organization	Kern River GSA
Secondary Implementing Organization	All of the Kern County Subbasin GSAs
Proposed Start Date	2/1/2020

Proposed End Date	7/31/2022
Scope Of Work	The scope of the project includes Grant Administration, Stakeholder Engagement / Outreach, GSP Development: Subbasin DMS Scoping and Development, and Review and Assessment. Deliverables include: executed contract with database development consultant; list of data types to be collected; report and recommendation on available formats for required information; and possibly recommendation and GSA Boards' decision to select a DMS package.
Project Description	The Kern County Subbasin is the largest Subbasin in California, with a complex water management structure, a large portfolio of local and imported water sources, and numerous large groundwater banking projects, collectively providing local and State-wide benefits for water supply. Given this framework, numerous structures for data management have been developed by local agencies for their own objectives, resulting in disparate data sets and isolated pieces of information. The Kern County Subbasin GSAs recognize the need to develop a centralized, Subbasin-wide DMS. Accordingly, the GSAs are cooperating on this proposal to support monitoring, evaluation, reporting, management, and, importantly, GSP implementation. The Subbasin GSAs have previously coordinated and collaborated on the basin-wide water modeling for GSP development and thus believe that this is the next step forward. The immediate need for a centralized DMS is highlighted by the GSAs' ongoing cooperative efforts for annual reporting. In order to comply with the requirements of SGMA for standardized reporting, and to coordinate on a Subbasin-wide basis for consistent data evaluation, it is crucial that a DMS be developed for the entire Subbasin that will allow the various GSAs to gather and share information regarding local groundwater conditions. The proposed DMS planning and scoping project will ultimately support Subbasin GSAs by providing (1) improved coordination of groundwater monitoring and management actions and (2) the ability to meet the reporting and implementation requirements of SGMA for the Kern County Subbasin.
Project Objective	The project objectives are to retain a contractor to develop, manage, and coordinate use of a Subbasin-wide DMS; identify the data types required to monitor the Subbasin's progress toward sustainability; and investigate, select, and procure a DMS with an appropriate configuration that combines technical rigor, flexibility, ease of use, and expansion capabilities to store data in text, spreadsheet, graphical, and map-based formats.

Project Benefits Information
No records found.

Budget Information	
Other Contribution	$0.00
Local Contribution	$0.00
Federal Contribution	$0.00
Inkind Contribution	$0.00
Amount Requested*	$500,000.00
Total Project Cost*	$500,000.00

Geographic Information						
Latitude*	**DD(+/-):**	35	**MM:**	25	**SS:**	39
Longitude*	**DD(+/-):**	119	**MM:**	19	**SS:**	37
Longitude/Latitude Clarification	Location of the approximate center of the Kern County Subbasin.					
Location	The Kern County Subbasin is located in the center of the southern end of the San Joaquin Valley.					
County*	Kern					
Ground Water Basin	5-022.14 San Joaquin Valley-Kern County					
Hydrologic Region	Tulare Lake					
Watershed	115 7557 South Valley Floor; 116 7558 South Valley Floor					

Legislative Information	
Assembly District*	32nd Assembly District, 34th Assembly District
Senate District*	16th Senate District, 18th Senate District
US Congressional District*	District 21 (CA), District 23 (CA)

Section : Questions

Q1. Project Description:

Provide a brief abstract of the proposal. This abstract must provide an overview of the proposal including the main issues and priorities addressed in the proposal. (25 words or less)*

This Proposal develops a data management system (DMS) that covers the Kern County Subbasin and allows Subbasin GSAs to improve GSP coordination, and implementation.

Q2. Previous Funding:

Has the applicant received prior funding through the Proposition 1 SGWP Round 2 grant?*

a) • Yes

b) No

If so, how much funds did the applicant receive?

$1,500,000

Q3. Project Representative:

Provide the name and details of the person responsible for signing and executing the grant agreement for the applicant. Persons that are subcontractors to be paid by the grant cannot be listed as the Project Representative. Other entities included in the GSA can be listed here.*

Rodney Palla
Chair, Kern River Groundwater Sustainability Agency
1600 Truxtun Avenue
Bakersfield, California, 93301
(661) 326-3767

Q4. Project Manager:

Provide the name, title, and contact information of the Project Manager from the applicant agency or organization that will be the day-to-day contact on this application.*

Kristin Pittack
Water Resources Planner, City of Bakersfield
1600 Truxtun Avenue
Bakersfield, CA 93301
(661) 326-3646

Q5. Eligibility:

Has the applicant met the requirements of DWR's CASGEM Program?*

a) • Yes

b) No

Q6.1. Eligibility:

Is the applicant an agricultural water supplier?*

a) Yes

b) • No

Q6.1.a Eligibility:

If yes, has the applicant submitted a complete Agricultural Water Management Plan (AWMP) to DWR?

a) Yes

b) No

Q6.1.b Eligibility:

If yes, has the AWMP been verified as complete by DWR?

a) Yes

b) No

Q6.1.c Eligibility:

If the AWMP has not been submitted, explain and provide the anticipated submittal date.

Q7.1. Eligibility:

Is the applicant an urban water supplier?*

a) Yes

b) • No

Q7.1.a Eligibility:

If yes, has the applicant submitted a complete Urban Water Management Plan (UWMP) to DWR?

a) Yes

b) No

Q7.1.b Eligibility:

If yes, has the UWMP been verified as complete by DWR?

a) Yes

b) No

Q7.1.c Eligibility:

If the UWMP has not been submitted, explain and provide the anticipated date for submittal.

Q8.1 Eligibility:

Is the applicant a surface water diverter?*

a) Yes

b) No

Q8.1.a Eligibility:

If yes, has the applicant submitted to the SWRCB their surface water diversion reports in compliance with requirements outlined in Part 5.1 (commencing with §5100) of Division 2 of the Water Code?

a) Yes

b) No

Q8.1.b Eligibility:

If the reports have not been submitted, explain and provide the anticipated date for meeting the requirements.

Q9. Eligibility:

Does the proposal include any of the following activities:

1.) The potential to adversely impact a wild and scenic river or any river afforded protection under the California or Federal Wild and Scenic Rivers Act
2.) Acquisition of land through eminent domain
3.) Design, construction, operation, mitigation, or maintenance of Delta conveyance facilities
4.) Acquisition of water except for projects that will provide fisheries or ecosystem benefits or improvements that are greater than required currently applicable environmental mitigation measures or compliance obligations
5.) Pay any share of the costs of remediation recovered from parties responsible for the contamination of a groundwater storage aquifer
6.) Projects or groundwater planning activities associated with adjudicated groundwater basins.

If yes, the project is not eligible for grant funding.*

a) Yes (not eligible for grant funding)

b) No

Q10. Eligibility: Consistency with California SB 985– Stormwater Resource Planning Act:

To satisfy SB 985 requirements, stormwater and dry weather capture project must be listed in a SWRP that is consistent with the relevant code provisions enacted by SB 985 (Water Code §10562 (b)(7)) as determined by the SWRCB.

a) This Project is Consistent

Q11. DA Cost Share Waiver or Reduction:

Are you applying for cost share waiver or reduction as a DA? Fill out Attachment 6 – DAC, SDAC, and/or EDA, as appropriate.*

a) Yes; See Attachment 6

b) No

Q12. Certification:

By submitting the application, the Project Director is certifying that:
a) The applicant is an eligible entity;
b) He/She is aware that any attachment exceeding the page limit listed in the attachment templates will not be reviewed;
c) He/She is aware that, once the proposal is submitted in GRanTS, any privacy rights and other confidentiality protections offered by law with respect to the application package and project location are waived; and
d) He/She has read and agrees to all of the Terms and Conditions of the grant agreement.*

a) • Yes (Certified)

b) No

Section : Climate Risk in Investments

Climate Risk in Investment

Q13: Does the organization have a strategic business plan?

a) • Yes

b) No

If Yes, please submit a copy.

Last Uploaded Attachments: Q13_Prop 68 Cost Share Packet_combined.pdf

Q14: Has the organization conducted a climate change vulnerability assessment?

a) Yes

b) • No

If Yes, please submit a copy.

Q15: Does the organization have a main contact person for climate change?

a) Yes

b) • No

If Yes, to what position in the origination does that person report?

Q16: Has the organization considered the risk of climate change in its capital reserves and investments? (Open ended; one-three paragraphs, with specific examples, should suffice).

This Proposal involves funding of a planning effort rather than an implementation project. As such, the Subbasin Data Management System Development project would not involve activities that could emit greenhouse gases or affect carbon sequestration. The project would have no effect related to climate change. Therefore, documentation of climate change effects is not applicable for this Proposal, applicant, or project proponents.

Section : Attachments

Attachment 1:Authorizing Documentation (e.g. resolution)

Upload Authorizing Documentation here. The Attachment is mandatory.*

Last Uploaded Attachments: Att1_SGM_AuthDoc_1of1.pdf

Attachment 2: Eligibility Applicant Documentation

Upload Eligibility Applicant Documentation here. **The attachment is mandatory.***

Last Uploaded Attachments: Att2_SGM_EligDoc_1of1.pdf

Attachment 3: Work Plan

Upload Work Plan here. (Applicant MUST use supplied template) **The attachment is mandatory.***

Last Uploaded Attachments: Att3_SGM_WrkPlan_1of1.pdf

Attachment 4: Budget

Upload Budget here. (Applicant MUST use supplied template) **The attachment is mandatory.***

Last Uploaded Attachments: Att4_SGM_Budget_1of1.pdf

Attachment 5: Schedule

Upload Schedule here. (Applicant MUST use supplied template) **The attachment is mandatory.***

Last Uploaded Attachments: Att5_SGM_Schedule_1of1.pdf

Attachment 6: SDAC, DAC, and/or EDA

Upload SDAC, DAC, and/or EDA (as applicable) here.

Last Uploaded Attachments: Att6_SGM_SDAC-DAC-EDA_1of1.pdf

KERN RIVER GSA

Rodney J. Palla, Chair
Bob Smith
Gene Lundquist

October 21, 2019

To: Kern Groundwater Authority
Buena Vista WSD GSA
Henry Miller WD GSA
Olcese WD GSA

Re: Reimbursement Agreement for the Kern County Subbasin – DWR Proposition 68 Grant Application Development and Grant Administration.

The Kern River Groundwater Sustainability Agency (KRGSA), the Kern Groundwater Authority (KGA), the Buena Vista WSD Groundwater Sustainability Agency (BVGSA), the Henry Miller WD Groundwater Sustainability Agency (HMGSA), and the Olcese WD Groundwater Sustainability Agency (OGSA) wish to participate in the Reimbursement Agreement for the Kern County Subbasin – DWR Proposition 68 Grant Application Development and Grant Administration (Grant).

On behalf of the Subbasin, the KRGSA has approved a contract with Horizon Water and Environment (Horizon) which includes a scope of work with the following tasks: 1) Develop and Submit Grant Application ($19,950); 2) Support Database Project Lead in Developing RFP for Database Developer ($1,990); and 3) Grant Administration ($27,680). Horizon's proposal for the scope of work is provided as Attachment 1. All parties agree to cost share this effort according to following terms and conditions:

The participant signatories below will pay their share of the proposed budget of $49,620 as shown on Attachment 2. The first two (2) tasks will be invoiced upon approval of this Agreement. Task three (3) will be billed as future Grant Administration work is performed. All payments shall be due 45 days after the receipt of invoice from the City of Bakersfield.

If the above terms and conditions are acceptable, please sign and date all copies of this letter and return them to the KRGSA. A fully executed original will be returned to all GSA's.

Sincerely,

Rodney Palla
Chairman

Accepted:

Kern Groundwater Authority

By:____________________

Title:____________________

Date:____________________

Buena Vista WSD GSA

By:____________________

Title:____________________

Date:____________________

Henry Miller WD GSA

By:____________________

Title:____________________

Date:____________________

Olcese WD GSA

By:____________________

Title:____________________

Date:____________________

Sincerely,

Rodney Palla
Chairman

Accepted:

Kern Groundwater Authority

By: [signature]

Title: CHAIR

Date: 10-23-2019

Buena Vista WSD GSA

By:____________________

Title:__________________

Date:__________________

Henry Miller WD GSA

By:____________________

Title:__________________

Date:__________________

Olcese WD GSA

By:____________________

Title:__________________

Date:__________________

Sincerely,

Rodney Palla
Chairman

Accepted:

Kern Groundwater Authority

By:______________________

Title:____________________

Date:____________________

Buena Vista WSD GSA

By:______________________

Title: Engineer - Manager

Date: 10-22-19

Henry Miller WD GSA

By:______________________

Title:____________________

Date:____________________

Olcese WD GSA

By:______________________

Title:____________________

Date:____________________

Sincerely,

Rodney Palla
Chairman

Accepted:

Kern Groundwater Authority

By:__________________

Title:__________________

Date:__________________

Buena Vista WSD GSA

By:__________________

Title:__________________

Date:__________________

Henry Miller WD GSA

By: [signature]

Title: PRESIDENT

Date: 10-22-19

Olcese WD GSA

By:__________________

Title:__________________

Date:__________________

Sincerely,

Rodney Palla
Chairman

Accepted:

Kern Groundwater Authority

By:____________________

Title:____________________

Date:____________________

Buena Vista WSD GSA

By:____________________

Title:____________________

Date:____________________

Henry Miller WD GSA

By:____________________

Title:____________________

Date:____________________

Olcese WD GSA

By:____________________

Title: James L. Nickel, President

Date: Oct. 22, 2019

Kern County Subbasin – DWR Proposition 68 Grant Application Development

Revised Proposal for Consultant Services Provided by Horizon Water and Environment

October 10, 2019

Horizon will develop a Proposition 68 grant application/proposal for the Kern County Subbasin based on the grant requirements provided by DWR. This application will rely heavily on materials Horizon previously developed preparing the Proposition 1 grant application. Horizon will update those materials as appropriate to reflect the status of current GSPs in the Kern County Subbasin.

Using these existing materials as a starting point, Horizon will develop the grant application efficiently and ensure that the information provided for the Prop 68 grant is consistent with, and builds on, the Proposition 1 grant received in 2017.

This scope of work assumes that one project will be included in the grant application:

- Project 1: Subbasin data management system development

Horizon will work with the appropriate GSAs to receive good baseline information or a project description for the project. Horizon will then use our grant application expertise to articulate how the project aligns and supports the primary objectives of the Proposition 68 Grant and why the Kern County Subbasin is an excellent fit for this grant. Following award of grant funding, Horizon will administer the grant reporting and invoicing process.

Horizon's work will be organized into the following tasks:

Task 1: Develop and Submit Grant Application

Develop Draft Application Materials

- Horizon will use the grant application requirements to frame and structure the grant submittal documents.
- Horizon will review DWR-provided templates to collect and organize project information for the grant application forms and Attachments (e.g., Work Plan, Schedule, Budget) and distribute them to the appropriate project leads.
- Horizon will coordinate data requests with the GSA staff members who will be serving as the project leads for the target project. Horizon will edit/adjust the project information as necessary to support the grant application.
- Horizon will generate draft grant application materials, including necessary text to populate the online GRanTS application tabs and required Attachments.
- Horizon will distribute the draft grant application materials to the KRGSA and other project lead GSAs for their review, with a due date to receive requested edits and/or comments.

Finalize Grant Application Materials

- Horizon will finalize the grant application materials based upon GSA review and feedback described above. Horizon will send final grant application materials to KRGSA and other project lead GSAs for final review and approval prior to DWR submittal.

Submit Grant Application to DWR

- Horizon will complete the online GRanTS application information tabs, and upload all Attachments, before DWR's application period deadline of 1 p.m. on November 1.

Task 2: Support Database Project Lead in Developing RFP for Database Developer

- Horizon will coordinate with Basin Database project lead (KGA, KRGSA, or a committee) to confirm the general database objectives and needs.
- Horizon will develop a draft RFP for review by project lead.
- Horizon will revise and develop final RFP for review and use by project lead.

This task assumes that the project lead, rather than Horizon, will administer the proposal process, including distribution of RFP, review and evaluation of proposals, and contracting of selected firm.

Task 3: Grant Administration *(pending award)*

Grant Initiation, Agreements, and Templates

- Following notification of grant award, Horizon will coordinate with DWR, KRGSA, and KGA to finalize grant materials.

Grant Implementation, Reporting, and Invoicing

- Horizon will develop and distribute templates for quarterly reports, invoices, and backup documentation.
- Horizon will identify deadlines for submittal of information from KRGSA and KGA and will review and clarify the submitted information each quarter to ensure that it meets grant requirements.
- Following review and revision, Horizon will submit reports and invoices to DWR.
- Horizon will coordinate with DWR regarding any needed revisions to submitted materials.
- Throughout the grant period, Horizon will communicate regularly with KRGSA and KGA to maintain the flow of information.

Grant Completion and Closeout

- Horizon will coordinate and review the project's draft Project Completion Report.
- Horizon will assist KRGSA and KGA in developing the Grant Completion Report.
- Horizon will coordinate and upload all completion reports to DWR.
- Horizon will develop a post-performance report template.
- Horizon will coordinate with project leads and DWR in grant closeout.

Cost Estimate:

Task	Estimated Cost
1. Develop and Submit Grant Application	$19,950
2. Support Database Project Lead in Developing RFP for Database Developer	$1,990
3. Grant Administration *(pending award)*	$27,680
Total	**$49,620**

Schedule:

Horizon will complete the grant submittal process on or before the DWR deadline of November 1, 2019, at 1:00 p.m. Tasks 2 and 3 will be completed following notification of grant award.

Attachment 2

Funding Contribution and Participation Percentages

Total Horizon Contract Amount:	$49,620.00
Funding Request for App/RFP:	$21,940.00

	Funding Entity	Funding Request
1	Arvin-Edison Water Storage District	$953.91
2	Buena Vista Water Storage District	$953.91
3	Bellridge Water Distrct	$953.91
4	Berrenda Mesa Water District	$953.91
5	Cawelo Water District	$953.91
6	City of Bakersfield	$953.91
7	Eastside Water Management Area	$953.91
8	Henry Miller	$953.91
9	Improvement District No. 4	$953.91
10	Lost Hills Water District	$953.91
11	Kern Delta Water District	$953.91
12	Kern-Tulare Water District	$953.91
13	Kern Water Bank Authority	$953.91
14	North Kern Water Storage District	$953.91
15	Olcese Water District	$953.91
16	Rosedale-Rio Bravo Water District	$953.91
17	Semitropic Water Storage District	$953.91
18	Shafter-Wasco Irrigation District	$953.91
18	Shafter-Wasco 7th Standard Annex	$953.91
19	South San Joaquin Municipal Utilities District	$953.91
20	Tejon-Castac Water District	$953.91
21	West Kern Water District	$953.91
22	Wheeler Ridge-Maricopa Water Storage District	$953.91
	Totals	$21,940.00

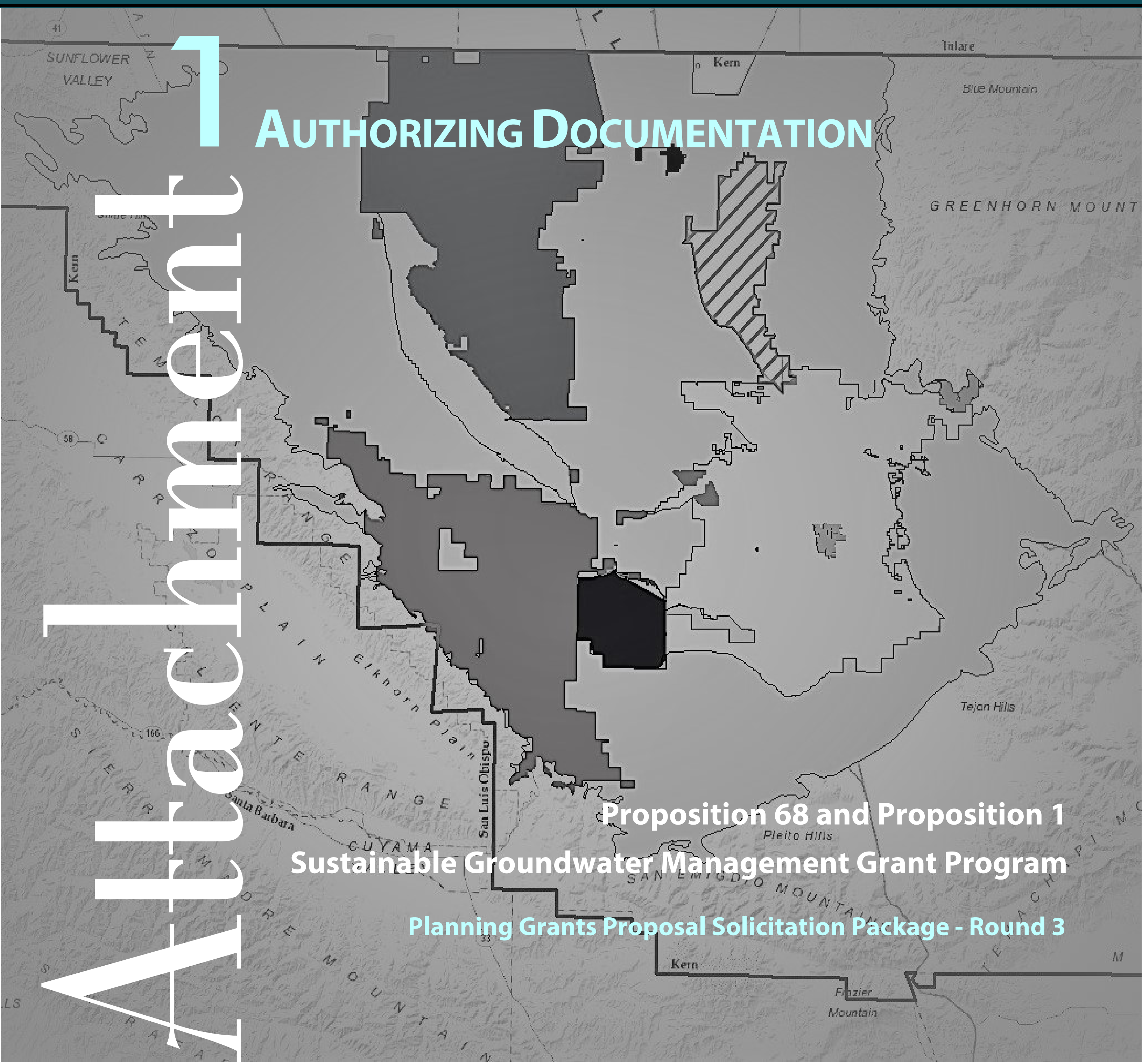
Note:

Managers/GSAs all agreed to use Horizon and to split the costs per agency.
Above funding request to cover Grant App. DMS RFP. Future Grant Admin to be billed per agency as costs incured (monthly).

Invoices:

KGA:	$16,216.52
KRGSA:	$2,861.74
BV	$953.91
Henry Miller:	$953.91
Olcese	$953.91
	$21,940.00

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II 2019 Grant Application



Attachment 1

Authorizing Documentation

Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Introduction

Attachment 1 includes authorizing documentation for submittal of this Proposition 68 and Proposition 1 Sustainable Groundwater Management Grant Program, Planning Grants Proposal Solicitation Package – Round 3 grant application. The applicant has provided a resolution adopted by the applicant's governing body designating an authorized representative to submit the application and execute an agreement with the State of California for a Sustainable Groundwater Management Grant.

Applicant Authorizing Documentation

The Kern River Groundwater Sustainability Agency (KRGSA) is pleased to serve as the applicant for Kern County Subbasin Groundwater Sustainability Plan Support – Phase II grant application. The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II application includes one project led by and supporting all the GSAs in the Kern County Subbasin. The proposed project will benefit the entire Kern County Subbasin.

KRGSA is a Groundwater Sustainability Agency (GSA) formed in 2016 under Section 10723.8 of the California Water Code and is comprised of public agency members including the City of Bakersfield, the Kern Delta Water District, and the Kern County Water Agency Improvement District No. 4. An excerpt from the GSA application package submitted to the California Department of Water Resources' (DWR's) Sustainable Groundwater Management Section on April 12, 2016, is included as supporting documentation with Attachment 2, Appendix A. Further information and the entire GSA application package may be found on KRGSA's website: http://www.kernrivergsa.org.

The Round 3 Planning Grants Proposal Solicitation Package states that eligible applicants are GSAs, member agencies of the GSAs, or member agencies of an approved Alternate to a GSP for the basin for which the application is submitted. The KRGSA is a GSA for a portion of the Kern County Subbasin (Basin Number 5-22.14) and, as such, is an eligible applicant for this Proposition 68 and Proposition 1 Sustainable Groundwater Management Grant Program, Planning Grants Proposal Solicitation Package – Round 3 grant application.

The KRGSA Executive Board adopted Resolution KRGSA 001-19 on October 21, 2019, authorizing KRGSA to submit this application to obtain a grant under the Sustainable Groundwater Management Grant Program and execute an agreement with the State of California to receive a grant under the Proposition 68 and Proposition 1 Sustainable Groundwater Management Grant Program, Planning Grants Proposal Solicitation Package – Round 3 grant opportunity. A copy of the resolution is included on the following pages.

RESOLUTION NO. KRGSA 001-19

A RESOLUTION BY THE KERN RIVER GROUNDWATER SUSTAINABILITY AGENCY (KRGSA) THAT APPLICATION BE MADE TO THE CALIFORNIA DEPARTMENT OF WATER RESOURCES TO OBTAIN A GRANT UNDER THE SUSTAINABLE GROUNDWATER PLANNING GRANT PROGRAM FOR THE KERN COUNTY SUBBASIN GROUNDWATER SUSTAINABILITY PLAN SUPPORT - PHASE II

WHEREAS, the California Department of Water Resources (DWR) is administering the Sustainable Groundwater Management (SGM) Grant Program Planning Grants using funds authorized by the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68) and the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1); and

WHEREAS, DWR will award $50 million for projects that develop and implement groundwater plans and projects; and

WHEREAS, Proposition 68 requires a minimum cost share of 25% of the total project cost, and Proposition 1 requires a minimum cost share of 50% of the total project cost; and

WHEREAS, only one grant will be awarded per basin; and

WHEREAS, the KRGSA represents all potential applicants in the kern subbasin, and

WHEREAS, DWR requires a resolution to be adopted by the applicant's governing body designating an authorized representative to submit the application and execute and agreement with the State of California for a SGM Grant; and

NOW, THEREFORE, BE IT RESOLVED, by the KRGSA as follows:

1. The above recitals and findings are true and correct and are incorporated herein by reference.

2. That application be made to the California Department of Water Resources to obtain a grant under the 2019 Sustainable Groundwater Planning Grant Program pursuant to the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) (Water Code Section 79700 et seq.) and/or the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68) for the Kern

County Subbasin Groundwater Sustainability Plan Support - Phase II.

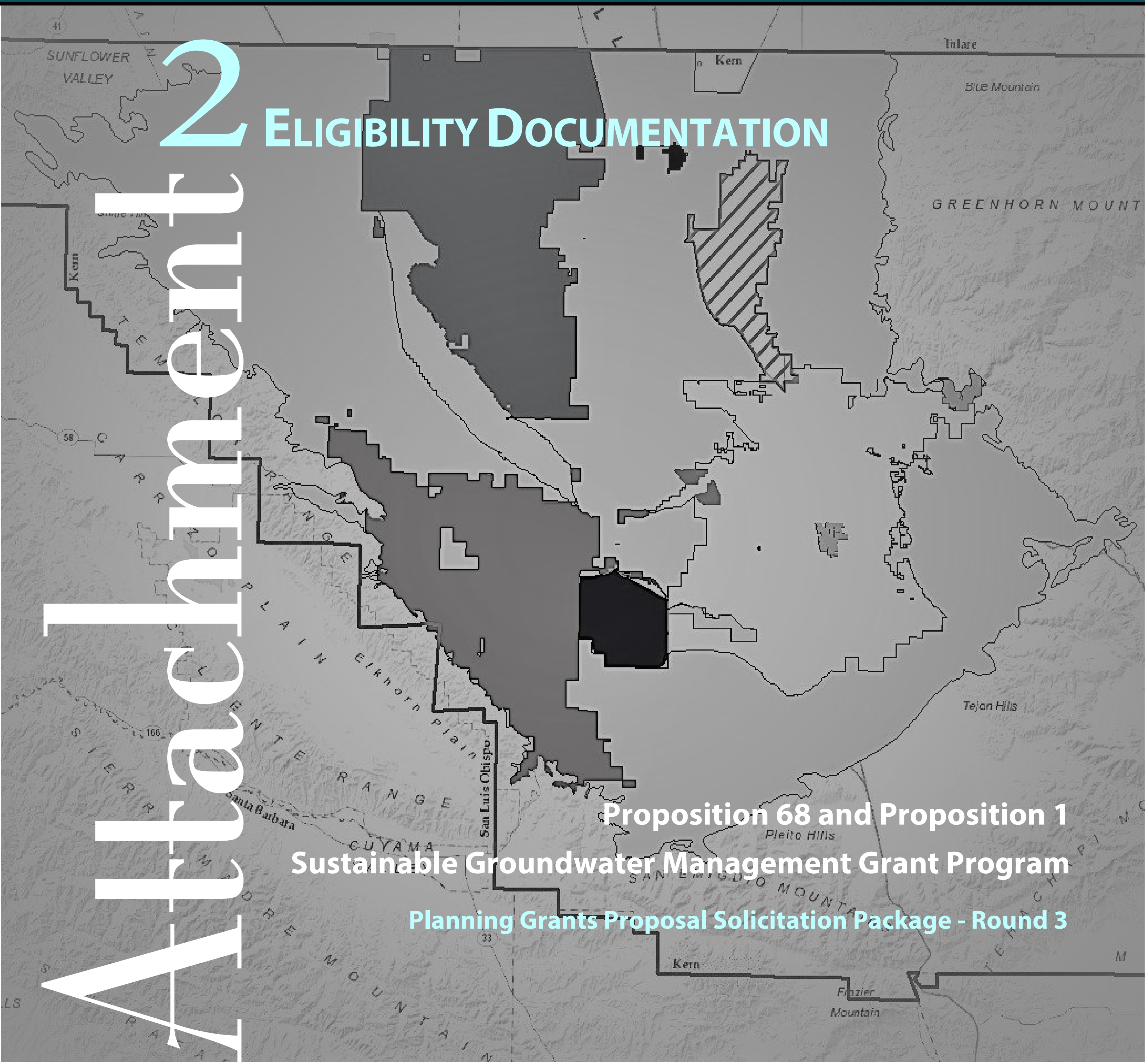
3. That the Board Chair of the KRGSA or his designee is hereby authorized and directed to prepare the necessary data, conduct investigations, file such application, and execute a grant agreement with the California Department of Water Resources and make amendments or changes thereto.

--------oo000oo--------

I HEREBY CERTIFY that the foregoing Resolution was passed and adopted by the Kern River Groundwater Sustainability Agency on OCT 21 2019.

Rodney S. Palla, Chairman

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II 2019 Grant Application



Attachment 2 Eligibility Documentation

Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Tables

Figures

Appendices

Introduction

Attachment 2 includes eligibility documentation for this Groundwater Sustainability Plan Support – Phase II Grant Application. Attachment 2 includes the following sections as required by the Proposal Solicitation Package (PSP):

A. Applicant Information
B. Agricultural Water Management Compliance
C. CASGEM Basin Prioritization and Compliance
D. Climate Change
E. Groundwater Management Compliance
F. Open and Transparent Water Data
G. Public Utilities and Mutual Water Companies
H. Stormwater Resource Plan (SWRP) Compliance
I. Surface Water Diverter Compliance
J. Sustainable Water Use and Demand Reduction
K. Urban Water Management Compliance
L. Water Metering Compliance

A. Applicant Information

The Kern River Groundwater Sustainability Agency (KRGSA) is pleased to serve as the applicant for Kern County's Kern County Subbasin Groundwater Sustainability Plan Support – Phase II grant application. The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II application includes one project led by and supporting all the GSAs in the Kern County Subbasin. . The proposed project will benefit the entire Kern County Subbasin.

The Kern County Subbasin has been identified as a critically overdrafted, high priority groundwater basin. The Proposal objective is to implement a high-priority project that provides direct groundwater planning benefits to the Subbasin, meets Groundwater Sustainability Plan (GSP) regulations, and meets the California Department of Water Resources' (DWR's) evaluation criteria for Sustainable Groundwater Management Grant Program, Round 3 Planning Grants funding.

This project is entitled Subbasin Data Management System Development and it will develop a critical groundwater sustainability planning element encompassing all parts of the Subbasin. The proposed project includes the following primary objectives to initiate developing the Subbasin's Data Management System (DMS): (1) conduct stakeholder outreach and engagement activities, (2) procure consultant assistance for DMS development, (3) identify DMS information requirements, (4) research and select the appropriate DMS approach for the Subbasin, (5) procure or design the DMS and refine and customize the DMS as needed, and (6) develop data protocols and templates (7) train GSA staff . If additional funding is required, the GSAs in the Kern subbasin have agreed to work together to either locate additional funding or to fund. This project is critical to meet immediate Kern County Subbasin GSP planning needs, as well as essential for the next steps in basin coordination and Sustainable Groundwater Management Act (SGMA) compliance requirements.

KRGSA is a Groundwater Sustainability Agency formed in 2016 under § 10723.8 of the California Water Code and is comprised of public agency members including the City of Bakersfield, the Kern Delta Water District, and the Kern County Water Agency Improvement District No. 4. An excerpt from the GSA application package submitted to DWR's Sustainable Groundwater Management Section on April 12, 2016, is included as supporting documentation in Appendix A to this Attachment 2. Further information may be found on KRGSA's website: http://www.kernrivergsa.org.

The Round 3 Planning Grants PSP states that eligible applicants are GSAs, member agencies of the GSAs, or member agencies of an approved Alternate to a GSP for the basin for which the application is submitted. KRGSA is a GSA for a significant portion of the critically overdrafted, high priority Kern County Subbasin (Basin Number 5-22.14) and as such is an eligible applicant for this Proposition 68 and Proposition 1 Sustainable Groundwater Management Grant Program, Planning Grants PSP – Round 3 grant application.

The KRGSA Executive Board adopted Resolution KRGSA 001-19 on October 21, 2019, authorizing KRGSA to submit this application on behalf of the entire Kern subbasin to obtain a grant under the Sustainable Groundwater Management Grant Program and execute an agreement with the State of California to receive a grant under the Proposition 68 and Proposition 1 Sustainable Groundwater Management Grant Program, Planning Grants PSP – Round 3 grant opportunity. A copy of the resolution is included in Attachment 1.

B. Agricultural Water Management Compliance

Agricultural Water Management eligibility for the applicant for this Proposal is discussed in this section.

The applicant, KRGSA, is not an agricultural water supplier. No agricultural water suppliers will receive funding from the proposed grant through a joint-powers agreement or other legal agreement. The project will be implemented by the applicant, KRGSA, and KGA on behalf of all the GSAs in the Subbasin. KGA is also a GSA within the basin, and KGA is not an agricultural water supplier. Neither the applicant nor the additional project proponent, KGA, is an agricultural water supplier, and as such these entities are not required to develop or submit Agricultural Water Management Plans (AWMPs).

Therefore, documentation of Agricultural Water Management Compliance is not applicable for this Proposal, applicant, or project proponents.

It is noted that while the applicant, KRGSA, is not an agricultural water supplier, one of the member agencies of the KRGSA is the Kern Delta Water District, which is required to develop and submit an AWMP. The Kern Delta Water District is in full agricultural water management compliance, having submitted and received DWR approval, with documentation provided in Appendix B.

C. CASGEM Basin Prioritization and Compliance

This section discusses California Statewide Groundwater Elevation Monitoring (CASGEM) eligibility status for the overall Proposal, project proponents, and the proposed project. The Subbasin Data Management System Development project proposed in this application package will benefit the entire Kern County Subbasin, identified as groundwater Subbasin number 5-022.14. Pursuant to Water Code § 10933(b) and Bulletin 118, DWR has designated the Kern County Subbasin as high priority and critically overdrafted.

Determining CASGEM compliance status for the overall Kern County Groundwater Basin (5-022.14) requires identifying:

(1) whether the entirety of the groundwater basin is monitored through identification and establishment of monitoring entities, and

(2) if monitoring data is uploaded to CASGEM regularly each spring and fall, once monitoring entities are established.

For the portion of high-priority basins that do not have a CASGEM monitoring entity, the grant applicant will not be eligible to receive grant funding (Water Code § 10933.7(a)). Consistent with Water Code § 10933.7(b), if the applicant area is demonstrated to be a DAC or SDAC, the project will be considered eligible for grant funding not withstanding CASGEM compliance.

The Subbasin Data Management System Development project will be implemented by the applicant, KRGSA, in collaboration with KGA on behalf of and in coordination with all the GSAs in the Subbasin. The applicant, KRGSA, is not identified as a CASGEM monitoring entity for the basin. KGA is also a GSA within the Kern County Subbasin. KGA is not a CASGEM monitoring entity. Neither the applicant nor the additional project proponent, KGA, is serving as a CASGEM monitoring entity for the basin. However, approximately 46% of the

Kern County groundwater basin is CASGEM compliant as described below, based on established monitoring entities that provide data to DWR's CASGEM program. This project includes a basin-wide project that will benefit the entire Subbasin, including the 54% non-CASGEM compliant area, of which 90% is characterized as Disadvantaged Community and, as such, is exempt from the requirement for CASGEM compliance.

Figure 2-1, below, depicts the Kern County Subbasin, showing areas where CASGEM monitoring entities have been established (green), and areas where CASGEM monitoring entities are not yet established (gray). This map shows that 46% of the basin is CASGEM compliant in terms of having established monitoring entities that meet CASGEM requirements.

Figure 2-1. Kern County Subbasin Area with Established Monitoring Entities

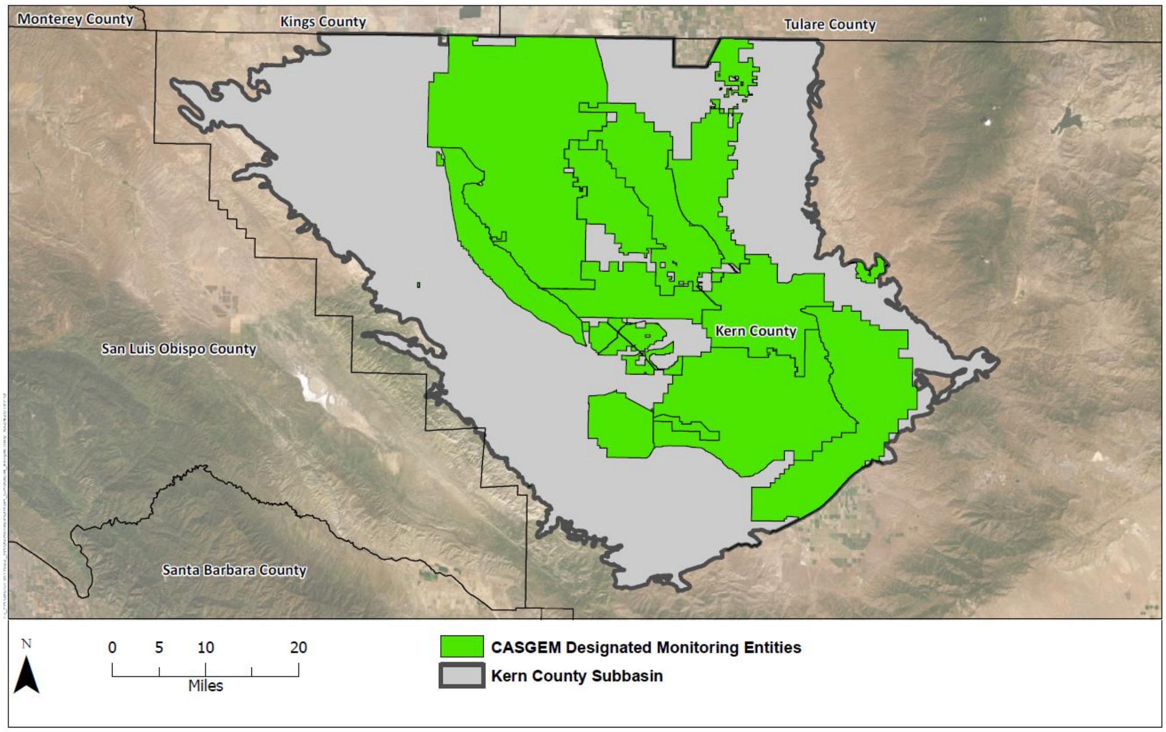
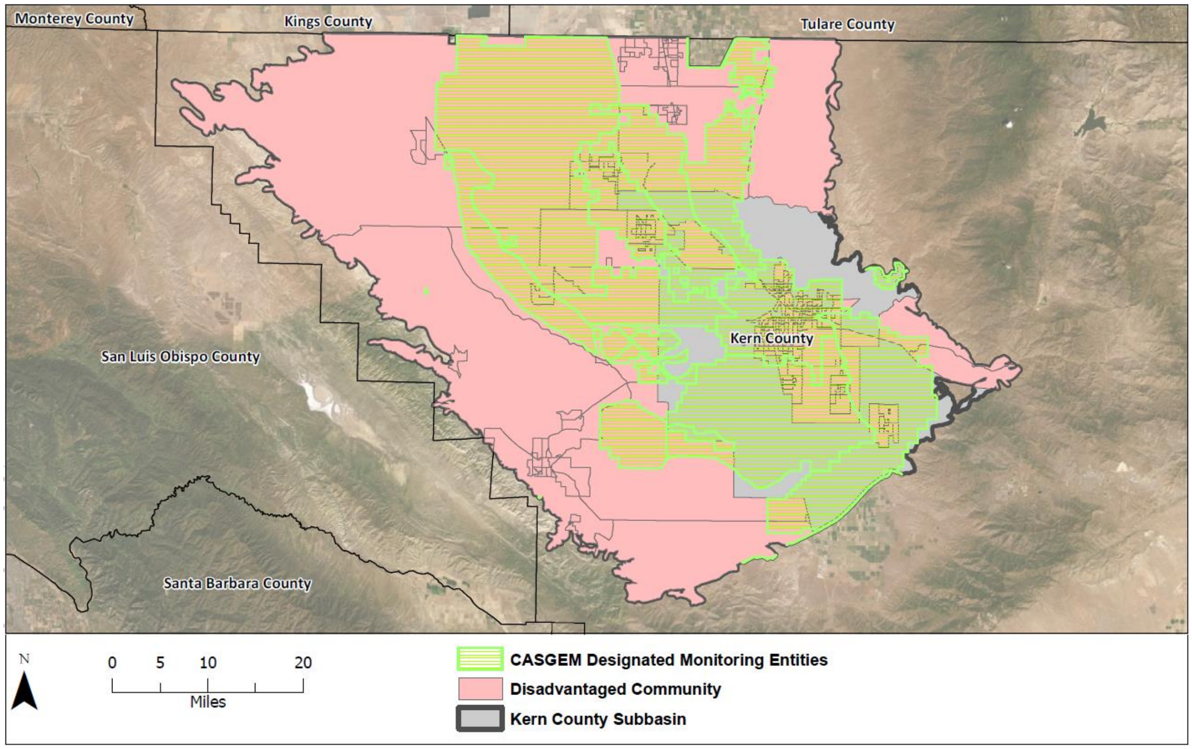


Figure 2-2, below, depicts the Kern County Subbasin, showing CASGEM compliant areas and DAC boundaries within the Subbasin (data acquired from DWR's DAC Mapping tools). This map shows that, within the 54% of the basin that is not CASGEM compliant (in terms of not having established monitoring entities); 90% of that area is characterized as a DAC, and as such, exempt from the PSP requirement for CASGEM compliance. It is noteworthy that only 5.6% of the Subbasin is both not CASGEM compliant and not DAC.

Figure 2-2. Kern County Subbasin Areas with Established Monitoring Entities and DAC Areas



CASGEM Monitoring Data – Current Submittal Status

Table 2-1, below, is featured on DWR's CASGEM website, and presents a list of the established CASGEM monitoring entities for the basin. The table also shows latest elevation data submitted as of October 23, 2019. This table shows that established monitoring entities are providing current elevation data.

Table 2-1. Kern County Subbasin Monitoring Entities and Data Submittal Status

Monitoring Entity	Groundwater Basin/ Subbasin Name	Groundwater Basin/ Subbasin Number	Authority Type	Last Elevation Data Submitted	Associated Well Count
Arvin-Edison Water Storage District	Kern County	5-022.14	Ground Water Management Agency	3/12/2019 5:01:00 PM	41
Cawelo Water District	Kern County	5-022.14	Ground Water Management Agency	3/11/2019 6:48:00 PM	7
Deer Creek & Tule River Authority	Kern County	5-022.14	Local Agency Pursuant to WC Part 2.75	2/25/2019 12:00:00 AM	3
Kern County Water Agency Improvement District No. 4	Kern County	5-022.14	Local Agency Pursuant to WC Part 2.75	3/6/2019 3:46:00 PM	5
Kern River Fan Group	Kern County	5-022.14	Voluntary Cooperative Groundwater Monitoring Association	4/1/2019 12:00:00 AM	34
Kern Water Bank Authority	Kern County	5-022.14	Voluntary Cooperative Groundwater Monitoring Association	7/16/2019 12:00:00 AM	15
Kern-Tulare Water District	Kern County	5-022.14	Local Agency Pursuant to IRWM	10/8/2019 12:00:00 AM	25
North Kern Water Storage District	Kern County	5-022.14	Local Agency Pursuant to WC Part 2.75	5/8/2019 12:00:00 AM	9
Semitropic Water Storage District	Kern County	5-022.14	Local Agency Pursuant to WC Part 2.75	6/8/2019 12:00:00 AM	46
Shafter-Wasco Irrigation District	Kern County	5-022.14	Local Agency Pursuant to WC Part 2.75	2/1/2019 12:00:00 AM	8
West Kern Water District	Kern County	5-022.14	Ground Water Management Agency	8/7/2019 12:00:00 AM	49

Source: DWR's CASGEM website.

The monitoring entities listed in Table 2-1 above are providing elevation data submitted for Kern County Subbasin and encompass approximately 46% of the Subbasin area. The other 54% of the Kern County Subbasin is not yet CASGEM compliant.

Conclusion

As described above, approximately 46% of the Kern County Groundwater Subbasin is CASGEM compliant from the perspective of having established monitoring entities, as well as from the perspective of providing monitoring data to DWR's CASGEM program. Figure 2-2 illustrates that, of the 54% of the basin that is not CASGEM compliant, 90%, or the great majority, is a DAC and, as such, exempt from the PSP requirement for CASGEM compliance. The remaining areas that are still not compliant and not DAC, 5.6% of the Subbasin, will not receive grant funding.

CASGEM compliance is sufficiently demonstrated for the Kern County Groundwater Subbasin for purposes of this grant proposal.

D. Climate Change

This section discusses Climate Change eligibility status for the overall Proposal. The SGM Grant Program 2019 Guidelines document requires that applicants seeking funding must demonstrate that the applicant's project contributes to addressing the risks in the region to water supply and water infrastructure arising from climate change (Water Code § 79742(e)). To the extent practicable, applicants must measure the amount of greenhouse gas emissions reduced and carbon sequestered resulting from an implementation project funded by the SGM Grant Program (Public Resources Code § 80001(b)(7)).

This Proposal involves funding of a planning effort rather than an implementation project. As such, the Subbasin Data Management System Development project would not involve activities that could emit greenhouse gases or affect carbon sequestration. The project would have no effect related to climate change. Therefore, documentation of climate change effects is not applicable for this Proposal, applicant, or project proponents.

E. Groundwater Management Compliance

This section discusses Groundwater Management Compliance eligibility status for the overall Proposal. The SGM Grant Program 2019 Guidelines document requires that, for groundwater implementation projects that directly affect groundwater levels or quality, the applicant must self-certify that one or more option below has been, or is currently, being satisfied.

SGMA (Water Code § 10720 et seq.) specifies actions for critically overdrafted groundwater basins, high and medium priority basins, and low and very low priority basins. Groundwater project proponents must demonstrate how their project is consistent with SGMA efforts in the basin. To be eligible to receive Implementation grant funds, applicants must be from a medium or high priority basin with either:

- An adopted GSP that has been submitted to DWR for review and deemed complete by DWR, or
- An approved Alternative to a GSP.

This Proposal involves funding of a planning effort rather than an implementation project that directly affects groundwater levels or quality. The proposed project, the Subbasin Data Management System (DMS) Development, will develop a critical groundwater sustainability tool encompassing all parts of the Subbasin. The proposed project consists of scoping and development of the DMS including activities such as: (1) conducting stakeholder outreach and engagement activities, (2) procuring consultant assistance for DMS development, (3) identifying DMS information requirements, (4) researching and selecting the appropriate DMS approach for the Subbasin, and (5) procuring and designing the DMS and customizing it as needed. This proposed project is critical to meet Kern County Subbasin GSP, basin coordination, and SGMA compliance needs.

This Proposal is entitled Kern County Subbasin Groundwater Sustainability Plan Support – Phase II. The first phase of this GSP support work is currently underway and is being funded under a Proposition 1 SGMA Round

2 Planning Grant entitled Kern County Subbasin Groundwater Sustainability Support – 2017 Grant Application. Activity under the Proposition 1 grant includes generating a GSP for KRGSA to be submitted to DWR as a deliverable. As of this writing (October 2019) the GSP is in draft form and will be submitted to DWR on or before January 31, 2020.

F. Open and Transparent Water Data

This section discusses Open and Transparent Water Data Compliance for the overall Proposal. The SGM Grant Program 2019 Guidelines document requires that recipients of State funds through grants or contracts for research or projects relating to the improvement of water or ecological data shall, as a condition of the receipt of a grant or contract, adhere to the protocols developed pursuant to subdivision (a) for data sharing, transparency, documentation, and quality control (Water Code § 12406(b)). KRGSA will adhere to all required data sharing, transparency, and documentation protocols.

G. Public Utilities and Mutual Water Companies

This section discusses Public Utilities and Mutual Water Companies Compliance for the overall Proposal. The SGM Grant Program 2019 Guidelines document requires that a project proposed by a public utility regulated by the Public Utilities Commission or a mutual water company shall have a clear and definite public purpose and shall benefit the customers of the water system and not the investors (Water Code § 79712(b)(1)).

This Proposal involves funding of a planning effort rather than an implementation project. The Subbasin Data Management System Development project it will develop a critical groundwater sustainability tool encompassing all parts of the Subbasin. The proposed project consists of scoping and development of the DMS. Once the planned DMS becomes operational, the collected data will inform understanding of existing and projected groundwater levels; consequently, this knowledge will contribute to addressing and reducing risks in the region to water supply and water infrastructure arising from climate change. This is a clear and definite public purpose and benefits the customers and residents of the entire project area, the Kern County Subbasin. There are no investors associated with this project, and there shall be no benefits to investors as a result of this project.

H. Stormwater Resource Plan (SWRP) Compliance

This section discusses Stormwater Resource Plan Compliance for the overall Proposal. The SGM Grant Program 2019 Guidelines document states that Senate Bill (SB) 985 (Water Code § 10563(c)) requires the development of a SWRP or functionally equivalent plan for stormwater and dry weather runoff capture projects to receive grant funds through these provisions.

This Proposal involves funding of a planning effort, not an implementation project. As such, the Subbasin Data Management System Development project would not involve activities that could affect stormwater or dry weather resources. Since this project will conduct no construction, a Stormwater Resource Plan will not be needed.

I. Surface Water Diverter Compliance

Surface Water Diverter eligibility for the overall Proposal is discussed in this section. The SGM Grant Program 2019 Guidelines document states that a diverter of surface water is not eligible for a water grant or loan awarded or administered by the State unless it complies with surface water diversion reporting requirements outlined in Part 5.1 of Division 2 of the Water Code.

The applicant, KRGSA, is not a surface water diverter. No surface water diverters will receive funding from the proposed grant through a joint-powers agreement or other legal agreement. The project included in this proposal will be implemented by the applicant, KRGSA, in collaboration with KGA on behalf of all the GSAs in the Subbasin. KGA is also a GSA within the basin, and KGA is not a surface water diverter. Neither the applicant nor the additional project proponent, KGA, is a surface water diverter, and as such these entities are not required to submit to the State Water Resources Control Board (SWRCB) surface water diversion reports in compliance with requirements outlined in Part 5.1 (commencing with Section 5100) of Division 2 of the Water Code.

Therefore, documentation of Surface Water Diverter Compliance is not applicable for this proposal, applicant, or project proponents.

It is noted that while the applicant, KRGSA, is not a surface water diverter, two of the member agencies of the KRGSA are surface water diverters. The City of Bakersfield and Kern Delta Water District have longstanding water rights on the Kern River. Both these member agencies are in full compliance with regard to submitting diversion reports with the SWRCB.

J. Sustainable Water Use and Demand Reduction

This section addresses Sustainable Water Use and Demand Reduction eligibility for the overall Proposal. The SGM Grant Program 2019 Guidelines document states that SBx7-7 (Water Code § 10608 et seq.) conditions the receipt of a water management grant or loan for urban water suppliers on gallons per capita per day reduction targets with the end goal of a 20% reduction by 2020.

As discussed below in Section K, Urban Water Management Compliance, the applicant, KRGSA, is not an urban water supplier. No urban water suppliers will receive funding from the proposed grant through a joint-powers agreement or other legal agreement. The Sustainable Water Use and Demand Reduction criterion is not applicable for this Proposal.

K. Urban Water Management Compliance

Urban Water Management eligibility for the applicant for this Proposal is discussed in this section. The applicant, KRGSA, is not an urban water supplier. No urban water suppliers will receive funding from the proposed grant through a joint-powers agreement or other legal agreement. The project included in this proposal will be implemented by the applicant, KRGSA, in collaboration with KGA on behalf of and in coordination with all the GSAs in the Subbasin. KGA is also a GSA within the basin, and KGA is not an urban water supplier. Neither the applicant nor the additional project proponent, KGA, is an urban water supplier, and as such these entities are not required to develop or submit Urban Water Management Plans, to maintain compliance with Sustainable Water Use and Demand Reduction, Part 2.55 of Division 6 (Water Code Section 10608 *et seq*.), or to comply with water metering requirements contained in Water Code Section 525 et seq.

Therefore, documentation of Urban Water Management Compliance is not applicable for this proposal, applicant, or project proponents.

It is noted that while the applicant, KRGSA, is not an urban water supplier, two of the KRGSA member agencies, the Kern County Water Agency Improvement District No. 4 and the City of Bakersfield, are required to develop and maintain an Urban Water Management Plan (UWMP) that is submitted to DWR for review. Kern County Water Agency Improvement District No. 4 is in full urban water management compliance, having submitted and received DWR approval on its 2015 UWMP, which is included in Appendix B. The City of Bakersfield's UWMP was submitted on June 30, 2017. Documentation is also included in Appendix B.

L. Water Metering Compliance

This section addresses Water Metering Compliance eligibility for the overall Proposal. The Round 3 Planning Grants Proposal Solicitation Package states that any urban water supplier applying for State grant funds for wastewater treatment projects, water use efficiency projects, drinking water treatment projects, or for a permit for a new or expanded water supply, shall demonstrate that they meet the water meter requirements in Water Code § 525 et seq.

The applicant, KRGSA, is not an urban water supplier. The project included in this proposal will be implemented by the applicant, KRGSA, in collaboration with KGA on behalf of and in coordination with all the GSAs in the Subbasin. KGA is also a GSA within the basin, and KGA is not an urban water supplier. Neither the applicant nor the additional project proponent, KGA, is an urban water supplier.

This Proposal is not seeking funding for a wastewater treatment project, water use efficiency project, drinking water treatment project, or permit for a new or expanded water supply.

Therefore, the Water Metering Compliance criterion is not applicable for this proposal, applicant, or project proponents.

It is noted that while the applicant, KRGSA, is not an urban water supplier, two of the KRGSA member agencies, the Kern County Water Agency Improvement District No. 4 is a treated water wholesaler and provides a supply to four customers. All connections are metered; however, ID4 is not required to obtain documentation because it is not a retail urban water supplier.

Appendix A

Kern River Groundwater Sustainability Agency
GSA Application Package (excerpt)

April 12, 2016 GSA application package cover letter submitted to DWR's Sustainable Groundwater Management Section

Full application package may be found on KRGSA's website: http://www.kernrivergsa.org

Kern River Groundwater Sustainability Agency

April 12, 2016

Mark Nordberg, GSA Project Manager
Sustainable Groundwater Management Section
California Department of Water Resources
P.O. Box 942836
Sacramento, California 94236-0001

Re: Notice of Decision to Become a Groundwater Sustainability Agency

Dear Mr. Nordberg,

Per Section 10723.8(a) of the California Water Code, the City of Bakersfield, the Kern Delta Water District, and the Kern County Water Agency Improvement District No.4 hereby give notice of their decision to form the Kern River Groundwater Sustainability Agency (GSA) for a portion of the Kern County Subbasin (Basin Number 5-22.14, DWR Bulletin 118) within the San Joaquin Valley Groundwater Basin.

The Sustainable Groundwater Management Act (SGMA), passed in 2014, requires that all basins designated as high- or medium-priority basins that are subject to critical overdraft conditions are to be managed under a groundwater sustainability plan (GSP) or coordinated GSPs (Section 10720.7). The Kern County Subbasin is a high-priority basin and is identified as having critical overdraft conditions. Information regarding the status of groundwater basins is provided by the California Department of Water Resources (DWR) at: http://www.water.ca.gov/groundwater/sgm/cod.cfm.

This GSA notification and supporting materials are submitted to DWR within 30 days of the decision to form the GSA by its member agencies per Water Code §10723.8(a).

Water Code §10723.8(a)(1) requires that this GSA notification include information regarding the service area boundaries of the GSA and the boundaries of the basin the GSA intends to manage. Exhibit 1 includes three maps to satisfy the requirements of Water Code §10723.8(a)(1). Map (A) shows the Kern River GSA boundary. Map (B) shows the Kern River GSA boundary within the Kern County Subbasin. Map (C) shows the boundaries of the service areas of the agencies that comprise the Kern River GSA. The digital GIS data corresponding to the GSA boundary maps shown in Exhibit 1 are included with this submittal and provided on compact disc.

Water Code §10723.8(a)(1) also requires information regarding other agencies managing or proposing to manage groundwater within the basin. At the time of this Kern River GSA Notification submittal to DWR, it is our understanding that the Buena Vista Water Storage District has submitted a Notification to Form a GSA with DWR for a portion of the Kern County Subbasin. Within the Kern County subbasin, we understand that other agencies may be considering or proposing to form GSAs to manage groundwater resources in their own services areas. To our knowledge at this time, the following entities have held either a public hearing or expressed interest in forming a GSA: the Kern Groundwater Authority (KGA) and the Olcese Water District. We understand that the Greenfield County Water District has held a public hearing, passed a resolution to form a GSA, and will be submitting their Notification to Form a GSA with DWR.

On March 1, 2016 the governing Board of the Kern Delta Water District held a public hearing (Water Code §10723.b) regarding formation of the Kern River GSA. On March 15, 2016 the Board passed Resolution 2016-03 wherein the District resolved to become a GSA in cooperation with the City of Bakersfield and Improvement District No.4 of the Kern County Water Agency for the portion of the Kern County Subbasin as shown in Exhibit 1. Exhibit 2 contains a copy of the approved resolution to form the Kern River GSA by the governing Board of the Kern Delta Water District. Exhibit 3 includes details regarding the public noticing of the March 1, 2016 hearing by the Kern Delta Water District. The noticing process was consistent with the requirements of Section 6066 of the California Government Code.

On March 2, 2016 the City Council of Bakersfield held a public hearing (Water Code §10723.b) regarding formation of the Kern River GSA. On March 30, 2016 the City Council passed Resolution 039-16 wherein the City resolved to become a GSA in cooperation with the Kern Delta Water District and Improvement District No.4 of the Kern County Water Agency for the portion of the Kern County Subbasin as shown in Exhibit 1. A copy of Resolution 039-16 is included in Exhibit 2. Details regarding the public noticing of the March 2, 2016 hearing by the City Council are provided in Exhibit 3 and are consistent with the requirements of Section 6066 of the California Government Code.

On March 31, 2016 the Board of Directors of the Kern County Water Agency on behalf of Improvement District No.4 held a public hearing (Water Code §10723.b) regarding formation of the Kern River GSA. On March 31, 2016 the Board of Directors passed Resolution 11-16 wherein the Kern County Water Agency, Improvement District No.4 resolved to become a GSA in cooperation with the Kern Delta Water District and the City of Bakersfield for the portion of the Kern County Subbasin as shown in Exhibit 1. A copy of Resolution 11-16 is included in Exhibit 2. Details regarding the public noticing of the March 31, 2016 hearing by the Board of Directors are provided in Exhibit 3 and are consistent with the requirements of Section 6066 of the California Government Code.

Exhibit 4 provides a memorandum of understanding (MOU) between the Kern Delta Water District, City of Bakersfield, and Kern County Water Agency Improvement District No.4 to form the Kern River GSA and manage groundwater resources sustainably within the GSA boundary. Please note that Exhibit C-1 to the MOU in Exhibit 4 contains a list of additional agencies that have joined the Kern River GSA. Exhibit 5 includes additional supporting documents related to these additional agencies that have joined the Kern River GSA.

Per California Water Code §10723.2, GSAs shall consider the interests of all beneficial uses and users of groundwater within their service area, as well as those responsible for implementing Groundwater Sustainability Plans (GSPs). Exhibit 6 lists interested parties developed pursuant to Water Code §10723.2 and describes how these users and uses will be considered during the development and operation of the Kern River GSA and implementation of the GSP for the Kern River GSA. If additional interested parties are discovered, they too will be included in the development and operation of the GSA and the development and implementation of the agency's sustainability plan (Water Code 10723.8(a)(4)).

Water Code §10723.4 states that a GSA shall also establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents. Any person may request, in writing, to be placed on the list of interested persons. The Kern River GSA will establish and maintain such a list of persons interested in receiving notices.

Except for the authorities granted to a GSA pursuant to Part 2.74 of Division 6 of the California Water Code (SGMA), no new bylaws, ordinances, or authorities have been adopted by the District or City at this time of forming the Kern River GSA (Water Code §10723.8(a)(3)).

The undersigned hereby represents that the information required by California Water Code §10728.3 is included within this notice and that the notification process is complete.

If you have any further questions or require any clarification regarding the information provided in this GSA Notification submittal, please do not hesitate to contact one of our GSA program coordinators as identified on the following page.

Thank you,

Rodney Palla
President, Board of Directors, Kern Delta Water District

Harold Hanson
Vice Mayor, City of Bakersfield

Ted Page
President, Board of Directors, Kern County Water Agency

GSA Program Coordinators

Art Chianello
Water Resources Manager
Water Resources Department
(661) 326-3715
achianel@bakersfieldcity.us

Mark Mulkay
General Manager
Kern Delta Water District
(661) 834-4656
mulkay@kerndelta.org

David Beard
Manager
Kern County Water Agency
Improvement District No. 4
(661) 634-1400
dbeard@kcwa.com

Exhibits:

Exhibit 1: GSA Maps – including (A) map of Kern River GSA boundary, (B) map of Kern River GSA boundary within Kern County Subbasin, and (C) map of Kern River GSA showing member agencies service area boundaries

Exhibit 2: GSA Forming Resolutions by Kern Delta Water District, City of Bakersfield, and Improvement District No. 4 of the Kern County Water Agency

Exhibit 3: Public Hearing Noticing Information for GSA Member Agencies

Exhibit 4: Memorandum of Understanding (MOU) Between the City of Bakersfield, Kern Delta Water District, and Improvement District No.4 of the Kern County Water Agency

Exhibit 5: Supporting Documents for Entities Also Joining the Kern River GSA

Exhibit 6: List of Interested Parties

Exhibit 7: List and Map of Disadvantaged Communities (DAC) in GSA

Appendix B

Compliance Documentation

UWMP Documentation

AWMP Documentation

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **EDMUND G. BROWN JR.,** *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

August 30, 2016

Mr. David Beard
Improvement District No. 4 Manager
Kern County Water Agency
3200 Rio Mirada Drive
Bakersfield, California 93308

RE: Urban Water Management Plan Requirements Addressed

Dear Mr. Beard:

The Department of Water Resources (DWR) has reviewed the Kern County Water Agency's 2015 Urban Water Management Plan (UWMP) that was received on June 24, 2016. The California Water Code (CWC) directs DWR to report to the California State Legislature once every five years on the status of submitted UWMPs. In meeting this legislative reporting requirement, DWR reviews all submitted UWMPs.

DWR's review of the Kern County Water Agency's 2015 UWMP has found that the UWMP addresses the requirements of the CWC. DWR's review of plans is limited to assessing whether suppliers have addressed the required legislative elements. In its review, DWR does not evaluate or analyze the supplier's UWMP data, projections or water management strategies. This letter acknowledges that the Kern County Water Agency's 2015 UWMP addresses the CWC requirements. The results of the review will be provided to DWR's Financial Assistance Branch.

If you have any questions regarding the review of the UWMP or urban water management planning please call Gwen Huff at 916-651-9672.

Sincerely,

Vicki Lake
Unit Chief
Urban Water Use Efficiency
(916) 651-0740

Electronic cc: Luis Avila
DWR

Jeff Eklund
Provost & Pritchard Consulting Group

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY

EDMUND G. BROWN JR., *Governor*

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

July 11, 2017

Art Chianello
Water Resources Manager
City of Bakersfield
1000 Buena Vista Road
Bakersfield, California 93311

RE: Urban Water Management Plan Submittal

Dear Mr. Chianello:

This is to inform you that the Department of Water Resources has received the 2015 Urban Water Management Plan for City of Bakersfield on June 30, 2017.

DWR reviews Plans as quickly as possible and in the order they are received. If you require an expedited review, please contact me.

Please feel free to contact Gwen Huff at (916) 651-9672 if you have any questions or would like to discuss the review of 2015 Urban Water Management Plans. Contact Ms. Huff, also, if you require an expedited review.

Vicki Lake
Unit Chief
Urban Water Use Efficiency
Department of Water Resources
(916) 651-0740

2015 Agricultural Water Management Plans List

2015 Agricultural Water Management Plans List

SBX 7-7 Plans

- Alta ID Water Management Plan
  - Vol 1 of 4
  - Vol 2 of 4
  - Vol 3 of 4
  - Vol 4 of 4
- Browns Valley ID 2016 AWMP
- Buena Vista 2015 AWMP
- Butte WD 2016 AWMP
- Byron Bethany ID_AWMP_Final_20171024
- Camrosa WD 2015 AWMP
- Carpinteria Valley WD 2015 AWMP
- Casitas MWD 2016 UWMP-AWMP
- Cawelo WD 2016 AWMP
- Corcoran AWMP Prepared Pursuant to Water Code Section 10826
- Consolidated ID 2016 AWMP
- Dudley Ridge 2015 AWMP
- Feather River Regional AWMP
  - Biggs-West Gridley WD 2015 AWMP
  - Richvale Irrigation District (2015 AWMP Update)
  - Western Canal Water District (WCWD)
- KernDelta WD 2015 AWMP
- Laguna ID AWMP 2015
- Lone Tree MWC 2016 AWMP
- Merced ID 2015 AWMP
- Modesto ID 2015 AWMP
- North Kern WSD 2015 AWMP
- Oakdale ID 2015 AWMP
- Orland Unit WUA AWMP 2017
- Rancho California WD 2015 AWMP UPDATE
- RD #2068 2016 AWMP
- Reclamation District #2035 2016 AWMP
- Riverdale ID 2016 AWMP

- San Diego Regional 2015 AWMP Part 1 | Part 2
- Semitropic WSD 2015 AWMP
- South San Joaquin ID AWMP 2015
- South Sutter WD 2015 AWMP
- Sutter Extension WD 2016 AWMP Final
- Turlock ID 2015 AWMP
- Ventura Co 2015 AWMP
- Wheeler Ridge-Maricopa 2015 AWMP
- Woodbridge ID 2016 AWMP
- Yolo County Flood Control and Water Conservation District
- Yuba Co WA 2015 AWMP

Federal Plans

- Arvin-Edison Water Basin plan
- Banta-Carbona ID 2015 WMP
- Central California ID WMP FINAL 6-2014
- Chowchilla WD 2015 Update
- Columbia Canal Co 2012 WMP
- Colusa Co WD WMP Oct2014
- Delano-Earlimart ID WMP
- Firebaugh Canal WD 2011 WMP
- Fresno Irrigation District Agricultural Water Management Plan
- Sacramento River Settlement Contractors WMP
  - RD 108 Water Measurement Program
  - Sutter Mutual WC Water Measurement Program
  - Sacramento River Settlement Contractors WMP 9.13.13 Update
  - GCID Water Measurement Compliance 2016 Update
  - Sacramento River Settlement Contractors 2016 Drought Mgmt Plan
- James ID 2016 AWMP
- Kern-Tulare WD 2016 AWMP
- Lindmore ID 2016 WMP & Supplemental Report
- Lower Tule River 2012 WMP Update
- Madera ID WMP 2014-04-01
- Maine Prairie WD 2015 WMP 2.2017
- Orange Cove ID 2015 WCP & Addendum
- Orland-Artois WD 2015 WMP
- Panoche WD WCP Final 3-24-14

- Patterson ID WMP 2016 Update
- Pixley ID 2012 WMP Update
- San Benito COWD 2015 WMP
- San Luis Canal Co WMP Final 6-2014
- San Luis WD 2015 Supplement Report
- Shafter-Wasco ID 2015 Addendum to WMP
- Solano ID 2015 AWMP
- Stockton-East WD 2015 AWMP 2017.08.01
- Tulare ID Water Management Plan
  - Agricultural Water Measurement Master Plan
  - Drought Management Plan
  - Water Management Plan 2010
  - Water Supply Summary
- West Stanislaus ID 2014 WMP
- Westlands WD Water Mangement Plan
  - Westlands WD Water Shortage Contingency Plan 4.13.2017
  - Westlands WD WMP 2012
  - Westlands WD Worksheet Supply and Demand Final 4.13.2017
  - Water Supply Summary
- Westside WD 2013 WMP

Wednesday, November 01, 2017

Water Suppliers Required and <u>Submitted</u> (<25,000 due 7/1/2016)	**Date Received**	**2015 & 2016 Plan Type/Date**	**>25,000 acres or as noted**	**Review Completed**
Lone Tree MWC	7/1/2015	SBX7-7	10-25,000 acres	X
Columbia Canal Co.	8/10/2015	CVPIA	10-25,000 acres	X
Firebaugh Canal W.D.	8/10/2015	CVPIA	10-25,000 acres	X
Central California ID	8/10/2015	CVPIA/ 2014		X
San Luis Canal Co	8/10/2015	CVPIA/ 2014		X
Corcoran ID	8/18/2015	SBX7-7/ 2015		X
Arvin-Edison WSD	11/12/2015	CVPIA/ 2013-updated		X
Tulare Lake Basin WSD	11/12/2015	SBX7-7/ 2015		X
San Benito WD	11/16/2015	CVPIA/ 2015		X
Alta ID	12/9/2015	SBX7-7/ 2015		X
Turlock ID	12/10/2015	SBX7-7/ 2015		X
Lower Tule River ID	12/21/2015	CVPIA/ 2012		X
Pixley ID	12/21/2015	CVPIA/ 2012		X
Chowchilla WD	12/22/2015	CVPIA/ 2015-updated		X
South San Joaquin ID	12/22/2015	SBX7-7/ 2015		X
Kern Delta WD	12/28/2015	SBX7-7/ 2015		X
Modesto ID	12/29/2015	SBX7-7/ 2015		X
Biggs-West Gridley WD	1/13/2016	SBX7-7/ 2015		X
North Kern WSD	1/19/2016	SBX7-7/ 2015		X
Dudley Ridge WD	1/20/2016	SBX7-7/ 2015	10-25,000 acres	X
Laguna ID	1/27/2016	SBX7-7/ 2015		X
Tulare ID	1/28/2016	CVPIA/ 2015-updated		X
Nevada ID	2/1/2016	SBX7-7/ 2015		X
Ventura Co Waterworks Dist 1	2/11/2016	SBX7-7/ 2015	<10,000 acres	
Shafter-Wasco ID	2/11/2016	CVPIA/ 2015-updated		X
Yolo Co FC&WCD	2/11/2016	SBX7-7/ 2015		X
Fresno ID	2/18/2016	CVPIA/ 2015		X
Western Canal WD	2/26/2016	SBX7-7/ 2015		X
Richvale ID	2/29/2016	SBX7-7/ 2015		X
Solano ID	2/29/2016	CVPIA/ 2016		X
Buena Vista WSD	3/4/2016	SBX7-7/ 2015		X

Carlsbad MWD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
City of Escondido*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
City of Oceanside*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
City of Poway*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Fallbrook Public Utilities District*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Olivenhaim MWD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Ramona MWD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Rincon del Diablo MWD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
San Dieguito WD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Santa Fe ID*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Vallecitos WD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Yuima MWD*	3/15/2016	SBX7-7/ 2015	<10,000 acres	
Valley Center MWD*	3/15/2016	SBX7-7/ 2015	10-25,000 acres	**X**
Rainbow MWD*	3/15/2016	SBX7-7/ 2015	10-25,000 acres	**X**
Camrosa WD	3/29/2016	SBX7-7/ 2015	<10,000 acres	
Oakdale ID	3/29/2016	SBX7-7/ 2015		**X**
Semitropic WSD	4/1/2016	SBX7-7/ 2015		**X**
Yuba County WA	4/4/2016	SBX7-7/ 2015	Wholesaler	
Wheeler-Ridge-Maricopa WSD	4/6/2016	SBX7-7/ 2015		**X**
Carpinteria Valley WD	4/22/2016	SBX7-7/ 2015	<10,000 acres	
South Sutter WD	4/29/2016	SBX7-7/ 2015		**X**
Rancho California WD	6/23/2016	SBX7-7/ 2016	10-25,000 acres	**X**
Patterson ID	6/28/2016	CVPIA/ 2016 Update	10-25,000 acres	**X**
Woodbridge ID	6/29/2016	SBX7-7	10-25,000 acres	**X**
Cawelo WD	6/29/2016	SBX7-7		**X**
Casitas MWD	7/1/2016	SBX7-7	<10,000 acres	
Merced ID	7/21/2016	SBX7-7		**X**
Browns Valley ID	7/22/2016	SBX7-7	10-25,000 acres	**X**
Reclamation District 2035	7/29/2016	SBX7-7	10-25,000 acres	**X**
Consolidated ID	8/9/2016	SBX7-7		**X**
James ID	8/26/2016	CVPIA	10-25,000 acres	**X**
Kern-Tulare WD	8/31/2016	CVPIA	10-25,000 acres	**X**
Reclamation District No. 2068	9/14/2016	SBX7-7	10-25,000 acres	**X**
West Stanislaus I.D.	9/16/2016	CVPIA	10-25,000 acres	**X**

Westside W.D.	9/21/2016	CVPIA	10-25,000 acres	X
Riverdale I.D.	11/15/2016	SBX7-7	10-25,000 acres	X
Sutter Extension WD	11/17/2016	SBX7-7	10-25,000 acres	X
Glenn-Colusa ID**	12/16/2016	CVPIA/Sac River		X
Butte WD	1/4/2017	SBX7-7	10-25,000 acres	
Princeton-Codora-Glenn ID**	1/6/2017	CVPIA/Sac River	<10,000 acres	X
Meridian Farms**	1/6/2017	CVPIA/Sac River	<10,000 acres	X
Anderson-Cottonwood ID**	1/6/2017	CVPIA/Sac River	<10,000 acres	X
Reclamation District No. 1004**	1/6/2017	CVPIA/Sac River	10-25,000 acres	X
Provident ID**	1/6/2017	CVPIA/Sac River	10-25,000 acres	X
Natomas MWC**	1/6/2017	CVPIA/Sac River	10-25,000 acres	X
Sutter Mutual WC**	1/6/2017	CVPIA/Sac River		X
Reclamation District No. 108**	1/6/2017	CVPIA/Sac River		X
San Luis WD	1/10/2017	CVPIA		X
Delano-Earlimart ID	1/30/2017	CVPIA		X
Maine Prairie W.D.	3/7/2017	CVPIA	10-25,000 acres	X
Westlands WD	4/13/2017	CVPIA		X
Banta-Carbona I.D.	4/19/2017	CVPIA	10-25,000 acres	X
Orland-Artois WD	4/25/2017	CVPIA		X
Madera ID	4/25/2017	CVPIA		X
Colusa Co. WD	5/2/2017	CVPIA		X
Orland Unit WUA	5/11/2017	SBX7-7	10-25,000 acres	X
Stockton-East WD	8/8/2017	CVPIA		X
Orange Cove ID	8/28/2017	CVPIA		X
Lindmore ID	9/15/2017	CVPIA	10-25,000 acres	X
Panoche WD	9/26/2017	CVPIA		X
Byron Bethany I.D.	10/31/2017	CVPIA	10-25,000 acres	

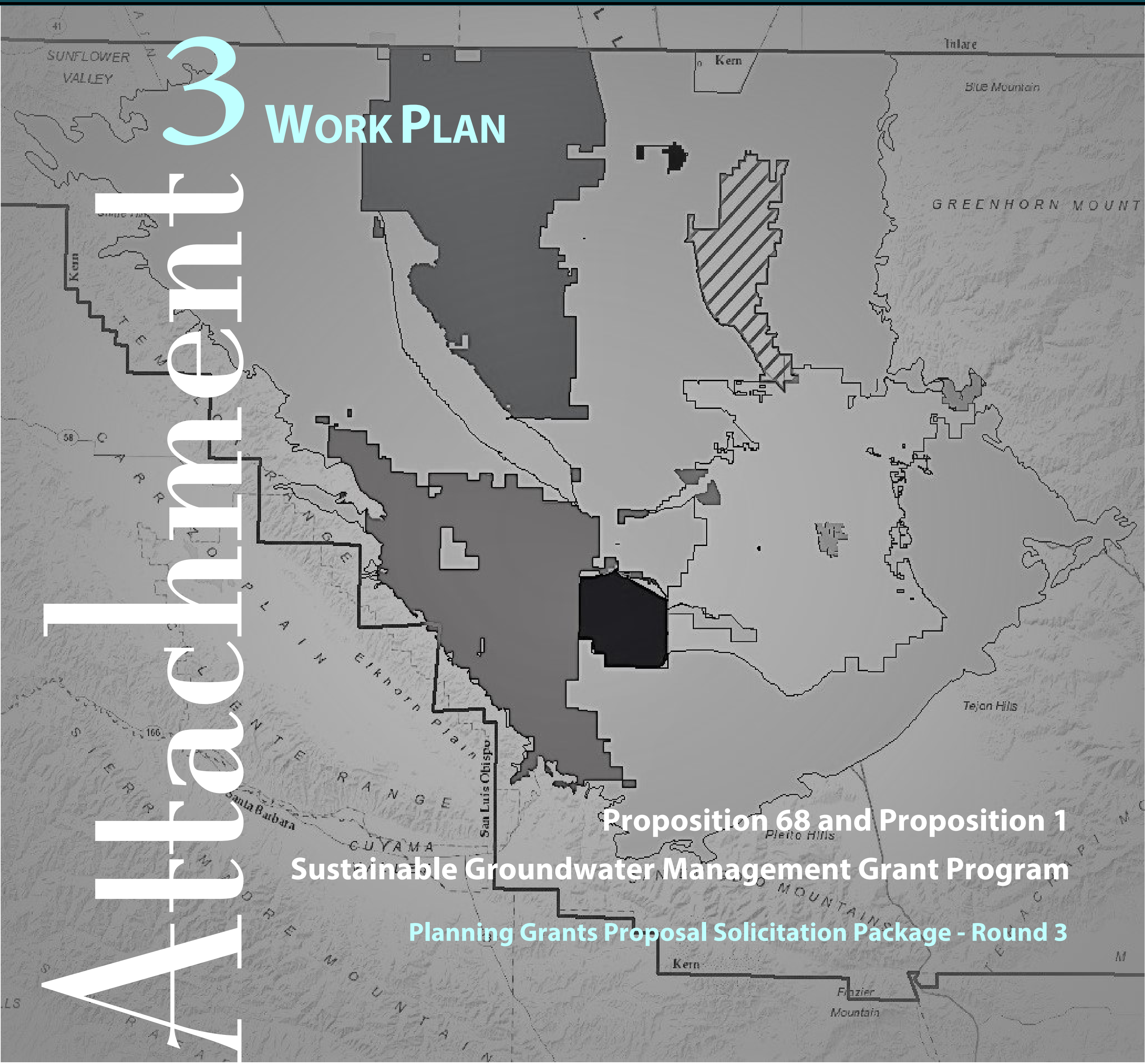
*San Diego Regional AWMP
**Sac R. Settlement Contractors

Water Suppliers Required, In Progress (<25,000 due 7/1/2016)	**2015-2016 Plan Type/Date**	**>25,000 acres or as noted**
Kings River W.D.	SBX7-7	10-25,000 acres
Ivanhoe I.D.	CVPIA	10-25,000 acres
Saucelito I.D.	CVPIA	10-25,000 acres
Terra Bella I.D.	CVPIA	10-25,000 acres
Tule Lake ID	CVPIA	
Water Suppliers Required, Not Submitted (<25,000 due 7/1/2016)		
Belridge WSD	SBX7-7	
Berrenda Mesa WD	SBX7-7	
Central San Joaquin WCD	CVPIA	
Del Puerto WD	CVPIA	
Lost Hills WD	SBX7-7	
Palo Verde ID	RRA***	
Southern San Joaquin MUD	CVPIA	
Angiola WD		
Bard WD	CVPIA	10-25,000 acres
Exeter I.D.	CVPIA	10-25,000 acres
Henry Miller W.D.	SBX7-7	10-25,000 acres
Lindsay-Strathmore I.D.	CVPIA	10-25,000 acres
Porterville I.D.	CVPIA	10-25,000 acres
Reclamation District No. 999	SBX7-7	10-25,000 acres
St. Johns W.D.	SBX7-7	10-25,000 acres

***Reclamation Reform Act of 1982

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II 2019 Grant Application

Attachment 3 Work Plan



Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Tables

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Work Plan

Grant Proposal Title:	**Kern County Subbasin Groundwater Sustainability Plan Support – Phase II**
Applicant:	**Kern River Groundwater Sustainability Agency**

Project Justification

A. Project Description

The Kern County Subbasin (Subbasin 5-022.14) is identified as a critically overdrafted basin where numerous water and irrigation districts, municipalities, industries, mutual water companies, small water systems, and Kern County residents rely on the shared groundwater resources. In compliance with the Sustainable Groundwater Management Act (SGMA), 11 groundwater sustainability agencies (GSAs) have been formed to cooperatively manage local groundwater in a sustainable manner within the Subbasin.

This proposal includes one critically important project, Kern County Subbasin Data Management System Development, which will be implemented by all the GSAs in the Kern County Subbasin. KRGSA is submitting this application on behalf of the entire Subbasin.

KRGSA on behalf of the Kern County Subbasin was awarded $1,500,000 in Proposition 1 SGMA Planning Grant funds for a suite of six GSP Development project components supporting the entire Kern County Subbasin and proposed under the 2017 Round 2 SGMA grant opportunity. These six project components are well underway and successfully nearing completion at the time of this writing. Given the funding guidelines associated with this 2019, Round 3 SGM Planning Grant opportunity, this proposal requests an additional $500,000 in Planning Grant funds, which if awarded, will mean that the Kern County Subbasin will have been awarded the published maximum of $2,000,000 in Proposition 68 and Proposition 1 SGM Planning Grant funding. The Kern County Subbasin is one of the most important groundwater resources in the state, given its large size, high population growth, large number of irrigated acres, reliance on groundwater, and historical groundwater impacts. In light of these relatively high basin prioritization criteria, the Subbasin supports numerous large groundwater banking projects of statewide importance, including the Kern Water Bank, among others. This Subbasin is deserving of earning up to the maximum of grant funding due to the importance of this Subbasin and its various planning needs and challenges.

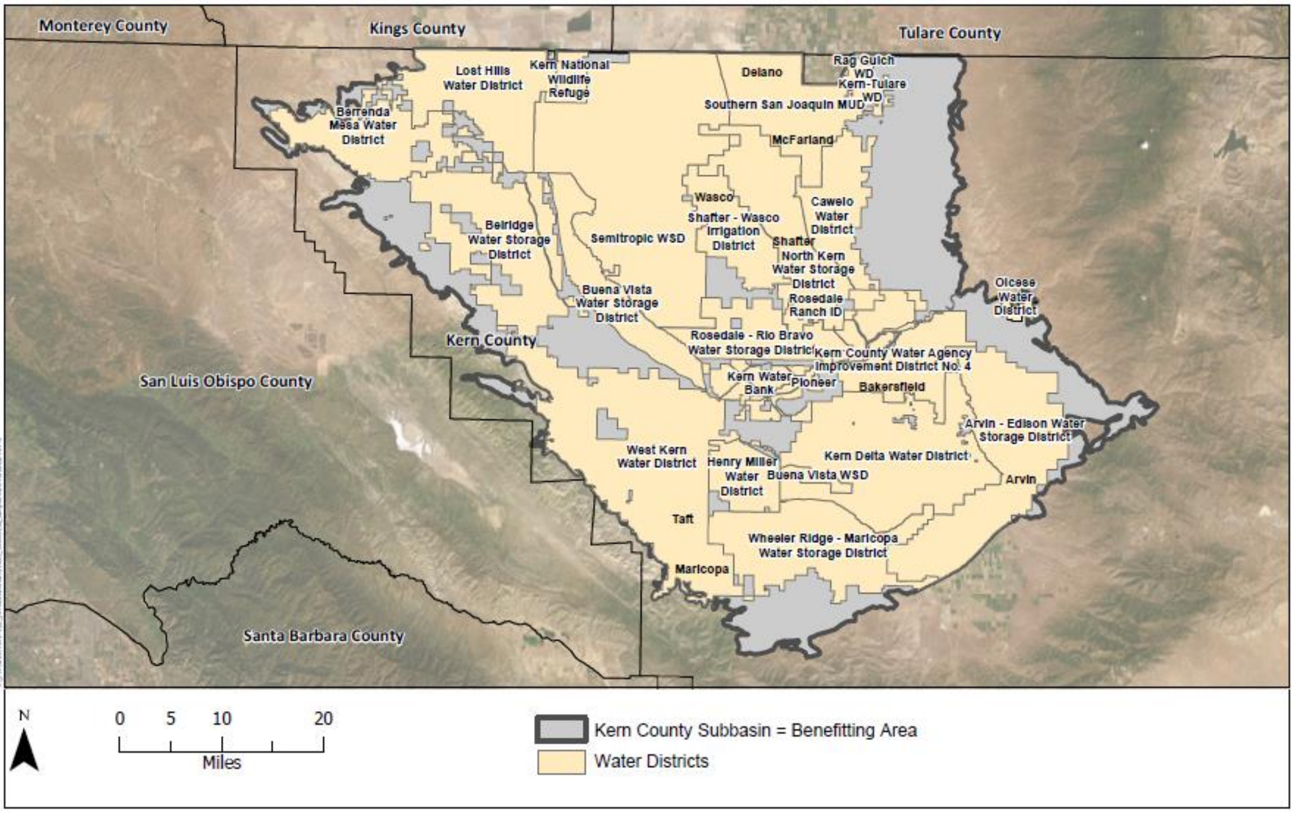
This project included in this proposal and described below will parlay the available $500,000 in Planning Grant funds to effectively initiate a data management system (DMS) that will benefit all GSAs in the Subbasin and directly support the cross-basin coordination effort.

Background and Need for the Project

Covering about 2,834 square miles, Kern County Subbasin is the largest subbasin in California with a complex water management structure, a large portfolio of local and imported water sources, and numerous large groundwater banking projects, collectively providing both local and State-wide benefits for water supply. The map provided in **Figure 3-1** below shows the boundaries of the Kern County Subbasin, which is also the area that would benefit from the proposed project, as well as the boundaries of the multiple water districts within the Subbasin. The general locations of Disadvantaged

Communities (DACs) are shown in bold-face type; a map showing the areas occupied by DACs is provided as Figure 6-1 in Attachment 6.

Figure 3-1. Kern County Subbasin and Benefitting Area



Given this framework, numerous approaches and systems for data management have been developed over time by each local agency for its own objectives – including regulatory compliance. This has resulted in a myriad of disparate data sets with different organizational structures, temporal and spatial scales, data standards, and assumptions regarding data accuracy and reliability. GSP regulations (Article 3, Section 352.6) require agencies to develop and maintain a data management system that is "capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin."

The Kern County Subbasin GSAs recognize the need to develop a centralized DMS on a Subbasin-wide basis. Accordingly, the GSAs in the Kern County Subbasin are cooperating on this proposal for a Subbasin-wide DMS to support monitoring, evaluation, reporting, management, and, importantly, GSP implementation. It is recognized that compilation of individual DMSs will require significant manipulation and re-structuring to create a centralized relational DMS that is populated with consistent data sets across the Subbasin.

One of the hallmarks of SGMA is a call for the integrated coordination of groundwater resources across a subbasin planning area. For the Kern County Subbasin, developing a shared, common, and consistent platform across the Subbasin is essential to continue the coordination developed with the C2VSim water modeling, monitoring network, and now annual reporting.

The immediate need for a centralized DMS is highlighted by the GSAs' ongoing cooperative efforts for annual reporting. Specifically, GSAs are working together to collaboratively prepare one Annual Report for each reporting period that covers the entire Subbasin rather than submitting a separate Annual Report from each GSA. As codified in SGMA, Chapter 6, Section 10728 of the California Water Code states:

> "On April 1 following the adoption of a groundwater sustainability plan and annually thereafter, a groundwater sustainability agency shall submit a report to the department containing the following information about the basin managed in the groundwater sustainability plan:
>
> (a) Groundwater elevation data.
>
> (b) Annual aggregated data identifying groundwater extraction for the preceding water year.
>
> (c) Surface water supply used for or available for use for groundwater recharge or in-lieu use.
>
> (d) Total water use.
>
> (e) Change in groundwater storage."

In order to comply with the requirements of SGMA for standardized reporting, and to coordinate on a Subbasin-wide basis for consistent data evaluation, it is crucial that a DMS be developed for the entire Subbasin that will allow the various GSAs to gather and share information regarding local groundwater conditions on a shared and consistent data platform.

Project Goals and Objectives

The overarching goal of the proposed Subbasin Data Management System Development project is to initiate the key steps to develop and build the Subbasin DMS, which will ultimately support Subbasin GSAs by providing (1) improved coordination of groundwater monitoring and management actions and (2) the ability to meet the reporting and implementation requirements of their respective groundwater sustainability plans (GSPs) and the California Department of Water Resources (DWR).

It is noted that the total cost to complete the entire DMS development for the Kern Subbasin will likely exceed the available grant funding of $500,000 under the Sustainable Groundwater Management (SGM) Grant Program, Round 3 (this grant application). This application is submitted to initiate the key steps to develop and build the Subbasin DMS. This Work Plan and the associated Budget and Schedule describe tasks to be funded under this grant and within the available funding, as well as additional tasks that will likely require additional funding, above and beyond this SGM Planning Grant, to be shared among Subbasin GSAs who have already developed successful cost sharing structures for numerous components of the GSP including coordinated development of the Subbasin-wide integrated surface water-groundwater model (C2VSimFG-Kern). The Subbasin GSAs are committed to providing sufficient funds and resources to complete the project.

The work plan steps requested under this grant will provide the necessary DMS framework, addressing needs and processes such as accessibility, transparency, functionality, reliability, and data sharing, among others. The DMS project description, budget, and schedule information provided in Attachments 3, 4, and 5 describe the tasks that will be conducted under the funding support of this grant.

The project objectives are as follows:

- Identify data types to be included in the DMS and required to monitor GSP implementation and Subbasin progress toward sustainability. (funded under this grant)
- Investigate and compare commercially available DMS packages and custom systems to determine the most appropriate and cost-effective format for the Kern County Subbasin DMS. (funded under this grant)

- Select a preferred DMS approach. (funded under this grant)
- Procure or design the DMS and customize as needed with an appropriate configuration that combines technical rigor, flexibility, ease of use, and expansion capabilities to store data in text, spreadsheet, graphical, and map-based formats. (partially funded under this grant; The any additional funding to be provided by Subbasin GSAs)
- Develop data templates that allow each GSA or participating agency to submit the required data in a consistent format that can be combined and adjusted to present information in both local and Subbasin-wide formats to meet DWR reporting requirements. (funded under this grant)
- Develop a DMS User's Manual and train GSA staff to gather, submit, and update the required data on a regular basis and in a consistent format. (funded under this grant
- Coordinate with local stakeholders, non-member agencies, and disadvantaged communities (DACs), such as the Cities of Shafter and Arvin and portions of the City of Bakersfield, that have potential activities, tasks, and/or components that are complementary to the DMS development project. (funded under this grant)

Tools to Be Developed

The proposed Subbasin Data Management System Development project will initiate the key steps to develop and build a critically important DMS for the Kern County Subbasin. Specific tools to be developed during implementation of this grant-funded scoping and development effort include the following:

- A process for identifying necessary data types;
- A comparison/decision-making tool for evaluating commercially available DMS packages and custom systems against the needs and resources of the Subbasin;
- The DMS itself, customized to meet the data needs of the Subbasin GSAs; and
- A DMS User's Manual to train GSA staff in the use of the DMS.

Differentiation from Round 2 Funding

KRGSA is the administering agency for Round 2 funding of six projects under the Kern County Subbasin Groundwater Sustainability Plan Support – 2017 Grant Application (DWR Agreement No. 4600012955):

- Component 1: Grant Administration (KRGSA responsibility)
- Component 2: Groundwater Modeling (KRGSA responsibility)
- Component 3: Groundwater Model Peer Review (KGA responsibility)
- Component 4: Hydrogeologic Conceptual Model and Groundwater Conditions (KGA responsibility)
- Component 5: Groundwater Sustainability Plan Coordination (KGA responsibility)
- Component 6: GSP Development (KRGSA responsibility)

No funding was requested from DWR in Round 2 for the purpose of developing a DMS for the Subbasin, nor is funding being applied to such efforts. The DMS development project included in this proposal is a new and unique project and in no manner duplicative of work included under the six components included in the Round 2 Proposition 1 grant.

Historically, individual GSAs and their member agencies have developed separate systems to comply with various regulations; however, the GSAs in the Kern County Subbasin recognized the need to develop a centralized DMS on a Subbasin-wide basis to specifically conform to the needs of the GSAs and reporting entities to support the Subbasin GSPs. Accordingly, the Subbasin GSAs are cooperating on this proposal for a Subbasin-wide DMS to support monitoring, evaluation, reporting, management, and, importantly, GSP implementation. Compiling the individual DMSs into a coherent system will require significant manipulation and re-structuring to create a centralized relational DMS that is populated with consistent data sets across the Subbasin.

The work being undertaken with Round 2 grant funds, which involves development of GSPs for GSAs in the Subbasin in compliance with SGMA, is proceeding in accordance with DWR-mandated deadlines and will be completed on schedule. No cost overruns have been identified for Round 2 projects, and no additional funding will be required for completion of these projects. No Round 3 funding is intended to be allocated toward these projects.

The Kern County Subbasin Data Management System Project being proposed for Round 3 funding will allow the GSAs to comply with the requirements of SGMA Article 2 (§ 352.6), which requires each GSA to develop and maintain a DMS that is capable of storing and reporting information relevant to the development or implementation of a GSP and monitoring of the basin. Also required under SGMA is the development of a coordinated DMS for the Subbasin (Article 8, § 357.4). The project will assist the GSAs in meeting the requirements of SGMA annual reporting to DWR by April 1 of each year following adoption of its GSP (§ 356.2), as well as the reporting standards provided in Article 3 (§ 352.4) and reporting provisions found in Article 4 (§ 353.4).

B. Project Benefits

Covering about 2,834 square miles, Kern County Subbasin is the largest subbasin in California with a complex water management structure, a large portfolio of local and imported water sources, and numerous large groundwater banking projects, collectively providing both local and State-wide benefits for water supply. Accordingly, the GSAs are cooperating on this proposal for a Subbasin-wide DMS to support monitoring, evaluation, reporting, management, and, importantly, GSP implementation.

The project has two primary benefits that relate to the Subbasin, DACs within the Subbasin area, and all beneficial users of Subbasin groundwater: (1) development of a Subbasin-wide database that will allow consistent collection and comparison of data from multiple GSAs; and (2) improved watershed coordination among the GSAs.

- Database Development: The project will allow the Subbasin GSAs to identify and develop a DMS suitable for collection, storage, and analysis of the various types of data to be generated to support their GSPs. The project will allow the Subbasin GSAs to comply with the requirements of SGMA Article 2 (§352.6), which requires each GSA to develop and maintain a DMS that is capable of storing and reporting information relevant to the development or implementation of a GSP and monitoring of the basin. The proposed project will develop a common data system that all GSAs in the Subbasin can use, and this will enable better coordination across the various GSAs. The goal of the DMS is to support Subbasin GSAs by providing (1) improved coordination of groundwater monitoring and management actions and (2) the ability to meet the reporting and implementation requirements of groundwater sustainability plans (GSPs) and the California Department of Water Resources (DWR).
- Watershed Coordination: Located in the largest county and the southern end of the DWR Tulare Lake Hydrologic Region, the Kern County Subbasin involves numerous large and small watersheds of the Sierra Nevada, San Emigdio and Tehachapi mountains, and the

Coast Ranges. As demonstrated through the Integrated Regional Water Management Planning (IRWMP) Group process, Subbasin agencies associated with these contributing watersheds have coordinated on multiple projects over the years and have continued working together collaboratively during the GSP process. To comply with SGMA requirements SGMA for standardized reporting, and to coordinate on a Subbasin-wide basis for consistent data evaluation, it is crucial that a DMS be developed collaboratively for the entire Subbasin, allowing GSAs to combine and share data and information regarding local groundwater conditions using a consistent and comprehensive data platform.

The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II 2019 Grant Application includes outreach, engagement, and support to benefit DACs throughout the entire Subbasin. During numerous community outreach meetings, DAC representatives have been engaged with questions and comments on Subbasin data.

The following DAC communities within the Kern County Subbasin are identified as cities or Census Designated Places (CDPs) in DWR’s DAC database. All communities qualifying as DACs within the Kern County Subbasin will benefit as a result of the DMS project.

Arvin
Buttonwillow CDP
Delano
Edmundson Acres CDP
Ford City CDP
Fuller Acres CDP
Greenfield CDP
Lamont CDP
Lost Hills CDP
Maricopa
McFarland
McKittrick CDP
Mettler CDP
Mexican Colony CDP
Oildale CDP
Richgrove CDP
Shafter
Smith Corner CDP
South Taft CDP
Taft
Taft Heights CDP
Tupman CDP
Valley Acres CDP
Wasco
Weedpatch CDP

The project would include outreach to DAC staff that are required to report under SGMA. Accessibility of data has been a highly sensitive issue to many stakeholders in the Subbasin with concerns about transparency and privacy. Consistent communication and transparency of the DMS development process will be key to obtaining support from the Subbasin’s beneficial users of groundwater. To support this budget category for Stakeholder Engagement, technical meetings will be held with the DAC staff that are required to report data to DWR, to obtain buy-in to the Subbasin DMS process.

As part of the IRWMP process, various groups were formed in the Kern County Subbasin as a means of developing a collaborative approach involving the governing group of water management districts, regional Stakeholders, and all other Interested Parties (e.g., landowners, public, local communities), all of which were working on regional water management planning and implementation activities.

DACs are directly represented in the IRWM groups through a DAC Representative, an elected member of the governing Regional Water Management Group who addresses the issues and needs of these areas. Moreover, the DACs are represented by a DAC “Work Group” consisting of individual participants from the following identified groups or communities: Ducor Community Services District, Buttonwillow County Water District, Bishop Acres Mutual Water Community, Semitropic School District, Pond Union School District, City of McFarland, City of Delano, City of Wasco, Lost Hills Utility District, Blackwells Corner, and Earlimart Public Utility District. The IRWM Group gives substantial consideration to the issues and needs of these DACs during all regional planning and implementation activities. The IRWM Group has worked closely with DACs for many years to identify DAC concerns and to promote potential solutions, either as standalone projects or programs or as a component of IRWM grant submissions.

Letters of support for the Kern County Subbasin Groundwater Sustainability Plan Support – Phase II 2019 Grant Application – including a joint letter signed by the agencies required to report under SGMA in the Subbasin – have been provided by several beneficial stakeholders and can be found in Attachment 6, Appendix C. As noted previously, outreach to DACs will continue to occur throughout development of the DMS. With grant funding, the DMS project will be better situated to conduct outreach to, engage, and include DACs and DAC concerns so that DACs will benefit from easier access to groundwater sustainability information.

C. Technical Expertise

The GSAs and participating agencies in the Kern County Subbasin have been working cooperatively for several years to develop GSPs that accurately depict the groundwater management conditions of the Subbasin. Accordingly, the Subbasin GSAs are familiar with the data types and sources in the Subbasin as well as the need to combine and share information. This process will ensure the accuracy of their respective GSPs within the larger Subbasin context and contribute to the success of management actions being proposed for implementation. This need for cooperative and consistent data collection, recordation, management, and use is the impetus for the Data Management System Development project being proposed for this grant.

Agencies involved in this project all involve talented engineers available to lead and assist with this proposed project. All of the agencies are familiar with groundwater data and have experience in groundwater monitoring and management. Thereby, agencies clearly contain the technical expertise to lead in the development of a Subbasin DMS. Many of the agencies also contain web-based technical expertise to provide oversight for potential development of web-based systems and/or complex database structures. GSAs have already demonstrated their collective technical expertise to lead and provide oversight for complex technical projects, including the development of a numerical integrated surface water–groundwater model for GSP applications. Data collection efforts for that model were successfully undertaken by agencies and their technical consultants. GSAs will employ rigorous *Request for Proposal/Qualifications* process to ensure that qualified and competent technical agents are retained for the complex DMS tasks.

KRGSA on behalf of the all the GSAs in the Kern County Subbasin was awarded $1,500,000 in Proposition 1 SGMA Planning Grant funds for a suite of six GSP Development project components supporting the entire Kern County Subbasin and proposed under the 2017 Round 2 SGMA grant opportunity. These six project components supported by the Proposition 1 planning grant have, and continue to, contribute to development of the all the GSPs in the Kern County Subbasin, which are currently undergoing public review and successfully nearing completion at the time of this writing. GSPs are on schedule to comply with the SGMA requirement that all GSPs for critically overdrafted basins be submitted to DWR by January 31, 2020. This success of the technical components of multiple GSPs, funded in part by a DWR grant, again demonstrates the ability of the GSAs to lead a large, complex technical project such as the DMS development, assisted again with DWR funding.

Letters of support for the Kern County Subbasin Groundwater Sustainability Plan Support – Phase II 2019 Grant Application have been provided by several beneficial stakeholders and can be found in Attachment 6, Appendix C.

Project Details

D. Scope of Work and Deliverables

a. Scope of Work

Subbasin Data Management System Development

Implementing Agency: KRGSA

Task (a): Grant Administration (funded under this grant)

This task includes managing and administering the project including invoicing, reporting, and grant contract administration.

1. **Grant Management**
   Coordinate with DWR and conduct administrative responsibilities to execute a Grant Agreement and ensure that all contract requirements are met.
2. **Invoicing**
   Prepare and submit to DWR invoices including back up documentation. Backup will be collected and organized by budget category, along with an Excel compatible summary document detailing the contents of the backup documentation.
3. **Report Preparation**
   Prepare and submit quarterly Progress Reports prepared in accordance with Exhibit F. Prepare and submit draft Grant Completion Report prepared in accordance with Exhibit F. Prepare a Final Grant Completion Report addressing the DWR Project Manager's comments and submit to DWR in accordance with the provisions of Exhibit F.

Deliverables:

- Executed Grant Agreement
- Invoices and associated backup documentation
- Quarterly Progress Reports
- Draft and Final Grant Completion Report

Task (b): Stakeholder Engagement / Outreach (funded under this grant)

Accessibility of data has been a highly sensitive issue to many stakeholders in the Subbasin with concerns about transparency and privacy. Consistent communication and transparency of the DMS development process will be key to obtaining support from the Subbasin's beneficial users of groundwater. To support this budget category for Stakeholder Engagement, technical meetings will be held with the DAC staff that are required to report data to DWR, to obtain buy-in to the Subbasin DMS process.

1. **Technical Meetings**
   Hold technical meetings with staff of DACs that are required to report data to DWR.

Deliverables:

- Meeting agenda with DAC staff
- Workshop presentation documentation

Task (c): GSP Development: Subbasin DMS Scoping and Development

1. **Retain Consultant to Assist with DMS Development** (funded under this grant)

This task includes (a) generating a Request for Proposals (RFP) seeking a qualified professional consulting firm that will assist with development, management, and coordination of the Data Management System (DMS), (b) issuing the RFP, and (c) contracting with the selected firm.

During RFP development, the GSAs will work together in a series of meetings to identify high-level goals and basin needs for ongoing data management. Considerations will include, but not be limited to, data coordination, transparency, sharing, and GSP-required components such as those needed to assist with the Subbasin water budget. Data tracking as required under SGMA will also be considered, including the need to track specific DWR-defined categories for water sources and sectors. In addition, DWR has not yet developed the online forms that may need to be completed for GSP annual reporting and may require specific data formatting in the DMS. Accordingly, the DMS will need to be sufficiently flexible to meet a variety of GSA needs.

The GSA group will discuss and identify a range of alternatives for various DMS levels of sophistication ranging from a relatively simply Subbasin-wide relational database to various web-based platforms with broader functionality and visualization tools. In addition, GSAs will reach out to GSAs in other subbasins to gain insight from "lessons learned" as others use existing DMS structures for SGMA purposes. In this manner, the GSAs will ensure that the RFP is written to target firms capable of providing the required technical services. The GSAs may prefer a phased approach, requiring different consulting services for each phase.

Deliverables:

- RFP
- Executed contract

2. **Identify Information Requirements for DMS** (funded under this grant)

   This task involves coordination with all the GSAs in the Subbasin and their groundwater consulting firms, to identify the types and sources of data required to monitor GSP implementation, to evaluate groundwater conditions, and to document Subbasin progress toward sustainability. The DMS consultant will work collaboratively with GSAs, a technical DMS subcommittee, and/or a designated Subbasin consultant to develop a list of necessary data types, sources, and preferred formats (e.g., text, spreadsheet, graphical, and map-based formats) for each, which will be presented to all the GSAs in the Subbasin for input and approval.

   Considerations will be given to data structures and formats being used for other monitoring programs in the Subbasin to provide efficiencies for agencies with multiple reporting obligations. The structure of State and local databases may also need to be considered if data will be downloaded periodically from existing sources. Some of this work will be accomplished in parallel with Task (c)(1) above to inform the needs of the RFP. Remaining work will be conducted in consultation with the DMS consultant to bring the required details of the DMS into focus.

   Deliverables:

   - List of data types and sources to be collected to meet ongoing requirements under SGMA

3. **Investigate and Select an Appropriate DMS** (funded under this grant;

   The DMS Consultant (contractor) will investigate and compare commercially available DMS packages and custom systems to determine the most cost-effective and usable format for the DMS. The comparison will focus on DMS features determined to be of highest priority by the GSAs and will include items such as levels of security, data entry and uploading, QA/QC, spatial or graphical visualization, potential linkage to other systems, an appropriate user interface, and, importantly, ease of use. Costs of software, support/upgrades, copyright protections, or other proprietary restrictions will be documented. The contractor will also consider the technical expertise of those users responsible for entering, uploading, and managing the system for the future. A flexible system that can be readily modified with additional modules or functions in the future may be desirable. Costs will be provided for both development and maintenance of the DMS.

The contractor will prepare a report identifying the commercially available packages and custom systems, detailing the advantages and disadvantages of each and offering a series of recommendations for GSA Boards' consideration.

Deliverables:

- Report with recommendation for GSA Boards' consideration
- GSA Boards' decision to select a DMS package

4. **Procure/Design and Customize the Selected DMS** (funded under this grant; additional funding to be provided by GSAs if needed)

   Following the GSA Boards' decision, the contractor will procure or design the selected DMS and customize as needed with an appropriate configuration that combines technical rigor, flexibility, ease of use, and expansion capabilities to store data in text, spreadsheet, graphical, and map-based formats, as needed. The system will be implemented according to the requirements identified in Task (c)(2).

   Deliverables:

   - Documentation of the Kern County Subbasin DMS

5. **Develop Data Protocols and Templates** (funded under this grant)

   The contractor will develop data templates that allow each GSA or participating agency to submit the required data in a consistent format that can be combined and adjusted to present information in both local and Subbasin-wide formats to meet DWR reporting requirements. Templates and tables will also be developed for DMS output and reporting. Importantly, protocols and a quality assurance/quality control (QA/QC) process will be developed and documented that considers data entry, uploading, downloading, and DMS accessibility. Protocols will also consider data protection and DMS security.

   Deliverables:

   - Data templates and tables

6. **Develop DMS User's Manual and Train GSA Staff** (funded under this grant)

   GSA staff will be trained in data collection, appropriate use of templates, and uploading procedures to ensure that all GSAs are providing consistent information to the DMS. In addition to the system documentation of the DMS system produced in Task (c)(4), the contractor will develop a functional user's manual that describes templates, outlines DMS protocols, and provides step-by-step procedures for a variety of users and uses.

   Deliverables:

   - Training session or module for GSA staff
   - User's Manual

7. **Review and Assessment of DMS** (funded by GSAs as needed)
   Monitoring and assessment activities will include initial review of the DMS by primary users (GSA staff and their groundwater consultants) to determine the suitability of templates for uploading

data and the suitability of the database for combining and using data. Numerous test runs of the new DMS will be conducted to work out system bugs and/or address functional issues. It is anticipated that one reporting period can be managed with the new DMS to provide a test case for future use. After grant completion, the DMS will be assessed on an ongoing basis for potential upgrades, additions or modifications to data, and other DMS adjustments to be funded by the GSAs.

Deliverables:

- Initial review and recommendations for modifications

Task (d): Monitoring / Assessment

This project is a planning effort and does not involve on-the-ground monitoring activities.

Deliverables:

- Initial review and recommendations for modifications

b. Project Deliverables

Deliverables to be provided as a result of implementing the proposed project will include the following items, presented by task:

Task (a): Grant Administration (funded under this grant)

Deliverables:

- Executed Grant Agreement
- Invoices and associated backup documentation
- Quarterly Progress Reports
- Draft and Final Grant Completion Report

Task (b): Stakeholder Engagement / Outreach (funded under this grant)

Deliverables:

- Technical meeting agenda with DAC staff that will be required to report data

Task (c): GSP Development: Subbasin DMS Scoping and Development

1. **Retain Consultant to Assist with DMS Development** (funded under this grant)

   Deliverables:

   - RFP
   - Executed contract

2. **Identify Information Requirements for DMS** (funded under this grant)

   Deliverables:

   - List of data types and sources to be collected to meet ongoing requirements under SGMA

3. **Investigate and Select an Appropriate DMS** (funded under this grant)

   Possible Deliverables to be provided under this grant:

   - Report with recommendation for GSA Boards' consideration

- GSA Boards' decision to select a DMS package

4. **Procure/Design and Customize the Selected DMS** (funded under this grant; additional funding to be provided by GSAs if needed)

   Deliverables:

   - Documentation of the DMS

5. **Develop Data Protocols and Templates** (funded under this grant)

   Deliverables:

   - Data templates and tables

6. **Develop DMS User's Manual and Train GSA Staff** (funded under this grant; additional funding to be provided by GSAs if needed)

   Deliverables:

   - Training session or module for GSA staff
   - User's Manual

7. **Review and Assessment of DMS** (funded by GSAs as part of GSP process)

   Deliverables:

   - Initial review and recommendations for modifications

Task (d): Monitoring / Assessment (funded by GSAs as part of GSP process)

This project is a planning effort and does not involve on-the-ground monitoring activities.

Environmental Compliance and Permitting

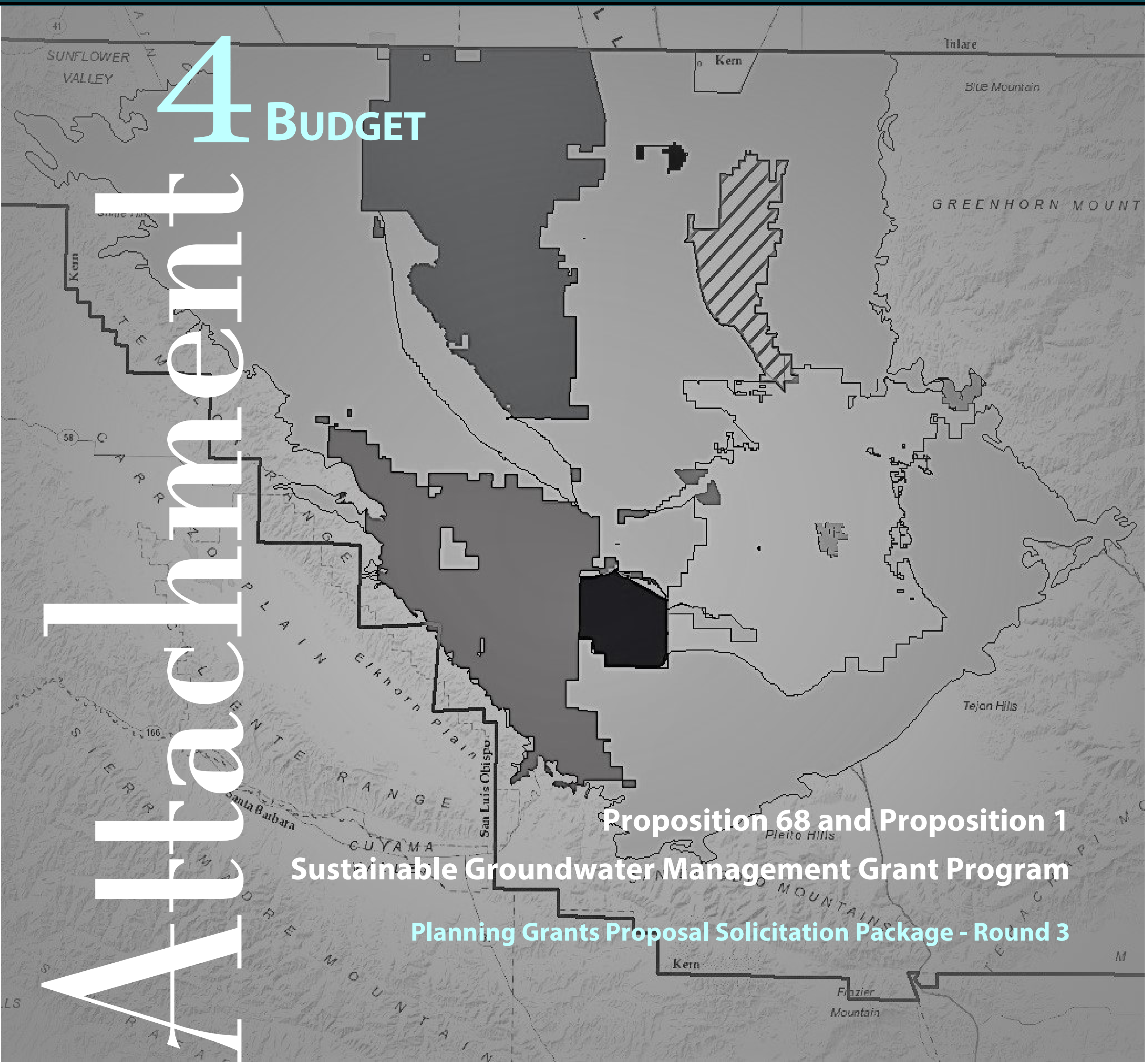
This Proposal covers the selection and development of a DMS for use by the entire Kern Subbasin to comply with SGMA. The Subbasin Data Management System Development Project does not qualify as a "Project" as defined under CEQA. Under CEQA, a "Project" refers to an action that has the potential to result in a physical change to the environment (Pub. Res. Code § 21065). This proposal consists of research, planning, and data collection and will not result in any foreseeable impact on or alteration of the physical landscape in any shape, matter, or form. Therefore, CEQA does not apply to this Proposal.

Miscellaneous

E. Project Support

A joint letter of support for the project, signed by the members of the entire Kern County Subbasin as well as participating DAC entities, is included in Attachment 6, Appendix C.

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II
2019 Grant Application



Attachment 4 Budget

Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Grant Proposal Summary Budget Table

Table 5A – Grant Proposal Summary Budget (No Components)

Grant Proposal Title: Kern County Subbasin Groundwater Sustainability Plan Support – Phase II

Applicant: Kern River Groundwater Sustainability Agency (KRGSA)

Grant Proposal serves a need of a DA?: X Yes ☐ No

Local Cost Share requested: ☐ 25% ☐ 15% ☐ 10% X 0%

Budget Categories[1]	(a) Requested Grant Amount	(b) Local Cost Share: Non-State Fund Source[2]	(c) Total Cost	(d) % Local Cost Share (Col (b)/ Col (c))
(a) Grant Agreement Administration	$25,000	$0	$25,000	0%
(b) Stakeholder Engagement / Outreach	$2,500	$0	$2,500	0%
(c) GSP Development – Subbasin DMS Scoping and Development	$472,500	$0	$472,500	0%
(d) Monitoring / Assessment	$0	$0	$0	$0
Grand Total *Sum rows (a) through (d) for each column*	**$500,000**	**$0**	**$500,000**	**0%**

[1] Only these Budget Categories shall be used. Tasks can be added for more detail.

[2] List sources of funding: *Assumes DAC waiver for local cost share*

Proposal/Component Detailed Budget Table

Table 6A – Proposal Detailed Budget (No Components)

Grant Proposal Title: Kern County Subbasin Groundwater Sustainability Plan Support - Phase II

Applicant: Kern River Groundwater Sustainability Agency (KRGSA)

Budget Categories[1]	(a) Requested Grant Amount	(b) Local Cost Share: Non-State Fund Source[2]	(c) Total Cost
(a) Grant Administration	**$25,000**	**$0**	***$25,000***
Task 1. Grant Management	$4,000	$0	
Task 2. Invoicing	$9,000	$0	
Task 3. Report Preparation	$12,000	$0	
(b) Stakeholder Engagement / Outreach	**$2,500**	**$0**	***$2,500***
Task 1. Technical Meetings	$2,500	$0	
(c) GSP Development: Subbasin DMS Scoping and Development	**$472,500**	**$0**	***$472,500***
Task 1. Retain Consultant to Assist with DMS Development	$2,500	$0	
Task 2. Identify Information Requirements for DMS	$2,500	$0	
Task 3. Investigate and Select an Appropriate DMS	$5,000	$0	
Task 4. Procure/Design and Customize the Selected DMS	$457,500	$0	
Task 5. Develop Data Protocols and Templates	$2,500	$0	
Task 6. Develop DMS User's Manual and Train GSA Staff	$2,500	$0	
Task 7. Review and Assessment of DMS	$0	$0	
(d) Monitoring / Assessment	**$0**	**$0**	
Grand Total *Sum rows (a) through (d) for each column*	***$500,000***	***$0***	***$500,000***

[1] Only these Budget Categories shall be used. Tasks can be added for more detail.

[2] List sources of funding: *Assumes DAC waiver for local cost share*

Budget Description

The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II proposal includes one project, which will benefit the entire Kern County Subbasin. Since only one component (or project) is proposed, Grant Administration has been included with the budget for the project, and the required budget templates 5A and 6A, intended for proposals that do not include multiple components, have been completed and presented above.

This section summarizes costs included in each budget category and describes how the values included in Table 6A, Proposal Detailed Budget, for the Kern County Subbasin Groundwater Sustainability Plan Support – Phase II were developed.

Budget Category (a): Grant Administration

The Direct Project Administration provided by KRGSA on behalf of all the GSAs in the Kern County Subbasin will support this project and will also oversee the implementation of overall grant funding such as executing a grant agreement with DWR, conducting reporting and invoicing, and ensuring that grant requirements are met. These tasks ensure that the project will be completed, DWR receives Quarterly and Final Project Completion Reports, invoicing and record-keeping are current, and other grant administrative functions are completed.

The Grant Administration budget was developed in order to keep these administration costs to within 5% of the award amount and maximize the grant funding utilized for the Subbasin Data Management System Development project, which is the critical GSP planning need in the Subbasin at this time. The total Budget Category (a) costs are therefore estimated at $25,000 – 5% of the total grant amount of $500,000.

The total of $25,000 for this Budget Category (a) includes $4,000 for Grant Administration, $9,000 for Invoicing, and $12,000 for Report Preparation. The Administration budget is well within DWR's guidance to keep costs to within 10% of the Grant Request. The Grant Administration budget is considered reasonable as it does not exceed 5% of the overall project budget and is consistent with DWR's guidance. This cost estimate is considered standard and was developed based on KRGSA, KGA, and the other GSA experience managing IRWM and SGMA grants in recent years.

The Grant Administration work will include effort from KRGSA's legal and accounting functions, as well as project managers as well as the GSAs in the Kern subbasin who will coordinate with KRGSA, assuring the timely completion of reporting tasks detailed in the Work Plan. A consultant may be added to assist the project team. Grant Administration effort may exceed amounts included in this budget; additional effort and costs required to complete the Grant Administration task will constitute Other Cost Share.

It is anticipated that a full DA waiver for Local Cost Share will be received for this Proposal. In anticipation of the full waiver, no Local Cost Share has been included with the Proposal Budget. Please see Attachment 6 – SDAC, DAC, EDA for documentation and narrative describing Disadvantaged Areas within the Kern County Subbasin project area.

Budget Category (b): Stakeholder Engagement / Outreach

The total cost of Stakeholder Engagement / Outreach, Budget Category (b), is $2,500, included as Grant Request. This cost estimate was developed based on KRGSA, KGA, and other the GSA experience in conducting Stakeholder Engagement and Outreach work in recent years and through development of Groundwater Sustainability Plans for the Subbasin. These costs represent a minimal level of Stakeholder Engagement associated specifically with this proposed grant-funded project, in order that the bulk of available grant funding can be allocated to implementation of the Subbasin Data Management System Development project, which is the critical GSP planning need in the Subbasin at this time.

If the actual level of effort needs to exceed amounts included in this budget to achieve project objectives, the additional costs required to complete the task will be paid by the GSAs.

It is anticipated that a full DA waiver for Local Cost Share will be received for this Proposal. In anticipation of the full waiver, no Local Cost Share has been included with the Proposal Budget. Please see Attachment 6 – SDAC, DAC, EDA for documentation and narrative describing Disadvantaged Areas within the Kern County Subbasin project area.

Budget Category (c): GSP Development: Subbasin DMS Scoping and Development

The total cost of GSP Development: Subbasin DMS Scoping and Development, Budget Category (c), is $472,500, included as Grant Request. This total Budget Category (c) cost of $472,500 constitutes the bulk of requested grant funding, in order to launch the scoping and development of the Subbasin's critical GSP planning effort, to develop a DMS for the Subbasin. This $472,500 Category (c) grant request is spread the anticipated seven tasks that will result in a fully functioning DMS. $2,500 is budgeted for Task 1, which includes developing a Request for Proposals and ultimately contracting with a Data Management System professional consultant to lead the DMS development process. Task 2 is budgeted at $2,500 and includes identification of the information requirements for the DMS. Allocated for Task 3, to investigate and ultimately select an appropriate DMS for the Subbasin is $5,000. Task 4 constitutes the bulk of the grant request in the amount of $457,500. Task 4, Procure, Design, and Customize the Selected DMS, is the focus of the Kern County Subbasin to accomplish the coordination of monitoring, management, and annual reporting going forward. Tasks 5 and 6 are supportive tasks to complete the development of a basin-wide coordinated DMS. Each of these tasks is allocated $2,500. Task 7, Review and Assessment of DMS, would be funded by the GSAs as part of their ongoing GSP process.

Budget Category (d): Monitoring / Assessment

This project is a planning effort and does not involve on-the-ground monitoring activities.

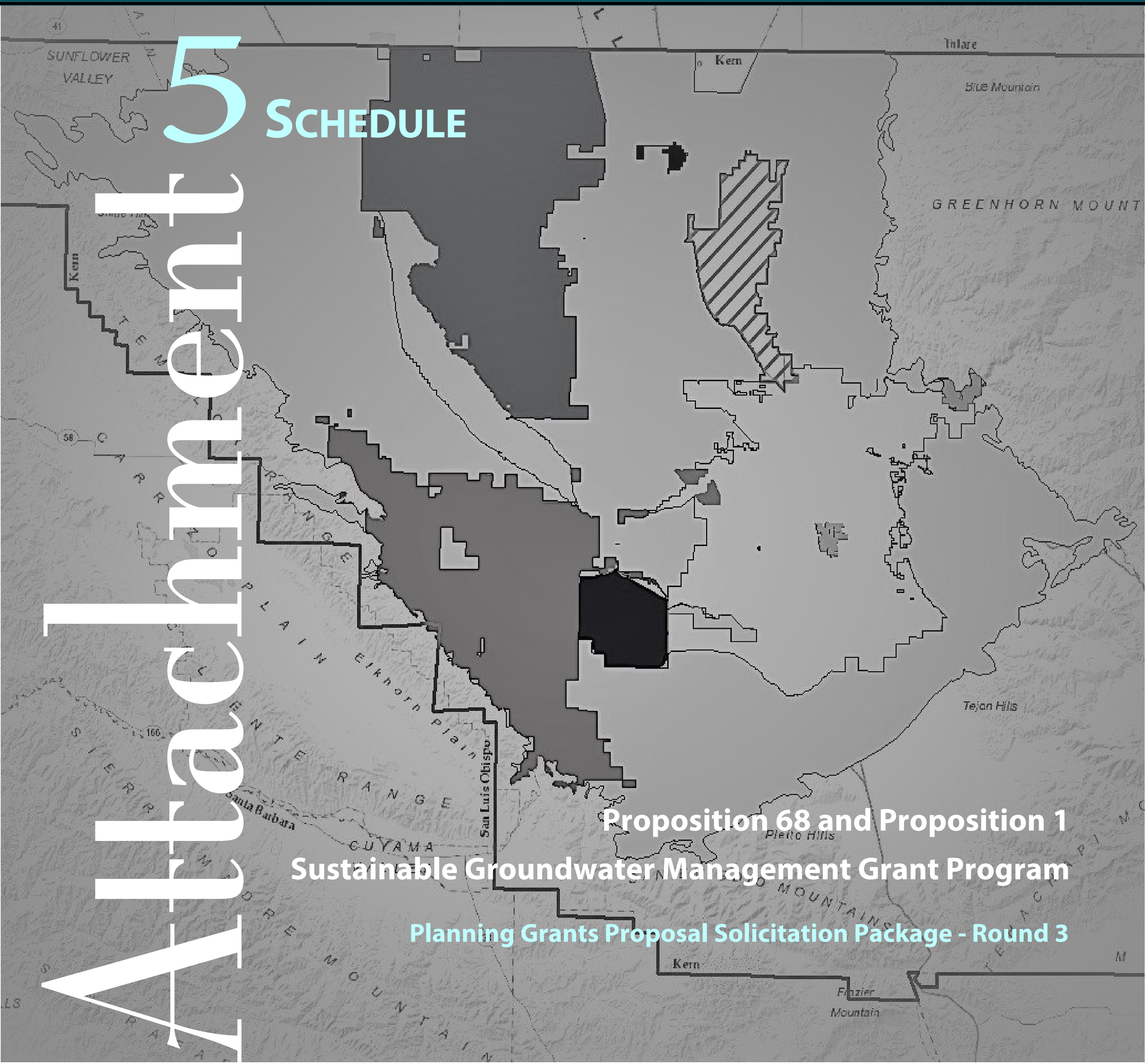
As described in Attachment 3, Work Plan, the intent is to make as much progress as possible toward development of a fully functioning DMS. The GSAs have committed to continue ongoing collaborative efforts towards accomplishing Subbasin-wide tasks to support GSP planning and implementation. The GSAs will support each task in the workplan as needed with the necessary level of effort to meet the project goals.

This cost estimate was developed based on KRGSA, KGA, and other GSA experience in contracting with professional consultants in recent years and through development of Groundwater Sustainability Plans for the Subbasin, as well as with input from consultants and industry professionals knowledgeable about DMS development and the data collection needs of the Subbasin's GSAs.

As described in Attachment 3, Work Plan, it is anticipated that the cost to fully develop an operational DMS for the Subbasin will far exceed grant funding available under this Round 3 Planning Grant opportunity. Additional resources beyond the funding available through this grant will be provided by Subbasin GSAs as necessary to complete the project and achieve a workable DMS that meets Subbasin needs. The Subbasin GSAs will coordinate to fund any additional project costs and have a demonstrated track record of doing so on many other GSP-related projects.

It is anticipated that a full DA waiver for Local Cost Share will be received for this Proposal. In anticipation of the full waiver, no Local Cost Share has been included with the Proposal Budget. Please see Attachment 6 – SDAC, DAC, EDA for documentation and narrative describing Disadvantaged Areas within the Kern County Subbasin project area.

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II 2019 Grant Application



Attachment 5 Schedule

Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Tables

Figures

None

Appendices

None

Schedule

Table 7A – Grant Proposal Schedule (No Components)

Grant Proposal Title: Kern County Subbasin Groundwater Sustainability Plan Support – Phase II

Applicant: Kern River Groundwater Sustainability Agency (KRGSA)

Categories	Start Date *(Earliest Start Date)*	End Date *(Latest End Date)*
(a) Grant Administration	**3/1/2020**	**7/31/2022**
Task 1. Grant Management	3/1/2020	7/31/2022
Task 2. Invoicing	6/1/2020	7/31/2022
Task 3. Report Preparation	6/1/2020	7/31/2022
(b) Stakeholder Engagement / Outreach	**4/1/2020**	**4/30/2022**
Task 1. Technical Meetings	4/1/2020	4/30/2022
(c) GSP Development: Subbasin DMS Scoping and Development	**2/1/2020**	**4/30/2022**
Task 1. Retain Consultant to Assist with DMS Development	2/1/2020	6/30/2020
Task 2. Identify Information Requirements for DMS	2/1/2020	9/30/2020
Task 3. Investigate and Select an Appropriate DMS	6/30/2020	4/30/2021
Task 4. Procure/Design and Customize the Selected DMS	5/1/2021	4/30/2022
Task 5. Develop Data Protocols and Templates	5/1/2020	4/30/2022
Task 6. Develop DMS User's Manual and Train GSA Staff	10/1/2021	4/30/2022
Task 7. Review and Assessment of DMS	7/1/2021	4/3/2022
(d) Monitoring / Assessment	N/A	N/A

Schedule Description

The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II proposal includes one project, which provides benefits for the entire Kern County Subbasin. Since there are no additional components included with this proposal, Grant Administration has been included with the Work Plan, Budget, and Schedule for the single project, and the required Schedule Table 7A, intended for proposals that do not include multiple components, has been completed and presented above.

This section summarizes the schedule established (and presented in Table 7A) for the Kern County Subbasin Groundwater Sustainability Plan Support – Phase II proposal.

The tasks listed in the schedules align with the same tasks identified and described in the Work Plan (Attachment 3) and Budget (Attachment 4), and use March 2020 as the assumed award date of the grant and launch of Grant Administration. Project implementation will likely begin prior to notification of award, potentially by February 2020.

All project implementation work will be complete by the end of April 2022. The schedule for Grant Administration extends through July 2022 when all final reports and invoicing will be complete for the grant.

The anticipated order of activities for completion of the project is as follows:

- Category (c), GSP Development: Subbasin DMS Scoping and Development, will begin immediately upon grant award with the process of hiring a DMS consultant (Task 1). The selected consultant will assist the GSAs with identifying information requirements for the DMS (Task 2). Task 2 begins concurrently with Task 1 to allow the identification of requirements to inform the RFP process in Task 1; the task continues to allow communication and consultation with the DMS Consultant on system requirements. After working collaboratively with the GSAs in Task 2, the DMS consultant will then investigate and recommend appropriate DMS options for selection by the GSAs' Boards (Task 3). KRGSA and KGA, on behalf of all the Subbasin GSAs, will procure the selected DMS and the consultant will customize it as needed (Task 4). This process is expected to continue through April 2022 with ongoing adjustments and customization. Task 4 is expected to be partially funded by the GSAs when grant funds are expended for this task. Concurrently with this process, the consultant and GSAs will develop protocols and data templates (Task 5), and will train GSA staff to use and populate the DMS following completion of these tasks (Task 6). Task 7 commences in 2021 when the DMS development is underway and continues throughout the grant period, allowing additional modifications to the DMS as the project is implemented.
- Category (b), Stakeholder Engagement/Outreach, will involve coordination of technical meetings with stakeholders and DACs throughout the process of DMS scoping and development.
- Category (a), Grant Administration, will involve management of the grant, invoicing, and report preparation before, during, and after completion of the grant activities.
- Category (d), Monitoring / Assessment, does not apply to this project as it is a planning effort and does not involve on-the-ground monitoring activities.

Environmental Compliance and Permitting

The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II proposal includes one project, which will benefit the entire Kern County Subbasin. This project, Subbasin Data Management System Development, is effectively a planning effort; no construction will take place under this project.

This grant proposal covers the preparation of Groundwater Sustainability Plans (GSPs) within the Kern County Subbasin. Under Water Code § 10728.6, CEQA does not apply to the preparation and adoption of Groundwater Sustainability Plans. Therefore, this Proposal is exempt from California Environmental Quality Act (CEQA) requirements.

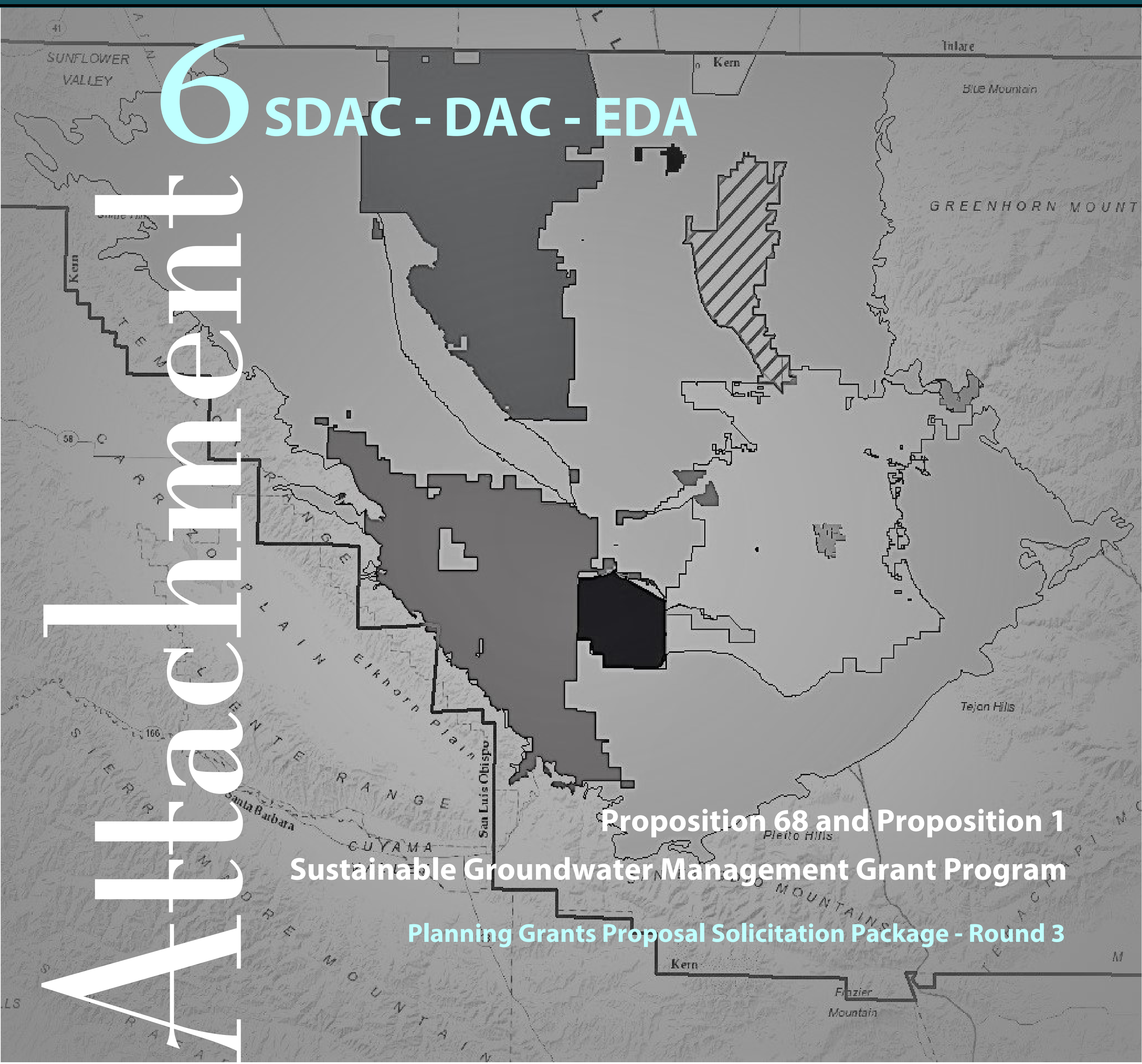
The proposed Subbasin Data Management System Development project will initiate the key steps to develop and build a Subbasin DMS, which will ultimately support Subbasin GSAs by providing (1) improved coordination of groundwater monitoring and management actions and (2) the ability to meet the reporting and implementation requirements of their respective GSPs and DWR. The development of a DMS does not meet the definition of a “Project” under CEQA, as it will not create any foreseeable impact on or alter the physical landscape in any shape, manner, or form. Under CEQA, a “Project” refers to an action that has the potential to result in a physical change to the environment (Pub. Res. Code § 21065). Therefore, CEQA does not apply to this project.

Development of a Subbasin Data Management System will not require any permits or regulatory agency approvals. Therefore, a process and schedule for securing permits and approvals is not necessary, and has not been included in this Proposal.

Kern County Subbasin Groundwater Sustainability Plan Support - Phase II 2019 Grant Application

Attachment 6

SDAC - DAC - EDA



Proposition 68 and Proposition 1

Sustainable Groundwater Management Grant Program

Planning Grants Proposal Solicitation Package - Round 3

Figures

Appendices

Introduction

According to Water Code § 79505.5, a disadvantaged community (DAC) is "a community with an annual median household income that is less than 80 percent of the Statewide annual median household income." These communities, widely dispersed throughout California and the Kern County Subbasin, are especially sensitive to groundwater overdraft and decreases in local water quality such as that in the Kern County Subbasin.

Attachment 6 – SDAC-DAC-EDA addresses the existence of DAC areas located within the Kern County Subbasin, and includes a map showing the Proposal benefit area and the location of DACs.

Location of DACs within the Proposal Area

The Kern County Subbasin (Proposal benefit area) is located in the Southern San Joaquin Valley, is a critically overdrafted, high priority groundwater basin and is home to numerous DAC Communities. The GSAs in the Kern County Subbasin identified DACs throughout the Subbasin by using the DWR's DAC Mapping Tool and ArcGIS Map Package. Geographically, the Kern County Subbasin is comprised of 79.5 percent Disadvantaged Communities.

The GSAs in the Subbasin have accurately discerned and mapped where DAC communities exist within the Subbasin. Figure 6-1, below, illustrates the Proposal benefit area and the location of DACs within the Kern County Subbasin.

The DAC Mapping tool and ArcGIS Map Package provide US Census data identifying DACs by "Block Groups", "Tracts", and "Places." The specific dataset used in the tool is the *US Census American Community Survey (ACS) 5-Year Data: 2012 – 2016* (with an MHI of $63,783 and hence calculated DAC threshold of $51,026).

According to the US Census Bureau:

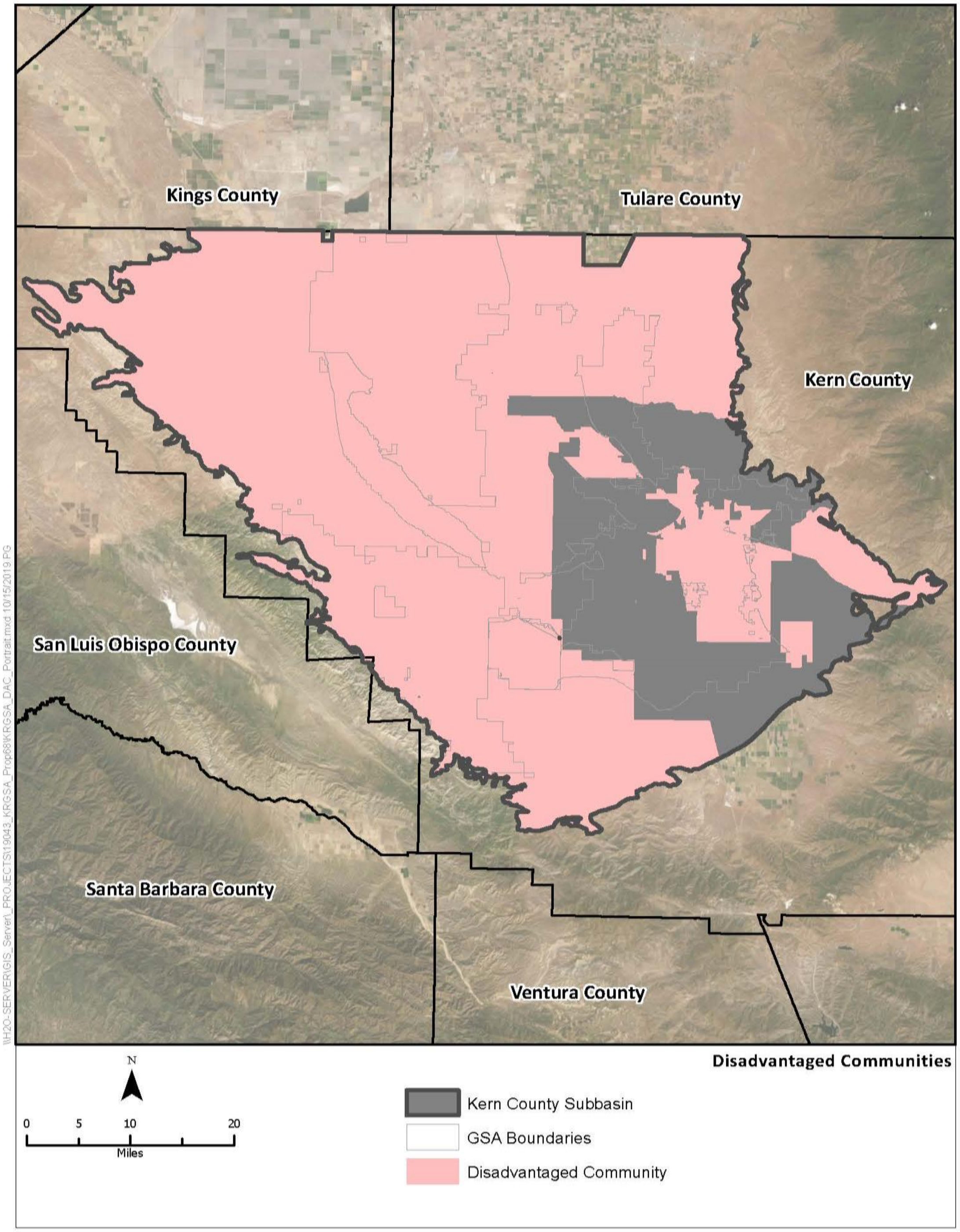
- Block Groups are statistical divisions of census tracts, generally defined to contain between 600 and 3,000 people.
- Census Tracts are small, relatively permanent statistical subdivisions of a county or equivalent entity. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people.
- Places can be defined as either incorporated or designated. Incorporated Places usually consist of a city, town, village, or borough, but can have other legal descriptions or boundaries. Designated Places usually coincide with visible features or the boundary of an adjacent incorporated place or another legal entity boundary, have no legal status, nor do these places have officials elected to serve traditional municipal functions.

For more information on the DAC Mapping Tool or ArcGIS Mapping Package, please visit: http://www.water.ca.gov/irwm/grants/resources_dac.cfm.

All communities qualifying as Disadvantaged Communities within the Kern County Subbasin (block groups, census tracts, and places) will benefit as a result of the Subbasin Data Management System Development project included in this Kern County Subbasin Groundwater Sustainability Plan Support – Phase II Proposal.

Figure 6-1 shows the location and extent of all Disadvantaged Communities within the Kern County Subbasin. These Disadvantaged Areas make up 79.5 percent of the Subbasin and Project area. All communities qualifying as DACs within the Kern County Subbasin will benefit as a result of the proposed project.

Figure 6-1. Disadvantaged Communities in the Kern County Subbasin



DAC Support and Outreach

The Kern County Subbasin Groundwater Sustainability Plan Support – Phase II grant application includes outreach, engagement, and technical support to benefit DACs throughout the entire Subbasin. All the GSAs in the Subbasin conduct regular Board meetings on a monthly basis to support development of their respective GSPs. All the GSAs in the Subbasin have undertaken coordination activities with the DACs in the Subbasin. Several of the DACs are represented by board members on the GSAs in the Subbasin.

The following DAC communities within the Kern County Subbasin are identified as cities or Census Designated Places (CDPs) in DWR's DAC database. All communities qualifying as DACs within the Kern County Subbasin will benefit as a result of the DMS project.

Arvin
Buttonwillow CDP
Delano
Edmundson Acres CDP
Ford City CDP
Fuller Acres CDP
Greenfield CDP
Lamont CDP
Lost Hills CDP
Maricopa
McFarland
McKittrick CDP
Mettler CDP
Mexican Colony CDP
Oildale CDP
Richgrove CDP
Shafter
Smith Corner CDP
South Taft CDP
Taft
Taft Heights CDP
Tupman CDP
Valley Acres CDP
Wasco
Weedpatch CDP

As part of the DMS project, the GSAs in the Subbasin would conduct outreach to all the DACs that will be required to report to DWR under SGMA. GSA staff would work with local DACs within their boundaries, relying on the existing relationships they have established and maintained during the GSP development process.

A joint letter of support for the Kern County Subbasin Groundwater Sustainability Plan Support – Phase II 2019 Grant Application endorsed by the GSAs and stakeholders that would benefit from the project is provided in Appendix C. As noted previously, outreach to DACs will continue to occur throughout development of the DMS. With grant funding, the DMS project will be better situated to conduct outreach to, engage, and include DACs and DAC concerns so that DACs will benefit from easier access to groundwater sustainability information.

Appendix C

Joint Letter of Support

HENRY MILLER WATER DISTRICT

TEJON-CASTAC WATER DISTRICT

Olcese Water District

November 15, 2019

Mr. Zaffar Eusuff, Program Manager
Financial Assistance Branch
California Department of Water Resources
PO Box 942836
Sacramento, CA 94326-0001

Ms. Kelley List, Project Manager
Sustainable Groundwater Management
Program, Round 3 Planning Grant
California Department of Water Resources
901 P Street
Sacramento, CA 94236

Subject: Letter of Support for Kern River Groundwater Sustainability Agency Leading the Kern County Subbasin Proposition 1 Round 3/Proposition 68 Planning Grant Application

Dear Mr. Eusuff and Ms. List:

The undersigned groups are submitting this letter in support of the Sustainable Groundwater Management – Proposition 1 Round 3/Proposition 68 Planning Grant Application submitted by the Kern River Groundwater Sustainability Agency (KRGSA), in coordination with the all the GSAs in the Kern County Subbasin. The demographics of the Subbasin service area establish it as a geographic area of largely disadvantaged communities in need of assistance and support. As representatives and water providers of Disadvantaged Communities (DACs) in the Kern County Subbasin, we jointly support this effort to achieve sustainable groundwater planning in the Kern County Subbasin.

Since the enactment of the Sustainable Groundwater Management Act (SGMA), the Kern County Subbasin GSAs have worked together to achieve sustainable groundwater management. Through a collaborative process involving more than a dozen member agencies and landowner representatives, GSAs in the Kern County Subbasin have coordinated on numerous GSP activities, including the following milestones:

- Produced a Subbasin-wide Sustainability Goal for achieving and maintaining sustainable groundwater management;
- Developed Sustainable Management Criteria to apply to the entire Subbasin, while allowing flexibility for local GSA control;
- Coordinated on a Subbasin-wide monitoring network and agreed on monitoring protocols for coordinated monitoring and groundwater evaluations;
- Shared costs and tasks for the development of a Subbasin-wide integrated surface water–groundwater model to analyze Subbasin water budgets and to support an evaluation of projects and management actions;
- Held two widely attended SGMA Open Houses to allow stakeholders to discuss the GSP process and requirements directly with GSA managers;
- Hosted numerous community, Board, public outreach, and stakeholder meetings, including many that were focused on the disadvantaged communities in the Subbasin; and
- Organized numerous committees to guide policy decisions, coordinate communication and outreach activities, and provide a forum for GSA managers to discuss and coordinate GSP elements.

While individual GSAs and their member agencies have developed separate Groundwater Sustainability Plans (GSPs) to comply with the SGMA regulations, the Kern GSAs recognized the need to develop a centralized, Subbasin-wide data management system (DMS) to support monitoring, evaluation, reporting, management, and, importantly, GSP implementation. We recognize that compilation of our individual systems will require significant manipulation and re-structuring to create a centralized relational DMS that is populated with consistent data sets across the Subbasin. For this reason, the GSAs of the Kern County Subbasin have agreed to coordinate to submit a Proposition 1 Round 3/Proposition 68 Planning Grant Application to take the first key steps in this process. Participating in the DWR grant funding program through continued Subbasin-wide Groundwater Sustainability Planning efforts is a good and essential step forward for DAC communities in the Kern County Subbasin.

We are pleased and supportive to see the inclusion and participation of Disadvantaged Communities and related stakeholders in the Kern County Subbasin's Groundwater Sustainability Planning efforts, and we believe that funding from this Grant Application will contribute to basin-wide groundwater planning efforts and benefit our community members. By funding the KRGSA's grant application in the full allotment of $500,000, DWR will ensure that all that disadvantaged communities in the Kern County Subbasin will benefit from improved groundwater management and sustainability. The grant funds will be instrumental to the DACs in the Kern County Subbasin by providing the mechanism for meeting their reporting requirements under SGMA and also providing the ability to review each other's data in the Subbasin.

We hope that DWR will fully fund the Kern County Subbasin Round 3 Planning Grant Application, and we look forward to seeing the benefits of this program within all of our service areas in the near future.

Sincerely,

Art Chianello
Water Resources Manager
City of Bakersfield

David Beard
Manager
Improvement District No. 4
Kern County Water Agency

Holly Melton
Water Resources Manager
Kern County Water Agency

L. Mark Mulkay
General Manager
Kern Delta Water District

Phil Nixon
General Manager
Westside District Water Authority

Jeof Wyrick
President
Henry Miller Water District

Dennis Atkinson
President of the Board
Tejon-Castac Water District

James L. Nickel
President
Olcese Water District

Jason Gianquinto
General Manager
Semitropic Water Storage District

Richard A. Diamond
General Manager
North Kern Water Storage District

Jonathan Parker
General Manager
Kern Water Bank Authority

Raul Barraza, Jr.
General Manager
Arvin Community Service District

Chad Hathaway
Board President
Eastside Water Management Area

Steven C. Dalke
General Manager
Kern-Tulare Water District

David Ansolabehere
General Manager
Cawelo Water District

Sheridan Nicholas, P.E.
Engineer-Manager
Wheeler Ridge-Maricopa Water Storage District

Tim Ashlock
Manager
Buena Vista GSA

Dana Munn
General Manager
Shafter-Wasco Irrigation District

Eric Averett
General Manager
Rosedale-Rio Bravo Water Storage District

Jeevan Muhar, P.E.
Engineer-Manager
Arvin-Edison Water Storage District

Greg A. Hammett
General Manager
West Kern Water District

KERN
GROUNDWATER AUTHORITY

November 20, 2019

To: **Kern River GSA**
Buena Vista WSD GSA
Henry Miller WD GSA
Olcese WD GSA

Re: Reimbursement Agreement for Annual Reporting of the Kern Sub-basin

The Kern Groundwater Authority (KGA), the Kern River Groundwater Sustainability Agency (KRGSA), the Buena Vista WSD Groundwater Sustainability Agency (BVGSA), the Henry Miller WD Groundwater Sustainability Agency (HMGSA), and the Olcese WD Groundwater Sustainability Agency (OGSA) wish to participate in the Reimbursement agreement for the Kern County Subbasin – 2020 Annual Reporting Requirement under SGMA.

On behalf of the Subbasin, the KGA has approved a contract with TODD Groundwater (Attachment 1) which includes a scope of work with the following tasks:
1) Prepare Data Requests and Templates ($10,554)
2) Prepare Groundwater Elevation Contour Maps ($26,749)
3) Review and Compile Hydrographs ($9,458)
4) Compile and Present Water Supply Data ($19,373)
5) Analyze Change in Groundwater in Storage ($32,518)
6) Document Progress in GSP Implementation ($10,639)
7) Prepare Drafts/Final Annual Report and Submit to DWR ($32,322)
8) Communication and Meetings ($33,216)
for a total amount of the contract of $174,830.

Also, on behalf of the Subbasin, the KGA has approved a contract with ITRC (Attachment 2) which includes a scope of work with the following tasks:
1) Provide monthly and annual ITRC-METRIC actual crop evapotranspiration (ETc) for the Kern Subbasin for 2017-2019.
2) Data will be extracted for each GSA within the subbasin and each irrigated field in each GSA monthly for 2017-2019
3) Data will be provided tabularly and monthly ETc images will be provided in GIS format
4) Short report discussing the general process and overall results will be provided
for a total amount of the contact of $16,000

All parties agree to cost share this effort according to following terms and conditions:

1. The participant signatories below will pay their share of the proposed budget of $190,830 as shown on Exhibit 1.
2. All payments from shall be due 45 days after the receipt of invoice from the KGA

If the above terms and conditions are acceptable, please sign and date this letter and return them to the KGA.

Sincerely,

KGA
Vice Chair

Accepted:

Kern River GSA

By:____________________________

Title:____________________________

Date:____________________________

Buena Vista WSD GSA

By:____________________________

Title:____________________________

Date:____________________________

Henry Miller WD GSA

By:____________________________

Title:____________________________

Date:____________________________

Olcese WD GSA

By:____________________________

Title:____________________________

Date:____________________________

Sincerely,

KGA
Vice Chair

Accepted:

Kern River GSA

By:______________________

Title: Chair

Date: 12/5/19

Buena Vista WSD GSA

By:______________________

Title:______________________

Date:______________________

Henry Miller WD GSA

By:______________________

Title:______________________

Date:______________________

Olcese WD GSA

By:______________________

Title:______________________

Date:______________________

Sincerely,

KGA
Vice Chair

Accepted:

Kern River GSA

By:____________________

Title:____________________

Date:____________________

Buena Vista WSD GSA

By: [signature]

Title: Engineer - Manager

Date: 1-8-2020

Henry Miller WD GSA

By:____________________

Title:____________________

Date:____________________

Olcese WD GSA

By:____________________

Title:____________________

Date:____________________

Sincerely,

KGA
Vice Chair

Accepted:

Kern River GSA

By:____________________

Title:____________________

Date:____________________

Henry Miller WD GSA

By: Jeof Wyrick

Title: PRESIDENT

Date: 11-19-19

Buena Vista WSD GSA

By:____________________

Title:____________________

Date:____________________

Olcese WD GSA

By:____________________

Title:____________________

Date:____________________

Sincerely,

KGA
Vice Chair

Accepted:

Kern River GSA

By:____________________

Title:____________________

Date:____________________

Buena Vista WSD GSA

By:____________________

Title:____________________

Date:____________________

Henry Miller WD GSA

By:____________________

Title:____________________

Date:____________________

Olcese WD GSA

By: [signature]

Title: James L. Nickel, President

Date: Dec. 17, 2019

ATTACHMENT 1

TODD GROUNDWATER

November 19, 2019

MEMORANDUM

To:	Kern Groundwater Authority (KGA) Patty Poire, Kern County Subbasin GSP Plan Manager
Cc:	Kern River Groundwater Sustainability Agency (KRGSA) Art Chianello, David Beard, and Mark Mulkay, KRGSA Plan Managers
From:	Phyllis Stanin, Vice President
Re:	Proposal – Preparation of GSP Annual Report for WY 2019 Kern County Subbasin Groundwater Sustainability Plans (GSP)

The Kern Groundwater Authority (KGA) is leading Subbasin-wide coordination efforts for development of Groundwater Sustainability Plans (GSP) including annual reporting on GSP implementation. Subbasin GSAs are cooperating in preparation of this first GSP Annual Report covering Water Year (WY) 2019 for the Kern County Subbasin. Todd Groundwater has been asked to prepare a proposal to prepare and submit the 2019 Annual Report.

The Kern County Subbasin is required to submit adopted GSPs covering the entire Subbasin to the Department of Water Resources (DWR) by January 31, 2020. Annual Reports are due to DWR "by April 1 of each year following the adoption of the Plan." (§356.2). Accordingly, the 2019 Annual Report is due to DWR by April 1, 2020, only two months after submittal of the GSPs.

1 APPROACH

Collectively, the extensive analyses and hydrogeologic products available in Subbasin GSPs provide a firm foundation for the 2019 Annual Report. Monitoring sites have already been identified, data are being collected, and water budget results are readily available from the historical and current study periods. We envision working cooperatively with Subbasin agencies and their consultants to compile and incorporate information that either is currently available or is being collected as part of GSP implementation.

Preparation of the 2019 Annual Report will follow regulatory guidance. Regulatory requirements for the GSP Annual Reports are provided in Article 7 of the GSP regulations (§ 356). Reporting standards for Annual Report data are provided in Article 3 (§352.4) and reporting provisions can be found in Article 4 (§353.4).

This first Annual Report will require extra analysis of the Subbasin water budget to "bridge" the time period between the end of the Subbasin current Study Period (WY 2015) and the reporting period of WY 2019. Although GSP Annual Reports are designed to describe conditions from the preceding water year only (i.e., WY 2019), regulations also require water budget results (i.e., change in groundwater in storage) to use "historical data to the greatest extent available, including from January 1, 2015 to the current reporting year." (§356.2 (b)(1)(B) and §356.2 (b)(5)(B)). The bridge analysis, combined with the GSP current Study Period, will cover the requirement of "January 1, 2015 to the current reporting year." GSP analyses from the Subbasin-wide historical and current Study Periods –covering WY 1995 through WY 2015 – can be used to satisfy the requirement of "historical data to the greatest extent available."

Regulations only appear to require historical data for hydrographs and change in groundwater in storage. Additional data, including reporting of groundwater extractions, surface water, and total water use by sectors, appear to only refer to the preceding year and not the "bridge" period.

It is anticipated that we will require clarification and interaction with DWR on several issues for the 2019 Annual Report. We recommend working directly with the Subbasin Plan Manager (Patty Poire) on any communications with DWR to ensure that the 2019 Annual Report will comply with regulations. In coordination with the Plan Manager, we will confirm with DWR the specific time period for which these other data sets must cover, seek DWR acceptance of recommended methods to incorporate into the 2019 Annual Report, and work with agencies to comply with DWR requirements.

In our role as the Watermaster Engineer for the Antelope Valley Watermaster, we have been submitting SGMA-compliant annual reports to DWR for several years. Although requirements for adjudicated basins are significantly different from critically over-drafted basins, many of the requested data sets and attachments are the same. This provides us with some insight as to how GSP annual reporting might be managed by DWR; some of these insights are incorporated into this scope of services, as relevant.

2 SCOPE OF SERVICES

In order for Subbasin agencies to begin planning for the required components of the 2019 Annual Report, an example template of the report has been prepared and provided with this proposal as **Attachment 1**. The template has been annotated with a mix of GSP requirements, assumptions for report development, and example text. Annotations also include assumptions and details of our proposed scope of services to allow agencies to better visualize how Subbasin data will be compiled, analyzed, and used in the Annual Report. Accordingly, **Attachment 1** serves as a companion document to this scope of services and is incorporated into the scope by reference.

Tasks associated with the proposed scope of services are summarized below. Also, please refer to **Attachment 1** for GSP requirements and additional assumptions and details for including the information in the 2019 Annual Report.

Table 1: 2019 Annual Report, Kern County Subbasin

	Task	Principal QA/QC $245	PM $245	Senior Engineer $230	Senior Hydrogeo $220	Staff Hydrogeo $165	Total Labor Hours	Total Labor	2% Comm Fee	GIS/ Graphics $125	Admin Costs $115	Other Direct Costs	10% Expense Fee	Total Costs
1	Prepare Data Requests and Templates		8	24		16	48	$ 10,120	$ 202	$ -	$ 230		$ -	$ 10,554
2	Prepare Groundwater Elevation Contour Maps		8	18	60	24	110	$ 23,260	$ 465	$ 3,000	$ -		$ -	$ 26,749
3	Review and Compile Hydrographs		6	16		16	38	$ 7,790	$ 156	$ 1,500	$ -		$ -	$ 9,458
4	Compile and Present Water Supply Data		14	36	14	12	76	$ 16,770	$ 335	$ 2,250	$ -		$ -	$ 19,373
5	Analyze Change in Groundwater in Storage		24	48	40	12	124	$ 27,700	$ 554	$ 4,000	$ 230		$ -	$ 32,518
6	Document GSP Progress		16	24		6	46	$ 10,430	$ 209	$ -	$ -	$ -	$ -	$ 10,639
7	Prepare Drafts/Final Annual Report and Submit to DWR	12	40	36	16	12	116	$ 26,520	$ 530	$ 5,000	$ 230		$ -	$ 32,322
8	Management, Communication and Meetings	4	80	24	12		120	$ 28,740	$ 575	$ 1,500	$ 460	$ 1,750	$ 175	$ 33,216
	Project Budget	**16**	**196**	**226**	**142**	**98**	**678**	**$ 151,330**	**$ 3,027**	**$ 17,250**	**$ 1,150**	**$ 1,750**	**$ 175**	**$ 174,830**

Task 1: Prepare Data Requests and Templates

The first step in this process involves development of a data request memorandum by Todd Groundwater, which will provide a list of data requirements from all Subbasin agencies and include data templates to facilitate data compilation and presentation. Todd Groundwater assumes introducing the data request memorandum and templates at a KGA-coordinated Subbasin Managers' Meeting, tentatively scheduled for November 8, 2019 (included in Task 8).

Task 2: Prepare Groundwater Elevation Contour Maps

We will obtain water level data from individual agencies for Spring and Fall 2019 measurements. We assume that data will be provided for the GSP water level monitoring sites but would be pleased to incorporate more data, if available. We will also work with KCWA, who leads an extensive water level monitoring program and may be able to provide additional data to improve map accuracy. Given the need for developing separate maps for each Principal Aquifer, the KCWA supplemental data from wells without construction information may not be included.

It is our understanding that GSAs have identified two primary Principal Aquifers that can be mapped in the Subbasin. Groundwater elevation contour maps will be prepared for each Principal Aquifer for Spring and Fall 2019 (4 total maps). It is also our understanding that two deeper Principal Aquifers, the Olcese Formation and the Santa Margarita Formation, have been identified in limited areas in the eastern Subbasin. If sufficient data are available for contouring groundwater elevations in these aquifers, we can also include them in the Annual Report. We assume that all groundwater elevations available for contouring will be provided by others (except for KRGSA data, which we will produce separately from this proposal).

We assume that groundwater level data will be provided in electronic (Excel) spreadsheets and include, at a minimum, well identifiers (matching hydrographs), date, X/Y or Lat/Long (with datum), depth to water, reference point elevation, water level elevations, and associated Principal Aquifer. GIS shapefiles are also appreciated, if available.

Data will be contoured initially using commercially-available software and then iteratively hand-modified for more accurate representations of groundwater elevations across the Subbasin. We will work directly with individual agencies if data issues are identified or if we require further clarification. If agencies have already developed groundwater elevation contour maps and wish to use the current contours, we can coordinate with the agency to obtain electronic maps or discuss other options. Several drafts of water level contour maps will be developed for review by individual agencies, as needed.

Task 3: Review and Compile Hydrographs

Groundwater elevation hydrographs will be compiled from Subbasin agencies for inclusion in the Annual Report. Hydrographs should be formatted to adhere with the *Data and*

Reporting Standards as prescribed in §352.4(e) of the GSP regulations and summarized in Section 2.2 of **Attachment 1**. In brief, each hydrograph should include a unique site identification number, ground surface elevation, and use the same scale to the greatest extent practical.

We will work with agencies to ensure relatively similar hydrograph formats including the same horizontal scale of October 1, 1994 through September 30, 2019 (WY 1995 – WY 2019), as needed; similar formats may facilitate DWR review. Closely-spaced hydrographs should incorporate the same vertical scales to the extent practicable in adherence with GSP regulations. Hydrographs may also include annotations to allow for easy well identification and understanding by DWR reviewers.

Overall trends and fluctuations as shown by the hydrographs for WY 2016 through WY 2019 will be described briefly in the context of water year type and the groundwater elevation contour maps. A map showing the location of submitted hydrographs will be developed and PDF files of each hydrograph will be included in an appendix of the Annual Report.

Task 4: Compile and Present Water Supply Data

Working with the individual agencies, Todd Groundwater will compile water supply data for the following categories:

- Groundwater Extractions
- Surface Water Supply
- Total Water Use.

For groundwater extractions, total extraction amounts for the preceding year are required, along with a map showing locations and volumes of production. Although data can be combined to report a total extraction from the Subbasin, some local data will be needed to develop groundwater extraction maps. First, we recommend development of a map showing general locations of active wells by type (agricultural, urban, banking recovery, etc.). This will illustrate concentrations of the various extraction types across the Subbasin. To meet the requirement of volumes, we recommend development of various "bubble" maps that illustrate relative volumes for various areas using circles of increasing diameter. We will recommend appropriate illustrations after a review of the available extraction data.

We will emphasize to DWR that management actions are being implemented for estimating groundwater extractions, but those actions were not in place in WY 2019. Therefore, the data will represent estimates, and can potentially be based on extractions associated with recent time periods as provided in the C2VSimFG-Kern model; extractions could be adjusted for current changes in local land use or known changes in extractions, as needed.

In addition to the map, groundwater extractions must be tabulated by water use sector (generally Urban, Agricultural, Managed Recharge, and Other - see Section 3 of **Attachment 1**). Methods and accuracy of measurements must also be included.

Data for total surface water supply (Section 4 in **Attachment 1**) are more likely to be available, but volumes are also required to be tabulated by water use source type. This categorization may be complicated for parties that frequently use water exchanges as part of their ongoing operations. We are assuming that surface water supply data will be provided to us by others (except for the KRGSA agencies), similar to the process conducted for the C2VSimFG-Kern model development.

Groundwater extractions and surface water supply will be combined for Total Water Use in Section 5 of the 2019 Annual Report. As indicated in **Attachment 1**, total water use must be categorized by both water use sector and water source type.

As noted in Sections 3, 4, and 5 of **Attachment 1**, DWR categories of water use sectors, methods/accuracy of measurement, and water use sources have been pulled from the DWR website used for SGMA reporting in adjudicated basins. Given the similarity of the SGMA reporting website organization and the requirements in the GSP regulations of Article 7, it seems reasonable to conclude that this organization will be maintained for reporting data in the GSP annual reports. Data requests and templates will be developed for these water use sectors, measurement methods, accuracy of measurements, and water source types for inclusion, as available (**Attachment 1**).

DWR will recognize that previous data were not likely collected in a manner to differentiate among these categories and some categorization of data will not be available for this first Annual Report. We will confirm with DWR that some data categorization will be unavailable and also that these data only need to be reported for WY 2019; GSP regulations do not indicate that these data need to be provided on an historical basis.

Finally, much of the requested data in this task overlaps with requirements for the updates of Agricultural Water Management Plans (AWMP) and Urban Water Management Plans (UWMPs) for 2020, due in 2021. We will note in the Annual Report that many of these requested data sets are currently being developed/revised in compliance with other planning processes, and data in this Annual Report will be superseded with improved data sets in future annual reports.

Task 5: Analyze Change in Groundwater in Storage

GSP regulations (§ 356.2 (b)(5)(B)) for the Annual Report require both a map and graph of changes in groundwater in storage be developed over the entire groundwater basin that meet the following requirements:

- Graphs depicting the annual and cumulative change in groundwater in storage "based on historical data to the greatest extent available, including from January 1, 2015 to the current reporting year," and
- "Change in groundwater in storage maps for each principal aquifer in the basin".

These requirements presents numerous technical challenges for the Kern County Subbasin (see also the discussion in Section 6.1 of **Attachment 1**).

Based our November 8, 2019, discussion at the Kern County Manager's Meeting, Todd Groundwater will develop change in groundwater in storage maps and graphs for the entire Kern County Subbasin using the C2VSimFG-Kern model. By doing so, we continue to update and use the primary DWR modeling tool with our local Kern County updates for evaluating basin conditions. For this task, we will use a methodology consistent with that used to develop change in groundwater storage graphs for the C2VSimFG-Kern Model Results technical memorandum, which is included in the KGA Umbrella and KRGSA GSPs. Using this approach, we will maintain consistency of method in presenting the basinwide change in groundwater in storage.

For this task, we will request WY2016 through WY2019 data from each district for measured managed water supply and demand data following the methodology used to update the C2VSimFG-Kern model for the Kern County historical water budgets. To meet this Annual Report schedule, this data needs to be delivered to Todd Groundwater no later than January 10, 2020. We will provide data templates to each district to provide monthly data for the following:

- Surface water imports and diversions (inflows and outflows) by source
- Application of surface water imports by category (e.g. irrigated agriculture, urban, managed aquifer recharge, or other uses).
- Groundwater banking and managed aquifer recharge by water district or agency,
- Groundwater banking pumping for export from the basin,
- Metered district groundwater recovery pumping,
- Metropolitan Bakersfield urban water deliveries and wastewater disposal, and
- Any other locally relevant water supply use or demands.

Todd Groundwater will update the natural hydrology for precipitation and flows in gauged streams (Kern River and Poso Creek). Precipitation data will be updated using publicly-available precipitation data from the PRISM Climate Group at Oregon State University. The monthly rainfall data for Kern County for WY2016 through WY2019 will be mapped into C2VSimFG-Kern input files. The Kern River and Poso Creek streamflow for WY2016 through WY2019 will be updated based on locally measured weir data.

Kern County GSAs will also separately contract with the Irrigation Training & Research Center (ITRC) at Cal Poly San Luis Obispo to deliver evapotranspiration (ET) using remote sensing data across the entire subbasin for determining agricultural demand corresponding to the WY 2016 through WY 2019. Todd Groundwater will utilize the ITRC ET data to develop ET rates for Kern County for this period for model input. To meet this Annual Report schedule, this data needs to be delivered to Todd Groundwater no later than January 17, 2020.

As mentioned previously, GSP regulations require a graph depicting the annual and cumulative change in groundwater in storage "based on historical data to the greatest extent available, including from January 1, 2015 to the current reporting year." (§ 356.2 (b)(5)(B)). To meet this requirement, the updated C2VSimFG-Kern subbasin-wide results will be appended to the historical C2VSimFG-Kern results for WY 1995 – WY 2015. One annual change in groundwater storage map will be developed for each year from WY2016 through WY2019 for the entire Kern County Subbasin using the C2VSimFG-Kern model results.

We will work with agencies to determine the best method for meeting this requirement and then coordinate through the Plan Manager to confirm acceptance of the method by DWR. Additional details are provided in Section 6.2 of **Attachment 1**.

Task 6: Document Progress in GSP Implementation

For this section, Todd Groundwater will work with individual agencies to obtain descriptions and information relating to GSP implementation plans and progress. For the 2019 Annual Report, this section will likely be relatively brief. DWR will recognize that the GSPs were only submitted two months prior to the preparation of this Annual Report and will understand that there will not be substantial progress in plan implementation. Nonetheless, we will document any ongoing activities toward plan implementation that agencies would like to include. In particular, the collection of the preceding year monitoring data and preparation of this First Annual Report are significant steps toward implementation.

Task 7: Prepare Administrative Draft, Draft, and Final Annual Report and Submit to DWR

Based on the tasks above, an Administrative Draft will be prepared for review by Subbasin agencies. Given the condensed schedule, this Administrative Draft will be provided in early February to allow agency input into the development process. It is recognized that the Administrative Draft will contain deficiencies, but the early release will allow comments on analysis methods and results prior to finalization of the technical analysis.

Comments will be incorporated into the Administrative Draft to develop a Draft Annual Report (probably release in early March). This will provide a more complete document for agency review and comment. A Final Draft will also be available prior to submittal for any last-minute minor additions or corrections. The target for the Final Draft is March 13. Todd Groundwater will coordinate with the Plan Manager on submittal of the report prior to the deadline of April 1.

Task 8: Communications and Meetings

As indicated above, there will be a need for communication with Subbasin GSAs and KGA member agencies to obtain comparable data across the entire Subbasin for inclusion in the 2019 Annual Report. Communications will include individual calls/emails with Subbasin agencies, conference calls during periodic meetings of GSA managers, and local in-person meetings to present progress to date and discuss outstanding items or issues.

The preparation of the Annual Report will occur at a busy time for Subbasin agencies. Finalization of GSPs and preparation for GSP submittals will be ongoing. To keep to the expedited schedule of the 2019 Annual Report, a significant amount of communication will be needed to allow Subbasin agencies to focus on required details of the 2019 Annual Report.

To expedite the process, Todd Groundwater will coordinate directly with the Subbasin Plan Manager, Patty Poire, to ensure timely data compilation, review, and incorporation of the required analyses to meet GSP Annual Report requirements. In particular, any questions or contacts with DWR regarding clarifications of Annual Report requirements will be coordinated through the Subbasin Plan Manager.

For budget and planning purposes, four in-person meetings are assumed as part of this scope. Because of the large number of attendees, the KGA Managers Meetings – typically held on Friday mornings – will be used as a forum for data requests, discussion, and comments regarding the Annual Report preparation process. These four meetings, along with the primary objectives and tentative dates, are summarized as follows:

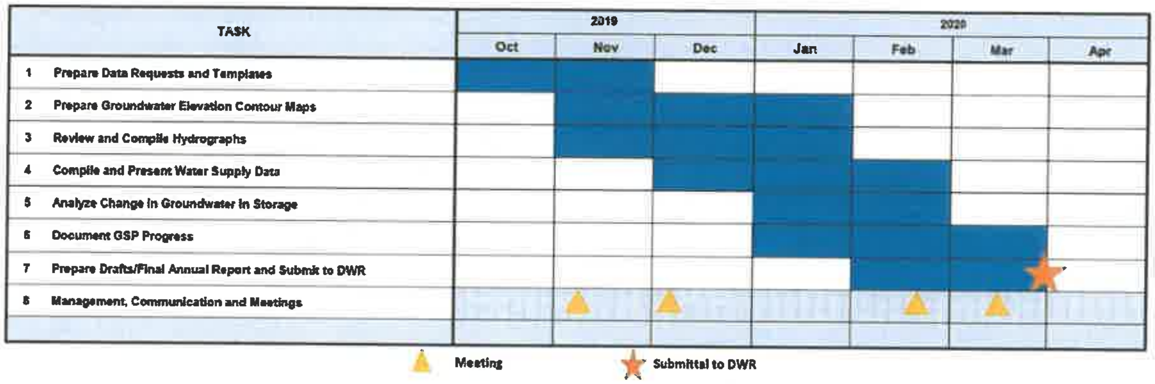
- Meeting No. 1: Provide data request memorandum and templates to agencies and discuss approach for technical analyses including historical change in groundwater in storage; tentatively scheduled for November 8, 2019
- Meeting No. 2: Finalize technical approach for Change in Groundwater in Storage and other technical analyses; tentatively scheduled for December 6, 2019
- Meeting No. 3: Review Administrative Draft Annual Report and address deficiencies; tentatively scheduled for February 21, 2019
- Meeting No. 4: Review Final Draft Annual Report; tentatively scheduled for March 13, 2019.

3 BUDGET AND SCHEDULE

Execution of the scope of work described herein is estimated to cost $174,830. This cost allows for a variety of technical methods to be considered and employed to meet regulatory requirements and the condensed schedule for Annual Report development. Table 1 shows costs by task, along with estimated labor hours and rates.

Our work on the Annual Report can begin in October with additional work on approach for Annual Report items. Technical work can begin in November when water level data from Fall 2019 have been collected and requested data have been compiled. With a submittal date of April 1, 2020, most of the work on the 2019 Annual Report will occur over four months (November through February) with final review and edits of the report targeted for March 2020. A proposed schedule, including the four meetings described in Task 8 is shown below.

Proposed Schedule for 2019 Annual Report, Kern County Subbasin



Please let us know if you have questions regarding this proposal. For the 2019 Annual Report, time is of the essence, and we stand ready to move the effort forward as soon as possible.

ATTACHMENT 1: EXAMPLE ANNOTATED TEMPLATE FOR 2019 ANNUAL REPORT

KERN COUNTY SUBBASIN

GROUNDWATER SUSTAINABILITY AGENCIES

Kern County Subbasin

Groundwater Sustainability Plans (GSPs)

First Annual Report
Water Year 2019

April 1, 2020

TODD GROUNDWATER

2490 Mariner Square Loop, Suite 215
Alameda, CA 94501
510.747.6920
www.toddgroundwater.com

Table of Contents

List of Tables

No table of contents entries found.

Potential List of Figures and Required Maps

Other figures, as needed

Appendices

List of Acronyms

AFY acre feet per year

...

EXECUTIVE SUMMARY

Provide an ***executive summary*** *and* ***location map*** *depicting the basin covered by the report (Reg. § 356.2(a)).*

1 INTRODUCTION

Include general information and location map for the basin covered by the report (Reg. § 356.2(a)).

This First Annual Report (2019 Annual Report) for the collective implementation of the Groundwater Sustainability Plans (GSPs) in the Kern County Subbasin is being prepared under the guidance of Water Code Section 10728. The 2019 Annual Report provides data and information for the entire Kern County Subbasin, including 11 GSAs that have cooperated in the preparation of five GSPs. Subbasin GSAs and GSP are shown on Figures 2 and 3, respectively.

1.1 Purpose of the 2019 Annual Report

The purpose of the 2019 Annual Report is to demonstrate that the GSPs in the Kern County Subbasin are being implemented in a manner that will achieve the sustainability goals that have been developed for the Subbasin and individual GSAs. The 2019 Annual Report provides an update on the groundwater conditions for **Water Year 2019**, and documents progress on GSP implementation. Data and analyses cover the period from October 1, 2018 through September 30, 2019; historical analyses are provided for context for some components, as required by the regulations.

Specifically, for this First Annual Report, some additional analyses have been required to cover the time period from October 1, 2015 through September 30, 2019 (WY 2016 through WY 2019). Inclusion of data from this four-year period provides a bridge between the end of the Current Study Period (WY 2015) of the Subbasin GSPs and the reporting period for this 2019 Annual Report (i.e., WY 2019).

1.2 Coordinated Submittal

Describe process by which Subbasin data were submitted and compiled.

All of the GSAs in the Kern County Subbasin have cooperated to prepare and submit this First Annual Report.

Figures and tables will be included for the GSAs and GSPs in the Subbasin.

As required by GSP regulations, this Annual Report contains... ***summarize organization and contents.***

2 GROUNDWATER ELEVATIONS

§ 356.2(b)(1)(A) Describe and present graphically, groundwater elevation data from monitoring wells identified in the monitoring network.

2.1 GROUNDWATER ELEVATION CONTOUR MAP FOR EACH PRINCIPAL AQUIFER

§ 356.2(b)(1)(A) ...illustrating, at a minimum, seasonal high and seasonal low. Assume submittal of 2 sets of maps with this Annual Report – Spring and Fall 2019, with a map per Principal Aquifer (4 maps total). Will we have Santa Margarita maps from Kern Tulare and others on the Eastside?

Assume that water level data will be provided in Excel and include, at a minimum, well identifiers (matching hydrographs), date, depth to water, reference point elevation, and water level elevations.

Data will be contoured initially using commercially-available software and then iteratively hand-modified for more accurate representations of groundwater elevations across the Subbasin. Multiple drafts of water level contour maps will be developed for review by individual agencies, as needed.

2.2 HYDROGRAPHS FROM WY 1995 THROUGH SEPTEMBER 2019

Assume that wells in the GSP monitoring networks used for GSP compliance monitoring will be provided by each agency for inclusion in the 2019 Annual Report. Hydrographs can be provided as pdf, described briefly in this section, and incorporated in an appendix.

Section will include and describe:

- Table of Wells and Submitting Agencies
- Figure 8: Hydrograph Location Map.
- Hydrographs to be included in Appendix A.

Hydrograph requirements for Annual Report *§ 356.2(b)(1)(B)*:

- Groundwater elevations
- Water Year Type
- Historical data to the greatest extent possible (WY 1995 – WY 2019)
- Locations, tied to the same datum

Hydrograph requirements from Data and Reporting Standards §352.4(e):

- Hydrographs shall be submitted electronically in accordance with the procedures in Article 4.
- Hydrographs shall include a unique site identification number and the ground surface elevation for each site
- Hydrographs shall use the same datum and scaling to the greatest extent practical

We assume that all submitted hydrographs from each agency will have the same horizontal scale beginning with October 1, 1994 and ending with September 30, 2019. The horizontal axis will have major tick marks for each water year (WY 1995 through WY 2019).

3 GROUNDWATER EXTRACTIONS

GSP requirements in § 356.2(b)(2).

3.1 Summary Extractions by Subbasin for WY 2019

Total groundwater extractions for the Subbasin for the preceding water year (WY 2019) will be summarized and provided in this section. Data should be collected by "best available measurement methods."

3.2 Table of Extractions

Based on our SGMA reporting in Adjudicated Basins, we anticipate the following formats from DWR regarding extraction data reporting. Data may not be available for all sectors for this first report.

- Water Use Sector (including volume, explanation, and uncertainty)
  - Urban
    - Large Landscape
    - Commercial
    - Industrial
    - Residential
  - Agricultural
  - Managed Wetlands
  - Managed Recharge
  - Other Sector

- Measurement Method (direct or estimate)
  - Meters
  - Electrical Records
  - Land use
  - Groundwater model
  - Reported by pumper
  - Other

- Accuracy of Measurements
  - Low, medium, high

3.3 Extractions Map

Map that illustrates the general location and volume of groundwater extractions § 356.2(b)(2).

This map will be developed with various formats, depending on the data provided. At a minimum, we assume preparation of a map will showing extraction wells by well type (agricultural, municipal, etc.), using available information from the agencies. To meet the criteria of showing volumes of extractions, we anticipate developing various "bubble" maps showing groundwater extractions for general areas.

4 SURFACE WATER SUPPLY

§ 356.2(b)(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

4.1 TOTAL SURFACE WATER USE

Total surface water use will be reported for the Kern County Subbasin, including a summary of the methods used to determine the volume and the associated uncertainty (high, medium, low). These data will be compiled from the individual agencies in the Subbasin.

4.2 SURFACE WATER BY SOURCE TYPE

Tables will be developed to document the volumes and associated uncertainty by Water Source Type:

- Local Surface Deliveries
- Local Imported Deliveries
- Colorado River Deliveries
- CVP Base and Project Deliveries
- Other Federal Deliveries
- State Water Project Deliveries
- Recycled Water
- Desalination Water
- Other

5 TOTAL WATER USE

§ 356.2(b)(4) Total water use.

Provide total volume of water used in the Subbasin for WY 2019, including the method used to determine and the level of uncertainty (low, medium, high)

- Collected using the best available measurement methods
- Table containing total water use by:
    - Water Use Sector
        - Urban
            - Large Landscape
            - Commercial
            - Industrial
            - Residential
        - Agricultural
        - Managed Wetlands
        - Managed Recharge
        - Other Sector
    - Water Source Type
        - Groundwater
        - Surface water
        - Recycled or reused water
        - Other

6 CHANGE IN GROUNDWATER IN STORAGE

6.1 MAP OF CHANGE IN GROUNDWATER IN STORAGE FOR THE SUBBASIN

§ 356.2(b)(5)(A) Change in ***groundwater in storage maps*** *for each principal aquifer in the basin.*

GSP regulations require an annual change in groundwater in storage map for the entire Kern County Subbasin be included in the Annual Report. We will follow up with DWR whether this requirement is for only the preceding year (WY 2019) or whether it applies to all four intervening water years (WYs 2016 through 2019).

Based our November 8, 2019, discussion at the Kern County Manager's Meeting, Todd Groundwater will develop change in groundwater in storage maps and graphs for the entire Kern County Subbasin using the C2VSimFG-Kern model. By doing so, we continue to update and use the primary DWR modeling tool with our local Kern County updates for evaluating basin conditions. For this task, we will use a consistent methodology to that used to develop change in groundwater storage graphs for the C2VSimFG-Kern Model Results technical memorandum that is included in the KGA Umbrella and KRGSA GSPs. Using this approach, we will maintain consistency of method in presenting the basinwide change in groundwater storage. One annual change in groundwater storage map will be developed for each year from WY2016 through WY2019 for the entire Kern County Subbasin using the C2VSimFG-Kern model results.

6.2 GRAPHS OF CHANGE IN GROUNDWATER IN STORAGE

§ 356.2(b)(5)(A) Graphs of Change of Groundwater in Storage showing:

- Water Year Type (Wet, Above Normal, Below Normal, Dry, Critically Dry)
- Groundwater Use
- Annual Change in groundwater in storage
- Cumulative change in groundwater in storage
- Based on historical data, to the greatest extent available, including from January 1, 2015 to the current reporting year

GSP regulations require a graph depicting the annual and cumulative change in groundwater in storage "based on historical data to the greatest extent available, including from January 1, 2015 to the current reporting year." (§ 356.2 (b)(5)(B)).

For the Kern County Subbasin, this graph will present annual changes in groundwater in storage from the C2VSimFG-Kern model. Model results provide an annual change in groundwater in storage for each year in the historical and current study periods (WY 1995 – WY 2015). New water budget analyses will be developed for the remaining time period WY 2016 – WY 2019. To meet the regulatory requirement for this graph, the updated C2VSimFG-Kern subbasin-wide results will be appended to the historical C2VSimFG-Kern results for WY 1995 – WY 2015.

7 PROGRESS IN GSP IMPLEMENTATION

§ 356.2(b)(5)(C) A description of progress towards implementing the Plan, including achieving interim milestones, and implementation of projects or management actions since the previous annual report.

For this section, we assume receipt of text from each GSAs/Districts that describes ongoing implementation of each GSP. A brief description of the projects and management actions being implemented will be included, as relevant. This section is not meant to repeat information in the recently-submitted GSPs and will simply refer to the GSPs as appropriate.

In particular, this section will describe relevant monitoring data and how these data are being used. GSP monitoring data can be summarized/included in an appendix. We will confirm with DWR how much of the data and formats are required to accompany the submission of the Annual Report.

8 REFERENCES AND TECHNICAL STUDIES

To be listed as needed.

9 APPENDICES

- Hydrographs and other data.
- Possible inclusion of other information, if determined to be needed by DWR.

ATTACHMENT 2

ITRC
moving water in new directions

Date:	**October 7, 2019**
To:	**Patty Poire, Planning Manager** **Kern Groundwater Authority** ppoire@kerngwa.com, **Mobile: (661)706-1989**
From:	**Dan Howes, Ph.D., P.E.** **Project Manager/Senior Engineer** **Irrigation Training and Research Center** **Cal Poly/ San Luis Obispo, CA 93407** **Cell: 858-354-0504** djhowes@calpoly.edu
Subject:	**Proposal for ITRC-METRIC evapotranspiration for Kern Subbasin (2017-2019)**

This proposal is being submitted to Kern Groundwater Authority (KGWA) by the Irrigation Training and Research Center (ITRC) at Cal Poly State University, San Luis Obispo.

Scope of Work

Update of ITRC-METRIC 2017-2019 Water Year and Calendar Year

ITRC will provide monthly and annual ITRC-METRIC actual crop evapotranspiration (ETc) for the Kern Subbasin for 2017-2019. The following items will be completed:

1. Data will be extracted for each GSA within the subbasin and each irrigated field in each GSA monthly for 2017-2019. We can also provide the data for parcels (larger than 5 acres).
2. Data will be provided tabularly and monthly ETc images will be provided in GIS format.
3. Short report discussing the general process and overall results will be provided.

Cost: **$16,000**

Deliverables

ETc data in tabular (MS EXCEL) and other formats (such as imager) provided on a flash drive or file transfer service.

Timeline for Project

Assuming the full 2019 results are desired, report and data will be provided by February 1, 2020. If water year only results are desired, results will be provided by November 20, 2019.

Contract

The person responsible for technical aspects of this contract will be:

Dan Howes
Project Manager, Irrigation Training and Research Center
Cal Poly
San Luis Obispo, CA 93401-0730
djhowes@calpoly.edu

The contract will be administered by:

Cal Poly Corporation
Building #15
One Grand Avenue
San Luis Obispo, CA 93407

Note: Dr. Howes should be the contact person.

Budget

The total budget is a fixed price Fee for Service of $16,000. The full amount will be invoiced when the draft results are transmitted to KGWA. The Cal Poly Corporation requests that a KGWA representative agree to the Standard Terms and Conditions, which are attached to this proposal. The signed approval can be scanned and submitted via e-mail to Dan Howes.

Invoicing and Payment

ITRC will submit to KGWA (Patty Poire), an invoice of the full fixed cost when transmitting the draft results.

Payment should be made payable to "Cal Poly Corporation" and sent to:

Dr. Dan Howes
Irrigation Training and Research Center (ITRC)
One Grand Ave
Bldg 8A
California Polytechnic State University
San Luis Obispo, CA 93407-0730

Authorization/Approval

Name of authorized ITRC representative: Daniel Howes

Daniel T Howes

Signature of ITRC representative

10/7/2019
date

Named of authorized Kern GWA representative: Patty Poire

Patty Poire

Signature of the representative:

11/20/2019
date

Irrigation Training & Research Center (ITRC)
Standard Terms and Conditions

THIS AGREEMENT is between the **Kern Groundwater Authority ("Client")** and the Cal Poly Corporation, a separate non-profit auxiliary organization for the California Polytechnic State University, hereinafter referred to as **"ITRC."**

1) **Ordering**: Clients may order services (specify a "Scope of Work") by submitting a written purchase order, a written request for services, by sending confirming e-mail, or by placing a telephone order. The Client must subsequently confirm all telephone orders in writing or via e-mail confirmation prior to commencement of work.
2) **Change Orders:** A Client may request additions or changes to an Order, but must be confirmed by written notice. Email is an acceptable form of writing. The Client will remain responsible for all work performed under the original agreement up until the time ITRC is officially notified of the change.
3) **Suspending or Stopping ITRC's Performance**: The Client may direct ITRC to suspend a portion or all of the work to be performed. In such case, the Client will remain responsible for all work performed up until the time ITRC became aware of Client's desire to discontinue the services. Any uncompleted services in progress at the time of discontinuation will be billed on a prorated basis, as determined by ITRC.
4) **Confidentiality:** ITRC shall keep documents and information identified by Client as confidential to the extent permitted by law, and will not disclose any such information to third parties. ITRC may publish announcements and summaries containing *non-confidential information* about this project in campus newsletters and annual report and other published documents on campus.
5) **Warranties**: Client understands that ITRC performs services only as specified by Client in the Services Agreement accepted by ITRC. ITRC does not make any express or implied warranties or guarantees of any kind to the Client. By their very nature, technical services, testing, analysis and other ITRC services are limited to expected measurement variability. ITRC represents that the Services shall be performed within the limits agreed with Client, and in a manner consistent with the level of care and skill ordinarily exercised by other providers of similar services under similar circumstances.
6) **Ownership of Data**: Data or information provided to ITRC by the Client shall remain the Client's property. Upon full payment to ITRC for all services provided by ITRC, data or information generated by ITRC for the Client shall become the Client's property. ITRC will retain exclusive ownership of any and all analytical methods, Quality Assurance/Quality Control protocols, and equipment developed by ITRC for performance of work by ITRC. ITRC Reports are for the exclusive use of the Client to whom they are addressed. The name of ITRC, Cal Poly Corporation, or California Polytechnic State University, or any symbols of them are not to be used by Client without prior written approval by the appropriate authorized representative.
7) **Indemnification:** Client and ITRC agree that by performing services hereunder, ITRC does not assume, shorten, cancel or undertake to discharge any duty or responsibility of Client to any other party or parties. No one other than Client shall have any right to rely on any Report or other representation or conduct of ITRC, and ITRC disclaims any obligations of any nature whatsoever with respect to such person. Client and ITRC agree, in consideration of ITRC under-taking to perform the ordered service(s) to protect, defend, indemnify, same harmless and exonerate each other from any and all claims, damages, expenses, either direct or consequential for injuries to persons or property arising out of or in consequence of the performance of the services hereunder unless caused by the sole negligence of the other party.
8) **Insurance:** Cal Poly Corporation maintains insurance coverage for its employees to perform professional services. If Client seeks greater protection than is provided by Cal Poly Corporation insurance, Client should obtain appropriate protection from suppliers or insurers.
9) **Limitation of Liability:** If ITRC should be found liable for any losses or damages attributable to the services hereunder in any respect, its liability shall in no event exceed the amount of the fee paid by Client for such services and Client's sole remedy at law or in equity shall be the right to recover up to such amount.
10) **Force Majeure:** Whenever performance by either party is delayed or prevented by an extraordinary event beyond the control of Client or ITRC, such delay or prevention shall be excused and the time of performance extended for the duration of the causative factor. In no event shall the occurrence of any such conditions excuse the Client of its obligations hereunder if services have been performed by ITRC.
11) **Payment of Invoices:** Client agrees to pay all invoices to ITRC within 30 days of invoice date, and if payment is not timely received, the Client agrees to pay a late payment charge on the unpaid balance at the maximum allowed by law.
12) **Governing Law**: This Agreement shall be governed in accordance with the laws of the State of California.

EXHIBIT 1

Funding Contributions

Total Contracts	$190,830.00
Todd Groundwater	$174,830.00
ITRC	$16,000.00

	Funding Entity	Funding Request
1	Arvin-Edison Water Storage District	$8,674.09
2	Buena Vista Water Storage District	$8,674.09
3	Cawelo Water District	$8,674.09
4	City of Bakersfield	$8,674.09
5	Eastside Water Management Area	$8,674.09
6	Henry Miller	$8,674.09
7	Improvement District No. 4	$8,674.09
8	Kern Delta Water District	$8,674.09
9	Kern County Water Agency - Pioneer Project	$8,674.09
10	Kern-Tulare Water District	$8,674.09
11	Kern Water Bank Authority	$8,674.09
12	North Kern Water Storage District	$8,674.09
13	Olcese Water District	$8,674.09
14	Rosedale-Rio Bravo Water District	$8,674.09
15	Semitropic Water Storage District	$8,674.09
16	Shafter-Wasco Irrigation District	$8,674.09
16	Shafter-Wasco 7th Standard Annex	$8,674.09
17	South San Joaquin Municipal Utilities District	$8,674.09
18	Tejon-Castac Water District	$8,674.09
19	West Kern Water District	$8,674.09
20	Westside District Water Authority	$8,674.09
21	Wheeler Ridge-Maricopa Water Storage District	$8,674.09
	Totals	$190,830.00

Invoices:

KGA:	$138,785.45
KRGSA:	$26,022.27
BV	$8,674.09
Henry Miller:	$8,674.09
Olcese	$8,674.09
	$190,830.00