SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
SPECIAL SESSION OF THE BOARD OF DIRECTORS
AUGUST 4, 2022 AGENDA
EAST ANAHEIM COMMUNITY CENTER- CANYON AND OAK ROOMS
8201 EAST SANTA ANA CANYON ROAD, ANAHEIM, CA 92808
ZOOM INFORMATION:
By Computer: https://bit.ly/3yVDheO

By Phone: 1 (669) 900-9128 Meeting ID: 834 1681 7373 Password: 051415

- Agendas and staff reports are posted on the GHAD's internet website (www.santiagoghad.org)
- A complete packet of information containing staff reports and exhibits related to each item is available for public review at least 72 hours prior to a Santiago GHAD Board meeting, or in the event that it is delivered to Boardmembers less than 72 hours prior to a GHAD Board meeting, as soon as it is delivered.

SPECIAL SESSION 5:00 P.M.

1. Call to Order and Roll Call - Chair and Boardmembers:
   Craig Schill, James Guziak, Hillard Kaplan, Hari Lal, and Marc Schwering

   A. Confirmation of Agenda Posting

2. Public Forum: Members of the Public May Comment (3 minutes per speaker)
   At this time, the public is permitted to address the GHAD Board on non-agendized items. In accordance with State Law, no action or discussion may take place on an item not appearing on the posted agenda. The Board may respond to statements made or questions asked or may request staff to report back at a future meeting concerning the matter. Please see "How to Submit Public Comments" on the GHAD's website www.santiagoghad.org.

3. Consent Items
   A. Approval of Minutes
      1. July 14, 2022 Regular Meeting

4. Reports:
   A. Chair and Boardmembers
   B. Plan Review Subcommittee - Boardmember Schill
   C. Standing Legal Committee - Boardmembers Schill and Lal

   D. Charles King Company (Merritt King to participate)
      1. Status of Vertical Wells
      2. Repairs and Well Maintenance
      3. Replacement of Electrical Pedestals
         A. 6836 Georgetown Circle
         B. 997 Vassar Circle

   E. ENGEO Incorporated
      1. Groundwater Level and Extraction: Monitoring and Evaluation
      2. Coordination and Documentation (Website and G.I.S.)

5. Financial Review
   A. Fiscal Year 2021-2022 Preliminary Financials through end of May 2022
   B. Fiscal Year 2021-2022 Quarter 4 Financials

6. Continued Items
   A. Subject: Resolution 2022/12 Accepting the Apportionment Model as Presented in the draft Engineer's Report and Directing ENGEO Incorporated

B. to Complete the Engineer's Report, Incorporating an Appropriate Projected GHAD Budget and Assessment Calculations for Each Parcel for a Possible GHAD Assessment
From: GHAD Manager

C. Subject: Resolution 2022/13 Approving an Assessment Budget for the Santiago GHAD Engineer's Report
From: GHAD Manager

D. Subject: Discussion of Vertical Dewatering Wells DW-23 and DW-25 status along Burlwood Drive
From: GHAD Manager

E. Subject: Discussion of Plan of Control Update
From: Boardmember Guziak

F. Subject: Alternative Proposed Budget and Report Solutions to Engineer's Report
From: Boardmember Lal

G. Subject: Alternative Economics-based Assessment of Special Benefit
From: Boardmember Kaplan

7. New Business

A. None

8. GHAD Manager's Report
A. Santiago GHAD Board Candidate Submissions for November 8, 2022 Election

9. Board Comments and Upcoming Topics of Discussion
A. Directors' Announcements
B. Set Date for Next Scheduled Board Meeting – September 1, 2022

10. Adjournment

SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
SPECIAL MEETING OF THE BOARD OF DIRECTORS
JULY 14, 2022

A Special Meeting of the Board of Directors of the Santiago Geologic Hazard Abatement District (SGHAD) was held on Thursday, July 14, 2022, at the East Anaheim Community Center, 8201 E. Santa Ana Canyon Road and via teleconference. The Meeting was called to order at 4:48 p.m. by the Santiago GHAD Chair, Craig Schill.	CALL TO ORDER

Directors Present:	James Guziak Hillard Kaplan Hari Lal Craig Schill Marc Schwering
Directors Absent:	None
Representing Cardinal:	Karen Holthe, Santiago GHAD Clerk
Representing ENGEO:	Jeff Adams Uri Eliahu Eric Harrell Haley Ralston Matt Swanson
Others Present:	Rudy Emami, Manager, City of Anaheim Dave Fernandez, GHAD Treasurer Approximately 105 other persons attended either in person or via teleconference. All persons addressing the Board are noted herein.

SGHAD Clerk Karen Holthe announced to all present that the Board would be adjourning to a Closed Session to meet with legal counsel regarding the ongoing arbitration matter with the City of Anaheim.	CLOSED SESSION ANNOUNCED
The Regular Meeting was adjourned to the Closed Session at 4:49 p.m. and was reconvened at 5:14 p.m.	ADJOURN/ RECONVENE
Mr. Eliahu reported that during the Closed Session the Board directed legal counsel to request a continuance for the date of the arbitration by approximately 60 days that was to be no later than December 5, 2022.	CLOSED SESSION REPORT
It was confirmed that the Special Meeting agenda had been posted on the street sign at Serrano and Williams Circle, as well as on the SGHAD website, more then 72 hours prior to the Meeting, in accordance with the Brown Act requirements.	AGENDA POSTING
There was a brief delay due to a technical difficulty with hearing the teleconference attendees, so until it was resolved the Board and Staff introduced themselves to all present, as there were many first-time attendees in the Meeting.	INTRODUCE BOD/STAFF

The Public Forum was opened for matters not appearing on the Regular agenda.	PUB. FORUM
Danny Williamson was present to inquire if the SGHAD was the only GHAD with such a limited Plan of Control, and to state that the City should take more responsibility for the matter.	DANNY WILLIAMSON
Brenda Banali was present to inquire how long the groundwater monitoring had been conducted and what happened to the water that was pumped out. Uri Eliahu responded that monitoring had been conducted since the formation of the SGHAD and the records had all been uploaded to the website, and that approximately 50,000 gallons of water per day were being pumped out, but with the mineral content of the water, it was not cost-effective to purify for other uses.	BRENDA BANALI
John Alevizos was present to comment about the Engineers Report and was asked to hold that comment until that agenda item was discussed. He then inquired how many members were in the SGHAD. It was responded there were 303 members of the SGHAD.	JOHN ALEVIZOS
Richard Cherney was present to inquire which of the Board members lived within the SGHAD at the time of the landslide and to state that the value of all residences in Anaheim Hills was negatively affected by the landslide.	RICHARD CHERNEY
Kaye Dabbs-Moyer was present to inquire what was being done to monitor land movement within the SGHAD. Matt Swanson was present and provided details on the monitoring of dewatering wells, horizontal drains, and the inclinometers on a contracted basis, noting there was no current land movement.	KAYE DABBS-MOYER
Jackie Chen was present to inquire whether sellers were required to notify buyers that the property was located within the SGHAD and to state they were never informed about the SGHAD when they purchased their property.	JACKIE CHEN
Ken Corman was present to inquire whether rain affected groundwater levels. The owner was advised that while rain was a factor, there were other factors that contributed to the groundwater levels.	KEN CORMAN
Rudy Emami was present and introduced himself as the Public Works Director for the City of Anaheim. Mr. Emami announced that the City would be hosting an informational meeting within the next couple of weeks to address the membership concerns with the City.	RUDY EMAMI
Scott Lee was present to inquire about the SGHAD Financials. Haley Ralston demonstrated where to find the SGHAD's Financial Statements on the website.	SCOTT LEE
Diana Flores was present and requested the facility Wi-Fi password.	DIANA FLORES
As there were no other members of the public who wished to address the Board on non-agenda items, the Public Forum was closed at 5:50 p.m.	PUBLIC FORUM

A Motion was duly made, seconded, and unanimously carried to move agenda items 4 and 5 to the end of the agenda, and go directly to agenda item 6A, to be followed immediately by items 7A and 7B.	AGENDA ITEM MOVED
Agenda item 6A, the Resolution 2022/12 to accept the apportionment model as presented in the draft Engineer's Report and directing ENGEO to complete the Engineer's Report was discussed. Uri Eliahu conducted a presentation of the allocation approach that had been utilized in creating the Draft F version of the Report. Mr. Eliahu reported that they had reviewed all input from the Board and SGHAD members and elaborated on the most recent revisions which revised the percentages to include 63 percent for those parcels within the landslide area, 18 percent for the groundwater recharge zone, 13 percent for those parcels which receive a seepage control benefit, and an additional 6 percent to all parcels for transportation and amenities factor benefits. Mr. Eliahu presented a brief synopsis of California Proposition 218 and the limitations and restrictions that the law imposed upon the District in what the required Engineer's Report must contain.	RESOLUTION 2022/12 ACCEPTANCE OF ENGINEER'S REPORT
A Public Forum was held to hear comments regarding the Engineer's Report as drafted.	PUB. FORUM
Teri Poitevin was present to inquire whether a diminution in property value should also be considered as a factor in the Engineer's Report. It was explained that the value of any property was not allowed to be considered for a Proposition 218 vote.	TERI POITEVIN
Brian Dougherty was present to express support for the Draft Engineer's Report and expressed disapproval of Director Lal's negative public comments at the June 23, 2022 Special Meeting and allegations of collusion between ENGEO and the City of Anaheim. Director Lal responded that the City's role in the matter should be greater than 9 percent and that he was not trying to compare the SGHAD's conspiracy to the City's conspiracy. Uri Eliahu responded that ENGEO had written the Plan of Control for many GHADs, and for all GHADS they managed in the State of California, that they had nothing to gain from the project, they had no hidden agenda, and that they were looking at facts, considering all input and had made changes to the draft Reports in response to that input.	BRIAN DOUGHERTY/ HARI LAL/ URI ELIAHU
Roger Allensworth was present to state he was not a member of the SGHAD, but that he was a real estate broker and general contractor who sold lots for the developer within the SGHAD in 1985. Mr. Allensworth stated the City of Anaheim was responsible for this problem and it was an unfair situation for the homeowners.	ROGER ALLENSWORTH
Manny Agahi was present to inquire what the City of Anaheim was willing to do about the situation and stated that since the City owned the streets, a street leak was a City problem.	MANNY AGAHI
An unidentified Meeting attendee inquired if any other California GHADs had annual assessments that ranged so widely: from $200.00 to $20,000.00. The response was negative.	ASSESSMENT RANGE

JEANNE RUSSELL

Jeanne Russell was present to urge attendees to read the Plan of Control as she was against any option which required the SGHAD to conduct repairs such as planting or v-ditch maintenance or repairs on private property. Director Schill responded that the current Plan of Control did not include those items.

BRIAN DOUGHERTY

Brian Dougherty stated that there were many viewpoints on the situation and that everyone needed to work together for the greatest good and try to produce a plan that was fair for everyone, noting that with a weighted vote, it appeared that twenty-six homeowners could potentially vote the entire assessment down.

AMANDA ARCHER

Amanda Archer was present to inquire who managed the money for the SGHAD and inquired about annual assessment increases. Uri Eliahu responded that the Board sets a budget which is managed by both the SGHAD manager and the SGHAD Treasurer, and that if the Prop 218 assessment were to pass, a cap would be set annually that was aligned with the CPI Index and the Board could levy up to that cap as needed.

DIANA FLORES

Diana Flores was present to state she was not able to locate any SGHAD By-Laws to ensure they were being followed. Uri Eliahu responded that the SGHAD was a State Agency that had no By-Laws, but that the Board was committed to transparency and had a thorough system of checks and balances in place.

JIM HALL

Jim Hall was present to state he had owned his home since 1978 and after the landslide occurred, property values had dropped by thirty percent overnight. Mr. Hall added that he was supportive of the SGHAD and thankful for the prevention of another landslide, as he had toured the Palos Verdes landslide and stated if there was another landslide within the SGHAD, then the mansions on the hill would be worth nothing.

RICHARD FARANO

Richard Farano was present to show the Meeting attendees a map of his former residence in Anaheim at 4056 E. Maple Tree Dr. and the area directly across the street where a landslide occurred in 2005 and all residences that used to be at that location had been razed and never rebuilt.

RUDY EMAMI

Rudy Emami read a prepared statement detailing that the previous lawsuits had resulted in payments to many homeowners, that the initial funding of the SGHAD in the amount of $3.5 million was approved at the time by the homeowners, and that many of the homeowners who received funding signed a release of future claims against the City. Mr. Emami clarified some statements that had been erroneously made that the arbitration judge did not force the City to split the cost of the Engineer's Report – that was a City decision – and that the $3.5 million was never intended to fund the SGHAD in perpetuity. Mr. Emami stated that other types of Special Districts fund their projects with bonds, such as school bonds, and that the past vote failed because the assessments were all the same, while the current option bases the amounts on special benefits received. Mr. Emami stated that if the Prop. 218 vote failed, the City of Anaheim would not take over the operations of the SGHAD, which was unfortunate because the dewatering system was the means to protect the homes from future landslides, and that Covenants were recorded to prevent future assessments to the City. Mr. Emami additionally stated that the proposed assessment to the City was already at approximately 10 percent which, as he had stated previously, was unprecedented and already legally challengeable. Mr. Emami finished his comments by recommending that the membership not ignore ENGEO and to not concoct a methodology that would be challenged, and while natural disasters happened, the City should not be responsible for those, and concluded with the statement that the City wanted to be part of the solution.

URI ELIAHU

Uri Eliahu made a clarification comment that it was legally possible to have a uniform Proposition 218 assessment, however, that required a 2/3 approval vote to pass.

RICK MOYER

Rick Moyer was present to state that the initial Prop. 218 vote was based on an Engineer's Report with a uniform assessment and that the current consideration of a Prop. 218 vote was based on a completely different Engineer's Report. Uri Eliahu responded by sharing some GHAD and legal history, which was that the assessments were uniform in other GHADS since 1979, in 1996 California passed Proposition 218, and that the 2018 assessment attempt included a broader scope for the GHAD (incl. v-ditch maintenance, post-fire recovery efforts, etc.). After the initial Proposition 218 vote failed in the SGHAD, a legal precedent was set regarding a Malibu GHAD court case and all subsequent, new GHAD Engineer's Reports were then prepared to provide assessment amounts based on specific benefits received.

KAYE DABBS-MOYER

Kaye Dabbs-Moyer stated that ENGEO should take into consideration the two engineer's reports that were written at the time of the landslide to review where the slide would go if it were to reactivate, as it was predicted to extend toward the west.

JAMES GUZIAK/URI ELIAHU

Director Guziak stated that an alternate proposal was about to be presented which alleged that the ENGEO report was flawed. As Mr. Eliahu had to leave to Meeting, Mr. Eliahu reiterated several points of his prior presentation and concluded that if the landslide were to reactivate, it would be worse than it was previously.

MANNY AGAHI

Manny Agahi inquired whose responsibility it was to repair the damage the City streets since Mr. Emani had stated that the City streets were neither parcels nor assessed. Mr. Emani responded that the repair responsibility depended on the specific situation and provided several examples of private maintenance of City streets by commercial businesses in the resort areas.

PUB. FORUM CLOSED

As there were no other members of the public who wished to address the Board on agenda item 6A, the draft Engineer's Report, the Public Forum was closed.

ASSESMT. BUDGET/ HARI LAL

Agenda item 7A, the Alternative Proposed Budget and Report Solutions to Engineer's Report was presented by Director Lal. Mr. Lal reviewed all categories and anticipated expenditures, noting that the proposed assessment budget would differ from the currently approved budget with a reduction in $75,000.00 for legal counsel expenses to reduce the proposed budget draft from $337,646.00 to $262,646.00 per year. It was additionally noted that inflation would need to be addressed on an annual basis which, if tied to inflation rate, would be an estimated 8 percent or $20,960.00 for a total annual budget to be used in the calculation of assessments of $283,606.00.

Agenda item 7B, the Alternative Economics-based Assessment of Special Benefit was presented by Director Kaplan. Mr. Kaplan referenced the forty-two properties that were parties to the Banner lawsuit and the properties of the plaintiffs of the Delmonico settlement and stated that he derived the apportionment of the assessments according to the estimated costs incurred during the prior landslide. Mr. Kaplan stated that ENGEO used no mathematical approach to the Engineer's Report drafts and they were not based on proper economic analysis. Mr. Kaplan continued that the Alternative Assessment he was proposing identified sixty-two properties in the deformation zone, and 252 properties in the seepage zone, with the assessments apportioned 2 to 1, with 30 percent of the assessment cost assigned to the City. Homeowner assessments in the Alternate Assessment plan would range from $290.00 to approximately $2,000.00. Mr. Kaplan concluded by stating that ENGEO did an adequate job as the SGHAD manager but did not have any economic expertise, and that a petition had already been circulated among residents on the landslide, voting down ENGEOs Report.	ALT. ASSESS. PLAN/ HILLARD KAPLAN
A Public Forum was held to hear comments regarding the Alternative Assessment plan as presented.	PUB. FORUM
Brian Dougherty stated that during the last Proposition 218 voting process there were three tiers offered, which also included a provision for reserve funding, noting that a fund for reserves needed to be built up now as well. Mr. Dougherty also stated the assessments needed to be proportionally represented.	BRIAN DOUGHERTY
Amanda Archer stated that the numbers presented assumed the City was paying the thirty percent and inquired of Director Kaplan if the numbers had been run if the City participation was removed. Dr. Kaplan responded that everyone's assessment would be increased by thirty percent.	AMANDA ARCHER
Director Guziak stated that Proposition 218 law requires an "Engineer's Report" be prepared to have a lawful vote, and being that Directors Kaplan and Lal were not engineers, the plan was subject to challenge. Director Kaplan responded that his formula was based on the Engineer's Report but comes to a different result.	JAMES GUZIAK
Yvonne Ybarra was present to state she was in support of Director Kaplan's plan.	YVONNE YBARRA
Jim Hall stated that the advantage to the ENGEO Report was that ENGEO was an impartial third party and inquired what would happen if the vote did not pass. Director Schill responded that arbitration with the City of Anaheim would continue so the future would be dependent upon the outcome of that legal matter.	JIM HALL
Richard Cherney commented that everyone was kidding themselves if they thought the vote would pass with the weighted vote, that it did not pass before because no one had enough information, and that the Board had done a good job at getting information out since then.	RICHARD CHERNEY

Uri Eliahu stated that he had rejoined the Meeting via Zoom while traveling and expressed appreciation for Director Kaplan's presentation. Mr. Eliahu stated that the method of defining the special benefit in Mr. Kaplan's plan was illegal under Proposition 218 and that ENGEO's job was to follow the law, and not to consider the popularity of the outcomes.	URI ELIAHU
Rick Moyer commented that the SGHAD was a peculiar GHAD in that all other GHADs had established assessments when formed and stated that it had been noted in 1992 that underground water was everywhere in the area, with the levels increasing due to irrigation and other factors, and that the 1993 landslide was a reactivated ancient landslide.	RICK MOYER
Manny Agahi inquired where the details of ENGEO's Engineer's Report draft could be located, and everyone was directed to the document location on the SGHAD website.	MANNY AGAHI
The Public Forum was interrupted with a Motion from Director Lal. A Motion was duly made, seconded, and failed to adopt a budget of $339,000.00 to use with the Engineer's Report draft. Directors Guziak, Schill and Schwering were opposed.	ASSESSMT. BUDGET FAILED
The Public Forum continued. Director Kaplan commented that his proposal was not a popularity contest and was based on economics where he had expertise, stating that he was increasing the value of seepage areas. Jeff Adams from ENGEO responded that they appreciated the Director's work and would continue to listen, but Uri Eliahu had pointed out earlier that the alternate assessment method suggested was not legal, stating that geologic hazards run with the land, not at a building footprint, so the approach of using a building footprint was not permitted. The key was to look at the total area. Director Kaplan disagreed, citing that if a landslide started, everyone would have to deal with the landmass and that value did matter. Mr. Adams responded that cost avoidance could not be the sole consideration.	HILLARD KAPLAN/ JEFF ADAMS
Pooyan Bahmani was present to state she owned the largest lot on Kentucky and much of the land was unusable as it was a slope, and that she agreed that the assessments must be legally defensible.	POOYAN BAHMANI
Rudy Emami suggested that everyone must find a middle ground, to not look for arbitrary challenges to the Engineer's report and to vote for a plan that followed the law and legal processes. He stated to assume the City was not involved and suggested that each affected homeowner's associations get involved in the solution as well.	RUDY EMAMI
A Motion was duly made, seconded, and unanimously carried to table all unaddressed agenda items to the next Meeting, tentatively scheduled for July 28, 2022 at 5:00 p.m.	ITEMS TABLED
There being no further business, the Meeting was adjourned at 8:44 p.m.	ADJOURN
Submitted by Karen Holthe, SGHAD Clerk	SUBMITTED

ATTEST: | ATTEST

_______________________________ _______________
Craig Schill, Chairperson Date

DIRECTOR CERTIFICATION | CERTIFIED

I certify that I am an appointed Director of the Santiago Geologic Hazard Abatement District and do hereby certify that the foregoing is a true and correct copy of the Minutes of the Santiago Geologic Hazard Abatement District Board of Directors Meeting held on July 14, 2022, as approved by the Board Members in attendance of the Meeting.

_______________________________ _______________
, Director Date

Santiago GHAD

Balance Sheet

As of May 31, 2022

	May 31, 2022	May 31, 2021
Assets		
Cash		
1030 - Cash SAN - Heritage Bank	36,502	1,351
Total Cash	36,502	1,351
Investments		
1130 - Investments SAN - TD Ameritrade	532,621	895,619
Total Investments	532,621	895,619
Total Assets	**569,122**	**896,970**
Liabilities		
Current Liabilities		
2000 - Accounts Payable	35,581	21,032
2020 - Accrued Expenses	39,301	2,000
Total Current Liabilities	74,882	23,032
Total Liabilities	74,882	23,032
Owners Equity		
Equity		
3000 - Paid-in Capital	1,437,157	1,437,157
3080 - Accumulated Other Comprehensive Income	5,428	5,428
3090 - SYS - Current Year Earnings	(354,721)	(231,458)
3100 - Retained Earnings	(593,623)	(337,188)
Total Equity	494,240	873,938
Total Owners Equity	494,240	873,938
Total Liabilities and Owners Equity	**569,122**	**896,970**

Created Date/Time: 06/17/2022, 15:13 **Start Period: 2022-11** **End Period: 2022-11**

Created By: ADMIN GHAD Treasurer **Ledger: Actual**

GL Variable 2: SAN GHAD Santiago GLVar 2

Santiago GHAD

Profit and Loss vs Budget

11 Months Ended May 31, 2022

	Actual Total	Budget Total	Difference	% of Budget
Total Revenue	0	0	0	
Expense				
Preventative Maintenance & Operations				
6005 - Scheduled Monitoring Events	30,498	43,300	(12,803)	70.43%
6115 - Electrical Charges	17,155	18,000	(845)	95.31%
6150 - Wells, Vaults, Casings, and Elec System	197,182	136,500	60,682	144.46%
6155 - Wells and Drain Maintenance	0	20,000	(20,000)	0.00%
Total Preventative Maintenance & Operations	244,835	217,800	27,035	112.41%
Administration and Accounting				
7005 - Administration and Accounting	51,634	24,000	27,634	215.14%
7105 - Assessment Role and Levy Update Prep	2,564	3,000	(436)	85.47%
7115 - Clerk	6,500	6,000	500	108.33%
7125 - CA Association of GHAD's Member	176	176	(0)	99.86%
7130 - Insurance - Directors and Officers	0	1,300	(1,300)	0.00%
7135 - Insurance - General Liability	1,116	770	346	144.94%
7140 - Legal Counsel	44,731	75,000	(30,269)	59.64%
7145 - Public Outreach	0	5,000	(5,000)	0.00%
7150 - Facilities Rental	0	600	(600)	0.00%
7155 - Management Fees	4,176	4,000	176	104.41%
Total Administration and Accounting	110,897	119,846	(8,949)	92.53%
Total Expense	355,732	337,646	18,086	105.36%
Net Ordinary Income	(355,732)	(337,646)	(18,086)	105.36%
Other Income/Expense				
4200 - Other Income	1,000	0	1,000	
8500 - Investment Income	539	0	539	
8503 - Change in Value of Investment	(527)	0	(527)	
Total Other Income	1,011	0	1,011	
Net Income	(354,721)	(337,646)	(17,075)	105.06%

Created Date/Time: 06/17/2022, 15:13
Created By: ADMIN GHAD Treasurer

Start Period: 2022-01
Ledger: Actual

End Period: 2022-11
Budget Ledger: 21/22 Annual Budget
GL Variable 2: SAN GHAD Santiago GLVar 2

Santiago GHAD

Profit and Loss

11 Months Ended May 31, 2022

	2022-01	2022-02	2022-03	2022-04	2022-05	2022-06	2022-07	2022-08	2022-09	2022-10	2022-11	Total
Total Revenue	0	0	0	0	0	0	0	0	0	0	0	0
Expense												
Preventative Maintenance & Operations												
6005 - Scheduled Monitoring Events	0	3,438	2,483	5,500	0	0	10,490	2,858	3,190	2,540	0	30,498
6115 - Electrical Charges	575	3,085	372	2,412	444	3,230	843	2,398	419	2,783	596	17,155
6150 - Wells, Vaults, Casings, and Elec System	10,125	10,125	10,125	10,125	10,125	10,125	46,751	10,125	53,682	10,125	15,749	197,182
Total Preventative Maintenance & Operations	10,700	16,647	12,980	18,037	10,569	13,355	58,084	15,381	57,290	15,448	16,345	244,835
Administration and Accounting												
7005 - Administration and Accounting	0	4,000	2,000	4,003	10	10	4,017	1,960	8,622	20,762	6,250	51,634
7105 - Assessment Role and Levy Update Prep	0	0	0	0	0	0	1,882	70	613	0	0	2,564
7115 - Clerk	500	0	725	500	825	500	1,000	500	500	700	750	6,500
7125 - CA Association of GHAD's Member	0	0	0	0	0	0	176	0	0	0	0	176
7135 - Insurance - General Liability	0	0	0	0	0	0	0	0	1,116	0	0	1,116
7140 - Legal Counsel	0	3,515	963	0	5,128	4,000	2,862	19,340	4,451	0	4,473	44,731
7155 - Management Fees	538	0	1,015	0	0	938	469	469	374	374	0	4,176
Total Administration and Accounting	1,038	7,515	4,703	4,503	5,963	5,448	10,405	22,339	15,675	21,836	11,473	110,897
Total Expense	11,738	24,162	17,682	22,540	16,531	18,802	68,489	37,720	72,965	37,283	27,818	355,732
Net Ordinary Income	(11,738)	(24,162)	(17,682)	(22,540)	(16,531)	(18,802)	(68,489)	(37,720)	(72,965)	(37,283)	(27,818)	(355,732)
Other Income/Expense												
4200 - Other Income	500	0	0	0	500	0	0	0	0	0	0	1,000
8500 - Investment Income	19	8	155	21	19	13	102	53	45	58	46	539
8503 - Change in Value of Investment	(37)	(13)	(43)	10	(63)	(53)	99	(103)	(252)	60	(132)	(527)
Total Other Income	482	(5)	112	31	457	(40)	200	(50)	(207)	118	(86)	1,011
Net Income	(11,256)	(24,167)	(17,571)	(22,508)	(16,075)	(18,843)	(68,289)	(37,770)	(73,172)	(37,166)	(27,904)	(354,721)

Created Date/Time: 06/17/2022, 15:13
Created By: ADMIN GHAD Treasurer

Start Period: 2022-01

End Period: 2022-11
Ledger: Actual
GL Variable 2: SAN GHAD Santiago GLVar 2

Income/Expense Reporting - Santiago GHAD

11 Months Ended May 31, 2022

GL Account ↑	Account ↑	Sum of Report Amount
4200 - Other Income	Santiago GHAD	$1,000.00
6005 - Scheduled Monitoring Events	ENGEO Incorporated	-$30,497.50
6115 - Electrical Charges	Anaheim Public Utility	-$15,306.22
	ENGEO Incorporated	-$1,849.00
6150 - Wells, Vaults, Casings, and Elec System	Charles King Company	-$185,161.76
	ENGEO Incorporated	-$12,020.50
7005 - Administration and Accounting	ENGEO Incorporated	-$54,634.25
7105 - Assessment Role and Levy Update Prep	ENGEO Incorporated	-$2,564.00
7115 - Clerk	Cardinal Property Management	-$6,500.00
7125 - CA Association of GHAD's Member	California Association of GHADs	-$175.75
7135 - Insurance - General Liability	Edgewood Partners Insurance Center	-$1,116.00
7140 - Legal Counsel	Benink & Slavens LLP	-$22,295.51
	Colantuono, Highsmith &Whatley PC	-$5,835.50
	JAMS	-$16,600.00
7155 - Management Fees	CAPTRUST	-$2,357.22
	GHAD Treasurer Inc	-$1,819.00
8500 - Investment Income		$538.58
8503 - Change in Value of Investment		-$527.35
Total		-$354,720.98

Santiago GHAD

Balance Sheet

As of June 30, 2022

	June 30, 2022	June 30, 2021
Assets		
Cash		
1030 - Cash SAN - Heritage Bank	12,993	0
Total Cash	**12,993**	**0**
Investments		
1130 - Investments SAN - TD Ameritrade	518,468	883,390
Total Investments	**518,468**	**883,390**
Total Assets	**531,461**	**883,390**
Liabilities		
Current Liabilities		
2000 - Accounts Payable	54,703	34,428
Total Current Liabilities	**54,703**	**34,428**
Total Liabilities	**54,703**	**34,428**
Owners Equity		
Equity		
3000 - Paid-in Capital	1,437,157	1,437,157
3080 - Accumulated Other Comprehensive Income	5,428	5,428
3090 - SYS - Current Year Earnings	(372,203)	(256,435)
3100 - Retained Earnings	(593,623)	(337,188)
Total Equity	476,758	848,961
Total Owners Equity	**476,758**	**848,961**
Total Liabilities and Owners Equity	**531,461**	**883,390**

Created Date/Time: 07/30/2022, 21:20 **Start Period: 2022-12** **End Period: 2022-12**
Created By: ADMIN GHAD Treasurer **Ledger: Actual**
GL Variable 2: SAN GHAD Santiago GLVar 2

Santiago GHAD

Profit and Loss vs Budget

12 Months Ended June 30, 2022

	Actual Total	Budget Total	Difference	% of Budget
Total Revenue	**0**	**0**	**0**	
Expense				
Preventative Maintenance & Operations				
6005 - Scheduled Monitoring Events	33,498	43,300	(9,803)	77.36%
6016 - Technical Consultants, Parcel Transfer (Outside Services)	324	0	324	
6115 - Electrical Charges	18,807	18,000	807	104.48%
6150 - Wells, Vaults, Casings, and Elec System	191,558	136,500	55,058	140.34%
6155 - Wells and Drain Maintenance	3,800	20,000	(16,200)	19.00%
Total Preventative Maintenance & Operations	**247,987**	**217,800**	**30,187**	**113.86%**
Administration and Accounting				
7005 - Administration and Accounting	63,452	24,000	39,452	264.38%
7105 - Assessment Role and Levy Update Prep	2,564	3,000	(436)	85.47%
7115 - Clerk	7,950	6,000	1,950	132.50%
7125 - CA Association of GHAD's Member	176	176	(0)	99.86%
7130 - Insurance - Directors and Officers	0	1,300	(1,300)	0.00%
7135 - Insurance - General Liability	1,940	770	1,170	251.99%
7140 - Legal Counsel	45,196	75,000	(29,804)	60.26%
7145 - Public Outreach	0	5,000	(5,000)	0.00%
7150 - Facilities Rental	0	600	(600)	0.00%
7155 - Management Fees	3,871	4,000	(129)	96.78%
Total Administration and Accounting	**125,149**	**119,846**	**5,303**	**104.42%**
Total Expense	**373,136**	**337,646**	**35,490**	**110.51%**
Net Ordinary Income	**(373,136)**	**(337,646)**	**(35,490)**	**110.51%**
Other Income/Expense				
4200 - Other Income	1,000	0	1,000	
8500 - Investment Income	641	0	641	
8503 - Change in Value of Investment	(708)	0	(708)	
Total Other Income	**933**	**0**	**933**	
Net Income	**(372,203)**	**(337,646)**	**(34,557)**	**110.23%**

Created Date/Time: 07/30/2022, 21:19 **Start Period: 2022-01** **End Period: 2022-12**

Created By: ADMIN GHAD Treasurer **Ledger: Actual** **Budget Ledger: 21/22 Annual Budget**

GL Variable 2: SAN GHAD Santiago GLVar 2

Santiago GHAD

Profit and Loss

12 Months Ended June 30, 2022

	2022-01	2022-02	2022-03	2022-04	2022-05	2022-06	2022-07	2022-08	2022-09	2022-10	2022-11	2022-12	Total
Total Revenue	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Expense													
Preventative Maintenance & Operations													
6005 - Scheduled Monitoring Events	0	3,438	2,483	5,500	0	0	10,490	2,858	3,190	2,540	0	3,000	33,498
6016 - Technical Consultants, Parcel Transfer (Outside Servic	0	0	0	0	0	0	0	0	0	0	0	324	324
6115 - Electrical Charges	575	3,085	372	2,412	444	3,230	843	2,398	419	2,783	596	1,652	18,807
6150 - Wells, Vaults, Casings, and Elec System	10,125	10,125	10,125	10,125	10,125	10,125	46,751	10,125	53,682	10,125	15,749	(5,624)	191,558
6155 - Wells and Drain Maintenance	0	0	0	0	0	0	0	0	0	0	0	3,800	3,800
Total Preventative Maintenance & Operations	**10,700**	**16,647**	**12,980**	**18,037**	**10,569**	**13,355**	**58,084**	**15,381**	**57,290**	**15,448**	**16,345**	**3,152**	**247,987**
Administration and Accounting													
7005 - Administration and Accounting	0	4,000	2,000	4,003	10	10	4,017	1,960	8,622	20,762	6,250	11,818	63,452
7105 - Assessment Role and Levy Update Prep	0	0	0	0	0	0	1,882	70	613	0	0	0	2,564
7115 - Clerk	500	0	725	500	825	500	1,000	500	500	700	750	1,450	7,950
7125 - CA Association of GHAD's Member	0	0	0	0	0	0	176	0	0	0	0	0	176
7135 - Insurance - General Liability	0	0	0	0	0	0	0	0	1,116	0	0	824	1,940
7140 - Legal Counsel	0	3,515	963	0	5,128	4,000	2,862	19,340	4,451	0	4,473	465	45,196
7155 - Management Fees	538	0	1,015	0	0	938	469	469	374	374	0	(305)	3,871
Total Administration and Accounting	**1,038**	**7,515**	**4,703**	**4,503**	**5,963**	**5,448**	**10,405**	**22,339**	**15,675**	**21,836**	**11,473**	**14,252**	**125,149**
Total Expense	**11,738**	**24,162**	**17,682**	**22,540**	**16,531**	**18,802**	**68,489**	**37,720**	**72,965**	**37,283**	**27,818**	**17,404**	**373,136**
Net Ordinary Income	**(11,738)**	**(24,162)**	**(17,682)**	**(22,540)**	**(16,531)**	**(18,802)**	**(68,489)**	**(37,720)**	**(72,965)**	**(37,283)**	**(27,818)**	**(17,404)**	**(373,136)**
Other Income/Expense													
4200 - Other Income	500	0	0	0	500	0	0	0	0	0	0	0	1,000
8500 - Investment Income	19	8	155	21	19	13	102	53	45	58	46	103	641
8503 - Change in Value of Investment	(37)	(13)	(43)	10	(63)	(53)	99	(103)	(252)	60	(132)	(181)	(708)
Total Other Income	**482**	**(5)**	**112**	**31**	**457**	**(40)**	**200**	**(50)**	**(207)**	**118**	**(86)**	**(78)**	**933**
Net Income	**(11,256)**	**(24,167)**	**(17,571)**	**(22,508)**	**(16,075)**	**(18,843)**	**(68,289)**	**(37,770)**	**(73,172)**	**(37,166)**	**(27,904)**	**(17,482)**	**(372,203)**

Created Date/Time: 07/30/2022, 21:18
Created By: ADMIN GHAD Treasurer

Start Period: 2022-01

End Period: 2022-12
Ledger: Actual
GL Variable 2: SAN GHAD Santiago GLVar 2

Income/Expense Reporting - Santiago GHAD

12 Months Ended June 30, 2022

GL Account ↑	Account ↑	Sum of Report Amount
4200 - Other Income	Santiago GHAD	$1,000.00
6005 - Scheduled Monitoring Events	ENGEO Incorporated	-$33,497.50
6016 - Technical Consultants, Parcel Transfer (Outside Services)	ENGEO Incorporated	-$324.00
6115 - Electrical Charges	Anaheim Public Utility	-$16,652.29
	ENGEO Incorporated	-$2,155.00
6150 - Wells, Vaults, Casings, and Elec System	Charles King Company	-$185,161.76
	ENGEO Incorporated	-$6,396.50
6155 - Wells and Drain Maintenance	ENGEO Incorporated	-$3,800.00
7005 - Administration and Accounting	ENGEO Incorporated	-$63,452.25
7105 - Assessment Role and Levy Update Prep	ENGEO Incorporated	-$2,564.00
7115 - Clerk	Cardinal Property Management	-$7,950.00
7125 - CA Association of GHAD's Member	California Association of GHADs	-$175.75
7135 - Insurance - General Liability	California Association of GHADs	-$824.30
	Edgewood Partners Insurance Center	-$1,116.00
7140 - Legal Counsel	Benink & Slavens LLP	-$22,760.01
	Colantuono, Highsmith &Whatley PC	-$5,835.50
	JAMS	-$16,600.00
7155 - Management Fees	CAPTRUST	-$2,204.79
	GHAD Treasurer Inc	-$1,666.57
8500 - Investment Income		$641.08
8503 - Change in Value of Investment		-$707.87
Total		-$372,203.01

Santiago Geologic Hazard Abatement District

Draft Engineer's Report Discussion

Date: July 14, 2022

Presented by: Jeff Adams, ENGEO Representative

Background

- Santiago GHAD formed on March 16, 1999 with the adoption of Resolution 99R-50 by the City of Anaheim
- Five Property Owners serve as the elected GHAD Board of Directors
- The Plan of Control allows for the GHAD to permanently monitor and maintain the Santiago landslide
- The GHAD was funded with through a settlement with the City of Anaheim for approximately $3,500,000
- The Fiscal Year 2022/23 estimates that the GHAD will have an account balance of approximately $180,000 on June 30, 2023

GHAD
GEOLOGIC HAZARD ABATEMENT DISTRICT

Partial List of Considerations

- Proposition 218 law
- Relevant precedents
- Landslide exploration studies
- Site performance and monitoring data
- Boardmember comments
- Community member comments

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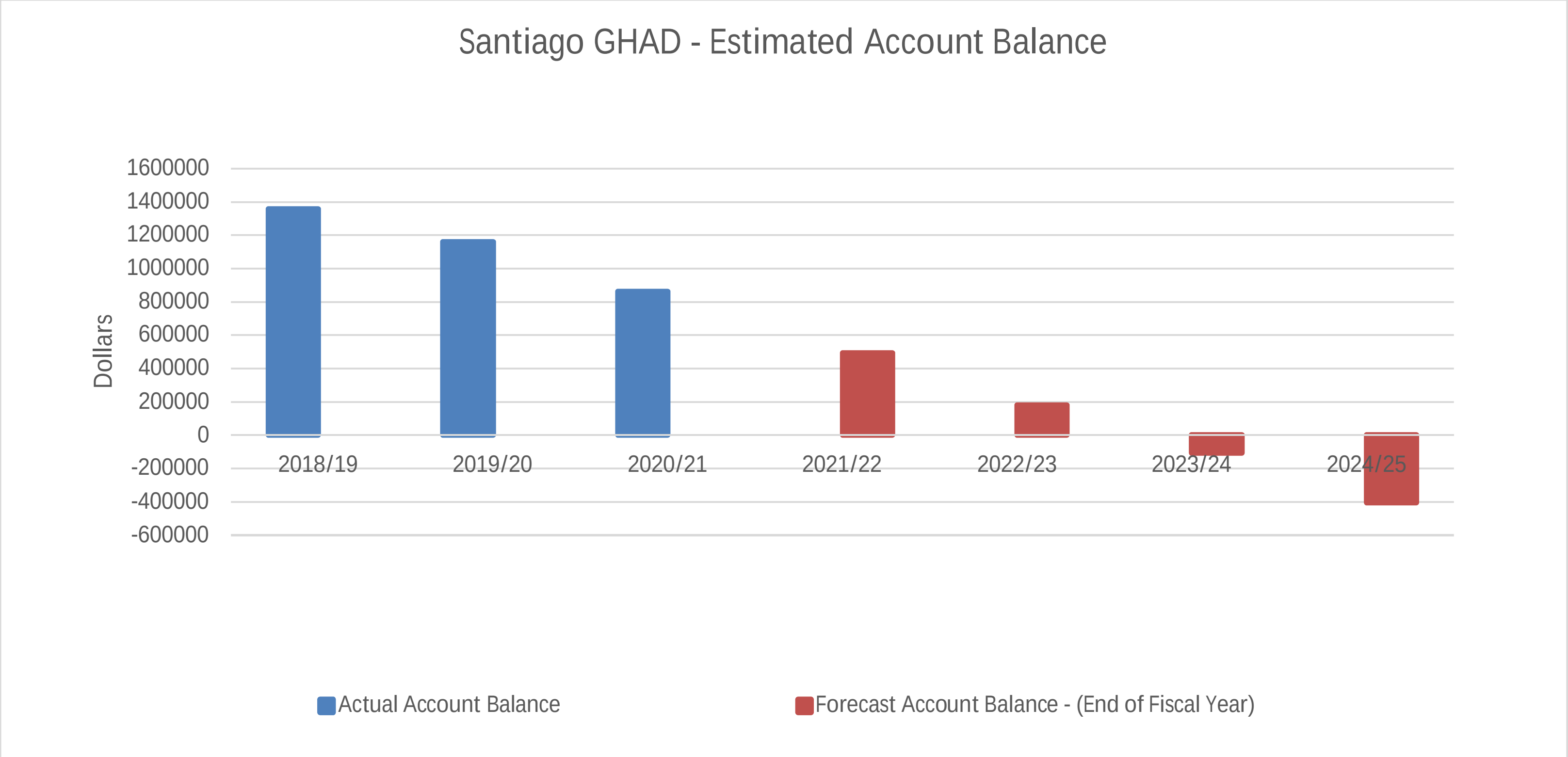
Fund Balance Summary

The proposed budget for the fiscal year 2022-2023 anticipates revenue of **$26,000** with an estimated reduction of **$313,566** to the account balance.

- Estimated Fund Balance (July 1, 2022)…………………. $492,613
- FY 2022-2023 Estimated Revenue..............................$26,000
- FY 2022-2023 Estimated Expenditures.......................($339,566)
- Estimated Fund Balance (June 30, 2023)....................$179,047

Account Balance – Four Year Forecast



Deferred Maintenance Summary

Improvement	Unit	Quantity	Unit Price	Total Costs	Maintenance, Repair, or Replacement Interval (years)	Annual Total
Vertical Dewatering Wells (37)						
· Maintenance or Repair	lineal foot	4,950	$ 100	$ 495,000	15	$33,000
· Replacement	lineal foot	4,950	$ 650	$ 3,217,500	40	$80,438
Monitoring Wells and Piezometers (48) (maintenance only)	lineal foot	6,500	$ 75	$ 487,500	30	$16,250
GHAD-maintained Connector Pipes to Public Storm Drain System	lump sum	1	$ 40,000	$ 50,000	2	$25,000
Horizontal Drains (86)	lineal foot	27789	$ 15	$ 416,835	30	$13,895
Inclinometers	lineal foot	2004	$ 50	$ 100,200	40	$2,505
Pedestals	each	39	$ 7,500	$ 292,500	30	$9,750
						$180,837

Selected References Reviewed

- Eberhart & Stone; Santiago Landslide, 1996
- Santiago Geologic Hazard Abatement District, Plan of Control, 1999
- Banner Lawsuit, 1994
- Delmonico Settlement Agreement, 1999
- Landslide Committee Meeting Notes, 1998
- Cotton, Shires & Associates, 2005

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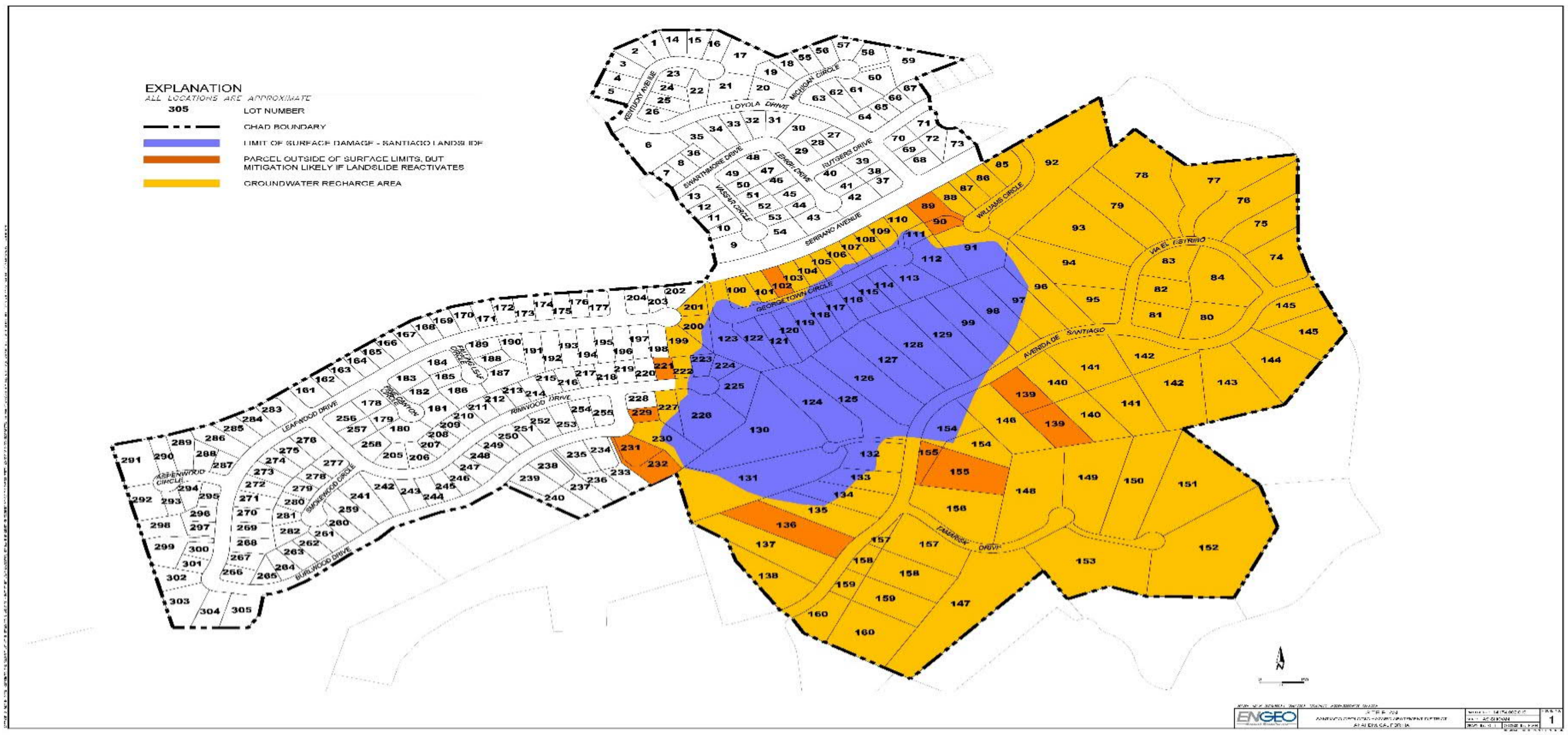
Parcel Designation



GHAD
GEOLOGIC HAZARD ABATEMENT DISTRICT

Engineer’s Report (Draft F)

- Provides overview and basis of assessment for following activities:
  - Oversight of GHAD operations, including reporting to the GHAD Board of Directors
  - Setting the annual levying of assessments on the property tax rolls
  - Engagement of technical professionals to perform monitoring duties described in POC
  - Performance of GHAD maintenance activities
  - Preparation of annual GHAD budgets and other documents for GHAD Board of Directors

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Special Benefit and Proportionality

- The improvements maintained by the GHAD (vertical production and observation wells, horizontal drains, and inclinometers) will confer some or all of the following special benefits
  - Protection from landsliding and ground deformation
  - Protection from loss of street/transportation access
  - Protection from loss of utilities an associated services
  - Groundwater seepage management, providing protection for properties and improvements
  - Consequential protection of properties and improvements from diminution of value

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Assessment Allocation

- Parcel area-based assessment:
- Properties within GHAD assigned 1 of 3 categories
  - Lots on landslide/at risk of deformation (63 percent)
  - Lots in groundwater recharge area (18 percent)
  - Lots receiving groundwater seepage control (13 percent)
- Lots receive a percentage allocation based on their fraction of area in the respective category
- Benefits of transportation access and amenities are assessed on per-parcel basis

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Draft F Revisions

- Assessment of HOA parcels
- Per lot assessment for transportation and amenities factors
- Overall assessment reduction for larger parcels based on revisions

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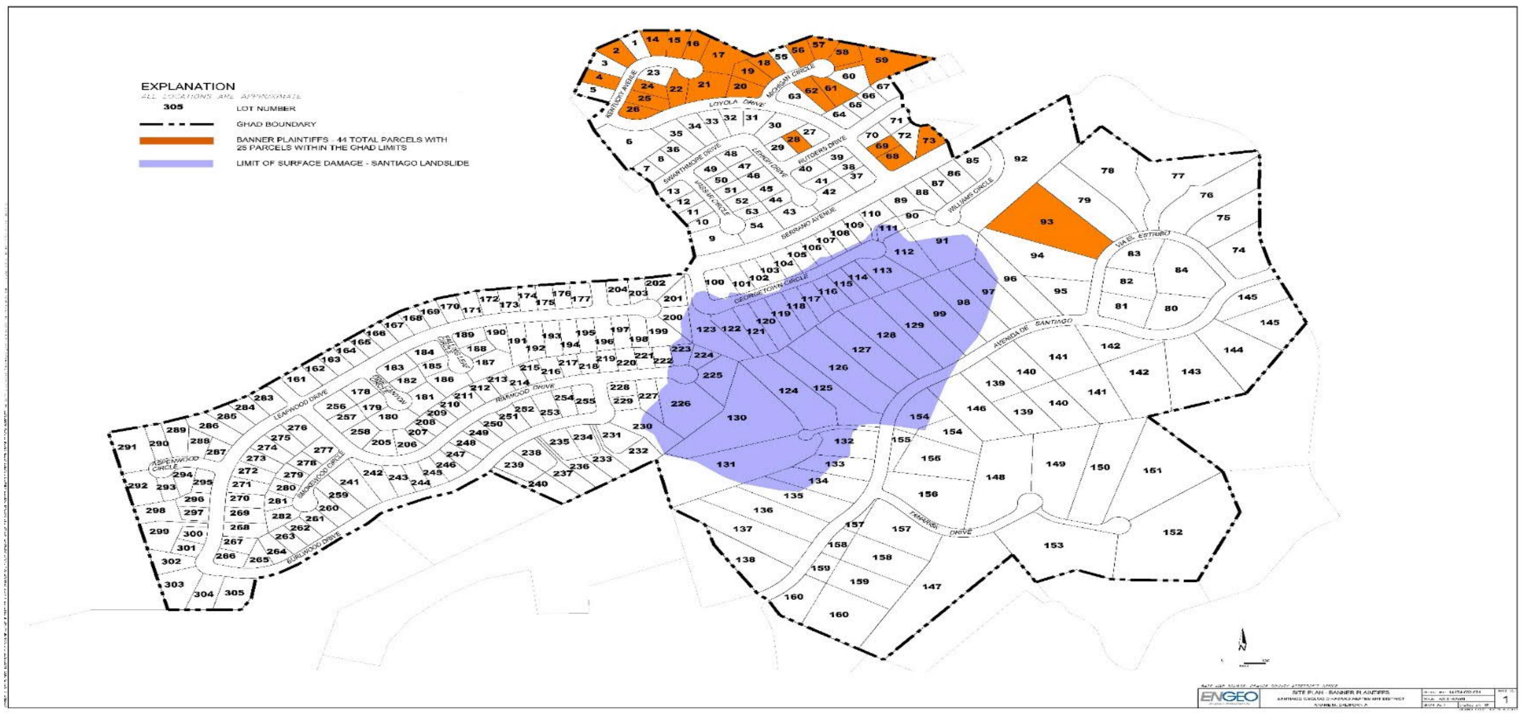
Questions?

Banner Plaintiffs



GHAD
GEOLOGIC HAZARD ABATEMENT DISTRICT

Delmonico Plaintiffs

GHAD
GEOLOGIC HAZARD ABATEMENT DISTRICT

Background (Landslide Committee Meeting Notes March 5, 1998)

<u>Landslide Committee Meeting Notes</u>

March 5,1998

Those attending: Mike Clayton, Mary Ann Adams, Al Murphy, Ed Muratori, Jerry Steiner; Pat Panik; Bill Stoner, and Sid Kanazawa from PM & S.

Bill Stoner said that as of last week there had been no re-activation of a deep slide. He said there are 2 possibilities for this:

1. The defective pipe has been removed
2. Dewatering is working

This is despite the fact that we have had more rain this year than in 1993. The attorneys have had no calls reporting damage from any residents, except in The Covey. It has not yet been determined whether the current problem on Pegasus is the result of a deep or surface slide. The man putting in the pumps called the City to tell them they had a problem in that area and they told him that Pegasus is a private street.

A bulge in the street on Swarthmore has been reported to Ed Muratori, but he has not yet had a chance to investigate this.

At the last status meeting, a trial date was set for Sept. 23,1998, but this is only for the inverse condemnation part of the case. This will involve all homeowners, but will not be tried before a jury. Pillsbury had wanted to try the full case but with selected homeowners such as the Delmonicos. However, the judge thought that would be too complex and feels he can try the entire inverse condemnation part of the case in 5 days. After that is decided, he thinks the rest of the parts of the case will fall into place. The next meeting with the judge is scheduled for March 23rd.

The judge said that if he can determine the size of the slide, then it might be able to be settled. The independent geologist will testify at the trial and his findings will carry a good deal of weight. Rutan and Tucker says the slide only involves 36 houses; PM&S believes it is much larger. So far, the judge has not allowed the independent geologist to say anything, but our attorneys don't believe he will say it is as large as Dennis Evans says it is.

A map prepared by Eberhart and Stone depicting what they believe to be the landslide was shown. Bill Stoner said Eberhart and Stone have been very careful to label this map "limits of surface damage" rather than "landlide boundaries".
Rutan and Tucker say the slide does not go north of Serrano.
Bill thinks our best chance to enlarge the size of the slide will be to the east and possibly to the Dentons on the other side. The attorneys

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Background (Landslide Committee Meeting Notes March 5, 1998)

are happy with the independent geologist ; he is known to be very honest and exact.

As far as loss of property values, this will be less of a factor as time goes on. If a geological hazard abatement district (GHAD) is set up, funded, and there is no land movement , there will probably be no stigma.

Bill says a big part of the City's motivation to settle is to keep Jerry Steiner quiet because of the impact his website has had.

The attorneys feel the City now realizes they are in a lose-lose situation if the case goes to trial. If they are proven to be at fault, they will have to pay the plaintiffs as well as fund the pumps. If they win the case, they will still have to set up the GHAD.

A maximum of $300,000 per year would be needed to pay for the pumps and maintenance. Of the $185,00 per year it currently costs, about $105,000 has been paid to Eberhart and Stone. So it should be possible to reduce that yearly figure if someone other than E&S were to administer it.

There is an alternative to pumping: a tunnel, but as clearance is required, the cost ($3.5-7 million dollars) is prohibitive. Additionally,risking liability to other property owners is the biggest problem.

It has been noted that pumps are a band-aid. Engineers said some houses could be stabilized with vertical caissons which would go into bedrock. The caissons would be concrete and steel, 5 feet in diameter and160 feet deep. They would be < 10 feet on center. While it is possible to do this, the cost for one house that was studied was estimated to be in excess of 2 million dollars.

The attorneys said the case is now at a critical juncture since people do not get serious until a trial date is set. With a trial date 6 months away the City now realizes the trial result will not solve the problem, it will simply mean that people will win or lose money. In negotiating, the City focused on the 36 houses they claim are the only ones involved and would settle for full value. The attorneys noted that it would be hard to get a hazard abatement district set up if only 36 houses are involved. If, however, all 240 houses are involved, then the cost could be spread out, since 10 % of residents must sign a petition to set up this district and 51% of the property value has to vote on it. The City has floated the idea of buying properties where the repair cost exceeds the value.

The tax implications of settlement amounts are different than a few years ago; it is harder to structure it as tax-free.

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Background (Landslide Committee Meeting Notes March 5, 1998)

As of now, the City has not offered any settlement money for pain and suffering.

The inverse condemnation part of the case is against the City only and does not involve any of the other defendants.

The City has offered 11-12 million dollars to settle which seems to be fairly solid and would come from developers, SOPAC,pipe manufacturers,insurance companies and the City. This was supposed to go to 25 million, but the City now feels the judge would not rule against them. The City would like the GHAD to be funded at 8 million dollars; our attorneys feel it could be adequately funded at about 3.5 million. They would prefer that more of the settlement money go into our pockets than be in a hazard abatement district, where a future surplus might then be used by the City for other purposes. Our attorneys have run the numbers and say that $3.5 million would pay for pumping,repairs,replacement and maintenance for many decades. THE ATTORNEYS WOULD LIKE INPUT FROM COMMITTEE MEMBERS REGARDING THE GHAD AMOUNT. IF YOU HAVE ANY THOUGHTS ON THIS,PLEASE CONTCT THEM.

The attorneys see 2 issues at stake:
1. Size of the landslide
2. Cause of the landslide

Of course, size is not important if the cause cannot be proven.
6 possible causes:
1.MWD 4.irrigation
2.utility trenches 5.plastic pipes
3.rain 6.service leaks from
meters,etc.

The last two are now seen as most likely. Investigation is continuing.

Dennis Evans is still looking at water balance:measuring the amount of water that comes in and the amount that goes out, whiile accounting for evaporation,transpiration, etc.

Our attorneys think it is possible the judge would decide that this is indeed a small slide as the City contends, but would agree with us that the City is responsible for causing it, which would allow us to collect.

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General Benefit

- General benefit to owners of properties outside of the GHAD and to other members of the general public
  - The availability to use through streets that may be impacted by the effects of landsliding
    - Off-site property owners whose primary access via Avenida de Santiago (City will be assessed a 30 percent premium on landslide areas)
  - Use of Serrano Avenue (assessment to City)

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SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
STAFF REPORT

TO: Santiago Geologic Hazard Abatement District ("GHAD") Board of Directors

FROM: GHAD Manager

BOARD MEETING DATE: August 4, 2022

SUBJECT: ADOPT Resolution 2022/12 accepting the apportionment model as presented in the draft Engineer's Report and directing ENGEO Incorporated to complete the Engineer's Report, incorporating an appropriate projected GHAD budget and apportionment calculations for each property for a possible assessment

RECOMMENDATION(S):

1. ADOPT the attached Resolution No. 2022/12 to do the following:

   (a) The GHAD Board ACCEPTS the apportionment model as presented in the draft Engineer's Report; and

   (b) The GHAD Board DIRECTS ENGEO Incorporated to complete the Engineer's Report, incorporating an appropriate projected GHAD budget and apportionment calculations for each property for a possible assessment

BACKGROUND:

The Anaheim City Council formed the Santiago Geologic Hazard Abatement District ("GHAD") on March 16, 1999, under the authority of the California Public Resources Code, Division 17, Section 26500 et seq. with the approval of City of Anaheim Resolution 99R-50. Five property owners within the GHAD serve as the Board of Directors of the Santiago GHAD.

The Anaheim City Council approved the Santiago GHAD Plan of Control ("Plan of Control") to allow the Santiago GHAD to permanently monitor and maintain the Santiago landslide. The Santiago GHAD is funded through a settlement with the City of Anaheim ("GHAD Distribution"). The GHAD Distribution cannot be used to fund activities or facilities which do not materially and substantially promote the objective of stabilizing past, present, and future land movement of the Santiago landslide." In 1999, the initial GHAD Distribution was approximately $3,500,000, and as of June 16, 2022, the fund balance was approximately $532,421.

To allocate assessments in proportion to special benefit conferred on assessed properties, a formula has been derived that estimates the special benefit conveyed by the GHAD. The formula includes several factors, which are weighted based on their relative effect on special benefit. Special benefit is derived considering the following factors, and weighting has been applied to each factor to note its relative importance as compared to other factors. Several factors have been incorporated into the analysis, including a respective properties' proximity to the delineated landslide, a respective properties' potential to experience geologic distress in the event of landslide mobilization, a landslide's proximity to the hydrogeologic watershed area that feeds groundwater mitigated by the pump system, and other properties that benefit from seepage control. Additionally, all residential properties benefit from the mitigation of geologic hazards to provide continued transportation access, access to amenities, and reduction of the potential property devaluation that could occur in the event of mobilization and manifestation of geologic hazards within the GHAD. The formula is presented in the draft Engineer's Report, an exhibit to the attached resolution.

FISCAL IMPACT:

The GHAD is currently funded 100% through the GHAD Distribution. Once the Engineer's Report is completed, if adopted and approved, the activities of the Santiago GHAD will be funded through the GHAD Distribution and assessments levied on properties within the GHAD.

ATTACHMENTS:

A. Resolution No. 2022/12, The Santiago Geologic Hazard Abatement District Accepts and Approves the GHAD Assessment Apportionment Model Presented in the Draft F GHAD Engineer's Report Dated July 11, 2022 and directs ENGEO Incorporated to complete the Engineer's Report incorporating an appropriate GHAD Budget and Apportionment Calculations for Each Property for a Possible Assessment

BOARD OF DIRECTORS OF THE
SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT

RESOLUTION NO. 2022/12

A RESOLUTION WHEREBY THE SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT (“SANTIAGO GHAD”) ACCEPTS AND APPROVES THE GHAD ASSESSMENT APPORTIONMENT MODEL PRESENTED IN THE DRAFT F ENGINEER’S REPORT DATED JULY 11, 2022 AND DIRECTS ENGEO INCORPORATED TO COMPLETE THE ENGINEER’S REPORT, INCORPORATING AN APPROPRIATE GHAD BUDGET AND APPORTIONMENT CALCULATIONS FOR EACH PROPERTY FOR A POSSIBLE ASSESSMENT.

WHEREAS, on March 16, 1999, the Anaheim City Council adopted Resolution No. 99R-50 approving and ordering the formation of the Santiago Geologic Hazard Abatement District ("Santiago GHAD"); and

WHEREAS, the Santiago GHAD is a political subdivision of the State of California, governed by state law (Pub. Res. Code § 26500 et seq.), and constitutes a legal entity separate and distinct from the City of Anaheim (“City”), with operations independent of City functions; and

WHEREAS, in order to pay for the cost and expenses of maintaining and operating the GHAD improvements as set forth in the Plan of Control, an assessment for GHAD services is to be considered for imposition on properties within the Santiago GHAD as reflected in the attached Engineer’s Report; and

WHEREAS, a draft Engineer’s Report has been prepared by the GHAD Manager to reflect the special benefit conferred to properties with the GHAD; the GHAD Manager is a registered professional engineer, certified in the State of California, in compliance with Public Resources Code section 26651(a) and section 4(b) of Article XIII (D) of the California Constitution; the Engineer’s Report attached hereto as Attachment A sets forth the purpose of the GHAD and a description of the method used in formulating the estimated assessments; and

NOW, THEREFORE, THE SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT DOES HEREBY RESOLVE AS FOLLOWS:

1. The GHAD Board has been presented the Draft F Engineer’s Report. The assessment apportionment model as presented assigns each property an assessment value in proportion to the special benefit derived by each respective property with respect to the mitigation, abatement, and control of geologic hazards; and

2. The GHAD Board accepts the apportionment model as presented in the Draft F Engineer’s Report; and

3. The GHAD Board directs that ENGEO Incorporated complete the Engineer’s Report, incorporating an appropriate projected GHAD budget and assessment calculations for each property for a possible assessment; and

3\. This Resolution shall become effective immediately upon its passage and adoption.

DATED: August 4, 2022

I, Karen Holthe, Clerk of the Santiago Geologic Hazard Abatement District, certify that the foregoing resolution was duly adopted by the Board of Directors of the District at a regular meeting held on the 4th day of August 2022 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

Clerk of the Santiago GHAD Board

ENGINEER'S REPORT

for

SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
ANAHEIM, CALIFORNIA

July 11, 2022

TABLE OF CONTENTS

ENGINEER'S REPORT

SANTIAGO
GEOLOGIC HAZARD ABATEMENT DISTRICT
(Pursuant to the Public Resources Code of the State of California, Section 26500 et seq.)

CERTIFICATION OF FILING

The GHAD provides monitoring and maintenance of improvements related to geologic hazard management within the District. The GHAD responsibilities, which are the subject of this report, are defined in the Plan of Control dated February 22, 1999, as any activity necessary, "…*to mitigate risk of reactivation of the Santiago landslide, to direct and fund operation of the dewatering system, monitoring of groundwater elevations and landslide movements, and to evaluate landslide stability on a regular basis for the life of those improvements potentially impacted by any renewed landslide movement,"* and those additional items list in Section IV.

This report consists of six parts, as follows.

I. INTRODUCTION AND BACKGROUND

II. GEOLOGIC HAZARD ABATEMENT DISTRICT BOUNDARY

III. SERVICE LEVELS

IV. DESCRIPTION OF GHAD-MAINTAINED IMPROVEMENTS

V. ASSESSMENT METHOD

VI. ASSESSMENT LIMIT - BUDGET PROJECTION

The undersigned respectfully submits the enclosed Engineer's Report.

Date: July 11, 2022 By: ENGEO Incorporated

_______________________________, GE
Uri Eliahu

ENGINEER'S REPORT

for

SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
ANAHEIM, CALIFORNIA
for the
ESTABLISHMENT OF AN ASSESSMENT LIMIT

I. INTRODUCTION AND BACKGROUND

The Anaheim City Council formed the Santiago Geologic Hazard Abatement District (GHAD) on March 16, 1999, under the authority of the California Public Resources Code, Division 17, Section 26500 et seq. with the approval of City of Anaheim Resolution 99R-50. Five property owners within the GHAD serve as the Board of Directors of the Santiago GHAD.

The Anaheim City Council approved the Santiago GHAD Plan of Control ("Plan of Control") to allow the Santiago GHAD to permanently monitor and maintain the Santiago landslide. The Santiago GHAD is funded through a settlement with the City of Anaheim ("GHAD Distribution"). The GHAD Distribution cannot be used to fund activities or facilities which do not materially and substantially promote the objective of stabilizing past, present, and future land movement of the Santiago landslide." In 1999, the initial GHAD Distribution was approximately $3,500,000, and as of April 28, 2022, the fund balance was approximately $568,297.

II. GEOLOGIC HAZARD ABATEMENT DISTRICT BOUNDARY

The boundary for the Santiago GHAD is shown in the Site Plan to Accompany Assessor's Parcel and Assessment Limit List (Exhibit A). The parcels within the GHAD are identified on the Assessor's Parcel Number and Assessment Limit List (Exhibit B).

III. SERVICE LEVELS

The GHAD's activities are those that promote the objective of stabilizing past, present, and future land movement of the Santiago landslide; and the issuance and servicing of bonds issued to finance any of the foregoing.

The GHAD provides for the administration and review of facilities within the budgeted limits as described in the Plan of Control and includes the following services.

1. Oversight of GHAD operations, including reporting to the GHAD Board of Directors.
2. Setting the annual levying of assessments on the property tax rolls.
3. Engagement of technical professionals to perform the monitoring duties as described in the Plan of Control.
4. Performance of GHAD maintenance activities.
5. Preparation of annual GHAD budgets and other documents and reports for consideration by the GHAD Board of Directors.

IV. DESCRIPTION OF THE IMPROVEMENTS MAINTAINED BY THE GHAD

The GHAD-maintained improvements in general include vertical production and observation wells, horizontal drains, and inclinometers.

V. ASSESSMENT METHOD AND BENEFIT

The improvements and GHAD responsibilities described in Section IV are distributed within the limits of the GHAD or immediately adjacent to the GHAD. The improvements described in this document allow protection from slope instability, a special benefit, to the assessed parcels. As provided in Section 5 of Resolution 99R-50, Approving Formation of the Santiago GHAD, "*The GHAD boundaries are larger than the Santiago landslide. The Plan of Control identifies potential geologic hazards for areas outlying the Santiago landslide other than those defined as existing for the Santiago landslide. Inclusion of the outlying properties in the GHAD is beneficial to those properties in that residents may have concerns regarding geologic hazards due to the proximity to the Santiago landslide, and the GHAD provides a mechanism to address and mitigate such future geologic hazards.*"

The improvements and responsibilities listed in Section IV provide specific benefits to the properties within the GHAD and the improvements are constructed for the benefit of those assessed as well as a minor general benefit to the general public. The subject parcels are only being assessed for the reasonable costs of the proportional specific benefits conferred on the parcels.

A. Special Benefit and Proportionality

The improvements described in this document will confer some or all of the following special benefits to the assessed parcels within the Santiago GHAD.

1. Protection from landsliding and ground deformation.
2. Protection from loss of street/transportation access.
3. Protection from loss of utilities an associated services.
4. Groundwater seepage management, providing protection for properties and improvements.
5. Consequential protection of properties and improvements from diminution of value resulting from manifestation of geologic instability.

Certain real properties within the GHAD are located within the limits of the Santiago landslide. These real properties, which would suffer damage from the primary effects of movement, receive a special benefit from the activities of the GHAD, which are intended to arrest movement of the landslide. Several real properties are located near the Santiago landslide and have been determined to be at risk of the secondary effects of landslide movement or ground-surface deformation, and therefore, receive a special benefit whose degree is equal to the benefit of real properties located within the limits of the Santiago landslide. Additionally, other real properties, located in the general vicinity of the Santiago landslide, are within a hydrogeologic zone within which groundwater levels are controlled via a pump and discharge system. These properties receive a proportional special benefit through the control of groundwater levels, which reduces the potential of distress to slopes and the ground, and reduces the potential for distress to structures and both surface and subsurface improvements. The degree of special benefit is lower than the special benefit to real properties proximate to the Santiago landslide or within the limits of the Santiago landslide. Still other real properties, outside of the limits of these three categories, receive a further diminished degree of special benefit related to the control of groundwater seepage. The control of groundwater seepage is beneficial, as it reduces the potential for distress to structures and both surface and subsurface improvements. The proportion of benefit with respect to each of these categories is presented below in the assessment allocation formula.

The mitigation of the aforementioned geologic and hydrologic issues minimize the potential for lost transportation facility and utility service access. These facilities consist of streets, sidewalks, and public utility conveyance systems (e.g., domestic potable water, wastewater sewerage, electrical conduits, natural gas lines, telecommunications systems). Minimization of the potential for interrupted service through the mitigation of geologic instability provides a special benefit to owners of real property within the district. Minimization of “stigma” associated with potential geologic instability within the GHAD has also been considered in the benefit calculations. Assignment of this special benefit is included with the allocations based on landsliding, ground deformation, groundwater level control, or groundwater seepage control. For each of these categories, real property owners derive special benefit based on proportional parcel area. Therefore, owners with greater parcel area derive greater special benefit than owners with lesser parcel area. The fraction of each respective parcel area has also been included and is presented below in the assessment allocation formula.

Because the real properties are improved with single-family homes and/or are occupied by transportation facilities (e.g., streets and sidewalks), each parcel is considered to use the transportation facilities on an equal basis and is thus assessed on a basis of an equal assessment portion per parcel. As with the special benefit related to transportation access, we have assumed the special benefit related to the preservation of amenities is conveyed to each parcel on an equal basis and is thus assessed on a basis of an equal assessment portion per parcel.

B. General Benefit

The Project does convey general benefit to owners of properties outside of the district and to other members of the general public. The general benefits associated with transportation access have been identified as being conveyed to members of the public who do not own real property within the district. These include the following.

- The availability to use through streets that may be impacted by the effects of landsliding.

There is a general benefit conveyed to the owners of properties outside of the district and to other members of the general public, which consists of uninterrupted transportation access for 13 properties whose transportation access is provided by Avenida de Santiago. This benefit is relatively small compared to the special benefit conveyed to real property owners of the GHAD, and the cost to confer this general benefit will be accounted for by a 30 percent premium escalator on the City of Anaheim’s public right-of-way area-based assessment within the Santiago landslide. The 30 percent is equivalent to the ratio of the number of these outside-of-GHAD properties to the total number of outside-of-GHAD properties and inside-of-GHAD properties whose property access would be affected should the Santiago landslide re-activate. Additionally, other properties outside of the GHAD receive a general benefit by having access to streets within the GHAD boundaries, most notably Serrano Avenue. This general benefit is accounted for by an area-based assessment for streets levied to the City of Anaheim.

C. Assessment Method

To allocate assessment in proportion to special benefit conferred on assessed parcels, a formula has been derived that estimates the special benefit conveyed by the Project. The formula includes several factors, which are weighted based on their relative effect on special benefit. Special benefit is derived considering the following factors, and weighting has been applied to each factor to note its relative importance as compared to other factors. Several factors have been incorporated into the analysis, including a respective parcel's proximity to the delineated landslide, a respective parcel's potential to experience geologic distress in the event of landslide mobilization, a landslide's proximity to the hydrogeologic watershed area that feeds groundwater mitigated by the pump system, and other parcels that benefit from seepage control. Additionally, all residential parcels benefit from the mitigation of geologic hazards to provide continued transportation access, access to amenities, and reduction of the potential property devaluation that could occur in the event of mobilization and manifestation of geologic hazards within the GHAD. We applied our professional judgment to the factor values regarding the relative efficacy of protective devices and projections of the effects of the Project:

$$T_i = \left((M_i + B_i)(R)\right)$$

$$M_i = \left(L\left(\frac{A_{Li}}{\sum_{i=1}^{n}(A_{Li})}\right)\right) + \left(G\left(\frac{A_{Gi}}{\sum_{i=1}^{p}(A_{Gi})}\right)\right) + \left(S\left(\frac{A_{Si}}{\sum_{i=1}^{q}(A_{Si})}\right)\right)$$

$$B_i = \left((P + Q)\left(\frac{1}{X}\right)\right)$$

T_i = Assessment at Parcel i
M_i = Geologic Assessment Factor at Parcel i
B_i= Uniform Assessment Factor at Parcel i (does not include City-owned street sections)
R = Total annual assessment-based revenue required to support the GHAD budget
L = Landslide/Surface Damage Factor
G = Groundwater Control Factor
S = Seepage Control Factor
A_{Li} = Area of Landslide/Surface Damage Parcel i
A_{Gi} = Area of Groundwater Control Parcel i
A_{Si} = Area of Seepage Control Parcel i
$\sum_{i=1}^{n}(A_{Li})$= Summation Area of Landslide/Surface Damage Parcel i for Parcels i to n
$\sum_{i=1}^{p}(A_{Gi})$= Summation Area of Groundwater Control Parcel i for Parcels i to p
$\sum_{i=1}^{q}(A_{Si})$= Summation Area of Seepage Control Parcel i for Parcels i to q
P = Transportation Access Factor
Q = Amenities Factor
X = No. of Parcels in GHAD (does not include City-owned street sections)

- Santiago Landslide Siting – Real properties situated within the limits of the Santiago landslide (including City of Anaheim-owned streets), that would suffer damage from the primary effects of movement, receive a special benefit from the activities of the GHAD, which are intended to arrest movement of the landslide. The special benefit derived is in direct proportion to the area of each parcel. The mitigation activities provide the largest respective portion of special benefit to properties within the limits of the Santiago landslide. These properties have been assigned a weighting factor of 0.63 (measured on a scale of 0 to 1).

- Potential Surface Damage Siting – As discussed, several real properties are located near the Santiago landslide and have been determined to be at risk of the secondary effects of landslide movement or ground surface deformation, and therefore, receive a special benefit whose degree is equal to the benefit of real properties located within the limits of the Santiago landslide. Given this net positive benefit conveyed, these properties (including City of Anaheim-owned streets) have been combined with the Santiago Landslide parcels and assigned a weighting factor of 0.63.
- Groundwater Management Area Siting – Select real properties located in the general vicinity of the Santiago landslide (including City of Anaheim-owned streets) are within a hydrogeologic zone within which groundwater levels are controlled via a pump and discharge system. These properties receive a proportional special benefit through the control of groundwater levels. The degree of special benefit is diminished as compared to the benefit of real properties located near or within the limits of the Santiago landslide. Because of the reduction of the special benefit, these lots have been assigned weighting factor of 0.18.
- Seepage Control Area Siting – The remaining properties within the GHAD (including City of Anaheim-owned streets) receive a further diminished degree of special benefit related to the control of groundwater seepage. The control of groundwater seepage is beneficial, as it reduces the potential for distress to structures and both surface and subsurface improvements. Because of the further reduction of the special benefit, these lots have been assigned weighting factor of 0.13.
- Transportation Factor – As discussed, preservation of access to transportation through mitigation of potential geologic instability within the GHAD is included, and the special benefit is conveyed to each residential parcel on an equal basis. The Transportation factor has been assigned a value of 0.03.
- Amenities Factor – As discussed, preservation of access to amenities through mitigation of potential geologic instability within the GHAD is included, and the special benefit is conveyed to each residential parcel on an equal basis. The Amenities factor has been assigned a value of 0.03.

The weighted values described above have been computed to reflect the relative importance of each factor in the judgment of the GHAD Manager and Assessment Engineer (ENGEO), then the resulting fractional value of the Geologic Assessment Factor is assigned to each parcel on a pro-rata basis based on respective area, A_{Li}, A_{Gi}, or A_{Si} of their respective parcel areas in their assigned categories, Landslide/Surface Damage, Groundwater Control, or Seepage Control. The Transportation Factor and Amenities Factor are assigned on an equal, per-residential-parcel basis. An assessment level is determined for each parcel based on these factors. In overview, a large-area parcel located within the Santiago landslide area will derive the greatest special benefit and, therefore, is assessed the largest amount. A small-area parcel located well outside of the vicinity of the Santiago landslide receives the least special benefit and is therefore assessed the smallest amount. Other parcels will range between these extremes.

A financial analysis was performed to provide a framework for an operating budget for the ongoing abatement, mitigation, prevention, and control of geologic hazards within the GHAD. In preparation of the budget, several factors were considered including:

- Site geology
- Site hydrogeology
- Proximity of geologic hazards to residences and improvements
- Improvements or structures
- Site access considerations
- Elements requiring routine maintenance

VI. ASSESSMENT - BUDGET

The purpose of this Engineer's Report is to establish the assessment level and the apportionment of the assessment within the GHAD. The annual budget in each subsequent fiscal year will apprise the GHAD Board of Directors of the estimated budget for the upcoming year and recommend an appropriate levy to support those activities.

Based on the estimated expenses for ongoing operations, a budget was prepared for the purpose of estimating the revised assessment levels (Exhibit C). Exhibit D shows a 10-year pro-forma budget for the Santiago GHAD.

This Engineer's Report has determined a unique assessment using the formula described above for each parcel. The assessment limits will be adjusted annually to reflect the percentage change in the Los Angeles-Long Beach-Anaheim Consumer Price Index (CPI) for All Urban Consumers. The assessment limit will be adjusted annually using an initial date of June 2022 for the CPI. Each subsequent annual adjustment will be calculated using the 12-month period from June to June. The assessments are to be levied beginning in the first assessment cycle of the fiscal year 2022-2023.

While the assumptions and estimated expenses listed in Exhibit C were used to determine the assessment levels for the GHAD, they do not represent the actual budget for any one year of the GHAD's operation. The Engineer anticipates that the projected expense amounts will be reached over time and that these amounts will be inflation-adjusted in the year that the expenses occur.

EXHIBIT A

Site Plan to Accompany Assessor's Parcel Number and Assessment Limit List for Santiago GHAD

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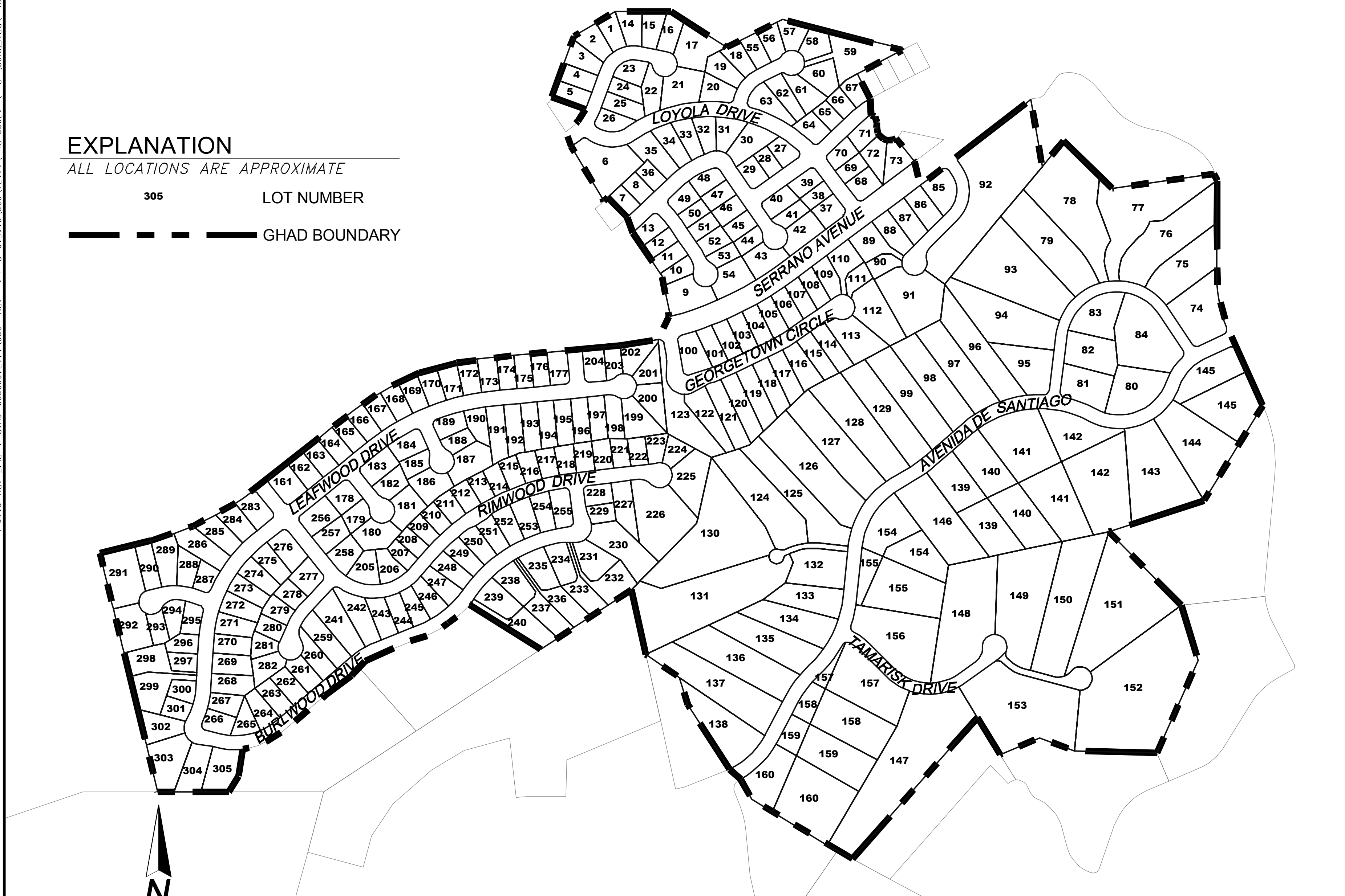
EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

305 LOT NUMBER

GHAD BOUNDARY



BASE MAP SOURCE: ORANGE COUNTY ASSESSOR'S OFFICE

ENGEO Expect Excellence

SITE PLAN TO ACCOMPANY ASSESSOR'S PARCEL NUMBER AND ASSESSMENT LIMIT LIST
SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
ANAHEIM, CALIFORNIA

PROJECT NO.: 14174.000.000	
SCALE: AS SHOWN	
DRAWN BY: GLJ	CHECKED BY: EWH

EXHIBIT
A

ORIGINAL FIGURE PRINTED IN COLOR

EXHIBIT B

Assessor's Parcel Number and Assessment Limit List for Santiago GHAD

			$466,900.40
			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-101-01	1	6841 E KENTUCKY AVE	$ 278.98
365-101-02	2	6831 E KENTUCKY AVE	$ 317.14
365-101-03	3	6821 E KENTUCKY AVE	$ 308.47
365-101-04	4	6811 E KENTUCKY AVE	$ 284.31
365-101-05	5	6801 E KENTUCKY AVE	$ 282.23
365-102-01	6	6796 E KENTUCKY AVE	$ 789.81
365-102-20	7	6825 E SWARTHMORE DR	$ 246.84
365-102-21	8	6835 E SWARTHMORE DR	$ 245.84
365-103-01	9	993 S VASSAR CIR	$ 487.26
365-103-02	10	983 S VASSAR CIR	$ 244.27
365-103-03	11	973 S VASSAR CIR	$ 257.35
365-103-04	12	963 S VASSAR CIR	$ 251.96
365-103-05	13	953 S VASSAR CIR	$ 266.57
365-111-01	14	6851 E KENTUCKY AVE	$ 306.05
365-111-02	15	6871 E KENTUCKY AVE	$ 306.63
365-111-03	16	6881 E KENTUCKY AVE	$ 301.14
365-111-04	17	6891 E KENTUCKY AVE	$ 526.50
365-111-05	18	6931 E MICHIGAN CIR	$ 281.31
365-111-06	19	6911 E MICHIGAN CIR	$ 320.63
365-111-07	20	6901 E MICHIGAN CIR	$ 318.91
365-111-08	21	6890 E KENTUCKY AVE	$ 493.77
365-111-09	22	6880 E KENTUCKY AVE	$ 322.90
365-111-10	23	6850 E KENTUCKY AVE	$ 280.23
365-111-11	24	6820 E KENTUCKY AVE	$ 253.95
365-111-12	25	6810 E KENTUCKY AVE	$ 302.00
365-111-13	26	6800 E KENTUCKY AVE	$ 268.84
365-112-01	27	6891 E RUTGERS DR	$ 258.39
365-112-02	28	6881 E RUTGERS DR	$ 229.60
365-112-03	29	6871 E RUTGERS DR	$ 267.34
365-112-04	30	934 S LEHIGH DR	$ 420.23
365-112-05	31	914 S LEHIGH DR	$ 309.27
365-112-06	32	6885 E SWARTHMORE DR	$ 284.95
365-112-07	33	6875 E SWARTHMORE DR	$ 303.61
365-112-08	34	6865 E SWARTHMORE DR	$ 330.56
365-112-09	35	6855 E SWARTHMORE DR	$ 413.95
365-112-10	36	6845 E SWARTHMORE DR	$ 237.12
365-113-01	37	997 S LOYOLA DR	$ 288.51
365-113-02	38	987 S LOYOLA DR	$ 226.62
365-113-03	39	977 S LOYOLA DR	$ 261.71
365-113-04	40	974 S LEHIGH DR	$ 288.69
365-113-05	41	984 S LEHIGH DR	$ 247.33
365-113-06	42	994 S LEHIGH DR	$ 380.52
365-113-07	43	995 S LEHIGH DR	$ 372.99
365-113-08	44	985 S LEHIGH DR	$ 231.84
365-113-09	45	975 S LEHIGH DR	$ 268.27
365-113-10	46	965 S LEHIGH DR	$ 265.40

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-113-11	47	955 S LEHIGH DR	$ 256.48
365-113-12	48	945 S LEHIGH DR	$ 265.60
365-113-13	49	952 S VASSAR CIR	$ 262.31
365-113-14	50	962 S VASSAR CIR	$ 230.19
365-113-15	51	972 S VASSAR CIR	$ 232.79
365-113-16	52	982 S VASSAR CIR	$ 262.04
365-113-17	53	992 S VASSAR CIR	$ 229.59
365-113-18	54	998 S VASSAR CIR	$ 409.30
365-121-01	55	6941 E MICHIGAN CIR	$ 264.07
365-121-02	56	6961 E MICHIGAN CIR	$ 283.12
365-121-03	57	6971 E MICHIGAN CIR	$ 291.47
365-121-04	58	6981 E MICHIGAN CIR	$ 319.00
365-121-05	59	6990 E MICHIGAN CIR	$ 720.07
365-121-06	60	6970 E MICHIGAN CIR	$ 367.19
365-121-07	61	6960 E MICHIGAN CIR	$ 341.26
365-121-08	62	6930 E MICHIGAN CIR	$ 323.69
365-121-09	63	6910 E MICHIGAN CIR	$ 358.90
365-121-10	64	6901 E RUTGERS DR	$ 291.76
365-121-11	65	6909 E RUTGERS DR	$ 232.33
365-121-12	66	6915 E RUTGERS DR	$ 233.21
365-121-13	67	6923 E RUTGERS DR	$ 252.97
365-122-01	68	990 S LOYOLA DR	$ 297.95
365-122-02	69	980 S LOYOLA DR	$ 235.85
365-122-03	70	970 S LOYOLA DR	$ 258.69
365-122-04	71	971 S SCRIPPS CIR	$ 282.13
365-122-05	72	981 S SCRIPPS CIR	$ 304.72
365-122-06	73	991 S SCRIPPS CIR	$ 321.16
365-201-01	74	6991 E VIA EL ESTRIBO	$ 1,244.86
365-201-02	75	6985 E VIA EL ESTRIBO	$ 1,298.92
365-201-03	76	6981 E VIA EL ESTRIBO	$ 1,941.56
365-201-04	77	6975 E VIA EL ESTRIBO	$ 2,305.33
365-201-06	78	6971 E VIA EL ESTRIBO	$ 2,600.93
365-201-07	79	6965 E VIA EL ESTRIBO	$ 1,825.46
365-202-01	80	6975 E AVENIDA DE SANTIAGO	$ 1,045.09
365-202-02	81	6950 E VIA EL ESTRIBO	$ 847.15
365-202-03	82	6960 E VIA EL ESTRIBO	$ 863.63
365-202-04	83	6970 E VIA EL ESTRIBO	$ 848.26
365-202-05	84	6990 E VIA EL ESTRIBO	$ 1,727.34
365-211-01	85	6991 E WILLIAMS CIR	$ 537.94
365-211-02	86	6971 E WILLIAMS CIR	$ 458.18
365-211-03	87	6951 E WILLIAMS CIR	$ 464.02
365-211-04	88	6931 E WILLIAMS CIR	$ 466.51
365-211-05	89	6921 E WILLIAMS CIR	$ 2,494.48
365-211-06	90	6911 E WILLIAMS CIR	$ 1,342.59
365-211-07	91	6901 E WILLIAMS CIR	$ 7,263.88
365-211-08	92	6950 E WILLIAMS CIR	$ 3,762.97
365-211-09	93	6961 E VIA EL ESTRIBO	$ 2,679.28
365-211-10	94	6955 E VIA EL ESTRIBO	$ 1,878.06
365-211-11	95	6951 E VIA EL ESTRIBO	$ 1,007.52

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-211-12	96	6949 E AVENIDA DE SANTIAGO	$ 7,005.05
365-211-13	97	6943 E AVENIDA DE SANTIAGO	$ 6,571.16
365-211-14	98	6937 E AVENIDA DE SANTIAGO	$ 6,807.59
365-211-15	99	6931 E AVENIDA DE SANTIAGO	$ 7,150.70
365-221-01	100	6807 E GEORGETOWN CIR	$ 2,367.81
365-221-02	101	6815 E GEORGETOWN CIR	$ 1,633.67
365-221-03	102	6823 E GEORGETOWN CIR	$ 1,574.20
365-221-04	103	6831 E GEORGETOWN CIR	$ 370.05
365-221-05	104	6839 E GEORGETOWN CIR	$ 1,598.93
365-221-06	105	6849 E GEORGETOWN CIR	$ 1,619.21
365-221-07	106	6857 E GEORGETOWN CIR	$ 1,579.49
365-221-08	107	6865 E GEORGETOWN CIR	$ 1,554.63
365-221-09	108	6873 E GEORGETOWN CIR	$ 1,565.84
365-221-10	109	6881 E GEORGETOWN CIR	$ 1,669.21
365-221-11	110	6889 E GEORGETOWN CIR	$ 2,118.47
365-221-12	111	6895 E GEORGETOWN CIR	$ 1,282.60
365-221-13	112	6890 E GEORGETOWN CIR	$ 4,437.70
365-221-14	113	6872 E GEORGETOWN CIR	$ 3,852.37
365-221-15	114	6864 E GEORGETOWN CIR	$ 2,083.76
365-221-16	115	6856 E GEORGETOWN CIR	$ 2,005.94
365-221-17	116	6848 E GEORGETOWN CIR	$ 2,238.58
365-221-18	117	6840 E GEORGETOWN CIR	$ 2,172.22
365-221-19	118	6832 E GEORGETOWN CIR	$ 2,288.21
365-221-20	119	6824 E GEORGETOWN CIR	$ 2,744.47
365-221-21	120	6816 E GEORGETOWN CIR	$ 2,738.45
365-221-22	121	6808 E GEORGETOWN CIR	$ 2,872.03
365-221-23	122	6800 E GEORGETOWN CIR	$ 3,010.59
365-221-24	123	NO ADDRESS	$ 5,191.64
365-221-25	124	6899 E AVENIDA DE SANTIAGO	$ 10,097.73
365-221-26	125	6901 E AVENIDA DE SANTIAGO	$ 9,029.96
365-221-27	126	6907 E AVENIDA DE SANTIAGO	$ 10,358.63
365-221-28	127	6913 E AVENIDA DE SANTIAGO	$ 8,474.41
365-221-29	128	6919 E AVENIDA DE SANTIAGO	$ 8,894.60
365-221-30	129	6925 E AVENIDA DE SANTIAGO	$ 7,526.36
365-231-01	130	6891 E AVENIDA DE SANTIAGO	$ 16,496.63
365-231-02	131	6881 E AVENIDA DE SANTIAGO	$ 18,820.29
365-231-03	132	6871 E AVENIDA DE SANTIAGO	$ 4,816.69
365-231-04	133	6861 E AVENIDA DE SANTIAGO	$ 4,132.14
365-231-05	134	6851 E AVENIDA DE SANTIAGO	$ 5,474.03
365-231-06	135	6841 E AVENIDA DE SANTIAGO	$ 6,776.24
365-231-07	136	6831 E AVENIDA DE SANTIAGO	$ 8,555.25
365-231-08	137	6821 E AVENIDA DE SANTIAGO	$ 1,950.88
365-231-09	138	6811 E AVENIDA DE SANTIAGO	$ 1,355.93
365-401-03	139	6930 E AVE DE SANTIAGO	$ 4,731.15
365-401-04	139	6930 E AVE DE SANTIAGO	$ 4,314.95
365-401-05	140	6940 E AVENIDA DE SANTIAGO	$ 1,022.76
365-401-06	140	6940 E AVENIDA DE SANTIAGO	$ 1,104.03
365-401-07	141	6950 E AVE DE SANTIAGO	$ 1,413.81
365-401-08	141	6950 E AVE DE SANTIAGO	$ 1,690.70

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-401-09	142	6960 E AVENIDA DE SANTIAGO	$ 1,042.22
365-401-10	142	NO ADDRESS	$ 2,136.53
365-401-11	143	6970 E AVE DE SANTIAGO	$ 2,269.46
365-401-12	144	6980 E AVENIDA DE SANTIAGO	$ 1,826.41
365-401-13	145	NO ADDRESS	$ 1,397.02
365-401-14	145	6990 E AVE DE SANTIAGO	$ 952.22
365-401-16	146	6920 E AVENIDA DE SANTIAGO	$ 8,619.17
365-431-01	147	1125 S TAMARISK DR	$ 4,100.78
365-441-01	148	1130 S TAMARISK DR	$ 2,645.20
365-441-02	149	1150 S TAMARISK DR	$ 2,532.89
365-441-03	150	1160 S TAMARISK DR	$ 2,494.93
365-441-04	151	1180 S TAMARISK DR	$ 3,366.05
365-441-05	152	1190 S TAMARISK DR	$ 5,056.70
365-441-06	153	1145 S TAMARISK DR	$ 3,234.30
365-451-01	154	6912 E AVENIDA DE SANTIAGO	$ 4,189.56
365-451-02	154	6912 E AVENIDA DE SANTIAGO	$ 4,661.04
365-451-03	155	6906 E AVE DE SANTIAGO	$ 1,830.29
365-451-04	155	6906 E AVE DE SANTIAGO	$ 7,693.19
365-451-05	156	1110 S TAMARISK DR	$ 1,997.10
365-451-06	157	6860 E AVE DE SANTIAGO	$ 1,614.38
365-451-07	157	6860 E AVE DE SANTIAGO	$ 238.37
365-451-08	158	6840 E AVE DE SANTIAGO	$ 405.72
365-451-09	158	6840 E AVE DE SANTIAGO	$ 1,426.48
365-451-10	159	6820 E AVE DE SANTIAGO	$ 1,244.82
365-451-11	159	6820 E AVE DE SANTIAGO	$ 419.72
365-451-12	160	6810 E AVE DE SANTIAGO	$ 912.79
365-451-13	160	6810 E AVE DE SANTIAGO	$ 1,926.15
368-021-01	161	6701 E LEAFWOOD DR	$ 351.06
368-021-02	162	6705 E LEAFWOOD DR	$ 284.13
368-021-03	163	6709 E LEAFWOOD DR	$ 285.38
368-021-04	164	6713 E LEAFWOOD DR	$ 275.96
368-021-05	165	6717 E LEAFWOOD DR	$ 266.78
368-021-06	166	6721 E LEAFWOOD DR	$ 283.42
368-021-07	167	6725 E LEAFWOOD DR	$ 281.77
368-021-08	168	6729 E LEAFWOOD DR	$ 280.53
368-021-09	169	6733 E LEAFWOOD DR	$ 282.69
368-021-10	170	6737 E LEAFWOOD DR	$ 282.71
368-021-11	171	6741 E LEAFWOOD DR	$ 281.07
368-021-12	172	6745 E LEAFWOOD DR	$ 284.00
368-021-13	173	6749 E LEAFWOOD DR	$ 278.90
368-021-14	174	6753 E LEAFWOOD DR	$ 260.13
368-021-15	175	6757 E LEAFWOOD DR	$ 257.14
368-021-16	176	6761 E LEAFWOOD DR	$ 254.88
368-021-17	177	6765 E LEAFWOOD DR	$ 284.77
368-022-01	178	1041 S PINE CANYON CIR	$ 302.65
368-022-02	179	1051 S PINE CANYON CIR	$ 261.13
368-022-03	180	1061 S PINE CANYON CIR	$ 405.64
368-022-04	181	1060 S PINE CANYON CIR	$ 378.27
368-022-05	182	1050 S PINE CANYON CIR	$ 297.58

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-022-06	183	1040 S PINE CANYON CIR	$ 335.65
368-022-07	184	1041 S FALLING LEAF CIR	$ 312.99
368-022-08	185	1051 S FALLING LEAF CIR	$ 250.00
368-022-09	186	1061 S FALLING LEAF CIR	$ 386.43
368-022-10	187	1060 S FALLING LEAF CIR	$ 445.43
368-022-11	188	1050 S FALLING LEAF CIR	$ 242.12
368-022-12	189	1040 S FALLING LEAF CIR	$ 272.65
368-022-13	190	6746 E LEAFWOOD DR	$ 287.38
368-022-14	191	6750 E LEAFWOOD DR	$ 376.01
368-022-15	192	6754 E LEAFWOOD DR	$ 344.50
368-022-16	193	6758 E LEAFWOOD DR	$ 328.01
368-022-17	194	6762 E LEAFWOOD DR	$ 324.37
368-022-18	195	6768 E LEAFWOOD DR	$ 319.15
368-022-19	196	6774 E LEAFWOOD DR	$ 312.69
368-022-20	197	6780 E LEAFWOOD DR	$ 312.30
368-022-21	198	6786 E LEAFWOOD DR	$ 304.31
368-022-22	199	6792 E LEAFWOOD DR	$ 2,682.81
368-022-23	200	6798 E LEAFWOOD DR	$ 2,211.52
368-022-24	201	6799 E LEAFWOOD DR	$ 401.07
368-022-25	202	6793 E LEAFWOOD DR	$ 318.03
368-022-26	203	6787 E LEAFWOOD DR	$ 246.21
368-022-27	204	6781 E LEAFWOOD DR	$ 305.54
368-031-01	205	1022 S RIMWOOD DR	$ 329.06
368-031-02	206	1026 S RIMWOOD DR	$ 287.85
368-031-03	207	1030 S RIMWOOD DR	$ 225.58
368-031-04	208	1034 S RIMWOOD DR	$ 237.18
368-031-05	209	1038 S RIMWOOD DR	$ 235.35
368-031-06	210	1042 S RIMWOOD DR	$ 241.70
368-031-07	211	1046 S RIMWOOD DR	$ 256.59
368-031-08	212	1050 S RIMWOOD DR	$ 252.28
368-031-09	213	1054 S RIMWOOD DR	$ 235.33
368-031-10	214	1058 S RIMWOOD DR	$ 233.50
368-031-11	215	1062 S RIMWOOD DR	$ 254.45
368-031-12	216	1066 S RIMWOOD DR	$ 254.76
368-031-13	217	1070 S RIMWOOD DR	$ 246.73
368-031-14	218	1074 S RIMWOOD DR	$ 248.96
368-031-15	219	1078 S RIMWOOD DR	$ 248.78
368-031-16	220	1082 S RIMWOOD DR	$ 254.58
368-031-17	221	1086 S RIMWOOD DR	$ 1,261.72
368-031-18	222	1090 S RIMWOOD DR	$ 1,234.23
368-031-19	223	1094 S RIMWOOD DR	$ 1,335.18
368-031-20	224	1098 S RIMWOOD DR	$ 1,436.89
368-031-21	225	1099 S RIMWOOD DR	$ 3,990.53
368-031-22	226	1093 S RIMWOOD DR	$ 7,833.34
368-031-23	227	1087 S RIMWOOD DR	$ 2,396.24
368-031-24	228	1099 S BURLWOOD DR	$ 259.27
368-031-25	229	1097 S BURLWOOD DR	$ 1,222.68
368-031-26	230	1095 S BURLWOOD DR	$ 4,699.31
368-031-27	231	1093 S BURLWOOD DR	$ 2,624.28

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-031-28	232	1091 S BURLWOOD DR	$ 2,982.24
368-031-29	233	1089 S BURLWOOD DR	$ 366.23
368-031-30	234	1085 S BURLWOOD DR	$ 348.99
368-031-31	235	1081 S BURLWOOD DR	$ 381.59
368-031-32	236	1077 S BURLWOOD DR	$ 398.96
368-031-33	237	1075 S BURLWOOD DR	$ 408.36
368-031-34	238	1071 S BURLWOOD DR	$ 377.49
368-031-35	239	1063 S BURLWOOD DR	$ 396.40
368-031-36	240	1059 S BURLWOOD DR	$ 493.73
368-032-01	241	1036 S BURLWOOD DR	$ 520.03
368-032-02	242	1040 S BURLWOOD DR	$ 446.84
368-032-03	243	1044 S BURLWOOD DR	$ 317.99
368-032-04	244	1048 S BURLWOOD DR	$ 269.10
368-032-05	245	1052 S BURLWOOD DR	$ 273.24
368-032-06	246	1056 S BURLWOOD DR	$ 303.78
368-032-07	247	1060 S BURLWOOD DR	$ 303.89
368-032-08	248	1064 S BURLWOOD DR	$ 311.91
368-032-09	249	1068 S BURLWOOD DR	$ 302.41
368-032-10	250	1072 S BURLWOOD DR	$ 297.89
368-032-11	251	1076 S BURLWOOD DR	$ 276.76
368-032-12	252	1080 S BURLWOOD DR	$ 295.91
368-032-13	253	1084 S BURLWOOD DR	$ 306.89
368-032-14	254	1088 S BURLWOOD DR	$ 296.29
368-032-15	255	1090 S BURLWOOD DR	$ 312.36
368-041-01	256	1010 S RIMWOOD DR	$ 355.75
368-041-02	257	1014 S RIMWOOD DR	$ 308.41
368-041-03	258	1018 S RIMWOOD DR	$ 327.55
368-042-01	259	1032 S BURLWOOD DR	$ 429.84
368-042-02	260	1028 S BURLWOOD DR	$ 335.86
368-042-03	261	1024 S BURLWOOD DR	$ 298.77
368-042-04	262	1020 S BURLWOOD DR	$ 293.89
368-042-05	263	1016 S BURLWOOD DR	$ 292.83
368-042-06	264	1012 S BURLWOOD DR	$ 298.00
368-042-07	265	1008 S BURLWOOD DR	$ 268.69
368-042-08	266	6608 E LEAFWOOD DR	$ 276.24
368-042-09	267	6616 E LEAFWOOD DR	$ 276.51
368-042-10	268	6624 E LEAFWOOD DR	$ 334.50
368-042-11	269	6632 E LEAFWOOD DR	$ 327.65
368-042-12	270	6640 E LEAFWOOD DR	$ 300.80
368-042-13	271	6648 E LEAFWOOD DR	$ 311.75
368-042-14	272	6656 E LEAFWOOD DR	$ 317.60
368-042-15	273	6664 E LEAFWOOD DR	$ 298.45
368-042-16	274	6672 E LEAFWOOD DR	$ 319.52
368-042-17	275	6680 E LEAFWOOD DR	$ 320.02
368-042-18	276	6690 E LEAFWOOD DR	$ 354.31
368-042-19	277	6691 E SMOKEWOOD CIR	$ 315.09
368-042-20	278	6681 E SMOKEWOOD CIR	$ 255.17
368-042-21	279	6661 E SMOKEWOOD CIR	$ 258.69
368-042-22	280	6651 E SMOKEWOOD CIR	$ 242.88

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-042-23	281	6631 E SMOKEWOOD CIR	$ 245.69
368-042-24	282	6621 E SMOKEWOOD CIR	$ 307.15
368-043-01	283	6691 E LEAFWOOD DR	$ 327.63
368-043-02	284	6683 E LEAFWOOD DR	$ 312.60
368-043-03	285	6675 E LEAFWOOD DR	$ 357.18
368-043-04	286	6667 E LEAFWOOD DR	$ 431.85
368-043-05	287	1024 S ASPENWOOD CIR	$ 250.42
368-043-06	288	1018 S ASPENWOOD CIR	$ 299.52
368-043-07	289	1012 S ASPENWOOD CIR	$ 403.54
368-043-08	290	1006 S ASPENWOOD CIR	$ 326.90
368-043-09	291	1000 S ASPENWOOD CIR	$ 681.91
368-043-10	292	1001 S ASPENWOOD CIR	$ 490.21
368-043-11	293	1007 S ASPENWOOD CIR	$ 245.91
368-043-12	294	1015 S ASPENWOOD CIR	$ 280.60
368-043-13	295	1021 S ASPENWOOD CIR	$ 260.60
368-043-14	296	6639 E LEAFWOOD DR	$ 258.78
368-043-15	297	6631 E LEAFWOOD DR	$ 243.86
368-043-16	298	6625 E LEAFWOOD DR	$ 439.53
368-043-17	299	6623 E LEAFWOOD DR	$ 516.65
368-043-18	300	6619 E LEAFWOOD DR	$ 248.55
368-043-19	301	6609 E LEAFWOOD DR	$ 248.80
368-043-20	302	6601 E LEAFWOOD DR	$ 393.71
368-043-21	303	1001 S BURLWOOD DR	$ 598.45
368-043-22	304	1003 S BURLWOOD DR	$ 434.35
368-043-23	305	1005 S BURLWOOD DR	$ 494.39
		City-owned streets in landslide/surf. def. - (Ave. de Santiago includes Escalator)	$ 15,493.58
		City-owned streets in GW recharge zone	$ 8,033.52
		City-owned streets in seepage zone	$ 14,652.56
			$466,900.40

EXHIBIT C

Santiago GHAD Budget

EXHIBIT C

Santiago Geologic Hazard Abatement District
Santiago Development
Budget – July 2022

ASSUMPTIONS

Total Number of Assessed Parcels/Street Units	316
Annual Adjustment in Assessment (estimated)	2%
Inflation (estimated)	2%
Investment Earnings (estimated)	1%
Frequency of Large-Scale Well Work (years)	40
Cost of Well Replacement (current $)	$3,217,500

ESTIMATED ANNUAL EXPENSES IN FY 2022/23 DOLLARS

Wells – Major Replacement (annualized)		$80,437
Utilities Electric		$18,000
Well Maintenance and Monitoring		$154,500
Geology and Monitoring		$43,300
Maintenance of Connector Pipes to Public Storm Drain		$25,000
Site Monitoring Program		$8,000
Monitoring Well and Piezometer Replacement (Annualized)		$16,250
Horizontal Drains (Annualized)		$13,895
Inclinometer and Pedestal Replacement (Annualized)		$12,255
Administration and Accounting		$51,537
County Fees		$1,409
Miscellaneous & Contingency (10%)		$42,317
	Total	$466,900

DRAFT

SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT
STAFF REPORT

TO: Santiago Geologic Hazard Abatement District ("GHAD") Board of Directors

FROM: GHAD Manager

BOARD MEETING DATE: August 4, 2022

SUBJECT: ADOPT Resolution 2022/13 accepting the assessment budget and directing ENGEO Incorporated to incorporate it into and complete the Engineer's Report, using it for apportionment calculations for each property for a possible assessment

RECOMMENDATION(S):

1. ADOPT the attached Resolution No. 2022/13 to do the following:

   (a) The GHAD Board ACCEPTS the assessment budget; and

   (b) The GHAD Board DIRECTS ENGEO Incorporated incorporate it into and complete the Engineer's Report, using it for apportionment calculations for each property for a possible assessment

BACKGROUND:

The Anaheim City Council formed the Santiago Geologic Hazard Abatement District ("GHAD") on March 16, 1999, under the authority of the California Public Resources Code, Division 17, Section 26500 et seq. with the approval of City of Anaheim Resolution 99R-50. Five property owners within the GHAD serve as the Board of Directors of the Santiago GHAD.

The Anaheim City Council approved the Santiago GHAD Plan of Control ("Plan of Control") to allow the Santiago GHAD to permanently monitor and maintain the Santiago landslide. The Santiago GHAD is funded through a settlement with the City of Anaheim ("GHAD Distribution"). The GHAD Distribution cannot be used to fund activities or facilities which do not materially and substantially promote the objective of stabilizing past, present, and future land movement of the Santiago landslide." In 1999, the initial GHAD Distribution was approximately $3,500,000, and as of June 16, 2022, the fund balance was approximately $532,421.

To allocate assessments in proportion to special benefit conferred on assessed properties, a formula has been derived that estimates the special benefit conveyed by the GHAD. The formula includes several factors, which are weighted based on their relative effect on special benefit. Special benefit is derived considering the following factors, and weighting has been applied to each factor to note its relative importance as compared to other factors. Several factors have been incorporated into the analysis, including a respective property's proximity to the delineated landslide, a respective property's potential to experience geologic distress in the event of landslide mobilization, a landslide's proximity to the hydrogeologic watershed area that feeds groundwater mitigated by the pump system, and other properties that benefit from seepage control. Additionally, all residential properties benefit from the mitigation of geologic hazards to provide continued transportation access, access to amenities, and reduction of the potential property devaluation that could occur in the event of mobilization and manifestation of geologic hazards within the GHAD. The formula is presented in the draft Engineer's Report, an exhibit to the attached resolution.

ENGEO has prepared an assessment allocation, demonstrating the proposed assessment on an individual property basis, utilizing the assessment budget which includes costs for deferred maintenance responsibilities and the Fiscal Year 2022/23 GHAD Program Budget for comparative purposes, an exhibit to the attached resolution.

FISCAL IMPACT:

The GHAD is currently funded 100% through the GHAD Distribution. Once the Engineer's Report is completed, if adopted and approved, the activities of the Santiago GHAD will be funded through the GHAD Distribution and assessments levied on properties within the GHAD.

ATTACHMENTS:

A. Resolution No. 2022/13, A Resolution to Approve an Assessment Budget for the Santiago Geologic Hazard Abatement District Engineer's Report

BOARD OF DIRECTORS OF THE
SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT

RESOLUTION NO. 2022/13

A RESOLUTION TO APPROVE AN ASSESSMENT BUDGET FOR THE SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT ENGINEER'S REPORT

WHEREAS, on March 16, 1999, the Anaheim City Council adopted Resolution No. 99R-50 approving and ordering the formation of the Santiago Geologic Hazard Abatement District ("Santiago GHAD"); and

WHEREAS, the Santiago GHAD is a political subdivision of the State of California, governed by state law (Pub. Res. Code § 26500 et seq.), and constitutes a legal entity separate and distinct from the City of Anaheim ("City"), with operations independent of City functions; and

WHEREAS, in order to pay for the cost and expenses of maintaining and operating the GHAD improvements as set forth in the Plan of Control, an assessment for GHAD services is to be considered for imposition on properties within the Santiago GHAD as reflected in the draft Engineer's Report; and

WHEREAS, Public Resources Code Sections 26650 et seq. authorize, after a noticed public hearing, the levy and collection of an assessment upon specially benefited property within the GHAD to pay for the maintenance and operation of GHAD improvements. Article XIII (D) of the California Constitution imposes additional requirements for the levy and collection of said assessment; and

WHEREAS, a draft Engineer's Report has been prepared by the GHAD Manager to reflect the special benefit conferred to properties with the GHAD; the GHAD Manager is a registered professional engineer, certified in the State of California, in compliance with Public Resources Code section 26651(a) and section 4(b) of Article XIII (D) of the California Constitution; the Engineer's Report attached hereto as Attachment A sets forth the purpose of the GHAD and a description of the method used in formulating the estimated assessments; and

WHEREAS, an assessment budget has been prepared for incorporation into the final Engineer's Report, attached hereto as Attachment A, and

WHEREAS, an assessment allocation has been prepared, demonstrating the proposed assessment on an individual property basis, utilizing the assessment budget and the 2022-2023 GHAD operating budget GHAD operating budget for comparative purposes, attached hereto as Attachment B, and

NOW, THEREFORE, THE SANTIAGO GEOLOGIC HAZARD ABATEMENT DISTRICT DOES HEREBY RESOLVE AS FOLLOWS:

1. The GHAD Board has been presented with and approves the identified assessment budget alternative. The budgeted assessment will be applied using the apportionment model presented in the Draft E Engineer's Report; and

2. The GHAD Board orders ENGEO Incorporated to prepare a final Engineer's Report, utilizing the assessment budget identified to determine property-specific assessment

levels. constructed pursuant to Public Resources Code sections 26500 et seq. shall be assessed against the property within the GHAD, which is benefited by the GHAD; and

3. The GHAD Board shall direct the Manager of the GHAD to schedule a Public Hearing for consideration of the final Engineer’s Report and issuance of a Notice of Intent to Order an Assessment; and

4. This Resolution shall become effective immediately upon its passage and adoption.

DATED: August 4, 2022

I, Karen Holthe, Clerk of the Santiago Geologic Hazard Abatement District, certify that the foregoing resolution was duly adopted by the Board of Directors of the District at a regular meeting held on the 4th day of August 2022 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

____
Clerk of the Santiago GHAD Board

Attachment A: Budget
Attachment B: Comparative Budget Allocation

Attachment A

Fiscal Year 2022/23 Budget and Annualized Deferred Maintenance Cost Estimates

FY 2022/23 Proposed Budget and Deferred Maintenance

Wells – Major Replacement (annualized)		$80,437
Utilities Electric		$18,000
Well Maintenance and Monitoring		$154,500
Geology and Monitoring		$43,300
Maintenance of Connector Pipes to Public Storm Drain		$25,000
Site Monitoring Program		$8,000
Monitoring Well and Piezometer Replacement (Annualized)		$16,250
Horizontal Drains (Annualized)		$13,895
Inclinometer and Pedestal Replacement (Annualized)		$12,255
Administration and Accounting		$51,537
County Fees		$1,409
Miscellaneous & Contingency (10%)		$42,317
	Total	$466,900

			$466,900.40
			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-101-01	1	6841 E KENTUCKY AVE	$ 278.98
365-101-02	2	6831 E KENTUCKY AVE	$ 317.14
365-101-03	3	6821 E KENTUCKY AVE	$ 308.47
365-101-04	4	6811 E KENTUCKY AVE	$ 284.31
365-101-05	5	6801 E KENTUCKY AVE	$ 282.23
365-102-01	6	6796 E KENTUCKY AVE	$ 789.81
365-102-20	7	6825 E SWARTHMORE DR	$ 246.84
365-102-21	8	6835 E SWARTHMORE DR	$ 245.84
365-103-01	9	993 S VASSAR CIR	$ 487.26
365-103-02	10	983 S VASSAR CIR	$ 244.27
365-103-03	11	973 S VASSAR CIR	$ 257.35
365-103-04	12	963 S VASSAR CIR	$ 251.96
365-103-05	13	953 S VASSAR CIR	$ 266.57
365-111-01	14	6851 E KENTUCKY AVE	$ 306.05
365-111-02	15	6871 E KENTUCKY AVE	$ 306.63
365-111-03	16	6881 E KENTUCKY AVE	$ 301.14
365-111-04	17	6891 E KENTUCKY AVE	$ 526.50
365-111-05	18	6931 E MICHIGAN CIR	$ 281.31
365-111-06	19	6911 E MICHIGAN CIR	$ 320.63
365-111-07	20	6901 E MICHIGAN CIR	$ 318.91
365-111-08	21	6890 E KENTUCKY AVE	$ 493.77
365-111-09	22	6880 E KENTUCKY AVE	$ 322.90
365-111-10	23	6850 E KENTUCKY AVE	$ 280.23
365-111-11	24	6820 E KENTUCKY AVE	$ 253.95
365-111-12	25	6810 E KENTUCKY AVE	$ 302.00
365-111-13	26	6800 E KENTUCKY AVE	$ 268.84
365-112-01	27	6891 E RUTGERS DR	$ 258.39
365-112-02	28	6881 E RUTGERS DR	$ 229.60
365-112-03	29	6871 E RUTGERS DR	$ 267.34
365-112-04	30	934 S LEHIGH DR	$ 420.23
365-112-05	31	914 S LEHIGH DR	$ 309.27
365-112-06	32	6885 E SWARTHMORE DR	$ 284.95
365-112-07	33	6875 E SWARTHMORE DR	$ 303.61
365-112-08	34	6865 E SWARTHMORE DR	$ 330.56
365-112-09	35	6855 E SWARTHMORE DR	$ 413.95
365-112-10	36	6845 E SWARTHMORE DR	$ 237.12
365-113-01	37	997 S LOYOLA DR	$ 288.51
365-113-02	38	987 S LOYOLA DR	$ 226.62
365-113-03	39	977 S LOYOLA DR	$ 261.71
365-113-04	40	974 S LEHIGH DR	$ 288.69
365-113-05	41	984 S LEHIGH DR	$ 247.33
365-113-06	42	994 S LEHIGH DR	$ 380.52
365-113-07	43	995 S LEHIGH DR	$ 372.99
365-113-08	44	985 S LEHIGH DR	$ 231.84
365-113-09	45	975 S LEHIGH DR	$ 268.27
365-113-10	46	965 S LEHIGH DR	$ 265.40

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-113-11	47	955 S LEHIGH DR	$ 256.48
365-113-12	48	945 S LEHIGH DR	$ 265.60
365-113-13	49	952 S VASSAR CIR	$ 262.31
365-113-14	50	962 S VASSAR CIR	$ 230.19
365-113-15	51	972 S VASSAR CIR	$ 232.79
365-113-16	52	982 S VASSAR CIR	$ 262.04
365-113-17	53	992 S VASSAR CIR	$ 229.59
365-113-18	54	998 S VASSAR CIR	$ 409.30
365-121-01	55	6941 E MICHIGAN CIR	$ 264.07
365-121-02	56	6961 E MICHIGAN CIR	$ 283.12
365-121-03	57	6971 E MICHIGAN CIR	$ 291.47
365-121-04	58	6981 E MICHIGAN CIR	$ 319.00
365-121-05	59	6990 E MICHIGAN CIR	$ 720.07
365-121-06	60	6970 E MICHIGAN CIR	$ 367.19
365-121-07	61	6960 E MICHIGAN CIR	$ 341.26
365-121-08	62	6930 E MICHIGAN CIR	$ 323.69
365-121-09	63	6910 E MICHIGAN CIR	$ 358.90
365-121-10	64	6901 E RUTGERS DR	$ 291.76
365-121-11	65	6909 E RUTGERS DR	$ 232.33
365-121-12	66	6915 E RUTGERS DR	$ 233.21
365-121-13	67	6923 E RUTGERS DR	$ 252.97
365-122-01	68	990 S LOYOLA DR	$ 297.95
365-122-02	69	980 S LOYOLA DR	$ 235.85
365-122-03	70	970 S LOYOLA DR	$ 258.69
365-122-04	71	971 S SCRIPPS CIR	$ 282.13
365-122-05	72	981 S SCRIPPS CIR	$ 304.72
365-122-06	73	991 S SCRIPPS CIR	$ 321.16
365-201-01	74	6991 E VIA EL ESTRIBO	$ 1,244.86
365-201-02	75	6985 E VIA EL ESTRIBO	$ 1,298.92
365-201-03	76	6981 E VIA EL ESTRIBO	$ 1,941.56
365-201-04	77	6975 E VIA EL ESTRIBO	$ 2,305.33
365-201-06	78	6971 E VIA EL ESTRIBO	$ 2,600.93
365-201-07	79	6965 E VIA EL ESTRIBO	$ 1,825.46
365-202-01	80	6975 E AVENIDA DE SANTIAGO	$ 1,045.09
365-202-02	81	6950 E VIA EL ESTRIBO	$ 847.15
365-202-03	82	6960 E VIA EL ESTRIBO	$ 863.63
365-202-04	83	6970 E VIA EL ESTRIBO	$ 848.26
365-202-05	84	6990 E VIA EL ESTRIBO	$ 1,727.34
365-211-01	85	6991 E WILLIAMS CIR	$ 537.94
365-211-02	86	6971 E WILLIAMS CIR	$ 458.18
365-211-03	87	6951 E WILLIAMS CIR	$ 464.02
365-211-04	88	6931 E WILLIAMS CIR	$ 466.51
365-211-05	89	6921 E WILLIAMS CIR	$ 2,494.48
365-211-06	90	6911 E WILLIAMS CIR	$ 1,342.59
365-211-07	91	6901 E WILLIAMS CIR	$ 7,263.88
365-211-08	92	6950 E WILLIAMS CIR	$ 3,762.97
365-211-09	93	6961 E VIA EL ESTRIBO	$ 2,679.28
365-211-10	94	6955 E VIA EL ESTRIBO	$ 1,878.06
365-211-11	95	6951 E VIA EL ESTRIBO	$ 1,007.52

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-211-12	96	6949 E AVENIDA DE SANTIAGO	$ 7,005.05
365-211-13	97	6943 E AVENIDA DE SANTIAGO	$ 6,571.16
365-211-14	98	6937 E AVENIDA DE SANTIAGO	$ 6,807.59
365-211-15	99	6931 E AVENIDA DE SANTIAGO	$ 7,150.70
365-221-01	100	6807 E GEORGETOWN CIR	$ 2,367.81
365-221-02	101	6815 E GEORGETOWN CIR	$ 1,633.67
365-221-03	102	6823 E GEORGETOWN CIR	$ 1,574.20
365-221-04	103	6831 E GEORGETOWN CIR	$ 370.05
365-221-05	104	6839 E GEORGETOWN CIR	$ 1,598.93
365-221-06	105	6849 E GEORGETOWN CIR	$ 1,619.21
365-221-07	106	6857 E GEORGETOWN CIR	$ 1,579.49
365-221-08	107	6865 E GEORGETOWN CIR	$ 1,554.63
365-221-09	108	6873 E GEORGETOWN CIR	$ 1,565.84
365-221-10	109	6881 E GEORGETOWN CIR	$ 1,669.21
365-221-11	110	6889 E GEORGETOWN CIR	$ 2,118.47
365-221-12	111	6895 E GEORGETOWN CIR	$ 1,282.60
365-221-13	112	6890 E GEORGETOWN CIR	$ 4,437.70
365-221-14	113	6872 E GEORGETOWN CIR	$ 3,852.37
365-221-15	114	6864 E GEORGETOWN CIR	$ 2,083.76
365-221-16	115	6856 E GEORGETOWN CIR	$ 2,005.94
365-221-17	116	6848 E GEORGETOWN CIR	$ 2,238.58
365-221-18	117	6840 E GEORGETOWN CIR	$ 2,172.22
365-221-19	118	6832 E GEORGETOWN CIR	$ 2,288.21
365-221-20	119	6824 E GEORGETOWN CIR	$ 2,744.47
365-221-21	120	6816 E GEORGETOWN CIR	$ 2,738.45
365-221-22	121	6808 E GEORGETOWN CIR	$ 2,872.03
365-221-23	122	6800 E GEORGETOWN CIR	$ 3,010.59
365-221-24	123	NO ADDRESS	$ 5,191.64
365-221-25	124	6899 E AVENIDA DE SANTIAGO	$ 10,097.73
365-221-26	125	6901 E AVENIDA DE SANTIAGO	$ 9,029.96
365-221-27	126	6907 E AVENIDA DE SANTIAGO	$ 10,358.63
365-221-28	127	6913 E AVENIDA DE SANTIAGO	$ 8,474.41
365-221-29	128	6919 E AVENIDA DE SANTIAGO	$ 8,894.60
365-221-30	129	6925 E AVENIDA DE SANTIAGO	$ 7,526.36
365-231-01	130	6891 E AVENIDA DE SANTIAGO	$ 16,496.63
365-231-02	131	6881 E AVENIDA DE SANTIAGO	$ 18,820.29
365-231-03	132	6871 E AVENIDA DE SANTIAGO	$ 4,816.69
365-231-04	133	6861 E AVENIDA DE SANTIAGO	$ 4,132.14
365-231-05	134	6851 E AVENIDA DE SANTIAGO	$ 5,474.03
365-231-06	135	6841 E AVENIDA DE SANTIAGO	$ 6,776.24
365-231-07	136	6831 E AVENIDA DE SANTIAGO	$ 8,555.25
365-231-08	137	6821 E AVENIDA DE SANTIAGO	$ 1,950.88
365-231-09	138	6811 E AVENIDA DE SANTIAGO	$ 1,355.93
365-401-03	139	6930 E AVE DE SANTIAGO	$ 4,731.15
365-401-04	139	6930 E AVE DE SANTIAGO	$ 4,314.95
365-401-05	140	6940 E AVENIDA DE SANTIAGO	$ 1,022.76
365-401-06	140	6940 E AVENIDA DE SANTIAGO	$ 1,104.03
365-401-07	141	6950 E AVE DE SANTIAGO	$ 1,413.81
365-401-08	141	6950 E AVE DE SANTIAGO	$ 1,690.70

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
365-401-09	142	6960 E AVENIDA DE SANTIAGO	$ 1,042.22
365-401-10	142	NO ADDRESS	$ 2,136.53
365-401-11	143	6970 E AVE DE SANTIAGO	$ 2,269.46
365-401-12	144	6980 E AVENIDA DE SANTIAGO	$ 1,826.41
365-401-13	145	NO ADDRESS	$ 1,397.02
365-401-14	145	6990 E AVE DE SANTIAGO	$ 952.22
365-401-16	146	6920 E AVENIDA DE SANTIAGO	$ 8,619.17
365-431-01	147	1125 S TAMARISK DR	$ 4,100.78
365-441-01	148	1130 S TAMARISK DR	$ 2,645.20
365-441-02	149	1150 S TAMARISK DR	$ 2,532.89
365-441-03	150	1160 S TAMARISK DR	$ 2,494.93
365-441-04	151	1180 S TAMARISK DR	$ 3,366.05
365-441-05	152	1190 S TAMARISK DR	$ 5,056.70
365-441-06	153	1145 S TAMARISK DR	$ 3,234.30
365-451-01	154	6912 E AVENIDA DE SANTIAGO	$ 4,189.56
365-451-02	154	6912 E AVENIDA DE SANTIAGO	$ 4,661.04
365-451-03	155	6906 E AVE DE SANTIAGO	$ 1,830.29
365-451-04	155	6906 E AVE DE SANTIAGO	$ 7,693.19
365-451-05	156	1110 S TAMARISK DR	$ 1,997.10
365-451-06	157	6860 E AVE DE SANTIAGO	$ 1,614.38
365-451-07	157	6860 E AVE DE SANTIAGO	$ 238.37
365-451-08	158	6840 E AVE DE SANTIAGO	$ 405.72
365-451-09	158	6840 E AVE DE SANTIAGO	$ 1,426.48
365-451-10	159	6820 E AVE DE SANTIAGO	$ 1,244.82
365-451-11	159	6820 E AVE DE SANTIAGO	$ 419.72
365-451-12	160	6810 E AVE DE SANTIAGO	$ 912.79
365-451-13	160	6810 E AVE DE SANTIAGO	$ 1,926.15
368-021-01	161	6701 E LEAFWOOD DR	$ 351.06
368-021-02	162	6705 E LEAFWOOD DR	$ 284.13
368-021-03	163	6709 E LEAFWOOD DR	$ 285.38
368-021-04	164	6713 E LEAFWOOD DR	$ 275.96
368-021-05	165	6717 E LEAFWOOD DR	$ 266.78
368-021-06	166	6721 E LEAFWOOD DR	$ 283.42
368-021-07	167	6725 E LEAFWOOD DR	$ 281.77
368-021-08	168	6729 E LEAFWOOD DR	$ 280.53
368-021-09	169	6733 E LEAFWOOD DR	$ 282.69
368-021-10	170	6737 E LEAFWOOD DR	$ 282.71
368-021-11	171	6741 E LEAFWOOD DR	$ 281.07
368-021-12	172	6745 E LEAFWOOD DR	$ 284.00
368-021-13	173	6749 E LEAFWOOD DR	$ 278.90
368-021-14	174	6753 E LEAFWOOD DR	$ 260.13
368-021-15	175	6757 E LEAFWOOD DR	$ 257.14
368-021-16	176	6761 E LEAFWOOD DR	$ 254.88
368-021-17	177	6765 E LEAFWOOD DR	$ 284.77
368-022-01	178	1041 S PINE CANYON CIR	$ 302.65
368-022-02	179	1051 S PINE CANYON CIR	$ 261.13
368-022-03	180	1061 S PINE CANYON CIR	$ 405.64
368-022-04	181	1060 S PINE CANYON CIR	$ 378.27
368-022-05	182	1050 S PINE CANYON CIR	$ 297.58

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-022-06	183	1040 S PINE CANYON CIR	$ 335.65
368-022-07	184	1041 S FALLING LEAF CIR	$ 312.99
368-022-08	185	1051 S FALLING LEAF CIR	$ 250.00
368-022-09	186	1061 S FALLING LEAF CIR	$ 386.43
368-022-10	187	1060 S FALLING LEAF CIR	$ 445.43
368-022-11	188	1050 S FALLING LEAF CIR	$ 242.12
368-022-12	189	1040 S FALLING LEAF CIR	$ 272.65
368-022-13	190	6746 E LEAFWOOD DR	$ 287.38
368-022-14	191	6750 E LEAFWOOD DR	$ 376.01
368-022-15	192	6754 E LEAFWOOD DR	$ 344.50
368-022-16	193	6758 E LEAFWOOD DR	$ 328.01
368-022-17	194	6762 E LEAFWOOD DR	$ 324.37
368-022-18	195	6768 E LEAFWOOD DR	$ 319.15
368-022-19	196	6774 E LEAFWOOD DR	$ 312.69
368-022-20	197	6780 E LEAFWOOD DR	$ 312.30
368-022-21	198	6786 E LEAFWOOD DR	$ 304.31
368-022-22	199	6792 E LEAFWOOD DR	$ 2,682.81
368-022-23	200	6798 E LEAFWOOD DR	$ 2,211.52
368-022-24	201	6799 E LEAFWOOD DR	$ 401.07
368-022-25	202	6793 E LEAFWOOD DR	$ 318.03
368-022-26	203	6787 E LEAFWOOD DR	$ 246.21
368-022-27	204	6781 E LEAFWOOD DR	$ 305.54
368-031-01	205	1022 S RIMWOOD DR	$ 329.06
368-031-02	206	1026 S RIMWOOD DR	$ 287.85
368-031-03	207	1030 S RIMWOOD DR	$ 225.58
368-031-04	208	1034 S RIMWOOD DR	$ 237.18
368-031-05	209	1038 S RIMWOOD DR	$ 235.35
368-031-06	210	1042 S RIMWOOD DR	$ 241.70
368-031-07	211	1046 S RIMWOOD DR	$ 256.59
368-031-08	212	1050 S RIMWOOD DR	$ 252.28
368-031-09	213	1054 S RIMWOOD DR	$ 235.33
368-031-10	214	1058 S RIMWOOD DR	$ 233.50
368-031-11	215	1062 S RIMWOOD DR	$ 254.45
368-031-12	216	1066 S RIMWOOD DR	$ 254.76
368-031-13	217	1070 S RIMWOOD DR	$ 246.73
368-031-14	218	1074 S RIMWOOD DR	$ 248.96
368-031-15	219	1078 S RIMWOOD DR	$ 248.78
368-031-16	220	1082 S RIMWOOD DR	$ 254.58
368-031-17	221	1086 S RIMWOOD DR	$ 1,261.72
368-031-18	222	1090 S RIMWOOD DR	$ 1,234.23
368-031-19	223	1094 S RIMWOOD DR	$ 1,335.18
368-031-20	224	1098 S RIMWOOD DR	$ 1,436.89
368-031-21	225	1099 S RIMWOOD DR	$ 3,990.53
368-031-22	226	1093 S RIMWOOD DR	$ 7,833.34
368-031-23	227	1087 S RIMWOOD DR	$ 2,396.24
368-031-24	228	1099 S BURLWOOD DR	$ 259.27
368-031-25	229	1097 S BURLWOOD DR	$ 1,222.68
368-031-26	230	1095 S BURLWOOD DR	$ 4,699.31
368-031-27	231	1093 S BURLWOOD DR	$ 2,624.28

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-031-28	232	1091 S BURLWOOD DR	$ 2,982.24
368-031-29	233	1089 S BURLWOOD DR	$ 366.23
368-031-30	234	1085 S BURLWOOD DR	$ 348.99
368-031-31	235	1081 S BURLWOOD DR	$ 381.59
368-031-32	236	1077 S BURLWOOD DR	$ 398.96
368-031-33	237	1075 S BURLWOOD DR	$ 408.36
368-031-34	238	1071 S BURLWOOD DR	$ 377.49
368-031-35	239	1063 S BURLWOOD DR	$ 396.40
368-031-36	240	1059 S BURLWOOD DR	$ 493.73
368-032-01	241	1036 S BURLWOOD DR	$ 520.03
368-032-02	242	1040 S BURLWOOD DR	$ 446.84
368-032-03	243	1044 S BURLWOOD DR	$ 317.99
368-032-04	244	1048 S BURLWOOD DR	$ 269.10
368-032-05	245	1052 S BURLWOOD DR	$ 273.24
368-032-06	246	1056 S BURLWOOD DR	$ 303.78
368-032-07	247	1060 S BURLWOOD DR	$ 303.89
368-032-08	248	1064 S BURLWOOD DR	$ 311.91
368-032-09	249	1068 S BURLWOOD DR	$ 302.41
368-032-10	250	1072 S BURLWOOD DR	$ 297.89
368-032-11	251	1076 S BURLWOOD DR	$ 276.76
368-032-12	252	1080 S BURLWOOD DR	$ 295.91
368-032-13	253	1084 S BURLWOOD DR	$ 306.89
368-032-14	254	1088 S BURLWOOD DR	$ 296.29
368-032-15	255	1090 S BURLWOOD DR	$ 312.36
368-041-01	256	1010 S RIMWOOD DR	$ 355.75
368-041-02	257	1014 S RIMWOOD DR	$ 308.41
368-041-03	258	1018 S RIMWOOD DR	$ 327.55
368-042-01	259	1032 S BURLWOOD DR	$ 429.84
368-042-02	260	1028 S BURLWOOD DR	$ 335.86
368-042-03	261	1024 S BURLWOOD DR	$ 298.77
368-042-04	262	1020 S BURLWOOD DR	$ 293.89
368-042-05	263	1016 S BURLWOOD DR	$ 292.83
368-042-06	264	1012 S BURLWOOD DR	$ 298.00
368-042-07	265	1008 S BURLWOOD DR	$ 268.69
368-042-08	266	6608 E LEAFWOOD DR	$ 276.24
368-042-09	267	6616 E LEAFWOOD DR	$ 276.51
368-042-10	268	6624 E LEAFWOOD DR	$ 334.50
368-042-11	269	6632 E LEAFWOOD DR	$ 327.65
368-042-12	270	6640 E LEAFWOOD DR	$ 300.80
368-042-13	271	6648 E LEAFWOOD DR	$ 311.75
368-042-14	272	6656 E LEAFWOOD DR	$ 317.60
368-042-15	273	6664 E LEAFWOOD DR	$ 298.45
368-042-16	274	6672 E LEAFWOOD DR	$ 319.52
368-042-17	275	6680 E LEAFWOOD DR	$ 320.02
368-042-18	276	6690 E LEAFWOOD DR	$ 354.31
368-042-19	277	6691 E SMOKEWOOD CIR	$ 315.09
368-042-20	278	6681 E SMOKEWOOD CIR	$ 255.17
368-042-21	279	6661 E SMOKEWOOD CIR	$ 258.69
368-042-22	280	6651 E SMOKEWOOD CIR	$ 242.88

			ASSESSMENT PER PARCEL
Assessor Parcel Number	**Lot No.**	**Site Address**	2023
368-042-23	281	6631 E SMOKEWOOD CIR	$ 245.69
368-042-24	282	6621 E SMOKEWOOD CIR	$ 307.15
368-043-01	283	6691 E LEAFWOOD DR	$ 327.63
368-043-02	284	6683 E LEAFWOOD DR	$ 312.60
368-043-03	285	6675 E LEAFWOOD DR	$ 357.18
368-043-04	286	6667 E LEAFWOOD DR	$ 431.85
368-043-05	287	1024 S ASPENWOOD CIR	$ 250.42
368-043-06	288	1018 S ASPENWOOD CIR	$ 299.52
368-043-07	289	1012 S ASPENWOOD CIR	$ 403.54
368-043-08	290	1006 S ASPENWOOD CIR	$ 326.90
368-043-09	291	1000 S ASPENWOOD CIR	$ 681.91
368-043-10	292	1001 S ASPENWOOD CIR	$ 490.21
368-043-11	293	1007 S ASPENWOOD CIR	$ 245.91
368-043-12	294	1015 S ASPENWOOD CIR	$ 280.60
368-043-13	295	1021 S ASPENWOOD CIR	$ 260.60
368-043-14	296	6639 E LEAFWOOD DR	$ 258.78
368-043-15	297	6631 E LEAFWOOD DR	$ 243.86
368-043-16	298	6625 E LEAFWOOD DR	$ 439.53
368-043-17	299	6623 E LEAFWOOD DR	$ 516.65
368-043-18	300	6619 E LEAFWOOD DR	$ 248.55
368-043-19	301	6609 E LEAFWOOD DR	$ 248.80
368-043-20	302	6601 E LEAFWOOD DR	$ 393.71
368-043-21	303	1001 S BURLWOOD DR	$ 598.45
368-043-22	304	1003 S BURLWOOD DR	$ 434.35
368-043-23	305	1005 S BURLWOOD DR	$ 494.39
		City-owned streets in landslide/surf. def. - (Ave. de Santiago includes Escalator)	$ 15,493.58
		City-owned streets in GW recharge zone	$ 8,033.52
		City-owned streets in seepage zone	$ 14,652.56
			$ 466,900.40

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CARDINAL
PROPERTY
MANAGEMENT
INC.

June 9, 2022

Santiago Geologic Hazard Abatement District
Attn: Eric Harrell, ENGEO, SGHAD Manager

Via: Email at: EHarrell@engeo.com

On behalf of the Board of Directors of the Window Hill Homeowners Association, I am reaching out to you again with a matter of continued concern.

At the most recent public Meeting of the SGHAD it was reported by a staff member of ENGEO that there were continued issues with the operation of the dewatering wells (DW-23 and DW-25) which are located on a public street (Burlwood) within the Window Hill Homeowners Association. It was disclosed that DW-23 was pumping 400 gallons of water per day, and DW-25 was no longer operating as intended.

The Board is most concerned about the continued street seepage on Burlwood and the news that one of the two wells were not functioning as intended when the City of Anaheim installed them in 1993 and as the SGHAD has continued to maintain since 1999. They requested I inform you that the Association and the residents of the community are concerned that underground water was not being routed away from homes appropriately and that the matter needed to be resolved before any nearby homes were damaged.

The Association has no responsibility for the maintenance, repairs or replacement of the dewatering wells or drain lines under the streets within this community. We hereby request that the SGHAD take immediate action to remedy this matter to prevent any further damage to the adjacent homes.

Sincerely,

Karen Holthe

Karen Holthe, CMCA, AMS, PCAM
Senior Account Manager
Window Hill Homeowners Association

2022 PROPOSED BUDGET FOR ASSESSMENT RE; ENGINEERS REPORT

BUDGET ITEM		BUDGET AMOUNT	PERCENT OF TOTAL BUDGET (FY 2021/22)	2023- Prop 218- Inflation Rate 8%
	TOTAL	**$0**	**0%**	
PREVENTEIVE MAINTENACNE AND OIPERATIONS				
Professional Services- ENGEO Vendor Contract-1 Scheduled Monitoring and Analysis Activities		$43,300		
	Subtotal	**$43,300**	**13%**	
Maintenance and Operations				
Vendor Contract 2- Merrit King - Well Vaults, Well Casings, and Electrical		$136,500		
Well and Drain Maintenance		$20,000		
Electrical Charges		$18,000		
	Subtotal	**$174,500**	**52%**	
Preventive Maintenance and Operations	**TOTAL**	**$217,800**		
ADMINISTRATION AND ACCOUNTING – GHAD MANAGER				
Vendor Contract 3 **ENGEO** – Management -Administration		$24,000		
ENGEO -Assessment Support Services		$3,000		
	Subtotal	**$27,000**	**8%**	
Outside Professional Services - Nontechnical				
Legal Counsel [Attny Fees For Lawsuit Against The City]		$75,000		
Vendor Contract 4 Clerk -		$6,000		
Vendor Contract 5 Treasurer		$4,000		
California Association of GHADs		$176		
Insurance – General Liability		$770		
Insurance – Directors and Officers		$1,300		
Public Outreach		$5,000		
Facilities Rental		$600		
	Subtotal	**$92,846**	**27%**	
Administration and Accounting	**TOTAL**	**$119,846**		
PROPOSED EXPENDITURES 2021/22	**TOTAL**	**$337,646- $75,000 = $262,646**		**+$20,960** **$283,606**

P	Lot Square Footage (SF)	Kaplan - $227,000	Engeo - $227,000	Kaplan - $330,000	Engeo - $330,000	Engeo - $466,900
1030 S RIMWOOD DR	5889.1	$200.00	$76.81	$290.75	$111.67	$157.99
987 S LOYOLA DR	5933.9	$201.52	$77.40	$292.96	$112.52	$159.19
992 S VASSAR CIR	6061.6	$205.86	$79.06	$299.26	$114.94	$162.62
6881 E RUTGERS DR	6062.1	$205.87	$79.07	$299.29	$114.95	$162.63
962 S VASSAR CIR	6087.3	$206.73	$79.40	$300.53	$115.42	$163.31
985 S LEHIGH DR	6158.4	$209.14	$80.33	$304.04	$116.77	$165.22
6909 E RUTGERS DR	6179.5	$209.86	$80.60	$305.08	$117.17	$165.78
972 S VASSAR CIR	6199.2	$210.53	$80.86	$306.06	$117.55	$166.31
6915 E RUTGERS DR	6217.2	$211.14	$81.09	$306.95	$117.89	$166.79
1058 S RIMWOOD DR	6230	$211.58	$81.26	$307.58	$118.13	$167.14
1054 S RIMWOOD DR	6308.7	$214.25	$82.29	$311.46	$119.62	$169.25
1038 S RIMWOOD DR	6309.6	$214.28	$82.30	$311.51	$119.64	$169.27
980 S LOYOLA DR	6331.1	$215.01	$82.58	$312.57	$120.05	$169.85
6845 E SWARTHMORE DR	6385.4	$216.85	$83.29	$315.25	$121.08	$171.31
1034 S RIMWOOD DR	6388.2	$216.95	$83.32	$315.39	$121.13	$171.38
6860 E AVE DE SANTIAGO	4366.73	$148.30	$84.58	$215.59	$122.95	$173.96
1042 S RIMWOOD DR	6582.5	$223.55	$85.86	$324.98	$124.81	$176.59
1050 S FALLING LEAF CIR	6600.5	$224.16	$86.09	$325.87	$125.16	$177.08
6651 E SMOKEWOOD CIR	6633.2	$225.27	$86.52	$327.48	$125.78	$177.95
6631 E LEAFWOOD DR	6675.3	$226.70	$87.07	$329.56	$126.57	$179.08
983 S VASSAR CIR	6693.1	$227.30	$87.30	$330.44	$126.91	$179.56
6631 E SMOKEWOOD CIR	6754.1	$229.37	$88.10	$333.45	$128.07	$181.20
6835 E SWARTHMORE DR	6760.5	$229.59	$88.18	$333.77	$128.19	$181.37
1007 S ASPENWOOD CIR	6763.6	$229.70	$88.22	$333.92	$128.25	$181.45
6787 E LEAFWOOD DR	6776.5	$230.14	$88.39	$334.56	$128.49	$181.80
1070 S RIMWOOD DR	6799	$230.90	$88.68	$335.67	$128.92	$182.40
6825 E SWARTHMORE DR	6803.6	$231.06	$88.74	$335.90	$129.01	$182.52
984 S LEHIGH DR	6824.8	$231.78	$89.02	$336.94	$129.41	$183.09
6619 E LEAFWOOD DR	6877.2	$233.56	$89.70	$339.53	$130.40	$184.50
1078 S RIMWOOD DR	6887	$233.89	$89.83	$340.01	$130.59	$184.76
6609 E LEAFWOOD DR	6888.1	$233.93	$89.84	$340.07	$130.61	$184.79
1074 S RIMWOOD DR	6894.6	$234.15	$89.93	$340.39	$130.73	$184.97
1051 S FALLING LEAF CIR	6939.4	$235.67	$90.51	$342.60	$131.58	$186.17
1024 S ASPENWOOD CIR	6957.7	$236.29	$90.75	$343.50	$131.93	$186.66
963 S VASSAR CIR	7024	$238.54	$91.62	$346.78	$133.19	$188.44
1050 S RIMWOOD DR	7037.7	$239.01	$91.79	$347.45	$133.45	$188.81
6923 E RUTGERS DR	7067.1	$240.00	$92.18	$348.91	$134.00	$189.59
6820 E KENTUCKY AVE	7109.5	$241.44	$92.73	$351.00	$134.81	$190.73
1062 S RIMWOOD DR	7130.7	$242.16	$93.01	$352.05	$135.21	$191.30

1082 S RIMWOOD DR	7136.4	$242.36	$93.08	$352.33	$135.32	$191.45
1066 S RIMWOOD DR	7144.2	$242.62	$93.18	$352.71	$135.46	$191.66
6761 E LEAFWOOD DR	7149.4	$242.80	$93.25	$352.97	$135.56	$191.80
6681 E SMOKEWOOD CIR	7161.8	$243.22	$93.41	$353.58	$135.80	$192.13
955 S LEHIGH DR	7218.2	$245.14	$94.15	$356.37	$136.87	$193.65
1046 S RIMWOOD DR	7222.8	$245.29	$94.21	$356.59	$136.96	$193.77
6757 E LEAFWOOD DR	7246.7	$246.10	$94.52	$357.77	$137.41	$194.41
973 S VASSAR CIR	7255.6	$246.41	$94.64	$358.21	$137.58	$194.65
6891 E RUTGERS DR	7300.3	$247.92	$95.22	$360.42	$138.42	$195.85
970 S LOYOLA DR	7313.1	$248.36	$95.39	$361.05	$138.67	$196.19
6661 E SMOKEWOOD CIR	7313.1	$248.36	$95.39	$361.05	$138.67	$196.19
6639 E LEAFWOOD DR	7317	$248.49	$95.44	$361.24	$138.74	$196.30
1099 S BURLWOOD DR	7338.3	$249.21	$95.72	$362.29	$139.15	$196.87
6753 E LEAFWOOD DR	7375.1	$250.46	$96.19	$364.11	$139.84	$197.86
1021 S ASPENWOOD CIR	7395.2	$251.15	$96.46	$365.10	$140.22	$198.40
1051 S PINE CANYON CIR	7418.2	$251.93	$96.76	$366.24	$140.66	$199.01
977 S LOYOLA DR	7443.2	$252.78	$97.08	$367.47	$141.13	$199.68
982 S VASSAR CIR	7457.5	$253.26	$97.27	$368.18	$141.41	$200.07
952 S VASSAR CIR	7468.8	$253.65	$97.42	$368.74	$141.62	$200.37
6941 E MICHIGAN CIR	7544.7	$256.22	$98.41	$372.48	$143.06	$202.41
965 S LEHIGH DR	7601.8	$258.16	$99.15	$375.30	$144.14	$203.94
945 S LEHIGH DR	7610.3	$258.45	$99.26	$375.72	$144.30	$204.17
953 S VASSAR CIR	7652.2	$259.88	$99.81	$377.79	$145.10	$205.29
6717 E LEAFWOOD DR	7661.2	$260.18	$99.93	$378.24	$145.27	$205.53
6871 E RUTGERS DR	7685.5	$261.01	$100.24	$379.44	$145.73	$206.18
975 S LEHIGH DR	7725.3	$262.36	$100.76	$381.40	$146.48	$207.25
1008 S BURLWOOD DR	7743.4	$262.97	$101.00	$382.29	$146.83	$207.74
6800 E KENTUCKY AVE	7749.8	$263.19	$101.08	$382.61	$146.95	$207.91
1048 S BURLWOOD DR	7761	$263.57	$101.23	$383.16	$147.16	$208.21
1040 S FALLING LEAF CIR	7913.5	$268.75	$103.22	$390.69	$150.05	$212.30
1052 S BURLWOOD DR	7939.1	$269.62	$103.55	$391.96	$150.54	$212.99
6713 E LEAFWOOD DR	8055.9	$273.59	$105.07	$397.72	$152.75	$216.12
6608 E LEAFWOOD DR	8068.2	$274.00	$105.24	$398.33	$152.99	$216.45
6616 E LEAFWOOD DR	8079.9	$274.40	$105.39	$398.91	$153.21	$216.76
1076 S BURLWOOD DR	8090.4	$274.76	$105.52	$399.43	$153.41	$217.05
6749 E LEAFWOOD DR	8182.3	$277.88	$106.72	$403.96	$155.15	$219.51
6841 E KENTUCKY AVE	8186.1	$278.01	$106.77	$404.15	$155.22	$219.61
6850 E KENTUCKY AVE	8239.5	$279.82	$107.47	$406.79	$156.23	$221.05
6729 E LEAFWOOD DR	8252.8	$280.27	$107.64	$407.44	$156.49	$221.40
1015 S ASPENWOOD CIR	8255.5	$280.36	$107.68	$407.58	$156.54	$221.48

6741 E LEAFWOOD DR	8275.9	$281.06	$107.94	$408.58	$156.92	$222.02
6931 E MICHIGAN CIR	8286.3	$281.41	$108.08	$409.10	$157.12	$222.30
6725 E LEAFWOOD DR	8306.1	$282.08	$108.34	$410.08	$157.50	$222.83
971 S SCRIPPS CIR	8321.4	$282.60	$108.54	$410.83	$157.79	$223.24
6801 E KENTUCKY AVE	8325.6	$282.74	$108.59	$411.04	$157.87	$223.36
6733 E LEAFWOOD DR	8345.4	$283.42	$108.85	$412.02	$158.24	$223.89
6737 E LEAFWOOD DR	8346.2	$283.44	$108.86	$412.05	$158.26	$223.91
6961 E MICHIGAN CIR	8364.1	$284.05	$109.09	$412.94	$158.60	$224.39
6721 E LEAFWOOD DR	8377.1	$284.49	$109.26	$413.58	$158.84	$224.74
6745 E LEAFWOOD DR	8401.9	$285.34	$109.59	$414.80	$159.31	$225.40
6705 E LEAFWOOD DR	8407.5	$285.53	$109.66	$415.08	$159.42	$225.55
6811 E KENTUCKY AVE	8415.3	$285.79	$109.76	$415.47	$159.57	$225.76
6765 E LEAFWOOD DR	8435.1	$286.46	$110.02	$416.44	$159.94	$226.29
6885 E SWARTHMORE DR	8442.9	$286.73	$110.12	$416.83	$160.09	$226.50
6709 E LEAFWOOD DR	8461.2	$287.35	$110.36	$417.73	$160.44	$226.99
6746 E LEAFWOOD DR	8547.2	$290.27	$111.48	$421.98	$162.07	$229.30
1026 S RIMWOOD DR	8567.4	$290.96	$111.75	$422.98	$162.45	$229.84
997 S LOYOLA DR	8595.7	$291.92	$112.12	$424.37	$162.99	$230.60
974 S LEHIGH DR	8603.5	$292.18	$112.22	$424.76	$163.14	$230.81
6971 E MICHIGAN CIR	8722.9	$296.24	$113.77	$430.65	$165.40	$234.02
6901 E RUTGERS DR	8735.5	$296.66	$113.94	$431.27	$165.64	$234.35
1016 S BURLWOOD DR	8781.4	$298.22	$114.54	$433.54	$166.51	$235.58
1020 S BURLWOOD DR	8827.3	$299.78	$115.14	$435.81	$167.38	$236.82
1080 S BURLWOOD DR	8914.2	$302.73	$116.27	$440.10	$169.03	$239.15
1088 S BURLWOOD DR	8930.5	$303.29	$116.48	$440.90	$169.34	$239.58
1050 S PINE CANYON CIR	8985.8	$305.17	$117.20	$443.63	$170.38	$241.07
1072 S BURLWOOD DR	8999.4	$305.63	$117.38	$444.30	$170.64	$241.43
990 S LOYOLA DR	9001.6	$305.70	$117.41	$444.41	$170.68	$241.49
1012 S BURLWOOD DR	9004	$305.78	$117.44	$444.53	$170.73	$241.56
6664 E LEAFWOOD DR	9023.3	$306.44	$117.69	$445.48	$171.10	$242.07
1024 S BURLWOOD DR	9037.1	$306.91	$117.87	$446.16	$171.36	$242.44
1018 S ASPENWOOD CIR	9069.2	$308.00	$118.29	$447.75	$171.97	$243.31
6640 E LEAFWOOD DR	9124.2	$309.87	$119.01	$450.47	$173.01	$244.78
6881 E KENTUCKY AVE	9139.1	$310.37	$119.20	$451.20	$173.29	$245.18
6810 E KENTUCKY AVE	9176	$311.62	$119.68	$453.02	$173.99	$246.17
1068 S BURLWOOD DR	9193.7	$312.23	$119.92	$453.90	$174.33	$246.65
1041 S PINE CANYON CIR	9203.8	$312.57	$120.05	$454.40	$174.52	$246.92
6875 E SWARTHMORE DR	9245.2	$313.97	$120.59	$456.44	$175.30	$248.03
1056 S BURLWOOD DR	9252.5	$314.22	$120.68	$456.80	$175.44	$248.22
1060 S BURLWOOD DR	9257.2	$314.38	$120.74	$457.03	$175.53	$248.35

6786 E LEAFWOOD DR	9275.4	$315.00	$120.98	$457.93	$175.88	$248.84
981 S SCRIPPS CIR	9292.9	$315.59	$121.21	$458.79	$176.21	$249.31
6781 E LEAFWOOD DR	9328.34	$316.80	$121.67	$460.54	$176.88	$250.26
6851 E KENTUCKY AVE	9350	$317.53	$121.95	$461.61	$177.29	$250.84
6871 E KENTUCKY AVE	9375.2	$318.39	$122.28	$462.86	$177.77	$251.51
1084 S BURLWOOD DR	9386.5	$318.77	$122.43	$463.41	$177.98	$251.82
6621 E SMOKEWOOD CIR	9397.4	$319.14	$122.57	$463.95	$178.19	$252.11
1014 S RIMWOOD DR	9451.8	$320.99	$123.28	$466.64	$179.22	$253.57
6821 E KENTUCKY AVE	9454.3	$321.08	$123.31	$466.76	$179.27	$253.64
914 S LEHIGH DR	9488.6	$322.24	$123.76	$468.46	$179.92	$254.56
6648 E LEAFWOOD DR	9595.4	$325.87	$125.15	$473.73	$181.94	$257.42
1064 S BURLWOOD DR	9602.1	$326.10	$125.24	$474.06	$182.07	$257.60
6780 E LEAFWOOD DR	9618.9	$326.67	$125.46	$474.89	$182.39	$258.05
1090 S BURLWOOD DR	9621.4	$326.75	$125.49	$475.01	$182.44	$258.12
6683 E LEAFWOOD DR	9631.8	$327.10	$125.63	$475.53	$182.63	$258.40
6774 E LEAFWOOD DR	9635.7	$327.24	$125.68	$475.72	$182.71	$258.50
1041 S FALLING LEAF CIR	9648.5	$327.67	$125.85	$476.35	$182.95	$258.85
6691 E SMOKEWOOD CIR	9739.1	$330.75	$127.03	$480.82	$184.67	$261.28
6831 E KENTUCKY AVE	9827	$333.73	$128.18	$485.16	$186.33	$263.64
6656 E LEAFWOOD DR	9847.1	$334.42	$128.44	$486.15	$186.72	$264.17
1044 S BURLWOOD DR	9863.6	$334.98	$128.65	$486.97	$187.03	$264.62
6793 E LEAFWOOD DR	9865.5	$335.04	$128.68	$487.06	$187.06	$264.67
6901 E MICHIGAN CIR	9903.5	$336.33	$129.17	$488.94	$187.79	$265.69
6981 E MICHIGAN CIR	9907.3	$336.46	$129.22	$489.13	$187.86	$265.79
6768 E LEAFWOOD DR	9913.7	$336.68	$129.31	$489.44	$187.98	$265.96
6672 E LEAFWOOD DR	9929.32	$337.21	$129.51	$490.21	$188.27	$266.38
6680 E LEAFWOOD DR	9951	$337.94	$129.79	$491.28	$188.69	$266.96
6911 E MICHIGAN CIR	9977.4	$338.84	$130.14	$492.59	$189.19	$267.67
991 S SCRIPPS CIR	10000	$339.61	$130.43	$493.70	$189.61	$268.28
6880 E KENTUCKY AVE	10074.8	$342.15	$131.41	$497.40	$191.03	$270.28
6930 E MICHIGAN CIR	10108.7	$343.30	$131.85	$499.07	$191.68	$271.19
6762 E LEAFWOOD DR	10138.2	$344.30	$132.23	$500.53	$192.24	$271.98
1006 S ASPENWOOD CIR	10247.1	$348.00	$133.66	$505.90	$194.30	$274.91
1018 S RIMWOOD DR	10274.8	$348.94	$134.02	$507.27	$194.83	$275.65
6691 E LEAFWOOD DR	10278.4	$349.06	$134.06	$507.45	$194.89	$275.75
6632 E LEAFWOOD DR	10279	$349.08	$134.07	$507.48	$194.91	$275.76
6758 E LEAFWOOD DR	10294.7	$349.62	$134.28	$508.25	$195.20	$276.18
1022 S RIMWOOD DR	10340	$351.15	$134.87	$510.49	$196.06	$277.40
6865 E SWARTHMORE DR	10404.3	$353.34	$135.71	$513.66	$197.28	$279.12
6624 E LEAFWOOD DR	10573.8	$359.10	$137.92	$522.03	$200.50	$283.67

1040 S PINE CANYON CIR	10623.1	$360.77	$138.56	$524.47	$201.43	$284.99
1028 S BURLWOOD DR	10632.1	$361.07	$138.68	$524.91	$201.60	$285.23
6960 E MICHIGAN CIR	10864.4	$368.96	$141.71	$536.38	$206.01	$291.47
6754 E LEAFWOOD DR	11004.1	$373.71	$143.53	$543.28	$208.65	$295.21
1085 S BURLWOOD DR	11197.11	$380.26	$146.05	$552.81	$212.31	$300.39
6701 E LEAFWOOD DR	11286	$383.28	$147.21	$557.19	$214.00	$302.78
6690 E LEAFWOOD DR	11425.9	$388.03	$149.03	$564.10	$216.65	$306.53
1010 S RIMWOOD DR	11487.6	$390.13	$149.84	$567.15	$217.82	$308.19
6675 E LEAFWOOD DR	11549.3	$392.22	$150.64	$570.19	$218.99	$309.84
6910 E MICHIGAN CIR	11623.1	$394.73	$151.60	$573.84	$220.39	$311.82
1089 S BURLWOOD DR	11938.7	$405.45	$155.72	$589.42	$226.38	$320.29
6970 E MICHIGAN CIR	11979.6	$406.84	$156.25	$591.44	$227.15	$321.38
6831 E GEORGETOWN CIR	8207.1	$278.72	$158.96	$405.19	$231.09	$326.96
995 S LEHIGH DR	12229.4	$415.32	$159.51	$603.77	$231.89	$328.09
6750 E LEAFWOOD DR	12359.1	$419.73	$161.20	$610.17	$234.35	$331.57
1071 S BURLWOOD DR	12423	$421.90	$162.04	$613.33	$235.56	$333.28
1060 S PINE CANYON CIR	12456.2	$423.02	$162.47	$614.97	$236.19	$334.17
994 S LEHIGH DR	12553	$426.31	$163.73	$619.75	$238.02	$336.77
1081 S BURLWOOD DR	12599.3	$427.88	$164.34	$622.03	$238.90	$338.01
1061 S FALLING LEAF CIR	12807.5	$434.95	$167.05	$632.31	$242.85	$343.60
6601 E LEAFWOOD DR	13120.6	$445.59	$171.13	$647.77	$248.79	$352.00
1063 S BURLWOOD DR	13236	$449.51	$172.64	$653.47	$250.97	$355.09
1077 S BURLWOOD DR	13346	$453.24	$174.07	$658.90	$253.06	$358.04
6799 E LEAFWOOD DR	9111.9	$309.45	$176.49	$449.86	$256.56	$363.00
1012 S ASPENWOOD CIR	13543.3	$459.94	$176.65	$668.64	$256.80	$363.34
1061 S PINE CANYON CIR	13633.3	$463.00	$177.82	$673.08	$258.51	$365.75
6840 E AVE DE SANTIAGO	9247.63	$314.06	$179.11	$456.56	$260.39	$368.41
1075 S BURLWOOD DR	13750.3	$466.97	$179.35	$678.86	$260.73	$368.89
998 S VASSAR CIR	13790.9	$468.35	$179.88	$680.86	$261.50	$369.98
6855 E SWARTHMORE DR	13990.9	$475.14	$182.49	$690.74	$265.29	$375.34
934 S LEHIGH DR	14261.19	$484.32	$186.01	$704.08	$270.41	$382.59
6820 E AVE DE SANTIAGO	9656	$327.93	$187.02	$476.72	$271.89	$384.68
1032 S BURLWOOD DR	14674.4	$498.35	$191.40	$724.48	$278.25	$393.68
6667 E LEAFWOOD DR	14761	$501.30	$192.53	$728.76	$279.89	$396.00
1003 S BURLWOOD DR	14868.4	$504.94	$193.93	$734.06	$281.93	$398.88
6625 E LEAFWOOD DR	15091.2	$512.51	$196.84	$745.06	$286.15	$404.86
1060 S FALLING LEAF CIR	15345	$521.13	$200.15	$757.59	$290.96	$411.67
1040 S BURLWOOD DR	15405.5	$523.18	$200.94	$760.58	$292.11	$413.29
6971 E WILLIAMS CIR	10777.6	$366.02	$208.75	$532.09	$303.47	$429.36
6951 E WILLIAMS CIR	10948	$371.80	$212.05	$540.51	$308.26	$436.15

6931 E WILLIAMS CIR	11020.6	$374.27	$213.45	$544.09	$310.31	$439.04
993 S VASSAR CIR	17144.1	$582.23	$223.61	$846.41	$325.08	$459.94
1001 S ASPENWOOD CIR	17270.9	$586.53	$225.27	$852.67	$327.48	$463.34
1059 S BURLWOOD DR	17422.2	$591.67	$227.24	$860.14	$330.35	$467.40
6890 E KENTUCKY AVE	17424	$591.73	$227.26	$860.23	$330.39	$467.45
1005 S BURLWOOD DR	17450.4	$592.63	$227.61	$861.53	$330.89	$468.15
6623 E LEAFWOOD DR	18408.1	$625.15	$240.10	$908.81	$349.05	$493.85
1036 S BURLWOOD DR	18553.2	$630.08	$241.99	$915.98	$351.80	$497.74
6891 E KENTUCKY AVE	18831.7	$639.54	$245.63	$929.73	$357.08	$505.21
6991 E WILLIAMS CIR	13103.8	$445.02	$253.80	$646.94	$368.97	$522.03
1001 S BURLWOOD DR	21926	$679.22	$285.99	$987.41	$415.75	$588.22
1000 S ASPENWOOD CIR	25515.7	$679.22	$332.81	$987.41	$483.82	$684.53
6990 E MICHIGAN CIR	27157.15	$679.22	$354.22	$987.41	$514.94	$728.56
6796 E KENTUCKY AVE	30156.6	$679.22	$393.34	$987.41	$571.81	$809.03
6950 E VIA EL ESTRIBO	22122.1	$679.22	$428.48	$987.41	$622.89	$881.30
6970 E VIA EL ESTRIBO	22154.7	$679.22	$429.11	$987.41	$623.81	$882.60
6960 E VIA EL ESTRIBO	22602.8	$679.22	$437.79	$987.41	$636.43	$900.45
6810 E AVE DE SANTIAGO	24036.57	$679.22	$465.56	$987.41	$676.80	$957.57
6990 E AVE DE SANTIAGO	25186.7	$679.22	$487.83	$987.41	$709.18	$1,003.39
6951 E VIA EL ESTRIBO	26799.4	$679.22	$519.07	$987.41	$754.59	$1,067.64
6940 E AVENIDA DE SANTIAGO	27244.1	$679.22	$527.68	$987.41	$767.12	$1,085.35
6960 E AVENIDA DE SANTIAGO	27811.7	$679.22	$538.68	$987.41	$783.10	$1,107.96
6975 E AVENIDA DE SANTIAGO	27895.4	$679.22	$540.30	$987.41	$785.45	$1,111.30
6940 E AVENIDA DE SANTIAGO	29614.3	$679.22	$573.59	$987.41	$833.85	$1,179.78
1097 S BURLWOOD DR	6287.3	$427.04	$578.90	$620.81	$841.57	$1,190.69
1090 S RIMWOOD DR	6351.3	$431.39	$584.79	$627.13	$850.13	$1,202.81
1086 S RIMWOOD DR	6503.7	$441.74	$598.82	$642.18	$870.53	$1,231.67
6895 E GEORGETOWN CIR	6619.5	$449.61	$609.48	$653.61	$886.03	$1,253.60
1094 S RIMWOOD DR	6911	$469.41	$636.32	$682.40	$925.05	$1,308.81
6911 E WILLIAMS CIR	6952.1	$472.20	$640.11	$686.46	$930.55	$1,316.59
6820 E AVE DE SANTIAGO	33720.6	$679.22	$653.12	$987.41	$949.47	$1,343.36
6991 E VIA EL ESTRIBO	33721.8	$679.22	$653.15	$987.41	$949.51	$1,343.41
6985 E VIA EL ESTRIBO	35298.5	$679.22	$683.69	$987.41	$993.90	$1,406.22
1098 S RIMWOOD DR	7474.9	$507.71	$688.24	$738.08	$1,000.53	$1,415.60
6811 E AVENIDA DE SANTIAGO	36961.1	$679.22	$715.89	$987.41	$1,040.72	$1,472.46
NO ADDRESS	38159.5	$679.22	$739.10	$987.41	$1,074.46	$1,520.20
6865 E GEORGETOWN CIR	8127.7	$552.05	$748.35	$802.54	$1,087.91	$1,539.23
6950 E AVE DE SANTIAGO	38649.4	$679.22	$748.59	$987.41	$1,088.26	$1,539.72
6873 E GEORGETOWN CIR	8189.8	$556.26	$754.07	$808.67	$1,096.22	$1,550.99
6840 E AVE DE SANTIAGO	39018.73	$679.22	$755.74	$987.41	$1,098.65	$1,554.43

6823 E GEORGETOWN CIR	8236.2	$559.42	$758.34	$813.25	$1,102.43	$1,559.77
6857 E GEORGETOWN CIR	8265.5	$561.41	$761.04	$816.14	$1,106.35	$1,565.32
6839 E GEORGETOWN CIR	8373.3	$568.73	$770.96	$826.79	$1,120.78	$1,585.74
6849 E GEORGETOWN CIR	8485.7	$576.36	$781.31	$837.88	$1,135.83	$1,607.02
6815 E GEORGETOWN CIR	8565.9	$581.81	$788.70	$845.80	$1,146.56	$1,622.21
6881 E GEORGETOWN CIR	8762.9	$595.19	$806.83	$865.26	$1,172.93	$1,659.52
6860 E AVE DE SANTIAGO	44499.01	$679.22	$861.89	$987.41	$1,252.96	$1,772.76
6906 E AVE DE SANTIAGO	9655.97	$655.85	$889.06	$953.44	$1,292.47	$1,828.65
6950 E AVE DE SANTIAGO	46724.9	$679.22	$905.00	$987.41	$1,315.64	$1,861.43
6990 E VIA EL ESTRIBO	47793.6	$679.22	$925.70	$987.41	$1,345.73	$1,904.01
6856 E GEORGETOWN CIR	10629.8	$721.99	$978.73	$1,049.59	$1,422.82	$2,013.07
6965 E VIA EL ESTRIBO	50655.4	$679.22	$981.13	$987.41	$1,426.31	$2,018.01
6980 E AVENIDA DE SANTIAGO	50683.1	$679.22	$981.66	$987.41	$1,427.09	$2,019.12
6955 E VIA EL ESTRIBO	52189.6	$679.22	$1,010.84	$987.41	$1,469.51	$2,079.13
6864 E GEORGETOWN CIR	11061.3	$751.30	$1,018.46	$1,092.20	$1,480.57	$2,094.79
6889 E GEORGETOWN CIR	11253.7	$764.37	$1,036.17	$1,111.20	$1,506.33	$2,131.23
6810 E AVE DE SANTIAGO	53592.24	$679.22	$1,038.01	$987.41	$1,509.00	$2,135.01
6981 E VIA EL ESTRIBO	54041.5	$679.22	$1,046.71	$987.41	$1,521.65	$2,152.91
6821 E AVENIDA DE SANTIAGO	54313.4	$679.22	$1,051.98	$987.41	$1,529.31	$2,163.74
6840 E GEORGETOWN CIR	11551.7	$784.61	$1,063.61	$1,140.62	$1,546.22	$2,187.66
1110 S TAMARISK DR	55661.4	$679.22	$1,078.09	$987.41	$1,567.26	$2,217.44
6798 E LEAFWOOD DR	11769.6	$799.41	$1,083.67	$1,162.14	$1,575.38	$2,228.93
6848 E GEORGETOWN CIR	11919.6	$809.60	$1,097.48	$1,176.95	$1,595.46	$2,257.34
6832 E GEORGETOWN CIR	12194.8	$828.29	$1,122.82	$1,204.12	$1,632.30	$2,309.45
NO ADDRESS	59728.1	$679.22	$1,156.85	$987.41	$1,681.77	$2,379.45
6807 E GEORGETOWN CIR	12636.1	$858.26	$1,163.45	$1,247.70	$1,691.36	$2,393.03
1087 S RIMWOOD DR	12793.7	$868.97	$1,177.96	$1,263.26	$1,712.46	$2,422.87
6921 E WILLIAMS CIR	13338.4	$905.97	$1,228.12	$1,317.04	$1,785.37	$2,526.03
6970 E AVE DE SANTIAGO	63605.1	$679.22	$1,231.95	$987.41	$1,790.94	$2,533.91
6975 E VIA EL ESTRIBO	64651.3	$679.22	$1,252.21	$987.41	$1,820.39	$2,575.58
1093 S BURLWOOD DR	14058	$954.84	$1,294.37	$1,388.10	$1,881.69	$2,662.31
6792 E LEAFWOOD DR	14382.5	$976.88	$1,324.25	$1,420.14	$1,925.12	$2,723.76
6816 E GEORGETOWN CIR	14691	$997.84	$1,352.66	$1,450.60	$1,966.42	$2,782.18
6824 E GEORGETOWN CIR	14724.4	$1,000.11	$1,355.73	$1,453.90	$1,970.89	$2,788.51
1160 S TAMARISK DR	70181.1	$679.22	$1,359.32	$987.41	$1,976.10	$2,795.88
1150 S TAMARISK DR	71288.3	$679.22	$1,380.76	$987.41	$2,007.27	$2,839.99
6971 E VIA EL ESTRIBO	73272.6	$679.22	$1,419.19	$987.41	$2,063.14	$2,919.04
6808 E GEORGETOWN CIR	15431.6	$1,048.14	$1,420.85	$1,523.73	$2,065.55	$2,922.44
1130 S TAMARISK DR	74563.8	$679.22	$1,444.20	$987.41	$2,099.50	$2,970.48
6961 E VIA EL ESTRIBO	75557.8	$679.22	$1,463.45	$987.41	$2,127.49	$3,010.08

1091 S BURLWOOD DR	16042.6	$1,089.64	$1,477.10	$1,584.06	$2,147.33	$3,038.15
6800 E GEORGETOWN CIR	16199.8	$1,100.32	$1,491.58	$1,599.58	$2,168.37	$3,067.92
1145 S TAMARISK DR	91745.5	$679.22	$1,776.99	$987.41	$2,583.29	$3,654.96
1180 S TAMARISK DR	95587.9	$679.22	$1,851.41	$987.41	$2,691.48	$3,808.04
6872 E GEORGETOWN CIR	20866.8	$1,358.43	$1,921.29	$1,974.81	$2,793.06	$3,951.76
1099 S RIMWOOD DR	21632.8	$1,358.43	$1,991.81	$1,974.81	$2,895.59	$4,096.82
6861 E AVENIDA DE SANTIAGO	22417.9	$1,358.43	$2,064.10	$1,974.81	$3,000.68	$4,245.51
6912 E AVENIDA DE SANTIAGO	22736.25	$1,358.43	$2,093.41	$1,974.81	$3,043.29	$4,305.80
6930 E AVE DE SANTIAGO	23431.42	$1,358.43	$2,157.42	$1,974.81	$3,136.34	$4,437.45
6890 E GEORGETOWN CIR	24112	$1,358.43	$2,220.08	$1,974.81	$3,227.43	$4,566.33
1125 S TAMARISK DR	117017	$679.22	$2,266.46	$987.41	$3,294.86	$4,661.73
6912 E AVENIDA DE SANTIAGO	25350.22	$1,358.43	$2,334.09	$1,974.81	$3,393.17	$4,800.83
1095 S BURLWOOD DR	25562.4	$1,358.43	$2,353.63	$1,974.81	$3,421.57	$4,841.01
6930 E AVE DE SANTIAGO	25738.94	$1,358.43	$2,369.88	$1,974.81	$3,445.20	$4,874.45
6871 E AVENIDA DE SANTIAGO	26213.2	$1,358.43	$2,413.55	$1,974.81	$3,508.68	$4,964.26
6851 E AVENIDA DE SANTIAGO	29857.6	$1,358.43	$2,749.10	$1,974.81	$3,996.49	$5,654.44
1190 S TAMARISK DR	144897.1	$679.22	$2,806.47	$987.41	$4,079.88	$5,772.42
6943 E AVENIDA DE SANTIAGO	35940.3	$1,358.43	$3,309.16	$1,974.81	$4,810.67	$6,806.38
6841 E AVENIDA DE SANTIAGO	37077.3	$1,358.43	$3,413.85	$1,974.81	$4,962.86	$7,021.71
6937 E AVENIDA DE SANTIAGO	37251.1	$1,358.43	$3,429.85	$1,974.81	$4,986.13	$7,054.62
6949 E AVENIDA DE SANTIAGO	38345.9	$1,358.43	$3,530.65	$1,974.81	$5,132.67	$7,261.95
6931 E AVENIDA DE SANTIAGO	39153.4	$1,358.43	$3,605.00	$1,974.81	$5,240.75	$7,414.88
6901 E WILLIAMS CIR	39780.9	$1,358.43	$3,662.78	$1,974.81	$5,324.75	$7,533.71
6925 E AVENIDA DE SANTIAGO	41236.1	$1,358.43	$3,796.76	$1,974.81	$5,519.53	$7,809.30
6906 E AVE DE SANTIAGO	42161.05	$1,358.43	$3,881.93	$1,974.81	$5,643.33	$7,984.47
1093 S RIMWOOD DR	42938.1	$1,358.43	$3,953.47	$1,974.81	$5,747.34	$8,131.62
6913 E AVENIDA DE SANTIAGO	46492.3	$1,358.43	$4,280.72	$1,974.81	$6,223.08	$8,804.72
6831 E AVENIDA DE SANTIAGO	46940.5	$1,358.43	$4,321.99	$1,974.81	$6,283.07	$8,889.60
6920 E AVENIDA DE SANTIAGO	47294.9	$1,358.43	$4,354.62	$1,974.81	$6,330.51	$8,956.72
6919 E AVENIDA DE SANTIAGO	48821.9	$1,358.43	$4,495.22	$1,974.81	$6,534.90	$9,245.90
6901 E AVENIDA DE SANTIAGO	49572.4	$1,358.43	$4,564.32	$1,974.81	$6,635.35	$9,388.03
6899 E AVENIDA DE SANTIAGO	55492.3	$1,358.43	$5,109.39	$1,974.81	$7,427.74	$10,509.14
6907 E AVENIDA DE SANTIAGO	56938.8	$1,358.43	$5,242.57	$1,974.81	$7,621.36	$10,783.08
6891 E AVENIDA DE SANTIAGO	90969.1	$1,358.43	$8,375.87	$1,974.81	$12,176.38	$17,227.74
6881 E AVENIDA DE SANTIAGO	103851.9	$1,358.43	$9,562.04	$1,974.81	$13,900.76	$19,667.49
City of Anaheim		$68,100.00	$20,667.09	$99,000.00	$30,044.66	$42,508.68

SANTIAGO GHAD ASSESSMENT PROPOSAL: AN IMPROVED APPROACH

Hillard Kaplan, Ph.D.

Economic Science Institute

Chapman University

ASSESSMENT PRINCIPLES

- Assessment be apportioned according the benefit received due to the services of the GHAD
- The benefit is defined as the cost avoided from the potential reactivation of the landslide if the GHAD services were discontinued
- Apportionment of the cost avoided is best evaluated by the distribution of costs incurred during the previous landslide that resulted in the creation of the Santiago GHAD
- Two major sources of evidence:
  - 1) Banner Lawsuit
  - 2) Delmonico Settlement

BANNER LAWSUIT PROPERTIES

15. The Subject Properties either adjoin or are in close proximity to Tracts Nos. 7587, 7918, 8075, 8375-8377, 8513-8516, 8520, 9080, 9133-9136, 9313, 10941, 10996-10998, 12147, 12700, 13760 (See Parcel Map 166-41). All or nearly all, such tracts and areas have been fully developed for, and improved with, residences.

BANNER LAWSUIT PROPERTIES I

The Subject Properties

12. The Subject Properties are located at:

Homeowners' Name(s)	Property Address
Banner, Richard R. Banner, Simone A.	6775 E. Kentucky Avenue Anaheim, CA 92807
Beyer, Margaret E.	6911 E. Michigan Circle Anaheim, CA 92807
Boetel, James C.	6820 E. Kentucky Avenue Anaheim, CA 92807
Burandt, Kenneth Burandt, Margo	1070 Via De Rosa Anaheim, CA 92807
Chambers, John W. Chambers, Mary M.	6811 Kentucky Avenue Anaheim, CA 92807
Craig, James R. Craig, Esther B.	6768 E. Kentucky Avenue Anaheim, CA 92807
Cranston, Harold M. Cranston, Yvonne	990 S. Scripps Circle Anaheim, CA 92807
Cucunato, Charles M. Cucunato, Donna	980 S. Rutgers Circle Anaheim, CA 92807
Deiss, James E. Deiss, Diana	990 South Rutgers Circle Anaheim, CA 92807
DeWars, James W. DeWars, Barbara A.	6890 E. Kentucky Avenue Anaheim, CA 92807
Franco, Lionel Franco, Alice I.	980 South Loyola Dr. Anaheim, CA 92807
Gabriel, James A. Gabriel, Diane	6778 E. Kentucky Avenue Anaheim, CA 92807
Greer, William T. Greer, Doreen F.	6960 E. Michigan Circle Anaheim, CA 92807
Guziak, James J. Guziak, Cynthia N.	6851 E. Kentucky Avenue Anaheim, CA 92807
Hines, Logan J. Hines, Dorothy	6971 E. Michigan Circle Anaheim, CA 92807
Kerr, Paul G. Kerr, Jackie M.	6800 E. Kentucky Avenue Anaheim, CA 92807
Keys, Jerry C. Ruffulo-Keys, Cheryl	6881 E. Kentucky Ave. Anaheim, CA 92807
Kotrappa, Vijay Kotrappa, Kavitha	985 Grinnell Street Anaheim, CA 92807
Kumar, Vinod Kumar, Usha	6871 East Kentucky Avenu Anaheim, CA 92807
Kunow, Bruce W.	6756 E. Kentucky Avenue Anaheim, CA 92807
Lamar, Robert C. Lamar, Carol Corinne	6910 E. Michigan Circle Anaheim, CA 92807
Lundin, Hoyt B. Lundin, Patricia A.	6735 Kentucky Avenue Anaheim, CA 92807
Lynn, Diane M.	6961 Via El Estribo Anaheim, CA 92807
McInally, Tom McInally, Lauren	957 S. Grinnell Street Anaheim, CA 92807
McPeek, Gerry V. McPeek, Frances M.	6975 E. Rutgers Drive Anaheim, CA 92807
Motzkus, John E. Motzkus, Nancy J.	6981 E. Michigan Circle Anaheim, CA 92807
Muratori, Edmond F. Muratori, Vera K.	6891 E. Kentucky Avenue Anaheim, CA 92807
O'Leary, Sher	6701 E. Kentucky Avenue Anaheim, CA 92807
Pirozzi, John E. Pirozzi, Lewana	991 Scripps Circle Anaheim, CA 92807
Reddish, Richard R. Reddish, Phyllis	6983 Rutgers Drive Anaheim, CA 92807
Reed, John M. Reed, Susan	6700 E. Johnstown Circle Anaheim, CA 92807
Ricasa, Marcelino R. Ricasa, Josefa L.	990 S. Loyola Drive Anaheim, CA 92807
Romanoski, Douglas B.	6961 E. Michigan Circle

BANNER LAWSUIT PROPERTIES II

Romanoski, Donna A.	Anaheim, CA 92807
Russell, Albert E. Russell, Jeanne C.	6880 E. Kentucky Avenue Anaheim, CA 92807
Rynda, John J. Rynda, Carolyn	6909 E. Rutgers Drive Anaheim, CA 92807
Samperisi, Angelo Samperisi, Barbara A.	6810 E. Kentucky Avenue Anaheim, CA 92807
Schaefer, Roger J. Schaefer Christine	6930 Michigan Circle Anaheim, CA 92807
Schroer, Dietrich Schroer, Lenore	6990 E. Michigan Circle Anaheim, CA 92807
Scrivner, David G. Scrivner, Carol C.	6931 E. Michigan Anaheim, CA 92807
Siegmann, Greg Siegmann, Susan E.	6831 E. Kentucky Avenue Anaheim, CA 92807
Turner, John Turner, Dawn	981 S. Rutgers Circle Anaheim, CA 92807
Vadkis, Andrew Romero, Yolanda	6701 E. Johnstown Circle Anaheim, CA 92807
Welsh, Eric A. Welsh, Elizabeth B.	1060 S. Pegasus Street Anaheim, CA 92807
Wittenberg, Peter F. Wittenberg, Diane E.	6999 E. Rutgers Drive Anaheim, CA 92807

GEOGRAPHICAL DISTRIBUTION OF BANNER LAWSUIT PROPERTIES

Street Name	# of Subject Properties	Location
E. Kentucky Avenue	17	North of Serrano
E. Michigan Circle	9	North of Serrano
Vie de Rosa	1	South of Serrano
S. Scripps Circle	2	North of Serrano
S. Rutgers Circle	2	North of Serrano
E. Rutgers drive	3	North of Serrano
S. Loyola Dr.	2	North of Serrano
Grinnell Street	2	North of Serrano
Via El Estribo	1	South of Serrano
E. Johnstown Circle	2	North of Serrano
S. Pegasus St	1	South of Serrano
Total	42	
Number North of Serrano	40	
Number South of Serrano	2	

EXCERPT FROM BANNER LAWSUIT

93. On or about January 17, 1993, a landslide, or series of landslides, occurred or reactivated in the Affected Area. There was substantial land movement affecting a large area in Anaheim Hills, including the Subject Properties (hereinafter "the Landslide".) The exact location(s) and extent of the Landslide is presently under investigation by Homeowners and defendants.

95. The Landslide is ongoing. Since the occurrence of the Landslide, the City of Anaheim has posted and/or evacuated approximately 45 homes in the Affected Area.

DAMAGES CLAIMED IN BANNER LAWSUIT

113. The Landslide has proximately caused:

- the imminent destruction of the Homeowners' homes;
- loss of use of the Subject Properties; and
- loss of value of the Subject Properties.

114. Continuing movement of the Hillside has caused the Homeowners' homes to deteriorate:

- some homes are so damaged, they may need to be demolished to avoid hazard;
- some homes are cracked and distressed even though still intact;

118. The damages of Homeowners exceed $300,000,000.

KNOWN DAMAGES TO CITY PROPERTY, SOUTH OF SERRANO

- Sewer Rupture – Vassar Circle
- Water line break – E. Kentucky Avenue
- Serrano Avenue

DELMONICO SETTLEMENT PLAINTIFFS ARE DISTRIBUTED THROUGHOUT THE GHAD

1.5 "PM&S Plaintiffs" means: all Plaintiffs represented by Pillsbury Madison & Sutro LLP in the Consolidated Action regardless of whether they are a Settling Plaintiff, named as follows: Kirk Adams; Mary Ann Adams; Roger Allensworth; Barbara Allensworth; Rahman Astarai; Ezat Astarai; Quentin Auerswald; Sadako Auerswald; Richard Banner; Simone Banner; Kathy Barbee; Harold Barber; Roberta Barber; Michael Barnes; Mary Barnes; Mark Bathen; Patricia Bathen; Carl Bendroff; Ann Bendroff; Bradley Benson; Patricia Benson; Brad Berryhill; Dorothy Berryhill; Margaret Beyer; Dhanesh Bhindi; Tazeem Bhindi; Andreas Biczi; Brigitte Biczi; Morris Binaco, Jr.; Doris Binaco; Paul Bloomfield; Maryann Needham; James Boetel; Michael Born; Mary Christine Born; Terry Brandt; Lydia Brandt; Roger Brown; Alouise Brown; Kenneth Burandt; Margo Burandt; Joseph Buser; Patricia Buser; Mike Canada; Tammye Canada; Robert Canossi; Gail Canossi; Michael Casagranda; Bette Casagranda; John Chambers;

Mary Chambers; Yuen Tsuen Chao; Sharon Chao; Gary Chase; Sharon Chase; I. Fan Chen; Mei Fen Chen; Peter Cheng; Linda Cheng; Wei-Ming Cheng; Fanny Cheng; Richard Cherney, Trustee of the Cherney 1981 Trust; Joseph Chiang; Sandy Yu Chiang; Joon Ho Choi; Jeong Ja Choi; Sung-Hong Choi; Koonhee Choi; Cheng-Che Chou, Elliott Christensen; Elizabeth Christensen; Eric Chu; Sandy Chu; John Chung; Catherine Chung; Ronald Ciampa; Coralinn Ciampa; Dan Clark (duly appointed successor-in-interest to Catherine Clark); Michael Clayton; Marilyn Clayton; William Collett; Kymberly Collett; Moses Cordova; Rachel Cordova; Kenneth Corman; Susan Corman; James Craig; Esther Craig; Harold Cranston; Yvonne Cranston; Gary Crosby; Joy Crosby; Charles Cundiff; Patsy Cundiff; Stanley Daniels (by his Estate); Angeline Daniels; Bruce Daniels; Gail Daniels; Robert Davis; Aminta Diaz; Steve DeBaun; Michelle DeBaun; Louis Delmonico; Maureen Delmonico; Dominic DeMaria; Ora DeMaria; Lorne Denton (by his Estate); Darlene Denton; Vijay Deshmukh; Manda Deshmukh; James DeWars; Barbara DeWars; Ray Diaz; Vivian Diaz; William Dinneen; Cynthia Dinneen; Steve Ditch; Leslie Ditch; Mark Dobley; Richard Doebler; Mary Doebler; Steven Dogris; Pamela Dogris; T. Page Eskridge; Helen Eskridge; Laurence Evans; Judy Evans; Marc Fields; Sally Fields; Orlando Flores; James Floyd; Yvonne Regalado-Floyd; Ledwin Fortini; Annalee Fortini; Lionel Franco; Alice Franco; Robert Franks; Margaret Franks; Ken Fuller, James Gabriel; Diane Gabriel; Kurt Gairing; Patricia Gairing; DeWhayne Gallups; Betty Gallups; Rafael Garcia; Irela Garcia; Daniel Gillen; Blanche Gillen; Glenn Gray; William Greer; Doreen Greer (by her Estate); Hugh Gregg; Marika Gregg; Philip Grenkavich; Charles Groncy; Paula Groncy; Ron Groves; Encarna Groves; James Guziak; Cynthia Guziak; Franklin Hanauer;

Kathryn Hanauer; Randy Hardison; Linda Hardison; Stanley Harris; Leona Harris; David Henson; Roberta Hering; J. Patrick Highfill; Eleanor Highfill; Douglas Himes; Kathleen Himes; Logan Hines; Dorothy Hines; Valerie Hoppe; William Hoppe; Paul Hornack; Ling-Chiung Huang; Ming Huang; Douglas Jacobs; Georgia Jacobs; Douglas Jacobs, Trustee of the Douglas Jacobs Trust U/A/D November 9, 1983; Baldev Jhita; Darshan Jhita; Ron Johnsen; Reba Johnsen; Barry Jones; Judith Jones; Brian Jorgensen; Jan Jorgensen; Louie Joseph; Adelle Joseph; Marekat Joseph; Sicily Joseph; James Kelly; Mary Linda Peck; Paul Kerr; Jackie Kerr; Jerry Keys; Cheryl Ruffulo-Keys; Ki-Hong Kim; Ai-Ja Kim; Bob King; Roberta King; Claire Koff; Rod Koral; Patricia Koral; Vijay Kotrappa; Kavitha Kotrappa; Chris Koukladas; Ann Koukladas; Carl Kroesen; Rosita Kroesen (by her Estate); Paul Kryger; Edwin Kulubya; Vinod Kumar; Usha Kumar; Bruce Kunow; Robert Lamar; Carol Lamar; Ernest Lane (by his Estate); Eileen Lane; Cecil Leach; Jacinta Lee; David Lee; Helena Lee; Louis Ron Lee; Mary Lynn Lee; Seung Jae Lee; In Jeong Lee; William Leon; Esstella Leon; So Keng Limsico; John Lindholm (by his Estate); Elvia Lindholm; Randy Miller (by his Estate); Lynda Long; Hoyt Lundin; Patricia Lundin; Gary Luque; Roberta Luque; Diane Lynn; Gregory MacIsaac; Barbara MacIsaac; Seta Maldjian; Joseph Marcinko; Marcia Marcinko; Oscar Martin; Barbara Martin; William Masters; Larry Mauzey; Linda Mauzey; Stuart May; Debra May; Tom McInally; Lauren McInally; Gerry McPeek; Frances McPeek; Bob Medina; Linda Medina; Richard Megna; Lucinda Megna; Steve Meimetis; Lawrence Mitchell, Sr., Sammie Mitchell; Francis Miyashiro; Mary Lou Miyashiro; Peter Morrey; Randal Moseley; Sandra Moseley; John Motzkus; Nancy Motzkus; Donald Mrla, Sr.; Julita Mrla; Edmund Muratori; Vera Muratori; Albert Murphy; Sarah Murphy; Ronald Muto; Ruth Muto; Mahrokh Namdarkhan; Jim Nau; E. Dolores Nau; W. Randall Nelson; Jean Ovelee Nelson; Sher O'Leary; Bartolomeo Palisi; Rosalie Palisi; Lawrence Panik; Patricia Panik; J.P. Patel; M.J. Patel; Joe Payne; Wanda Payne; John Pirozzi; Lewana Pirozzi; Alan Plante; JoAnn Plante; Louis Quezada; Jacqueline Quezada; John Quinn; Diane Quinn; Richard Rainie; Estelle Rainie; George Reardon; Kathlee Reardon; Richard Reddish; Phyllis Reddish; Edna Regino; Rodeo Regino (by his Estate); Salvador Reyes; Barbara Reyes; Marcelino Ricasa; Josefa Ricasa; Stan Richards; Gail Richards; Sid Richter; Frances Richter; Dennis Riggs; Cynthia Riggs; Dennis Rios; Connie Rios; Douglas Romanoski; Donna Romanoski; Richard Rubino; Harriet Rubino; Larry Rushing; Ilo Rushing; Albert Russell; Jeanne Russell; John Rynda; Carolyn Rynda; Jose Salcedo, Jr.; Isabel Salcedo; Glenn Salsbury; Marilyn Salsbury; Angelo Samperisi; Barbara Samperisi; Julio Sanches; Charlene Sanches; Sampat Saste; Sushama Saste; Sherman Sawin; Gloria Sawin; Roger Schaefer; Christine Schaefer; James Scheible; Linda Scheible; Richard Schleicher; Sylvia Schleicher; S. Michael Schreiber; Janet Schreiber; Dietrich Schroer; Lenore Schroer; Lawrence Schwartz; Joanne Schwartz; Edward Scott; Ruey Scott; David Scrivner; Carol Scrivner; Greg Siegmann; Susan Siegmann; Peter Siow; Ma. Theresa Siow; Ronald Skaggs; R.J. Slaughter; Shirlee Slaughter; Saeed Soltani; Cliff Springmeier; Michael Stafford; Linda Stafford; Phillip Stein (by his Estate); Susan Stein; Arlen Steiner; Gerald Steiner; Sandra Steiner; Ralph Stirling; Keith Pedersen; Khalil Subat; Manija Subat; Larry Sutton; Pamela Sutton; William Tabb; Carolyn Tabb; Enliang Tom Tang; Wai-Ming Tang; Clifton Tatro; Robby Tatro; Walter Timoshuk; Christine Timoshuk; Paul Tippin; Karen Tippin; Ray Tripicchio; Rosalie Tripicchio; Hisato

Tsujimura; Loretta Tsujimura; Jeffrey Turner; Gail Turner; Darlene Turpin; Jose Luis Valdez; Maria Carmen Valdez; Hector Velasco; Irene Velasco; Abdul Wahid; Romana Wahid; Robert Warren; Karen Warren; Eric Welsh; Elizabeth Welsh; Herbert Wester; C.L. Wester; Maximilian Whang; Hannelore Whang; Garry White; Carol White; Gilbert Wiggam; Kathleen Wiggam; Constance Mills; Roger Williamson, Bonnie Williamson, Paul Williamson, Diane Williamson, Dennis Wilson; Elizabeth Wilson; Bill Wissman; Kay Wissman; Peter Wittenberg; Diane Wittenberg; Alvin Yee; Faye Yee; K. Calvin Yip; Katie Ng Yip; Samuel Young; Sandra Young; John Zamora; and Linda Zamora.

A SETTLEMENT EXAMPLE (NORTH OF SERRANO)

Hiroshi Fujisaki
Judge of The Los Angeles Superior Court
Retired
Action Dispute Resolution Services
2049 Century Park East, Suite 350
Los Angeles, California 90067-3239

Tel (310) 201-0010

Fax (310) 201-0016

December 22, 1999

Re: Allocation of Anaheim Hills Litigation Proceeds

Claimant: Muratori
Property: 6891 E. Kentucky Avenue

I have evaluated your claims, together with the data provided to me by the remediation cost analysis experts and real estate appraisal expert retained by your attorneys, and my visual site inspection. The data considered included the estimated costs of future repairs of landslide damages, loss of value, past landslide repairs, evacuation expenses, easement impact, emotional distress, and factors unique to individual plaintiffs.

The net available litigation proceeds are unfortunately insufficient to compensate each plaintiff to the full extent of their claims. Each plaintiff's claim was quantified monetarily, and calculated into a ratio to the total claims of all of the plaintiffs. The allocated sum is the percentage of the litigation proceeds which reflects the ratio of a plaintiff's claim to the total claims of all of the plaintiffs.

The allocated sum available for distribution is dependent upon the actual net litigation proceeds available for distribution after deduction of expenses of this process, thus may be adjusted upon final distribution.

The allocated sum for your claim is $27,971.62.

As stated in my previous letter, any questions regarding this allocation must be in writing. I will attempt to respond within five business days. If, after receiving my response, you want an individual hearing regarding my allocation to you, I must receive your written request for such a hearing no later than ten days from the date of my letter setting forth the allocation or you will have waived your right to such a hearing. Your written request must set out each issue about which you wish to be heard. My secretary will advise you of the time and place for the hearing.

Anyone who requests a hearing will bear all expenses associated with the proceeding. All time incurred by me, the geotechnical consultant, the appraisers or the cost of repair estimators in preparing for and attending the hearing will be your personal responsibility. Based upon the issues you raise, I will estimate the amount of time the hearing is likely to take and the cost of the hearing must be paid in advance. Any shortfall due to the hearing running longer than I estimate will be deducted from your ultimate allocation. Any excess will be refunded to you. For your information, my time will be billed at my usual rate of $300 per hour. The appraisers' time will be billed at an hourly rate of $125, the cost of repair estimator will be billed at his hourly rate of $100.

PILLSBURY MADISON & SUTRO LLP

DELMONICO V. CITY OF ANAHEIM, ET AL.

ALLOCATION EXPLANATION

The letter from Judge Fujisaki sets forth the net dollar amount of your share of the settlement. To help explain the total value of your award, PILLSBURY MADISON & SUTRO LLP prepared this breakdown showing you the gross dollar value of your award.

Client Name:	Muratori	
Property Address:	6891 E. Kentucky Avenue	
GROSS AWARD		83,953
ALLOCATION OF DEDUCTIONS		
ATTORNEY FEES	21,129	
LITIGATION COSTS (Est'd)	13,248	
GHAD FUNDING	16,605	
TOTAL DEDUCTIONS	50,982	
NET AWARD*		**32,972**
RETAINER REFUND & ADVANCE (already distributed)	5,000	
ADDITIONAL AMOUNT TO BE DISTRIBUTED*		**$27,972**

*Plus or minus 3% due to expenses yet to be incurred and interest earnings accruing daily on the settlement proceeds.

INFORMATION OVERLOOKED IN ENGEO'S RECENT ASSESSMENT PROPOSAL

- Historical documents providing evidence of damages sustained from the Santiago Landslide in 1993-94
- Evidence showing extensive damage to properties outside the deformation zone, especially to the north of Serrano Avenue
- Damages to city property outside of Avenida de Santiago, and the risk to city property on Serrano Avenue and to the north
- A proper assessment should assess all properties in relation to the area and the city both for its properties in the area and for transport access to adjacent areas.

SERVICES PROVIDED TO ALL PARCELS AND CITY PROPERTY IN GHAD

- 1. Protection from landsliding and ground deformation.
- 2. Protection from loss of street/transportation access.
- 3. Protection from loss of utilities an associated services.
- 4. Groundwater seepage management, providing protection for properties and improvements.
- 5. Consequential protection of properties and improvements from diminution of value resulting from manifestation of geologic instability.

AN IMPROVED ECONOMICALLY-JUSTIFIED FORMULA FOR ASSESSMENT

- Definition of terms:
  - At= Total Area in GHAD
  - Ai= Area in lot of GHAD property owner i
  - Ap= Total Area of property owners in GHAD = ∑_1^305▒A_i
  - Ac= Total Area of city property including road, sidewalks, and utilities in GHAD
  - Ao= Total Areas that are neither owned by the city or property owners in GHAD, such as HOA common areas
  - At= Ap+ Ac+ Ao
    - $T_i=\frac{A_i}{2A_c+A_p}*T$
  - Ab= Total Benefit Area in GHAD = At- Ao = Ap+ Ac
    - $T_2=\frac{2A_c}{2A_c+A_p}*T$
  - T = Total Annual Costs for GHAD services
  - T_i = Annual Costs for Property Owner I
  - T_c = Annual Costs for City
- Assessment Formula
- $T = T_C + \sum_1^{305} T_i$
- $T_i=\frac{A_i}{2A_c+A_p}*T$
- $T_c=\frac{2A_c}{2A_c+A_p}*T$
- Note: City Areas are charged at twice their area, due to 1) damage avoided on those areas; 2) Access-loss for traffic to adjacent areas.

REQUEST TO ENGEO

- Apply this formula to the two cost estimates for annual services and generate a new assessment for each parcel owner and the city
  - Based on average actual costs over last three years
  - Based on 3-year average plus estimated deferred maintenance
- Present the report to the full board at a closed session prior to any meetings with the city

SANTIAGO LANDSLIDE

ANAHEIM HILLS

ANAHEIM, CALIFORNIA

W.O. 165140.69 June 28, 1996

VOLUME I

EBERHART & STONE, INC.
GEOLOGICAL AND GEOTECHNICAL CONSULTANTS

SANTIAGO LANDSLIDE

ANAHEIM HILLS

ANAHEIM, CALIFORNIA

W.O. 165140.69 June 28, 1996

VOLUME I

Prepared for:

City of Anaheim
Office of City Attorney
200 South Anaheim Boulevard, Suite 356
Anaheim, California 92805

733 WEST TAFT AVENUE • ORANGE • CALIFORNIA 92665 (714) 921-4810 • FAX (714) 921-1031

EBERHART & STONE, INC.
GEOLOGICAL AND GEOTECHNICAL CONSULTANTS

City of Anaheim
Office of City Attorney
Anaheim Civic Center
200 South Anaheim Boulevard, Suite 356
Anaheim, California 92805

June 28, 1996
W.O. 165140.69

Attention: Malcolm E. Slaughter, Deputy City Attorney

Gentlemen:

The firm of Eberhart & Stone, Inc., is pleased to submit its report for the "Santiago Landslide". This report documents the conditions and incidents associated with the ground deformation leading to the City of Anaheim declaration of emergency response in January 1993. Subsequent implementation of an extensive ground water withdrawal system, investigation of area geology and hydrogeology, monitoring activities, evaluation of stability, and the resultant conclusions and recommendations are also presented in the report text and its appendices. The report includes data collected from field monitoring of the landslide through December 1995.

A brief overview of important events, conditions, and issues has been prepared to assist interested parties. This "summary" begins on the next page. Eberhart & Stone, Inc., appreciates the opportunity to provide consulting services related to the "Santiago Landslide".

If you have any questions regarding this report, or if this firm can be of further service to you, please do not hesitate to call.

Respectfully submitted,

EBERHART & STONE, INC.

Mark W. McLarty
Sr. Engineering Geologist
CEG 1107

James M. Lancaster Jr.
Engineering Geologist
CEG 1927

Reviewed by:

Steven P. Alford
Sr. Engineer
RCE 34276 Exp. 9/30/99

Dan R. Eberhart
President
CEG 965

Gerald L. Stone
Vice President
RCE 32233 Exp. 12/31/96

MWM:JML:SPA:DRE:GLS:mt:ph (c:\165140.69\16514069.020)

Enclosure: Overview

OVERVIEW

The Santiago Landslide is a term applied to an area of locally discontinuous ground deformation encompassing roughly 25 acres. Ground deformations associated with the landslide were first observed by this firm in July 1992. Tension cracks near Avenue de Santiago and pressure ridges traversing the Rimwood Drive cul-de-sac area were interpreted to define an incipient failure mass. The fully developed (mature) portion of the landslide was limited to about the westerly one-third of the ultimate deformation area. Observed 1992 displacements were very small, the maximum being less than 0.2-foot.

Movement accelerated during the weekend of January 16-17, 1993, after heavy seasonal rainfall of December 1992 through early January 1993. Original landslide mobilization and subsequent acceleration were predominantly attributable to rising ground water. Clearly, area dewatering was the only action available to reduce and control the destabilizing effects of these adverse ground water accumulations. Dewatering efforts initiated in January/February 1993 had a great influence on both the total landslide displacement and its potential enlargement. Resultant ground water withdrawal volumes were sufficient to stop significant mass movement by the end of January 1993. Of equal importance, dewatering appears to have mitigated propagation of a continuous landslide slip surface eastward from the locus of movement on the west. Consequently, total translational displacement was minimal, ranging from a maximum of about one foot for the western deformation to probably less than 0.1-foot on the east. Gross movement has not been detected since February 1993.

It is not known what the final configuration, extent, and magnitude of sliding would have been without the dewatering effort. However, geologic and topographic relationships, along with the stability models, provide some insight. Two controlling conditions are predominant:

- The presence and orientation of pre-existing planes of weakness.
- The critical influence of ground water.

Stability analyses show greater resistance to sliding in the eastern portion of the landslide, even considering the January 1993 ground water regimen. Mobilization of substantial resisting forces is evidenced by ground deformation manifesting and localized in the Georgetown Circle area. Deformation represents the weakest link in available resisting masses and may be related to the presence of inferred faulting. Computed factors of safety for about the eastern half of Georgetown Circle are substantially above unity owing to northeasterly deepening of the projected slip surface. Consequently, much of the potential slide mass is supported down-dip and was, therefore, self-buttressing once its strength was mobilized.

The western portion of the landslide had matured, however, and an essentially continuous rupture surface had formed. As movement increased, basal shearing propagated easterly and was being resisted, as discussed above. Stability analyses and subsurface geometry indicate that the portion of the landslide east of Georgetown Circle would probably resist failure. Had movement continued unabated, a translational boundary could have formed in the hillside between Georgetown Circle and Avenida de Santiago, probably near the west end of Georgetown Circle.

Cessation of earth movements and associated deformation was, and remains, dependent upon control of local ground water. The installed dewatering system is considered capable, under most conditions, of reducing ground water levels to or below those levels recorded on October 5, 1994, by early autumn of each year. It is recommended that the October 5, 1994, ground water levels be used as a goal for annual operation of the system.

Continued stability of the deformation area and adjoining terrain will necessitate effective dewatering for the foreseeable future. Additional dewatering and observation wells are recommended for key areas to further assist risk reduction. However, it is paramount that the installed ground water control and observation system be closely monitored and maintained at maximum efficiency. Recommendations to accomplish these objectives prescribe the frequency, documentation, and evaluation of ongoing operations for the system.

The fact that area stability is dependent on the control of ground water cannot be overemphasized. Therefore, it must be recognized that the dewatering systems have to be effectively operated and carefully monitored indefinitely.

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APPENDIX

1.0 INTRODUCTION

The "Santiago Landslide" is the term applied to an area of locally discontinuous ground deformation encompassing roughly 25 acres of developed and natural terrain in the Anaheim Hills area of Anaheim, California. Ground deformations associated with the landslide were first observed by this firm in July 1992. On January 19, 1993, the aerial extent and rate of movement increased, causing the City of Anaheim to declare an emergency incident. As a result, local evacuation of residents, restricted access, and emergency abatement efforts were implemented.

The City retained Eberhart & Stone, Inc. (E&S), to investigate geologic/ geotechnical conditions associated with the Santiago Landslide. Considerable geologic/geotechnical and hydrogeologic information was gathered in the course of study. Details of the technical investigations, remedial actions, and ongoing monitoring are described in subsequent sections. Conclusions and recommendations derived from analyses and interpretations of the resultant data follow the descriptive sections.

Distinctions in terminology have been made in discussing the landforms and identifying geographic areas in the context of this document. A fairly large area was ultimately researched and is generally referred to as the "study area" (see Geologic Map in Volume III, Plate B.1). Recent ground cracks, bulges, or other features evidencing strain phenomena, including that effecting improvements, are described as distress, damages, and deformations. Strain-related changes ultimately, but with some discontinuity, defined a boundary for an approximately 25-acre parcel of land which has been referred to as the Santiago Landslide.

Very little translational movement was measured. Maximum displacement was slightly more than one foot, and significant portions of the area identified as "landslide" exhibit very little or no discernible evidence of change. The stability conditions for the "landslide area" are quite variable, and only a portion of the landmass exhibits mature landslide features.

The terrain traversed and bounded by the ground deformations was previously subdivided and developed for residential use beginning in the early 1970's, with construction of major access routes and mass grading for private properties. Final grading and residential construction, with subsequent occupancy, dates from the early to mid-1980's in the vicinity of Georgetown Circle, Williams Circle, and Rimwood Drive. Avenida de Santiago follows a ridgeline above these neighborhoods and fronts large view lots which were essentially built-out in the late 1980's. Prior to residential development, regional construction was limited to water-supply improvements: the Metropolitan Water District Lower Feeder/ Santiago Lateral pipeline to Irvine Lake (early 1960's), and Walnut Canyon Reservoir (completed in 1969).

These properties occupy relatively high-relief, hilly terrain formed by up-lift and erosion of the underlying sedimentary rocks. Rock characteristics, ground water conditions, and local topography were the primary factors investigated to gain an understanding of the Santiago Landslide phenomenon.

1.1 SERVICES

The consulting services addressed in this report are the following:

- Determine and evaluate local geologic, geotechnical, and hydrogeologic influences.
- Assist abatement efforts.
- Assess stability.
- Recommend procedures for long-term control.

1.2 PHASES OF WORK

The phases of consulting services can be divided into three parts:

- Pre-Emergency Investigation (2.1);
- Initial Emergency Response (2.2);
- Additional Geotechnical Investigation (2.3).

This report presents the results of this firm's investigative work and the emergency response measures undertaken by the City of Anaheim. Included are analyses of the conditions promoting ground movements, evaluation and conclusions concerning site stability, and capability of the recommended dewatering system to control ground water fluctuations. On the basis of these evaluations, recommendations for future geologic/ geotechnical studies and continued monitoring were developed, as were suggestions for modification and maintenance of the existing dewatering system. Following is a summary of the services addressed in this report.

2.0 CONSULTING SERVICES

2.1 PRE-EMERGENCY INVESTIGATION

Consulting services by Eberhart & Stone, Inc., began with a request by the City of Anaheim to observe pavement distress of the Rimwood Drive cul-de-sac. A site visit by staff members on July 2, 1992, revealed cracking and heaving of asphalt pavement and horizontal and vertical displacements of the curb, gutter, and sidewalk. Similar distress was observed at the southwest corner of Georgetown Circle, near the intersection of Georgetown Circle and Serrano Avenue. Subsequent observations of the private cul-de-sac leading to 6881, 6891, 6899, and 6901 Avenida de Santiago disclosed tension cracks in the pavement and adjacent slopes.

At the request of the City, the proposed investigation of the landslide was separated into two phases. Phase I was designed as a limited investigation to formulate tentative opinions as to the nature of the observed distress so that a more detailed Phase II study could be planned.

Phase I consisted of the following tasks:

- Compilation and review of geologic/geotechnical data obtained from the City's files for the study area;
- Procurement, examination, and interpretation of aerial photographs and topographic maps;
- Surface geologic mapping of the distressed area;
- Drilling, logging, and sampling of the materials exposed in four bucket-auger exploratory borings within roadways adjacent areas of recognized distress;
- Laboratory testing of selected soil and rock samples;
- Analysis of the geologic/geotechnical conditions relative to the existing distress.

A summary of Phase I results was submitted to the City of Anaheim on November 9, 1992. Observed ground movement and the related distress were limited to the private cul-de-sac leading to residences at 6881 - 6901 Avenida de Santiago, the Rimwood Drive cul-de-sac and adjacent residential properties, and the bend in Georgetown Circle near its intersection with Serrano Avenue. Based on the limited subsurface information and geologic mapping, displacements were interpreted to be related to incipient failure of a relatively large landmass, possibly an ancient landslide. Laboratory data and boring logs obtained during Phase I are included in Volumes I and II, respectively, of this report.

In response to this preliminary conclusion, the City of Anaheim created a contingency plan for the possibility of landslide movements. A meeting was held on December 9, 1992, with the City of Anaheim and homeowners who could be potentially affected by additional movement. Topics included a discussion of the results of the Phase I investigation and the possible implementation of the City of Anaheim's contingency plan.

Authorization to proceed with the Phase II investigation was received from the City of Anaheim on December 17, 1992. The Phase II investigation was designed to help define the geology and geometry of potential ground movement.

The scope of work for the Phase II investigation was to consist of the following:

- Compilation and review of geotechnical data obtained during previous investigations, including the Phase I study;
- Continued observation, mapping, and compilation of the evidence of ground movement and associated distress within the roadways and adjacent residential properties;
- Periodic field measurements to monitor movements;
- Mapping of geologic conditions;
- Drilling, logging, and sampling of eight exploratory bucket-auger borings;
- Laboratory testing of selected soil and rock samples;
- Development of a three-dimensional model of the suspected landslide;
- Engineering analyses to assess the stability of the suspected landslide;
- Design and evaluation of possible methods for control of the suspected landslide and rough estimates for the cost of their implementation;
- Preparation of a geologic/geotechnical investigative report.

Field work for the Phase II investigation commenced on December 21, 1992, with bucket-auger borings on Georgetown Circle. Work was slowed and became extremely dangerous due to rainfall, high ground water, and borehole caving. Although numerous attempts were made to excavate the proposed bucket-auger borings, none of the four borings undertaken (B-5 through B-8) were completed or logged to the depths anticipated, due to the dangerous conditions. The boring logs from Phase II are included in Volume II. By January 15, 1993, it was evident that subsurface exploration by bucket-auger drilling techniques could not provide the necessary data. The City was informed that alternative subsurface exploration was warranted. The methods discussed included: installation of slope inclinometers and/or tiltmeters; drilling of relatively deep rotary or core borings; and the use of borehole geophysical techniques.

2.2 INITIAL EMERGENCY RESPONSE

During the weekend of January 16 and 17, 1993, movement within the study area accelerated. On the morning of January 18, 1993, the City of Anaheim requested that representatives of Eberhart & Stone, Inc., observe the conditions. Shortly thereafter, the City of Anaheim opted to implement its emergency response contingency plan. An Emergency Operation Center was established by the Fire Department at Fire Station Number 9.

2.2.1 Observations and Recommendations

Consulting services during the initial emergency response included the following:

- 24-hour observations and documentation of damages during the first five days of the emergency;
- Establishment of a land survey to help determine the direction and magnitude of movement;
- Planning and set-up of an emergency dewatering system for the area involved;
- Implementation of ground water withdrawal monitoring systems;
- Procurement and study of additional aerial photographs and topographic maps;
- Mapping of the distress features;
- Response to public reports of damage;
- Installation of inclinometers;

- Logging, when possible, borings for dewatering wells, observation wells, and inclinometers.

A summary of observations as discussed with the City is presented below:

- The area of movement was larger than observed at the completion of Phase I;
- Tension cracks increased in length and width between 6851 and 6937 Avenida de Santiago;
- Maximum movement in front of 6901 Avenida de Santiago increased to about 4 inches vertical and 2 inches horizontal;
- Deformation at the Rimwood Drive cul-de-sac continued to enlarge;
- Compressional features developed in the pavement of Georgetown Circle;
- The eastern margin of the distress was not defined;
- Public and private properties traversed by ground cracks were damaged;
- Numerous ground water seeps and springs were observed in the study area.

Based on the observations made during the first 24-hour period, the following conclusions and recommendations were postulated and presented to the City of Anaheim:

- Damage to some swimming pools was severe enough to permit water to drain into the ground;
- Continued movement threatened site improvements;
- Rise in ground water appears to have promoted accelerated movement;
- Gas lines on Georgetown Circle, Rimwood Drive, and the private cul-de-sac of Avenida de Santiago should be removed from service;
- Area water and sewer lines, as well as the remaining gas lines, should be monitored and taken out of service if damaged;
- Open ground cracks should be sealed or covered to limit the infiltration of surface water;

- Swimming pools should be drained;

- All new reports of distress and/or changing conditions within and adjacent the area experiencing distress should be investigated;

- Dewatering should begin as soon as possible utilizing both horizontal and vertical wells;

- A survey net should be implemented to monitor movements.

The City of Anaheim's response to the above recommendations included the evacuation of effected residences, the sealing or covering of open ground cracks and redirecting surface drainage to limit water infiltration, assessment of city utility services for damage and their removal from service if necessary, requesting Southern California Gas Company to remove gas lines from service in the effected area, and the draining of swimming pools. In addition, the city gave authorization to proceed with the recommended dewatering and established survey control to monitor ground surface movements.

2.2.2 Implementation of Emergency Measures

The following sections describe implementation of the recommendations during the emergency response.

2.2.2.1 Land Surveys: By 11:00 PM on January 18, 1993, five simple extensometer points were established across areas of visible distress. These monitoring points were oriented perpendicular to tension cracks on the private cul-de-sac of Avenida de Santiago, and across the compressional features in Georgetown Circle and Rimwood Drive.

Each extensometer consisted of a nail driven into the pavement on either side of the distress feature. Measurements of horizontal separation were made between the outside edges of nail heads utilizing a steel measuring tape. Subsequent measurements were made in the same manner with the same tape. A table of resultant data is included in Volume Va, Table A.1.

A more precise survey was subsequently implemented to monitor horizontal and vertical displacements and allow vector resolution of movement. By 3:45 PM, January 19, 1993, City of Anaheim survey crews had established survey traverses for each area of the extensometer points. An additional survey line was set up along Serrano Avenue, extending from Leafwood Drive to Williams Circle. Field survey data produced from January 19, 1993, through March 29, 1993, by the City of Anaheim are presented in Volume Va of this report.

2.2.2.2 Drainage and Ground Cracks: Throughout the emergency, the City of Anaheim monitored city and private properties for open ground cracks and ponded water. Open cracks were sealed or covered to limit surface water infiltration. Where practical, water impoundments were drained, and surface water was redirected to limit further ponding.

2.2.2.3 Swimming Pools: The potential for large volumes of water to infiltrate the subsurface from damaged swimming pools was a concern. By January 18, 1993, the swimming pools at 6871 Avenida de Santiago and 1095 Burlwood Drive had drained into the subsurface through cracks caused by landslide movement. Therefore, it was recommended that all swimming pools in the effected area be emptied by pumping. This was accomplished by the City of Anaheim Fire Department by January 22, 1993.

2.2.2.4 Dewatering System: Based on the premise that rising ground water during late December 1992 and early January 1993 was responsible for accelerated ground movement, a priority was placed on the implementation of a dewatering program. Initial dewatering efforts were concentrated in areas where ground water was observed to be at or near the surface. Vertical wells (DW) and horizontal wells (H) were located with the intent to lower ground water in the most efficient manner. By January 28, 1993, twenty-two (22) vertical and twenty-three (23) horizontal dewatering wells were in service, extracting about 267,000 gallons of water per day (see Figure A.1, Table D.1, and Figure D.2 in Volume VIIa). By this date, the rate of movement had slowed and the drilling of vertical dewatering wells was suspended to release manpower and equipment for installation of ground water monitoring wells (P wells). The remaining vertical dewatering wells were drilled during the period of February 17, 1993, through March 24, 1993. Drilling of the horizontal dewatering wells continued unabated through March 24, 1993.

Thirty-two (32) vertical wells and eighty-seven (87) horizontal wells were eventually installed. Power for the well pumps was supplied by the City of Anaheim, via above-ground wiring and/or rented generators. Discharge piping for the dewatering system conveyed flow at grade to undamaged storm drains. The dewatering systems, including electrical power and discharge piping, were ultimately placed underground by the supervision of the City of Anaheim and in accordance with design specifications provided by the Civil Engineering firm of Crosby, Mead, Benton and Associates, Inc. As-built plans for the dewatering discharge system are included in Volume VIIa.

Vertical dewatering wells were constructed to depths which varied from 50 feet to 300 feet below grade. The completion date, depth, and drilling method for each well are given in Table B, Volume VIIa.

Each well was logged from boring returns by representatives of this firm or the firm of Law Crandall. Resultant logs are included as DW-1.1 through DW-35.1 in Volume II.

The initial dewatering wells were shallow, 50 feet to 60 feet in depth, at locations where ground water was known to be very near the ground surface and where relatively permeable bedrock materials were suspected. Most of these shallow wells were drilled with 24-inch-diameter truck-mounted bucket-auger drill rigs during the period of January 20 through 28, 1993. Subsequent wells, varying from 90 feet to 300 feet deep, were drilled utilizing 14-inch-diameter mud-rotary and air-rotary drilling techniques, and a Texoma 24-inch-diameter auger beginning February 17, 1993, and continuing through March 24, 1993. Dewatering well design and construction were accomplished by the City of Anaheim's dewatering contractor, Hydroquip, Inc. Well locations and construction details are presented on Plate B.1, Volume II, and Plate E.1, Volume VIIa, respectively. After the initial pump rates decreased, each dewatering well pump was set-up to operate through timer and load-detection circuits. These circuits allowed the pump to operate for a fixed time period and then shut off for a fixed time period. Initially, the pumps were set for 30-minute intervals. The load-detection circuits also protected the pumps from damage due to cavitation.

Horizontal wells were installed to promote gravity drainage, particularly where surface seepage was observed and in areas inaccessible to vertical well drilling equipment. Horizontal wells were constructed by drilling at a gradient slightly above horizontal. To maintain borehole integrity and facilitate flow, horizontal wells were lined with slotted, 1½-inch-diameter, Schedule 40, P.V.C. casing.

Eighty-seven (87) horizontal wells were constructed. Cursory logging of materials was accomplished by the drilling contractor as each well was drilled. Contractor observation of the drill cuttings provided a simple "driller's log" of the materials encountered. The locations of the horizontal wells and their estimated positions beneath the ground surface are shown on the Location Map-Horizontal Wells, included as Plate B.2 in Volume II.

The horizontal wells were installed by two contractors, Pac West, Inc. (H wells), and Soil Sampling Service, Inc. (HD wells). Pac West operated up to three drilling units consisting of a portable guide frame using a remotely powered hydraulic drill. These compact units facilitate rapid set-up in limited space. The first horizontal wells (H wells) were located at the toe-of-slope on the south side of Serrano Avenue to penetrate soil and rock underlying Georgetown Circle. Subsequent horizontal wells were installed in the slope below and north of Serrano Avenue, and at the toe-of-slope southerly of Georgetown Circle ascending toward Avenida de Santiago. Sixty-nine (69) hydro-augers were constructed by Pac West, ranging in length from 85 feet to 620 feet. The completion date and length of each horizontal well are given in Table C, Volume VIIa.

Soil Sampling Service, Inc., operated a self-contained, tractor-mounted horizontal drill rig called the "Aardvark". This larger, more powerful unit was utilized to drill the longer horizontal wells (HD), where access permitted. The Aardvark was placed in service on February 5, 1993, to install drains north of Serrano Avenue at the base of the larger slopes. Eighteen (18) horizontal wells were drilled by the Aardvark, extending up to 800 feet into the hillside. The completion date and length of each well are presented in Table C, Volume VIIa.

As each vertical and horizontal dewatering well was completed, its discharge rate in gallons per minute was determined. Measurements of ground water production were initially made twice per week by volumetric methods using calibrated containers and a stop watch. After May 1993, periodic monitoring was reduced to once every three months. At the end of April 1994, flowmeters were installed on the vertical dewatering wells. Data collection from flowmeters and measurement of the horizontal well discharge have continued every three months to the present. Production summaries are presented in Table D.1, Volume VIIa.

2.2.2.5 Observation Wells: Ground water observation (P) wells were drilled and installed to monitor the hydrological conditions within and adjacent the distress area, and to help evaluate the effectiveness of the dewatering system. These wells were installed with slotted pipe for their entire length.

The first twenty-two (22) ground water observation wells were drilled to help evaluate the effectiveness of the initial installation of vertical and horizontal dewatering wells. The observation wells were drilled during the period of February 5 through 12, 1993. Six (6) additional observation wells were drilled during the second week of April 1993, following the completion of the last dewatering wells. Each observation well was drilled with a truck-mounted, rotary-wash drill rig to depths ranging from 50 feet to 260 feet. As each well was drilled, a log of the cuttings was prepared. These well logs are included as P-1.1 through P-28.3 in Volume II, and their locations are shown on the Location Map-Trenches and Vertical Borings, Plate B.1, Volume II.

All of the observation wells were completed and developed by Hydroquip, Inc. Details regarding their construction are presented on Plate E.1 in Volume VIIa.

Monitoring of the observation wells began immediately upon their completion, utilizing a battery-powered water-level indicator. The frequency of monitoring was initially about every 48 hours and was subsequently decreased as ground water levels stabilized. Hydrographs for each observation well are presented as Figures B.1 through B.28 in Volume VIIb.

2.2.2.6 <u>Underground Utilities</u>: Many buried utilities in the distress area were damaged by the cumulative ground movement. The damaged utilities included water, sewer, and gas pipelines.

In an effort to eliminate the potential for infiltration, due to water line leaks, water service to the evacuated area was terminated by the City of Anaheim. Water lines that provided service to adjacent areas and were threatened by continued movement and distress were either isolated by shut-off valves or were relocated above grade. The 12-inch-diameter main water line beneath Serrano Avenue, from east of Williams Circle to west of Leafwood Circle, was temporarily replaced with an above-ground, 6-inch-diameter steel line situated along the south side of Serrano Avenue. The 12-inch-diameter water line beneath Avenida de Santiago, between Via El Estribo and Tamarisk Drive, was initially replaced with an above-ground 6-inch-diameter aluminum pipe placed along the north side of the street. Subsequently, a temporary 4-inch-diameter P.V.C. pipe was placed along the south side of the street.

Throughout the emergency, the City of Anaheim monitored sewer mains and storm drains for cracks and dislocations. Monitoring was accomplished by direct and remote observation. The remote system consisted of a television camera mounted on a miniature tractor. This unit was capable of examining pipelines as small as 6 inches in diameter. The following information for sanitary sewer breaks was supplied by the City of Anaheim's Department of Maintenance. Some of these breaks can be attributed to the landslide, while others may have predated it.

1. 01-18-93, Avenida de Santiago (private cul-de-sac): large vertical offset, 106.4 feet from manhole at 0+00 toward cul-de-sac manhole at 3+00.

2. 01-18-93, Rimwood Drive: cracks and offsets, 34 feet to 53 feet from manhole at 15+99 (cul-de-sac) toward 12+86 (Burlwood Drive).

3. 01-22-93, Avenida de Santiago: cracks, 2 feet to 10 feet from manhole at 17+58 (private cul-de-sac intersection) to south, uphill toward manhole at 19+41.

4. 01-22-93, Avenida de Santiago: 1-inch offset, 95 feet from manhole at 19+41 toward manhole at 17+58.

5. 01-28-93, Vassar Circle: cracked joints, 8 feet to 20 feet from cul-de-sac manhole at 3+30 toward Swarthmore Drive manhole at 0+00.

6. 02-05-93, Avenida de Santiago: cracks and offset, 96 feet from manhole at 17+58 downhill toward manhole at 14+48.

7. 02-10-93, Georgetown Circle: cracks and offset, 118 feet from cul-de-sac manhole at 13+28 toward Williams Circle.

8. 02-10-93, Georgetown Circle: two laterals broken at main, 38 feet from cul-de-sac manhole at 13+28 toward Williams Circle.

The locations of the sewer breaks, as numbered above, are shown on portions of the City of Anaheim's sewer maps (S-211, S-217, S-287, and S-288) and are included as Plate G.1 in Volume Va.

With the termination of water services to the evacuated residences, water infiltration from broken sewer lines was eliminated within the evacuated area. However, the sewer main on Avenida de Santiago serviced several residences south and west of the evacuated area. As indicated above, three points of damage to this sewer main were observed, requiring it to be removed from service. In order to maintain service to these residences, the sewer line was plugged, and a temporary sewer line was placed above ground from about 6900 to 6950 Avenida de Santiago.

One gas line break was recorded by the Southern California Gas Company. The break occurred on January 19, 1993, on a private gas supply line feeding a pool heating system at 6890 Georgetown Circle (based on personal communication with Randy Willis, Southern California Gas Company). To reduce the threat of potential fire or explosion caused by leaking gas lines, gas meters were removed, and the incoming gas supply lines were capped within the emergency area.

Prior to reoccupation of the evacuated area, underground utility lines were repaired or replaced. Utility line rehabilitation included the copper water services installed to accommodate minor future ground adjustments, shut-off valves positioned to isolate both gas and water mains passing through or into the emergency area, and the installation of flexible joints in water mains. In addition, private property owners were required to verify plumbing integrity and to repair any problems prior to reoccupation.
Many of the excavations made to access the underground utilities were observed by a geologist from this firm. Where significant observations could be made and where conditions were relatively safe for entry, these excavations were entered and a graphic log of the exposed conditions made. Resultant logs include the excavations for installation of the water main flexible joints, and a sewer repair at the easterly end of Rimwood Drive. The graphic logs of these excavations are included as Plate A.1, Volume II. The locations of the trenches logged are shown on the Location Map - Trenches and Vertical Borings, Plate B.1 in Volume II.

2.2.2.7 <u>Property Owner Reports of Distress</u>: During the emergency response, the City of Anaheim established a procedure for property owners to report distress. These reports were submitted to the Emergency Operations Center (EOC) for evaluation and distribution to the appropriate agency. Those reports forwarded to Eberhart & Stone, Inc., were reviewed and assessed. Report features considered pertinent to evaluation of the local geologic conditions were examined and documented. Resultant documentation was transmitted to the Incident Commander in charge of the EOC.

2.2.2.8 <u>Inclinometers</u>: Inclinometer installations were completed to provide the following information:

- To determine the extent and depth of horizontal ground deformation.

- To monitor the magnitude and rate of deformation.

Inclinometers are devices used for monitoring deformation of casing installed within the deforming landmass. A probe designed to measure inclination with respect to the vertical is lowered into the casing. The inclinometer system has the following major components:

- A permanently installed, plastic guide casing with integral tracking grooves to orient the inclinometer probe.

- A portable inclinometer probe containing two gravity-sensing transducers.

- A portable instrument with power supply, probe inclination data display, and memory circuits.

- A graduated electrical cable linking the probe to the instrument.

Ten inclinometer casings (SI) were installed within and adjacent the suspected landslide area. The casings were installed in six-inch-diameter to eight-inch-diameter, rotary-wash boreholes to depths ranging from 180 feet to 260 feet. Logs of each boring are included as SI-1.1 through SI-10.2 in Volume II. The locations of inclinometer casings are shown on the Location Map-Trenches and Vertical Borings, Plate B.1 in Volume II.

Inclinometers were completed using RST Instruments' flush-coupled 2.75-inch and 3.34-inch (outside diameter) ABS inclinometer casing with a snap-seal "o-ring" coupling system. The annular space between the borehole wall and the inclinometer casing was filled to within about one foot of the ground surface with a bentonite-cement or sand-fly ash-cement grout. Bentonite-cement grouts were pumped into the annular space through a tremmie pipe as it was slowly withdrawn by the drill rig. Sand-fly ash-cement grout was emplaced by pressure grouting through staged grout tubes affixed to the inclinometer casing. The depth, tubing diameter, and backfill material for each inclinometer are provided in Table E, Volume Va. Construction details are presented on Plate E.1 in Volume VIIa.

After installation of the casing, an initial or baseline determination of casing inclination was accomplished with a Mark IV inclinometer probe. The probe was lowered to the bottom of the casing, and readings were taken at two-foot vertical intervals as the probe was raised incrementally to the top of the casing. The differences between these baseline measurements and subsequent sets of data can define the magnitude and direction of a change in the casing inclination.

The Mark IV inclinometer probe measures casing inclination in two mutually perpendicular, near-vertical planes as defined by the tracking grooves. Thus, horizontal movement vectors can be computed from differences in comparative data sets.

The inclinometer probe employs two force-balance accelerometers to measure its orientation relative to the local gravity field. Two readings were taken for each data set to verify consistency. Minor differences were corrected by using "checksum" methods for calculation of the cumulative deviations.

2.2.2.9 Aerial Photographs: Numerous aerial photographs that depict surface features prior to, during, and subsequent to residential development of the study area have been obtained and studied. Initially, stereo photography taken in 1952 by the U.S. Department of Agriculture, and orthophoto maps based on 1974 photography from the U.S.D.A. Soil Survey of Orange County and the Western Part of Riverside County, were available to study the area.

Additional stereo pairs were obtained from the Fairchild Aerial Photography Collection (1931, 1939, and 1947), Continental Aerial Photo, Inc. (1952, 1967, 1970, 1973, 1975, 1977, 1978, 1981, 1983, 1990, 1992, and 1993), Geo-Tech Imagery Int. (Infrared, 1987), and Robert J. Lung & Associates (1993). A full listing of the aerial photographs studied is presented in the Reference List, Appendix C, Volume I. Aerial photograph interpretations aided in the evaluation of the geologic conditions of the study area.

2.2.2.10 Topographic Maps: 40-scale grading plans obtained during the pre-emergency investigation were used as a base map during the first weeks of the emergency. In addition to the grading plans, U.S.G.S. 7.5-minute Orange and Blackstar Canyon Quadrangles served as a basis for site location and regional mapping. Additional 40-scale site development plans depicting the pre-development topography were obtained from Willdan Engineering Associates.

A current topographic map of the area was produced by Robert J. Lung & Associates. This topographic map was compiled at a contour interval of one foot using aerial photographs dated January 28, 1993. Resultant maps at scales of 1" = 40' and 1" = 100' were used to locate and plot exploratory excavations, surface geology, and distress features.

2.3 ADDITIONAL GEOTECHNICAL INVESTIGATION

Acquired geologic and hydrogeologic information was compiled and analyzed during mid to late 1993. As a result, the additional work listed below was accomplished.

- Drilling and logging of five continuous diamond-core borings;
- Geophysical logging of the additional borings;
- Geophysical logging of selected inclinometers and observation wells;
- Construction of piezometers in the five core borings;
- Slug testing of piezometers in the five core borings;
- Laboratory testing of selected core samples retrieved from the five core borings;
- Instrumentation of selected observation wells;
- Pump testing of selected dewatering wells;
- Monitoring of installed instrumentation;
- Analyses and evaluation of the resultant geotechnical database.

2.3.1 Diamond-Core Borings

Five rotary-wash, diamond-core borings were drilled during April and May, 1994. Two borings were located at the ends of Georgetown Circle (PZ-1, 199 feet deep, and PZ-2, 192 feet deep). Two were positioned on the slopes above Williams Circle (PZ-3, 234 feet deep) and above Georgetown Circle (PZ-4, 204 feet deep). The final boring (PZ-5, 214 feet deep) was drilled on Vassar Circle north of Serrano Avenue. The borings are shown on the Location Map - Trenches and Vertical Borings, Plate B.1, Volume II.

The PZ holes were drilled with a Longyear LF70 rotary-wash rig equipped with an HQ-sized drill rod and a Longyear double-tube, wire-line core barrel utilizing a diamond-core bit. This system is capable of producing a 2.5-inch-diameter core in 5-foot lengths.

The Longyear core barrel consists of an inner split-tube assembly in which the core is recovered, an outer protective tube, and a drill bit assembly. The inner tube assembly remains relatively stationary as the outer barrel and drill bit are rotated. As the drill bit and outer tube advance into the rock, the core is captured and retained by the inner split tube. At the completion of each core run, the inner tube is disconnected from the outer barrel, and the inner tube with its rock core are retrieved through the center of the drill rod by means of a wire-line lift system. While the rock core is being removed from the inner split tube, a second inner tube is lowered through the drill rod string and locked into the outer tube assembly, allowing drilling operations to continue.

As each core run was retrieved, a geologist from this firm cleaned and photographed the core. Percent core recovery, determination of rock quality designation, and descriptive logs of the core were prepared (see PZ-1.1 through PZ-5.15, Volume II). In order to preserve the core for future reference, the core was typically covered with plastic sleeves and placed in poly core boxes for transportation and storage.

2.3.2 Geophysical Logging

Borehole geophysical surveys were used to measure the properties of strata penetrated by the diamond-core borings (PZ borings). Geophysical logging was conducted by Colog, Inc. The types of data acquired in each of the PZ borings, a description of each type of log, copies of the geophysical logs, and data obtained from the Acoustic Televiewer are presented in Volume IV.

Natural gamma emissions were also measured in selected cased borings completed earlier. They included inclinometer borings SI-1, SI-3, SI-4, SI-5, SI-6, SI-7, and SI-8, observation wells P-22 and P-25, and dewatering well DW-32. Resultant logs were subsequently used to aid in correlation of geologic and hydrogeologic data from the PZ borings.

2.3.3 Piezometer Installation

Multipoint piezometers were installed in each of the PZ borings to monitor the hydrogeologic conditions at various depths. The water-bearing strata chosen for monitoring were determined from evaluation of the boring logs, geophysical data, and local ground water elevations. The zones selected are composed of materials that appear to be relatively permeable and are below the static water level. It was determined that one piezometer should monitor strata below, and one above, the stratigraphic horizon of the projected failure surface in each of the five PZ borings. The piezometer identification, placement depth, and materials monitored are listed in Table A.3 in Volume VIIb. As shown in the table, PZ2-A, PZ3-B, PZ4-B, PZ5-A, and PZ5-B monitor zones in sandstone of the Soquel Member. In addition, PZ3-B monitors a perched water zone in sandstone of the Soquel Member. The other PZ installations monitor siltstone and sandstone interbeds in the La Vida Member.

2.3.3.1 Construction: Each of the five diamond-core borings was reamed with a 7⅞-inch drill bit to produce a minimum 8-inch-diameter completed hole. Reaming was accomplished by truck-mounted, rotary drill rigs from Lang Drilling (Longyear LK30E) and G&S Drilling (Midway 13M). Bentonite drilling mud, with no additives, was utilized in reaming the borings and was removed by flushing.

Each of the five PZ borings was completed by installing two standpipes isolated by bentonite and grout seals. Each of these standpipes consisted of a 5-foot section of 0.020-inch slotted 1 1/4-inch-diameter Schedule 40 PVC pipe extending to the water-bearing zone selected. Water levels in each standpipe are monitored by dedicated electrical pressure transducers and data loggers. A third shallow piezometer was installed in the upper portions of PZ-3 and PZ-5. This third piezometer consisted of a pressure transducer embedded in a sand-filled sock directly in the boring. The as-built configurations for the five PZ borings are depicted on Plate E.1 in Volume VIIa.

The wellheads were completed with a concrete vault installed below grade. A wellhead seal for the instrumentation cables during water injection testing was designed and is shown in Figure C.1, Volume VIIb.

2.3.4 Ground Water Monitoring and Testing

2.3.4.1 Monitoring: Monitoring of ground water levels in the observation wells (P wells) has continued on a regular basis since installation. These measurements are made using a battery-powered water level indicator. In May 1994, pressure transducers and automated data loggers were installed in fifteen (15) of the ground water observation wells. Instruments consist of a cylindrical, single-channel logger connected to vibrating-wire pressure transducers and RTD temperature sensors. The logger hangs from the top of the observation well casing with its feed cable connected to the pressure transducer at the bottom of the well. Hydrographs showing ground water levels versus time are presented in Volume VIIb.

Monitoring of the five PZ borings was accomplished by utilizing vibrating-wire pressure transducers connected to multi-channel data loggers protected by weather-resistant boxes in each PZ wellhead vault.

The data loggers for both the PZ and P wells can record various data, including water pressure, temperature, battery levels, and relative humidity. The loggers can be set to record the data at various time intervals. Data are downloaded in the field to a notebook computer and subsequently transferred to a desk-top computer in the office for evaluation.

The 32 dewatering wells were modified with flowmeters and observation pipes. Totalizing flowmeters were installed at the discharge of each well so that the volume of water pumped during a specified period of time could be measured more efficiently. Observation pipes provide access to measure water levels in each well, particularly during pump testing. The observation pipes consist of a five-foot section of 2-inch-diameter Schedule 40 PVC pipe at the top of the well, connected to a 1¼-inch-diameter pipe extending to within several feet of the well bottom. During pump testing, a pressure transducer and data logger are suspended from the 2-inch-diameter pipe. Installation of the observation pipes and flowmeters was accomplished by the City of Anaheim's dewatering contractor, King Pump and Dewatering Corporation, during April and May of 1994.

2.3.4.2 <u>Piezometer (PZ) Tests</u>: At the completion of the piezometer installation, the casing was pressure tested to verify isolation from the other casings in each boring. The deepest piezometers were pressurized with water at 15 psi to 20 psi for at least one hour, while monitoring the water levels in the adjacent shallower casings. To prevent perturbation from nearby dewatering wells, pumps were turned off for at least three days prior to and after each test. If no water fluctuations were observed in the shallower casing, direct-path intra-borehole integrity was verified.

Test data were recorded at ten-second intervals at the start of each pressure test, with longer sample intervals as the test progressed. This sequence facilitated frequent measurements during the early portion of the test when pressure was changing rapidly, and conserved logger memory and power during later stages of the test.

Table A.4, in Volume VIIa, provides the water elevation prior to testing, test length, average pressurized injection flow rate, and whether or not communication was observed for each piezometer installation. None of the multiple piezometer casings showed evidence of communication within each borehole.

The pressure-test data from the PZ piezometers, collected during decline (fall-off) of bottom-hole pressure after closing off water supply, were subsequently analyzed using the Miller-Dyes-Hutchinson method (Erlougher, 1977). In this method, a plot of falling pressure vs. the log of time is utilized. Methodology is equivalent to that of Jacobs, described in DeWeist (1965), except that a plot of log pressure vs. log of time is made first to find the end of wellbore storage, skin effects, and "after-flow". These properties can have a significant influence on aquifer characterization calculations in fall-off tests. The calculated values of transmissivity (T), permeability (K), and storage coefficients (S), as well as permeability results from core samples, are shown in Table A.5, Volume VIIb.

Porosities (n) were estimated by several methods in the PZ wells, including resistivity logs, sonic logs, direct laboratory testing of core samples, and barometric efficiency analyses (see Table A.2, Volume VIIb).

2.3.4.3 Dewatering (DW) Well Pumping Tests: Pump tests of selected dewatering wells were conducted to determine aquifer properties. Six wells were selected for testing: DW-10, DW-18, DW-27, DW-28, DW-29, and DW-30. The test wells were selected based on pumping rates, availability of observation wells, and geologic conditions penetrated by the wells.

Nearby dewatering wells, observation wells, and piezometers were used as test observation wells during pump testing. Water levels were measured using vibrating-wire pressure transducers and data loggers relocated from observation wells. Prior to each test, instrumentation was installed in the wells, and the pumps were shut off to allow water levels to equilibrate. Table A.1, Volume VIIb, indicates the wells that were used as test observation wells for each pump test.

The totalizing flowmeter was read prior to testing and periodically during the test to verify a fairly constant flow rate for each well that was pump tested. The pumps are normally operated on a timer circuit which controls the time interval between successive pumping cycles. The time during which the pump operates the pumping cycle is determined by a load-detection circuit, which turns the pump off and prevents cavitation when the well bore is emptied. At the completion of each pumping cycle, the timer is automatically reset and the process is repeated. The timer, and in some cases the overload sensor, had to be disconnected for the duration of the pump test.

Pump test preparation included turning off the test well and any nearby pumping wells. A minimum period of three days, and up to a week, of recovery was allowed. During this time, the test well and any wells utilized as observation wells were monitored to determine the rate of water level rise and the equilibrium water level.

Following the recovery period, the test well flowmeter was read and the pump turned on. In some wells (DW-18, DW-27, and DW-28), foreign material had clogged the pump intake, raising the pump load somewhat. For these tests, the overload sensitivity was reduced to keep the pump operating until the obstruction was cleared. In each of these wells, the flow rate was different, but constant, before and after the obstruction was cleared. When the pumping water level was observed to have dropped below the pump set depth, or when the overload detection circuit shut the pump off automatically, the test was ended, the pump turned off, and water level recovery monitored until gound water approached the pre-pumping elevation. In most cases, however, the well could be monitored for a longer period. In some wells, the water level was still recovering from long-term dewatering operations and the shut-off of nearby well pumps.

The data loggers on the pressure transducers installed in each dewatering well tested were programmed for an increasing interval of time between water level measurements during the pump tests. At the start of testing, the interval between measurements was 10 seconds. After every 100 measurements, the interval was increased automatically to 3 times the preceding interval, to a maximum of 10 minutes for the duration of the test and recovery period. Nearby test observation wells were maintained at 20-minute intervals between measurements. Following recovery of the tested wells and nearby observation wells, the data loggers were downloaded to a notebook computer.

Results from the pump tests, including transmissivity, permeability, storage coefficient, specific storage, and radius of influence, are presented in Table A.6, Volume VIIb.

2.3.5 Additional Review and Geologic Mapping

Additional geotechnical information was obtained through the City files as technical reports from G. A. Nicoll & Associates, Geo-Ekta, Inc., and Earth Research, Inc. Information from these sources was compiled and reviewed. A listing of references is presented in the Reference List, Appendix C, Volume I.

In order to verify geologic interpretations from review and compilation of available information, additional geologic mapping was necessary. Field studies were accomplished in the southern portion of the project area (south of Avenida de Santiago) to verify contacts and outcrop locations of the Puente (sandstone and siltstone units) and Topanga Formations. Mapped data were recorded on the 40-scale project topographic maps and are presented on the Geologic Map, Plate B.1, Volume III.

2.3.6 Laboratory Testing

2.3.6.1 Engineering Properties: Laboratory tests were performed on selected samples obtained during the pre-emergency drilling, underground installation of the dewatering system, and core drilling phases of the investigation. A description of the laboratory test methods and the results of the testing are included in Appendix D, Volume I.

2.3.6.2. <u>Water Chemistry</u>: In October 1994, the PZ installations were cleaned by airlifting. Water samples for chemical analysis were taken after the wells had recovered. The results of chemical analyses are shown in Appendix E in Volume I.

3.0 DEVELOPMENT HISTORY AND CONDITIONS

3.1 LOCATION

The area of investigation occupies a portion of a northwesterly facing slope in the Anaheim Hills area of Anaheim, California. Study was focused on an area of approximately 25 acres defined by discontinuous ground deformation involving forty-six residences within Tracts 7587, 9080, 9133, 9134, and 10996. The limits of observed ground deformation are generally rectangular in shape. The distress area is generally bounded on the northwest by Georgetown Circle and the Rimwood Drive cul-de-sac, and on the southeast by a portion of Avenida de Santiago and an adjoining private cul-de-sac. The southwesterly limit crosses primarily undeveloped terrain and tends to be poorly defined. The magnitude of deformation decreases and becomes indistinguishable to the northeast in the area near and above the Williams Circle cul-de-sac. The study area in relation to the terrain is shown on the Site Location Map, Plate A.1 in Volume I.

3.2 DEVELOPMENT SUMMARY

Early development of the Anaheim Hills portion of the study area began with construction of the Metropolitan Water District's Lower Feeder/Santiago Lateral from Santa Ana Canyon to Irvine Lake, 1955-56. During the mid 1960's, geotechnical and geologic reconnaissance reports were conducted for planning of future residential development. By 1965, the Walnut Canyon Reservoir was under construction, and the impoundment was reportedly filled by 1969.

Plans for regional development of the area in the immediate vicinity of the Santiago Landslide were completed, and grading in accordance with those plans was begun, in 1971. The initial grading operations typically consisted of the excavation of bedrock and soil materials from ridgelines and topographic prominences situated along the southerly margins of development, and the subsequent placement of fills within canyons and on natural slopes at lower elevations to the north. These operations produced large areas of nearly level or gently sloping ground separated by intervening cut and fill slopes inclined at 2:1 (horizontal:vertical) gradients. These grading operations also included the construction of arterial roadways for the southern end of Nohl Ranch Road, Serrano Avenue from Nohl Ranch Road to Hidden Canyon, Loyola Drive, Kentucky Avenue north of Serrano Avenue, and the northerly portion of Avenida de Santiago. At the completion of this phase of development, significant portions of the natural topography that bounded the northerly and southerly margins of development remained essentially unchanged. The large nearly level areas created during the initial phase of grading were subsequently regraded for residential development from about 1974 through 1978. Regrading of these areas created the individual building pads, access roadways, and intervening slopes that exist today.

Rough grading for most of the residential tracts south of Avenida de Santiago dates from about 1985. However, fine grading associated with residential construction on previously undeveloped lots has continued to the present time. The most recent mass grading for tract development was completed in early 1992 for the custom lots along Point Premier, situated near the western terminus of Avenida de Santiago.

3.3 TOPOGRAPHY AND DRAINAGE

The study area is located on the northerly edge of the Santa Ana Mountains on a relatively broad topographic prominence composed of narrow canyons and intervening ridgelines known collectively as the Peralta Hills. To the east, these hills merge with the higher and more extensive Santa Ana Mountains. To the west, the hills gradually narrow and decrease in elevation, forming the ridgeline known as Burruel Point which ends just east of the Santa Ana River near the community of Olive.

The area of ground movements occupies the northwesterly flank of one of the highest and most prominent northeast-trending ridgelines within the Peralta Hills. Prior to residential development, north-facing natural slopes were inclined at gradients of 6:1 to 2:1 (horizontal:vertical). The south-facing ridgeline flank remains relatively undeveloped and is characterized by steeper slopes inclined at gradients ranging from about 4:1 to 1:1. Local topographic relief is on the order of 200 feet, with the highest elevation about 1,100 feet above sea level.

The crest of the ridgeline is also a major drainage divide separating northerly and southerly surface flow. Prior to development, drainage to the north flowed from the ridgeline via unnamed intervening canyons into Walnut Canyon and, ultimately, into the nearby Santa Ana River. Drainage to the south was directed downslope into southwest-trending canyons, the most prominent being Weir Canyon. These in turn empty into Santiago Creek, which flows into the Santa Ana River at a location south of the city of Orange.

Land development grading has created relatively level terraced lots, associated streets, and intervening cut and fill slopes. Slopes were graded at a 2:1 (horizontal:vertical) ratio. A band of essentially natural hillside topography crosses the central portion of the study area between Avenida de Santiago and Georgetown Circle.

3.4 VEGETATION AND LANDSCAPING

Native vegetation consists of grasses and low chaparral-type brush, with scattered oak trees along many of the canyon bottoms. Non-irrigated vegetation accounts for approximately 50% of the watershed area.

Graded open-space areas are extensively planted with tall fescue-type grasses and ornamental shrubs and trees. Residential lots support a wide variety of ornamental vegetation. Irrigated vegetation accounts for approximately 26% of the watershed area.

3.5 PRECIPITATION

Daily precipitation records were obtained from five nearby reporting stations. Daily precipitation records from the Lewis Substation, in downtown Anaheim, provide data from July 1879 through June 1995. Daily precipitation records from the other four reporting stations encompass the period from September 1989 through June 1995 (see Appendix E through G in Volume VI). The locations of the precipitation stations and their relationship to the study area are shown on the Location Map-Precipitation Stations, Figure D.1, Volume VI.

Yearly precipitation totals from the 1895-1896 rainfall year through the 1994-1995 rainfall year for the study area have been calculated from a regression analysis comparing the rainfall levels at Yorba Reservoir and Villa Park Dam with the Lewis Substation. The final computed relationships are as follow:

Study Area 24-Hour Rainfall (in.) = 1.075 x Lewis 24-Hour Rainfall (in.) + 0.07

and

Study Area Yearly Rainfall (in.) = 1.064 x Lewis Yearly Rainfall (in.) + 0.62

Annual rainfall for the study area for the last 100 years is presented in Table B.1, Volume VI. A graph of yearly rainfall records from 1955 through 1995 for the study area is presented on Figure C.1, Volume VI. Superimposed on this figure are highlights of major developments for the area.

The 1994-95 rainfall year is estimated to have produced 28.38 inches of rainfall in the landslide area. This amount places the 1994-1995 rainfall year as the fifth wettest year in the last 100 years (see Table B.1, Volume VI), surpassed only by the rainfall in 1982-1983 (28.5 inches), 1992-1993 (29.12 inches), 1977-1978 (32.57 inches), and 1940-1941 (36.30 inches).

During the nine years prior to landsliding (1983 to 1992), the average yearly rainfall for the study area was only 11.85 inches. This is 2.87 inches per year less than the 100-year average. During this drought period, only 2 years had rainfall above the 100-year average, 1985-1986 at 16.02 inches and 1991-1992 at 18.92 inches.

Rainfall during the 1994-1995 season included several sustained, high intensity storms which appear to have affected most of the P and PZ monitoring wells. The only wells for which continuous data are available are the wells which were instrumented during the period in which rainfall was received. These wells can be divided into two categories: wells which registered response to individual rainfall events and wells which showed a gradual rise in water levels. Rainfall effects observable in the non-instrumented wells are limited to whether or not a net rise in the water level occurred during the rainfall period. In addition, four wells were dry during the 1994-1995 rainfall period and one well, P-14, was obstructed by roots.

4.0 GEOLOGY

4.1 DEPOSITIONAL HISTORY

The study area is located at the northwestern margin of the Santa Ana Mountains, part of a series of elongate, northwesterly trending mountains and intervening valleys that comprise the Peninsular Ranges Geomorphic Province. This province extends southward from its boundary with the Transverse Ranges Geomorphic Province, located roughly 18 miles north of the Santa Ana River, to the tip of Baja California, some 900 miles to the south. Typically, the mountains of the Peninsular ranges are composed of asymmetrically tilted crustal blocks, bounded by northwesterly trending fault zones. The Santa Ana River, which separates the Santa Ana Mountains from the relatively low Puente Hills to the north, is antecedent, establishing and maintaining its relative position during uplift.

The northerly portion of the Santa Ana Mountains forms the southerly margin of the Los Angeles Basin, a deep structural depression receiving nearly continuous sedimentation since the late Cretaceous period. During the middle Miocene, much of the Los Angeles Basin, including what is today the northern edge of the Santa Ana Mountains, was submerged beneath the sea. This submergence resulted in the deposition of relatively thick and widespread deposits of marine sedimentary rocks that are locally covered by marine volcanic rocks. The marine sediments consist predominantly of sandstone, conglomeratic sandstone, and minor siltstone that have been assigned to the Topanga Formation. The overlying El Modeno Volcanics are composed of basalt and andesite flows and flow breccias. Near the end of the middle Miocene, the northerly margin of the Santa Ana Mountains emerged from the sea and was subjected to erosion. Locally, the erosion cycle may have been rather extensive, removing most of the volcanic rock, if present, and some of the underlying Topanga Formation.

Subsequent submergence marked the beginning of an extensive period of accelerated crustal subsidence and deposition that began in the late Miocene and continued uninterrupted to the Pliocene epoch. As the area now occupied by the northerly Santa Ana Mountains was submerged, the isolated remnants of the El Modeno Volcanics and the bedded strata of the Topanga Formation were buried by upper Miocene siltstone and shale of the La Vida Member of the Puente Formation. These sediments were subsequently covered by the remaining members of the Puente Formation: the Soquel, Yorba, and Sycamore Canyon Members.

As the central portion of the Los Angeles Basin continued to subside during the Pliocene, its margins, including the northerly portion of the Santa Ana Mountains, began to rise and emerge from the sea. Continued uplift and subsequent erosion through the Pliocene and Pleistocene epochs has stripped the upper members of the Puente Formation sediments from the northern portion of the Santa Ana Mountains. In the study area, continued erosion has formed a topographic surface that exposes the lower portion of the Soquel Member and the underlying La Vida Member.

The uplifted and exposed strata have been continuously subjected to the processes of weathering and erosion. Steeper slopes are typically supported by relatively resistant rock. Where the topography is more gently inclined, these weathering processes have produced relatively thick mantles of surficial deposits.

4.2 STRATIGRAPHY

The Soquel (Tps) and La Vida (Tplv) Members underlie the study area. Other rocks beneath the Puente Formation are the middle Miocene El Modeno Volcanics (Temb) and the Topanga Formation (Tt). Only the Soquel and La Vida Members of the Puente Formation and the Topanga Formation were mapped on the surface and/or encountered in excavations during this investigation. A number of surficial soil units derived from the local bedrock materials have also been delineated within the study area. The bedrock and soil stratigraphic units are discussed in greater detail below.

The upper Miocene Puente Formation outcrops in and underlies much of the Anaheim Hills area and is divided into four members (Schoellhamer and others, 1954). The members in stratigraphic order from youngest to oldest are: Sycamore Canyon Member; Yorba Member; Soquel Member; and La Vida Member. The regional geologic conditions in the vicinity of the Santiago Landslide, as depicted in the California Division of Mines and Geology, Bulletin 204, are shown in Figures B.1 and B.2, included in Volume I. Superimposed on the regional map are the location of the Santiago Landslide, major access roads, and an index for the 40-scale topographic maps provided by R.J. Lung & Associates.

4.2.1 Topanga Formation (Tt)

Sedimentary strata of the Topanga Formation are exposed in a continuous band along the southerly slope that descends from the ridgeline occupied by Robbers Peak to the west and Avenida de Santiago to the east. Several outcrops are also present along Hidden Canyon Road, south of the Avenida de Santiago intersection. The Topanga Formation was encountered in recent borings only at observation wells P-26 and P-27 in the easterly portion of the study area. Geologic mapping of tunnel and trench exposures for the nearby M.W.D. Santiago Lateral also identified Topanga Formation along much of the alignment in the vicinity of Hidden Canyon Road (Metropolitan Water District, 1956).

The observed exposures typically consist of moderately to thickly bedded, fine to coarse grained sandstone, silty sandstone, and conglomeratic sandstone that vary from tan to dark brown in color.

The Topanga Formation is likely present only at great depth below the distress area. However, stratigraphic and structural relationships with the overlying Puente Formation are considered integral to an understanding of the local geologic conditions. Geologic mapping of the Topanga Formation was typically limited to exposures in the immediate vicinity of the unconformity with the overlying Puente Formation/El Modeno Volcanics.

4.2.2 El Modeno Volcanics (Temb)

Exposures of the El Modeno Volcanics are limited to a few deeply weathered outcrops in the southerly portion of the study area. Most of these volcanic deposits appear to have been eroded away, and the stratigraphic position marks the unconformity between Topanga Formation and overlying Puente Formation sediments. No subsurface exposures of the El Modeno Volcanics are reported in the numerous geotechnical excavations made within the study area.

On the basis of regional exposures, the El Modeno Volcanics are described as extrusive flow and pyroclastic rocks deposited on eroded Topanga Formation sediments. This sequence of rocks includes a basal basalt flow, overlain successively by an intermediate palagonite tuff and tuff breccia, followed by an upper andesite flow or flow breccia (Yerkes, 1957). Most of these rocks were removed by erosion at the close of the middle Miocene prior to deposition of the overlying La Vida Member of the Puente Formation. Deeply weathered, isolated remnants of the basal basalt flow are all that appear to remain. At the surface, their vulnerability to weathering results in subdued and eroded topography with a relatively thick, dark gray to reddish brown clayey soil. Outcrops are gray to dark green and slightly vesicular.

4.2.3 Puente Formation, La Vida Member (Tplv)

In general, the mapped extent of the La Vida Member forms a broad arc around the westerly to southeasterly perimeter of the study area. The La Vida Member consists of an upper siltstone and shale unit; a middle sandstone unit; and a lower siltstone and shale unit. The thick middle sandstone unit is atypical for the La Vida Member, which normally consists predominantly of siltstones and shales. Based on geologic mapping of outcrops south of Avenida de Santiago, the stratigraphic thickness of the La Vida Member is estimated to be about 400 feet in the study area.

The lower siltstone and shale unit of the La Vida Member ($Tplv_{slt}$) was exposed in the graded areas on the ridgeline between the end of Avenida de Santiago and Robbers Peak, and underlies adjoining natural slopes. A nearly continuous band of this unit is present along the southerly and easterly facing slopes below the cul-de-sac streets of Point Premier and Tamarisk Drive (see Geologic Map, Plate B.1, Volume III). Natural exposures are limited to erosion scars and steep terrain, due to a thick mantle of residual soil. Although this unit was exposed in some geotechnical excavations in conjunction with development of Tract 10998 near Tuckaway Circle (Converse, 1980), subsurface exposures during recent drilling were limited to observation wells P-26 and P-27. On the basis of drilling logs for P-26, the estimated stratigraphic thickness of the lower siltstone unit is about 80 feet to 90 feet.

In appearance, the lower unit is similar to the upper siltstone and shale, consisting predominantly of brown to gray clayey siltstone and shale with thin interbeds of fine grained sandstone. A one-foot-thick white to tan bentonitic bed was exposed on the unimproved road extending west from the end of Avenida de Santiago. This bed dips northeasterly and was previously mapped by Yerkes (1957) as an andesitic tuff. The occurrence of thin bentonite beds and sheared clay seams is common in the La Vida Member. Typically, these beds are only seen in fresh exposures and are not easily recognized in natural outcrops, due to their soft erodible nature.

In outcrops, the lower ±20 feet consist of a limey white siltstone that is locally very fractured and free draining. The free-draining nature of the lower portion of this unit allows growth of oak trees and cacti, similar to growth exhibited on most sandstone units, whereas the typical growth on siltstone units consists of grasses and wild mustard.

The base of the lower siltstone and shale unit rests unconformably upon an erosional surface that truncates both the El Modeno Volcanics and the Topanga Formation. Locally, low points in the erosional surface have collected metamorphic and volcanic clasts up to 2 inches in diameter. Where thick residual soil covered this contact, the presence of these clasts in the residual soil was used to define the base of the La Vida Member.

The middle sandstone unit ($Tplv_{ss}$) was mapped in the steep natural slopes that descend to the southwest and southeast from Point Premier (Tract 13760). As observed in outcrops, the sandstone unit has an estimated stratigraphic thickness of about 80 feet to 100 feet. The middle sandstone unit may have been encountered in some shallow backhoe trenches near Point Premier (Geo-Ekta, 1989). However, the most definitive subsurface occurrence of this unit is at observation well P-26, where the base of the middle sandstone, the lower siltstone, and the underlying Topanga Formation were apparently encountered. Projections of the middle sandstone unit are at great depth below the distress area.

The basal portion of the sandstone unit tends to be fine grained, and the upper portion consists primarily of fine to coarse-grained sandstone with local conglomerates. The upper contact with overlying siltstone and shale is gradational, consisting of interbedded sandstone and siltstone. The lower contact is also gradational, but appears to be generally more distinct. The gradational character of these contacts and possible local facies changes has resulted in some uncertainty regarding the thickness, depth, and extent of this unit, particularly in the vicinity of the distress area where it is believed to be about 250 feet to 350 feet below the ground surface.

A thick sequence of sandstone southeast and east of the distress area, in the vicinity of Via El Estribo and Tamarisk Drive, has been mapped by others as the Soquel Member of the Puente Formation. This sequence of sandstone appears to rest conformably on the La Vida Member, which at this location consists predominantly of siltstone, roughly 100 feet thick, and does not appear to contain the middle sandstone unit. This interpretation was initially presented by Schoellhamer, et al. (1954). Subsequent investigations have continued this interpretation. This is in sharp contrast to the thickness of the La Vida Member as shown by Schoellhamer in the southwesterly extremity of the study area. At this location, the La Vida Member, including the middle sandstone, is on the order of about 600 feet to 700 feet thick (Structural Section G-J, Schoellhamer, et al., 1981).

These differences in stratigraphic thickness were reassessed on the basis of the local drilling exposures, aerial photo review, and geologic mapping. The sandstone and siltstone exposures near Via El Estribo and Tamarisk Drive are now interpreted to represent the middle sandstone unit and the underlying lower siltstone unit of the La Vida Member (see Geologic Map, Plate B.1, and Geologic Cross-Section 8-8′, Plate C.2, in Volume III). This interpretation differs from published geologic literature.

The upper siltstone and shale unit underlies the westerly and southwesterly perimeter of the distress area and is well exposed in the cut slope above Rimwood Drive. This upper unit was also encountered in most of the geotechnical excavations in the westerly portion of the study area, but was present only in deeper borings to the north and east.

The upper La Vida Member consists predominantly of siltstone and shale with minor thin interbeds of sandstone. Weathered exposures are typically friable, consisting of oxidized light brown to gray siltstones streaked by caliche along fractures and bedding planes. Relatively unoxidized exposures in the deeper exploratory borings consist of dark gray to black siltstones and shales that are laminated to thinly bedded. Interbedded sandstones are typically micaceous, very fine to fine grained, and vary from gray to blue-gray in color. These interbeds are predominantly 1/16-inch to ½-inch in thickness, but are locally up to five feet thick. Sheared clay seams, typically

½-inch to 2½ inches thick, and up to 6 inches thick, were observed in borings.

4.2.4 Puente Formation, Soquel Member (Tps)

The Soquel Member of the Puente Formation is exposed at the ground surface and underlies much of the study area. The Soquel Member is distinguished by its light gray to yellow-brown, very fine to very coarse grained, poorly sorted feldspathic sandstone. Interbeds of silty fine grained micaceous sand and pebble conglomerates are common, along with brown to dark gray laminated siltstones. The sandstone is moderately indurated and locally friable. Siltstone interbeds were characteristically hard, brittle, and locally siliceous. Based upon interpretation of subsurface data, it appears that the shale interbeds could extend laterally up to 100 feet. Weathered outcrops of the Soquel Member typically are yellow-brown, whereas fresh exposures and unoxidized rock appear light gray. Bedding is massive to poorly developed and best defined by siltstone and pebble interbeds. The Soquel Member also contains local thin bentonite beds and sheared clay seams, as observed in a few borings.

The best exposure of the Soquel - La Vida contact was seen in the cut slope ascending from the Rimwood Drive cul-de-sac as an abrupt sandstone-siltstone interface. However, the majority of the subsurface contact exposures were gradational, consisting of a zone of interbedded sandstone and siltstone over stratigraphic distances of five feet to more than fifty feet. In this transition zone, the contact was defined as the top of the predominantly siltstone section. On natural slopes, mapping of the contact relied on vegetation change, soil color change, and the presence or absence of clayey soil. Structure contours of the contact were developed on the basis of available boring logs to allow three-dimensional resolution of the local geologic structure (see Plate D.1, Volume III). The contact surface is generally consistent with the northerly inclination of the strata. However, local flattening, steepening, and apparent offsets are indicated by the data in some areas.

4.2.5 Surficial Units (Qls, Qal, af)

A relatively thick mantle of surficial soil materials covers most of the bedrock in the study area, particularly where the topography is relatively gentle. The surficial units include artificial fill, residual soil, colluvium, alluvium, and shallow landslides. Although each of these units has been observed and/or is reported in the study area, only prominent thicknesses of landslides (Qls), alluvium (Qal), and artificial fill (af) have been included on the Geologic Map (Plate B.1, Volume III).

4.2.5.1 Landslides (Qls): Numerous landslides have been mapped in the Peralta Hills by previous investigators: U.S.G.S., O.M. 154, 1954; and C.D.M.G. in Preliminary Report 15, 1973, and Bulletin 204, 1981. Bulletin 204 distinguishes between bedrock landslides, probable bedrock landslides, and possible bedrock landslides. Two possible bedrock landslides were plotted by the C.D.M.G. in the study area, as shown on the Regional Geology Map, Figure B.2, Volume I, and on the Composite Geologic Map, Plates A.1 through A.8, Volume III. In addition, many smaller landslides were mapped by consultants prior to mass grading in the Anaheim Hills area.

4.2.5.2 Surficial Failures: Shallow slump debris of the residual soil, colluvium, and weathered rock is commonly found on the natural slopes in the Anaheim Hills area. Such deposits form lobate-shaped soil slump masses and channeled debris flows which can vary from a few feet to as much as 10 feet or more in thickness. These failures generally occur where surficial materials become saturated during locally intense or prolonged rainfall.

4.2.5.3 Alluvium (Qal): Minor volumes of recent alluvium occupy the bottoms of the active drainage courses and canyons. These materials are generally composed of sand/silt mixtures with local rock fragments and gravels.

4.2.5.4 Colluvium: Colluvial deposits are produced by the accumulation of soil and weathered rock debris that migrates down slope by the processes of creep, erosion, and soil flow. Such deposits also thicken in the down-slope direction. Colluvial deposits, including what has been previously mapped as slope wash, are recognized in the study area. In addition, a colluvial deposit was encountered along the ridgeline occupied by Avenida de Santiago, coincident with the area interpreted as the head scarp of the Santiago Landslide. Colluvial soils are composed of varying mixtures of silty clay and clayey silt, with some fine grained sand. Colluvial soils are commonly streaked with caliche or gypsum salts, and contain numerous rodent burrows and platy fragments of weathered siltstone.

4.2.5.5 Residual Soil: A moderately well-developed mantle of residual soil typically covers most of the natural topography, particularly in low-relief areas. Residual soils derived from weathering of underlying siltstone typically consist of dark gray to black silty clay and clayey silt, and usually contain platy fragments of the parent rock. Typically, these soils support a relatively thick growth of grass and wild mustard. In contrast, sandstone yields light brown to rusty brown sand with minor silt and clay. Sandy soils are typically vegetated by chaparral, brush, cacti, and, locally, oak trees.

4.2.5.6 Artificial Fill (af): The most significant fills are the extensive and relatively deep canyon fills located primarily north of Serrano Avenue within portions of Tracts 7918, 8376, 8377, 9080, and 9133. Additional side-hill fills were constructed in conjunction with the grading of Avenida de Santiago and associated residential tracts. Earth-fill materials were derived from nearby excavations of weathered bedrock and surficial soil materials. Where compacted fill materials were encountered in the subsurface excavations, they consist of dark gray to brown silty clay/clayey silt, or tan to brown, fine to coarse-grained sand and silty sand, locally containing angular fragments of siltstone and sandstone.

4.3 GEOLOGIC STRUCTURE

The regional geologic structure of the Peralta Hills in the northern Santa Ana Mountains is characterized by a north-dipping homocline with local folds and faults. Of these two secondary structural components, faulting appears to dominate.

4.3.1 Faults

Regional faulting follows two major orientations, north-northeast and northwest, as shown on the Regional Geology Map, Plate B.2, Volume I. Recognized faults in the study area generally trend north-northeast. The direction and magnitude of the displacements along these faults are uncertain. Nearby regional faults of this orientation typically exhibit apparent offsets with the northwesterly side down. The offsets shown on the geologic cross-sections, included as Plates C.1 and C.2 in Volume III, represent apparent displacements. Some local faults were also recognized by previous investigators, as shown on the Composite Geologic Map, Plates A.1 through A.8, Volume III. Faults were mapped by Dames & Moore for the Walnut Canyon Reservoir, during the construction of the M.W.D. Santiago Lateral Tunnel, and by subsequent land development studies.

Several additional faults were recognized in the study area during this investigation. Three of these appear to be significant in understanding the recent ground movement. Each of these faults has been named to facilitate discussion.

The most easterly of these faults is the inferred Avenida de Santiago Fault (A.D.S.), which approximately parallels the headward limits of ground deformation in the central portion of the distress area (see Geologic Map, Plate B.1, Volume III). This fault appears to be the extension of a major fault mapped northeast of the landslide by Schoellhamer, et al. (1981). Southwesterly extension of this fault into the study area is suggested by a prominent aerial photo lineament. Crushed bedrock and/or faults were mapped along portions of this lineament during construction of the M.W.D. Santiago Tunnel and in grading excavations east of Hidden Canyon Road and northerly of Tamarisk Drive. The best evidence of the A.D.S. Fault in the vicinity of the Santiago Landslide is the presence of a ground water barrier defined by an abrupt increase in water level elevations from west to east between wells DW-28 and P-22. Higher ground water elevations and apparently steep northwesterly flow gradients from the Via El Estribo area are evidence of the continuity of this ground water barrier to the northeast. An area of persistent ground water seepage is also present in the area where the suspected fault trace crosses Hidden Canyon Road. Although no definitive exposures of the fault were encountered during the recent study, steeply dipping joints, fractures, and faults in the vicinity exhibit a preferred orientation approximately parallel to the suspected fault trace.

The fault crossing the Rimwood Drive cul-de-sac has been designated the Rimwood Fault and marks the westerly extent of landslide deformation. An approximately ±200-foot length of this fault was recognized and mapped during grading of the area by Converse, Davis and Associates in 1972. Recent landslide movement has defined this fault at the surface for a distance of about 500 feet. The fault was observed in an exploratory boring, B-2, on Rimwood Drive and in a nearby sewer excavation trench, T-6. It is thought to have been penetrated in other borings on Georgetown Circle, Serrano Avenue, and Vassar Circle. Where observed, the Rimwood Fault consists of a gouge zone approximately 6 inches to 1 foot thick with an adjacent zone of sheared rock up to 2 feet thick. The fault strikes approximately north-south with a dip of 45 degrees to 55 degrees to the east.

The third fault consists of a number of subparallel fractures and inferred fault features that are collectively called the Georgetown Fault Zone. The fault system is interpreted from surface deformation, differences in subsurface lithologies, and subtle ground water barriers. Ground deformations include cracks, bulging, and the apparent offset of geologic contacts.

Although somewhat removed from the distress area, a fourth northeasterly trending fault in the southeasterly portion of the study area likely has some influence on the local hydrogeologic conditions. As encountered near the south portal of the nearby M.W.D. tunnel, this fault consists of an 8-foot thickness of bluish gray clay gouge (M.W.D., 1956). The possible southwesterly extension of this fault was mapped at the southern extremity of the study area near Point Premier, where it appears to offset the La Vida Member/Topanga Formation contact. The thickness of the gouge zone in the tunnel exposures suggests a major offset, but Topanga Formation was identified on both sides of the fault. This and a nearby smaller fault were observed to act as ground water barriers in the tunnel excavation. A northwesterly striking fault near the north portal similarly impeded subsurface flow, impounding ground water in the intervening fault block (in the vicinity of Via El Estribo). Several springs have historically been observed in this area.

4.3.2 Folds

Homoclinal northerly dips ranging from about 15 degrees to 30 degrees are shown by outcrop pattern and bedding attitudes throughout most of the study area. A prominent departure from this structure is present in the vicinity of Via El Estribo, where westerly to northwesterly dipping strata predominate. This broad band of a more westerly dip orientation appears to continue southward along the A.D.S. Fault into the area of Tamarisk Drive. Two broad, north-plunging folds also appear to be superimposed on the homoclinal structure in the southerly and easterly portions of the study area. As-built geology for residential lots along Point Premier indicates that a shallowly plunging syncline is present beneath the tract, with a fold axis that approximately follows the street alignment (Geo-Ekta, 1990). A similar shallowly plunging anticline appears to be present paralleling Hidden Canyon Road near its intersection with Avenida De Santiago.

Other notable departures from the homoclinal structure appear to be present in the vicinity of PZ-3, where south and west-dipping strata were observed, and in the vicinity of the Rimwood Drive cul-de-sac, where local east-dipping bedding was mapped. Local small-scale folding and faulting are likely to be present throughout the study area, particularly within the La Vida Member siltstone units.

4.3.3 Santiago Landslide

The Santiago Landslide is the term applied to an area of locally discontinuous ground deformation encompassing roughly 25 acres. The recognized patterns of deformation and their projections define a somewhat rectangular shape, suggesting that boundaries are controlled by linear geologic structures. Mapped ground deformation features are presented on the Ground Deformation Map, Plate H.1, Volume Va.

4.3.3.1 Surface Expression: The headward limit of movement is defined by a series of tension cracks along the crest of the ridgeline occupied by Avenida de Santiago. The initial pattern of fractures extended from behind the rear yard of 6851 Avenida de Santiago, northeast across the private cul-de-sac, and along Avenida de Santiago to the rear slope of the residence at 6943 Avenida de Santiago. The largest ground displacements appear to have been centered near the private cul-de-sac and decrease to the southwest and northeast, becoming indistinguishable at the rear of 6851 and 6943 Avenida de Santiago. A subsequent set of cracks developed along a more south-southwesterly orientation, diverging from the first set at the front of 6943 Avenida de Santiago. These cracks continue to the southeast corner of 6912 Avenida de Santiago.

The lateral (easterly and westerly) flanks of the landslide are not defined by surface distress. Moderately incised, natural draws near each end of the tension crack system provide the most likely location for lateral boundaries to descend the hillside. The magnitude of movement at the easterly and westerly margins of the distress area was not sufficient to develop boundary features.

Toe deformation is relatively well defined in the area of the Rimwood Drive cul-de-sac, and the largest ground displacements extend, respectively, about 200 feet and 300 feet northerly and southerly from the centerline of the roadway. Minor compressional features and the associated distress were observed about 100 feet beyond each end of the toe deformation, but an actual boundary could not be discerned.

From the "knuckle" at Georgetown Circle to the Williams Circle cul-de-sac, at the probable eastern limits of deformation, distress is manifested as several discontinuous zones of bulged asphalt concrete pavement and damaged concrete pavement. The mode of deformation is clearly compressional in most areas, but a well-defined rupture surface does not appear to have developed.

4.3.3.2 Subsurface Extent: The Santiago Landslide headscarp and toe are roughly parallel and linear features that appear to be fault controlled. Although the headscarp fractures do not directly coincide with the A.D.S. Fault, they do appear to be related to a system of steeply dipping fractures and joints north of and parallel to the fault. A continuous slip surface from head to toe is limited in extent to only the west-central portion of the 25-acre land mass. The recognized toe of the landslide, about 500 feet in length, is coincident with the Rimwood Fault which dips to the southeast beneath the slide mass at an angle of 45 degrees to 55 degrees.

The slip surface or base of the landslide follows several sheared clay seams within the upper siltstone and shale unit of the La Vida Member. The stratigraphic location of this surface is complicated by apparent offsets along the Georgetown Fault Zone and its associated faults. East of this fracture system, the failure surface is typically 20 feet to 40 feet below the contact between the La Vida and Soquel Members. To the west, the slip surface appears to follow a deeper stratigraphic horizon within the La Vida Member.

In the area of the Avenida de Santiago private cul-de-sac, the failure surface is about 90 feet deep (SI-4). Beneath the slope descending to Georgetown Circle, at SI-9, the slide is approximately 160 feet deep. Near the westerly end of Georgetown Circle, the slide surface is postulated to be at a depth of about 120 feet to 140 feet. The stratigraphic sequence associated with the slip surface deepens in the easterly portion of the slide. The projected sole of the landslide in the area of the Rimwood Drive is on the order of 75 feet to 100 feet deep. Slip surface interpretations are shown on the Geologic Cross-Sections, Plates C.1 and C.2, Volume III.

4.3.3.3 <u>Ground Movements</u>: Distress directly attributable to the Santiago Landslide movement was documented by AAKO Geotechnical in a Field Memorandum dated June 19, 1992. The reported features included leaking pools and uneven flatwork at 6851, 6861, and 6871 Avenida de Santiago. The memorandum indicated that 6880, 6891, 6899, and 6901 Avenida de Santiago may also have been experiencing similar problems.

Pavement cracks and residential distress were reportedly observed by the homeowner at 1090 Rimwood Drive early in 1992. By June of 1992, cracks in block walls, interior walls, and driveways had been observed by the homeowners at 1090, 1093, 1094, and 1098 Rimwood Drive. The bulge of the Rimwood Drive cul-de-sac pavement had developed to the extent that it was obvious to the residents by mid-June 1992 (letter dated July 24, 1992, by Professional Management Associates).

Mobilization of the landslide mass, in the months prior to January 1993, appears to have occurred at a relatively slow and, apparently, continuous rate. Distress was relatively minor in magnitude and was confined mainly to the area of the Avenida de Santiago private cul-de-sac and the Rimwood Drive cul-de-sac. Accelerated movement in January 1993 expanded deformation to the northeast. In the headscarp area, ground cracks propagated to the northeast, then to the southwest, as the areas of deformation increased in size.

Movement and the resulting distress in the headscarp area, from mid-January to early February 1993, were originally confined to the series of tension cracks that extended from 6943 to 6851 Avenida de Santiago. The magnitude of movement of this series of cracks across the private cul-de-sac was estimated at 3 inches to 4 inches vertically and 2 inches horizontally by January 18, 1993. Rough field surveys indicated that an additional ½-inch of horizontal movement had occurred by the end of January 19, 1993 (see Section 2.2.2.1 and Plate A.1, Volume Va). On-going survey monitoring revealed additional horizontal movement of 2.2 inches to 3.0 inches by January 30, 1993, with a direction of N40-60W. The rate of movement estimated from the survey data prior to the start of dewatering was 0.7-inch to 0.8-inch per day. From the start of dewatering to January 23, 1993, the rate of movement averaged 0.4-inch to 0.7-inch per day, but rapidly decelerated to 0.08-inch to 0.12-inch per day by January 28, 1993 (see Figures C.1 through C.4 and D.1 through D.4, Volume Va.)

A second series of cracks on Avenida de Santiago appeared about January 21, 1993, southeast of the original set. First evidence of this second series of cracks consisted of small tension cracks across the driveway and adjacent yard areas of 6920 Avenida de Santiago. By the end of January, this set of cracks had propagated both north, across Avenida de Santiago to merge with the original cracks, and southerly along the rear of the structure at 6912 Avenida de Santiago, extending to the toe of the fill slope north of 6906 Avenida de Santiago. The separations on these cracks ranged from hairline to 3/4-inch in a direction of about N35W.

Movement at the landslide toe was monitored in the Rimwood Drive cul-de-sac area. Distress resulting from the movement was primarily evidenced by compressional bulging and buckling of the asphalt pavement and adjoining concrete. Major damage occurred to the pool of 1095 Burlwood Drive and the residential structure of 1093 Rimwood Drive. The measured horizontal movement during the 24 hours beginning at about 11:00 PM, January 18, 1993, was about 11/16-inch (see Section 2.2.2.1 and Plate A.1, Volume Va). Survey data for the Rimwood Drive cul-de-sac from January 19, 1993, to January 29, 1993, indicate horizontal displacements of 3.3 inches to 3.7 inches, oriented N20-30W. Based upon the deflection of the curb and gutter in the Rimwood Drive cul-de-sac, the total movement as of about January 28, 1993, was estimated at 12 inches to 14 inches. The rate of movement estimated from the survey data prior to dewatering was 0.95-inch to 1.0 inch per day. From the start of dewatering to January 23, 1993, the rate of movement was estimated at 0.59-inch to 0.67-inch per day, decelerating to an estimated 0.08-inch to 0.14-inch per day between January 23, 1993, and January 28, 1993.

Initial bulging of the asphalt pavement of Georgetown Circle developed prior to January 18, 1993. The magnitude of this deformation was not determinable. However, from January 18 to 19, 1993, field measurements across the bulges indicated that up to ½-inch of compressional shortening had occurred (see Section 2.2.2.1 and Plate A.1, Volume Va). Survey monitoring across the street from curb-to-curb performed January 19 through 27, 1993, indicated additional horizontal shortening of about 1 inch, and was thought to be confined to the north side of the street (see Field Survey Data, Appendix B, Volume Va). Some of the properties on the north side of Georgetown Circle suffered distress as the compressional strain effecting the roadway was transmitted to the residences by the rigid concrete driveways.

5.0 HYDROGEOLOGY

Local ground water is controlled by a complex regimen of differing stratigraphic, structural, and hydrogeologic characteristics of the bedrock, as well as differing water sources. Considerable investigation was directed toward determining the distribution of ground water as a key factor in modeling the stability of the area. Abatement efforts rely on dewatering as the primary factor for improving stability. Four ground water conditions are considered important to this investigation and are identified by the following dates.

- January 20, 1993: accelerated landslide movement promoted by the rainfall early in the 1992-1993 rain year. Ground water elevations were sufficient to cause rapid translation of portions of the study area, and the local factor of safety was clearly below unity.

- February 15, 1993: the ground water elevations shortly after ground movement ceased, as determined by land survey and other surface indicators. The landslide stability is improved by the early water withdrawals to establish a minimum factor of safety slightly above unity.

- October 5, 1994: a low stand of ground water in the area monitored, ascribed to nearly two years of dewatering combined with about average rainfall for 1993-1994.

- August 9, 1995: effects of diminished capacity in the dewatering system due to maintenance issues, when combined with the fifth highest rainfall total in the past 100 years.

Ground water elevation data were predominantly obtained from hydrographs for the various observation wells. Supplemental information was collected from production wells, horizontal wells, exploration borings, and springs. Ground water data were compiled for the above dates and reduced to phreatic contours (ground water maps). Resultant ground water maps were essential to defining site stability conditions and understanding the current ground water system. The "natural" ground water migration and gross storage have been substantially modified by the ongoing dewatering effort. Resultant water distributions are useful to help define water barriers, local gradients, and the influence of rock properties on the ground water system. Recent monitoring data also provide a basis for predicting system response to rainfall. Data for all the observation and piezometer wells are depicted on hydrographs which plot water elevation as a function of time (date). Also shown are rainfall amounts for the same time line. As discussed below, very limited information is available for the study area prior to 1993.

5.1 HISTORY OF GROUND WATER OBSERVATIONS

5.1.1 1948 to 1972

Available information suggests that ground water elevations in the area were relatively high prior to development. Evidence for this condition is found in early geotechnical investigations and initial rough grading reports (see Historical Water Seepage Map, Plate D.1, Volume VIIb).

Field work accomplished by the U.S.G.S. from 1948 to 1953, and published as OM154 in 1954, documents seeps along the present alignment of Hidden Canyon Road. In addition, a report by the M.W.D. notes that ground water was encountered during the construction of the Santiago Tunnel in 1955-1956, adjacent the alignment of Hidden Canyon Road. Faults crossing the tunnel alignment near the north and south portals were observed to be barriers to flow from the fault block comprising the central section of the tunnel. A 1964 study, "Geologic Reconnaissance, Nohl Ranch, 600 Acre Parcel", by Converse Foundation Engineers, identifies two "moist areas" in the vicinity of the Hidden Canyon Road, and a spring roughly 500 feet south of the intersection of Hidden Canyon Road and Overlook Drive. Converse considered this ground water to be associated with faults and "therefore may represent local perched water in concentrated fracture zones rather than the general water table." During the construction of the Walnut Canyon Reservoir (1965-1967), seepage was encountered in the excavations for the dam.

The 1971 geotechnical investigation by Converse, Davis and Associates (formerly Converse Foundation Engineers) noted seasonal springs in several drainage courses. Springs were mapped in future Tract 8376 near the intersections of Swarthmore Drive and Purdue Circle, and Swarthmore Drive and Lehigh Drive, at elevations of roughly 785 feet and 770 feet, respectively. Both springs were considered controlled by the installation of a canyon subdrain (Converse 1972), and are now covered with approximately 75 feet and 90 feet of fill, respectively. Springs were also observed in the southwestern portion of what is now Tract 9135, south and west of the terminus of Smokewood Circle. All springs reported in 1971 and 1972 were estimated by Converse to flow at a rate of about one gallon per minute.

In addition to the springs described above, seepage was reported in two of the thirteen exploratory borings logged by Converse, Davis and Associates. Converse Boring BH-5, located south of the intersection of Georgetown Circle and Serrano Avenue, encountered minor seepage at an elevation of 905 feet, approximately 28 feet below the ground surface. Their Boring BH-6, located north of the study area in Walnut Canyon, had seepage at an elevation of 641 feet.

5.1.2 1972 to January 20, 1993

The final report on tract grading for the lands south of Serrano Avenue (Converse, Davis and Associates, October 1972) indicates that several seeps were encountered along the major drainage courses and in the southwestern portion of Tract 9135, west of the Smokewood Circle cul-de-sac. Springs and seepage in 1971 and 1972 reported by Converse Consultants, as discussed above, were considered local phenomena caused by "anomalies" in the bedrock structure. Their reports state that local ground water was controlled by the construction of subdrain systems.

During final grading and subsequent development of the study area from 1976 to 1979, springs were observed in Tract 9080, on the south side of Williams Circle along the toe of the existing cut slope, and on the south side of Serrano Avenue east of Williams Circle. In addition, springs continued to be active in the southwestern portion of Tract 9135. Reportedly, these water sources were controlled by subsurface collectors and drainage systems.

Ground water data were obtained during this firm's pre-emergency Phase I investigation in September 1992. At that time, seepage was encountered in Borings B-1 through B-3 on Rimwood Drive at depths varying from 9 feet (elevation 932) to 35.5 feet (elevation 907) below the ground surface. Seepage was also encountered in Boring B-4, on the Avenida de Santiago private cul-de-sac, 59 feet below the ground surface (elevation 995). Borings B-5 through B-8, excavated along Georgetown Circle in December 1992 and January 1993, encountered ground water ranging from 15 feet to 34 feet below the ground surface (elevations 893 to 870, respectively).

5.1.3 January 20, 1993, to February 15, 1993

As of January 20, 1993, following the rainfall of early January, ground water seepage or springs were observed at the following locations:

- Slope below Serrano Avenue at the Lehigh Drive and Vassar Circle cul-de-sacs;
- Swale above Williams Circle opposite 6991 Williams Circle;
- Swale above the Williams Circle cul-de-sac;
- Slope and gullies at the rear of 6840 to 6872 Georgetown Circle;
- Greenbelt area of Hidden Canyon Drive above Serrano Avenue;
- Canyon above 1093 and 1095 Burlwood Drive;

- Ascending slope on the south side of Smokewood Circle;

- Various locations at the toe of slope opposite 1008 to 1052 Burlwood Drive.

Dewatering wells excavated from January 20 through January 27, 1993, encountered high ground water, particularly in the area of Georgetown Circle. Prior to pumping, standing water was measured 10 feet below the ground surface in DW-1 on Georgetown Circle. Ground water was also observed during the drilling of the other dewatering wells along the Williams-Georgetown alignment (DW-2, DW-3, DW-5, and DW-21). Water varied from 1 foot below the ground surface in DW-21 (elevation 905.3) to 18 feet below the ground surface in DW-3 (elevation 894).

A contour map of the estimated ground water surface elevations on January 20, 1993, was prepared from observations of surface seeps and measurements of water levels immediately after the drilling of the early dewatering wells (see Plate D.2, Volume VIIb). These data were supplemented with information from exploratory borings B-1 through B-8, drilled prior to the accelerated movement of the landslide, and observation wells completed during February of 1993. The information from exploratory borings B-1 through B-8 was utilized to estimate the minimum ground water elevations. Water levels from observation wells were extrapolated from the hydrographs to January 20, 1993, and were used to verify the ground water levels obtained from the dewatering wells and surface seeps, as well as to supplement ground water information where data was lacking (see Hydrograph and Rainfall Plots, Figures B.1 to B.28, Volume VIIb).

The ground water contour map for January 20, 1993, depicts a generally northwesterly gradient, roughly paralleling the topography. Two ground water highs are prominent: 1) the hill encircled by Via El Estribo at the east end of Avenida de Santiago, and 2) the west end of Avenida de Santiago south of the private cul-de-sac. Ground water contours appear to show limited influence by local geologic structures.

By February 9, 1993, twenty-two (22) vertical and forty (40) horizontal dewatering wells had been completed, and the ground water elevation beneath the area of Georgetown Circle had dropped considerably. At the easterly end of Georgetown Circle, ground water levels had fallen from 13 feet beneath the ground surface, as observed in DW-5 on January 21, 1993, to roughly 29 feet beneath the ground surface, as observed in P-3 on February 9, 1993. At the westerly end of Georgetown Circle, after the completion of drilling for DW-1 on January 20, 1993, ground water levels were about 10 feet beneath the ground surface, and by February 9, 1993, the ground water surface, as observed in P-4, was nearly 38 feet below the ground surface, a decline of about 28 feet in 20 days.

5.1.4 February 15, 1993, to October 5, 1994

By February 15, 1993, 22 observation wells had been completed and their water levels recorded. These data became the basis for the February 15, 1993, ground water contour map, depicted on Plate D.3 in Volume VIIb. In areas where observation wells had not yet been completed, estimates of ground water elevations were made by extrapolation of the hydrograph plots to February 15, 1993. In general, ground water elevations depicted on the February 15, 1993, contour map are 5 feet to 30 feet lower when compared to January 20, 1993.

In May 1994, the original dewatering well pumps were replaced by the City of Anaheim's dewatering well contractor. In an effort to improve efficiency, some of the new pump motors had a slightly lower horse-power rating. In addition, the timers for the pumps were reset from the initial 30-minute cycle to intervals that varied from 45 minutes to 1½ hours.

These changes ultimately limited the dewatering system's ability to maintain the lowered ground water levels initially achieved. Reduced capacity to respond to rising ground water levels as a result of increased surface infiltration was not fully recognized until the summer of 1995. Recognition that the system was not functioning at full capacity was hampered by the slow rise in ground water levels and the lack of significant rainfall during the 1993-1994 rainfall year. An indication that the capacity of the dewatering system had been reduced can, in retrospect, be seen in the subtle upward trends in five of the observation well hydrographs, beginning around May of 1994 (P-8, P-11, P-12, P-13, and P-22). However, hydrographs for most of this time period typically show a downward trend, becoming more or less asymptotic to the October 5, 1994, ground water levels.

5.1.5 October 5, 1994, to August 9, 1995

By September of 1994, ground water levels reached a relatively constant low, suggesting a balance between the volume of inflow and the combined volume from dewatering and natural outflow. This low stand of ground water is depicted by the October 5, 1994, ground water contour map included as Plate D.4, Volume VIIb. The map shows that, northwest of the A.D.S. Fault in the thick section of Soquel sandstone, water elevations declined more than 100 feet when compared to January 20, 1993. Typical water elevation reduction ranged from 20 feet to 40 feet (see Plate D.6, Volume VIIb).

In January 1995, water levels rose in the observation wells following rainfall. Initially, the rising levels were attributed solely to the heavy rainfall during the 1994-1995 rainfall season. However, as water levels continued to rise, it became apparent that the dewatering system was not functioning at its full capacity. Investigation of the problem during July and August 1995 revealed several causes for the reduced capacity. These included:

- Changes in pump capacity and extended duration between pumping cycles which significantly reduced ground water discharge from DW-10, DW-19, DW-20, DW-32, and, possibly, DW-34.
- Mechanical problems with DW-28, DW-30, and, possibly, DW-34.
- Loss of electrical power to DW-9, DW-15, and DW-35 as a result of a traffic accident at the intersection of Georgetown Circle and Serrano Avenue in June or July of 1995.

All of these factors produced a significant decrease in discharge from the dewatering system which, when combined with infiltration from the 1994-1995 rainfall season, resulted in the unexpected rises in ground water.

5.1.6 August 9, 1995, to December 1995

By August 15, 1995, electrical power was restored to the damaged wells, and wells with mechanical problems were corrected. In addition, the interval between pumping cycles was reduced in most of the dewatering wells, and, in wells that had a history of high production, pump timers were disconnected to provide full-time pumping. These changes resulted in a sharp increase in ground water discharge from the well field (see Table D.1 and Figure D.2, Volume VIIa). Subsequently, a large drop in ground water elevations was observed throughout the well field. The sharp reduction in ground water elevations is illustrated on the hydrographs for P-3, P-4, P-8, P-11, and P-13.

A contour map of ground water on August 9, 1995, is depicted on Plate D.5, Volume VIIb. August 1995 data are about 10 feet to 15 feet above the low stand of October 1994. The greatest rise appears in the area of the Avenida de Santiago private cul-de-sac, where water accumulation is as much as 40 feet above the October 1994 low.

5.2 LOCAL HYDROGEOLOGIC SYSTEM

5.2.1 Bedrock Characteristics

Fracture permeability controls storage and flow of water in the local bedrock units. Shallower, weathered deposits are classified as unconfined aquifers. Landslide boundaries are largely controlled by faulting, and the fault systems form hydraulic barriers and conduits depending on associated fracturing and/or gouge development. The effects of these phenomena are discernible on the various ground water maps. The net result is a northeasterly trending compartmentalization of the shallow ground water system, with dominant outflow to the northeast. The only evidence of confined ground water conditions was detected significantly below the base of the landslide.

5.2.1.1 La Vida Member: As observed in B-1, B-2, DW-13, DW-16, and on the slope above Rimwood Drive, the La Vida Member is highly fractured and weathered. The fractured nature of the bedrock allows for the relatively rapid flow of ground water through the rock, particularly compared to the deeper, less weathered, and less fractured siltstone. Ground water within the weathered siltstone appears to be unconfined, with flow dominated by fractures.

At depth, the relatively unweathered siltstone is less fractured. Ground water appears to flow along interbedded sandstone beds and fractures. Local confined conditions were observed at depth, in some PZ installations, for some sandstone interbeds below the projected base of the landslide.

5.2.1.2 Soquel Member: Generally, ground water is unconfined throughout the Soquel Member. However, local perched water was observed above the phreatic surface on cemented zones or siltstone interbeds.

Differences in permeability are generally governed by the degree of weathering, degree of cementation, and grain-size distribution. Both weathering and fracturing decrease with depth, except in the vicinity of faults where fractures and/or cementation and gouge control water movement.

5.2.2 Faults as Barriers and Conduits

The dominant northeasterly oriented structural pattern of faults in the study area is significant, creating barriers as well as conduits for flow. It appears that the two major boundary faults (the Rimwood and A.D.S. Faults) act as substantial barriers to flow, while parallel systems of open fractures and joints are conduits.

5.2.2.1 Rimwood Fault: The Rimwood Fault was observed to have a well developed clayey gouge zone, 6 inches to 1 foot thick, with an adjacent zone of sheared rock up to 2 feet thick. Where observed, it appears that the clayey gouge is impenetrable to flow across the fault. A water elevation difference of up to 25 feet is shown on the October 5, 1994, ground water contour map across the fault.

Both PZ-5 and DW-35 penetrate the Rimwood Fault and are separated by roughly 200 feet. Apparent responses to turning on and off DW-35 were observed in PZ5-C at a depth of 198 feet. Drawdown of fifty-eight feet was observed in PZ5-C when DW-35 was restarted after shut down. No response was observed in PZ5-B at a depth of 100 feet. The rapid response of PZ5-C to the pumping of DW-35 indicates they are most likely connected by fractures associated with the Rimwood Fault.

5.2.2.2 A.D.S. Fault: The actual hydrogeologic characteristics of the earth materials that make up the A.D.S. Fault have not been directly observed or quantified. However, evidence suggests that the fault represents a significant barrier to ground water flow. This is illustrated by the persistent ground water high east of the fault in the vicinity of Via El Estribo (P-22), as contrasted by suppressed ground water elevations west of the fault (DW-28). The difference in ground water levels across the A.D.S. Fault in the vicinity of Avenida de Santiago is as much as 90 feet, as shown on the October 5, 1994, ground water contour map. This difference is a result of the extensive ground water withdrawals from the dewatering wells located along Avenida de Santiago. Even though the A.D.S. Fault appears to be a significant barrier boundary, the pattern of the ground water contours suggests that the fault is not impermeable, or that a system of open fractures parallels the fault. Such a system may supply water to the springs at the fault intersection with Hidden Canyon Road to the northeast.

Other faults exposed during excavation of the tunnel segment of the M.W.D. Santiago Lateral act as barrier boundaries. These faults, when combined with the A.D.S. Fault, trap ground water in the Via El Estribo area.

5.2.2.3 Georgetown Fault Zone: Pump test data for DW-10 indicate a prominent barrier boundary roughly 40 feet from the well. Although the location and orientation of the barrier are not defined, it appears to be linear. In addition, neither P-4 nor P-2, 50 feet and 85 feet away from DW-10, respectively, were influenced during the well testing. The barrier appears to be associated with the Georgetown Fault Zone (see Section 4.3.1).

5.2.3 Sources of Recharge

Infiltration of surface water and subsurface inflow are the only sources of recharge to the ground water system in the study area. Subsurface flow indicated by the ground water contour maps is to the north and northeast from the topographic high along Avenida de Santiago. Inflow volume is not quantifiable and likely varies seasonally or in response to dewatering. The greatest sources of local infiltration are irrigation and rainfall. All other water sources are considered insignificant.

By January 1979, most development within the study area had been completed, and residential irrigation patterns had been established. During the 3-year period of 1977 to 1980, the 2nd, 9th, and 7th largest rainfall seasons since 1895 were recorded for the area. 1980 was followed by two years of near-normal rainfall, and then by the 4th highest recorded rainfall of 1982-1983. During the six-year period, 1977-1983, aggregate rainfall totaled over 137 inches, an average of 22.9 inches per year. For the 9 years encompassing the 1983-1984 through 1991-1992 rainfall seasons, the area averaged 11.9 inches of rain, 2.9 inches per year less than the historic average since 1895.

By June of 1992, ground water levels had risen to the point where distress associated with initial movements of the Santiago Landslide was obvious. Owing to the fact that incipient failure was preceeded by 9 years of drought, irrigation was the dominant water source during early mobilization of the landslide.

Several researchers have indicated that residential irrigation can be equated to roughly 50 inches to 140 inches of rainfall per year. These quantities are roughly 4 times to 10 times the average annual rainfall.

5.2.4 Discharge

Discharge from the ground water system occurs by: evapotranspiration, springs, subsurface flow, and the dewatering system. In the context of this evaluation, discharge from the dewatering system is considered the most significant and is easily quantified.

Artificial discharge from the ground water system as a result of dewatering efforts includes pumping from vertical dewatering wells and flow from the horizontal dewatering wells (see Section 2.2.2.4). Water production from the dewatering system has ranged from a low of about 25,000 gpd in early summer 1995, to a high of about 267,000 gpd in late February 1993. The total estimated discharge from January 27, 1993, to December 6, 1995, is about 79,500,000 gallons (244 acre-feet).

Estimated discharge rates from the dewatering system at dates that are critical to evaluation of landslide stability or maintenance of the dewatering system are outlined in the table below. Included in the table are brief summaries of the landslide stability conditions (Factor of Safety, F.S.) considered significant for the corresponding dates and discharges.

Ground Water Contour Map	Discharge From Dewatering System in gpd	Significant Conditions
January 20, 1993	0	Landslide in an accelerated state of movement. High ground water levels produce lowest F.S.

Ground Water Contour Map	Discharge From Dewatering System in gpd	Significant Conditions
February 15, 1993	188,000	Gross landslide movement is attenuated. Ground water levels drop 5 feet to 30 feet below 1-20-93 level to produce F.S. ≈ 1.0.
October 5, 1994	43,000	Pumping of well field achieves maximum practical sustainable low ground water elevations with corresponding maximum F.S. Ground water levels fall more than 100 feet in some areas and are typically 20 feet to 40 feet lower than 1-20-93 levels.
August 9, 1995	25,000	Impaired well field capacity and rainfall infiltration (5th highest yearly rainfall on record) produce intermediate, high ground water elevations without renewed landslide movement. Ground water rises to within 10 feet to 30 feet below 1-20-93 levels.

5.3 EVALUATION OF DEWATERING SYSTEM

Hydrographs for the observation wells in the study area provide an empirical basis for evaluating the dewatering system. The hydrograph records of ground water response to all or a portion of 1992-1993, 1993-1994, and 1994-1995 rainfall seasons are available for evaluation.

The 1992-1993 hydrograph record suggests that the dewatering system had a dramatic impact in lowering water levels in the study area. In reality, the initial lowering of ground water levels by the dewatering system was augmented by subsurface outflow, reduced infiltration from rainfall (less than 4 inches from March to June 1993), and greatly reduced infiltration from irrigation during the evacuation and reoccupation phases of the emergency. The relative contribution that each of these factors had on lowering ground water levels is unknown. The dramatic declines in water levels, as shown on the hydrographs, lead to the conclusion that the dewatering system played the most significant role in lowering ground water levels.

The 1993-1994 hydrograph record shows very little response to either rainfall (12.4 inches) or increased irrigation that likely accompanied homeowner reoccupation. Field observations of landscaped areas throughout the study area indicate that irrigation for the 1993-1994 rainfall season was at or below normal. The 1993-1994 hydrograph record clearly demonstrates the ability of the dewatering system to keep water levels from rising in response to about average rainfall and irrigation that was probably average or below normal.

The 1994-1995 hydrograph record provides an excellent test of the dewatering system. Rainfall for the season was well above normal at 28 inches (5th highest on record), and irrigation was probably normal for the study area. Subsequent rises in ground water are shown on the August 9, 1995, ground water map and, although substantial, did not produce renewed movement of the landslide.

Ground water rises or declines as a function of the imbalance in discharge and recharge. Many of the water categories that comprise discharge and recharge are difficult to quantify. However, two water volumes, rainfall and well production, can be quantified and are routinely measured, along with ground water elevations in the monitoring wells. The combined database provides a means for evaluating the effectiveness of the dewatering system.

The amount of rainfall and irrigation that contributes to the ground water is difficult to quantify. Rainfall infiltration is a function of storm duration, intensity, and the hydrogeologic properties of the surficial materials. The complexity of the system can be simplified by considering the rise in ground water during a rainfall year as a function of the rainfall total and by assuming that irrigation remains relatively constant year to year. Of the rainfall seasons available for evaluation, only 1994-1995 has both rainfall that produces a rise in ground water and irrigation that is likely "normal". Therefore, if the dewatering capacity remains the same, any rainfall season comparable to 1994-1995 would also produce similar rises in ground water levels. Owing to the reduced capacity of the dewatering system in early 1995, the actual rises in ground water should be significantly less.

In order to determine how the dewatering system might respond to rainfall seasons greater than the 28 inches for 1994-1995, a simple linear relationship between rainfall and ground water rise was assumed. By assuming a record 36 inches of rain in 1994-1995, instead of the 28 inches, corresponding ground water rises can be estimated. These rises were added to the low-stand water level (October 5, 1994) to produce a ground water contour map equivalent to what might represent a 36-inch rainfall season (see Plate D.8, Volume VIIb).

Water elevation difference maps compare the predicted 36-inch rainfall season ground water contours to those for January 20, 1993, and February 15, 1993 (see Plates D.9 and D.10, Volume VIIb). These maps were subsequently evaluated to determine the effectiveness of the existing dewatering system and, where appropriate, make recommendations to enhance its performance.

The difference map comparing the predicted ground water levels from a 36-inch rainfall year and the January 20, 1993, conditions shows that the 36-inch rainfall would produce ground water levels ranging from 10 feet to 80 feet below those of January 20, 1993.

A similar difference map comparing the predicted ground water levels from a 36-inch rainfall year and the February 15, 1993, levels clearly illustrates that only the area between the Rimwood and Georgetown Faults, south of Georgetown Circle, could experience water rises above the February 15, 1993, data. Most areas of the map predict that the 36-inch rainfall would produce water elevations between 10 feet to 60 feet below those of February 15, 1993.

Both comparisons are interpreted to indicate that even a record rainfall should not cause ground water rises which duplicate the critical high water levels of January 1993. However, it should be recognized that this positive forecast is dependent on establishing a low-stand ground water level (October 5, 1994) prior to the rainy season and implementing the recommendations to maintain, effectively operate, monitor, and augment the current dewatering system as set forth in Sections 8.2 through 8.2.3 of this report. These interpretations are based upon a conservative model utilizing data from the past two years. Monitoring of the ground water system's response to future rainfall will provide further data which should confirm the effectiveness of the dewatering system.

6.0 ENGINEERING EVALUATION

6.1 EVALUATION OF INCLINOMETER DATA

Ten inclinometer casings were installed, as described in Section 2.2.2.8, to monitor subsurface movements in and adjacent the landslide. Reading of the inclinometer casings was initiated on February 23, 1993, and has continued at regular intervals through December 6, 1995. All of the casings were installed after gross movement of the landslide had ceased, as indicated by the surface deformation survey data. Therefore, the primary function of the inclinometers is to confirm that mass movement has attenuated. Additionally, the inclinometer data were used to discern and evaluate minute deflections at discrete elevations within the casings. With respect to their primary purpose, inclinometer data confirm the results of surface monitoring. Gross movement ended prior to casing installation and has not recurred.

Evaluations of very small accumulative casing deflections resulted in the recognition of two basic patterns of deformation. The first is a relatively broad bowing of the casing over several feet of the borehole length without net displacement and is attributed to incomplete grouting of the annular space between the casing and surrounding rock. Typically, the resultant bows or bends are oriented in directions that are inconsistent with the direction of known ground movement. Examples of bowed casings include SI-1, from 87 feet to 102 feet, and at various depths in SI-2.

The second pattern of casing deformation is defined by minute cumulative deflections at discrete casing elevations. Typically, these deflections increase through time and are oriented in directions consistent with known landslide surface movements. Such deflections are interpreted to represent minor adjustment of the landslide mass at the slip surface. Where present, the depth and direction of deformation have been used, along with other geologic data, to better define the subsurface configuration of the landslide's slip surface.

Very small offsets are evident in SI-4, SI-5, and SI-9. SI-4 registered a total deflection of 0.052-inch, at a depth of 90 feet, in a direction of about N58W. The deflection was measured on December 6, 1995, in comparison to a baseline of March 1, 1993. As of December 5, 1995, SI-5 had a total deflection of 0.095-inch, at a depth of 100 feet, in a direction of N10E when compared to the February 28, 1993, baseline. Using a baseline of April 6, 1993, the SI-9 measurements of December 6, 1995, produced a total deflection of 0.014-inch, oriented N25W at a depth of 160 feet. The magnitude and direction of these deflections are shown on the Deflection Resolution Plots, Plates F.1 through F.4, and on the Ground Deformation Map, Plate H.1, all in Volume Va of the Appendix.

6.2 EVALUATION OF STABILITY

The geomorphic feature described as the Santiago Landslide appears to consist of a single bedrock mass in two distinctly different states of stress. The western portion of the landslide was fully mobilized in January 1993. In contrast, the eastern portion of the distress area does not appear to have been subjected to stresses great enough to produce a continuous, well developed failure surface. Incomplete propagation of a failure surface beneath the eastern portion of the distress area is evidenced by the lack of translational deflections in SI-1 and SI-2 and the absence of features that define a toe. The distress recognized in most of the Georgetown Circle area is attributed to deformation as rock mobilized resistance to stress imposed on the area by incipient failure of upslope and adjoining bedrock areas. These interpretations are supported by field observations and analytic models. A general limit equilibrium method, contained in the Slope Stability Program, PC-SLOPE, developed by Geo-Slope International Ltd., was used to compute the factors of safety with respect to various ground water conditions.

Five geologic cross-sections were used as a basis for evaluating the stability of the distress area. Four of the cross-sections (1-1', 2-2', 3-3', and 4-4') are roughly parallel to and oriented in the general direction of landslide movement, as defined by surface monitoring and the inclinometers. Cross-Sections 1-1', 2-2', and 3-3' transect the western, fully mobilized failure area. Each of these sections are separated from each other by approximately 165 feet. Cross-Section 4-4' is situated about 340 feet northeast of Cross-Section 3-3', extending through a portion of the landslide area that does not appear to have a continuous well developed failure surface. The fifth cross-section (8-8') is oriented toward the northeast, parallel to the dip of bedding.

Evaluation of landslide stability was conducted in two phases. The first phase determined the shear strength parameters for the landslide at failure. Resultant parameters were subsequently used in the second phase of analysis to determine factors of safety for each cross-section with respect to specific ground water levels. Weighted factors of safety were determined for the portion of the distress area encompassed by Cross-Sections 1-1', 2-2', 3-3', and 4-4' for the ground water levels of January 20, 1993, February 15, 1993, October 5, 1994, and August 9, 1995.

The relatively weak geologic materials representing the failure surface of the landslide were only encountered and sampled in the core borings PZ-1 through PZ-5 and in the sewer trench excavation, Trench 6, at the end of Rimwood Drive. Similar materials exposed in outcrops and excavations adjacent the landslide area were also sampled and tested. These samples are limited in number and represent an extremely small sampling of the landslide slip surface. In addition, the results of the laboratory tests suggest that the sampled shear surface strength is adequate to resist sliding.

A more representative strength of the materials along which sliding has occurred was determined by "back-calculation". In order to refine the strength parameters applied to the failure surfaces, numerous trial analyses were conducted on Cross-Sections 1-1′ through 4-4′ using the high ground water elevation of January 20, 1993. Values of cohesion and angle of internal friction were varied from 50 psf to 150 psf and 8.5° to 11°, respectively, to produce factors of safety near unity for ground water levels of January 20, 1993. The results of these analyses indicate that the strength of the failure surface can be represented by C = 100 psf and ϕ = 10°.

PC-Stable 5, with its ability to search for and evaluate numerous composite planar modes of failure, was used to determine if other parallel failure surfaces, either above and/or below the surfaces modeled, could be more critical. Search results indicate that the geologically defined surfaces modeled are critical, and that the Rimwood Fault played an essential role in the formation of the Santiago Landslide. It is not likely that a failure plane could propagate across bedding to form a landslide without the pre-existing plane of weakness created by the Rimwood Fault.

The strength parameters of the failure surfaces as determined in the first phase of analyses, C = 100 psf and ϕ = 10°, were subsequently used to evaluate the stability of Cross-Sections 1-1′ through 4-4′ and 8-8′, with respect to the ground water levels of January 20, 1993, February 15, 1993, October 5, 1994, and August 9, 1995. The data defining the analyses, and their results, are presented in Volume Vb.

The results of these analyses are tabulated below:

	FACTORS OF SAFETY			
CROSS-SECTION	01-20-93	02-15-93	10-05-94	08-09-95
1-1′	0.96	1.01	1.09	1.08
2-2′	1.04	1.09	1.23	1.17
3-3′	0.97	1.06	1.22	1.14
4-4′	1.10	1.21	1.41	1.40
8-8′	1.01	1.10	1.31	1.24

In order to consider a three-dimensional effect in an estimate of the gross stability, averaged factors of safety were computed using the weighting technique of Lambe and Whitman (1969). These weighted averages for all ground water dates were produced by multiplying the factor of safety calculated for each cross-section by its total driving force. The sum of these products is then divided by the sum of the driving forces to yield the weighted factor of safety for a set of cross-sections.

Two earth masses were considered:

Case 1. The mobilized, western portion of the distress area, as depicted by Cross-Sections 1-1', 2-2', and 3-3';

Case 2. The western and central areas combined to assess the influence of boundary effects between the fully and partially developed landslide rupture surface and its propagation eastward, as shown on Cross-Sections 1-1', 3-3', and 4-4'.

Resultant weighted factors of safety are tabulated below:

	WEIGHTED FACTORS OF SAFETY			
CASE & CROSS-SECTION	01-20-93	02-15-93	10-05-94	08-09-95
CASE 1 1-1', 2-2', & 3-3'	0.99	1.06	1.20	1.14
CASE 2 1-1', 3-3', & 4-4'	1.02	1.11	1.28	1.24

The most significant conclusion derived from the analyses is the effect that ground water has on site stability. Reductions in the water levels between January 20, 1993, to February 15, 1993, arrested movement. Maximum stability requires maximum ground water drawdown. These analytic results are further corroborated by the field observations:

- On January 20, 1993, the landslide was fully mobilized for Case 1.
- By February 15, 1993, early dewatering had minimized slide movement for Case 1, and the factor of safety was just above unity.
- The eastern portions of the distress area did not mature into a fully mobilized slide mass for Case 2.

Analytic models and field experience demonstrate that the greatest risk of future deformation or reactivation involves the western, mature landslide mass. The eastern, about two-thirds, portion of the deformation area is not likely to experience additional movements without antecedent translation to the west. It is further concluded that high ground water alone cannot cause formation of a landslide east of about Cross-Section 3-3′ due to favorable geology.

7.0 CONCLUSIONS

Conclusions in this report are opinions based on this firm's investigation, previous geotechnical reports by others, exploration, testing, experience with similar projects, and professional judgment. Opinions presented herein are applicable to the study area denoted in this report and are subject to change as additional data are available.

The conclusions within this section are based upon the existing development as depicted on the topographic maps by Robert J. Lung & Associates, 1993.

Any remedial repairs should be in accordance with applicable local codes and the recommendations within this report.

7.1 DEFORMATION HISTORY

The "Santiago Landslide" is the term applied to an area of locally discontinuous ground deformation encompassing roughly 25 acres in the study area. The earliest recognition of potential landslide-type deformation was observed by this firm in July 1992. Tension cracks near Avenida de Santiago and pressure ridges traversing the Rimwood Drive cul-de-sac area were interpreted to define an incipient failure mass. Mature landslide translation was limited to a strip of land involving about the westerly one-third of the ultimate deformation area. Observed 1992 displacements were very small, the maximum being less than 0.2-foot.

Movement accelerated during the weekend of January 16-17, 1993, after heavy seasonal rainfall of December 1992 through early January 1993. Original landslide mobilization and subsequent acceleration were predominantly attributable to rising ground water. Clearly, area dewatering was the only action available to reduce and control the destabilizing effects of these adverse ground water accumulations. Dewatering efforts initiated in January/February 1993 had a great influence on both the total landslide displacement and its potential enlargement. Resultant ground water withdrawal volumes were sufficient to stop significant mass movement by the end of January 1993. Total translational displacement was minimal, ranging from a maximum of about one foot for the western deformation to probably less than 0.1-foot on the east. Gross movement has not been detected since February 1993.

The fundamental sequence of deformation is outlined below, along with important geologic and rock-mechanical influences:

- Northerly dipping Puente Formation, upper La Vida Member, siltstone and shale experience localized shearing in response to regional folding and faulting, particularly as a consequence of its position between the thick Soquel Member and middle La Vida sandstones.

- Faults and stratigraphy create hydrogeologic discontinuities, both horizontal and vertical, which compartmentalize and restrict ground water drainage, allowing local elevated water tables with seeps and springs.

- Land development modifies surface drainage and establishes irrigation as a source of infiltration, resulting in rising ground water despite drought conditions during the nine years prior to landslide mobilization.

- Inclined planes of geologically weak materials (faults, shears, bedding planes) combine with the effects of rising ground water to destabilize the west side of distress area; deformation is observed.

- Additional rises in ground water from 1992-1993 rainfall cause acceleration of deformation.

- Ground movement on the west presses against the central and eastern segment of the distress area in the direction of deepening basal shear horizon (i.e., the down-dip component of displacement).

- Strength and mass to resist western ground movement is mobilized with attendant deformation: tension cracks propagate eastward along Avenida de Santiago and compression bulges rise along Georgetown Circle.

- Loss of support adjacent the original headscarp crack allows southerly enlargement of the landslide deformation south of Avenida de Santiago.

- Emergency dewatering lowers water tables, thereby increasing resisting forces; landslide translation and associated deformation stop.

- Minor ground adjustments continue locally; no gross or mass displacements are measured at inclinometer casings or land survey networks since approximately February 1993.

- The temporary above-ground portions of the dewatering system are reconstructed underground.

- Ground water monitoring systems and protocol are established.

It is not known what the final configuration, extent, and magnitude of sliding would have been without the dewatering effort. However, geologic and topographic relationships, along with the stability models, provide some insight. Two controlling conditions are predominant:

- The presence and orientation of pre-existing planes of weakness.

- The critical influence of ground water.

Stability analyses show greater resistance to sliding in the east, even considering the high ground water conditions in January 1993. Mobilization of substantial resisting forces is evidenced by ground deformation in the Georgetown Circle area. Deformation represents the weakest link in available resisting masses and may be related to the presence of inferred faults. Computed factors of safety for about the eastern half of Georgetown Circle are substantially above unity owing to northeasterly deepening of the projected slip surface. Consequently, much of the potential slide mass is supported down-dip and was, therefore, self-buttressing once its strength was mobilized.

To the west, however, landsliding had matured and an essentially continuous rupture surface had formed. As movement increased, basal shearing propagated easterly and was being resisted, as discussed above.

7.2 GEOLOGY

Local bedrock materials consist of Miocene Puente Formation sedimentary units: Soquel sandstone and La Vida shales. The strata are tilted northerly in the area of interest at inclinations about equal to the natural topography. These members of the Puente Formation contain clay seams, altered ash beds, and weak lithologies. The La Vida Member is considered the most prone to landsliding due to the weak, fissile clay shales and shears.

Geologic materials and structure can be problematic where bedding and other geologic planes of weakness intercept the ground surface. Several faults have played a significant role in defining the boundaries of the ground movement and the migration of ground water. The Rimwood Fault transversing the Rimwood Drive cul-de-sac was crucial to landslide formation. The potential for landsliding involving the Puente Formation in the Peralta Hills was recognized by all previous geologic investigations.

7.3 PRECIPITATION

The average rainfall for the site is 14 inches to 15 inches per year. Rainfall for the 1992-1993 rainfall year totaled about 29 inches and was the third highest rainfall total since 1892. Rainfall records for the site indicate that seventeen rainfall years have exceeded 20 inches, with seven of those years exceeding 25 inches. The maximum rainfall was about 36 inches in the 1940-1941 rainfall year. The rainfall total of 28.38 inches that fell during the 1994-1995 rainfall year was the fifth highest recorded. This rainfall did not cause reactivation of ground deformation, even though the rainfall total was only 3/4-inch less than the 1992-1993 rainfall total.

7.4 GROUND WATER

Locally adverse geologic structure was destabilized by rising ground water. Landform modifications and irrigation as a result of development in the study area have contributed to rising ground water. Mass grading in the study area has reduced surface gradients, thus, increasing the potential for surface infiltration. Irrigation and urbanization have substantially increased the amount of potential water available for infiltration. In addition, some residential properties in the study area are poorly drained, with surface depressions that further augment infiltration of surface water.

The results of the hydrogeologic evaluation indicate that the local ground water system is complex, consisting of three ground water bodies separated by faults. These faults are substantial barriers and direct ground water flow to the northeast. Fracture permeability dominates most infiltration, storage, and flow of ground water.

Water levels on four specific dates help define the water barriers, local gradients, directions of flow, and area stability. Post-development rising ground water precipitated the movements reported in June 1992. Subsequent events are characterized by the following four ground water dates:

- January 20, 1993 - Heavy rains in December 1992 and January 1993 led to accelerated ground movement in January 1993.

- February 15, 1993 - Dewatering efforts reduce water levels and stop gross landslide movement.

- October 5, 1994 - Low stand water level achieved by dewatering system.

- August 9, 1995 - Diminished capacity of dewatering system, combined with a near-record rainfall, does not cause renewed ground movement nor exceed the February 15, 1993, ground water levels.

The exceptionally high rainfall total for 1994-1995 provided a good test of the ability of the dewatering system to cope with such conditions, despite its reduced capacity at the time. The observation well hydrographs for the 1994-1995 rainfall year show that water levels will rise in the short-term. However, ground water elevations remained substantially below the January 1993 levels. The installed dewatering system is considered capable, under most conditions, of reducing water to or below levels of October 5, 1994, by early autumn of each year. It is recommended that the October 5, 1994, water data be used as a goal for annual operation of the system.

Ground water elevations predicted for a record 36-inch rainfall, by extrapolation from 28 inches during 1994-1995, are significantly lower than the critical levels of January 1993. Assuming that late summer-early autumn ground water conditions are equal to or lower than those of October 5, 1994, and that irrigation volumes remain similar to those for the 1994-1995 rainfall season, the potential for renewed landslide movement appears remote. However, the predicted water levels for 36 inches of rain rise above the February 15, 1993, water levels by up to 10 feet in a small area southeast of Rimwood Drive. Therefore, additional dewatering wells in the westerly portion of the deformation area are recommended.

Cessation of earth movements and associated deformation was, and remains, totally dependent on control of local ground water. Continued stability of the deformation area and adjoining terrain will necessitate effective dewatering for the foreseeable future. Additional dewatering and observation wells are recommended for key areas to further assist risk reduction. However, it is paramount that the installed ground water control and observation system be maintained at maximum efficiency and closely monitored. Recommendations to accomplish these objectives prescribe the frequency, documentation, and evaluation of ongoing operations for the system.

7.5 STABILITY

Stability models to evaluate the conditions of deformation and benefits of water withdrawal were analyzed using the four ground water levels/dates listed on the previous page. Geologic and hydrogeologic data were plotted for a series of parallel cross-sections oriented in the direction of ground movement obtained from monitoring data. Computed factors of safety (F.S.) are based on a back calculation of rock strength data which yield sliding for the western portion of the deformation area, i.e., F.S. $\leq$ 1.0, when ground water rises to January 20, 1993, conditions. Early dewatering efforts, as portrayed by ground water elevations of February 15, 1993, abated gross movement as confirmed by a F.S. slightly above unity for that date. The maximum stability achieved by ground water withdrawal efforts was computed for the low stand of October 5, 1994, which yields a F.S. in the range of 1.2 to 1.3.

All factors of safety were weighted by cross-section driving forces to determine the "weighted average" representing different segments of the deformation area. The F.S. values cited above apply to the western landslide terrain. Stability improves to the east. Landslide movement was not directly down-dip of bedding. Analysis of the potential for failure in the dip direction (Cross-Section 8-8') shows an increased resistance due to self-buttressing, with a F.S. >1.2.

8.0 RECOMMENDATIONS

Recommendations in this report are opinions based on this firm's investigation, previous geotechnical reports by others, exploration, testing, experience with similar projects, and professional judgment. Recommendations presented herein are applicable to the study area denoted in this report and are subject to change as additional data are available.

The recommendations within this section are based upon the existing development as depicted on the topographic maps by Robert J. Lung & Associates, 1993.

Any remedial repairs should be in accordance with applicable local codes and the recommendations within this report. Remedial studies or improvements related to the ongoing stabilization efforts within the Santiago Landside area should be reviewed by Eberhart & Stone, Inc., to determine the effects these studies or stabilization efforts may have on the Santiago Landslide.

The foregoing descriptive and analytic discussions show that stability of the distress area, including the mobilized portion of the Santiago Landslide, can be maintained by controlling local ground water. Mitigation of future movement is dependent on ensuring that ground water levels do not approach those recorded in late January through early February 1993. Recommendations to assist achieving this fundamental objective are provided in subsequent sections. Basic dewatering recommendations are divided into two subjects:

- Operation of existing dewatering and ground water monitoring systems.
- Additional dewatering and monitoring wells.

Suggested guidelines for other monitoring, maintenance, and review issues are also provided.

8.1 DEWATERING PROGRAM

In order to reduce the threat of seasonal rainfall infiltration causing recharge of ground water to levels approaching those of early 1993, every effort should be taken to establish a low water stand by October 1st of each year. The low stand is equivalent to the October 5, 1994, water levels subsequently modified by additional dewatering wells. Typically, ground water elevations should not be allowed to rise above the levels that occurred on August 9, 1995. The agency responsible for administration of the dewatering program should retain the appropriate technical and related support services to conduct recommended ground water monitoring, evaluations of discharge volumes, and system maintenance. The fact that area stability is dependent on the control of ground water cannot be overemphasized. Therefore, it must be recognized that the dewatering systems have to be effectively operated and carefully monitored indefinitely.

8.2 CURRENT DEWATERING SYSTEM

At present, the dewatering system consists of pumped vertical wells, gravity drains, and an array of monitoring wells. Past experience with the system demonstrates the capability to achieve the recommended October 5, 1994, criterion. However, changes to the system by both environmental effects and maintenance activities can compromise the system's capacity. The following recommendations are directed toward enhancing efficiency and providing the additional dewatering capacity necessary to maintain stability.

8.2.1 Dewatering Well Modifications

All pumped wells are provided with timers to control pumping cycles. It is recommended that pump motor circuits be converted to pressure-controlled switches where possible, particularly the more productive wells. This modification will increase daily discharge volumes by allowing pumps to respond to demand. A pump contractor or fluid control specialist should be consulted to design the optimum system for the dewatering wells. The objective is to remove as much water as possible from each well, as allowed by inflow, thereby maximizing total discharge and maintaining minimum ground water levels.

8.2.2 Maintenance and Report Protocol

A maintenance schedule for the vertical dewatering wells has been established by the City of Anaheim's dewatering contractor, and should be continued. Each pumping well should be inspected for deterioration and/or malfunctions on a monthly basis. In addition, a yearly cleaning and detailed examination of the entire dewatering system should be conducted. Annual service should include inspection of all horizontal drains, vertical dewatering wells, and conveyance piping to check for damage or reduced capacity.

Inspection results, along with any repairs or alterations to the systems, must be documented by written reports. Reports should identify all wells by the nomenclature used herein and be submitted to both the administrative agency and its technical consultant within 5 days of completing the inspection, service, repair, or modification work.

8.2.3 Ground Water Monitoring Systems

Water monitoring consists of collecting and reducing data on a regular schedule from P-wells and PZ-wells. At present, well data are collected monthly, and this schedule should be continued through at least 1996. It is likely that the frequency of monitoring data collection can be decreased as more water history is acquired. Additional water level data should be plotted on the hydrograph for each well or piezometer, along with rainfall.

The summation of water flows from flowmeters for dewatering wells and horizontal drains, and well water levels, should be completed quarterly and well performance reviewed. Routine servicing of all water monitoring systems should be conducted on at least the quarterly schedule, or more frequently if needed.

Monitoring results and assessment of the dewatering system performance should be submitted to the administrative entity each quarter. The report should summarize the water monitoring results, provide recommendations for repairs or modifications to the system, and evaluate ground water conditions with respect to achieving the target October 5, 1994, levels by the end of the third quarter (October 1).

8.3 ADDITIONAL DEWATERING WELLS

Seven additional dewatering well locations have been identified. These wells are intended to increase pumping capacity in the critical western portion of the distress area. It is recommended that the wells be installed in phases to allow evaluation of their effect. The first two new wells are recommended for:

- The end of the private Avenida de Santiago cul-de-sac, 250 feet deep.

- The open-space area between Rimwood Drive and Georgetown Circle, 200 feet deep.

These two wells should be installed and operated for at least 6 months to assess their effectiveness and assist in determining the need for up to five additional wells located at:

- Approximately 100 feet north of Tamarisk Drive and Avenida de Santiago, 250 feet deep;

- Rimwood Drive cul-de-sac, 200 feet deep;

- Georgetown Circle near DW-3, 200 feet deep;

- Vassar Circle cul-de-sac, 200 feet deep;

- Georgetown Circle near DW-4, 200 feet deep.

The need for any of the five additional wells should be assessed on an individual basis, and each well should be operated long enough to determine its effectiveness prior to installation of additional wells. The approximate locations of the recommended dewatering wells are shown on Plate H.1 in Volume I.

Any new dewatering well should be logged by a California Certified Engineering Geologist. The need, if any, for geophysical downhole logging should be assessed as each well is drilled.

8.4 ADDITIONAL OBSERVATION WELLS

It is recommended that the existing ground water monitoring system be supplemented with eight new open-standpipe observation wells and that two existing observation wells be deepened. Five new observation wells should be located on Avenida de Santiago and its private cul-de-sac. These five wells should be at least 300 feet deep. Three 200-foot-deep monitoring wells are recommended, one each on Georgetown Circle, Williams Circle, and Serrano Avenue. The approximate locations of the recommended observation wells are shown on Plate H.1 in Volume I.

Both P-5 and P-6, on the western margin of the landslide, are currently registering ground water levels at or near their bottoms, and should be deepened to at least 150 feet.

It is anticipated that all new wells will be drilled using rotary-wash equipment with a 6-inch-diameter drill bit. Each well should be logged by a California Certified Engineering Geologist. The need, if any, for geophysical logging should be assessed as the monitoring wells are drilled. Pressure transducers with automated data loggers should be installed in new observation wells. Monitoring well construction should comply with applicable regulatory requirements.

8.5 INFILTRATION

8.5.1 Irrigation Reduction

Control of irrigation is considered important to successfully reduce the influence of surface water on the ground water system. Irrigation of landscaped areas should be dictated by evapotranspiration (E.T.). During periods of rainfall, irrigation of landscaped areas should be curtailed or cut-off completely, depending on the amount of rainfall and E.T. All irrigation systems, including plumbing, sprinkler heads, and timers, should be checked regularly to ensure that the irrigation systems are functioning properly. If feasible, drought-resistant plant varieties should be used to replace vegetation with high water needs.

8.5.2 Surface Drainage

Landscaped and hardscaped areas of private and public lands should be maintained to ensure positive drainage. Low areas that collect or pond surface water should be eliminated. All surface drainage not currently conveyed to an approved drainage device will need to be redirected to do so in accordance with the City of Anaheim's standard specifications.

8.5.2.1 Terrace Drains: All previously graded slopes were originally constructed with concrete drainage benches to collect and convey runoff to the streets or storm drains. These devices should be checked at regular intervals to assure that they are not damaged or blocked by debris. Damaged drainage devices should be repaired.

It is recommended that paved bench drains be designed and constructed for the natural slope between Georgetown Circle and Avenida de Santiago to collect runoff from the hillside. Slope drains should be designed by a civil engineer with input from an engineering geologist.

8.5.2.2 Crack Sealing: Cracked pavements, swimming pools, and hardscape should be sealed. Crack sealing should be verified prior to each rainy season.

In natural areas prone to high surface infiltration, gunite, thin masonry, concrete or asphalt slope paving, or other impermeable cover could be used to minimize infiltration of surface water. A case-by-case surface infiltration study could be used to determine the areas where surface barriers would be most helpful. Likely candidates are the ground cracks along Avenida de Santiago and areas exposing permeable sandstone.

In areas where open bedrock ground cracks and fractures are present, inclined boreholes could be used to locate and fill subsurface voids with a viscous, sand-cement grout. Grouting of open fractures can significantly reduce the rate of surface water infiltration.

8.5.2.3 Future Development: Future development will provide additional sources of water and increase the potential for surface infiltration. An increase in surface infiltration could have a detrimental effect on the stability of the landslide. Therefore, the effect of future development on ground water levels, the existing dewatering system, and landslide stability must be addressed prior to approval of any new development, particularly in the areas south and west of Avenida de Santiago.

8.6 INCLINOMETERS

Ongoing monitoring of inclinometer casings has not shown any significant movements in the subsurface since 1993. At this time, it is not considered cost-effective to continue measurements at quarterly intervals. It is recommended that yearly monitoring be conducted in the future. If unusual, new distress is observed, or if ground water rises to levels approaching those of early 1993, the inclinometers will provide a means for monitoring subsurface deformation and early detection of renewed landslide translation.

8.7 ANNUAL REPORT

It is recommended that an annual summary report be prepared and distributed by the technical consultant to all interested parties by July 31 of each year. The document should address the year's water history and maintenance issues warranting attention, and provide conclusions and recommendations as to the status of area stability. It may also be advisable to schedule a meeting of all parties to review and plan the ongoing operations requirement.

8.8 GEOLOGIC HAZARD ABATEMENT DISTRICT

Maintenance of the existing dewatering system and monitoring of ground water conditions are essential for maintaining the level of stability that has been achieved by the existing dewatering system and for the continued evaluation of environmental effects that could threaten stability in the future. The implementation of a Geologic Hazard Abatement District (GHAD) provides a means of raising the necessary funds for maintaining, monitoring, and managing the dewatering system for the benefit of all properties threatened by renewed landslide movement. For these reasons, a GHAD is recommended for the area affected by the Santiago Landslide. The GHAD should be established in accordance with California Law (CPRC Sections 26500-26654).

8.9 ALTERNATIVE DEWATERING SYSTEM

The current dewatering system requires a substantial annual expense to achieve and maintain the low-stand ground water elevation that is considered necessary for maintaining the existing state of stability. Expenditures for operation, maintenance, and monitoring of the system will continue as long as the potential for high ground water remains. Therefore, the existing dewatering operation and its associated costs are likely to remain necessary indefinitely.

The current dewatering system relies primarily on the ability of electrically powered pumps to extract water from the ground water system beneath the landslide area. However, it may be possible to construct an alternative dewatering system that relies on gravity drainage to maintain the low ground water levels necessary for stability. Such a system could consist of one or more adits excavated beneath the landslide area from a drainage outlet point, possibly located in Oak Canyon. These adits would be connected to a system of drainage galleries designed to intersect geologic conditions that convey or impede subsurface water. Such a system may be capable of eliminating, or substantially reducing, the need for the existing pumps and wells, eliminating much of the annual costs associated with pump operation and maintenance, and dramatically reducing annual monitoring costs. Implementation of a gravity dewatering system would likely have a lengthy construction period and high initial capitalization cost. Details for the design and construction of a gravity dewatering system are beyond the scope of this investigation. The cost to design and construct a gravity dewatering system could range from 3 million dollars to 5 million dollars.

* * * END * * *

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Agency	Date Flown	Flight No.	Frame No.	Scale
Fairchild Aerial Photography Collection	05-22-31	C-1590	11-13	1" = 1500′
	10-15-39	C-5925	198 & 199	1" = 2000′
	08-28-47	C-11730	9:13-9:15	1" = 1200′
	09-01-47	C-11730	15:109-15:110	1" = 1200′
Robert J. Lung & Associates (W.O. 32388)	01-28-93	1	1-7	1" = 305′
	01-28-93	2	1-7	1" = 305′
	01-28-93	3	1-7	1" = 305′
	01-28-93	4	1-3	1" = 305′
	01-28-93	5	1-5	1" = 450′
	01-28-93	6	1-5	1" = 450′
Continental Aerial Photo, Inc.	12-26-52	SK	57 & 58	1" = 1000′
	03-30-67	2	75 & 76	1" = 1000′
	01-30-70	60-5	48 & 49	1" = 1000′
	10-29-73	132-9	6 & 7	1" = 1000′
	01-13-75	157-10	7 & 8	1" = 1000′
	01-24-77	181-10	8 & 9	1" = 1000′
	12-14-78	203-10	10 & 11	1" = 1000′
	01-31-81	211-10	11 & 12	1" = 1000′
	04-02-83	218-10	11 & 12	1" = 1000′
	06-12-90	C84-15	20 & 21	1" = 1000′
	01-29-92	C85-6	8 & 9	1" = 1000′
	03-05-93	C11-4	9-11	1" = 1000′
Geo-Tech Imagery Int. (Infared)	03-16-87	F6-8	9578-9579	1" = 2000′
United States Department of Agriculture	12-12-52	AXK - 3K	10-12	1" = 1667′
	12-26-52	AXK - 5K	56-58	1" = 1667′

D.1

DESCRIPTION OF LABORATORY TESTING

Atterberg Limits: Atterberg limits were determined from liquid limit and plastic limit tests to establish criteria for classification of typical materials. These tests were based on ASTM D 4318 method of testing. The results of these tests are presented in Table D.2, in this volume.

Classification: Field classifications were verified in the laboratory by visual and tactile identification. Soils have been classified in accordance with the Unified Soils Classification System.

Moisture-Density: Moisture density determinations were conducted on relatively undisturbed samples. The results are presented on the Boring Logs, B-1 through B-8, in Volume II.

Determined Total Volume: Determinations of total volume of soil by displacement were performed on selected samples using the U.S. Army Corps of Engineers Test Method EM 1110-2-1906. The results are presented in the Determined Total Volume by Displacement Method, Table D.3, in this volume.

Direct Shear: Direct shear tests were performed on samples remolded in brass rings with 2.5-inch inside diameters. The direct shear test specimens were then inundated until the sample was saturated under normal loads and during shearing. The results presenting ultimate, peak, and resheared values of Phi and C are presented in Table D.4 in this volume. Direct shear tests for soils under consolidated-drained conditions were conducted in accordance with ASTM D 3080-90.

SUMMARY OF ATTERBERG LIMITS

SAMPLE NUMBER	DEPTH (FT)	CORE RUN NO.	DESCRIPTION	LIQUID	PLASTIC	PLASTICITY	CLASSIFICATION
PZ-2	163.0	58	Sandy-clayey silt	43	34	9	ML
PZ-2	166.0	59	Sandy-clayey silt	46	30	16	ML
PZ-2	167.0	59	Sandy silt	33	26	7	ML
PZ-4	94.0	22	Clayey silt	--	--	NP	ML
PZ-4	159.5	37	Sandy-clayey silt	41	34	7	ML
PZ-4	160.0	37	Sandy silt	42	35	7	ML
PZ-5	202.5	53	Clayey silt	--	--	NP	ML

NP denotes nonplastic

DETERMINED TOTAL VOLUME OF SOIL BY DISPLACEMENT METHOD

SAMPLE	DEPTH (FEET)	DESCRIPTION	WET DENSITY OF SOIL gm/cc	WET DENSITY OF SOIL, pcf
PZ-3 (Core Run 9)	37.0	Sandstone, vf. to vc. (yellow-brown)	2.31	144.3
PZ-3 (Core Run 42)	193.0	Shale, with interbedded sandstone, (black)	2.64	164.8
PZ-4 (Core Run 26)	114.0	Shale, (black) with interbedded sandstone (gray)	2.16	134.9
PZ-5 (Core Run 53)	202.5	Shale, (black)	2.14	133.4

SUMMARY OF DIRECT SHEAR TESTS

LOCATION	TYPE	ϕ (degrees)	c (psf)
Cut Area West of Avenida de Santiago	Reshear	17	30
	Ultimate	23	300
	Peak	30	600

TABLE E.1
WATER CHEMISTRY

WELL / PARAMETER	PZ1-C	PZ1-D	PZ2-A	PZ2-C	PZ3-B	PZ3-D	PZ4-B	PZ4-C	PZ5-B	PZ5-C
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	2.10	ND	1.60		5.60	ND	0.50	ND	6.40	ND
Boron	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	71.0	53.1	49.0	98.1	75.0	76.2	49.0	72.1	80.0	67.1
Iron	12.6	21.0	13.8	31.0	5.3	4.0	18.2	9.3	109.0	12.6
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	0.72	0.63	0.55	0.69	0.64	0.20	0.46	0.11	4.06	1.29
Magnesium	56.1	62.3	35.6	137.0	37.2	45.1	41.6	37.7	112.0	78.3
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	13.2	14.3	16.5	14.0	15.1	10.0	12.8	7.3	52.4	10.7
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	162.0	120.0	215.0	115.0	144.0	148.0	160.0	123.0	276.0	197.0
Chloride	158.0	142.0	196.0	232.0	204.0	202.0	204.0	210.0	202.0	169.0
Sulfate	135.0	78.0	88.1	118.0	96.1	82.0	76.1	78.0	208.0	84.0
Total Phosphorus (as PO_4)	1.33	0.47	1.00	0.37	1.13	0.27	0.65	1.00	2.45	0.08
Nitrate	4.60	5.70	3.60	2.40	ND	ND	ND	0.02	7.21	4.90
Nitrite	0.20	0.29	0.12	0.09	ND	ND	ND	0.22	0.36	0.25
Total N	13.30	9.80	15.10	10.20	10.80	9.20	11.20	2.10	25.20	8.40
Fluoride	0.17	0.27	0.24	0.21	0.37	0.19	0.15	0.37	0.45	0.14
Silica	14.0	12.0	8.1	12.0	4.1	2.0	4.0	ND	46.0	3.0
Total Dissolved Solids	564	462	585	692	512	487	505	451	936	641
Total Organic Carbon	14	11	21	14	12	7	8	5	39	12
pH	7.38	7.65	7.49	7.70	7.75	7.33	7.39	7.30	7.95	7.97
Specific conductance (μmho/cm)	830	697	869	1054	761	734	751	691	1263	940

All results in mg/l unless otherwise specified. ND = None Detected

THE GEOLOGICAL SOCIETY OF AMERICA

The Santiago Landslide and Associated Ridge-top Graben (Sackungen): Implications for Paleoseismic Landslide Studies

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Key Terms: ***Ridge-top Graben, Sackungen, Landslide, Paleoseismology, Rainfall***

ABSTRACT

Some recent paleoseismic studies have focused on dating ridge-top graben deposits to evaluate the timing of paleoseismic events. By contrast, our study of the Santiago landslide demonstrates that ridge-top grabens also can be associated with aseismic, deep-seated landsliding. The Santiago landslide in Anaheim Hills, California, failed during the winter of 1992–1993 in response to elevated groundwater conditions associated with intense rainfall. The head of the active landslide included a zone of extensional deformation along the bounding ridgeline. Interpretation of historical, aerial photographs indicates that the active landslide is a re-activated, ancient, deep-seated, translational landslide and an associated ridge-top graben. Large-diameter borings within the ridge-top graben encountered thick colluvium, steeply dipping colluvium-filled fractures, and shears with normal offsets. In contrast to the rupture surface within the central part of the landslide, the basal rupture surfaces in the graben area had significantly less gouge. We interpret this contrast in gouge development as an indication that the ridge-top graben developed later than the original landslide by upslope progression of the deformation. Our limit-equilibrium, slope-stability analyses indicate that either high groundwater or seismic ground motion could have previously activated the ancient landslide and ridge-top graben. Because colluvial deposits preserved within the ridge-top graben and produced by these two different types of triggering events could be misinterpreted as representing the late Quaternary paleoseismic record, these features are not useful for paleoseismic studies unless aseismic activation can be clearly precluded.

INTRODUCTION

The Santiago landslide, located in the Anaheim Hills area of the northern Santa Ana Mountains, California (Figure 1), is an active landslide that produced extensional deformation within the adjacent part of the upslope bounding ridgeline. Initial movement of the landslide caused minor cracks in road surfaces during 1992 (Barrows et al., 1993). This was followed in January 1993 by major episodes of landslide movement following intense rainfall in December 1992 and January 1993 (Slosson and Larson, 1995). Initial investigations (McLarty and Lancaster, 1999a) concluded that elevated groundwater conditions triggered landslide movement and that the maximum displacement was approximately 1 ft (0.3 m). A zone of extensional ground cracks was mapped along the ridgeline at the head of the landslide in January 1993; these ground-crack data were incorporated into our engineering geologic map (Figure 2). Movement of the landslide and opening of the associated ridge-top graben occurred during a seismically quiescent period when groundwater levels were elevated (Barrows et al., 1993). Thus, re-activation was related to groundwater conditions associated with intense rainfall rather than strong seismic shaking.

There are several different interpretations for the origin of ridge-top grabens (sackungen). Some have hypothesized that sackungen develop by slow, gravitational deformation of ridgelines (Tabor, 1971; Varnes et al., 1989; Bovis and Evans, 1995; McCalpin and Irvine, 1995; and Thompson, 1997). Others have interpreted sackungen development as a response to loss of buttressing and to stress relief associated with late Pleistocene deglaciation (Bovis, 1982; Agliardi et al., 2001; Kellogg, 2001a; and Smith, 2001). A third hypothesis is that these grabens open in response to strong seismic shaking and ridge-top shatter (Beck, 1968; Clague, 1979; Wallace, 1984; Morton and Sadler, 1989; and Kellogg, 2001b). One argument for the seismic origin of sackungen is the abundance of these features in some regions with high rates of seismic activity (Radbruch-Hall, 1978; Hart, 2001). Several studies in the Santa Cruz Mountains of northern California following the 1989 Loma Prieta earthquake (Ponti and Wells, 1991; Nolan and Weber, 1998) reported apparent, active opening of sackungen in response to strong seismic shaking. McCalpin (1999) trenched across a ridge-top graben in central Nevada that was active during two historical

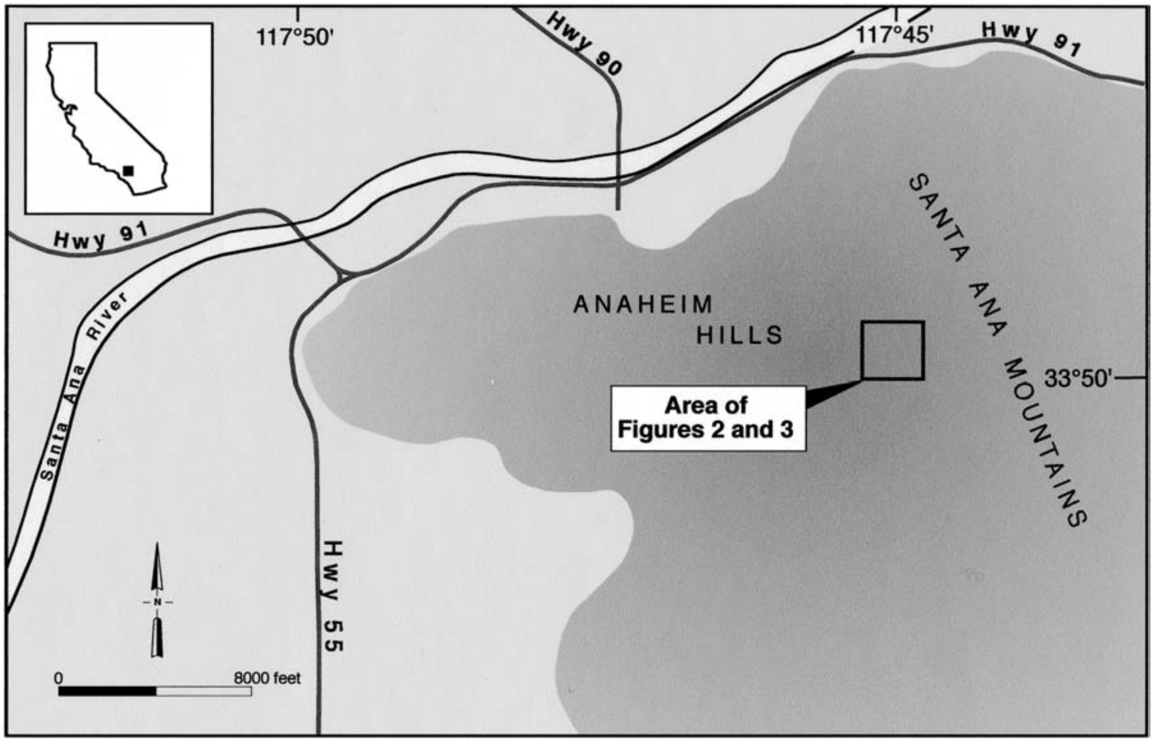

Figure 1. The Santiago landslide is located in the northern Santa Ana Mountains of southern California. 1 ft = 0.3048 m.

earthquakes and found evidence of four prehistoric, graben-opening events that the author interpreted as paleoseismic in origin. McCalpin and Hart (2001) interpreted sackungen deposits in the San Gabriel Mountains of southern California as paleoseismic in origin and compared graben-opening events with paleoseismic events recorded at nearby fault trench sites.

Jibson (1996) suggested that sackungen might be useful as paleoseismic sites only if landsliding that resulted from high groundwater can be analytically precluded. However, few studies have analytically demonstrated a seismic origin for these features. If ridge-top grabens in seismically active regions develop and activate solely in response to strong seismic ground-shaking, the in-fill deposits would indeed provide a paleoseismic record. However, if these features also activate by aseismic landsliding resulting from elevated groundwater, then their use in paleoseismic studies would be severely limited.

GEOLOGIC SETTING

The geology of the Anaheim Hills area is characterized by a northward-dipping section of sandstone and siltstone of the Miocene-age Puente Formation (Schoellhamer et al., 1981). Our field mapping of the Santiago landslide and adjacent parts of the Anaheim Hills indicates that bedding dips range from 7° to 25° to the north, and strikes range from northeast to northwest (Figure 2). The Santiago landslide apparently failed along a surface aligned roughly parallel or sub-parallel to bedding within the Puente Formation.

The Santiago landslide occurred within the Soquel Member and uppermost part of the La Vida Member of the Puente Formation. The sandstone of the Soquel Member consists of multiple, fining-upward sequences of very coarse- to medium-grained sandstone that is poorly cemented and weak; the sandstone is locally interbedded with siltstone. The siltstone of the underlying La Vida Member is interbedded with very thin beds of fine-grained, ripple-laminated sandstone. These rocks were deposited in a submarine fan environment within the rapidly subsiding Los Angeles basin during Miocene time (Critelli et al., 1995; Bjorklund et al., 2002).

Beginning in Pliocene time, compressional uplift of the Santa Ana Mountains (Gath and Grant, 2003) produced tilting of the Tertiary sedimentary section in the Anaheim Hills area. Recent mapping of a series of fluvial terraces directly west of the Anaheim Hills showed that uplift of the

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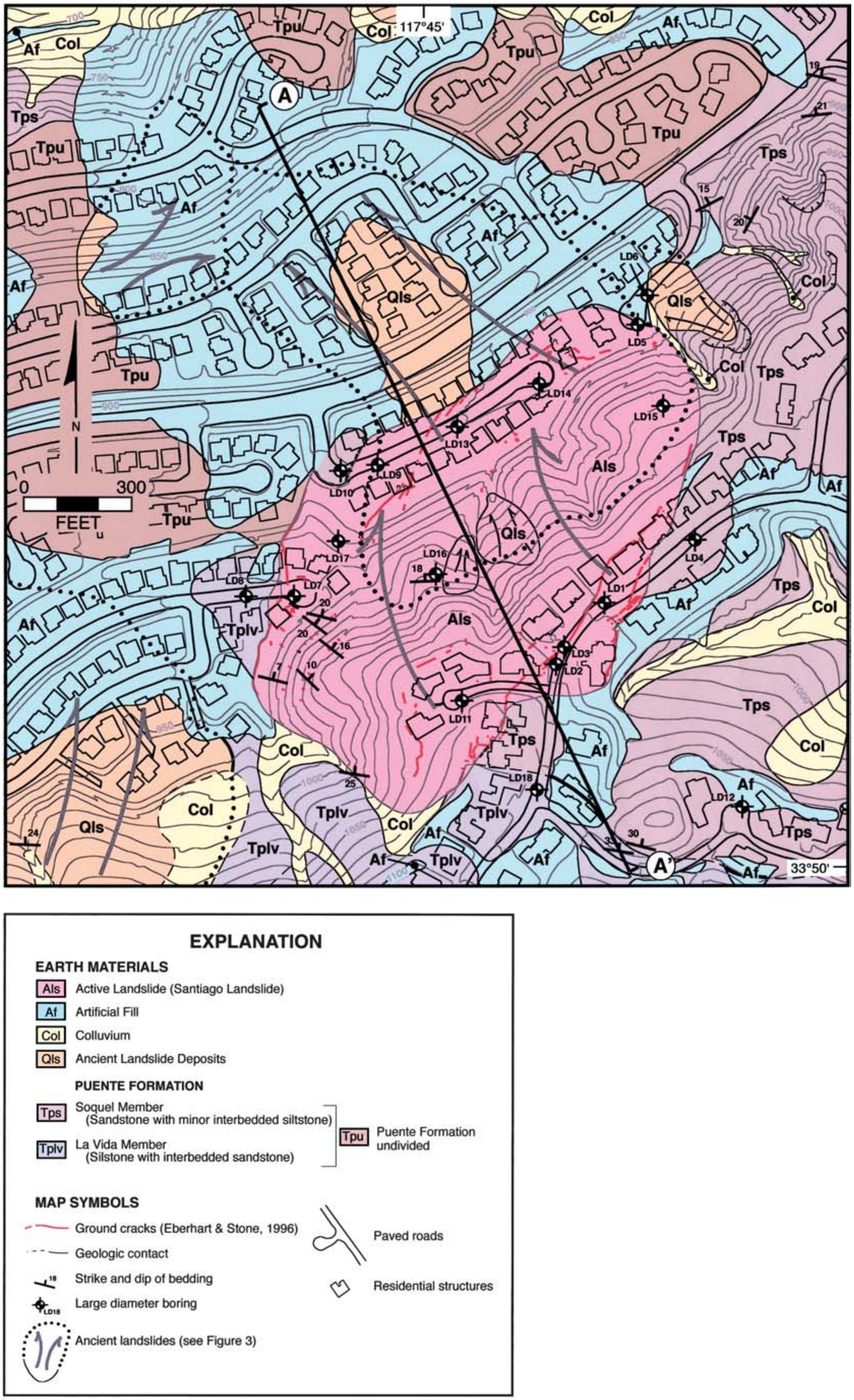
Figure 2. Geologic map of the Santiago landslide and surrounding region. Base map shows the topography during 1993 with elevations in feet above mean sea level. 1 ft = 0.3048 m.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EXPLANATION
EARTH MATERIALS
Als Active Landslide (Santiago Landslide)
Af Artificial Fill
Col Colluvium
Qls Ancient Landslide Deposits
PUENTE FORMATION
Tps Soquel Member
(Sandstone with minor interbedded siltstone)
Tplv La Vida Member
(Silstone with interbedded sandstone)
Tpu Puente Formation undivided
MAP SYMBOLS
Ground cracks (Eberhart & Stone, 1996)
Geologic contact
Strike and dip of bedding
Large diameter boring
Ancient landslides (see Figure 3)
Paved roads
Residential structures

Santa Ana Mountains has continued into Quaternary time (Gath and Grant, 2002). It is hypothesized that blind thrust faults are responsible for this active uplift, and that these faults might produce large-magnitude earthquakes.

Strong seismic shaking in the Anaheim Hills area results primarily from earthquakes on nearby strike-slip and thrust faults. Major earthquakes on the Elsinore and Whittier faults are capable of producing peak ground accelerations in the range of 0.39 to 0.46 g in the Anaheim Hills (Boore et al., 1997). The Elsinore fault has a recurrence interval for large-magnitude (ground-rupturing) earthquakes of approximately 200 years (Treiman and Lundberg, 2003). The Whittier fault has a recurrence interval of 760 (+640, –274) years (Working Group on California Earthquake Probabilities, 1995). Earthquakes on nearby blind thrust faults, such as the Puente Hills blind thrust system (Shaw et al., 2002), can produce peak ground accelerations in the range of 0.2 to 0.3 g in the Anaheim Hills. Dolan et al. (2003) identified at least four large-magnitude (M_w 7.2 to 7.5), Holocene earthquakes on the Puente Hills system. Because strong seismic ground shaking likely affected the Anaheim Hills area repeatedly during late Quaternary time, it could have contributed to landsliding and opening of the ridge-top graben.

Mass grading of the Anaheim Hills area during the 1970s filled drainage valleys and excavated spur ridges to develop level building pads and roads for residential development. The toe of the Santiago landslide lies within a part of the development where the topography was highly modified by grading. Although less-extensive grading was completed along the northeast-trending ridgeline at the head of the landslide, the subtlest geomorphic features were obliterated or substantially altered.

GEOMORPHIC EVALUATION

We evaluated the pre-development geomorphology by interpreting stereo pairs of historical aerial photographs. Drainage development and incision followed the uplift of the Anaheim Hills area, and several large, deep landslides failed into the incised valleys. These landslides are depicted on our photogeologic map (Figure 3). Over time, erosion and drainage incision modified the morphology of these deep landslides.

The upper part of one of these Quaternary landslides (landslide A in Figure 3) coincides with the lower part of the modern Santiago landslide. Drainage incision has dissected the body of the ancient landslide and partially obscured the morphology. However, the dissected head scarp of the ancient landslide is still clearly evident.

Directly southeast of the head scarp of landslide A, a well-developed graben with a prominent, northwest-facing scarp and more-subdued, southeast-facing scarp crosses the ridge obliquely. Between these scarps is an elongate depression that forms the axis of the graben and has a dark appearance on the aerial photographs. We interpret the dark tones within the graben as evidence of lush vegetation, perhaps grasses, that flourished in the thick colluvium that filled the depression. This contrasts with the sparser vegetation on the surrounding parts of the ridge where the soil is thin.

The head of the Santiago landslide correlates closely with the ridge-top graben that is visible in the historical aerial photographs. Based on the map relationships with landslide A and the ridge-top graben, we hypothesize that the graben developed as a result of the upslope progression of landsliding during late Quaternary time.

SUBSURFACE INVESTIGATION OF THE SANTIAGO LANDSLIDE

We conducted a subsurface investigation consisting of downhole logging of 18 large-diameter bucket auger borings drilled within the head, toe, and body of the Santiago landslide and within adjacent areas off the landslide. The boring locations are shown in Figure 2. The borings drilled within the body and toe of the landslide encountered a basal rupture surface with a well-developed gouge bounded by highly polished, striated surfaces (Figure 4). The thickness of the basal rupture gouge in these borings ranges from 0.1 to 3 ft (0.03 to 0.9 m).

By contrast, the borings within the ridge-top graben encountered a basal rupture surface with less gouge development; the thickness of the observed clay gouge ranges from 0.1 to 1 in. (0.25 to 2.5 cm). In the ridge-top graben area, numerous open fractures, colluvium-filled fractures, and steeply dipping shears with normal offsets were encountered above the basal rupture surface.

The log of boring LD-3 (Figure 5) provides a good example of the geology exposed within borings in the ridge-top graben area. In the upper 3 ft (0.9 m), the boring encountered artificial fill placed during mass grading. Below the fill is an 11 ft (3.4 m) thick deposit of colluvium. Below the colluvium, the sandstone has abundant open fractures and colluvium-filled fractures that widen upward; one of these fractures has a distinct normal offset. At a depth of 35 ft (10.7 m), the polished and striated basal rupture surface of the landslide has a relatively thin, 0.1 to 1.0 in. (0.25 to 2.5 cm) thick, clay gouge.

In boring LD-2, we encountered thick colluvium and colluvium-filled fractures up to 1.5 ft (0.5 m) wide that extend to a depth of approximately 24 ft (7.3 m). These fractures strike roughly parallel to the ridge-top graben. The fractures in the ridge-top graben area apparently filled with colluvium after earlier graben-opening events.

RAINFALL AND GROUNDWATER

The Santiago landslide and associated ridge-top graben failed during a period of intense rainfall during December

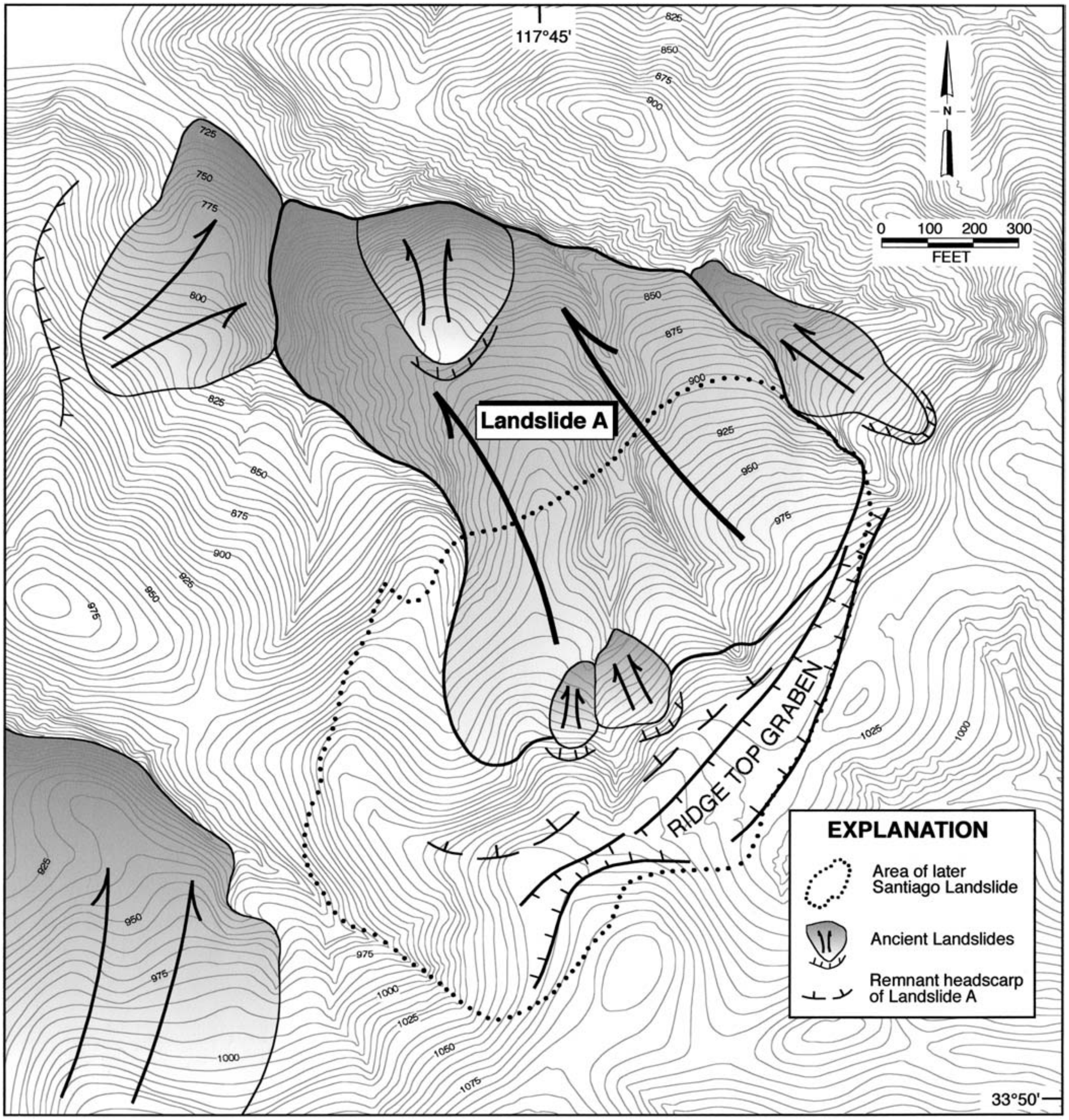

Figure 3. A photogeologic map of ancient landslides in the vicinity of the Santiago landslide. Topographic base shows conditions before mass grading. The elevations are in feet above mean sea level. 1 ft = 0.3048 m.

1992 and January 1993. Fifteen inches (38 cm) of rain, 102% of the 14.7-in. (37.3-cm) average annual rainfall for Orange County, fell during those two months (Figure 6). Rainfall during the previous year was also above average and undoubtedly contributed to elevated groundwater conditions. Figure 6 shows the yearly rainfall record for two nearby rainfall stations. Rainfall during the winter of 1992–1993 was exceptionally high when compared with the rainfall record from preceding years.

Piezometer data from Eberhart and Stone (1996) indicate that groundwater levels were elevated within the landslide mass and surrounding area at the time of failure (Figure 7). Subsequent installation of dewatering wells and horizontal drains has lowered groundwater

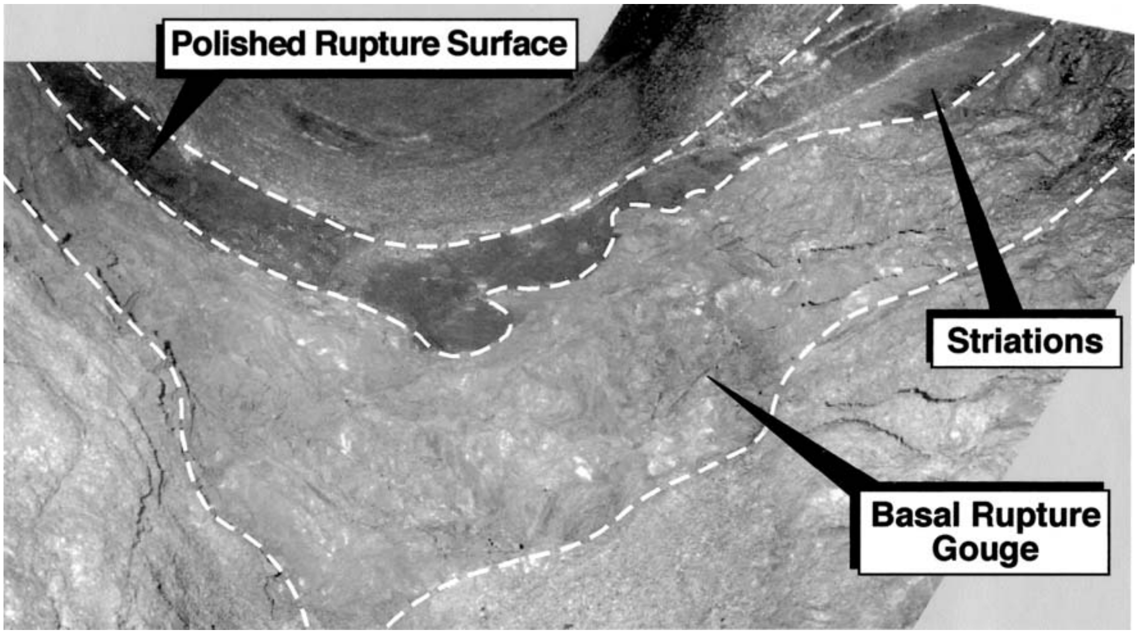

Figure 4. Photograph looking upward at the basal rupture surface of the Santiago landslide in boring LD-15 located within the central portion of the landslide. Note the polished, striated, upper-bounding surface that overlies a thick, cohesive gouge.

levels and substantially improved the stability of the landslide mass (McLarty and Lancaster, 1999b). The Santiago Landslide has not moved since completion of the dewatering system.

Little historical data are available regarding the groundwater conditions in the Anaheim Hills area before development. Early geotechnical investigations did not include installation of piezometers to evaluate the groundwater levels. Exploratory borings drilled before development were few, widely spaced, and generally shallow; most did not encounter groundwater. However, earlier investigations of the Santa Ana Mountains showed springs in the area of landslide A (Schoellhamer et al., 1954). Permeable strata that are exposed in the vicinity of the Santiago landslide can be traced up-dip through the subsurface to a south-facing, anti-dip slope where recharge occurs.

If landslides and associated ridge-top graben in the Anaheim Hills area are currently being activated during wet winters (such as 1992–1993), then it is highly likely that they would have been activated during the even wetter periods of late Quaternary time. Several paleoclimatic studies conducted in southern California have found evidence of wet periods during late Pleistocene and Holocene time. Templeton (1964, described in Stout, 1977) evaluated the latest Pleistocene rainfall history of southern California using dendrochronologic analysis of cypress samples recovered from the La Brea tar pits and concluded that average annual precipitation during a late Pleistocene wet period (14.90 ka to 14.89 ka) ranged from two to five times the current average annual rainfall for Los Angeles. Quade et al. (2003) studied wetland deposits in southern Nevada and found evidence for three late Pleistocene-to-Holocene wet periods, dated at <26.3 to 16.4 ka, 14.5 to 12.3 ka, and 11.6 to 9.5 ka, when groundwater recharge and discharge from desert springs was high. Miller et al. (2001) studied fan development of debris flow at Silurian Lake in the Mojave desert and found evidence of a wet period between 6.5 and 6.3 ka. Owen et al. (2003) dated latero-frontal moraines in the San Bernardino Mountains of southern California and found four glacial advances dated at 20 to 18 ka, 16 to 15 ka, 13 to 12 ka, and 9 to 5 ka; the authors further concluded that these glacial advances occurred during periods of increased winter precipitation and decreased summer temperatures. Clearly, the late Quaternary climate included wet periods when groundwater recharge rates were relatively high, increasing the probability of aseismic activation of deep-seated landslides and ridge-top grabens.

LIMIT-EQUILIBRIUM ANALYSES

Although the late Quaternary paleohydrologic and paleoseismic conditions that resulted in the upslope progression and graben development are not known directly from this study, we evaluated the contribution of both strong seismic shaking and elevated groundwater by performing limit-equilibrium slope-stability analysis on cross section A-A′. Specifically, we used the pre-grading profile and modeled landslide A and the ridge-top graben as a single block with a tension crack at the upslope end. These analyses were performed using three different groundwater levels (Figure 8). The highest groundwater

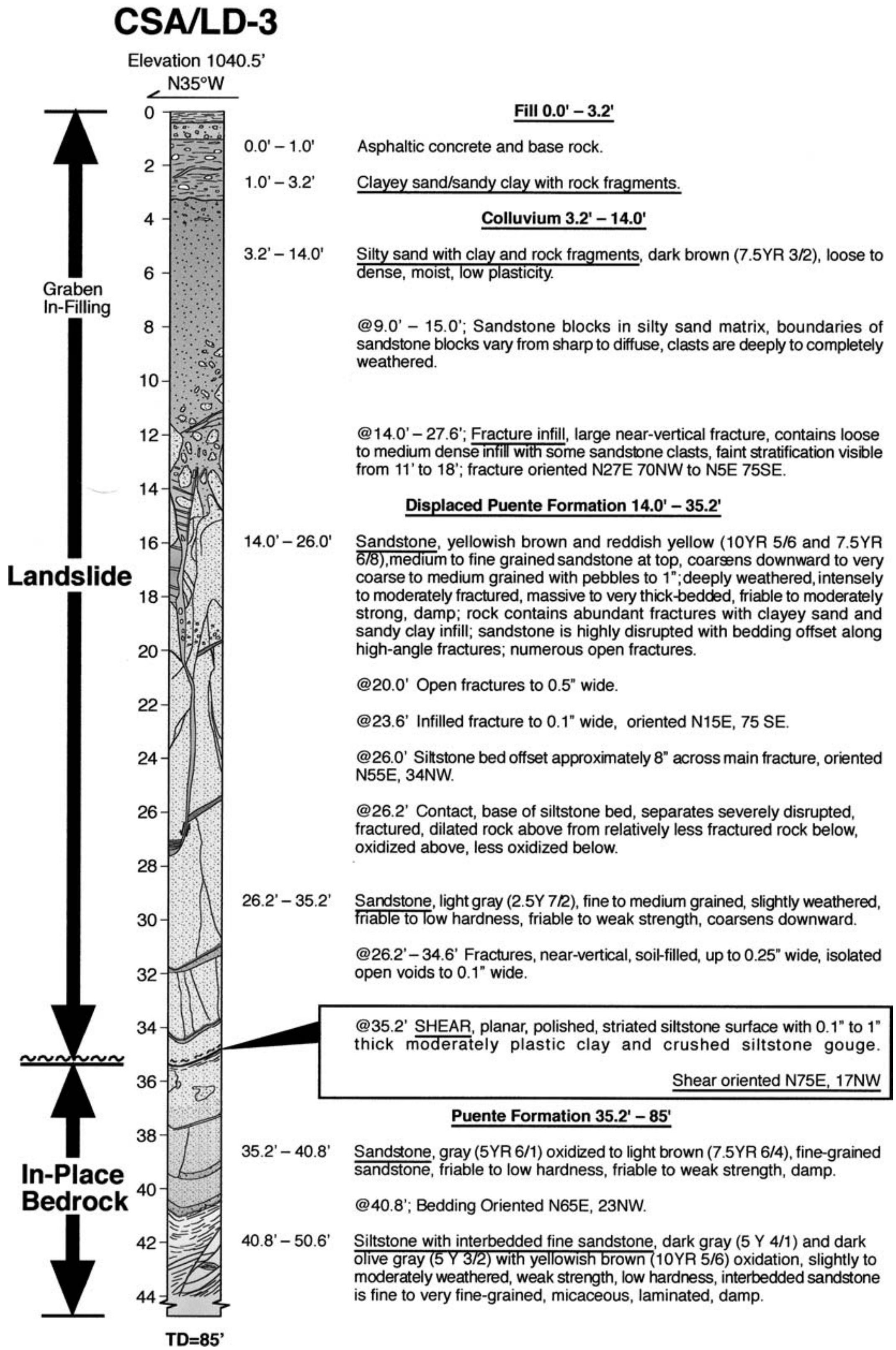

Figure 5. Log of boring LD-3 within the ridge-top graben. Note the thick accumulation of colluvium and steeply dipping, colluvium-filled fractures. 1 ft = 0.3048 m.

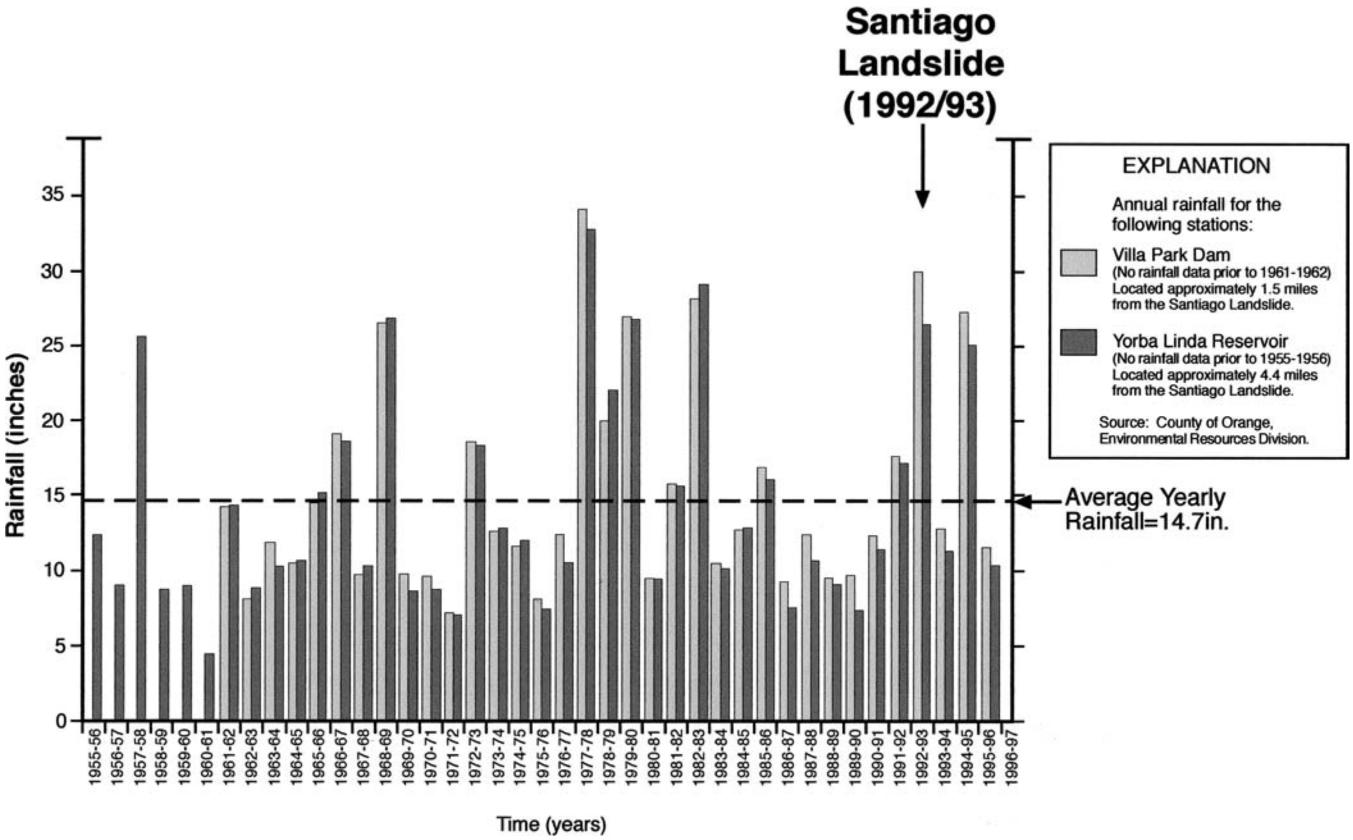

Figure 6. Rainfall records for stations located within 5 miles (8 km) of the Santiago landslide. 1 in. = 25.4 mm.

level corresponds to the level at the time of failure during January 1993. The lowest groundwater level approximates conditions during a dry period, when groundwater levels were below the rupture surface of the landslide. The third groundwater level is a hypothetical intermediate piezometric surface used to complete the analysis. To evaluate displacement resulting from seismic ground motion, we used a computer program by Jibson and Jibson (2002) that incorporates the methods of both Newmark (1965) and Bray and Rathje (1998). The seismic-displacement input-parameters are provided on Table 1, and the results of our analysis are shown on Table 2.

DISCUSSION

Our subsurface observations support the hypothesis that a well-developed, ridge-top graben is present at the head of the Santiago landslide. The presence of a thick accumulation of colluvium is not easily explained in a ridge-top setting without graben development. Open and colluvium-filled vertical fractures, as well as shears having normal displacements, also indicate a history of extensional deformation of the ridgeline.

A representative cross section (A-A′, Figure 7) shows our interpretation of the subsurface relationships between landslide A, the ridge-top graben, and the Santiago landslide. The development of a thick, basal rupture gouge in the body and toe of landslide A implies that either this ancient landslide has experienced considerably more displacement than the ridge-top graben or that the basal rupture surface followed a weak bed that thinned toward the ridge-top. The development of a thick, basal rupture gouge would require repeated displacements that would total more than the approximately 1-ft (0.3-m) maximum displacement that was recorded during the 1992–1993 event. The geomorphology of the ancient landslide that is visible in aerial photographs before development also implies that landslide A has experienced considerable, cumulative displacement. Thus, we propose a model in which landslide A originally failed without involving the ridgeline and development of the graben followed as a result of upslope progression of the landsliding. This progression likely resulted from development of a steep head scarp and loss of lateral support along the ridgeline.

Our limit-equilibrium analysis confirms that at the highest groundwater level, the landslide and graben activated, as they did during January 1993; the calculated seismic displacements at this groundwater level are large (3.2 m to 8.1 m). At the intermediate and low ground-

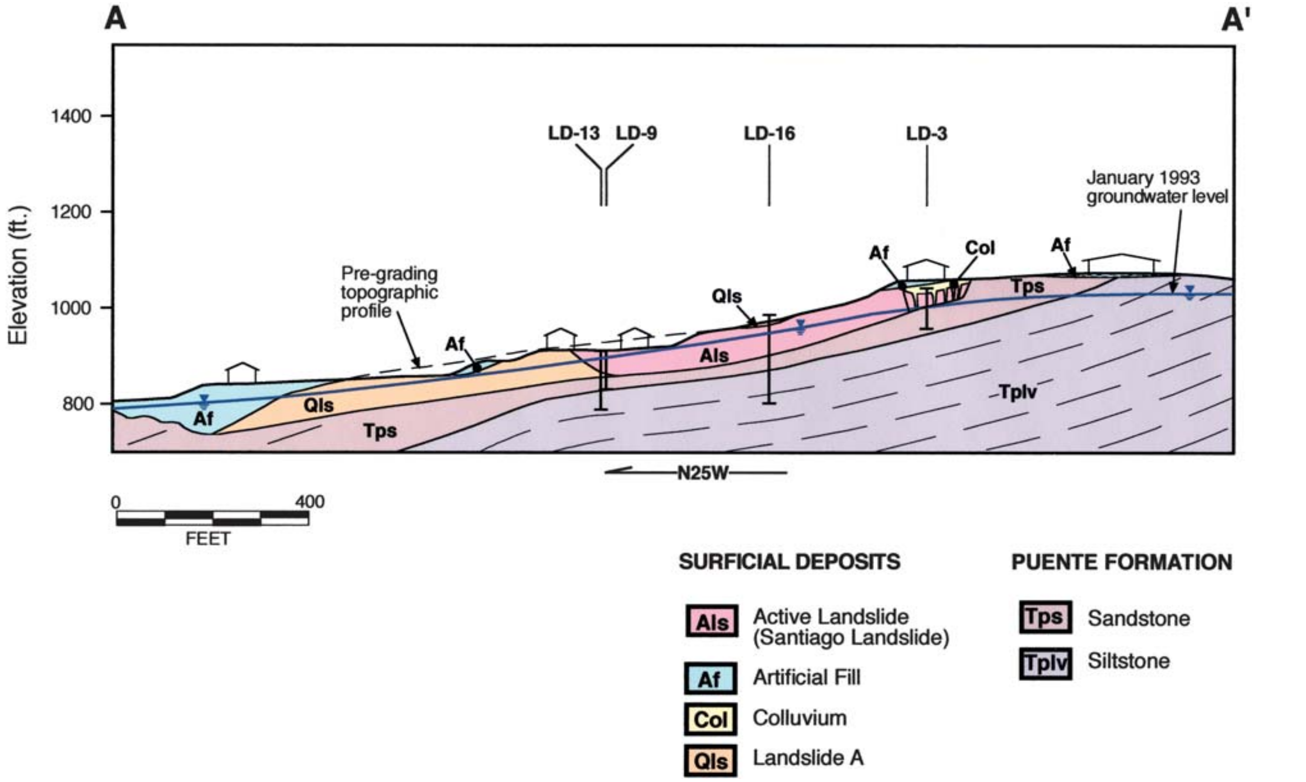

Figure 7. Cross section A-A′ illustrating the subsurface relationships between the Santiago landslide and landslide A. Also note the high groundwater levels during January 1993 when the Santiago landslide was active. 1 ft = 0.3048 m.

water levels, our analysis shows that the landslide and graben remain static unless triggered by seismic ground motion. Therefore, our analysis shows that past activation of landslide A and the associated ridge-top graben likely occurred in response to either high groundwater or strong seismic ground motion.

CONCLUSIONS AND IMPLICATIONS FOR PALEOSEISMIC STUDIES

The Santiago landslide and the associated ridge-top graben provide an example of the re-activation of a ridge-top graben by aseismic landsliding related to elevated groundwater conditions. Based on our limit-equilibrium analyses, both elevated groundwater and strong seismic shaking have likely triggered previous movement episodes of the landslide and the ridge-top graben. Colluvial wedges preserved within the ridge-top graben and produced by these very different triggering events would be indistinguishable and could be misinterpreted as representing the late Quaternary paleoseismic record. Therefore, we conclude that ridge-top graben deposits should be used to date paleoseismic events only if the potential for activation by aseismic landsliding associated

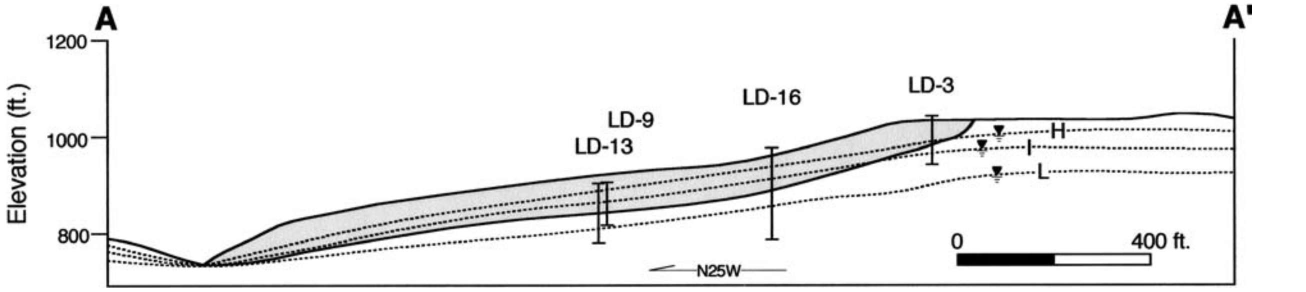

Figure 8. Generalized cross section A-A′ used for limit-equilibrium analyses. The topographic profile depicts conditions before mass grading. The static factors of safety (FS) for the three groundwater conditions are: 1.0 for high (H), 1.15 for intermediate (I), and 1.3 for low (L) groundwater conditions. 1 ft = 0.3048 m.

Table 1. *Seismic ground motion parameters.*

Fault	Distance to Fault (km)	Mw	PGA* (g)
Elsinore	6.5	6.7	0.46
Whittier	6.6	6.8	0.39

*Boore et al. (1997).

Table 2. *Seismic-displacement calculation results.*

Groundwater Level	Ky	Estimated Displacement
High	0.001	126 to 310 in. (3.2 to 7.9 m)[1] 319 in. (8.1 m)[2]
Intermediate	0.03	70 to 172 in. (1.8 to 4.4 m)[1] 34 in. (0.9 m)[2]
Low	0.055	43 to 138 in. (1.1 to 3.5 m)[1] 19 in. (0.5 m)[2]

[1]Estimated displacements by method of Bray and Rathje (1998).
[2]Estimated displacements by method of Newark (1965).

with intense rainfall and high-groundwater conditions can be clearly precluded.

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EXPLANATION

(LOCATIONS APPROXIMATE)

P-28	OBSERVATION WELL
PZ-5	STANDPIPE PIEZOMETER
DW-38	VERTICAL DEWATERING WELL
H-69	HORIZONTAL DEWATERING WELL Note: Dashed where drilled but not cased
CH-2 and HD-16	HORIZONTAL DEWATERING WELL Note: Dashed where drilled but not cased
SI-10	INCLINOMETER

Note: All locations are approximate.

Approximate Scale in Feet

LOCATION PLAN
SGHAD Monitoring/Dewatering Facilities
Santiago Geologic Hazard Abatement District
Anaheim, California

By: jbd	Date: Dec. 2012	Project No. 3-212-1024
amec		Plate

SANTIAGO GHAD ASSESSMENT PROPOSAL: AN IMPROVED APPROACH

Hillard Kaplan, Ph.D.
Economic Science Institute
Chapman University

ASSESSMENT PRINCIPLES

- Assessment be apportioned according the benefit received due to the services of the GHAD
- The benefit is defined as the cost avoided from the potential reactivation of the landslide if the GHAD services were discontinued
- Apportionment of the cost avoided is best evaluated by the distribution of costs incurred during the previous landslide that resulted in the creation of the Santiago GHAD
- Two major sources of evidence:
  - 1) Banner Lawsuit
  - 2) Delmonico Settlement

SERVICES PROVIDED TO ALL PARCELS AND CITY PROPERTY IN GHAD

- 1. Protection from landsliding and ground deformation.
- 2. Protection from loss of street/transportation access.
- 3. Protection from loss of utilities an associated services.
- 4. Groundwater seepage management, providing protection for properties and improvements.
- 5. Consequential protection of properties and improvements from diminution of value resulting from manifestation of geologic instability.

BANNER LAWSUIT PROPERTIES I

The Subject Properties

12. The Subject Properties are located at:

Homeowners' Name(s)	Property Address
Banner, Richard R. Banner, Simone A.	6775 E. Kentucky Avenue Anaheim, CA 92807
Beyer, Margaret E.	6911 E. Michigan Circle Anaheim, CA 92807
Boetel, James C.	6820 E. Kentucky Avenue Anaheim, CA 92807
Burandt, Kenneth Burandt, Margo	1070 Via De Rosa Anaheim, CA 92807
Chambers, John W. Chambers, Mary M.	6811 Kentucky Avenue Anaheim, CA 92807
Craig, James R. Craig, Esther B.	6768 E. Kentucky Avenue Anaheim, CA 92807
Cranston, Harold M. Cranston, Yvonne	990 S. Scripps Circle Anaheim, CA 92807
Cucunato, Charles M. Cucunato, Donna	980 S. Rutgers Circle Anaheim, CA 92807
Deiss, James E. Deiss, Diana	990 South Rutgers Circle Anaheim, CA 92807
DeWars, James W. DeWars, Barbara A.	6890 E. Kentucky Avenue Anaheim, CA 92807
Franco, Lionel Franco, Alice I.	980 South Loyola Dr. Anaheim, CA 92807
Gabriel, James A. Gabriel, Diane	6778 E. Kentucky Avenue Anaheim, CA 92807
Greer, William T. Greer, Doreen F.	6960 E. Michigan Circle Anaheim, CA 92807
Guziak, James J. Guziak, Cynthia N.	6851 E. Kentucky Avenue Anaheim, CA 92807
Hines, Logan J. Hines, Dorothy	6971 E. Michigan Circle Anaheim, CA 92807
Kerr, Paul G. Kerr, Jackie M.	6800 E. Kentucky Avenue Anaheim, CA 92807
Keys, Jerry C. Ruffulo-Keys, Cheryl	6881 E. Kentucky Ave. Anaheim, CA 92807
Kotrappa, Vijay Kotrappa, Kavitha	985 Grinnell Street Anaheim, CA 92807
Kumar, Vinod Kumar, Usha	6871 East Kentucky Aven Anaheim, CA 92807
Kunow, Bruce W.	6756 E. Kentucky Avenue Anaheim, CA 92807
Lamar, Robert C. Lamar, Carol Corinne	6910 E. Michigan Circle Anaheim, CA 92807
Lundin, Hoyt B. Lundin, Patricia A.	6735 Kentucky Avenue Anaheim, CA 92807
Lynn, Diane M.	6961 Via El Estribo Anaheim, CA 92807
McInally, Tom McInally, Lauren	957 S. Grinnell Street Anaheim, CA 92807
McPeek, Gerry V. McPeek, Frances M.	6975 E. Rutgers Drive Anaheim, CA 92807
Motzkus, John E. Motzkus, Nancy J.	6981 E. Michigan Circle Anaheim, CA 92807
Muratori, Edmond F. Muratori, Vera K.	6891 E. Kentucky Avenue Anaheim, CA 92807
O'Leary, Sher	6701 E. Kentucky Avenue Anaheim, CA 92807
Pirozzi, John E. Pirozzi, Lewana	991 Scripps Circle Anaheim, CA 92807
Reddish, Richard R. Reddish, Phyllis	6983 Rutgers Drive Anaheim, CA 92807
Reed, John M. Reed, Susan	6700 E. Johnstown Circle Anaheim, CA 92807
Ricasa, Marcelino R. Ricasa, Josefa L.	990 S. Loyola Drive Anaheim, CA 92807
Romanoski, Douglas B.	6961 E. Michigan Circle

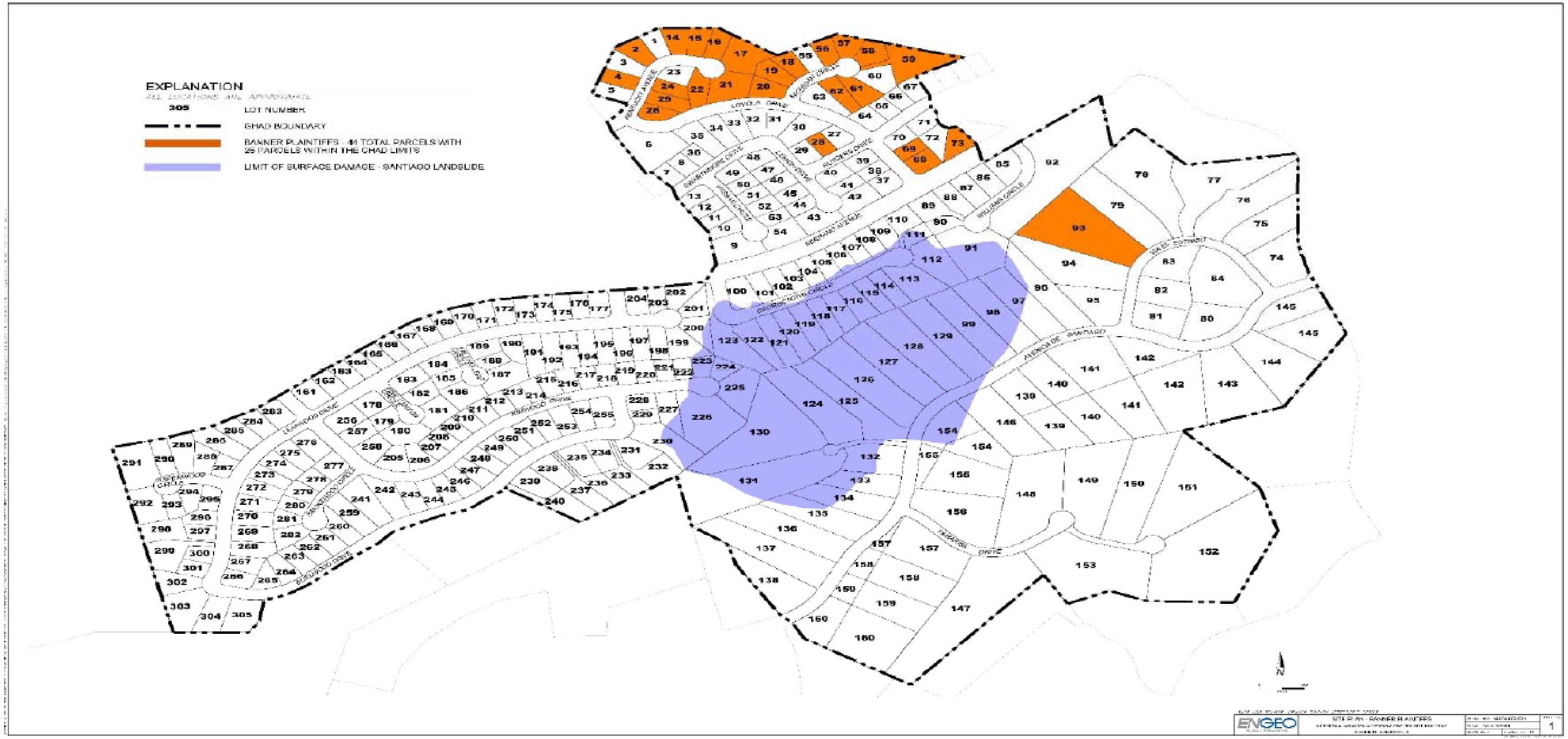
BANNER LAWSUIT PROPERTIES II

Romanoski, Donna A.	Anaheim, CA 92807
Russell, Albert E. Russell, Jeanne C.	6880 E. Kentucky Avenue Anaheim, CA 92807
Rynda, John J. Rynda, Carolyn	6909 E. Rutgers Drive Anaheim, CA 92807
Samperisi, Angelo Samperisi, Barbara A.	6810 E. Kentucky Avenue Anaheim, CA 92807
Schaefer, Roger J. Schaefer Christine	6930 Michigan Circle Anaheim, CA 92807
Schroer, Dietrich Schroer, Lenore	6990 E. Michigan Circle Anaheim, CA 92807
Scrivner, David G. Scrivner, Carol C.	6931 E. Michigan Anaheim, CA 92807
Siegmann, Greg Siegmann, Susan E.	6831 E. Kentucky Avenue Anaheim, CA 92807
Turner, John Turner, Dawn	981 S. Rutgers Circle Anaheim, CA 92807
Vadkis, Andrew Romero, Yolanda	6701 E. Johnstown Circle Anaheim, CA 92807
Welsh, Eric A. Welsh, Elizabeth B.	1060 S. Pegasus Street Anaheim, CA 92807
Wittenberg, Peter F. Wittenberg, Diane E.	6999 E. Rutgers Drive Anaheim, CA 92807

GEOGRAPHICAL DISTRIBUTION OF BANNER LAWSUIT PROPERTIES

Street Name	# of Subject Properties	Location
E. Kentucky Avenue	17	North of Serrano
E. Michigan Circle	9	North of Serrano
Vie de Rosa	1	South of Serrano
S. Scripps Circle	2	North of Serrano
S. Rutgers Circle	2	North of Serrano
E. Rutgers drive	3	North of Serrano
S. Loyola Dr.	2	North of Serrano
Grinnell Street	2	North of Serrano
Via El Estribo	1	South of Serrano
E. Johnstown Circle	2	North of Serrano
S. Pegasus St	1	South of Serrano
Total	42	
Number North of Serrano	40	
Number South of Serrano	2	

Banner Lawsuit Properties in orange: ENGEO Map

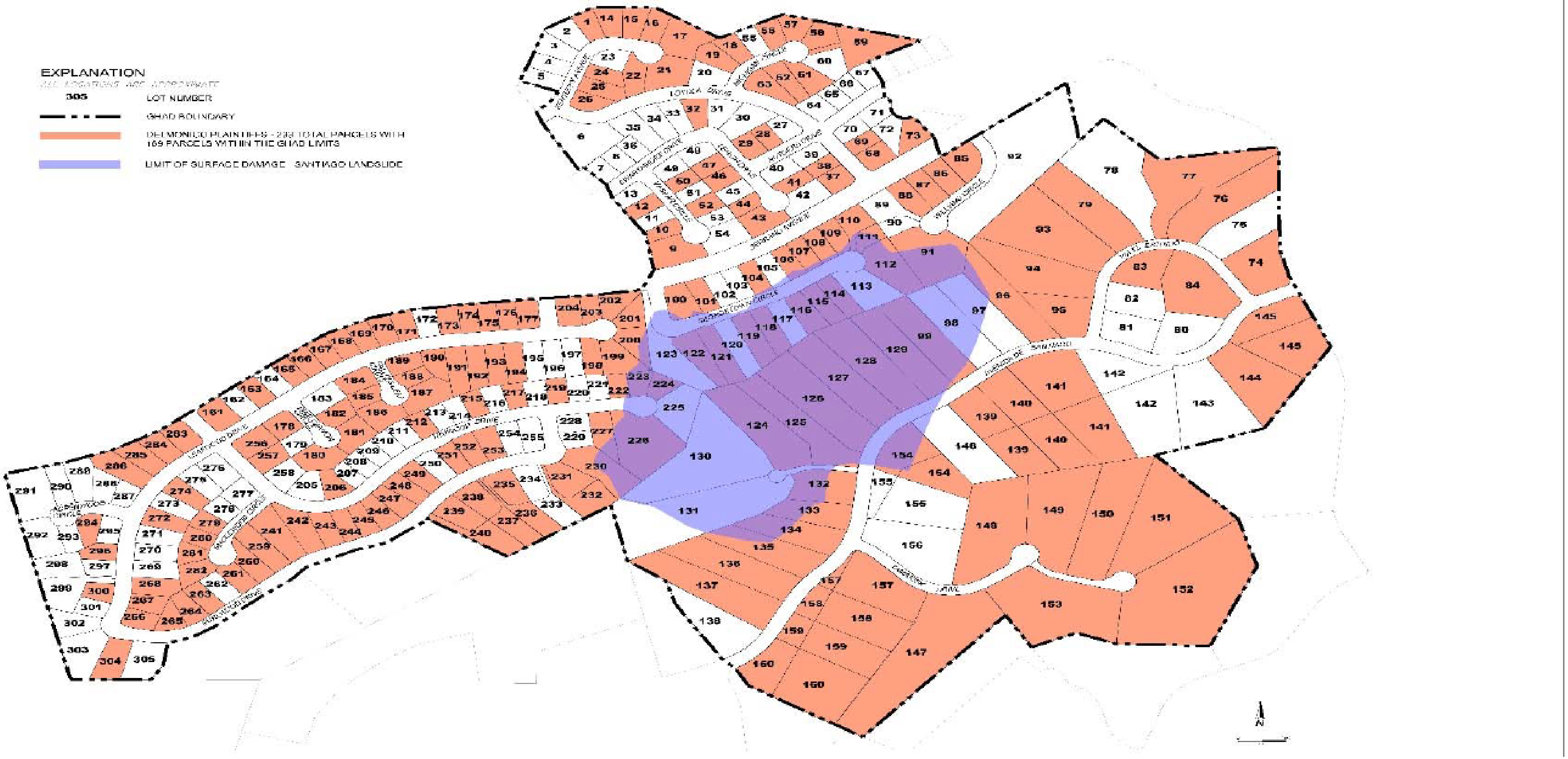


EXCERPT FROM BANNER LAWSUIT

20. The Affected Area is geologically unstable. At all times relevant herein, this fact was known or should have been known by Defendants. Defendants recognized or should have recognized that the Affected Area contained a prehistoric landslide(s) and high groundwater levels and that the cutting, filling, grading or other alteration of the natural soil, changes in drainage, the surface water and groundwater flow, and the introduction of water into the subsurface could trigger landslide movement in the Affected Area.

33. Each of the developments and subdivisions necessarily required the importation of large quantities of water into the Affected Area and required vast changes to the natural soil. Defendants were aware of this fact and the topographical and geological features of the Affected Area which, as set forth herein, were incompatible with such development, when they approved all aspects of the development of each tract individually and the area as a whole, and for each individual parcel therein, including the Subject Properties.

Delmonico Lawsuit Properties in orange: ENGE0 Map



DAMAGES CLAIMED IN BANNER LAWSUIT

113. The Landslide has proximately caused:

- the imminent destruction of the Homeowners' homes;
- loss of use of the Subject Properties; and
- loss of value of the Subject Properties.

114. Continuing movement of the Hillside has caused the Homeowners' homes to deteriorate:

- some homes are so damaged, they may need to be demolished to avoid hazard;
- some homes are cracked and distressed even though still intact;

118. The damages of Homeowners exceed $300,000,000.

KNOWN DAMAGES TO CITY PROPERTY, NORTH OF SERRANO

- Sewer Rupture – Vassar Circle
- Water line break – E. Kentucky Avenue
- Serrano Avenue

Hiroshi Fujisaki
Judge of The Los Angeles Superior Court
Retired
Action Dispute Resolution Services
2049 Century Park East, Suite 350
Los Angeles, California 90067-3239

Tel (310) 201-0010

Fax (310) 201-0016

December 22, 1999

Re: Allocation of Anaheim Hills Litigation Proceeds

Claimant: Muratori
Property: 6891 E. Kentucky Avenue

I have evaluated your claims, together with the data provided to me by the remediation cost analysis experts and real estate appraisal expert retained by your attorneys, and my visual site inspection. The data considered included the estimated costs of future repairs of landslide damages, loss of value, past landslide repairs, evacuation expenses, easement impact, emotional distress, and factors unique to individual plaintiffs.

The net available litigation proceeds are unfortunately insufficient to compensate each plaintiff to the full extent of their claims. Each plaintiff's claim was quantified monetarily, and calculated into a ratio to the total claims of all of the plaintiffs. The allocated sum is the percentage of the litigation proceeds which reflects the ratio of a plaintiff's claim to the total claims of all of the plaintiffs.

The allocated sum available for distribution is dependent upon the actual net litigation proceeds available for distribution after deduction of expenses of this process, thus may be adjusted upon final distribution.

The allocated sum for your claim is $27,971.62.

As stated in my previous letter, any questions regarding this allocation must be in writing. I will attempt to respond within five business days. If, after receiving my response, you want an individual hearing regarding my allocation to you, I must receive your written request for such a hearing no later than ten days from the date of my letter setting forth the allocation or you will have waived your right to such a hearing. Your written request must set out each issue about which you wish to be heard. My secretary will advise you of the time and place for the hearing.

Anyone who requests a hearing will bear all expenses associated with the proceeding. All time incurred by me, the geotechnical consultant, the appraisers or the cost of repair estimators in preparing for and attending the hearing will be your personal responsibility. Based upon the issues you raise, I will estimate the amount of time the hearing is likely to take and the cost of the hearing must be paid in advance. Any shortfall due to the hearing running longer than I estimate will be deducted from your ultimate allocation. Any excess will be refunded to you. For your information, my time will be billed at my usual rate of $300 per hour. The appraisers' time will be billed at an hourly rate of $125, the cost of repair estimator will be billed at his hourly rate of $100.

A SETTLEMENT EXAMPLE (NORTH OF SERRANO)

PILLSBURY MADISON & SUTRO LLP

DELMONICO V. CITY OF ANAHEIM, ET AL.

ALLOCATION EXPLANATION

The letter from Judge Fujisaki sets forth the net dollar amount of your share of the settlement. To help explain the total value of your award, PILLSBURY MADISON & SUTRO LLP prepared this breakdown showing you the gross dollar value of your award.

Client Name:	Muratori	
Property Address:	6891 E. Kentucky Avenue	
GROSS AWARD		83,953
ALLOCATION OF DEDUCTIONS		
ATTORNEY FEES	21,129	
LITIGATION COSTS (Est'd)	13,248	
GHAD FUNDING	16,605	
TOTAL DEDUCTIONS	50,982	
NET AWARD*		**32,972**
RETAINER REFUND & ADVANCE (already distributed)	5,000	
ADDITIONAL AMOUNT TO BE DISTRIBUTED*		**$27,972**

*Plus or minus 3% due to expenses yet to be incurred and interest earnings accruing daily on the settlement proceeds.

INFORMATION OVERLOOKED IN ENGEO'S RECENT ASSESSMENT PROPOSAL

- Historical documents providing evidence of damages sustained from the Santiago Landslide in 1993-94
- Evidence showing extensive damage to properties outside the deformation zone, especially to the north of Serrano Avenue
- Damages to city property outside of Avenida de Santiago, and the risk to city property on Serrano Avenue and to the north
- A proper assessment should assess all properties in relation to the area and the city both for its properties in the area and for transport access to adjacent areas.

Problems with ENGEO Assessment Approach

- No underlying mathematical models justify the apportionment proportions
- Approach undervalues the importance of seepage damage as can be seen by distribution of plaintiff damages and the ongoing seepage in wells 23 and 25
- It assesses all the unimproved land on the slope to each owner, leading to exaggerated assessments on people with large lots on the slope
- Because of the overassessment of the slopes, the city is underassessed (only 9%). City properties actually represent about 38% of the improved properties.
- **The proposed budget is highly inflated at $466,900 when it should be closer to $235,000**

Unimproved Land for Highest Assessed Property

AN IMPROVED ECONOMICALLY-JUSTIFIED FORMULA FOR ASSESSMENT

- Following Engeo, properties are divided into whether they are in the seepage zone (252 properties) or in the deformation zone (62 properties)
- Properties in the deformation zone are assigned twice the benefit (2) of properties in the deformation zone (1)
- Benefit is multiplied by lot acreage up to maximum of 20,000 sq ft. Lots of greater than 20,000 sq/ft are assigned 20,000 sq ft.
- The sum of all city properties are assigned 30% of the total benefit, while constituting over 38% of improved land

- Definition of terms:
  - A_i= Area in lot of GHAD property owner if < 20,000 sq ft; 20,000 if greater than 20,000 sq ft
  - T = Total Annual Costs for GHAD services
  - T_c = Annual Costs for City = 0.3*T
  - T_i = Annual Costs for Property Owner *i* if in the seepage zone
  - $T_{j\,=}$ Annual Costs for Property Owner *j* if in the deformation zone
  - $T = T_c + \sum_1^{252} T_i + \sum_1^{62} T_j$
  - T_c = Annual Costs for City = 0.3*T
  - T_i = Annual Costs for Property Owner *i* if in the seepage zone $=.7*T*\frac{A_i}{\sum_1^{252} A_i + (2*\sum_1^{62} A_j)}$
  - $T_{j\,=}$ Annual Costs for Property Owner *j* if in the deformation zone = $=.7*T*\frac{2*A_j}{\sum_1^{252} A_i + (2*\sum_1^{62} A_j)}$

COST COMPARISON AT $227,000

Site Address	Kaplan Proposal at $227,000	Engeo Proposal at $227,000
Lowest Assessments		
1030 S RIMWOOD DR	$200.00	$76.81
987 S LOYOLA DR	$201.52	$77.40
992 S VASSAR CIR	$205.86	$79.06
6881 E RUTGERS DR	$205.87	$79.07
962 S VASSAR CIR	$206.73	$79.40
985 S LEHIGH DR	$209.14	$80.33
6909 E RUTGERS DR	$209.86	$80.60
972 S VASSAR CIR	$210.53	$80.86
Midrange Assessments		
6880 E KENTUCKY AVE	$342.15	$131.41
6930 E MICHIGAN CIR	$343.30	$131.85
6762 E LEAFWOOD DR	$344.30	$132.23
1006 S ASPENWOOD CIR	$348.00	$133.66
1018 S RIMWOOD DR	$348.94	$134.02
6691 E LEAFWOOD DR	$349.06	$134.06
6632 E LEAFWOOD DR	$349.08	$134.07
6758 E LEAFWOOD DR	$349.62	$134.28
Highest Assessments		
6831 E AVENIDA DE SANTIAGO	$1,358.43	$4,321.99
6920 E AVENIDA DE SANTIAGO	$1,358.43	$4,354.62
6919 E AVENIDA DE SANTIAGO	$1,358.43	$4,495.22
6901 E AVENIDA DE SANTIAGO	$1,358.43	$4,564.32
6899 E AVENIDA DE SANTIAGO	$1,358.43	$5,109.39
6907 E AVENIDA DE SANTIAGO	$1,358.43	$5,242.57
6891 E AVENIDA DE SANTIAGO	$1,358.43	$8,375.87
6881 E AVENIDA DE SANTIAGO	$1,358.43	$9,562.04

COST COMPARISON AT $330,000

Site Address	Kaplan Proposal at $330,000	Engeo Proposal at $330,000
Lowest Assessments		
1030 S RIMWOOD DR	$290.75	$111.67
987 S LOYOLA DR	$292.96	$112.52
992 S VASSAR CIR	$299.26	$114.94
6881 E RUTGERS DR	$299.29	$114.95
962 S VASSAR CIR	$300.53	$115.42
985 S LEHIGH DR	$304.04	$116.77
6909 E RUTGERS DR	$305.08	$117.17
972 S VASSAR CIR	$306.06	$117.55
Midrange Assessments		
6880 E KENTUCKY AVE	$499.07	$191.68
6930 E MICHIGAN CIR	$500.53	$192.24
6762 E LEAFWOOD DR	$505.90	$194.30
1006 S ASPENWOOD CIR	$507.27	$194.83
1018 S RIMWOOD DR	$507.45	$194.89
6691 E LEAFWOOD DR	$507.48	$194.91
6632 E LEAFWOOD DR	$508.25	$195.20
6758 E LEAFWOOD DR	$510.49	$196.06
Highest Assessments		
6831 E AVENIDA DE SANTIAGO	$1,974.81	$6,283.07
6920 E AVENIDA DE SANTIAGO	$1,974.81	$6,330.51
6919 E AVENIDA DE SANTIAGO	$1,974.81	$6,534.90
6901 E AVENIDA DE SANTIAGO	$1,974.81	$6,635.35
6899 E AVENIDA DE SANTIAGO	$1,974.81	$7,427.74
6907 E AVENIDA DE SANTIAGO	$1,974.81	$7,621.36
6891 E AVENIDA DE SANTIAGO	$1,974.81	$12,176.38
6881 E AVENIDA DE SANTIAGO	$1,974.81	$13,900.76

CONCLUSIONS

- ENGEO assessment proposal is not economically sound and suffers from five major flaws
- ENGEO assessment proposal is over-inflated and the goal should be to reduce rather than increase costs
- I offered an improved, economically sound, assessment formula
- Full Assessment list is attached/
- Request that community members be allowed to choose which assessment approach they wish to vote on

Site Address	Lot Square Footage (SF)	Zone	Kaplan Proposal at $227,000	Engeo Proposal at $227,000	Kaplan Proposal at $330,000	Engeo Proposal at $330,000	Engeo Proposal at $466,900
1030 S RIMWOOD DR	5889.1	Seepage	$200.00	$76.81	$290.75	$111.67	$157.99
987 S LOYOLA DR	5933.9	Seepage	$201.52	$77.40	$292.96	$112.52	$159.19
992 S VASSAR CIR	6061.6	Seepage	$205.86	$79.06	$299.26	$114.94	$162.62
6881 E RUTGERS DR	6062.1	Seepage	$205.87	$79.07	$299.29	$114.95	$162.63
962 S VASSAR CIR	6087.3	Seepage	$206.73	$79.40	$300.53	$115.42	$163.31
985 S LEHIGH DR	6158.4	Seepage	$209.14	$80.33	$304.04	$116.77	$165.22
6909 E RUTGERS DR	6179.5	Seepage	$209.86	$80.60	$305.08	$117.17	$165.78
972 S VASSAR CIR	6199.2	Seepage	$210.53	$80.86	$306.06	$117.55	$166.31
6915 E RUTGERS DR	6217.2	Seepage	$211.14	$81.09	$306.95	$117.89	$166.79
1058 S RIMWOOD DR	6230	Seepage	$211.58	$81.26	$307.58	$118.13	$167.14
1054 S RIMWOOD DR	6308.7	Seepage	$214.25	$82.29	$311.46	$119.62	$169.25
1038 S RIMWOOD DR	6309.6	Seepage	$214.28	$82.30	$311.51	$119.64	$169.27
980 S LOYOLA DR	6331.1	Seepage	$215.01	$82.58	$312.57	$120.05	$169.85
6845 E SWARTHMORE DR	6385.4	Seepage	$216.85	$83.29	$315.25	$121.08	$171.31
1034 S RIMWOOD DR	6388.2	Seepage	$216.95	$83.32	$315.39	$121.13	$171.38
6860 E AVE DE SANTIAGO	4366.73	Seepage	$148.30	$84.58	$215.59	$122.95	$173.96
1042 S RIMWOOD DR	6582.5	Seepage	$223.55	$85.86	$324.98	$124.81	$176.59
1050 S FALLING LEAF CIR	6600.5	Seepage	$224.16	$86.09	$325.87	$125.16	$177.08
6651 E SMOKEWOOD CIR	6633.2	Seepage	$225.27	$86.52	$327.48	$125.78	$177.95
6631 E LEAFWOOD DR	6675.3	Seepage	$226.70	$87.07	$329.56	$126.57	$179.08
983 S VASSAR CIR	6693.1	Seepage	$227.30	$87.30	$330.44	$126.91	$179.56
6631 E SMOKEWOOD CIR	6754.1	Seepage	$229.37	$88.10	$333.45	$128.07	$181.20
6835 E SWARTHMORE DR	6760.5	Seepage	$229.59	$88.18	$333.77	$128.19	$181.37
1007 S ASPENWOOD CIR	6763.6	Seepage	$229.70	$88.22	$333.92	$128.25	$181.45
6787 E LEAFWOOD DR	6776.5	Seepage	$230.14	$88.39	$334.56	$128.49	$181.80
1070 S RIMWOOD DR	6799	Seepage	$230.90	$88.68	$335.67	$128.92	$182.40
6825 E SWARTHMORE DR	6803.6	Seepage	$231.06	$88.74	$335.90	$129.01	$182.52
984 S LEHIGH DR	6824.8	Seepage	$231.78	$89.02	$336.94	$129.41	$183.09
6619 E LEAFWOOD DR	6877.2	Seepage	$233.56	$89.70	$339.53	$130.40	$184.50
1078 S RIMWOOD DR	6887	Seepage	$233.89	$89.83	$340.01	$130.59	$184.76
6609 E LEAFWOOD DR	6888.1	Seepage	$233.93	$89.84	$340.07	$130.61	$184.79
1074 S RIMWOOD DR	6894.6	Seepage	$234.15	$89.93	$340.39	$130.73	$184.97
1051 S FALLING LEAF CIR	6939.4	Seepage	$235.67	$90.51	$342.60	$131.58	$186.17
1024 S ASPENWOOD CIR	6957.7	Seepage	$236.29	$90.75	$343.50	$131.93	$186.66
963 S VASSAR CIR	7024	Seepage	$238.54	$91.62	$346.78	$133.19	$188.44
1050 S RIMWOOD DR	7037.7	Seepage	$239.01	$91.79	$347.45	$133.45	$188.81
6923 E RUTGERS DR	7067.1	Seepage	$240.00	$92.18	$348.91	$134.00	$189.59
6820 E KENTUCKY AVE	7109.5	Seepage	$241.44	$92.73	$351.00	$134.81	$190.73
1062 S RIMWOOD DR	7130.7	Seepage	$242.16	$93.01	$352.05	$135.21	$191.30
1082 S RIMWOOD DR	7136.4	Seepage	$242.36	$93.08	$352.33	$135.32	$191.45
1066 S RIMWOOD DR	7144.2	Seepage	$242.62	$93.18	$352.71	$135.46	$191.66
6761 E LEAFWOOD DR	7149.4	Seepage	$242.80	$93.25	$352.97	$135.56	$191.80
6681 E SMOKEWOOD CIR	7161.8	Seepage	$243.22	$93.41	$353.58	$135.80	$192.13
955 S LEHIGH DR	7218.2	Seepage	$245.14	$94.15	$356.37	$136.87	$193.65
1046 S RIMWOOD DR	7222.8	Seepage	$245.29	$94.21	$356.59	$136.96	$193.77
6757 E LEAFWOOD DR	7246.7	Seepage	$246.10	$94.52	$357.77	$137.41	$194.41
973 S VASSAR CIR	7255.6	Seepage	$246.41	$94.64	$358.21	$137.58	$194.65
6891 E RUTGERS DR	7300.3	Seepage	$247.92	$95.22	$360.42	$138.42	$195.85
970 S LOYOLA DR	7313.1	Seepage	$248.36	$95.39	$361.05	$138.67	$196.19
6661 E SMOKEWOOD CIR	7313.1	Seepage	$248.36	$95.39	$361.05	$138.67	$196.19
6639 E LEAFWOOD DR	7317	Seepage	$248.49	$95.44	$361.24	$138.74	$196.30
1099 S BURLWOOD DR	7338.3	Seepage	$249.21	$95.72	$362.29	$139.15	$196.87
6753 E LEAFWOOD DR	7375.1	Seepage	$250.46	$96.19	$364.11	$139.84	$197.86
1021 S ASPENWOOD CIR	7395.2	Seepage	$251.15	$96.46	$365.10	$140.22	$198.40
1051 S PINE CANYON CIR	7418.2	Seepage	$251.93	$96.76	$366.24	$140.66	$199.01
977 S LOYOLA DR	7443.2	Seepage	$252.78	$97.08	$367.47	$141.13	$199.68
982 S VASSAR CIR	7457.5	Seepage	$253.26	$97.27	$368.18	$141.41	$200.07
952 S VASSAR CIR	7468.8	Seepage	$253.65	$97.42	$368.74	$141.62	$200.37
6941 E MICHIGAN CIR	7544.7	Seepage	$256.22	$98.41	$372.48	$143.06	$202.41
965 S LEHIGH DR	7601.8	Seepage	$258.16	$99.15	$375.30	$144.14	$203.94
945 S LEHIGH DR	7610.3	Seepage	$258.45	$99.26	$375.72	$144.30	$204.17
953 S VASSAR CIR	7652.2	Seepage	$259.88	$99.81	$377.79	$145.10	$205.29
6717 E LEAFWOOD DR	7661.2	Seepage	$260.18	$99.93	$378.24	$145.27	$205.53
6871 E RUTGERS DR	7685.5	Seepage	$261.01	$100.24	$379.44	$145.73	$206.18
975 S LEHIGH DR	7725.3	Seepage	$262.36	$100.76	$381.40	$146.48	$207.25
1008 S BURLWOOD DR	7743.4	Seepage	$262.97	$101.00	$382.29	$146.83	$207.74
6800 E KENTUCKY AVE	7749.8	Seepage	$263.19	$101.08	$382.61	$146.95	$207.91
1048 S BURLWOOD DR	7761	Seepage	$263.57	$101.23	$383.16	$147.16	$208.21
1040 S FALLING LEAF CIR	7913.5	Seepage	$268.75	$103.22	$390.69	$150.05	$212.30
1052 S BURLWOOD DR	7939.1	Seepage	$269.62	$103.55	$391.96	$150.54	$212.99
6713 E LEAFWOOD DR	8055.9	Seepage	$273.59	$105.07	$397.72	$152.75	$216.12
6608 E LEAFWOOD DR	8068.2	Seepage	$274.00	$105.24	$398.33	$152.99	$216.45
6616 E LEAFWOOD DR	8079.9	Seepage	$274.40	$105.39	$398.91	$153.21	$216.76
1076 S BURLWOOD DR	8090.4	Seepage	$274.76	$105.52	$399.43	$153.41	$217.05

Site Address	Lot Square Footage (SF)	Zone	Kaplan Proposal at $227,000	Engeo Proposal at $227,000	Kaplan Proposal at $330,000	Engeo Proposal at $330,000	Engeo Proposal at $466,900
6749 E LEAFWOOD DR	8182.3	Seepage	$277.88	$106.72	$403.96	$155.15	$219.51
6841 E KENTUCKY AVE	8186.1	Seepage	$278.01	$106.77	$404.15	$155.22	$219.61
6850 E KENTUCKY AVE	8239.5	Seepage	$279.82	$107.47	$406.79	$156.23	$221.05
6729 E LEAFWOOD DR	8252.8	Seepage	$280.27	$107.64	$407.44	$156.49	$221.40
1015 S ASPENWOOD CIR	8255.5	Seepage	$280.36	$107.68	$407.58	$156.54	$221.48
6741 E LEAFWOOD DR	8275.9	Seepage	$281.06	$107.94	$408.58	$156.92	$222.02
6931 E MICHIGAN CIR	8286.3	Seepage	$281.41	$108.08	$409.10	$157.12	$222.30
6725 E LEAFWOOD DR	8306.1	Seepage	$282.08	$108.34	$410.08	$157.50	$222.83
971 S SCRIPPS CIR	8321.4	Seepage	$282.60	$108.54	$410.83	$157.79	$223.24
6801 E KENTUCKY AVE	8325.6	Seepage	$282.74	$108.59	$411.04	$157.87	$223.36
6733 E LEAFWOOD DR	8345.4	Seepage	$283.42	$108.85	$412.02	$158.24	$223.89
6737 E LEAFWOOD DR	8346.2	Seepage	$283.44	$108.86	$412.05	$158.26	$223.91
6961 E MICHIGAN CIR	8364.1	Seepage	$284.05	$109.09	$412.94	$158.60	$224.39
6721 E LEAFWOOD DR	8377.1	Seepage	$284.49	$109.26	$413.58	$158.84	$224.74
6745 E LEAFWOOD DR	8401.9	Seepage	$285.34	$109.59	$414.80	$159.31	$225.40
6705 E LEAFWOOD DR	8407.5	Seepage	$285.53	$109.66	$415.08	$159.42	$225.55
6811 E KENTUCKY AVE	8415.3	Seepage	$285.79	$109.76	$415.47	$159.57	$225.76
6765 E LEAFWOOD DR	8435.1	Seepage	$286.46	$110.02	$416.44	$159.94	$226.29
6885 E SWARTHMORE DR	8442.9	Seepage	$286.73	$110.12	$416.83	$160.09	$226.50
6709 E LEAFWOOD DR	8461.2	Seepage	$287.35	$110.36	$417.73	$160.44	$226.99
6746 E LEAFWOOD DR	8547.2	Seepage	$290.27	$111.48	$421.98	$162.07	$229.30
1026 S RIMWOOD DR	8567.4	Seepage	$290.96	$111.75	$422.98	$162.45	$229.84
997 S LOYOLA DR	8595.7	Seepage	$291.92	$112.12	$424.37	$162.99	$230.60
974 S LEHIGH DR	8603.5	Seepage	$292.18	$112.22	$424.76	$163.14	$230.81
6971 E MICHIGAN CIR	8722.9	Seepage	$296.24	$113.77	$430.65	$165.40	$234.02
6901 E RUTGERS DR	8735.5	Seepage	$296.66	$113.94	$431.27	$165.64	$234.35
1016 S BURLWOOD DR	8781.4	Seepage	$298.22	$114.54	$433.54	$166.51	$235.58
1020 S BURLWOOD DR	8827.3	Seepage	$299.78	$115.14	$435.81	$167.38	$236.82
1080 S BURLWOOD DR	8914.2	Seepage	$302.73	$116.27	$440.10	$169.03	$239.15
1088 S BURLWOOD DR	8930.5	Seepage	$303.29	$116.48	$440.90	$169.34	$239.58
1050 S PINE CANYON CIR	8985.8	Seepage	$305.17	$117.20	$443.63	$170.38	$241.07
1072 S BURLWOOD DR	8999.4	Seepage	$305.63	$117.38	$444.30	$170.64	$241.43
990 S LOYOLA DR	9001.6	Seepage	$305.70	$117.41	$444.41	$170.68	$241.49
1012 S BURLWOOD DR	9004	Seepage	$305.78	$117.44	$444.53	$170.73	$241.56
6664 E LEAFWOOD DR	9023.3	Seepage	$306.44	$117.69	$445.48	$171.10	$242.07
1024 S BURLWOOD DR	9037.1	Seepage	$306.91	$117.87	$446.16	$171.36	$242.44
1018 S ASPENWOOD CIR	9069.2	Seepage	$308.00	$118.29	$447.75	$171.97	$243.31
6640 E LEAFWOOD DR	9124.2	Seepage	$309.87	$119.01	$450.47	$173.01	$244.78
6881 E KENTUCKY AVE	9139.1	Seepage	$310.37	$119.20	$451.20	$173.29	$245.18
6810 E KENTUCKY AVE	9176	Seepage	$311.62	$119.68	$453.02	$173.99	$246.17
1068 S BURLWOOD DR	9193.7	Seepage	$312.23	$119.92	$453.90	$174.33	$246.65
1041 S PINE CANYON CIR	9203.8	Seepage	$312.57	$120.05	$454.40	$174.52	$246.92
6875 E SWARTHMORE DR	9245.2	Seepage	$313.97	$120.59	$456.44	$175.30	$248.03
1056 S BURLWOOD DR	9252.5	Seepage	$314.22	$120.68	$456.80	$175.44	$248.22
1060 S BURLWOOD DR	9257.2	Seepage	$314.38	$120.74	$457.03	$175.53	$248.35
6786 E LEAFWOOD DR	9275.4	Seepage	$315.00	$120.98	$457.93	$175.88	$248.84
981 S SCRIPPS CIR	9292.9	Seepage	$315.59	$121.21	$458.79	$176.21	$249.31
6781 E LEAFWOOD DR	9328.34	Seepage	$316.80	$121.67	$460.54	$176.88	$250.26
6851 E KENTUCKY AVE	9350	Seepage	$317.53	$121.95	$461.61	$177.29	$250.84
6871 E KENTUCKY AVE	9375.2	Seepage	$318.39	$122.28	$462.86	$177.77	$251.51
1084 S BURLWOOD DR	9386.5	Seepage	$318.77	$122.43	$463.41	$177.98	$251.82
6621 E SMOKEWOOD CIR	9397.4	Seepage	$319.14	$122.57	$463.95	$178.19	$252.11
1014 S RIMWOOD DR	9451.8	Seepage	$320.99	$123.28	$466.64	$179.22	$253.57
6821 E KENTUCKY AVE	9454.3	Seepage	$321.08	$123.31	$466.76	$179.27	$253.64
914 S LEHIGH DR	9488.6	Seepage	$322.24	$123.76	$468.46	$179.92	$254.56
6648 E LEAFWOOD DR	9595.4	Seepage	$325.87	$125.15	$473.73	$181.94	$257.42
1064 S BURLWOOD DR	9602.1	Seepage	$326.10	$125.24	$474.06	$182.07	$257.60
6780 E LEAFWOOD DR	9618.9	Seepage	$326.67	$125.46	$474.89	$182.39	$258.05
1090 S BURLWOOD DR	9621.4	Seepage	$326.75	$125.49	$475.01	$182.44	$258.12
6683 E LEAFWOOD DR	9631.8	Seepage	$327.10	$125.63	$475.53	$182.63	$258.40
6774 E LEAFWOOD DR	9635.7	Seepage	$327.24	$125.68	$475.72	$182.71	$258.50
1041 S FALLING LEAF CIR	9648.5	Seepage	$327.67	$125.85	$476.35	$182.95	$258.85
6691 E SMOKEWOOD CIR	9739.1	Seepage	$330.75	$127.03	$480.82	$184.67	$261.28
6831 E KENTUCKY AVE	9827	Seepage	$333.73	$128.18	$485.16	$186.33	$263.64
6656 E LEAFWOOD DR	9847.1	Seepage	$334.42	$128.44	$486.15	$186.72	$264.17
1044 S BURLWOOD DR	9863.6	Seepage	$334.98	$128.65	$486.97	$187.03	$264.62
6793 E LEAFWOOD DR	9865.5	Seepage	$335.04	$128.68	$487.06	$187.06	$264.67
6901 E MICHIGAN CIR	9903.5	Seepage	$336.33	$129.17	$488.94	$187.79	$265.69
6981 E MICHIGAN CIR	9907.3	Seepage	$336.46	$129.22	$489.13	$187.86	$265.79
6768 E LEAFWOOD DR	9913.7	Seepage	$336.68	$129.31	$489.44	$187.98	$265.96
6672 E LEAFWOOD DR	9929.32	Seepage	$337.21	$129.51	$490.21	$188.27	$266.38
6680 E LEAFWOOD DR	9951	Seepage	$337.94	$129.79	$491.28	$188.69	$266.96
6911 E MICHIGAN CIR	9977.4	Seepage	$338.84	$130.14	$492.59	$189.19	$267.67
991 S SCRIPPS CIR	10000	Seepage	$339.61	$130.43	$493.70	$189.61	$268.28

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6880 E KENTUCKY AVE	10074.8	Seepage	$342.15	$131.41	$497.40	$191.03	$270.28
6930 E MICHIGAN CIR	10108.7	Seepage	$343.30	$131.85	$499.07	$191.68	$271.19
6762 E LEAFWOOD DR	10138.2	Seepage	$344.30	$132.23	$500.53	$192.24	$271.98
1006 S ASPENWOOD CIR	10247.1	Seepage	$348.00	$133.66	$505.90	$194.30	$274.91
1018 S RIMWOOD DR	10274.8	Seepage	$348.94	$134.02	$507.27	$194.83	$275.65
6691 E LEAFWOOD DR	10278.4	Seepage	$349.06	$134.06	$507.45	$194.89	$275.75
6632 E LEAFWOOD DR	10279	Seepage	$349.08	$134.07	$507.48	$194.91	$275.76
6758 E LEAFWOOD DR	10294.7	Seepage	$349.62	$134.28	$508.25	$195.20	$276.18
1022 S RIMWOOD DR	10340	Seepage	$351.15	$134.87	$510.49	$196.06	$277.40
6865 E SWARTHMORE DR	10404.3	Seepage	$353.34	$135.71	$513.66	$197.28	$279.12
6624 E LEAFWOOD DR	10573.8	Seepage	$359.10	$137.92	$522.03	$200.50	$283.67
1040 S PINE CANYON CIR	10623.1	Seepage	$360.77	$138.56	$524.47	$201.43	$284.99
1028 S BURLWOOD DR	10632.1	Seepage	$361.07	$138.68	$524.91	$201.60	$285.23
6960 E MICHIGAN CIR	10864.4	Seepage	$368.96	$141.71	$536.38	$206.01	$291.47
6754 E LEAFWOOD DR	11004.1	Seepage	$373.71	$143.53	$543.28	$208.65	$295.21
1085 S BURLWOOD DR	11197.11	Seepage	$380.26	$146.05	$552.81	$212.31	$300.39
6701 E LEAFWOOD DR	11286	Seepage	$383.28	$147.21	$557.19	$214.00	$302.78
6690 E LEAFWOOD DR	11425.9	Seepage	$388.03	$149.03	$564.10	$216.65	$306.53
1010 S RIMWOOD DR	11487.6	Seepage	$390.13	$149.84	$567.15	$217.82	$308.19
6675 E LEAFWOOD DR	11549.3	Seepage	$392.22	$150.64	$570.19	$218.99	$309.84
6910 E MICHIGAN CIR	11623.1	Seepage	$394.73	$151.60	$573.84	$220.39	$311.82
1089 S BURLWOOD DR	11938.7	Seepage	$405.45	$155.72	$589.42	$226.38	$320.29
6970 E MICHIGAN CIR	11979.6	Seepage	$406.84	$156.25	$591.44	$227.15	$321.38
6831 E GEORGETOWN CIR	8207.1	Seepage	$278.72	$158.96	$405.19	$231.09	$326.96
995 S LEHIGH DR	12229.4	Seepage	$415.32	$159.51	$603.77	$231.89	$328.09
6750 E LEAFWOOD DR	12359.1	Seepage	$419.73	$161.20	$610.17	$234.35	$331.57
1071 S BURLWOOD DR	12423	Seepage	$421.90	$162.04	$613.33	$235.56	$333.28
1060 S PINE CANYON CIR	12456.2	Seepage	$423.02	$162.47	$614.97	$236.19	$334.17
994 S LEHIGH DR	12553	Seepage	$426.31	$163.73	$619.75	$238.02	$336.77
1081 S BURLWOOD DR	12599.3	Seepage	$427.88	$164.34	$622.03	$238.90	$338.01
1061 S FALLING LEAF CIR	12807.5	Seepage	$434.95	$167.05	$632.31	$242.85	$343.60
6601 E LEAFWOOD DR	13120.6	Seepage	$445.59	$171.13	$647.77	$248.79	$352.00
1063 S BURLWOOD DR	13236	Seepage	$449.51	$172.64	$653.47	$250.97	$355.09
1077 S BURLWOOD DR	13346	Seepage	$453.24	$174.07	$658.90	$253.06	$358.04
6799 E LEAFWOOD DR	9111.9	Seepage	$309.45	$176.49	$449.86	$256.56	$363.00
1012 S ASPENWOOD CIR	13543.3	Seepage	$459.94	$176.65	$668.64	$256.80	$363.34
1061 S PINE CANYON CIR	13633.3	Seepage	$463.00	$177.82	$673.08	$258.51	$365.75
6840 E AVE DE SANTIAGO	9247.63	Seepage	$314.06	$179.11	$456.56	$260.39	$368.41
1075 S BURLWOOD DR	13750.3	Seepage	$466.97	$179.35	$678.86	$260.73	$368.89
998 S VASSAR CIR	13790.9	Seepage	$468.35	$179.88	$680.86	$261.50	$369.98
6855 E SWARTHMORE DR	13990.9	Seepage	$475.14	$182.49	$690.74	$265.29	$375.34
934 S LEHIGH DR	14261.19	Seepage	$484.32	$186.01	$704.08	$270.41	$382.59
6820 E AVE DE SANTIAGO	9656	Seepage	$327.93	$187.02	$476.72	$271.89	$384.68
1032 S BURLWOOD DR	14674.4	Seepage	$498.35	$191.40	$724.48	$278.25	$393.68
6667 E LEAFWOOD DR	14761	Seepage	$501.30	$192.53	$728.76	$279.89	$396.00
1003 S BURLWOOD DR	14868.4	Seepage	$504.94	$193.93	$734.06	$281.93	$398.88
6625 E LEAFWOOD DR	15091.2	Seepage	$512.51	$196.84	$745.06	$286.15	$404.86
1060 S FALLING LEAF CIR	15345	Seepage	$521.13	$200.15	$757.59	$290.96	$411.67
1040 S BURLWOOD DR	15405.5	Seepage	$523.18	$200.94	$760.58	$292.11	$413.29
6971 E WILLIAMS CIR	10777.6	Seepage	$366.02	$208.75	$532.09	$303.47	$429.36
6951 E WILLIAMS CIR	10948	Seepage	$371.80	$212.05	$540.51	$308.26	$436.15
6931 E WILLIAMS CIR	11020.6	Seepage	$374.27	$213.45	$544.09	$310.31	$439.04
993 S VASSAR CIR	17144.1	Seepage	$582.23	$223.61	$846.41	$325.08	$459.94
1001 S ASPENWOOD CIR	17270.9	Seepage	$586.53	$225.27	$852.67	$327.48	$463.34
1059 S BURLWOOD DR	17422.2	Seepage	$591.67	$227.24	$860.14	$330.35	$467.40
6890 E KENTUCKY AVE	17424	Seepage	$591.73	$227.26	$860.23	$330.39	$467.45
1005 S BURLWOOD DR	17450.4	Seepage	$592.63	$227.61	$861.53	$330.89	$468.15
6623 E LEAFWOOD DR	18408.1	Seepage	$625.15	$240.10	$908.81	$349.05	$493.85
1036 S BURLWOOD DR	18553.2	Seepage	$630.08	$241.99	$915.98	$351.80	$497.74
6891 E KENTUCKY AVE	18831.7	Seepage	$639.54	$245.63	$929.73	$357.08	$505.21
6991 E WILLIAMS CIR	13103.8	Seepage	$445.02	$253.80	$646.94	$368.97	$522.03
1001 S BURLWOOD DR	21926	Seepage	$679.22	$285.99	$987.41	$415.75	$588.22
1000 S ASPENWOOD CIR	25515.7	Seepage	$679.22	$332.81	$987.41	$483.82	$684.53
6990 E MICHIGAN CIR	27157.15	Seepage	$679.22	$354.22	$987.41	$514.94	$728.56
6796 E KENTUCKY AVE	30156.6	Seepage	$679.22	$393.34	$987.41	$571.81	$809.03
6950 E VIA EL ESTRIBO	22122.1	Seepage	$679.22	$428.48	$987.41	$622.89	$881.30
6970 E VIA EL ESTRIBO	22154.7	Seepage	$679.22	$429.11	$987.41	$623.81	$882.60
6960 E VIA EL ESTRIBO	22602.8	Seepage	$679.22	$437.79	$987.41	$636.43	$900.45
6810 E AVE DE SANTIAGO	24036.57	Seepage	$679.22	$465.56	$987.41	$676.80	$957.57
6990 E AVE DE SANTIAGO	25186.7	Seepage	$679.22	$487.83	$987.41	$709.18	$1,003.39
6951 E VIA EL ESTRIBO	26799.4	Seepage	$679.22	$519.07	$987.41	$754.59	$1,067.64
6940 E AVENIDA DE SANTIAGO	27244.1	Seepage	$679.22	$527.68	$987.41	$767.12	$1,085.35
6960 E AVENIDA DE SANTIAGO	27811.7	Seepage	$679.22	$538.68	$987.41	$783.10	$1,107.96
6975 E AVENIDA DE SANTIAGO	27895.4	Seepage	$679.22	$540.30	$987.41	$785.45	$1,111.30

Site Address	Lot Square Footage (SF)	Zone	Kaplan Proposal at $227,000	Engeo Proposal at $227,000	Kaplan Proposal at $330,000	Engeo Proposal at $330,000	Engeo Proposal at $466,900
6940 E AVENIDA DE SANTIAGO	29614.3	Seepage	$679.22	$573.59	$987.41	$833.85	$1,179.78
1097 S BURLWOOD DR	6287.3	Deformation	$427.04	$578.90	$620.81	$841.57	$1,190.69
1090 S RIMWOOD DR	6351.3	Deformation	$431.39	$584.79	$627.13	$850.13	$1,202.81
1086 S RIMWOOD DR	6503.7	Deformation	$441.74	$598.82	$642.18	$870.53	$1,231.67
6895 E GEORGETOWN CIR	6619.5	Deformation	$449.61	$609.48	$653.61	$886.03	$1,253.60
1094 S RIMWOOD DR	6911	Deformation	$469.41	$636.32	$682.40	$925.05	$1,308.81
6911 E WILLIAMS CIR	6952.1	Deformation	$472.20	$640.11	$686.46	$930.55	$1,316.59
6820 E AVE DE SANTIAGO	33720.6	Seepage	$679.22	$653.12	$987.41	$949.47	$1,343.36
6991 E VIA EL ESTRIBO	33721.8	Seepage	$679.22	$653.15	$987.41	$949.51	$1,343.41
6985 E VIA EL ESTRIBO	35298.5	Seepage	$679.22	$683.69	$987.41	$993.90	$1,406.22
1098 S RIMWOOD DR	7474.9	Deformation	$507.71	$688.24	$738.08	$1,000.53	$1,415.60
6811 E AVENIDA DE SANTIAGO	36961.1	Seepage	$679.22	$715.89	$987.41	$1,040.72	$1,472.46
NO ADDRESS	38159.5	Seepage	$679.22	$739.10	$987.41	$1,074.46	$1,520.20
6865 E GEORGETOWN CIR	8127.7	Deformation	$552.05	$748.35	$802.54	$1,087.91	$1,539.23
6950 E AVE DE SANTIAGO	38649.4	Seepage	$679.22	$748.59	$987.41	$1,088.26	$1,539.72
6873 E GEORGETOWN CIR	8189.8	Deformation	$556.26	$754.07	$808.67	$1,096.22	$1,550.99
6840 E AVE DE SANTIAGO	39018.73	Seepage	$679.22	$755.74	$987.41	$1,098.65	$1,554.43
6823 E GEORGETOWN CIR	8236.2	Deformation	$559.42	$758.34	$813.25	$1,102.43	$1,559.77
6857 E GEORGETOWN CIR	8265.5	Deformation	$561.41	$761.04	$816.14	$1,106.35	$1,565.32
6839 E GEORGETOWN CIR	8373.3	Deformation	$568.73	$770.96	$826.79	$1,120.78	$1,585.74
6849 E GEORGETOWN CIR	8485.7	Deformation	$576.36	$781.31	$837.88	$1,135.83	$1,607.02
6815 E GEORGETOWN CIR	8565.9	Deformation	$581.81	$788.70	$845.80	$1,146.56	$1,622.21
6881 E GEORGETOWN CIR	8762.9	Deformation	$595.19	$806.83	$865.26	$1,172.93	$1,659.52
6860 E AVE DE SANTIAGO	44499.01	Seepage	$679.22	$861.89	$987.41	$1,252.96	$1,772.76
6906 E AVE DE SANTIAGO	9655.97	Deformation	$655.85	$889.06	$953.44	$1,292.47	$1,828.65
6950 E AVE DE SANTIAGO	46724.9	Seepage	$679.22	$905.00	$987.41	$1,315.64	$1,861.43
6990 E VIA EL ESTRIBO	47793.6	Seepage	$679.22	$925.70	$987.41	$1,345.73	$1,904.01
6856 E GEORGETOWN CIR	10629.8	Deformation	$721.99	$978.73	$1,049.59	$1,422.82	$2,013.07
6965 E VIA EL ESTRIBO	50655.4	Seepage	$679.22	$981.13	$987.41	$1,426.31	$2,018.01
6980 E AVENIDA DE SANTIAGO	50683.1	Seepage	$679.22	$981.66	$987.41	$1,427.09	$2,019.12
6955 E VIA EL ESTRIBO	52189.6	Seepage	$679.22	$1,010.84	$987.41	$1,469.51	$2,079.13
6864 E GEORGETOWN CIR	11061.3	Deformation	$751.30	$1,018.46	$1,092.20	$1,480.57	$2,094.79
6889 E GEORGETOWN CIR	11253.7	Deformation	$764.37	$1,036.17	$1,111.20	$1,506.33	$2,131.23
6810 E AVE DE SANTIAGO	53592.24	Seepage	$679.22	$1,038.01	$987.41	$1,509.00	$2,135.01
6981 E VIA EL ESTRIBO	54041.5	Seepage	$679.22	$1,046.71	$987.41	$1,521.65	$2,152.91
6821 E AVENIDA DE SANTIAGO	54313.4	Seepage	$679.22	$1,051.98	$987.41	$1,529.31	$2,163.74
6840 E GEORGETOWN CIR	11551.7	Deformation	$784.61	$1,063.61	$1,140.62	$1,546.22	$2,187.66
1110 S TAMARISK DR	55661.4	Seepage	$679.22	$1,078.09	$987.41	$1,567.26	$2,217.44
6798 E LEAFWOOD DR	11769.6	Deformation	$799.41	$1,083.67	$1,162.14	$1,575.38	$2,228.93
6848 E GEORGETOWN CIR	11919.6	Deformation	$809.60	$1,097.48	$1,176.95	$1,595.46	$2,257.34
6832 E GEORGETOWN CIR	12194.8	Deformation	$828.29	$1,122.82	$1,204.12	$1,632.30	$2,309.45
NO ADDRESS	59728.1	Seepage	$679.22	$1,156.85	$987.41	$1,681.77	$2,379.45
6807 E GEORGETOWN CIR	12636.1	Deformation	$858.26	$1,163.45	$1,247.70	$1,691.36	$2,393.03
1087 S RIMWOOD DR	12793.7	Deformation	$868.97	$1,177.96	$1,263.26	$1,712.46	$2,422.87
6921 E WILLIAMS CIR	13338.4	Deformation	$905.97	$1,228.12	$1,317.04	$1,785.37	$2,526.03
6970 E AVE DE SANTIAGO	63605.1	Seepage	$679.22	$1,231.95	$987.41	$1,790.94	$2,533.91
6975 E VIA EL ESTRIBO	64651.3	Seepage	$679.22	$1,252.21	$987.41	$1,820.39	$2,575.58
1093 S BURLWOOD DR	14058	Deformation	$954.84	$1,294.37	$1,388.10	$1,881.69	$2,662.31
6792 E LEAFWOOD DR	14382.5	Deformation	$976.88	$1,324.25	$1,420.14	$1,925.12	$2,723.76
6816 E GEORGETOWN CIR	14691	Deformation	$997.84	$1,352.66	$1,450.60	$1,966.42	$2,782.18
6824 E GEORGETOWN CIR	14724.4	Deformation	$1,000.11	$1,355.73	$1,453.90	$1,970.89	$2,788.51
1160 S TAMARISK DR	70181.1	Seepage	$679.22	$1,359.32	$987.41	$1,976.10	$2,795.88
1150 S TAMARISK DR	71288.3	Seepage	$679.22	$1,380.76	$987.41	$2,007.27	$2,839.99
6971 E VIA EL ESTRIBO	73272.6	Seepage	$679.22	$1,419.19	$987.41	$2,063.14	$2,919.04
6808 E GEORGETOWN CIR	15431.6	Deformation	$1,048.14	$1,420.85	$1,523.73	$2,065.55	$2,922.44
1130 S TAMARISK DR	74563.8	Seepage	$679.22	$1,444.20	$987.41	$2,099.50	$2,970.48
6961 E VIA EL ESTRIBO	75557.8	Seepage	$679.22	$1,463.45	$987.41	$2,127.49	$3,010.08
1091 S BURLWOOD DR	16042.6	Deformation	$1,089.64	$1,477.10	$1,584.06	$2,147.33	$3,038.15
6800 E GEORGETOWN CIR	16199.8	Deformation	$1,100.32	$1,491.58	$1,599.58	$2,168.37	$3,067.92
1145 S TAMARISK DR	91745.5	Seepage	$679.22	$1,776.99	$987.41	$2,583.29	$3,654.96
1180 S TAMARISK DR	95587.9	Seepage	$679.22	$1,851.41	$987.41	$2,691.48	$3,808.04
6872 E GEORGETOWN CIR	20866.8	Deformation	$1,358.43	$1,921.29	$1,974.81	$2,793.06	$3,951.76
1099 S RIMWOOD DR	21632.8	Deformation	$1,358.43	$1,991.81	$1,974.81	$2,895.59	$4,096.82
6861 E AVENIDA DE SANTIAGO	22417.9	Deformation	$1,358.43	$2,064.10	$1,974.81	$3,000.68	$4,245.51
6912 E AVENIDA DE SANTIAGO	22736.25	Deformation	$1,358.43	$2,093.41	$1,974.81	$3,043.29	$4,305.80
6930 E AVE DE SANTIAGO	23431.42	Deformation	$1,358.43	$2,157.42	$1,974.81	$3,136.34	$4,437.45
6890 E GEORGETOWN CIR	24112	Deformation	$1,358.43	$2,220.08	$1,974.81	$3,227.43	$4,566.33
1125 S TAMARISK DR	117017	Seepage	$679.22	$2,266.46	$987.41	$3,294.86	$4,661.73
6912 E AVENIDA DE SANTIAGO	25350.22	Deformation	$1,358.43	$2,334.09	$1,974.81	$3,393.17	$4,800.83
1095 S BURLWOOD DR	25562.4	Deformation	$1,358.43	$2,353.63	$1,974.81	$3,421.57	$4,841.01
6930 E AVE DE SANTIAGO	25738.94	Deformation	$1,358.43	$2,369.88	$1,974.81	$3,445.20	$4,874.45
6871 E AVENIDA DE SANTIAGO	26213.2	Deformation	$1,358.43	$2,413.55	$1,974.81	$3,508.68	$4,964.26
6851 E AVENIDA DE SANTIAGO	29857.6	Deformation	$1,358.43	$2,749.10	$1,974.81	$3,996.49	$5,654.44
1190 S TAMARISK DR	144897.1	Seepage	$679.22	$2,806.47	$987.41	$4,079.88	$5,772.42

Site Address	Lot Square Footage (SF)	Zone	Kaplan Proposal at $227,000	Engeo Proposal at $227,000	Kaplan Proposal at $330,000	Engeo Proposal at $330,000	Engeo Proposal at $466,900
6943 E AVENIDA DE SANTIAGO	35940.3	Deformation	$1,358.43	$3,309.16	$1,974.81	$4,810.67	$6,806.38
6841 E AVENIDA DE SANTIAGO	37077.3	Deformation	$1,358.43	$3,413.85	$1,974.81	$4,962.86	$7,021.71
6937 E AVENIDA DE SANTIAGO	37251.1	Deformation	$1,358.43	$3,429.85	$1,974.81	$4,986.13	$7,054.62
6949 E AVENIDA DE SANTIAGO	38345.9	Deformation	$1,358.43	$3,530.65	$1,974.81	$5,132.67	$7,261.95
6931 E AVENIDA DE SANTIAGO	39153.4	Deformation	$1,358.43	$3,605.00	$1,974.81	$5,240.75	$7,414.88
6901 E WILLIAMS CIR	39780.9	Deformation	$1,358.43	$3,662.78	$1,974.81	$5,324.75	$7,533.71
6925 E AVENIDA DE SANTIAGO	41236.1	Deformation	$1,358.43	$3,796.76	$1,974.81	$5,519.53	$7,809.30
6906 E AVE DE SANTIAGO	42161.05	Deformation	$1,358.43	$3,881.93	$1,974.81	$5,643.33	$7,984.47
1093 S RIMWOOD DR	42938.1	Deformation	$1,358.43	$3,953.47	$1,974.81	$5,747.34	$8,131.62
6913 E AVENIDA DE SANTIAGO	46492.3	Deformation	$1,358.43	$4,280.72	$1,974.81	$6,223.08	$8,804.72
6831 E AVENIDA DE SANTIAGO	46940.5	Deformation	$1,358.43	$4,321.99	$1,974.81	$6,283.07	$8,889.60
6920 E AVENIDA DE SANTIAGO	47294.9	Deformation	$1,358.43	$4,354.62	$1,974.81	$6,330.51	$8,956.72
6919 E AVENIDA DE SANTIAGO	48821.9	Deformation	$1,358.43	$4,495.22	$1,974.81	$6,534.90	$9,245.90
6901 E AVENIDA DE SANTIAGO	49572.4	Deformation	$1,358.43	$4,564.32	$1,974.81	$6,635.35	$9,388.03
6899 E AVENIDA DE SANTIAGO	55492.3	Deformation	$1,358.43	$5,109.39	$1,974.81	$7,427.74	$10,509.14
6907 E AVENIDA DE SANTIAGO	56938.8	Deformation	$1,358.43	$5,242.57	$1,974.81	$7,621.36	$10,783.08
6891 E AVENIDA DE SANTIAGO	90969.1	Deformation	$1,358.43	$8,375.87	$1,974.81	$12,176.38	$17,227.74
6881 E AVENIDA DE SANTIAGO	103851.9	Deformation	$1,358.43	$9,562.04	$1,974.81	$13,900.76	$19,667.49
City of Anaheim			$68,100.00	$20,667.09	$99,000.00	$30,044.66	$42,508.68