CALIFORNIA COASTAL COMMISSION
CENTRAL COAST DISTRICT OFFICE
725 FRONT STREET, SUITE 300
SANTA CRUZ, CA 95060
PHONE: (831) 427-4863
FAX: (831) 427-4877
WEB: WWW.COASTAL.CA.GOV

F10b

Click here to see additional correspondence received.

Appeal filed:	7/21/2010
49th day:	waived
Staff report prepared:	2/17/2011
Staff report prepared by:	J.Bishop
Staff report approved by:	D.Carl
Hearing date:	3/11//2011

APPEAL STAFF REPORT
SUBSTANTIAL ISSUE DETERMINATION

Appeal number.....**A-3-SLO-10-039, Main Street Bridge Replacement**

Applicant.....San Luis Obispo County Public Works Department

Appellant.....Lynne Harkins

Local government .....San Luis Obispo County

Local decision .....Approved by San Luis Obispo County on June 22, 2010 (Coastal Development Permit (CDP) DRC2009-00041).

Project location .....Bridge crossing (over Santa Rosa Creek) at and directly east of the Main Street/Santa Rosa Creek Road intersection in the community of Cambria.

Project description.....Construction of a new 2-lane bridge and related elements (including abutment work, road approach modifications, and rip-rap along stream channel), removal of the existing 2-lane bridge (once the new bridge is finished), and restoration along former bridge alignment.

File documents.....Administrative record for San Luis Obispo County CDP DRC2009-00041; San Luis Obispo County Appeal Response (Additional Information dated January 12, 2011); San Luis Obispo County certified Local Coastal Program (LCP).

Staff recommendation ...**No Substantial Issue**

A. Staff Recommendation

1. Summary of Staff Recommendation

San Luis Obispo County approved a CDP authorizing the County Public Works Department to replace the Main Street Bridge with a new bridge on a parallel alignment over Santa Rosa Creek in the community of Cambria. The County's CDP action was appealed to the Commission, with the Appellant contending that the project does not meet LCP requirements for protecting and enhancing environmentally sensitive habitat area (ESHA)/Santa Rosa Creek, the scenic and visual character of the area, and public access. In sum, the Appellant contends that other alternative alignments and bridge designs would better protect coastal resources.

The San Luis Obispo County LCP requires the protection of scenic coastal areas, unique and attractive features of the landscape, unusual landforms, scenic vistas, and sensitive habitats. The LCP also contains a specific requirement for bridge construction over creeks requiring that an approved bridge project be the least environmentally damaging feasible alternative.

The County indicates that the replacement bridge is necessary because the existing bridge does not meet the traffic and safety needs of the community. As described by the County, the existing bridge on Main Street is inadequate to provide safe passage over the long term. The bridge has been designated functionally obsolete by Caltrans under federal standards due to deck geometry and load capacity. The County has also raised concerns regarding public safety, citing evidence of bridge rail strikes by vehicles.

The proposed project would replace the existing two lane 30-foot wide by 90-foot long T-girder bridge and center pier support (i.e., in the creek bed) with a 37.5-foot wide by 150-foot long cast-in-place concrete single span bridge (without any in-creek supports). In order to support the new clear span bridge, the project includes construction of abutments at the creek bank edge and the placement of rip-rap to protect the abutments. The project also includes realignment of Main Street upstream of the existing bridge, realignment of the Main Street/Santa Rosa Creek intersection, as well as demolition and removal of the existing bridge after the new bridge is constructed. The former bridge location and areas surrounding the new bridge would be restored.

According to the County's environmental documents, project plans, and supplemental information, the project will temporarily disturb approximately 0.68 acres of stream habitat in and around the bridge area, and will require that 2 oak trees and 17 willows be removed. The project will also allow for existing abutments and supports that currently extend into the stream corridor to be removed, and for this area to be restored to a more natural stream geometry and vegetation community. Specifically, the project includes various restoration components, including removal of exotic plant species in the area, restoration of the area from which the old bridge would be removed, and extensive planting of natives in and around the project site. All told, habitat restoration and enhancement will occur over roughly an acre. Thus, although the proposed project will have some riparian corridor impacts, it will also result in some significant benefit; particularly in relation to removing the existing in-stream support column and pulling out the large area of abutment on either side of the creek bed that currently constrict Santa Rosa Creek at this location.

The LCP contemplates and allows some level of stream habitat impacts for such a project. The key factor in this LCP analysis is determining the least environmentally damaging feasible alternative. At this site, the analysis boils down to two primary issues: 1) whether the replacement bridge can be located on the same alignment to potentially reduce impacts; and 2) abutment methods and the degree of abutment protection necessary.

With respect to the question of alignment alternatives, information has been provided by the County demonstrating that the estimated linear stream channel and area of habitat impacts are comparable for each of the alignment alternatives considered (upstream, downstream, and existing alignment). Staff has reviewed this information and believes that it fairly represents potential impacts in each scenario,

including because construction access necessarily affects a larger area than any potential final alignment in all cases. Likewise, post-construction habitat restoration measures for each scenario will generally improve the overall habitat conditions in the area equally. As such, the County believes that the approved upstream alignment is the least environmentally damaging feasible alignment alternative. Staff generally agrees that the environmental impacts to habitat of each of the alignments appear to be similar, such that there is not an environmentally preferable siting alternative based solely on analyzing impacts to the stream and adjacent habitat from among the choices.

Other project elements highlighted by the County in support of the upstream alignment include avoiding road closures and traffic control during construction, as well as improved roadway geometrics and access restrictions to adjacent properties for the completed project. According to the County, when all factors are considered, the selected upstream alignment is the least environmentally damaging feasible alignment, and also the project that best meets the overall community objectives. The County's rationale in this respect appears sound, and Commission staff concurs that the proposed upstream alignment will result in fewer impacts to traffic and will avoid significant re-alignment of adjacent driveways, which would create environmental impacts of their own. Thus, the proposed upstream alignment is the least environmentally damaging feasible alignment in this circumstance, consistent with the LCP.

Given that determination, the next question is whether the County could use alternative bridge/abutment designs to further limit stream habitat impacts. The primary questions in this respect are whether to use rip-rap and lesser abutment structures (as proposed), or to use greater abutment structures without rip-rap, including potentially using more substantial and deeper caissons located further away from the creek bank and requiring a longer span. In sum, the rip-rap abutment methodology, where the rip-rap is embedded in the creek bank and covered with soil and vegetated with riparian species, as proposed, appears to result in less habitat harm in the long run, and less coastal resource impacts overall. On this point staff notes that this issue has previously arisen for County bridge projects on appeal before the Commission, and that the County has demonstrated that it has been successful in integrating rip-rap covered in vegetation into similar creek environs.

Thus, staff believes that the bridge siting and design is consistent with the LCP in terms of stream habitat issues.

The Appellant also contends that the County-approved project is inconsistent with the shoreline access policies of the LCP because the County approved bridge design does not adequately foster pedestrian and bicycle use. In this case, the County evaluated a variety of access improvements to the bridge design. The County concluded that a 5-foot wide striped shoulder (Class II bikeway) was appropriate in this case. To reduce creek bank impacts the County reduced the overall bridge width by using 5-foot wide shoulders instead of 8-foot wide shoulders. There is no curb, gutter, or sidewalk on this stretch of Main Street and the County believes that pedestrian access on this bridge would not be safe. Commission staff has visited the site and concurs that given the inland location of the bridge (roughly 3 miles from the shoreline) and various site constraints (sensitive habitats, steep slopes, narrow road prism, limited site lines, and higher traffic speeds in the area), it is not necessary to incorporate a dedicated pedestrian accessway on the bridge for LCP compliance. Main Street at this location is not a primary public recreational access corridor, and it is not likely to become an access corridor of the type

necessitating Class I dedicated pedestrian/bicycle components. On the contrary, this stretch of Main Street is well inland from the coast in an area where a bike lane, as proposed, should offer adequate space within which recreational pedestrian and bicycle access can occur consistent with the LCP. An argument could be made that future public recreational access needs might be different than they are today, but there are no LCP plans for that to occur here, and the setting (including steep topography approaching the bridge) is not generally conducive to this location becoming more than an offshoot from the main coastal trail in this area, including with respect to the CCT. In addition, the idea of requiring dedicated bridge space would also require more stream habitat impact, and such a trade-off does not appear warranted under the LCP in this case. As it is, the project would widen the bridge from what is present now (going from about 30 to 37 feet in width), and will provide more space within which shared public access activities should be able to be adequately accommodated. Thus, this particular appeal contention does not raise a substantial issue.

The Appellant also contends that the new bridge would not adequately protect the public viewshed, and would not be consistent with the character of the area. The new bridge would be made of concrete, and would include 3-foot tall see-through barriers on either side. While different from the look of the existing bridge, the new bridge is best described as fairly low key, and should effectively blend into the setting over time, consistent with LCP requirements. Thus, this appeal contention also does not raise a substantial issue.

In conclusion, it is clear that the appeal raises some valid coastal resource questions. In the time since this matter was appealed, staff has researched bridge design standards and related issues, and spent considerable time coordinating with the County to best understand bridge related issues and requirements as they apply to this site. The conclusion of these efforts is that it appears that the County approved project has been designed in a manner that avoids coastal resource impacts as much as possible and includes appropriate restoration/enhancement to offset impacts, and that there isn't a feasible bridge replacement project that would lead to significantly less resource degradation. Moreover, the project overall will result in significant restoration/enhancement of this stream reach, including by moving significant abutment area out of the stream channel, eliminating the existing center bridge support in favor of a longer clear span, and aggressive restorative planting throughout. So, although the appeal raises some valid questions regarding the proposed project's environmental impacts, the project appears to be fully consistent with the LCP, so that the appeal contentions do not raise a substantial issue regarding the project's conformance with the LCP.

Staff recommends that the Commission find that the appeal raises no substantial issue and decline to take jurisdiction over the CDP for this project. The motion and the resolution to implement this recommendation are found directly below.

2. Staff Recommendation on Substantial Issue

Staff recommends that the Commission determine that **no substantial issue exists** with respect to the grounds on which the appeal was filed. A finding of no substantial issue would mean that the County's decision in this matter would be final (conversely, a finding of substantial issue would bring the project under the jurisdiction of the Commission for hearing and action).

Motion. I move that the Commission determine that Appeal Number A-3-SLO-10-039 raises no substantial issue with respect to the grounds on which the appeal has been filed under Section 30603 of the Coastal Act. I recommend a yes vote.

Staff Recommendation of No Substantial Issue. Staff recommends a **YES** vote. Passage of this motion will result in a finding of No Substantial Issue and adoption of the following resolution and findings. If the Commission finds No Substantial Issue, the Commission will not hear the application de novo and the local action will become final and effective. The motion passes only by an affirmative vote by a majority of the Commissioners present.

Resolution to Find No Substantial Issue. The Commission hereby finds that Appeal Number A-3-SLO-10-039 does not present a substantial issue with respect to the grounds on which the appeal has been filed under Section 30603 of the Coastal Act regarding consistency with the certified Local Coastal Program and/or the public access policies of the Coastal Act.

Report Contents

B.Findings and Declarations

The Commission finds and declares as follows:

1. Project Location

The project area is located approximately three miles inland from the Pacific Ocean on Main Street in Cambria. This portion of Main Street is slightly out of the main downtown area, and functions as the eastern entrance to the community, providing access from Highway One to Santa Rosa Creek Road and further on into the town of Cambria. About ¼-mile past the bridge site, Main Street transitions into the heart of downtown Cambria, ultimately reconnecting to Highway One near the ocean.[1]

Main Street Bridge lies east of the downtown village at the mouth of a narrow valley near the confluence of Santa Rosa and Fiscalini creeks. Santa Rosa Creek is a perennial creek and originates in the steep Santa Lucia Range and flows through the community of Cambria to the ocean. Hilly terrain is located both to the north and east, peaking at Scott Rock, a prominent geologic feature and landmark east of the bridge. Relatively flat valley floor terrain is located in the immediate area surrounding the bridge and on the pastureland to the southwest.

Main Street Bridge was constructed as part of State Highway One in 1922, prior to the realignment of Highway One further west in the 1960's. The existing bridge is comprised of two T-girder spans, each about 45 feet long. The existing bridge has a center pier, which has a history of catching debris during flood events. As debris accumulates on the existing pier, the flood water is constricted and the creek backwater rises, contributing to flooding, pier scour, and bank erosion. The bridge has been deemed functionally obsolete[2] by Caltrans due to inadequate deck width and load capacity, and has been subject to persistent scour, especially at the center pier in the Santa Rosa Creek channel (see Exhibits 1 and 2).

2. Project Description

The proposed project would replace the Main Street Bridge with a new bridge on a parallel alignment. The new bridge construction will involve: construction of a new 37.5 ft. wide and 150 ft. long cast in place concrete bridge, realignment of Main Street to the upstream side of the existing bridge, realignment of the Main Street/Santa Rosa Creek Road intersection including construction of acceleration and deceleration tapers, creek work including potentially diversion or dewatering and placement of rip-rap on the banks, demolition and removal of the existing bridge structure, and complete restoration of the construction area (see Exhibit 3 for project Site Plan/Detail).

A. Site Preparation

Initial construction activities would include clearing, grubbing, removing and disposing of vegetation and debris in the construction zone. In addition to the bridge location itself, the construction zone would also include a construction staging area. Equipment access to the creek bed would be provided at the bridge, likely requiring the construction of a dirt access road down the bank and into the channel itself.

[1] In other words, Main Street provides a "loop" from inland Highway One that extends into Cambria and then back to Highway One again.

[2] The functional obsolete designation is a design or configuration issue not one of structural adequacy. The federal government will designate a bridge as "functionally obsolete" if the number of lanes on the bridge doesn't meet current standards, the vertical clearance above the bridge is restrictive or the roadway alignment is not ideal. Additionally, a bridge may be designated functionally obsolete if it has a lower load capacity or water frequently overtops the bridge.

The proposed project would also involve roadway excavation, embankment construction, and disposal of material.

The County proposes a summer work window to avoid times when the creek flows more substantially. Should the creek have water at that time, the County would divert the creek flow in the construction area (about a 200-foot long stream section) using temporary cofferdams constructed of visqueen and sandbags filled with clean sand. The cofferdam structure would include a culvert sized to promote a minimum of six-inch water depth, and movement of fish through the project area. The County has prepared a Diversion and Dewatering Plan for this element of the project.

The County would retain the services of a biological resources monitor who would be involved in pre-construction coordination meetings, grading, erosion control, scheduling, as well as construction activities. In addition, the County has proposed numerous other mitigation measures aimed at reducing the impacts to protected resources prior to commencement of construction (e.g., flagging project limit areas, identifying appropriate equipment staging areas, finalizing drainage, sedimentation, and erosion control plans, and marking trees for protection, etc.).

B. Construction Activities

The replacement bridge would be constructed immediately upstream of the existing bridge on a similar skew to the creek (i.e., at a similar angle) as the existing bridge, which is slightly off perpendicular. The bridge would be 37.5-feet wide (including two 12-foot travel lanes, two 5-foot striped bike lanes (Class II Bikeways), and two 1.9-foot Type 80 concrete barrier railings), and would extend approximately 150 feet across the creek. A single-span, cast-in-place, pre-stressed, concrete box girder bridge is proposed. In addition, roadway work would consist of realigning Main Street to the upstream side of the existing bridge. The intersection of Santa Rosa Creek Road with Main Street just north of the bridge would be reconstructed to conform with the realigned roadway. Main Street would be widened at the intersection to provide standard deceleration and acceleration tapers on Main Street at the intersection. Two driveways just east of the bridge site would also be reconstructed to conform to the realigned roadway.

The new bridge would require concrete support abutments along both banks of the creek. These abutments would be located further away from the creek centerline than the existing abutments and along the top edge of its bank. The abutments would include a series of concrete piles driven down through the soil into shallow bedrock to hold in place the abutment footings (piles would be driven down through the creek bank approximately 71 feet below the footing at the north abutment and 56 feet below the footing at the south abutment). The abutments would be blanketed at their base by approximately 2,500 cubic yards of riprap of various sizes (ranging from 200 to 1,000 pounds). In total there would be roughly 130 linear feet of rock at the north abutment and 115 linear feet of rock placed at the south abutment.

C. Site Restoration

Upon completion of construction activities, the old bridge would be removed and impacted areas would be restored in accordance with a Habitat Restoration Plan prepared for the project. Affected areas would be cleared of construction-related debris, and trenches, holes, and pits created during the construction

phase would be filled. All impacted creek bed areas would be restored to their pre-project condition, and the rock slope protection areas would be capped with soil and aggressively vegetated through the rock. Revegetation efforts would be initiated prior to use and operation of the new bridge; including replanting all affected areas with appropriate riparian species consistent with existing species found in adjacent riparian areas. Plant material for mitigation will be propagated from seeds and cuttings of plants along Santa Rosa Creek. Oaks will be replanted at a ratio of 4:1. Restoration of the old roadbed alignment will include ripping/plowing to minimize soil compaction and hydroseeding with an appropriate native seed mix. Replacement plantings will be maintained for a period of five years or until the plantings are established in the landscape such that they can survive without additional care. Construction is estimated to take 6 to 9 months, and would take place during the dry season when flowing water is low or absent (between May 1 and October 31) to minimize impacts on creek resources.

3. San Luis Obispo County CDP Approval

The proposed project was originally approved on April 16, 2010 by the Administrative Hearing Officer at the Planning Department. The Administrative Hearing Officer's decision was subsequently appealed to the County Board of Supervisors by Lynne Harkins, the current Appellant to the Commission. On June 22, 2010 the Board of Supervisors affirmed the decision of the Administrative Hearing Officer, thus approving a CDP the project.

Notice of the Board of Supervisor's action on the CDP was received in the Coastal Commission's Central Coast District Office on July 7, 2010 (see Exhibit 4). The Coastal Commission's ten-working day appeal period for this action began on July 8, 2010 and concluded at 5 p.m. on July 21, 2010. One valid appeal (see below) was received during the appeal period.

4. Appeal of San Luis Obispo County CDP Approval

A. Appeal Procedures

Coastal Act Section 30603 provides for the appeal to the Coastal Commission of certain CDP decisions in jurisdictions with certified LCPs. The following categories of local CDP decisions are appealable: (a) approval of CDPs for development that is located (1) between the sea and the first public road paralleling the sea or within 300 feet of the inland extent of any beach or of the mean high tide line of the sea where there is no beach, whichever is the greater distance, (2) on tidelands, submerged lands, public trust lands, within 100 feet of any wetland, estuary, or stream, or within 300 feet of the top of the seaward face of any coastal bluff, and (3) in a sensitive coastal resource area; or, for counties, approval of CDPs for development that is not designated as the principal permitted use under the LCP. In addition, any local action (approval or denial) on a CDP for a major public works project (including a publicly financed recreational facility and/or a special district development) or an energy facility is appealable to the Commission. This project is appealable on three separate grounds: 1) it involves development located within 100 feet of a wetland/stream; 2) it is located in a sensitive coastal resource area; and 3) it involves a major public works project.

The grounds for appeal under Section 30603 are limited to allegations that the development does not conform to the certified LCP and/or to the public access policies of the Coastal Act. Section 30625(b) of the Coastal Act requires the Commission to conduct a de novo CDP hearing on an appealed project unless a majority of the Commission finds that "no substantial issue" is raised by such allegations. Under Section 30604(b), if the Commission conducts a de novo hearing and ultimately approves a CDP for a project, the Commission must find that the proposed development is in conformity with the certified LCP.

The only persons qualified to testify before the Commission on the substantial issue question are the Applicant, persons who made their views known before the local government (or their representatives), and the local government. Testimony from other persons regarding substantial issue must be submitted in writing. Any person may testify during the de novo CDP determination stage of an appeal.

B. Summary of Appeal Contentions

The Appellant (Lynne Harkins) contends that the County-approved project raises issues with respect to the project's conformance with core LCP policies related to the protection of ESHA, visual and scenic resources, and public access. In sum, the Appellant contends that other alternative alignments and bridge designs would better protect coastal resources. See Exhibit 5 for the full appeal document.

In response to the appeals, the County prepared additional information in support of their action (see documents dated February 20, 2009 and January 12, 2011 in Exhibit 7).

5. Substantial Issue Determination

A. Applicable Policies

The LCP requires protection of ESHA. Santa Rosa Creek and its riparian corridor are identified as Sensitive Resource Areas ("SRAs") and Environmentally Sensitive Habitat Areas (ESHAs) in the LCP. This LCP designation entitles these areas to special protections, including with respect to bridge work specifically that requires the selection of the least environmentally damaging feasible alternative (LCP ESHA Policies 1-3, 20-23, 25-28, and 29-30; LCP Coastal Zone Land Use Ordinance (CZLUO) Section 23.07.170(d)).

The LCP also requires protection of public viewsheds, character, and aesthetics within the coastal zone. Specifically, the LCP requires the protection of scenic coastal areas and requires that unique and attractive features of the landscape, unusual landforms, scenic vistas, and sensitive habitats be protected (LCP Visual and Scenic Resource Policies 1 and 2).

In addition, like the Coastal Act, the LCP requires maximum public access to be provided with new development projects (LCP Shoreline Access Policy 2).

See applicable LCP policies in Exhibit 6.

B. Analysis

Bridge improvement or replacement projects are typically proposed because of some problem with the bridge itself, and/or because of traffic and safety needs. In such cases, it is important that these problems and needs be clearly identified and substantiated, and that the response be as focused as possible to address the problems while limiting environmental impacts as much as is possible. The County has made a valid case that the bridge on Main Street is inadequate to provide safe passage over the long term. As described, the bridge has been designated functionally obsolete by Caltrans and the County has raised legitimate concerns regarding public safety, including citing evidence of bridge rail strikes by vehicles at this location.

Stream Habitat

The proposed project raises stream habitat ESHA concerns. The proposed project would replace the existing two lane 30-foot wide by 90-foot long T-girder bridge and center pier with a 37.5-foot wide by 150-foot long cast-in-place concrete single span bridge. In order to support the new bridge, the project will require creek bank and creek bed excavation, construction of abutments, and the placement of rip-rap to protect the abutments (a total of 2,500 cubic yards of rip-rap in all). In order to secure the abutments in place, a series of concrete piles would be driven down through the creek bank to an elevation 71 feet below the footing at the north abutment and 56 feet below the footing at the south abutment footings. The new bridge would be a free-span bridge with no in-stream support. The project also includes realignment of Main Street upstream of the existing bridge, realignment of the Main Street/Santa Rosa Creek intersection, as well as demolition and removal of the existing bridge. The former bridge location and areas surrounding the new bridge would be restored.

According to the County's environmental documents, project plans, and supplemental information, the project will temporarily disturb approximately 0.68 acres of stream habitat in and around the bridge area, and will require that 2 oak trees and 17 willows be removed. An additional 6 oak trees and 20 willows will be impacted due to construction activities in close proximity. The project will also allow for existing abutments and supports that currently extend into the corridor to be removed, and for this area to be restored to a more natural stream geometry and vegetation community. Specifically, the project includes various restoration components, including removal of exotic plant species in the area, restoration of the area from which the old bridge would be removed, and extensive planting of natives in and around the project site. The mitigation requirement for oak tree removal is 4:1 for trees removed and 2:1 for trees impacted. Therefore, the County conditions of approval require them to replant a minimum of 20 oak trees and 74 willows. All told, habitat restoration and enhancement will occur over roughly an acre. Thus, although the proposed project will have some riparian corridor impacts, it will also result in some significant benefit; particularly in relation to removing the existing in-stream support column and pulling out the large area of abutment on either side of the creek bed that currently constricts Santa Rosa Creek at this location.

The LCP consistency analysis recognizes that bridge replacement projects have stream habitat impacts given the nature of the environment in which they are necessarily located. In other words, the LCP contemplates and allows some degree of such impacts for such a project. The key factor in this analysis is determining the least environmentally damaging feasible alternative. At this site, that analysis primarily boils down to two primary issues: 1) whether the replacement bridge can be located on the

same alignment to potentially reduce impacts; and 2) abutment methods and the degree of abutment protection necessary.

Alignment Alternatives

With respect to the question of alignment alternatives, information has been provided by the County demonstrating that the estimated linear stream channel and area of habitat impacts are comparable for each of the alignment alternatives considered (see graphic depictions of the construction area near the creek and a calculation of the disturbance footprint for each alternative analyzed in Exhibit 6). The County's documentation fairly represents potential impacts in each scenario, including because necessary construction access affects a larger area than any potential final alignment in all cases. Likewise, post-construction habitat restoration measures for each scenario will generally improve the overall habitat conditions in the area equally. Each potential alignment will remove an existing support pier from the center of the creek channel to reduce creek impediments, will "open up" the channel which is currently constricted with abutments, rock slope protection (rip-rap) and sediment, and will improve riparian habitat after mitigation through the restoration efforts described. In all cases, County conditions require a Habitat Mitigation and Monitoring Plan (see County special condition #4). In addition, a biological monitor is required during construction (see County special condition #17). As such, the County believes that the approved upstream alignment is the least environmentally damaging feasible alignment alternative. The Commission agrees that the County has presented substantial evidence supporting its conclusion that all of the proposed alternative alignments appear to have at least as many environmental impacts as the County's proposed alignment. There do not appear to be any alternative alignments that reduce impacts to coastal resources in any significant and meaningful way.

Other project elements highlighted by the County that play into the alternatives analysis include avoiding road closures and traffic control during construction, as well as improved roadway geometrics and access restrictions to adjacent properties for the completed project. According to the County, when all factors are considered, the selected alignment is the least environmentally damaging feasible alignment, and also the project that best meets the overall community objectives. The County's rationale in this respect appears sound, and the Commission concurs that the proposed upstream alignment is the preferred alternative in this circumstance and that it is consistent with the LCP.

Bridge/Abutment Design

Given that determination, the next question is whether the County could use alternative bridge/abutment designs to further limit stream habitat impacts. The primary questions in this respect are whether to use rip-rap and lesser abutment structures (as proposed), or to use greater abutment structures without rip-rap, including potentially using more substantial and deeper caissons located further away from the creek bank and requiring a longer span. In the case of the County's proposed version, the abutments would be protected and shouldn't be undermined, even in a large scour event. If the alternative of a greater abutment structure were used, it appears that the abutments themselves would need to be enlarged, embedded further away from the creek channel, and to a greater depth. Given the erodible nature of the creek bank, it is likely that these abutments/caissons would eventually be daylighted under heavy erosional events, leading to additional work along the "new" stream edge, including potentially (if not likely) rip-rap at that time, and greater impacts in the longer term. In addition, increasing the span

length would result in a higher bridge profile. Raising the profile of the bridge would necessarily cause the road elevation to be significantly higher than adjacent driveways and road intersections on either side of the bridge crossing, leading to additional road impacts. According to the County, this would result in costly modifications and potentially detrimental drainage issues on adjacent properties. In sum, the rip-rap abutment methodology, where the rip-rap is embedded in the creek bank and covered with soil and vegetated with riparian species as proposed, would appear to result in less habitat harm in the long run, and less coastal resource impacts overall than a greater abutment structure alternative. The Commission notes that this issue has previously arisen for County bridge projects on appeal before the Commission, and that the County has demonstrated that it has been successful in integrating rip-rap covered in vegetation into similar creek environs.

Mercury

The issue of possible mercury contamination due to bridge construction activities has also been raised by the Appellant. The project includes creek stabilization, re-contouring, discharge of surface and groundwater by diverting and dewatering existing flows, and vegetation removal. Santa Rosa Creek is known to contain mercury contamination from previous historical upstream mining operations. According to the Appellant, project activities have the potential to release buried mercury into surface waters from the disturbance of sediment and organic matter in the creek channel. In addition, the Appellant contends that the removal of riparian vegetation reduces the potential for uptake of mercury by this vegetation, thus causing increased levels to disperse through the watershed.

According to the County, mercury levels are "below applicable regulatory thresholds for water and sediment based on monitoring performed by the Regional Water Quality Control Board (RWQCB) upstream of the project site." The County approval also requires RWQCB sign off on a comprehensive stormwater pollution prevention plan (or a SWPPP). Also, County conditions require implementation of a comprehensive Drainage, Sedimentation, and Erosion Control Plan (County Special conditions # 3, #64 and #65). In addition, multiple construction related BMP's are required through the County's project approval (training, staging, monitoring, stockpiling of materials, etc.). In short, the County has tested for mercury, has taken adequate precautions to avoid problems associated with it, and, no substantial issue is raised with respect to the appeal contentions related to mercury contamination resulting from the project.

Public Access

The Appellant also contends that the County approved project is inconsistent with the shoreline access policies of the LCP because the proposed bridge design does not adequately foster pedestrian and bicycle use. In this case, the County evaluated a variety of access improvements to the bridge design. According to the County, due to the steep terrain and narrow corridor it is not feasible to have pedestrian facilities on the bridge or on Main Street south of the bridge location. There is no curb, gutter, or sidewalk on this stretch of Main Street and the County believes that pedestrian access on this bridge would not be safe. The County concluded that a 5-foot wide striped shoulder (Class II bikeway) was appropriate in this case. In an effort to reduce creek bank impacts the County reduced the overall bridge width using 5-foot wide shoulders instead of 8-foot wide shoulders.

Commission staff has visited the site and the Commission concurs that given the inland location of the

bridge (roughly 3 miles from the shoreline) and the various site constraints identified (sensitive habitats, steep slopes, narrow road prism, limited site lines, and high traffic speeds in the area), it is not necessary to incorporate a dedicated pedestrian accessway on the bridge for LCP compliance. Main Street at this location is not a primary public recreational access corridor, and it is not likely to become an access corridor of the type necessitating dedicated Class I pedestrian/bicycle components. On the contrary, this stretch of Main Street is well inland from the coast in an area where a bike lane, as proposed, should offer adequate space within which recreational pedestrian and bicycle access can occur consistent with the LCP. It is possible that an argument could be made that future public recreational access needs might be different than they are today, but there are no LCP plans for that to occur here, and the setting (including steep topography approaching the bridge) is not generally conducive to this location becoming more than an offshoot from the main coastal trail in this area, including with respect to the CCT. Likewise, the idea of requiring dedicated bridge space would also require more stream habitat impact, and such trade-off does not appear warranted under the LCP in this case. As it is, the project would widen the bridge from what is present now (going from about 30 to 37 feet in width), and will provide more space within which shared public access activities should be able to be adequately accommodated.

The Santa Rosa Creek Trail, as mentioned in the County General Plan, is intended to be a Class I bikeway connecting the Cross Town Trail (an LCP recognized public accessway) to Coast Union High School on Santa Rosa Creek Road. The County has discussed this trail as it relates to the bridge replacement at length with the County Parks Department and the Cambria Community Services District. This future trail would cross Main Street at the intersection with Santa Rosa Creek Road and continue along to the high school. In other words, this trail would be entirely located on the upcoast side of the bridge site, and would not cross the bridge. The County supports improving public access in the corridor with respect to the trail traversing across Main Street, however this trail project has not been initiated nor does it have the required funding or easements at this time. This bridge replacement project will not negatively impact the future trail project in this area.

Thus, this appeal contention does not raise a substantial issue.

Public Views/Character

The Appellant also contends that the new bridge would not adequately protect the public viewshed, and would not be consistent with the character of the area.

As described in the County's environmental review document, the town of Cambria is noted for its picturesque rural setting. The tourist-oriented village is skirted by well-maintained homes, including older Victorian homes and rural barns. The bridge project site lies on the southern edge of the village where not many buildings are located. Rolling grassy slopes and agricultural fields along the riparian fringe of Santa Rosa Creek and tall pines visible from Main Street all contribute to the pastoral setting. One built feature of note in the project area is the large-scale ranch entrance located east of Main Street to the south of the Santa Rosa Creek. A fairly extensive ungrouted stone wall and entry gateway, constructed from large timbers hung with an artistic steel gate, add to the unique character of the area as one enters or exits the downtown village.

The proposed longer and wider bridge design raises some concerns with impacts to the character of the existing landscape. The new bridge would be made of concrete, and would include 2.8-foot tall see through barriers on either side. While different from the look of the existing bridge, the new bridge is best described as fairly low key, and should effectively blend into the setting over time consistent with LCP requirements. Thus, this appeal contention also does not raise a substantial issue.

C. Conclusion – No Substantial Issue

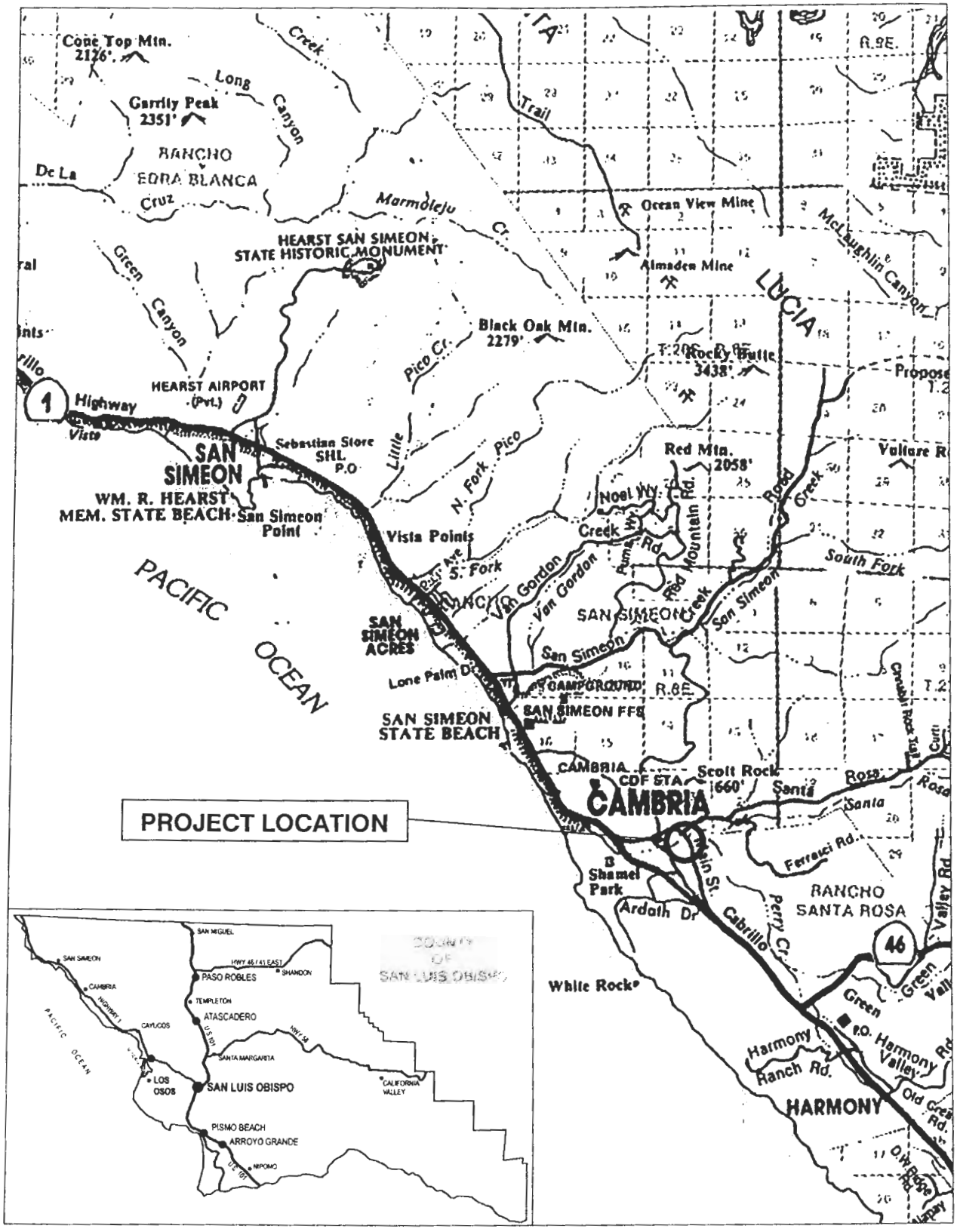
In conclusion, it is clear that the proposed project will have an effect on coastal resources. However, the Commission has explored and researched bridge standards and related issues as a means to best understand bridge related issues and requirements as they apply to this site. Based on this information, it appears that the County-approved project has been designed in a manner that avoids coastal resource impacts as much as possible and includes appropriate restoration/enhancement to offset impacts, and that there isn't a feasible bridge replacement project that would lead to significantly less resource degradation. Moreover, the project overall will result in significant restoration/enhancement of this stream reach, including by moving a significant abutment area out of the stream channel, eliminating the existing center bridge support in favor of a longer clear span, and aggressive restorative planting throughout. Thus, although the appeal raises valid questions regarding the environmental impacts of the project, the Commission finds that the project conforms to the LCP, so the appeal contentions do not raise a substantial issue of the project's conformance with the LCP.

Coastal Act Section 30625(b) requires the Commission to hear an appeal unless it determines that no substantial issue exists with respect to the grounds on which the appeal has been filed.[3] Overall, the County has provided adequate factual and legal support for its decision that the approved development would be consistent with the applicable policies in the certified LCP (Exhibit 5). The scope of the project is relatively small, consisting of one two-lane single span bridge (150-fet long and 37.5-feet wide). The coastal resources involved are significant, but the County-approved project appropriately addresses potential impacts, and results in enhancement of resources overall. The County's decision followed the analytic framework for considering a bridge project and drew appropriate conclusions, and no adverse precedent will be set for future interpretations of the LCP. Finally, the appeal does not raise issues of regional or statewide significance.

For the reasons stated above, the Commission finds that Appeal Number A-3-SLO-10-039 does not present a substantial issue with respect to the grounds on which the appeal has been filed under Section 30603 of the Coastal Act regarding consistency with the certified LCP and/or the public access policies of the Coastal Act and declines to take jurisdiction over the CDP for this project.

[3] The term "substantial issue" is not defined in the Coastal Act or its implementing regulations. In previous decisions on appeals, the Commission has generally been guided by the following factors in making substantial issue determinations: the degree of factual and legal support for the local government's decision; the extent and scope of the development as approved or denied by the local government; the significance of the coastal resources affected by the decision; the precedential value of the local government's decision for future interpretations of its LCP; and, whether the appeal raises only local issues as opposed to those of regional or statewide significance.

Main Street Bridge at Santa Rosa Creek ED 00-168

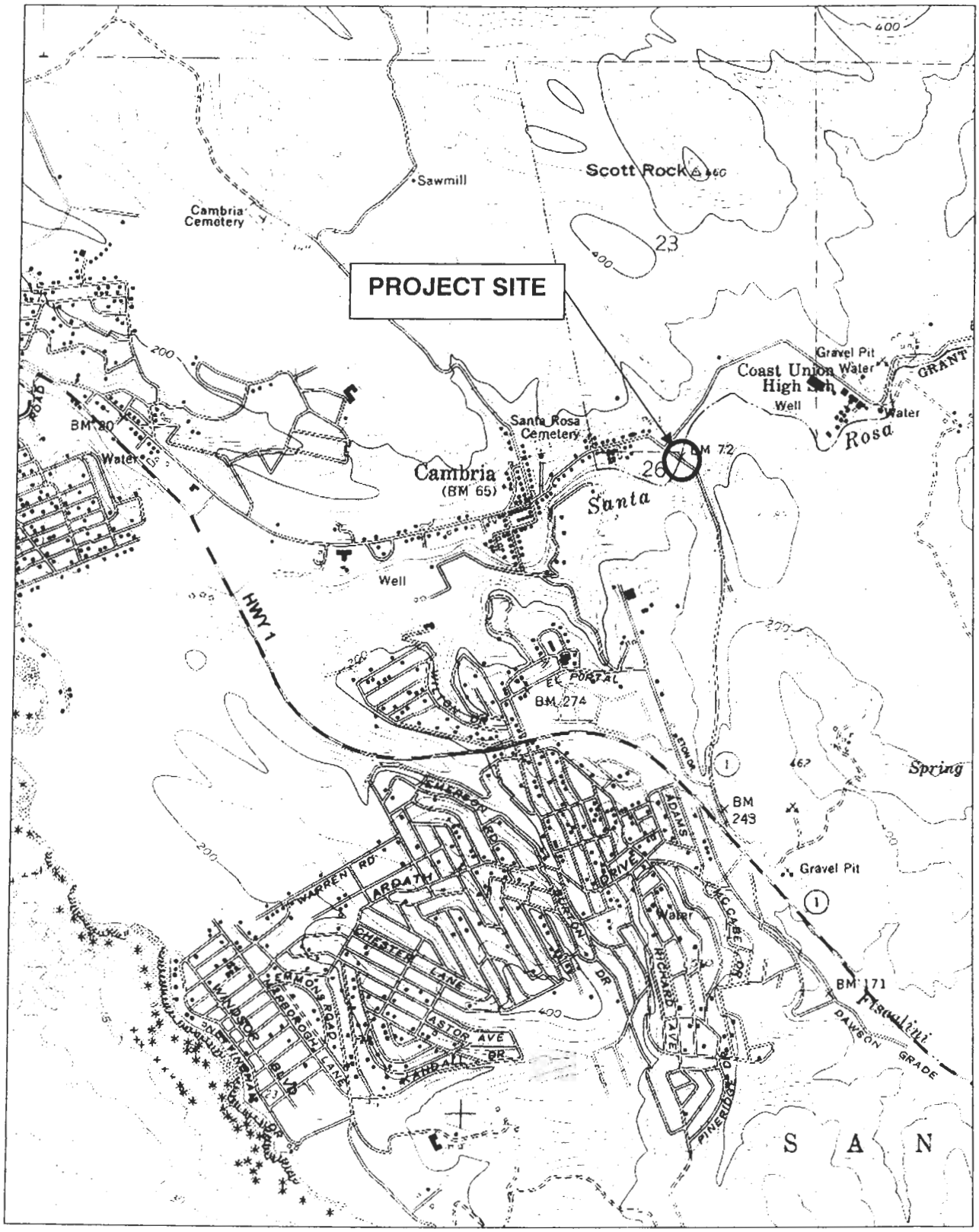


Source: Compass Maps

NORTH
Not to Scale

VICINITY MAP
FIGURE 1

CCC Exhibit 1
(page 1 of 2 pages)

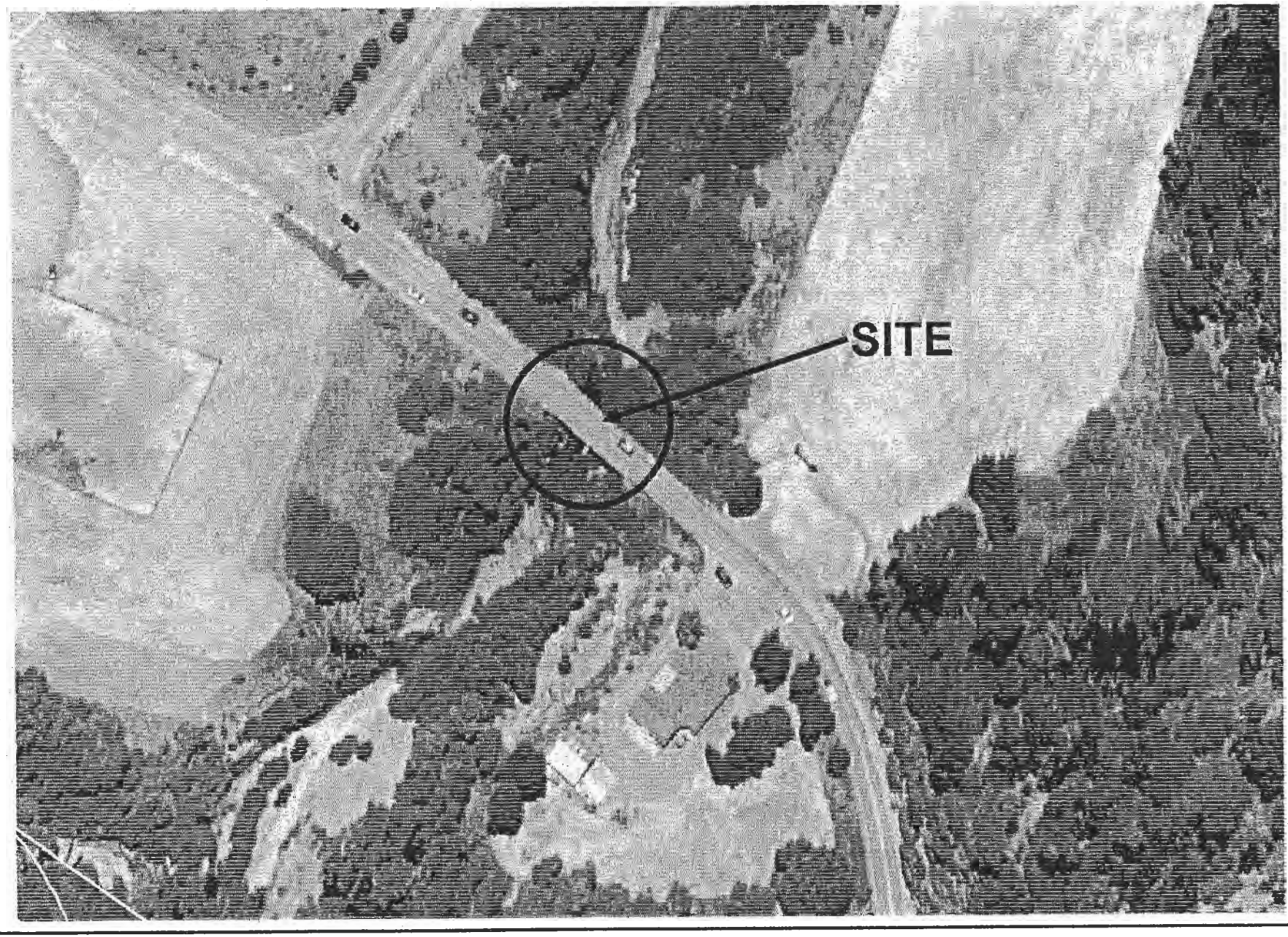


NORTH
Not to Scale

TOPOGRAPHIC MAP OF PROJECT AREA

CCC Exhibit 1
(page 2 of 2 pages)

SAN LUIS OBISPO COUNTY DEPARTMENT OF BUILDING AND PLANNING



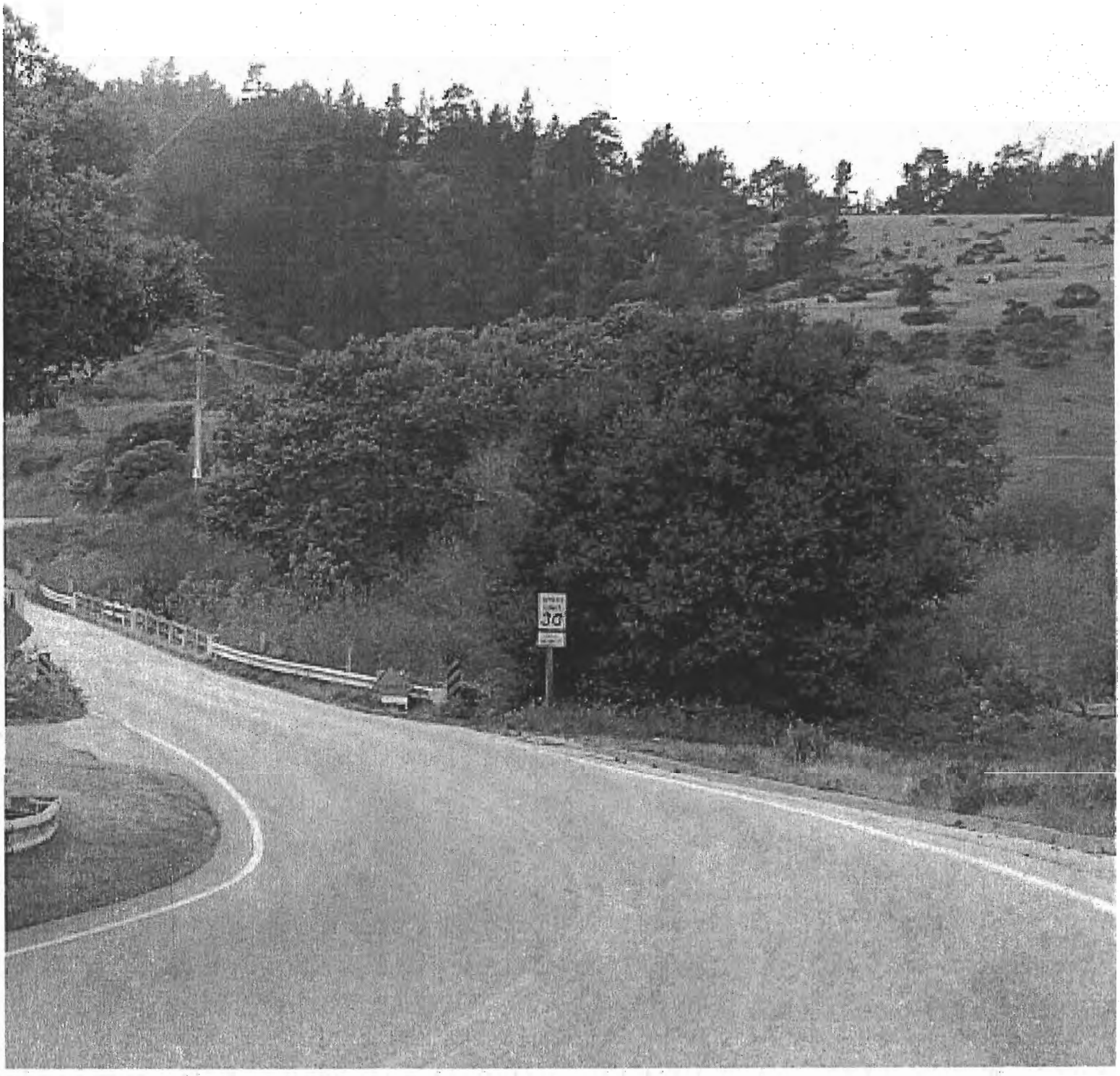
CCC Exhibit 2
(page 1 of 5 pages)

PROJECT

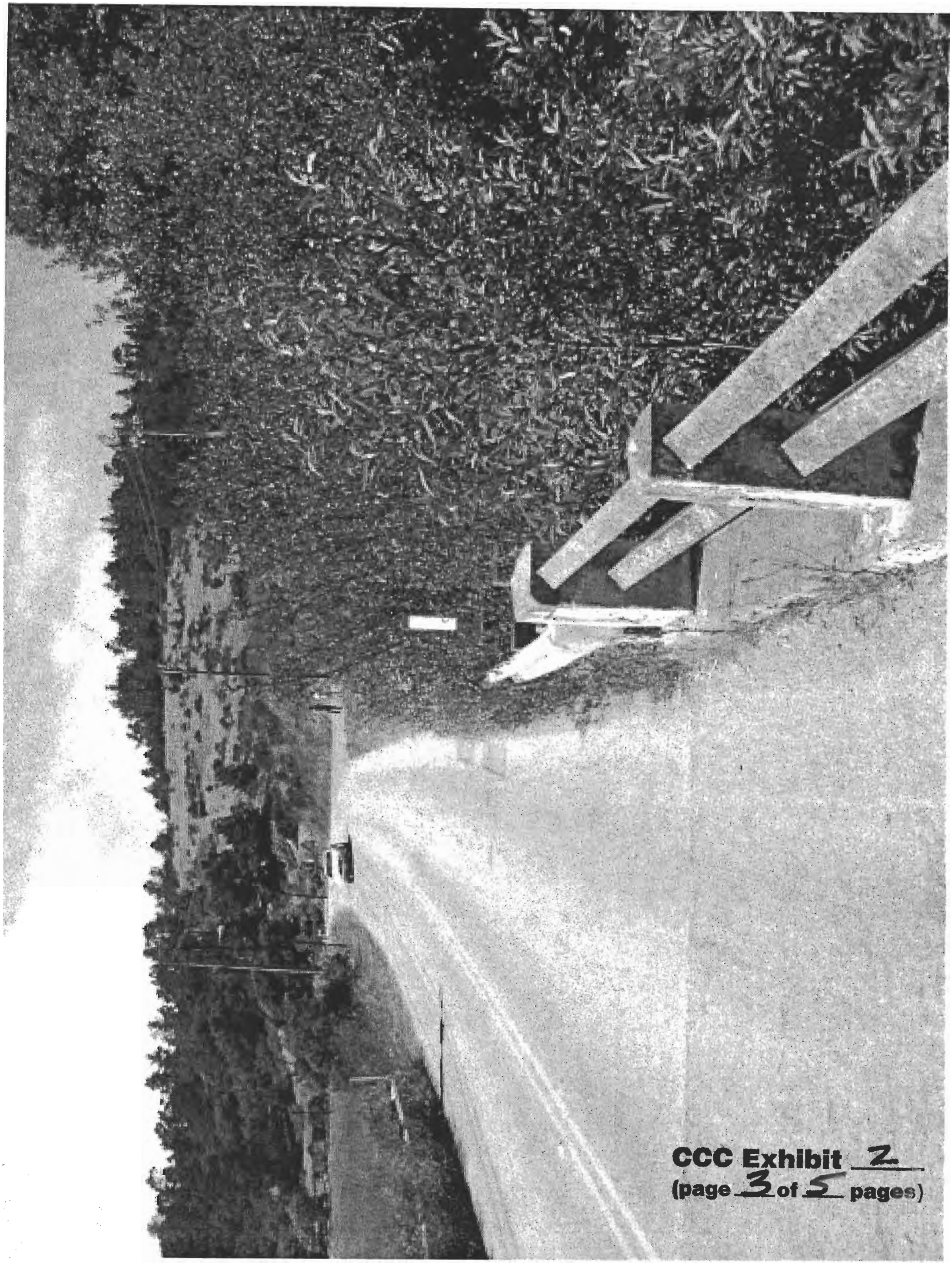
Minor Use Permit/Coastal Development Permit DRC2009-00041
County of San Luis Obispo, Dept. of Public Works

EXHIBIT

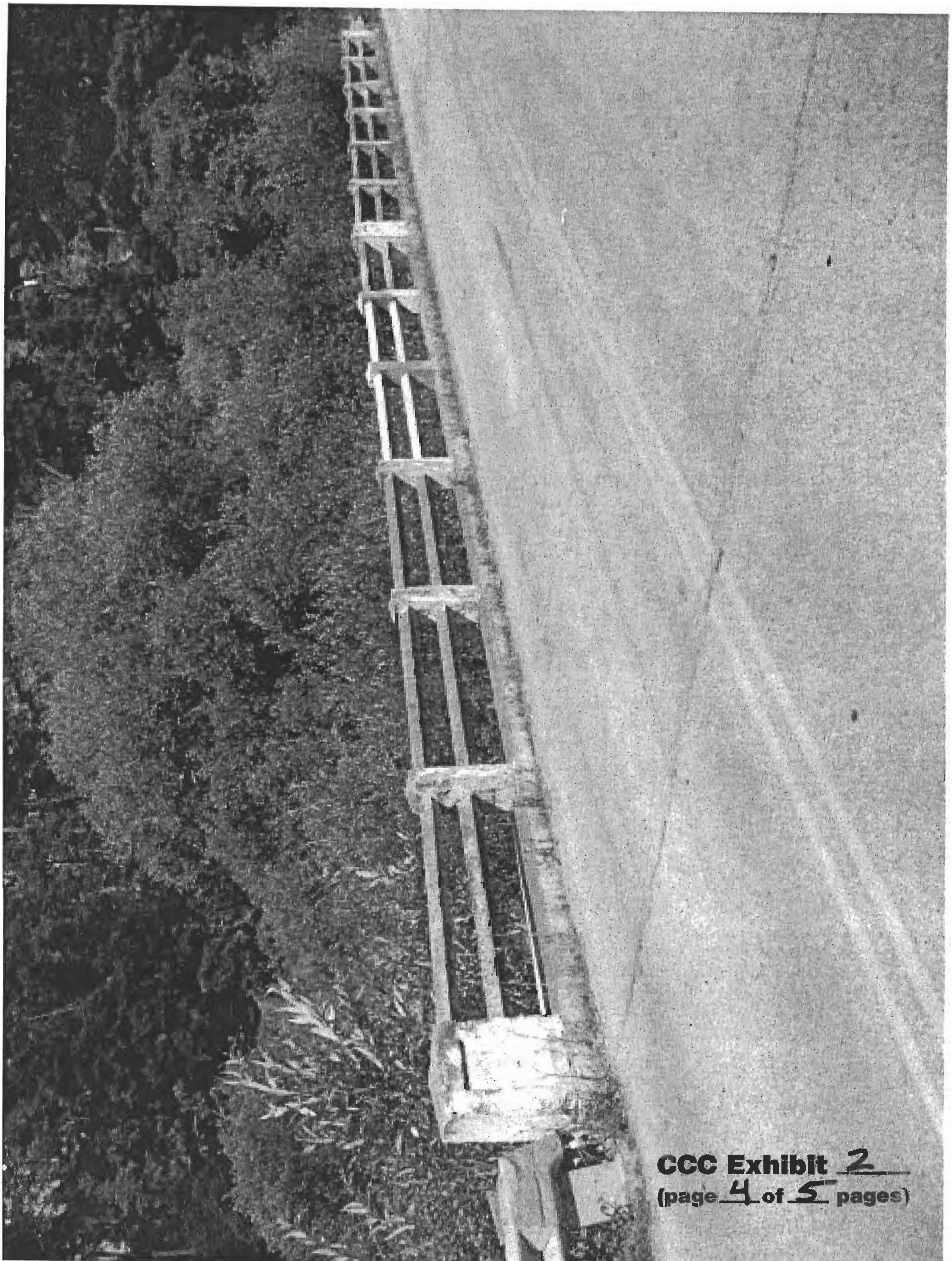
Aerial Photograph



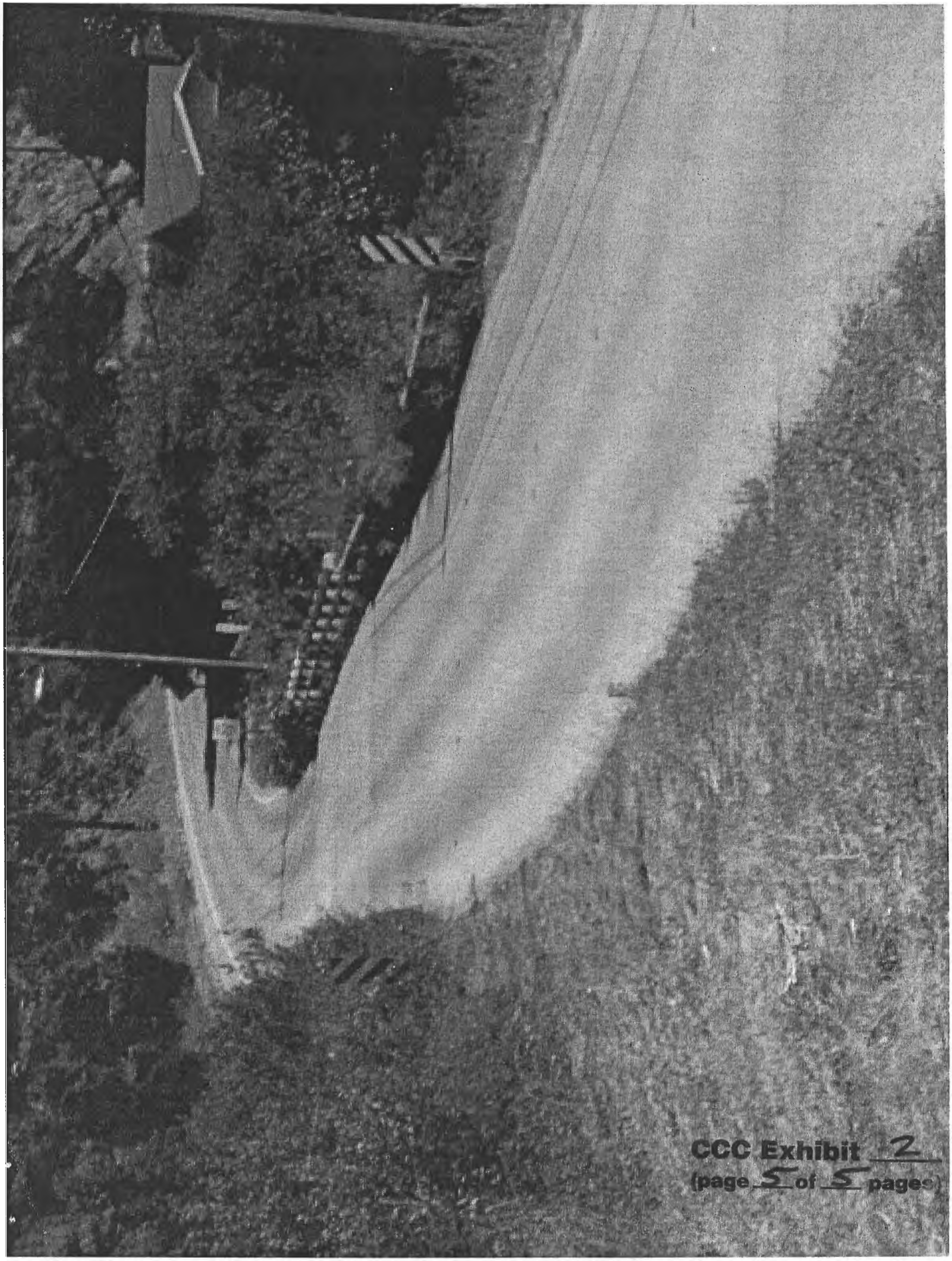
CCC Exhibit 2
(page 2 of 5 pages)



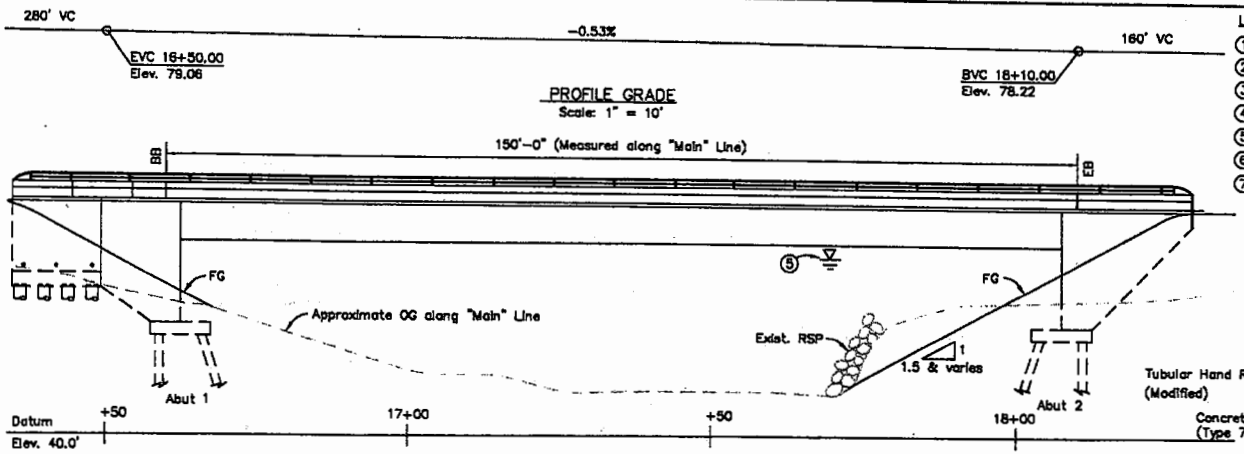
CCC Exhibit 2
(page 3 **of** 5 **pages)**

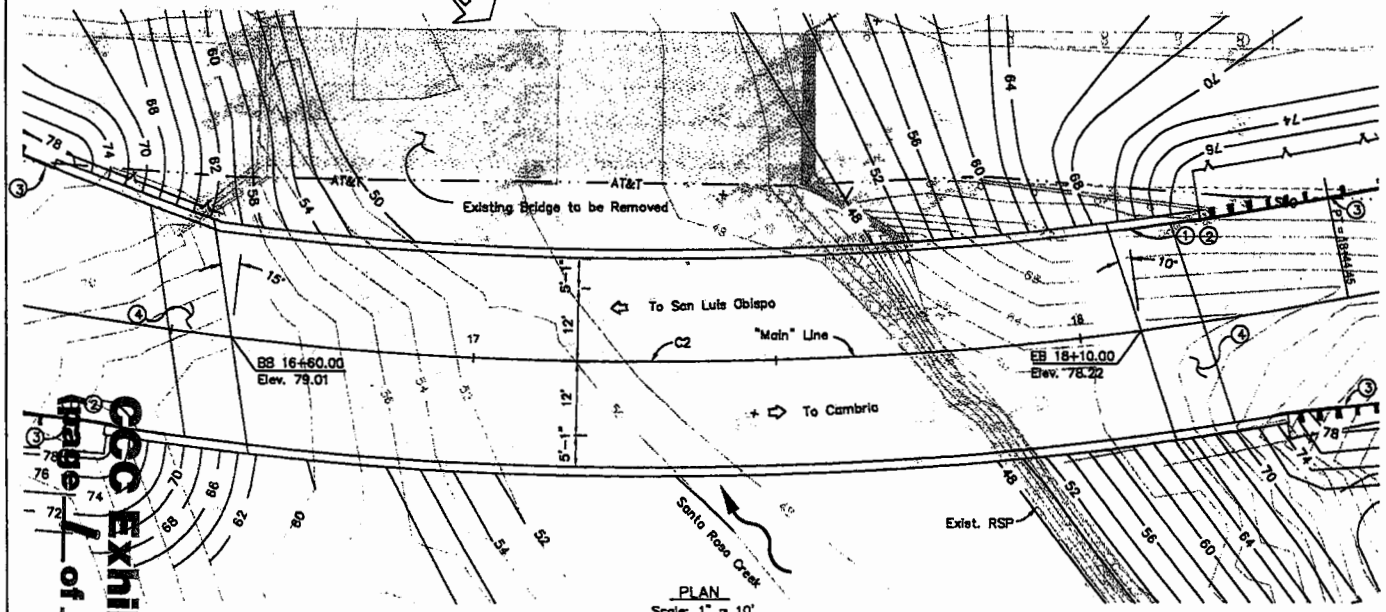


CCC Exhibit 2
(page 4 of 5 pages)



CCC Exhibit 2
(page 5 of 5 pages)





ELEVATION
Scale: 1" = 10'

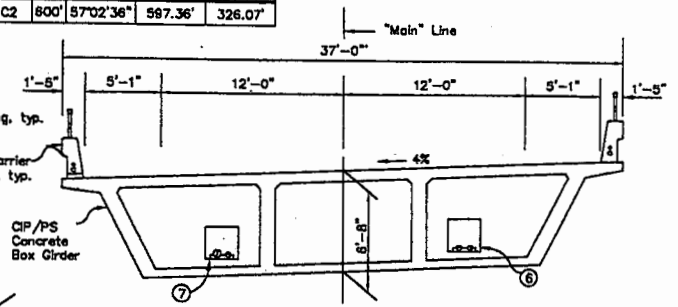
Notes:
1. Bridge skew not shown
2. New RSP not shown
3. South Retaining walls at Abut 1 shown, North Ret. wall is different

PLAN
Scale: 1" = 10'

LEGEND

1. Paint "Br. No. 49C-0337" and year completed
2. Paint "Main Street Bridge"
3. Metal Beam Guard Railing, see Roadway Plans
4. Approach Slab Type EQ10
5. See Hydrologic Summary on "Foundation Plan" sheet
6. 2-4"ø PVC Conduits for AT&T
7. 1-6"ø & 1-4"ø PVC conduits for PG&E

CURVE DATA				
CURVE	R	Δ	L	T
C2	600'	57°02'36"	597.36'	326.07'



TYPICAL SECTION
Scale: 1/4" = 1'

NOTES

1. For Design Notes see "Deck Contours" Sheet
2. The contractor shall verify all controlling field dimensions before ordering or fabricating any materials.
3. For Pile Data Table, see "FOUNDATION PLAN" sheet.
4. Utilities not shown, see roadway plans for utility locations.
5. See Roadway Plans for Lane layout & Grading Details
6. See "TYPICAL SECTION" Sheet for utility openings.

Section identification

Standard plan sheet No. / Detail number

STANDARD PLANS, DATED MAY, 2006

A10A-B	ACRONYMS AND ABBREVIATIONS
A10C-D	SYMBOLS
A62-A	EXCAVATION AND BACKFILL MISCELANEOUS DETAILS
A62-C	LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL-BRIDGE
A77K1-2	METAL BEAM GUARD RAILING - CONNECTIONS TO BRIDGE RAILINGS WITH SIDEWALKS DETAILS
B0-1	BRIDGE DETAILS
B0-3	BRIDGE DETAILS
B0-5	BRIDGE DETAILS
B0-13	BRIDGE DETAILS
B2-3	16" AND 24" CAST-IN-DRILLED-HOLE CONCRETE PILE
B2-8	PILE DETAILS-- CLASS 200
B6-21	JOINT SEALS (MAXIMUM MOVEMENT RATING =2")
B7-1	BOX GIRDER DETAILS
B7-10	UTILITY OPENING - BOX GIRDER
B11-51	TUBULAR HAND RAILING
B11-55	CONCRETE BARRIER TYPE 732
B14-5	WATER SUPPLY LINE DETAILS

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal

REGISTERED ENGINEER - CIVIL

Md. Wahiduzzaman No. C49538 Exp. 9/30/10 CIVIL

PLANS APPROVAL DATE

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

DESIGN	MDW	XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	Md. Wahiduzzaman PROJECT ENGINEER	BRIDGE NO. 49C-0337
DETAILS			LAYOUT	MDW			POST MILE
QUANTITIES			SPECIFICATIONS				

DESIGN OR DESIGN SIGNOFF

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

CU EA 05-927220L

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)

GENERAL PLAN

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY): 12/08/07 | 05/28/08 | 12/19/08

SHEET 1 OF 12

CCC Exhibit 3 (Page 1 of 11 pages)

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

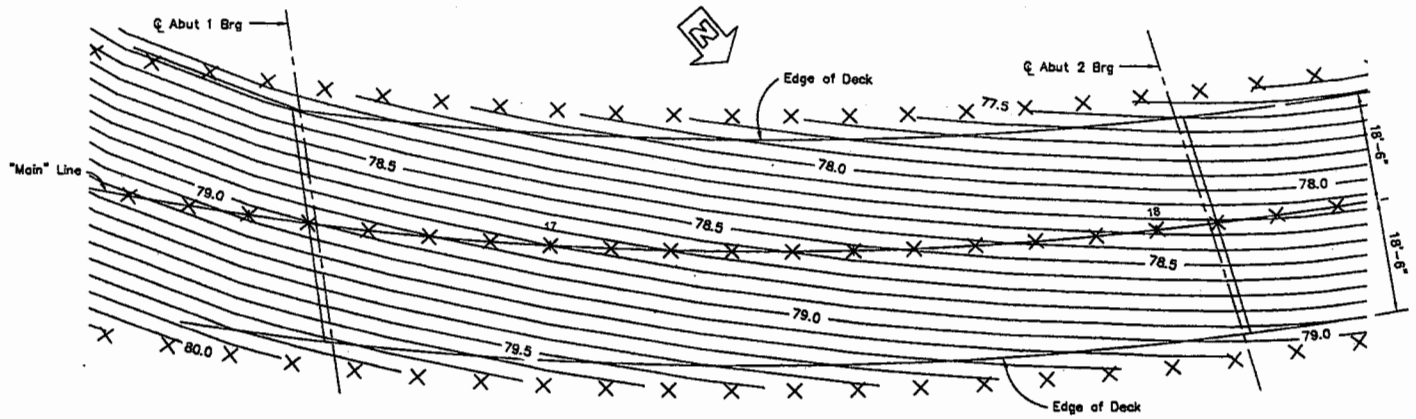
95% Submittal

REGISTERED ENGINEER – CIVIL

PLANS APPROVAL DATE

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

REGISTERED PROFESSIONAL ENGINEER
Md. Wahiduzzaman
No. C49836
Exp. 9/30/10
CIVIL
STATE OF CALIFORNIA



DECK CONTOURS
Scale: 1" = 10'

NOTES:

1. X – 10' intervals along station line.
2. Contours do not include camber.
3. Contour interval is 0.10'.

QUANTITIES

GENERAL NOTES
LOAD FACTOR DESIGN

DESIGN: BRIDGE DESIGN SPECIFICATIONS – April 2000 (LFD)
(1996 AASHTO with interims and revisions by CALTRANS)

DEAD LOAD: Includes 35 psf for future wearing surface

LIVE LOAD: HS-20-44 and alternative and permit design loads.

SEISMIC DESIGN: Caltrans Seismic Design Criteria (SDC)
Version 1.4 June 2006

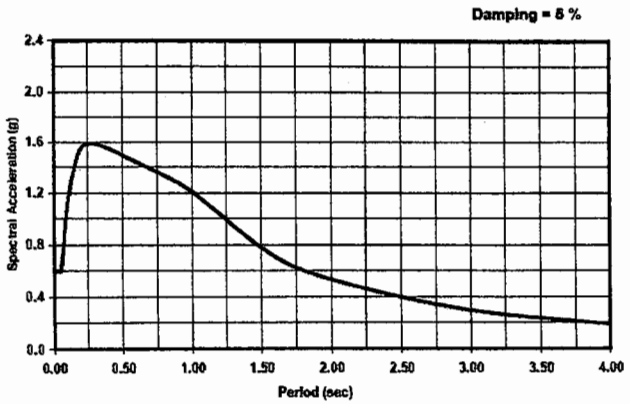
SEISMIC LOADING: SDC ARS Curve for Soil Profile D (M=7.25±0.25)
Peak Rock Acceleration = 0.6g
modified for fault proximity

REINFORCED CONCRETE: f_y = 60,000 psi
f'_c = 3,600 psi (unless otherwise specified)
n = 9

TRANSVERSE DECK SLABS (Working Stress Design):
f_s = 20,000 psi
f_c = 1,200 psi
n = 10

PRESTRESSED CONCRETE: For "Prestressing Notes" See "Girder Layout" Sheet.

STRUCTURAL STEEL: ASTM A709 Grade 50



ACCELERATION RESPONSE
SPECTRA CURVE

- Structural Concrete, Bridge (3,600 psi @ 28 days)
- Structural Concrete, Bridge (5,000 psi @ 28 days)
- Structural Concrete, Bridge Footing
- CIDH Pile Concrete (f'_c = 4,200 psi @ 28 days)

CONCRETE STRENGTH AND TYPE LIMITS
No Scale

INDEX TO BRIDGE PLANS

DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD		PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	Md. Wahiduzzaman PROJECT ENGINEER	BRIDGE NO. 49C-0337	MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
DETAILS	BY	CHECKED	LAYOUT	BY MDW	CHECKED			POST MILE *	DECK CONTOURS
QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY	CLASS AND SPECIAL CHECKED		CU EA 05-927220L	DISREGARD PRINTS BEARING EARLIER REVISION DATES	REVISION DATES (PRELIMINARY STAGE ONLY) 12/08/07 05/26/08 12/19/08 — SHEET 2 OF 12

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

EXHIBIT C
Page 2 of 3 pages

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

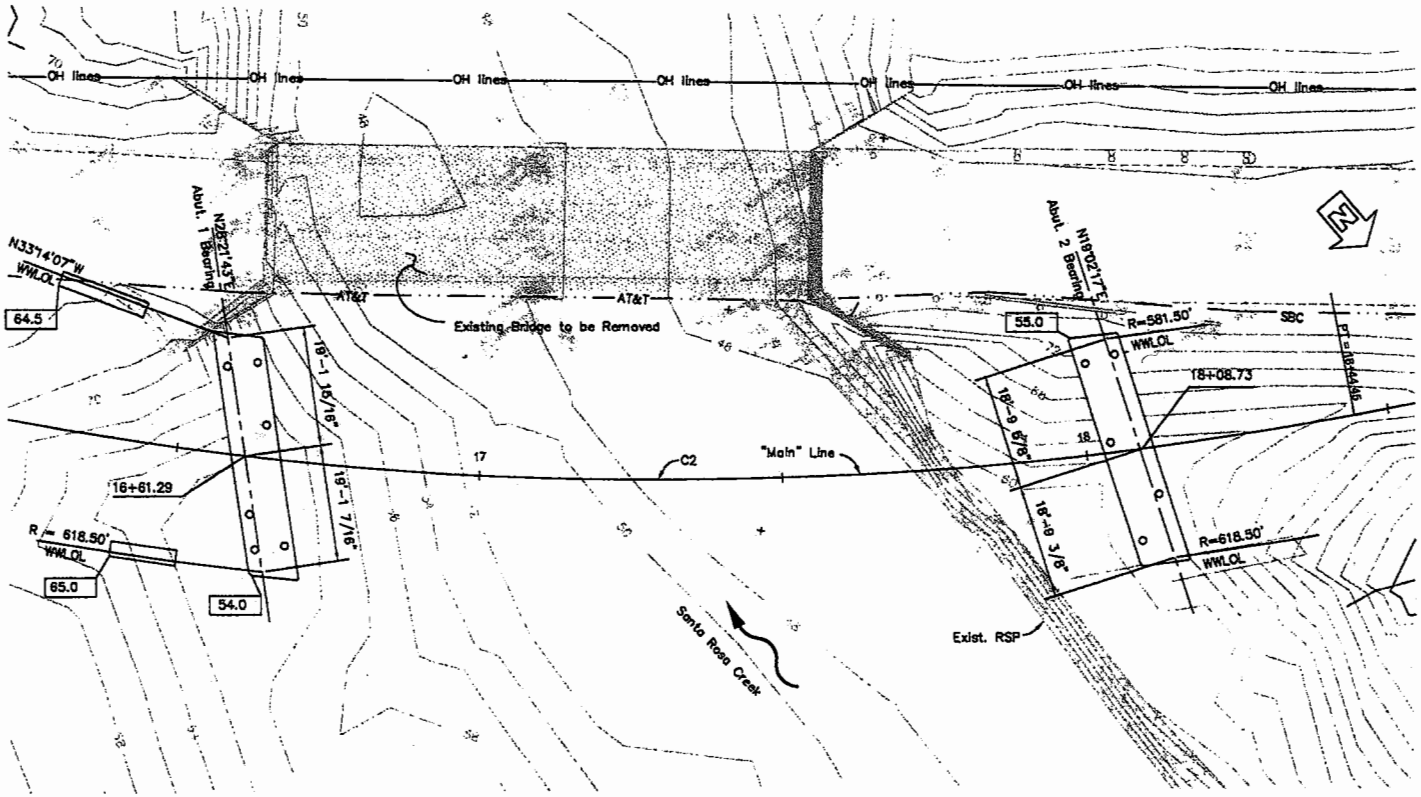
95% Submittal

REGISTERED ENGINEER – CIVIL

PLANS APPROVAL DATE

Md. Wahiduzzaman
No. C49838
Exp. 9/30/10
CIVIL
REGISTERED PROFESSIONAL ENGINEER
STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117



PLAN
Scale: 1" = 10'

NOTES:

XX.X Indicates bottom of abutment, footing or anchor block elevation.

Indicates original ground elevation.

o Indicates Pile (Not all piles shown)

Existing Utility locations shown are approximate.

See Roadway Plans for additional information.

See Roadway Plans for R/W & TCE Maps.

Overhead lines exist on site.

Existing wingwall will interfere with the new wingwall for abutment on the left side of begining of bridge.

HYDROLOGIC SUMMARY

Drainage Area: = 44.7 square miles

	Design Flood	Base Flood	Overtopping Flood
Frequency (years)	50	100	>200
Discharge (CFS)	15,400	19,800	>25,000
Water Surface (elev. at bridge)	67.97	70.25	78.96

Flood plain data are based upon information available when the plans were prepared and are shown to meet Federal requirements. The accuracy of said information is not warranted by the State or County and interested or affected parties should make their own investigations.

BENCH MARKS:

THE BENCHMARK FOR THIS PROJECT WAS TAKEN FROM A FOUND BRASS DISK IN THE NORTHEAST WINGWALL OF THE BRIDGE OVER SANTA ROSA CREEK DESIGNATED "Y 693" HAVING AN ELEVATION OF 74.14 BASED ON NAVD88 DATUM.

PILE DATA TABLE

Location	Pile Type	Design Loading (kip)	Nominal Resistance		Design Tip Elevation (ft)	Specified Tip Elevation (ft)
			Compression (kip)	Tension (kip)		
Bridge Abut 1	HP 14x73	200	400	0	-2 (1), 7 (3)	-2
Bridge Abut 2	HP 14x73	200	400	0	-16 (1), 7 (3)	-16

Note: Design Tip elevation is controlled by the following demands: (1) Compression, (2) Tension and (3) Lateral Loads. Retaining Wall pile data not shown in the table.

DESIGN OVERSIGHT	DESIGN	MDW	XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	
	DETAILS			LAYOUT	MDW	
SIGNOFF DATE	QUANTITIES			SPECIFICATIONS		

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

BRIDGE NO. 49C-0337
POST MILE -

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)

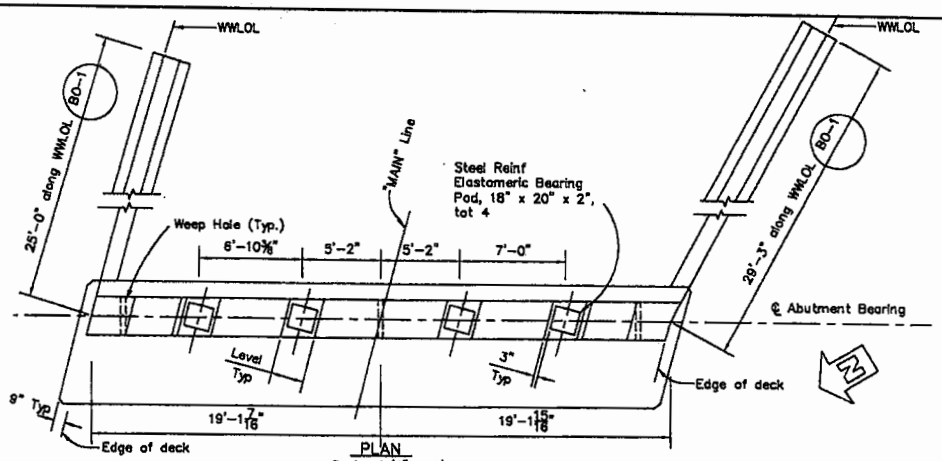
FOUNDATION PLAN

DISREGARD PRINTS BEARING EARLIER REVISION DATES ——

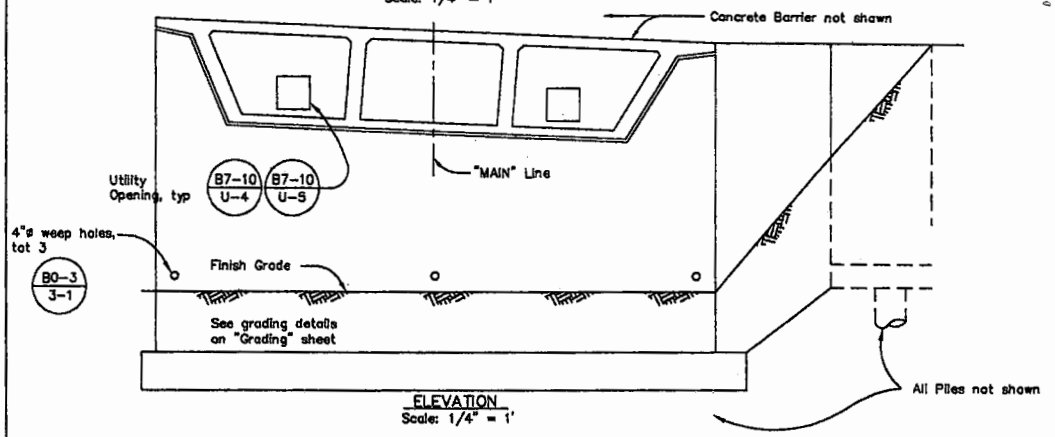
REVISION DATES (PRELIMINARY STAGE ONLY): 12/06/07 06/26/08 12/19/08

SHEET 3 OF 12

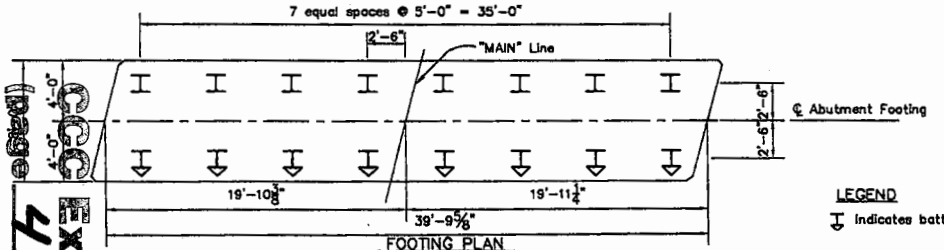
Page 3 of 3 pages



PLAN
Scale: 1/4" = 1'



ELEVATION
Scale: 1/4" = 1'

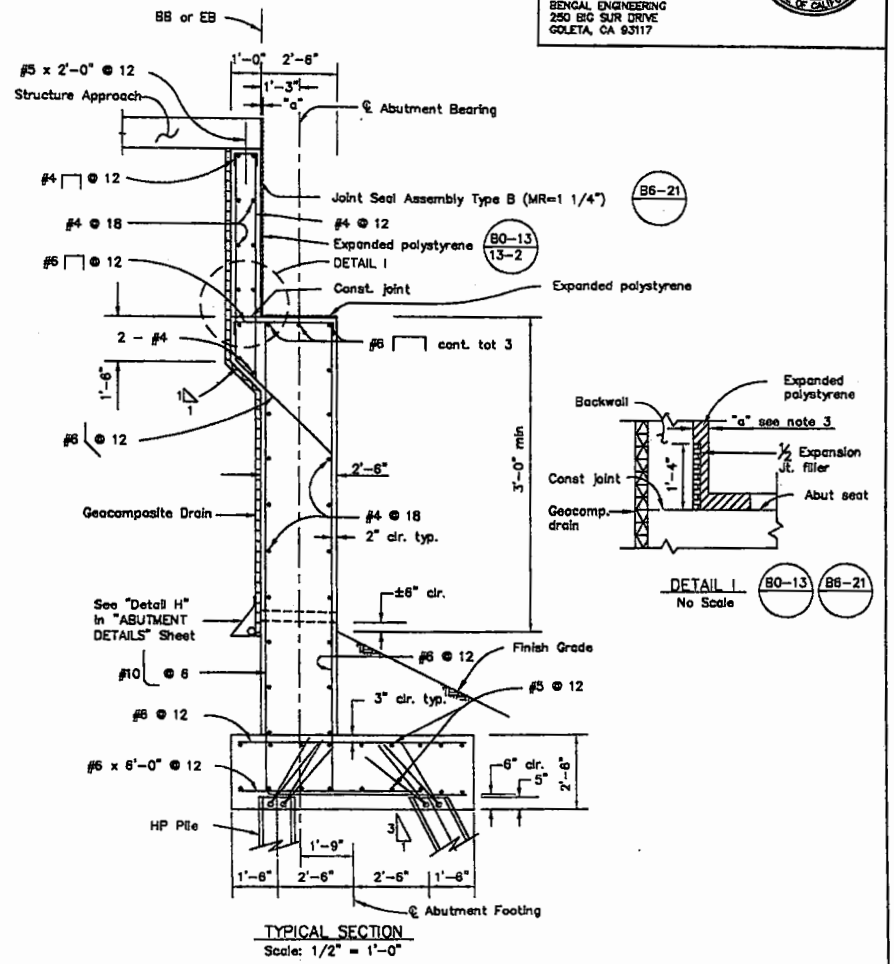


FOOTING PLAN
Scale: 1/4" = 1'

LEGEND
Indicates battered pile

Notes:

1. For sections and details not shown, see "Abutment Details" sheet.
2. RSP not shown.
3. Refer to table in B6-21



DETAIL I
No Scale
B0-13 B6-21

TYPICAL SECTION
Scale: 1/2" = 1'-0"

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal
REGISTERED ENGINEER – CIVIL
PLANS APPROVAL DATE

Md. Wahiduzzaman No. C49838 Exp. 9/30/10 CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIC SUR DRIVE
GOLETA, CA 93117

DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	
DETAILS	BY	CHECKED	LAYOUT	BY MDW	CHECKED
QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY	CHECKED

DESIGN OVERSIGHT
SIGNATURE DATE

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

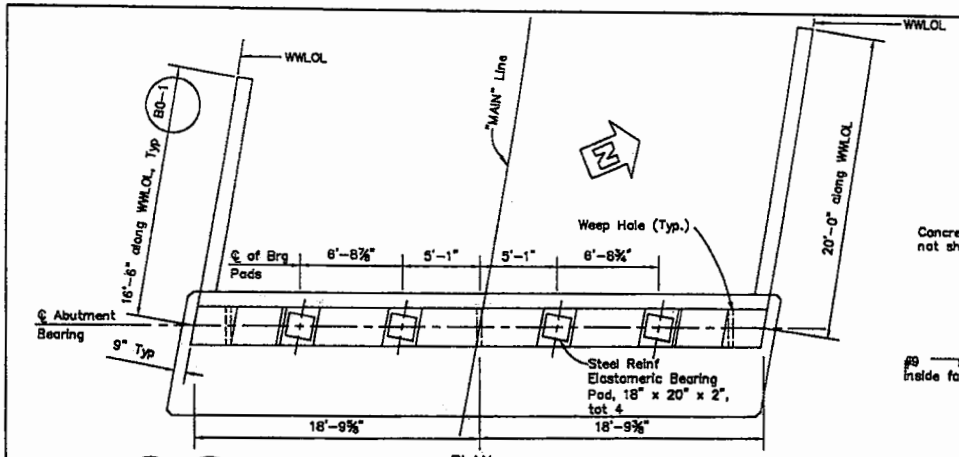
BRIDGE NO. 49C-0337
POST MILE

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
ABUTMENT 1 LAYOUT

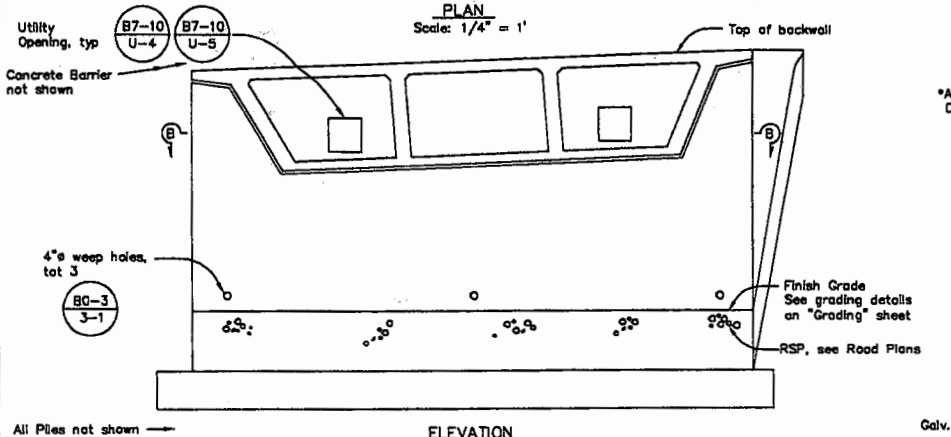
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)			SHEET	OF
12/06/07	06/26/08	12/19/08	4	12

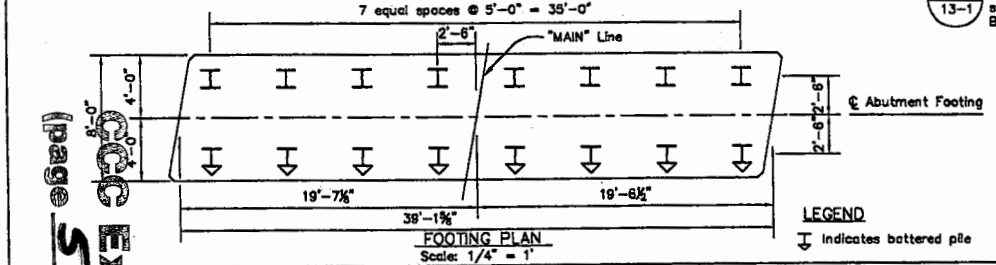
Exhibit 4 (3 pages)
Page 4 of 4



PLAN
Scale: 1/4" = 1'



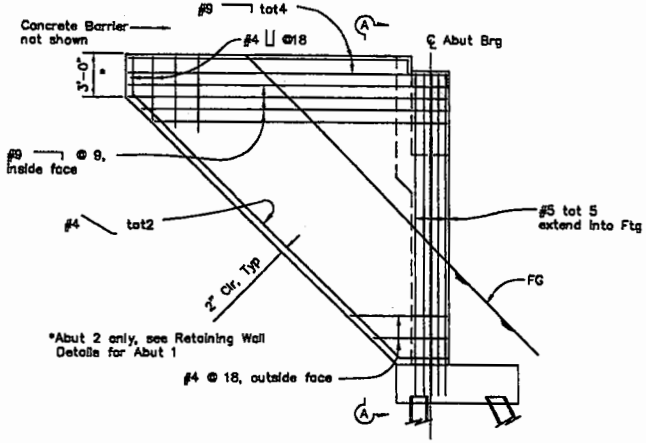
ELEVATION
Scale: 1/4" = 1'



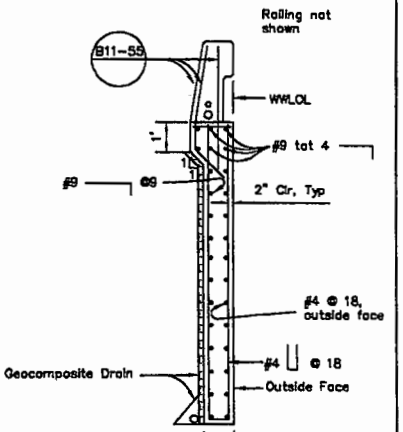
FOOTING PLAN
Scale: 1/4" = 1'

LEGEND
↧ Indicates battered pile

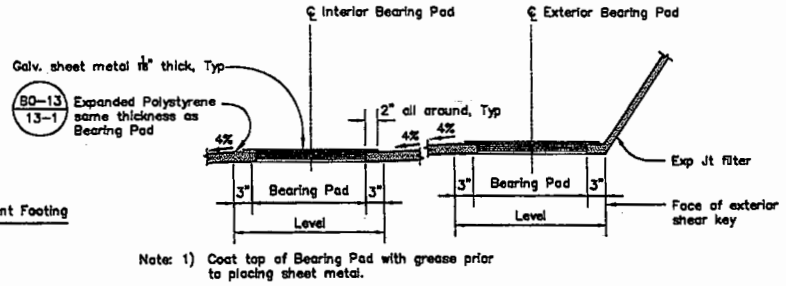
Notes:
1. For sections and details not shown, see "Abutment Details" sheet.
2. RSP not shown.



WINGWALL ELEVATION
Scale: 1/4" = 1'



SECTION A-A
Scale: 1/2" = 1'
B0-1



Note: 1) Coat top of Bearing Pad with grease prior to placing sheet metal.

BEARING PAD DETAIL
No Scale

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal
REGISTERED ENGINEER – CIVIL
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Md. Wahiduzzaman — No. C49833 — Exp. 9/30/10 — CIVIL — STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

DESIGN OVERSIGHT	DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD
SIGNOFF DATE	DETAILS	BY	CHECKED	LAYOUT	BY MDW CHECKED
	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY CHECKED QUALITY ASSURANCE

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

BRIDGE NO. 49C-0337
POST MILE *

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)

ABUTMENT 2 LAYOUT

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY): 12/06/07 | 08/26/08 | 12/19/08

SHEET 5 OF 12

EXHIBIT 1 Page 5 of 12

Page 3 of 3

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

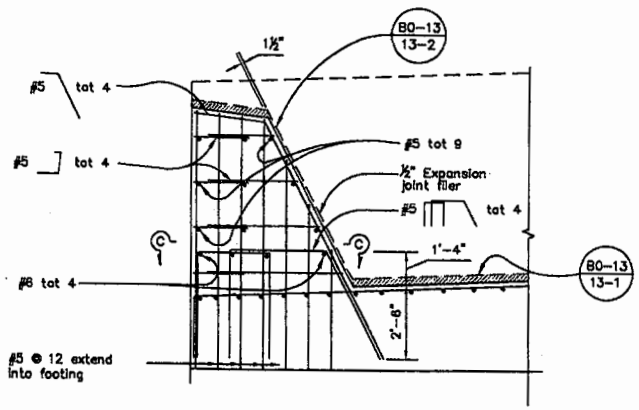
95% Submittal

REGISTERED ENGINEER – CIVIL

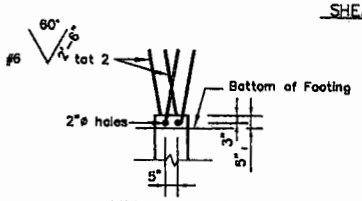
PLANS APPROVAL DATE

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

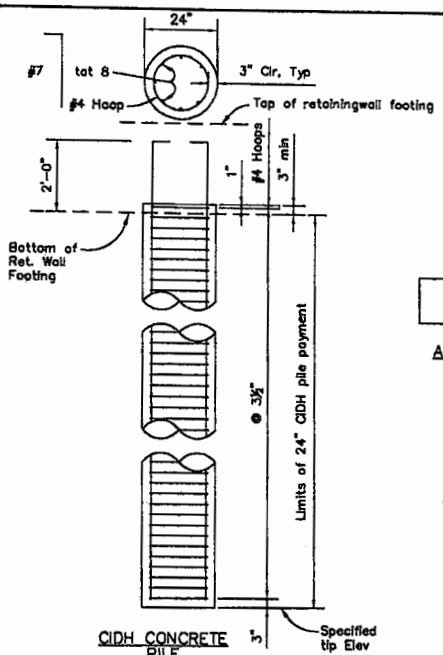
REGISTERED PROFESSIONAL ENGINEER – STATE OF CALIFORNIA
Md. Wohiduzzaman
No. C49838
Exp. 9/30/10
CIVIL



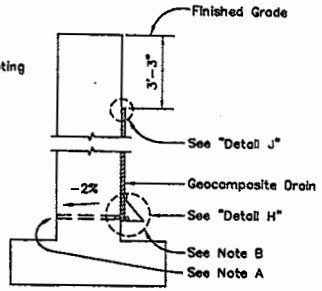
SHEAR KEY ELEVATION
Scale: 1/2" = 1'



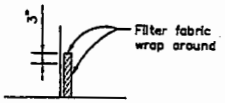
STEEL PILE ANCHOR
No Scale



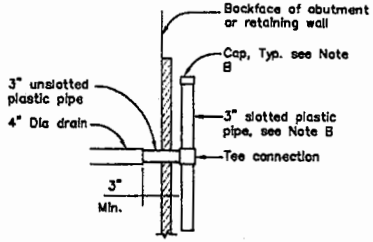
CIDH CONCRETE PILE
No Scale



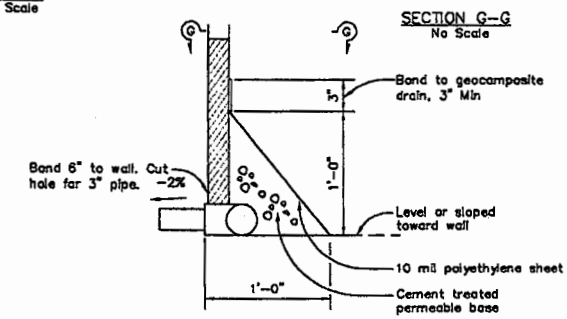
ABUTMENT SECTION
No Scale



DETAIL J
No Scale



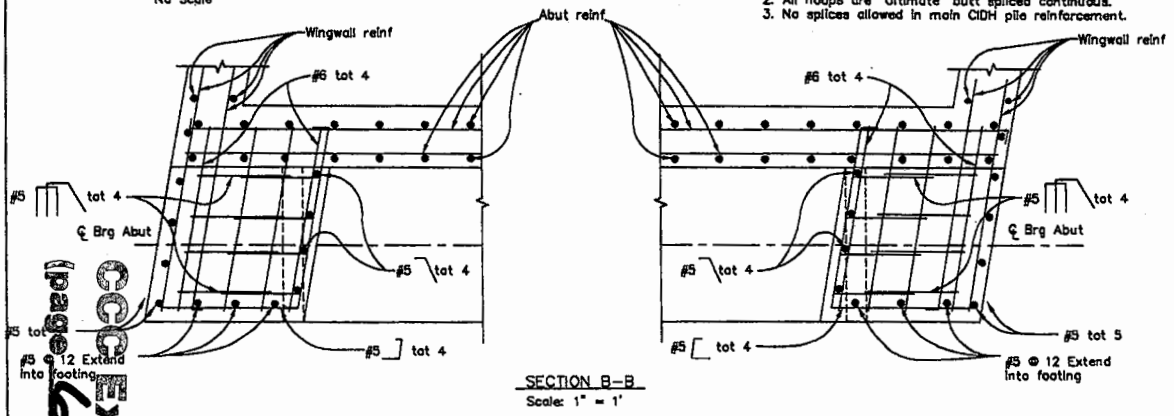
SECTION G–G
No Scale



DETAIL H
No Scale

Notes:

1. For details and notes not shown, see B2-3
2. All hoops are "Ultimate" butt spliced continuous.
3. No splices allowed in main CIDH pile reinforcement.



SECTION B–B
Scale: 1" = 1'

Notes:

A. 4" Dia drains at intermediate sag points and at 25' max center to center. Exposed wall drains shall be located 3"± above finished grade.

B. Geocomposite drain, cement treated permeable base, and 3" Dia slotted plastic pipe continuous behind abutment. Cap ends of pipe. Provide "Tee" connection at each 4" Dia drain.

C. Connect the low end of plastic pipe to the main outlet pipe as applicable.

WEEP HOLE AND COMPOSITE DRAIN
Alternative to Bridge Detail

Notes:

1. For location of section B–B, see "Abutment 2 Layout" sheet. B0-3 / 3-1
2. Abut 1 shown, abut 2 similar.

DESIGN	MDW	XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	
DETAILS			LAYOUT	MDW	
QUANTITIES			SPECIFICATIONS		

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wohiduzzaman
PROJECT ENGINEER

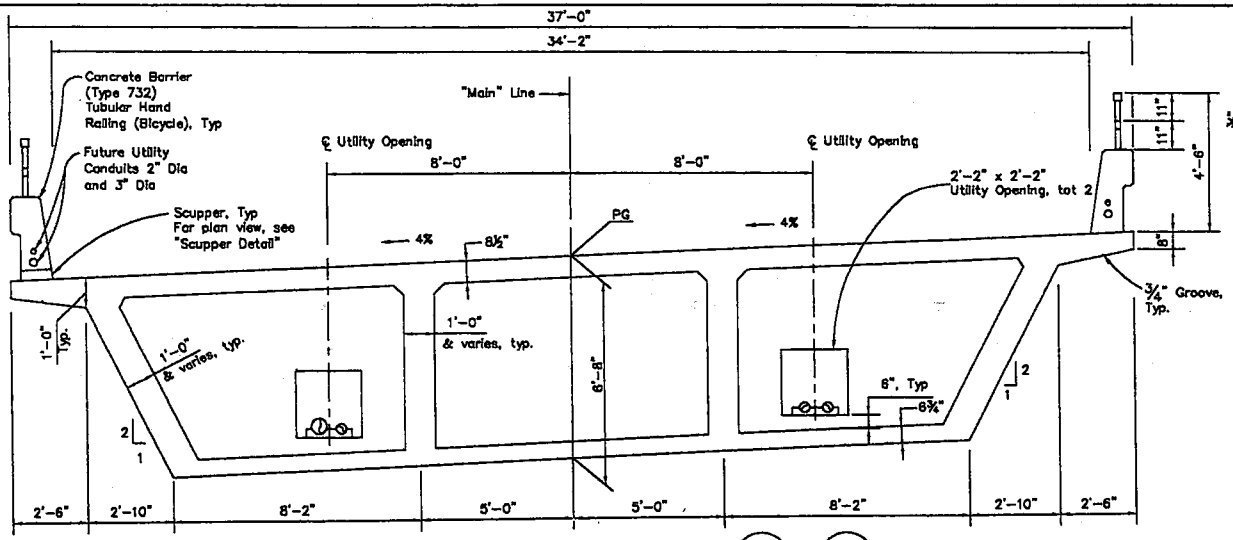
CU
EA 05-927220L

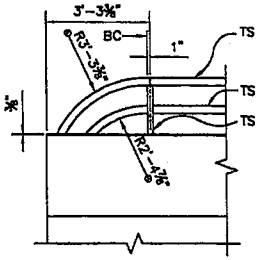
BRIDGE NO.	
49C-0337	MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
POST MILE	ABUTMENT DETAILS
*	

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)				SHEET	OF
12/06/07	08/24/08	12/19/08		8	12

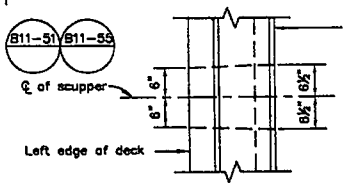
Exhibit C (page 67 of 73 pages)





TUBULAR HANDRAILING MODIFIED (BICYCLE)
Scale: 1/2" = 1'

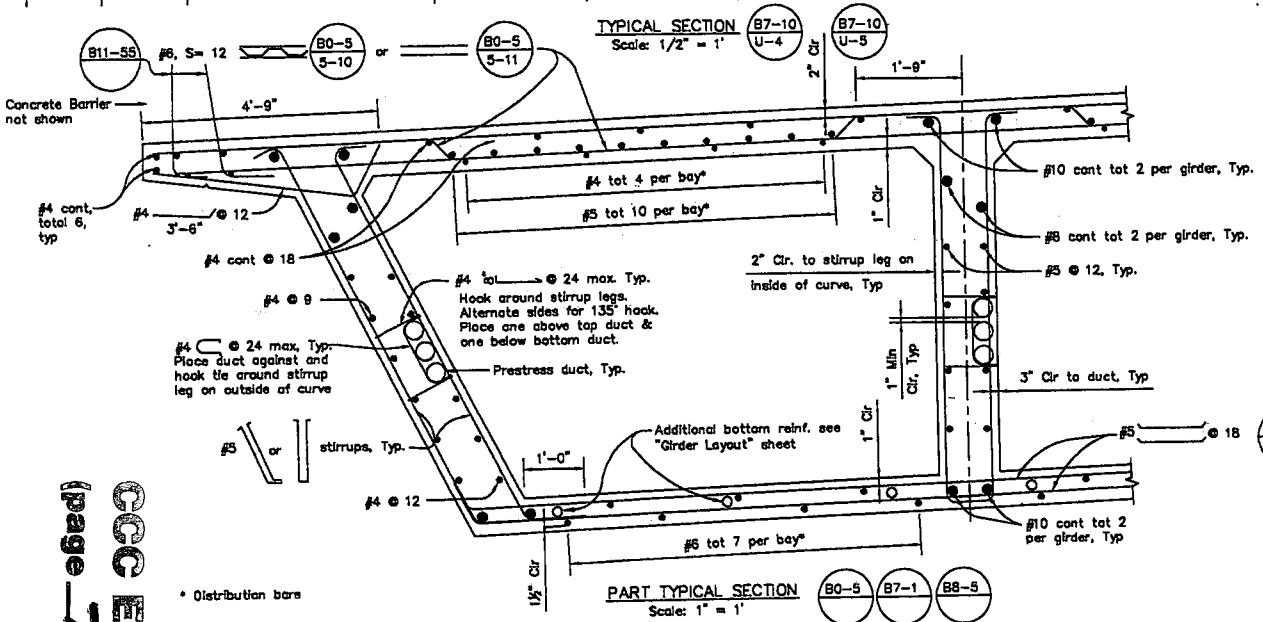
B11-51 B11-55



*Place scuppers at 18' max intervals along the barrier on left side of superstructure or as directed by the engineer.

SCUPPER DETAILS
Scale: 1" = 1'

B0-5 5-10 B0-5 5-11



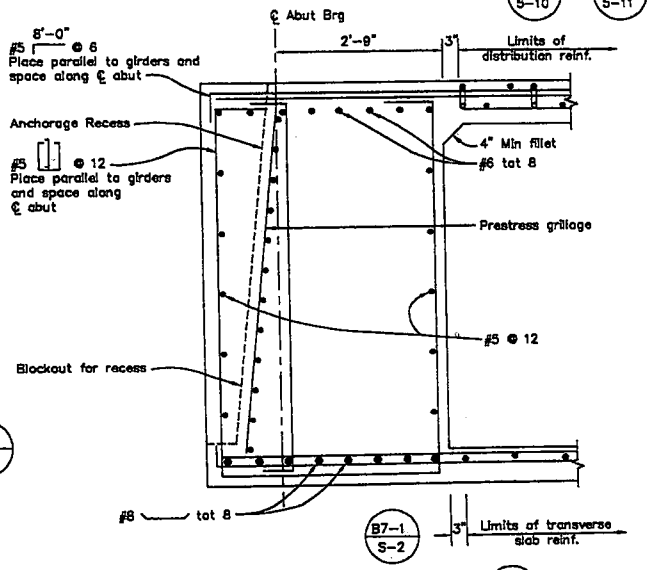
TYPICAL SECTION
Scale: 1/2" = 1'

B7-10 U-4 B7-10 U-5

* Distribution bars

PART TYPICAL SECTION
Scale: 1" = 1'

B0-5 B7-1 B8-5



END DIAPHRAGM
Scale: 1" = 1'

B8-5

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal

REGISTERED ENGINEER - CIVIL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Md. Wahiduzzaman — No. C49838 — Exp. 9/30/10 — CIVIL — STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 ISC SUR DRIVE
COLETA, CA 93117

DESIGN OVERSIGHT	DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD
SIGNOFF DATE	DETAILS	BY	CHECKED	LAYOUT BY MDW	CHECKED
	QUANTITIES	BY	CHECKED	SPECIFICATIONS BY	CHECKED

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

BRIDGE NO. 49C-0337
POST MILE

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)

TYPICAL SECTION

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY): 12/06/07 05/26/08 12/19/08

SHEET 7 OF 12

EXHIBIT C
Page 7 of 11
3 pages

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

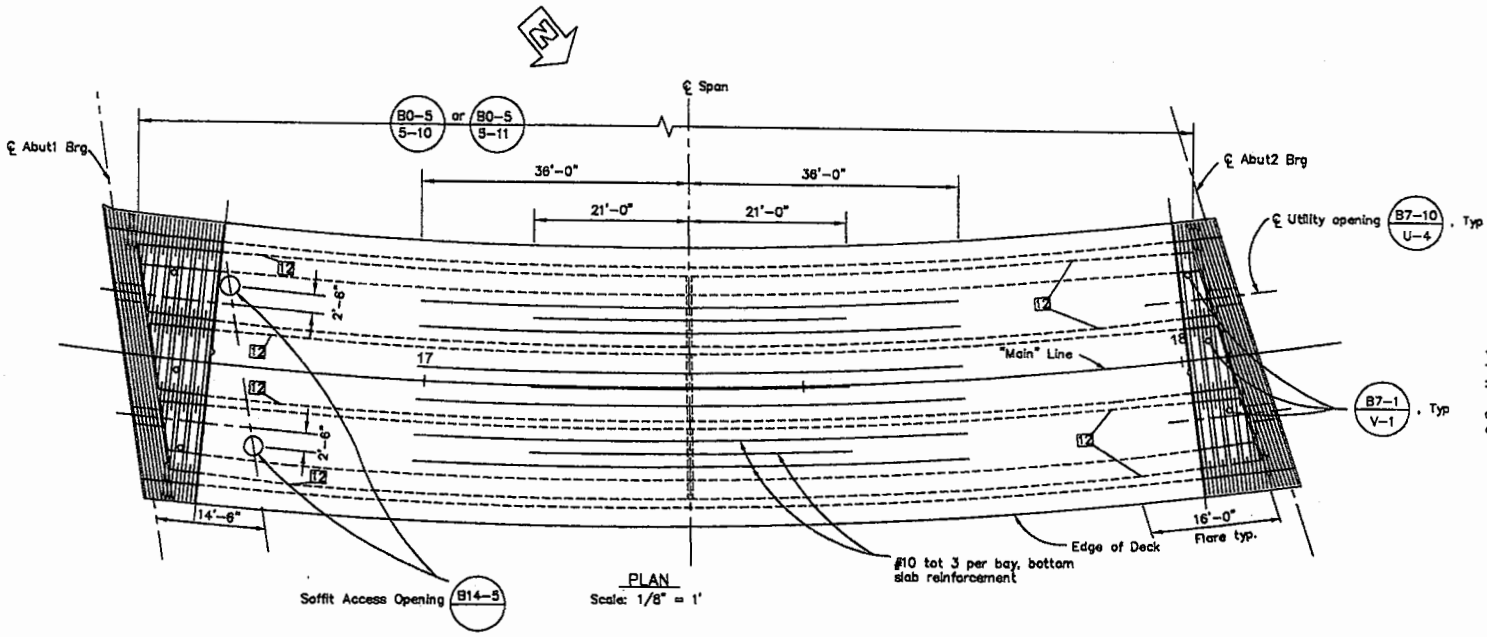
95% Submittal

REGISTERED ENGINEER – CIVIL

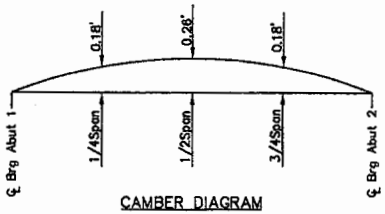
PLANS APPROVAL DATE

Md. Wahiduzzaman No. C49536 Exp. 9/30/10 CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117



PLAN
Scale: 1/8" = 1'



CAMBER DIAGRAM

(Does not include allowance for Falsework settlement)

PRESTRESSING NOTES

270 KSI Low Relaxation Strand:

P_{jack}	=	11,000 Kips
Anchor Set	=	⅜"
Total Number of Girders	=	4

Distribution of Prestress force (Pjack) between girders/ducts shall not exceed the ratio of 3:2. Maximum final force variation between girders shall not exceed 725 kips.

Concrete: f'c = 5,000 psi @ 28 days
f'ci = 3,600 psi @ time of stressing
Contractor shall submit elongation calculations based on initial stress at ⊠ = 0.947 times jacking stress.

μ = 0.15; K = 0.0002

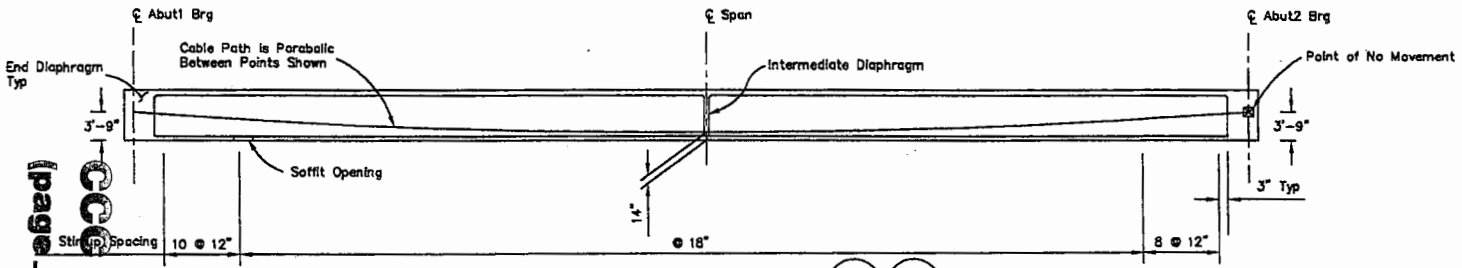
⊠ = indicates theoritical point of no movement for one end stressing.

Denotes width of girder.

Note:

1) For additional top and bottom reinf. see "Typical Section" sheet.

2) All Girders flares to 18" wide at the end diaphragms.

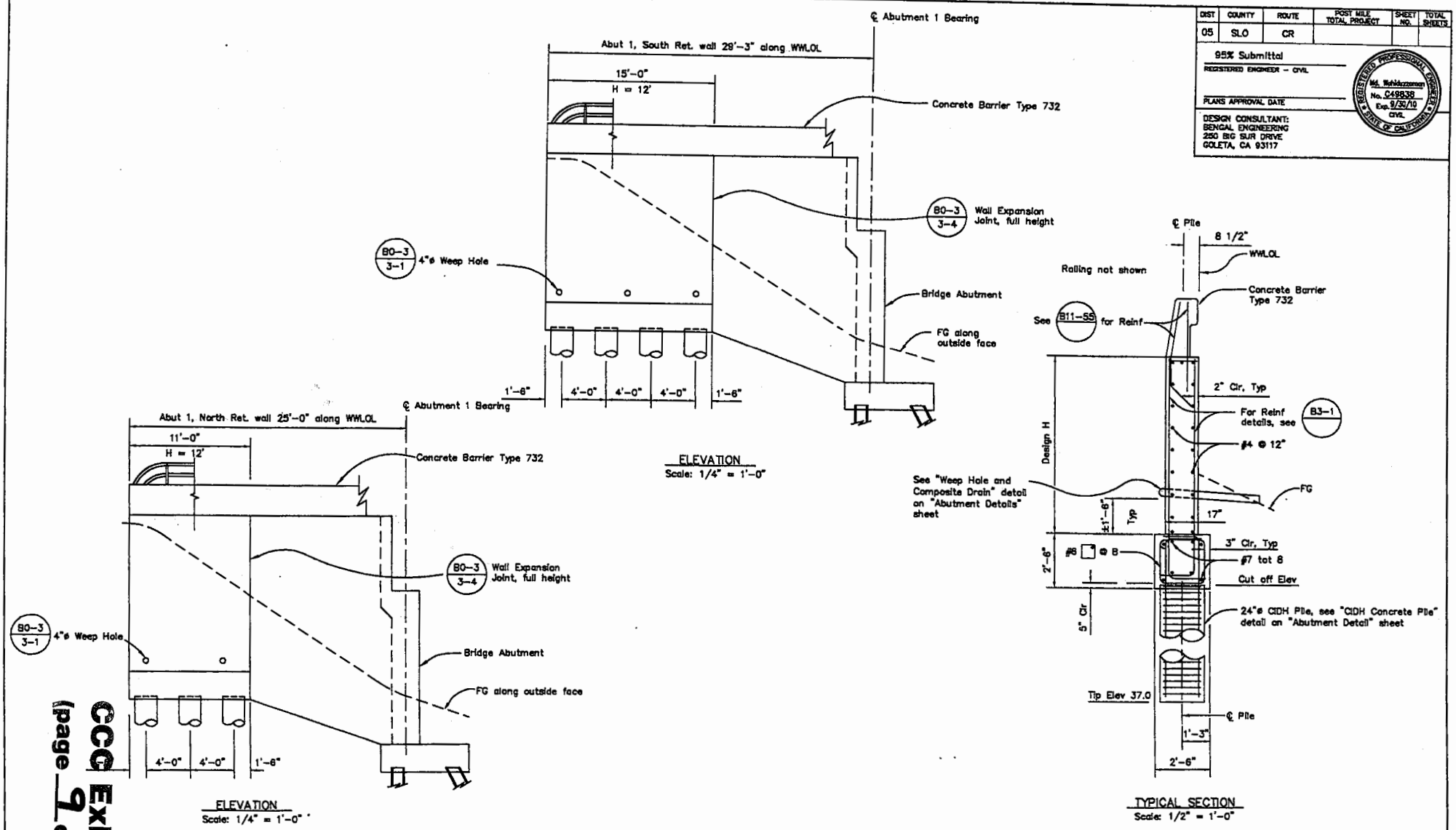


LONGITUDINAL SECTION B7-1 B8-5
No Scale

DESIGN OVERSIGHT	DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	Md. Wahiduzzaman PROJECT ENGINEER	BRIDGE NO. 49C-0337	MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)		
SIGNATURE DATE	DETAILS	BY	CHECKED	LAYOUT	BY MDW	CHECKED		POST MILE	GIRDER LAYOUT		
	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY	CHECKED	CU EA 05-927220L	DISREGARD PRINTS BEARING EARLIER REVISION DATES	REVISION DATES (PRELIMINARY STAGE ONLY) 12/06/07 08/26/08 12/19/08	SHEET 8	OF 12

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

Exhibit C page 8 of 3 page(s)



DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal

REGISTERED ENGINEER – CIVIL

PLANS APPROVAL DATE

Md. Wahiduzzaman No. C49838 Exp. 9/30/10 CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

DESIGN OVERSIGHT	DESIGN	MDW	XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD
SIGNOFF DATE	DETAILS			LAYOUT	MDW
	QUANTITIES			SPECIFICATIONS	

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

BRIDGE NO. 49C-0337
POST MILE -

MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)

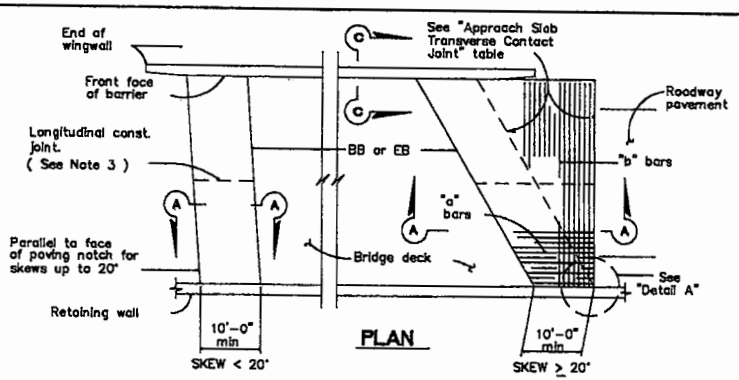
RETAINING WALL DETAILS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

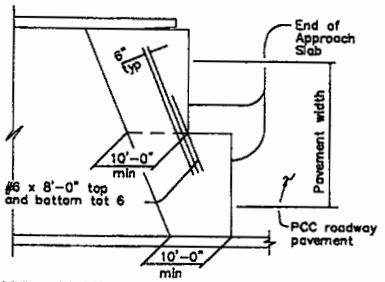
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)						SHEET	OF
12/08/07	08/26/08	12/19/08				9	12

CCC Exhibit 3 (page 9 of 11 pages)

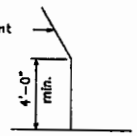


PLAN



STRUCTURE APPROACH - END STAGGER DETAIL

No Scale



DETAIL A

No Scale

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

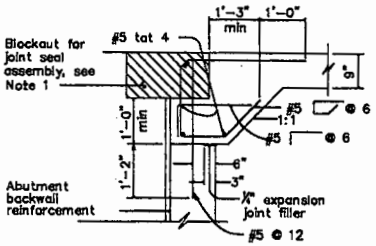
95% Submittal

REGISTERED ENGINEER – CIVIL

Md. Wahiduzzaman
No. C49838
Exp. 9/30/10
CIVIL
REGISTERED PROFESSIONAL ENGINEER
STATE OF CALIFORNIA

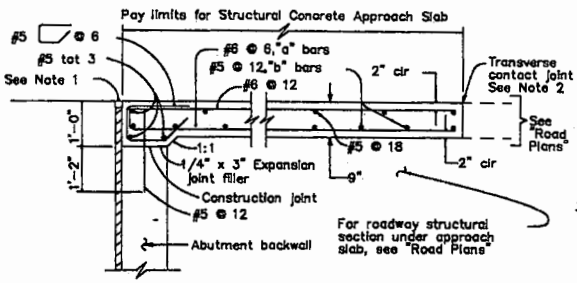
PLANS APPROVAL DATE

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117



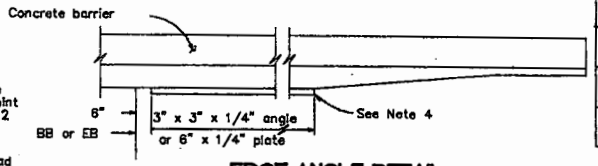
MR > 2"

SEAT TYPE ABUTMENT SECTION A-A



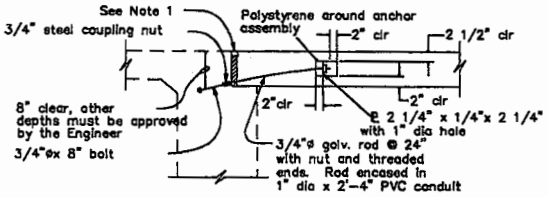
MR ≤ 2"

Note: Seat Type Abutment shown, for Diaphragm Type Abutment, see "Abutment Tie Details".

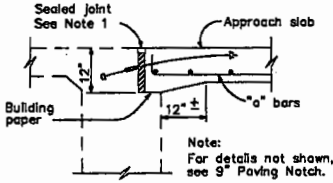


EDGE ANGLE DETAIL

APPROACH SLAB TRANSVERSE CONTACT JOINT		
STRUCTURE SKEW	AC APPROACH PAVEMENT	PCC APPROACH PAVEMENT
< 20°	Parallel to face of paving notch	Parallel to face of paving notch
20° – 45°	Parallel to face of P N use (Detail A)	Stagger lines 24' to 36' apart
> 45°	Parallel to face of P N use (Detail A)	Stagger at each lane line

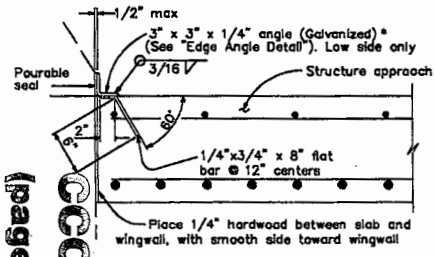


9" PAVING NOTCH

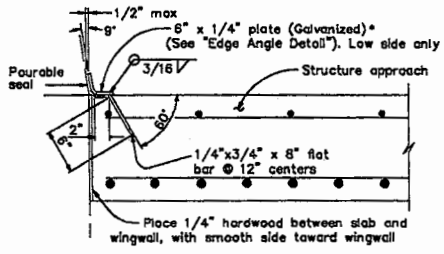


12" PAVING NOTCH

DIAPHRAGM TYPE ABUTMENT ABUTMENT TIE DETAILS

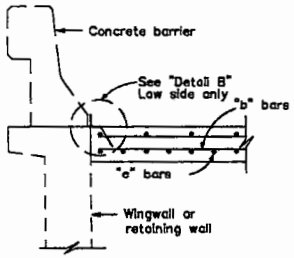


* (TO BE USED WITH TYPE 25 OR TYPE 27 CONCRETE BARRIER)



* (TO BE USED WITH TYPE 732 OR TYPE 736 CONCRETE BARRIER)

DETAIL B



SECTION C-C

NOTES:

1. For details not noted or shown, see Structure Plans. Adjust bar reinforcement to clear a sawcut for sealed joint, when required.
2. For transverse contact joint with new PCC paving, refer to Standard Plan P10.
3. Longitudinal construction joints, when permitted by the Engineer, shall be located on lane lines.
4. End angle or plate at beginning of barrier transition, end of wing wall or end of structure approach as applicable.
5. At the contractor's option, approach slab transverse reinforcement may be placed parallel to paving notch. Spacing of transverse reinforcement is measured along C\roadway.
6. For drainage details, see Structure Plans.

DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD
DETAILS	BY	CHECKED	LAYOUT	BY MDW CHECKED
QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY PLANS AND SPECS COMPARED

DESIGN OVERSIGHT
SIGNOFF DATE

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

PREPARED FOR THE
COUNTY OF SAN LUIS OBISPO
DEPARTMENT OF PUBLIC WORKS

Md. Wahiduzzaman
PROJECT ENGINEER

CU
EA 05-927220L

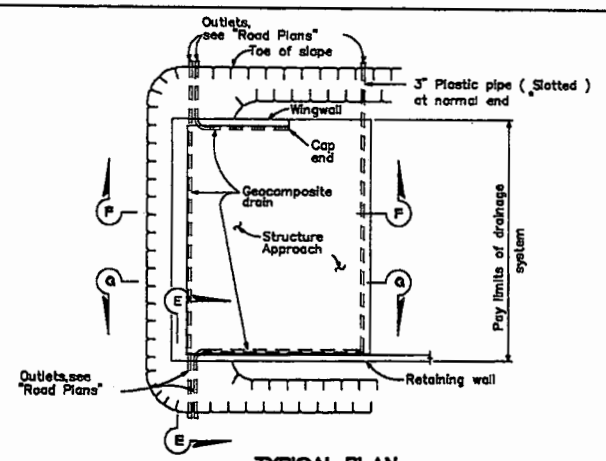
BRIDGE NO.	MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
49C-0337	
POST MILE	STRUCTURE APPROACH TYPE EQ(10)
*	

DISREGARD PRINTS BEARING EARLIER REVISION DATES ——

REVISION DATES (PRELIMINARY STAGE ONLY): 12/06/07 | 06/24/08 | 12/19/08

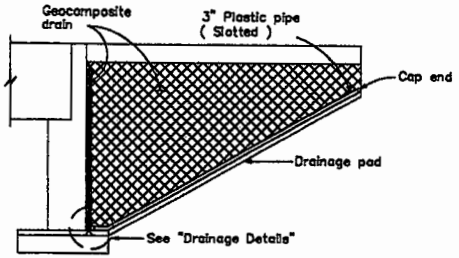
SHEET 10 OF 12

CCC Exhibit D (page 10 of 13 pages)



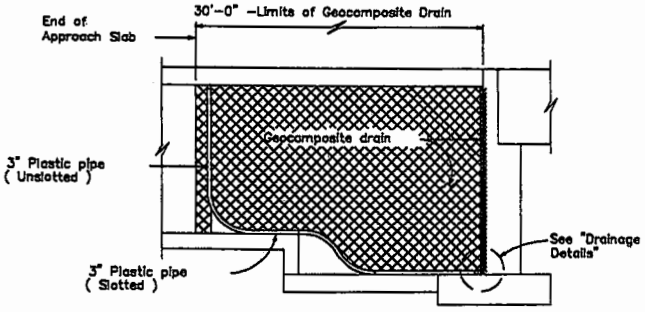
TYPICAL PLAN

*For pipe layout at staggered end, see "Detail B".



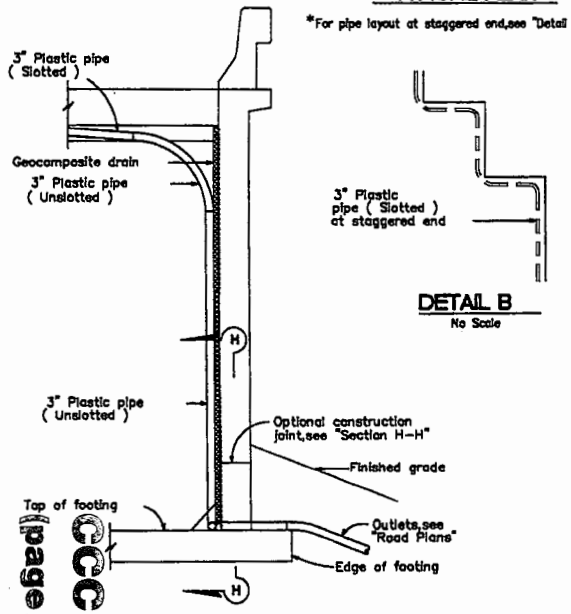
CANTILEVER WINGWALL

SECTION F-F



RETAINING WALL WINGWALL

SECTION G-G

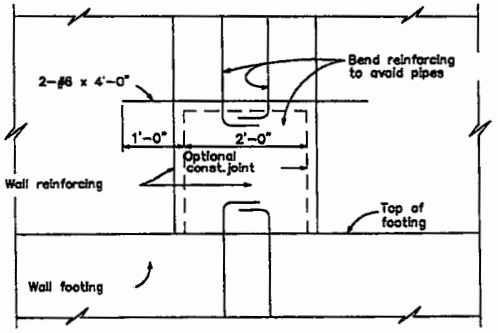


SECTION E-E

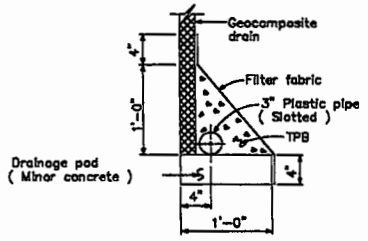
NOTE: Bends and junctions in 3" plastic pipe are 30" radius min.

DETAIL B

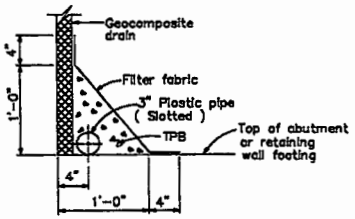
No Scale



SECTION H-H



WITHOUT FOOTING



WITH FOOTING

DRAINAGE DETAILS

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
05	SLO	CR			

95% Submittal

REGISTERED ENGINEER -- CIVIL

Md. Wahiduzzaman No. C49836 Exp. 9/30/10 CIVIL — REGISTERED PROFESSIONAL ENGINEER — STATE OF CALIFORNIA

PLANS APPROVAL DATE

DESIGN CONSULTANT:
BENGAL ENGINEERING
250 BIG SUR DRIVE
GOLETA, CA 93117

DESIGN OVERSIGHT	DESIGN	BY MDW	CHECKED XX	LOAD FACTOR DESIGN	LIVE LOADING: HS20-44 AND ALTERNATIVE AND PERMIT DESIGN LOAD	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	Md. Wahiduzzaman PROJECT ENGINEER
SIGNOFF DATES	DETAILS	BY	CHECKED	LAYOUT	BY MDW		
	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY		CU 05-927220L

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 3

BRIDGE NO.	MAIN ST. BRIDGE OVER SANTA ROSA CR. (REPL.)
49C-0337	
POST MILE	STRUCTURE APPROACH DRAINAGE DETAILS
•	

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES (PRELIMINARY STAGE ONLY): 12/08/07 08/26/08 12/19/08

SHEET 11 OF 12

EXHIBIT CCC page 11 of 17 pages

SAN LUIS OBISPO COUNTY
DEPARTMENT OF PLANNING AND BUILDING

JUN 21 2010
FINAL LOCAL ACTION NOTICE
REFERENCE # 3-SLO-10-138
APPEAL PERIOD 7/8-7/21/2010

RECEIVED
JUL 07 2010
CALIFORNIA COASTAL COMMISSION CENTRAL COAST AREA

John Farhar
County of San Luis Obispo
Public Works Dept.
County Gov't Center, Rm. 207
San Luis Obispo, CA 93408

NOTICE OF FINAL COUNTY ACTION

HEARING DATE: June 22, 2010

SUBJECT: County File No. – DRC 2009-00041
Minor Use Permit/Coastal Development Permit

LOCATED WITHIN COASTAL ZONE: YES

The above-referenced application was approved by the Board of Supervisors, based on the approved Findings and Conditions, which are attached for your records. This Notice of Final Action is being mailed to you pursuant to Section 23.02.033(d) of the Land Use Ordinance.

This action is appealable to the California Coastal Commission pursuant to regulations contained in Coastal Act Section 30603 and the County Coastal Zone Land Use Ordinance 23.01.043. These regulations contain specific time limits to appeal, criteria, and procedures that must be followed to appeal this action. The regulations provide the California Coastal Commission ten (10) working days following the expiration of the County appeal period to appeal the decision. This means that no construction permits can be issued until both the County appeal period and the additional Coastal Commission appeal period have expired without an appeal being filed.

Exhaustion of appeals at the county level is required prior to appealing the matter to the California Coastal Commission. This second appeal must be made directly to the California Coastal Commission Office. Contact the Commission's Santa Cruz Office at (831) 427-4863 for further information on their appeal procedures.

If the use authorized by this Permit approval has not been established, or if substantial work on the property towards the establishment of the use is not in progress after a period of twenty-four (24) months from the date of this approval or such other time period as may be designated through conditions of approval of this Permit, this approval shall expire and become void unless an extension of time has been granted pursuant to the provisions of Section 23.02.050 of the Land Use Ordinance.

CCC Exhibit 4
(page 1 of 20 pages)

If the use authorized by this Permit approval, once established, is or has been unused, abandoned, discontinued, or has ceased for a period of six (6) months, or conditions have not been complied with, such Permit approval shall become void.

If you have questions regarding your project, please contact me at (805) 781-5198.

Sincerely,

AIRLIN SINGEWALD
Coastal Planning and Permitting

cc: California Coastal Commission,
725 Front Street, Suite 300, Santa Cruz, California 95060
Lynne Harkins, P.O. Box 606, Cambria, CA 93428

(Planning Department Use Only – for California Coastal Commission)

Date NOFA copy mailed to Coastal Commission: July 1, 2010

Enclosed:
__X__ Staff Report(s))
__X__ Resolution with Findings and Conditions

BOARD OF SUPERVISORS

COUNTY OF SAN LUIS OBISPO, STATE OF CALIFORNIA

Tuesday, June 22, 2010

PRESENT: Supervisors: Bruce S. Gibson, Adam Hill, K.H. 'Katcho' Achadjian, James R. Patterson and Chairperson Frank Mecham

ABSENT: None

In the matter of **RESOLUTION NO. 2010-204:**

This is the time set for a hearing to consider an appeal by Lynne Harkins of the Planning Department Hearing Officer's approval of a request by the Department of Public Works for a Minor Use Permit/Coastal Development Permit to allow the replacement of the functionally obsolete Main Street Bridge with a new bridge on a parallel alignment which will result in the disturbance of a 5.5 acre area located east of the Main Street/Santa Rosa Creek Road intersection in the community of Cambria; 2nd District.

Ms. Lynne Harkins - Appellant: speaks.

Chairperson Mecham: opens the floor to public comment without response.

Ms. Harkins: provides closing statements.

Thereafter, on motion of Supervisor Bruce S. Gibson, seconded by Supervisor James R. Patterson, and on the following roll call vote:

AYES: **Supervisors: Bruce S. Gibson, James R. Patterson, Adam Hill, K.H. 'Katcho' Achadjian, Chairperson Frank Mecham**
NOES: **None**
ABSENT: **None**

the Board denies the appeal by Lynne Harkins and RESOLUTION NO. 2010-204, a resolution affirming the decision of the hearing officer and conditionally approving the application of the County of San Luis Obispo, Department of Public Works, for Minor Use Permit/Coastal Development Permit DRC2009-00041, based on the findings in Exhibit A and the Conditions in Exhibit B, Adopted.

06/25/10 ar
cc: Planning (2)
filed

STATE OF CALIFORNIA)
) ss.
County of San Luis Obispo)

I, **JULIE L. RODEWALD**, County Clerk and ex-officio Clerk of the Board of Supervisors, in and for the County of San Luis Obispo, State of California, do hereby certify the foregoing to be a full, true and correct copy of an order made by the Board of Supervisors, as the same appears spread upon their minute book.

WITNESS my hand and the seal of the said Board of Supervisors, affixed this 25th day of June, 2010.

(SEAL)

JULIE L. RODEWALD
County Clerk and Ex-Officio Clerk of the Board of Supervisors

By: _____
Deputy Clerk

6 C-2

IN THE BOARD OF SUPERVISORS
COUNTY OF SAN LUIS OBISPO, STATE OF CALIFORNIA

Tuesday, June 22, 2010

PRESENT: Supervisors Bruce S. Gibson, Adam Hill, K.H. 'Katcho' Achadjian, James R. Patterson and Chairperson Frank Mecham

ABSENT: None

RESOLUTION NO. 2010-204

RESOLUTION AFFIRMING THE DECISION OF THE HEARING OFFICER AND CONDITIONALLY APPROVING THE APPLICATION OF THE COUNTY OF SAN LUIS OBISPO, DEPARTMENT OF PUBLIC WORKS, FOR MINOR USE PERMIT/COASTAL DEVELOPMENT PERMIT DRC2009-00041

The following resolution is now offered and read:

WHEREAS, on April 16, 2010, the Zoning Administrator of the County of San Luis Obispo (hereinafter referred to as the "Hearing Officer") duly considered and conditionally approved the application of the County of San Luis Obispo, Department of Public Works, for Minor Use Permit/Coastal Development Permit DRC2009-00041; and

WHEREAS, Lynne Harkins has appealed the Hearing Officer's decision to the Board of Supervisors of the County of San Luis Obispo (hereinafter referred to as the "Board of Supervisors") pursuant to the applicable provisions of Title 23 of the San Luis Obispo County Code; and

WHEREAS, a public hearing was duly noticed and conducted by the Board of Supervisors on June 22, 2010, and a determination and decision was made on June 22, 2010; and

WHEREAS, at said hearing, the Board of Supervisors heard and received all oral and written protests, objections, and evidence, which were made, presented, or filed, and all persons present were given the opportunity to hear and be heard in respect to any matter relating to said appeal; and

WHEREAS, the Board of Supervisors has duly considered the appeal and finds that the appeal should be denied and the decision of the Hearing Officer should be affirmed subject to the findings and conditions set forth below.

NOW, THEREFORE, BE IT RESOLVED AND ORDERED by the Board of Supervisors of the County of San Luis Obispo, State of California, as follows:

1. That the recitals set forth hereinabove are true, correct and valid.

2. That the Board of Supervisors makes all of the findings of fact and determinations set forth in Exhibit A attached hereto and incorporated by reference herein as though set forth in full.

3. That the negative declaration prepared for this project is hereby approved as complete and adequate and as having been prepared in accordance with the provisions of the California Environmental Quality Act.

4. That the Board of Supervisors has reviewed and considered the information contained in the negative declaration together with all comments received during the public review process prior to approving the project.

5. That the appeal filed by Lynne Harkins is hereby denied and the decision of the Hearing Officer is affirmed that the application of the County of San Luis Obispo, Department of Public Works, for Minor Use Permit/Coastal Development Permit DRC2009-00041 is hereby approved subject to the conditions of approval set forth in Exhibit B attached hereto and incorporated by reference herein as though set forth in full.

Upon motion of Supervisor Gibson, seconded by Supervisor Patterson, and on the following roll call vote, to wit:

AYES: Supervisors Gibson, Patterson, Hill Achadjian, Chairperson Mecham

NOES: None

ABSENT: None

ABSTAINING: None

the foregoing resolution is hereby adopted.

Frank Mecham
Chairperson of the Board of Supervisors

ATTEST:

JULIE L. RODEWALD
Clerk of the Board of Supervisors

By: Annette Ramirez
Deputy Clerk

[SEAL]

APPROVED AS TO FORM AND LEGAL EFFECT:

WARREN R. JENSEN
County Counsel

By: /s/ James B. Orton
Deputy County Counsel

Dated: June 7, 2010

STATE OF CALIFORNIA)
ss
COUNTY OF SAN LUIS OBISPO)

I, **JULIE L. RODEWALD,** County Clerk of the above entitled County, and Ex-Officio Clerk of the Board of Supervisors thereof, do hereby certify the foregoing to be a full, true and correct copy of an order entered in the minutes of said Board of Supervisors, and now remaining of record in my office.

Witness, my hand and seal of said Board of Supervisors this June 22, 2010.

JULIE L. RODEWALD
County Clerk and Ex-Officio Clerk
of the Board of Supervisors

By: Annette Ramirez
Deputy Clerk

EXHIBIT A - FINDINGS

Environmental Determination

A. The Environmental Coordinator, after completion of the initial study, finds that there is no substantial evidence that the project may have a significant effect on the environment, and the preparation of an Environmental Impact Report is not necessary. Therefore, a Mitigated Negative Declaration (pursuant to Public Resources Code Section 21000 et seq., and CA Code of Regulations Section 15000 et seq.) has been issued on January 28, 2010 for this project. Mitigation measures are proposed to address Aesthetics, Agriculture, Air Quality, Biological Resources, Geology and Soils, Hazards, and Transportation/Circulation and are included as conditions of approval.

Minor Use Permit

B. The proposed project or use is consistent with the San Luis Obispo County General Plan and Local Coastal Plan because the use is an allowed use consistent with the allowed uses permitted within wetland and riparian setbacks per CZLUO Section 23.07.172d(1) and as conditioned is consistent with all of the General Plan and Local Coastal Plan policies.

C. As conditioned, the proposed project or use satisfies all applicable provisions of Title 23 of the County Code and the Local Coastal Plan.

D. The establishment and subsequent operation or conduct of the use will not, because of the circumstances and conditions applied in the particular case, be detrimental to the health, safety or welfare of the general public or persons residing or working in the neighborhood of the use, or be detrimental or injurious to property or improvements in the vicinity of the use because the project would replace an existing functionally obsolete bridge with a new bridge, and would be conditioned to implement a Conceptual Habitat Mitigation and Monitoring Plan to reduce the project's biological impacts to a level of insignificance. The project will not increase demand or use of the existing bridge as it's designed to accommodate the existing traffic demand and capacities on Main Street. The project is subject to Ordinance, Building Code, and engineering requirements designed to address health, safety and welfare concerns.

E. The proposed project or use will not be inconsistent with the character of the immediate neighborhood nor contrary to its orderly development because the project would replace an existing functionally obsolete bridge with a new bridge and would be conditioned to implement a Habitat Mitigation and Monitoring Plan to reduce the project's biological impacts to a level of insignificance.

F. The proposed project or use will not generate a volume of traffic beyond the safe capacity of all roads providing access to the project, either existing or to be improved with the project because the proposed project would replace an existing obsolete bridge with a new bridge that is designed to accommodate the existing traffic demand and capacities for Main Street. The replacement bridge would be constructed on a parallel alignment immediately upstream from the existing bridge, allowing the existing bridge to remain open during construction work.

Coastal Access

G. The proposed use is in conformity with the public access and recreation policies of Chapter 3 of the California Coastal Act, because the project is not adjacent to the coast and the project will not inhibit access to the coastal waters and/or recreation areas.

Sensitive Resource Areas (SRA)

H. The development will not create significant adverse effects on the natural features of the site or vicinity that were the basis for the Sensitive Resource Area designation, and will preserve and protect such features through the site design, because the applicant analyzed three alternative alignments (upstream, downstream, and the existing alignment) as well as alternative bridge designs, and concluded that each alternative would have comparable environmental impacts. In addition, the applicant would implement a habitat mitigation and monitoring program to reduce the project's biological impacts to a level of insignificance.

I. Natural features and topography have been considered in the design and siting of all proposed physical improvements and the project has been conditioned to avoid and minimize impacts to the sensitive resources within the construction area. Best management practices will be implemented during construction to avoid spills and leaks, erosion, and other forms of disturbance to the SRA. Erosion control measures, bank stabilization, and revegetation will restore temporarily disturbed areas. The long term effect of the project will be beneficial to the identified sensitive resource with the conditions applied to the project.

J. The proposed clearing of topsoil, trees, is the minimum necessary to achieve safe and convenient access and siting of proposed structures, and will not create significant adverse effects on the identified sensitive resource, because best management practices will be implemented during construction to minimize impacts and disturbance to the SRA. Erosion control measures, bank stabilization, and revegetation will restore temporarily disturbed areas. The long term effect of the project will be beneficial to the identified sensitive resource with the conditions applied to the project.

K. The soil and subsoil conditions are suitable for any proposed excavation and site preparation and drainage improvements have been designed to prevent soil erosion, and sedimentation of streams through undue surface runoff, because best management practices will be applied to the project to limit potential drainage impacts including but not limited to erosion control measures, bank stabilization, and revegetation will restore temporarily disturbed areas as soon as feasible. The long term effect of the project will be beneficial to the identified sensitive resource with the conditions applied to the project.

Environmentally Sensitive Habitats

L. There will be no significant negative impact on the identified sensitive habitat and the proposed use will be consistent with the biological continuance of the habitat because the applicant analyzed three alternative alignments (upstream, downstream, and the existing alignment) as well as alternative bridge designs, and concluded that each alternative would have comparable environmental impacts. In addition, the applicant would implement a habitat mitigation and monitoring program to reduce the project's biological impacts to a level of insignificance.

M. The proposed use will not significantly disrupt the habitat because the applicant analyzed three alternative alignments (upstream, downstream, and the existing alignment) as well as alternative bridge designs, and concluded that each alternative would have comparable environmental impacts. In addition, the applicant would implement a habitat mitigation and monitoring program to reduce the project's biological impacts to a level of insignificance.

Streams and Riparian Vegetation

N. The proposed project consists of the replacement of an existing functionally obsolete bridge which is an allowable use and will be located adjacent and within the creek channel for Santa Rosa Creek. The applicant analyzed three alternative alignments (upstream, downstream, and the existing alignment) as well as alternative bridge designs, and concluded that each alternative would have comparable environmental impacts. In addition, the applicant would implement a habitat mitigation and monitoring program to reduce the project's biological impacts to a level of insignificance.

O. Adverse environmental effects have been mitigated to the maximum extent feasible based on implementation of the proposed Habitat Mitigation and Monitoring Plan.

P. The adjustment to the riparian setback is necessary to allow the project because alternative designs were considered and determined to be more environmentally damaging.

Q. The adjustment to the riparian setback is the minimum that would allow for the project.

Wetlands

R. Alternative routes are infeasible or more environmentally damaging.

S. Adverse environmental effects are mitigated to the maximum extent feasible.

T. The site would be physically unusable for the principal permitted use (bridges) unless the setback is reduced.

U. The reduction is the minimum that would enable the principle permitted use (bridges) to be established on the site after all practical design modification have been considered.

Archeological Sensitive Area

V. The site design and development incorporate adequate measures to ensure that archeological resources will be acceptably and adequately protected because the Archaeological Survey Report (ASR; Far Western, 2004b) prepared for the project concluded that the site does not contain known archaeological resources and that the project is not likely to impact cultural resources.

EXHIBIT B - CONDITIONS OF APPROVAL

Approved Development

1. This approval authorizes the replacement of the functionally obsolete Main Street Bridge, constructed in 1922, with a new bridge on a parallel alignment. The project would result in the disturbance of approximately 5.5 acres for the following development:

   a. Construction of a new 37.5 foot wide and 150 foot long cast-in-place concrete bridge.
   b. Realignment of Main Street upstream of the existing bridge.
   c. Realignment of the Main St. / Santa Rosa Creek Rd. intersection including construction of acceleration and deceleration tapers.
   d. Creek work including diversion or dewatering and placement of rip-rap on banks.
   e. Demolition and removal of the existing bridge structure.

Site Development

2. **Prior to commencement of construction activities**, project plans shall show all development consistent with the approved site plan and approved project description.

3. **Prior to commencement of construction activities**, the County shall obtain all necessary permits and approval from state and federal agencies, including, but not limited to:

   - Authorization from the US Army Crop of Engineers (ACOE) under Section 404 of the Clean Water Act.
   - Water Quality Certification from the Regional Water Quality Control Board (RWQCB) under Section 401 of the Clean Water Act.
   - A Streambed Alteration Agreement with the California Department of Fish and Game (CDFG) under Section 1602 of the Fish and Game Code.
   - Consultation with the United States Fish and Wildlife Service (USFWS) regarding the California red-legged frog and tidewater goby and the National Marine Fisheries Service (NMFS) regarding south-central California coast steelhead trout pursuant to Section 7 of the Endangered Species Act.

Aesthetics

4. **Prior to commencement of construction activities,** detailed revegetation/planting plans and maintenance and monitoring plans as part of a Habitat Mitigation and Monitoring Plan shall be prepared. The revegetation plan shall include:

   - Placement of appropriate riparian species consistent with existing species found in adjacent riparian areas. Plant material for mitigation shall be propagated from seed and cuttings of plants along Santa Rosa Creek.
   - Replacement of each oak to be removed at a rate of 6 to 1. Oaks shall be placed to provide signature framing without blocking vistas of surrounding hills as seen from Main Street. Container sizes of oaks shall be no larger than 5 gallons. All plant materials shall be checked to ensure they are not root bound and are free of diseases and pests.
   - Restoration of the old roadbed alignment shall include 1) ripping/plowing to minimize soil compaction; and 2) hydroseeding with an appropriate native seed mix.
   - Replacement plantings shall be appropriately maintained for a period of five years or until the plantings are established in the landscape such that they can survive without additional care. Any plants that die shall be replaced.

- Monitoring of the revegetated area shall be conducted as required by the Habitat Monitoring and Mitigation Plan prepared for the project.

5. **Prior to commencement of construction activities,** efforts shall be made to select rock rip-rap which matches the color of native rock in the creek channel or nearby native rock outcroppings.

Agriculture

6. The County shall minimize temporary construction impacts to Agriculture designated land by locating, to the degree feasible, construction materials and staging construction activities on land designated for other than agricultural use, including Public Facilities land owned by the Cambria Community Services District.

7. For any construction staging or storage proposed on Agriculture designated land, specifically APN 013-151-003, the County shall avoid impacts to soil resources with the following measures:

   - Utilize a geotextile membrane atop the native soils prior to the placement of any stockpile fill or base materials such as gravel. Remove all fill material upon completion of the project and restore native soil to its previous condition.
   - Coordinate construction with the property owner and any farm lessee/operator in order to avoid or minimize impacts to the agricultural utilization of the property.

8. The County shall take measures to provide timely and updated information to agricultural users of the bridge and intersection, including early notice of planned temporary closures and/or detours that might affect the movement of agricultural goods and personnel. Notice should be provided to growers along the length of Santa Rose Creek Road.

Air Quality

9. Prior to the initiation of demolition activities, the County shall complete the following:

   - Notify the APCD.
   - Submit an asbestos survey conducted by a Certified Asbestos Inspector to the APCD.
   - Implement applicable APCD removal and disposal requirements of identified asbestos-containing material.

10. Prior to the initiation of demolition activities, the County shall implement lead abatement pursuant to the California Division of Occupation and Health requirements.

11. During construction and ground-disturbing activities, the County shall implement the following dust control measures. These measures shall be shown on project plans. In addition, the contractor or builder shall designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent the transport of dust off site. Their duties shall include holiday and weekend periods when work may not be in progress. The name and telephone number of such persons shall be provided to the APCD prior to commencement of construction.

    - Reduce the amount of disturbed area where possible.

- Unpaved areas subject to vehicle traffic must be stabilized by being kept adequately wetted, treated with a chemical dust suppressant, or covered with material that contains less than 0.25 percent asbestos.
- Use water trucks or sprinkler systems in sufficient quantity to prevent airborne dust from leaving the site. Increased watering frequency shall be required whenever wind speeds exceed 15 mph. Reclaimed (non-potable) water shall be used whenever possible.
- Storage piles and disturbed areas not subject to vehicular traffic must be stabilized by being kept adequately wetted, treated with a chemical dust suppressant, or covered with material that contains less than 0.25 percent asbestos.
- Permanent dust control measures identified in the approved project revegetation and landscape plans shall be implemented as soon as possible following completion of any soil-disturbing activities.
- Exposed ground areas that are planned to be reworked at dates greater than one month after initial grading shall be sown with a fast germinating native grass seed and watered until vegetation is established.
- Disturbed soil areas not subject to revegetation shall be stabilized using approved chemical soil binders, jute netting, or other methods approved in advance by the APCD.
- Roadways, driveways, sidewalks to be paved shall be completed as soon as possible, and building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
- Construction vehicle speed shall not exceed 15 mph on any unpaved surface at the construction site, unless the road surface and surrounding area is sufficiently stabilized to prevent vehicles and equipment traveling more than 15 miles per hour from emitting dust that is visible crossing the project boundaries.
- All trucks hauling dirt, sand, soil, or other loose materials are to be covered or shall maintain at least two ft of freeboard (minimum vertical distance between the top of the load and the top of the trailer) in accordance with California Vehicle Code Section 23114.
- Activities shall be conducted so that no track-out from construction is visible on paved roadways open to the public.
- Install wheel washers where vehicles enter and exit unpaved roads onto streets, or wash off trucks and equipment leaving the site.
- Sweep streets at the end of each day if visible soil material is carried onto adjacent paved roads. Water sweepers with reclaimed water shall be used where feasible.
- Equipment and operations shall not cause the emission of dust that is visible outside of the project area.

12. **Prior to the initiation of grading activities**, the County shall conduct a geologic investigation to determine if naturally occurring asbestos is present at the project site. The survey shall include the investigation of utility piping and conduits which are known to be present within the immediate area of the bridge. If naturally occurring asbestos is not present, an exemption request shall be filed with the APCD. If naturally occurring asbestos is present, the County shall comply with CCR 93105, the Asbestos Air Toxics Control Measure (ATCM) for Construction, Grading, Quarrying, and Surface Mining Operations. The County shall report the discovery of naturally-occurring asbestos, serpentine, or ultramafic rock to the APCD no later than the next business day. ATCM requirements may include, but are not limited to, the preparation of an Asbestos Dust

Mitigation Plan and Heath and Safety Program for the review and approval of the APCD. The County shall complete necessary notification to the APCD.

13. **During construction and ground disturbing activities**, the County shall implement the following measures. These measures shall be shown on project plans.

    - Maintain all construction equipment in proper tune according to the manufacturer's specifications.
    - Fuel all off-road and portable diesel-powered equipment, including but not limited to bulldozers, graders, cranes, loaders, scrapers, backhoes, generator sets, compressors, and auxiliary power units, with CARB-certified motor vehicle diesel fuel (non-taxed version suitable for use off-road).
    - Maximize to the extent feasible the use of diesel construction equipment meeting the CARB's 1996 or newer certification standard for off-road heavy-duty diesel engines.

14. The County shall obtain any necessary California statewide portable equipment registration or APCD permits for portable equipment used during construction, including but not limited to the following:

    - Power screens, conveyors, diesel engines, and/or crushers;
    - Portable generates greater than 50 horsepower;
    - IC engines;
    - Unconfined abrasive blasting operations;
    - Concrete batch plants;
    - Rock and pavement crushing;
    - Tub grinders; and
    - Trommel screens.

15. **Prior to initiation of construction activities**, the County shall obtain all required equipment use permits from the APCD.

Biological Resources

16. **Prior to commencement of construction activities,** the project site shall be clearly flagged or fenced so that the contractor is aware of the limits of allowable site access and disturbance. Areas within the designated project site that do not require regular access shall be clearly flagged as off-limit areas to avoid/discourage unnecessary damage to sensitive habitats or existing vegetation within the project site.

17. A qualified biologist shall ensure compliance with all regulatory permit conditions. Monitoring shall be at a frequency and duration determined during consultation with responsible agencies [e.g., National Marine Fisheries Service (NOAA Fisheries), USFWS, and CDFG].

18. **During project activities,** a qualified biologist shall coordinate with state and federal agencies, the County, and the construction contractor to ensure construction schedules comply with biological mitigation requirements.

19. **During project activities,** all project-related spills of hazardous materials within or adjacent to the project site shall be cleaned up immediately. Spill prevention and cleanup materials shall be on-site at all times during construction.

20. **During project activities,** no pets shall be allowed on the construction site.

21. **During project activities,** erosion control measures shall be implemented. Silt fencing and barriers (e.g., hay bales) shall be installed between the project site and adjacent wetland areas. At a minimum, silt fencing shall be checked and maintained on a daily basis throughout the construction period. Any meshes and coir rolls used for the project shall be of natural fiber. The contractor shall also apply adequate dust control techniques, such as site watering, during construction.

22. **During project activities,** all work occurring within the stream channel shall be conducted "in the dry." Cofferdams constructed out of sandbags and visqueen shall be placed at the downstream and upstream limits of the project site and dewatering/diversion operations shall be implemented.

23. **During project activities,** the cleaning and refueling of equipment and vehicles shall occur only within a designated staging area and at least 65 ft from any riparian habitat, wetland, or water body. This staging area shall conform to Best Management Practices (BMPs) applicable to attaining zero discharge of stormwater runoff. At a minimum, all equipment and vehicles shall be checked and maintained on a daily basis to ensure proper operation and avoid potential leaks or spills.

24. **Prior to the onset of work,** the permittee shall prepare a plan to allow a prompt and effective response to any accidental spills. All workers shall be informed of the importance of preventing spills and of the appropriate measures to take should a spill occur.

25. **During project activities,** all trash that may attract predators shall be properly contained, removed from the work site and disposed of regularly. Following construction, all trash and construction debris shall be removed from work areas.

26. **Following project completion,** sandbag material shall be disposed offsite. Sandbag material shall not be returned to the creek channel.

27. **Following project completion,** creek banks impacted as a result of construction or other activities shall be revegetated as soon as possible, using appropriate native ground covers according to an approved mitigation plan.

28. **Following project completion,** stream contours shall be returned to their original condition.

29. A qualified biologist shall ensure that the spread or introduction of invasive exotic plant species would be avoided to the maximum extent possible. When practicable, invasive exotic plants in the project site shall be removed and properly disposed of. Control of exotic species shall be included as part of revegetation and subsequent monitoring plans.

30. To control erosion during and after project implementation, the County shall implement BMPs, as identified by the RWQCB.

31. All significant, native vegetation adversely affected during site construction shall be inventoried by the qualified biologist, and the nature of impact characterized (e.g., removed, trimmed, root zone compacted, root zone excavated).

32. The applicant shall begin implementation of the Conceptual Habitat Mitigation and Monitoring Plan (CHMMP) (refer to Appendix G of the Natural Environment Study Report for the project), as amended consistent with State and Federal permits, immediately following project completion. This shall include compensatory mitigation for impacts to the riparian corridor within the project site, including native revegetation of all bare soil and impacted vegetation. On-site and in-kind mitigation for temporary impacts to riparian vegetation would be mitigated at a 1:1 ratio and permanent impacts would be mitigated at a 2:1 ratio.

33. Project construction shall occur after higher spring flows have subsided to a point where complete dewatering can be accomplished.

34. **Prior to commencement of construction activities,** the streambed of Santa Rosa Creek within the project site shall be dewatered. The contractor shall follow the stream diversion and dewatering plan prepared for the project. The form and function of the diversion and all pumps included in the dewatering strategy shall be checked throughout project construction by a qualified biologist to ensure a dry work environment and minimize impacts to aquatic species. An appropriate stream diversion system must be approved by NMFS. The stream diversion and dewatering plan shall be conducted under the direct and continuous supervision of a qualified biologist to ensure the proper form and function of the diversion. The diversion structure shall be monitored throughout project construction by the work crews, and by a qualified biologist.

35. **Prior to commencement of construction activities,** a qualified biologist shall conduct a training session for all construction personnel. At a minimum, the training shall include a description of the tidewater goby, steelhead, red-legged frog and their habitats, the importance of the species and their habitats, the general measures that are being implemented to conserve the species as they relate to the project, and the boundaries within which the project may be accomplished. Workers shall be required to sign a training sheet stating that they have attended the training session, and understand the regulatory implications of "take" as it is defined within the Endangered Species Act. Workers shall also be instructed on what actions to take in the event that listed species are observed on the project site during construction. Brochures, books, and briefings may be used in the training session, provided that a qualified person is on hand to answer any questions.

36. **Prior to commencement of construction activities,** and under the authorization of the Biological Opinion (BO) authorizing take of tidewater goby and steelhead trout, all fish within the project site, specifically the listed species, shall be captured by qualified fisheries biologists. All fish shall be captured by nets or by hand. The fish shall be temporarily placed in five-gallon buckets and shall be relocated from the dewatered project site to appropriate upstream and downstream locations.

37. **During project activities,** if pumps are incorporated to assist in temporarily dewatering the site, intakes shall be completely screened with no larger than 0.2-in wire mesh to prevent tidewater goby, steelhead young-of-year, and California red-legged frogs from entering the pump system. Water shall be released or pumped downstream at an

appropriate rate to maintain downstream flows during construction. The methods and materials used in any dewatering shall be determined by the Federal Highway Administration (FHWA) in consultation with the USFWS on a site-specific basis. Upon completion of construction activities, any diversions or barriers to flow shall be removed in a manner that would allow flow to resume with the least disturbance to the substrate. Alteration of the streambed shall be minimized to the maximum extent possible; any imported material shall be removed from the streambed upon completion of the project. Pumps shall release the additional water to a settling basin allowing the suspended sediment to settle out prior to re-entering Santa Rosa Creek outside of the isolated area.

38. **During project activities,** diverted water shall be released downstream at an appropriate rate to maintain downstream flows. Upon completion of construction activities, any barriers to flow shall be removed in a manner that would allow flow to resume with the least disturbance to the substrate.

39. Riprap walls shall be designed with gaps maintained between the boulders to allow for fish refugia. These gaps should not be filled with cobbles or other materials.

40. Riprap wall boulders shall be inter-planted with willow stakes to maintain riparian canopy over the creek. This work may need to be done during riprap wall construction to ensure that proper depth of willow stakes is achieved..

41. An energy dissipater shall be installed downstream of riprap wall (i.e. root wads, riffle/pools, baffles, rocks).

42. Large woody debris or trees within the stream channel or on the lower banks of the stream shall not be removed. If woody debris is causing erosion problems, it may be relocated to another portion of the stream in consultation with a qualified biologist.

43. The following habitats shall be replaced in kind if any are lost due to bridge removal activities; backwater pool, deep scour pool and quality habitat created by the undercut middle bridge pier footing.

44. Prior to project implementation, all fish within the project site, specifically the federally threatened steelhead shall be captured by a qualified biologist. All fish shall be captured by nets or by hand. The fish shall be temporarily placed in five-gallon buckets and shall be relocated to appropriate upstream and downstream locations. All captured and relocated fish shall be counted and classified into the appropriate age class. In the event of a steelhead death, NMFS shall be contacted and the steelhead shall be removed from the project site and kept in a freezer until further direction from NMFS.

45. Prior to construction, the applicant shall retain a fisheries biologist with expertise in the areas of resident or anadromous salmonid biology and ecology; fish/habitat relationships; biological monitoring; and, handling, collection, and relocating salmonid species.

46. Only USFWS-approved biologists shall participate in activities associated with the capture, handling, and monitoring of California red-legged frogs.

47. Ground disturbance shall not begin until written approval is received from the USFWS that the biologist is qualified to conduct the work.

48. A USFWS-approved biologist shall survey the project site 48 hours before the onset of work activities. If any life stage of the California red-legged frog is found and these individuals are likely to be killed or injured by work activities, the approved biologist shall be allowed sufficient time to move them from the site before work activities begin. The USFWS-approved biologist shall relocate the California red-legged frogs the shortest distance possible to a location that contains suitable habitat and shall not be affected by the activities associated with the proposed project. The USFWS-approved biologist shall maintain detailed records of any individuals that are moved (e.g., size, coloration, any distinguishing features, photographs, preferably digital) to assist the biologist in determining whether translocated animals are returning to the point of capture.

49. A USFWS-approved biologist shall be present at the work site until all California red-legged frogs have been removed, workers have been instructed, and disturbance of the habitat has been completed. After this time, the state or local sponsoring agency shall designate a person to monitor on-site compliance with all minimization measures. The USFWS-approved biologist shall ensure that this monitor receives the training outlined in mitigation measure BR-20 above and in the identification of California red-legged frogs. If the monitor or the USFWS-approved biologist recommends that work be stopped because California red-legged frogs would be affected to a degree that exceeds the levels anticipated by the FHWA and the USFWS during the review of the proposed action, they shall notify the resident engineer (the engineer that is directly overseeing and in command of construction activities) immediately. The resident engineer shall either resolve the situation by eliminating the effect immediately or require that all actions that are causing these effects be halted. If work is stopped, the USFWS shall be notified as soon as is reasonably possible.

50. Habitat contours shall be returned to their original configuration at the end of the project activities. This measure shall be implemented in all areas disturbed by activities associated with the project, unless the USFWS and FHWA determine that it is not feasible or modification of original contours would not benefit the California red-legged frog.

51. The number of access routes, size of staging areas, and the total area of activity shall be limited to the minimum necessary to achieve the project goal. Environmentally Sensitive Areas shall be established to confine access routes and construction areas to the minimum area necessary to complete construction, and minimize the impact to California red-legged frog habitat; this goal includes locating access routes and construction areas outside of wetlands and riparian areas to the maximum extent practicable.

52. The FHWA shall attempt to schedule work activities for times of the year when impacts to the California red-legged frog would be minimal. For example, work that would affect large pools that may support breeding would be avoided, to the maximum degree practicable, during the breeding season (Novernber through May). Isolated pools that are important to maintain California red-legged frogs through the driest portions of the year would be avoided, to the maximum degree practicable, during the late summer and early fall. Habitat assessments, surveys, and informal consultation between the FHWA and the USFWS during project planning shall be used to assist in scheduling work activities to avoid sensitive habitats during key times of year.

53. To control sedimentation during and after project implementation, the FHWA and sponsoring agency shall implement BMPs outlined in any authorizations or permits, issued under the authorities of the Clean Water Act, that it receives for the specific project. If BMPs are ineffective, the FHWA shall attempt to remedy the situation immediately, in consultation with the USFWS.

54. Unless approved by the USFWS, water shall not be impounded in a manner that may attract California red-legged frogs.

55. A qualified biological monitor shall survey the project site for the presence of foothill yellow-legged frog, Coast Range Newt, Southwestern pond turtle, and two-striped garter snake immediately prior to any riparian vegetation or instream disturbance. If these species are detected, a qualified biologist shall capture and relocate them to suitable habitat outside of the project area. A "letter of permission" must be obtained from CDFG to relocate these species of concern.

56. A qualified biological monitor shall perform daytime and nighttime surveys of the project site (existing bridge, hollow trees) for the presence of pallid bat immediately prior to any construction activities at the project site. If bats are determined to be using the existing bridge as a daytime roost, demolition activities shall be postponed until no bats are observed to be roosting during the day, to allow for the installation of exclusion netting to prevent any bat roosting prior to demolition. If exclusion netting is used, the netting shall have very small openings and shall not act as a mist net that will snare bats. Netting shall not be placed over maternal roosts during the breeding season, which is typically completed in September. The new bridge structure shall include roosting sites similar to the existing bridge.

57. Removal of vegetation and existing nests (i.e., the barn owl nest underneath the bridge) shall be conducted in the fall and winter (between September 15 and February 1) after fledging and before the initiation of breeding activities. The timing of nest removal may differ due to variations in breeding activity.

58. Netting shall be installed on underside of the existing bridge (after nests and/or vegetation have been removed) to discourage birds from nesting in this area.

59. The County shall retain a qualified biologist to conduct pre-construction surveys for nesting bird species within the project area. If active nests are observed, the County shall either: 1) wait for the nesting birds to fledge and leave the project area; or, 2) consult with the appropriate resource agency and secure impact authorization prior to site disturbance. Surveys should be conducted during the appropriate seasons of the year and should be consistent with regulatory requirements, if applicable.

60. To mitigate the loss of barn owl nesting habitat provided by the old bridge, at least two owl boxes shall be attached to the new bridge. One additional owl box shall be placed nearby to provide an alternative nesting site during construction/demolition.

61. The applicant shall begin implementation of the CHMMP, as amended by state and federal permit requirements, immediately following project completion.
62. A qualified biologist shall be available to ensure that all practicable measures are employed to avoid incidental disturbance of aquatic habitats and disturbance to special-status species. The biologist shall be a liaison between state and federal agencies and

the construction contractor regarding compliance with mitigation requirements. Compensatory mitigation for impacts to wetlands shall be implemented at an onsite 1:1 in-kind mitigation for temporary impacts and a 2:1 in-kind mitigation for permanent impacts.

Cultural Resources

63. In the event previously undiscovered archaeological resources are unearthed or discovered during any construction activities, the following standards apply:

    - Construction activities shall cease, and the Environmental Coordinator and Department of Planning and Building shall be notified so that the extent and location of discovered materials may be recorded by a qualified archaeologist and disposition of artifacts may be accomplished in accordance with state and federal law.
    - In the event archaeological resources are found to include human remains, or in any other case where human remains are discovered during construction, the County Coroner is to be notified in addition to the Environmental Coordinator ad the Department of Planning and Building so that proper disposition may be accomplished.

Geology and Soils

64. **Prior to the commencement of construction,** the County shall prepare a Drainage, Sedimentation, and Erosion Control Plan prepared and signed by a Registered Civil Engineer. The plan shall meet the requirements of Sections 23.05.020 *et seq.*, 23.05.034, and 23.05.082(a) of the Land Use Ordinance and shall be approved by the County Division of Environmental and Resource Management in consultation with the County Public Works Department.

65. **Prior to the commencement of construction,** the County shall prepare a Best Management and Pollution Prevention Practices Plan for the review and approval of the County Environmental Coordinator in consultation with CDFG, RWQCB, and ACOE. The plan shall outline proposed BMPs to control erosion and prevent sedimentation from entering the creeks and tributaries, methods to prevent accidental spills, and a proposed clean-up plan.

66. The construction of the proposed project shall comply with the applicable provisions of Sections 23.05.040 *et seq.* of the Land Use Ordinance.

Hazards/Hazardous Materials

67. If a hazardous spill is discovered prior to or during bridge replacement activities, soil samples shall be analyzed and recommended additional actions to further characterize potential problems shall be completed and implemented in accordance with federal, state, and local requirements.

68. Any staging or equipment/vehicle parking areas shall be free of combustible vegetation and work crews shall have shovels and a fire extinguisher on site during all construction activities.

Preservation of Trees and Native Vegetation

69. **At the time of application for construction permits,** the applicant shall submit to the Department of Planning and Building for review and approval a landscape/tree replacement plan that shows:

- The planting of all open areas of the site disturbed by project construction with native, drought and fire resistant species that are compatible with the habitat values of the surrounding forest. In addition, non-native, invasive, and water intensive (e.g. turf grass) landscaping shall be prohibited on the entire site.

- The proposed location of the 30 new oak trees that are required to be planted to mitigate for the removal of 2 oak trees and impacts to 6 oak trees on site.

70. **At the time of application for construction permits,** construction and grading plans shall show the following information:

    - The "project limit area," including all areas of grading (including cut and fill areas, utility trenching and offsite improvements) and vegetation removal, the development footprint (i.e., all structures and/or site disturbance) necessary fire clearances and staging areas for all construction activities, the location of those activities, and areas for equipment and material storage.

    - Identify any necessary tree trimming. Plan notes shall indicate a skilled arborist, or accepted arborist's techniques, will be used when removing tree limbs.

    - Plan notes shall indicate wherever soil compaction from construction will occur within driplines that the compacted root zone area shall be aerated by using one of the following techniques: i) injecting pressurized water; ii) careful shallow ripping that radiates out from the trunk (no cross-root ripping); or iii) other County-approved techniques.

    - Plan notes shall indicate no more than one-third of the area of the drip-line around any tree to be retained should be disturbed.

Transportation/Circulation

71. Prior to the commencement of construction, construction notification signs shall be placed on roads surrounding the project area. Construction areas shall be marked with highly visible (i.e., bright orange) construction fencing.

Water

72. On a daily basis, the County shall check and maintain all equipment and vehicles that would be operated within the identified work area to ensure proper operation and avoid potential leaks or spills.

General Conditions (valid for the life of the project)

73. This land use permit is valid for a period of 24 months from its effective date unless time extensions are granted pursuant to Coastal Zone Land Use Ordinance Section 23.02.050 or the land use permit is considered vested. This land use permit is considered to be vested once a construction permit has been issued and substantial site work has been completed. Substantial site work is defined by Coastal Zone Land Use Ordinance Section 23.02.042 as site work progressed beyond grading and completion of structural foundations; and construction is occurring above grade.

74. All conditions of this approval shall be strictly adhered to, within the time frames specified, and in an on-going manner for the life of the project. Failure to comply with these conditions of approval may result in an immediate enforcement action by the Department of Planning and Building. If it is determined that violation(s) of these conditions of approval have occurred, or are occurring, this approval may be revoked pursuant to Section 23.10.160 of the Coastal Zone Land Use Ordinance.

STATE OF CALIFORNIA – THE RESOURCES AGENCY ARNOLD SCHWARZENEGGER, Governor
CALIFORNIA COASTAL COMMISSION
CENTRAL COAST DISTRICT OFFICE
725 FRONT STREET, SUITE 300
SANTA CRUZ, CA 95060-4508
VOICE (831) 427-4863 FAX (831) 427-4877

RECEIVED
JUL 21 2010
CALIFORNIA
COASTAL COMMISSION
CENTRAL COAST AREA

APPEAL FROM COASTAL PERMIT DECISION OF LOCAL GOVERNMENT

Please Review Attached Appeal Information Sheet Prior To Completing This Form.

SECTION I. Appellant(s)

Name: Lynne Harkins
Mailing Address: PO Box 606
City: Cambria Zip Code: 93428 Phone: 805 927-7271 or cell 444-4424

SECTION II. Decision Being Appealed

1. Name of local/port government: County of San Luis Obispo

2. Brief description of development being appealed: Replacement of functionally obsolete Main Street Bridge on a parallel alignment

3. Development's location (street address, assessor's parcel no., cross street, etc.):
The project site is located within the County right-of-way directly east of the Main Street/ Santa Rosa Creek Road intersection in the community of Cambria -and beyond Right of Way, which needs to be acquired.

4. Description of decision being appealed (check one.):

✓ Approval; no special conditions >
Approval with special conditions:
Denial

Note: For jurisdictions with a total LCP, denial decisions by a local government cannot be appealed unless the development is a major energy or public works project. Denial decisions by port governments are not appealable.

TO BE COMPLETED BY COMMISSION:

APPEAL NO: A-3-SLO-10-039
DATE FILED: July 21, 2010
DISTRICT: Central Coast

CCC Exhibit 5
(page 1 of 5 pages)

APPEAL FROM COASTAL PERMIT DECISION OF LOCAL GOVERNMENT (Page 2)

5. Decision being appealed was made by (check one):

Planning Director/Zoning Administrator
✓ <City Council/Board of Supervisors >
Planning Commission
Other

6. Date of local government's decision: June 22, 2010

7. Local government's file number (if any): DRC 2009-00041

SECTION III. Identification of Other Interested Persons

Give the names and addresses of the following parties. (Use additional paper as necessary.)

a. Name and mailing address of permit applicant: SLO County/ Public Works Dept
County Gov't Center, Rm 207
San Luis Obispo, CA 93408

b. Names and mailing addresses as available of those who testified (either verbally or in writing) at the city/county/port hearing(s). Include other parties which you know to be interested and should receive notice of this appeal.

(1) John Farhar, et al- SLO County Public Works/ SLO address above

(2) Airlin Singwald-SLO County Planning/SLO address above

(3) Lynne Harkins-address above

(4)

CCC Exhibit 5
(page 2 of 5 pages)

APPEAL FROM COASTAL PERMIT DECISION OF LOCAL GOVERNMENT (Page 3)

SECTION IV. Reasons Supporting This Appeal

PLEASE NOTE:

- Appeals of local government coastal permit decisions are limited by a variety of factors and requirements of the Coastal Act. Please review the appeal information sheet for assistance in completing this section.
- State briefly your reasons for this appeal. Include a summary description of Local Coastal Program, Land Use Plan, or Port Master Plan policies and requirements in which you believe the project is inconsistent and the reasons the decision warrants a new hearing. (Use additional paper as necessary.)
- This need not be a complete or exhaustive statement of your reasons of appeal; however, there must be sufficient discussion for staff to determine that the appeal is allowed by law. The appellant, subsequent to filing the appeal, may submit additional information to the staff and/or Commission to support the appeal request.

The LCP for San Luis Obispo County requires at least two reasonable/feasible alternatives to the proposed bridge project. One of the county's alternatives does not meet the reasonable standard, as that new bridge alternative would pass so very close to a nearby residence. The county says it is a "technically feasible" alternative which seems to fall well short of the mark in terms of rigorous pursuit of alternatives which will minimize impacts to coastal resources-biological and visual, especially. In ESHA's, the removal or disturbance of native riparian vegetation is prohibited unless for road crossings where "there is no feasible alternative". The County seems far from having exhausted alternatives that could possibly substantially reduce loss of wetlands, riparian vegetation/habitat-including steelhead and tidewater goby habitat. Further consideration of the bridge alternative such as widening or replacement which entails working within the existing alignment could reduce ESHA destruction.
Visual resources will be greatly impaired by the proposed bridge's denuding of that area of Santa Rosa Creek for construction of the proposed bridge- upstream of the current alignment. The County is saying that of their three alternatives, none is environmentally better than the others. This leads them to tighten their embrace of their choice. It leads me to think that, in the spirit of restoring and enhancing coastal resources they would do well explore other possibilities. I would like the Coastal Commission to determine if there is any way to reduce the proposed actions impacts to the exceptional environment of coastal resources.

The proposed new bridge will have a higher profile and create a wider turn in Main Street ; making it entirely possible that the large banks of rip-rap that this new construction requires to protect it from the creek will be visible for many years as one drives south on Main Street. The revegetation, if it goes well, will take at least five years to get established. I question doing this, especially given that Main Street and this bridge are part of historic Highway 1 (before Highway 1 was moved west, about a mile, in the 1960's) .

The destruction of about 5 acres of riparian habitat as a result of moving the bridge over and demolishing

the old one also is of concern because of the documented
presence of mercury in the watershed generally and near the base of the existing bridge specifically. The issues raised by mercury, especially with regard to riparian
vegetation have, in my view, not been adequately addressed by the County.

The issue of public access is also relevant here because I feel that the proposed design does not adequately foster the increase of
pedestrian and bicycle traffic-that it does not conform to the "complete streets" model which the county claims it will follow. Main
Street has been neglected for the 30 years I've been coming to Cambria and its dangers for pedestrians and cyclists will only be exacerbated by
a bridge construction which will de facto increase speeds without an increase in safety for pedestrians and cyclists as they approach or exit the bridge
on Main Street.

APPEAL FROM COASTAL PERMIT DECISION OF LOCAL GOVERNMENT (Page 4)

SECTION V. Certification

The information and facts stated above are correct to the best of my/our knowledge.

L.M. Harkins= Lynne Harkins
Signature of Appellant(s) or Authorized Agent

Date: July 21, 2010

Note: If signed by agent, appellant(s) must also sign below.

Section VI. Agent Authorization

I/We hereby
authorize

to act as my/our representative and to bind me/us in all matters concerning this appeal.

Signature of Appellant(s)

Date:

CCC Exhibit 5
(page 5 of 5 pages)

Applicable LCP Policies and Ordinances

Environmentally Sensitive Habitat Areas (ESHA)

Policy 1: Land Uses Within or Adjacent to Environmentally Sensitive Habitats. *New development within or adjacent to locations of environmentally sensitive habitats (within 100 feet unless sites further removed would significantly disrupt the habitat) shall not significantly disrupt the resource. Within an existing resource, only those uses dependent on such resources shall be allowed within the area. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTIONS 23.07.170-178 OF THE COASTAL ZONE LAND USE ORDINANCE (CZLUO).]*

Policy 2: Permit Requirement. *As a condition of permit approval, the applicant is required to demonstrate that there will be no significant impact on sensitive habitats and that proposed development or activities will be consistent with the biological continuance of the habitat. This shall include an evaluation of the site prepared by a qualified professional which provides: a) the maximum feasible mitigation measures (where appropriate), and b) a program for monitoring and evaluating the effectiveness of mitigation measures where appropriate. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTIONS 23.07.170-178 OF THE CZLUO.]*

Policy 3: Habitat Restoration. *The county or Coastal Commission should require the restoration of damaged habitats as a condition of approval when feasible. Detailed wetland restoration criteria are discussed in Policy 11. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.170 OF THE CZLUO.]*

Policy 20: Coastal Streams and Riparian Vegetation. *Coastal streams and adjoining riparian vegetation are environmentally sensitive habitat areas and the natural hydrological system and ecological function of coastal streams shall be protected and preserved. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD AND PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 21: Development in or Adjacent to a Coastal Stream. *Development adjacent to or within the watershed (that portion within the coastal zone) shall be sited and designed to prevent impacts which would significantly degrade the coastal habitat and shall be compatible with the continuance of such habitat areas. This shall include evaluation of erosion and runoff concerns. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD AND PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 22: Fish and Game Review of Streambed Alterations. *Significant streambed alterations require the issuance of a California Department of Fish and Game 1601-1603 agreement. The Department should provide guidelines on what constitutes significant streambed alterations so that the county and applicants are aware of what is considered a "significant" streambed alteration.*

In addition, streambed alterations may also require a permit from the U.S. Army Corp of Engineers. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD AND PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]

Policy 23: County and State Review of Coastal Stream Projects. *The State Water Resources Control Board and the county shall ensure that the beneficial use of coastal stream waters is protected, for projects over which it has jurisdiction. For projects which do not fall under the review of the State Water Resources Control Board, the county (in its review of public works and stream alterations) shall ensure that the quantity and quality surface water discharge from streams and rivers shall be maintained at levels necessary to sustain the functional capacity of streams, wetland, estuaries and lakes. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD AND PURSUANT TO SECTION 23.07.174 OF THE CZLUO.].*

Policy 25: Streambed Alterations. *Channelizations, dams or other substantial alterations of rivers and streams shall be limited to: a) necessary water supply projects, b) flood control projects when there are no other feasible methods for protecting existing structures in the flood plain and where such protection is necessary for public safety or to protect existing development, and c) development where the purpose is to improve fish and wildlife habitat. All projects must employ the best feasible mitigation measures. Maintenance and flood control facilities shall require a coastal development permit. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 26: Riparian Vegetation. *Cutting or alteration of naturally occurring vegetation that protects riparian habitat is not permitted except for permitted streambed alterations (defined in Policy 23) and where no feasible alternative exists or an issue of public safety exists. This policy does not apply to agricultural use of land where expanding vegetation is encroaching on established agricultural uses. Minor incidental public works project may also be permitted where no feasible alternative exists including but not limited to utility lines, pipelines, driveways and roads. Riparian vegetation shall not be removed to increase agricultural acreage unless it is demonstrated that no impairment of the functional capacity of the habitat will occur. Where permitted, such actions must not cause significant stream bank erosion, have a detrimental effect on water quality or quantity, or impair the wildlife habitat values of the area. This must be in accordance with the necessary permits required by Sections 1601 and 1603 of the California Fish and Game Code. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 27: Stream Diversion Structures. *Stream diversion structures on streams appearing as dotted or dash lines on the largest scale U.S.G.S. quadrangle maps shall be sited and designed to not impede up and downstream movement of native fish or to reduce stream flows to a level which would significantly affect the biological productivity of the fish and other stream organisms. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 28: Buffer Zone for Riparian Habitats. *In rural areas (outside the USL) a buffer setback zone of 100 feet shall be established between any new development (including new agricultural development) and the upland edge of riparian habitats. In urban areas this minimum standard shall be 50 feet except where a lesser buffer is specifically permitted. The buffer zone shall be maintained in natural condition along the periphery of all streams. Permitted uses within the buffer strip shall be limited to passive recreational, educational or existing nonstructural agricultural developments in accordance with adopted best management practices. Other uses that may be found appropriate are limited to utility lines, pipelines, drainage and flood control facilities, bridges and road approaches to bridges to cross a stream and roads when it can be demonstrated that: 1) alternative routes are infeasible or more environmentally damaging and 2) adverse environmental effects are mitigated to the maximum extent feasible. Lesser setbacks on existing parcels may be permitted if application of the minimum setback standard would render the parcel physically unusable for the principal permitted use. In allowing a reduction in the minimum setbacks, they shall be reduced only to the point at which a principal permitted use (as modified as much as is practical from a design standpoint) can be accommodated. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.174 OF THE CZLUO.]*

Policy 29: Protection of Terrestrial Habitats. *Designated plant and wildlife habitats are environmentally sensitive habitat areas and emphasis for protection should be placed on the entire ecological community. Only uses dependent on the resource shall be permitted within the identified sensitive habitat portion of the site.*

Development adjacent to environmentally sensitive habitat areas and holdings of the State Department of Parks and Recreation shall be sited and designed to prevent impacts that would significantly degrade such areas and shall be compatible with the continuance of such habitat areas. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.176 OF THE CZLUO.]

Policy 30: Protection of Native Vegetation. *Native trees and plant cover shall be protected wherever possible. Native plants shall be used where vegetation is removed. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.07.176 OF THE CZLUO.]*

CZLUO Section 23.07.170 - Environmentally Sensitive Habitats:

The provisions of this section apply to development proposed within or adjacent to (within 100 feet of the boundary of) an Environmentally Sensitive Habitat as defined by Chapter 23.11 of this title.

...

d. Alternatives analysis required. *Construction of new, improved, or expanded roads, bridges and other crossings will only be allowed within required setbacks after an alternatives analysis has been completed. The alternatives analysis shall*

examine at least two other feasible locations with the goal of locating the least environmentally damaging alternative. When the alternatives analysis concludes that a feasible and less environmentally damaging alternative does not exist, the bridge or road may be allowed in the proposed location when accompanied by all feasible mitigation measures to avoid and/or minimize adverse environmental effects. If however, the alternatives analysis concludes that a feasible and less environmentally damaging alternative does exist, that alternative shall be used and any existing bridge or road within the setback shall be removed and the total area of disturbance restored to natural topography and vegetation.

Visual and Scenic Resources

Policy 1: Protection of Visual and Scenic Resources. *Unique and attractive features of the landscape, including but not limited to unusual landforms, scenic vistas and sensitive habitats are to be preserved protected, and in visually degraded areas restored where feasible. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD.]*

Policy 2: Site Selection for New Development. *Permitted development shall be sited so as to protect views to and along the ocean and scenic coastal areas. Wherever possible, site selection for new development is to emphasize locations not visible from major public view corridors. In particular, new development should utilize slope created "pockets" to shield development and minimize visual intrusion. [THIS POLICY SHALL BE IMPLEMENTED AS A STANDARD.]*

Public Access

Policy 2: New Development. *Maximum public access from the nearest public roadway to the shoreline and along the coast shall be provided in new development. Exceptions may occur where (1) it is inconsistent with public safety, military security needs, or the protection of fragile coastal resources; (2) adequate access exists nearby, or; (3) agriculture would be adversely affected. Such access can be lateral and/or vertical. Lateral access is defined as those accessways that provide for public access and use along the shoreline. Vertical access is defined as those accessways which extend to the shore, or perpendicular to the shore in order to provide access from the first public road to the shoreline. [THIS POLICY SHALL BE IMPLEMENTED PURSUANT TO SECTION 23.04.420 a. AND c. OF THE CZLUO.]* ...

SAN LUIS OBISPO COUNTY
DEPARTMENT OF PUBLIC WORKS
Paavo Ogren, Director

County Government Center, Room 207 • San Luis Obispo, CA 93408 • (805) 781-5252
Fax (805) 781-1229 email address: pwd@co.slo.ca.us

February 20, 2009

Jonathon Bishop
California Coastal Commission
Central Coast District Office
725 Front Street, Suite 300
Santa Cruz, CA 95060-4508

TO: Jonathan Bishop, Staff Analyst

FROM: Cori Marsalek, Bridge Program Manager

SUBJECT: Project Referral for Cambria Main Street Bridge Replacement (ED 00-168 / 300180)

Thank you for December 12, 2008 letter regarding the above referenced Project Referral. This correspondence is intended to address your concerns in Question and Answer format.

Maximum Public Access

"Given the project's close proximity to downtown, area schools, and other cross-town access features (both existing and conceptual), this project has the potential to benefit public access and recreation opportunities. In order to best maximize these opportunities consistent with the Coastal Act and LCP, please consider a bridge design that utilizes a 4 or 5 foot wide pedestrian/bicycle access way, separated from traffic by a barrier or vertical displacement on one or both sides of the bridge (e.g. sidewalk, or some other form of separation). We feel this could be an important feature both for maximum access and to facilitate bicycle and pedestrian safety in this area."

Consistent with the County Bikeways Plan, 5 foot striped bike lanes (Class II Bikeways) are proposed for both Main Street and Santa Rosa Creek Road within the project limits.

The County does not have plans to place curb, gutter, and sidewalk on this portion of Main Street. AASHTO's "*A Policy on Geometric Design of Highways and Streets*" states that for streets with shoulders and no curbs, such as Main Street, the clear roadway width of bridges should be the same as the approach roadway width. Due to the steep terrain and narrow corridor it is not feasible to have pedestrian facilities on

Main Street south of the bridge location. Placing sidewalk on the bridge would encourage pedestrian use which is unsafe.

In an effort to minimize the footprint of the new bridge the County approved a design exception to allow 5 foot shoulders rather than the standard 8 foot shoulders. Five foot shoulders are more consistent with the approach roadway beyond the project limits. During the expected life of the proposed bridge it is highly unlikely the approaches beyond the project limits would be widened to more than 34 feet of total paved width.

The Santa Rosa Creek Trail as mentioned in the County General Plan is intended to be a Class I bikeway connecting the Cross Town Trail to Coast Union High School on Santa Rosa Creek Road. The County has discussed this trail as it relates to the bridge replacement at length with the County Parks Department and the Cambria Community Services District. The future trail would cross Main Street at the intersection with Santa Rosa Creek Road and continue along Santa Rosa Creek Road to the high school. The County supports improving public access in the corridor with respect to the trail traversing across Main Street. This trail project has not been initiated nor does it have the required funding or easements at this time. The proposed bridge replacement project will not negatively impact the future trail project.

The County proposes to retain the current design with 12' travel lanes and 5' bike lanes.

Abutments

Please evaluate alternative abutment designs that could be utilized to limit ESHA impacts, including using caissons and span designs that may enable the elimination of rock rip-rap protection.

The bridge abutments are currently designed to be founded on deep pile foundations or caissons but this does not eliminate the need for rip-rap. Pile foundations were determined to be needed by the geotechnical investigation for structural stability because of the soft, erodible soil at this site.

The bridge span length was determined by calculating the height of the bridge needed for channel flow and then carrying the span back to a reasonable point where the abutments were far enough back from the bank to give them enough soil around them to engage for seismic stability but not so far back that they unnecessarily added cost to the project.

Increasing the span length would increase the depth of the structure, resulting in a higher bridge. Raising the profile of the bridge would cause the road elevation to be significantly higher than adjacent driveways and intersection. This would result in very costly modifications to the driveways and roads and also result in potentially detrimental drainage issues for adjacent properties.

Rip-rap

Is it possible to eliminate the use of rip-rap in the creek channel? If not, we encourage you to reuse/relocate the existing rip-rap rather than adding additional rock into the creek channel.

The existing bank material consists of highly erodible loam and alluvium soils. Santa Rosa Creek is in an active state of channel enlargement resulting in bank erosion and widening. Therefore, some form of bank stabilization must be done to protect the bridge footings from scour, which in turn protects the road approached from being washed downstream. Setting the abutments farther back and lengthening the bridge or adding caissons to the abutment system will not help as neither addresses the bank erosion. The County believes the use of rock slope protection softened with the use of willow plantings is the best way to maintain the banks and the stability of the bridge.

The Design Hydraulic Study recommends that slope protection be placed on all disturbed banks 2-feet above the 100-year flood water surface elevation. The size of the rip-rap used is dictated by the velocity of Santa Rosa Creek. Existing rock may be used for the rock slope protection considering it can be certified to meet the specifications. Due to the extent of the rock slope protection required by the Design Hydraulic Study it is unlikely that we will be able to avoid importing rock. Prior to construction, efforts will be made to select rock rip-rap which matches the color of native rock in the creek channel or nearby native rock outcroppings.

Bridge Treatment

Due to the location of the project in a scenic area, please evaluate the use of alternative bridge treatments to allow the project to be subordinate to the natural setting of the area (texturing, coloration, use of alternative materials, etc.).

As currently designed, the entire abutment walls and much of the abutment wingwalls will be covered with rock slope protection. Architectural treatment can be applied to the visible portion of the abutments. The County proposes to use a colored texture that will blend in with the surrounding area.

Bridge Railings

It appears from the project plans that the bridge will utilize metal beam guard railing (type 732). A number of new and/or alternative see-through designs are available that would help minimize visual intrusion. We note these bridge railings could also be designed to work together with the pedestrian/bicycle access way barrier described above.

The County understands the concern the Commission has with the visual impact of the bridge railing. The Type 732 Concrete Barrier is 1'-5" wide while the Type 80 Concrete Barrier is 1'-9" wide. Modifying the barrier will result in an 8" increase in the overall bridge width. Although the Type 80 Concrete Barrier is quite a bit heavier and more expensive to construct than Type 732, changing the barrier would likely not require a redesign of the bridge. The County proposes to use the Type 80 Concrete Barrier instead of the Type 732 to help minimize the visual intrusion.

Restoration Landscaping

The project referral did not provide any detail on restoration landscaping. To the degree that vegetation removal cannot be avoided through alternative bridge designs and construction methods, please incorporate appropriate landscape

restoration and enhancement efforts into the project utilizing native plant species appropriate to the riparian corridor of Santa Rosa creek.

The County has a conceptual Habitat Restoration Plan which includes planting willows in the Rock Slope Protection. The plan includes the placement of appropriate riparian species consistent with existing species found in adjacent riparian areas. Plant material for mitigation will be propagated from seed and cuttings of plants along Santa Rosa Creek. Oaks will be replaced at a rate of 4 to 1. Restoration of the old roadbed alignment will include 1) ripping/plowing to minimize soil compaction; and 2) hydroseeding with an appropriate native seed mix. Replacement plantings shall be appropriately maintained for a period of five years or until the plantings are established in the landscape such that they can survive without additional care. Any plants that die will be replaced.

Summary

The County believes the proposed project balances the need to maximize public access opportunities, protects valuable resources and reflects the least environmentally damaging feasible project. The changes proposed above should also help the project blend in with the natural character of the area. We appreciate your careful review of this project and hope we are on way to creating a cooperative work product.

The County held an Open House meeting in Cambria on February 5, 2009 to let the community see our plans and give them an opportunity to voice any concerns. We also plan to give a presentation at an upcoming North Coast Advisory Council meeting. The current project schedule shows the Mitigated Negative Declaration complete by June 2009, after which we would proceed with obtaining the necessary permits and easements, then go to construction in Spring 2011.

Please contact me at (805) 781-4995 to review the project further or clarify any remaining areas of concern.

Sincerely,

CORI MARSALEK
Project Manager

c: Mike Giuliano, Caltrans District 5, District Local Assistance Engineer
John Farhar, San Luis Obispo County Environmental Programs Division

File: 300180

L:\DESIGN\FEB09\CCC Response Letter.doc.cm.taw

SAN LUIS OBISPO COUNTY
DEPARTMENT OF PUBLIC WORKS
Paavo Ogren, Director

County Government Center, Room 207 • San Luis Obispo, CA 93408 • (805) 781-5252
Fax (805) 781-1229 email address: pwd@co.slo.ca.us

January 12, 2011

Jonathan Bishop
California Coastal Commission
725 Front Street, Suite 300
Santa Cruz, CA 95060-4508

Subject: Additional Information for the County of San Luis Obispo's Cambria Main Street Bridge Replacement Project (Commission Appeal No. A-3-SLO-10-039)

Dear Mr. Bishop:

Thank you for the December 7, 2010, conference call regarding the above referenced project. This correspondence is intended to address various concerns brought up during our discussion.

Project Purpose

The Federal Highway Administration's (FHWA) Highway Bridge Program (HBP) provides local agencies with federal-aid funding to replace and rehabilitate local bridges. Caltrans Office of Local Assistance oversees funding by agreement with FHWA for authorization to utilize funds under the Highway Bridge Program.

Highway Bridge Program funding eligibility is based on a bridge's sufficiency rating, which is determined through a complex calculation using inspection data compiled by Caltrans. The sufficiency rating combines the condition and functional adequacy data into a single number. Sufficiency rating values range from 0 (low) to 100 (high). When the sufficiency rating on a bridge is 50 or less and is designated as "structurally deficient" or "functionally obsolete" the bridge qualifies for federal replacement funding.

The "functionally obsolete" designation is an issue of design or configuration and not one of structural adequacy. The federal government will designate a bridge as "functionally obsolete" if the number of lanes and or shoulder width on the bridge does not meet current standards, the vertical clearance above the bridge is restrictive, or the roadway alignment is not ideal. Additionally, a bridge may be designated functionally obsolete if it has a lower load capacity or if water frequently overtops the bridge. The Main Street Bridge is functionally obsolete due to deck geometry and load capacity, and has a Sufficiency Rating (SR) of 48.7, making it eligible for replacement under the Highway Bridge Program.

Local Coastal Plan (LCP) Issues

San Luis Obispo County's LCP recognizes that bridge replacement projects may have impacts to Environmentally Sensitive Habitat Areas (ESHA) given the nature of the environment in which they are out of necessity located. In other words, the LCP contemplates and allows some degree of ESHA impacts for such a project. The key factor in scoping a bridge replacement project is identifying the

least environmentally damaging feasible alternative. At this site, that analysis primarily boils down to two issues: 1) whether the replacement bridge can be located on the same alignment; and 2) the degree of abutment protection necessary.

Alignment Alternatives

The following graphics have been attached to this letter:

- Upstream Alignment Alternative
- Existing Alignment Alternative
- Upstream vs. Existing Alignment Alternative

These graphics demonstrate that the estimated linear stream channel and area of ESHA impacts are comparable for each of the alternatives considered. Since each alternative could be considered the least environmentally damaging feasible alternative, the project that best meets the overall objectives would be the most appropriate to construct. Other project objectives that must be considered include road closure during construction, as well as roadway geometrics and access restriction to adjacent properties for the completed project.

Closure of the road and establishment of detour routes on surrounding residential streets for the duration of construction would be required in order to construct on the existing alignment (see attached Detour Exhibit). These residential streets are not designed to handle the volume and type of traffic that Main Street currently carries. While temporary road closures are anticipated for the upstream alignment alternative to allow for completing the construction of the abutments and road approaches, most of the construction can be completed while maintaining traffic on Main Street over the existing bridge. The community of Cambria has expressed great concern with closing Main Street due to the impacts to emergency responders, schools, agriculture, and tourism. The County approved project would better serve the overall traffic requirements of the community.

The existing alignment alternative does not address the existing deficiencies in the roadway geometry at the site which is in part evidenced by the documented number of times the bridge rail has been hit by vehicles. The County approved project provides a larger radius curve through the site to help mitigate this issue.

A residence exists adjacent to the southwest corner of the existing bridge. Due to the hydraulics of Santa Rosa Creek the new bridge deck will be constructed approximately 5-feet higher than the existing bridge. Access to the property on the southwest corner of the bridge would be extremely difficult with the existing alignment alternative due to the change in elevation and the increase in roadway width. The upstream alignment will allow for access to this property and will result in increased stopping sight distance at the driveway approach.

Abutment Protection

Santa Rosa Creek is in an active state of channel enlargement resulting in bank erosion and channel widening. Anthropological activities, such as farming, mining, and building, have contributed to these changes in the watershed. The existing bank material is highly erodible and the ability for native riparian vegetation to hold the stream banks in place is greatly diminished when exposed to high water velocities.

For either alternative, the proposed abutments are located further upslope of the existing bridge abutments helping to reduce upstream flood risk and scour. Bank stabilization must be done to protect the bridge abutments from damage resulting from bank erosion, which in turn protects the road approaches from being washed downstream. The County believes the use of rock slope

protection sized appropriately for the high velocities in Santa Rosa Creek will not only maintain the creek banks and ensure the stability of the bridge but will provide a substrate for riparian vegetation to grow.

The habitat conditions of the area will be improved with the removal of the existing exotic plant species dominating the area including extensive amounts of ivy and Vinca currently suffocating much of the native vegetation. Compensatory mitigation, required by the regulatory agencies, will be provided onsite and directly adjacent to the project site further improving the habitat conditions through the strict use of native plants suited to the project area.

Mercury

With respect to the question of mercury in Santa Rosa Creek, we understand the levels are below applicable regulatory thresholds for water and sediment based on monitoring performed by the Regional Water Quality Control Board (RWQCB) upstream of the project site. Standard permit conditions issued by the RWQCB through their water quality certification and Construction Stormwater Permitting (SWPPP) will require the County to prevent sediment from leaving the project site through the use of construction erosion control measures and long-term restoration and revegetation efforts. While the consequences of historic mercury mining in the area is an issue that the County and several state and federal partner agencies continue to address through various means and at several locations, we do not believe this project will exacerbate the mercury problem in any way.

Summary

The County believes the proposed project has been designed to avoid impacts to valuable coastal resources as much as possible and reflects the least environmentally damaging feasible project. Although the appeal raises important LCP issues, the County is confident they do not rise to the level of substantial LCP nonconformance.

Please contact me at (805)781-5252 to review the project further or if there are any outstanding questions we can address.

Sincerely,

CORI MARSALEK
Project Manager

Enclosures

File: 300180

c: Mark Hutchinson, Environmental Programs Division Manager
John Farhar, Environmental Resource Specialist
Dave Flynn, Deputy Director of Public Works
Garin Schneider, Caltrans District 5, District Local Assistance Engineer

L:\DESIGN\JAN11\CCC Appeal Letter 01-12-2011.doc.CM:lc

AREA OF IMPACT = 0.674 AC
LENGTH OF IMPACT = 191 L.F.

0 30' 60'
CONTOUR INTERVAL= 2'

SAN LUIS OBISPO COUNTY PUBLIC WORKS DEPARTMENT

MAIN STREET BRIDGE REPLACEMENT EXISTING ALIGNMENT ALTERNATIVE

AREA OF IMPACT = 0.676 AC.
LENGTH OF IMPACT = 174 L.F.

0 30' 60'

CONTOUR INTERVAL= 2'

SAN LUIS OBISPO COUNTY PUBLIC WORKS DEPARTMENT

MAIN STREET BRIDGE REPLACEMENT UPSTREAM ALIGNMENT ALTERNATIVE

CCC Exhibit 7
(page 9 of 11 pages)

UPSTREAM ALIGNMENT ALT. IMPACT BOUNDARY

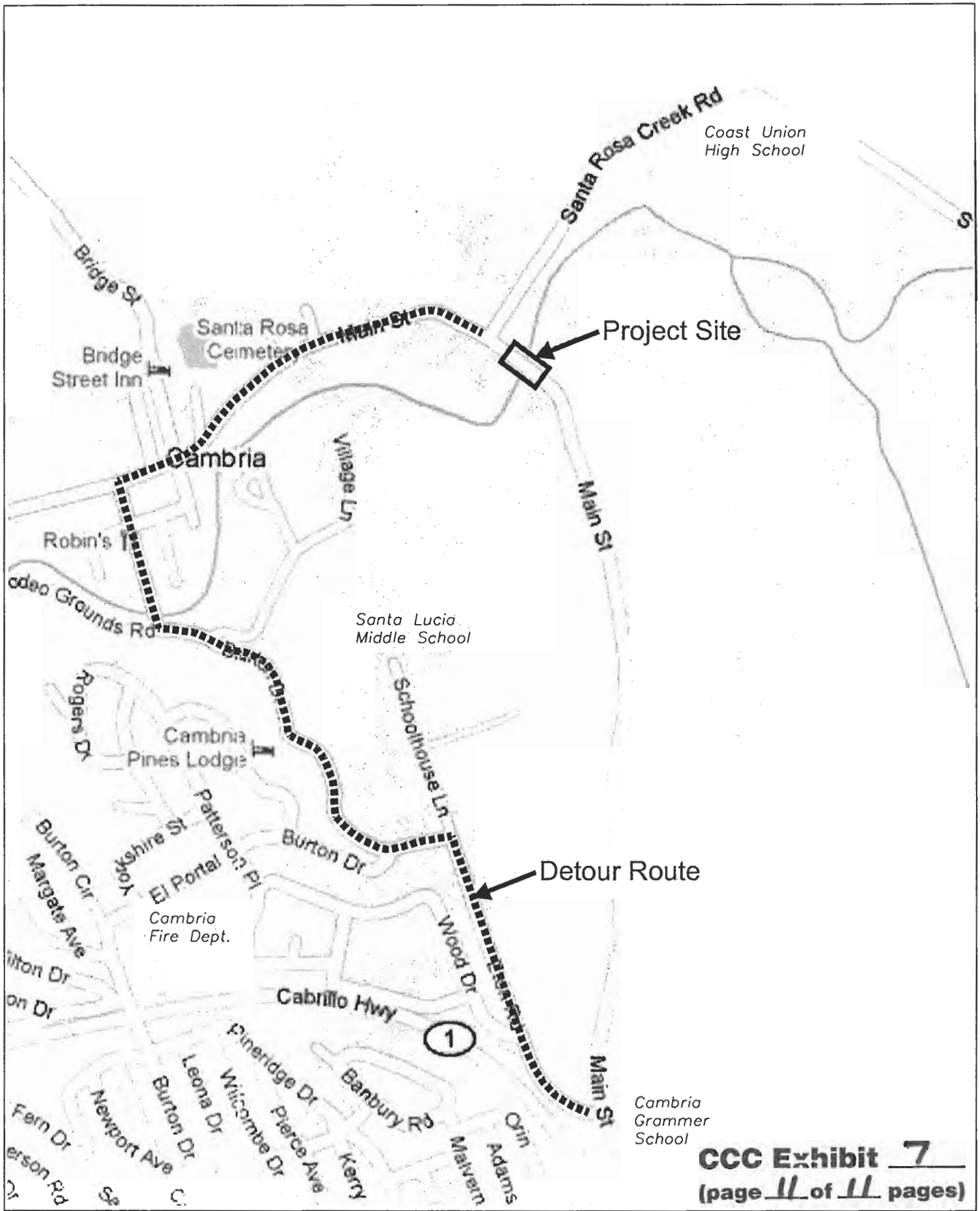
EXISTING ALIGNMENT ALT. IMPACT BOUNDARY

0 30' 60'

CONTOUR INTERVAL= 2'

SAN LUIS OBISPO COUNTY PUBLIC WORKS DEPARTMENT

MAIN STREET BRIDGE REPLACEMENT - UPSTREAM VS. EXISTING EXHIBIT



CCC Exhibit 7
(page 11 of 11 pages)

SAN LUIS OBISPO COUNTY PUBLIC WORKS DEPARTMENT

MAIN STREET BRIDGE REPLACEMENT DETOUR EXHIBIT

V:\AUTOCAD CIVIL 3D PROJECTS\CIVIL 3D 2010\BRIDGES\Santa Rosa Creek\Coastal Commission Exhibits.dwg, 1/12/2011 3:05:36 PM

Jonathan Bishop

From: Sara Wan [lwan22350@aol.com]
Sent: Monday, September 20, 2010 1:17 PM
To: 'Lynne Harkins'; Jonathan Bishop
Subject: RE: Main Street Bridge/Cambria-Supporting data/info for appeal

Please understand that this constitutes ex-parte communications which I must report. I would hope that you will have a chance to meet and talk with our staff prior to their staff report to avoid problems at the hearing

Sara Wan

From: Lynne Harkins [mailto:l.harkins@charter.net]
Sent: Monday, September 20, 2010 12:20 PM
To: jbishop@coastal.ca.gov
Cc: Sara Wan
Subject: Main Street Bridge/Cambria-Supporting data/info for appeal

Hello,Mr. Bishop-
Am sending some things which I sent to you last April -with added information and contact possibilities.
Are you able to tell me if this appeal is likely to be on next month's agenda?

Thank you for your time.

Best Regards,

Lynne Harkins

Biological Resources
1.

Groundwater level is very close to creek at proposed project site. The Cty describes the possible necessity of installing a well to pump out the
creekbed (even after creek is diverted) because of presence of groundwater.

From SLO County Dept of Public Works/Planning:...
" It is expected that simply diverting the flow of Santa Rosa Creek through the project site may not adequately dewater the project site. In this event, the contractor may excavate and insert awell point into the streambed. The groundwater would be pumped to adequately dewater the project site. ..."

In July of 2009 ,Total mercury of 120 ppb was found in wet sediment sample from Santa Rosa Creek at Main St. bridge project site. (Testing for total mercury at other downstream SR Creek sites found mercury in higher concentrations and in its methylated form at mouth of creek...about 2.5 miles downstream of project site.)
Potential sources of Hg release:
Public Works Engineer estimated that 1500 cubic yards would be excavated at site.
Research has shown that willow roots take up and sequester both organic and inorganic forms of

mercury.
The project site is densely vegetated with willows along creek banks. The removal of these willows
to allow for bridge construction in different alignment will create potential for mobilizing mercury from sediment disturbance
and willow destruction.

From the California Toxics Rule-guidance for freshwater mercury limits is .05 parts per billion for Total Fraction-that is for both dissolved and suspended mercury.

The substantial root systems from willows (and cottonwoods) which line the banks means not only would Hg sequestering potential be lost, but that killing willow plants by ripping out their top portions may well lead to mobilizing Hg, as the roots for those plants die and decay; thus increasing potential for ground and surface waters contamination.

In research published last summer, inorganic and organic mercury were shown to be transported to nearshore marine environment by means of groundwater; contributing in a significant way to marine Hg in a way which hadn't been previously researched/verified.

I spoke with one of the groundwater/marine Hg researchers- Russell Flegal, a Professor of Environmental Toxicology at UCSC, and told him of my
sampling, the Hg level and my concern about the willow removals at Main St. Bridge. Professor Flegal said I made "a good
argument for leaving the willows where they are". He also said that though he could only work with agencies, he
wouldn't mind my quoting him as saying that.

I provide his contact information in event that Coastal staff are able to follow-up /confirm.

http://www.etox.ucsc.edu/fac_res/flegal.html

=

Senior Biologist mpaul@dfg.ca.gov is working with local Greenspace to improve SR Creek for Steelhead. She told
me that Hg can be a problem at all stages of Steelheads' lives and the draft SR Watershed Management Plan names
.12 mg/kg (=120 parts per billion/ppb) total mercury as the level for "Threshold Effects".
This supports that the matter needs more analysis for impacts to Coastal Biological Resources than the County has done.

3.

Any mercury (Hg) mobilized inland in a coastal stream
has potential to be transported to nearshore southern sea otter habitat, affecting the food chain and otter diet-
with possible negative impacts on otter health.

In the report (pdf included)"Comparison of trace element concentrations in livers of diseased, emaciated and non-diseased southern
sea otters from the California coast."

To maintain their high metabolism, sea otters consume 20% of their body weight daily and this high food intake rate can contribute to elevated exposure to trace metals (Kannan et al., 2004).

While certain toxic metals (e.g., Cd, Pb) can diminish the adaptive capacity of exposed individuals, other heavy metals (e.g., Cu, Zn) are essential for ef¬€ective immune functioning, and some metals (e.g., Hg, Be) can initiate inappropriate immune responses, leading to autoimmune disease (Lynes et al., 2006).

The relationships of toxic metals (e.g., Hg, Pb) with essential elements such as Mn, Co, Cu, and Zn varied between the diseased/emaciated and the non-diseased groups. No signif¬□cant correlation was found between Hg and Mn, Co, Cu, or Zn in non-diseased otters. However, in diseased and emaciated sea otters, Hg was signif¬□cantly correlated with Mn, Co, Cu, and Zn. Similarly, Pb was not correlated with Mn, Cu, and Zn in non-diseased sea otters, but it was signif¬□cantly correlated with Mn, Cu, and Zn in diseased and emaciated sea otters. These results suggest that in diseased and emaciated animals, several toxic metals (e.g., Cd, Hg, Pb) act in concert to alter the homeostasis of essential elements. The association between toxic and essential elements in diseased individuals may ref¬,ect sequestration of the metals by binding proteins such as metallothioneins, which play a major role in regulating the availability of metals for metal-dependent proteins.

Begin forwarded message:

From: Lynne Harkins <L.Harkins@charter.net>"
Date: April 16, 2010 1:32:11 PM PDT
To: Tom Luster <TLuster@coastal.ca.gov>
Subject: add'l on Main St Bridge

Otters and mercury input perhaps relevant because whatever affects surface/ground waters ends up in the ocean...

and...
While County MUP/Coastal permit doc cites 2/6 oaks and 17/20 willows as what will/might be taken out by putting 37' bridge to the right (east) of existing bridge in these first 2 looking north photos,
there are mature cottonwoods not even mentioned (big mercury uptakers) and alders,too, I think on the banks which are bristling with willows that have completely overgrown such rock work as is there now. New bridge would be 37' wide a few feet east of existing alignment entailing riprap about 50-70' on either side of it taking out a lot of ESHA. Would take out a lot,if not all of tallest cottonwoods,

and there's a M pine behind there too. Utility pole has to be moved at intersection there w/ SR Creek Rd.

Thank you-LH

Environ. Sci. Technol. 2009, 43, 5652–5659

Submarine Groundwater Discharge of Total Mercury and Monomethylmercury to Central California Coastal Waters

FRANK J. BLACK,*,†,‡ ADINA PAYTAN,§ KAREN L. KNEE,§,∥ NICHOLAS R. DE SIEYES,⊥ PRIYA M. GANGULI,† ELLEN GRAY,§ AND A. RUSSELL FLEGAL†

WIGS Laboratory, Department of Environmental Toxicology, and Institute of Marine Sciences, University of California, Santa Cruz, California 95064, Department of Geological & Environmental Sciences, Stanford University, Stanford, California 94305-2115, and Department of Civil and Environmental Engineering, Stanford University, Stanford, California 94305-4020

Received February 20, 2009. Revised manuscript received May 12, 2009. Accepted May 14, 2009.

Fluxes of total mercury (Hg_T) and monomethylmercury (MMHg) associated with submarine groundwater discharge (SGD) at two sites on the central California coast were estimated by combining measurements of Hg_T and MMHg in groundwater with the use of short-lived, naturally occurring radium isotopes as tracers of groundwater inputs. Concentrations of Hg_T were relatively low, ranging from 1.2 to 28.3 pM in filtered groundwater, 0.8 to 11.6 pM in filtered surface waters, and 2.5 to 12.9 pM in unfiltered surface waters. Concentrations of MMHg ranged from <0.04 to 3.1 pM in filtered groundwater, <0.04 to 0.53 pM in filtered surface waters, and 0.07 to 1.2 pM in unfiltered surface waters. Multiple linear regression analysis identified significant ($p < 0.05$) positive correlations between dissolved groundwater concentrations of Hg_T and those of NH_4^+ and SiO_2, and between dissolved groundwater concentrations of MMHg and those of Hg_T and NH_4^+. However, such relationships did not account for the majority of the variability in concentration data for either mercury species in groundwater. Fluxes of Hg_T via SGD were estimated to be 250 ± 160 nmol day^{-1} m^{-1} of shoreline at Stinson Beach and 3.0 ± 2.0 nmol m^{-2} day^{-1} at Elkhorn Slough. These Hg_T fluxes are substantially greater than net atmospheric inputs of Hg_T reported for waters in nearby San Francisco Bay. Calculated fluxes of MMHg to coastal waters via SGD were 10 ± 12 nmol day^{-1} m^{-1} of shoreline at Stinson Beach and 0.24 ± 0.21 nmol m^{-2} day^{-1} at Elkhorn Slough. These MMHg fluxes are similar to benthic fluxes of MMHg out of surface sediments commonly reported for estuarine and coastal environments. Consequently, this work demonstrates that SGD is an important source of both Hg_T and MMHg to coastal waters along the central California coast.

Introduction

Mercury is a toxic heavy metal found at elevated levels in the environment due to anthropogenic activities (*1*, *2*). Methylated forms of mercury are the most toxic, with monomethylmercury (MMHg) being of most concern for ecological and human health because it is readily biomagnified in aquatic food chains (*3*, *4*). Wildlife are at risk because of environmental mercury exposure (*5*), and elevated mercury levels have resulted in fish consumption advisories for some freshwater, estuary, and coastal areas in North America and Europe. Although fish represent an important protein source for humans and fisheries form the economic backbone of many coastal areas, the consumption of fish is also the pathway responsible for most human exposure to mercury (*3*). However, many aspects of mercury's cycling in marine ecosystems remain unknown (*6*, *7*), among them the source of MMHg that is biomagnified to potentially toxic levels.

Although elevated levels of mercury in groundwater and soil pore waters have been reported in coastal plains (*8*, *9*) and the potential importance of groundwater-surface water interactions in the migration of mercury has been suggested (*10*), groundwater was not previously believed to be an important transport medium for mercury in the environment (*11*). Recent studies of mercury dynamics in subterranean estuaries in Massachusetts (*12*) and northern France (*13*) have suggested that the flux of total mercury (Hg_T) to the ocean via groundwater discharge may be more important than previously believed, and may even be the dominant input of mercury to some coastal systems. These new results corroborate research over the last two decades demonstrating that groundwater inputs of nutrients and pollutants to coastal zones can be substantial and significantly affect coastal ecosystems (*14*–*18*). There have been very few studies of MMHg in groundwater, and we are not aware of any reports on MMHg fluxes in submarine groundwater discharge (SGD). Despite this, given concentrations of MMHg in groundwater elsewhere (*10*, *19*) and recent reports of Hg_T in groundwater discharge to coastal ecosystems (*12*, *13*), SGD may represent a previously unidentified source of MMHg to coastal waters.

The potential for subterranean estuaries to be an important source of mercury to marine waters is exceptionally high along the central California coast. The reasons for this are: (1) the area's location within the highly mineralized circum-Pacific mercury belt and the existence of several large economic mercury deposits responsible for the contamination of surface waters in the region (*20*, *21*), (2) the presence of oil-bearing rock formations along the central California coast coupled with the co-occurrence of mercury with hydrocarbon deposits (*22*, *23*), (3) the same geothermal processes responsible for past mercury mineralization and association with metalliferous deposits may result in currently active hydrothermal systems that are prevalent in the region being a source of mercury to groundwater (*23*, *24*), and (4) anthropogenic activities (e.g., mining and industrial processes) have created a large reservoir of contaminant mercury at the land-sea interface in central California (*25*), much of which exists in soils and unconsolidated sediment where the mercury may be methylated and subsequently advected and discharged to coastal waters via SGD.

Here we describe measurements of Hg_T, MMHg, and nutrients (NH_4^+, NO_3^-, PO_4^{3-}, and SiO_2) in groundwater and

* Corresponding author phone: (609) 258-2849; e-mail: fblack@princeton.edu.
† WIGS Laboratory, Department of Environmental Toxicology, University of California.
‡ Current address: Department of Geosciences, Princeton University, Princeton, New Jersey 08544.
§ Institute of Marine Sciences, University of California.
∥ Department of Geological & Environmental Sciences, Stanford University.
⊥ Department of Civil and Environmental Engineering, Stanford University.

10.1021/es900539c CCC: $40.75
Published on Web 06/08/2009

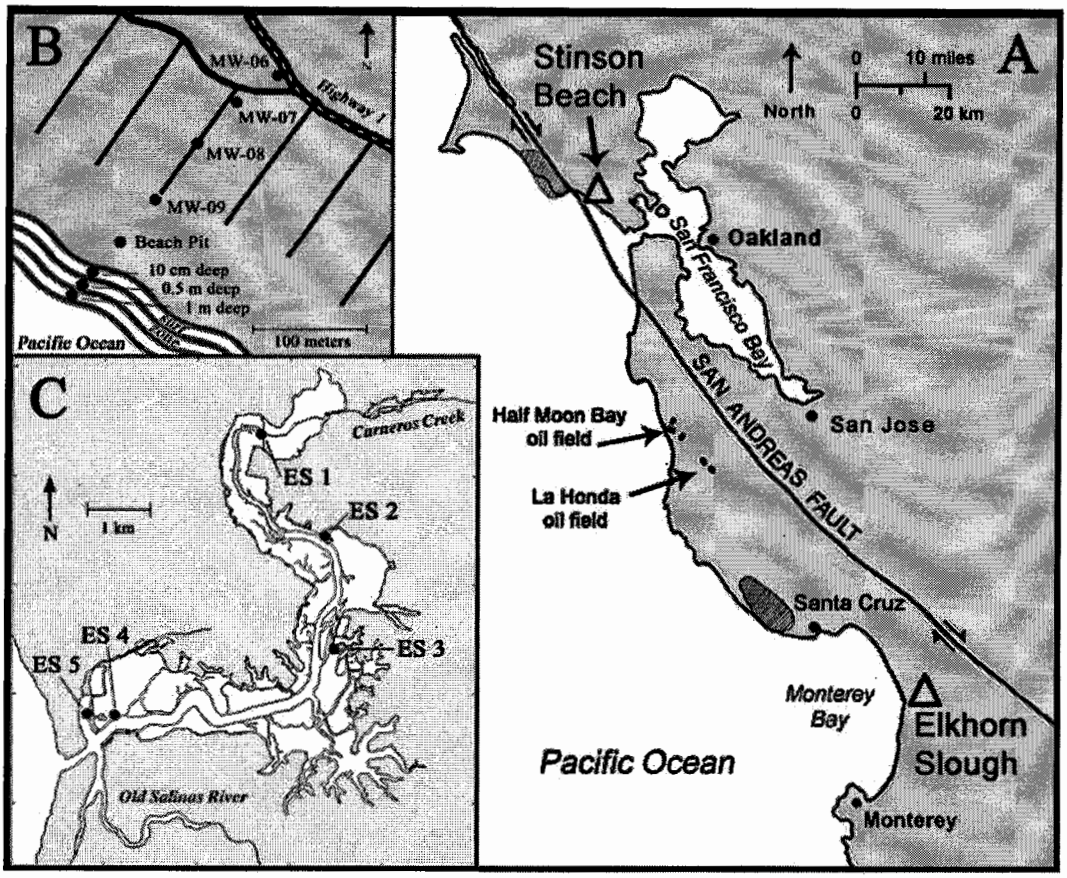


FIGURE 1. (A) Location of the study sites, Stinson Beach and Elkhorn Slough, on the central California coast. Cross-hatched areas in A denote location of oil-bearing sandstone intrusions. (B) Location of sampling wells and surface water sites at Stinson Beach. (C) Sites of groundwater and surface water sample collection at Elkhorn Slough.

adjacent surface waters at two locations along the central California coast. These data were combined with measurements of naturally occurring radium (Ra) isotopes and other hydrological parameters to calculate SGD related fluxes of mercury species and elucidate the role of other variables controlling these fluxes. We present the first reported estimates of MMHg fluxes to coastal waters via SGD, and discuss the importance of SGD as a source of Hg_T and MMHg to coastal ecosystems relative to other sources.

Materials and Methods

Study Sites. Stinson Beach (Figure 1) is an open-ocean, southwest-facing, reflective beach composed principally of medium grain sand with mixed semidiurnal tides and a high energy surf zone. The central California coast is characterized by a Mediterranean climate, with rainfall occurring predominately during the winter between November and April. Land cover in the area is primarily forested, but a small coastal town using individual septic systems for wastewater disposal is located along the beach. Microbial pollution and elevated nutrient levels have been documented in the subsurface, as has groundwater discharge to the Pacific Ocean (*26*). The unconfined aquifer is composed primarily of beach and dune sands underlain by lacustrian clay, which in turn is underlain by an assemblage of highly fractured sandstone, limestone, and shale (*26*).

Stinson Beach is located near the San Andreas Fault system (Figure 1), which is associated with mercury mineralization in the region (*23*). Groundwater movement along faults might therefore encounter naturally occurring mercury in the subsurface before discharging to the ocean. Stinson Beach is also located near oil-bearing sandstone units, the weathering of which may release mercury into local groundwater. Discharge of nutrient-rich septic effluent to shallow groundwater results in reducing conditions within a few meters of the water table, which could increase microbial MMHg production and export from the surficial aquifer.

Elkhorn Slough is a small, shallow (mean depth ~2.5 m), tidally flushed estuary that empties into Monterey Bay (Figure 1). The estuary is comprised of a main channel that reaches approximately 11 km inland and numerous tidal creeks and wetlands that surround the main channel. Mudflats comprise ~59% of Elkhorn Slough's area, and intertidal salt marshes an additional ~29% (*27*). Freshwater inputs are minimal, and in the winter rainy season are limited to Carneros Creek at the head of the slough, and in the summer dry season to the Old Salinas River channel near the mouth of the slough via Moss Landing Harbor. The estuary's tidal prism accounts for 60–75% of the mean estuary volume (*28*). Estimates of mean water residence time in Elkhorn Slough's main channel are on the order of ~1 day, but can be substantially greater in the tidal flats and upper reaches of the slough during the dry season (*28*).

The regional water table near Elkhorn Slough has experienced substantial overdraft because of intensive agricultural practices, and saltwater intrusion has become increasingly common (*27*). As a result, advective inputs of fresh groundwater represent only a minor source of freshwater to the slough. Nevertheless, recent work suggests that tidally controlled recirculated seawater through wetland sediments is significant and can account for 12% of the water volume of the slough daily (*29*). Elkhorn Slough is surrounded by large tracts of wetlands, which are hotspots for the production of MMHg (*30–32*). We hypothesized that the tidally driven seawater recirculation through surficial mudflat sediments [illegible]

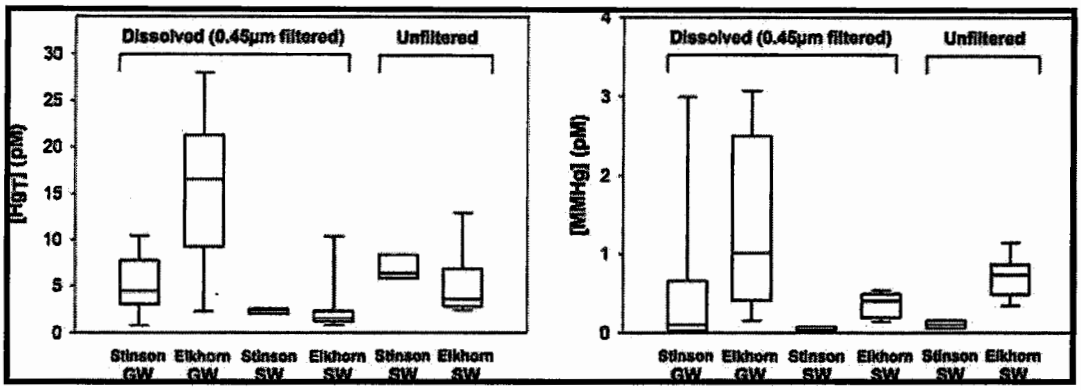


FIGURE 2. Box plots of Hg_T and MMHg concentrations in 0.45 μm filtered and unfiltered groundwater (GW) and surface waters (SW) at Elkhorn Slough and Stinson Beach. The median is represented by the middle line of each box, hinges represent the 25% quartiles, and whiskers represent the 5 and 95 percentiles.

results in substantial transfer of nutrients to the slough and adjacent coastal waters (*29*) would also transport MMHg.

Sample Collection. Groundwater and surface seawater samples were collected along ~300 m cross-shore transects at Stinson Beach (Figure 1) on October 31, 2007 (one transect at high tide) and July 7, 2008 (one transect at low tide, a second transect at high tide). Filtered (0.45 μm) groundwater samples were collected from one hand-dug pit in the beach zone and four inland wells with PVC casings installed to depths of 3–6 m such that they intersect the unconfined coastal aquifer within 250 m inland of the high tide line (see de Sieyes et al. (*26*)). Filtered and unfiltered surf zone seawater was collected along cross-shore transects (3 sample points per transect) extending ~20 m out into the surf zone, where water depths were approximately 10 cm, 0.5 m, and 1 m.

Filtered and unfiltered surface waters and filtered groundwater were collected at Elkhorn Slough along an ~10 km transect (Figure 1) on June 18, 2008, from the head of the slough to its mouth. On June 19, 2008, multiple samples were collected at a single point (ES 2) as part of a seven hour time series. At each sampling site or time in Elkhorn Slough, a groundwater sample (from a 1–2 m deep hand-dug pit employed to retrieve groundwater from the surficial unconfined aquifer) and adjacent surface water samples were collected as close together temporally and spatially as possible.

Both groundwater and surface water samples were collected using trace metal clean techniques with the use of a peristaltic pump using Teflon sampling lines with C-Flex tubing in the pump head. Methods for acid cleaning sample bottles, filters, and tubing are in the Supporting Information. Filtered water samples were collected using an acid cleaned 0.45 μm polypropylene cartridge filter (Osmonics) fitted to the end of the sample line. Because the advection of sediment- or particle-associated nutrients or mercury species is unlikely in the subsurface on time scales of interest to our study, filtered (0.45 μm) groundwater samples were collected at all sites, but only limited sampling of unfiltered groundwater was undertaken. Samples for Hg_T and MMHg were collected in acid-cleaned Teflon bottles, placed on ice in the field, and kept cold and dark until transported back to the laboratory where they were preserved the same evening. Samples for Hg_T were preserved by amendment to 1% BrCl, except for organic rich unfiltered groundwater, which was amended to 2% BrCl. MMHg samples were preserved by amendment to either 18 mM H_2SO_4 (saline and brackish samples) or 30 mM HCl (low salinity samples). Samples were stored in the dark at either 4 °C (MMHg samples) or room temperature (Hg_T samples) and were analyzed within 2 months of collection.

Dissolved radium was extracted from ~100 L water samples in the field by filtering through columns of MnO_2-impregnated acrylic fiber at a flow rate not exceeding 1 L min^{-1} (*33*, *34*). Untreated acrylic fiber plugs were used to prevent the contamination of the MnO_2 fiber with particulate matter. The fibers were removed from the columns and stored in plastic bags until processing and analysis. The collection and analysis of nutrient samples and suspended particulate matter samples using established techniques are described in the Supporting Information.

Sample Analysis. Total mercury concentrations were determined by oxidation with BrCl, reduction with $SnCl_2$, gold trap amalgamation, and quantification by cold vapor atomic fluorescence spectrometry (CVAFS) using established methods (*35*). The average daily Hg_T detection limit, calculated as 3× the standard deviation of Milli-Q water blanks amended to 1% BrCl, was 0.5 pM. The relative standard deviation of samples ($n = 3$) collected and analyzed for Hg_T in triplicate averaged (mean ± s.d.) 6 ± 7%, whereas field blanks (Milli-Q water pumped in the field through sample tubing and filter) averaged 1.2 ± 0.4 pM Hg_T ($n = 3$).

MMHg concentration measurements were made on 45 mL aliquots by distillation, aqueous phase ethylation, separation by gas chromatography, thermal decomposition, and quantification by CVAFS (*36*). Each set of up to 20 MMHg samples distilled was accompanied by at least two distillation blanks (Milli-Q water amended to either 30 mM HCl or 0.1 M KCl and 18 mM H_2SO_4) and two MMHg matrix spikes. MMHg matrix spike recoveries ($n = 11$) averaged 93 ± 10%. The MMHg detection limit, calculated as 3× the standard deviation of distillation blanks ($n = 10$), was 0.04 pM MMHg. The relative standard deviation of samples ($n = 3$) collected and analyzed for MMHg in triplicate averaged 8 ± 6%, and MMHg field blanks ($n = 3$) averaged 0.02 ± 0.02 pM. Tests for artifactual formation of MMHg and methods for its correction are described in the Supporting Information.

MnO_2 fibers used for collecting Ra isotopes were rinsed with Ra-free water to remove salts and particles, then hand-squeezed to remove excess water. Activities of the short-lived isotopes ^{223}Ra and ^{224}Ra were measured within 2 days of collection using a delayed coincidence counter (*33*, *37*). Samples were rerun 3–6 weeks after collection to account for ^{228}Th-supported ^{224}Ra activity, which accounted for ~3% of the original ^{224}Ra activity. Uncertainties associated with Ra isotope activities were calculated using the method of Garcia-Solsona et al. (*38*) and averaged 34 and 3% for ^{223}Ra and ^{224}Ra, respectively.

Results and Discussion

Hg_T Concentrations in Groundwater and Surface Waters. Concentrations of Hg_T in groundwater were greater than those in adjacent surface waters (Figure 2). However, Hg_T levels were relatively low (<29 pM) in all samples and displayed only modest spatial and temporal variability (Figures 3 and 4, and Figure 2 in the Supporting Information).

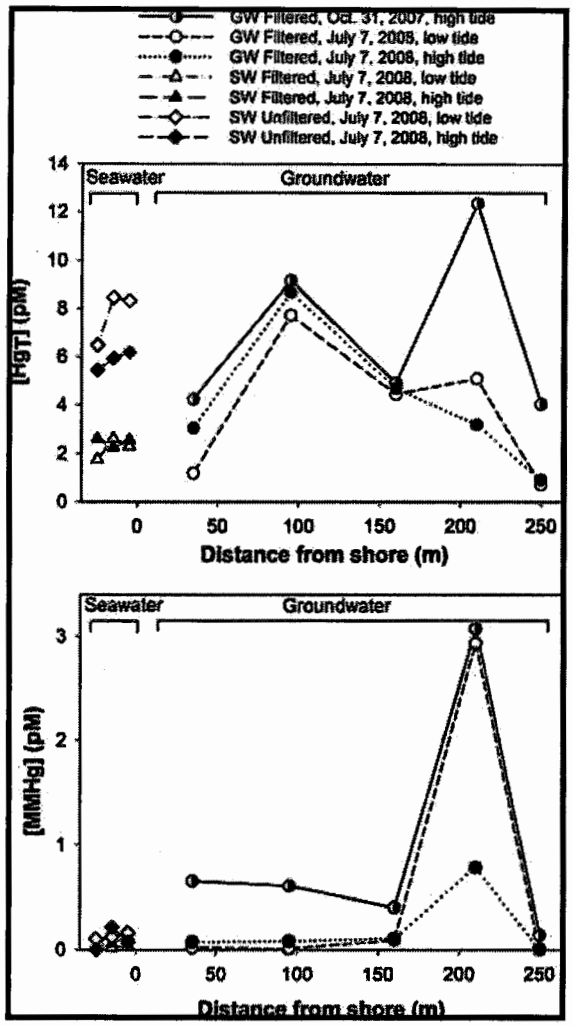


FIGURE 3. Concentrations of Hg_T (top plot) and MMHg (bottom plot) in filtered and unfiltered groundwater (GW) and surface seawater (SW) measured at Stinson Beech.

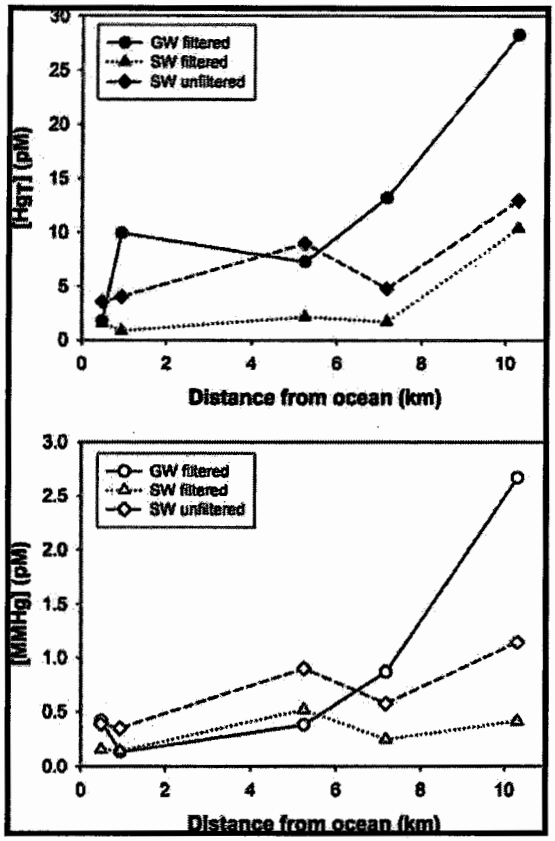


FIGURE 4. Concentrations of Hg_T (top plot) and MMHg (bottom plot) in filtered and unfiltered groundwater (GW) and adjacent surface waters (SW) along transect of Elkhorn Slough sampled June 18, 2008.

Concentrations of Hg_T in filtered groundwater ranged from 1.2 to 12.4 pM at Stinson Beach and 1.8–28.3 pM at Elkhorn Slough (Figure 2). These Hg_T concentrations are similar to those reported for groundwater studies in some areas (*11, 13, 19*), but somewhat lower than those in others (*8, 9, 12*). Concentrations of Hg_T in filtered surface water samples ranged from 1.7 to 2.6 pM at Stinson Beach and 0.8–11.6 pM at Elkhorn Slough, while Hg_T concentrations in unfiltered surface water samples ranged from 5.4 to 8.5 pM at Stinson Beach and 2.5–12.9 pM at Elkhorn Slough (Figure 2). These Hg_T concentrations are typical of uncontaminated coastal and estuarine surface waters (39–44), but are higher than in continental shelf and open ocean waters (<3 pM) (*6*).

Dissolved Hg_T levels were generally only slightly higher in groundwater compared to adjacent surface waters (Figures 3 and 4 and Figure 2 in the Supporting Information). Exceptions to this trend were near the head of Elkhorn Slough, where concentrations of dissolved Hg_T were substantially higher in groundwater than surface water. The similarity between dissolved concentrations of Hg_T in groundwater and surface waters is attributed to mercury being very particle reactive. Values of log K_d (partition coefficient) for Hg_T in surface seawater at Stinson Beach were in the range 5.0–5.6, which is typical of values reported for coastal and estuarine waters elsewhere (39–44). Log K_d values for Hg_T in Elkhorn Slough surface waters were noticeably lower, with a range of 3.3–4.0. Sampling of unfiltered groundwater for both mercury and suspended solids was only conducted at Elkhorn Slough, where log K_d values for Hg_T in groundwater were ~1.5 in the harbor at the mouth of the slough and 4.2–5.8 near the head of the slough. The lower degree of partitioning of Hg_T onto the solid phase in groundwater in the harbor was likely due to the unconfined aquifer material here being composed of coarse quartz sands with low organic matter content, compared to the much smaller particle sizes and higher organic matter content characterizing the aquifer moving toward the head of the slough. Similar reasoning was invoked by Bone et al. (*12*) to explain the low K_d values for Hg_T in groundwater measured in that study.

MMHg Concentrations in Groundwater and Surface Waters. Concentrations of filtered MMHg in groundwater varied more than those in surface waters (Figure 2), ranging from below the limit of detection (0.04 pM) to 3.1 pM at Stinson Beach and 0.13–3.1 pM at Elkhorn Slough (see Figures 3 and 4 and Figure 2 in the Supporting Information). Previous studies reported that MMHg was not detectable (<0.04 pM) in groundwater of a subterranean estuary (*13*), but that MMHg ranged from <0.04 to 2.9 pM in groundwater of a wetland-forested watershed (*19*) and 0.6–35 pM in near surface groundwater from a peatland (*10*). MMHg concentrations measured in coastal groundwater in our study were intermediate of these and within the range generally reported for estuarine and coastal sediment porewaters (*31, 32, 45–51*).

MMHg concentrations in filtered surface water samples ranged from below the detection limit to 0.13 pM at Stinson Beach and from 0.14 to 0.53 pM at Elkhorn Slough, whereas MMHg concentrations in unfiltered surface water samples ranged from 0.07 to 0.25 pM at Stinson Beach and from 0.35 to 1.2 pM at Elkhorn Slough (Figures 3 and 4 and Figure 2 in the Supporting Information). MMHg levels in surface seawater are within the range typically reported for coastal and estuary waters elsewhere (*39–44*).

Values of log K_d for MMHg were in the range 5.1−6.2 for surface seawater at Stinson Beach and 4.5−5.1 for surface waters of Elkhorn Slough. These values of K_d for MMHg are higher than those for Hg_T in the same waters, which is unusual, although the reason for this is unclear. Log K_d values for MMHg in groundwater were ~1.9 at Moss Landing Harbor at the mouth of the slough and 3.0−3.3 near the head of the slough. The lower K_d values for MMHg in groundwater measured at the mouth of the slough compared to further inland was similar to the trend described for Hg_T above, and likely controlled by the same differences in aquifer material.

Large variations in the percentage of Hg_T as MMHg in groundwater were measured, indicating that conditions in some regions of these subterranean estuaries are more conducive than others to the net production of MMHg and/or its partitioning into the dissolved phase relative to Hg_T. The percentage of Hg_T present as MMHg in groundwater tended to be relatively high at Elkhorn Slough (3−23%), but was low at Stinson Beach (<16%), with the exception of groundwater from well MW-07 (25−58%). This particular well also had consistently higher MMHg concentrations than elsewhere at Stinson Beach (Figure 3) and high concentrations of dissolved NH_4^+ (57−510 μM) that were 3× greater than those at any other Stinson Beach well sampled during the study. Perennially high fecal indicator bacteria and nitrogen concentrations measured at MW-07 in 2005−2007 indicate septic effluent contamination at that location (N. R. de Sieyes, unpublished data), implying a possible connection between this MMHg hotspot and groundwater contamination by sewage. The lack of a decreasing seaward trend in groundwater MMHg concentration at wells between MW-07 and the ocean (Figure 2), as would be expected because of the seaward direction of groundwater flow (*26*) and dilution in the brackish mixing zone, is likely the result of nonconservative behavior of MMHg in this region of the subterranean estuary.

The high percentage of Hg_T as MMHg in unfiltered surface waters at Elkhorn Slough (9−33%) is in contrast to both surface waters at Stinson Beach (<4%) and coastal and estuary surface waters elsewhere, where MMHg generally constitutes <4% of the total mercury pool (*39*−*44*). This difference is likely because wetlands (such as those surrounding Elkhorn Slough) are hotspots for the production of MMHg (*30*−*32*) that can subsequently be advected to adjacent surface waters.

In contrast to surface waters, sediment porewaters typically have a high ratio of MMHg to Hg_T because surficial sediments are important sites of microbial production of MMHg (*39, 52*−*54*). Thus, the high percentage of Hg_T as MMHg measured in groundwater in this study (up to 58%) is typical of surficial sediment porewaters. However, previous studies of MMHg in sediment porewaters have typically focused on the upper 10−15 cm of sediments and have shown that MMHg concentrations and net mercury methylation potentials are often greatest near the oxic/suboxic interface and decrease above and below this depth (*31, 45, 50, 54, 55*).

The groundwater collected in this study was from wells with screen intervals of 1.5−3 m at Stinson Beach and from 1−2 m deep pits at Elkhorn Slough. Our groundwater samples essentially represent a composite of groundwater collected across a large vertical depth interval far greater than 10 cm, which in the case of Elkhorn Slough spanned the oxic/suboxic interface. Given the previously reported low concentration of MMHg in many sediment porewaters on either side of the oxic/suboxic interface, one would therefore have expected the MMHg concentrations in these composite samples to be low. But instead, the MMHg concentrations and the %MMHg measured were relatively high in a number of samples from both Stinson Beach and Elkhorn Slough. This observation may indicate that the production and/or transport of MMHg occur over a wider depth interval in coastal groundwater systems compared to nontidally flushed estuary and coastal sediments.

Temporal variability and the effect of daily tidal cycle on concentrations of Hg_T and MMHg in groundwater and surface waters (of which there was relatively little and no consistent patterns discernible) are discussed in the Supporting Information.

Correlations between Groundwater Concentrations of Mercury Species and Nutrients. Concentration data for mercury species (Hg_T and MMHg), dissolved nutrients (NH_4^+, NO_3^-, PO_4^{3-}, SiO_2), and ancillary parameters (pH, salinity, temperature, total suspended solids, distance from shore) were analyzed by multiple linear regression to identify correlations between mercury species and other variables. When treating dissolved Hg_T in groundwater as the dependent variable the only factors contributing to the model at the $p = 0.05$ level were dissolved concentrations of NH_4^+ and SiO_2. The multiple linear regression analysis for dissolved MMHg in groundwater revealed that only dissolved concentrations of Hg_T and NH_4^+ contributed to the model at the $p = 0.05$ level. This is in contrast to concentrations of filtered or unfiltered MMHg in surface waters, which did not correlate with any of the variables measured ($p > 0.1$, multiple linear regression). Thus, a weak positive relationship ($r^2 = 0.31$, $p = 0.003$) was found to exist between dissolved MMHg and Hg_T in groundwater, but not in adjacent surface waters (see Figure 1 in the Supporting Information).

Bone et al. (*12*) found no discernible relationship between concentrations of Hg_T in coastal groundwater and those of iron, dissolved organic matter, or chloride, despite their ability to influence the transport and fate of Hg_T. Our results suggest that the transport and partitioning of Hg_T between the solid phase and dissolved phase in the groundwater systems we studied are controlled by similar mechanisms to those of NH_4^+ and SiO_2, but differ from those controlling NO_3^- and PO_4^{3-}. The positive correlation between dissolved NH_4^+ and both Hg_T and MMHg in groundwater may be related to the remineralization of organic matter, which would release NH_4^+ and organic matter-bound mercury species into solution. Another possibility is that reducing conditions in the subsurface would favor the presence of NH_4^+ (mean NH_4^+ concentration in Elkhorn Slough groundwater was 460 ± 390 μM compared to 47 ± 90 μM for NO_3^-), the microbial production of MMHg, and the release of sorbed Hg_T and MMHg due to the reductive dissolution of manganese and iron oxyhydroxides.

The production, decomposition, and export of MMHg from sediments are controlled by the complex interplay of various geochemical, biological, and physical factors (*39, 49, 50, 52, 54, 55*). These include parameters measured in this study (pH, temperature, salinity, and nutrients) that influence sorption as well as microbial community diversity and respiration rates. However, the multiple linear regression model could account for only 36% of the variance in groundwater MMHg concentrations ($r^2 = 0.36$, $p < 0.001$), so the two variables found to have significant correlations with MMHg (dissolved Hg_T and NH_4^+) were apparently not the only factors controlling concentrations of MMHg in the two groundwater systems studied.

Fluxes of Hg_T and MMHg to Coastal Waters via Submarine Groundwater Discharge. Hg_T and MMHg concentration data were used to calculate fluxes by combining them with estimates of SGD, which were in turn based on excess radium activities and a simple mass balance model (*17, 18, 37*). A SGD flux at Stinson Beach of 30 ± 11 L min^{-1} m^{-1} of shoreline was calculated from the average excess ^{224}Ra activity of 24 ± 4 dpm (100 L)$^{-1}$ at the surf zone (within 20 m from the shoreline), a residence time of water at this site of 6 h (based on estimates of littoral drift, tide cell spacing, and

dilution length scales), and unconfined coastal aquifer groundwater ^{224}Ra levels of 81 ± 27 dpm (100 L)$^{-1}$. Uncertainties associated with the SGD fluxes are based on uncertainty in ^{224}Ra activities, whereas uncertainties reported for fluxes of Hg_T and MMHg in SGD presented below are reported with respect to both the variability in the groundwater concentration of mercury species and uncertainties in the SGD flux. At Stinson Beach, the average concentration of dissolved Hg_T in groundwater from the beach pits and well MW-09 was 5.7 ± 3.2 pM (groundwater composition at these locations nearest the beach best represents the discharging mixture of fresh and saline groundwater). This corresponds to a dissolved Hg_T flux of 170 ± 110 pmol min^{-1} m^{-1} of shoreline (250 ± 160 nmol m^{-1} day^{-1}). The average concentration of MMHg in groundwater at Stinson Beach (beach pits and well MW-09 only) was 0.24 ± 0.26 pM, corresponding to a MMHg flux in SGD of 7.2 ± 8.2 pmol min^{-1} m^{-1} of shoreline (10 ± 12 nmol m^{-1} day^{-1}). SGD fluxes at Stinson Beach were normalized to shoreline length (m^{-1}) rather than area (m^{-2}) because there were insufficient data to accurately define the area of the seepage face at this coastal ocean beach site.

At Elkhorn Slough, excess ^{224}Ra in the main channel averaged 42 ± 8 dpm (100 L)$^{-1}$ and the average groundwater (pits) ^{224}Ra was 450 ± 130 dpm (100 L)$^{-1}$. Using channel volume and a water residence time of 1 day for the main channel (*28*), SGD flux to the slough was estimated at 5.3 ± 1.8 × 10^5 m^3 day^{-1}. Using the average dissolved Hg_T concentration in Elkhorn Slough groundwater of 15 ± 9 pM (15 ± 9 nmol m^{-3}), this corresponds to a dissolved Hg_T flux of 8.0 ± 5.5 mmol day^{-1} to the tidal estuary. The area of the slough is 2.7 × 10^6 m^2, giving a Hg_T flux via SGD of 3.0 ± 2.0 nmol m^{-2} day^{-1} when normalized to area. This flux is greater than that reported by Bone et al. (*12*) for Waquoit Bay, MA (0.47–1.9 nmol m^{-2} day^{-1}). The average dissolved MMHg concentration in groundwater at Elkhorn Slough (1.2 ± 1.0 pM) was similarly used to estimate a dissolved MMHg flux of 0.65 ± 0.58 mmol day^{-1} to the tidal estuary, giving an area-normalized MMHg flux via SGD of 0.24 ± 0.21 nmol m^{-2} day^{-1}.

Although our SGD fluxes are based on data collected over only a few sampling events, they are consistent with previous estimates based on more extensive Ra data sets and/or hydraulic gradients and Darcy–Dupuit estimates in these same systems (*26, 29*). Using previously published SGD fluxes for Stinson Beach (17–23 L min^{-1} m^{-1} (*26*)), we calculate a dissolved Hg_T flux of 160 ± 95 nmol day^{-1} m^{-1} of shoreline, and a MMHg flux in SGD of 6.9 ± 7.5 nmol day^{-1} m^{-1} of shoreline. At Elkhorn Slough, tidally driven seawater recirculation through the surficial marsh sediments was previously reported to be 6.8 × 10^5 m^3 day^{-1} (*29*). Using this SGD flux, we calculate a dissolved Hg_T flux at Elkhorn Slough of 3.9 ± 2.2 nmol m^{-2} day^{-1} when normalized to area. Similarly, we calculate a dissolved MMHg flux of 0.31 ± 0.33 nmol m^{-2} day^{-1} at Elkhorn Slough when normalized to area.

Comparison of Fluxes of Mercury Species via SGD to Other Sources. The importance of the fluxes of Hg_T and MMHg via SGD to coastal waters estimated above can be evaluated by comparing them to other sources (see Table 1 in the Supporting Information). In marine environments that do not receive substantial fluvial inputs and are not directly affected by local sources of mercury pollution, inputs of Hg_T are generally dominated by atmospheric deposition (*1, 2*). Net Hg_T atmospheric deposition to surface waters of nearby San Francisco Bay have been estimated to be roughly 0.19 nmol m^{-2} day^{-1} (*56, 57*). The Hg_T fluxes in SGD we calculated (3.0 ± 2.0 nmol m^{-2} day^{-1} at Elkhorn Slough) are an order of magnitude greater than that atmospheric deposition rate.

The MMHg fluxes in SGD calculated in this study (0.24 ± 0.21 nmol m^{-2} day^{-1} for Elkhorn Slough) are greater than previously reported MMHg benthic fluxes out of surficial estuary and coastal sediments due to diffusion and bioirrigation (0–0.16 nmol m^{-2} day^{-1}) estimated from concentration gradients between pore waters and overlying waters or using laboratory based flux chambers employing sediment cores (*31, 45, 46, 48–51*). MMHg fluxes to overlying waters measured using in situ benthic flux chambers, which will capture inputs from SGD and other advective processes, are considerably greater and range from −1.5 to 10.9 nmol m^{-2} day^{-1} (*31, 45–47*). Although it is difficult to distinguish between different components contributing to these fluxes, our results suggest that the higher in situ measured MMHg benthic fluxes are likely in part due to the role of SGD as a source and means of transporting MMHg to overlying waters both from and through surficial and deep sediments.

Surficial sediments are widely held to be the dominant source of MMHg to estuary and coastal waters (*31, 45, 46, 50*). Thus, the observation that SGD inputs of MMHg are greater than fluxes out of surficial coastal sediments due to diffusion and bioirrigation indicates that benthic inputs of MMHg may be controlled to a greater degree by the flux of submarine groundwater into the system and the parameters impacting this flux. Such a comparison also suggests that estimates of MMHg benthic fluxes derived from laboratory based (rather than in situ) flux chambers or calculated from MMHg concentration gradients are likely to substantially underestimate in situ MMHg fluxes as they do not capture MMHg fluxes from SGD and other advective processes. This in turn suggests that inputs of MMHg, the form of mercury of most concern for marine ecosystems, to some coastal waters may be considerably greater than previously thought.

Acknowledgments

We thank the Elkhorn Slough National Estuarine Research Reserve and Stinson Beach County Water District for access to sample sites and background information. We acknowledge Lydia Jennings and Scott Katz for assistance with sample collection. Funding was provided by the California Sea Grant Program, the National Sea Grant Program under NOAA Grant NA04OAR4170038, and a UC Santa Cruz Chancellor's Dissertation Year Fellowship.

Supporting Information Available

Analytical details and data related to ancillary parameters and temporal variability in Hg_T and MMHg concentrations (PDF). This material is available free of charge via the Internet at http://pubs.acs.org.

Literature Cited

(1) Mason, R. P.; Sheu, G. R. Role of the ocean in the global mercury cycle. *Global Biogeochem. Cycles* **2002**, *16*, 1093.

(2) Sunderland, E. M.; Mason, R. P. Human impacts on open ocean mercury concentrations. *Global Biogeochem. Cycles* **2007**, *21*, GB4022.

(3) National Research Council. *Toxicological Effects of Methylmercury*; National Academy Press: Washington, D.C., 2000.

(4) Mergler, D.; Anderson, H. A.; Chan, L. H. M.; Mahaffey, K. R.; Murray, M.; Sakamoto, M.; Stern, A. H. Methylmercury exposure and health effects in humans: A worldwide concern. *Ambio* **2007**, *36*, 3–11.

(5) Scheuhammer, A. M.; Meyer, M. W.; Sandheinrich, M. B.; Murray, M. W. Effects of environmental methylmercury on the health of wild birds, mammals, and fish. *Ambio* **2007**, *36*, 12–18.

(6) Fitzgerald, W. F.; Lamborg, C. H.; Hammerschmidt, C. R. Marine biogeochemical cycling of mercury. *Chem. Rev.* **2007**, *107*, 641–662.

(7) Munthe, J.; Bodaly, R. A.; Branfireun, B. A.; Driscoll, C. T.; Gilmour, C. C.; Harris, R.; Horvat, M.; Lucotte, M.; Malm, O. Recovery of mercury-contaminated fisheries. *Ambio* **2007**, *36*, 33–44.

(8) Barringer, J. L.; Szabo, Z. Overview of investigations into mercury in ground water, soils, and septage, New Jersey coastal plain. *Water, Air, Soil Pollut.* **2006**, *175*, 193–221.

(9) Barringer, J. L.; Szabo, Z.; Kauffman, L. J.; Barringer, T. H.; Stackelberg, P. E.; Inahnenko, T.; Rajagopalan, S.; Krabbenhoft, D. P. Mercury concentrations in water from an unconfined aquifer system, New Jersey coastal plain. *Sci. Total Environ.* **2005**, *346*, 169–183.
(10) Branfireun, B. A.; Heyes, A.; Roulet, N. T. The hydrology and methylmercury dynamics of a Precambrian Shield headwater peatland. *Water Resour. Res.* **1996**, *32*, 1785–1794.
(11) Krabbenhoft, D. P.; Babiarz, C. The role of groundwater transport in aquatic mercury cycling. *Water Resour. Res.* **1992**, *28*, 3119–3128.
(12) Bone, S. E.; Charette, M. A.; Lamborg, C. H.; Gonneea, M. E. Has submarine groundwater discharge been overlooked as a source of mercury to coastal waters. *Environ. Sci. Technol.* **2007**, *41*, 3090–3095.
(13) Laurier, F. J. G.; Cossa, D.; Beucher, C.; Brévière, E. The impact of groundwater discharges on mercury partitioning, speciation and bioavailability to mussels in a coastal zone. *Mar. Chem.* **2007**, *104*, 143–155.
(14) Charette, M. A.; Buesseler, K. O. Submarine groundwater discharge of nutrients and copper to an urban subestuary of Chesapeake Bay (Elizabeth River). *Limnol. Oceanogr.* **2004**, *49*, 376–385.
(15) Johannes, R. E. The ecological significance of the submarine discharge of ground water. *Mar. Ecol.: Prog. Ser.* **1980**, *3*, 365–373.
(16) Krest, J. M.; Moore, W. S.; Gardner, L. R.; Morris, J. T. Marsh nutrient export supplied by groundwater discharge: evidence from radium measurements. *Global Biogeochem. Cycle* **2000**, *14*, 167–176.
(17) Moore, W. S. Large groundwater inputs to coastal waters revealed by ^{226}Ra enrichment. *Nature* **1996**, *380*, 612–614.
(18) Paytan, A.; Shellenbarger, G. G.; Street, J. H.; Gonneea, M. E.; Davis, K.; Young, M. B.; Moore, W. S. Submarine groundwater discharge: An important source of new inorganic nitrogen to coral reef ecosystems. *Limnol. Oceanogr.* **2006**, *51*, 343–348.
(19) Stoor, R. W.; Hurley, J. P.; Babiarz, C. L.; Armstrong, D. E. Subsurface sources of methyl mercury to Lake Superior from a wetland-forested watershed. *Sci. Total Environ.* **2006**, *368*, 99–110.
(20) Ganguli, P. M.; Mason, R. P.; Abu-Saba, K. E.; Anderson, R. S.; Flegal, A. R. Mercury speciation in drainage from the New Idria mercury mine, California. *Environ. Sci. Technol.* **2000**, *34*, 4773–4779.
(21) Rytuba, J. J. Mercury mine drainage and processes that control its environmental impact. *Sci. Total Environ.* **2000**, *260*, 57–71.
(22) Jonasson, I. R.; Boyle, R. W. Geochemistry of mercury and origins of natural contamination of the environment. *Can. Inst. Mining Bull.* **1972**, *65*, 8–15.
(23) Peabody, C. E.; Einaudi, M. T. Origin of petroleum and mercury in the Culver-Baer cinnabar deposit, Mayacmas district, California. *Econ. Geol.* **1992**, *87*, 1078–1103.
(24) Fein, J. B.; Williams-Jones, A. E. The role of mercury-organic interactions in the hydrothermal transport of mercury. *Econ. Geol.* **1997**, *92*, 20–28.
(25) Conaway, C. H.; Black, F. J.; Brieb, T. M.; Roy, S.; Flegal, A. R. Mercury in the San Francisco Estuary. *Rev. Environ. Res. Contam.* **2008**, *194*, 29–54.
(26) de Sieyes, N. R.; Yamahara, K. M.; Layton, B. A.; Boehm, A. B. Submarine discharge of nutrient-enriched fresh groundwater at Stinson Beach, California is enhanced during neap tides. *Limnol. Oceanogr.* **2008**, *53*, 1434–1445.
(27) *Elkhorn Slough Tidal Wetland Strategic Plan*; Elkhorn Slough Tidal Wetland Project: Elkhorn Slough, CA, 2007.
(28) Broenkow, W. W.; Beaker, L. C. *A 30-Year History of Tide and Current Measurements in Elkhorn Slough, California*; Scripps Institute of Oceanography Library: La Jolla, CA, 2005.
(29) Breier, J. A.; Nidzieko, N.; Monismith, S.; Moore, W.; Paytan, A. Tidally driven chemical fluxes across the sediment-surface water interface in Elkhorn Slough, California: evidence from a coupled geochemical and hydrodynamic approach. *Limnol. Oceanogr.* **2009**, submitted.
(30) Babiarz, C.; Hurley, J.; Benoit, J.; Shafer, M.; Andrewn, A.; Webb, D. Seasonal influences on partitioning and transport of total and methylmercury in rivers from contrasting watersheds. *Biogeochemistry* **1998**, *41*, 237–257.
(31) Choe, K. Y.; Gill, G. A.; Lehman, R. D.; Han, S.; Heim, W. A.; Coale, K. H. Sediment-water exchange of total mercury and monomethyl mercury in the San Francisco Bay-Delta. *Limnol. Oceanogr.* **2004**, *49*, 1512–1527.
(32) Heim, W. A.; Coale, K. H.; Stephenson, M.; Choe, K. Y.; Gill, G. A.; Foe, C. Spatial and habitat-based variations in total and methyl mercury concentrations in surficial sediments in the San Francisco Bay-Delta. *Environ. Sci. Technol.* **2007**, *41*, 3501–3507.
(33) Moore, W. S.; Arnold, R. Measurement of ^{223}Ra and ^{224}Ra in coastal waters using a delayed coincidence counter. *J. Geophys. Res.* **1996**, *101*, 1321–1329.
(34) Rama; Todd, J. F.; Butts, J. L.; Moore, W. S. A new method for the rapid measurement of ^{224}Ra in natural waters. *Mar. Chem.* **1987**, *22*, 43–54.
(35) *Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry*; U.S. Environmental Protection Agency: Washington, D.C., 2002.
(36) *Method 1630, Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry*; U.S. Environmental Protection Agency: Washington, D.C., 2001.
(37) Moore, W. S. Sources and fluxes of submarine groundwater discharge delineated by radium isotopes. *Biogeochemistry* **2003**, *66*, 75–93.
(38) Garcia-Solsona, E.; Garcia-Orellana, J.; Masqué, P.; Dulaiova, H. Uncertainties associated with ^{223}Ra and ^{224}Ra measurements in water via a Delayed Coincidence Counter (RaDeCC). *Mar. Chem.* **2008**, *109*, 198–219.
(39) Baeyens, W.; Meuleman, C.; Muhaya, B.; Leermakers, M. Behaviour and speciation of mercury in the Scheldt estuary (water, sediments and benthic organisms). *Hydrobiologia* **1998**, *366*, 237–257.
(40) Balcom, P. H.; Hammerschmidt, C. R.; Fitzgerald, W. F.; Lamborg, C. H.; O'Connor, J. S. Seasonal distributions and cycling of mercury and methylmercury in waters of New York/New Jersey Harbor Estuary. *Mar. Chem.* **2006**, *109*, 1–17.
(41) Benoit, J. M.; Gilmour, C. C.; Mason, R. P.; Riedel, G. S.; Riedel, G. F. Behavior of mercury in the Patuxent River estuary. *Biogeochemistry* **1998**, *40*, 249–265.
(42) Conaway, C. H.; Squire, S.; Mason, R. P.; Flegal, A. R. Mercury speciation in the San Francisco Bay estuary. *Mar. Chem.* **2003**, *80*, 199–225.
(43) Faganeli, J.; Horvat, M.; Covelli, S.; Fajon, V.; Logar, M.; Lipej, L.; Cermelj, B. Mercury and methylmercury in the Gulf of Trieste (northern Adriatic Sea). *Sci. Total Environ.* **2003**, *304*, 315–326.
(44) Leermakers, M.; Galletti, S.; De Galan, S.; Brion, N.; Baeyens, W. Mercury in the southern North Sea and Scheldt estuary. *Mar. Chem.* **2001**, *75*, 229–248.
(45) Covelli, S.; Faganeli, J.; De Vittor, C.; Predonzani, S.; Acquavita, A.; Horvat, M. Benthic fluxes of mercury species in a lagoon environment (Grado Lagoon, Northern Adriatic Sea, Italy). *Appl. Geochem.* **2008**, *23*, 529–546.
(46) Covelli, S.; Faganeli, J.; Horvat, M.; Brambati, A. Benthic fluxes of mercury and methylmercury in the Gulf of Trieste. *Estuarine, Coastal Shelf Sci.* **1999**, *48*, 415–428.
(47) Gill, G. A.; Bloom, N. S.; Cappellino, S.; Driscoll, C. T.; Dobbs, C.; McShea, L.; Mason, R.; Rudd, J. Sediment-water fluxes of mercury in Lavaca Bay, Texas. *Environ. Sci. Technol.* **1999**, *33*, 663–669.
(48) Hammerschmidt, C. R.; Fitzgerald, W. F. Sediment-water exchange of methylmercury determined from shipboard benthic flux chambers. *Mar. Chem.* **2008**, *109*, 86–97.
(49) Hammerschmidt, C. R.; Fitzgerald, W. F.; Balcom, P. H.; Visscher, P. T. Organic matter and sulfide inhibit methylmercury production in sediments of New York/New Jersey Harbor. *Mar. Chem.* **2008**, *109*, 165–182.
(50) Hammerschmidt, C. R.; Fitzgerald, W. F.; Lamborg, C. H.; Balcom, P. H.; Visscher, P. T. Biogeochemistry of methylmercury in sediments of Long Island Sound. *Mar. Chem.* **2004**, *90*, 31–52.
(51) Mason, R. P.; Kim, E. H.; Cornwell, J.; Heyes, D. An examination of the factors influencing the flux of mercury, methylmercury and other constituents from estuarine sediment. *Mar. Chem.* **2006**, *102*, 96–110.
(52) Benoit, J. M.; Gilmour, C. C.; Heyes, A.; Mason, R. P.; Miller, C. L. Geochemical and biological controls over methylmercury production and degradation in aquatic environments. In *Biogeochemistry of Environmentally Important Trace Elements*; Cai, Y., Braids, O. C., Eds.; ACS Symposium Series No. 835; American Chemical Society: Washington, D.C., 2003; pp 262–297.
(53) Gilmour, C. C.; Henry, E. A.; Mitchell, R. Sulfate stimulation of mercury methylation in fresh-water sediments. *Environ. Sci. Technol.* **1992**, *26*, 2281–2287.

(54) King, J. K.; Kostka, J. E.; Frischer, M. E.; Saunders, F. M.; Jahnke, R. A. A quantitative relationship that demonstrates mercury methylation rates in marine sediments are based on community composition and activity of sulfate-reducing bacteria. *Environ. Sci. Technol.* **2001**, *35*, 2491–2496.

(55) Marvin-Dipasquale, M. C.; Agee, J. Microbial mercury cycling in sediments of the San Francisco Bay-Delta. *Estuaries* **2003**, *26*, 1517–1528.

(56) Macleod, M.; Mckone, T. W.; Mackay, D. Mass balance for mercury in the San Francisco Bay Area. *Environ. Sci. Technol.* **2005**, *39*, 6721–6729.

(57) Tsai, P.; Hoenicke, R. *San Francisco Bay Atmospheric Deposition Pilot Study, Part 1: Mercury*; San Francisco Estuary Institute: San Francisco, CA, 2001.

ES900539C

ELSEVIER

Chemosphere 65 (2006) 2160–2167

CHEMOSPHERE

www.elsevier.com/locate/chemosphere

Comparison of trace element concentrations in livers of diseased, emaciated and non-diseased southern sea otters from the California coast

Kurunthachalam Kannan [a,*], Tetsuro Agusa [b], Emily Perrotta [a], Nancy J. Thomas [c], Shinsuke Tanabe [b]

[a] *Wadsworth Center, New York State Department of Health and Department of Environmental Health Sciences, State University of New York at Albany, Empire State Plaza, P.O. Box 509, Albany, NY 12201-0509, USA*
[b] *Center for Marine Environmental Studies (CMES), Ehime University, Bunkyo-cho 2-5, Matsuyama 790-8577, Japan*
[c] *US Geological Survey-Biological Resources Division, National Wildlife Health Center, 6006 Schroeder Road, Madison, WI 53711-6223, USA*

Received 10 January 2006; received in revised form 5 June 2006; accepted 6 June 2006
Available online 17 July 2006

Abstract

Infectious diseases have been implicated as a cause of high rates of adult mortality in southern sea otters. Exposure to environmental contaminants can compromise the immuno-competence of animals, predisposing them to infectious diseases. In addition to organic pollutants, certain trace elements can modulate the immune system in marine mammals. Nevertheless, reports of occurrence of trace elements, including toxic heavy metals, in sea otters are not available. In this study, concentrations of 20 trace elements (V, Cr, Mn, Co, Cu, Zn, Rb, Sr, Mo, Ag, Cd, In, Sn, Sb, Cs, Ba, Hg, Tl, Pb, and Bi) were measured in livers of southern sea otters found dead along the central California coast ($n = 80$) from 1992 to 2002. Hepatic concentrations of trace elements were compared among sea otters that died from infectious diseases ($n = 27$), those that died from non-infectious causes ($n = 26$), and otters that died in emaciated condition with no evidence of another cause of death ($n = 27$). Concentrations of essential elements in sea otters varied within an order of magnitude, whereas concentrations of non-essential elements varied by two to five orders of magnitude. Hepatic concentrations of Cu and Cd were 10- to 100-fold higher in the sea otters in this study than concentrations reported for any other marine mammal species. Concentrations of Mn, Co, Zn, and Cd were elevated in the diseased and emaciated sea otters relative to the non-diseased sea otters. Elevated concentrations of essential elements such as Mn, Zn, and Co in the diseased/emaciated sea otters suggest that induction of synthesis of metallothionein and superoxide dismutase (SOD) enzyme is occurring in these animals, as a means of protecting the cells from oxidative stress-related injuries. Trace element profiles in diseased and emaciated sea otters suggest that oxidative stress mediates the perturbation of essential-element concentrations. Elevated concentrations of toxic metals such as Cd, in addition to several other organic pollutants, may contribute to oxidative stress-meditated effects in sea otters.

Keywords: Sea otters; Trace metals; Cadmium; Marine mammals; Immune suppression

1. Introduction

The southern sea otter (*Enhydra lutris nereis*) population inhabits the central California coast including the Monterey Bay National Marine Sanctuary. This species is listed as 'threatened' under the Endangered Species Act. Southern sea otters have made a slower than expected recovery after a drastic decline in their population prior to the 20th century, due to hunting (Estes, 1990). After a decade of population growth from the mid 1980s to the mid 1990s, the population of southern sea otters exhibited a slow

* Corresponding author. Tel.: +1 518 474 0015; fax: +1 518 473 2895.
E-mail address: kkannan@wadsworth.org (K. Kannan).

0045-6535/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.chemosphere.2006.06.003

decline in the late 1990s. After a high of 2377 animals in 1995, the population declined to 2090 animals in 1999 (Hanni et al., 2003), increased to 2825 individuals in 2004 (Kannan et al., 2004), and then dropped back to 2735 in 2005 (USGS, 2005). Overall, this subspecies of sea otter has exhibited a sluggish population growth rate, averaging ~5% per year, while other populations of sea otters exhibited 17–20% growth per year (Estes, 1990). The decline observed in the late 1990s was attributed to high adult mortality rates, with infectious disease being the major cause of death (Thomas and Cole, 1996). Multiple pathogens were implicated in these deaths, including pathogens such as *Coccidioides immitis* and *Toxoplasma gondii* (Hanni et al., 2003). These findings suggest that the immune systems of mature animals in this population may be compromised (Schwartz et al., 2005).

The southern sea otter population is just one example, in an increasing trend worldwide, of reports of disease and mass mortality events affecting marine mammals (Harvell et al., 1999). The problems facing marine mammal populations, including southern sea otters, are likely multi-factorial (Schwartz et al., 2005) and include effects from habitat destruction, pollutants, municipal runoff, global climate change, and over-harvesting of marine resources. In attempts to elucidate the relationship between pollutants and health of southern sea otters, earlier studies reported exposure concentrations of several organic contaminants (Kannan et al., 1998, 2004; Nakata et al., 1998; Bacon et al., 1999). However, because the contaminants exist in complex mixtures and because interactions can potentially occur among contaminants, nutritional status, and other environmental factors, establishment of a link between contaminant exposure and large-scale mortality events in marine mammals is a challenging task. One approach is to carry out systematic postmortem investigations to establish the disease status of contaminated animals in a relatively large sample (when available) from a single species. In this study, concentrations of 20 trace elements were measured in livers of sea otters to compare exposure levels between diseased and non-diseased individuals. To our knowledge, this is the first report of trace element concentrations in livers of free-ranging sea otters.

Unlike trace organic contaminants, many trace elements are essential for survival. However, both excesses and deficiencies of these trace elements lead to adverse effects. The essential elements include Co, Cr, Cu, Fe, Mg, Mn, Ni, Mo, Se, and Zn; the non-essential elements include As, Ag, Au, Be, Cd, Cs, Li, Hg, Pb, Sn, and Sr (Davis and Mertz, 1987). Certain heavy metals modify immune function via influences on a number of distinct and intriguing mechanisms (Lynes et al., 2006). While certain toxic metals (e.g., Cd, Pb) can diminish the adaptive capacity of exposed individuals, other heavy metals (e.g., Cu, Zn) are essential for effective immune functioning, and some metals (e.g., Hg, Be) can initiate inappropriate immune responses, leading to autoimmune disease (Lynes et al., 2006). High exposure to trace elements has been shown to affect immune parameters such as natural killer cell activity, phagocytosis, and lymphocyte proliferation (Bennett et al., 2001; Kakuschke et al., 2005). Studies of the mechanisms involved in different metal-mediated effects are needed to elucidate the consequences of environmental exposure to trace metals. In this study, we tested the hypothesis that exposure to elevated levels of certain toxic metals may compromise the immune system of sea otters and make them susceptible to pathogens. The goal of this study was to examine the association between hepatic trace element concentrations and pathological conditions in southern sea otters.

2. Materials and methods

2.1. Samples

A sample of adult female animals ($n = 80$) was selected from an archive of over 300 beached southern sea otters found freshly dead, between 1992 and 2002, along the central California coast (Fig. 1). We chose samples based on gender and age so as to eliminate these as confounding factors. Additionally, female sea otters were chosen because of their more localized movement patterns, which make them more suitable indicators of local sources of pollution (Ralls et al., 1996). Postmortem examinations were performed at the USGS National Wildlife Health Center (NWHC) in Madison, Wisconsin, for the determination of cause of death (COD). The COD was classified, based on necropsy findings, as one of four categories: emaciation, infectious disease, trauma, and other (Thomas and Cole, 1996). Each class is further divided into more specific subclasses. In this

Fig. 1. Sampling locations of dead southern sea otters from the central California coast.

study, we grouped animals that died of infectious diseases into a 'diseased' group ($n = 27$), and trauma and other into the 'non-diseased' group ($n = 26$). On the basis of body/nutritional condition at the time of necropsy, emaciated otters were grouped into a separate category ($n = 27$). Otters in the emaciation category include those that died in emaciated condition and had no evidence of other causes of death; these otters may have died from starvation or from debilitating physiological or functional abnormalities not apparent at necropsy. The emaciation category includes otters that died with evidence of recent pregnancy and mating ($n = 18$); dental diseases ($n = 4$); or no other co-factors ($n = 5$). Samples from the infectious disease category include those that died of acanthocephalan peritonitis ($n = 3$), protozoal encephalitis ($n = 2$), or fatal infections by bacteria ($n = 14$), fungi ($n = 3$), or parasites ($n = 1$). Also grouped in this category were other fatal cardiovascular ($n = 2$) and neurological ($n = 2$) infections. The category 'other' was comprised of animals that died of various gastrointestinal disorders such as intestinal torsions ($n = 5$), miscellaneous individual problems ($n = 3$), neoplasia ($n = 3$), or from undetermined ($n = 9$) causes. The category 'trauma' included otters that died from gun shot ($n = 3$) or shark bite ($n = 3$). In this study, we combined 'trauma' and 'other' into the other group.

2.2. Trace element analysis

Liver samples were collected from the carcasses at the time of necropsy, wrapped in aluminum foil, placed in sterile sampling bags (TWIRL'EM; Fisher Scientific International Inc., Hampton, NH, USA), and stored at −20 °C until analysis. Trace metals were analyzed following the method described elsewhere (Anan et al., 2002; Agusa et al., 2005). Prior to analysis, liver samples were freeze-dried and homogenized; an aliquot (~0.1 g) of the sample was weighed in a vial lined with Teflon® Liver samples were digested overnight in concentrated nitric acid (2 ml). Samples were then further digested in a microwave oven for 7 min at 200 W; this step was repeated three times. Concentrations of 19 trace elements (V, Cr, Mn, Co, Cu, Zn, Rb, Sr, Mo, Ag, Cd, In, Sn, Sb, Cs, Ba, Tl, Pb, and Bi) were determined by an inductively coupled plasma-mass spectrometer (ICP-MS) (Hewlett Packard-4500, Avondale, PA, USA), using yttrium (Y) as an internal standard. Concentrations of Hg were determined by a cold vapor atomic absorption spectrometer (Model HG-3000; Sanso, Tsukuba, Japan). The limit of detection for trace elements was 1 ng/g, dry wt, except for Sb and Cs (10 ng/g, dry wt) and Hg (50 ng/g, dry wt). Accuracy of the analysis was examined by analyzing Certified Reference Materials: dogfish muscle (DORM2; National Research Council, Ottawa, ON, Canada) and bovine liver (SRM1577b; National Institute of Standards and Technology, Gaithersburg, MD, USA) along with the samples. Recoveries of all the elements were in the range of 89–104%. The results are expressed on a dry weight basis.

Statistical analyses were performed using Statgraphics® 5 (Manugistics, Inc., Rockville, MD, USA). Concentrations of trace elements in sea otters did not follow a normal distribution, except Rb (Shapiro-Wilks W test; $p < 0.05$ for Rb). Therefore, the non-parametric Mann–Whitney U test was applied, to allow comparison of concentrations between two groups. Comparison of multiple groups was performed using ANOVA. Values below the limit of detection were assigned zero for the analysis.

3. Results and discussion

3.1. Residue levels and patterns

Those trace elements that were present at mean concentrations greater than 3 μg/g occurred in the following order, for both diseased/emaciated and non-diseased sea otters: Zn > Cu > Cd > Hg > Mn > Rb (Table 1, Fig. 2). Distribution of those trace elements that were present at less than 3 μg/g showed some differences among diseased, emaciated and non-diseased sea otters. Diseased and emaciated sea otters had a concentration pattern of Ag > Sr > Sn > Cr > Mo > Pb > V > Co > Ba > Cs > Sb > Bi > In > Tl, while non-diseased otters had relatively higher hepatic concentrations of Sr compared to Ag, Bi compared to Cs, and Sb compared to In (Sr > Ag > Sn > Cr > Mo > Pb > V > Co > Ba > Bi > Cs > Sb > In > Tl). Many of these elements (e.g., Mn, Co, Cu, and Zn) are essential for life and play important roles in enzyme chemistry. Concentrations of essential elements are regulated by homeostasis; therefore, the range of concentrations of essential elements in healthy individuals is expected to be small. Prior to this study, reports of normal concentration ranges of trace elements in healthy sea otters were not available. The only earlier study that measured trace elements in sea otter was for a captive aquarium specimen ($n = 1$) from Japan (Ninomiya et al., 2004). Hepatic concentrations of Cd, Pb, Zn, and Cu in this adult female sea otter were 0.36, 0.07, 31 and 17 μg/g, wet wt, respectively (Ninomiya et al., 2004). Based on an average moisture content of 70% in liver (as measured in our study), hepatic concentrations of Cd, Pb, Zn, and Cu expressed on a dry weight basis were 1.2, 0.24, 102 and 57 μg/g, respectively (Ninomiya et al., 2004). The mean concentration of Cd in our sea otter samples was approximately 100-fold higher, and those of Zn and Cu were 2- to 3-fold higher than those reported for the captive sea otter.

Concentration ranges for essential elements in livers of sea otters varied within an order of magnitude in our study (Fig. 3). The mean concentration of Zn was the highest among all of the trace elements analyzed, with a range of 95.0–542 μg/g, dry wt (mean ± SD: 230 ± 92.3 μg/g). Zn is an essential element, required for the functioning of enzymes that are involved in DNA and RNA synthesis. The concentration of Cu ranged from 26.3 to 401 μg/g (mean: 133 μg/g), and that of Mn ranged from 2.37 to 47.4 μg/g, dry wt (mean: 16.8 μg/g).

Table 1
Mean, median, and range of trace element concentrations (μg/g, dry wt) in livers of southern sea otters

	Overall ($n = 80$)		Non-diseased ($n = 26$)		Emaciated ($n = 27$)		Infectious-diseased ($n = 27$)		Detectable observations
	Mean (range)	Median	Mean (range)	Median	Mean (ranges)	Median	Mean (range)	Median	
V	0.181 (0.03–2.8)	0.125	0.175 (0.03–0.53)	0.140	0.131 (0.038–0.73)	0.110	0.236 (0.032–2.8)	0.15	54/54; 26/26
Cr	0.532 (0.16–2.3)	0.470	0.604 (0.18–2.3)	0.475	0.563 (0.18–1.2)	0.520	0.433 (0.16–0.86)	0.41	54/54; 26/26
Mn	16.9 (2.4–47)	14.6	12.9 (2.37–29.5)	11.1	19.4 (8.31–45.9)	17.4	18.0 (6.06–47.4)	14.4	54/54; 26/26
Co	0.079 (0.02–0.25)	0.071	0.066 (0.016–0.17)	0.062	0.091 (0.033–0.25)	0.080	0.082 (0.036–0.19)	0.072	54/54; 26/26
Cu	133 (26.3–401)	112	124 (45.3–274)	115	161 (37.4–401)	126	115 (26.3–337)	107	54/54; 26/26
Zn	230 (95–542)	209	202 (95–376)	180	248 (135–440)	224	239 (117–542)	208	54/54; 26/26
Rb	2.88 (0.91–6.3)	2.94	3.09 (0.91–6.33)	3.14	2.78 (1.76–4.24)	2.69	2.76 (1.57–4.29)	2.92	54/54; 26/26
Sr	1.46 (0.08–23)	0.583	1.76 (0.12–19)	0.705	1.74 (0.161–22.9)	0.550	0.909 (0.079–8.3)	0.54	54/54; 26/26
Mo	0.52 (0.08–1.3)	0.479	0.55 (0.08–1.25)	0.484	0.475 (0.224–1.02)	0.457	0.518 (0.266–1.09)	0.518	54/54; 26/26
Ag	1.59 (0.16–5.8)	1.10	1.52 (0.17–5.1)	0.875	1.95 (0.2–5.8)	1.50	1.30 (0.16–5.3)	1.1	54/54; 26/26
Cd	91.9 (0.002–728)	58.4	63 (0.002–199)	47.8	123 (24.4–728)	82.1	89 (6.66–402)	54.8	54/54; 26/26
In	0.01 (<0.001–0.028)	0.002	0.01 (<0.001–0.028)	0.003	0.003 (<0.001–0.02)	0.002	0.007 (<0.001–0.019)	0.003	31/54; 14/26
Sn	1.11 (0.077–9.87)	0.381	1.61 (0.077–9.87)	0.404	0.628 (0.086–6.96)	0.322	1.096 (0.077–6.04)	0.399	54/54; 26/26
Sb	0.01 (<0.01–0.02)	0.010	0.02 (<0.01–0.02)	0.015	<0.01–0.01	0.01	0.015 (<0.01–0.02)	0.015	7/54; 4/26
Cs	0.02 (<0.01–0.03)	0.020	0.02 (<0.01–0.03)	0.020	0.016 (<0.01–0.02)	0.020	0.014 (<0.01–0.03)	0.01	45/54; 18/26
Ba	0.02 (0.006–0.16)	0.017	0.03 (0.007–0.1)	0.018	0.028 (0.007–0.16)	0.017	0.021 (0.006–0.12)	0.015	54/54; 26/26
Hg	17.8 (0.480–128)	12.0	19.3 (0.480–128)	11.0	18.4 (1.4–62)	13.0	15.6 (2.3–72)	12	54/54; 26/26
Tl	0.003 (<0.001–0.014)	0.002	0.002 (<0.001–0.013)	0.002	0.003 (<0.001–0.008)	0.002	0.003 (<0.001–0.014)	0.002	43/54; 17/26
Pb	0.22 (0.02–1.1)	0.118	0.31 (0.022–1.06)	0.120	0.169 (0.02–0.552)	0.122	0.200 (0.019–0.956)	0.116	54/54; 26/26
Bi	0.01 (<0.001–0.075)	0.007	0.01 (<0.001–0.075)	0.008	0.009 (<0.001–0.035)	0.008	0.013 (<0.001–0.072)	0.004	50/54; 25/26

Detectable observations represent samples with concentrations above the limit of detection. Values below the detection limit were assigned zero for calculating mean and median. n of 54 for diseased and emaciated groups and n of

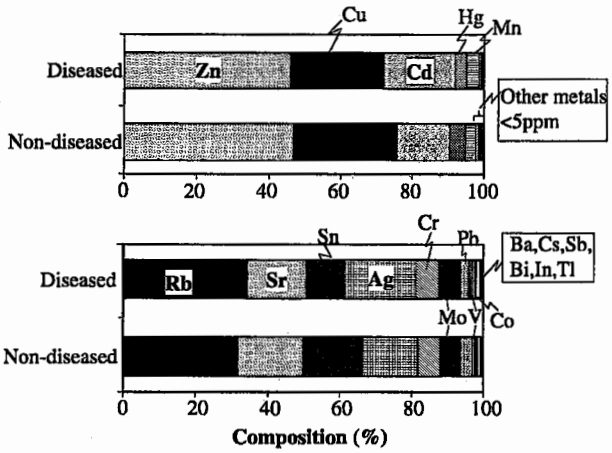


Fig. 2. Relative distribution of trace elements, for diseased (includes infectious-diseased and emaciated) and non-diseased sea otters. The upper panel represents trace metals with mean hepatic concentrations >3 μg/g, dry wt whereas the lower panel represents trace metals with mean hepatic concentrations <3 μg/g, dry wt.

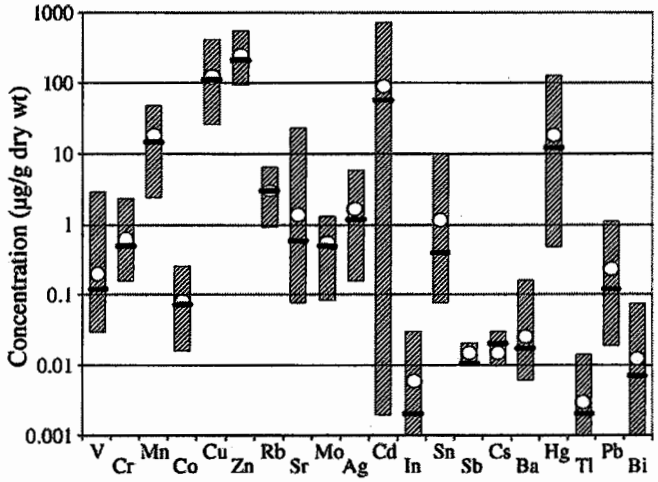


Fig. 3. Trace element concentrations in southern sea otter liver tissue ($n = 80$; all otters including diseased, emaciated and non-diseased). For each element, the vertical bar represents the range, the circle is the mean, and the horizontal line is the median (detection limit of Cs and Sb was 10 ng/g, dry wt, and that of In, Tl and Bi was 1 ng/g, dry wt).

Concentrations of non-essential elements (e.g., Cd, Hg, Pb, Sn, and Sr) varied considerably, across two to five orders of magnitude, in the livers of sea otters. Mean concentrations of Cd and Hg exceeded 15 μg/g. A concentration of 728 μg/g for Cd was the highest concentration measured for any metal in this study. Hg concentrations varied by three orders of magnitude, from 0.480 to 128 μg/g. Among the other known toxic metals, Pb was found in all of the samples analyzed, at concentrations ranging from 0.019 to 1.06 μg/g.

No earlier studies reported the concentrations of trace elements in free-ranging sea otters. In comparison with the concentrations reported for other marine mammals (e.g., Anan et al., 2002; Kunito et al., 2004), concentrations of Cu and Cd in the livers of the sea otters in our study

were elevated. For example, a general range of concentrations of Cu and Cd in livers of marine mammals was 5–50 μg/g and 0.5–25 μg/g, dry wt, respectively (we removed the outliers from the cited studies; Law et al., 2001; Anan et al., 2002; Kunito et al., 2004). Mean concentrations of Cu and Cd in the livers of our sea otters were greater than the highest concentrations reported for several marine mammal species (Anan et al., 2002; Kunito et al., 2004). When the concentrations were compared with those reported for marine mammals from the North American coasts, mean concentrations of Cu and Cd in the livers of our sea otters were 5- to 10-fold greater than those reported for spinner dolphins (*Stenella longirostris*), and 10- to 100-fold greater than those reported for gray whales (*Eschrichtius robustus*) from the southeast Gulf of California (Ruelas-Inzunza and Páez-Osuna, 2002). Hepatic Cu concentrations were 5-fold higher, and Cd concentrations were 100-fold higher in southern sea otters than those reported for bottlenose dolphins (*Tursiops truncatus*) from the Gulf of Mexico (Meador et al., 1999). Elevated concentrations of Cu in sea otters may be related to such sources as Cu-based antifouling paints used on ships and boats. Data collected from 1977 to 1990 by the California State Mussel Watch program showed an increase in Cu concentrations in mussels over that time period (Lauenstein and Daskalakis, 1998). Sea otters feed on mollusks, crustaceans, and various sessile and slow-moving benthic invertebrates, which are known to accumulate elevated levels of Cu. Similarly, high concentrations of Cd in sea otters may be related to their diet comprising of mussels and clams, which accumulate elevated levels of Cd in their tissues (Croteau et al., 2005). Furthermore, to maintain their high metabolism, sea otters consume 20% of their body weight daily and this high food intake rate can contribute to elevated exposure to trace metals (Kannan et al., 2004).

3.2. Comparison among diseased, emaciated and non-diseased groups

Differences in hepatic trace element concentrations among 'infectious-diseased' ($n = 27$), 'emaciated' ($n = 27$), and non-diseased ($n = 26$) sea otters were examined (Table 2). Hepatic concentrations of trace elements did not vary significantly between emaciated and infectious-diseased groups except for Cu in which emaciated otters had significantly higher concentrations than in diseased otters. Overall, concentrations of Mn and Co were significantly higher ($p \leqslant 0.05$) in both emaciated and infectious-diseased animals than in non-diseased animals (Table 2). Concentrations of Cd were significantly higher in emaciated sea otters than in non-diseased sea otters ($p < 0.05$). Similarly, Cd concentrations were marginally significant between diseased and non-diseased sea otters ($p = 0.07$). Concentrations of Zn in diseased and emaciated sea otters were marginally higher than those in non-diseased sea otters ($p = 0.06$).

Although both Mn and Co are essential for the activation of enzymes involved in protein and fat metabolism,

Table 2
Statistical significance in the concentrations of trace elements among infectious-diseased, emaciated, and non-diseased sea otters from the California coast

	M–W *U* test Emaciated versus non-diseased	M–W *U* test Emaciated versus diseased	ANOVA All three categories
V	$p > 0.05$	$p > 0.05$	$p > 0.05$
Cr	$p > 0.05$	$p > 0.05$	$p > 0.05$
Mn	$p < \mathbf{0.05}$	$p > 0.05$	$p < \mathbf{0.05}$
Co	$p < \mathbf{0.05}$	$p > 0.05$	$p = \mathbf{0.05}$
Cu	$p > 0.05$	$p < \mathbf{0.05}$	$p > 0.05$
Zn	$p = 0.06$	$p > 0.05$	$p = 0.07$
Rb	$p > 0.05$	$p > 0.05$	$p > 0.05$
Sr	$p > 0.05$	$p > 0.05$	$p > 0.05$
Mo	$p > 0.05$	$p > 0.05$	$p > 0.05$
Ag	$p > 0.05$	$p > 0.05$	$p > 0.05$
Cd	$p < \mathbf{0.05}$	$p > 0.05$	$p = 0.06$
In	$p > 0.05$	$p > 0.05$	$p > 0.05$
Sn	$p > 0.05$	$p > 0.05$	$p > 0.05$
Sb	NA	NA	NA
Cs	$p > 0.05$	$p > 0.05$	$p > 0.05$
Ba	$p > 0.05$	$p > 0.05$	$p > 0.05$
Hg	$p > 0.05$	$p > 0.05$	$p > 0.05$
Tl	$p > 0.05$	$p > 0.05$	$p > 0.05$
Pb	$p < \mathbf{0.05}$	$p > 0.05$	$p > 0.05$
Bi	$p > 0.05$	$p > 0.05$	$p > 0.05$

M–W *U* test = Mann–Whitney *U* test; ANOVA: analysis of variance.

chronic overdose or prolonged exposure to Mn can cause severe disruption of the mammalian central nervous system (Pearson and Greenway, 2005). Mn is a constituent of manganese superoxide dismutase (MnSOD), the principal antioxidant enzyme present in mitochondria. Levels of MnSOD increase in response to oxidative stress and free-radical production (Pal et al., 1999). Oxidative stress is perceived as a secondary phenomenon, a consequence of tissue injury. For example, excess production of $O_2^{\cdot-}$, H_2O_2, and other reactive species by phagocytes, at sites of chronic inflammation, can cause severe damage. Tissue injury can release metal ions from their storage sites within cells, leading to $OH^{\cdot}$ generation. Malnutrition, as in emaciated otters, or infectious diseases, as observed in diseased sea otters, can elevate MnSOD levels (Berger et al., 2004). High hepatic Mn levels in diseased sea otters may be attributed to oxidative stress-mediated production of MnSOD. Another explanation for the high concentrations of Mn in diseased otters is decreased excretion due to impaired liver function. Mn accumulation in individuals with liver dysfunction has been shown to contribute to neurological problems and Parkinson's disease-like symptoms (Pal et al., 1999; Berger et al., 2004). Nevertheless, we do not know whether the high concentration of Mn in the diseased and emaciated sea otters was a cause or a consequence of disease.

The higher concentrations of Co in diseased and emaciated sea otters compared to that in non-diseased sea otters further support the hypothesis of oxidative stress-mediated perturbation of essential element homeostasis. Co is a constituent of vitamin B_{12} (cobalamin), which is essential for

the metabolism of homocysteine. Homocysteine levels in the blood increase in diseased mammals, and ultimately induce lipid peroxidation and oxidative stress (Zock and Katan, 1998). To protect tissues from oxidative stress, synthesis of vitamin B_{12} (and therefore, hepatic concentrations of Co) increases (Stampfer and Malinow, 1995). Vitamin B_{12} synthesis is regulated by homeostasis.

Higher concentrations of Zn in diseased/emaciated sea otters than in non-diseased sea otters may be related to an increase in Zn-containing SOD (CuZn-SOD), which is produced as a consequence of oxidative stress. Oxidative stress can be caused by exposure to organic contaminants and/or toxic metals. Concentrations of organic contaminants such as polychlorinated biphenyls, tributyltin, and DDT have been found previously to be elevated in southern sea otters, particularly in diseased individuals (Kannan et al., 1998, 2004; Nakata et al., 1998). The occurrence of high concentrations of Zn in diseased marine mammals (seals and porpoises) has been reported (Anan et al., 2002; Bennett et al., 2001). The association between Zn concentration and disease status was thought to result from Zn redistribution and disturbances in homeostatic regulation of Zn, in response to diseases (Bennett et al., 2001; Anan et al., 2002). Overall, elevated levels of essential elements in diseased sea otters indicate that diseased otters have altered homeostasis of essential elements.

Elevated exposure to toxic metals such as Cd and immunotoxic organic pollutants could be contributing to the initiation of cascades of complex reactions that alter the homeostasis of essential elements. As mentioned above, hepatic concentrations of Cd were significantly higher in emaciated otters and marginally higher in diseased sea otters than in non-diseased sea otters. Furthermore, mean concentrations of Cd in our sea otters were higher than those reported previously for other marine mammals. Due to the preferential enrichment of Cd in kidney over liver, concentrations of Cd are expected to be much higher in kidneys of sea otters than the concentrations that we found in livers. For example, the concentration of Cd in the kidney of a captive sea otter was 13-fold higher than that in its liver (Ninomiya et al., 2004). Although kidney was not analyzed in our study, these results suggest that Cd is a critical toxic metal in sea otters. Accordingly, elevated concentrations of Cd in diseased and emaciated individuals suggest that this metal played some role in disease. Cd stimulates metallothionein synthesis and interferes with Cu and Zn metabolism. Metallothionein synthesis is induced in humans following exposure to metals such as Cd, or as a result of malnutrition or oxidative stress (Min, 2000). Despite the protective role of metallothionein, this compound becomes less effective in protecting animals from Cd toxicity in malnourished animals such as the emaciated and diseased sea otters in our study (Shimizu and Morita, 1990). Differences in the concentrations of trace elements other than Mn, Co, Cd, and Zn were not statistically significant between the diseased and the non-diseased groups.

High concentration of Cd in livers of sea otters is a cause for concern. The critical limit suggested for damage to kidney cortex of humans and laboratory animals vary from 50 to 200 μg/g, wet wt (Elinder and Järup, 1996; Sonne-Hansen et al., 2002). Approximately, 15% of the sea otters analyzed had liver concentrations >50 μg/g, on a wet weight basis (calculated based on a moisture content of 70% in liver, in this study). However, kidneys of sea otters may contain higher concentrations of Cd because of its preferential accumulation, and further studies should analyze kidneys.

The results of this study suggest that elevated concentrations of essential elements such as Mn, Co, and Zn in diseased and emaciated otters may be a consequence of oxidative stress. Elevated exposure to toxic metals such as Cd may have contributed to this condition. It is believed that exposure to stressors, including organic contaminants and toxic metals, causes oxidative stress, which leads to the synthesis of metallothionein and SOD involved in cellular defense mechanisms. Although SOD is important for scavenging free radicals, an excess of SOD can be deleterious, as found in studies with mice (Amstad et al., 1991; White et al., 1991), and presumably in other mammals as well. To investigate the association of elevated trace elements with SOD, it would be valuable to measure superoxide dismutase in sea otter liver tissue.

3.3. Relationships among trace elements

We examined relationships among trace metals in the livers of sea otters by non-parametric Kendall's Tau correlation analysis (Table 3). Trace element concentrations below the limit of detection were assigned a value of zero for this analysis. Among the essential elements, Zn, Cu, Co, and Mn were significantly correlated with each other and with several other trace metals. It is interesting to note that all four of these metals are components of SOD or are involved in oxidative stress-related defense. All four of these essential elements were significantly correlated with concentrations of Cd in both diseased/emaciated and non-diseased otters. Concentrations of Ag and Cs were correlated with Cu, Mn, and Zn concentrations.

The relationships of toxic metals (e.g., Hg, Pb) with essential elements such as Mn, Co, Cu, and Zn varied between the diseased/emaciated and the non-diseased groups. No significant correlation was found between Hg and Mn, Co, Cu, or Zn in non-diseased otters. However, in diseased and emaciated sea otters, Hg was significantly correlated with Mn, Co, Cu, and Zn. Similarly, Pb was not correlated with Mn, Cu, and Zn in non-diseased sea otters, but it was significantly correlated with Mn, Cu, and Zn in diseased and emaciated sea otters. These results suggest that in diseased and emaciated animals, several toxic metals (e.g., Cd, Hg, Pb) act in concert to alter the homeostasis of essential elements. The association between toxic and essential elements in diseased individuals may reflect sequestration of the metals by binding proteins such

Table 3
Matrix of Kendall's Tau correlation coefficients among trace element concentrations in livers of southern sea otters

	V	Cr	Mn	Co	Cu	Zn	Rb	Sr	Mo	Ag	Cd	In	Sn	Sb	Cs	Ba	Hg	Tl	Pb	Bi
V	1.00	−0.06	0.03	0.06	0.07	0.03	−0.14	0.06	0.07	−0.06	−0.14	**0.26****	**0.28****	−0.05	−0.06	0.07	0.09	0.13	**0.36****	0.05
Cr		1.00	0.14	−0.04	0.14	0.09	**0.22****	0.14	0.11	**0.16***	**0.16***	0.06	0.14	0.12	**0.32****	**0.22****	−0.03	−0.03	0.07	0.03
Mn			1.00	**0.29****	**0.37****	**0.55****	**0.17***	−0.09	**0.21****	**0.33****	**0.38****	**0.20***	**0.21****	0.15	**0.47****	**0.16***	**0.19***	−0.03	**0.20***	0.07
Co				1.00	**0.16***	**0.30****	0.11	−0.09	0.08	**0.19***	**0.28****	−0.13	−0.13	0.08	0.12	−0.01	**0.16***	0.15	−0.04	0.13
Cu					1.00	**0.38****	**0.24****	−0.05	**0.18***	**0.37****	**0.17***	0.14	**0.19***	**0.23***	**0.32****	0.15	**0.17***	0.07	**0.21****	**0.26****
Zn						1.00	0.14	−0.12	0.12	**0.41****	**0.36****	0.04	0.09	0.09	**0.36****	0.11	**0.15***	0.06	0.13	**0.17***
Rb							1.00	−0.02	**0.35****	**0.17***	0.09	0.06	**0.16***	0.13	**0.52****	0.02	0.02	−0.08	**0.18***	0.06
Sr								1.00	0.02	−0.02	0.02	−0.06	0.04	0.04	−0.02	**0.19***	−0.02	−0.11	−0.03	0.04
Mo									1.00	0.09	0.02	**0.19***	**0.22****	0.13	**0.35****	0.11	0.07	0.00	**0.28****	0.03
Ag										1.00	**0.41****	−0.14	−0.08	**0.28****	**0.31****	**0.21****	0.03	0.07	−0.04	0.10
Cd											1.00	−0.02	0.08	**0.26****	**0.30****	0.15	0.04	0.12	−0.02	−0.01
In												1.00	**0.74****	0.07	**0.23***	0.03	0.02	0.07	**0.62****	−0.09
Sn													1.00	0.01	**0.27****	0.05	0.10	−0.09	**0.60****	−0.03
Sb														1.00	**0.31****	0.13	0.00	**0.21***	0.04	0.08
Cs															1.00	**0.18***	0.13	−0.09	**0.21***	0.07
Ba																1.00	−0.04	−0.03	0.02	0.01
Hg																	1.00	**−0.17***	−0.00	**0.32****
Tl																		1.00	0.07	0.05
Pb																			1.00	−0.05
Bi																				1.00

* Correlation is significant at 0.05 level (two-tailed).
** Correlation is significant at 0.01 level (two-tailed).

as metallothioneins, which play a major role in regulating the availability of metals for metal-dependent proteins.

The results of this study indicate that concentrations of several trace elements are increased in diseased and emaciated sea otters. We do not know whether these increases are a cause or a consequence of the pathological condition. Increases in the concentrations of essential elements such as Mn, Co, and Zn appear to be a consequence of oxidative stress. It is probable that infection by microorganisms, as well as exposure to toxic contaminants, induces oxidative stress. The production of reactive oxygen species (i.e., oxidative stress) may have an adverse effect on the immune system. Further studies are needed to assess the role of toxic metals, both alone and in concert with organic contaminants, in suppressing the immune system in marine mammals. Elevated concentrations of Cd in sea otters appear to be a particular concern. Furthermore, our study suggests that trace elements provide potential markers by which we can understand oxidative stress-mediated perturbations to the health of marine mammals.

Acknowledgements

This study was funded by a grant from the Monterey Bay Sanctuary Foundation. A portion of the study is supported by grants from "21st Century Center for Excellence (COE) Program" from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

References

Agusa, T., Matsumoto, T., Ikemoto, T., Anan, Y., Kubota, R., Yasunaga, G., Kunito, T., Tanabe, S., Ogi, H., Shibata, Y., 2005. Body distribution of trace elements in black-tailed gulls from Rishiri Island, Japan: age-dependent accumulation and transfer to feathers and eggs. Environ. Toxicol. Chem. 24, 2107–2120.

Amstad, P., Peskin, A., Shah, G., Mirault, M.E., Movet, R., Zbinden, I., Cerutti, P., 1991. The balance between Cu, Zn-superoxide dismutase and catalase affects the sensitivity of mouse epidermal cells to oxidative stress. Biochemistry 30, 9305–9313.

Anan, Y., Kunito, T., Ikemoto, T., Kubota, R., Watanabe, I., Tanabe, S., Miyazaki, N., Petrov, E.A., 2002. Elevated concentrations of trace elements in Caspian seals (*Phoca caspica*) found stranded during the mass mortality events in 2000. Arch. Environ. Contam. Toxicol. 42, 354–362.

Bacon, C.E., Jarman, W.M., Estes, J.A., Simon, M., Norstrom, R.J., 1999. Comparison of organochlorine contaminants among sea otter (*Enhydra lutris*) populations in California and Alaska. Environ. Toxicol. Chem. 18, 452–458.

Bennett, P.M., Jepson, P.D., Law, R.J., Jones, B.R., Kuiken, T., Baker, J.R., Rogan, E., Kirkwood, J.K., 2001. Exposure to heavy metals and infectious disease mortality in harbor porpoises from England and Wales. Environ. Pollut. 112, 33–40.

Berger, M.M., Jia, X.Y., Legay, V., Aymard, M., Tilles, J.G., Lina, B., 2004. Nutrition- and virus-induced stress represses the expression of manganese superoxide dismutase in vitro. Exp. Biol. Med. 229, 843–849.

Croteau, M.N., Luoma, S.N., Stewart, A.R., 2005. Trophic transfer of metals along freshwater food webs: evidence of cadmium biomagnification in nature. Limnol. Oceanogr. 50, 1511–1519.

Davis, G.K., Mertz, W., 1987. Copper. In: Mertz, W. (Ed.), Trace Elements in Human and Animal Nutrition, fifth ed., Vol. 1. Academic Press, San Diego, CA, USA, pp. 301–364.

Elinder, C.G., Järup, L., 1996. Cadmium and health risks: recent findings. Ambio 5, 370–373.

Estes, J.A., 1990. Growth and equilibrium in sea otter populations. J. Anim. Ecol. 59, 385–401.

Hanni, K.D., Mazet, J.A.K., Gulland, F.M.D., Estes, J., Staedler, M., Murray, M.J., Miller, M., Jessup, D.A., 2003. Clinical pathology and assessment of pathogen exposure in southern and Alaskan sea otters. J. Wildlife Dis. 39, 837–850.

Harvell, C.D., Kim, K., Burkholder, J.M., Colwell, R.R., Epstein, P.R., Grimes, D.J., Hofmann, E.E., Lipp, E.K., Osterhaus, A.D.M.E., Overstreet, R.M., Porter, J.W., Smith, G.W., Vasta, G.R., 1999. Emerging marine diseases – climate links and anthropogenic factors. Science 285, 1505–1510.

Kakuschke, A., Valentine-Thon, E., Griesel, S., Fonfara, S., Siebert, U., Prange, A., 2005. Immunological impact of metals in harbor seals (*Phoca vitulina*) of the North Sea. Environ. Sci. Technol. 39, 7568–7575.

Kannan, K., Guruge, K.S., Thomas, N.J., Tanabe, S., Giesy, J.P., 1998. Butyltin residues in southern sea otters (*Enhydra lutris nereis*) found dead along California coastal waters. Environ. Sci. Technol. 32, 1169–1175.

Kannan, K., Kajiwara, N., Watanabe, M., Nakata, H., Thomas, N., Stephenson, M., Jessup, D.A., Tanabe, S., 2004. Profiles of polychlorinated biphenyl congeners, organochlorine pesticides, and butyltins in southern sea otters and their prey. Environ. Toxicol. Chem. 23, 49–56.

Kunito, T., Nakamura, S., Ikemoto, T., Anan, Y., Kubota, R., Tanabe, S., Rosas, F.C.W., Fillmann, G., Readman, J.W., 2004. Concentration and subcellular distribution of trace elements in liver of small cetaceans incidentally caught along the Brazilian coast. Mar. Pollut. Bull. 49, 574–587.

Lauenstein, G.G., Daskalakis, K.D., 1998. US long-term coastal contaminant temporal trends determined from mollusk monitoring programs, 1965–1993. Mar. Pollut. Bull. 37, 6–13.

Law, R.J., Bennett, M.E., Blake, S.J., Allchin, C.R., Jones, B.B., Spurrier, C.J.H., 2001. Metals and organochlorines in pelagic cetaceans stranded on the coasts of England and Wales. Mar. Pollut. Bull. 42, 522–526.

Lynes, M.A., Fontenot, A.P., Lawrence, D.A., Rosenspire, A.J., Pollard, K.M., 2006. Gene expression influences on metal immunomodulation. Toxicol. Appl. Pharmacol. 210, 9–16.

Meador, J.P., Ernest, D., Hohn, A.A., Tilbury, K., Gorzelany, J., Worthy, G., Stein, J.E., 1999. Comparison of elements in bottlenose dolphins stranded on the beaches of Texas and Florida in the Gulf of Mexico over a one-year period. Arch. Environ. Contam. Toxicol. 36, 87–98.

Min, K.S., 2000. The physiological significance of metallothionein in oxidative stress. Biomed. Res. Trace Elem. 11, 150–160.

Nakata, H., Kannan, K., Jing, L., Thomas, N., Tanabe, S., Giesy, J.P., 1998. Accumulation patterns of organochlorine pesticides and polychlorinated biphenyls in southern sea otters (*Enhydra lutris nereis*) found stranded along coastal California, USA. Environ. Pollut. 103, 45–53.

Ninomiya, R., Koizumi, N., Murata, K., 2004. Metal concentrations in the liver and kidney of aquatic mammals and penguins. Biol. Trace Elem. Res. 97, 135–147.

Pal, P.K., Samii, A., Calne, D.B., 1999. Manganese neurotoxicity: a review of clinical features, imaging and pathology. Neurotoxicology 20, 227–238.

Pearson, G.F., Greenway, G.M., 2005. Recent developments in manganese speciation. Trends Anal. Chem. 24, 803–809.

Ralls, K., Eagle, T.C., Siniff, D.B., 1996. Movement and special patterns of California sea otters. Canad. J. Zool. 74, 1841–1849.

Ruelas-Inzunza, J., Páez-Osuna, F., 2002. Distribution of Cd, Cu, Fe, Mn, Pb and Zn in selected tissues of juvenile whales stranded in the SE Gulf of California (Mexico). Environ. Int. 28, 325–329.

Schwartz, J., Aldridge, B., Blanchard, M., Mohr, F.C., Stott, J., 2005. The development of methods for immunophenotypic and lymphocyte function analyzes for assessment of Southern sea otter (*Enhydra lutris nereis*) health. Vet. Immunol. Immunopathol. 104, 1–14.

Shimizu, M., Morita, S., 1990. Effects of fasting on cadmium toxicity, glutathione metabolism, and metallothionein synthesis in rats. Toxicol. Appl. Pharmacol. 103, 28–39.

Sonne-Hansen, C., Dietz, R., Leifsson, P.S., Hyldstrup, L., Riget, F.F., 2002. Cadmium toxicity to ringed seals (*Phoca hispida*): an epidemiological study of possible cadmium-induced nephropathy and osteodystrophy in ringed seals from Qaanaaq in northwest Greenland. Sci. Total Environ. 295, 167–181.

Stampfer, M.J., Malinow, M.R., 1995. Can lowering homocysteine levels reduce cardiovascular risk? New Engl. J. Med. 332, 328–329.

Thomas, N.J., Cole, R.A., 1996. The risk of disease and threats to the wild population. Endangered Species Update 13, 24–28.

USGS, 2005. California sea otter numbers down, but overall population trends healthy. Mar. Pollut. Bull. 50, 795–796.

White, C.W., Avraham, K.B., Shanley, P.F., Groner, Y., 1991. Transgenic mice with expression of elevated levels of copper-zinc superoxide dismutase in the lungs are resistant to pulmonary oxygen toxicity. J. Clin. Invest. 87, 2162–2168.

Zock, P.L., Katan, M.B., 1998. Diet, LDL oxidation, and coronary artery disease. Am. J. Clin. Nutr. 68, 759–760.