

PRELIMINARY
DRAINAGE ANALYSIS

SANTA BARBARA ZOOLOGICAL GARDENS
OVERALL SITE DRAINAGE UPDATE

500 NINOS DRIVE
SANTA BARBARA, CALIFORNIA



PREPARED FOR:

SANTA BARBARA ZOOLOGICAL GARDENS

May 22, 2006

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W.O. 0539

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PURPOSE OF REPORT

The purpose of this report is to analyze existing and proposed drainage characteristics of the individual project sites proposed for the Santa Barbara Zoological Gardens, as well as the overall site, and to determine the necessity of mitigation measures required as a result of increased hardscape coverage and corresponding peakflows. This report is based on conceptual level plans for the various sites proposed, and is not intended as a basis for construction of specific drainage improvements.

PROJECT DESCRIPTION

The Santa Barbara Zoological Gardens property is an irregularly shaped lot bounded by Highway 101 to the north, the bird refuge to the east, Cabrillo Street to the south and Ninos Drive to the west in the City of Santa Barbara. The site address is identified as 500 Ninos Drive.

The project proposes to redevelop 5 separate areas within the boundaries of the zoo, including the following:

- 1) Wave Restaurant, 2) Maintenance Yard, 3) Condor Exhibit, 4) Lemur/Langer Building Renovation, 5) Channel Island Foxes Exhibit, 6) Discovery Center

METHOD OF ANALYSIS (See Appendix A)

This analysis is based on topography compiled by C&C Aerial Mapping, Inc. dated December, 2003 and the conceptual architectural plans as prepared by Andy Neuman and Blackbird Architects. Drainage quantification was modeled using the Rational Method. Hardscape and landscape areas were delineated using both the project topographic map and the conceptual architectural plans, as well as the aerial photograph.

Runoff calculations were made for the existing and proposed conditions for each project sub-area for the 25 and 100 year storm events using the Rational Method and runoff intensities from Santa Barbara County Flood Control and Water Conservation District "Program Rational - XL" hydrologic computer software program. Calculation results for the 25-year and 100-year peakflows have been presented herein. Detailed copies of the various runoff calculations are attached in Appendix A.

EXISTING SITE DRAINAGE (See Figure A)

As shown on Figure A, there are five primary tributary areas and five primary regions of discharge on the zoo property, the total area of which is approximately 18.5 acres. The limits of the tributary areas for the zoo are identified on Figure A as Region 1, Region 2, Region 3, Region 4 and Region 5. Off-site drainage does not appear to make a significant contribution to overall site drainage.

Region 1, which is the largest of the four areas, encompasses an area of approximately 7.4 acres. Drainage from this region primarily discharges as sheetflow along the westerly and southerly boundaries of the zoo property to the bird refuge. Additionally, there are several bio-swailes and bio-basins along the westerly perimeter of the zoo property which are tributary to the bird refuge. A portion of the drainage in the northwesterly area of Region 1 drains to a water feature that is referred to as the Gibbon Moat. Overflow from the Gibbon Moat also drains to the bird refuge. The Wave Restaurant, Channel Island Foxes Exhibit, and Condor Exhibit sites are located in Region 1.

Region 2 encompasses approximately 4.1 acres and has a high proportion of hardscape coverage consisting mostly of buildings and patio/walkway area. Drainage from Region 2 discharges both as sheet flow and storm drain outflow into the railroad right of way via a system of area drains and storm drain conduits, as well as overland sheet flow drainage, across the northerly property boundary. There is an asphalt concrete driveway which parallels a portion of the zoo railroad along a segment of the northeasterly property boundary. Drainage from the upper portions of Region 2 travels down the ramp and along the train tracks to a series of drainage inlets located near the zoo entrance which daylight at the northerly property line and into the railroad right of way. The Discovery Center and Lemur/Langer Building Renovation sites are located within the boundary of Region 2.

Region 3 encompasses approximately 2.8-acres which includes a large landscaped area and the existing zoo maintenance area. Drainage from upper areas of Region 3 is comprised primarily of sheet flow drainage which enters a concrete swale positioned along the maintenance access road leading toward the southwest corner of the site. Drainage in the concrete swale enters the Cabrillo Road right of way where it is conveyed in a concrete channel to a bio-basin just upstream of the Bird Refuge. The bio-basin overflows into the bird refuge. The Maintenance Yard site is located within Region 3.

Region 4 encompasses approximately 1.1-acres and is the smallest of the individual tributary areas. Runoff from Region 4 is composed primarily of sheet flow drainage which travels across the southwesterly property boundary into the adjacent earthen drainage swale which leads to the concrete swale tributary to Region 3, as described above.

Region 5 covers an area of 3.1-acres and is the region with the highest proportion of hardscape surface. Region 5 encompasses the parking facility for the zoo as well as a small portion of the entrance area. Drainage generated in the area generally flows in a southwesterly direction toward the flood control channel adjacent to Ninos Drive. Runoff follows the existing slope of the parking lot until it reaches a drainage inlet at the southwestern corner. The drainage inlet is connected to a storm drain which discharges into the flood control channel on the east side of Ninos Drive. No improvements are proposed within the limits of Region 5.

The following table indicates the areas and total peakflows from each of the five drainage regions.

TABLE 1 – EXISTING PRE-PROJECT TRIBUTARY AREA PEAKFLOWS

AREA DESIGNATION	STUDY AREA (AC)	Q ₂₅ (CFS)	Q ₁₀₀ (CFS)
Region 1 (Condors, Foxes, Wave Restaurant)	7.41	9.48	12.02
Region 2 (Lemur/Langer, Discovery Center)	4.06	8.27	10.48
Region 3 (Maintenance Yard)	2.83	3.75	4.76
Region 4 (Existing On-site Drainage Channel)	1.07	1.42	1.80
Region 5 (Existing Parking Lot)	3.12	10.56	13.38
Total Study Area	18.49	33.48	42.43

EXISTING INDIVIDUAL PROJECT DRAINAGE (See Figures 1-5)

Exhibits have been prepared which indicate on a conceptual basis, the approximate limits of each of the five project sites to be redeveloped, the existing and proposed site conditions, as well as identifying the approximate limits of existing and proposed hardscape and landscape areas within the study area. In addition, existing drainage peakflows have been calculated for each of the five project areas, and are presented in Table 2 as follows.

TABLE 2 – EXISTING INDIVIDUAL STUDY AREA PEAKFLOWS

AREA DESIGNATION	STUDY AREA (AC)	Q ₂₅ (CFS)	Q ₁₀₀ (CFS)
Wave Restaurant (Region 1, See Figure 1)	0.23	0.41	0.52
Maintenance Yard (Region 3, See Figure 2)	0.70	1.20	1.52
Condor Exhibit (Region 1, See Figure 3)	0.34	0.54	0.69
Lemur/Langer Exhibit (Region 2, See Figure 4)	0.34	0.47	0.59
C.I. Foxes Exhibit (Region 2, See Figure 4B)	0.08	0.09	0.12
Discovery Center (Region 2, See Figure 5)	0.64	1.03	1.30

PROPOSED SITE DRAINAGE (See Exhibit A)

A portion of this analysis includes examining the effect of the proposed improvements on the total quantity of runoff in each drainage region. Table 3 shows the post project peakflows for each of the previously described drainage regions. Table 4 indicates the pre-project and post-project peakflows, as well as the difference and percentage of difference in each separate drainage region.

TABLE 3 – PROPOSED POST-PROJECT TRIBUTARY AREA PEAKFLOWS

AREA DESIGNATION	STUDY AREA (AC)	Q ₂₅ (CFS)	Q ₁₀₀ (CFS)
Region 1 (Condors Foxes, Wave Restaurant)	7.41	9.61	12.17
Region 2 (Lemur/Langer, Discovery Center)	4.06	8.46	10.72
Region 3 (Maintenance Yard)	2.83	3.83	4.85
Region 4 (Existing On-site Drainage Channel)	1.07	1.43	1.81
Region 5 (Existing Parking Lot)	3.12	10.56	13.38
Total Study Area	18.49	33.87	42.92

TABLE 4 – RUNOFF QUANTITY CHANGES DUE TO PROPOSED DEVELOPMENT

<u>Peakflows:</u>					Pre-Project	Post-Project		
	Pre-Proj.	Post- Proj.			Peakflows	Peakflows		%
Q	C	C	I (in./hr.)	A (ac.)	Q (cfs)	Q (cfs)	Change	Change
<u>Region 1</u>								
Q25 =	0.403	0.408	3.18	7.408	9.48	9.61	0.12	1%
Q100 =	0.403	0.408	4.03	7.408	12.02	12.17	0.16	1%
<u>Region 2</u>								
Q25 =	0.640	0.655	3.18	4.063	8.27	8.46	0.19	2%
Q100 =	0.640	0.655	4.03	4.063	10.48	10.72	0.24	2%
<u>Region 3</u>								
Q25 =	0.418	0.426	3.18	2.827	3.75	3.83	0.07	2%
Q100 =	0.418	0.426	4.03	2.827	4.76	4.85	0.09	2%
<u>Region 4</u>								
Q25 =	0.418	0.420	3.18	1.068	1.42	1.43	0.01	1%
Q100 =	0.418	0.420	4.03	1.068	1.80	1.81	0.01	1%
<u>Region 5</u>								
Q25 =	0.824	0.824	3.18	4.030	10.56	10.56	0.00	0%
Q100 =	0.824	0.824	4.03	4.030	13.38	13.38	0.00	0%

The final design of the drainage systems, including detention facilities, will need to be undertaken in the final design phase for each of the respective projects.

PROPOSED INDIVIDUAL PROJECT DRAINAGE (See Figures 1A-5A)

The individual project area exhibit maps have roughly identified the project limits, proposed hardscape areas and proposed landscape areas. In addition, the design peakflows have been calculated for each site and compared to the pre-project peakflows to determine if there is a need for onsite stormwater detention facilities. Peakflow calculation results for each of the sub-sites are presented in Table 5 below.

TABLE 5 – PROPOSED INDIVIDUAL STUDY AREA PEAKFLOWS

AREA DESIGNATION	STUDY AREA (AC)	Q ₂₅ (CFS)	Q ₁₀₀ (CFS)
Wave Restaurant (Region 1, See Figure 1)	0.23	0.47	0.60
Maintenance Yard (Region 3, See Figure 2)	0.70	1.48	1.87
Condor Exhibit (Region 1, See Figure 3)	0.34	0.48	0.61
Lemur/Langer Exhibit (Region 2, See Figure 4)	0.30	0.67	0.85
C.I. Foxes Exhibit (Region 2, See Figure 4B)	0.08	0.11	0.13
Discovery Center (Region 2, See Figure 5)	0.64	1.03	1.30

INDIVIDUAL PROJECT ANALYSIS RESULTS

The following table summarizes the existing and proposed peakflows, as well as the change in peakflow values.

TABLE 6 – PRE VS. POST INDIVIDUAL STUDY AREA PEAKFLOWS

AREA DESIGNATION	Q ₂₅ pre	Q ₂₅ post	Q ₂₅ change	Q ₂₅ %change
Wave Restaurant (Region 1)	0.41	0.48	0.06	15.2%
Maintenance Yard (Region 3)	1.20	1.48	0.28	23.3%
Condor Exhibit (Region 1)	0.54	0.48	-0.06	-11.4%
Lemur/Langer Exhibit (Region 2)	0.47	0.67	0.20	43.7%
C.I. Foxes Exhibit (Region 2)	0.09	0.11	0.01	15.7%
Discovery Center (Region 2)	1.03	1.03	0.00	0.2%

AREA DESIGNATION	Q ₁₀₀ pre	Q ₁₀₀ post	Q ₁₀₀ change	Q ₁₀₀ %change
Wave Restaurant (Region 1)	0.52	0.60	0.0795	15.2%
Maintenance Yard (Region 3)	1.52	1.87	0.35	23.3%
Condor Exhibit (Region 1)	0.69	0.61	-0.08	-11.4%
Lemur/Langer Exhibit (Region 2)	0.5	0.85	0.26	43.7%
C.I. Foxes Exhibit (Region 2)	0.12	0.14	0.02	15.7%
Discovery Center (Region 2)	1.30	1.30	0.00	0.2%

See Appendix A for detailed calculations, including unrounded figures.

Based on the calculated data presented in Table 6 above, it can be seen that there is an increase in the peakflow from the proposed Wave Restaurant Site, Maintenance Yard, Lemur/Langer Building Renovation, and Channel Island Foxes Exhibit. In addition, there is peakflow decrease in the area of the proposed Condor Exhibit and a slight increase in peakflow from the Discovery Center area.

CONCLUSION

This analysis was performed to estimate the "before" (existing) and "after" (improved) project stormwater peakflows using the 25 and 100-year design storm events. Results of this analysis show that the proposed individual project sites would affect runoff within each drainage region as shown in Table 6. Table 6 indicates that the Lemur/Langer Building Renovation improvements have the maximum increase in runoff of approximately 44%.

In addition, the proposed developments would affect stormwater runoff within each individual development area as indicated in Table 5.

It is recommended that at each project area, where there is an increase in runoff, utilize some form of stormwater detention to mitigate increased runoff from the site as a result of that site development. Specifically, it is recommended that some form of detention facility be provided for the Wave Restaurant, Maintenance Yard, Lemur/Langer Building Renovation, Discovery Center and Channel Islands Foxes Exhibit. Potential detention facilities could include rock filled detention trenches, underground tank storage facilities, or

other methods to be determined in the final design phase. Sample details of potential detention facilities, which may be created in addition to open pond areas, which include rock filled detention trenches and subsurface tank storage systems, have been included as Appendix B.

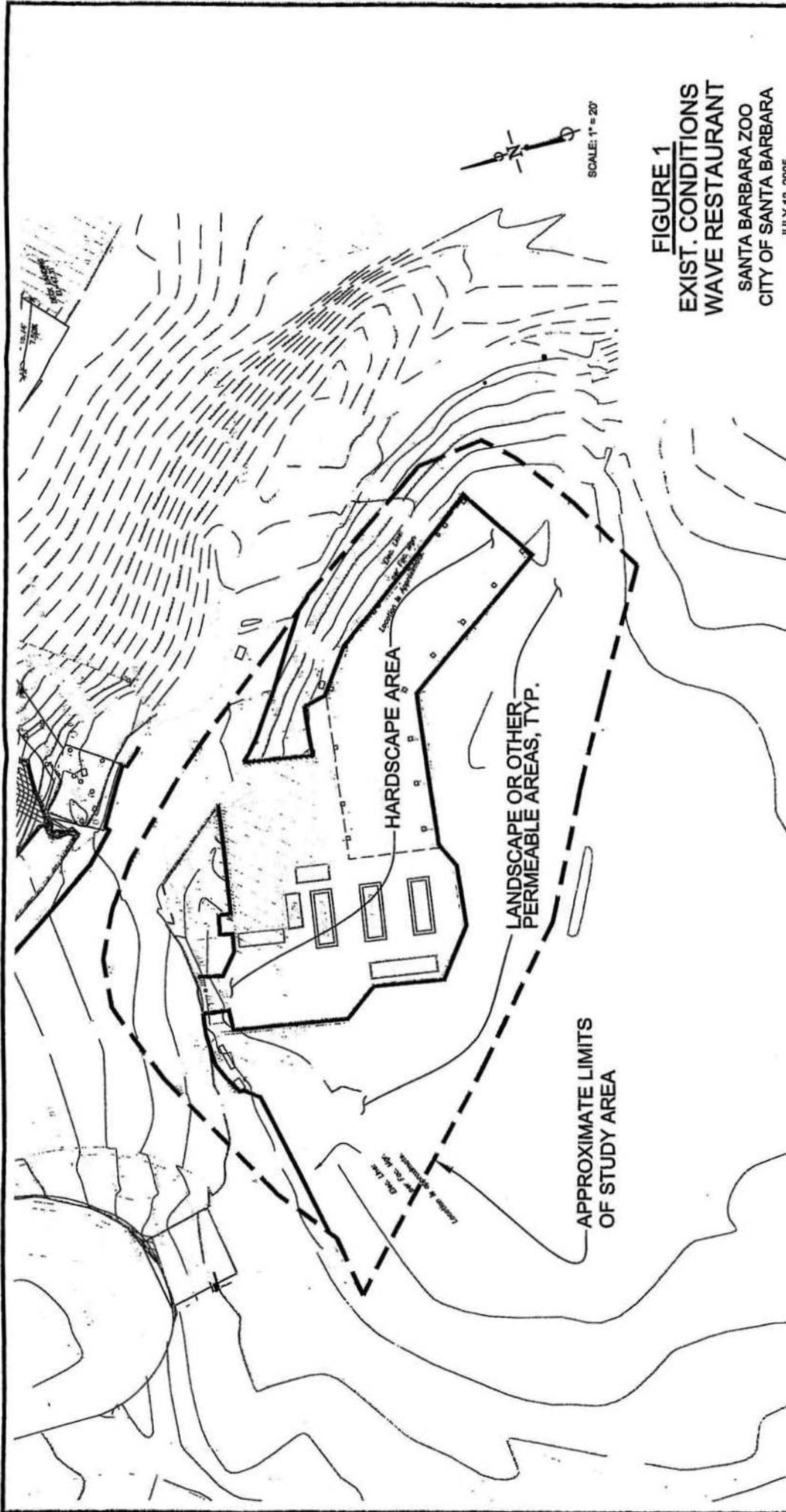


FIGURE 1
EXIST. CONDITIONS
WAVE RESTAURANT
 SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 JULY 13, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 500 East Montecito Street
 Santa Barbara, California 93103
 Telephone (805) 966-5224

BY: _____ DATE: _____

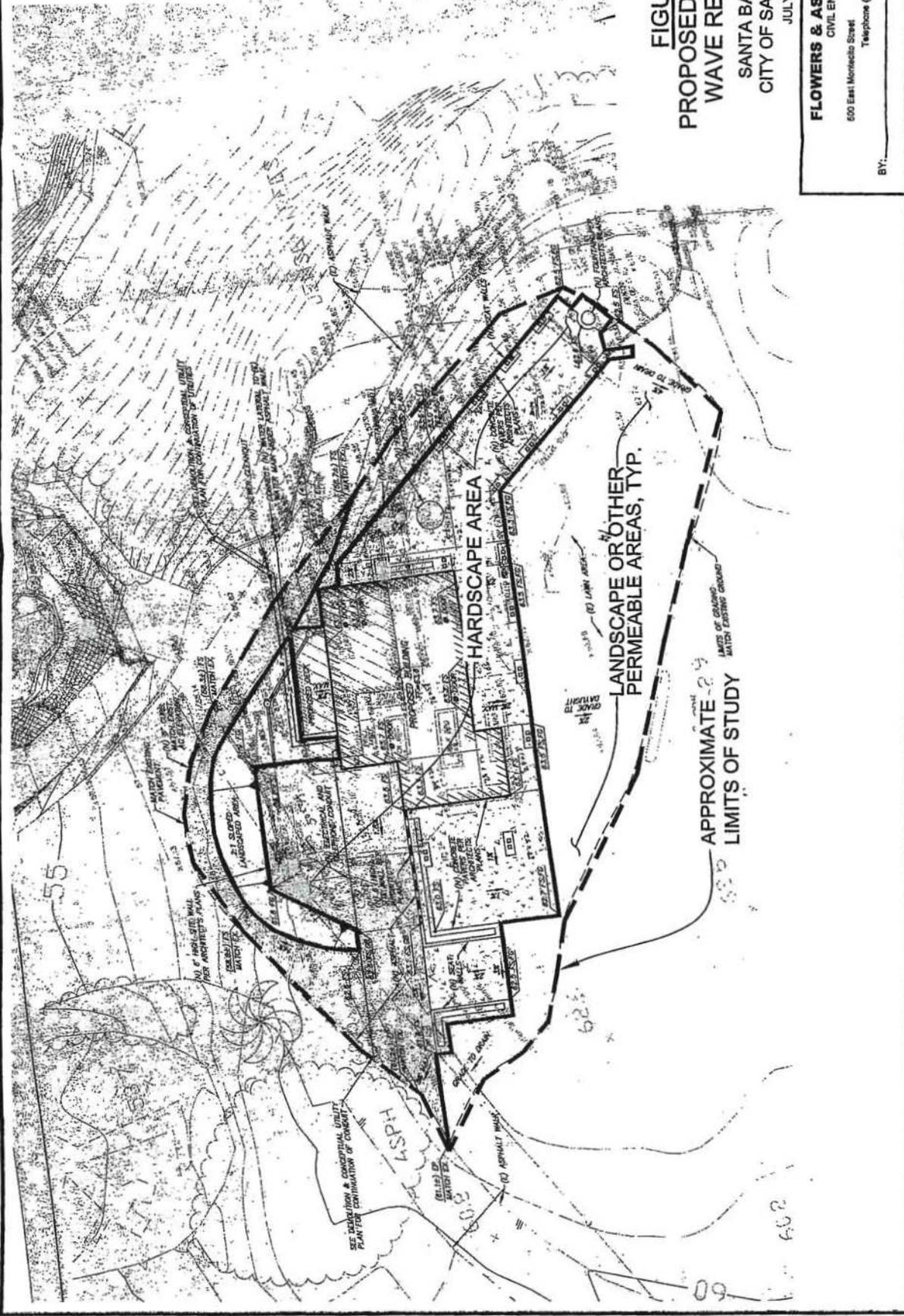


FIGURE 1A
PROPOSED CONDITIONS
WAVE RESTAURANT
 SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 JULY 13, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 600 East Montecito Street
 Santa Barbara, California 93103
 Telephone (805) 966-2224

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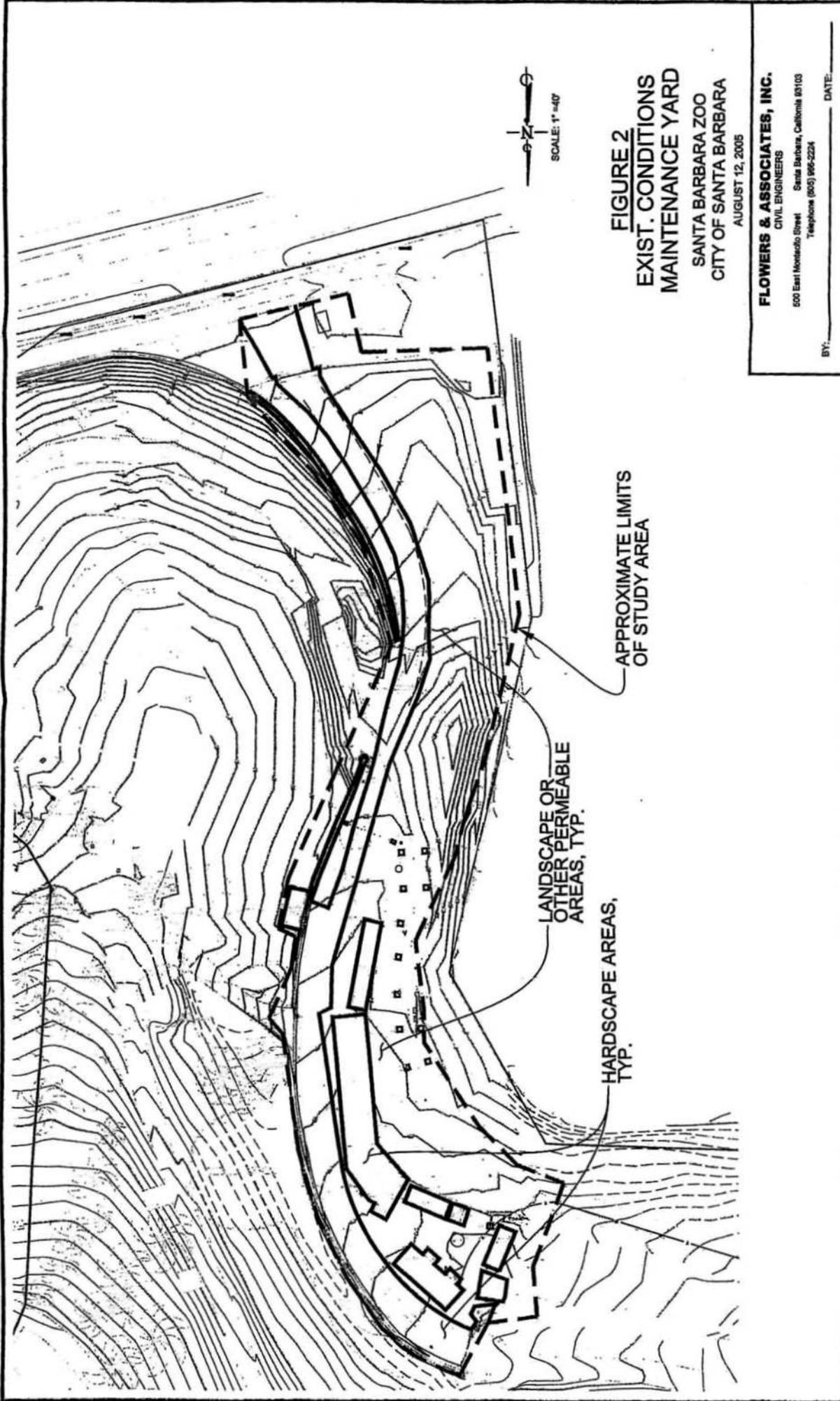
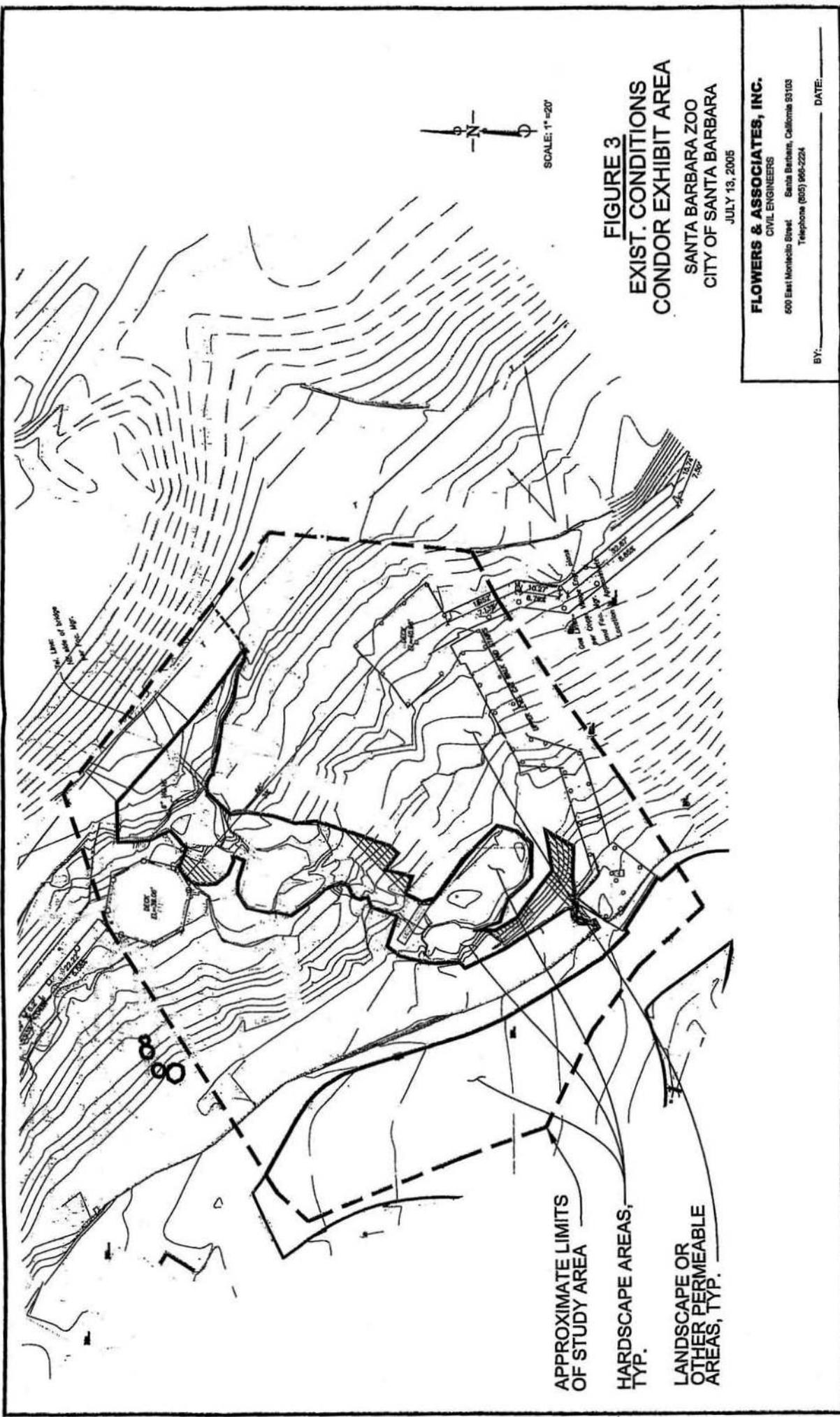


FIGURE 2
EXIST. CONDITIONS
MAINTENANCE YARD

SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 AUGUST 12, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 500 East Montecito Street Santa Barbara, California 93103
 Telephone (805) 966-2224
 BY: _____ DATE: _____



APPROXIMATE LIMITS OF STUDY AREA

HARDSCAPE AREAS, TYP.

LANDSCAPE OR OTHER PERMEABLE AREAS, TYP.

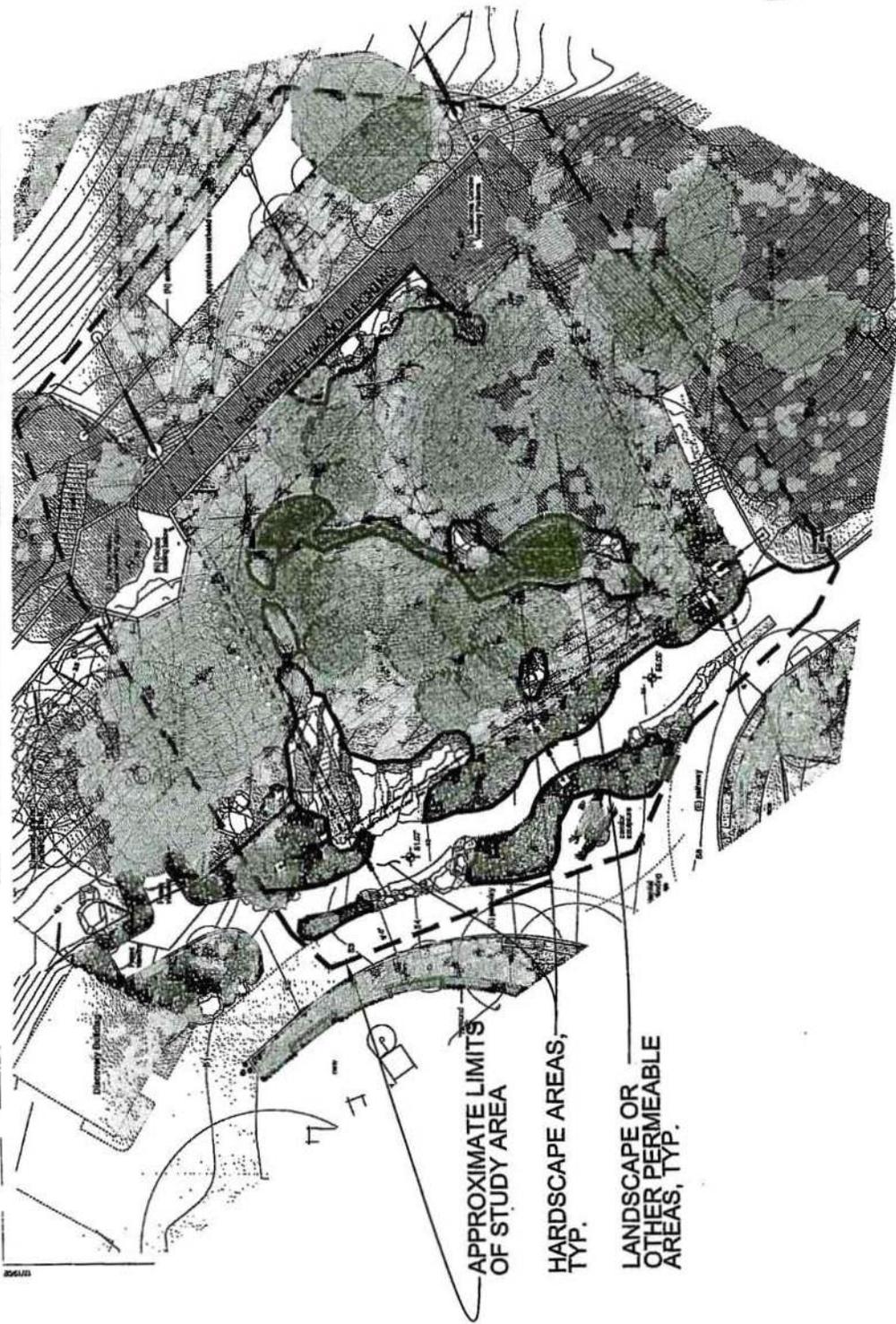
SCALE: 1"=20'

FIGURE 3
EXIST. CONDITIONS
CONDOR EXHIBIT AREA
 SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 JULY 13, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 600 East Montebello Street Santa Barbara, California 93103
 Telephone (805) 966-2224

BY: _____ DATE: _____

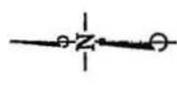
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APPROXIMATE LIMITS
OF STUDY AREA

HARDSCAPE AREAS,
TYP.

LANDSCAPE OR
OTHER PERMEABLE
AREAS, TYP.



SCALE: 1"=20'

FIGURE 3A
PROPOSED CONDITIONS
CONDOR EXHIBIT AREA
 SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 JULY 13, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 500 East Montecito Street
 Santa Barbara, California 93103
 Telephone (805) 966-2224

BY: _____ DATE: _____

PLOTTED: Jun 19, 2006 - 1:01pm

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W.O. 0539

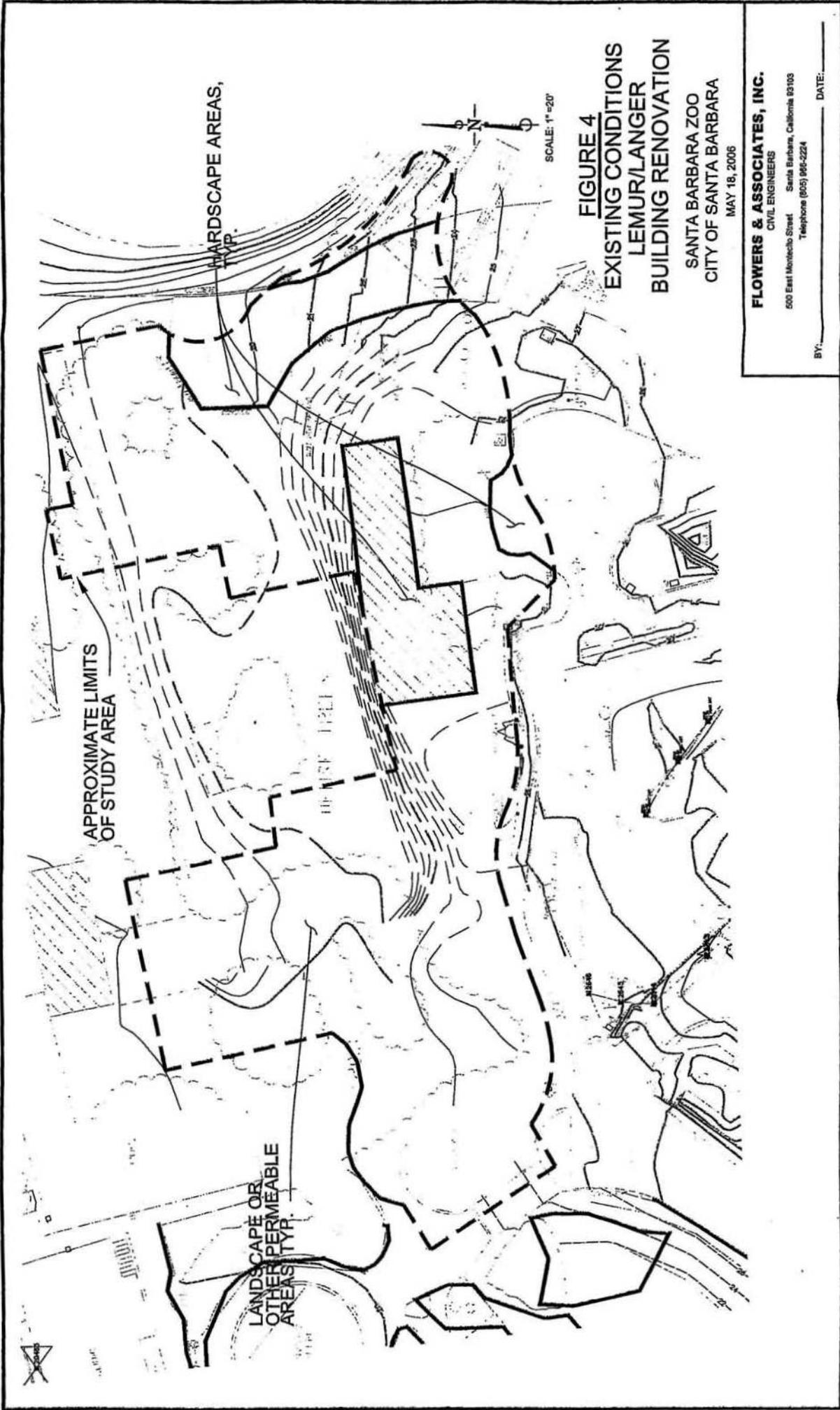


FIGURE 4
EXISTING CONDITIONS
LEMUR/LANGER
BUILDING RENOVATION

SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 MAY 18, 2006

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 600 East Montecito Street Santa Barbara, California 93103
 Telephone (805) 966-2224

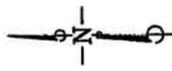
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APPROXIMATE LIMITS
OF STUDY AREA

HARDSCAPE AREAS,
TYP.

LANDSCAPE OR
OTHER PERMEABLE
AREAS, TYP.



SCALE: 1"=20'

FIGURE 4A PROPOSED CONDITIONS LEMUR/LANGER BUILDING RENOVATION

SANTA BARBARA ZOO
CITY OF SANTA BARBARA

MAY 16, 2006

FLOWERS & ASSOCIATES, INC.

CIVIL ENGINEERS

800 East Montecito Street Santa Barbara, California 93103
Telephone (805) 966-2224

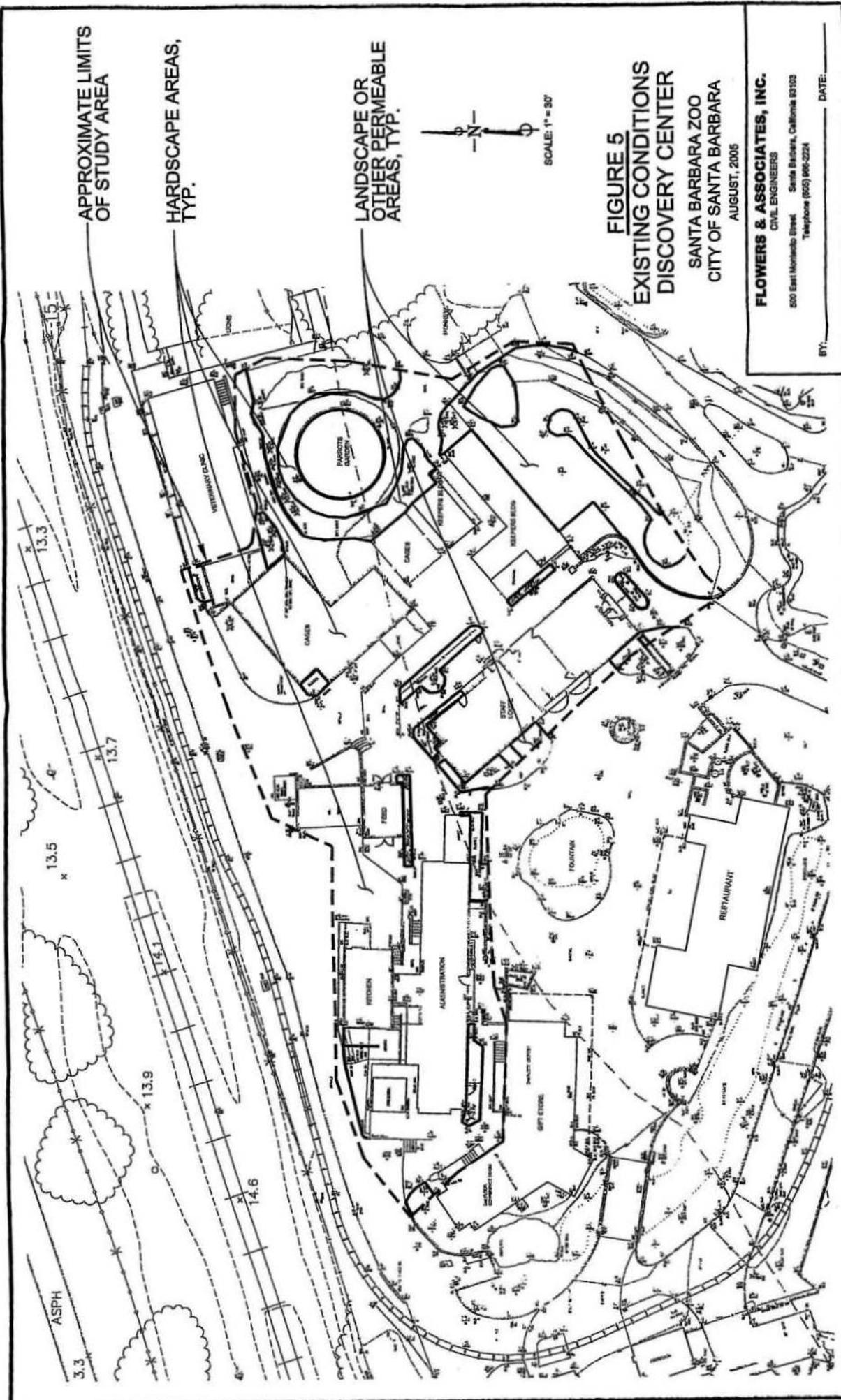
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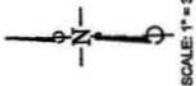




APPROXIMATE LIMITS OF STUDY AREA

HARDSCAPE AREAS, TYP.

LANDSCAPE OR OTHER PERMEABLE AREAS, TYP.



**FIGURE 5
EXISTING CONDITIONS
DISCOVERY CENTER**

SANTA BARBARA ZOO
CITY OF SANTA BARBARA
AUGUST, 2005

FLOWERS & ASSOCIATES, INC.
CIVIL ENGINEERS
500 East Montebello Street Santa Barbara, California 93103
Telephone (805) 966-2224

BY: _____ DATE: _____

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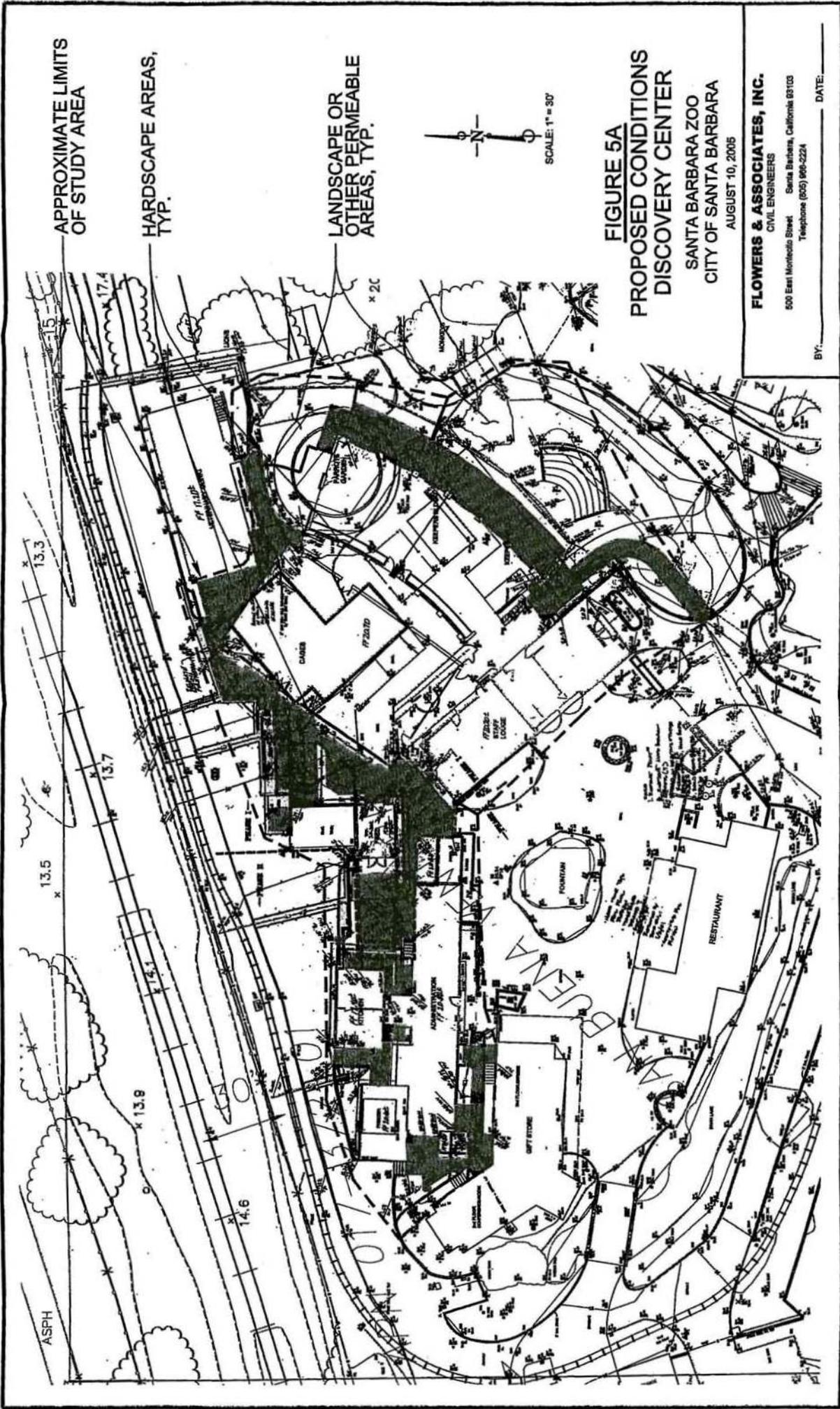


FIGURE 5A
PROPOSED CONDITIONS
DISCOVERY CENTER

SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 AUGUST 10, 2005

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 500 East Montebello Street Santa Barbara, California 93103
 Telephone (805) 966-2224

BY: _____ DATE: _____

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APPROXIMATE LIMITS
 OF STUDY AREA

HARDSCAPE AREAS,
 TYP.

LANDSCAPE OR
 OTHER PERMEABLE
 AREAS, TYP.



ANALYSIS

ASPH

RESTAURANT

FOUNTAIN

FISHBONE
 LOBBY

COURT

PLANTING

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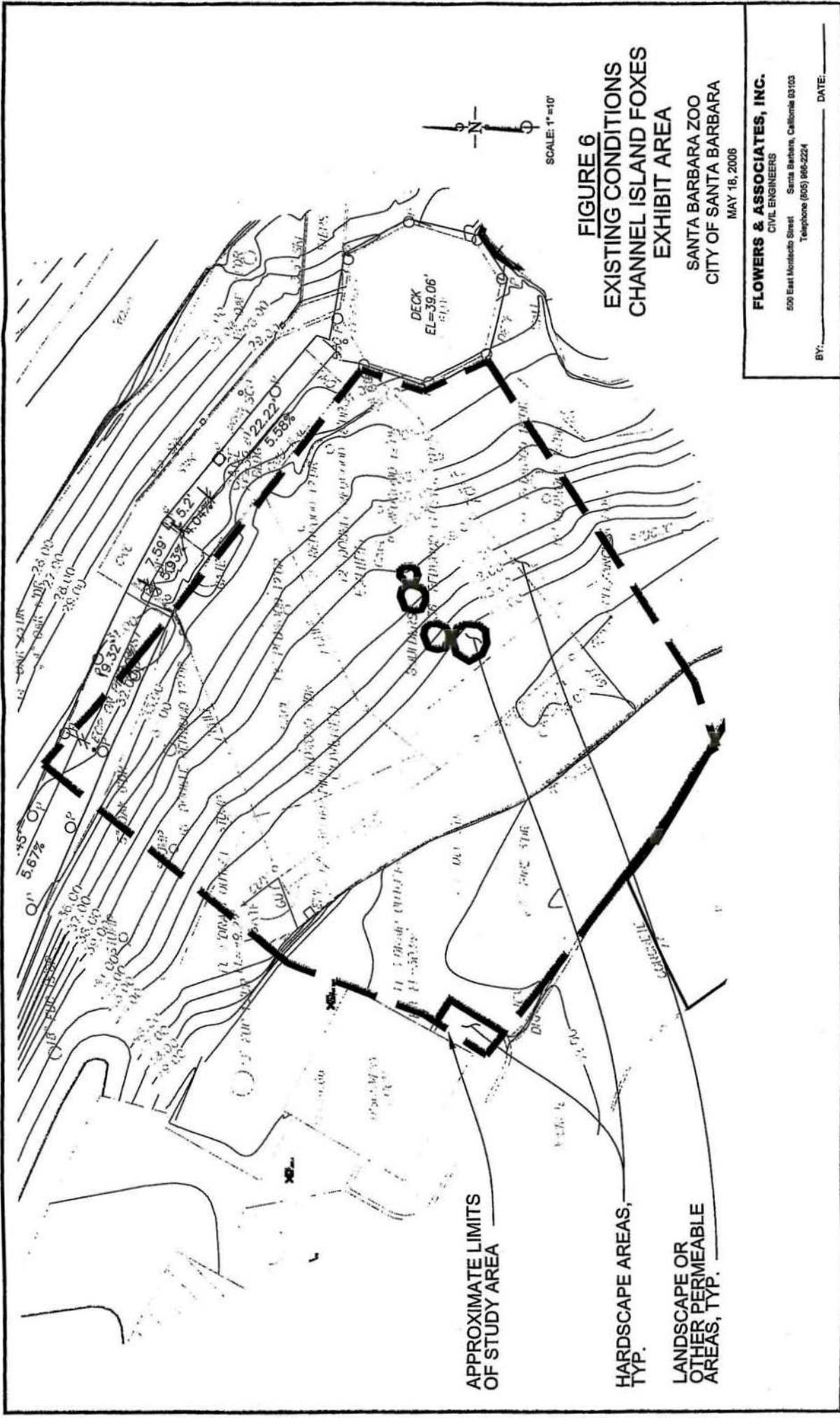


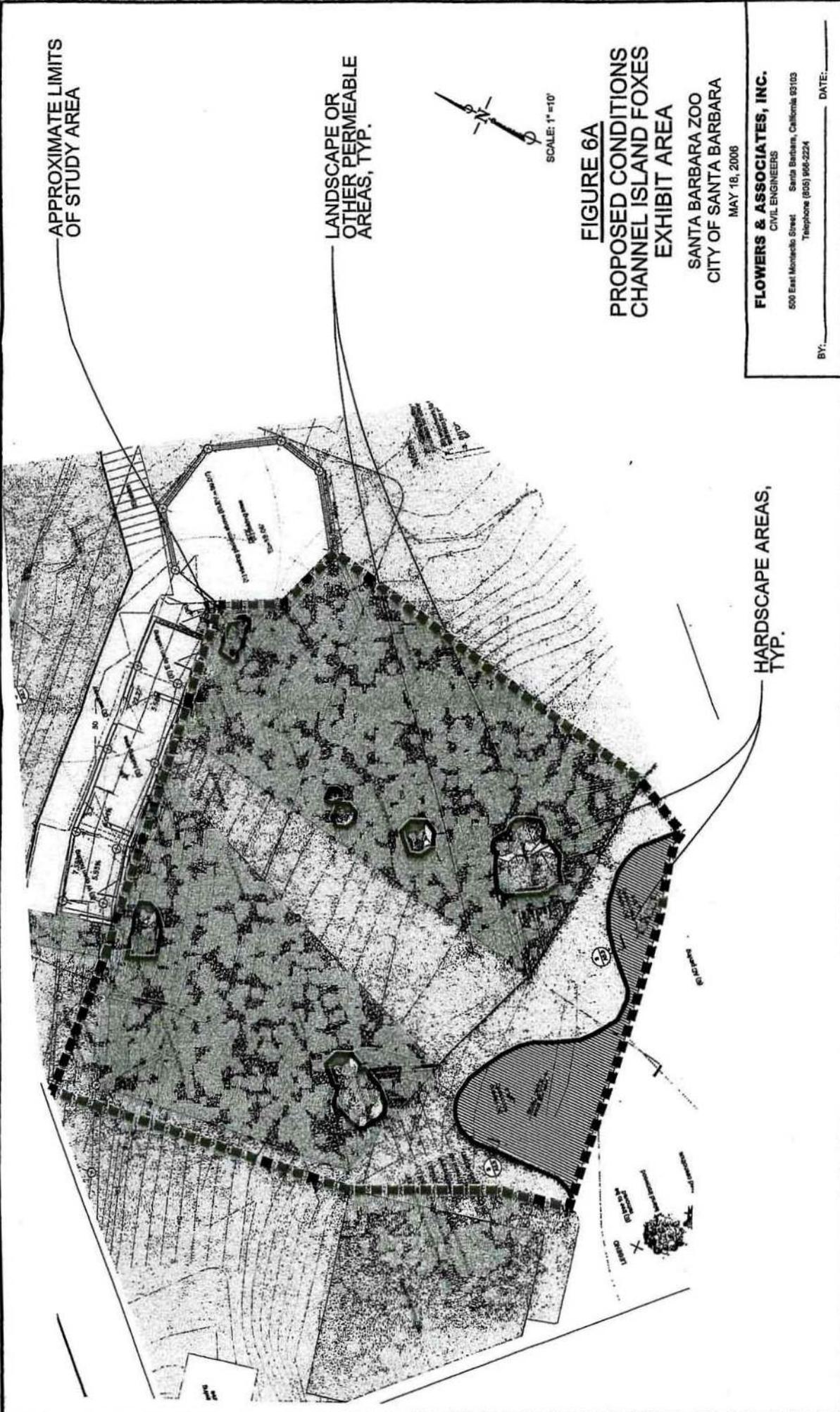
FIGURE 6
EXISTING CONDITIONS
CHANNEL ISLAND FOXES
EXHIBIT AREA

SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 MAY 16, 2006

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 500 East Montecito Street
 Santa Barbara, California 93103
 Telephone (805) 966-2224

BY: _____ DATE: _____

PLOTTED: Jun 19, 2006 - 1:09pm 0539drainage_exbt1_20050711.dwg W.O. 0539



APPROXIMATE LIMITS OF STUDY AREA

LANDSCAPE OR OTHER PERMEABLE AREAS, TYP.

HARDSCAPE AREAS, TYP.

FIGURE 6A
PROPOSED CONDITIONS
CHANNEL ISLAND FOXES
EXHIBIT AREA

SANTA BARBARA ZOO
 CITY OF SANTA BARBARA
 MAY 18, 2006

FLOWERS & ASSOCIATES, INC.
 CIVIL ENGINEERS
 600 East Montecito Street Santa Barbara, California 93103
 Telephone (805) 968-2224

BY: _____ DATE: _____

W.O. 0539

0539_Island fox.dwg

PLOTTED: Jun 19, 2006 -- 1:29pm

APPENDIX A

HYDROLOGY ANALYSIS

(BEFORE AND AFTER PROJECT PEAKFLOW CALCULATIONS)

Project Area: Pre and Post Project Peakflows - Zoo

Region 1 = 7.408 ac.
 Region 2 = 4.063 ac.

Region 3 = 2.827 ac.
 Region 4 = 1.068 ac.
 Region 5 = 3.121 ac.

Rainfall Intensity:

(per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.61 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.63 in/hr
 I 100 = 4.03 in/hr

tc = 12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Pre-project	Region 1*	Region 2*	Region 3*	Region 4*	Region 5*
Blds/Roof: (C=0.90)	5.0%	30.0%	5.0%	5.0%	2.5%
AC/Conc. (C=0.85)	5.0%	25.0%	8.0%	8.0%	92.0%
Landscape: (C=0.35)	90.0%	45.0%	87.0%	87.0%	5.5%
Weighted "C" =	0.403	0.640	0.418	0.418	0.824

Coefficient of Runoff: Post-Project

Pre-project	Region 1*	Region 2*	Region 3*	Region 4*	Region 5*
Blds/Roof: (C=0.90)	5.5%	29.0%	6.0%	5.0%	2.5%
AC/Conc. (C=0.85)	5.5%	29.0%	8.5%	8.5%	92.0%
Landscape: (C=0.35)	89.0%	42.0%	85.5%	86.5%	5.5%
Weighted "C" =	0.408	0.655	0.426	0.420	0.824

*Approximate % of coverage area

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Region 1								
Q25 =	0.403	0.408	3.18	7.408	948	961	0.12	1%
Q100 =	0.403	0.408	4.03	7.408	12.02	12.17	0.16	1%
Region 2								
Q25 =	0.640	0.655	3.18	4.063	827	846	0.19	2%
Q100 =	0.640	0.655	4.03	4.063	1048	1072	0.24	2%
Region 3								
Q25 =	0.418	0.426	3.18	2.827	375	388	0.07	2%
Q100 =	0.418	0.426	4.03	2.827	476	485	0.09	2%
Region 4								
Q25 =	0.418	0.420	3.18	1.068	142	143	0.01	1%
Q100 =	0.418	0.420	4.03	1.068	130	131	0.01	1%
Region 5								
Q25 =	0.824	0.824	3.18	4.030	1056	1056	0.00	0%
Q100 =	0.824	0.824	4.03	4.030	1338	1338	0.00	0%

Project Area: Pre and Post Project Peakflows - Wave Restaurant Site

Study Area = 0.234 ac.

Rainfall Intensity:

(per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.61 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.68 in/hr
 I 100 = 4.03 in/hr

tc = 12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Coefficient of Runoff: Post-Project

Pre-project

Blds/Roof: 0.074 ac @ C = 0.90
 Conc. Patio: 0.073 ac @ C = 0.85
 Pavement: 0.106 ac @ C = 0.85
 Landscape: 0.181 ac @ C = 0.35
 0.234

Post-project

Blds/Roof: 0.031 ac @ C = 0.90
 Conc. Paver * 0.068 ac @ C = 0.85
 Pavement: 0.103 ac @ C = 0.85
 Landscape: 0.103 ac @ C = 0.35
 0.234

Overall Weighted "C" = 0.55

Overall Weighted "C" = 0.64

*Note: Concrete Pavers have been conservatively assumed to have a runoff coefficient of standard concrete. Final specification of permeable concrete pavers may decrease runoff coefficient and peakflow.

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.094	40%	0.131	56%	16%
Total Landscape	0.140	60%	0.103	44%	-16%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.55	0.64	3.18	0.234	0.4120	0.4748	0.0627	15.2%
Q100 =	0.55	0.64	4.03	0.234	0.5222	0.6017	0.0795	15.2%

Project Area: Pre and Post Project Peakflows - Maintenance Yard Site

Study Area = 0.697 ac.

Rainfall Intensity: (per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.63 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.66 in/hr
 I 100 = 4.03 in/hr

tc = 12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Coefficient of Runoff: Post-Project

Pre-project

Blds/Roof: 0.057 ac @ C = 0.90
 Conc. Patio: 0.027 ac @ C = 0.85
 Pavement: 0.167 ac @ C = 0.85
 Landscape: 0.437 ac @ C = 0.35
 0.697

Post-project

Blds/Roof: 0.157 ac @ C = 0.90
 Conc. Paver * 0.275 ac @ C = 0.85
 Pavement: 0.099 ac @ C = 0.85
 Landscape: 0.271 ac @ C = 0.35

Overall Weighted "C" = 0.54

Overall Weighted "C" = 0.67

*Note: Concrete Pavers have been conservatively assumed to have a runoff coefficient of standard concrete. Final specification of permeable concrete pavers may decrease runoff coefficient and peakflow.

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.261	37%	0.427	61%	24%
Total Landscape	0.437	63%	0.271	39%	-24%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.54	0.67	3.18	0.697	12011	14785	0.2774	23.1%
Q100 =	0.54	0.67	4.03	0.697	15221	18736	0.3515	23.1%

Project Area: Pre and Post Project Peakflows - Condor Exhibit

Study Area = 0.335 ac.

Rainfall Intensity:

(per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.61 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.68 in/hr
 I 100 = 4.03 in/hr

tc =12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Coefficient of Runoff: Post-Project

Pre-project

Boulder	0.028	ac @ C =	0.90
Water Area:	0.022	ac @ C =	0.85
Pavement:	0.052	ac @ C =	0.85
Landscape:	0.234	ac @ C =	0.35
	0.336		

Post-project

Boulder	0.020	ac @ C =	0.90
Water Area:	0.009	ac @ C =	0.85
Pavement:	0.035	ac @ C =	0.85
Landscape:	0.272	ac @ C =	0.35
	0.336		

Overall Weighted "C"= 0.51

Overall Weighted "C"= 0.45

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.102	30%	0.064	19%	-11%
Total Landscape	0.234	70%	0.272	81%	11%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.51	0.45	3.18	0.335	0.5405	0.4789	-0.0617	-11.4%
Q100 =	0.51	0.45	4.03	0.335	0.6851	0.6069	-0.0782	-11.4%

Project Area: Pre and Post Project Peakflows - Lemur / Langur Building Rehabilitation

Study Area = 0.341 ac.

Rainfall Intensity: (per SB County Flood Control Rational XL Software for South Coast)

I 25 = 3.18 in/hr tc = 12 min. (SB County Min)
 I 100 = 4.03 in/hr

Coefficient of Runoff: Pre-Project

Pre-project			
Blds/Roof:	0.051 ac @ C =	0.90	
Conc.	0.005 ac @ C =	0.85	
Pavement:	0.023 ac @ C =	0.85	
Landscape:	0.290 ac @ C =	0.35	
	0.341		

Coefficient of Runoff: Post-Project

Post-project			
Blds/Roof:	0.059 ac @ C =	0.90	
Conc.	0.059 ac @ C =	0.85	
Pavement:	0.059 ac @ C =	0.85	
Landscape:	0.162 ac @ C =	0.35	
	0.339		

Overall Weighted "C"= 0.43

Overall Weighted "C"= 0.62

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.051	15%	0.177	52%	37%
Total Landscape	0.290	85%	0.162	48%	-37%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.43	0.62	3.18	0.341	0.4651	0.6685	0.2034	43.7%
Q100 =	0.43	0.62	4.03	0.341	0.5391	0.8372	0.2578	43.7%

Project Area: Pre and Post Project Peakflows - Channel Islands Foxes Exhibit

Study Area = 0.080 ac.

Rainfall Intensity:

(per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.61 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.68 in/hr
 I 100 = 4.03 in/hr

tc = 12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Coefficient of Runoff: Post-Project

Pre-project

Boulder: 0.001 ac @ C = 0.90
 Water Area: 0.000 ac @ C = 0.85
 Pavement: 0.001 ac @ C = 0.85
 Landscape: 0.079 ac @ C = 0.35
 0.080

Post-project

Boulder: 0.003 ac @ C = 0.90
 Water Area: 0.000 ac @ C = 0.85
 Pavement: 0.007 ac @ C = 0.85
 Landscape: 0.070 ac @ C = 0.35
 0.080

Overall Weighted "C" = 0.36

Overall Weighted "C" = 0.41

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.001	1%	0.010	12%	11%
Total Landscape	0.079	99%	0.070	88%	-11%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.36	0.41	3.18	0.080	0.0917	0.1051	0.0143	15.7%
Q100 =	0.36	0.41	4.03	0.080	0.1154	0.1336	0.0182	15.7%

Project Area: Pre and Post Project Peakflows - Discovery Center

Study Area = 0.636 ac.

Rainfall Intensity:

(per SB County Flood Control Rational XL Software for South Coast)

I 10 = 2.61 in/hr
 I 25 = 3.18 in/hr
 I 50 = 3.68 in/hr
 I 100 = 4.03 in/hr

tc = 12 min. (SB County Min)

Coefficient of Runoff: Pre-Project

Coefficient of Runoff: Post-Project

Pre-project

Post-project

Conc: 0.368 ac @ C = 0.85
 Pavement: 0.158 ac @ C = 0.85
 Landscape: 0.111 ac @ C = 0.35
 0.636

Conc: 0.370 ac @ C = 0.85
 Pavement: 0.159 ac @ C = 0.85
 Landscape: 0.108 ac @ C = 0.35
 0.636

Overall Weighted "C"= 0.508

Overall Weighted "C"= 0.509

Pre-Project / Post-Project Surface Coverage Quantity Comparison (ac.)

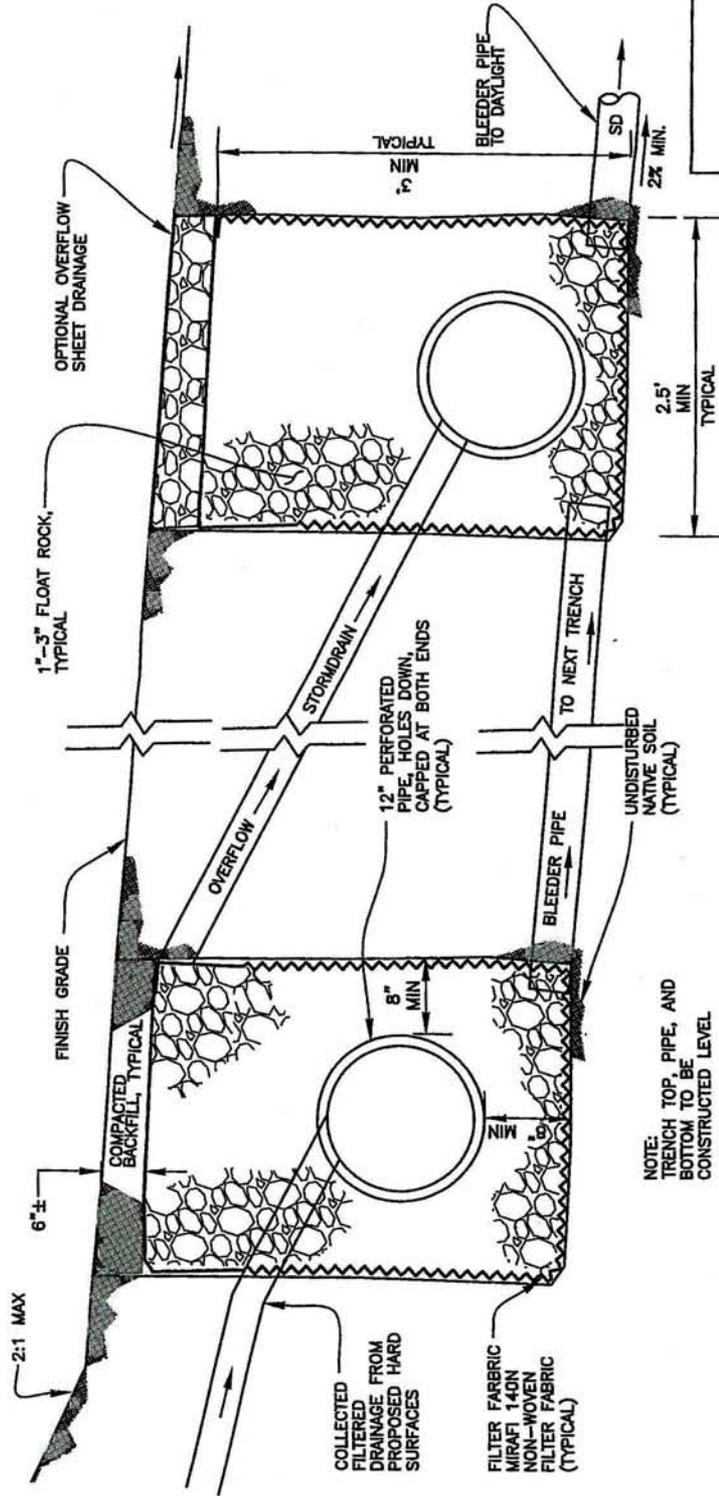
	Pre-proj.	% of total	Post-proj.	% of total	Change
Total Hardscape	0.526	82.6%	0.529	83.1%	0.5%
Total Landscape	0.111	17.4%	0.108	16.9%	-0.5%

Peakflows:

Q	Pre-Proj. C	Post-Proj. C	I (in./hr.)	A (ac.)	Pre-Project Peakflows Q (cfs)	Post-Project Peakflows Q (cfs)	Change	% Change
Q25 =	0.508	0.509	3.18	0.636	10273	10291	0.0019	0.2%
Q100 =	0.508	0.509	4.03	0.636	13018	13042	0.0024	0.2%

APPENDIX B

SAMPLE DETENTION FACILTY DETAILS



NOTE:
TRENCH TOP, PIPE, AND
BOTTOM TO BE
CONSTRUCTED LEVEL

DRAINAGE DISPERSION/DETENTION TRENCH SYSTEM DETAIL
NOT TO SCALE

APPENDIX B
DETENTION SYSTEM
CROSS SECTION
SCHEMATIC-B

SANTA BARBARA ZOO
CITY OF SANTA BARBARA
AUGUST 4, 2005

FLOWERS & ASSOCIATES, INC.
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NOT TO SCALE

DATE: _____
DWG: 0539.dwg