Appendix A

Notice of Preparation & Comment Letters

Notice of Preparation

To: State Clearinghouse
1400 Tenth Street, Sacramento, CA 95814
(Address)

From: Katherine Mrowka
State Water Resources Control Board, Division of Water Rights
P.O Box 2000, Sacramento, CA 95812-2000
(Address)

Subject: Notice of Preparation of a Draft Environmental Impact Report

State Water Resources Control Board will be the Lead Agency and will prepare an environmental impact report for the project identified below. We need to know the views of your agency as to the scope and content of the environmental information which is germane to your agency's statutory responsibilities in connection with the proposed project. Your agency will need to use the EIR prepared by our agency when considering your permit or other approval for the project.

The project description, location, and the potential environmental effects are contained in the attached materials. A copy of the Initial Study (☐ is ☒ is not) attached.

Due to the time limits mandated by State law, your response must be sent at the earliest possible date but not later than 30 days after receipt of this notice.

Please send your response to Katherine Mrowka at the address shown above. We will need the name for a contact person in your agency.

Project Title: Eastwood/Odello Water Right Change Petition

Project Applicant, if any:

Date March 4, 2014

Signature Katherine Mrowka

Title Senior Water Resource Control Engineer

Telephone (916) 341-5363

Reference: California Code of Regulations, Title 14, (CEQA Guidelines) Sections 15082(a), 15103, 15375.

I. INTRODUCTION

The Environmental Impact Report (EIR) is an environmental review document that will be prepared in compliance with the California Environmental Quality Act (CEQA) of 1970, as amended. Under CEQA, the purpose of the EIR is to inform decision makers and the general public of the environmental effects of a proposed project. The purpose of EIR process is to provide environmental information sufficient to evaluate a proposed project and its potential for significant impacts on the environment, to establish methods for addressing potential impacts, and to identify and consider alternatives to a project. In accordance with the requirements of Article 9 of the CEQA Guidelines, the EIR for this proposed project will include:

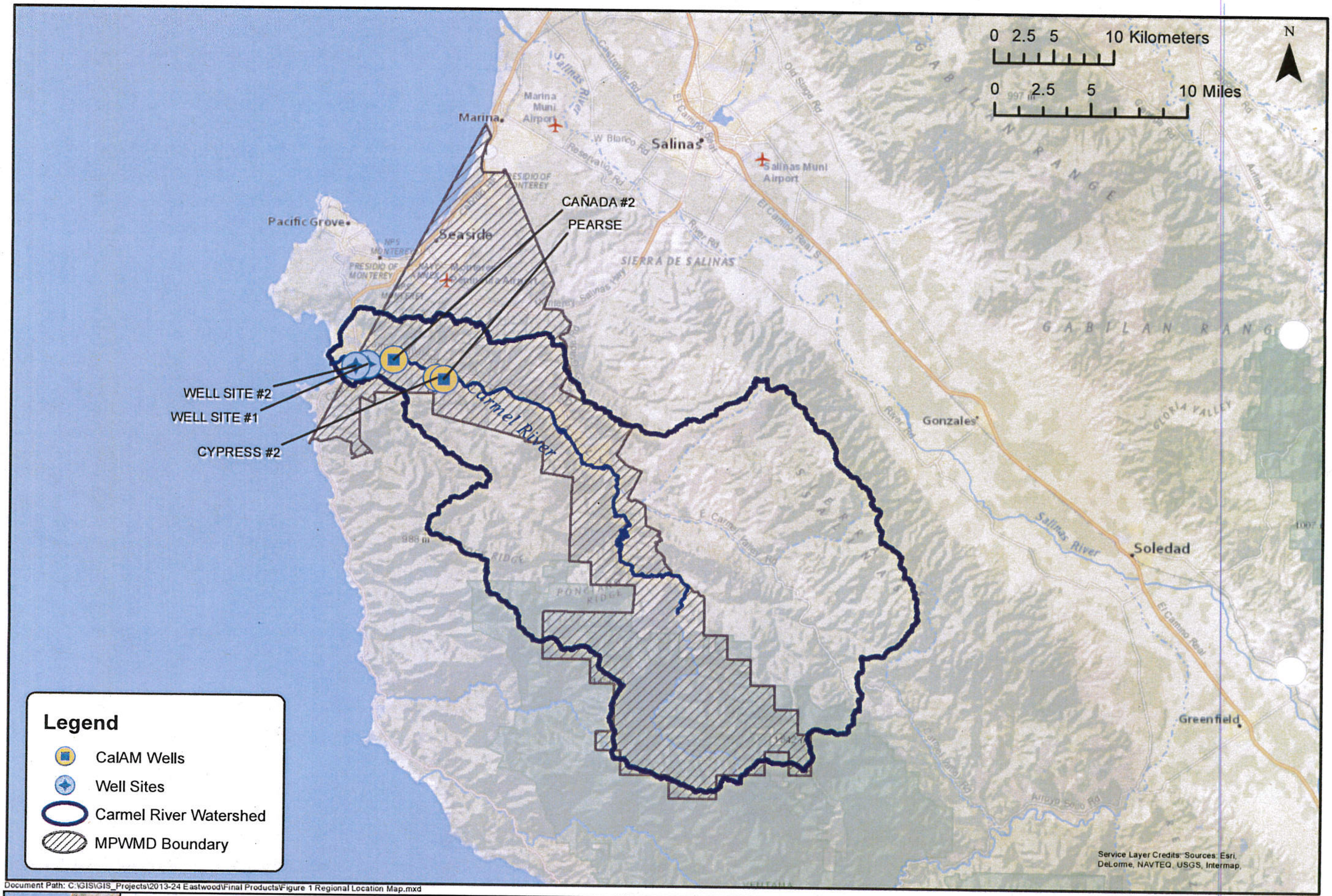
- A summary of the EIR;
- A project description;
- A description of the existing environmental setting, potential environmental impacts, and mitigation measures (if applicable);
- Alternatives to the proposed project;
- Environmental consequences, including: (a) any significant environmental effects which cannot be avoided if the project is implemented; (b) any significant irreversible environmental changes and irretrievable commitments of resources; (c) the growth-inducing impacts of the proposed project, (d) effects found not to be significant, and (e) cumulative impacts;
- A list of organizations and persons consulted; and
- The EIR preparers.

The following is a general overview of the proposed project and anticipated environmental effects.

II. PROJECT LOCATION

The proposed project consists of a change petition for existing water right License 13868 (Application 30497B), which currently authorizes diversions from the alluvial aquifer associated with the Carmel River for the irrigation of adjacent agricultural lands in Monterey County, CA. The Carmel River is part of the Carmel River watershed, which consists of approximately 250 square miles (**Figure 3-1**). The Carmel River flows northwest from the Santa Lucia Mountains, through Carmel Valley, and into the Pacific Ocean. The Carmel River originates approximately 35 miles upstream from the Pacific Ocean at an elevation of 3,500 feet above sea level. The watershed is bounded by the Sierra de Salinas ranges on the northeast and the Santa Lucia Range on the southeast. These ranges are characterized by steep slopes and dense foliage. The valley floor, which covers approximately six (6) square miles and contains the alluvial aquifer, consists primarily of areas of agricultural and urban development.

License 13868 currently authorizes the diversion of water from the Carmel River through two (2) points of diversion located south of the river and east of State Route (SR) 1, for irrigation of lands within the existing authorized place of use, which consists of approximately 99.0 acres (see **Figure 2**). The proposed project, which is described below, would split License 13868 into two (2) new licenses. As part of this process, the project would result in changes in the authorized points of diversion, place of use, and purpose of use.



Document Path: C:\GIS\GIS_Projects\2013-24 Eastwood\Final Products\Figure 1 Regional Location Map.mxd

Title: **Regional Location**

Date:	1/14/2014
Scale:	1 inch = 6 miles
Project:	2013-24

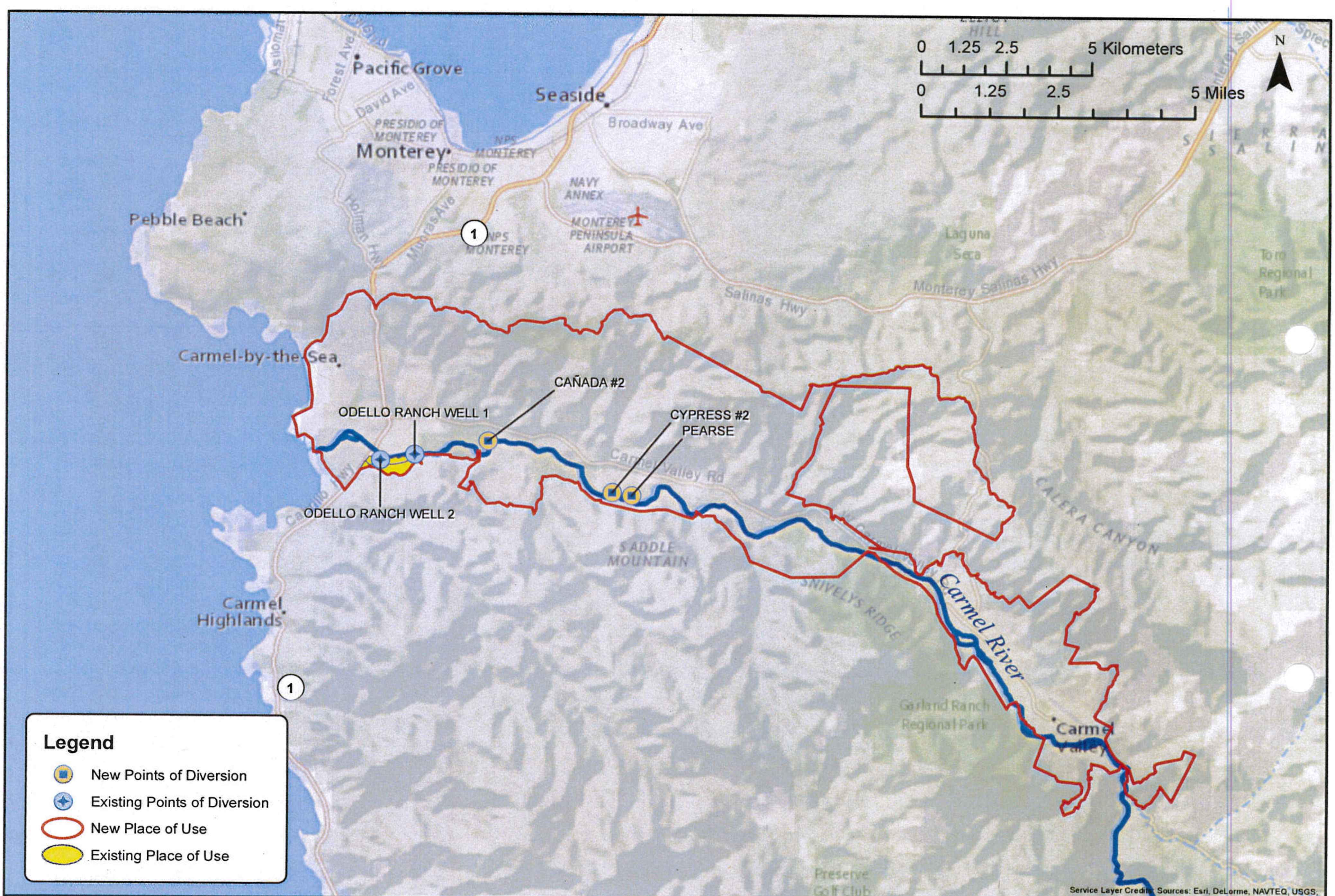
Monterey | Truckee | San Jose

Denise Duffy and Associates, Inc.

Environmental Consultants Resource Planners

947 Cass Street, Suite 5
Monterey, CA 93940
(831) 373-4341

Figure
3-1



Title:

Project Vicinity

Document Path: C:\GIS\GIS_Projects\2013-24 Eastwood\Final Products\Figure 2 Project Vicinity Map.mxd

Date: 10/17/2013

Scale: 1 inch = 2 miles

Project: 2013-24

Monterey | Truckee | San Jose
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Figure 2

The change petition for the proposed project, as amended on October 2, 2013, asks the STATE WATER BOARD to add three (3) new authorized points of diversion along the Carmel River at existing California-American Water (Cal-Am) operated wells. These facilities are located within the alluvial portion of the Carmel River in Carmel Valley, CA. The petition also requests a change to the existing authorized place of use. The proposed place of use includes the 99.0-acre authorized place of use in the existing license and 16,595 acres of Cal-Am's service area in the Carmel River watershed and 526 acres of Cal-Am's service area within the City of Carmel-by-the-Sea **(Figure 2).** The petition also requests that municipal use be added to the authorized purposes of use. The STATE WATER BOARD issued its public notice of this petition on December 31, 2013.

III. PROJECT DESCRIPTION

The purpose of the project is to seek authorization from the STATE WATER BOARD for changes to water-right License 13868 to include changes to the authorized points of diversion, place of use, and purposes of use, so that licensees may: 1) provide water to serve existing legal lots of record within the Carmel River watershed or City of Carmel-by-the-Sea, through new connections or increased uses of water at existing service addresses, 2) protect and enhance the Carmel River and associated environment by dedicating a portion of the existing water right to instream uses, and 3) provide a supplemental water supply to Cal-Am on an interim basis, to help Cal-Am meet its obligations under STATE WATER BOARD Order WR 95-10. If the STATE WATER BOARD grants the petition for this project, then License 13868 would be split into two new licenses: License 13868A and 13868B.[1] License 13868A would include new authorized points of diversion, places of use, and purposes of use, so that potable water for municipal purposes could be provided to existing lots of records within the parts of Cal-Am's service area that are within the Carmel River watershed or the City of Carmel-by-the-Sea. License 13868B would provide for the dedication of the remaining rights in License 13868 to instream uses. The project would not increase the maximum authorized annual diversion rate or the maximum authorized instantaneous diversion rate beyond the existing authorized rates in License 13868 (see **Table 1**).[2]

In addition to the changes to the existing license, the project also would involve the adoption of a new rule by the Monterey Peninsula Water Management District (MPWMD or District). The new rule, which would be similar to District Rule 23.5, would allow MPWMD to issue water use permits to owners of existing lots of record within the parts of Cal-Am's service area that are within the Carmel River watershed or the City of Carmel-by-the-Sea, and that have entered into subscription agreements with the licensees.

The following is a brief overview of the existing license and the proposed new licenses.

License 13868 (Existing)

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[1] The new licenses would supersede the existing license upon issuance by SWRCB. The SWRCB posted copies of draft Licenses 13868A and 13868B on its public website with the SWRCB's public notice of the petition to change License 13868.

[2] Upon issuance of the new licenses, the applicant would form a limited liability company (LLC) for the purposes of holding and administering water License 13868A. This company would be responsible for entering into subscription agreements with owners of parcels in the part of Cal-Am's service area that is within the Carmel River watershed or the City of Carmel-by-the-Sea for water provided under License 13868A.

License 13868 contains two authorized points of diversion, which are located approximately 300 and 1,100 yards east of SR 1. The authorized purpose of use is irrigation and the authorized place of use consists of 99.0 acres of land located within the Carmel River watershed (**Figure 2**). The maximum authorized annual diversion rate is 131.8 acre-feet per annum (afa). The maximum authorized instantaneous diversion rate is 0.45 cubic feet per second (cfs).

License 13868A (Proposed)

License 13868A would include the existing authorized points of diversion, place of use and purpose and new authorized points of diversion, place of use and purpose of use. The new authorized points of diversion would include three (3) existing Cal-Am owned and operated wells in the lower Carmel Valley. These wells are the Rancho Canada No. 2, Cypress No. 2 and Pearce wells. The new authorized purpose of use would include municipal use and the new authorized place of use would consist of 16,595 acres of Cal-Am's service area in the Carmel River watershed and 526 acres of Cal-Am's service area within the City of Carmel-by-the-Sea (**Figure 2**).[3] All diversions under License 13868A would occur through existing Cal-Am wells and all conveyances would occur through Cal-Am's existing conveyance system. Accordingly, the project would not include any new or expanded wells or water conveyance facilities. This license would have an authorized maximum annual diversion rate of 85.6 afa.[4] This license would have an authorized maximum instantaneous diversion rate of 0.37 cfs. The authorized diversion season for License 13868A would be the same as the authorized diversion season for License 13868, January 1 through December 31.

License 13868B (Proposed)

License 13868B would dedicate 46.2 afa to instream uses. This license would not include any authorized points of diversion. The proposed authorized place of use would consist of the Carmel River (Subterranean Stream). The proposed authorized purpose of use would be preserving and enhancing fish and wildlife resources and riparian vegetation. This dedication would support in-stream uses in the Carmel River between the existing authorized points of diversion in License 13868 and the mouth of the Carmel River Lagoon. The dedicated flow rate for this license would be 0.08 cfs.

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[3] Not all water available for diversion and use under License 13868A would initially be used by owners of existing lots of record who would enter into subscription agreements with licensees. During this interim period, excess water not consumed by subscribers would be made available for three potential interim uses: (a) temporary use as a supplemental supply to help Cal-Am meet its obligations under SWRCB Order WR 95-10, (b) temporary irrigation use to establish native vegetation as part of on-going planned restoration efforts associated with the Carmel River Restoration and Environmental Enhancement Project, and (c) possibly agricultural irrigation on land currently owned by the Big Sur Land Trust. Uses (b) and (c) would occur within the existing authorized place of use in License 13868.

[4] This annual amount equals the estimated total annual estimated evapotranspiration from applied water (ETAW) that is occurring with the current diversions and irrigation use of water under License 13868. (See April 15, 2013 Davids Engineering Technical Memorandum, "Odello Ranch Crop ET and ET of Applied Water Estimates," p. 27, Table 11)

Table 1. Existing vs. Proposed Maximum Authorized Diversion Rates			
Diversion Allowed	**Water Right License**		
	Existing License 13868	**Proposed New License 13868A**	**Proposed New License 13868B**
Maximum Annual Rate of Diversion (afa)	131.8	85.6	46.2
Maximum Instantaneous Rate (cfs)	0.45	0.37	0.08

IV. PROBABLE ENVIRONMENTAL EFFECTS

The EIR will evaluate potential direct and indirect environmental effects associated with the implementation of the proposed project. The EIR will assess the following potential environmental effects:

Aesthetic Resources: The EIR will evaluate visual/aesthetic impacts related to the Project. The project would use three (3) existing Cal-Am wells as additional authorized points of diversion for License 13868A. The project would not include the construction of any new water supply facilities. The proposed project would dedicate License 13868B to instream uses and would not cause and/or otherwise affect the existing visual environment. The project would not result in any direct aesthetic-related impacts because the project would not include any physical changes to the environment or construction of new improvements. The project could indirectly impact existing visual resources by providing additional water supplies for existing legal lots of record. The project would not, however, facilitate any new development or growth beyond existing planned levels. While potential visual impacts associated with the development of existing lots of record would be addressed through site-specific evaluation and standard development review processes (e.g. site plan review, building permits, and grading permits) and compliance with applicable City and/or County requirements, the EIR will evaluate both the direct and indirect aesthetic-related effects associated with the project.

Air Quality and Greenhouse Gas Emissions: The project would not directly result in any potentially significant air quality impacts. The project would not include any improvements to existing facilities or the construction of new water supply infrastructure. As a result, the project would not result in any temporary air quality emissions in connection with construction-related activities. The project may result in indirect air quality impacts by accommodating previously planned development. The project could indirectly affect air quality by accommodating development on existing lots of record. The EIR will include an evaluation of potential air quality and greenhouse gas emissions associated with the project.

Biological Resources: The EIR will evaluate potential direct and indirect impacts to biological resources, including, but not limited to special-status animal and plant species, sensitive habitats and aquatic resources. The increases in diversions at the proposed new authorized diversion points for License 13868A could result in localized impacts due to changes in hydrology and surface water flow rates. The EIR will identify potential species within the project vicinity that could be affected by the project, including potential impacts to sensitive species due to changes in surface flows. The EIR will identify corresponding mitigation measures, if necessary. In addition, the EIR will also evaluate, to the extent feasible, the potential indirect or secondary effects associated with the project.

Cultural Resources: The project would not directly affect cultural resources. The project would not directly result in any physical development or impacts on the environment. Development activities associated with the development of existing lots of record could impact previously unknown or buried cultural resources and/or otherwise adversely affect an existing cultural resource. The extent of potential indirect impacts is contingent upon site specific and project specific features. The EIR will evaluate secondary or indirect impacts due to the implementation of the project.

Geology and Soils: The project would not include the development of any new physical improvements, and no ground disturbing activities are proposed as part of the project. As a result, the project would not result in any direct impacts due to geology and/or soils. The project could, however, result in secondary impacts. Secondary impacts could include increases in erosion due to ground disturbing activities or similar impacts associated with development of existing lots of record. While the extent of impacts would be contingent upon site-specific and project-specific factors, the EIR will identify potential seismic, liquefaction, landslide, soil erosion, and expansive soil impacts that could occur indirectly due to the project. The EIR will evaluate potential indirect impacts associated with the project.

Hazards and Hazardous Materials: The project would not result in any direct impacts due do to hazards or hazardous materials. The project would not include any physical improvements to existing Cal-Am facilities and no hazardous material usage is proposed. As a result, the project would not result in any direct impacts related to hazards and hazardous materials. The project could result in secondary impacts related to the development of existing legal lots of record. These developments could involve the use and/or storage of hazards and potentially hazardous materials during construction and operation. The extent of potential impacts would depend upon the nature of development and site-specific/project-specific factors. The EIR will include an evaluation of secondary impacts related to the project to the extent those potential impacts can reasonably be identified.

Hydrology and Water Quality: The project could result in direct impacts to surface water and groundwater resources through increased diversions at three (3) existing Cal-Am wells, under License 13868A. These increased diversions would result in localized increases in groundwater withdrawals, which could affect adjacent wells. These increased diversions also could affect existing surface water resources by changing existing flow rates. The EIR will evaluate the potential impacts to groundwater resources associated with proposed diversions at the three (3) existing Cal-Am wells, under License 13868A. The EIR will also evaluate potential direct impacts to surface water resources due to the changes in points of diversion from the existing wells to the proposed new points of diversion. The EIR will also evaluate the potential indirect impacts to surface water resources in connection with the project. Potential secondary impacts could entail localized increases in surface runoff due to the introduction of impervious surfaces, increased erosion, and localized water quality impacts associated with development of existing lots of record. The extent of secondary impacts is contingent upon site-specific and project-specific factors and the EIR will evaluate such secondary impacts to the extent that they can reasonably be identified.

Land Use and Planning: The project is not anticipated to result in any significant land use related impacts. The EIR will evaluate the proposed project for consistency with applicable plans, policies, and regulations to the extent they are applicable to the proposed project. Potential impacts related to growth inducement considerations will be evaluated separately.

Noise: The project would not include the construction of any new water supply infrastructure. The project would utilize existing Cal-Am facilities as new authorized points of diversion under License 13868A. As a result, the project would not cause any direct noise-related impacts. The EIR will evaluate the potential secondary impacts associated with the project. Potential secondary noise impacts would primarily be associated with temporary construction-related activities on existing lots of record.

Population and Housing: The project would enhance the reliability of the water supply within the Carmel River watershed area and the City of Carmel-by-the-Sea and would provide supplemental water supply to serve existing legal lots of record in those areas. Accordingly, the project would accommodate existing planned growth and development by providing a supplemental water supply. The project would provide water to serve existing approved developments and existing lots of record for residential and commercial uses, as well as accommodate expansions and changes of existing commercial or residential uses on existing lots of record. The project would not provide any water supplies for lots that might be created in the future through new subdivisions. The EIR will describe the relationship of water supply to population growth in the area. The EIR will evaluate the potential growth inducing impacts associated with the project.

Transportation and Traffic: The proposed project would not involve any new construction. As a result, the proposed project would not directly result in any significant transportation-related impacts. The project could result in secondary transportation/traffic related impacts due to the development of existing lots of record. The EIR will describe the indirect impacts associated with the project and will evaluate secondary impacts related to the project to the extent that such potential impacts can reasonably be identified.

Other Environmental Issues: The EIR will also evaluated other environmental issues in accordance with the requirements of CEQA, including potential impacts on public services and utilities, including the proposed project's potential effects on water supply reliability, energy delivery systems due to fossil-fuel resource use, and agricultural, mineral, and forest resources. The EIR also will evaluate potential growth-inducing impacts that could result from implementation of the project. The EIR will evaluate whether the project could result in impacts that would be significant when combined with the impacts of other past, present and reasonably foreseeable future projects (i.e., cumulative impacts).

Alternatives: CEQA requires that an EIR evaluate a reasonable range of feasible alternatives to the proposed project, or to the location of the project, that would attain most of the basic project objectives but that could avoid or substantially lessen any of the significant effects of the project. The EIR will identify the potentially significant impacts of the proposed project. The findings of the EIR's impact analysis will guide the refinement of an appropriate range of feasible alternatives to be evaluated in the EIR. The EIR will include, at a minimum, a discussion of impacts associated with the No Project Alternative.

MONTEREY PENINSULA
WATER
MANAGEMENT DISTRICT

March 25, 2014

Katherine Mrowka
Senior Water Resource Control Engineer
SWRCB, Division of Water Rights
PO Box 2000
Sacramento, CA 95812-2000

Subject: **MPWMD Comments on Notice of Preparation of Draft EIR for Eastwood/Odello Water Right Change Petition, Carmel River, Monterey County; SCH# 2014031008**

Dear Ms. Mrowka:

The Monterey Peninsula Water Management District (MPWMD or District) appreciates this opportunity to comment on the above-referenced Notice of Preparation (NOP) of an Environmental Impact Report (EIR) for the proposed Change Petition for water rights associated with the Eastwood/Odello property along the lower Carmel River. A portion of existing rights would be transferred to California American Water (Cal-Am) for use by the community, while a remainder portion will be dedicated for instream benefits. The MPWMD is responsible for integrated water resources management for the Monterey Peninsula; its boundaries include the lower Carmel River watershed and the Cal-Am service area.

This letter is written to advise you that the MPWMD Rules & Regulations (Rule 20, 21 and 22) require written District approval to amend an existing Water Distribution System (WDS). In this case, the District will serve as a Responsible Agency under the California Environmental Quality Act (CEQA) and rely on the certified EIR for this project.

The District concurs with the NOP (page 5) statement that dedications of Cal-Am water for use on subscriber projects within the Carmel River watershed or the City of Carmel-by-the-Sea will entail a new rule promulgated by MPWMD, similar to the current Rule 23.5. It is noted that Rule 23.5 also refers to required fees for an MPWMD Water Permit as specified in Rule 24 (fee based on proposed fixture units).

Thank you for your consideration. I can be reached at 831/658-5650 or dstoldt@mpwmd.net if you have questions.

Sincerely,

David J. Stoldt
General Manager

cc: Henrietta Stern, Project Manager
Larry Hampson, District Engineer

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State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

March 28, 2014

Katherine Mrowka
Division of Water Rights
State Water Resources Control Board
Post Office Box 2000
Sacramento, California 95812-2000
Fax (916) 341-5400
E-mail kathy.mrowka@waterboards.ca.gov

Subject: Notice of Preparation of a Draft Environmental Impact Report, SCH No. 2014031008, Eastwood/Odello Water Right Change Petition for License 13868 (Application 30497B), Carmel River, Carmel River Subterranean Stream, Monterey County

Dear Ms. Mrowka:

The California Department of Fish and Wildlife (Department) has reviewed the Notice of Preparation (NOP) for a Draft Environmental Impact Report (DEIR) on the Eastwood/Odello Water Right Change Petition (Project). The proposed Project is a change petition application seeking to split the existing License 13868 into two rights to appropriate water from the Carmel River.

The Clint Eastwood and Margaret Eastwood Trust (Licensees) are requesting authorization from the State Water Resources Control Board (State Water Board) to split the existing License 13868 into two licenses, which will be denominated as License 13868A and 13868B, and if issued would supersede License 13868. Currently, the maximum authorized annual diversion for License 13868 is 131.8 acre-feet per annum (afa). The licensees are requesting that 85.6 afa of this total amount be allocated under License 13868A and dedicated to municipal and irrigation uses. The proposed place of use for License 13868A would include the 99.0-acre authorized place of use in the existing license and would add 16,595 acres of California American Water Company's (Cal-Am's) service area in the Carmel River watershed and 526 acres of Cal-Am's service area within the City of Carmel-by-the-Sea. License 13868 currently authorizes the diversion of water from the Carmel River aquifer through two points of diversion (POD) for irrigation of adjacent agricultural lands. Three new POD along the Carmel River at existing Cal-Am operated wells would be added to License 13868A. The remaining 46.2 afa would be allocated to License 13868B and dedicated to instream use for fish and wildlife enhancement pursuant to Water Code Section 1707. The Project would not increase the maximum authorized annual diversion rate or the maximum authorized instantaneous diversion rate beyond the existing authorized rates in License 13868, though as described above, the place of use would be modified.

The proposed purpose of the Project is to seek authorization from the State Water Board for changes to License 13868 so that the Licensee may: 1) provide water to serve existing legal lots of record within the Carmel River watershed or City of Carmel-by-the-Sea, through new connections or increased uses of water at existing service addresses, 2) protect and enhance the Carmel River and associated environment by dedicating a portion of the existing water right to instream uses, and 3) provide a supplemental water supply to Cal-Am on an interim basis, to help Cal-Am meet its obligations under State Water Board Order WR 95-10.

On January 30, 2014, the Department provided the State Water Board with a letter of protest (Protest) to the change petition application (Application 30497B). The Department's right to protest is based on State Water Code Section 1703.1 and Section 1330; Title 23, California Code of Regulations (CCR), Section 843 and other provisions of law. The Department's main concern as stated in the Protest is summarized below, and the protest letter is included as Attachment 1.

<u>Summary of Protest</u>

The Department believes that the annual appropriation of up to 85.6 acre-feet of water for municipal use outside of the Carmel River watershed may result in direct and cumulative adverse impacts to fish and wildlife resources of the Carmel River. These impacts include reducing instream flows needed to maintain fish and wildlife habitat within and adjacent to the river. Previous and continued unpermitted water diversions from the Carmel River by Cal-Am have already resulted in substantially reduced flow in the river, changed the channel sediment regime, and reduced the groundwater (aquifer) table. These impacts substantially contributed to the near extirpation of the steelhead trout (*Oncorhynchus mykiss irideus*) run and eliminated large reaches of riparian habitat. The South-Central California Coast Steelhead (SCCCS) Distinct Population Segment (DPS) is a State Species of Special Concern (SSSC), listed as threatened under the Federal Endangered Species Act (FESA), and the Carmel River is designated by FESA as critical habitat for the SCCCS DPS. Additionally, impacts from water diversions may have affected other special status species dependent upon the Carmel River and its riparian corridor, including the SSSC and federally threatened California red-legged frog (*Rana draytonii*) and SSSC western pond turtle (*Emys marmorata*). Though not addressed in the Department's letter of protest, the federally endangered and SSSC tidewater goby (*Eucyclogobius newberryi*) may occur in the vicinity and be affected by water diversions from the Carmel River. The Department is concerned that the proposed change petition may result in additional direct and cumulative adverse impacts to these and other valuable fish and wildlife resources supported by the Carmel River and its associated riparian, wetland, and lagoon/estuary habitats.

In addition to the potential impacts to resources stated above, the Department believes that the changes requested in the petition violate the intent of State Water Board Order 95-10 and WR 2009-0060 as outlined below.

- Order WR 2009-0060
    - Conclusions section (page 56) states in part that "Monterey Peninsula Water Management District's (MPWMD's) water allocation program sets aside water for growth within the limits of the supply of water available within its jurisdiction. **MPWMD views water illegally diverted from the river by Cal-Am as available water supply for growth. Because water has been available for growth, the peninsula cities and their residents have had little incentive to support or pay for a project or projects to obtain a legal supply of water that can be substituted for the illegal diversions from the river**. In consideration of the foregoing, we conclude that **Cal-Am should be prohibited from further degrading conditions in the river by diverting water from the river for new service connections**, and that Cal-Am should be **required to reduce the amount of water being diverted from the river to serve existing service connections. In reaching this conclusion, we are particularly mindful that (a) the lower 6.5 miles of the Carmel River bed are dry for 5 to 6 months of each year, (b) the steelhead is a threatened species, (c) the river has been declared to be critical habitat for the steelhead...."**[1]

    - Condition #2 states "Cal-Am **shall not divert water from the Carmel River for new service connections or for any increased use of water at existing service addresses resulting from a change in zoning or use**. Cal-Am may supply water from the river for new service connections or for any increased use at existing service addresses resulting from a change in zoning or use after October 20, 2009, provided that any such service had obtained all necessary written approvals required for project construction and connection to Cal-Am's water system prior to that date."[1]

- June 7, 2013 Memorandum of Understanding (MOU) by and between Cal-Am and Eastwood (attachment to Petition)

[1] Emphasis added.

- Proposed Actions (page 2) states in part that "Eastwood proposes to use the Eastwood/Odello water right for the following uses: (1) for **use by Cal-Am on an interim basis to reduce deficits in Cal-Am's rights to divert Carmel River water supplies, consistent with term 2 on page 40 of Order WR 95-10;** (2) **for use** on existing lots of record within the Carmel River watershed or **the City of Carmel for new connections or increased uses of water at existing service addresses.**"[2]

- EXHIBIT A - Proposed Actions and Proposed Process…from Use of Eastwood/Odello Water Right (attachment to Petition)
  - Proposed Eastwood and Cal-Am Actions section states in part that, "The LLC will enter into **subscription agreements with owners of parcels in the part of Cal-Am's service area** that is within the Carmel River watershed or the City of Carmel. Under these agreements, **these parcel owners will receive contractual rights to use their parts of the LLC's water right for water supplies for new construction or remodels on existing lots of record.**"[2]

  - Proposed Water Supply Conveyance and Temporary Water Transfer Agreement section states in part that, "**Cal-Am will** divert and **use water under the unused portion of the LLC's water right License 13868A** each year for diversions from the Carmel River for **deliveries to Cal-Am's customers** in the Carmel River watershed or the City of Carmel. **These diversions and use will be part of Cal-Am's compliance with term 2 on page 40 of Order WR 95-10**, under which Cal-Am may contract with holders of appropriative rights to divert and use water from the Carmel River. **As the parcel owners that sign subscription agreements with the Eastwood LLC use more water under License 13868A, there will be corresponding reductions in the amount of water that will be available for use by Cal-Am under License 13868A.**"[2]

  - Proposed Process section states in part that, "Eastwood's change petition with the SWRCB will **ask the SWRCB to confirm that SWRCB Order WR 2009-0060** (as modified by Order WR 2010-0001) **does not prohibit Cal-Am from diverting and conveying water under the Eastwood LLC's water-right License 13868A to Eastwood's subscribers.**"[2]

Absent the "unused portion of the Licensee's water right License 13868A" that Cal-Am will temporarily use to offset their illegal diversions, which will eventually cease as

[2] Emphasis added.

"parcel owners that sign subscription agreements with the Eastwood LLC use more water under License 13868A," this Project does nothing to reduce the amount of water Cal-Am is illegally diverting from the Carmel River, as required by Order 95-10 and WR 2009-0060.

Additional NOP Comments

- Condition 2 of Order WR 2009-0060 prohibits Cal-Am from diverting water from the Carmel River for new service connections or for increased water use at existing service connections due to a change in zoning or use. Condition 2 of Order 95-10 requires that Cal-Am diligently obtain water from other sources of supply in addition to obtaining appropriative permits for water unlawfully diverted from the Carmel River and Subterranean River. The Department believes that the change petition authorizing Cal-Am to divert and convey water under License 13868A would amount to a violation of the intent of Orders 95-10 and WR 2009-60. The State Water Board may not approve a license that is in violation of an Order, and has to make findings consistent with their Orders. Therefore we recommend the State Water Board provide a rationale in the DEIR as to why the approval of the proposed change petition would not be in violation of any existing Order.

- The Draft License 13868B proposes to dedicate approximately 42 afa of water for instream use for the benefit of fish and wildlife resources pursuant to Water Code (WC) § 1707. The WC § 1701 states that a licensee may at any time after a notice of application is given change the point of diversion, place of use, or purpose of use from that specified in the application, permit, or license; but such change may be made only with the permission of the State Water Board. The Department is concerned that WC § 1707 does not otherwise obligate or commit the Licensee to dedicate the water to instream use in perpetuity. The NOP does not include an analysis of the probable environmental effects for License 13868B. The environmental effects for License 13868B should not be considered de minimus due to its purpose of use since the Licensee may apply to change the purpose of use at any time pursuant to WC § 1701. For the Draft License 13868B to have the intended environmental benefits, the State Water Board permit must include a condition that requires that the purpose of use be dedicated in perpetuity as instream use. Another potential option would be for the Licensee to sign a civil agreement with the Department dedicating in perpetuity the instream use amount for License 13868B.

- The DEIR should disclose the existing lots of record that may potentially enter into subscription agreements with the Licensee, and which lots are located outside of the Carmel River watershed. Environmental impacts related to construction or development of these lots should be analyzed in the DEIR. The Department is concerned that Project-related construction of undeveloped lots has the potential to result in additional impacts to biological resources, in areas inside and outside of the Carmel River watershed. In addition to the special status species mentioned previously, other special status species known to occur within the Carmel River watershed and the surrounding areas include: the federally and State threatened California tiger salamander (*Ambystoma californiense*); federally endangered Smith's blue butterfly (*Euphilotes enoptes smithi);* federally threatened and Rare Plant Rank (RPR) 1B.2 Gowen cypress (*Hesperocyparis goveniana*); federally and State endangered and RPR 1B.1 Tidestrom's lupine (*Lupinus tidestromii*); State endangered seaside bird's-beak (*Cordylanthus rigidus* ssp. *littoralis);* federally and State endangered coastal dunes milk vetch (*Astragalus tener* var. *titi*); federally and State endangered Menzies' wallflower (*Erysimum menziesii*); federally and State endangered Hickman's cinquefoil (*Potentilla hickmanii*); federally and State endangered Monterey clover (*Trifolium trichocalyx*); federally endangered and State threatened Monterey gilia (*Gilia tenuiflora* ssp. *arenaria*); federally and State endangered beach layia (*Layia carnosa*); State rare and RPR 1B.1 Pacific Grove clover (*Trifolium polyodon*); federally endangered Yadon's rein orchid (*Piperia yadonii*); RPR 1B.1 Eastwood's goldenbush (*Ericameria fasciculata*); RPR 1B.2 marsh microseris (*Microseris paludosa*); RPR 1B.2 Hooker's manzanita (*Arctostaphylos hookeri* ssp. *hookeri*); RPR 1B.2 Carmel Valley bush-mallow (*Malacothamnus palmeri* var. *involucratus*); RPR 1B.2 sandmat manzanita (*Arctostaphylos pumila*); RPR 1B.2 Jolon clarkia (*Clarkia jolonensis*); RPR 1B.2 Hutchinson's larkspur (*Delphinium hutchinsoniae*); RPR 1B.1 Kellogg's horkelia (*Horkelia cuneata* var. *sericea*); RPR 1B.2 Monterey cypress (*Hesperocyparis macrocarpa*); RPR 1B.1 Monterey pine (*Pinus radiata*); RPR 1B.2 Santa Lucia bush-mallow (*Malacothamnus palmeri* var. *palmeri*); RPR 1B.3 Pinnacles buckwheat (*Eriogonum nortonii*); RPR 1B.2 Hospital Canyon larkspur (*Delphinium californicum* ssp. *interius*); RPR 1B.2 pine rose (*Rosa pinetorum*); RPR 1B.1 pink Johnny-nip (*Castilleja ambigua* var. *insalutata*); RPR 1B.2 fragrant fritillary (*Fritillaria liliacea*); and RPR 1B.2 Hickman's onion (*Allium hickmanii*).

- The Department recommends that focused biological surveys be conducted at the appropriate times of year and by qualified biologists/botanists to determine what sensitive species are potentially occurring on these lots well in advance of any ground-disturbing activities. This information is necessary to identify any appropriate species-specific avoidance, minimization, and mitigation measures necessary to reduce potential impacts to special status biological resources to less than significant and subsequently include these measures in the California Environmental Quality Act (CEQA) document as enforceable conditions of approval for this Project.

- Permit 20905 was issued to Clint and Margaret Eastwood on March 5, 1997, which authorized diversion of a maximum of 195.9 afa over 134 acres. That permit was subsequently split between the Eastwoods and the Big Sur Land Trust (BSLT), with Permit 20905A issued to the BSLT for a maximum amount of 28.14 afa over 49.1 acres of land; and Permit 20905B issued to Clint and Margaret Eastwood for a maximum of 167.76 afa over 54.9 acres. The Eastwoods subsequently were issued License 13868, for a maximum of 131.8 afa to be utilized over 99-acre Place of Use (POU). It is not clear, given the history of this water right, how the 99 acres in License 13868 (and proposed for License 13868A) relates to the 54.9 acres POU identified in Permit 20905B.

- The 134-acre Odello parcel has had a complicated history after purchase by the Eastwoods, including the donation of lands to the BSLT (and potentially the County of Monterey), At the time of the original water right application in 1995, the application was portrayed by the applicant as a way to establish value for tax purposes to support a donation. The value of donated land and water was further complicated by the transfer of development rights from the original Odello property to the Cañada Woods East development; and potentially by the purchase or trade of lands which became the Cañada Woods East development after transfer to the Eastwoods (the so-called Cusack lands, approximately 400 acres which had been owned by the BSLT and under conservation easement to the benefit of the County of Monterey). Please identify what mechanism was utilized to retire any water right which was identified as a donation, so that any water which was reported as "donated" would not be subsequently reauthorized for use by way of any subsequent application.

Department Jurisdiction

Trustee Agency Authority: The Department is a Trustee Agency with responsibility under CEQA for commenting on projects that could impact plant and wildlife resources. Pursuant to Fish and Game Code Section 1802, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of those species. As a Trustee Agency for fish and wildlife resources, the Department is responsible for providing, as available, biological expertise to review and comment upon environmental documents and impacts arising from project activities, as those terms are used under CEQA (Division 13 [commencing with Section 21000] of the Public Resources Code).

Responsible Agency Authority: The Department has regulatory authority over projects that could result in the "take" of any species listed by the State as threatened or endangered, pursuant to Fish and Game Code Section 2081. If the Project could result in the "take" of any species listed as threatened or endangered under the California Endangered Species Act (CESA), the Department may need to issue an Incidental Take Permit (ITP) for the Project. CEQA requires a Mandatory Finding of Significance if a project is likely to substantially impact threatened or endangered species (sections 21001{c}, 21083, Guidelines sections 15380, 15064, 15065). Impacts must be avoided or mitigated to less than significant levels unless the CEQA Lead Agency makes and supports a Statement of Overriding Consideration (SOC). The CEQA Lead Agency's SOC does not eliminate the project proponent's obligation to comply with Fish and Game Code Section 2080.

The Department also has regulatory authority with regard to activities occurring in streams and/or lakes along with riparian habitat associated with and supported by watercourses, that could adversely affect any fish or wildlife resource, pursuant to Fish and Game Code sections 1600 *et seq*. If a Project could substantially divert or obstruct the natural flow of any river, stream or lake; substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake; or deposit or dispose of debris, waste, sediment, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake, notification of Lake or Streambed Alteration to the Department is required. Acquisition of a Lake and Streambed Alteration Agreement (LSAA) for the Project would be required, and we recommend that the Project proponents consult with the Department well in advance of Project implementation. The Department recommends that the Environmental Impact Report (EIR) inform Project proponents of this responsibility. It is important to note that the Department is required to comply with CEQA in the issuance or the renewal of an LSAA. For this particular Project, the Department would be acting as a Responsible Agency and would need to rely upon the EIR prepared for the Project. For additional information on notification requirements, please contact our staff in the Lake and Streambed Alteration Program at (559) 243-4593.

Bird Protection: The Department has jurisdiction over actions which may result in the disturbance or destruction of active nest sites or the unauthorized "take" of birds. Fish and Game Code sections that protect birds, their eggs and nests include, sections 3503 (regarding unlawful "take," possession or needless destruction of the nest or eggs of any bird), 3503.5 (regarding the "take," possession or destruction of any birds-of-prey or their nests or eggs), and 3513 (regarding unlawful "take" of any migratory nongame bird). In the event that Project-related vegetation removal will occur, it is advised that appropriate avoidance and minimization measures for raptors and other nesting birds potentially present in the Project site vicinity be addressed in the EIR.

Federally Listed Species: The Department also recommends consulting with the United States Fish and Wildlife Service (USFWS) on potential impacts to federally listed species including, but not limited to California red-legged frog, and California tiger salamander. Similarly, for potential effects to SCCC DPS and its critical habitat, the Department recommends consultation with the National Marine Fisheries Service (NMFS). "Take" under FESA is more broadly defined than CESA; "take" under FESA also includes significant habitat modification or degradation that could result in death or injury to a listed species by interfering with essential behavioral patterns such as breeding, foraging, or nesting. Consultation with the USFWS and NMFS in order to comply with FESA is advised well in advance of Project implementation.

Depending upon the information provided in the DEIR, the Department may have additional comments and recommendations regarding potential Project-related impacts and avoidance, minimization, and mitigation measures. If you have any questions regarding this protest, please contact Annette Tenneboe, Senior Environmental Scientist (Specialist), at (559) 243-4014 extension 231; annette.tenneboe@wildlife.ca.gov, or by writing to the California Department of Fish and Wildlife at 1234 East Shaw Avenue, Fresno, California 93710.

Sincerely,

Jeffrey R. Single, Ph.D.
Regional Manager
California Department of Fish and Wildlife, Central Region

Attachment

cc: See Page Ten

cc: Jacqueline Pearson Meyer
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California Department of Fish and Wildlife

April 2, 2014

Roy L. Thomas, DDS
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Carmel, CA 93923
831 625-2255

Katherine Mrowka
State Water Resources Control Board
Division of Water Rights
P.O. Box 2000
Sacramento, CA 95812-2000

Re: Eastwood/Odello Water Right Change Petition

Dear Ms. Mrowka;

I would like to at first protest the fact that I never received the NPO, therefore I have very little time to respond.

It is very important to understand the current conditions on the lower Carmel River. They are nothing like what was described by the Balanced Hydrologics report or the reference of Kondolf and Curry 1986. The section below Schulte Road Bridge has more spawning gravel than anywhere below Los Padres Dam. It has pools, riffles and riparian vegetation. It produces more and bigger young steelhead per foot than the upper river as long as it has flow.

In the last two seasons more than 90 steelhead redds have been documented in this reach. This represents 180 spawning fish. Even at very low flows that happen most every year, tens of thousands of young of the year steelhead migrate to the lagoon often at flows of .1cfs. These migrations occur mostly at night (we have videos). It is critical to understand that the environmental conditions on the Carmel cannot be evaluated with average flows. It is a Mediterranean drought flood river. In many years like the last three, this project as described would have negative effects on not only young of the year and smolts, but also on adults who come in when the lagoon spills at flow of 40 cfs or less. There are critical riffles that have to be passed that cannot be considered passable at less than 125 cfs.

The data provided by Balanced Hydrologics underplay the effects of the new Eastwood diversions by assuming a constant rate over all wells and not addressing the fact that instead of the .16 cfs reduction at each well, the net effect is .39 cfs after the lowest well. The wells often are not operated at a constant rate. They tend to be operated at night to save on PG&E.

Also, it is a requirement that the lowest wells are operated until they cannot meet demand. This means at least some of the time the Eastwood water comes all from one well.

They describe zero flows will increase by 2% in dry time and somehow 2% is not significant. They describe a draw down of .25 feet at each well that add up to .75 feet that is taken out of surface flow or .93 feet after 100 days of pumping. Who is to know how much of the Eastwood water is pumped at any one time? The use of FEMA data and aerial views of wet or dry river conditions offer little to the understanding of how easy it is to lose 1 to .1 cfs that are necessary to pass young of year to the lagoon.

The conclusion, “no impact to inflows to the lagoon would result”, is just not true during the low flows of the spring and early summer.

The riparian section describes a draw down of “less than 1 foot over a 7 day period or seasonable draw down of 4 feet.” This is significant in dry years and delays flow to the lagoon in fall. The report states, “It is possible that the proposed project could trigger irrigation slightly sooner than under existing conditions if the additional project draw down results in exceedance of an irrigation threshold that would not otherwise have been crossed.” If the project was done this year or in the 1976 – 1977 drought there would be greater than a 4 foot draw-down.

The 46.2 cfs “Dedicated to in stream uses”, has virtually no environmental use if as planned, it is left 50 feet underground. It would be much more useful to the fish and wildlife if it were pumped into the river channel near the lagoon. Then it could be added to the CRSA Well Water Enhancement Project which is planned to provide a cool fresh water refugia for fish and wildlife. It will provide an escape from the destruction of lagoon habitat caused by large waves overtopping the sandbar and filling the lagoon with salt water and seaweed. The saltwater and decaying seaweed can destroy all oxygen and kill every aquatic creature that needs fresh water or oxygen.

The river substrate and habitat has changed greatly since the studies and reports used in Balanced Hydrologics’ document. The reach below Schulte Road Bridge used to be mainly sand, now it has most of the river’s spawning gravel. The gravel reaches down to the lagoon. The CRSA has documented 41 redds in 2012 and 51 redds in 2013. This demonstrates a very large concentration of steelhead spawning in this lower reach. This is the case because there is very little usable spawning gravel above Schulte Bridge to San Clemente Dam. The same is the case between Los Padres and San Clemente. There are also at least two critical riffles that have poor, to no fish passage below 125 cfs. One is at the near Carmel Gauge; the other is at the upper bend above upper most Golf Cart Bridge at Rancho Canada.

Contrary to Balanced Hydrologics' report, there is very good habitat from Schulte Bridge to the lagoon. There are deep pools and runs with lots of gravel and riparian vegetation. All that is missing is water. As the river is pumped dry, fish rescuers find by far, more fish and larger fish than are found in the river above Schulte Bridge. Many thousands of small steelhead migrate to the lagoon as the river is pumped down.

The data from CRSA and the MPWMD shows the vast majority of the rescued steelhead comes from the river below Schulte Road. Fisheries biologist, Dave Ditmar, has reported that the average size of rescued fish is larger from the lower river reaches. Valuable rearing habitat is abundant in the lower river as long as it has flowing water. A local, Bob Zampatti, reports that before all the Cal-Am wells went in, even in the driest years, there were pools in the lower river that supported steelhead all summer. Flows of less than1 cfs, along with subsurface percolation can support pools with hold over juvenile steelhead and occasional adult.

The project needs to be evaluated using a much closer examination of critical stream flow in the lower river for the use of young of the year (YOY) steelhead. It is extremely important in all years that these fish make it to the lagoon. YOY can and do migrate into the lagoon in large numbers as long as there are fractions of a cubic foot of flow and connectivity to the lagoon. These fish migrate mostly at night and make the run as the flow drops below 1 cfs and the temperature begins to rapidly rise.

The water flows 3 cfs to the final loss of connectivity to the lagoon needs to be analyzed against the effects of the project. The timing and the rate of river flow loss varies with weather and all pumping activity. I believe that in every year that the connection to the lagoon is finally broken the project will have some roll or effect.

I am including an attachment of, "The Natural Control of Salmon and Trout Population in Streams", N.J. Milner J.M. Elliott. This paper expands on the importance of the early life stages YOY that are important to the survival of the Carmel River Steelhead.

Sincerely,
Roy L. Thomas, DDS

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The natural control of salmon and trout populations in streams

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Abstract

This paper reviews current understanding of factors controlling salmonid populations in streams and how this contributes to better fisheries management. Salmonid populations are regulated by density-dependent mortality, typically during the early stages of free-living life after fry emerge from spawning gravels. After the early regulatory phase, mortality is controlled mainly by density-independent factors. The relative contributions of density-dependent and density-independent factors to population variability are outlined, noting the special importance of environmental impacts such as flow and temperature extremes. Stock–recruitment relationships are discussed, with an emphasis on understanding the uncertainties and risks inherent in modelling wild populations. Key subjects for future research are identified. The challenge for science in the future lies in two areas: first, incorporating uncertainties into population modelling and management decision making, and second improving the understanding of processes regulating populations through long term studies.

Keywords: Population dynamics; *Salmo trutta*; *Salmo salar*; Density-dependence; Density-independence; Stock–recruitment; Variation; Management

1. Introduction

Fish populations are subject to natural control processes that continually modify and adjust the structure and abundance of populations and their life cycles in response to a wide range of factors. This paper discusses population dynamics of the Atlantic salmon (*Salmo salar* L.) and the migratory (sea trout) and non-migratory (brown trout) forms of trout (*S. trutta* L.).

Effective fisheries management is dependent upon, among other things, knowledge of how fish populations are regulated naturally and thus how they might respond to management intervention. Most salmonid populations are naturally highly variable, with respect to their abundance and life history features, both within populations over time and between populations. This can cause difficulties for managers because it introduces uncertainties into stock assessment and into the prediction of management outcomes. An understanding of population dynamics can show why these uncertainties arise, how to quantify them, and how to optimise management decisions.

The spatial and temporal variability of populations operate within constraints imposed by the environment and genetic predisposition of the fish, but within these limits there is often considerable flexibility. For example, in migratory salmonids, changes in growing conditions in fresh water are thought to influence smolt

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age and size, and thus survival at sea, resulting in complex, interrelated adjustments throughout the life cycle. Genetic adaptation to local stream conditions also exerts its effect by modifying the processes expressed through population dynamics.

Population dynamics is a wide subject and here we concentrate on those aspects that are particularly pertinent to management, namely processes regulating abundance, especially the compensatory mechanisms; stock–recruitment relationships; population variability, and the interdependence of traits such as growth, survival and maturation. We generalise across salmon and trout wherever possible, but note the species distinctions where they are known to be significant and take examples from other species where they are appropriate.

2. Populations, management units and sampling

Populations are usually defined as biological units that are reproductively discrete, but their dynamics have been studied at widely ranging scales from local sites (<10 m stream lengths) up to whole catchments (generally <500 km). As more is learnt about homing and genetics of salmonids, the points at which populations start and finish become more difficult to define, but also more critical as the evolutionary significance of sub-structuring within rivers becomes clearer (Youngson et al., 2003).

For economic, legal and practical reasons, fisheries management is usually applied to *stocks*, being groupings of populations that are regarded as having broadly similar biology and genetics, and experience similar environmental conditions and exploitation regimes, to which they display broadly similar responses. Distinctions have been made between evolutionarily significant units (ESUs) and operationally significant units (OSUs) (Dodson et al., 1998). ESUs are considered to be the appropriate unit to ensure biological conservation, but the OSU has been the conventional grouping for practical management, synonymous with stock here. This scale issue is important, because survival traits and other adaptive features of life cycles that influence the dynamics of each population (ESU) may not be measurable or applicable at an OSU scale. Therefore, without care, management choices could be sub-optimal for some ESUs. In the following account the terms stock and population will be freely interchanged, and a distinction made only where it is necessary to clarify meaning.

The practical issues of sampling efficiency and survey design are important in understanding sources of variation in populations. The abundance of fish in a stream section is the net effect of births, deaths, immigration, and emigration. Typically, numbers decrease with age in the total population, but in a short stream section, where local habitat may favour a particular life stage of fish, the age structure is often unbalanced, with perhaps more 1- or 2-year olds present than younger fish. Consequently, adjacent stream sections may have very different salmonid population structures, depending on the habitat they offer. In practice, the information on stream populations usually comes from sampling comparatively short sections (e.g., 50–100 m), each containing a biased sample of the total population. Age structure may also vary between years as random events alter recruitment and survival. This combined with the varying efficiency of sampling in different habitat types, increases variability and attendant uncertainty in population data.

For migratory species, total counts of inputs (spawners) and outputs (smolts) from streams can be made using traps or counters. In theory these could be made without sampling error, but in practice measurement errors always arise. The total counting option is desirable, but it is expensive and not often available. Moreover, on its own, it does not help in understanding processes within streams. To properly understand population dynamics, a combination of whole catchment and local site sampling is required, over many years. This has rarely been achieved (e.g., Elliott, 1993a) and is a long-standing research need.

3. Life cycles of salmonids

Salmon and trout have life cycles that are comparatively complex and highly variable between populations (Elliott, 1994; Hutchings and Jones, 1998; Jonsson, 1985, 1989). The anadromous forms migrate between a freshwater reproductive and juvenile phase, typically in the upper reaches of rivers, and a growth phase, typically in the larger habitats of lower rivers, lakes or the sea.

The eggs are laid in redds in gravel in the autumn and winter and hatch in early spring. The alevins remain in the gravel for a short period, feeding on their yolk sacs, then emerge as fry to begin feeding on drifting invertebrates. The early post-emergence phase is a crucial one in which fry develop the swimming behaviour to maintain position and feed in flowing water and during which dispersion from the redds occurs. This phase is typified by aggressive, territorial behaviour and high mortality rates that regulate population size (Kalleberg, 1958; Le Cren, 1973; Elliott, 1994; Heland, 1999). The surviving parr spend between 1 and 3 (usually 2) years in streams in Britain, but longer (up to 7 years) in colder regions such as Scandinavia and Canada (Gibson, 1993). Finally, they undergo physiological changes that pre-adapt them to life in the sea and migrate as smolts in April–May. Smolts move in large numbers and are particularly vulnerable to predation in fresh water, estuaries and at sea (Feltham, 1990; Hvidsten and Møkkelgjerd, 1987; Kennedy and Greer, 1988). Both salmon and trout exhibit a wide range in life history strategies, expressed through, for example, different age-at-maturation and migration patterns. Although European Atlantic salmon are typically anadromous, there are examples of landlocked races (e.g., Berg, 1985). Trout in particular are highly variable in their degree of migratory habit, exhibiting a continuum from merely local spring redistribution (<100 m) within small streams (Milner et al., 1979), through to migrations into lakes, estuaries and sea feeding grounds (Jonsson, 1985; Northcote, 1992; Elliott, 1994; Baglinière and Maisse, 1999).

At sea, most European Atlantic salmon post-smolts make long migrations to feeding grounds off the Faroes or West Greenland (Hansen and Quinn, 1998) before maturing and returning to natal rivers after 1–4 years. For both species, growth is rapid in the marine phase, dependent upon sea-feeding. Sea trout exhibit considerable geographical variation in marine growth and pattern of maturation and return, that may be due partly to differences in coastal sea-feeding conditions (Fahy, 1978; Solomon, 1995), but may also be adaptations to particular river structures. In both species there is sex-selective migration with, in general, more females than males migrating to sea or lakes. Residency is often associated with early male maturation (Gibson, 1993; Jonsson, 1989) and can occur in a high proportion of the males in some sea trout populations (Campbell, 1977). Maturing male parr form a significant part of the breeding population in some salmon stocks and represent one of two distinct reproductive tactics (the other being the production of anadromous males that compete aggressively for mates). Fleming (1996) has reviewed the evolutionary origins and implications of these strategies. Sex-linked migration is thought to provide an opportunity to increase fecundity and egg size, which are strongly, positively correlated with female size (Pope et al., 1961; Elliott, 1995; Fleming, 1996). The mechanisms behind trade-offs between life history traits and the interrelationships between genotypic and phenotypic variation are attracting more attention which will improve understanding of salmonid life history variation (Stearns, 1992; Fleming, 1996).

Homing to natal rivers is particularly strong in salmon (Stabell, 1984), maintaining reproductive isolation, with its implications for local genetic adaptation (Youngson et al., 2003). Sea trout make less extensive migrations, mainly confined to coastal waters, and tagging studies suggest that, like salmon, homing specificity is high (Sambrook, 1983; Le Cren, 1985; Solomon, 1995).

In summary, the generalised salmonid life cycle is capable of adaptation to a wide range of environmental conditions, but with a complex and still poorly understood interaction between environmental and genetic factors. It can involve extensive migrations, and thus exposure to many types of environmental influences from oceanic climate change to impacts of local land use. The migratory habit, seen to various degrees across most trout and salmon populations, leads to a spatial separation between a regulatory phase, mostly in the early juvenile stages in nursery areas, and a growth phase (benefiting egg production) in the larger habitats occupied by pre-adults.

4. Population regulation

4.1. Basic principles of stock and recruitment

Given the territorial nature of juvenile salmonids and their requirement for food, there is clearly a limit to the number of fish that any stream can support. At low spawning densities, because competition is limited, reproduction is efficient and the number of juveniles produced is closely proportional to the spawning level. As spawning numbers increase so does competition amongst the young fry, and density-dependent factors serve to restrict the population as the carrying capacity is approached (Fig. 1a). Carrying capacity varies dependent upon species, age of fish, nature of the habitat, food availability and time of year (see Armstrong et al., 2003, for a detailed discussion). An example of a stock–recruitment curve from the River Bush in Northern Ireland is shown in Fig. 1b. This is based upon repeated annual measurement of the number of salmon smolts (recruits) emigrating from the river and the number of adults (expressed here as equivalent egg deposition) that produced them. The two curvilinear relationships between stock and recruitment in Fig. 1b are based upon the same data, but are calculated using different mathematical models. Survival rate (between eggs and older stages) does not suddenly change, as implied diagrammatically in Fig. 1a. It is usually found to decrease with increasing spawner density, changing most rapidly as the carrying capacity is approached (Fig. 1c). The term "recruits" can apply to any stage in the life cycle, such as the adult progeny of a year class just before they become vulnerable to a fishery, or to adult spawners returning to their natal stream. In migratory salmonid studies, consideration of parr or smolts as recruits is a convenience, because it marks the end of a distinct biological phase. It also has management significance, because it signals the production of the fresh water phase and is the last chance to measure the size of a year class until adults return from the sea 1–3 years later.

4.2. Factors influencing abundance

Abundance of stream-dwelling salmonids is influenced by two broad categories of process. First, density-dependent feedback mechanisms, such as territorial competition or limited food availability, can be said to truly *regulate* abundance. Secondly, density-independent processes (such as climate), which act unpredictably to *determine* abundance and, because they can have large effects on survival, may obscure the underlying density-dependent processes. Much of population dynamics is concerned with distinguishing between these processes, understanding

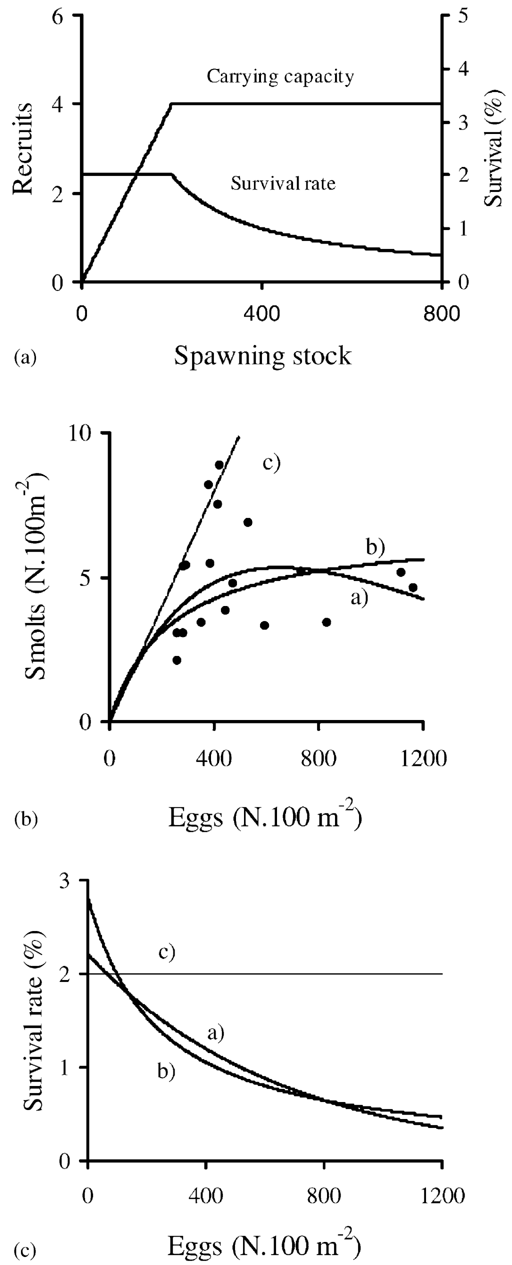


Fig. 1. (a) Diagrammatic representation of recruitment constrained by carrying capacity, showing survival rate (% egg to recruit) changing with spawning stock. (b) Stock-recruit curves for salmon from the River Bush (northern Ireland (adapted from Kennedy and Crozier, 1993), showing (a) dome-shaped (Ricker) and (b) asymptotic (Beverton and Holt) relationships. Line (c) shows directly proportionate survival (egg to smolt) at an arbitrary 2%. (c) Survival rates (%) between egg and smolt stages for the stock–recruitment relationships shown in figure (b).

their effects and assessing their relative contributions to population variation.

4.3. Density-dependent effects on abundance

Density-dependent mortality is a prerequisite for persistent populations that are apparently stable and by implication regulated (Elliott, 2001). Population regulation implies that the relationship between spawning stock and recruits is not random or simply proportionate. The stock–recruitment (S–R) relationship expresses the form that regulation takes in a population. However, it is notoriously difficult to collect the data required to elucidate S–R relationships, because it is necessary to measure populations over many generations or across many experimental populations, with appropriate variation in spawning stock size. This requires long-term programmes and sometimes elaborate facilities which are hard to fund. Moreover, in the field situation, there are practical problems, such as coping with long-term environmental changes that, by influencing survival or growth rates, for example may alter the relationship between spawners and recruits during the period of observations. Hilborn and Walters (1992) have reviewed the issues underlying this so-called non-stationarity.

Density-dependent processes can be positive or negative, i.e., the probability of individual survival increases or decreases with density. Positive density-dependence occurs with some forms of fishing pressure and predation, in which high density, possibly accompanied by shoaling behaviour, reduces the chances of individual deaths (Solomon, 1982; Hansen and Jonsson, 1985; Hvidsten and Johnsen, 1993). Negative density-dependence is more common and arises from the classic negative feedback mechanisms that regulate abundance, such as territorial competition for food and space, disease and parasitism. A further distinction should be made between internal density-dependent factors such as spawner abundance, density of each cohort of fish and external density-dependent factors such as the density of other cohorts of the same or different species, incidence of predators, disease or parasites. Habitat availability and quality is in a special category, being a resource that, by limiting carrying capacity, stimulates density-dependence to operate.

Factors may change from positive to negative depending on stock density. For example, increasing spawner density at very low levels may be a positive factor, increasing the chance of finding a mate; whereas at higher densities behavioural interference between spawners or over-cutting of redds may lead to negative density-dependence (Solomon, 1985).

The evidence for density-dependent regulation of abundance in the salmonid life cycle is overwhelming and governs the general form of stock–recruitment relationships for salmon (Gibson, 1993) and trout (Elliott, 1994). However, the point at which it begins to operate, its intensity and thus the precise form of the stock–recruitment relationship is less clear.

4.4. Timing of density-dependent mortality

Density-dependent mortality only operates for comparatively short periods of the life cycle, during critical stages, when regulation is achieved by competition for limited resources. In a long-term study on sea trout, Elliott (1993a) showed that regulation of population size was achieved through density-dependent mortality operating over a short critical period (30–70 days) when the fry dispersed from the spawning gravels. Thereafter, survival was shown to be proportionate, influenced by density-independent factors. The detailed studies of Elliott have not been carried out for salmon, so the precise timing of any critical phase is not known. However a similar type of analysis on a Norwegian salmon population showed that density-dependent regulation operated in the early life of salmon too, sometime between the egg and smolt stages (Jonsson et al., 1998). Other studies have also demonstrated density-dependent regulation in salmon early in fresh water life, although it may be sustained for longer than trout, at least through the first summer (Gee et al., 1978; Egglishaw and Shackley, 1977; Gardiner and Shackley, 1991). Thereafter, up to the smolt stage, survival has generally been found to be density-independent in salmon (Gee et al., 1978; Whalen et al., 2000). Competition between year classes has also been reported, but the evidence for it is conflicting and it has been proposed that, in most natural situations, the niche separation of different fish sizes and species is enough to keep inter-year class and inter-specific competition at low levels (see review by Gibson, 1993). However, it is difficult to distinguish between volitional niche preferences and active segregation due to competition. There is evidence that inter-specific competition can occur between salmon and trout, with the latter generally out-competing salmon (Kennedy and Strange, 1986); but whilst there is overlap, the two species display adaptations to different preferred habitats (Armstrong et al., 2003; Bremset and Heggenes, 2000).

All the cases above show that the main density-dependent regulating processes act during the fresh water, mostly very early, juvenile phase. However, Elliott and Hurley (1998) have demonstrated regulation in the adult phase (female spawners), rather than the juvenile phase of a non-migrant brown trout population. This may have been a consequence of the harsh upland environment and low population densities that prevailed in this particular situation.

Studying population dynamics in the sea is practically difficult, but observations on salmon returning to the River Imsa, Norway, show that marine survival is density-independent (Jonsson et al., 1998). Similarly, for sea trout, Elliott (1993c) has shown that numbers of returning females were directly proportional to the numbers of smolt emigrants. This lack of observable density-dependence may be a consequence of the large scale of marine habitat in comparison with the limiting rearing capacity in fresh water. More research is required on marine population dynamics to establish when, where and how mortality occurs (Potter and Crozier, 2000).

4.5. Density-independent factors affecting survival

Density-independent factors include a wide range of variables that cause sometimes extensive, but unpredictable, mortality at any stage in the life cycle and at any density.

Examples include the impact of siltation that, by impairing water flow through gravels, reduces oxygen delivery and causes mortality of incubating eggs. Although much of the work relates to North American salmonid species (e.g., Chapman and McLeod, 1987), the principle applies equally to Atlantic salmon (Scott and Beaumont, 1994) and brown trout (Acornley and Sear, 1999). Other water quality parameters such as acidity (Lacroix, 1985; Milner and Varallo, 1988; Turnpenny et al., 1988) or pesticides (Alabaster, 1969; Moore and Waring, 1998; Fairchild et al., 1999) also cause proportionate, density-independent mortality through direct toxicity or secondary responses brought about by reduced physiological tolerance. Impacts caused by extremes of flow are particularly important. Droughts and high temperatures were believed to be responsible for low survival in sea trout in Black Brows Beck that otherwise were controlled mainly by density-dependent mortality (Elliott et al., 1997). In contrast, Jensen and Johnsen (1999) reported low survival in trout resulting from low temperatures and high discharges acting during the alevin stage. Egg washout at high flows and desiccation at low flows have been reported (Milner et al., 1981; Crisp et al., 1984). Impacts from density-independent factors acting in fresh water may reveal themselves later in terms of maturation rates, smolt numbers, smolt size and marine survival (e.g., Whalen et al., 2000; Elliott, 1993c; Nicieza and Braña, 1993; Power and Power, 1994; Salminen, 1997). Such effects are likely to be increasingly important if, as predicted, climate change leads to greater extremes and variability of temperature, rainfall and flow regimes (McKenzie Hedger et al., 2000; Dempson et al., 2001).

Carrying capacity, as determined by habitat features (Armstrong et al., 2003), is independent of density, but creates a bottleneck, typically for space and food, that increases competition, thus leading to density-dependent effects. Key stages where such bottlenecks have been demonstrated are the early post-emergent fry stage, and at spawning when limited availability of spawning gravel can cause density-dependent regulation of breeding female trout numbers (Elliott and Hurley, 1998). For long periods of life, the density of stream-dwelling salmonids may be below the limiting carrying capacity appropriate to their life stage, having been controlled by an earlier limiting bottleneck.

The response of a population to density-dependent or independent factors is influenced by the fitness of individual fish. This in turn is influenced by their genetic makeup and so genotype is a crucially important density-independent variable (Youngson et al., 2003).

4.6. Self-thinning

At any given temperature, the resources needed by individual juvenile trout or salmon increase as they grow. Therefore, assuming that the total availability of space and food is constant, the number of fish in a given area can be expected to decrease as the mean weight increases, due to competition for limiting resources. This process is termed “self-thinning”. On theoretical grounds, the gradient of the thinning slope (log number of fish against log mean weight) might be expected to vary, depending on whether food (energy) or space is limiting (Grant and Kramer, 1990; Grant, 1993). If the total available energy limits production and is constant, then self-thinning may be a special case of the energy equivalence hypothesis. This proposes that the total energy demand of a population filling a habitat to carrying capacity is constant, whether the population comprises many small or few large individuals.

There is compelling evidence for an inverse relationship between numbers and weights of salmonid fishes. Grant and Kramer (1990) showed that many populations of salmonids appeared to thin at gradients consistent with space being the factor that limited carrying capacity. Other studies suggested that populations of salmon and trout may self-thin at gradients consistent with the energy equivalence hypothesis (Bohlin et al., 1994; Elliott, 1993b). More recent work (Steingrímsson and Grant, 1999) showed that food and space limitations may in fact generate similar thinning gradients and moreover, because food supply changes with time, thinning gradients are plastic and can be expected to deviate from the energy equivalence hypothesis.

A reduction in numbers as fish grow is not itself an indication of self-thinning because mortality can be expected with time due to density-independent factors. A between-population comparison that suggests adherence to the energy equivalence hypothesis indicates that self-thinning may have occurred at some time previously (during a bottleneck) but cannot be used to infer that it is a continuous process (Armstrong, 1997). Furthermore, evidence shows that consistency between predicted thinning gradients and observed changes in weight and numbers can be coincidental and not a result of sustained density-dependent processes (Armstrong, 1997). Because of the potential variability in thinning gradients, depending on temporal variation in food availability, it may be difficult to assess whether populations are at their carrying capacity by measuring gradients of change in mean weight and density over time. Further variation in thinning gradients would be expected as the suitability of habitat varies with the size of the fish (Steingrímsson and Grant, 1999; Armstrong et al., 2003). Self-thinning is an interesting process that no doubt occurs when salmonid fish are growing through bottlenecks (Elliott, 1990).

4.7. Some issues with stock–recruitment relationships

Stock–recruitment curves (Fig. 1b) describe how a population, or a stock comprising several populations, will respond to variation in spawner density, brought about for example fishing controls, habitat management or environmental factors affecting survival. However, there are several contentious issues surrounding their derivation and use.

The stock–recruitment curve may vary in shape according to the type of model fitted. The commonest choice is between a dome-shaped curve (Ricker, 1954) and an asymptotic one (Beverton and Holt, 1957) (Fig. 1b). These are both two-parameter models and with others, such as the three-parameter Shepherd model (Shepherd, 1982), provide for a wide family of curves ranging from continually ascending to sharply domed. The distinction is important, theoretically and for practical management, because the dome shape implies some optimum level of spawning; whereas an asymptote indicates that increasing spawners will also reduce survival, but not to the extent that absolute recruit numbers decrease. Depending on which model is applied, the management strategy might be different (Potter et al., 2003). It is important that the data are used to test for the most appropriate model (Elliott, 1985; Jonsson et al., 1998). It is also important, when fitting mathematical models, not to lose sight of the ecological processes controlling abundance; these are complex and may involve redistribution of fish in response to habitat availability, in addition to mortality.

The scale at which they are derived may influence the forms of these curves. A whole river stock–recruitment curve can be thought of as a weighted mean curve comprising many others typical of the representative stream types prevailing in the catchment (Wyatt and Barnard, 1997a,b). There is some pattern emerging for migratory salmonids in which studies at small scale (e.g., <50 m stream lengths) tend to produce dome-shaped, but rarely flat-topped curves (Elliott, 1994; Gee et al., 1978; Gardiner and Shackley, 1991). In contrast, those derived at whole tributary or river scale may produce either flat-topped or gently rising curves (Buck and Hay, 1984; Ward and Slaney, 1993; Jonsson et al., 1998). If this is shown to be a real effect, it could be because at a small scale there are genuine functional relationships between individuals and between fish and their immediate habitat. When stock–recruitment curves are based on counts for whole rivers, the dilution of spawners spread out over a widely ranging habitat, with inevitably varying local intensities of spawning, coupled with some redistribution of juveniles, may mean that the over-compensatory effects are not so readily detected. Thus, it would be risky to draw conclusions about the management response of a whole river stock solely from the stock–recruitment relationship for a small stream section. Stock–recruitment curves should be developed for key habitat types (Gibson, 1993) and be expressed on a scale compatible with the management regime. This is the basis for current approaches to adjusting stock–recruitment curves for rivers where original data are lacking (Prévost and Porcher, 1996; Wyatt and Barnard, 1997a,b; Bradford et al., 2000; Milner et al., 2000).

The shape of curves at very low stock densities is a problem for two reasons. First, there is a paucity of data at low stock densities, which means that it has proved difficult to establish between-river differences in the initial slope of the curves, equivalent to density-independent survival. On the limited evidence available, density-independent survival appears similar across a range of river types (ICES, 1994), but this conclusion requires validation. Second, conventional models may not accurately describe populations at very low levels and lead to over-optimistic estimates of safe harvest levels (Barrowman and Myers, 2000). The line of the curve may not pass through the origin, because recruitment is effectively prevented at some very low spawner density. This effect has been reported in salmon by Chadwick (1985) and could be explained by a critical abundance of spawners, below which the chance of encounters between mating fish is greatly diminished (Solomon, 1985). The effect requires a switch from positive to negative density-dependent mortality as spawners increase at very low levels (see Section 4.3). This process, could have important implications for the survival, extinction rate and recovery of localised, small stocks, which would be susceptible to chance fluctuations in spawner abundance and exhibit rapid terminal decline below some critical level (Routledge and Irvine, 1999). Research is needed to learn more about stock–recruitment at low stock densities and over a wider range of stream types than has been studied to date.

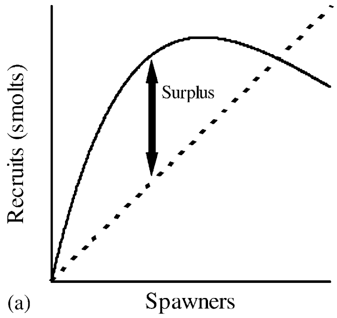
For many salmon stocks, current spawning abundance may be at levels where the distinction between dome or asymptotic curves becomes unimportant, because both predict increasing recruitment as stock increases over lower spawning levels. Stocks might be held at such levels by high exploitation and/or by high mortality in fresh water or at sea.

4.8. Applications of stock–recruitment curves

The two main phases of the life cycle, regulation and adult growth, can be brought together into a single life cycle model that offers several applications for management. An example is outlined below for salmon.

Consider the directly proportional relationship between smolts and adult spawners in a stock, brought about by density-independent marine survival (see above). This is conveyed in Fig. 2a by the straight line, with the dependent variable (spawners) on the *x*-axis. The survival of smolts, sex ratio and fecundity of spawners determine the slope of this line. Onto this relationship can be superimposed the freshwater stock–recruitment relationship (a Ricker curve is used for this example), with the dependent variable (smolts) on the *y*-axis. In this example, eggs are the unit of spawning stock, but numbers of females or total spawners could also be used. Both lines are estimated from river-specific data collected through long-term monitoring and assessment, or by extrapolation and transportation methods where necessary (Wyatt and Barnard, 1997b; Milner et al., 2000).

These two lines represent a full life cycle model and allow the estimation of abundance at two key stages (smolts and spawners) for any starting value of spawner density. Two important features are seen in Fig. 2a. First, at the intersection point of the two lines the number of smolts produced at that level of spawners results in the same number of spawners returning, so the population exactly replaces itself and remains in equilibrium. The straight line is termed the *replacement* line and the intersection the *replacement* point. Secondly, at spawning stock levels less than the



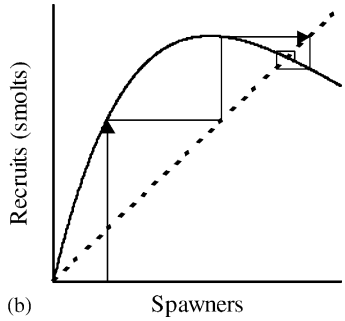


Fig. 2. (a) Full life cycle model showing a density-dependent freshwater regulatory component (solid line) and a marine stage having proportionate survival (dashed line). The surplus production of recruits is estimated by the difference between the two lines, and position of the maximum surplus is shown (arrow). (b) Life cycle model, showing how a population returns to an equilibrium point, starting from a low spawning level.

replacement point more smolts are produced than are needed to replace their parents, giving rise to a surplus of adults. This surplus production is the "spare" capacity that fisheries exploit, but it also has great biological significance. Surplus production insures the stock against random events that may reduce survival and, through density-dependent survival, regulates an unexploited stock at an average level around the replacement point. This can be seen by tracking generations, starting from some arbitrary low spawner level brought about by chance low survival, using the lines in Fig. 2b. At stock levels above the replacement point, lower egg-smolt survival produces a corresponding reduction in returning spawners. The same process applies to asymptotic (e.g., Beverton and Holt) curves, and in all cases the stability and response times will vary according to the model parameters shaping the S–R curve of a particular population (Ricker, 1954). This introduces additional uncertainty into assessments if the OSU (see Section 2) comprises several different populations.

This simple model illustrates responses to variables that are relevant to fisheries management. For example, if stock experiences reduced survival at sea because of climate change then the replacement line will move to the left (because it will take more smolts to produce a returning spawner). The stock will then stabilise around a new replacement point. Similarly, if exploitation is applied to the stock, to cause a reduction in survival between smolt and spawner, then the same stock level change will occur. Inspection of Fig. 2a shows that changes in freshwater carrying capacity (equivalent to the peak, or asymptote, of the curve) or in density-independent survival (equivalent to the initial slope of the curve) will also cause predictable changes in equilibrium stock. Likewise, the returns to be expected from given spawner levels will vary as these conditions change.

Such changes are typical issues facing managers. Life cycle models, with the appropriate cautions (see below), introduce structure and objectivity into options appraisal and enable managers to predict the outcome of their actions. An important contemporary issue is the use of stock–recruitment curves to set reference points for stock management (Wyatt and Barnard, 1997a; Milner et al., 2000; Prévost and Chaput, 2001). Fig. 3 illustrates three common options for reference points. The replacement point (S_r) of an unexploited population defines the stock level expected with no

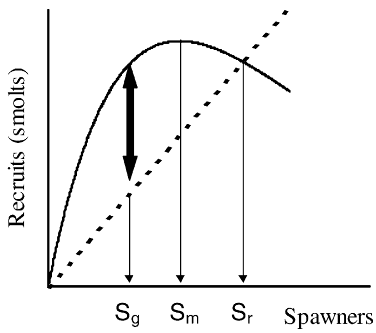


Fig. 3. Life cycle model showing three common options for biological reference points: S_r: equilibrium stock level for replacement in unexploited population, S_m: stock level providing maximum recruits, S_g: stock level providing maximum surplus production.

exploitation. The peak of a dome-shaped curve (S_m) defines a stock that produces the largest number of recruits and thus defines an exploitation level that maximises returning spawners. This point cannot be objectively defined for an asymptotic or rising curve, although some proportion of the asymptote could be arbitrarily set as a reference point. Finally, the stock level S_g, defines a spawning level that maximises the potential catch level. While this is attractive for fisheries management purposes, it has some drawbacks if used alone as a stock reference point (Milner et al., 2000). An advantage of S_g is that it can be estimated from any form of stock–recruitment curve. The merits of these reference points and their application to management are discussed elsewhere by Potter et al. (2003).

4.9. Variability in stock–recruitment

A feature of stock–recruitment curves is the high variability usually seen in the data (e.g., Fig. 1b). The resulting variance can mask the influence of density-dependent regulation causing the predictive power of some stock–recruitment relationships to be rather low, leading to uncertainty and risks when making management decisions. This uncertainty does not invalidate the use of such models, but does require that the errors and risks are quantified as far as practicable and taken into account for management (Hilborn and Walters, 1992). This area of work is rapidly expanding, as statistical methods develop and computing power increases.

Elliott (1994) showed that the variance in recruits increased over the lifetime of a year class, correspondingly, spawner level explained a reducing proportion of the recruit variance, presumably as random effects accumulated. In Black Brows Beck sea trout, egg density explained 95% of the variance seen in early summer fry, but only 44% of the variance in eggs laid by the returning survivors of the same year class. A similar trend has been reported in salmon. In a recent extension to the Shelligan Burn study, the proportion of variance of November parr explained by the density of early summer fry was 66% (Gardiner, unpublished), compared with earlier estimates of 46 and 63% for 1 and 2 year olds respectively (Gardiner and Shackley, 1991). Jonsson et al. (1998) found that initial egg density explained 49% of smolt variance in the River Imsa, but only 22% of the variance in eggs from these smolts was accounted for by their parental egg density.

4.10. Processes controlling growth and maturation

Growth rate might be expected to be influenced by fish density, because it represents an individual's success in acquiring energy through food. But results on this point have been inconsistent, which may partly reflect species differences as well as the circumstances of individual studies. For sea trout in Black Brows Beck, mean growth rate and mean size were found to be independent of density, although *variability* in size was inversely density-dependent during the critical period for sea trout (Elliott, 1994). Gardiner and Shackley (1991) showed that growth was density-dependent in salmon, over the first growing season, but Gee et al. (1979) were unable to demonstrate density-dependent growth (expressed as production/biomass ratios) in salmon in the River Wye. Gibson (1993), in a review of salmon production, reported inconsistencies between various authors, in the effect of density on growth, and suggested that this may have been due to differences in food availability and/or habitat between different studies. He noted that over a range of streams varying greatly in productivity, high growth was positively associated with high density in relatively rich sites. However, in a single stream type, higher density usually gave lower growth. Comparisons should thus only be made under similar habitat and productivity conditions. Gibson (1993) also noted that the links between fish size for age, productive capacity and abundance, offered potential for models that might aid stock assessment. These models are related conceptually to the *percent habitat saturation* models discussed more recently by Grant et al. (1998).

The incidence of density-dependent growth may be variable and the mechanisms not yet fully understood, but it has significant implications for fishery scientists and managers. In sea trout and in salmon, the majority of females go to sea as smolts, but a sizeable minority of males (more in sea trout than salmon) remain in fresh water and mature (Jonsson and Jonsson, 1993; Jonsson et al., 1998). The choice between these two options (migration or maturation) seems to be based on the growth rates of young first year fish well before either smolting or maturation take place, 7–10 months in the case of smolting and 12 months in the case of maturation (Metcalfe, 1998). There are well-established latitudinal variations in growth rate and smolt age of both species (Jonsson and Jonsson, 1993; Metcalfe, 1998) that may reflect temperature-related growth opportunity (Metcalfe, 1998).

Metcalfe (1998) has produced models of the life history responses based on hatchery experimental studies, showing systematic changes in life history features (smolt age, sex ratio of smolts, mean smolt size, etc.) that might be influenced by climate or habitat change, for example, it would be useful to test these models in populations of wild fish, which tend to grow more slowly than hatchery-reared fish.

Empirical links between freshwater performance (as revealed in smolt size and age) and subsequent growth, survival and maturation at sea have been well-established (Bilton et al., 1982; Ward and Slaney, 1988; Erikson, 1989; Elliott, 1993c; Nicieza and Braña, 1993; Salminen, 1997). However, there are inconsistencies between studies, probably reflecting variations in marine environments experienced by the stocks and species examined (Salminen, 1997). The underlying mechanisms controlling marine growth, survival and maturation, particularly the roles of environment and genetics, are still unclear and require further study (Mills, 2000).

5. Conclusions

Salmonid life cycles are highly variable, displaying flexibility in adapting to different and variable environments. The study of population dynamics still has a long way to go before the understanding of processes matches all the management questions that need to be answered. Nevertheless, many basic principles have emerged which, coupled with rapid improvements in statistics and computing, are permitting the translation of current understanding into management tools.

The regulation of salmonid populations through density-dependent feedback mechanisms is now a well-established principle, but studies on this have still only been applied to a very limited range of stream types and species. The application of stock–recruitment models to management has forced the critical review of available data and will, hopefully, lead to long-term studies targeted on priority issues. Lack of such information will continue to be a major constraint until financial commitment is made to support long-term ecological studies.

Critical periods, when population regulation occurs in early freshwater life, have been demonstrated (most clearly for sea trout), but there is still ignorance about regulatory processes at other times and about how the small stream studies translate to larger habitats. Over-wintering habitat may be a further bottleneck, but its effect on populations has not yet been clearly or consistently shown.

The impacts of predation also remain unclear. Bird predation, for example, undoubtedly removes large numbers of salmonid juveniles in some cases, but overall population responses have remained surprisingly hard to demonstrate (Kennedy and Greer, 1988; Feltham, 1990; Carss and Marquiss, 1999). This may reflect the difficulty in detecting such effects against the high variability of whole river population sizes.

The reality of self-thinning as a discrete process is questionable, but the debate around it has been productive in establishing at least the questions about limiting factors, if not all the answers. Even if cohorts do not follow thinning lines, the carrying capacity may. Self-thinning may therefore be important in defining the carrying capacities for fish of different sizes for comparison with standing stock. This study area may offer good opportunities for developing alternative freshwater assessment models.

Multispecies models are also required. Interactions between salmon and trout are partly offset by niche separation, but migratory trout are sometimes the largest contributors of eggs in river systems and a complete lack of interaction would be surprising. Energetics and biomass production models also offer potential for better understanding of the processes at work in rivers. Nutrient flux between marine and freshwater environments by post-spawning salmon mortality is an important mechanism maintaining freshwater production in some Pacific salmon species (Elliott et al., 1997). Atlantic salmon and sea trout, because of their lower spawning densities and life cycle, have a less dramatic biomass transfer and lower mortality rate than Pacific species. Nevertheless, the process may be significant in very low nutrient status waters (Lyle and Elliott, 1998). The topic requires further investigation.

The importance of random environmental events cannot be overstated. The variability that this introduces into population models can mask the underlying regulatory mechanisms and has previously led to fundamental debate over the existence and role of density-dependence (see Elliott, 1994, for a review relating to salmonids). The ability of density-dependent regulation to protect populations at low spawner densities is still not well understood and is an obvious subject for study. This knowledge gap, and the related issue of population structuring in large river systems, is particularly relevant to declining stocks, management of which requires a great degree of caution.

Most population dynamics studies have been carried out in fresh water. However, the mechanisms controlling salmon and sea trout at sea are still poorly understood, but in spite of the technical difficulties and high costs, further progress is anticipated as this becomes an increasingly important research area (Mills, 2000). Performance at sea may also be influenced by events in fresh water. The roles of stream habitat and population density in influencing the trade-offs between growth, maturation and smolting require further work, for both trout and salmon.

Almost all management decisions about fisheries involve "what if" testing of options, which may be implicitly or explicitly formalised through models that pull together our understanding of biological processes. In adopting models, scientists and managers come up against the issues of variability and uncertainty in application of the science to their problems. These difficulties stem variously from poor understanding of processes, forced errors in measurement and from the variability due to random events in nature. A tendency in the past has been to assume that science will be able to explain all or most of this variation. However, that may not be possible, practicable or affordable. So, the challenge for the future lies in two areas. First, in recognising such uncertainty as an inherent feature of natural systems and learning to incorporate it into decisions by re-phrasing management questions and scientific answers. Second, in agreeing what are the key issues for research and investing in targeted studies, which will often have to be long-term, to improve our understanding of processes regulating populations.

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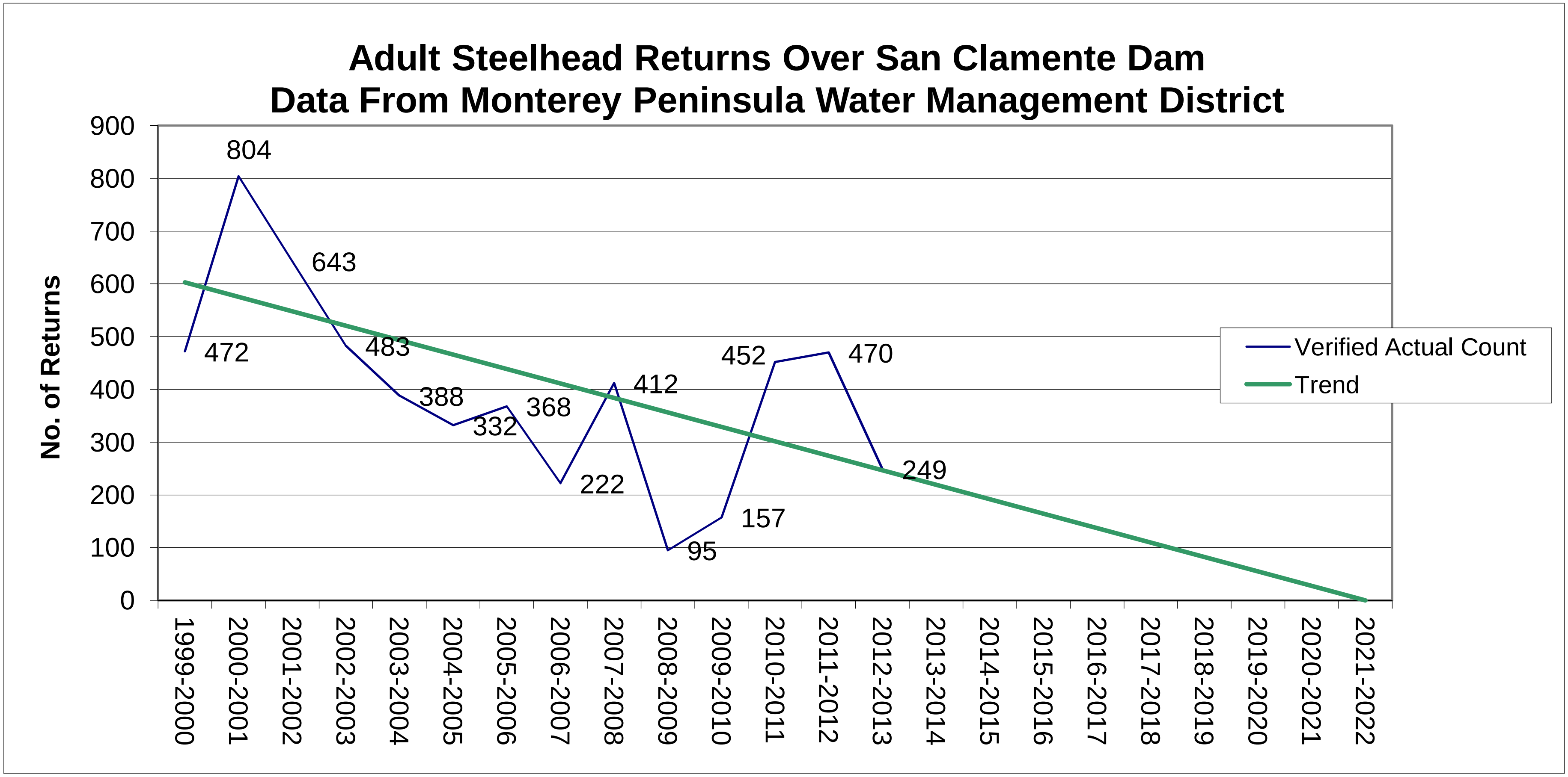
Adult Steelhead Returns Over San Clamente Dam
Data From Monterey Peninsula Water Management District
No. of Returns
900
800
700
600
500
400
300
200
100
0
804
643
472
483
388
332
368
222
412
95
157
452
470
249
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
2008-2009
2009-2010
2010-2011
2011-2012
2012-2013
2013-2014
2014-2015
2015-2016
2016-2017
2017-2018
2018-2019
2019-2020
2020-2021
2021-2022
Verified Actual Count
Trend

Appendix B

California Natural Diversity Database Occurrence Data

Special Status Species Table

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
MAMMALS			
Lasiurus cinereus Hoary bat	-- / CNDDB / --	Prefers open habitats or habitat mosaics with access to trees for cover and open areas or edge for feeding. Generally roost in dense foliage of trees; does not use buildings for roosting. Winters in California and Mexico and often migrates towards summer quarters in the north and east during the spring. Young are born and reared in summer grounds, which is unlikely to occur in California.	**Unlikely:** No suitable habitat within project site.
Neotoma macrotis luciana Monterey dusky-footed woodrat	-- / CSC / --	Forest and oak woodland habitats of moderate canopy with moderate to dense understory. Also occurs in chaparral habitats.	**Present:** Monterey dusky-footed woodrats are known to occur within the Carmel River corridor.
Reithrodontomys megalotis distichlis Salinas harvest mouse	-- / CNDDB / --	Known only to occur from the Monterey Bay region. Occurs in fresh and brackish water wetlands and probably in the adjacent uplands around the mouth of the Salinas River.	**Unlikely:** No suitable habitat within project site. Project site is outside of the currently known range for this species
Taxidea taxus American badger	-- / CSC / --	Dry, open grasslands, fields, pastures savannas, and mountain meadows near timberline are preferred. The principal requirements seem to be sufficient food, friable soils, and relatively open, uncultivated grounds.	**Unlikely:** No suitable habitat within project site.
BIRDS			
Agelaius tricolor Tricolored blackbird (nesting colony)	-- / CSC / --	Nest in colonies in dense riparian vegetation, along rivers, lagoons, lakes, and ponds. Forages over grassland or aquatic habitats.	**Moderate:** Suitable habitat present within the Carmel River corridor. The nearest CNDDB occurrence is approximately 4.1 miles from the project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Athene cunicularia Burrowing owl (burrow sites & some wintering sites)	-- / CSC / --	Year round resident of open, dry grassland and desert habitats, and in grass, forb and open shrub stages of pinyon-juniper and ponderosa pine habitats. Frequent open grasslands and shrublands with perches and burrows. Use rodent burrows (often California ground squirrel) for roosting and nesting cover. Pipes, culverts, and nest boxes may be substituted for burrows in areas where burrows are not available.	**Unlikely:** No suitable habitat within project site.
Buteo regalis Ferruginous hawk (wintering)	-- / WL/ --	An uncommon winter resident and migrant at lower elevations and open grasslands in the Modoc Plateau, Central Valley, and Coast Ranges and a fairly common winter resident of grassland and agricultural areas in southwestern California. Frequent open grasslands, sagebrush flats, desert scrub, low foothills surrounding valleys, and fringes of pinyon-juniper habitats. Does not breed in California.	**Unlikely:** No suitable habitat within project site.
Charadrius alexandrinus nivosus Western snowy plover (nesting)	FT / CSC / --	Sandy beaches on marine and estuarine shores, also salt pond levees and the shores of large alkali lakes. Requires sandy, gravelly or friable soil substrate for nesting.	**Unlikely:** No suitable habitat within project site.
Cypseloides niger Black swift (nesting)	-- / CSC / --	Regularly nests in moist crevice or cave on sea cliffs above the surf, or on cliffs behind, or adjacent to, waterfalls in deep canyons. Forages widely over many habitats.	**Unlikely:** No suitable habitat within project site.
Eremophila alpestris actia California horned lark	-- / WL / --	Variety of open habitats, usually where large trees and/or shrubs are absent. Found from grasslands along the coast to deserts at sea-level and alpine dwarf-shrub habitats are higher elevations. Builds open cup-like nests on the ground.	**Unlikely:** No suitable habitat within project site.
Falco mexicanus Prairie falcon (nesting)	-- / WL / --	Associated primarily with perennial grasslands, savannahs, rangeland, some agricultural fields, and desert scrub areas. Uses open terrain for foraging; nests in open terrain with canyons, cliffs, escarpments, and rock outcrops.	**Unlikely:** No suitable habitat within project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Oceanodroma homochroa Ashy storm-petrel (nesting colony)	-- / CSC / --	Tied to land only to nest, otherwise remains over open sea. Nests in natural cavities, sea caves, or rock crevices on offshore islands and prominent peninsulas of the mainland.	**Unlikely:** No suitable habitat within project site.
Pelecanus occidentalis californicus California brown pelican (nesting colony & communal roosts)	-- / CFP / --	Found in estuarine, marine subtidal, and marine pelagic waters along the California coast. Usually rests on water or inaccessible rocks, but also uses mudflats, sandy beaches, wharfs, and jetties.	**Unlikely:** No suitable habitat within project site.
Riparia riparia Bank swallow (nesting)	-- / ST / --	Nest colonially in sand banks. Found near water; fields, marshes, streams, and lakes.	**Unlikely:** No suitable habitat within project site.
REPTILES AND AMPHIBIANS			
Ambystoma californiense California tiger salamander	FT / ST&CSC /--	Annual grassland and grassy understory of valley-foothill hardwood habitats in central and northern California. Need underground refuges and vernal pools or other seasonal water sources.	**Unlikely:** No suitable habitat within project site.
Anniella pulchra California legless lizard (includes *A. p. nigra* and *A. p. pulchra* as recognized by the Department)	-- / CSC / --	Requires moist, warm habitats with loose soil for burrowing and prostrate plant cover, often forages in leaf litter at plant bases; may be found on beaches, sandy washes, and in woodland, chaparral, and riparian areas.	**Moderate:** Suitable habitat is present within the Carmel River corridor. The CNDDB reports several non-specific occurrences of this species within the quads evaluated.
Emys marmorata Western pond turtle (includes *E. m. pallida* and *E. m. marmorata* as recognized by the Department)	-- / CSC / --	Associated with permanent or nearly permanent water in a wide variety of habitats including streams, lakes, ponds, irrigation ditches, etc. Require basking sites such as partially submerged logs, rocks, mats of vegetation, or open banks.	**Known:** Western pond turtles are known to occur within the Carmel River corridor.
Phrynosoma blainvillii Coast horned lizard	-- / CSC / --	Associated with open patches of sandy soils in washes, chaparral, scrub, and grasslands.	**Unlikely:** No suitable habitat within project site.
Rana draytonii California red-legged frog	FT / CSC / --	Lowlands and foothills in or near permanent or late-season sources of deep water with dense, shrubby, or emergent riparian vegetation. During late summer or fall adults are known to utilize a variety of upland habitats with leaf litter or mammal burrows.	**Known:** CRLF are known to occur within the Carmel River corridor.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Thamnophis hammondii Two-striped garter snake	-- / CSC / --	Associated with permanent or semi-permanent bodies of water bordered by dense vegetation in a variety of habitats from sea level to 2400m elevation.	**Moderate:** Suitable habitat present within the project site. The nearest CNDDB occurrence is approximately 10.6 miles from the project site.
FISH			
Eucyclogobius newberryi Tidewater goby	FE / CSC / --	Brackish water habitats, found in shallow lagoons and lower stream reaches.	**Unlikely:** No suitable habitat within project site.
Oncorhynchus mykiss irideus Steelhead (South/Central California Coast ESU)	FT / -- / --	Coastal perennial and near perennial streams, with suitable spawning and rearing habitat and no major barriers.	**Known:** Steelhead are known to occur in within the Carmel River.
INVERTEBRATES			
Coelus globosus Globose dune beetle	-- / CNDDB / --	Coastal dunes. These beetles are primarily subterranean, tunneling through sand underneath dune vegetation.	**Unlikely:** No suitable habitat within project site.
Danaus plexippus Monarch butterfly	-- / CNDDB / --	Overwinters in coastal California using colonial roosts generally found in Eucalyptus, pine and acacia trees. Overwintering habitat for this species within the Coastal Zone represents ESHA. Local ordinances often protect this species as well.	**Unlikely:** No suitable habitat within project site.
Euphilotes enoptes smithi Smith's blue butterfly	FE / -- / --	Most commonly associated with coastal dunes and coastal sage scrub plant communities in Monterey and Santa Cruz Counties. Plant hosts are *Eriogonum latifolium* and *E. parvifolium.*	**Unlikely:** No suitable habitat within project site.
Linderiella occidentalis California linderiella (fairy shrimp)	-- / CNDDB / --	Ephemeral ponds with no flow. Generally associated with hardpans.	**Unlikely:** No suitable habitat within project site.
PLANTS			
Agrostis lacuna-vernalis Vernal pool bent grass	--/--/1B	Vernal pool mima mounds at elevations of 115-145 meters. Known only from Butterfly Valley and Machine Gun Flats of Ft. Ord National Monument. Annual herb in the Poaceae family; blooms April-May.	**Unlikely:** No suitable habitat within project site. Project site is outside of the currently known range for this species.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Allium hickmanii Hickman's onion	-- / -- / 1B	Closed-cone coniferous forests, maritime chaparral, coastal prairie, coastal scrub, and valley and foothill grasslands at elevations of 5-200 meters. Bulbiferous perennial herb in the Alliaceae family; blooms March-May.	**Unlikely:** No suitable habitat within project site.
Arctostaphylos edmundsii Little Sur manzanita	-- / -- / 1B	Coastal bluff scrub and chaparral on sandy soils at elevations of 30-105 meters. Evergreen shrub in the Ericaceae family; blooms November-April.	**Unlikely:** No suitable habitat within project site.
Arctostaphylos hookeri ssp. *hookeri* Hooker's manzanita	-- / -- / 1B	Closed-cone coniferous forest, chaparral, cismontane woodland, and coastal scrub on sandy soils at elevations of 85-536 meters. Evergreen shrub in the Ericaceae family; blooms January-June.	**Unlikely:** No suitable habitat within project site.
Arctostaphylos montereyensis Toro mazanita	-- / -- / 1B	Maritime chaparral, cismontane woodland, and coastal scrub on sandy soils at elevations of 30-730 meters. Evergreen shrub in the Ericaceae family; blooms February-March.	**Unlikely:** No suitable habitat within project site.
Arctostaphylos pajaroensis Pajaro manzanita	-- / -- / 1B	Chaparral on sandy soils at elevations of 30-760 meters. Evergreen shrub in the Ericaceae family; blooms December-March.	**Unlikely:** No suitable habitat within project site.
Arctostaphylos pumila Sandmat manzanita	-- / -- / 1B	Openings of closed-cone coniferous forests, maritime chaparral, cismontane woodland, coastal dunes, and coastal scrub on sandy soils at elevations of 3-205 meters. Evergreen shrub in the Ericaceae family; blooms February-May.	**Unlikely:** No suitable habitat within project site.
Astragalus tener var. *tener* Alkali milk-vetch	-- / -- / 1B	Playas, valley and foothill grassland on adobe clay, and vernal pools on alkaline soils at elevations of 1-60 meters. Annual herb in the Fabaceae family; blooms March-June.	**Unlikely:** No suitable habitat within project site.
Astragalus tener var. *titi* Coastal dunes milk-vetch	FE / SE / 1B	Often found in vernally mesic, sandy areas of coastal bluff scrub, coastal dunes, and coastal prairie at elevations of 1-50 meters. Annual herb in the Fabaceae family; blooms March-May.	**Unlikely:** No suitable habitat within project site.
Castilleja ambigua var. insalutata Pink johnny-nip	-- / -- / 1B	Coastal prairie and coastal scrub at elevations of 0-100 meters. Annual herb in the Orobanchaceae family; blooms May-August.	**Unlikely:** No suitable habitat within project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Centromadia parryi ssp. *congdonii* Congdon's tarplant	-- / -- / 1B	Valley and foothill grassland on alkaline soils at elevations of 0-230 meters. Annual herb in the Asteraceae family; blooms May-November.	**Unlikely:** No suitable habitat within project site.
Chorizanthe pungens var. *pungens* Monterey spineflower	FT / -- / 1B	Maritime chaparral, cismontane woodland, coastal dunes, coastal scrub, and valley and foothill grassland on sandy soils at elevations of 3-450 meters. Annual herb in the Polygonaceae family; blooms April-July.	**Unlikely:** No suitable habitat within project site.
Chorizanthe robusta var. *robusta* Robust spineflower	FE / -- / 1B	Openings in cismontane woodland, coastal dunes, maritime chaparral, and coastal scrub on sandy or gravelly soils at elevations of 3-300 meters. Annual herb in the Polygonaceae family; blooms April-September.	**Unlikely:** No suitable habitat within project site.
Clarkia jolonensis Jolon clarkia	-- / -- / 1B	Cismontane woodland, chaparral, riparian woodland, and coastal scrub at elevations of 20-660 meters. Annual herb in the Onagraceae family; blooms April-June.	**Moderate:** Marginally suitable habitat present within the project site. The CNDDB reports a non-specific occurrence of this species within the project site from 1903.
Collinsia multicolor San Francisco collinsia	-- / -- / 1B	Closed-cone coniferous forest and coastal scrub, sometimes on serpentinite soils, at elevations of 30-250 meters. Annual herb in the Plantaginaceae family; blooms March-May.	**Unlikely:** No suitable habitat within project site.
Cordylanthus rigidus ssp. *littoralis* Seaside bird's-beak	-- / SE / 1B	Closed-cone coniferous forests, maritime chaparral, cismontane woodlands, coastal dunes, and coastal scrub on sandy soils, often on disturbed sites, at elevations of 0-425 meters. Annual hemi-parasitic herb in the Orobanchaceae family; blooms April-October.	**Unlikely:** No suitable habitat within project site.
Delphinium californicum ssp. interius Hospital Canyon California larkspur	-- / -- / 1B	Openings in chaparral, coastal scrub, and mesic areas of cismontane woodland at elevations of 230-1095 meters. Perennial herb in the Ranunculaceae family; blooms April-June.	**Unlikely:** No suitable habitat within project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Delphinium hutchinsoniae Hutchinson's larkspur	-- / -- / 1B	Broadleaved upland forest, chaparral, coastal scrub, and coastal prairie at elevations of 0-427 meters. Perennial herb in the Ranunculaceae family; blooms March-June.	**Unlikely:** No suitable habitat within project site.
Ericameria fasciculata Eastwood's goldenbush	-- / -- / 1B	Openings in closed-cone coniferous forest, maritime chaparral, coastal dunes, and coastal scrub on sandy soils at elevations of 30-275 meters. Evergreen shrub in the Asteraceae family; blooms July-October.	**Unlikely:** No suitable habitat within project site.
Eriogonum nortonii Pinnacles buckwheat	-- / -- / 1B	Chaparral and valley and foothill grassland on sandy soils, often on recent burns, at elevations of 300-975 meters. Annual herb in the Polygonaceae family; blooms May-September.	**Unlikely:** No suitable habitat within project site.
Erysimum ammophilum Sand-loving wallflower	-- / -- / 1B	Openings in maritime chaparral, coastal dunes, and coastal scrub on sandy soils at elevations of 0-60 meters. Perennial herb in the Brassicaceae family; blooms February-June.	**Unlikely:** No suitable habitat within project site.
Erysimum menziesii Menzies' wallflower	FE / SE / 1B	Coastal dunes at elevations of 0-35 meters. Perennial herb in the Brassicaceae family; blooms March-September.	**Unlikely:** No suitable habitat within project site.
Fritillaria liliacea Fragrant fritillaria	-- / -- / 1B	Cismontane woodland, coastal prairie, coastal scrub, and valley and foothill grassland, often serpentinite, at elevations of 3-410 meters. Bulbiferous perennial herb in the Liliaceae family; blooms February-April.	**Unlikely:** No suitable habitat within project site.
Gilia tenuiflora ssp. *arenaria* sand gilia	FE / ST / 1B	Openings in maritime chaparral, cismontane woodland, coastal dunes, and coastal scrub on sandy soils at elevations of 0-45 meters. Annual herb in the Polemoniaceae family; blooms April-June.	**Unlikely:** No suitable habitat within project site.
Hesperocyparis goveniana Gowen cypress	FT / -- / 1B	Closed-cone coniferous forest and maritime chaparral at elevations of 30-300 meters. Evergreen tree in the Cupressaceae family. Natively occurring only at Point Lobos near Gibson Creek and the Huckleberry Hill Nature Preserve near Highway 68.	**Unlikely:** No suitable habitat within project site. Project site is outside of the known range for this species.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Hesperocyparis macrocarpa Monterey cypress	-- / -- / 1B	Closed-cone coniferous forest at elevations of 10-30 meters. Evergreen tree in the Cupressaceae family. Natively occurring only at Cypress Point in Pebble Beach and Point Lobos State Park; widely planted and naturalized elsewhere.	**Unlikely:** No suitable habitat within project site. Project site is outside of the known range of this species.
Horkelia cuneata ssp. sericea Kellogg's horkelia	-- / -- / 1B.1	Openings of closed-cone coniferous forests, maritime chaparral, coastal dunes, and coastal scrub on sandy or gravelly soils at elevations of 10-200 meters. Perennial herb in the Rosaceae family; blooms April-September.	**Unlikely:** No suitable habitat within project site.
Lasthenia conjugens Contra Costa goldfields	FE / -- / 1B	Mesic areas of valley and foothill grassland, alkaline playas, cismontane woodland, and vernal pools at elevations of 0-470 meters. Annual herb in the Asteraceae family; blooms March-June.	**Unlikely:** No suitable habitat within project site.
Layia carnosa Beach layia	FE / SE / 1B	Coastal dunes and coastal scrub on sandy soils at elevations of 0-60 meters. Annual herb in the Asteraceae family; blooms March-July.	**Unlikely:** No suitable habitat within project site.
Legenere limosa Legenere	-- / -- / 1B	Vernal pools and wetlands at elevations of 1-880 meters. Annual herb in the Campanulaceae family; blooms April- June.	**Moderate:** Marginally suitable habitat present within the project site. The nearest CNDDB occurrence is approximately 8.3 miles from the project site.
Lupinus tidestromii Tidestrom's lupine	FE / SE / 1B	Coastal dunes at elevations of 0-100 meters. Perennial rhizomatous herb in the Fabaceae family; blooms April-June.	**Unlikely:** No suitable habitat within project site.
Malacothamnus palmeri var. *involucratus* Carmel Valley bush-mallow	-- / -- / 1B	Chaparral, cismontane woodland, and coastal scrub at elevations of 30-1100 meters. Perennial deciduous shrub in the Malvaceae family; blooms May-October.	**Unlikely:** No suitable habitat within project site.
Malacothamnus palmeri var. *palmeri* Santa Lucia bush-mallow	-- / -- / 1B	Chaparral on rocky soils at elevations of 60-360 meters. Perennial deciduous shrub in the Malvaceae family; blooms May-July.	**Unlikely:** No suitable habitat within project site.
Malacothrix saxatilis var. *arachnoidea* Carmel Valley macothrix	-- / -- / 1B	Chaparral and coastal scrub on rocky soils at elevations of 25-1036 meters. Perennial rhizomatous herb in the Asteraceae family; blooms June-December.	**Unlikely:** No suitable habitat within project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Microseris paludosa Marsh microseris	-- / -- /1B	Closed-cone coniferous forest, cismontane woodland, coastal scrub, and valley and foothill grassland at elevations of 5-300 meters. Perennial herb in the Asteraceae family; blooms April-July.	**Unlikely:** No suitable habitat within project site.
Monolopia gracilens Woodland wollythreads	-- / -- / 1B	Openings of broadleaved upland forest, chaparral, cismontane woodland, North Coast coniferous forest, and valley and foothill grassland on serpentinite soils at elevations of 100-1200 meters. Annual herb in the Asteraceae family; blooms February-July.	**Unlikely:** No suitable habitat within project site.
Pinus radiata Monterey pine	-- / -- / 1B	Closed-cone coniferous forest and cismontane woodland at elevations of 25-185 meters. Evergreen tree in the Pinaceae family. Only three native stands in CA at Ano Nuevo, Cambria, and the Monterey Peninsula; introduced in many areas.	**Unlikely:** No suitable habitat within project site. The CNDDB reports an occurrence of this species that includes the project site; however, this species is unlikely to occur within the Carmel River corridor.
Piperia yadonii Yadon's rein orchid	FE / -- / 1B	Sandy soils in coastal bluff scrub, closed-cone coniferous forest, and maritime chaparral at elevations of 10-510 meters. Annual herb in the Orchidaceae family; blooms February-August.	**Unlikely:** No suitable habitat within project site.
Plagiobothrys uncinatus Hooked popcorn-flower	-- / -- / 1B	Chaparral, cismontane woodlands, and valley and foothill grasslands on sandy soils at elevations of 300-760 meters. Annual herb in the Boraginaceae family; blooms April-May.	**Unlikely:** No suitable habitat within project site.
Potentilla hickmanii Hickman's cinquefoil	FE / SE / 1B	Coastal bluff scrub, closed-cone coniferous forests, vernally mesic meadows and seeps, and freshwater marshes and swamps at elevations of 10-149 meters. Perennial herb in the Rosaceae family; blooms April-August.	**Moderate:** Suitable habitat present within the Carmel River corridor. The nearest CNDDB occurrence is approximately 2.8 miles north of the project site.
Rosa pinetorum Pine rose	-- / -- / 1B	Closed-cone coniferous forest at elevations of 2-300 meters. Perennial shrub in the Rosaceae family; blooms May-July. Possible hybrid of *R. spithamea*, *R. gymnocarpa*, or others; further study needed.	**Unlikely:** No suitable habitat within project site.
Sidalcea malachroides Maple-leaved checkerbloom	-- / -- / List 4	Broadleaved upland forest, coastal prairie, coastal scrub, North Coast coniferous forest, and riparian woodlands, often in disturbed areas, at elevations of 2-730 meters. Perennial herb in the Malvaceae family; blooms March-August.	**Unlikely:** No suitable habitat within project site.

Species	Status (Service/ Department/CNPS)	General Habitat	Potential Occurrence within Project Vicinity
Stebbinsoseris decipiens Santa Cruz microseris	-- / -- / 1B	Broadleaved upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, and openings in valley and foothill grassland, sometimes on serpentinite, at elevations of 10-500 meters. Annual herb in the Asteraceae family; blooms April-May.	**Unlikely:** No suitable habitat within project site.
Tortula californica California screw moss	-- / -- / 1B	Valley and foothill grassland and chenopod scrub on sandy soils at elevations of 10-1460. Moss in the Pottiaceae family.	**Unlikely:** No suitable habitat within project site.
Trifolium buckwestiorum Santa Cruz clover	-- / -- / 1B	Gravelly margins of broadleaved upland forest, cismontane woodland, and coastal prairie at elevations of 105-610 meters. Annual herb in the Fabaceae family; blooms April-October.	**Unlikely:** No suitable habitat within project site.
Trifolium hydrophilum Saline clover	-- / -- / 1B	Marshes and swamps, mesic and alkaline valley and foothill grassland, and vernal pools at elevations of 0-300 meters. Annual herb in the Fabaceae family; blooms April-June.	**Moderate:** Marginally suitable habitat present within the project site. The nearest CNDDB occurrence is approximately 5.1 miles from the project site.
Trifolium polyodon Pacific Grove clover	-- / SR / 1B	Mesic areas of closed-cone coniferous forest, coastal prairie, meadows and seeps, and valley and foothill grassland at elevations of 5-120 meters. Annual herb in the Fabaceae family; blooms April-July.	**Unlikely:** No suitable habitat within project site.
Trifolium trichocalyx Monterey clover	FE / SE / 1B	Sandy openings and burned areas of closed-cone coniferous forest at elevations of 30-240 meters. Annual herb in the Fabaceae family; blooms April-June.	**Unlikely:** No suitable habitat within project site.

STATUS DEFINITIONS

Federal

FE = listed as Endangered under the federal Endangered Species Act

FT = listed as Threatened under the federal Endangered Species Act

FC = Candidate for listing under the federal Endangered Species Act

-- = no listing

State

SE = listed as Endangered under the California Endangered Species Act

ST = listed as Threatened under the California Endangered Species Act
SR = listed as Rare under the California Endangered Species Act
SC = Candidate for listing under the California Endangered Species Act
CSC = California Department of Fish and Game Species of Concern
CFP = California Fully Protected Animal
WL = California Department of Fish and Game Watch List
-- = no listing

California Native Plant Society
1B = List 1B species; rare, threatened or endangered in California and elsewhere
List 4 = Limited distribution (CNPS Watch List)
-- = no listing

POTENTIAL TO OCCUR
Present = known occurrence of species within the site; presence of suitable habitat conditions; or observed during field surveys
High = known occurrence of species in the vicinity from the CNDDB or other documentation; presence of suitable habitat conditions
Moderate = known occurrence of species in the vicinity from the CNDDB or other documentation; presence of marginal habitat conditions within the site
Low = species known to occur in the vicinity from the CNDDB or other documentation; lack of suitable habitat or poor quality
Unlikely = species not known to occur in the vicinity from the CNDDB or other documentation, no suitable habitat is present within the site
Not Present = species was not observed during surveys

Appendix C-1

Geomorphic & Hydrologic Context Memorandum
(Balance, 2014a)

Memorandum

To: Denise Duffy, Denise Duffy & Associates

From: Scott Brown and Ed Ballman

Date: January 13, 2014

Subject: Geomorphic and hydrologic context for Eastwood/Odello water rights change petition, Monterey County, California

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Introduction

Clint Eastwood and The Margaret Eastwood Trust (collectively "Eastwood") have filed a petition to change an existing water right license for the Eastwood/Odello property, which is located just upstream of Highway 1 in the Carmel River Watershed (Figure 1). If this petition is granted, then a portion of the water right would be used in the future for pumping at three California American Water Company (Cal-Am) municipal supply wells that are among the most downstream of Cal-Am's wells. Balance has been asked to assist in the assessment of the potential hydrologic and geomorphic impacts related to this water rights change petition. This technical memorandum analyzes relevant geomorphic and hydrologic issues associated with the proposed project, and it discusses other planned projects within the watershed that may affect cumulative impacts.

Background

The existing water right license for the Eastwood/Odello property[1] (License 13868) authorizes diversion of up to 131.8 acre-feet per year (af/yr) at a maximum rate of 0.45 cubic feet per second (cfs) from two wells adjacent to the lower Carmel River to irrigate adjoining farmland. The existing diversion point is at a single well (Odello #2) on the

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[1] The Eastwood/Odello property is also known (and formerly was known) as the Odello East property.

Eastwood/Odello property[2]. The change petition asks the State Water Resources Control Board to split water right License 13868 into two new licenses. New License 13868A, would authorize diversions of up to 85.6 af/yr total at three upstream locations, with a maximum instantaneous rate of 0.37 cfs, and would authorize municipal use in addition to the existing irrigation use. The three proposed new points of diversion are at the following Cal-Am production wells, in order from downstream to upstream: Cañada #2, Cypress, and Pearse (Figure 2). These wells are all actively pumped and provide water to the Cal-Am distribution system. New License 13868B, representing roughly one third of the water right (46.2 af/yr), would be dedicated to instream uses (fish and wildlife habitat) in the reach of the Carmel River from the Odello East property to the river mouth. No diversions would be authorized under License 13868B, and water under this license would be dedicated to instream flows at a rate of 0.08 cfs.

The present authorized points of diversion, and places and purposes of use in License 13838 would be retained in new License 13838A, thereby continuing to authorize some interim irrigation of the currently irrigated Eastwood/Odello parcels.

Purpose

This memo presents findings related to potential impacts of the proposed project on hydrologic and geomorphic aspects of habitat value, and what those potential impacts may actually mean in the field. We evaluated a number of varied effects, principally using aerial photographs and a field reconnaissance. Among the potential effects we considered are:

- Direct effects on instream flows, including those that affect smolt emigration to the lagoon and ocean;
- Effects on the vigor or viability of woody riparian vegetation along the river and the floodplain, both within the area of active drawdown cones of the wells that

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[2] The existing license authorizes pumping from two wells on the property. Only one of those wells (Odello #2) has been actively used in the recent past. Thus, the existing conditions include pumping from only one of the wells.

would be used for the proposed project and within the alluvial corridor in general;

- Potential cumulative effects relative to other past, present and reasonably foreseeable projects in the area that are likely to affect flows and/or aquifer levels within the pertinent reach of the Carmel River over the coming years.

This memo builds on a previous Balance technical review of two reports submitted in support of the proposed project (Woyshner and White, 2013): 1) a technical memorandum by Davids Engineering (dated April 15, 2013) that summarized the results of a root-zone water balance model to estimate crop-water use and deep percolation of water diverted from the Carmel Valley Aquifer to irrigate pastures on the Odello Ranch, near the mouth of the Carmel River; and 2) a report by West Yost Associates Consulting Engineers (dated June 2013, revised October 2013) that evaluated the potential effects on groundwater and surface water resources of pumping water under roughly two-thirds of the existing water right from wells located farther upstream, as proposed in the petition. This memo also considers a technical memorandum (Macaulay, 2013) that describes estimated monthly diversion rates under the current license and for the proposed project.

There were several important findings from the Macaulay and West Yost reports relevant to the analysis and discussion herein:

- The maximum sustained rate[3] of additional pumping at each of the three Cal-Am wells as a result of the proposed changes in water right License 13868 is estimated to be 0.16 cfs.

- The proposed project's effects would be discernible at river flows of up to 5 cfs. There might be some smaller effects at somewhat higher river flows, but these potential effects are too small to readily quantify. Because the proposed project would change the points of diversion for 85.6 af/year to upstream locations, it

[3] The maximum sustained rate was calculated by estimating the monthly distribution of pumping volume and selecting the highest month (July). That volume was assumed to be pumped at a constant rate over the month.

has the potential to result in a decrease in the occurrence of river flows in the affected river reach between zero and five cfs from 16% of the time throughout a typical year to 14% of the time after the change in diversion location, and an increase in the duration of zero-flow conditions in this reach from 37% of the time to 39% of the time during a typical year. In most years, no detectable change is expected from December through the end of March due to high flows in the stream during that time period.

- Estimated additional groundwater drawdown at the Carmel River as a result of the proposed project ranges from 0.08 to 0.25 feet after 30 days of pumping and from 0.10 to 0.31 feet after 100 days of pumping at each of the three Cal-Am wells included in the current water rights change petition[4].

Hydrologic and geomorphic context

The proposed project is located within the lower Carmel River watershed, between Highway 1 and Shulte Road (Figure 1). Through this reach, the Carmel River is a broad channel, approximately 200 feet wide, incised 10 feet or more below the surrounding floodplain. This reach of the river typically dries up completely by July in most years (NMFS, 2002), and thus is considered a migration reach and does not provide steelhead rearing habitat (Snider, 2013).

The geomorphic character and hydrologic function of the Carmel River is dominated by large, episodic events (Kondolf and Curry, 1986), especially those associated with watershed-scale wildfires (Hecht, 1981). These large events supply and transport a large amount of sediment within the stream channel, and can cause significant reconfiguration of channel bedforms and features. The bed of the lower Carmel River is dominated by sand and fine-gravel deposits, though some larger gravel and cobble deposits are also present.

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[4] The wells were analyzed individually. To provide a conservatively high estimate of the potential impact, West Yost analyzed the draw-down assuming that the entire Eastwood/Odello water right amount would be pumped solely at each well.

Aerial Photograph Analysis

The West Yost report discussed above provided an analysis of potential impacts to streamflow at the USGS gage, located at Via Mallorca (River Mile 3.24). In order to place these findings in the context of the entire reach-of-interest for this proposed project, we conducted an aerial photograph assessment of the reach. Our objectives were to identify the representativeness of the flow conditions at the USGS gage relative to other reaches of the creek, and to better understand where, when and how flow continuity to the ocean – which is relevant for downstream-migrating smolts – comes to a seasonal end. Additionally, we sought to assess whether the flow ranges used in the West-Yost report (0 cfs, 0 to 5 cfs and above 5 cfs) for its analyses of flows at the USGS gage are appropriate longitudinally along the creek[5], and what additional insight might be gained by reviewing flow conditions along the entire length of the relevant reach of the Carmel River.

Two questions that we sought to answer were:

1. When flow is zero at the USGS gage, are there other reaches of the lower Carmel River with sustained wetted conditions[6] that might be impacted by the proposed project?

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[5] West Yost analyzed the potential effects of the Project on flows at the USGS gage using a flow duration analysis, concentrating on the occurrence of zero flow, flows between zero and 5 cfs, and flows greater than 5 cfs. Our analysis sought to assess what conditions other parts of this reach of the Carmel River are experiencing for each of the flow 'bins' at the USGS gage.

[6] In this context, we use "wetted conditions" or "wetted reach" to include segments of the channel that have low flow (possibly with some minor dry segments), or segments without surface flow, but with water partially or fully filling some or all of the deeper pools. At low flows, it is often difficult to fully assess flow continuity using aerial photographs, so we use this more-general classification as a way to highlight relative conditions in the stream and the potential relationship to riparian habitat.

2. When low baseflows are measured at the USGS gage, is flow continuity already broken elsewhere on the lower Carmel River, such that out-migrant smolts cannot swim out to the ocean during spring months?

Table 1 (attached) summarizes the aerial photographs that were used for our analysis, the resolution and readability of each photo, the daily mean flow at the USGS gage on the day the photo was taken, and a short description of our findings. We assessed flow conditions in the Carmel River from Schulte Road (River Mile 6.7) downstream to the Carmel River Lagoon, noting the presence or absence of flow across channel bars and/or remnant pools that appeared to have water. The survey was not intended as an extensive catalog of such features, because photo resolution, shadows, overhanging riparian vegetation, and other factors obscured portions of the channel in many of the photographs. Instead, our intent was to get a general sense of which reaches may or may not be wetted when various flows are occurring at the USGS gage.

Results

The following points outline the relevant results of the aerial photograph survey:

- The USGS gage appears to be a good indicator of the presence of flow throughout the lower Carmel River. For days when the River was flowing at the gage, aerial photographs show a continuous or near-continuous channel thread throughout the assessment reach.

- Flow or wetted conditions were noted at and downstream of Schulte Road in a number of photographs when much or all the stream further downstream appeared to be dry. The downstream extent of this wetted reach varied between 0.3 miles (on 9/29/2009), and 0.9 miles (on 9/27/2006) downstream from Schulte Road. The reach was also flowing on 5/31/2007 when downstream conditions were predominantly dry (it would later dry by 7/29/2007). The point on the River closest to the Pearse Well is about 0.1 miles downstream of the 9/27/2006 wetted reach (approximately 1 mile downstream of Schulte Road).

- A second sustained wetted reach (relative to dry conditions at the USGS gage) was identified in several photographs, present at and/or downstream of Valley Greens Drive, approximately 1.3 miles upstream of the USGS gage (1.4 miles upstream of the Cañada #2 well and 0.6 miles downstream of the Cypress well).

Within this reach, wetted conditions or isolated pools were identified in photos from 9/29/2009, 5/31/2007, 6/19/2007, 7/29/2007 (a single pool), and possibly 7/22/1987 and 10/28/1970, when the reach at the USGS gage was dry.

- Aerial photos from 8/26/2011 show conditions representative of continuous flow from Schulte Road to the Lagoon when daily average flow at the USGS gage was 8 cfs. Aerial photos from 9/8/2008 are of poor quality, but also appear to show a thin thread of baseflow throughout the lower Carmel River when daily mean flow was 6 cfs at the USGS gage.

Conclusions

We draw the following conclusions from our aerial photograph assessment:

- When flow is present at the USGS gage, continuous flow conditions are likely to be present in the Carmel River throughout the entire reach downstream of Schulte Road. Given that the aerial photograph analysis suggested continuous flow at values of 6 to 8 cfs at the USGS gage, the 5 cfs flow rate used in the West Yost analysis to divide historical flows into two groups appears to be a reasonable approximation of the flow value at the gage when continuous flow throughout this reach may begin to cease in the lower Carmel River as flows recede.

- With the exception of short segments near Schulte Road and Valley Greens Drive, the lower Carmel River appears to dry rapidly when flow reaches zero at the USGS gage. Most notably, 10 days after flow ceased at the USGS gage in 2007, no residual pools could be seen in the photos except in the short reaches at Schulte Road and Valley Greens Drive.

- The maximum downstream extent of the downstream end of the wetted reach at Schulte Road mentioned above appears to end approximately 0.1 miles or more (depending on the year) upstream of the point on the River closest to the Pearse well. The Pearse well is the furthest of the three wells from the River, with estimated additional drawdown as a result of the proposed project of only 0.10 feet (see riparian vegetation discussion below).

- The upstream end of the wetted reach near Valley Greens Drive is approximately 0.6 miles downstream of the Cypress well, and the downstream end of the reach is approximately 1.4 miles upstream of the Cañada #2 well. At the closest point on the river to those wells, it appears to undergo similar rates of drying as the USGS gage reach, so the West-Yost flow duration analysis is certainly relevant to the reaches of the Carmel River near these two wells. (In fact the Cañada #2 well is less than 0.1 miles downstream of the USGS gage.)

- It is important to note that even though the reaches near Schulte Road and Valley Greens Drive remain wetted longer than the USGS gage reach, the channel still dries completely at these locations in many years (8/14/2008 and 10/1/2002, for example). In 2007, for example, the reach downstream of Schulte Road remained wetted for at least a month after flow had ceased at the USGS gage, but had dried completely within one additional month.

Streamflow Analyses

Changes in Discharge in the lower Carmel River

As discussed above, the proposed project would not involve any new diversions from the lower Carmel River sub-basin. Rather, it would involve changes in the locations of diversions under an existing water right in connection with a change in purpose of use—from agricultural to municipal. With these changes, there also would be some changes in how the diversions would be distributed throughout the year. The potential effects of these changes on seasonal flows in the Carmel River, and related impacts to various life stages of aquatic species in the stream are discussed in the following paragraphs.

To analyze the potential impacts of these changes, we compared the existing monthly distribution of pumping from the Odello well to the estimated monthly distribution of pumping under this water right that will occur if it is changed as proposed in the change petition (Macaulay, 2013)[7]. Table 2 compares the monthly pumping rates that would occur under the proposed project with present monthly pumping rates. As the

[7] For proposed project conditions, we used an estimated rate of pumping based on the maximum monthly demands of the project (Macaulay, 2013). These estimated rates are higher than the pumping rates that actually will occur with the proposed project because the sum of these maximum monthly rates exceeds the annual limit for proposed License 13868A.

table shows, the changes in monthly pumping rates would result in no change or an increase in flow within the project reach during 6 months of the year (May through October). Reach-wide net reductions in flow would be very minor (at most 0.05 cfs) and would occur in the winter months when river flows normally are at the highest levels. For the purposes of this analysis, we assume that any net change in pumping rate (positive or negative) would result in a corresponding change in streamflow in the Carmel River during times when surface flow is present in the stream[8]. Accordingly, based on the changes in pumping rates shown in Table 2, streamflows are expected to be the same or higher from May through October, and streamflows are expected to be slightly less from November through April, under the proposed project.

The environmental impact report for the Aquifer Storage and Recovery Project (ASR EIR) (Jones and Stokes, 2006) used several different flow thresholds in its impact analysis for potential effects on various life stages of aquatic species in the Carmel River. This EIR states that habitat for steelhead was constrained under the following conditions in the lower Carmel River:

- Winter downstream migration: this habitat is limited when flow falls below 10 cfs during the months of October through March following storms of sufficient magnitude to stimulate downstream migration.
- Smolt Emigration: this habitat is limited when flow at the USGS gage location falls below 10 cfs during the months of April and May.
- Juvenile rearing: this habitat is limited when flow falls below 1 cfs during the months of June through December.

To estimate the magnitude and significance of the changes in river flows that would occur with the proposed project, we applied the estimated seasonal changes in pumping rates (Table 2) to the 52-year USGS record of daily streamflow at Via Mallorca, which is located approximately in the middle of the lowermost reach of the Carmel

[8] This assumption is conservative, as changes in groundwater pumping would not necessarily result in a one-to-one correlation to changes in flow due to aquifer dynamics and distance between the well and the Carmel River, among other factors.

River. Table 3 compares the impacts of these changes in flow relative to the suitable habitat conditions for various life-stages of steelhead that were identified in the ASR EIR (Jones and Stokes, 2006).

Riffle Passage

Another important aspect of the hydrologic context is the relationship of the potential reductions in flow as a result of the proposed project to what that physically means in the context of fish passage. The lower Carmel River channel is typically on the order of 150 to 300 feet wide. Even at relatively low flows, the riffles are on the order of 15 to 30 feet wide, as measured in the aerial photographs at visible riffles when flow is present (Figure 3). At those widths, reductions in flow results in a much smaller drop in flow depth than would occur in a more confined riffle setting.

As an attempt to quantify the potential impacts of the proposed project on fish passage flows, we conducted an analysis of riffle depth using an existing HEC-RAS flood-control model of the lower Carmel River (originally prepared by FEMA in 2007). We selected four prominent riffles from the model (Figure 4), and iteratively calculated the critical flow, assuming passage depth criteria of greater than 0.3 feet for smolts and 0.7 feet for adults across at least 25% of the riffle width[9]. The results of this analysis, summarized in Table 4, show that the model identifies existing critical flows in the Carmel River as on the order of 25 to 60 cfs for adult passage, and 11 to 16 cfs for smolt outmigration. We calculated the change in depth at these flow rates that would result from a reduction of 0.16 cfs, which corresponds to the maximum sustained pumping rate of the proposed changed water right (West Yost, 2013). Per the modeling analysis, a 0.16-cfs reduction in those flows results in decreases in water depth at the riffles modeled ranging from no detectable change to a maximum of 0.02 feet. 0.16 cfs is the maximum estimated pumping rate, and it would occur in July when the stream normally is dry or nearly dry in most years and there is no in-stream aquatic habitat. Thus the estimated impact is conservatively high and actual reduction in depth during

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[9] Criteria from CDFG, 2013. Detailed passage analysis also requires that 10% of this depth must be contiguous; however the cross-section resolution did not allow for us to adequately assess this criterion.

periods relevant to adult passage and smolt migration would be less than the negligible changes noted in Table 4.

We recognize that a flood-control model may not provide sufficient cross-section detail or resolution to do a detailed fish passage assessment, so these calculations are just rough estimates. However, this analysis does illustrate the nearly imperceptible impacts that the proposed project's expected flow reductions are likely to have on adult fish passage or smolt migration in the affected reach of the Carmel River.

Impacts to Geomorphic River Function

The geomorphic character and hydrologic function of the Carmel River is dominated by large, episodic events (Kondolf and Curry, 1986), especially those associated with watershed-scale wildfires (Hecht, 1981). As such, the small amount of flow that would be involved in the proposed project is insignificant compared to the types of flows that account for sediment transport, pool-riffle maintenance, channel erosion and deposition, and other geomorphic functions of the river.

Impacts to Lagoon Function

The Eastwood/Odello well that currently pumps water under License 13868 is located approximately 0.5 miles up-valley of the South Arm of the Carmel Lagoon, which provides important summer rearing habitat for threatened steelhead trout, western pond turtle, and California red-legged frogs, among other species (Casagrande, 2006). Under existing conditions, groundwater is pumped at the Odello well and used for irrigation of pasture at the site. A portion of this water is consumed by the pasture vegetation (and other evapotranspiration), with the remainder returning as infiltration to the aquifer or supporting flows in the Carmel River and ultimately the Lagoon.

The proposed project would change the location of some pumping under the existing water right to three Cal-Am wells that are located a few miles farther up the lower Carmel River Valley. A portion of the existing water right equal to the estimated average amount of return flow and undiverted water[10] from current irrigation of the Eastwood/Odello property (46.2 acre-feet per year; Davids Engineering, 2013; Macaulay, 2013) would not be diverted and instead would be dedicated to instream uses. This dedication will ensure that there is no net loss of water from the aquifer as a result of the proposed project. For this reason, the proposed project would only involve changes in points of diversion; because the net volume of water that is being pumped now is already accounted for in the water balance for the lagoon under existing conditions, no impact to inflows to the lagoon would result from the proposed project.

Impacts to Riparian Vegetation

In addition to the potential impacts to Carmel River low flows and in-stream habitat discussed above, changing the point of diversion for a portion of the Eastwood/Odello water right to the three Cal-Am wells would result in increased pumping from these wells. The issue presented is whether or not these increases in pumping of these wells will significantly increase stress to riparian vegetation that relies on groundwater when soil-moisture declines after the rainy season.

McNiesh (1986) assessed the influence of groundwater drawdown on riparian vegetation, looking specifically at vegetation near several Cal-Am wells within the lower Carmel Valley. He was able to discern a significant correlation between groundwater drawdown and water-stress levels in plants, establishing guidelines that could be used to determine if and when supplemental irrigation is needed to maintain a healthy riparian corridor. His findings are summarized as follows:

- Drawdown (relative to winter base levels) of less than 1 foot over a 7-day period, or total seasonal drawdown of less than 4 feet, has little to no effect on riparian stress.

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[10] Return flow is the 38.4 AF of deep infiltration (water that is neither consumed nor evapotranspirated by irrigated vegetation and percolates below the root zone); undiverted water is the difference between the full water right and the average annual water use (7.8 AF).

- Drawdown of 1 to 2 feet in a 7-day period, or total seasonal drawdown of 4 to 8 feet will result in mild water stress.
- Drawdown of more than 2 feet in a 7-day period or total seasonal drawdown greater than 8 feet will result in severe water stress.
- Rate of groundwater drawdown appears to be a more significant limiting factor than seasonal drawdown, in part because riparian vegetation is better able to acclimate to higher seasonal fluctuations by developing a deeper root system. (Constraints on the rate of drawdown are related to the time it takes for the plant to shift the “active” root zone, which can be an issue regardless of how deep the total root structure is.)

Seasonal drawdown at the Cal-Am wells under existing conditions is regularly 5 to15 feet in normal years, and during drought years groundwater can be as much as 50 feet below ground surface (West Yost, 2013). MPWMD maintains a Riparian Corridor Management Program that includes, among other activities, periodic irrigation around Cal-Am wells in the lower Carmel Valley to offset impacts to vegetation caused by groundwater drawdown (MPWMD, 2013). The irrigation program offsets the tendencies of the wells to diminish the amount of woody riparian vegetation over their drawdown cones. During the 1976-77 drought, loss of substantial amounts of riparian woodland due to prolonged deep drawdowns resulted in very significant bank retreat, deposition in the channel, and loss of instream habitat values for many years. Under current practices, irrigation has proven successful in sustaining the needed riparian fringe and preventing such impacts.

West Yost (2013) estimated the additional drawdown resulting from the proposed project at each of the Cal-Am wells where water would be pumped. For each of these wells, they estimated incremental drawdown at other nearby wells and at the closest point within the Carmel River; the results relative to the Carmel River are summarized in Table 5.

The values listed in Table 5 indicate that the proposed project would result in an approximate 2-4% increase in drawdown relative to existing conditions at the River near the various Cal Am wells. As discussed above, stated ranges of plant stress levels (McNiesh, 1986) are on the order 0 to 4, 4 to 8, and greater than 8 feet of seasonal groundwater decline (relative to winter base levels). While we recognize that these thresholds are somewhat arbitrary and the actual correlation of seasonal groundwater decline relative to riparian stress is a continuum, the scale of potential additional drawdown as a result of the proposed project is small (at most 0.31 foot) relative to threshold range and the existing seasonal fluctuations within the aquifer.

MPWMD bases their irrigation mitigation program on weekly measurements of water level at several monitoring wells within the lower Carmel River aquifer. Riparian irrigation is triggered when certain thresholds that are based on the McNiesh criteria are exceeded. It is possible that the proposed project could trigger irrigation slightly sooner than under existing conditions if the additional project drawdown results in exceedence of an irrigation threshold that would not otherwise have been crossed. However, this potential change in irrigation schedule would not result in a significant change in the amount of water extracted from the aquifer, because:

1. The amount of additional drawdown is small relative to the magnitude of the threshold ranges, and thus unlikely to often result in the crossing of a particular threshold based on the weekly well readings; and

2. The irrigation water applied to the riparian vegetation is, in theory, simply replacing water that would otherwise have been consumed by vegetation, had the water levels not exceeded the stress threshold.

Cumulative Impacts

The West Yost (2013) report and the above discussion describe the proposed project's estimated direct impacts relative to existing conditions. As discussed below, several upcoming projects may affect the potential significance of the impacts of the proposed project on a cumulative basis.

Monterey Peninsula Water Supply Project

In 2012, Cal-Am Water submitted an application for a new water project. The MPWSP consists of several distinct components: a source water intake system (slant wells); a 9.6 million-gallon-per-day desalination plant; a brine discharge system; product water conveyance pipelines and storage facilities; and an aquifer storage and recovery (ASR) system. The project could permit the desalination facility to produce 9,750 acre-feet of water per year[11] of desalinated ocean water to supply water for the Monterey Peninsula. As with the GWR Project (described below), the desalination plant is intended to provide additional supply in order to meet the State Water Board cutback requirements to diversions from the Carmel River watershed. The project is planned to be completed by the end of 2017. Any reductions in Cal-Am pumping as a result of this project would offset potential small impacts associated with the proposed project.

Monterey Peninsula Groundwater Replenishment Project

The Monterey Regional Water Pollution Control Agency (MRWPCA) is currently planning a Groundwater Replenishment Project (GWR Project) that would use reclaimed water from a variety of sources to recharge the Seaside Groundwater Basin. Source-water for the project would be from reclaimed and treated produce wash-water, agricultural tile-drain water, stormwater runoff, and treated municipal effluent. The facility is planned to be operational by the end of 2016 in order to comply with a State Water Resources Control Board Order (SWRCB 2009-0060) to reduce Cal-Am Carmel River diversions to 3,376 AFY.

The primary goal of the project is to:

> "provide 3,500 acre-feet per year (AFY) of high quality replacement water to California American Water Company (or Cal-Am) for delivery to its customers in the Monterey District service area; thereby enabling Cal-Am to reduce its diversions from the Carmel River system by this same amount."[12]

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[11] This project would produce 6,250 AF per year if the GWR Project described below is approved and proceeds on schedule.

[12] Monterey Peninsula Groundwater Replenishment Project Environmental Impact Report, Notice of Preparation, pg. 1; available at http://www.mpwaterreplenishment.org/index.php

This planned reduction in Cal-Am's pumping of water from the Carmel River watershed is forty times the amount of water of the 85.6 AF associated with the proposed project[13].

San Clemente Dam Removal and Carmel River Reroute

San Clemente Dam, constructed on the Carmel River in 1921 approximately 20 miles upstream of the river mouth, has lost nearly all of its usable capacity due to sedimentation in the reservoir. To alleviate seismic safety concerns, to restore habitat, and to improve anadromous fish access to the upper portions of the watershed, California American Water (CAW), the California Coastal Conservancy (CCC), and the national Marine Fisheries Services (NOAA Fisheries) developed a solution that will remove the existing dam, re-route a segment of the Carmel River into lowermost San Clemente Creek, and sequester reservoir sediment within the abandoned arm of the Carmel River (CA DWR, 2012). This project was selected from a number of different alternatives to provide the required benefits to public safety and to reduce potential environmental impacts.

While this is a significant project within the Carmel River watershed, the concerns addressed in the San Clemente Dam Removal and Carmel River Reroute Project EIR relative to downstream impacts were primarily related to potential impacts of sedimentation and increased turbidity within the lower Carmel River (CA DWR, 2012). The proposed project would not involve the construction of any new facilities, and therefore would not result in any impacts relating to sedimentation or increase in turbidity. Moreover, significant impacts to water supply within the lower Carmel Valley were not identified in that EIR. Thus, cumulative effects on flows of the Dam Removal project relative to the proposed project are not expected.

Rancho Cañada Village

The Rancho Cañada project is a residential development proposed within the lower Carmel River valley, adjacent to the Carmel River. The project would replace a portion

[13] Also, it is important to reiterate that the proposed Project would be a change of an existing water right and would not result in a net increase in pumping from the Carmel River aquifer on an annual basis.

of an existing golf course with residential units and a restored riparian open-space corridor. The original proposal included 281 residential units, and the anticipated water use would be less than that currently used to operate and irrigate the existing golf course at the site (Jones and Stokes, 2008). Since that analysis was conducted, the Rancho Cañada project has been reduced to 125 units, and would correspondingly be expected to use even less water. Thus the Rancho Cañada Village project would not result in negative cumulative impacts related to the proposed Eastwood/Odello water rights change petition.

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TABLES

Table 1. Aerial photograph assessment of in-stream conditions in the lower Carmel River, Monterey County, California. This analysis was intended to describe flow and pool conditions in the River relative to conditions at the USGS gage at Via Mallorca. The assessment covered the reach between Highway 1 and Shulte Road (River Mile 6.7).

Date of aerial photograph	Source[1]	Quality[2]	Daily average flow at USGS gage[3]	Pool condition[4]	Riffle condition[5]	Comments	Condition of barrier bar[6]	MPWMD water year type[7]
5/5/2012	Google Earth	Very good	43	all full	all flowing	flow throughout lower Carmel river; kayaker in creek within Golf Course reach downstream of USGS gage	open	dry
12/2/2011	Google Earth	fair (heavy shadows	15	all full	all flowing	continuous flow throughout	closed	dry
11/2/2011	Google Earth	poor (obscured by fog below USGS gage	12	all full	all flowing	appears to be continuous flow above USGS gage (obscured by fog below)	not visible	dry
8/26/2011	Google Earth	good	8	all full	all flowing	appears to be continuous flow throughout entire assessment reach	closed	above normal
2/3/2011	Google Earth	fair - good	61	all full	all flowing	continuous flow throughout	open	above normal
7/13/2010	Google Earth	good	28	all full	almost all flowing	lots of bar area exposed near hwy 1, but still seems to be flowing continuously or near-continuous	closed	above normal
10/27/2009	Google Earth	fair (heavy shadows	24	all full	all flowing	photo only goes up to Valley Greens Dr.; but continuously flowing up to that point	closed	above normal
9/29/2009	Google Earth	good	0	a few have water	most are dry	wetted for 1/3-mile d/s of Shulte Rd, but almost completely dry d/s of that point	closed	normal
9/27/2009	Google Earth	fair	0	a few have water	most are dry	same as 9/29/09	closed	normal
5/24/2009	Google Earth	good	22	all full	all flowing	continuous flow throughout; riffles seem narrower than typical for May conditions	closed	normal
4/18/2009	Google Earth	Very good	58	all full	all flowing	much wetter than 5/24 conditions; photo only goes to USGS gage	open	normal
4/10/2009	Google Earth	very poor (obscured by clouds)	83	n/a	n/a	only single flight line u/s of USGS gage	n/a	normal

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Date of aerial photograph	Source[1]	Quality[2]	Daily average flow at USGS gage[3]	Pool condition[4]	Riffle condition[5]	Comments	Condition of barrier bar[6]	MPWMD water year type[7]
3/18/2009	Google Earth	good	186	all full	all flowing	coverage extends only to just downstream of USGS gage	n/a	normal
8/14/2008	Google Earth	fair	0	all dry	all dry	completely dry (coverage ends 0.4 miles u/s of USGS gage)	closed	normal
7/29/2007	Google Earth	excellent	0	almost all dry	all dry	completely dry u/s of WTP at Carmel Lagoon, with the possible exception of a single pool downstream of Valley Greens Drive	closed	critically dry
6/19/2007	Google Earth	good	0	some have water	some flowing	similar conditions to 5/31/07; photo does not show conditions u/s of Valley Greens Dr.; thread of flow along Odello East property u/s of Hwy 1	closed	critically dry
5/31/2007	Google Earth	very good	0 (flow ceased 10 days previously)	most are dry	most are dry	photo is from 10 days after flow ceased at USGS gage; mostly dry, but short flowing/isolated pool reach u/s of Rancho San Carlos Rd. and d/s of Shulte Rd.; also appears to be flowing just u/s of Hwy 1	closed	critically dry
9/27/2006	Google Earth	good	0	most are dry	very few have flow	coverage only to just below Valley Greens Dr.; possible wetted conditions just d/s of VG Dr.; wetted reach d/s of Shulte Rd.	n/a	wet
6/6/2006	USGS	very good	67	all full	all flowing	continuous surface flow (d/s end of coverage at Hwy 1)	n/a	wet
5/24/2006	Google Earth	fair-good (some clouds)	117	all full	all flowing	continuous flow	open	wet
12/31/2004	Google Earth	good	2320	all full	all flowing	continuous flow	open	wet
6/30/2004	Google Earth	fair (poor resolution)	0	almost all dry	all dry	short wetted segment d/s of Shulte Rd; otherwise dry	closed	below normal

Table 1. Aerial photograph assessment of in-stream conditions in the lower Carmel River, Monterey County, California. This analysis was intended to describe flow and pool conditions in the River relative to conditions at the USGS gage at Via Mallorca. The assessment covered the reach between Highway 1 and Shulte Road (River Mile 6.7).

Date of aerial photograph	Source[1]	Quality[2]	Daily average flow at USGS gage[3]	Pool condition[4]	Riffle condition[5]	Comments	Condition of barrier bar[6]	MPWMD water year type[7]
10/1/2002	Google Earth	good	0	all dry	all dry	completely dry u/s of WTP at Carmel Lagoon	closed	normal
6/8/2002	USGS	poor	6	all full	possibly most are flowing	appears to be thin thread of flow throughout; possibly dry near RSC Rd.	closed	below normal
9/6/1998	Google Earth	poor (especially u/s of Hwy 1)	15	all full	all flowing	difficult to discern flow in downstream reach, but it appears to be there, especially given the conditions at the barrier bar	open (?)	extrememly wet
5/13/1994	USGS	poor (scale)	9.2	all full	all flowing	seems to have continuous flow	n/a	critically dry
8/27/1993	USGS	fair/poor	0	likely most are dry	most are dry	coverage only to Valley Greens Dr.; channel appears dry, but difficult at this scale and wash-out of photo; might be evidence of a thread several hundred feet u/s of hwy 1	closed	wet
6/12/1993	USGS	fair/poor	33	all full	all flowing	possible dry riffle d/s of Valley Green Dr.; very thin or discontinuous thread through golf course d/s of USGS gage; otherwise looks like continuous thread	n/a	wet
6/15/1989	USGS	poor	0	some have water	some are flowing	threaded channel is present at and just below Shulte; very difficult to see d/s of VGD, but appears dry	closed	critically dry
7/22/1987	USGS	poor	0	most are dry	possibly some riffles flowing	channel either color-washed out or has no flow; possibly thin thread just d/s of VGD, and d/s of Shulte Rd, but appears very dry from RSC Rd. to Lagoon	closed	dry

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Date of aerial photograph	Source[1]	Quality[2]	Daily average flow at USGS gage[3]	Pool condition[4]	Riffle condition[5]	Comments	Condition of barrier bar[6]	MPWMD water year type[7]
3/12/1973	USGS	good	715	all full	all flowing	fairly high flow in River; almost no bar exposure d/s of RSC Rd; some bars exposed u/s of RSC Rd, but channel is mostly full from bank-to-bank	n/a	wet
11/22/1972	USGS	poor	19	n/a	n/a	resolution not good enough to assess flow conditions	n/a	wet
10/25/1972	USGS	fair	0	almost all dry	almost all dry	stream appears completely dry with possible exception of at and u/s of Shulte Rd.	closed	wet (critically dry in WY1972)
10/28/1970	USGS	fair	0	most are dry	most are dry	appears to be wetted reach at and just u/s of Vally Greens Dr.; then dry to Shulte; dry d/s of VGDr.	closed	below normal
5/18/1968	USGS	poor (resolution)	0.26	unknown	possibly most are flowing	thin thread of flow in some locations, obscured in others; resolution too poor to identify breaks in surface flow	closed	critically dry
5/14/1956	UC SCz Library	fair (poor resolution but relatively veg-free)	n/a	all full	all flowing	appears to be continuously flowing	open	wet
5/22/1954	USGS	good	n/a	all full	almost all are flowing	heavy riparian in lower section, but exposed riffles all have flow; might be dry in several hundred foot reach d/s of Sulte (appears to be in-stream dam at Shulte)	open	dry
7/15/1953	USGS	poor	n/a	n/a	n/a	only covers very upstream end of reach; difficult to assess conditions given photo resolution	n/a	normal

[1] USGS photos were downloaded from www.earhexplorer.usgs.gov.

[2] Photo quality (subjective classification) based on ability to assess in-stream pool and riffle conditions; poor resolution or contrast, prominent shadows, presence of clouds, heavy riparian vegetation, and other factors affected the quality of this assessment.

[3] USGS gage 11143250 at Via Mallorca; period of record is 1962 to present.

Table 1. **Aerial photograph assessment of in-stream conditions in the lower Carmel River, Monterey County, California.** This analysis was intended to describe flow and pool conditions in the River relative to conditions at the USGS gage at Via Mallorca. The assessment covered the reach between Highway 1 and Shulte Road (River Mile 6.7).

Date of aerial photograph	Source[1]	Quality[2]	Daily average flow at USGS gage[3]	Pool condition[4]	Riffle condition[5]	Comments	Condition of barrier bar[6]	MPWMD water year type[7]

[4] Condition of riffles (flowing or dry) within the assessment reach as observed in aerial photograph; intended to represent general conditions, not as a catalog of the condition at every riffle; flowing riffles were most easily identified where channel threads cross from one bank to the other across a medial channel bar.

[5] Condition of pools (full, dry, etc.) within the assessment reach as observed in aerial photograph; intended to represent general conditions, not as a catalog of every pool that contains water, as some pools are obscured or otherwise not detectable in photographs due to photo quality.

[6] Condition of the mouth of the Carmel River (as observed in aerial photograph), which is periodically closed due to the build-up of a barrier beach under low-flow conditions.

[7] A water year begins on October 1 and ends on September 30 of the named year. For example, water year 2013 (WY 2013) began on Oct. 1, 2012, and concluded on September 30, 2013. Water year type is listed strictly by water year, even though conditions observed in aerial photos from early in the water year are more representative of the previous water year type.

Table 2. Comparison of monthly pumping rates for the Odello/Eastwood agricultural well to the estimated pumping for municipal supply under the proposed water rights change petition. This comparison shows that there will be the same or less water pumped from the Carmel River Aquifer during the months of May through October, and slightly more water pumped during November through April. Thus streamflow in the Carmel River is expected to be the same or higher from May through October, and slightly less from November through April. See Table 3 for summary of impacts related to this change.

	Jan *(cfs)*	Feb *(cfs)*	Mar *(cfs)*	Apr *(cfs)*	May *(cfs)*	Jun *(cfs)*	Jul *(cfs)*	Aug *(cfs)*	Sep *(cfs)*	Oct *(cfs)*	Nov *(cfs)*	Dec *(cfs)*
Existing conditions (agricultural consumption at the Odello/Eastwood property)[1]	0.05	0.05	0.07	0.11	0.15	0.18	0.18	0.18	0.16	0.14	0.09	0.06
Post-project conditions (municipal pumping at the Cañada #2, Cypress, and Pearse wells)[2]	0.10	0.10	0.10	0.13	0.15	0.15	0.16	0.16	0.15	0.14	0.11	0.11
Estimated change in pumping rate (post-project minus existing conditions)	0.05	0.05	0.04	0.02	0.00	-0.03	-0.02	-0.02	-0.01	0.00	0.02	0.04

Notes:

[1] Agricultural consumption includes only that portion of the water right being transferred for municipal supply (the portion consumed by crops during irrigation); the remainder of the water right will be held on-site to be used to support riparian functions; (Davids Engineering, 2013).

2 Post-project pumping at Cal-Am wells was estimated based on maximum pumping amounts from recent Cal-Am water demand patterns; see Macaulay (2013) for full discussion.

Table 3. Summary of potential impacts to streamflow between Shulte Road and Highway 1 as a result of the Odello/Eastwood water rights change petition, lower Carmel River watershed, Monterey County, California. Days were calculated using the USGS "Near Carmel" daily streamflow record (1963-2013). Post-project conditions were calculated by adding/subtracting the potential maximum change in average monthly pumping rate of the Odello/Eastwood proposed points of diversion to/from the daily flow at the USGS gage. See Table 2 for summary of these temporal shifts in pumping.

		Days of constraint to fall/winter downstream migration[1]			Days of constraint to spring smolt outmigration[2]			Days of constraint to summer juvenile rearing[3]		
Year type[4]	Number of years in record	Pre-project average days per year	Post-project average days per year	Change in number of days per year	Pre-project average days per year	Post-project average days per year	Change in number of days per year	Pre-project average days per year	Post-project average days per year	Change in number of days per year
Extremely Wet	7	75.7	76	0.3	0	0	0	93.7	93.7	0
Wet	6	80.2	80.7	0.5	0	0	0	142.2	142.2	0
Above Normal	8	67.9	68.1	0.2	1.3	1.3	0	97.3	97.8	0.5
Normal	11	70.5	72.9	2.4	5.1	5.1	0	144.8	144.9	0.1
Below Normal	5	80.4	80.6	0.2	12.6	12.6	0	176.8	177.4	0.6
Dry	6	80.5	81.3	0.8	25.8	25.8	0	163	163.2	0.2
Critically Dry	9	152.9	153.3	0.4	55.3	55.6	0.3	209	209.3	0.3
All years	52	88.3	89.1	0.8	15.0	15.1	0.1	146.6	146.8	0.2

Notes:

[1] Downstream migration is constrained when Carmel River flows fall below 10 cfs during the months of October through March, per Aquatic resources analysis in the ASR EIR (Jones and Stokes, 2006). Note that this analysis includes days of zero flow early in the wet season prior to high flows that might trigger outmigration, so the actual number of constraining days would be less. The change in the number of days, however, is likely reflective of actual change in constraining days.

[2] Smolt outmigration is constrained when Carmel River flows fall below 10 cfs during the months of April and May, per Aquatic resources analysis in the ASR EIR (Jones and Stokes, 2006).

[3] Juvenile rearing habitat is constrained when flow at the Near Carmel gage falls below one cfs during the months of June-December, per Aquatic resources analysis in the ASR EIR (Jones and Stokes, 2006). It is important to note that the lower Carmel is completely dry during much of this period.

[4] Water year type as classified by MPWMD. A water year begins on October 1 and ends on September 30 of the named year. For example, water year 2013 (WY 2013) began on Oct. 1, 2012, and concluded on September 30, 2013.

Table 4. Preliminary assessment of critical flows for fish passage in the lower Carmel River.

Riffle location	Existing conditions				With project					
	Adults		Smolt		Adults			Smolt		
	Flow[1] *(cfs)*	Depth[2] *(ft.)*	Flow[1] *(cfs)*	Depth[2] *(ft.)*	Flow[3] *(cfs)*	Depth[4] *(ft.)*	Change in depth *(ft.)*	Flow[3] *(cfs)*	Depth[4] *(ft.)*	Change in depth *(ft.)*
0.36 miles downstream of Via Mallorca	60	0.70	16	0.30	59.84	0.70	0.00	15.84	0.30	0.00
0.20 miles upstream of Via Mallorca	36	0.70	11	0.30	35.84	0.68	-0.02	10.84	0.30	0.00
0.14 miles upstream of Rancho San Carlos Rd.	56	0.70	13	0.30	55.84	0.70	0.00	12.84	0.29	-0.01
0.42 miles downstream of Valley Greens Dr.	25	0.70	13	0.30	24.84	0.70	0.00	12.84	0.29	-0.01

[1] Calculated flow that meets the cooresponding depth criteria for 25% of the width of the riffle.

[2] Critical depth for fish passage, per CDFG (2013).

[3] Critial flow minus 0.16 cfs (proposed maximum sustained Project pumping rate)

[4] Calculated depth of the critical flow with Project pumping.

Table 5. Summary of estimated additional drawdown at Cal-Am wells as a result of the proposed Eastwood/Odello water rights change petition. Results show the incremental additional drawdown that could be attributed to the Project if all of the proposed Project water were pumped from the listed well.

Well	Distance to Carmel River (feet)	Additional drawdown (ft.) after 30 days of sustained pumping	Additional drawdown (ft.) after 100 days of sustained pumping
Cañada #2	121	0.21	0.25
Cypress	137	0.25	0.31
Pearse	477	0.08	0.1

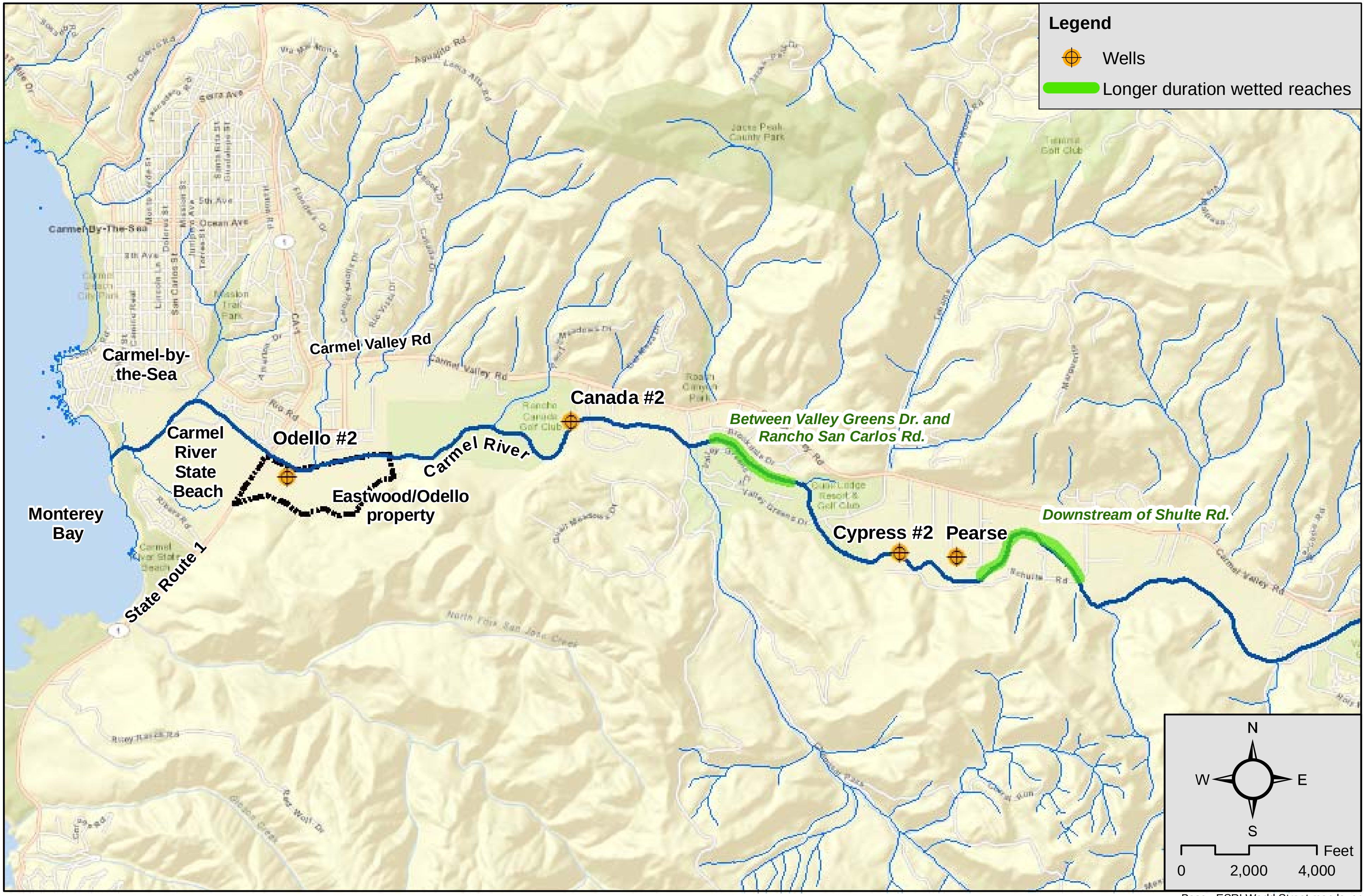
FIGURES

Base: ESRI World Street map layer

Balance Hydrologics, Inc.

213116 Fig 1 loc.mxd

Figure 1. Project location and road crossings map, lower Carmel River Watershed, Monterey County, California.



Base: ESRI World Street map layer

Balance Hydrologics, Inc.

213116 Fig 2 wells.mxd

Figure 2. Location of wells within the lower Carmel River basin. Map also shows locations of stream reaches (in green) that remain wetted for slightly longer durations than the rest of the lower Carmel River.

Flow = 58 cfs
Riffle width = 38 ft.

Flow = 22 cfs
Riffle width = 21 ft.

Flow = 8 cfs
Riffle width = 16 ft.

Source (all photos): Google Earth

Balance Hydrologics, Inc.®

Figure 3. Comparison of riffle widths at different flows, Lower Carmel River, Monterey County, California. The riffle shown in the photos is located 0.3 miles downstream of the USGS gaging station at Via Mallorca. Yellow bars mark the location of a width measurement representative of the riffle. All three photos are shown at the same scale (photo width ~ 420 feet). Flow values shown are daily mean flow at the USGS gage reported on the day the photo was taken.

Base: ESRI World Street map layer

Balance Hydrologics, Inc.

Figure 4. Location of riffles used to assess fish passage flows within the lower Carmel River

213116 Fig 4 riffles.mxd

Appendix C-2

Addendum to Geomorphic & Hydrologic Context Memorandum (Balance, 2014b)

Memorandum

To: Denise Duffy, Denise Duffy & Associates

From: Scott Brown and Ed Ballman

Date: April 29, 2014

Subject: Addendum to 'Geomorphic and hydrologic context' memorandum for Eastwood/Odello water rights change petition, Monterey County, California

Introduction

In January 2014, Balance Hydrologics prepared a memorandum titled 'Geomorphic and hydrologic context for Eastwood/Odello water rights change petition, Monterey County, California'. Several parties have inquired about how the analysis and results in that memorandum compare to the results of a series of critical riffle monitoring studies performed by MPWMD between 2010 and 2013. The MPWMD studies (Hamilton, 2010, 2011, 2012, and 2013) were conducted in connection with the mitigation monitoring requirements in MPWMD's Aquifer Storage and Recover project FEIR (2006).

This memorandum discusses the findings of our analysis regarding the potential impacts to adult steelhead migration fish passage that could occur as a result of implementation of the Eastwood/Odello water rights change petition project, as these findings relate to the findings in the MPWMD reports.

Discussion

MPWMD conducted annual surveys of the lower Carmel River (downstream of River Mile 5.5) to assess locations and conditions where upstream migration of adult steelhead might be constrained or blocked. At each of five locations of potential impairment, MPWMD surveyed channel cross-sections and compared the results to impairment and blockage criteria that were described in the ASR FEIR (see Hamilton, 2010-2013, for descriptions of the specific methods that MPWMD used). The following table summarizes the results of MPWMD's analysis:

Water Year	Blocked Riffles	Impaired Riffles	Non-impaired Riffles
2010	1 site blocked (at 48 cfs)	1 site impaired (at 57 cfs)	no impaired riffles at 159, 89, and 73 cfs
2011	none	some impaired riffles at 73, 84, and 94 cfs	no impaired riffles at 99 and 122 cfs
2012	1 site blocked (at 50 cfs)	3 sites impaired (at 62 and 68 cfs)	no impaired riffles at 103 and 78 cfs
2013	none	2 sites impaired (at 77 cfs)	3 sites not impaired (at 77 cfs)

While riffle configuration and conditions can vary from year to year, the results of MPWMD's studies that are summarized above generally indicate that upstream adult steelhead migration passage at some riffles is likely to be blocked at river flows of less than 50 cfs, may be impaired at river flows between 50 and 90 cfs, and is unlikely to be impaired at river flows greater than 90 cfs.

To prepare the analysis described in our January 2014 memorandum, Balance utilized a HEC-RAS model for four riffle locations in the lower Carmel River to assess the potential magnitude of impacts to fish passage that could occur as a result of implementation of the Eastwood/Odello water rights change petition project (see Table 4 and Figure 4 in Brown and Ballman, 2014). The results of our analysis indicate that critical river-flow thresholds for adult upstream migration in the lower Carmel River are on the order of 25 to 60 cfs, and that the reductions in depth that would occur as a result of implementation of the Eastwood/Odello project at these river flows would be less than 0.02 feet at one of the four riffles and less than 0.005 feet (essentially zero) at the other three riffles[1].

[1] We also assessed critical flows for smolt migration, but the MPWMD studies only dealt with adult migration, so we address only this type of migration in this memorandum.

Conclusions

The results of our previous analysis of critical flows for adult steelhead upstream migration passage indicate that passage in the lower Carmel River can be constrained or blocked at river flows between 25 and 60 cfs. These river flows are somewhat less than, but of similar magnitude to, the range of threshold river flows for 'blocked' and 'impaired' conditions that are identified in the MPWMD reports. If the critical river flow thresholds for adult steelhead upstream migration passage in the lower Carmel River are, in fact, greater than the river flow thresholds we identified in our analysis (as the MPWMD reports suggest), then the potential impacts of the Eastwood/Odello project on upstream adult steelhead migration passage depths would probably be even less than the maximum 0.02-foot depth reduction discussed in our memorandum. This is because, at the critical river flow thresholds identified in the MPWMD reports, the potential reduction of 0.16 cfs in river flow that could occur with implementation of the Eastwood/Odello project would be lower percentages of the river flows than the percentages of the 0.16 flow reduction to the threshold river flows that we identified in our analysis. For this reason, we would expect that the Eastwood/Odello project would have similar or lesser impacts on river depths at the critical riffles at the MPWMD range of critical river flow thresholds[2].

The additional information in the MPWMD reports therefore indicates that our analysis of the potential impacts of the Eastwood/Odello project on adult steelhead migration passage resulted in equal or greater estimated impacts than the estimated impacts that resulted from the flows described in the MPWMD analysis. Our January 2014 memorandum therefore accurately describes, or may overestimate, the very small changes in riffle water depth at critical flows that could result from implementation of the Eastwood/Odello water rights change petition project.

[2] In other words, if 25 to 60 cfs minus 0.16 cfs results in a 0.02-foot or less reduction in depth, we would expect a similar or lower-magnitude reduction in depth for 50 to 90 cfs minus 0.16 cfs.

References

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