Drainage Study

OTAY RANCH RESORT VILLAGE

County of San Diego, California

Preparation/Revision Date:
September 12, 2014

Prepared for:

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Declaration of Responsible Charge

I hereby declare that I am the engineer of work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current standards.

I understand that the check of project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

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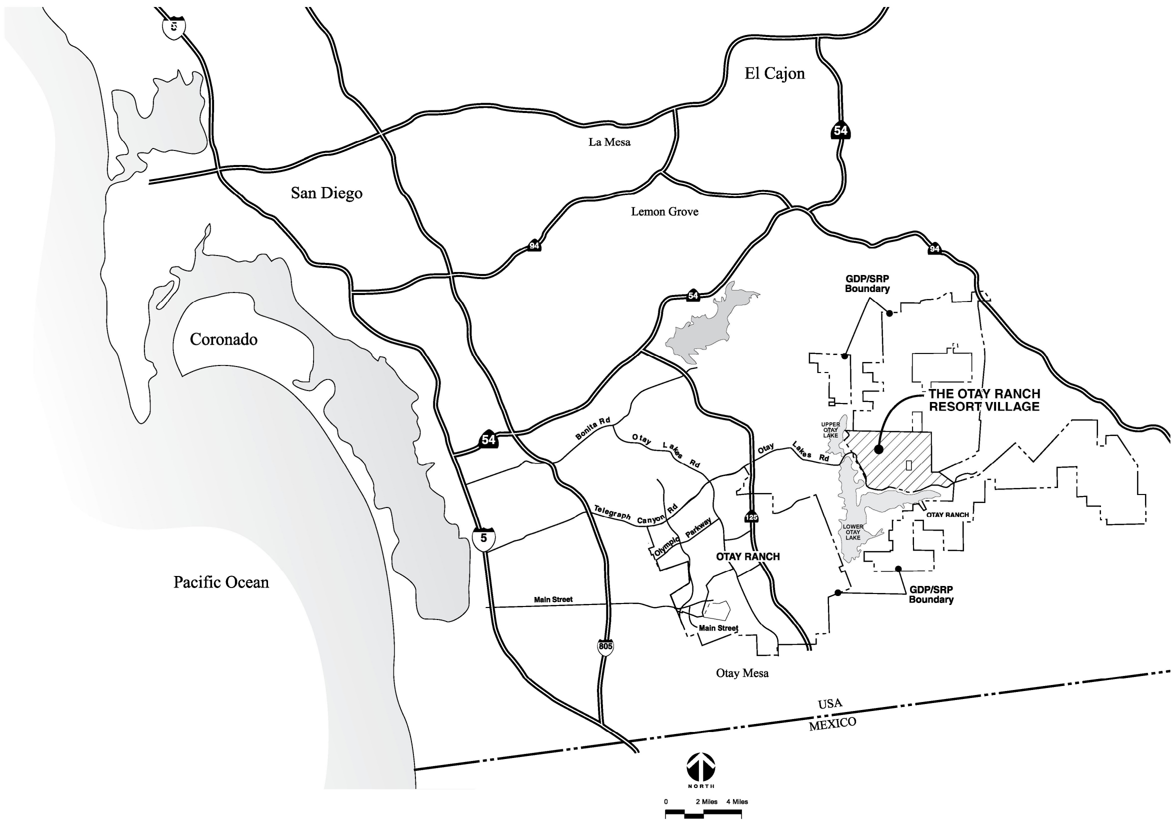
CHAPTER 1 - EXECUTIVE SUMMARY

1.1 Introduction

The Otay Ranch Resort Village is located in the County of San Diego, in the Proctor Valley Parcel of the Otay Subregional Plan (Otay SRP) approximately one-quarter mile east of the City of Chula Vista (see Regional Location Map). Access is provided via Telegraph Canyon Road which transitions into Otay Lakes Road, and forms the southern boundary of the Project site.



REGIONAL LOCATION MAP

The Otay Ranch Resort Village's approximate 1,889-acre planning area[1] consists of a broad mesa sloping to the south, broken by several steep canyons draining from north to south. Portions of the relatively flat mesa extend north into the Jamul Mountains, becoming part of steeper slopes. Site elevations range from approximately 500 feet above mean sea level (AMSL) at the southern end of the property to approximately 1,500 feet AMSL in the northeastern portions. The project area lies within the watershed of the Otay River, a westerly flowing stream with a tributary watershed of approximately 145 square miles. The site is upstream of Savage Dam, which creates Lower Otay Reservoir. The Otay Ranch Resort Village site vegetation consists of native coastal sage scrub and grassland habitats disturbed by grazing. Some riparian vegetation occurs in drainage areas of the site.

The Otay Ranch Resort Village is located at the interface of urban development and scenic open space. The Otay Valley Parcel of Otay Ranch, the Eastlake Vistas residential community, the Eastlake Woods residential community, and the U.S. Olympic Training Center compose the edge of urban development to the west. Lower Otay Reservoir, a water supply reservoir owned by the City of San Diego, is located to the south. Upper Otay Reservoir and the Birch Family Estate are located to the northwest. A temporary ultra-light gliding and parachuting airport is located at the eastern end of the Lower Otay Reservoir on City of San Diego property. An inactive quarry operation is located further to the east.

Proposed Plan

The proposed land uses consist of single-family neighborhoods, a mixed use residential and commercial use neighborhood, a resort hotel with associated ancillary facilities, an elementary school site, a site for public safety facilities, open space, Preserve land, and park and recreational uses.

The proposed specific plan includes approximately 525.0 acres designated for 1,881 single-family detached homes. Five single-family neighborhoods are planned with average densities ranging from 3.2 to 4.4 dwelling units per acre.

A Mixed Use neighborhood of 14.1 acres is proposed to contain 57 attached homes. The mixed use area includes up to 20,000 square feet of commercial uses.

Approximately 17.4 acres are identified for a resort hotel complex with a maximum of 200 guest rooms and up to 20,000 square feet of ancillary uses including meeting rooms, a conference center, offices, shops, and restaurants.

The specific plan proposes to reserve a 2.1 acre public safety site and a 10.0 acre elementary school site.

Nine parks are planned on 28.6 acres, the largest of which is a 10.3 acre public neighborhood park site. The remaining parks range from 1.3 acres to 2.9 acres.

The Otay Ranch Resort Village planning area also includes about 144 acres of open space and approximately 1,089 acres of Preserve land. Open space generally consists of large manufactured slopes outside of neighborhoods and brush

[1] Includes 20-acre NAP parcel, actual project area is approximately 1,869 acres.

management areas. Preserve land is usually undisturbed lands or restored habitats set aside for dedication to the Otay Ranch Preserve Owner Manager in satisfaction of Otay Ranch RMP conveyance requirements.

Internal circulation comprises about 39.0 acres of the planning area.

The impact of development along and within Otay Lakes Road was also included with the hydrologic and hydraulic analysis of this study. Otay Lakes Road adjacent to Village 13 is approximately 4.15 miles long and accounts for approximately 47.72 acres of which about 30 acres is impervious surfaces such as pavement, curb, and sidewalk.

All runoff from the project site currently discharges to the Lower Otay Reservoir via one of 23 existing culverts under Otay Lakes Road. Development of the site will not cause any diversion to or from the Lower Otay Reservoir watershed. Water from Otay Reservoir (and, thus, from the entire catchment of the reservoir) rarely discharges to the Otay River downstream of Savage Dam. Water from Otay Reservoir is conveyed in a pipeline to the Otay Water Treatment Plant, treated to drinking water standards, and distributed as potable water to homes and businesses in the City of San Diego and neighboring communities. The only time any water is released from Otay Reservoir to the Otay River downstream is when the reservoir fills up and overflows, which has happened only seven times since 1917. The City of San Diego has stated that they will impound the maximum amount of water possible.

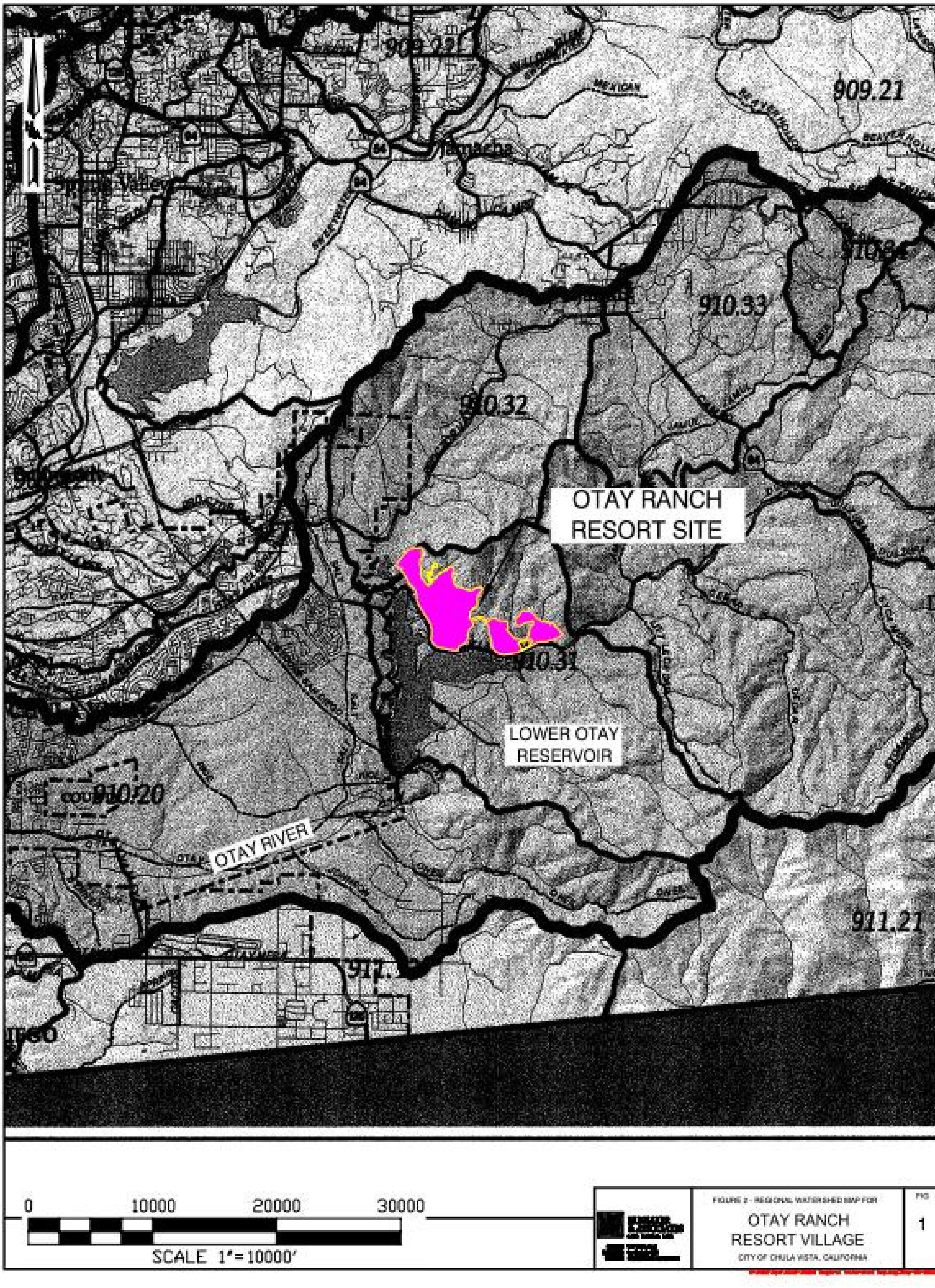

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FIGURE 2 - REGIONAL WATERSHED MAP FOR
OTAY RANCH
RESORT VILLAGE
CITY OF CHULA VISTA, CALIFORNIA
FIG
1

This Otay Ranch Resort Village Master Drainage Study has been prepared to assess the pre-developed and developed condition peak runoff rates from the proposed Otay Ranch Resort Village site as well as offsite runoff conveyed through the project site. Additionally, this report addresses the adequacy of the receiving conveyance systems to which the proposed project drains.

No previous hydrologic analyses are known to exist for the project site. Since the site lays outside any FEMA floodplain boundaries no Letters of Map Revision will be required.

All methodology used in this analysis is consistent with standards set forth by the San Diego County Hydrology Manual (SDCHM). Since the total contributing watershed area to each discharge culvert is less than one square mile in Pre and/or Post-Development conditions (except for culverts 7 and 18 with 1.02 and 1.56 sq-miles of contributing area, respectively) the Rational Method was used to determine peak flow rates. Watersheds in excess of 1.0 square mile have been analyzed using HEC HMS software. Per County of San Diego methodology, which is detailed in section 2.1, all hydrologic results correspond to the 100-year design storm. Additionally, per request of the City of San Diego, the 2 year storm event has been analyzed using HEC HMS software to demonstrate no decrease in runoff from smaller storm events. Refer to section 8.4 for these results.

Per County of San Diego drainage criteria for the Post-Developed condition, and following County of San Diego recommendations , the Rational Method has also been used to determine peak design flow rates since all the contributing drainage areas are less than 1.0-square mile (except for culverts 7 & 18). The AES-2010 computer software was used to model the runoff response per the Modified Rational Method. Methodology used for the computation of design rainfall events, runoff coefficients, and rainfall intensity values are consistent with criteria set forth in the most current SDCHM. A more detailed explanation of methodology and model development used for this analysis is listed in Chapter 2 of this report.

Treatment of storm water runoff has been addressed in a separate report, titled the "Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan" by Hunsaker & Associates dated September 2014.

1.2 Summary of Pre-Developed Conditions

The existing Otay Ranch Resort Village project site contains no development. On-site topography is characterized by steep hills, incised canyon and vegetation consisting mainly of brush. No development exists in off-site areas which drain through the project site.

As shown on the Pre-Developed Condition Watershed Map in Chapter 5, runoff from the project area drains via one of 23 existing culverts under Otay Lakes Road to the Lower Otay Reservoir. Table 1 below summarizes the existing culverts under Otay Lakes Road as well as corresponding contributing drainage areas. Culvert sizes in Table 1 were obtained by field survey.

TABLE 1 - Summary of Existing Culvert Data under Otay Lakes Road

Culvert Number**	Existing Drainage Area to Culvert (acres)	100-year Existing Peak Flow (cfs)	Culvert Size
1A	28.1	43.9	24" CMP pipe
1B	6.5	11.1	24" CMP pipe
2	38.7	53.7	24" CMP pipe
3	Not affected by Development	Not affected by Development	2 - 10'x10' Boxes
4	117.1	172.0	24" CMP pipe
5	30.8	48.4	24" CMP pipe
6	155.8	194.9	24" CMP pipe
7	461.7	568.6***	36" RCP pipe
8	23.3	34.4	12" CMP pipe
9	105.5	121.9	24" RCP pipe
10	12.2	18.8	21" CMP pipe
11	7.0	10.9	18" CMP pipe
12	14.5	22.1	18" CMP pipe
13	9.5	14.9	18" RCP pipe
14	12.6	20.4	18" RCP pipe
15	293.5	296.5	18" RCP pipe
16	86.2	97.8	24" CMP pipe
16A	8.4	14.2	18" CMP pipe
17	20.6	30.6	24" CMP pipe
17A	6.0	11.0	15" PVC pipe
18	893.9	896.5***	66" CMP pipe
18A	9.7	16.5	18" corrugated HDPE pipe
19	59.0	85.4	24" CMP pipe
20	61.2	86.9	9'x5' Box
Total	**2,461.8**	**2,871.4***	-

*Total peak flow from Methodology explained in section 3.4.2 of the SDCHM. Confluence calculations are shown in Chapter 7.
** See Chapter 5 (Existing Conditions Hydrology Maps) for location of culverts.
***Culverts 7 & 18 analyzed using HEC HMS Software.

While a small portion of the Project area drains to Culvert 3 in Pre-Development conditions, this area will be incorporated into the drainage area of Culvert 7 in Post-

Development conditions, and no Post-Development area will drain to Culvert 3. Therefore, the hydrologic and hydraulic analysis of Culvert 3 is out of the scope of this report, as its contributing area will reduce in Post-Development conditions and the peak flow will be reduced. As the contributing area of Culvert 3 corresponds with the watershed area of a large tributary of the Otay River upstream of the Reservoir, an hydrologic analysis of the peak flow of Culvert 3 would be regional in nature, and unnecessary given the Project does not drain there in Post-Development conditions. Additionally, the fraction of the area diverted to Culvert 7 corresponds to less than 0.1% of the total contributing area to Culvert 3.

Table 2 summarizes the 100-year Pre-Development peak flows to each of the 23 discharge locations. All flows listed in Table 2 were generated using the AES-2010 program and the methodology explained in the SDCHM (with exception of culverts 7 & 18 which have been analyzed using HEC HMS software). Table 2 also shows the current capacity of the existing culvert as obtained with Culvert Master (see Chapter 7), and the possibility of overtopping in a 100-year storm event, comparing the culverts' capacity with the calculated 100-year peak flow.

TABLE 2 - Summary of Pre-Developed Flows to Existing Culverts

Culvert Number	100- Year Existing Peak Flow (cfs)	Existing Culvert Capacity "C" (cfs)	Roadway Overtopping Potential in 100-Year Storm
1A	43.9	28.9	Yes, minor
1B	11.1	28.9	No
2	53.7	45.9	Yes, minor
4	172.0	37.14	Yes, significant
5	48.4	41.07	Yes, minor
6	194.9	42.52	Yes, significant
7	568.6*	135.0	Yes, significant
8	34.4	3.5	Yes, significant
9	121.9	49.0	Yes, significant
10	18.8	19.7	No
11	10.9	13.0	No
12	22.1	13.8	Yes, minor
13	14.9	17.0	No
14	20.4	19.7	Yes, minor
15	296.5	25.7	Yes, significant
16	97.8	35.2	Yes, significant
16A	14.2	15.4	No
17	30.6	44.57	No
17A	11.0	10.2	Yes, minor
18	896.5*	443.4	Yes, significant
18A	16.5	12.6	Yes, minor

19	85.4	42.0	Yes, significant
20	86.9	540.4	No

*Culverts 7 & 18 analyzed using HEC HMS software.

As shown in Table 2, 73% of the analyzed existing culverts under Otay Lakes Road (16 of 22) are undersized in the existing condition and require upgrades to prevent roadway overtopping during the design flow event. Only 6 culverts have enough capacity to avoid overtopping in Pre-Development conditions during a 100-year storm event.

Supporting calculations for the data presented in Table 2 are located in Chapter 3 of this report. The corresponding hydrology map is located in Chapter 5.

1.3 Summary of Developed Conditions

Development of the 1,889 acre Otay Ranch Resort Village will include the construction of residential dwelling units, a resort site, multiple park sites, and a school site. Roughly 754 acres of the 1,889 acre study area will be developed, while 1,135 acres will remain undeveloped.

Natural runoff from most areas north of the project site will be separated from developed site runoff via separate storm drain systems (see areas in blue in Chapter 6). Thus, runoff from natural (undeveloped) areas would continue to drain directly to the Lower Otay Reservoir and not mix with runoff from the development until downstream of the proposed water quality basins (after low flows from the development areas have been treated). However, due to storm drain optimization, and to avoid a double storm drain system in many streets, runoff from some natural areas will mix with runoff from developed areas and discharge into water quality basins (see natural areas in the Proposed Conditions Watershed Map, Chapter 6 as part of the contributing area of all basins except Basin 4).

All runoff from the developed Otay Ranch Resort Village project site will drain to the Lower Otay Reservoir. The runoff from the 85th percentile storm, as defined by the SDCHM, and drier weather runoff from developed areas of the proposed project will be diverted to seven water quality basins. Runoff in excess of the runoff volume produced by the 85th percentile storm will discharge to the Otay Lakes Road culverts and on to the Lower Otay Reservoir. The performance of the Water Quality Basins is described in depth in the "Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan" by Hunsaker & Associates dated September 2014. Development of the project site will not cause any diversion to or from the Lower Otay Reservoir watershed.

At the downstream end of the internal storm drain systems, the culvert crossings at Otay Lakes Road will be upsized to prevent roadway overtopping during the 100-year design event. Table 3 summarizes the 100-year developed condition peak flows to each of the discharge locations at Otay Lakes Road.

Supporting calculations for the data presented in Table 3 is located in Chapter 4 of this report. The corresponding post-development Hydrology Map is shown in Chapter 6.

TABLE 3 - Summary of Post-Developed Condition Flows

Culvert Number	**Total Post-Developed Area to Culvert (acres)**	**100-Year Developed Peak Flow (cfs)**
1A	29.6	46.9
1B	6.2	14.52
2	31.80	47.97
4	15.90	48.22
6	205.00	436.26
7	653	937.9*
9	133.1	199.9
12	8.5	20.4
14	10.7	30.2
15	241.5	256.3
16	129.90	223.31
18	996.2	1,198.5*
19	4.5	11.67
20	20.56	44.82
TOTAL	**2,486.46***	**3,516.9**

*Culverts 7 & 18 analyzed with HEC HMS software.

1.4 Analysis and Results

1.4.1 Hydrology

1.4.1.2 Rational Method

Typically only the 100 year extreme rainfall event is analyzed. However, per request of the City of San Diego the 2 year event has been analyzed as well to demonstrate no decrease in runoff to Lower Otay Reservoir. Table 4 summarizes the global effect of on-site development in the discharge of the 100-year peak flow event to Lower Otay Reservoir. The 2 year event analysis is summarized in Section 8.4. The total Post-Development area is less than 1% larger than the total Pre-Development area because of the difference in alignment of Otay Lakes Road in Pre and Post Development Conditions. Additionally, there is a small area draining to Culvert 3 in existing conditions which drains to Culvert 7 in Post-Development conditions.

TABLE 4 - Summary of Pre Vs Post-Developed Condition Total Flows to Lower Otay Reservoir

Condition	Tributary Area (acres)	100-Year Peak Flow (cfs)
Pre-Developed	2,461.8	2,871.4
Post-Developed	2,486.5	3,516.9
DIFFERENCE	**+ 24.7***	**+ 645.5**
Adjusted Pre-Development	2,486.5	2,900.2*
DIFFERENCE (after adjustment)	**0**	**+616.7**

*: Areas do not match because small changes in alignment and section of Otay Lakes Rd and pre-development area draining to culvert 3 not considered in the analysis. Pre-development peak flow proportional to the area in the adjusted area.

Since the capacity of the Lower Otay Reservoir is more than sufficient to convey the proposed peak flow increases and all culverts will be upsized to convey the projected 100-year peak flow under Otay Lakes Road, no detention basins are required as part of the proposed project. The internal diversions between culverts is not significant since all culverts will be sized to safely convey the 100-year design storm and their outfalls immediately drain to the Lower Otay Reservoir, which effectively mitigates any flood control and erosion concerns.

Table 6 provides details of the major culvert upgrades under Otay Lakes Road. All existing culverts will be upgraded as part of the improvements of the adjacent Otay Lakes Road to be undertaken as part of the proposed project. Per data received from the City of San Diego Water Department and FEMA, a tailwater elevation of approximately 490.7 feet has been determined for the Lower Otay Reservoir (reference section 7.6 for calculations). This elevation represents the maximum water surface elevation of Lower Otay Reservoir when the 100 year flow is routed through the Savage Dam spillway. Additionally, per request of the City of San Diego, a separate culvert analysis has been prepared based on a maximum tailwater elevation of 491.3 (which corresponds to the top of the Savage Dam spillway gates).

From an analysis of Table 6, nine culverts will be abandoned (culverts 5, 8, 10, 11, 13, 16A, 17, 17A, 18A), two culverts will be reduced (culverts 19, 20), one culvert will remain the same size but improved (Culvert 4), one culvert will be extended (Culvert 3, corresponding with the double 10'x10' box) and ten culverts will be greatly improved.

Regarding the peak flow comparison from Pre and Post-Development conditions, six discharge locations out of 23 will increase their peak flows, and only four of those significantly (more than 80%: culverts 6, 7, 9 & 16). Table 6 also shows the velocity of discharge in Pre and Post-Development conditions for the respective 100-year peak flows. The Post-Development culverts will avoid overtopping and the excessive erosion associated with it, and will discharge the 100-year peak flow with reduced velocity when compared to Pre-Developed conditions.

1.4.1.3 NRCS Unit Hydrograph Method

The NRCS Unit Hydrograph was applied to the watersheds draining to proposed culverts 7 and 18 since these areas exceed 640 acres of total tributary area. According to the HEC-HMS output, the pre and post-development flow rates and corresponding watershed areas are shown below in Table 5. Complete results and calculations are shown in Chapters 3 and 4.

TABLE 5 - Summary of Unit Hydrograph Calculations

Culvert #	Existing Condition		Proposed Condition	
	Total Area (ac)	Q100 (cfs)	Total Area (ac)	Q100 (cfs)
7	461.7	568.6	653.0	937.9
18	893.9	896.5	996.2	1198.5

1.4.2 Additional Culvert Considerations: Freeboard and Dam Definition.

All culverts were designed with a minimum of 1 ft of freeboard for the 100-year peak flow, although all but culverts 1 and 7 have at least 2.0' of freeboard. Regarding dam considerations, per the Statues and Regulations pertaining to Supervision of Dams and Lakes, Division of Safety of Dams, Chapter 1, 6004 a), no road or highway fill or structure shall be considered a dam, and therefore the ponding upstream of culverts are not subject to dam regulations (see Chapter 7).

TABLE 6 - Summary of Pre-Development and Post Development 100-year peak flows per Culvert and Proposed Culvert Upgrades at Otay Lakes Road

Culvert #	100- Year Existing Peak Flow (cfs) and Discharged Velocity (ft/s)*	100- Year Developed Peak Flow (cfs) & Discharged Velocities (ft/s)** *** ****	Existing Culvert size	Proposed Culvert Size
1A	43.9 / *11.6*	46.9 / 10.4 / 11.5 / 10.0	24" CMP pipe	30" RCP pipe
1B	11.1 / 9.3	14.5 / 7.6 / 7.6 / 6.3	24" CMP pipe	24" RCP pipe
2	53.7 / *14.7*	47.97 / 10.3 / 6.8 / 6.8	24" CMP pipe	36" RCP pipe
3	Not affected by Development	Not affected by Development	2 – 10' x 10' boxes	Extension of the 2 – 10' by 10' boxes
4	172.0 / *11.9*	48.22 / 10.3 / 6.8 /6.8	24" CMP pipe	36" RCP pipe
5	48.4 / *13.1*	0 (diverted to 4)	24" CMP pipe	none
6	194.9 / *13.6*	**436.3 / 17.0 / 15.4 / 15.4**	24" CMP pipe	72" RCP pipe
7	568.6 / *20.3*	**937.9 / 20.4 / 15.2 / 14.5**	36" RCP pipe	8'x10' Box
8	34.4 / *5.2*	0 (diverted to 7)	12" CMP pipe	none
9	121.9 / *15.6*	**199.9 / 14.1 / 13.8 / 13.3**	24" RCP pipe	54" RCP pipe
10	18.8 / *8.3*	0 (diverted to 12)	21" CMP pipe	none
11	10.9 / *10.5*	0 (diverted to 12)	18" CMP pipe	none
12	22.1 / *15.5*	20.4 / 8.1 / 8.1 / 7.5	18" CMP pipe	24" RCP pipe
13	14.9 / *13.7*	0 (diverted to 14)	18" RCP pipe	none
14	20.4 / *13.6*	**30.2 / 9.1 / 8.9 / 7.6**	18" RCP pipe	30" RCP pipe
15	296.5 / *14.5*	256.3 / 4.8 / 1.2 / 1.5	18" RCP pipe	Contech 23A6
16	97.8 / 11.2	**223.3 / 14.9 / 11.4/ 11.4**	24" CMP pipe	60" RCP pipe
16A	14.2 / *11.6*	0 (diverted to 16)	18" CMP pipe	none
17	30.6 / *9.8*	0 (diverted to 16)	24" CMP pipe	none
17A	11.0 / *12.6*	0 (diverted to 16)	15" PVC pipe	none
18	896.5 / *18.7*	**1,198.5 / 14.3 / 11.6 / 9.8**	66" CMP pipe	Contech 23A6-6
18A	16.5 / *7.6*	0 (diverted to 18)	18" HDPE pipe	none
19	85.4 / *13.4*	11.7 / 7.4 / 7.1 / 5.8	24" CMP pipe	24" RCP pipe
20	86.9 / *10.3*	44.8 / 10.1 / 9.6 / 8.1	9'x5' Box	36" RCP pipe

*Discharge velocity assumes that overtopping of Otay Lakes Road will occur at locations where existing pipes that do not have the capacity to convey 100-year existing flows.

**1st value for discharge velocity is based on free outfall scenario, i.e. no tailwater assumed. Analysis conducted using FlowMaster software.

***2nd value for discharge velocity is based on tailwater elevation of 490.7 which corresponds to 100-year water surface elevation of Lower Otay Reservoir. Reference section 7.6. Analysis conducted using CulvertMaster software except culverts 2,4, 6, and 16 which used Hydroflow Express software.

****3rd value for discharge velocity is based on a tailwater elevation of 491.3 which corresponds to the top of the Savage Dam spill way gates (additional calculation prepared per request of the City of San Diego). Analysis conducted using HydraFlow Express software.

1.4.3 Open Channel Inundation Summary

Table 7 shows the resulting open channel flow depth at various node locations for the proposed post-development condition. Rational method flow rates were used for tributary areas less than 640 acres, while Unit Hydrograph flow rates were used for tributary areas greater than 640 acres (Nodes 1633 and 1635).

TABLE 7 - Summary of Flow Depths for Open Channels

Hydrology Node	Channel Slope (%)	Tributary Area (ac)	Q100 (cfs)	Flow Depth (ft)
1211	8.3	80.9	134.67	1.89
1311	2.7	58.2	104.14	2.08
1364	7	175.4	266.9	3.55
1408	4.5	157.9	189.39	1.37
1416	2.7	241.5	256.35	2.44
1504	12	31.2	55.48	0.84
1633	10	652.6	723.05	4.61
1635	3	996.2	1198.5	3.37
1642	16	126.6	174.65	1.55
1708	15	27.2	45.64	0.83
1712	15	24.2	38.52	0.75
2403	6.9	25.7	35.72	0.65
2503	9.3	28.6	40.17	0.68

1.5 Hydromodification Considerations

For Hydromodification analysis refer to ""Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan", Hunsaker & Associates, San Diego, September 2014.

1.6 Conclusions and Recommendations

- The proposed project will increase the Post-Development 100-year peak flow by about 619 cfs from 2,900 cfs to 3,519 cfs. However, Post-Development peak flows will increase in only six culverts, and be reduced or remain the same in the remaining 17.

- While development of the project site would increase design flow rates as compared to Pre-Development conditions, the increases will be mitigated by the construction or improvements of culverts under Otay Lakes Road. These culverts have been designed to safely convey the developed condition 100-year peak flow. Flooding concerns downstream of Otay Lakes Road are mitigated by the large storage volume provided by the Lower Otay Reservoir.

- Because the existing culverts are generally undersized, Post-Development culverts will significantly reduce the risk of overtopping. Some of the existing culverts can be overtopped with storm events smaller than the 2 yr storm as their capacity is less than one-third of the 100-year peak flow and the 2yr-6 hr storm event in the area is only half of the 100yr-6hr storm event according to the 6 hr precipitation maps displayed in the SDCHM.

- As most of the existing culverts discharge under pressure from moderate to large storms, Post-Development conditions will reduce the velocity of the flows discharged into Lower Otay Reservoir.

- It is expected that the overall potential for erosion reduces as a consequence of the development, despite the increase in peak flow in six of the culverts. A detailed explanation is presented in the "Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan". It is expected that the proposed project will help to reduce the sediment deposition in Lower Otay Reservoir as long as the proper erosion and sediment control measures are taken during construction.

- The proposed project will be designed to comply with all water quality standards and waste discharge requirements. Storm water treatment design is further discussed in the "Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan".

- Development of the project site will not degrade potential beneficial uses of downstream water bodies as designated by the Regional Water Quality Control Board, including water bodies listed on the Clean Water Section 303d list.

- Minor alterations of the existing drainage pattern, required as part of the proposed development, will be mitigated in a manner that would prevent substantial erosion or siltation onsite or offsite. Energy dissipater systems will be designed at all proposed culvert outfalls.

- Development of the project site does not encroach on any 100-year flood hazard areas as defined by FEMA. As such, no CLOMR is required.

- Prior to recordation of the final map, 100-year flood lines will be established for any lot encumbered by drainage channel conveying a watershed area in excess of 25 acres. Any such floodplain boundary shall be clearly delineated on the non-title information sheet of the final map.

- On-site and off-site drainage easements shall be provided to the satisfaction of the Director of Public Works.

- A flowage easement shall be granted to the San Diego County Flood Control District if any lots are subject to inundation by the 100-year flood from a drainage area in excess of one square mile.

- The Otay Ranch Resort Village Drainage Study and the CEQA Preliminary Stormwater Management Plan for this project will be submitted to the City of San Diego for review.

1.7 References

Reference "“Otay Ranch Resort Village CEQA Preliminary Storm Water Management Plan*",* Hunsaker & Associates, San Diego, September 2014.

Model Standard Urban Storm Water Mitigation Plan for San Diego County, Port of San Diego, and Cities in San Diego County; February 14, 2002.

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CHAPTER 2

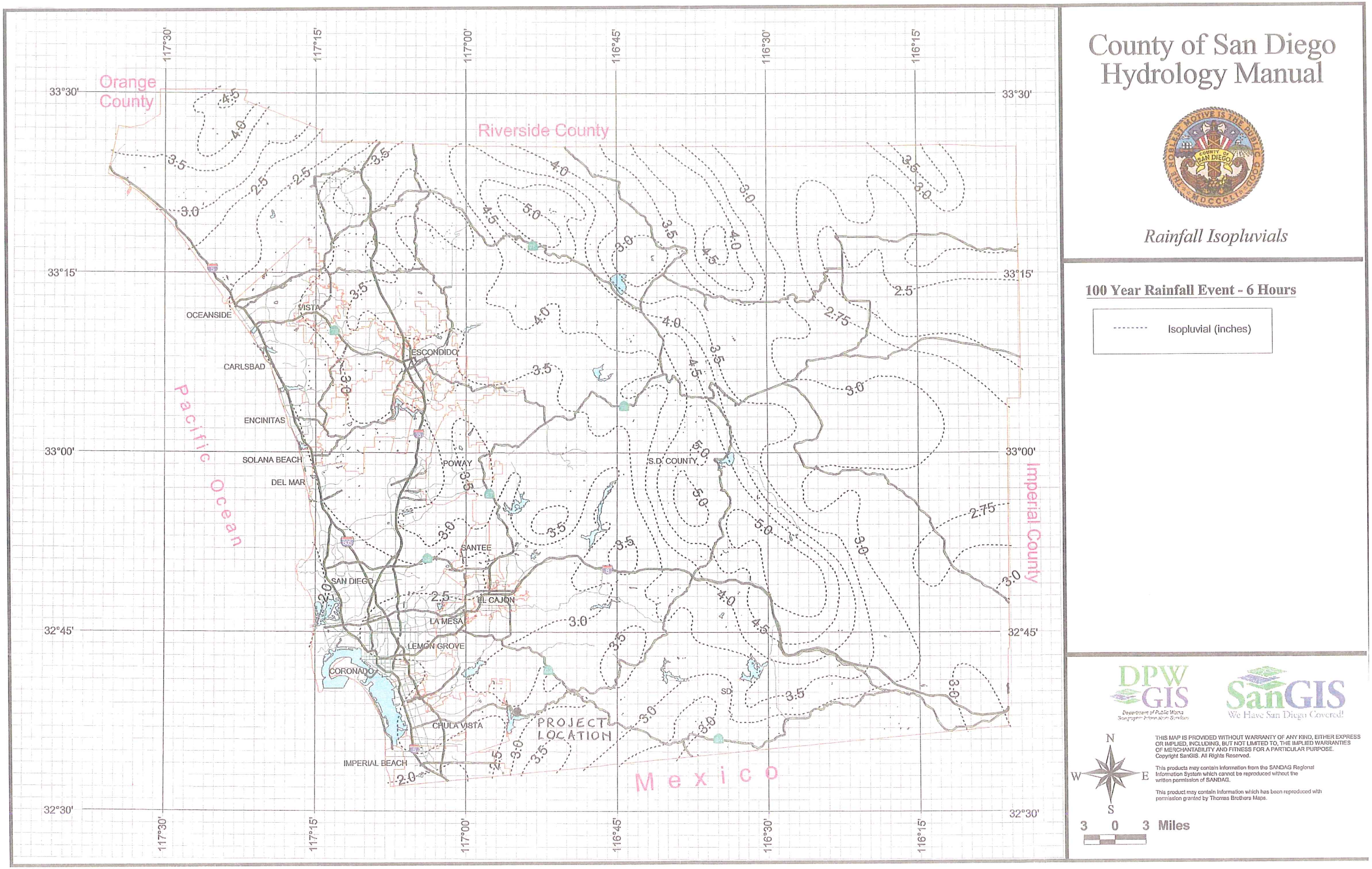
METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.1 – Design Rainfall Determination

CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.1 – 100-Year, 6-Hour Rainfall Isopluvial Map


County of San Diego
Hydrology Manual
Rainfall Isopluvials
100 Year Rainfall Event - 6 Hours
Isopluvial (inches)
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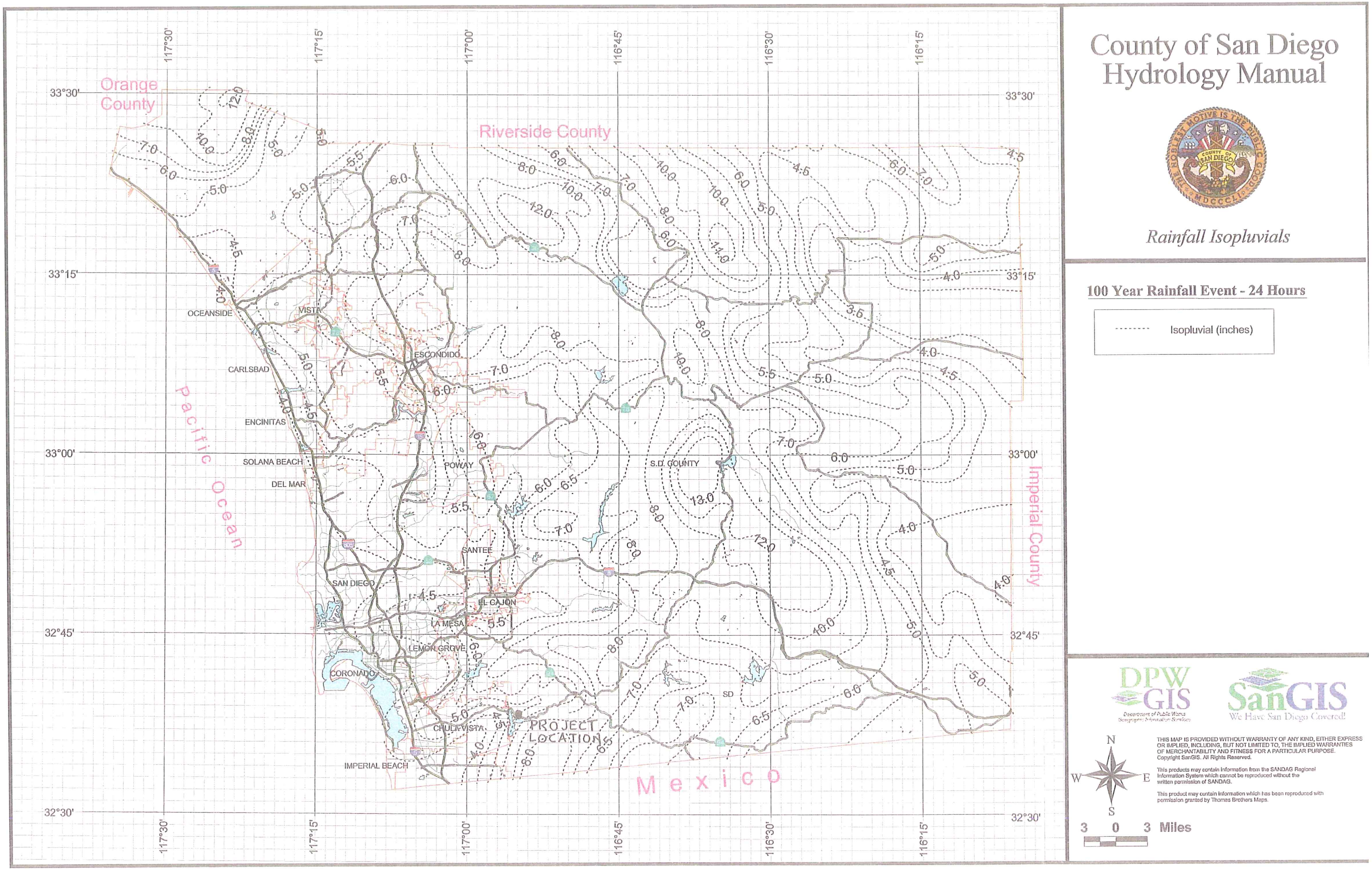
CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.1 – 100-Year, 24-Hour Rainfall Isopluvial Map


County of San Diego
Hydrology Manual
Rainfall Isopluvials
100 Year Rainfall Event - 24 Hours
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CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.2 – Runoff Coefficient Determination

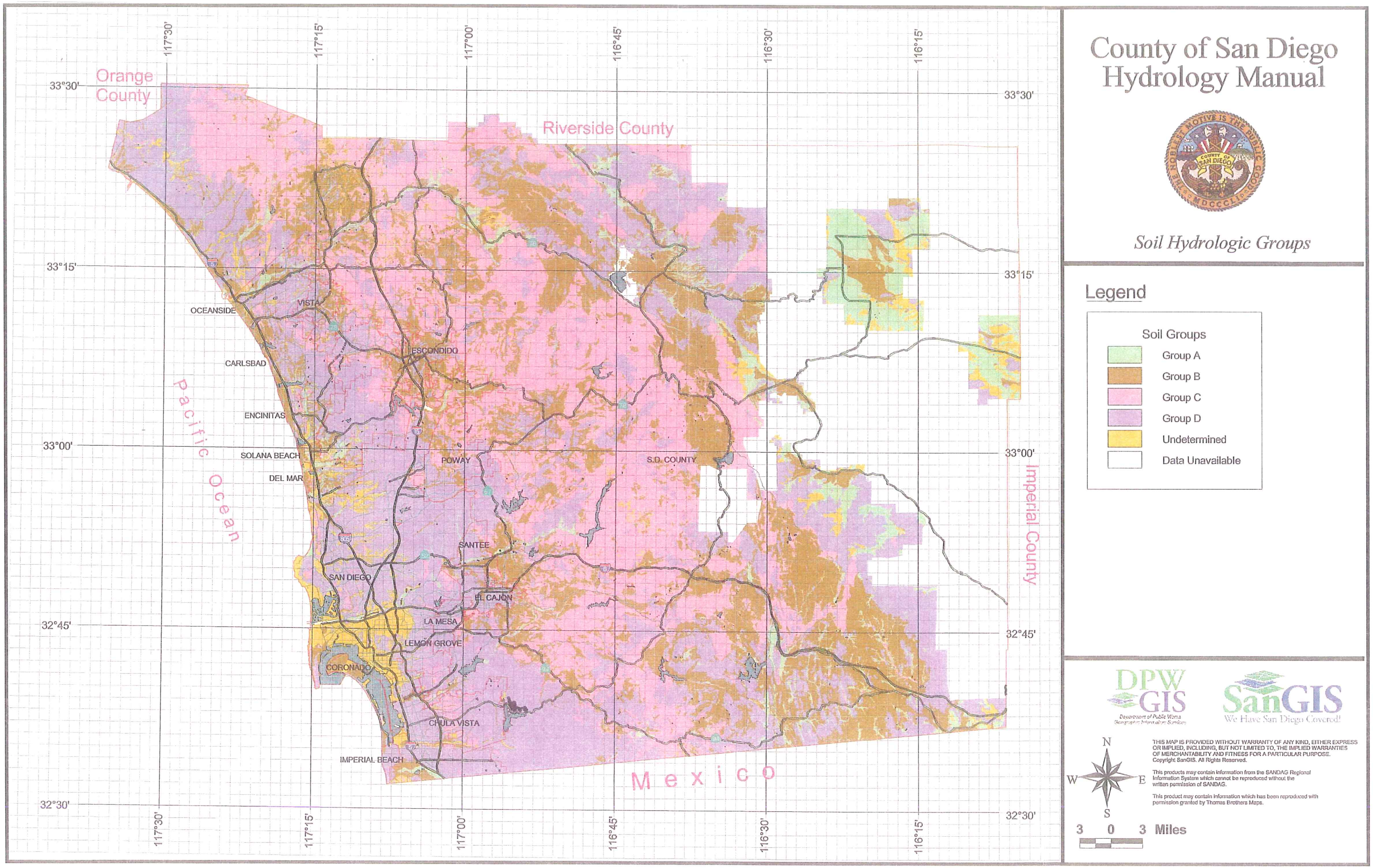
Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).

DU/A = dwelling units per acre

NRCS = National Resources Conservation Service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Soil Hydrologic Groups
Legend
Soil Groups
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Group B
Group C
Group D
Undetermined
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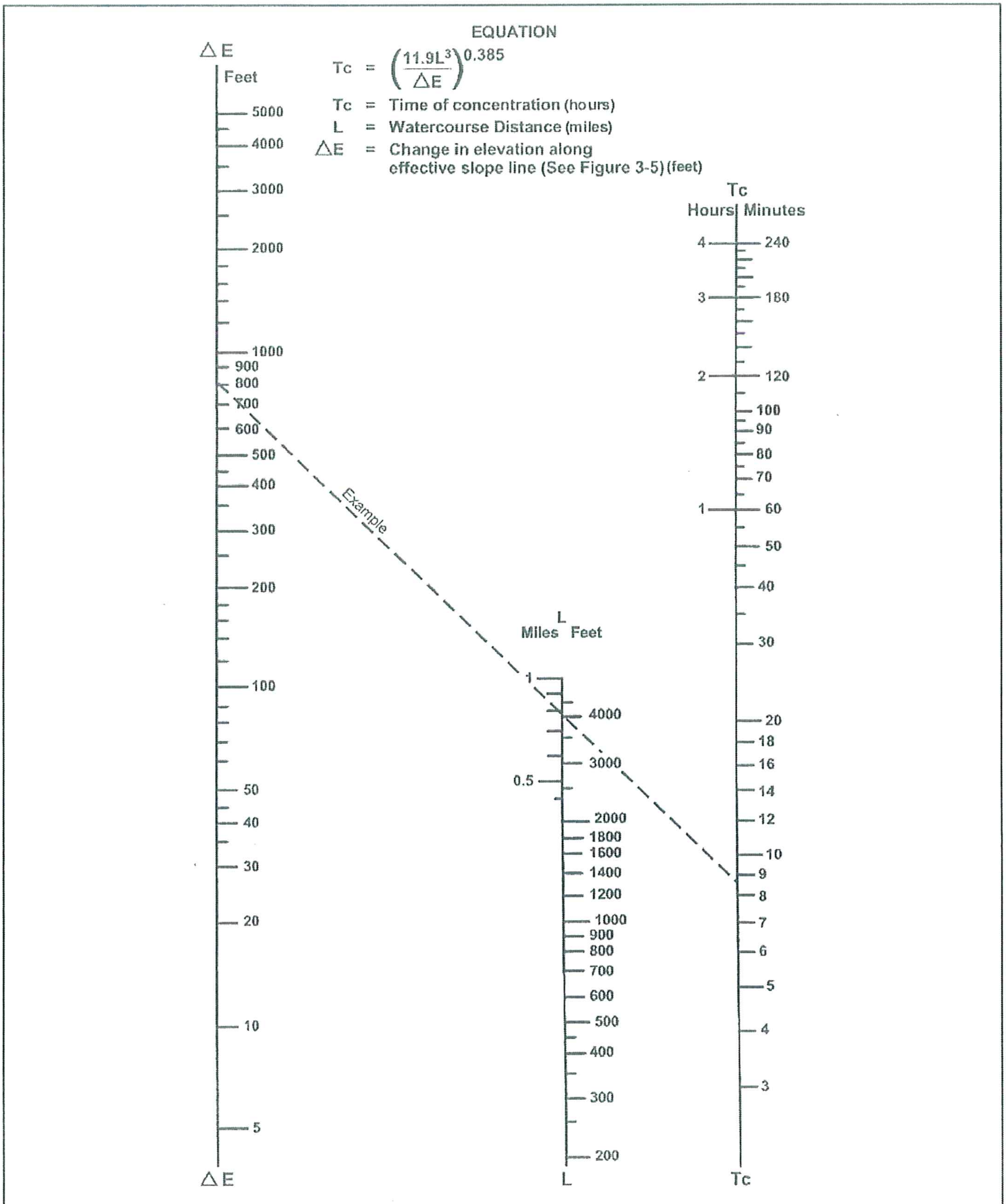
CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – Peak Intensity Determination



SOURCE: California Division of Highways (1941) and Kirpich (1940)

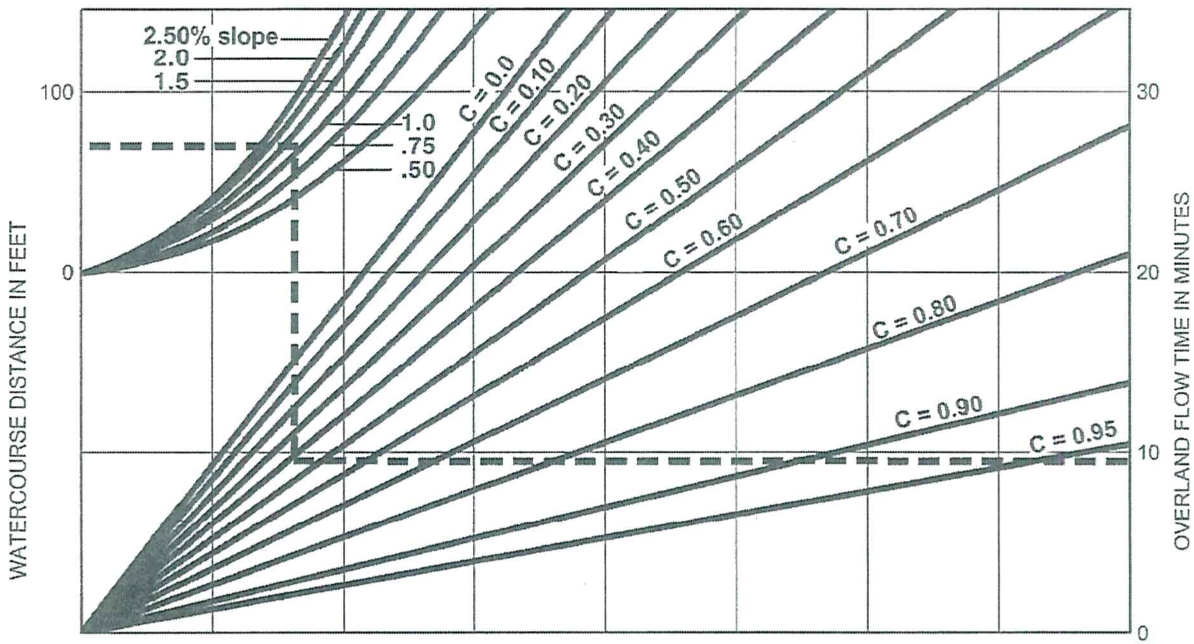
FIGURE **3-4**

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – Urban Watershed Overland Time of flow Nomograph



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet

Slope (s) = 1.3%

Runoff Coefficient (C) = 0.41

Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

3-3

Rational Formula - Overland Time of Flow Nomograph

CHAPTER 2

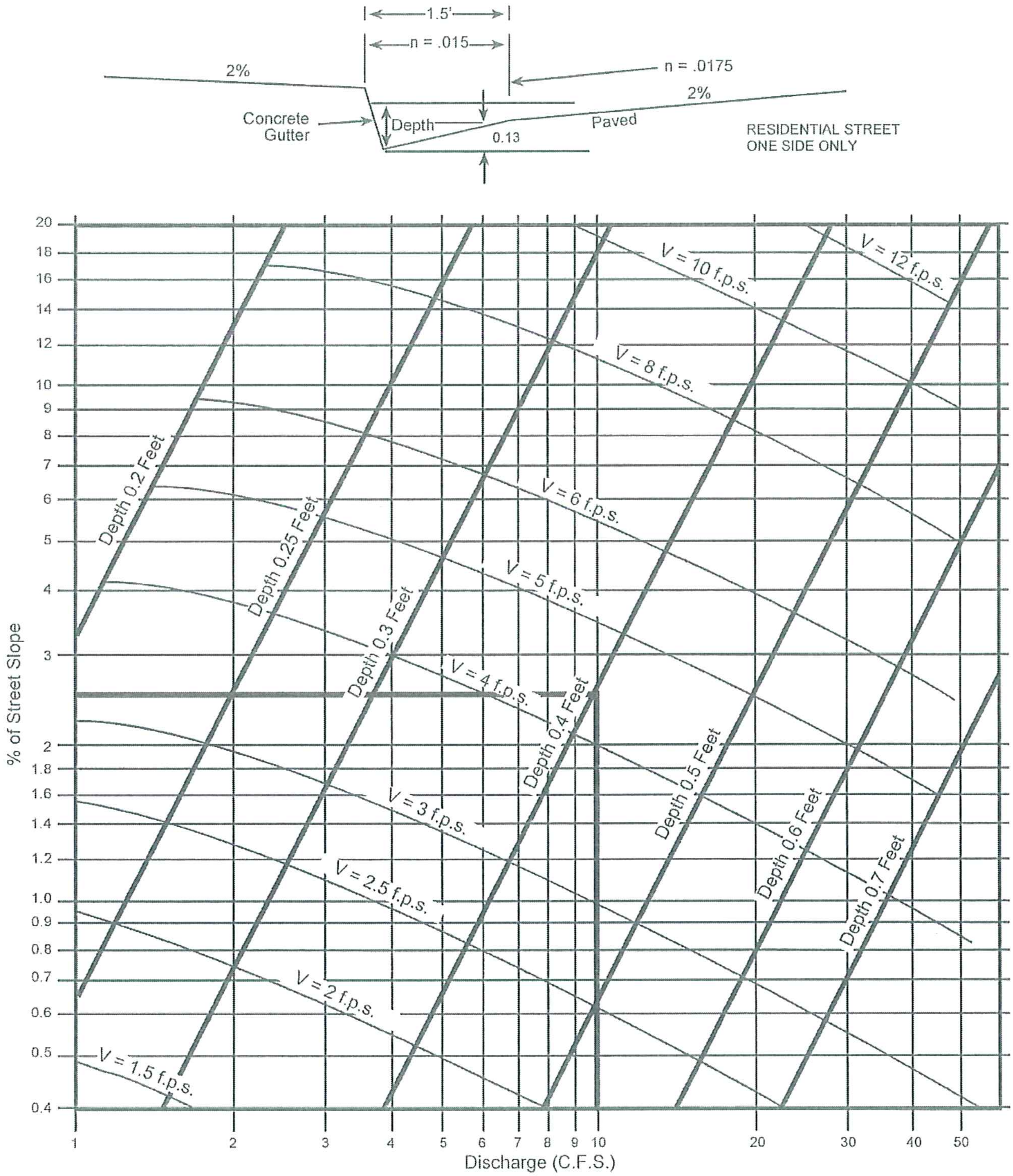
METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – Natural Watershed Overland Time of flow Nomograph

CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – Gutter and Roadway Discharge (Velocity Chart)



EXAMPLE:
Given: Q = 10   S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

FIGURE **3-6**

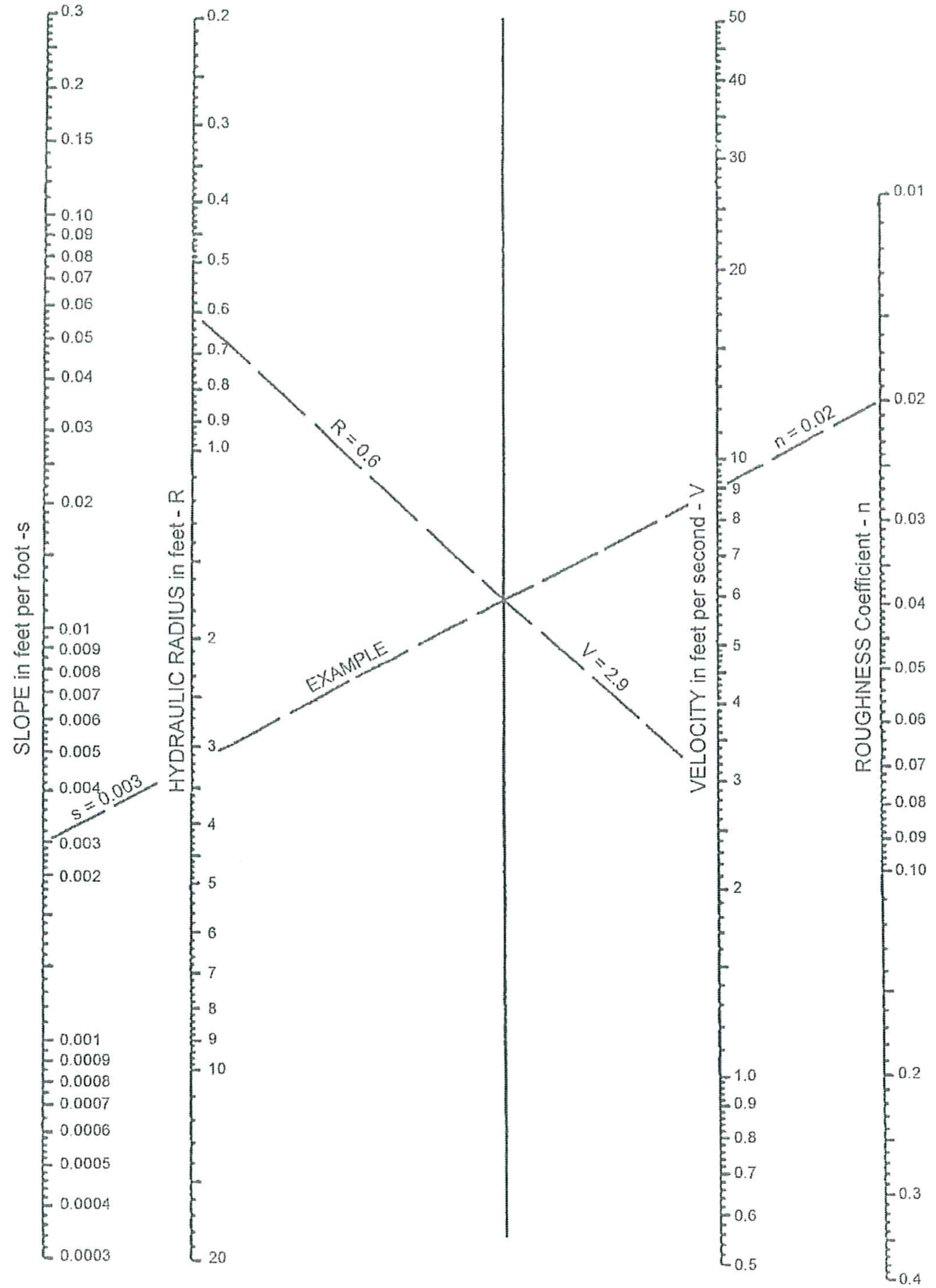
Gutter and Roadway Discharge - Velocity Chart

CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – Manning's Equation Nomograph

EQUATION: $V = \frac{1.49}{n} R^{2/3} s^{1/2}$



GENERAL SOLUTION

SOURCE: USDOT, FHWA, HDS-3 (1961)

FIGURE

3-7

Manning's Equation Nomograph

CHAPTER 2

METHODOLOGY – RATIONAL METHOD PEAK FLOWRATE DETERMINATION (ULTIMATE CONDITIONS)

2.3 – San Diego County Intensity-Duration Design Chart