Appendix H

Hydrology and Water Quality

MOFFATT & NICHOL

250 West Wardlow Road
P.O. Box 7707
Long Beach, California 90807

(562) 426-9551
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November 24, 2004

City of Long Beach
Department of Public Works
333 W. Ocean Blvd., 9th Floor
Long Beach, CA 90802

Attention: Mr. Mark Christoffels, City Engineer

Subject: Long Beach Memorial Medical Center Expansion Project
Hydrology Study for the Environmental Impact Report
Department of Planning & Building Case No. 0406-20
M&N File: 5500

Dear Mark,

Thank you for our previous meetings regarding the Long Beach Memorial Medical Center Expansion Project. For the EIR, we have prepared a Hydrology Study and have submitted a draft to Sapphos, Inc. for incorporation into the EIR. The EIR process is moving along rapidly and we respectfully request that the Hydrology Study be reviewed by your office before the EIR is sent out for comments. Enclosed are three copies of the Hydrology Study for your review and approval.

We appreciated the assistance of Ed Aldridge of your staff, who provided us with information on the new storm drain in Atlantic Avenue between Columbia Street and Spring Street adjacent to the medical center campus.

Sincerely,

Jim D. Faul, P.E.
Chief Civil Engineer

Enclosures
cc:\ Pat Johner, LBMMC (w/ enclosure)
Marie Campbell, Sapphos (w/ enclosure)
John King, Adams
George Johnson, M&N
Edwin Reyes, M&N

HYDROLOGY AND WATER QUALITY REPORT

LONG BEACH MEMORIAL MEDICAL CENTER

Prepared by:

MOFFATT & NICHOL
250 West Wardlow Road
Long Beach, CA 90807
(562) 426-9551

November 2004

LONG BEACH MEMORIAL MEDICAL CENTER EXPANSION
HYDROLOGY AND WATER QUALITY

INTRODUCTION

The Long Beach Memorial Medical Center Expansion project addresses proposed master planning for land uses and the development of specific project elements, within the approximately 54-acre project site in the Long Beach Memorial Medical Center located in the City of Long Beach, County of Los Angeles, California. The Campus is located less than a mile south of U.S. Interstate 405 (San Diego Freeway), approximately 1 mile east of U.S. Interstate 710 (Long Beach Freeway), approximately 1 mile north of State Route 1 (Pacific Coast Highway). The Campus is bound on the north by East Spring Street, on the east by Atlantic Avenue, on the south by Willow Street, and on the west by Long Beach Boulevard. The Campus includes two licensed hospitals, Long Beach Memorial Medical Center (LBMMC) and Miller Children's Hospital (MCH), and related facilities and infrastructure.

This analysis of storm water and water quality is undertaken to determine if there may be an impact on the environment from the proposed expansion of the Long Beach Memorial Medical Center (LBMMC) in accordance with Section 15063 of the State of California Environmental Quality Act (CEQA).

Referenced documents include the CEQA Statute and Guidelines, the Los Angeles County Department of Public Works Hydrology Manual, the National Pollutant Discharge Elimination System (NPDES) municipal permit requirements as regulated by the Los Angeles Regional

Water Quality Control Board of the State Water Resources Control Board (SWRCB), and the California Storm Water Best Management Practice Handbook for Construction Activity.

This section briefly discusses the technical analysis of the hydrology and water quality as it relates to the expansion of the Long Beach Memorial Medical Center. More specifically, the analysis looks at possible impacts the project has on the parameters in question, and provides for possible mitigation measures if necessary.

EXISTING CONDITIONS

The 54-acre Campus is completely developed and characterized by six general land uses: (1) inpatient medical facilities, (2) outpatient medical facilities, (3) mixed-use facilities (nonresidential), (4) utilities, (5) circulation, and (6) parking. There are two licensed hospitals within the Campus, LBMMC and MCH. These facilities are centrally located on the Campus, north of 27th Street, east of Long Beach Boulevard, south of Columbia Street, and west of Atlantic Avenue. In addition to inpatient services, outpatient services are provided in structures located south of 27th Street, including a child care center, nutrition programs, and outpatient clinics. Approximately 1.93 acres are dedicated to circulation within the Campus, not including public right-of-ways. There are a total of 3,452 parking spaces located in 11 locations throughout the Campus, including 135 surplus parking spaces.

This type of site is characterized as fully developed which requires the use of the highest runoff coefficient when calculating storm water flows that could be generated from the project site during a design storm event.

Stormwater runoff from areas east of Atlantic Avenue and areas north of Spring Street are conveyed to a 54 inch storm drain that traverses east-west through the hospital site. The 54-inch storm drain joins a 90-inch storm drain located at the west side of the railroad tracks which conveys the stormwater to a storm water pump station at the Los Angeles River. The hydrologic calculations utilized the maximum allowable time of concentration for developed areas. The calculation shows that the 54 inch storm drain is capable of collecting and conveying the stormwater runoff from the upstream area. This also shows that the hospital site is not susceptible to flooding regardless of development within the hospital site or offsite of the hospital.

EXISTING STORM DRAINAGE SYSTEMS

The elevation of the project site ranges from 19 feet above mean sea level to approximately 67 feet above mean sea level. Currently, site drainage is either directed to adjacent streets following the natural topography of the existing land or is collected in on-site storm drain pipes that connect to the 54-inch storm drain. Street flow is directed to existing storm drains.
A separate 54-inch storm drain intercepts storm water from the area east of California Avenue at 27th Street and conveys the storm water westerly to the Los Angeles River. This regional storm drain system is sized in a manner to handle the storm water flows from the upstream surrounding areas. The proposed improvements do not have a component that would otherwise increase storm water runoff beyond normal rainfall amounts, as it is in the existing condition. Further analysis of storm water facilities is not warranted.

PROPOSED CONDITIONS

The proposed project consists of a Master Plan of Land Uses that provides a conceptual framework for reorganization of the six existing land uses: (1) inpatient medical facilities, (2) outpatient medical facilities, (3) mixed-use facilities (nonresidential), 94) utilities, (5) circulation, and (6) parking. Within this conceptual framework, six proposed project elements could be constructed within the next 5 to 10 years: (1) Todd Cancer Institute (TCI), (2) Miller Children's Hospital –Pediatric Inpatient Tower, Utility Trench, and Central Plant Building, (3) Miller Children's Hospital – Pediatric Outpatient Building, (4) Miller Children's Hospital – Link Building, (5) Roadway Realignment and (6) Parking Program.

The TCI would facilitate expansion of the Campus by relocating cancer treatment programs currently located within the licensed hospital facility and other diverse locations to a single building dedicated to cancer treatment programs. The comprehensive expansion of MCH would ultimately consist of three new buildings: the pediatric inpatient tower, the pediatric outpatient building, and the link building supporting mixed uses that would connect the inpatient tower and the outpatient building.

A new mixed-use building connecting the pediatric inpatient tower and the pediatric outpatient building would be located southwest of the intersection of Atlantic Avenue and Columbia Street. The existing land use at this location is an 86-stall, multilevel parking structure that would be demolished to accommodate the proposed inpatient tower. Access to the mixed-use building would be provided on multiple floors from the inpatient hospital to the north and the outpatient building to the south. Grade-level pedestrian entrances would also be provided on the east and west facades. The MCH link building would provide approximately 20,000 gross square feet.

The link building tower would consist of a 50-foot-high, three-story building that would contain retail spaces, offices, and retail food service for the users of the adjacent inpatient tower and outpatient building. Nonresidential space would be provided. The structure's ground floor would be located below grade, with the upper three floors rising above grade.
Vehicular and pedestrian circulation patterns would be improved through realignment of selected internal roadways and a signage and wayfinding program. Specifically, a 520-linear-foot section of the alignment of Patterson Street/Memorial Medical Center drive as it extends through the Campus would be realigned southward approximately 300 feet from its current intersection at Atlantic Avenue, near 28th Street on the east side of the Campus, to make a connection with the existing alignment of Patterson Street at Atlantic Avenue. As a result, the intersection of Atlantic Avenue and 28th Street would become a T-intersection. The new Patterson Street roadway would consist of two site entry lanes and three site exit lanes with an automated traffic control gate for each lane. The present roadway is approximately 85 feet wide at Atlantic Avenue. Within the campus roadway would narrow to 40 feet where it transitions to the existing Patterson Street near Pasadena Avenue. The planned street realignment will be designed to meet existing grades along the edge of existing development. Implementation of this design will result in overall street grades and drainage patterns that are subsequently similar to existing conditions. Therefore, the hydrology and storm water drainage conditions that result from the planned project will be substantially the same as existing conditions. The drainage would continue to follow a similar pattern, with similar velocities and quantities.

The planned roadway realignment will require some realignment of the on-site storm water drainage facilities.

The hydrology of the proposed project site would not be altered to the point that an impact would occur on the time of concentration for storm water runoff; therefore, the peak flow rate of runoff would not deviate from existing conditions.

STORMWATER QUALITY

As a part of the NPDES permit issued to Los Angeles County by the Regional Water Quality Control Board, the Stormwater Management Program in the City of Long Beach requires new developments to meet the permit requirements through a Standard Urban Stormwater Mitigation Plan (SUSMP). The Long Beach Memorial Medical Center Expansion does fall into the category of projects requiring a SUSMP, and overall compliance with the NPDES permit programs. The SUSMP outlines the planned activities and structures, called Best Management Practices (BMPs), to reduce or eliminate non-storm discharges to the storm water system. These requirements meet the water quality standards as set forth by the presiding agencies, and address storm runoff quantity and flow rate, suspended solids (primarily from erosion), and contaminants such as phosphorus (primarily from landscaping) and hydrocarbons (primarily from automobiles).

The Long Beach Memorial Medical Center expansion should not have an adverse effect on the storm water runoff. The proposed structures and surrounding features replace a nearly impervious surface consisting of a surface parking lot, a concrete parking structure and roadways, thereby maintaining the current runoff coefficient rate of storm water and attenuating the peak discharge rate of the site to the surrounding environment. In addition, through the proper design of landscape features and site grading, as well as implementation of structural

BMPs, the site will effectively treat the runoff to a higher quality than what is currently discharged.

The primary objectives of the 1987 amendments to the Clean Water Act that established a framework for regulating stormwater discharges from municipal, industrial, and construction activities under the NPDES include:

- Effectively prohibit non-stormwater discharges, and
- Reduce the discharge of pollutants from stormwater conveyance systems to the maximum extent practicable.

Water Quality impacts may occur when the project is under construction and after construction is complete and the project is in operation. To minimize water quality impacts, a project must implement measures that will minimize the discharge of pollutants of concern to the storm drain system. Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at a concentrations or loads considered potentially toxic to humans and/or flora and fauna. However, it is possible that a combination of BMPs not so designated, may in a particular circumstance, be better suited to maximize the reduction of the pollutants. Implementation of temporary measures must occur during construction of the project and permanent storm water quality management measures must be implemented in the project design. In conjunction with preparation of the project construction documents, the design engineer should incorporate permanent Best Management Practices (BMPs) into the project.

For a roadway project, there are a limited number of BMPs that may be appropriate for incorporation into the project. The related BMPs should be consistent with those measures being implemented by the City of Long Beach who would be the agency responsible for ongoing maintenance of the BMPs.

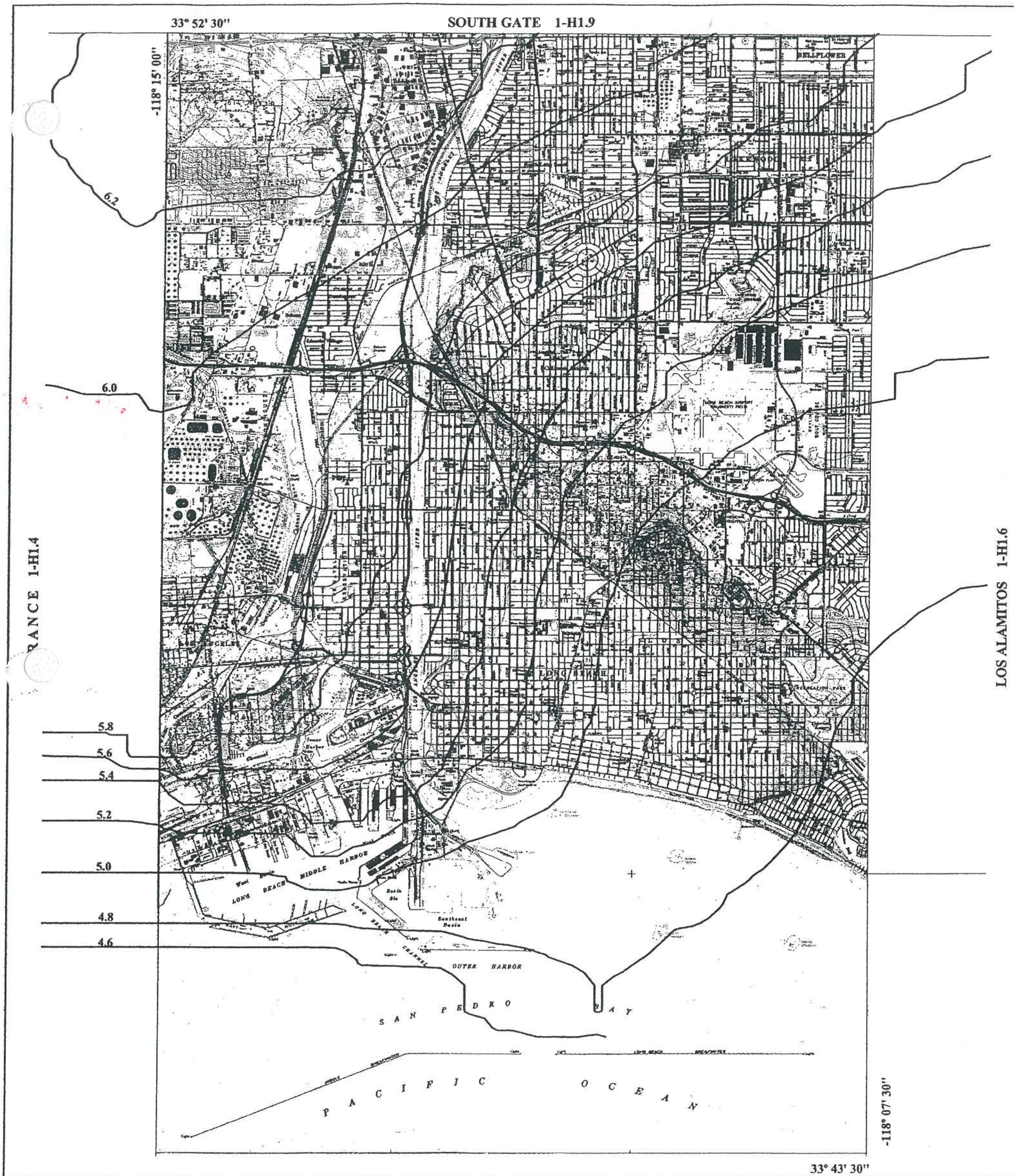
Some permanent means that may be considered in the design phase include:

- Catch basin inserts
- Use of drip or low flow irrigation systems to present discharge of non-storm event flows to the storm drain system.
- Catch basin stenciling
- Provision of trash receptacles

The City of Long Beach currently has a street sweeping program that would remove miscellaneous trash debris and sediment that may accumulate in street gutters.

During the construction phase of the project, the construction must implement temporary BMPs to prevent transport of Pollutant of Concern from the construction site to the storm drainage system. The BMPs should apply to both the actual work areas as well as contractor staging areas. Selection of construction related BMPs will be in accordance with the requirements of the California Storm Water Best Management Practice Handbook for Construction Activity.

The proposed project, through the development of a SUSMP, will incorporate BMPs that will effectively reduce or eliminate the discharge of total suspended solids (TSS), or suspended sediment, offsite. Currently, BMPs are not incorporated on the project site, so providing the BMPs in the new development will actually enhance the water quality discharged from the site. To implement these requirements, the project will prepare a Local Storm Water Pollution Prevention Plan. If construction occurs between October 1 of one year and April 15 of the following year, a Wet Weather Erosion Control Plan must also be prepared and implemented by the contractor.



N W E S

7.2 INCHES OF RAINFALL

25-YEAR 24-HOUR ISOHYET REDUCTION FACTOR: 0.878
10-YEAR 24-HOUR ISOHYET REDUCTION FACTOR: 0.714

LONG BEACH 50-YEAR 24-HOUR ISOHYET

1-H1.5

LOS ANGELES COUNTY PUBLIC WORKS Public Service That Works

PROPORTION IMPERVIOUS

Residential

Single-Family	0.418
Two-Unit	0.418
Three-Unit	0.682
Four-Unit	0.819
Five-Unit	0.855

Commercial

Stores, Office Buildings, Manufacturing Outlets	0.909
Shopping Centers (Regional), Restaurants, Service Shops, Auto Equipment, Parking Lots	0.946
Shopping Centers (Neighborhood), Motels, Hotels, Kennels, Professional Buildings, Banks, Service Stations	0.958
Supermarkets	0.976
Department Stores	0.985

Industrial

Mineral Processing	0.473
Open Storage	0.655
Motion Picture, Radio, Television	0.819
Manufacturing, Warehousing, Storage, Parking	0.909
Food Processing Plants, Lumber Yards	0.958

Institutional Property

Colleges, Universities	0.473
Homes for the Aged	0.682
Hospitals, Cemeteries, Mausoleums, Mortuaries	0.744
Churches, Schools	0.819

LONG BEACH MEMORIAL MEDICAL CENTER
10 - YEAR HYDROLOGY

Project	Subarea	Area (acres)	%imp	Frequency	Soil Type	Length (ft)	Slope (ft/ft)	Isohyet (in.)	Tc-calculated (min.)	Intensity (in./hr)	Cu	Cd	Flowrate (cfs)
10 - YEAR FREQUENCY													
LBMMC	1A	4.1	0.95	10	14	520	0.083	4.1412	6	2.27	0.67	0.89	8.28
LBMMC	18	0.59	0.95	10	14	900	0.085	4.1412	9	1.87	0.59	0.88	0.97
LBMMC	11	8.64	0.95	10	14	1200	0.086	4.1412	11	1.71	0.54	0.88	13.00
LBMMC	10	1.31	0.95	10	14	600	0.056	4.1412	7	2.11	0.64	0.89	2.46
LBMMC	2	4.16	0.95	10	14	680	0.022	4.1412	10	1.78	0.56	0.88	6.52
LBMMC	12	9.75	0.95	10	14	1200	0.059	4.1412	12	1.64	0.52	0.88	14.07
LBMMC	19	2.52	0.95	10	14	650	0.018	4.1412	10	1.78	0.56	0.88	3.95
LBMMC	21	1.6	0.95	10	14	450	0.022	4.1412	7	2.11	0.64	0.89	3.00
LBMMC	13	3.76	0.95	10	14	550	0.051	4.1412	7	2.11	0.64	0.89	7.06
LBMMC	3	1.31	0.95	10	14	320	0.053	4.1412	5	2.47	0.69	0.89	2.88
LBMMC	4	1.5	0.95	10	14	300	0.028	4.1412	5	2.47	0.69	0.89	3.30
LBMMC	5	3.53	0.95	10	14	500	0.02	4.1412	8	1.98	0.62	0.89	6.22
LBMMC	17	0.37	0.95	10	14	480	0.02	4.1412	8	1.98	0.62	0.89	0.65
LBMMC	16	0.35	0.95	10	14	480	0.02	4.1412	8	1.98	0.62	0.89	0.62
LBMMC	15	19.25	0.95	10	14	2395	0.02	4.1412	22	1.23	0.39	0.87	20.60
LBMMC	14	12.82	0.95	10	14	1260	0.02	4.1412	14	1.52	0.48	0.88	17.15
LBMMC	8	12.33	0.95	10	14	675	0.017	4.1412	10	1.78	0.56	0.88	19.31
LBMMC	6	3.11	0.95	10	14	395	0.035	4.1412	6	2.27	0.67	0.89	6.28
LBMMC	9	2.09	0.95	10	14	380	0.037	4.1412	6	2.27	0.67	0.89	4.22
LBMMC	7	1.9	0.95	10	14	440	0.033	4.1412	7	2.11	0.64	0.89	3.57
LBMMC	1	20.5	0.95	10	14	1660	0.0185	4.1412	17	1.39	0.44	0.88	25.08

Drainage Area Map No. LONG Beach Memorial Medical Center
Ref. **10 - Year Frequency**
Initial T_c 5 minutes

Zone K

Date Oct 12, 200 By JR Chk By JG

Comments	HYDROLOGY							HYDRAULIC CAPACITY					
	Line Desig.	ΔA Acres	ΔA Avr. Slope	C'	ΔAC'	ΣA Acres	Design Q_{10} (cfs)	Conduit Size D (in)	Percent Full	HGL Slope (ft/ft)	Length L (ft)	Vel. V (ft/sec)	Max Pipe Q (cfs)
Area 1A - JS1	L1A	4.10	0.083	0.95	3.90	4.10	8.28	18	35.75	0.083	319.50	14.60	32.55
Areas 18, 11, 10 - JS2	L1	10.54	0.076	0.95	10.01	14.64	24.71	18	71.04	0.076	302.00	18.40	31.15
Areas 2 & 12 -JS3	L2	13.91	0.041	0.95	13.21	28.55	45.30	18	100.00	0.041	53.50	12.04	22.88
Areas 19, 21 & 13 - JS4	L3	7.88	0.03	0.95	7.49	36.43	59.31	24	100.00	0.030	308.34	12.47	42.15
Areas 3,4,5,17,16, 15 & 14 - MH1	L4	39.13	0.026	0.95	37.17	75.56	110.73	54	67.43	0.005	389.00	9.70	149.57
Area 6 - JS15	L6	3.11	0.035	0.95	2.95	78.67	117.01	54	70.28	0.005	560.00	9.80	149.57
Areas 8 & 9 - JS11	L7	14.42	0.037	0.95	13.70	93.09	140.54	54	82.97	0.005	380.00	9.96	149.57
Areas 1, 7 - JS12	L8	22.40	0.026	0.95	21.28	115.49	169.19	54	84.77	**0.007 *	150+/-	11.77	176.97

* * The last section of 54-inch pipe before it discharges into the 90-inch storm drain will flow full at the peak runoff with the hydraulic grade elevated approximately 0.65-foot above the soffit of the 54-inch pipe at the upstream manhole.

4

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\lbmmc.fm2
Worksheet	.013
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.083000	ft/ft
Diameter	18.00	in
Discharge	8.28	cfs

Results		
Depth	0.54	ft
Flow Area	0.57	ft^2
Wetted Perimeter	1.92	ft
Top Width	1.44	ft
Critical Depth	1.11	ft
Percent Full	35.75	
Critical Slope	0.007636	ft/ft
Velocity	14.60	ft/s
Velocity Head	3.31	ft
Specific Energy	3.85	ft
Froude Number	4.10	
Maximum Discharge	32.55	cfs
Full Flow Capacity	30.26	cfs
Full Flow Slope	0.006214	ft/ft
Flow is supercritical.		

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Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\lbmmc.fm2
Worksheet	.013
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.076000	ft/ft
Diameter	18.00	in
Discharge	24.71	cfs

Results		
Depth	1.07	ft
Flow Area	1.34	ft^2
Wetted Perimeter	3.01	ft
Top Width	1.36	ft
Critical Depth	1.49	ft
Percent Full	71.04	
Critical Slope	0.051092	ft/ft
Velocity	18.40	ft/s
Velocity Head	5.26	ft
Specific Energy	6.33	ft
Froude Number	3.27	
Maximum Discharge	31.15	cfs
Full Flow Capacity	28.96	cfs
Full Flow Slope	0.055342	ft/ft
Flow is supercritical.		

6

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\lbmmc.fm2
Worksheet	.013
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.041000	ft/ft
Diameter	18.00	in

Results		
Depth	18.0	in
Discharge	21.27	cfs
Flow Area	1.77	ft^2
Wetted Perimeter	4.71	ft
Top Width	0.00	ft
Critical Depth	1.47	ft
Percent Full	100.00	
Critical Slope	0.036971	ft/ft
Velocity	12.04	ft/s
Velocity Head	2.25	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	22.88	cfs
Full Flow Capacity	21.27	cfs
Full Flow Slope	0.041000	ft/ft

7

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\lbmmc.fm2
Worksheet	lbmmc
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.030000	ft/ft
Diameter	24.00	in

Results		
Depth	2.00	ft
Discharge	39.18	cfs
Flow Area	3.14	ft^2
Wetted Perimeter	6.28	ft
Top Width	0.00	ft
Critical Depth	1.95	ft
Percent Full	100.00	
Critical Slope	0.026570	ft/ft
Velocity	12.47	ft/s
Velocity Head	2.42	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	42.15	cfs
Full Flow Capacity	39.18	cfs
Full Flow Slope	0.030000	ft/ft

8

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\lbmmc.fm2
Worksheet	.013
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Diameter	54.00	in
Discharge	110.73	cfs

Results		
Depth	36.4	in
Flow Area	11.41	ft^2
Wetted Perimeter	8.67	ft
Top Width	4.22	ft
Critical Depth	3.10	ft
Percent Full	67.43	
Critical Slope	0.004734	ft/ft
Velocity	9.70	ft/s
Velocity Head	1.46	ft
Specific Energy	4.50	ft
Froude Number	1.04	
Maximum Discharge	149.57	cfs
Full Flow Capacity	139.04	cfs
Full Flow Slope	0.003171	ft/ft
Flow is supercritical.		

9

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\sanpedro.fm2
Worksheet	LB
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Diameter	54.00	in
Discharge	117.01	cfs

Results		
Depth	3.16	ft
Flow Area	11.94	ft^2
Wetted Perimeter	8.95	ft
Top Width	4.11	ft
Critical Depth	3.18	ft
Percent Full	70.28	
Critical Slope	0.004911	ft/ft
Velocity	9.80	ft/s
Velocity Head	1.49	ft
Specific Energy	4.65	ft
Froude Number	1.01	
Maximum Discharge	149.57	cfs
Full Flow Capacity	139.04	cfs
Full Flow Slope	0.003541	ft/ft

Flow is supercritical.

10

Worksheet
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\sanpedro.fm2
Worksheet	LB
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.005000	ft/ft
Diameter	54.00	in
Discharge	140.54	cfs

Results		
Depth	3.73	ft
Flow Area	14.11	ft^2
Wetted Perimeter	10.31	ft
Top Width	3.38	ft
Critical Depth	3.49	ft
Percent Full	82.97	
Critical Slope	0.005716	ft/ft
Velocity	9.96	ft/s
Velocity Head	1.54	ft
Specific Energy	5.28	ft
Froude Number	0.86	
Maximum Discharge	149.57	cfs
Full Flow Capacity	139.04	cfs
Full Flow Slope	0.005108	ft/ft
Flow is subcritical.		

=

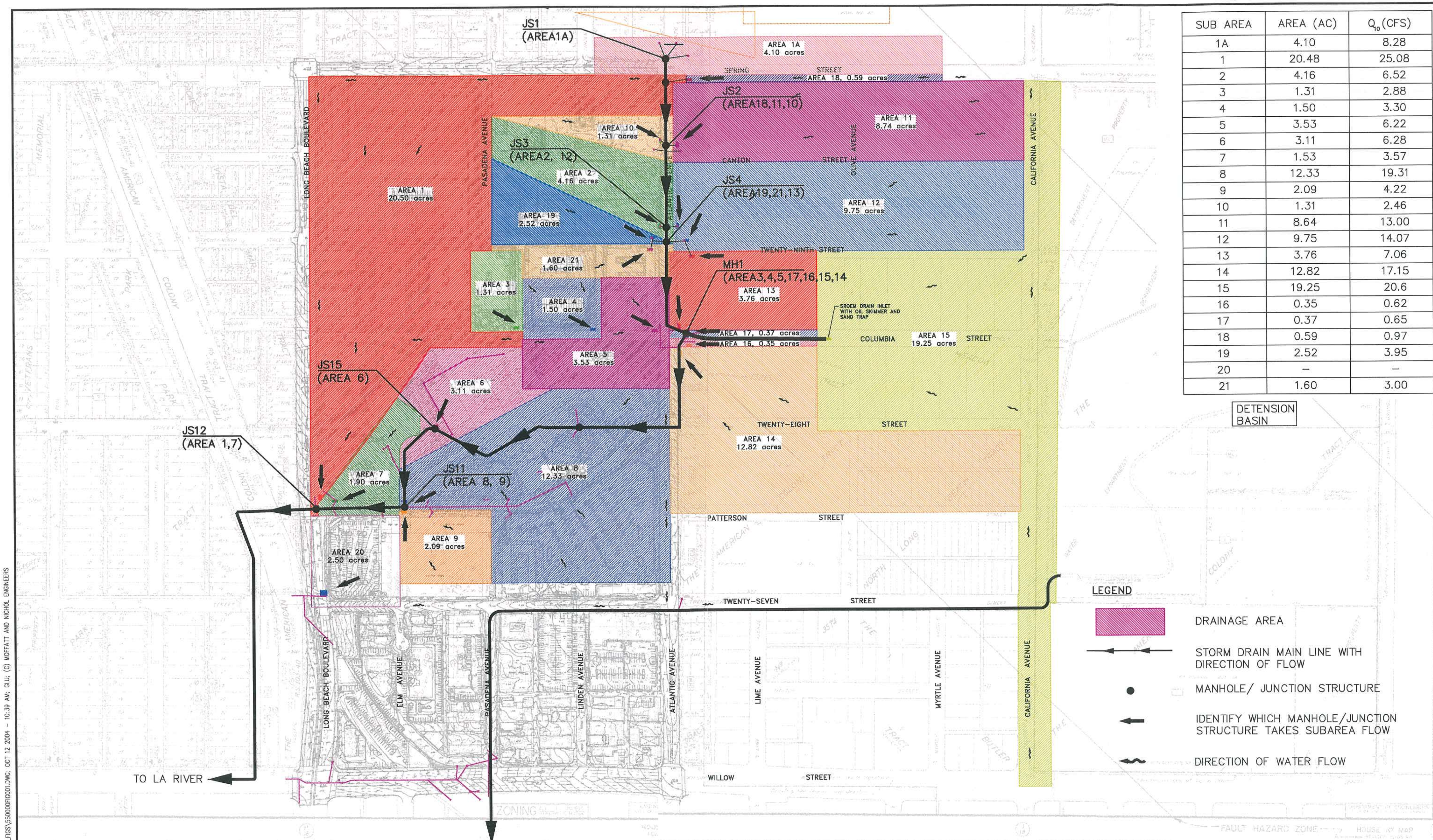
LB
Worksheet for Circular Channel

Project Description	
Project File	c:\docume~1\jreyes\my documents\haestad\fmw\sanpedro.fm2
Worksheet	LB
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.013	
Channel Slope	0.007000	ft/ft
Diameter	54.00	in
Discharge	169.19	cfs

Results		
Depth	45.8	in
Flow Area	14.38	ft²
Wetted Perimeter	10.53	ft
Top Width	3.23	ft
Critical Depth	3.79	ft
Percent Full	84.77	
Critical Slope	0.007073	ft/ft
Velocity	11.77	ft/s
Velocity Head	2.15	ft
Specific Energy	5.97	ft
Froude Number	0.98	
Maximum Discharge	176.97	cfs
Full Flow Capacity	164.52	cfs
Full Flow Slope	0.007403	ft/ft
Flow is subcritical.		

12



SUB AREA	AREA (AC)	Q_{10} (CFS)
1A	4.10	8.28
1	20.48	25.08
2	4.16	6.52
3	1.31	2.88
4	1.50	3.30
5	3.53	6.22
6	3.11	6.28
7	1.53	3.57
8	12.33	19.31
9	2.09	4.22
10	1.31	2.46
11	8.64	13.00
12	9.75	14.07
13	3.76	7.06
14	12.82	17.15
15	19.25	20.6
16	0.35	0.62
17	0.37	0.65
18	0.59	0.97
19	2.52	3.95
20	–	–
21	1.60	3.00

MOFFATT & NICHOL
250 WARDLOW ROAD
LONG BEACH, CALIFORNIA, 90807
562-426-9551

LONG BEACH MEMORIAL MEDICAL CENTER EXPANSION

HYDROLOGY MAP

EXHIBIT A