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Staff:	Robert S. Merrill
Staff Report:	April 29, 2010
Hearing Date:	May 12, 2010

STAFF REPORT: PERMIT AMENDMENT

APPLICATION NO.:	**1-83-270-A**
APPLICANTS:	Bower Limited Partnership
AGENT:	Alan Block, Law Office of Block & Block; George Rau, RAU & Associates
PROJECT LOCATION:	On the west side of Highway One, upslope from the Gualala River estuary, approximately 500 feet south of its outlet to the Pacific Ocean, at 39250 South Highway One in Gualala, Mendocino County (APN 145-261-05).
DESCRIPTION OF PROJECT PREVIOUSLY APPROVED:	Construction of a 120-foot-long wooden retaining wall, west of an existing market adjacent to the bluff edge and Gualala River
DESCRIPTION OF CURRENT AMENDMENT REQUEST:	Amend the permit to allow for (1) replacement of the constructed 70-foot-long wooden retaining wall with an approximately 105-foot-long "Geoweb" retaining wall extending across the subject property with an approximately 30-foot-long concrete block end wall at the southern end of the retaining wall, (2) installation of 118 linear feet of 12-inch storm drain with a storm drain manhole, and (3) replacement of an existing underground septic tank.

SUBSTANTIVE FILE: (1) Mendocino County CDP No. 55-2006;
DOCUMENTS (2) Mendocino County Local Coastal Program

SUMMARY OF STAFF RECOMMENDATION:

The staff recommends that the Commission approve with conditions, the proposed amended development involving (1) replacement of the constructed 70-foot-long wooden retaining wall with an approximately 105-foot-long "Geoweb" bluff retaining wall extending across the top of the bluff face with an approximately 30-foot-long concrete block end wall at the southern end of the retaining wall, (2) installation of 118 linear feet of 12-inch storm drain with a storm drain manhole, and (3) replacement of an existing underground septic tank. The approximately ½-acre parcel is located in the commercial area of Gualala along the east side of the Gualala River Estuary, in southern Mendocino County.

In 1981, the North Coast Regional Commission approved CDP NCR-80-P-75, for the building of the Surf Supermarket located on the subject parcel (APN 145-261-05). As a condition of approval, CDP NCR-80-P-75 required recordation of an offer to dedicate a 25-foot-wide easement for public access and passive recreation along the bluff. CDP No. NCR-80-P-75 specified that the supermarket building would be set back 35 feet at its northwest corner and 55 feet at its southwest corner from the bluff edge. However, when the building was constructed in the early 1980s, the structure was constructed such that the southwest corner is set back only 24 feet from the bluff edge. Thus, the constructed building was therefore placed directly within the area offered for public access along the bluff constituting a violation of CDP NCR-80-P-75. In an effort to protect the public access required by CDP NCR-80-P-75, the Commission subsequently approved CDP 1-83-270 authorizing a 120-foot-long wood retaining wall west of the market along the edge of the bluff. Special Condition No. 1 of CDP No. 1-83-270 requires that the retaining wall be maintained for the life of the development on the site. the original retaining wall that was constructed failed and was destroyed in landsliding that occurred in the winter of 2005-2006. The resulting slide scarp is over steepened and unstable and threatens the bluff edge where the public access easement exists. The amendment request was submitted to comply with the requirements of Special Condition No. 1 of the original permit by proposing a new retaining wall to replace the wall that has failed and thereby protect the public access easement.

As cited above, LUP Policy 3.4-10 and Coastal Zoning Code Section 20.500.020(E)(1) prohibit the development of retaining walls and other shoreline structures unless such structures are determined to be necessary either for the protection of (1) existing development, (2) public beaches, or (3) coastal dependent uses. the public access easement and the trail it will accommodate provides important coastal access and is a coastal dependent use. As maintenance of a retaining wall in this location has been

required by the Commission since 1983 to protect the public access easement and as the easement has been directly threatened by an adjacent bluff landslide, staff believes that the proposed Geoweb wall is necessary for the protection of a coastal dependent use consistent with the requirements of LUP Policy 3.4-10 and Coastal Zoning Code Section 20.500.020(E)(1).

To ensure consistency with the visual resources protection, stormwater runoff, and other policies of the certified Mendocino County LCP, staff is recommending that the following special conditions be added to the permit in addition to recommending that an existing condition (Special Condition No. 1) of the original permit requiring maintenance of the retaining wall for the life of the development on the subject parcel be modified and reimposed.

- Add Special Condition No. 3 to require the permittee to submit final soil stabilization and drainage improvement plans for the review and approval of the Executive Direct that substantially conform to the submitted plans but are revised to provide that (a) the Geoweb Retaining Wall shall be aligned such that the seaward edge of the top of the wall conforms with the existing slope break rather than extend outward to minimize landform alteration, (b) the storm drain proposed to extend across APN 145-261-05 include inline drains to capture runoff from the parcel that flows towards the bluff and an on-site infiltration interceptor to capture any pollutants contained in the run-off and . treat or filter stormwater runoff from each storm, up to and including the 85th percentile, 24-hour storm event to protect water quality, (c) the end wall proposed at the southern end of the subject parcel be designed to accommodate a crossing by the public access trail in its existing location and in a manner consistent with Mendocino County CDP No. 23-03 granted to the Redwood Coast Land Conservancy for construction of the public access trail and related improvements to ensure the connectivity of the trail will be maintained, (d) an end wall at the north end of the parcel be provided to protect against end-erosion effects unless the Commission ultimately approves the adjoining extension of the wall which is the subject of Appeal No. A-1-MEN-08-015, (e) the permittee replace in-kind and in a manner consistent with Mendocino County CDP No. 23-03 any existing public access improvements developed by the Redwood Coast Land Conservancy on APN 145-261-05 and in adjoining areas disturbed by the development authorized under CDP No. 1-83-270-A, and (f) that native species compatible with the Northern coastal scrub habitat on the existing bluff face be planted in the outer cells of the Geoweb wall and be maintained to help make the wall as compatible as possible with the character of the existing bluff setting.
- Add Special Condition No. 4 to require the submittal for the review and approval of the Executive Director a plan for restoring and enhancing the northern coastal scrub habitat located on the portions of the bluff face below the exposed portions of the Geoweb retaining wall that will be disturbed by the development and/or backfilled

to help make the wall as compatible as possible with the character of the existing bluff setting;

- Add Special Condition No. 5 to require the permittee to submit for the review and approval of the Executive Director color samples of the proposed Geoweb material and that the color be black or a dark earth tone color to blend into the natural environment of the bluff;.
- Add Special Condition No. 6 to require the use of various best management practices to control erosion and sedimentation impacts on the Gualala River Estuary;
- Add Special Condition No. 7 to require the applicants to execute and record a deed restriction detailing the specific development authorized under the permit; identifying all applicable special conditions attached to the permit; providing notice to future owners of the terms and limitations placed on the use of the property, including requirements for maintenance of the retaining wall and restoration of the bluff face vegetation; and
- Add Special Condition No. 8 to require that the coastal development permit amendment be deemed issued upon the commission's approval and will not expire**.**

Staff recommends that the Commission find that as conditioned, the proposed amended development is consistent with all applicable policies of the certified Mendocino County LCP and adopt the staff recommendation.

The Motion to adopt the staff recommendation is found on Page 7.

STAFF NOTES:

1. Procedural Note

Section 13166 of the California Code of Regulations states that the Executive Director shall reject an amendment request if: (a) it lessens or avoids the intent of the approved permit; unless (b) the applicant presents newly discovered material information, which he or she could not, with reasonable diligence, have discovered and produced before the permit was granted.

On December 13, 1983, the Commission granted Coastal Development Permit No. 1-83-270 to John Bower for construction of a 120-foot-long wooden retaining wall, west of an existing market adjacent to the bluff edge and Gualala River. The permit application had been submitted in part to resolve a permit violation involving the development of the Surf Supermarket in a location closer to the bluff edge than authorized under Coastal

Development Permit No. NCR-80-P-75, granted by the North Coast Regional Commission in 1981. CDP No. NCR-80-P-75 specified that the supermarket building would be set back 35 feet at its northwest corner and 55 feet at its southwest corner from the bluff edge. As a condition of approval, CDP NCR-80-P-75 required recordation of an offer to dedicate a 25-foot-wide easement for public access and passive recreation along the bluff seaward of the supermarket. In 1994, the Redwood Coast Land Conservancy (RCLC) accepted the offers-to-dedicate public access easements described above. The RCLC has received CDPs from Mendocino County to construct a bluff top trail, known as the Gualala Bluff Trail. However, when the building was constructed in the early 1980s, the structure was constructed such that the southwest corner is set back only 24 feet from the bluff edge. Thus, the constructed building was therefore placed directly within the area offered for public access along the bluff constituting a violation of CDP NCR-80-P-75. A Mutual Settlement Agreement and Release by and between Bower Limited Partnership (BLP), John H. Bower, Redwood Coast Land Conservancy (RCLC), Shirley Eberly, Lois Lutz, and California Coastal Commission was established in 2007 (Case No. SCUK CVG 0594172). The agreement provides, in part, to the applicant (Bower Limited Partnership) access and use of the easement area for uses that are "*not inconsistent with the public pedestrian access authorized by the May 2004 Mendocino County coastal development permit.*" In an effort to protect the public access required by CDP NCR-80-P-75, the Commission subsequently approved CDP 1-83-270 authorizing a 120-foot-long wood retaining wall west of the market along the edge of the bluff. Special Condition No. 1 of CDP No. 1-83-270 requires that the retaining wall be maintained for the life of the development on the site. The original retaining wall as constructed was only approximately 70-feet long rather than the 120-foot-length authorized and required to be maintained under CDP No. 1-83-270. In the winter of 2005-2006, a debris flow caused the wall to fail and the wall has completely collapsed. To comply with Special Condition No. 1 of CDP No. 1-83-270, the subject coastal development permit amendment application has been submitted to the Coastal Commission by Bower Limited Partnership to replace the failing retaining wall behind the supermarket. Staff believes that the proposed amended development as conditioned would be consistent with the Commission's intent in granting the original permit with conditions to ensure that a retaining wall be maintained in this location to protect the lateral public access easement. Thus, the Executive Director has determined that the proposed amendment as conditioned would not lessen or avoid the intent of the approved permit. Therefore, the Executive Director has accepted the amendment request for processing.

2. Commission Jurisdiction and Standard of Review

The Commission approved the original project in 1983, prior to certification of the Mendocino County LCP. As the LCP was not certified, the standard of review for the original permit was the Chapter 3 policies of the Coastal Act. After approving a coastal development permit, the Commission retains jurisdiction over all permit amendments. The Mendocino County LCP was effectively certified in October of 1992. Pursuant to

Section 30604(b) of the Coastal Act, after effective certification of an LCP, the standard of review for all coastal permits and permit amendments within a certified area is the certified LCP and, for areas located between the first through public road and the sea, the public access and recreation policies of the Coastal Act. Thus, the standard of review for the permit amendment is the Mendocino County LCP and the public access and recreation policies of the Coastal Act.

3. Scope

This staff report addresses only the coastal resource issues affected by the proposed permit amendment, provides recommended special conditions to reduce and mitigate significant impacts to coastal resources caused by the development as amended in order to achieve consistency with the LCP, and provides findings for conditional approval of the amended development. All other analyses, findings, and conditions related to the originally permitted development, except as specifically affected by the current permit amendment request and addressed herein, remain as stated within the original permit approval adopted by the Commission on December 13, 1983 attached as Exhibit No. 8.

4. Addendum

This staff report does not contain the complete findings for approval of the project. Staff was unable to complete the findings prior to the mailing of the staff report. However, staff will present the remaining portion of the recommended findings for approval of the project as part of the addendum at the Commission meeting. The findings contained in both this staff report and its addendum will reflect the basis for approval with conditions.

5. Related Appeal

The applicant proposes to extend the replacement retaining wall that is proposed under Permit Amendment 1-83-270 to the north across the top of the bluff face of APN 145-261-13 within the area of Mendocino County's coastal permit jurisdiction. The portion of the wall proposed on APN 145-261-13 is the subject of related Appeal No. A-1-MEN-05-015, an appeal of the decision of Mendocino County to grant local CDP Permit No. 55-2006 for construction of this portion of the retaining wall. On April 11, 2008, the Coastal Commission found that the appeal of the County's approval of Permit No. 55-2006 raised a substantial issue with respect to the grounds on which the appeal was filed, pursuant to Section 30625 of the Coastal Act and Section 13115 of Title 14 of the California Code of Regulations. As a result, the County's approval is no longer effective, and the Commission must consider the project *de novo*. The Commission's continued de novo hearing on Appeal No. A-1-MEN-05-015 had been scheduled for the Commission's May 12, 2010 meeting but has been postponed. The hearing for this new retaining wall located north of the site now before the Commission will be rescheduled for an upcoming Commission meeting.

I. MOTION, STAFF RECOMMENDATION, AND RESOLUTION:

The staff recommends that the Commission adopt the following resolution:

Motion:

I move that the Commission approve the proposed amendment to Coastal Development Permit No. 1-83-270 pursuant to the staff recommendation.

Staff Recommendation of Approval:

Staff recommends a **YES** vote. Passage of this motion will result in approval of the permit amendment as conditioned and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of the Commissioners present.

Resolution to Approve with Conditions:

The Commission hereby approves the proposed permit amendment and adopts the findings set forth below, subject to the conditions below, on the grounds that the development with the proposed amendment, as conditioned, will be in conformity with the certified Mendocino County Local Coastal Program. Approval of the permit amendment complies with the California Environmental Quality Act because all feasible mitigation measures and alternatives have been incorporated to substantially lessen any significant adverse impacts of the amended development on the environment.

II. STANDARD CONDITIONS: See Attachment A.

III. SPECIAL CONDITIONS:

Note: The original permit (CDP No. 1-83-270) contained two special conditions. Special Condition No. 1 of the original permit is modified and superseded by Special Condition No. 1 of CDP Amendment No. 1-83-270-A. Special Condition No. 2 of the original permit is reimposed without any changes as a condition of CDP Amendment No. 1-83-270-A and remains in full force and effect. Special Condition Nos. 3-8 are additional new special conditions attached to CDP Amendment No. 1-83-270-A. For comparison, the text of the original permit conditions is included in Exhibit No 8.

Deleted wording within the modified special conditions is shown in **~~bold strikethrough~~** text, and new condition language appears as **bold double-underlined** text.

1. ~~**Prior to transmittal of this permit, the applicant shall agree, in a form acceptable to the Executive director to maintain the proposed retaining wall as well as the existing dedicated accessway. The applicant shall agree to maintain the accessway for a period of 21 years or until the accessway is accepted by either a public or private agency.**~~ The **permittee shall maintain the** retaining wall **authorized by CDP Amendment No. 1-83-270-A** ~~**shall be maintained**~~ for the life of the development on site. ~~**The offer shall bind any and all successors and assigns of the applicant or landowner**~~.

3. Revised Final Soil Stabilization and Drainage Improvement Plans

A. PRIOR TO COMMENCEMENT OF CONSTRUCTION OF THE DEVELOPMENT AUTHORIZED BY COASTAL DEVELOPMENT PERMIT AMENDMENT NO. 1-83-270-A, the permittee shall submit to the Executive Director, for review and written approval, final soil stabilization and drainage improvement plans that substantially conforms to the proposed soil stabilization and drainage improvement plans shown on sheets C100, C110, C200, C300, C400, C500, C504, C505, C600, C601, C610, C611, C620, C621, and C630 titled "Soil Stabilization and Drainage Improvements" dated April, 2008, attached as Exhibit No. 5 of the staff report, but shall be revised to include the following provisions:

1.) The Geoweb Retaining Wall shall be aligned such that the seaward edge of the top of the wall conforms with the existing slope break . The approved drainage improvements and septic tank replacement shall be repositioned as necessary to accommodate the required realignment of the approved wall.

2.) The storm drain proposed to extend across APN 145-261-05 shall include inline drains to capture runoff from the parcel that flows towards the bluff and an on-site infiltration interceptor to capture any pollutants contained in the run-off. The system shall be designed to treat or filter stormwater runoff from each storm, up to and including the 85th percentile, 24-hour storm event

3.) The end wall proposed at the southern end of APN 145-261-05 shall be designed to accommodate a crossing by the public access trail in its existing location and in a manner consistent with Mendocino County CDP No. 23-03 granted to the Redwood Coast Land Conservancy for construction of the public access trail and related improvements.

4.) At the northern end of APN 145-261-05, an end wall extending inland generally perpendicular to the Geoweb retaining wall of a design similar to the end wall approved at the southern end of APN 145-261-

05 or its equivalent shall be included to protect against erosion around the north end of the wall. The end wall shall be designed to accommodate a crossing by the public access trail in its existing location and in a manner consistent with Mendocino County CDP No. 23-03 granted to the Redwood Coast Land Conservancy for construction of the public access trail and related improvements. The end wall shall also be designed to accommodate the possible future extension of a bluff retaining wall to the north on the adjacent parcel. This northern end wall on APN 145-261-05 need not be included if the Commission approves Appeal No. A-1-MEN-08-015 for a continuation of the Geoweb retaining wall on to adjoining APN 145-261-13.

5.) **The permittee shall replace in-kind and in a manner consistent with Mendocino County CDP No. 23-03 any existing public access improvements developed by the Redwood Coast Land Conservancy on APN 145-261-05 and in adjoining areas disturbed by the development authorized under CDP No. 1-83-270-A**

6.) **All plantings on the face of the Geoweb retaining wall shall be maintained in good condition throughout the life of the project to ensure continued compliance with the approved final landscaping provisions of the plans. If any of the trees and plants to be planted die, become decadent, rotten, or weakened by decay or disease, or are removed for any reason, they shall be replaced no later than May 1st of the next spring season in-kind or with another native species common to the coastal Mendocino County area that will grow to a similar or greater height;**

7.) **All proposed plantings shall be native species and compatible with the plantings to be planted as part of the Northern coastal scrub restoration plan required by Special Condition No. 4, below. All proposed plantings shall be obtained from local genetic stocks within Mendocino County. If documentation is provided to the Executive Director that demonstrates that native vegetation from local genetic stock is not available, native vegetation obtained from genetic stock outside the local area, but from within the adjacent region of the floristic province, may be used. No plant species listed as problematic and/or invasive by the California Native Plant Society, the California Invasive Plant Council, or by the State of California shall be planted or allowed to naturalize or persist within the development site. No plant species listed as a 'noxious weed' by the State of California or the U.S. Federal Government shall be utilized within the property;**

8.) **Rodenticides containing any anticoagulant compounds, including but not limited to, Bromadiolone, Brodifacoum, or Diphacinone, shall not be used; and**

9.) **The success of the plantings shall be monitored on a regular basis for five years, and monitoring results shall be submitted annually to the Executive Director by December 31 of each calendar year.**

B. **The permittee shall undertake development in accordance with the approved final plan. Any proposed changes to the approved final plan shall be reported to the Executive Director. No changes to the approved final plan shall occur without a Commission amendment to this coastal development permit unless the Executive Director determines that no amendment is legally required.**

4. **Northern Coastal Scrub Habitat Restoration Plan**

A. **PRIOR TO COMMENCEMENT OF CONSTRUCTION OF THE DEVELOPMENT AUTHORIZED BY COASTAL DEVELOPMENT PERMIT AMENDMENT NO. 1-83-270-A, the permittee shall submit for the review and approval of the Executive Director a plan for restoring and enhancing the northern coastal scrub habitat located on the portions of the bluff face below the exposed portions of the Geoweb retaining wall that will be disturbed by the development and/or backfilled. The plan shall be prepared by a qualified botanist or licensed landscape architect and shall prepared in consultation with the Redwood Coast Land Conservancy, the Dorothy King Young Chapter of the California Native Plant Society, and the Mendocino Coast Cooperative Weed Management Area.**

(1) **The plan shall demonstrate that**

i. **Northern coastal scrub habitat shall be restored all along the portions of the bluff face on APN 145-261-05 below the exposed portions of the Geoweb retaining wall that will be disturbed by the development and/or backfilled;**

ii. **The Northern coastal scrub habitat shall visually buffer the base of the Geoweb retaining wall from Gualala Point Regional Park;**

iii. **Invasive weeds shall be eliminated from the disturbed bluff area;**

iv. **Only those plants that are drought tolerant and native to "northern coastal scrub" habitats of Mendocino County shall be used;**

v. **All proposed plantings shall be obtained from local genetic stocks within Mendocino County. If documentation is provided to the Executive Director that demonstrates that native vegetation from local genetic stock is not available,**

native vegetation obtained from genetic stock outside the local area, but from within the adjacent region of the floristic province, may be used. No plant species listed as problematic and/or invasive by the California Native Plant Society, the California Invasive Plant Council, or by the State of California shall be planted or allowed to naturalize or persist on the parcel. No plant species listed as a "noxious weed" by the State of California or the U.S. Federal Government shall be utilized within the property;

vi. **No rodenticides of any kind shall be utilized within the property that is the subject of CDP No. 1-83-270-A;**

vii. **All plantings shall be maintained in good condition throughout the life of the project. If any of the plants to be planted die, become decadent, rotten, or weakened by decay or disease, or are removed for any reason, they shall be replaced no later than May 1st of the next spring season in-kind or with another native Northern coastal scrub species; and**

viii. **The success of the restoration plan shall be monitored on a regular basis, and monitoring results shall be submitted annually to the Executive Director by December 31 of each calendar year.**

(2) **The plan shall include, at a minimum, the following components:**

i. **A final landscape site plan depicting the species, size, and location of all plant materials to be planted on the property, any irrigation system, delineation of the approved development, and all other landscape features;**

ii. **A schedule for the planting of the landscaping; and**

iii. **A narrative description of the methods to be used for invasive plant removal; and**

iv. **A monitoring plan for evaluating the success of the restoration plan.**

B. **The permittee shall undertake development in accordance with the approved final plan. Any proposed changes to the approved final plan shall be reported to the Executive Director. No changes to the approved final plan shall occur without a Commission amendment to this coastal development permit unless the Executive Director determines that no amendment is legally required.**

5. Color of Geoweb Material

PRIOR TO COMMENCEMENT OF CONSTRUCTION OF THE DEVELOPMENT AUTHORIZED BY COASTAL DEVELOPMENT PERMIT AMENDMENT NO. 1-83-270-A, the permittee shall submit for the review and approval of the Executive Director color samples of the proposed Geoweb material. The color of the Geoweb material shall be black or a dark earth tone color.

6. Best Management Practices & Construction Responsibilities

The permittee shall comply with the following construction-related requirements:

A. **Any and all excess excavated material resulting from construction activities shall be removed and disposed of at a disposal site outside the coastal zone or placed within the coastal zone pursuant to a valid coastal development permit;**

B. **Straw bales, coir rolls, or silt fencing structures shall be installed prior to and maintained throughout the construction period to contain runoff from construction areas, trap entrained sediment and other pollutants, and prevent discharge of sediment and pollutants down slope toward the Gualala River;**

C. **On-site vegetation shall be maintained to the maximum extent feasible during construction activities;**

D. **Any disturbed areas shall be replanted or seeded and if necessary mulched as soon as feasible following completion of construction, but in any event no later than May 1st of the next spring season consistent with the final approved plan required by Special Condition Nos. 3 and 4 above;**

E. **All on-site stockpiles of construction debris shall be covered and contained at all times to prevent polluted water runoff;**

F. **No ground-disturbing activities shall occur during the period of October 15 and April 15 to minimize the potential for soil disturbance during the rainy season; and**

G. **Noise generating construction activities shall be limited in duration to the hours between 8:00 a.m. and 5:00 p.m., Monday through Friday only so as to limit noise impacts to nearby visitor serving facilities.**

7. Deed Restriction

PRIOR TO COMMENCEMENT OF CONSTRUCTION OF THE DEVELOPMENT AUTHORIZED BY COASTAL DEVELOPMENT PERMIT AMENDMENT NO. 1-83-270-A, the permittee shall submit to the Executive Director for review and approval documentation demonstrating that the applicant has executed and recorded against the parcel(s) governed by this permit a deed restriction, in a form and content acceptable to the Executive Director: (1) indicating that, pursuant to this permit, the California Coastal Commission has authorized development on the subject property, subject to terms and conditions that restrict the use and enjoyment of that property; and (2) imposing the Special Conditions of this permit as covenants, conditions and restrictions on the use and enjoyment of the Property. The deed restriction shall include a legal description of the entire parcel or parcels governed by this permit. The deed restriction shall also indicate that, in the event of an extinguishment or termination of the deed restriction for any reason, the terms and conditions of this permit shall continue to restrict the use and enjoyment of the subject property so long as either this permit or the development it authorizes, or any part, modification, or amendment thereof, remains in existence on or with respect to the subject property.

8. Permit Expiration & Condition Compliance

This coastal development permit shall be deemed issued upon the Commission's approval and will not expire. Failure to comply with the special conditions of this permit may result in the institution of an action to enforce those conditions under the provisions of Chapter 9 of the Coastal Act.

IV. FINDINGS & DECLARATIONS

The Commission finds and declares the following:

A. BACKGROUND

Permit History

In 1981, the North Coast Regional Commission approved CDP NCR-80-P-75, granted to the Redwood Empire Title Company, for the building of the Surf Supermarket located on the subject parcel (APN 145-261-05). As a condition of approval, CDP NCR-80-P-75 required recordation of an offer to dedicate a 25-foot-wide easement for public access and passive recreation along the bluff. John J. and Ida L. Bower recorded the offers to dedicate required by the permit and the Commission issued the CDP for the construction of Surf Supermarket. CDP No. NCR-80-P-75 does not authorize use of any portion of the easement for a parking lot or placement of any structures or materials in any portion of the easement.

CDP No. NCR-80-P-75 specified that the supermarket building would be set back 35 feet at its northwest corner and 55 feet at its southwest corner from the bluff edge. However, when the building was constructed in the early 1980s, the structure was constructed such that the southwest corner is set back only 24 feet from the bluff edge. Thus, the constructed building was therefore placed directly within the area offered for public access along the bluff constituting a violation of CDP NCR-80-P-75. In an effort to protect the public access required by CDP NCR-80-P-75, the Commission subsequently approved CDP 1-83-270 authorizing a 120-foot-long wood retaining wall west of the market along the edge of the bluff (See Exhibit 8). Special Condition No. 1 of CDP No. 1-83-270 requires that the retaining wall be maintained for the life of the development on the site. To comply with Special Condition No. 1 of CDP No. 1-83-270, the subject coastal development permit amendment application has been submitted to the Coastal Commission by Bower Limited Partnership to replace the failing retaining wall behind the supermarket. Specifically, the proposed amendment requests authorization to (1) replace the constructed 70-foot-long wooden retaining wall with an approximately 105-foot-long "Geoweb" retaining wall extending across the subject property with an approximately 30-foot-long concrete block end wall at the southern end of the retaining wall, (2) install 118 linear feet of 12-inch storm drain with a storm drain manhole, and (3) replace an existing underground septic tank.

In a related action, the applicant proposes to extend the replacement retaining wall that is proposed under Permit Amendment 1-83-270-A to the north across the top of the bluff face of APN 145-261-13 within the area of Mendocino County's coastal permit jurisdiction. The portion of the wall proposed on APN 145-261-13 is the subject of related Appeal No. A-1-MEN-05-015, an appeal of the decision of Mendocino County to grant local CDP Permit No. 55-2006 for construction of this portion of the retaining wall (The boundary between the portion of the proposed retaining wall that is the subject of Permit Amendment 1-83-270-A and that portion that is the subject of Appeal No. A-1-MEN-05-015 is shown in Exhibit 3). On April 11, 2008, the Coastal Commission found that the appeal of the County's approval of Permit No. 55-2006 raised a substantial issue with respect to the grounds on which the appeal was filed, pursuant to Section 30625 of the Coastal Act and Section 13115 of Title 14 of the California Code of Regulations. As a result, the County's approval is no longer effective, and the Commission must consider the project *de novo*. The Commission has not yet acted on the project de novo.

Subdivision of Adjoining Property to the North

In 1977, the North Coast Regional Commission granted CDP NCR-77-C-115 to John and Ida Bower for a land division of 4.5 acres immediately adjacent to the north of the supermarket parcel (APN 145-261-05) into 3 lots of 1.9, 1.0, and 1.6 acres (APNs 145-261-11, 145-261-12, and 145-261-13). APNs 145-261-11 and 145-261-12 are developed with motels and APN 145-261-13, the site that is the subject of related Appeal No. A-1-MEN-08-015, is developed with a strip of commercial units bordering Highway One

which are leased by separate commercial entities. Parcel 13, is the southernmost of this group of three parcels. As a condition of the 1977 land division, the Commission required recordation of an offer to dedicate a 25-foot-wide lateral bluff top access easement and a five-foot-wide vertical access easement from Highway One to the mean high water line of the Gualala River. As they did for the offer to dedicate required by CDP NCR-80-P-75, John J. and Ida L. Bower recorded the offer to dedicate required by CDP Nos. NCR-77-C-115 for the subdivision and the Commission issued the CDP. CDP Nos. NCR-77-C-115 and NCR-80-P-75 do not authorize use of any portion of the easement for a parking lot or placement of any structures or materials in any portion of the easement.

Gualala Bluff Trail

In 1994, the Redwood Coast Land Conservancy (RCLC) accepted the offers-to-dedicate public access easements described above. The RCLC has received CDPs from Mendocino County to construct a bluff top trail, known as the Gualala Bluff Trail. Phase I of this trail, in a portion of the easement resulting from CDP NCR-77-C-115 (three-lot subdivision), was completed in 1998. The CDP for Phase II of this trail, which includes Parcel 13, the Surf Supermarket property, and another parcel further south (Oceansong Restaurant), was approved by Mendocino County in 2004 (CDP 23-03).

Following issuance of the CDP for Phase II of the Gualala Bluff Trail in 2004, Bower Limited Partnership initiated litigation against RCLC, with a cross-complaint filed by the Coastal Commission, over several issues regarding the easements on Parcels 5 and 13, including the validity of RCLC's acceptance of the easement on Parcel 13, the permissible scope of development of public pedestrian access on the parcels, the location of the public pedestrian access easements on the parcels, and alleged Coastal Act violations for unpermitted development within the easements.

Mutual Settlement Agreement and Release Between Involved Parties

A Mutual Settlement Agreement and Release by and between Bower Limited Partnership (BLP), John H. Bower, Redwood Coast Land Conservancy (RCLC), Shirley Eberly, Lois Lutz, and California Coastal Commission was established in 2007 (Case No. SCUK CVG 0594172). The agreement provides, in part, to the applicant (Bower Limited Partnership) access and use of the easement area for uses that are "*not inconsistent with the public pedestrian access authorized by the May 2004 Mendocino County coastal development permit*." The agreement specifies that such access and use may include, but is not limited to, replacement of the retaining wall on Parcel 5, installation of a retaining wall on Parcel 13, and installation and relocation of necessary utilities on Parcels 5 and 13, provided that BLP obtains all necessary permits for such work, including coastal development permits where required. The agreement also states that RCLC understands and agrees that such

work may result in temporary disruption and/or temporary relocation of pedestrian access on RCLC's easement area and that BLP further agrees that to the extent that any of its use of or access to the easement area damages the public pedestrian access amenities constructed by RCLC, BLP will expeditiously repair such damage at BLP's expense. While the agreement establishes that uses "*not inconsistent with the public pedestrian access authorized by the May 2004 Mendocino County coastal development permit*" may be located within the public access easement area, the agreement in no way obligates the County or the Coastal Commission to approve a CDP for such uses but rather, expressly requires the applicant to obtain all necessary permits form the County or the commission for any development located within the public access easement area.

B. SITE DESCRIPTION

The subject site is an approximately half-acre blufftop parcel located on the west side of Highway One, upslope from the Gualala River estuary, approximately 500 feet south of its outlet to the Pacific Ocean, at 39250 South Highway One in Gualala, Mendocino County (APN 145-261-05) (See Exhibits 1-3). The parcel is planned and zoned Gualala Village Mixed Use (GVMU) in the County's LCP. As discussed above, the subject parcel is developed with a supermarket and related ancillary facilities authorized by previous coastal development permits granted by the Commission. Also as discussed above, a partially improved portion of the Gualala Bluff Top Trail, which provides public access along the bluff, extends through a 25-foot-wide public access easement along the bluff edge of the property.several commercial buildings and the recently constructed Gualala Bluff Trail.

The bluff face contains a bare scarp from a landslide that destroyed the original retaining wall constructed pursuant to CDP 1-83-270 (See Exhibit 4). The otherwise vegetated bluff face is composed mostly of a Northern coastal scrub plant community interspersed with various ruderal and exotic species. This habitat is not consisdered to be an environmentally sensitive habitat area (ESHA), although the intertidal waters of the estuary and adjoing riparian areas are a form of ESHAThe proposed wall is located more than 50 feet away from these environmentally sensitive areas.

The site is located across the Gualala River from a sand spit separating the river from the ocean. The sand spit and the land area to the south is part of Guala Point Regional Park, a Sonoma County park.

C. AMENDMENT DESCRIPTION

The proposed amendment request would modify CDP No. 1-83-270 to add authorization to (1) replace the constructed 70-foot-long wooden retaining wall with an approximately

105-foot-long "Geoweb" retaining wall extending across the subject property with an approximately 30-foot-long concrete block end wall at the southern end of the retaining wall, (2) install118 linear feet of 12-inch storm drain with a storm drain manhole, and (3) replace an existing underground septic tank.

The proposed Geoweb wall is a form of retaining wall that would extend along the face of the bluff at the project site. The Geoweb wall is different from common retaining walls made of concrete blocks or driven sheetpiles in that it is a flexible, three-dimensional cellular confinement system, using interconnected strips of curved and perforated polyethylene to form layers of interconnected cells. The proposed Geoweb wall would utilize layers of cells approximately 3-1/2 feet wide. Each layer of cells is filled with earthen material before the next layer of Geoweb cells is placed on top of the previous layer. Gradually, the layers of cells are built up to the desired height flush with the top of the bluff. The proposed Geoweb wall would be built to the top of the bluff. The vertical length of the proposed wall will vary from approximately 13 to 27 feet, with the greater vertical length occurring at the site of the landslide where the Geoweb wall will be two-tiered. As proposed, some portions of the wall would be placed within excavated portions of the bluff, others alongside the bluff, and still others extending out from the bluff with backfill placed behind. Some portions of the face of the Geoweb wall would be covered with backfill. The outer cells of the exposed Geoweb wall would be filled with topsoil and planted with native vegetation to help mute the appearance of the wall.

The approved development would involve approximately 1,376 cubic yards of grading within an excavation area of approximately 3,547 square feet along the bluff. The 3,547 square feet of vegetated bluff to be excavated is comprised of invasive, ruderal plant species as well as areas of native northern coastal scrub habitat.

D. CONFORMANCE WITH LCP LIMITATIONS ON CONSTRUCTION OF RETAINING WALLS

LCP Policies and Standards:

LUP Policy 3.4-12 and Coastal Zoning Code Section 20.500.020(E)(1) state:

> *Seawalls, breakwaters, revetments, groins, harbor channels and other structures altering natural shoreline processes or retaining walls shall not be permitted unless judged necessary for the protection of existing development or public beaches or coastal dependent uses. Allowed developments shall be processed as conditional uses, following full environmental geologic and*

> *engineering review. This review shall include site-specific information pertaining to seasonal storms, tidal surges, tsunami runups, littoral drift, sand accretion and beach and bluff face erosion. In each case, a determination shall be made that no feasible less environmentally damaging alternative is available and that the structure has been designed to eliminate or mitigate adverse impacts upon local shoreline sand supply and to minimize other adverse environmental effects. The design and construction of allowed protective structures shall respect natural landforms, shall provide for lateral beach access, and shall minimize visual impacts through all available means.* (emphasis added)

Discussion

The proposed Geoweb wall is a form of retaining wall that would extend along the face of the bluff at the project site. As discussed above, the Geoweb wall is different from common retaining walls made of concrete blocks or driven sheetpiles in that it is composed of a flexible, three-dimensional cellular confinement system, using interconnected strips of curved and perforated polyethylene to form layers of interconnected cells that are filled with earthen material and stacked on top of each other. The constructed Geoweb wall forms a barrier to retain the bluff behind it.

The above cited policies set limitations on the construction of retaining walls. Neither the certified Mendocino County LCP nor the Coastal Act contain a definition of "retaining wall." However, Webster's New World Dictionary, Third Collegiate Edition, defines "retaining wall" as "a wall built to keep a bank of earth from sliding or water from flooding." The bluff face at the subject property has experienced a significant debris flow or slide that destroyed the previous retaining wall built along the bluff face pursuant to the original permit. As the primary intent of constructing the proposed Geoweb wall is to prevent additional sliding of the bluff face and protect development and uses on the blufftop, and as the proposed Geoweb structure with its numerous layers of interconnected cells filled with earthen material placed on top of each other form a kind of wall, the Commission finds that the proposed Geoweb structure constitutes a "retaining wall."

LUP Policy 3.4-12 and Coastal Zoning Code Section 20.500.020(E)(1) apply to retaining walls that alter natural shoreline processes. The erosion of bluffs along a shoreline is a natural shoreline process. The subject site has experienced landsliding that has eroded both the parts of the bluff composed of previously placed fill as well as lower parts of the bluff below the previously placed fill. Much of the eroded sediment enters coastal waters and serves to nourish coastal and estuarine beaches and sand spits. The construction of the Geoweb wall will slow this natural erosion and beach nourishment process, thus altering natural shoreline processes.

As cited above, LUP Policy 3.4-10 and Coastal Zoning Code Section 20.500.020(E)(1) prohibit the development of retaining walls and other shoreline structures unless such structures are determined to be necessary either for the protection of (1) existing development, (2) public beaches, or (3) coastal dependent uses. As discussed above, In 1981, the North Coast Regional Commission approved CDP NCR-80-P-75, for the building of the Surf Supermarket located on the subject parcel (APN 145-261-05). As a condition of approval, CDP NCR-80-P-75 required recordation of an offer to dedicate a 25-foot-wide easement for public access and passive recreation along the bluff. CDP No. NCR-80-P-75 specified that the supermarket building would be set back 35 feet at its northwest corner and 55 feet at its southwest corner from the bluff edge. However, when the building was constructed in the early 1980s, the structure was constructed such that the southwest corner is set back only 24 feet from the bluff edge. Thus, the constructed building was therefore placed directly within the area offered for public access along the bluff constituting a violation of CDP NCR-80-P-75. In an effort to protect the public access required by CDP NCR-80-P-75, the Commission subsequently approved CDP 1-83-270 authorizing a 120-foot-long wood retaining wall west of the market along the edge of the bluff. Special Condition No. 1 of CDP No. 1-83-270 requires that the retaining wall be maintained for the life of the development on the site.

As noted above, the original retaining wall that was constructed failed and was destroyed in landsliding that occurred in the winter of 2005-2006. The resulting slide scarp is over steepened and unstable and threatens the bluff edge where the public access easement exists. The amendment request was submitted to comply with the requirements of Special Condition No. 1 of the original permit by proposing a new retaining wall to replace the wall that has failed and thereby protect the public access easement.

The public access easement has been accepted and is managed by the Redwood Coast Land Conservancy (RCLC). Assisted by grant money provided by the California Coastal Conservancy, the RCLC has been developing the Gualala Bluff Top Trail within this particular easement and adjoining easements that extend along the downtown commercial district of Gualala . The Gualala Bluff Top Trail is considered a link in the California Coastal Trail. Thus, the public access easement and the trail it will accommodate provides important coastal access and is a coastal dependent use. As maintenance of a retaining wall in this location has been required by the Commission since 1983 to protect the public access easement and the easement has been directly threatened by an adjacent bluff landslide, the Commission finds that the proposed Geoweb wall is necessary for the protection of a coastal dependent use consistent with the requirements of LUP Policy 3.4-10 and Coastal Zoning Code Section 20.500.020(E)(1).

E. California Environmental Quality Act

Section 13096 of the Commission's administrative regulations requires Commission approval of coastal development permit applications to be supported by a finding showing the application as modified by any conditions of approval to be consistent with any applicable requirements of the California Environmental Quality Act (CEQA). Section 21080.5(d)(2)(A) of CEQA prohibits a proposed development from being approved if there are feasible alternatives or feasible mitigation measures available which would substantially lessen any significant adverse effect which the activity may have on the environment.

The Commission incorporates its findings on LCP and Coastal Act consistency at this point as if set forth in full. These findings address and respond to all public comments regarding potential significant adverse environmental effects of the project that were received prior to preparation of the staff report. As discussed above, the proposed amended development as conditioned is consistent with the policies of the certified Mendocino County Local Coastal Program. Mitigation measures which will minimize all adverse environmental impacts have been required as permit amendment special conditions. As conditioned, there are no feasible alternatives or feasible mitigation measures available, beyond those required, which would substantially lessen any significant adverse impact that the activity may have on the environment. Therefore, the Commission finds that the proposed amended development, as conditioned to mitigate the identified impacts, can be found to be consistent with the requirements of the Coastal Act to conform to CEQA.

V. EXHIBITS:

1. Regional Location Map
2. Vicinity Map
3. Amendment Project Site
4. Site Photographs
5. Project Plans
6. Revised Project Description
7. Botanical Surveys
8. Original Permit Staff Report
9. Applicant’s Correspondence
10. General Correspondence

ATTACHMENT A:

STANDARD CONDITIONS

1. Notice of Receipt and Acknowledgment. The permit is not valid and development shall not commence until a copy of the permit, signed by the permittee or authorized agent, acknowledging receipt of the permit and acceptance of the terms and conditions, is returned to the Commission office.

2. Interpretation. Any questions of intent of interpretation of any condition will be resolved by the Executive Director or the Commission.

3. Assignment. The permit may be assigned to any qualified person, provided assignee files with the Commission an affidavit accepting all terms and conditions of the permit.

4. Terms and Conditions Run with the Land. These terms and conditions shall be perpetual, and it is the intention of the Commission and the permittee to bind all future owners and possessors of the subject property to the terms and conditions.

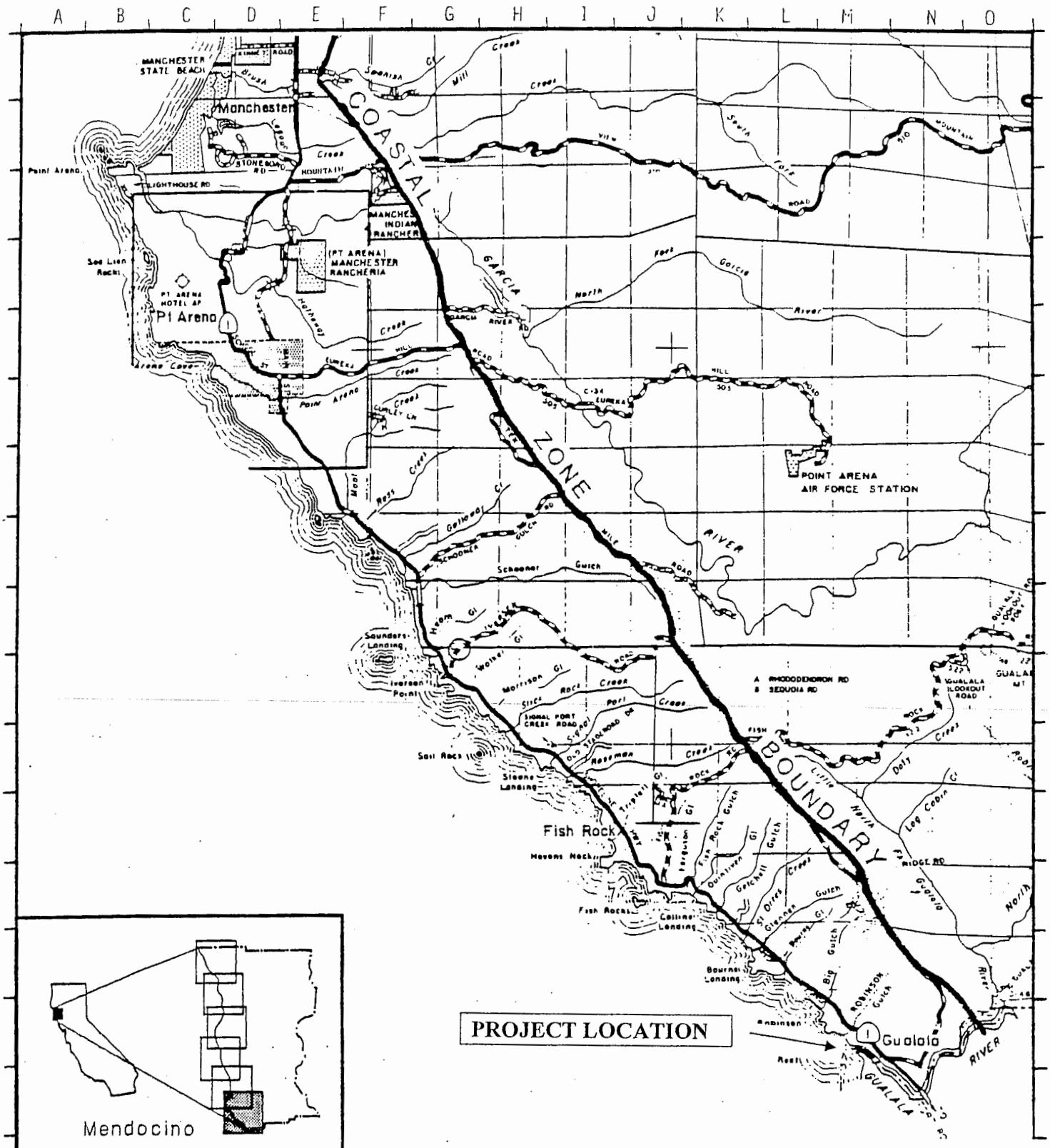


EXHIBIT NO. 1

APPEAL NO.
1-83-270-A1
BOWER LIMITED PARTNERSHIP

REGIONAL LOCATION MAP

California Coastal Commission

LOCATION MAP

1 0

County of Mendocino

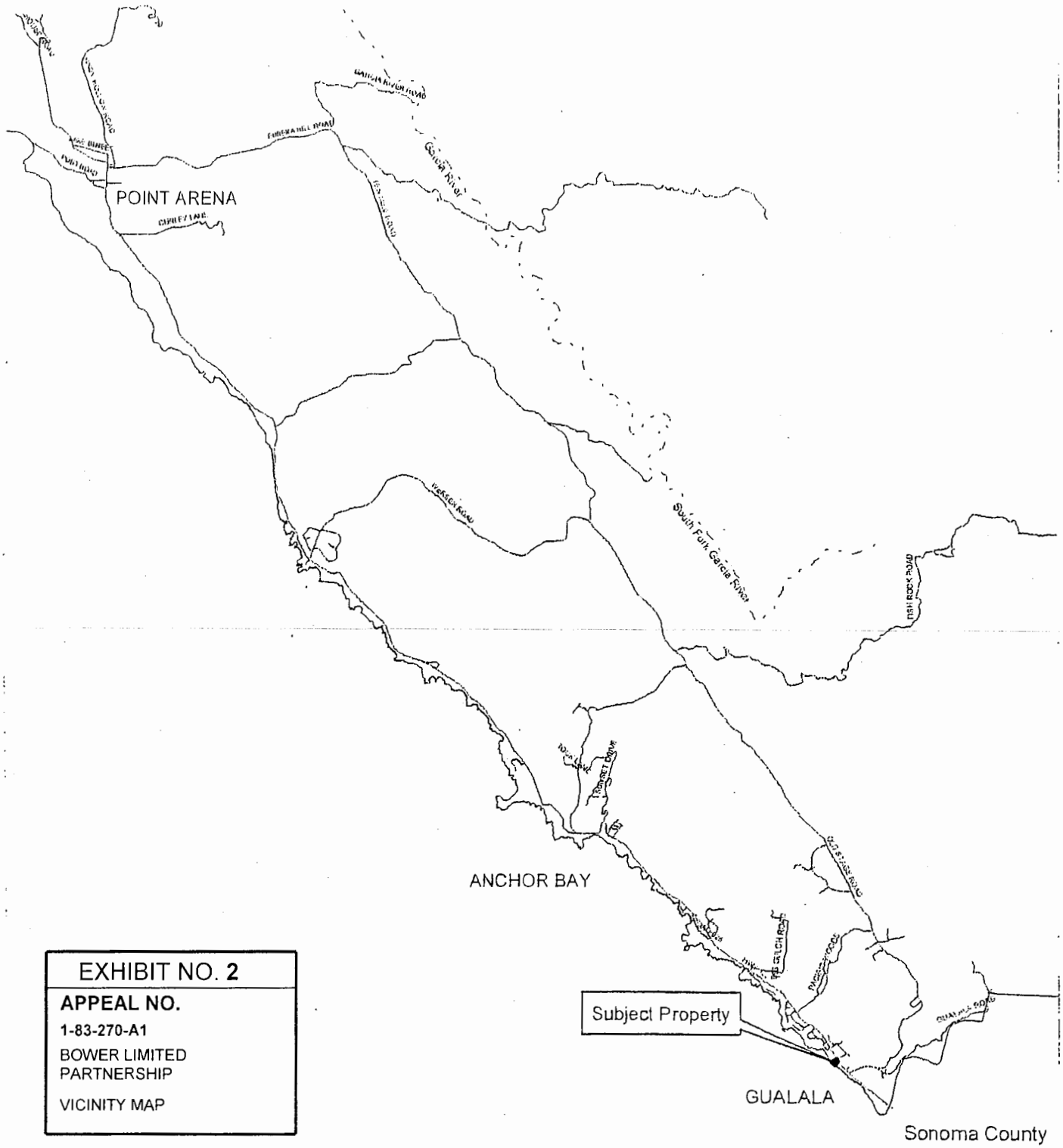


EXHIBIT NO. 2

APPEAL NO.

1-83-270-A1

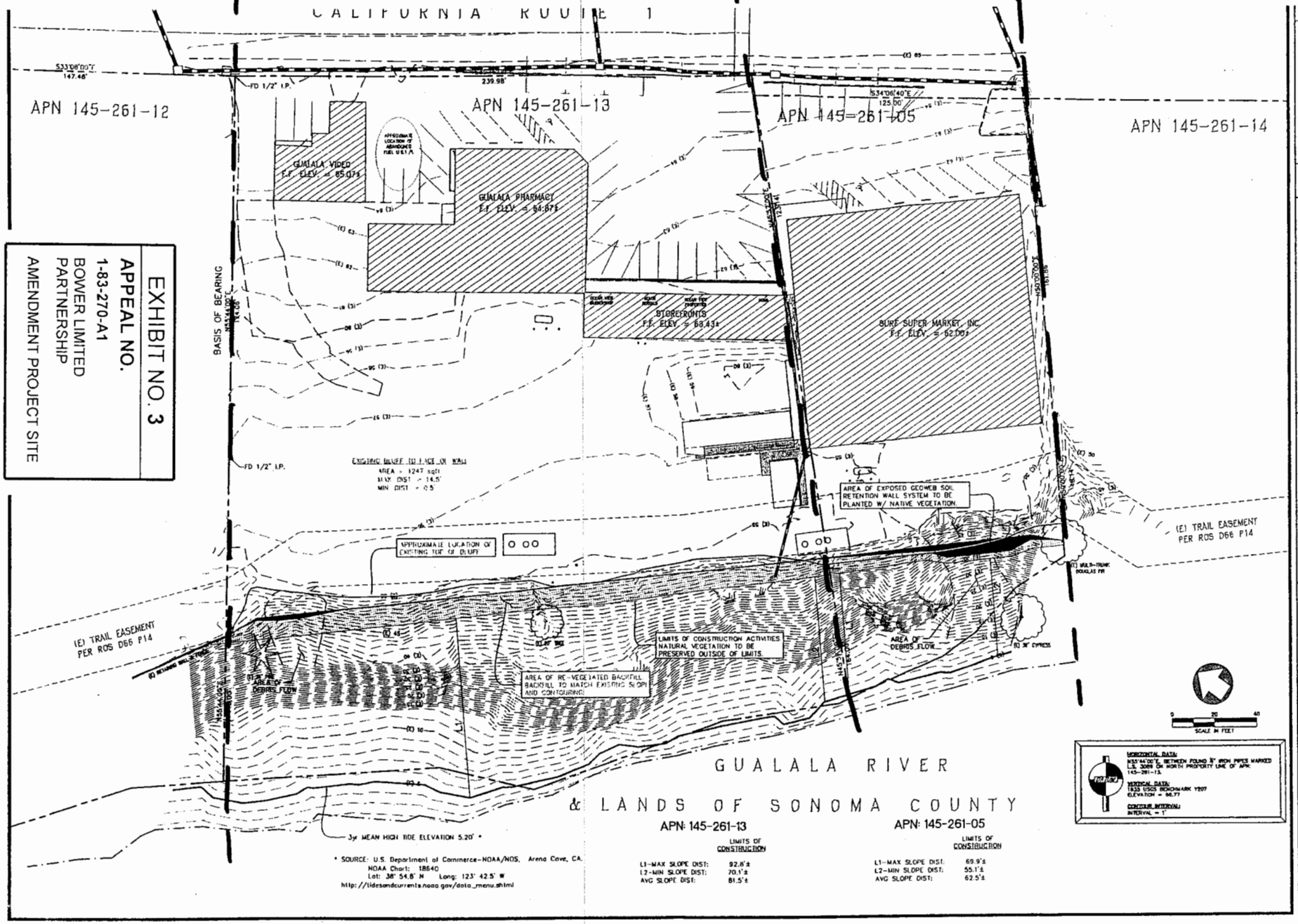
BOWER LIMITED PARTNERSHIP

VICINITY MAP

LOCATION MAP

APPEAL NO. A-1-MEN-08-015
SITE

CDP 1-83-270-A
PERMIT AMENDMENT
SITE



APN: 145-261-13

LIMITS OF CONSTRUCTION

L1-MAX SLOPE DIST:	92.8'±
L2-MIN SLOPE DIST:	70.1'±
AVG SLOPE DIST:	81.5'±

APN: 145-261-05

LIMITS OF CONSTRUCTION

L1-MAX SLOPE DIST:	69.9'±
L2-MIN SLOPE DIST:	55.1'±
AVG SLOPE DIST:	62.5'±

* SOURCE: U.S. Department of Commerce-NOAA/NOS, Arena Cove, CA.
NOAA Chart: 18640
Lat: 38° 54.8' N Long: 123° 42.5' W
http://tidesandcurrents.noaa.gov/data_menu.shtml

HORIZONTAL DATUM:
N55°44'00"E, BETWEEN FOUND 3/4" IRON PIPES MARKED L.S. 3089 ON NORTH PROPERTY LINE OF APN: 145-291-13.

VERTICAL DATUM:
1935 USGS BENCHMARK Y207
ELEVATION = 96.77

CONTOUR INTERVAL:
INTERVAL = 1'

EXHIBIT NO. 3
APPEAL NO.
1-83-270-A1
BOWER LIMITED PARTNERSHIP
AMENDMENT PROJECT SITE

BY:	REVISION	DATE
DRA	WALL CROSS SECTIONS	12/5/08
DRA	SHEET 3a AND 3c	11/10/07
DRA	ALTERNATE WALL SECTIONS	01/09/08

DRAWING: BOTANICAL SURVEY EXHIBIT
CONSTRUCTION ACTIVITY ZONE
PROJECT: SURF MARKET IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-1936 · UKIAH, CA 95482

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE: JAN, 2008
SCALE: AS SHOWN
DRAWN: DRA
CHECKED: GDR
JOB NO. R05024
SHEET 1.1

Z:\R05024\Drawings\$PLANSETS\Wall Permit App Drawings 072006\Botanical Survey Exhibit-1A.dwg, 02/04/2008 9:2[illegible]:03 AM, 1:2

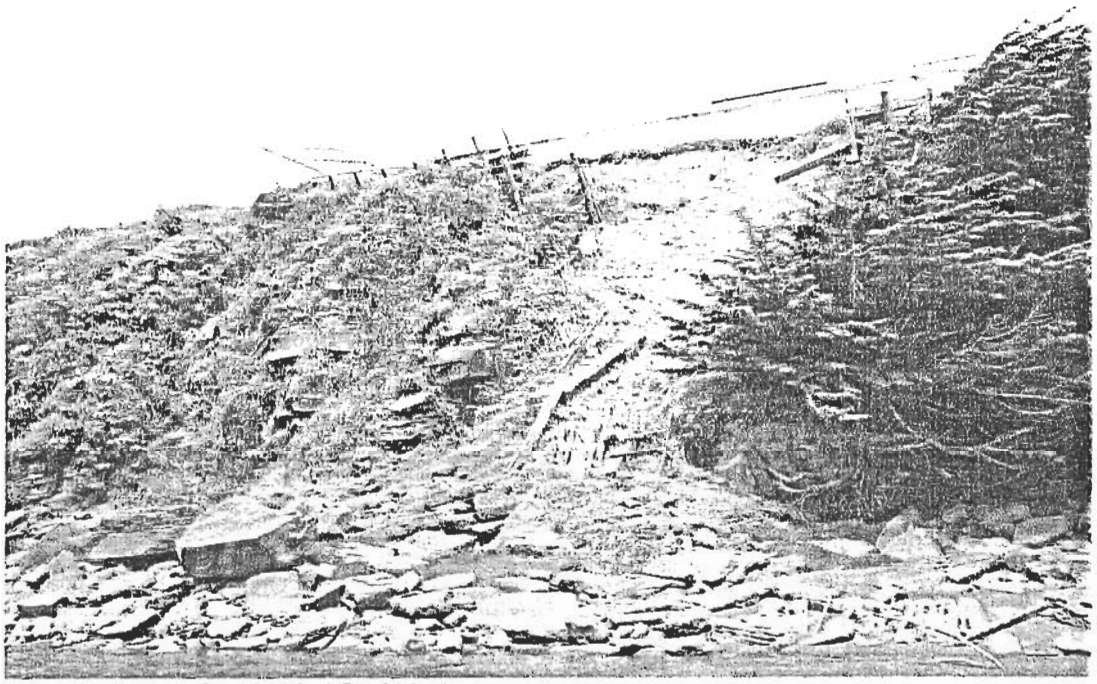


Photo 1. Debris flow behind Surf Market

Photo 2. Fill failure

EXHIBIT NO. **4**

APPEAL NO.

1-83-270-A1

BOWER LIMITED PARTNERSHIP

SITE PHOTOS (1 of 3)

Photo 3. Sediment delivery to estuary.

Photo 4. Sediment delivery to estuary.

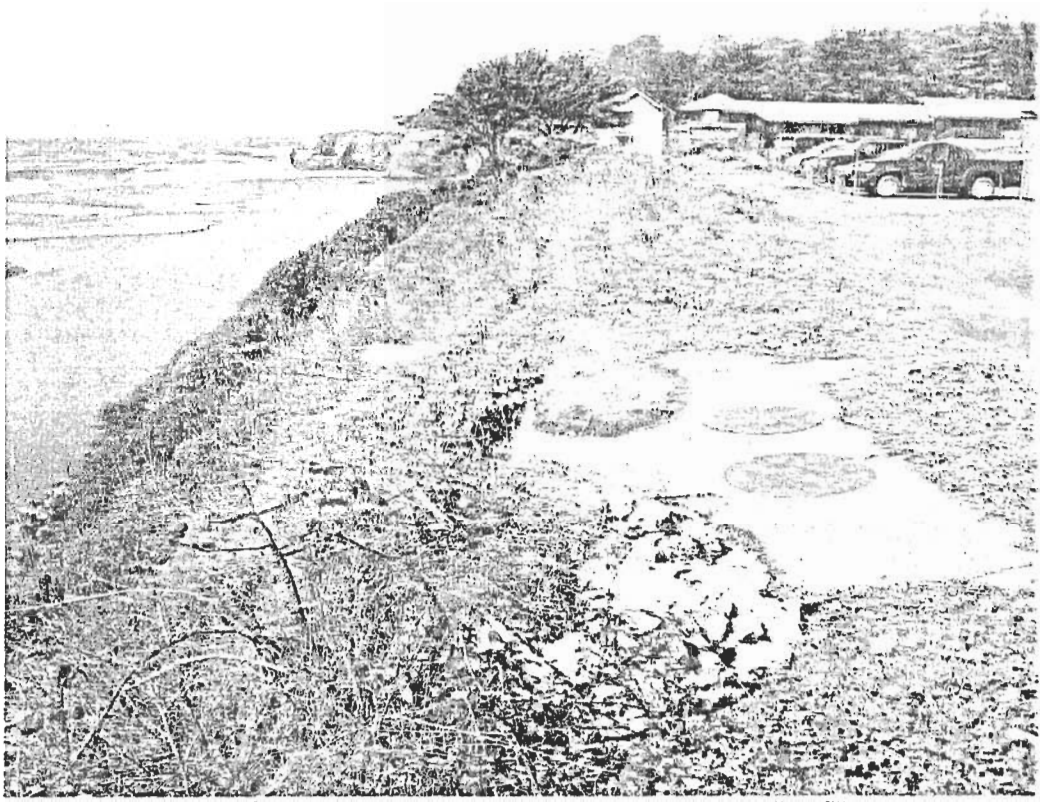


Photo 5. Exposed traffic slab covering interceptor tank due to eroding fill.

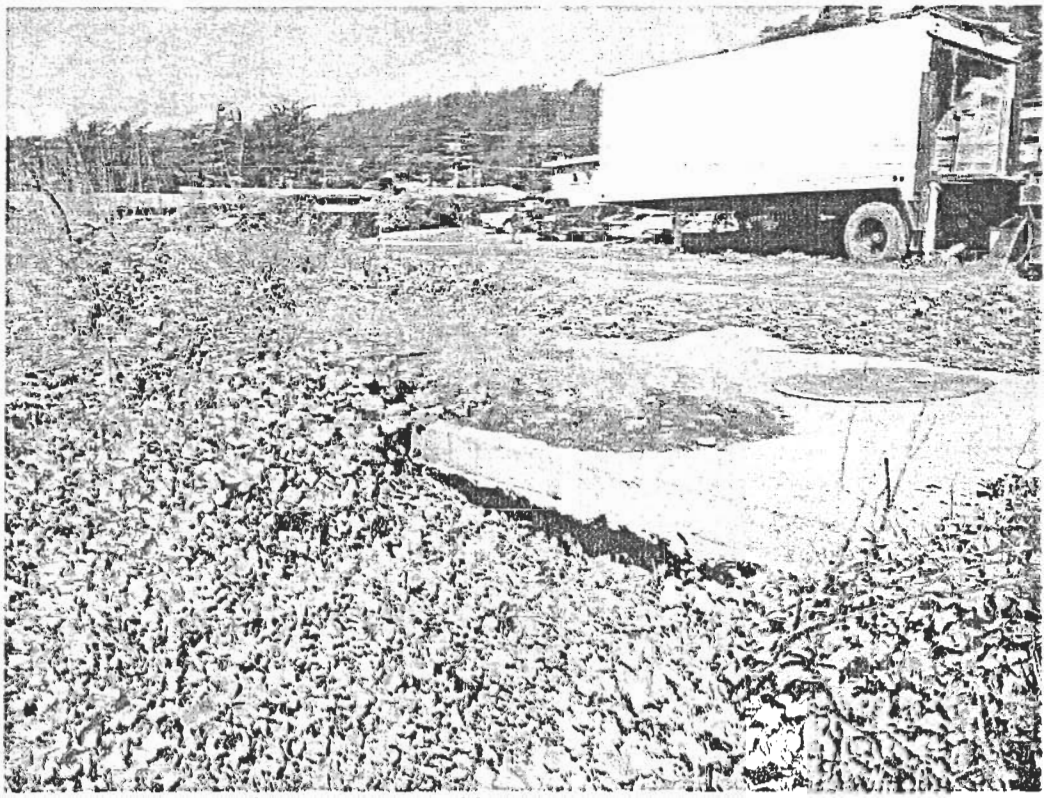


Photo 6. Exposed traffic slab at edge of fill.

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

BY	REVISION	DATE

DRAWING: EXISTING CONDITIONS
PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-6536 · NOVA, CA 95482

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE:	APR. 2008
SCALE:	AS SHOWN
DRAWN:	DG
CHECKED:	CS
JOB NO.	R0924
SHEET	C100

REGISTERED PROFESSIONAL ENGINEER · GREGORY S. RAU · NO. 21908 · EXP. 6-30-09 · CIVIL · STATE OF CALIFORNIA

BASIS OF BEARING
S 56°37'00" W, BETWEEN FOUND MONUMENTS AS SHOWN ON A MAP FILED IN MAP CASE 2, DRAWER 31, PAGE 24, M.C.R.

DATUM
1935 U.S.G.S. BENCH MARK "Y207" ELEVATION=66.77'

CONTOUR INTERVAL
CONTOUR INTERVAL = 2'

SCALE IN FEET: 0, 20, 40

CALIFORNIA ROUTE 1

GUALALA RIVER & LANDS OF SONOMA COUNTY

APN 145-261-14

APN 145-261-05

APN 145-261-13

APN 145-261-12

APN: 145-261-05
CDP Amendment No. 1-83-270-A1

APN: 145-261-13
Appeal No. A-1-MEN-08-015
CDP 55-2006

SURF SUPER MARKET, INC.
F.F. ELEV. = 65.03±

STOREROOMS
F.F. ELEV. = 63.43±

GUALALA PHARMACY
F.F. ELEV. = 64.87±

GUALALA VIDEO
F.F. ELEV. = 65.07±

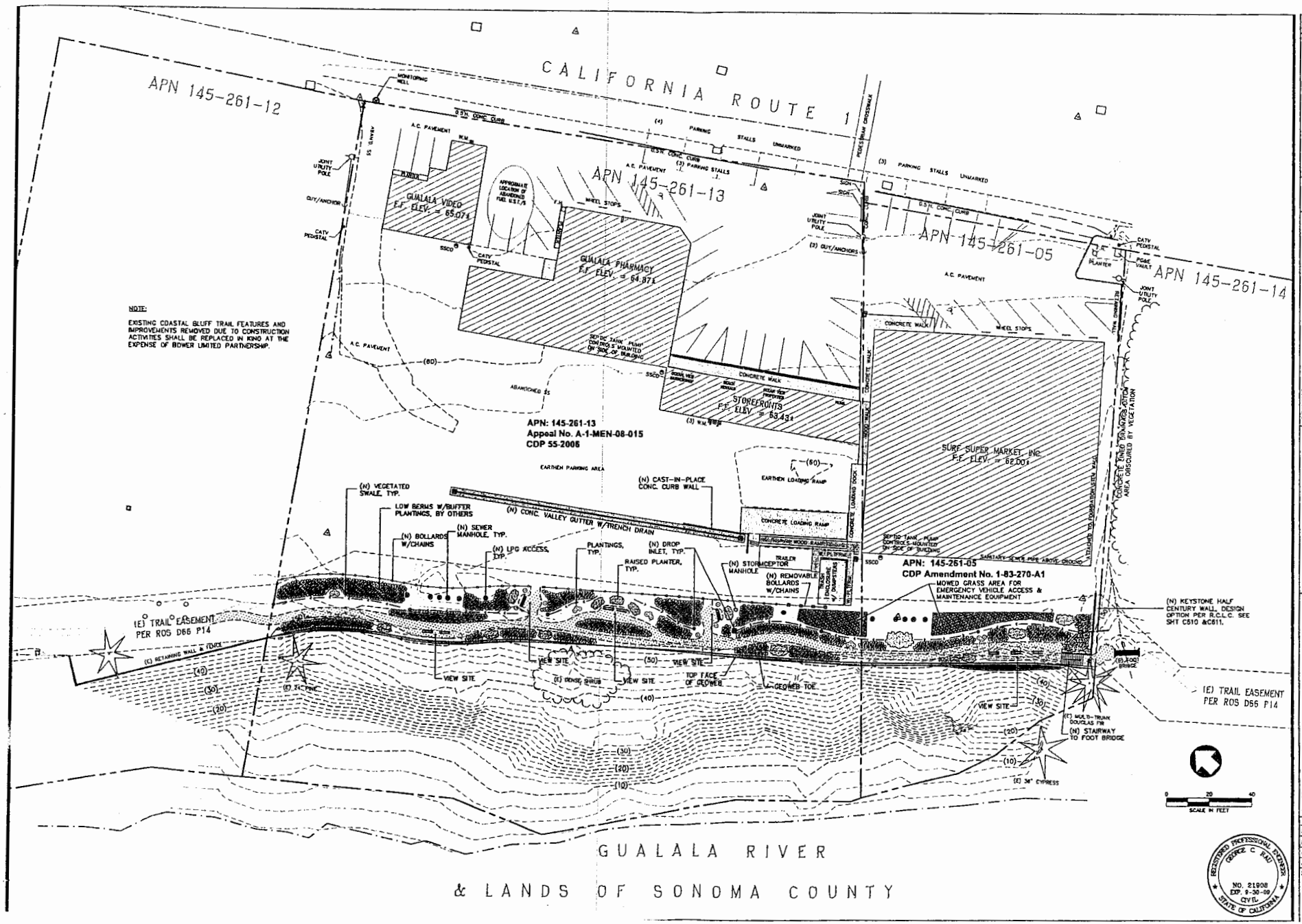
(E) TRAIL EASEMENT PER ROS D66 P14

BASIS OF BEARING
S56°32'00"W
74.00'

EXHIBIT NO. 5

APPEAL NO.
1-83-270-A1
BOWER LIMITED PARTNERSHIP

PROJECT PLANS (1 of 11)



BY:	REVISION	DATE

DRAWING: SITE PLAN

PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH FINE STREET (707) 461-1026 · SEBASTOPOL, CA 95472

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP

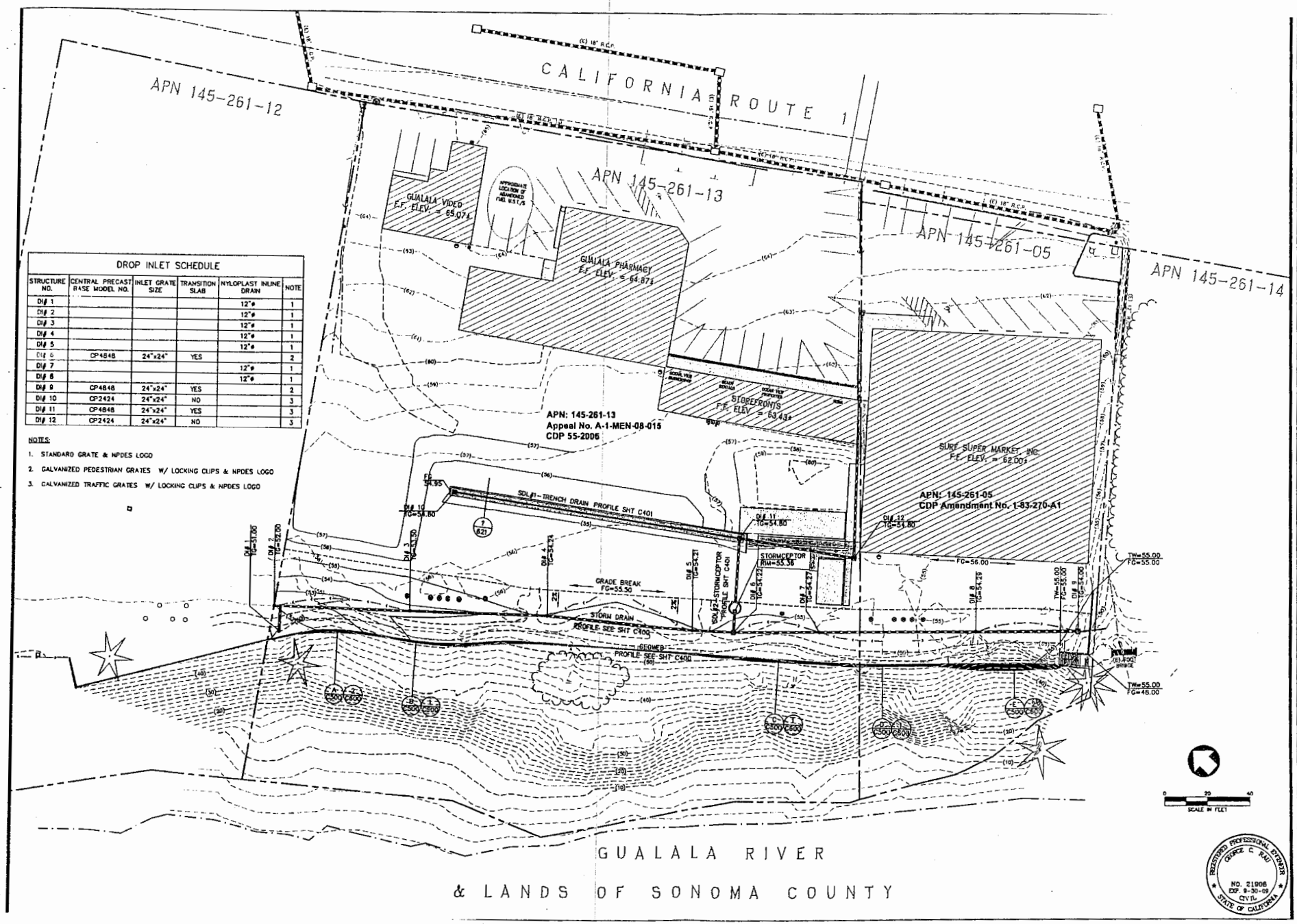
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE: April 2008
SCALE: AS SHOWN
DRAWN: DRA
CHECKED: GCR
JOB NO. R05024
SHEET

C110

REGISTERED PROFESSIONAL ENGINEER
GEORGE C. RAU
NO. 21908
EXP. 9-30-09
CIVIL
STATE OF CALIFORNIA

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION



DROP INLET SCHEDULE

STRUCTURE NO.	CENTRAL PRECAST BASE MODEL NO.	INLET GRATE SIZE	TRANSITION SLAB	NYLOPLAST INLINE DRAIN	NOTE
DI# 1				12"ø	1
DI# 2				12"ø	1
DI# 3				12"ø	1
DI# 4				12"ø	1
DI# 5				12"ø	1
DI# 6	CP4848	24"x24"	YES		2
DI# 7				12"ø	1
DI# 8				12"ø	1
DI# 9	CP4848	24"x24"	YES		2
DI# 10	CP2424	24"x24"	NO		3
DI# 11	CP4848	24"x24"	YES		3
DI# 12	CP2424	24"x24"	NO		3

NOTES:

1. STANDARD GRATE & NPDES LOGO
2. GALVANIZED PEDESTRIAN GRATES W/ LOCKING CLIPS & NPDES LOGO
3. GALVANIZED TRAFFIC GRATES W/ LOCKING CLIPS & NPDES LOGO

BY:	REVISION	DATE

DRAWING: GRADING & DRAINAGE PLAN

PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
301 NORTH MAIN STREET (707) 462-1636 UKIAH, CA 95482

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP

LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE: April, 2008
SCALE: AS SHOWN
DRAWN: DRA
CHECKED: GCR
JOB NO. R05021

REGISTERED PROFESSIONAL ENGINEER
GEORGE C. RAU
NO. 21906
EXP. 9-30-09
CIVIL
STATE OF CALIFORNIA

SHEET C200

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

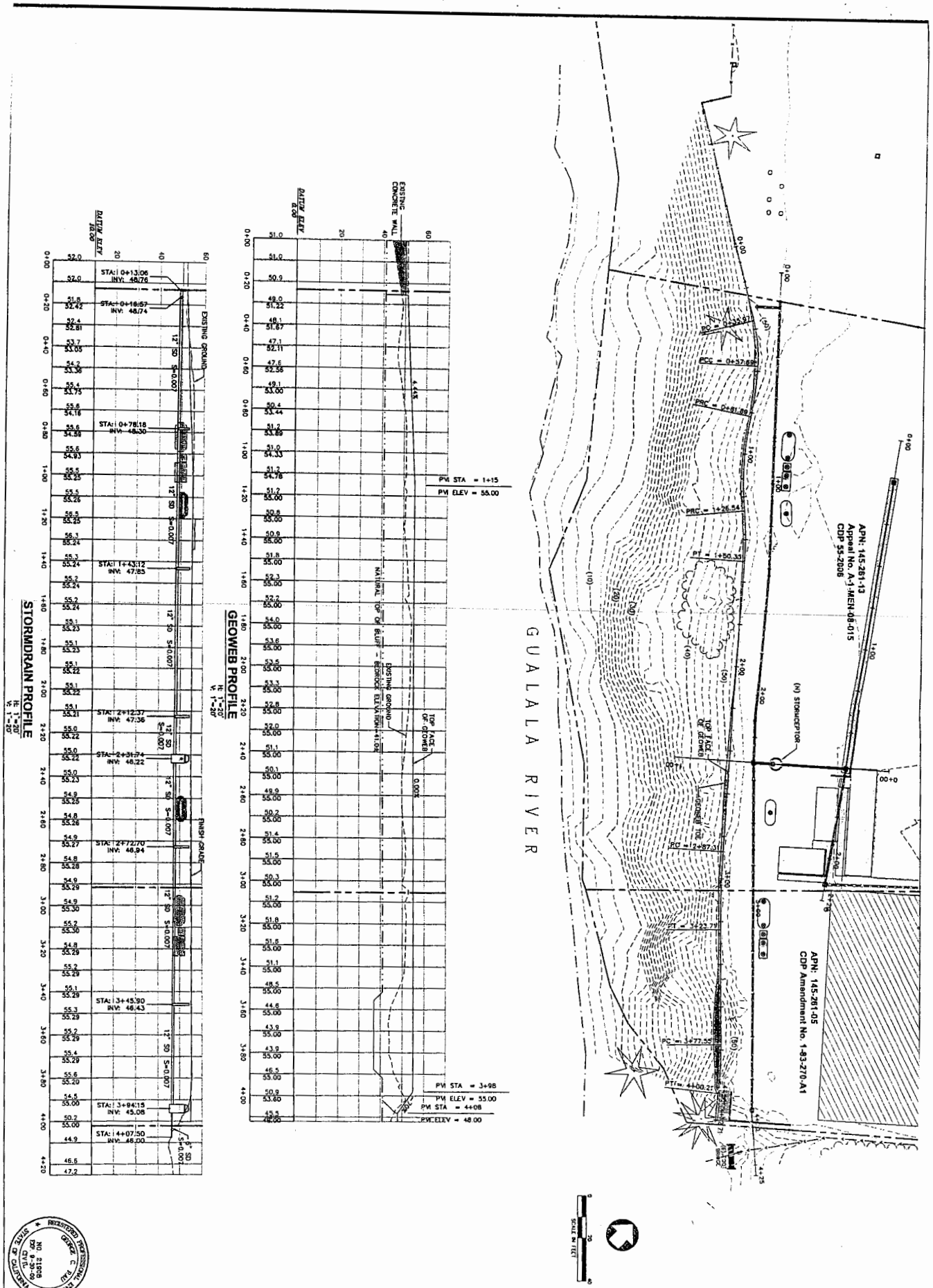
CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

OWNER:	BOWER LIMITED TRUST BOWER LIMITED PARTNERSHIP	DATE:	MAY 6, 2008
LOCATION:	39200 - 39250 S. HIGHWAY 1 GUALALA, CALIFORNIA	SCALE:	AS SHOWN
		DRAWN:	DRK
		CHECKED:	GER
		JOB NO.	R05021
		SHEET	C300

DRAWING:	UTILITY PLAN
PROJECT:	SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

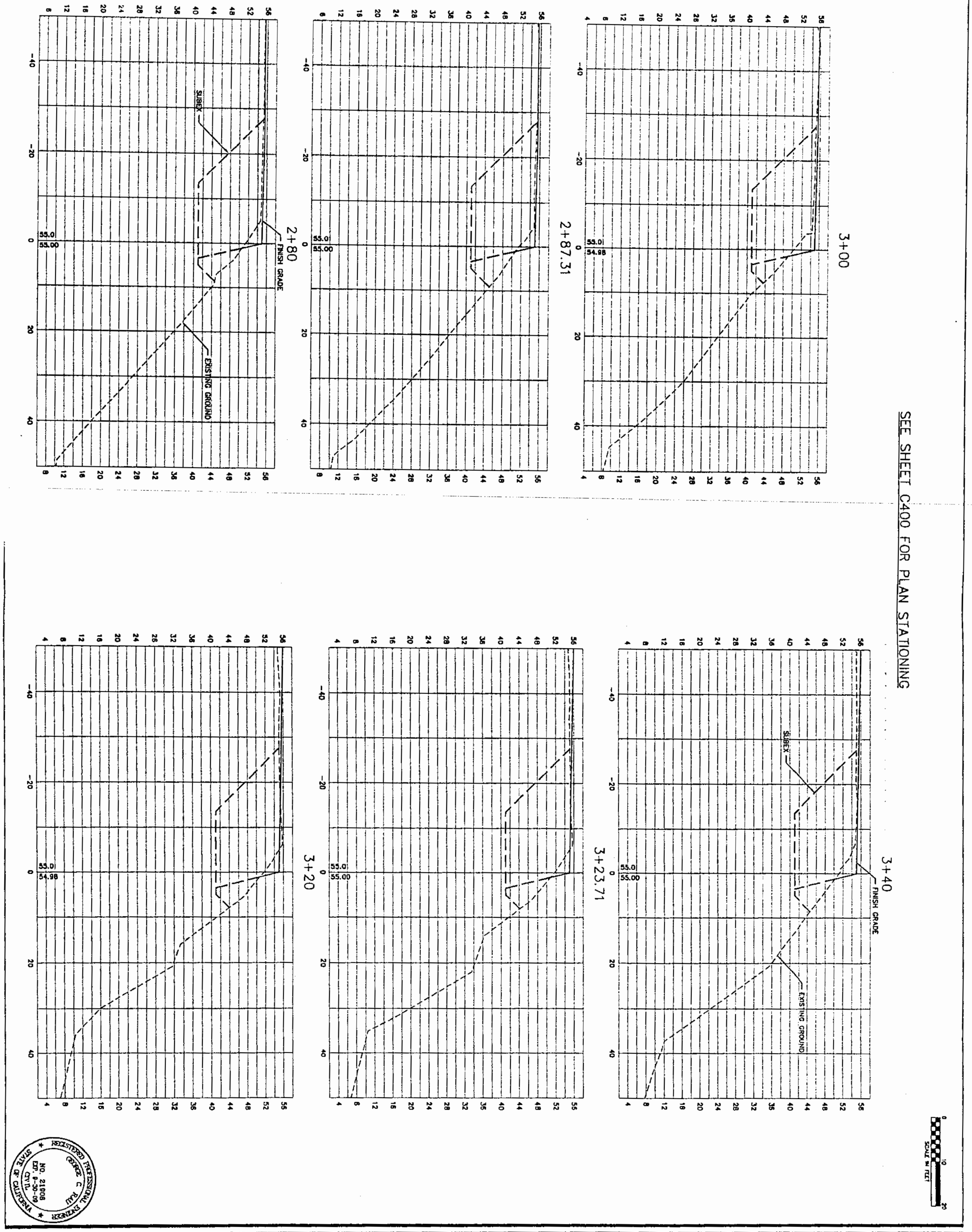
RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
110 NORTH PINE STREET · (707) 462-4368 · UKIAH, CA 95482

NO.	DATE	REVISION	BY:



C400	OWNER: BOWER LIMITED TRUST BOWER LIMITED PARTNERSHIP	RAU AND ASSOCIATES INC. CIVIL ENGINEERS · LAND SURVEYORS 100 NORTH PINE STREET- (707) 462-6538 - UKIAH, CA 95482	DRAWING: PLAN & PROFILE GEOWEB & STORM DRAIN	DATE	REVISION	BY:
	LOCATION: 39200 - 39250 S. HIGHWAY 1 GUALALA, CALIFORNIA		PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS			

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION



DATE: APR. 2008 SCALE: AS SHOWN DRAWN: DKA CHECKED: DCR JOB NO. R05024 SHEET C504	OWNER: BOWER LIMITED TRUST BOWER LIMITED PARTNERSHIP LOCATION: 39200 - 39250 S. HIGHWAY 1 GUALALA, CALIFORNIA	RAU AND ASSOCIATES INC. CIVIL ENGINEERS · LAND SURVEYORS 100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482	DRAWING: SECTIONS STA: 2+80 - 3+40 PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

DATE	REVISION	BY:

REGISTERED PROFESSIONAL ENGINEER GEORGE C. RAU NO. 21808 EXP. 9-30-09 CIVIL STATE OF CALIFORNIA

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

BY:	REVISION	DATE

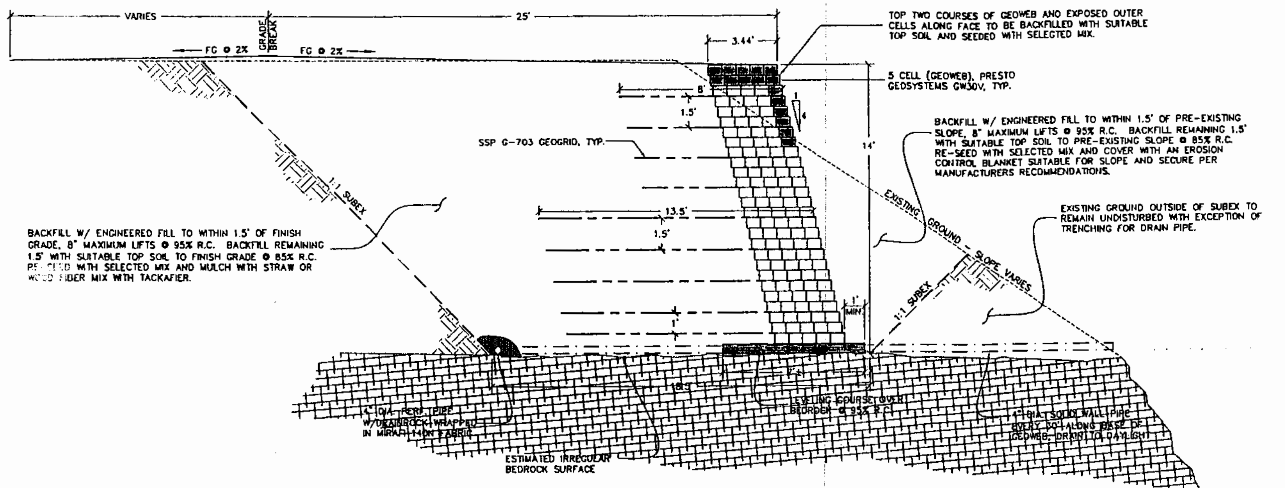
DRAWING: SECTIONS
STA: 3+60 - 4+12.71
PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

R&U AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 461-1550 · UKIAH, CA 95482

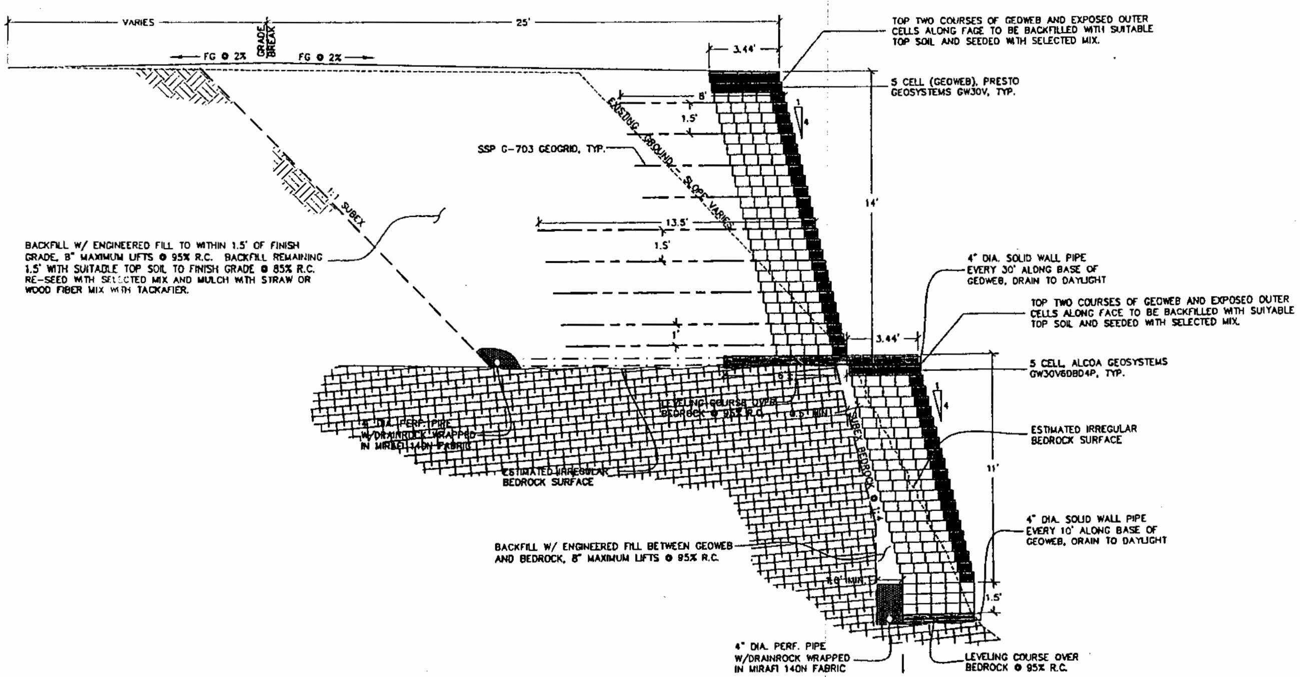
OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE:	JULY, 2008
SCALE:	AS SHOWN
DRAWN:	DRA
CHECKED:	GCR
JOB NO.	N0502A
SHEET	C505

SEE SHEET C400 FOR PLAN STATIONING


VARIES
25'
FG @ 2%
GRADE BREAK
FG @ 2%
3.44'
TOP TWO COURSES OF GEOWEB AND EXPOSED OUTER CELLS ALONG FACE TO BE BACKFILLED WITH SUITABLE TOP SOIL AND SEEDED WITH SELECTED MIX.
5 CELL (GEOWEB), PRESTO GEOSYSTEMS GW30V, TYP.
8'
1.5'
SSP G-703 GEOGRID, TYP.
14'
BACKFILL W/ ENGINEERED FILL TO WITHIN 1.5' OF PRE-EXISTING SLOPE, 8" MAXIMUM LIFTS @ 95% R.C. BACKFILL REMAINING 1.5' WITH SUITABLE TOP SOIL TO PRE-EXISTING SLOPE @ 85% R.C. RE-SEED WITH SELECTED MIX AND COVER WITH AN EROSION CONTROL BLANKET SUITABLE FOR SLOPE AND SECURE PER MANUFACTURERS RECOMMENDATIONS.
1:1 SUBEX
EXISTING GROUND - SLOPE VARIES
EXISTING GROUND OUTSIDE OF SUBEX TO REMAIN UNDISTURBED WITH EXCEPTION OF TRENCHING FOR DRAIN PIPE.
13.5'
1.5'
BACKFILL W/ ENGINEERED FILL TO WITHIN 1.5' OF FINISH GRADE, 8" MAXIMUM LIFTS @ 95% R.C. BACKFILL REMAINING 1.5' WITH SUITABLE TOP SOIL TO FINISH GRADE @ 85% R.C. RE-SEED WITH SELECTED MIX AND MULCH WITH STRAW OR WOOD FIBER MIX WITH TACKAFIER.
1:1 SUBEX
1' MIN
4" DIA. PERF. PIPE W/DRAINROCK WRAPPED IN MIRAFI 140N FABRIC
LEVELING COURSE OVER BEDROCK @ 95% R.C.
4" DIA. SOLID WALL PIPE EVERY 50' ALONG BASE OF GEOWEB, DRAIN TO DAYLIGHT
ESTIMATED IRREGULAR BEDROCK SURFACE

1 TYPICAL GEOWEB SECTION (NON DEBRIS FLOW AREA)


VARIES
25'
FG @ 2%
GRADE BREAK
FG @ 2%
3.44'
TOP TWO COURSES OF GEOWEB AND EXPOSED OUTER CELLS ALONG FACE TO BE BACKFILLED WITH SUITABLE TOP SOIL AND SEEDED WITH SELECTED MIX.
5 CELL (GEOWEB), PRESTO GEOSYSTEMS GW30V, TYP.
8'
1.5'
SSP G-703 GEOGRID, TYP.
EXISTING GROUND - SLOPE VARIES
14'
1:1 SUBEX
13.5'
1.5'
BACKFILL W/ ENGINEERED FILL TO WITHIN 1.5' OF FINISH GRADE, 8" MAXIMUM LIFTS @ 95% R.C. BACKFILL REMAINING 1.5' WITH SUITABLE TOP SOIL TO FINISH GRADE @ 85% R.C. RE-SEED WITH SELECTED MIX AND MULCH WITH STRAW OR WOOD FIBER MIX WITH TACKAFIER.
4" DIA. SOLID WALL PIPE EVERY 30' ALONG BASE OF GEOWEB, DRAIN TO DAYLIGHT
TOP TWO COURSES OF GEOWEB AND EXPOSED OUTER CELLS ALONG FACE TO BE BACKFILLED WITH SUIYABLE TOP SOIL AND SEEDED WITH SELECTED MIX.
3.44'
5 CELL ALCOA GEOSYSTEMS GW30V6DB04P, TYP.
LEVELING COURSE OVER BEDROCK @ 95% R.C.
4" DIA. PERF. PIPE W/DRAINROCK WRAPPED IN MIRAFI 140N FABRIC
ESTIMATED IRREGULAR BEDROCK SURFACE
ESTIMATED IRREGULAR BEDROCK SURFACE
SUBEX BEDROCK @ 1:4
11'
BACKFILL W/ ENGINEERED FILL BETWEEN GEOWEB AND BEDROCK, 8" MAXIMUM LIFTS @ 95% R.C.
4" DIA. SOLID WALL PIPE EVERY 10' ALONG BASE OF GEOWEB, DRAIN TO DAYLIGHT
1.5'
4" DIA. PERF. PIPE W/DRAINROCK WRAPPED IN MIRAFI 140N FABRIC
LEVELING COURSE OVER BEDROCK @ 95% R.C.

2 TYPICAL GEOWEB SECTION - DEBRIS FLOW AREA

NOTES:

1. EXCAVATE AND SHAPE FOUNDATION SOILS TO THE GRADES, ELEVATIONS AND DIMENSIONS SHOWN ON THE CONSTRUCTION DRAWINGS.

2. VERIFY THAT THE FOUNDATION SOIL SATISFIES THE DESIGN STRENGTH REQUIREMENTS. IF UNACCEPTABLE SOILS ARE ENCOUNTERED, THEY SHALL BE REMOVED AND REPLACED WITH ENGINEERED FILL AS DIRECTED BY THE PROJECT ENGINEER.

3. PLACE SPECIFIED GRANULAR BASE (LEVELING PAD) MATERIALS TO THE LINES AND GRADES SHOWN ON THE CONSTRUCTION DRAWINGS AND COMPACT TO A MINIMUM 95% OF STANDARD PROCTOR DRY DENSITY (SPDD). IF SPECIFIED, EXPAND GEOWEB FOOTING SECTIONS INTO POSITION ON THE THE PREPARED SUBGRADE (OR BASE) AND TEMPORARILY ANCHOR AT THE CORNERS AND ALONG THE EDGES.

4. OVERFILL GEOWEB CELLS WITH THE SPECIFIED GRANULAR INFILL MATERIAL. THE MAXIMUM PARTICLE SIZE OF THE INFILL MATERIAL SHALL NOT BE GREATER THAN 50 mm (2 in). COMPACT THE INFILL MATERIAL AND SURROUNDING FILL TO A MINIMUM 95% OF SPDD. REMOVE EXCESS FILL TO LEVEL WITH THE TOP OF THE CELLS.

5. INSTALL PERFORATED SUBDRAIN PIPE, WRAPPED WITH THE SPECIFIED NONWOVEN GEOTEXTILE, OR BACKFILL WITH CLEAR STONE, WRAPPED IN A NONWOVEN GEOTEXTILE, ADJACENT TO THE FOOTING OR AS SHOWN ON THE CONSTRUCTION DRAWINGS. PLACE DRAINAGE SYSTEM AT A MINIMUM GRADIENT OF 1% TO THE SPECIFIED OUTLETS. CONNECT SUBDRAIN PIPES TO SPECIFIED OUTLETS WITH T-CONNECTORS. WRAP OUTLET PIPES WHICH PASS THROUGH FOOTING OR WALL SECTIONS WITH GEOTEXTILE TO PREVENT LOSS OF CELL INFILL MATERIALS. CONNECT OUTLET PIPES TO SITE DRAINAGE SYSTEM IF PRESENT, OR ENSURE THAT DISCHARGE AT OUTLETS WILL NOT CAUSE LOCALIZED EROSION. COMPACT FILL MATERIALS SURROUNDING THE DRAINAGE SYSTEM.

6. WHERE SPECIFIED, PLACE GEOTEXTILE OVER THE BASE AND EXTEND UP THE FACE OF THE EXCAVATION AND PIN INTO POSITION. ALLOW 300 mm (12 in) OVERLAPS AT ADJOINING SECTIONS OF GEOTEXTILE. WHERE GEOCOMPOSITE DRAINAGE MATERIALS ARE SPECIFIED, ENSURE THAT EACH STRIP IS CONTINUOUS AND FULLY ENCAPSULATED WITH A GEOTEXTILE TO AN UNRESTRICTED OUTLET.

7. EXPAND GEOWEB SECTIONS, DIMENSIONED ACCORDING TO THE CONSTRUCTION DRAWINGS INTO POSITION USING STRETCHER FRAMES, TEMPORARY STAKES OR OTHER SUITABLE METHOD TO TEMPORARILY HOLD IN PLACE. INTERLEAF OR OVERLAP EDGES OF ADJACENT SECTIONS IN EACH LAYER, ACCORDING TO WHICH SIDE WALL PROFILES ABUT. ENSURE THAT ALL ADJOINING SECTIONS ARE FLUSH AT THE JOINTS AND ADJOINING CELLS ARE FULLY STAPLED.

8. PLACE SPECIFIED INFILL MATERIAL TO APPROXIMATELY 50 mm (2 in) ABOVE THE CELL WALLS. COMPACT INFILL AND BACKFILL MATERIALS TO A MINIMUM 95% OF SPDD AND REMOVE EXCESS MATERIAL ABOVE THE CELL WALLS. USE WALK-BEHIND COMPACTION EQUIPMENT TO COMPACT MATERIAL WITHIN THE GEOWEB SECTIONS AND WITHIN 1 m (3 ft) OF THE BACK OF GEOWEB SECTIONS.

9. PLACED SUBSEQUENT LAYERS WITH THE SPECIFIED SET BACK AND ALIGN GEOWEB SECTIONS TO AVOID OVERHANGING OF UPPER SECTIONS OVER LOWER SECTIONS.

10. WHERE DIFFERENT INFILL MATERIALS ARE SPECIFIED FOR THE OUTER CELLS (EG. TOPSOIL/VEGETATED), THE FOLLOWING PROCEDURES MAY BE USED.

A) COVER OUTER CELLS WITH REMOVABLE BOARD WHILE FILLING BACK CELLS. PLACE SPECIAL INFILL IN OUTER CELLS BEFORE ADVANCING TO THE NEXT LAYER.

B) LEAVE OUTER CELLS OPEN BUT USE EXTRA CARE TO FILL BACK CELLS AND AVOID EXCESSIVE SPILLAGE INTO OUTER CELLS. WHERE THE SPECIFIED OUTER CELL INFILL AND VEGETATION WILL TOLERATE IT, SOME SPILLAGE OF GRANULAR INFILL INTO THE OUTER CELLS IS ACCEPTABLE.

REINFORCED WALL SYSTEMS

1. INSTALL GEOSYNTHETIC REINFORCEMENT BETWEEN GEOWEB SECTIONS AT THE SPECIFIED ELEVATIONS. PLACE THE LEADING EDGE OF THE GEOSYNTHETIC AT THE FRONT FACE OF THE GEOWEB SECTION TO BE PLACED AND EXTEND THE SPECIFIED DISTANCE (I.E. LENGTH) OVER THE COMPACTED BACKFILL. ENSURE THAT THE GEOSYNTHETIC REINFORCEMENT IS PLACED WITH THE HIGH STRENGTH DIRECTION PERPENDICULAR TO THE WALL FACE.

2. PLACE AND INFILL THE NEXT GEOWEB SECTION ON TOP OF THE GEOSYNTHETIC REINFORCEMENT.

3. MANUALLY TENSION THE GEOSYNTHETIC AND HOLD TAUT (TEMPORARY STAKES OR OTHER METHOD) DURING PLACEMENT OF THE SPECIFIED BACKFILL SOIL.

4. PLACE BACKFILL MATERIAL WITHIN REINFORCED SOIL ZONE IN 200 mm (8 in) LIFTS AND COMPACT TO A MINIMUM 95% OF SPDD. ENSURE THAT THE GEOSYNTHETIC REINFORCEMENT REMAINS TAUT AND IS NOT DISPLACED WHILE PLACING THE BACKFILL MATERIAL. THIS IS BEST ACCOMPLISHED BY PLACING THE BACKFILL AT THE BACK OF THE GEOWEB SECTIONS AND SPREADING TOWARD THE BACK OF THE REINFORCED SOIL ZONE. SHAPE AND COMPACT THE BACKFILL LEVEL WITH THE TOP OF THE GEOWEB SECTIONS PRIOR TO PLACING THE NEXT LAYER.

5. PLACE AND COMPACT RETAINED SOILS (FILL SITUATIONS) BEHIND THE REINFORCED SOIL ZONE IN 200 mm (8 in) LIFTS AND COMPACT TO A MINIMUM 95% OF SPDD.

REGISTERED PROFESSIONAL ENGINEER GEORGE C. RAU NO. 21908 EXP. 9-30-09 CIVIL STATE OF CALIFORNIA

BY	REVISION	DATE

DRAWING: DETAILS TYPICAL GEOWEB SECTION

PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482

OWNER: BOWER LIMITED TRUST BOWER LIMITED PARTNERSHIP

LOCATION: 39200 - 39250 S. HIGHWAY 1 GUALALA, CALIFORNIA

DATE:	April, 2008
SCALE:	AS SHOWN
DRAWN:	DRA
CHECKED:	GCR
JOB NO.	R05024
SHEET	C600

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

BY:	REVISION	DATE

DRAWING: DETAILS
GEOWEB
PROJECT: SOIL STABILIZATION & DRAINAGE IMPROVEMENTS

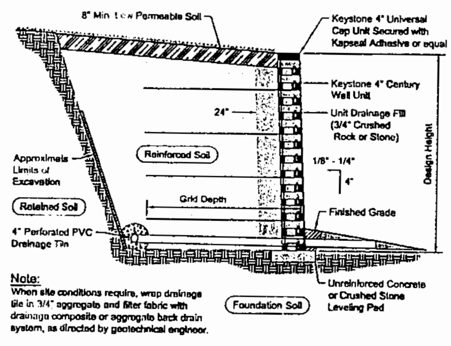
RAD AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE:	JULY, 2008
SCALE:	AS SHOWN
DRAWN:	DSA
CHECKED:	DJS
JOB NO.	R0504
SHEET	C601

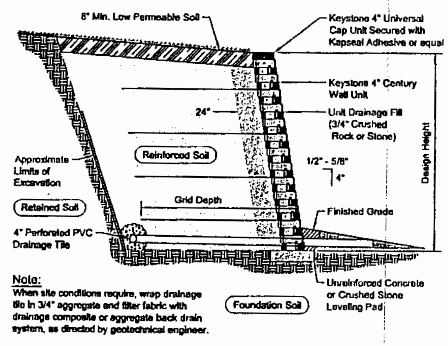
REGISTERED PROFESSIONAL ENGINEER * DAVID C. RAU * NO. 21908 EXP. 6-30-09 CIVIL STATE OF CALIFORNIA

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION



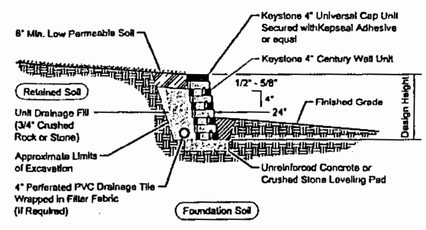
Note:
When site conditions require, wrap drainage tile in 3/4" aggregate and filter fabric with drainage composite or aggregate back drain system, as directed by geotechnical engineer.

Typical Reinforced Wall Section
4" Century Wall Unit - Near Vertical Setback

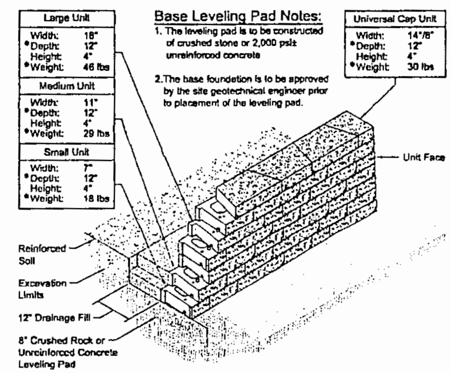


Note:
When site conditions require, wrap drainage tile in 3/4" aggregate and filter fabric with drainage composite or aggregate back drain system, as directed by geotechnical engineer.

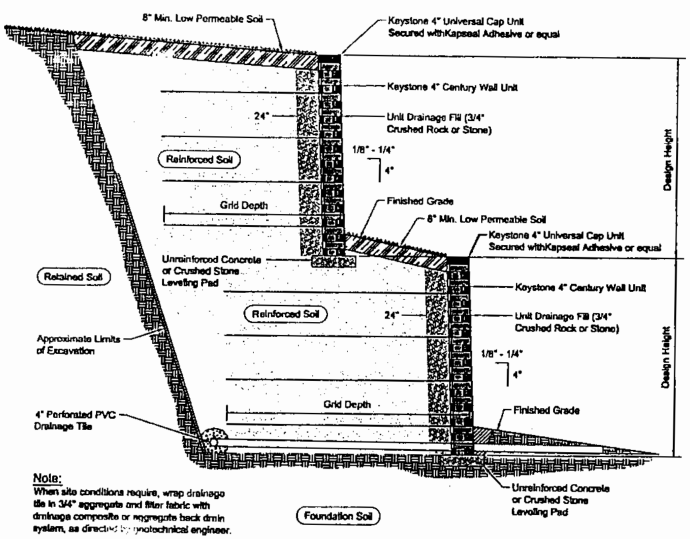
Typical Reinforced Wall Section
4" Century Wall Unit - 1/2" Setback



Typical Gravity Wall Section
4" Century Wall Unit - 1/2" Setback

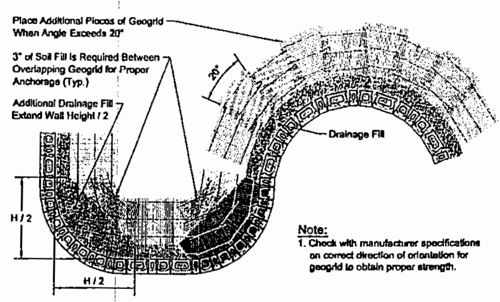


Century Wall Unit/Base Pad Isometric Section View
* Dimensions & Weight May Vary by Region



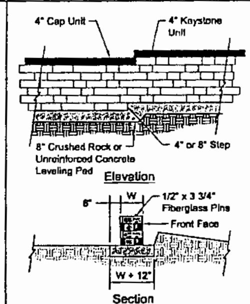
Note:
When site conditions require, wrap drainage tile in 3/4" aggregate and filter fabric with drainage composite or aggregate back drain system, as directed by geotechnical engineer.

Typical Reinforced Tiered Wall Section
4" Century Wall Unit - Near Vertical Setback

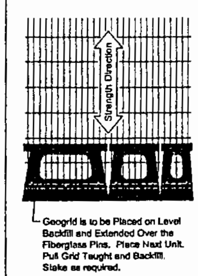


Note:
1. Check with manufacturer specifications on correct direction of orientation for geogrid to obtain proper strength.

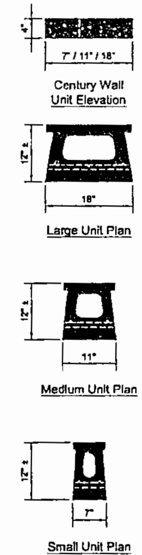
Geogrid Installation on Curves



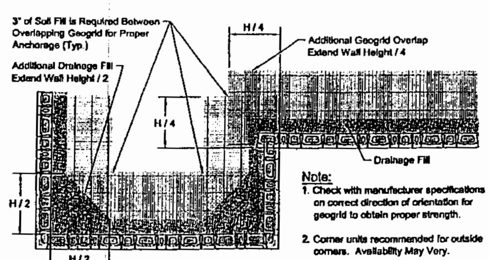
Leveling Pad and Cap Step Detail



Grid & Pin Connection



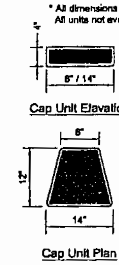
Century Wall Unit



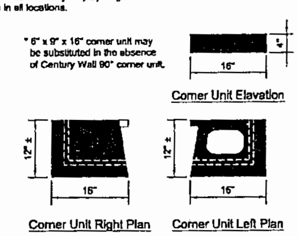
Note:
1. Check with manufacturer specifications on correct direction of orientation for geogrid to obtain proper strength.
2. Corner units recommended for outside corners. Availability May Vary.

Geogrid Installation at Corners

* All dimensions are nominal and may vary by Region. All units not available in all locations.



Universal Cap Unit

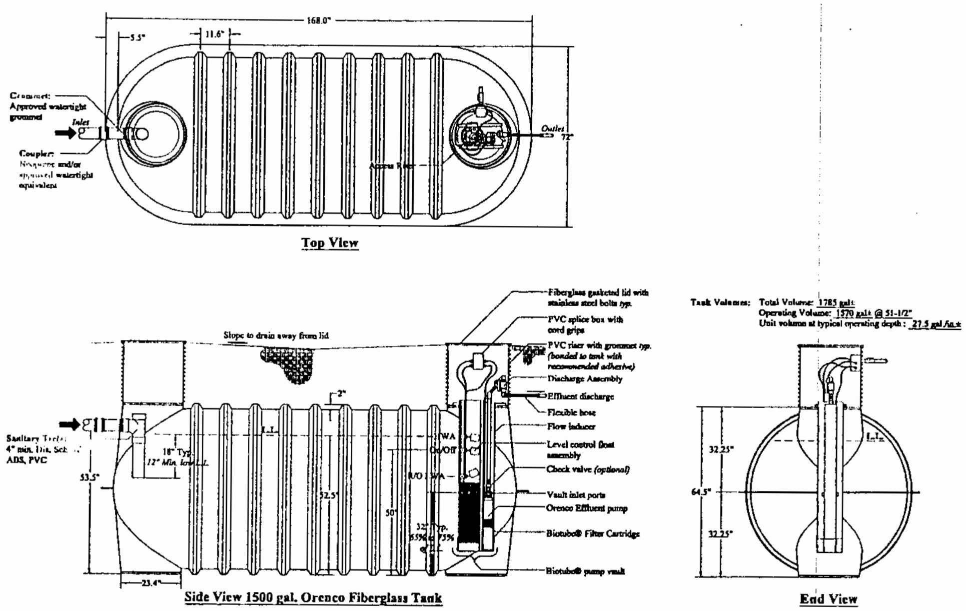


Century Wall 90° Corner Unit

KEYSTONE RETAINING WALL SYSTEMS
A CONTECH COMPANY
4444 W 78th Street
Minneapolis, MN 55435
952-897-1040

REGISTERED PROFESSIONAL ENGINEER GEORGE C. RAU NO. 21908 EXP. 9-30-09 CIVIL STATE OF CALIFORNIA

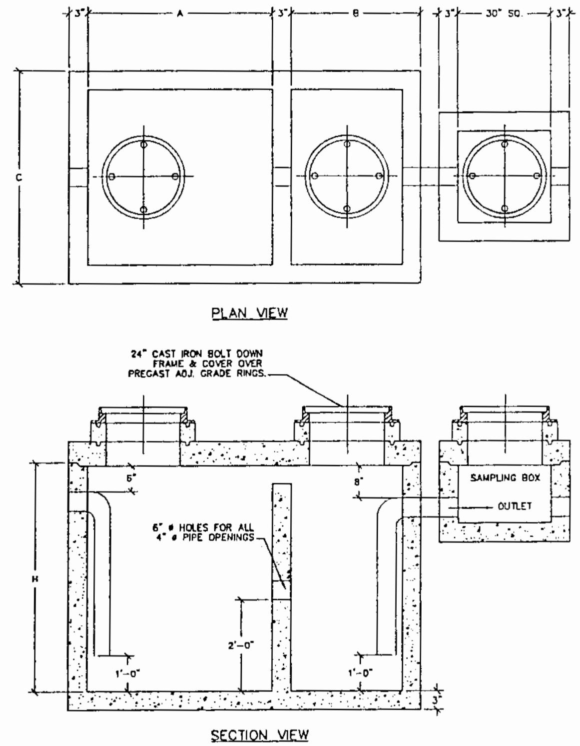
BY:	
REVISION	
DATE	
DRAWING:	DETAILS - TYPICAL KEYSTONE WALL
PROJECT:	SOIL STABILIZATION & DRAINAGE IMPROVEMENTS
RAU AND ASSOCIATES INC.	CIVIL ENGINEERS · LAND SURVEYORS 100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482
OWNER:	BOWER LIMITED TRUST BOWER LIMITED PARTNERSHIP
LOCATION:	39200 - 39250 S. HIGHWAY 1 GUALALA, CALIFORNIA
DATE:	April, 2008
SCALE:	AS SHOWN
DRAWN:	DRA
CHECKED:	GCR
JOB NO.	R05024
SHEET	C610



168.0"
5.5"
11.6"
Grommet: Approved watertight grommet
Inlet
Coupler: Neoprene and/or approved watertight equivalent
Outlet
72"
Top View
Fiberglass gasketed lid with stainless steel bolts typ.
PVC splice box with cord grips
PVC riser with grommet typ. (bonded to tank with recommended adhesive)
Discharge Assembly
Effluent discharge
Flexible hose
Flow inducer
Level control float assembly
Check valve (optional)
Vault inlet ports
Orenco Effluent pump
Biotube® Filter Cartridge
Biotube® pump vault
Slope to drain away from lid
Sanitary Tee: 4" min. Dia. Sch. 40 ABS, PVC
18" Typ.
12" Min. below I.L.
53.5"
23.4"
52.5"
50"
Side View 1500 gal. Orenco Fiberglass Tank
Tank Volumes: Total Volume: 1785 gals
Operating Volume: 1570 gals @ 51-1/2"
Unit volume at typical operating depth: 27.5 gal/in.
32.25"
64.5"
32.25"
End View

ORENCO 2-COMPARTMENT 1,500 GALLON FIBERGLASS TANK

ORENCO SYSTEMS, INC. (800)348-9843



DIMENSION TABLE
(TWO CHAMBERS)

CAPACITY GALLONS	A	B	C	H			WEIGHT POUNDS
560	3'-0"	2'-0"	3'-0"	6'-0"			13,000
785	4'-0"	3'-0"	3'-0"	6'-0"			16,000
1050	4'-0"	3'-0"	4'-0"	6'-0"			18,000
1200	5'-0"	3'-0"	4'-0"	6'-0"			19,700
1500	5'-0"	3'-0"	5'-0"	6'-0"			22,000
2000	6'-0"	4'-0"	5'-0"	6'-0"			25,200
3000	8'-6"	4'-0"	6'-0"	6'-0"			32,000

NOTES :

1. CONCRETE COMPRESSIVE STRENGTH=4000 PSI AT 28 DAYS.
2. REINFORCING STEEL TO MEET THE DESIGN REQUIREMENTS OF H20 TRAFFIC LOADS FOR THE TOP SLAB, AND 50 pcf LATERAL SOIL PRESSURE FOR THE WALLS AND THE FLOOR.
3. CONTRACTOR TO SUPPLY AND INSTALL: PIPE AND FITTINGS, NON-SHRINK GROUT AT THE PIPE PENETRATIONS, JOINT SEAL AT ALL PRECAST JOINTS, WATERPROOF COATING IF REQUIRED.

CP PRECAST TWO-CHAMBER SAND & GREASE INTERCEPTOR
Dwg No. S&G Page No. 8-3, 8-4 N.T.S.

REGISTERED PROFESSIONAL ENGINEER GEORGE C. RAU NO. 21908 EXP. 9-30-09 CIVIL STATE OF CALIFORNIA

DATE: April, 2008
SCALE: AS SHOWN
DRAWN: DRA
CHECKED: GCR
JOB NO. R05024
SHEET C630

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP
LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET · (707) 462-6536 · UKIAH, CA 95482

DRAWING: DETAILS
SANITARY SEWER
PROJECT: SOIL STABILIZATION &
DRAINAGE IMPROVEMENTS

DATE	REVISION	BY

CALIFORNIA COASTAL COMMISSION PERMIT & BIDDING PURPOSES ONLY - NOT FOR CONSTRUCTION

GEORGE C. RAU, P.E.
PRESIDENT
JAVIER J. RAU
VICE PRESIDENT
WALTER HAYDON, P.L.S.
ROGER VINCENT, P.E.
CATHY A. McKEON, P.E.

RAU AND ASSOCIATES INC.

CIVIL ENGINEERS • LAND SURVEYORS

EXHIBIT NO. 6
APPEAL NO.
1-83-270-A1
BOWER LIMITED PARTNERSHIP
REVISED PROJECT DESCRIPTION (1 of 32)

June 16, 2008

RECEIVED
JUN 20 2008
CALIFORNIA COASTAL COMMISSION

Bob Merrill
California Coastal Commission
North Coast District Office
710 E Street, Suite 200
Eureka, CA 95501-1865

Job Number R05024

RE: CDP AMENDMENT APPLICATION NO. 1-83-270-A1 (BOWER LIMITED PARTNERSHIP); ALTERNATIVE GEOWEB DESIGN

Dear Bob:

Tiffany had asked for a project description of the revised design for the above referenced project. We have just completed the revised plans and project statistics (attached). This letter provides further information about the project.

The project has been redesigned in keeping with the associated project to the north currently under your review (Appeal No. A-1-MEN-08-015). The concrete Ultrablock retaining wall that was originally designed to replace the failed wood retaining wall behind the Surf Market has been replaced with a more environmentally friendly technology, Geoweb cellular confinement system (Geoweb), to repair and stabilize the area of the failed wall and debris flow. Geoweb will stabilize the fill without requiring a retaining wall or the use of concrete. The Geoweb technology allows for a more natural looking slope face by having the ability to create contours and quickly establish vegetation on the face of the slope.

After hearing concerns voiced at the Coastal Permit Administrator (CPA) hearing last fall by project opponents regarding the aesthetics of the wall, particularly by the California Native Plant Society (CNPS) regarding the difficulty of finding plants to successfully climb and screen the wall, we revisited the possibility of an alternative design. We had previously considered a number of different retaining structure and slope stabilization designs before we selected the original concrete block design. We reviewed alternative designs again at the request of Coastal Commission staff, and in November 2007 in response to appellant Drouillard, who suggested a variety of different wall designs. Each time we determined that the concrete gravity wall was the only feasible option due to the height of the wall required at the large debris flow behind the Surf Market and for longevity in a harsh coastal environment. Since the wall that had failed was constructed of wood, we selected a material that would have the longest life and would not require maintenance for long-term function.

One of the designs we had previously considered was the Geoweb system. The specifications for this system showed that the maximum height was 20 feet. The section height required for the debris flow behind the Surf Market is over 25 feet. For this reason we dismissed the Geoweb system as an option. Following the CPA hearing in November and upon learning of the Board of Supervisors appeal, we again researched options for a solution that would address the concerns raised by project opponents. We contacted the distributor of the Geoweb system to see if there were any situations in which the wall could be constructed higher than 20 feet. We provided the project plans and detailed site information to a consulting engineer for Geoweb and spent several weeks providing details as they attempted a preliminary design. It was with this level of detailed research that we discovered

that the Geoweb system could work at the Surf Super site with a specially designed, two-tiered wall system.

As you can see from the attached project statistics, when compared to the original concrete block structure, the Geoweb system significantly reduces the project footprint, grading volumes and vegetation removal, while providing a completely vegetated slope face that will blend in with the natural environment. Case studies show this system has been used in other coastal bluff settings and sensitive environments, and is in general use by Caltrans, State Parks and other public agencies. For these reasons we were enthusiastic about the new design and were confident that issues regarding aesthetics and revegetation success would be alleviated by using Geoweb technology.

Information about Geoweb technology is attached. Additional product information, case studies and photos can be viewed at the distributor's website: http://www.sspco.com/geoweb/geoweb_earthret.html.

Plans for the alternative design are attached for your review. The rest of the project, including drainage improvements and stormwater treatment facilities remains unchanged. There are minor changes in the location of interceptor tanks, as shown in the plans. We have added some details at the south end of the project site including stairs to the footbridge and a small retaining wall for the stairs.

BENEFITS OF THE NEW DESIGN

The new design will have a smaller footprint in that the limits of disturbance will not be as close to the estuary and excavation will not have to extend as far east towards the market. As a result, the amount of existing vegetation that will be disturbed is considerably less. See tables below and project statistics (attached) for changes in grading volumes, excavation area, and revegetation areas, all of which are significantly reduced with the new design[1].

Table 1. Changes in the Extent of Grading and Vegetation Removal[2]

	Original Design (Concrete Block Wall)	Alternative Design (Geoweb System)	Δ	% Δ
Excavation Volume (cubic yards)	2,008	1,376	-632	-31%
Excavation Area (square feet)	7,521	3,547	-3,974	-53%
Revegetation Area (square feet)[3]	6,853	3,171	-3,682	-54%

[1] The figures in Table 1 represent the portion of wall on APN 145-261-05 only. A similar reduction in the extent of grading and vegetation impacts is also noted on APN 145-261-13.
[2] The values in Table 1 are approximate. Values are based on preliminary improvement plans and estimated depth to bedrock, which is variable and cannot be fully known until excavation occurs.
[3] In order to accurately compare revegetation areas for both designs, the estimate in Table 1 does not include planting on the face of the Geoweb. The face of the Geoweb will also be planted with native vegetation, unlike the concrete block wall design which depended on climbing and hanging vine-like species planted at the base and top of the wall.

Table 2. Changes to Construction Activity Zone in Relation to Gualala River

Distance to Mean High Tide (Feet)	Original Design (Concrete Block Wall)	Alternative Design (Geoweb System)	Δ[4]
Maximum Slope Distance	43.1±	69.9±	+26.8 feet
Minimum Slope Distance	28.4±	55.1±	+26.7 feet
Average Slope Distance	35.8±	62.5±	+26.7 feet

Vegetation removal resulting from grading activities will be significantly less due to a reduction in the volume and area of excavation. The extent of vegetation to be removed has dropped from 7,521 ft^2 to 3,547 ft^2, a reduction of 53 percent. The Geoweb is designed so that vegetation can successfully grow on the face of the slope. Cells within the Geoweb are filled with topsoil and planted; vegetation grows vertically from the cells and perforations in the Geoweb material allow for root growth. The overall chances for vegetative success at the site are improved with the new design.

One of the primary concerns raised by project opponents was the appearance of the concrete wall and the ability to successfully conceal it with native vegetation. The new design will allow the face of the slope to be mostly vegetated within 1-2 years. We are consulting with a local restoration organization and a botanist who works specifically with the Geoweb system in order to ensure the proper selection of plant materials for the slope based on a recommended plant list prepared specifically for the Gualala area. We have provided a potential plant list to RCLC and CNPS and will ask for their input about plant selection before designing the revegetation plan.

Increased vegetative cover and more diverse plant life will provide improved habitat for small animals, birds and insects.

The reduced footprint increases the buffer between the construction activity zone and the edge of the estuary by over 26 feet, resulting in a minimum 55-foot buffer between construction activities and mean high tide (exhibit attached).

The aesthetic impacts are significantly reduced. Geoweb technology was designed so that it would, in a short period of time, become invisible in the natural landscape. The protected slope will be mostly vegetated within 1-2 years following construction. Within several years vegetation will completely cover the structure so that it blends with the natural environment. See "after" photos of case studies (attached).

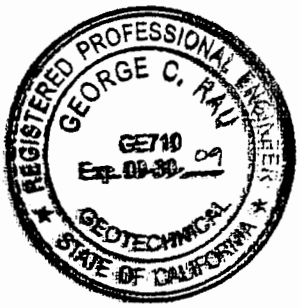
Because the fabric of the Geoweb system is flexible, it can be installed along contours on the face of the fill slope to look more natural. You can see from the plans that we have been able to create a softer, more natural looking edge than we were able to with the concrete blocks. The top of the Geoweb will be between 0" and 8" above finished grade, unlike the concrete wall which extended between 0.5 to 2.0 feet above finished grade. Product materials consist of polymer-based fabric and anchors, aggregate and soil, so there will be no concrete materials near the estuary.

[4] The numbers in this column represent how much farther the construction activity zone will be from the estuary's edge (mean high tide) due to the new project design. Sources: Botanical Survey Exhibit Construction Activity Zone, August 2007 (concrete wall design) and January 2008 (Geoweb design).

If you have any questions regarding the new design please feel free to contact me or George at (707) 462-6536.

Very truly yours,

Julie Price
Environmental Planner



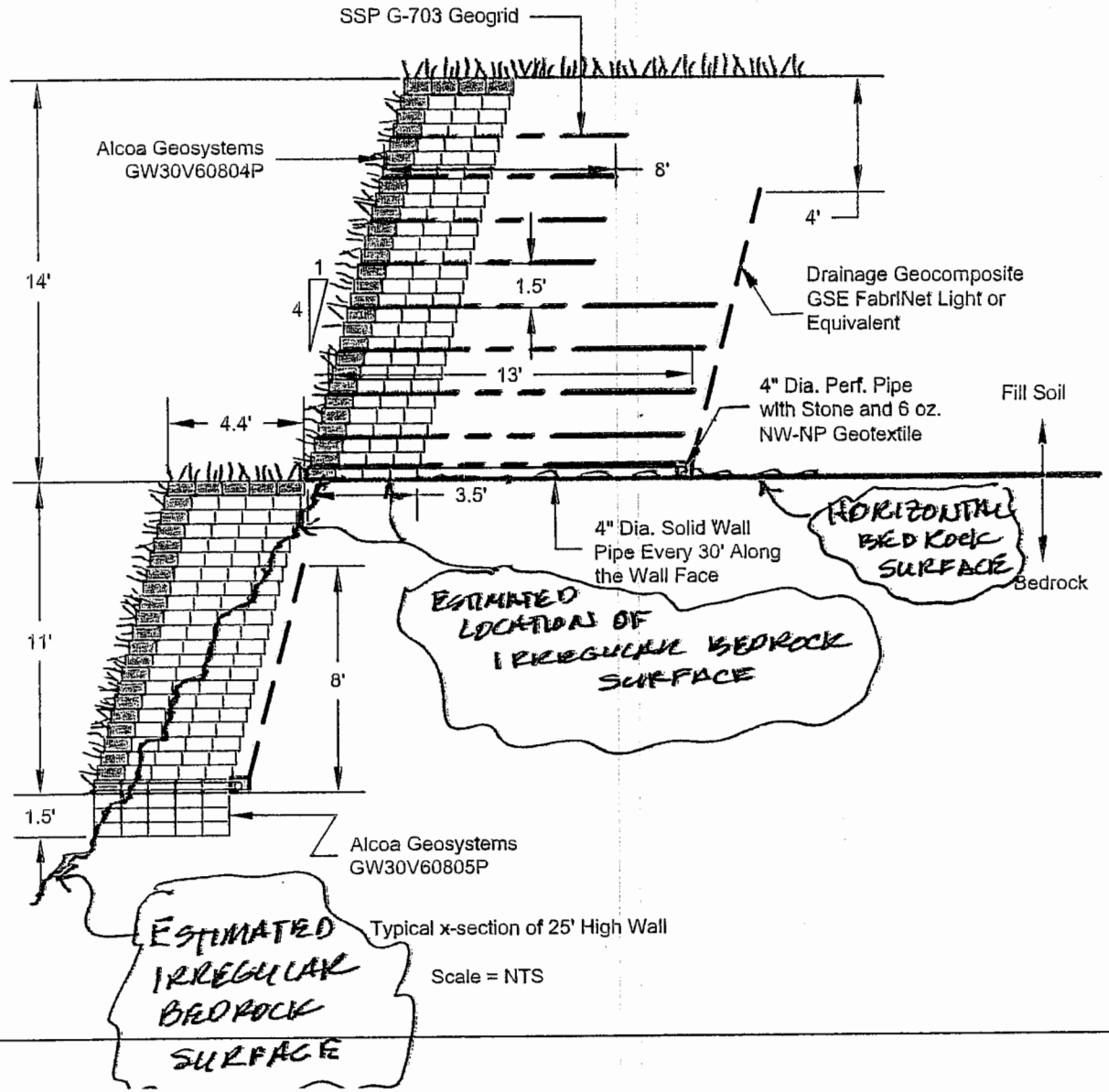
Reviewed by:
George C. Rau
Registered Civil Engineer, C21908
Registered Geotechnical Engineer, GE710
Expires 9-30-2009

CC: John Bower, Bower Limited Partnership
Alan Block, Law Offices of Alan Robert Block

Attachments: (Revised) Project Plans
(Revised) Project Statistics
Construction Activity Zone Exhibit
Geoweb Case Studies
Geoweb Specifications

Notes:

1. Refer to the design report for additional information.
2. This design is based upon the unique characteristics of only genuine Geoweb system components. Accessories utilized for this project and in this design are patented products that are only for use with Genuine Geoweb Cellular Confinement product. Any use of this design for any other product is strictly prohibited.
3. Vary Geogrid dimensions at the same ratio to the wall height as indicated in this x-section.



Typical x-section of 25' High Wall

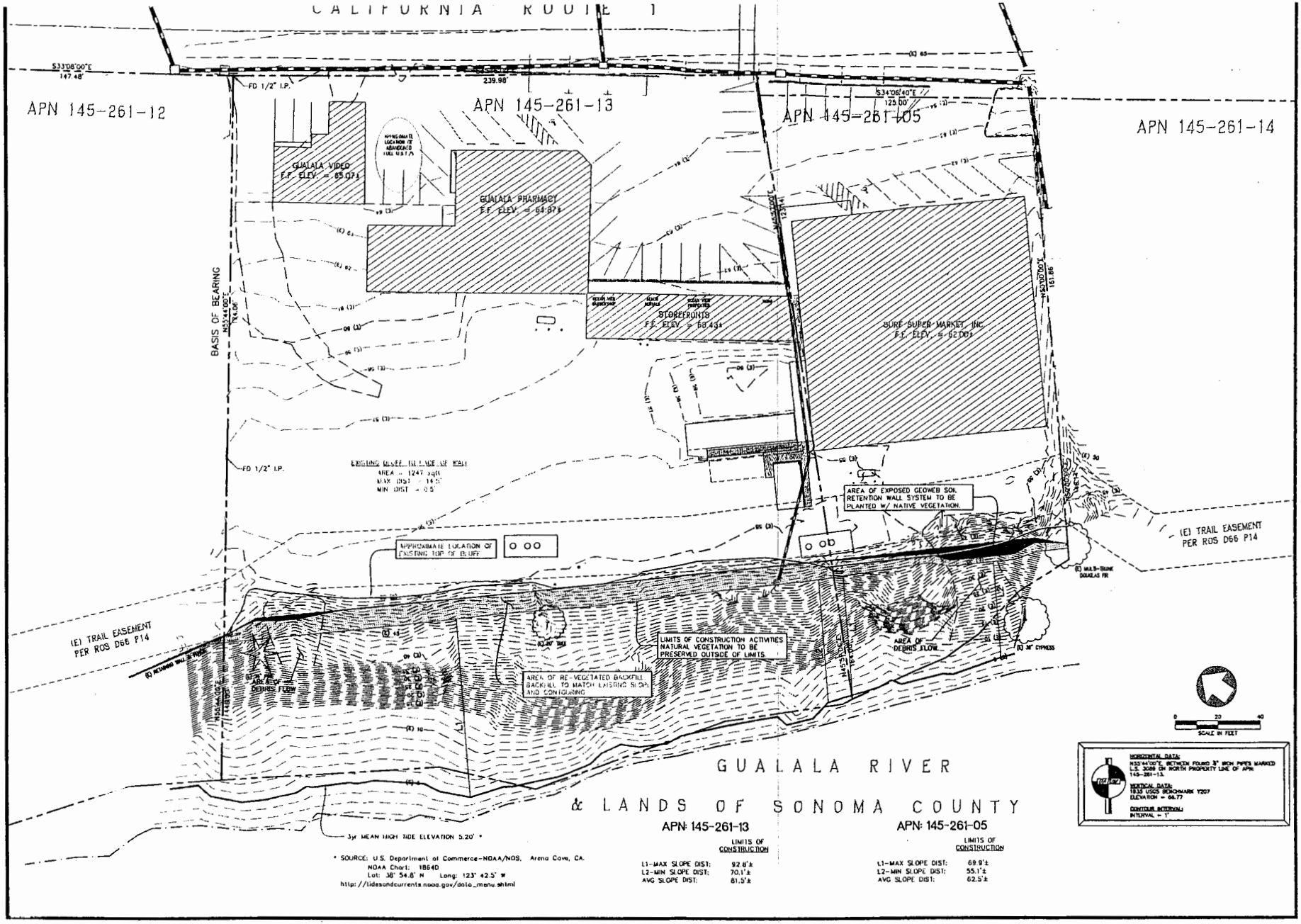
Scale = NTS

Cave Engineering, LLC
9600 Great Hills Trl, Suite 150W
Austin, TX 78759
512-340-2330

Preliminary Drawings
Surf Market Improvements

Designed by: DN
Drawn by: DN

Sheet
1 of 1



BY:	REVISION	DATE
DRA	WALL CROSS SECTIONS	12/4/06
DRA	SHEET 3a AND 3c	11/16/07
DRA	ALTERNATE WALL SECTIONS	01/09/08

DRAWING: BOTANICAL SURVEY EXHIBIT
CONSTRUCTION ACTIVITY ZONE

PROJECT: SURF MARKET IMPROVEMENTS

RAU AND ASSOCIATES INC.
CIVIL ENGINEERS · LAND SURVEYORS
100 NORTH PINE STREET (707) 462-4336 UKIAH, CA 95482

OWNER: BOWER LIMITED TRUST
BOWER LIMITED PARTNERSHIP

LOCATION: 39200 - 39250 S. HIGHWAY 1
GUALALA, CALIFORNIA

DATE: JAN. 2008
SCALE: AS SHOWN
DRAWN: DRA
CHECKED: GDR
JOB NO. R05024
SHEET 1.1

Z:\R05024\Drawings\ISP\LANSETS\Wall Permit App Drawings 07\2006\Botanical Survey Exhibit-1A.dwg, 01/14/2008 9:29:03 AM, 1:2

TABLE C. PROJECT STATISTICS: **Original Design (Ultrablock Concrete Wall) vs. Alternative Design (Geoweb System)**

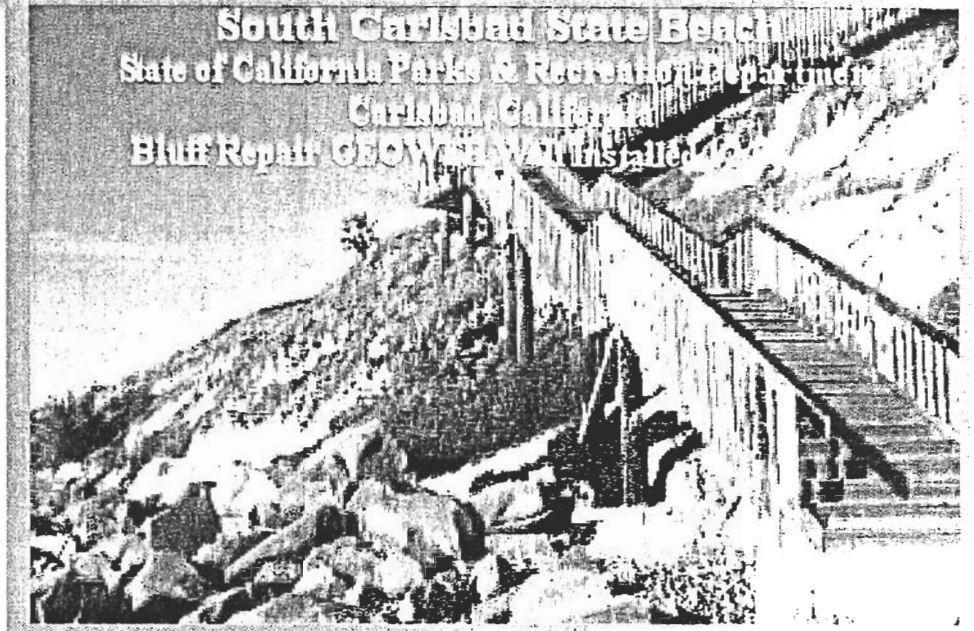
	APN	Original Design (Ultrablock)	Alternative Design (Geoweb)	Δ	% Δ
1. Excavation Volume (cy)	145-261-13	6,024	3,243	-2,781	-46%
	145-261-05	2,008	1,376	-632	-31%
	Total	8,032	4,619	-3,413	-42%
2. Average Depth of Excavation and Wall Construction (ft)	145-261-13	18	13	-5	-28%
	145-261-05	22.5	17	-5.5	-24%
	Total	N/A	N/A	N/A	N/A
3. Maximum Depth of Excavation and Wall Construction (ft)	145-261-13	25	14	-11	-44%
	145-261-05	30	25.0	-5	-17%
	Total	N/A	N/A	N/A	N/A
4. Total Surface Area of Disturbance (Excavation Area) (sf)	145-261-13	23,485	9,508	-13,977	-60%
	145-261-05	7,521	3,547	-3,974	-53%
	Total	31,006	13,055	-17,951	-58%
5. Vegetation Removal (sf)	145-261-13	9,685	4,353	-5,332	-55%
	145-261-05	7,521	3,547	-3,974	-53%
	Total	17,206	7,900	-9,306	-54%
6. Revegetation Area (does not include "wall" face)(sf)	145-261-13	8,343	4,154	-4,189	-50%
	145-261-05	6,853	3,171	-3,682	-54%
	Total	15,196	7,325	-7,871	-52%
7. Average Exposed Surface Area (sf)	145-261-13	2,523	2,288	-235	-9%
	145-261-05	1,175	940	-235	-20%
	Total	3,698	3,228	-470	-13%
8. Average Planted Wall Area (sf)	145-261-13	0	2,288	2,288	2288%
	145-261-05	0	940	940	940%
	Total	0	3,228	3,228	3228%
9. Maximum Height of Structure (ft)	145-261-13	≤25	≤14	-11	-44%
	145-261-05	≤30	≤25	-5	-17%
	Total	N/A	N/A	N/A	N/A
10. Maximum Height of Structure above Existing & Finished Grade (ft)	145-261-13	≤11	≤10	-1	-9%
	145-261-05	≤25	≤18	-7	-28%
	Total	N/A	N/A	N/A	N/A
11. Length of Retaining Structure (ft)	145-261-13	286	286	0	0
	145-261-05	94	94	0	0
	Total	380	380	0	0

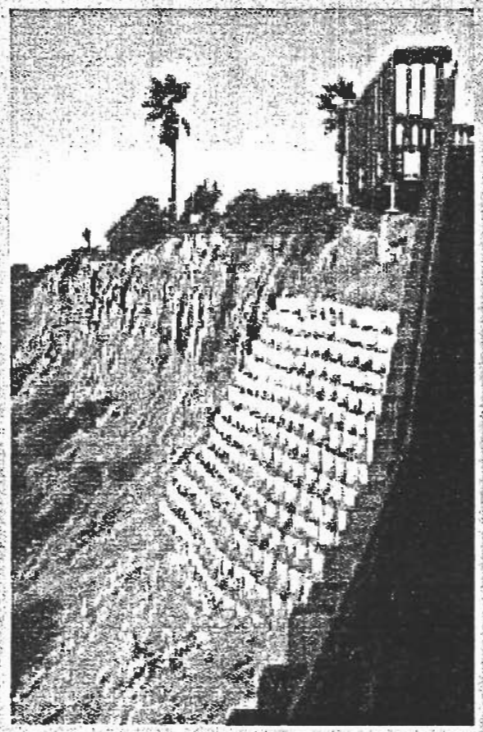
Prepared by Rau and Associates, Inc. June 2008

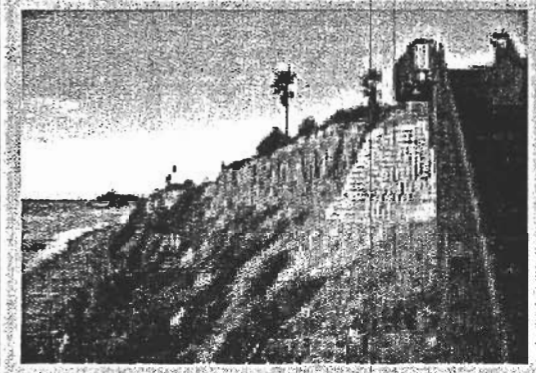
The values in Table C are approximate. Values are based on preliminary improvement plans and estimated depth to bedrock, which is variable and cannot be fully known until excavation occurs.

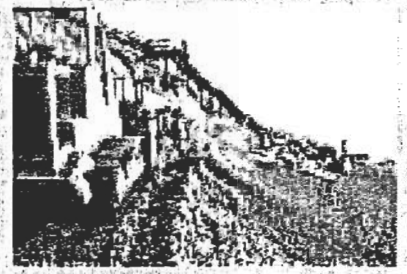
CALIFORNIA COASTAL PROTECTION

Utilizing the GEOWEB® Cellular Confinement System







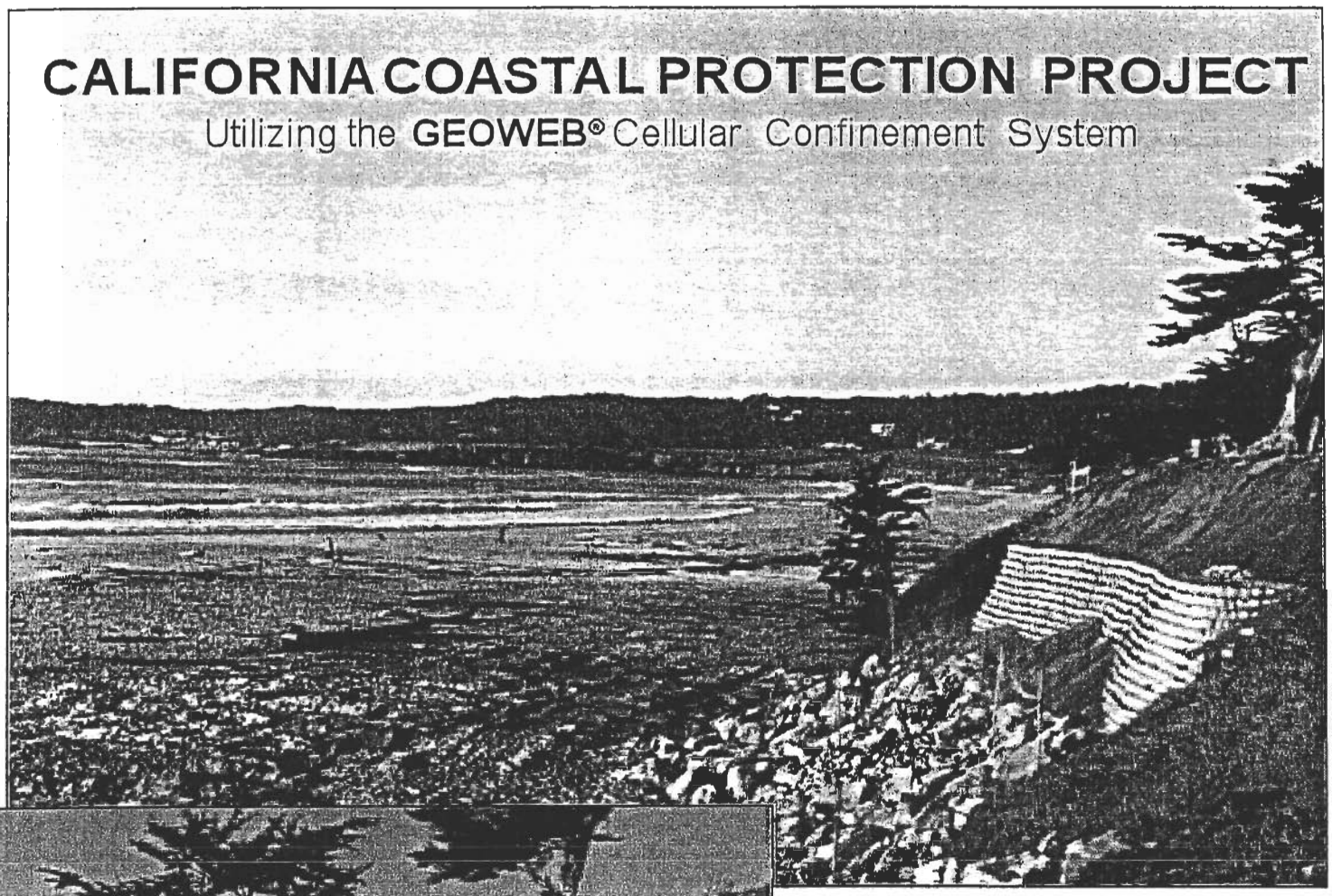


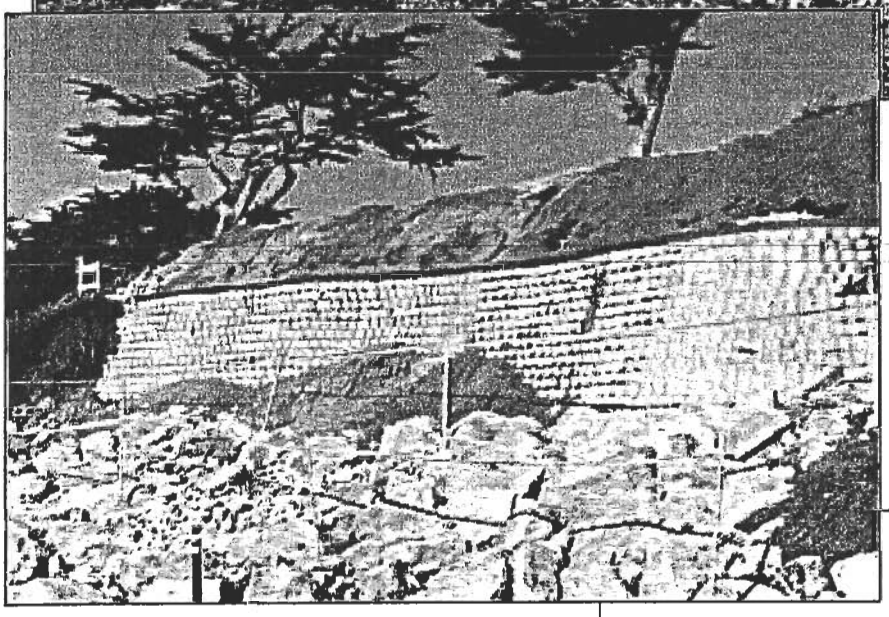
Soil Stabilization Products Company, Inc.
PO Box 2779 Merced, CA 95344-0779
Ph: (800) 523-9992 or (209) 383-3296
Fax: (209) 383-7849 Email: info@sspco.com
Website: http://www.sspco.com

SSPCo®

CALIFORNIA COASTAL PROTECTION PROJECT

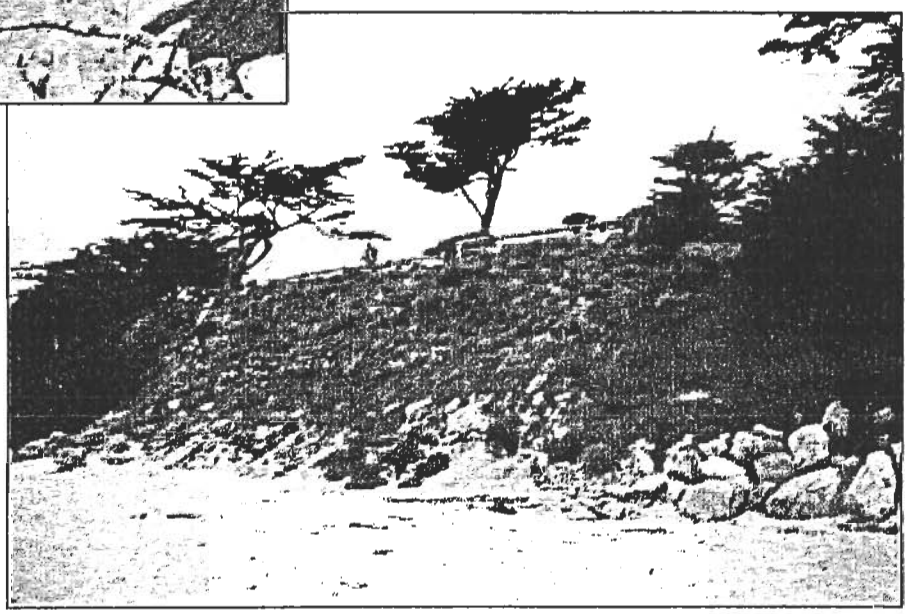
Utilizing the **GEOWEB®** Cellular Confinement System





Owner: City of Carmel
Carmel, California

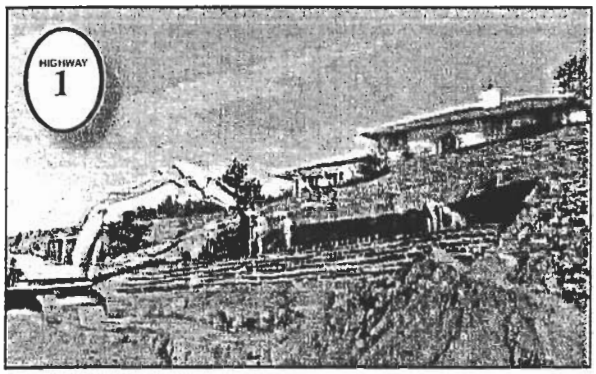
Views of revegetating wall (below), newly constructed wall (left), and newly constructed wall with Pebble Beach beyond Carmel Bay (above)

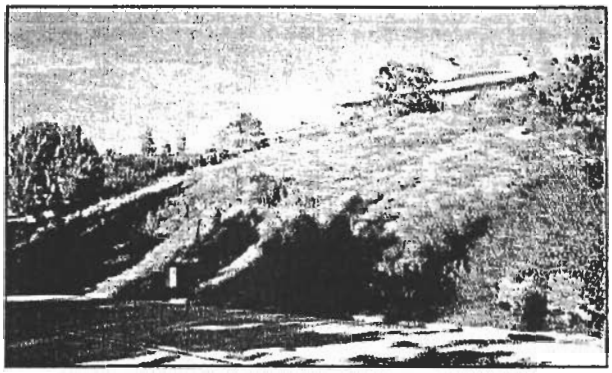


Soil Stabilization Products Company, Inc.

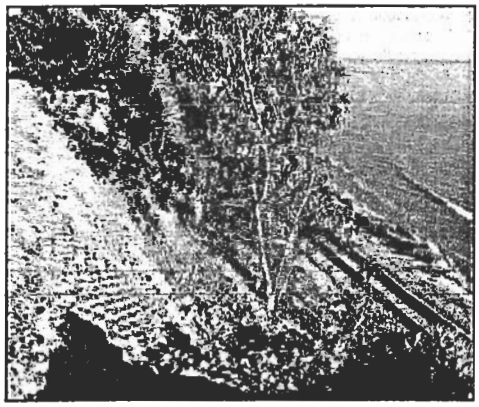
PO Box 2779 Merced, CA 95344-0779
Phone: (800) 523-992 or (209)383-3296
Fax: (209) 383-7849
E-mail: info@sspco.org Website: http://www.sspco.org

1991 Repair of Slope Failure in Watsonville





A saturated soil condition in the winter of '91-'92 that resulted in the failure of a 2H:1V slope on the frontage road serving Highway 1. Because the location of the slope failure was highly visible, immediately downhill from a private residence, and next to a roadway drain inlet, Caltrans engineers needed a repair technique that would control sedimentation problems and be invisible following a season's growth of vegetative cover. The slide area was excavated to competent soils, then a drainage net which routed subsurface water to a perforated 6" diameter drainage pipe was installed. Compacted granular infill was then placed in lifts and the **GEOWEB**® System fascia was installed and infilled with soils that would support revegetation at the face of the slope. The finished slope face received a landscaping treatment which was protected by an erosion control blanket. Monitoring the project in subsequent years, the slope quickly blended in with its surroundings. Now, more than a decade later, the house above provides the only visual clue that can be used to reference the site of the repair.



2002 Coastal Slide Repair

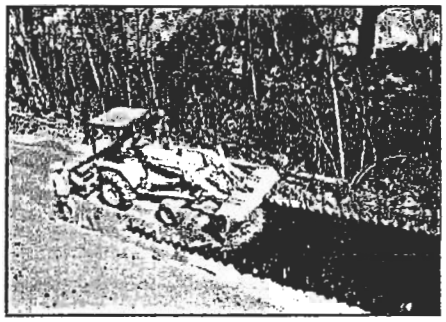
A **GEOWEB** System retaining wall was constructed south of Santa Barbara along the coast in an area known as Summerland. Wedged between Highway 101 and the railroad tracks, this steep and narrow site was an ideal application for a **GEOWEB** System earth retention installation. Designed to support vegetative cover, the tan colored **GEOWEB** System installation will blend well with the natural soil cover until the hydroseeded surfaces establish vegetative cover, much like the installation picture on page 3 at left at Los Trancos Creek.

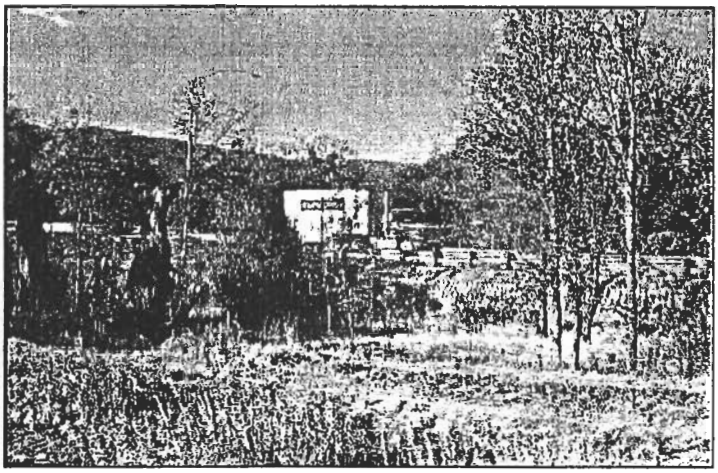
HIGHWAY 101

1995 Highway 101 Retaining Wall

A **GEOWEB** System retaining wall was specified as a means of meeting right-of-way requirements for an onramp to Highway 101 in Santa Margarita. Completed in the fall of 1995, this installation demonstrates the **GEOWEB** System's flexibility in tight building circumstances.

HIGHWAY 101





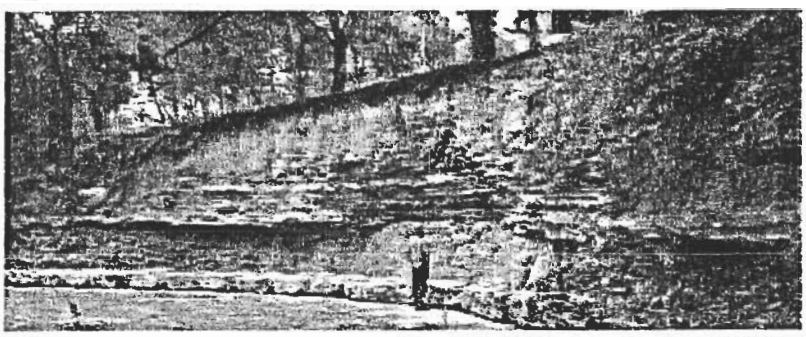
GEOWEB is a registered trademark of Presto Products Company

GEOWEB® Cellular Confinement System

West Bouldin Creek

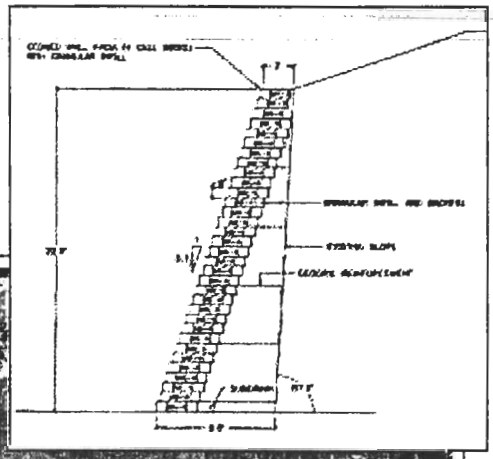
Watershed Protection Program
City of Austin

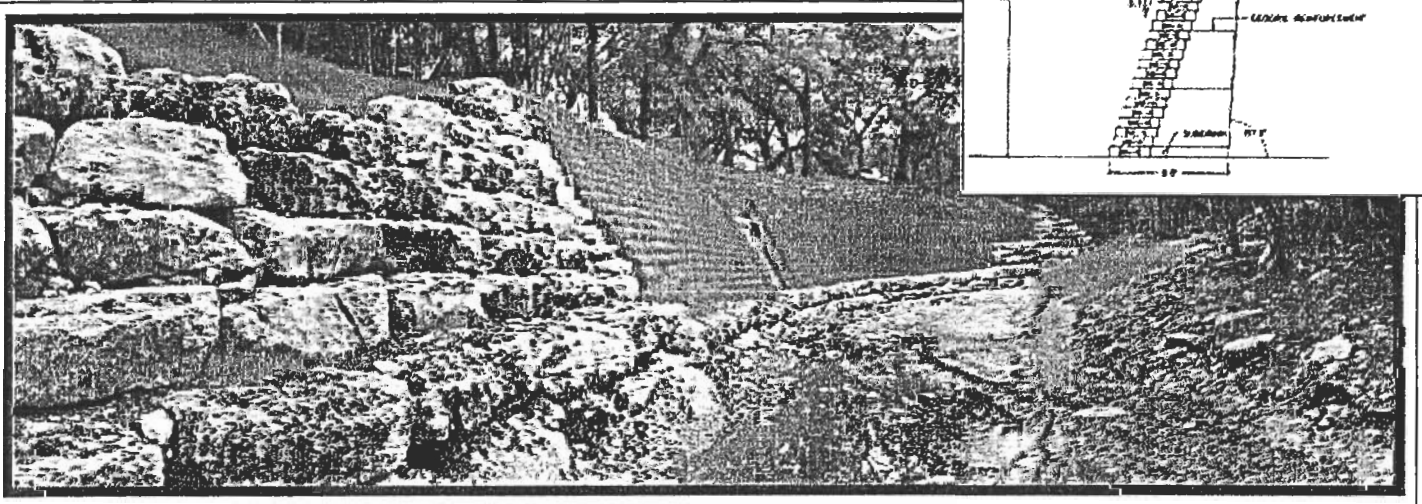
The Watershed Protection Department of the City of Austin is enthusiastic about cellular confinement technology. Though only recently added as a favorite system in their problem solving toolkit, this technology has been applied with dramatic success by in-house personnel in designing and building a 22 foot retaining wall to reinforce an eroding streambank. West Bouldin Creek makes a 90 degree turn at South Sixth Street in Austin which focuses erosive forces on the outside bank of the stream adjacent to the roadway. These focused flows had caused undermining of the more than 20 foot high embankment, and emergency repairs had to be effected before the roadway was impacted. Designers wanted the repair to incorporate a long term solution which could resist these erosive pressures without sacrificing the natural creekside appearance. For this application they chose the GEOWEB Cellular Confinement System over the more conventional gabion basket design.



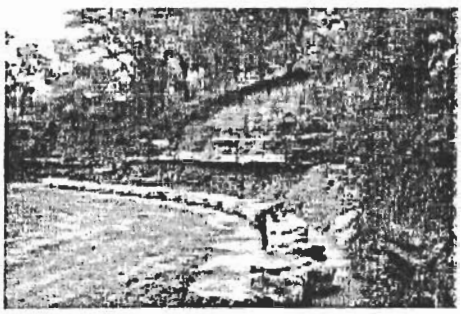
West Bouldin Creek wall prior to installation of the GEOWEB Cellular Confinement System

The GEOWEB Cellular Confinement System design was developed by department engineering staff with product support by SSPCo and preliminary design assistance by Presto Products Company. A sand colored face provided for a natural appearance during revegetation. Perforations in the interior cell walls enabled lateral movement of water out of the interior, and wall batter was designed to accommodate native shrub plantings of sufficient size to speed revegetation.

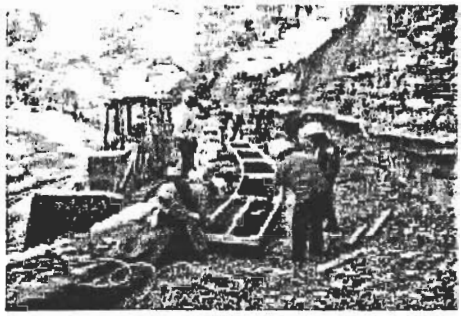




Revegetation of the West Bouldin Creek wall after installation of the GEOWEB Cellular Confinement System

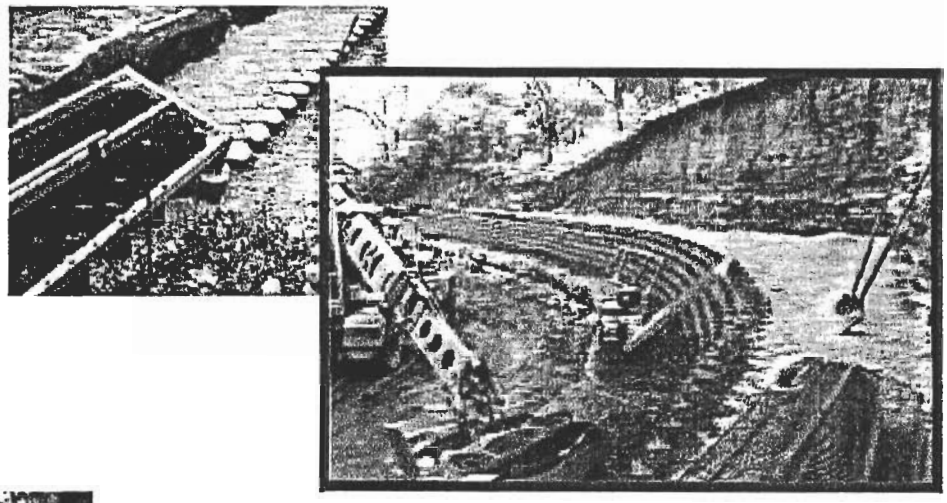


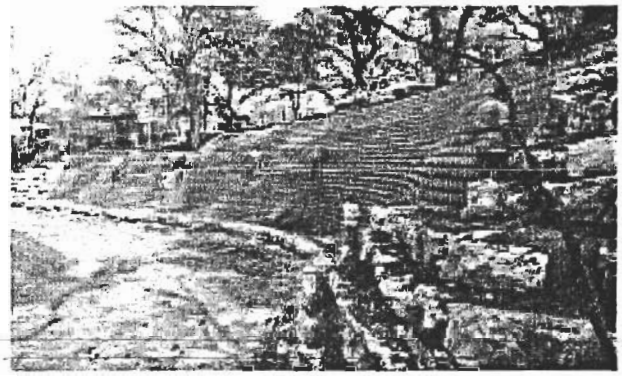
Placing layer of stone at base of wall



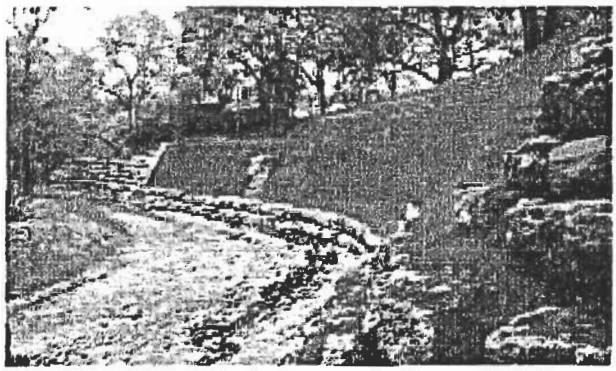
City crews installing the GEOWEB sections

Michael Kelly, watershed engineer, summarized the experience of design and installation, "Though GEOWEB was new to everyone in the department from design staff to the installation crew, with SSPCo assistance and InterSol preliminary design help, we were able to produce a finished product which has amazed everyone and came in at 1/3 the cost it would have been if it had gone out to competitive bid."





Planting native shrubs and grasses in the wall face



Finished wall revegetating just one month after construction

SOIL STABILIZATION PRODUCTS COMPANY, INC.

PO Box 2779, Merced, CA 95344-0779
Phone: (209) 383-3296 or (800) 523-9992 Fax: (209) 383-7849
E-mail: info@sspco.org Website: http://www.sspco.org

City of Austin

Founded by Congress, Republic of Texas, 1839
Municipal Building, Eighth at Colorado P.O. Box 1088, Austin, Texas 78767 Telephone 512/499-2400

Mr. Mel Lee
Soil Stabilization Products Company, Inc.
P.O. Box 2779
Merced, CA 95344

August 23, 1999

Mr. Lee,

I am writing in response to the superior service you have provided to the City of Austin, Watershed Protection Department. Specifically, Soil Stabilization Products Company has provided the assistance necessary for our engineering staff to design a reinforced Geoweb Cellular Confinement System to prevent further erosion of a steep streambank on West Bouldin Creek in Austin, TX.

The site in question has vertical bluffs up to 22 ft. in height adjacent to a roadway. The action of the stream has caused undermining of the bluff. Our project goals are to prevent further erosion of the bluff while maintaining the natural appearance of the streambank. Hard armor designs would satisfy our stability needs, but would compromise the aesthetic of the project. We turned to SSPC, Inc. for advice on the feasibility of a vegetated Geoweb wall to solve our problem. Our staff was familiar with the concept of Geowebs, but had never designed or implemented such a system.

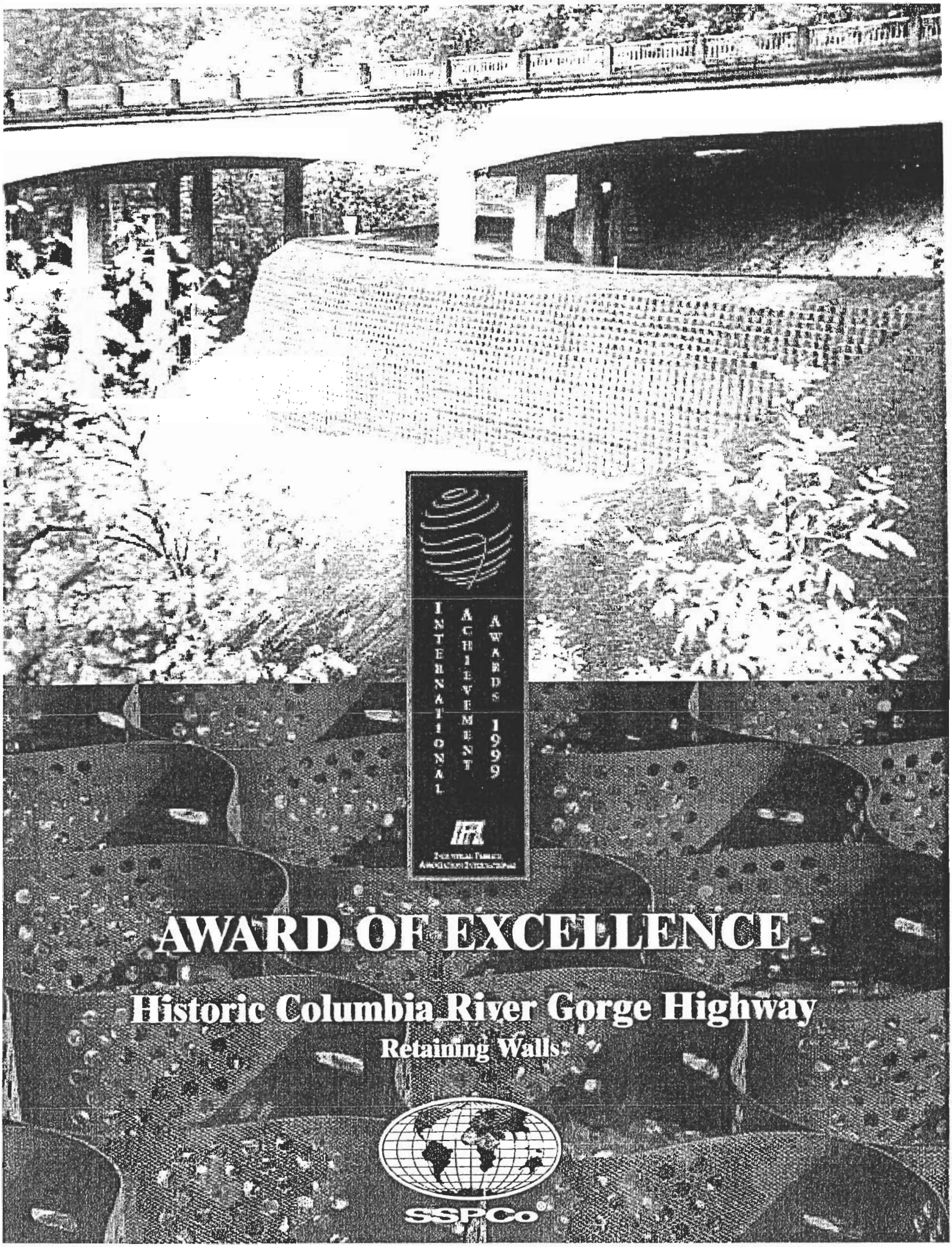
SSPC, Inc. provided the necessary information on material specifications and design aids that allowed our staff to design the steep reinforced system. The most useful service your team provided was the technical assistance provided by both Samuel Landrith and James Walls of InterSol Engineering. With their input, City Of Austin engineers were able to design a structurally sound wall that will be vegetated on the face. Mr. Walls of InterSol engineering performed internal stability analyses that not only corroborated our analysis, but resulted in a more elegant, cost-effective design. Originally, our staff engineers had designed the wall to be all Geoweb. Mr. Walls suggested that the same structural integrity could be attained using geogrid inclusions with a Geoweb facia. Our staff is familiar with using geogrid reinforcements, thus we were pleased to learn that we could integrate geogrid into our design. This design change will facilitate construction of the wall by our crews who are familiar with geogrid, but not Geoweb installation.

Additionally, Mr. Lee, I appreciate the manner in which you provided expeditious project management. Your coordination ensured that we were able to secure all information necessary to design the project and procure the materials in a timely manner. The City Of Austin was acting under emergency action to complete this project before the roadway was impacted.

To summarize, SSPC, Inc. has allowed our engineers to gain the skills needed to design Geoweb walls. This technology is a valuable tool in our constant quest to stabilize slopes while preserving a vegetated face to the public. We will continue to explore other applications of Geoweb systems and look forward to working with your staff on future projects. I will provide photographic and narrative accounts of the project as it nears completion.

Sincerely,

Mike Kelly, E.I.T
City of Austin
Watershed Engineering and Field Operations
WATERSHED PROTECTION DEPARTMENT


INTERNATIONAL ACHIEVEMENT AWARDS 1999
AWARD OF EXCELLENCE
Historic Columbia River Gorge Highway
Retaining Walls
SSPCo

COLUMBIA RIVER GORGE
RETAINING WALLS

This geocomposite earth retention project along the Columbia Gorge highlights an increasing trend toward application of geocell or cellular confinement product technology for fully vegetated protection structures (greenwalls) in situations which were once limited to the use of obtrusive manmade reinforcements constructed of concrete materials, shotcrete, rock rip rap, rock-filled gabion baskets, metal bin walls and sheet pilings, wood crib walls, used automobile tires and other even less desirable materials.

The Tanner-Moffett project, constructed along the Oregon side of the Columbia River is located in a highly scenic natural area where the Columbia River carves through the Cascade Mountains. The Columbia River Gorge was given protection with National Scenic Area status in 1986. The original paved highway, now known as Historic Columbia River Gorge Highway 30, has long since been divided up into isolated sections by the construction of the Bonneville Dam and the I-84 highway. When a plan was proposed to connect two sections of Highway 30 by constructing one mile of highway from Tanner Creek to Moffet Creek, including a bike path and pedestrian way that would eventually become part of a 100 mile trail extending from Portland to The Dalles, lead agency Oregon Department of Transportation (Oregon DOT) took on both the engineering design challenge and a public relations challenge in coordinating the involvement of multiple public agencies. Since the scenic corridor encompasses forests, creeks, waterfalls and shoreline visible from both the Washington and Oregon sides of the Columbia River, Oregon DOT design engineering staff had to coordinate input from the Washington Department of Transportation, the Federal Highway Administration, the US Forest Service, and local county and city governments, while addressing the environmental and aesthetic requirements of the Historic Columbia River Highway Advisory Committee and the Columbia Gorge Commission.

One of the most challenging problems during this phase was the design of a series of switchbacks to gradually bring the bike path from highway level down to the level of the creek at the point where Tanner Creek passes under the bridge. The site provides a spectacular view of the river and the Cascade Mountains in profile. Retaining walls were going to be necessary to keep the newly steepened side slopes in place, but they would have to be attractive and look natural. An earth retention structure using a geocell facia was selected as a more suitable option than gabions. Final design was supplied by Oregon DOT, and the walls were constructed as an FHWA Experimental Feature Project in recognition that this was the state's first experience with a geocomposite wall design of this nature.

Six walls were ultimately required, one more than 16 feet in height. All were constructed with high strength woven geotextile fabrics for soil reinforcement. The **GEOWEB**® Cellular Confinement System was used as the facia and manufactured with a texturized outer face colored green to harmonize with the surrounding landscape until vegetation could be fully established. The **GEOWEB** cells within the interior wall used the standard perforated **GEOWEB** System cell wall design, providing lateral drainage and increased root lock-up for the vegetative cover. A substantial natural spring was discovered behind one of the walls after construction was completed. With the perforated cells within the wall, lateral drainage was already a built-in feature. An underground drainage pipe system was installed to move the water downhill, protecting the slope below the retaining walls from erosion by the focused water flow.

The **GEOWEB** greenwalls were ideally suited for the unique engineering and environmental challenges presented by the Tanner-Moffett project. Oregon DOT engineers are using the design experience gained on this greenwall project to address ongoing earth retention requirements.

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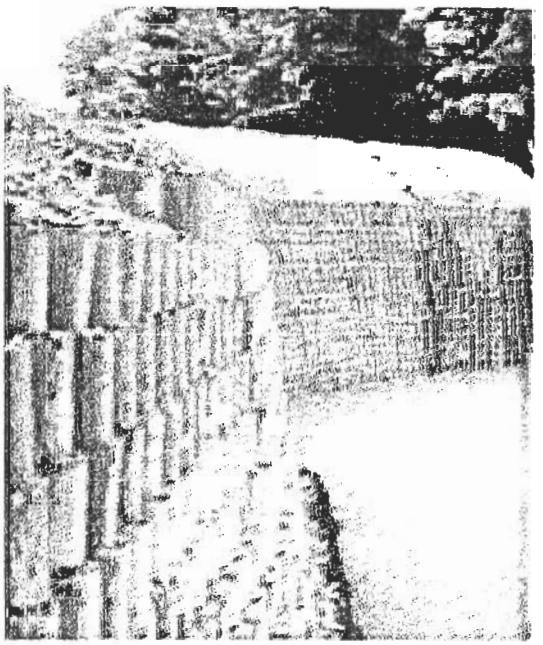

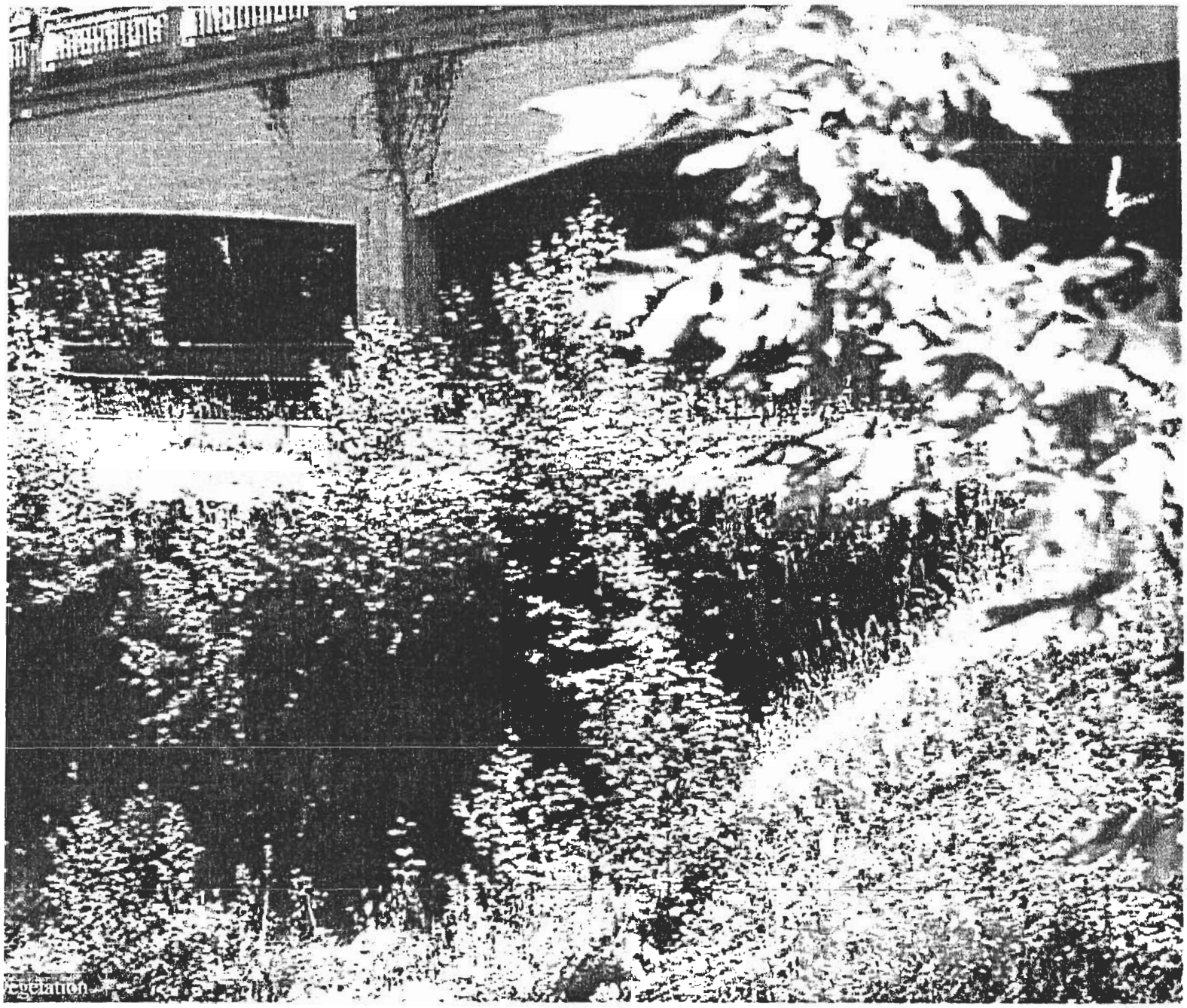

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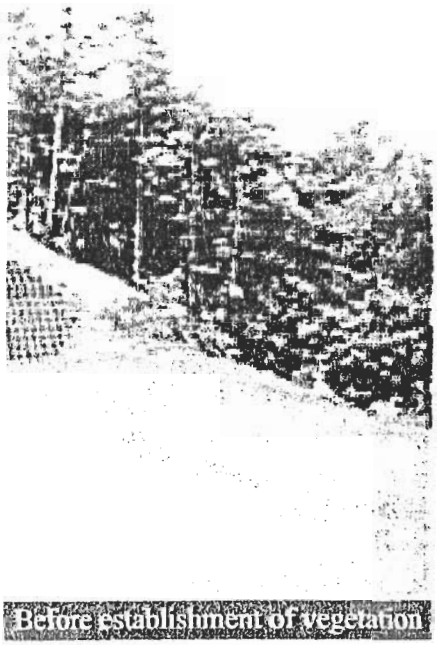
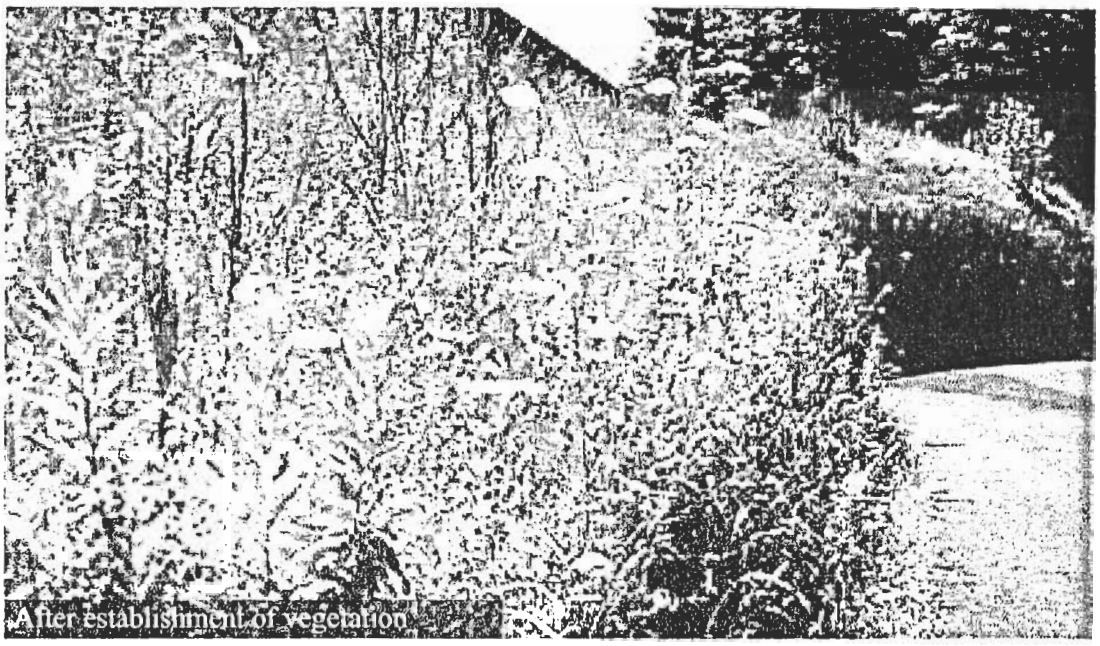
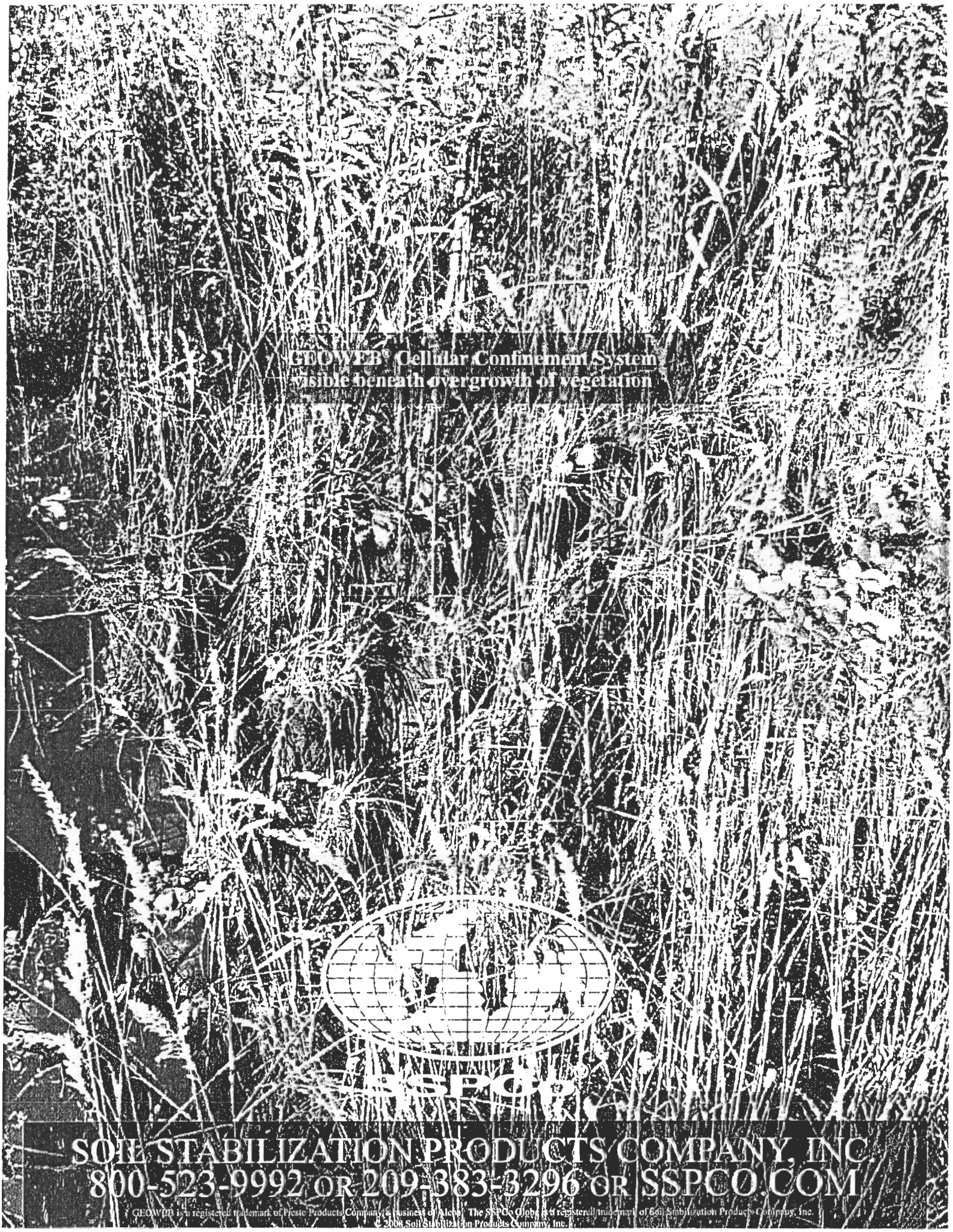


Before establishment of vegetation



After establishment of vegetation

GEOWEB® CELLULAR CONFINEMENT SYSTEM



SOIL STABILIZATION PRODUCTS COMPANY, INC.
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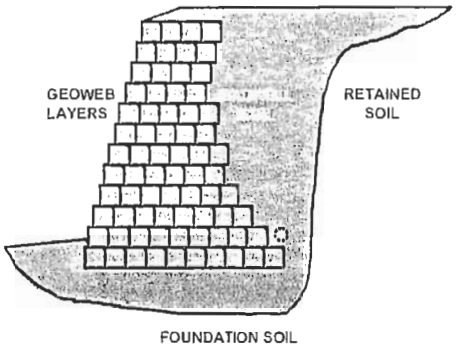
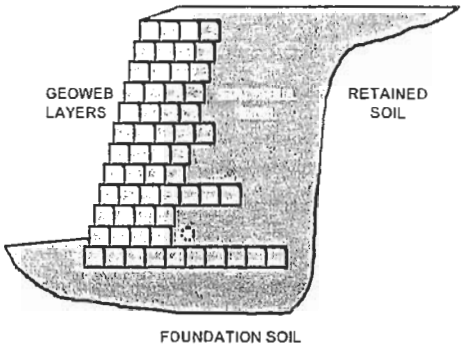
THE GEOWEB® EARTH RETENTION SYSTEM
TECHNICAL OVERVIEW

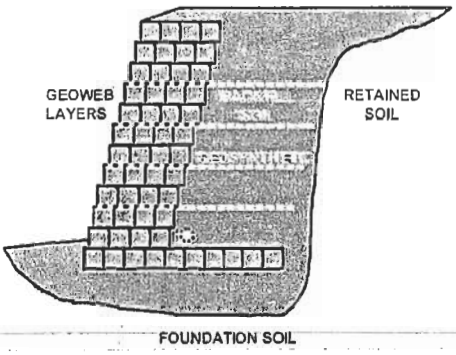
GEOWEB GRAVITY WALL



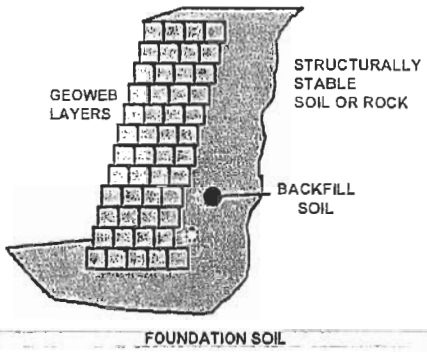
GEOWEB ZONED GRAVITY WALL



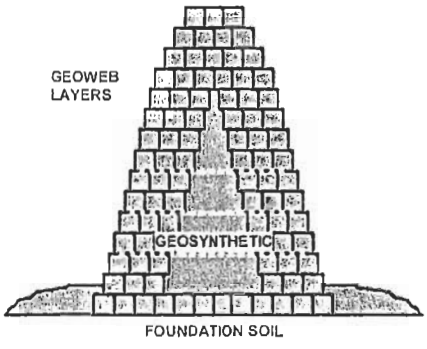
GEOCOMPOSITE GRAVITY WALL



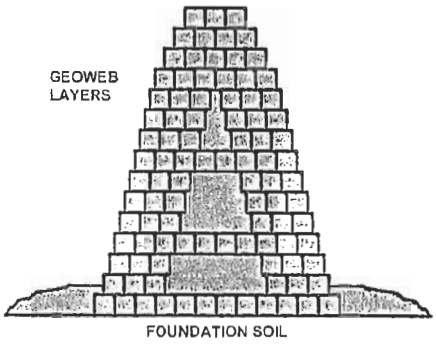
GEOWEB FACIA



FREE-STANDING GEOCOMPOSITE WALL



FREE-STANDING GEOWEB WALL



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THE GEOWEB® EARTH RETENTION SYSTEM TECHNICAL OVERVIEW

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THE GEOWEB® EARTH RETENTION SYSTEM
TECHNICAL OVERVIEW

INTRODUCTION

The use of earth retention structures has expanded in recent years as (1) transportation upgrades are increasingly constructed within existing rights-of-way and (2) development of prime industrial, residential, and commercial property has spilled on to sites requiring additional improvement. The Geoweb cellular confinement system has been specifically developed to meet the challenges that *change-in-grade* construction present, particularly when foundation conditions are predominately compressible soils. The versatility of the Geoweb cellular confinement system is shown on the front page, illustrating the basic earth retention structures that can be formed using the product. Presented here is an explanation of technical and design requirements for selecting the most appropriate Geoweb earth retention structure for your project.

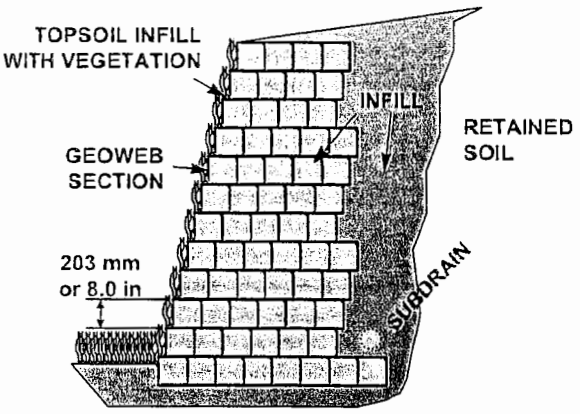

Figure 1 Vegetated Wall

Earth retention structures are commonly incorporated into civil construction work to accommodate irregular topography and to facilitate grade separation. Their use, in place of simple earth slopes, is generally dictated by the severity of grade change and by availability or cost of land within a project site. Typical applications utilizing this technology are:

- Widening within existing rights-of-way
- Adding a lane of traffic or parking
- Grading development sites to boundary limits
- Providing truck or emergency vehicle access
- Expanding sports fields & storage yards
- Reshaping & stabilizing storm water channels
- Building storm water detention structures
- Repair of failed slopes and retention structures
- Safety barriers along transportation corridors
- Energy absorbers
- Noise attenuation walls

A typical Geoweb earth retention structure is illustrated in Figure 1.

The primary function of an earth structure is to provide a very steep, or in some cases vertical surface, which is erosion resistant and structurally stable under its self-weight and externally imposed loads. The near vertical *change in grade* requires that earth materials be stacked higher and steeper than their internal shear strength properties will permit. Consequently, the magnitude of lateral earth pressure, which these earth structures must resist, is directly related to:

- Height of the *change in grade,*
- Internal shear strength of the earth materials,
- Geometry of slope above the structure, and
- Magnitude of any imposed surcharge loading.

Table 1 Geoweb Earth Retention Structure Selection Guidelines

	GRAVITY SYSTEMS		GEOCOMPOSITE SYSTEMS	
Constraints	Full Geoweb	Zoned Geoweb	Geosynthetic / Geoweb	Slope
Wall Heights	< 6.1 m (20 ft)	>3.5 m (12 ft)	> 3 m (10 ft)	>2 m (7 ft)
Limited Excavation Area	Acceptable	Acceptable	Possible	Unfeasible
Foundation Conditions	Competent to Variable	Competent to Variable	Competent to Poor	Competent to Poor
Infill/Backfill Requirements	Granular Only	Granular Only	Granular / Site Soils	Granular / Site Soils
Availability of Granular Fill	Plentiful	Plentiful	Limited to Scarce	Limited to Scarce

The project sites soil conditions, availability of suitable backfill materials, economics and the completed aesthetics govern which Geoweb retention structure would be most appropriate. Table 1 provides a brief summary of the key criteria that favor certain types of Geoweb earth retention structures.

The basic Geoweb system can be readily adapted to a wide range of design requirements and site conditions. The extreme versatility of Geoweb results from its inherent flexibility, unique load-deformation behavior, and suitability with a wide range of infill materials and foundation soils. This permits Geoweb earth retention structures to cost-effectively replace conventional earth retention structures such as:

- Concrete cantilever
- Mechanically Stabilized Earth (MSE) or Earth-anchored systems
- Soldier pile & lagging with or without tiebacks
- Concrete gravity
- Concrete crib
- Timber crib
- Sheet pile

GEOWEB SYSTEM ADVANTAGES

Durability

Retention structures using the Geoweb cellular confinement system provide superior resistance to attack from chemicals, water and freeze-thaw that beset many earth retention systems. Polyethylene plastic used to make Geoweb products is resistant to penetration by water, eliminating any potential for cracking, spalling, splintering, or corrosion that initiates deterioration of concrete, steel, and timber-based earth retention systems. Consequently, the system is well suited to structures that are exposed to seawater, extreme pH soils, or road de-icing salts and chemicals.

Components used in Geoweb earth retention structures are durable. The longevity of naturally occurring aggregate and other soils utilized in Geoweb earth retention structures has been well documented in the engineering literature. Geosynthetic reinforcement used to stabilize backfill soils is manufactured from specially formulated polymers engineered to resist creep and environmental degradation throughout the design life of the structure. By implementing geosynthetic industry standard Task Force 27 design guidelines, a safe working strength, LTDS, for geosynthetic reinforcement can be determined for any design life ranging from 5 to 120 years.

Performance

Geoweb confinement systems provide the most flexible retention structure available today. This flexibility permits Geoweb walls to be constructed over more variable and compressible foundation soils than allowed with conventional earth retention structures having rigid structural facing systems. This flexibility provides the designer and owner of earth retention structures a confined mass that can tolerate large deformation without loss of structural integrity or adversely affecting the aesthetics, especially with vegetated facing treatment. Since the Geoweb facia and soil reinforced system are constructed using similar soils, differential movement is minimized, allowing construction on foundation soils that would require a deep foundation for more conventional retaining walls.

Ease of Construction

Individual Geoweb sections are compact and lightweight. A single forty-foot container can hold the required number of sections to construct 1,240 m² (13,300 ft²) of Geoweb wall face, making shipping costs, even to remote locations, very reasonable. Installers can easily handle the Geoweb sections in all temperatures, making it one of the fastest manually constructed facing systems available. Sections are quickly expanded, positioned, infilled, and compacted by typical construction crews. By extending soil reinforcement, such as geotextiles and geogrids, between Geoweb layers at predetermined elevations, the system becomes an MSE structure.

Infill Materials

Multi-layer Geoweb sections in earth retention structures are generally infilled with select, free-draining granular materials, such as sand, gravel or graded stone. To enhance the erosion resistance, the outer Geoweb cells may be filled with concrete. To enhance appearance, the outer Geoweb cells may be filled with vegetated topsoil (see Figure 1).

The polymer nature of both the Geoweb wall sections and the geosynthetic soil reinforcement also permits the use of some fine grained cohesive soil backfill (i.e., CL, ML, SC with PI<20). Since corrosion of the Geoweb facing or geosynthetic soil-reinforcement-elements is typically not possible, utilization of available cohesive soils is an important factor in the selection and use of soil reinforced Geoweb retaining walls. Use of available site soils generally translates into significant cost savings over other types of soil retention structures. However, site soils must be verified by site-specific engineering for a given project.

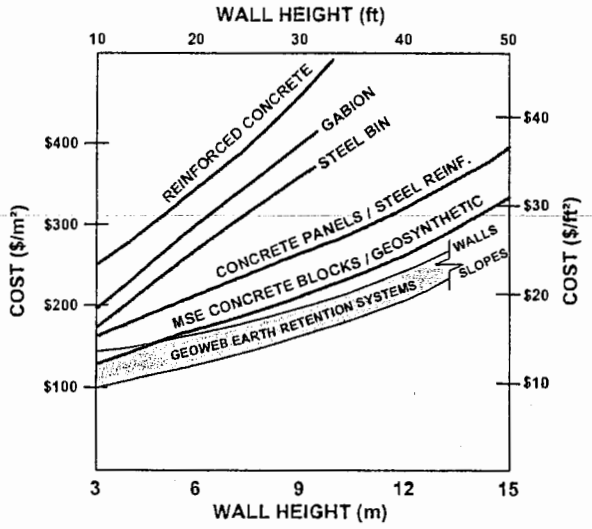

Figure 2 Installed Cost Comparison

Economics

Geoweb retention structures are cost competitive with other conventional earth retention systems (see Figure 2). This graph illustrates that, depending upon wall height, Geoweb retention structures offer a 25 to 50 % cost savings over conventional cast-in-place concrete retaining walls. Although the installed cost for all earth retention systems will vary with site specific conditions such as; accessibility, soil conditions, cost of infill and compaction of infill, labor rates, surcharge loading, length of wall, etc.. This installed cost graph (Figure 2), indicates *relative* cost competitiveness by comparing Geoweb structures built in 1988 with the cost of more conventional earth retention construction methods as compiled by the California DOT in 1986.

Environment

Geoweb retention walls represent an advanced system in protecting the environment. The polymer based products utilized with naturally occurring soils/aggregates comprise a system which is extremely resistant to deterioration. Furthermore, if deterioration begins, the process is slow, and harmful toxin or contaminant by-products are not generated.

The environmental impact of a retaining wall on an area can be visual or even physical, as an obstacle to wildlife. The Geoweb retention wall system minimizes both impacts by blending into the natural environment with vegetated faclngs and different colored (black, tan, green and white) products. The vegetated face treatment also provides a surface which has noise absorbing tendencies.

ENGINEERING CONCEPTS

The Geoweb system is a flexible, three-dimensional cellular confinement system, formed with surface-textured strips of polyethylene. The individual strips are inter-connected by a series of offset, full-depth, ultrasonically welded seams. When expanded, the strips form the walls of an integrated cellular (honeycomb) structure into which selected fill materials are placed and compacted. The engineering properties of the confined mass reflect the inherent strength of the compacted infill material and the high *lateral restraint* provided by the Geoweb cell. The load deformation performance of infilled Geoweb is significantly different from that of an equivalent mass of unconfined infill material. The confining cell structure imparts an *effective cohesion* to the infill material, thereby increasing its *shear strength* and *stiffness*. This improvement results from the *hoop strength* of the cell walls, the *passive resistance* of the adjacent cells and the high *frictional interaction* between the infill and the cell walls (Bathurst & Karpurapu). Consequently, a very efficient soil matrix is created by using the Geoweb cellular confinement system and granular soil infills.

The large frictional resistance between infilled layers permits stacking subsequent layers of Geoweb sections to create a composite structure that behaves as a monolithic gravity mass, which is flexible enough to conform to variable foundation conditions. This frictional resistance allows Geoweb sections to be used either as a self-contained gravity retaining wall or as a narrow, uniform facia system for soil-reinforced retaining walls.

GEOWEB WALL SELECTION

Selection of the appropriate Geoweb earth retention system will be governed by the project constraints shown in Table 1. The first step in systematically evaluating those criteria is to define the wall geometry, surcharge loading, excavation limits, and soil/groundwater conditions at the specific wall location. This is facilitated by generating a plan and profile drawing of the wall to understand its relationship to existing and proposed finish grades. The drawing should contain the location of any proposed or existing structures including underground utilities and property boundaries that may affect wall construction. Based upon wall location (cut or fill), foundation conditions, and the availability/cost of suitable granular infill soils, select the general type of Geoweb retention structure to design; gravity or soil-reinforced. Many combinations can

result using these two basic configurations, with economics and site constraints being the determining factors.

Global Stability

Final selection should be made based upon engineering design of the Geoweb retention structure which must address the major modes of potential failure; external, internal, local, and global stability. *Global stability* (Figure 3) *of the earth retention structures should be addressed by the site geotechnical or civil engineer* and is generally independent of wall type selected.

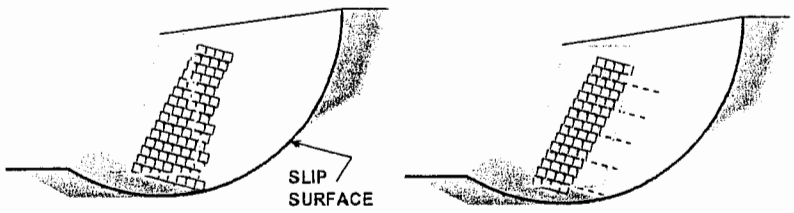

Figure 3 Global Slope Stability

DESIGN GUIDELINES

Following is a summary of the engineering calculations used to analyze gravity (A) and soil reinforced (B) Geoweb walls. The generalized geometric and soil properties for these two types of Geoweb earth retention structures are shown in Figure 4 and Figure 5. The complex calculations for soil reinforced steepened slope design are generally done with computer programs and will not be presented. For a more detailed explanation of these calculations refer to the listed references.

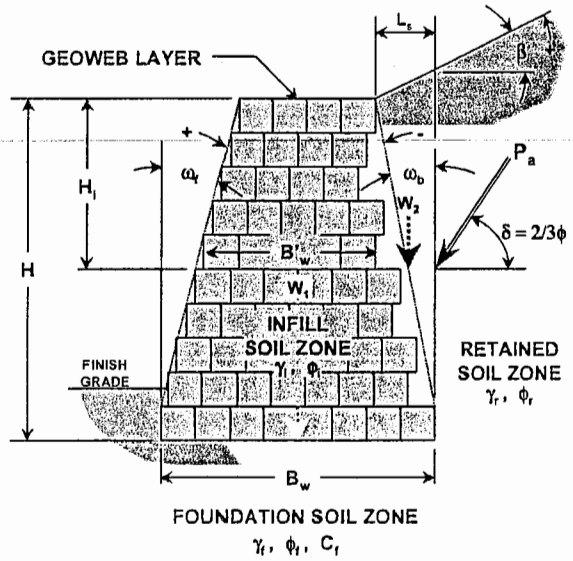

Figure 4 Design Model, Gravity Geoweb Wall

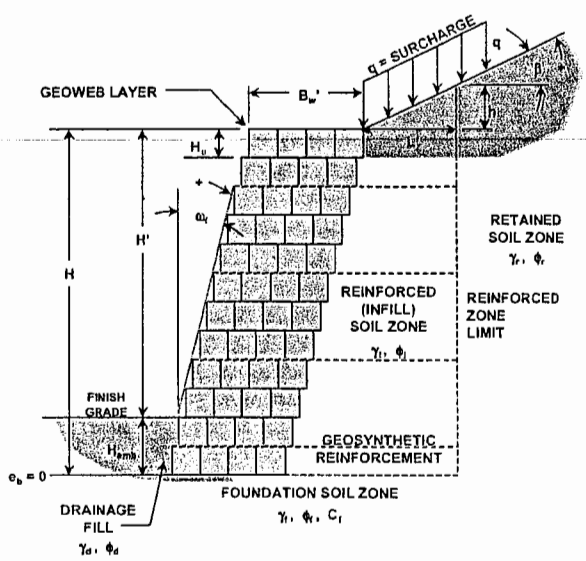

Figure 5 Design Model, Soil Reinforced Geoweb Wall

Step 1 Determine the earth pressure coefficient

Determine the earth pressure coefficient, K_a:

A. For Gravity walls (Full & Zoned) utilize Coulomb earth pressure theory K_a (after Jumikis):

$$K_a = \frac{\cos^2(\phi + \omega_b)}{\cos^2 \omega_b \cos(\omega_b - \delta)\left[1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\cos(\omega_b - \delta)\cos(\omega_b + \beta)}}\right]^2}$$

NOTE: Assume ω_b = 0 for individual analysis of Geoweb wall sections.

B. For Soil Reinforced walls utilize Rankine earth pressure theory, $K_{a'}$ (after AASHTO, FHWA, & Task Force 27):

$$K_{a'} = \cos\beta \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

EXTERNAL STABILITY

The general failure modes for external stability are shown in Figure 6.

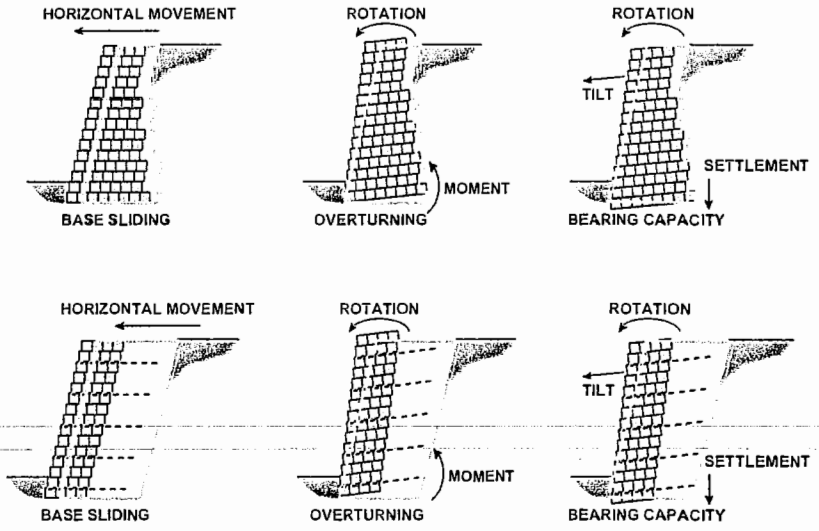

Figure 6 External Stability Modes of Failure

Step 2 Determine the earth forces

Determine the earth forces acting for external stability:

A. For gravity walls use total height of stacked Geoweb sections, H:

$$P_{sh} = 0.5 K_a \gamma_r H^2 \cos\delta$$

$$P_{sv} = 0.5 K_a \gamma_r H^2 \sin\delta$$

$$P_{qh} = K_a q H \cos\delta$$

$$P_{qv} = K_a q H \sin\delta$$

B. For soil reinforced walls use height (H+h) at the back of the reinforced soil mass and $K_{a'}$ based upon ϕ_r:

$$P_s = 0.5\, K_a\, \gamma_r\, (H + h)^2 \cos\beta$$

$$P_q = K_a\, q\, (H + h) \cos\beta$$

Step 3 Determine the weight of the wall

Determine the weight of the wall for sliding resistance:

$$W' = \left[(H B_w) - (0.5 H^2 \tan\omega_f) \right] \gamma_i$$

A. For gravity walls use total weight of stacked Geoweb sections, plus weight of retained soil in front of heel of base layer, plus dead load surcharge in front of heel of base layer.

$$W' = W_1 + W_2 + L_S \gamma_r$$

for $\omega_b \leq 0$, $W = W'$

for $\omega_b > 0$, $W = W' + \left(0.5\, H^2 \tan\omega_b \right) \gamma_i$

B. For soil reinforced walls use entire width of the reinforced zone, L, to resist sliding:

$$W_r = \left[(H L) - \left(0.5\, H^2 \tan\omega_f \right) + \left(0.5\, h L' \right) \right] \gamma_i$$

Step 4 Determine the Factor of Safety against sliding

Determine the Factor of Safety against sliding, FS_{sl}. Conceptually this is the sliding resistance generated at the base of the structure due to self-weight, divided by the lateral forces trying to move the structure outward, as shown in Figure 6. Generally, a FS_{sl} greater than 1.5 is acceptable for design.

A. For gravity walls determine sliding resistance along base width, B_W, using lowest value of ϕ_i or ϕ_f: [ϕ_f used for illustrative purposes]

$$FS_{sl} = \frac{(W' + P_{sv} + P_{qv}) \tan\phi_f}{(P_{sh} + P_{qh})} + c_f B_w \text{ or}$$

$$FS_{sl} = \frac{(W' + P_{sv} P_{qv}) \tan\phi_i}{(P_{sl} + P_{qh})}$$

B. For soil reinforced walls determine sliding along base length of reinforcement, i.e. the width of the reinforced zone, L, using lowest value of ϕ_i, ϕ_d or ϕ_f: [ϕ_f used for illustrative purposes]

$$FS_{sl} = \frac{W_r \tan\phi_f}{(P_s + P_q)}$$

Note: The complexity of the remaining analyses dictates that the calculations be presented on a conceptual basis only. The exact equations will not be presented, but the reader is encouraged to obtain the appropriate reference to review the entire set of calculations for each analysis.

Step 5 Determine the Factor of Safety against overturning

Determine the Factor of Safety against overturning, FS_{ot}. The tendency for the structure to rotate is evaluated by comparing the moments resisting rotation, generated by the self weight of the structure, to the driving moments initiated by the imposed lateral loads. Overturning about the toe of the structure is analyzed to protect against excessive outward tilting and distortion. A FS_{ot} greater than 2.0 indicates suitable performance.

$$FS_{ot} = \frac{\text{Moments}_{resisting}}{\text{Moments}_{driving}}$$

A. For gravity walls determine the moments resisting overturning about the toe of base width, B_W as shown in Figure 4.

B. For soil reinforced walls sum moments about the toe of the structure, along the base length of geosynthetic reinforcement, L, as shown in Figure 5.

Step 6 Determine the Factor of Safety against bearing capacity failure

Determine the Factor of Safety against bearing capacity failure, FS_{bc}. A conventional bearing capacity analysis is performed by comparing the calculated *ultimate* and *allowable* bearing pressure determined from soils testing and analysis by a geotechnical engineer to the calculated *applied* bearing stress using a conservative Meyerhof stress distribution. Generally, a FS_{bc} greater than 2.0 for gravity walls and 2.5 for soil reinforced walls is acceptable.

$$FS_{bc} = \frac{\text{Bearing Pressure}_{ultimate}}{\text{Bearing Stress}_{applied}}$$

A. For gravity walls, determine the applied bearing pressure for the effective base width, B_w after taking eccentricity into account.

B. For soil reinforced walls, determine the applied bearing pressure along the base length of geosynthetic reinforcement, L, as shown in Figure 5.

INTERNAL STABILITY

The general modes of failure for internal stability are shown in Figure 7.

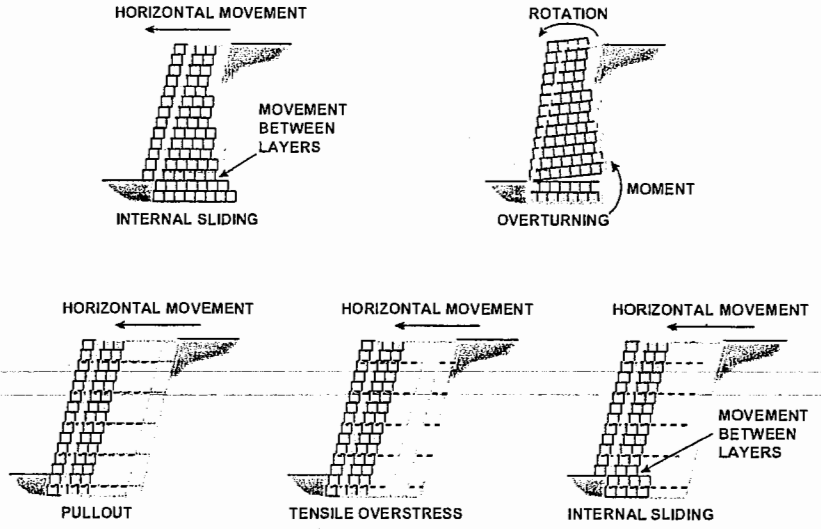

Figure 7 Internal Stability Modes of Failure

Step 7 Determine the Factor of Safety against an internal sliding failure

Determine the Factor of Safety against an internal sliding failure, FS_{sl}. This analysis is very similar to the earlier external sliding analysis, except the sliding surface exits through the Geoweb facia at some point less than the full wall height, H. It ensures that the reduction of Geoweb base width with increasing wall height for gravity walls, and increase in vertical spacing of geosynthetic reinforcement with height for soil-reinforced walls, does not create a more critical sliding surface than the full height of the structure (See EXTERNAL STABILITY, Step 4). Generally, a FS_{sl} greater than 1.5 is acceptable for design.

$$FS_{sl} = \frac{\text{Sliding Resistance}}{\text{Lateral Forces}_{applied}}$$

A. For gravity walls, determine the external applied lateral forces for each incremental height of wall, Hi, as measured from the top of wall to the bottom of each Geoweb layer. Compare that to the sliding resistance of the Geoweb base width, B'_W for that layer, as shown in Figure 4.

B. For soil reinforced walls, determine the external applied lateral forces for each incremental height of wall, i.e. the bottom of each Geoweb layer. Compare the external applied lateral forces to the sliding resistance on the geosynthetic reinforcement, plus the sliding resistance at the layer width, $B_{W'}$ where the potential failure surface may exit, as shown in Figure 5.

Step 8 Determine the Factor of Safety against internal overturning

Determine the Factor of Safety against internal overturning, $\mathbf{Fs_{ot}}$, for each incremental height H_i, using the base width B'_W at each layer level, see Figure 4. A $\mathbf{FS_{ot}}$ greater than 2.0 indicates suitable performance.

$$\mathbf{FS_{ot}} = \frac{\text{Moments}_{\text{resisting}}}{\text{Moments}_{\text{driving}}}$$

A. For gravity walls determine the moments resisting overturning about the toe of each base width, B'_W for each incremental height, H_i, see Figure 7.

This concludes the engineering analysis required for the design of gravity Geoweb walls, except for Step 16. The following analytical steps refer to soil reinforced walls only.

Step 9 Determine the design properties of the geosynthetic reinforcement

Determine the design properties of the geosynthetic reinforcement, consisting of a Long Term Design Strength **LTDS** and a coefficient of interaction $\mathbf{C_i}$. Guidelines for interpreting manufacturer supplied test data on geosynthetic reinforcement and determining design properties are provided in industry standards for geosynthetic reinforcement (Task Force 27, Christopher et. al., & Simac et. al.). The procedures for determining **LTDS** include the partial safety factors for effects of; (1) creep performance, (2) construction induced site damage, (3) chemical durability, (4) biological durability, and (5) other uncertainty factors.

Step 10 Determine the load applied to each geosynthetic reinforcement layer

Determine the load applied to each geosynthetic reinforcement layer resisting the applied lateral stress to maintain internal stability. For internal stability $K_{a'}$ is based upon ϕ_i:

B. For any selected vertical spacing of geosynthetic reinforcement, calculate the contributory area, A_C of each layer from the midpoints between layers above and below it. The applied force to each geosynthetic layer, Fg, will be equal to the average lateral stress at depth D (midpoint) of contributory area, as shown in this equation:

$$\mathbf{F_g} = (\gamma_i D + q) K_{a'} A_C \cos\beta$$

Step 11 Determine the Factor of Safety against tensile overstress

Determine the Factor of Safety against tensile overstress, $\mathbf{FS_{tos}}$. This factor of safety ensures there is sufficient allowable tensile capacity in the geosynthetic reinforcement to resist the applied force. For routine structures the $\mathbf{FS_{tos}}$ is generally considered sufficient when greater than 1.0. However, for more important structures, the $\mathbf{FS_{tos}}$ is usually increased to a minimum of 1.2. The $\mathbf{FS_{tos}}$ is calculated as:

$$\mathbf{FS_{tos}} = \frac{\text{LTDS}}{F_g}$$

B. The $\mathbf{FS_{tos}}$ should be calculated for each geosynthetic layer in the proposed reinforcement layout (vertical spacing) for soil reinforced walls.

Step 12 Determine the Factor of Safety against pullout

Determine the Factor of Safety against pullout of the geosynthetic reinforcement FS_{po} for each reinforcement layer. This factor of safety ensures that the load applied to the geosynthetic reinforcement is transferred to the soil in the anchorage zone, i.e., beyond the internal failure plane. The minimum FS_{po} generally used in design is 1.5. The FS_{po} is calculated as follows:

$$FS_{po} = \frac{AC}{F_g}$$

B. The anchorage capacity, AC for any geosynthetic reinforcement, may be calculated using its pullout properties, C_i, available anchorage length, L_a and depth to the midpoint, d, of the anchorage length as shown in the following equation.

$$AC = 2L_a C_i \gamma_i d \tan\phi_i$$

LOCAL STABILITY

Local stability analyses for the specific modes of failure shown in Figure 8, ensure that the Geoweb facia and soil reinforcement function together as one composite structure.

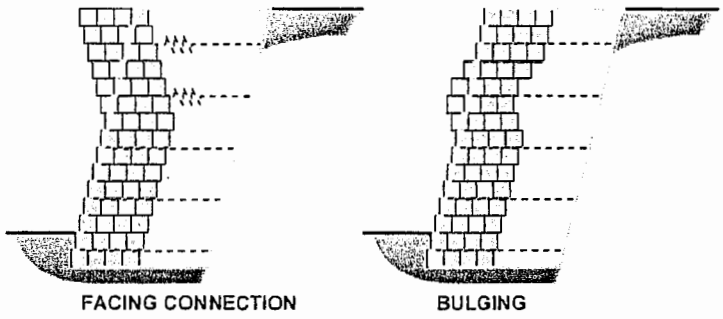

Figure 8 Local Stability Modes of Failure

Step 13 Determine the Factor of Safety against failure of the connection

Determine the Factor of Safety against failure of the connection between the geosynthetic reinforcement and the Geoweb facing, FS_{cs}. Connection strength, C_s, of MSE wall systems are typically determined through full-scale laboratory testing of the specific geosynthetic reinforcement with the MSE facing system (Bathurst & Simac). Based on the granular fills normally used with Geoweb systems, the connection will have a predominantly frictional component and thus can be calculated with a reasonable degree of accuracy. For both critical and non-critical structures a minimum FS_{cs} of 1.5 is considered acceptable.

B. Calculate the factor of safety for connection strength FS_{cs} of each layer as:

$$FS_{cs} = \frac{C_s}{F_g}$$

Step 14 Probability of bulging between layers

The probability of bulging between layers of geosynthetic reinforcement is determined by analyzing the shear capacity between Geoweb layers relative to the applied shear force. The applied shear force at the bottom of any layer is determined as the 'total lateral earth force', less the calculated applied force in the geosynthetic layers above that layer. The shear capacity S_C between Geoweb layers was determined using full scale testing (Bathurst 1987) and is available upon request.

B. The shear capacity S_C should be calculated at the bottom of each Geoweb layer. The factor of safety for shear capacity FS_{sc} is calculated as shown:

$$FS_{sc} = \frac{S_C}{\left(\text{Lateral Force}_{applied} - \sum F_{g(\text{layers above})}\right)}$$

Step 15 Maximum Unreinforced Height

B. The height of Geoweb wall above the uppermost geosynthetic reinforcement layer should be analyzed as a gravity structure to ensure adequate stability against sliding and overturning as described in calculation Step 7A and Step 8A.

Step 16 Properly designed drainage system

A properly designed drainage system is essential to good performance of Geoweb retaining walls. Generally, the granular infill used with Geoweb walls provides a good drainage media for relief of hydrostatic pressure and should be extended 300 to 600mm (12 to 24 in) behind the Geoweb sections as shown in Figure 1. If the retained soil has a finer gradation than the infill soil, it should be protected by a geotextile filter. For submerged walls, coastal structures, or sites with significant groundwater flow, a more comprehensive drainage design may be required.

Available Tools & Services

Presto Geosystems and its authorized distributors offer assistance to anyone interested in evaluating, designing, building or purchasing a Geoweb earth retention system. You may access these services by calling 800-548-3424 or 920-738-1118. In addition to working directly with you, the following information has been specifically developed and available for your use with the **Geoweb Earth Retention System**.

General Overview	Product data, basic engineering concepts and theory for general application of the Geoweb system.
Application Overview	How the system works, specific to the application area.
Case Histories	Specific project information on the design, construction and performance of the Geoweb system for all application areas.
SPECMaker® Specification Development Tool	A software tool available to develop complete material and construction specifications specific both to the application area and to details controlling the specific project.

Design Package

System Component Guideline	A set of tables relating system components to application areas.
Request for Project Evaluation	An application-specific project checklist to ensure all relevant data is collected for detailed engineering design of the Geoweb system.
Material Specification	An inclusive specification for most variations of the Geoweb material, anchoring materials, tendons, etc. See SPECMaker® Tool.
CSI Format Specifications	Comprehensive guide specification & product description of the Geoweb cellular confinement system in the standard CSI format.
Construction Specifications	Available through SPECMaker® Tool.
AutoCAD® Drawings	Drawings in DWG format and paper copy providing all the engineering details needed for plans with the Geoweb system.
Technical Overview	An application-specific, in-depth discourse centered on the theory and application of theory to solving problems with the Geoweb system.

Construction Package

Installation Guideline	An illustrated, application-specific, guideline for installation of the Geoweb system.

Other Resources

Videos	***Advancing Geotechnology*** ***Construction Techniques – Load, Slope & Channel*** ***Construction Techniques – Earth Retention***	Available in Multiple Languages
Technical Resources Library CD	All of the above and more. Requires Microsoft® Internet Explorer 4.0 and Windows® 95 minimum.	
Project Evaluation Service	Available through authorized distributors and representatives for all applications of the Geoweb cellular confinement system.	

Disclaimer

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References

1. AASHTO, *Standard Specifications for Highway Bridges*, AASHTO, Washington, DC, 15 ed., (1992)
2. Bathurst, R.J., and Karpurapu, R., *Large Scale Triaxial Compression Testing of Geocell Reinforced Granular Soils*, Geotechnical Testing Journal, Vol. 16, pp. 296-303, Sept. (1993).
3. Bathurst, R.J., and Crowe, R.E., *Recent Case Histories of Flexible Geocell Retaining Walls in North America*, Recent Case Histories of Permanent Geosynthetic Reinforced Soil Retaining Walls, Tokyo, Japan (1992).
4. Bathurst, R.J. & Simac, M.R., *Laboratory Testing of Modular Masonry Concrete Block-Geogrid Facing Connections*, ASTM Symposium on Geosynthetic Soil Reinforcement Testing, STP 1190, Jan (1993).
5. Berg, R.R., *Guidelines for Design, Specification, & Contracting of Geosynthetic Mechanically Stabilized Earth Slopes on Firm Foundations*, publication of the US Department of Transportation - FHWA, Washington, DC (1993).
6. Caltrans, *Alternative Earth Retaining Systems in California Highway Practice*, (June 1986).
7. Christopher, B.R., et.al., *Reinforced Soil Structures: Volume 1, Design and Construction Guidelines*, Report No. FHWA-RD-89-043, FHWA, Washington, DC, (Nov. 1989).
8. Crowe, R.E., *Steepened Slopes*, presented at The Technical University of Nova Scotia lecture series on Applications of Geosynthetics to Civil Engineering, (1988).
9. Crowe, R.E., Bathurst, R.J. and Alston, C. *Design and Construction of a Road Embankment Using Geosynthetics*, 42'nd Canadian Geotechnical Conference, Winnipeg Manitoba, pp. 266-271, October 1989.
10. Jumikis, A.R., *Soil Mechanics*, D. Van Nostrand Company Inc., New York, NY (1962).
11. Simac, M.R., Bathurst, R.J., Berg, R.R., Lothspeich, S.E., *Design Manual for Segmental Retaining Walls*, National Concrete Masonry Association, Herndon, VA (1993).
12. Task Force 27, AASHTO-AGC-ARTBA Joint Committee on In Situ Soil Improvement Techniques: Guidelines *for the Design of Mechanically Stabilized Earth Walls*, AASHTO, Washington, DC, August (1990).
13. Task Force 27, AASHTO-AGC-ARTBA Joint Committee on In Situ Soil Improvement Techniques: "Design Guidelines for Use of Extensible Reinforcement (Geosynthetic) for Mechanically Stabilized Earth Walls in Permanent Applications", AASHTO, Washington, DC, (1990)