Paraiso Springs Resort – Drainage Analysis and Drainage Plan Comments

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DATE:	May 2, 2012
PROJECT NUMBER:	434834.03

The purpose of this Technical Memorandum (TM) is to provide responses to Monterey County Water Resources Agency (MCWRA) review comments on the Memorandum titled *Paraiso Springs Resort – Response to Hydrology and Hydraulic Analysis and Erosion Control Measures Review Comments* dated October 28, 2008. MCWRA Comments were provided in a letter from Jennifer Bodensteiner to Jacqueline Onciano dated November 24, 2010. A copy of this letter is included in Attachment 1 for reference.

Response to Drainage Analysis and Drainage Plan Comments

The comments indicate that MCWRA standard design policy "requires stormwater detention facilities designed to limit the 100-year post-development runoff rate to the 10-year pre-development runoff rate." It was further clarified during a conference call on February 12, 2012 that this standard design policy is for a 2-hour storm event.

This TM presents the preliminary design of a detention basin for the Project that is sized to comply with the MCWRA standard design policy. A hydrologic analysis was developed to support this preliminary design utilizing data from the 2008 Memorandum.

Hydrologic Analysis

A hydrologic analysis was developed to comply with the MCWRA's standard design policy that the 100-year post-development runoff rate must be limited to the 10-year pre-development runoff rate for a 2 hour storm event. This analysis was conducted using the Rational Method to calculate peak storm runoff

$$Q = KCiA$$

where Q is the peak runoff rate, K is 1.0 in U.S customary units, C is the runoff coefficient, i is the average rainfall intensity for a specific return period and duration (t_c), and A is the drainage area (Mays, 2001).

Rainfall intensity, i, was calculated using the equation and data provided on Plate 25 (MCDPW, 1977) for return periods of 10-years and 100-years as required by the standard design policy. The duration, also known as time of concentration (t_c), used in the rainfall intensity calculations was developed using the US Soil Conservation Service (SCS) lag equation, which is an empirical equation that requires the longest flow path, SCS curve number (CN), and average watershed slope as inputs (Mays 2001).

Analysis Results

The results of the revised hydrologic analysis are shown below. Calculations are included in Attachment 2. Supporting documentation for these calculations is included in Attachment 3 through Attachment 6.

Table 1 summarizes the 10-year pre-development runoff rates by subbasin.

TABLE 1
10-Year Pre-Development Runoff Rates

Subbasin	C (-)	*i* (in/hr)	A (acres)	Q (cfs)
N	0.41	0.33	17.5	2.4
S	0.41	0.28	17.8	2.0
V	0.41	0.29	44.2	4.6
			TOTAL	9.0

in/hr = inches per hour
cfs = cubic feet per second

Table 2 summarizes the 100-year post-development runoff rates by subbasin.

TABLE 2
100-Year Post-Development Runoff Rates

Subbasin	C (-)	*i* (in/hr)	A (acres)	Q (cfs)
N	0.74	0.60	17.5	7.3
S	0.70	0.50	17.8	7.1
V	0.62	0.49	44.2	12.4
			TOTAL	26.8

in/hr = inches per hour
cfs = cubic feet per second

Table 3 compares the runoff volume that will need to be detained onsite to comply with the MCWRA standard design policy.

TABLE 3
Onsite Detention Volume Required for Compliance

Table Head	2-Hour Volume (CF)	2 Hour Volume (MG)	2 Hour Volume (ac-ft)
100-year Post-Development	192,740	1.5	4.4
10-year Pre-Development	64,820	0.5	1.5
Difference	127,920	1.0	2.9

CF = cubic feet
MG = million gallons
ac-ft = acre feet

Based on this analysis, the Project will include a detention basin sized to hold a minimum of 2.9 acre-feet. The detention basin will be approximately 100 feet by 100 feet at the bottom with side slopes of 2:1 and a depth of 10 feet. The proposed location for the detention basin is shown on the site map in Attachment 3.

References

Mays, Larry W. 2001. *Water Resources Engineering*. John Wiley & Sons, Inc. 1st ed.

Monterey County Department of Public Works (MCDPW). 24 October 1977. *Standard Details Rainfall Intensities Chart, Plate 25.*

Monterey County Water Resources Agency (MCWRA). Jennifer Bodensteiner, CFM. 24 November 2010. *Paraiso Springs Resort (PLN 040183) Response to Preliminary Engineering Reports for Paraiso Hot Springs Resort, prepared by CH2M HILL, dated August 2010.*

Natural Resources Conservation Service (NRCS), United States Department of Agriculture. 12 April 2011. Web Soil Survey 2.3. < http://websoilsurvey.nrcs.usda.gov/>. 2 May 2012.

Attachments

1. MCWRA Comment Letter
2. Hydrologic Analysis Calculations
3. Project Site Map and Subbasin Delineation
4. Proposed Developed Area Calculations
5. Web Soil Survey 2.3 Output for the Project Site
6. Curve Number Determination

Attachment 1
MCWRA Comment Letter

MONTEREY COUNTY

WATER RESOURCES AGENCY

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(831)755-4860
FAX (831) 424-7935

CURTIS V. WEEKS
GENERAL MANAGER

STREET ADDRESS
893 BLANCO CIRCLE
SALINAS, CA 93901-4455

November 24, 2010

Jacqueline Onciano, Planning & Building Services Manager
Monterey County Resource Management Agency
Planning Department
168 W. Alisal Street, 2nd Floor
Salinas, CA 93901

SUBJECT: Paraiso Springs Resort (PLN 040183) Response to Preliminary Engineering Reports for Paraiso Hot Springs Resort, prepared by CH2MHILL, dated August 2010.

Dear Ms. Onciano:

After reviewing the subject reports the Monterey County Water Resources Agency (Agency) has the following comments:

Water Demand

The *Estimated Potable Water Demand and Potable Water Source Technical Memorandum* contained within the subject reports did not include the following assumptions in the water balance calculations:

- Pre-project water use and Pre-project recharge
- Post-project water use for the spa facility
- Post-project recharge

The Agency recommends the Paraiso Springs Resort water balance follow the water balance template prepared for the Omni Subdivision (PC 020344). The revised water balance analyses should be included DEIR.

Drainage Analysis & Drainage Plan

According to the *Hydrology and Hydraulic Analysis and Erosion Control Measures Technical Memorandum* contained within the subject reports, detention ponds are not proposed and stormwater runoff will be mitigated through the use of retention/infiltration facilities. Therefore, the project does not comply with the Agency's standard design policy that requires stormwater detention facilities designed to limit the 100-year post-development runoff rate to the 10-year pre-development rate.

If stormwater retention facilities are proposed, the design criteria should be approved by the Agency prior to the preparation of the preliminary drainage calculations and preliminary drainage plan. Additionally, a geologic report should be included in the DEIR analyzing the suitability of subsurface materials for stormwater retention, and the potential impacts to geologic hazards should be analyzed.

The memorandum did not include information regarding the proposed stormwater retention design criteria, preliminary drainage calculations, or a preliminary drainage plan. These items should be included in the DEIR.

Stream Setback

The Draft EIR should include a site plan showing all proposed development setback 50 feet from *top-of-bank* (as defined in Monterey County Code Chapter 16.16) of the watercourse referred to in the ADEIR as the "Paraiso Springs drainage". If development is proposed within 50 feet of the *top-of-bank*, the DEIR should address the two provisions outlined in Chapter 16.16.050K of the Monterey County Code.

The Agency requests the opportunity to review the water balance analyses, preliminary drainage analysis, preliminary drainage plan, and the stream setback plan prior to the release of the DEIR. If you have any questions, please feel free to contact me at (831) 755-4860.

Sincerely,

Jennifer Bodensteiner

Jennifer Bodensteiner, CFM
Water Resources Hydrologist
Floodplain Management and Development Review Section

Attachment 2
Hydrologic Analysis Calculations

PARAISO SPRINGS RESORT

Pre-Development Subbasin Details

Subbasin [a]	Area (SF)	Area (acres)	Longest Flow Path, L (LF)	Max Elev	Min Elev	Slope, S (%)	CN [b]
N	762,317	17.50	2,933	1,110	880	7.8%	69
S	776,457	17.83	3,564	1,193	880	8.8%	72
V	1,927,175	44.24	3,546	1,295	1,005	8.2%	62
Watershed	3,465,949	79.57					

a. Subbasins are delineated in Attachment 3

b. Composite CN based on Table 8.7.3 (Mays, 2001), see Attachment 6

PARAISO SPRINGS RESORT										
Post-Development Subbasin Details										
			Longest Flow					Impervious [c]		
Subbasin [a]	Area (SF)	Area (acres)	Path, L (LF)	Max Elev	Min Elev	Slope, S (%)	CN [b]	(SF)	(acres)	(% area)
N	762,317	17.50	2933	1110	880	7.8%	85	384,320	8.82	50%
S	776,457	17.83	3564.00	1193.00	880.00	8.8%	87	332,675	7.64	43%
V	1,927,175	44.24	3781	1315	1005	8.2%	74	445,100	10.22	23%
Watershed	3,465,949	79.57						1,162,095	26.68	34%

a. Subbasins are delineated in Attachment 3

b. Composite CN based on Table 8.7.3 (Mays, 2001), See Attachment 6

c. All developed areas are assumed to be impervious, see Attachment 4

PARAISO SPRINGS RESORT

Time of Concentration (t_c) Calculations

SCS Lag Equation

t_c = (100*L^0.8*[(1000/CN)-9]^0.7)/(1900*S^0.5)

Table 15.2.4 (Mays, 2001)

10-Year Pre-Development

Subbasin	L (LF)	CN	S (%)	t_c (min)
N	2,933	76	7.8%	307
S	3,564	67	8.8%	431
V	3,546	62	8.2%	503

100-Year Post-Development

Subbasin	L (LF)	CN	S (%)	t_c (min)
N	2,933	85	7.8%	228
S	3,564	87	8.8%	234
V	3,546	74	8.2%	365

In the rational method each sewer is designed individually and independently (except for the computation of sewer flow time) and the corresponding rainfall intensity i is computed repeatedly for the area drained by the sewer. For a given sewer, all the different areas drained by this sewer have the same i. Thus, as the design progresses towards the downstream sewers, the drainage area increases and usually the time of concentration increases accordingly. This increasing t_c in turn gives a decreasing i that should be applied to the entire area drained by the sewer.

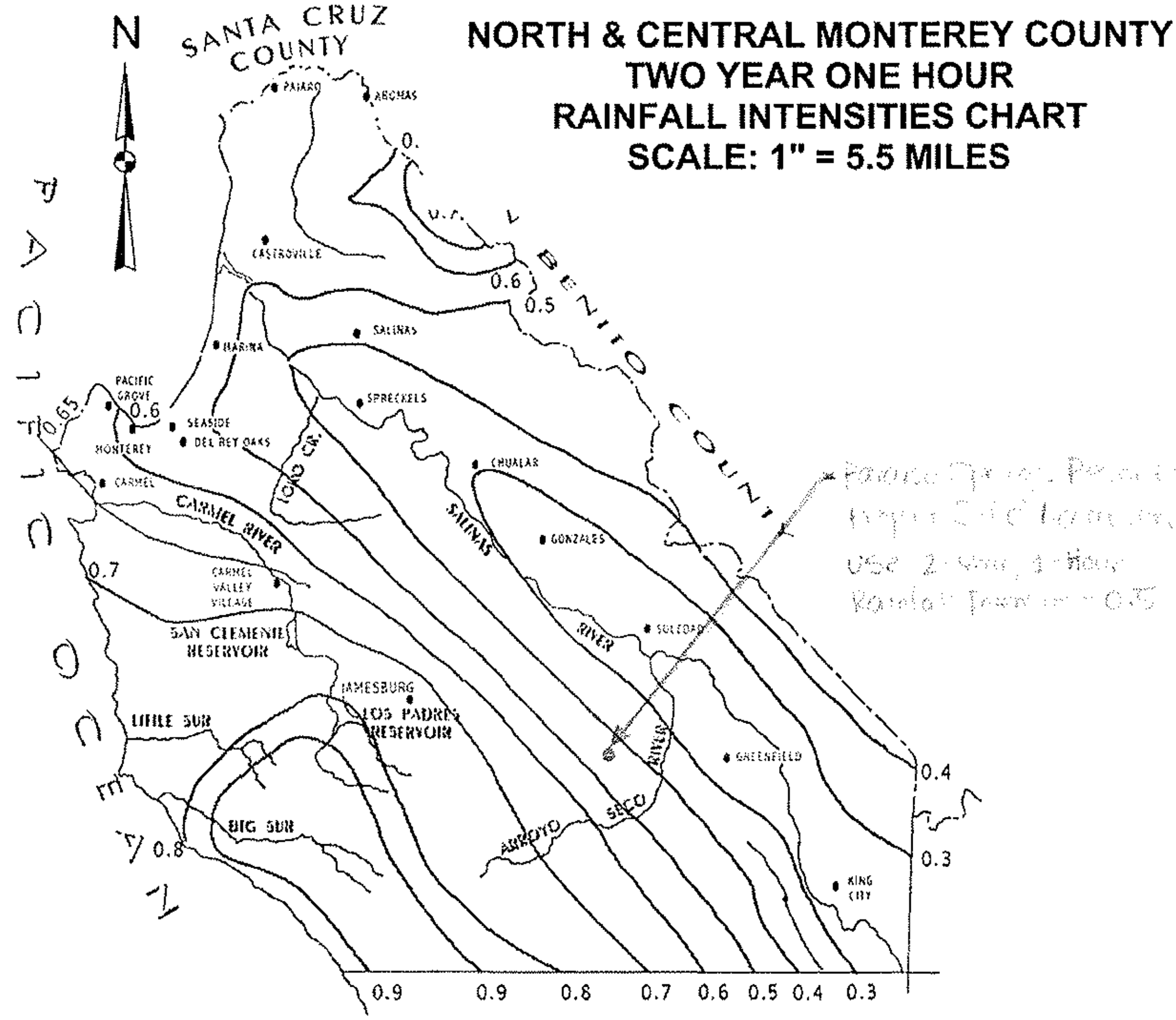
Inlet times, or times of concentration for the case of no upstream sewers, can be computed using a number of methods, some of which are presented in Table 15.2.4. The longest time of concentration among the times for the various flow routes in the drainage area is the critical time of concentration used.

Table 15.2.4 Summary of Time of Concentration Formulas

Method and Date	Formula for t_c (min)	Remarks
Kirpich (1940)	$t_c = 0.0078L^{0.77}S - 0.385$ L = length of channel/ditch from headwater to outlet, ft S = average watershed slope, ft/ft	Developed from SCS data for seven rural basins in Tennessee with well-defined channel and steep slopes (3% to 10%); for overland flow on concrete or asphalt surfaces multiply t_c by 0.4; for concrete channels multiply by 0.2; no adjustments for overland flow on bare soil or flow in roadside ditches.
California Culverts Practice (1942)	$t_c = 60(11.9L^3/H)^{0.385}$ L = length of longest watercourse, mi H = elevation difference between divide and outlet, ft	Essentially the Kirpich formula; developed from small mountainous basins in California (U.S. Bureau of Reclamation, 1973, 1987).
Izzard (1946)	$t_c = \dfrac{41.025(0.0007i + c)L^{0.33}}{S^{0.333}i^{0.667}}$ i = rainfall intensity, in/h c = retardance coefficient L = length of flow path, ft S = slope of flow path, ft/ft	Developed in laboratory experiments by Bureau of Public Roads for overland flow on roadway and turf surfaces; values of the retardance coefficient range from 0.0070 for very smooth pavement to 0.012 for concrete pavement to 0.06 for dense turf; solution requires iteration; product i times L should be < 500.
Federal Aviation Administration (1970)	$t_c = 1.8(1.1 - C)L^{0.50}/S^{0.333}$ C = rational method runoff coefficient L = length of overland flow, ft S = surface slope, %	Developed from airfield drainage data assembled by the Corps of Engineers; method is intended for use on airfield drainage problems, but has been used frequently for overland flow in urban basins.
Kinematic wave formulas (Morgali and Linsley (1965); Aron and Erborge (1973))	$t_c = \dfrac{0.94L^{0.6}n^{0.6}}{(i^{0.4}S^{0.3})}$ L = length of overland flow, ft n = Manning roughness coefficient i = rainfall intensity in/h S = average overland slope ft/ft	Overland flow equation developed from kinematic wave analysis of surface runoff from developed surfaces; method requires iteration since both i (rainfall intensity) and t_c are unknown; superposition of intensity–duration–frequency curve gives direct graphical solution for t_c.
SCS lag equation (U.S. Soil Conservation Service (1975))	$t_c = \dfrac{100L^{0.8}[(1000/\text{CN}) - 9]^{0.7}}{1900S^{0.5}}$ L = hydraulic length of watershed (longest flow path), ft CN = SCS runoff curve number S = average watershed slope, %	Equation developed by SCS from agricultural watershed data; it has been adapted to small urban basins under 2000 acres; found generally good where area is completely paves; for mixed areas it tens to overestimate; adjustment factors are applied to correct for channel improvement and impervious area; the equation assumes that $t_c = 1.67 \times$ basin lag.

PARAISO SPRINGS RESORT			
Rainfall Intensity Calculations			
From Plate 25 (MCDPW, 1977)			
2 year i	0.5	in/hr	
10 year i	0.74	in/hr	
100 year i	1.1	in/hr	
$i_t = 7.75 * i / sqrt(t_c)$			
10-Year Pre-Development			
Subbasin	**i (in/hr)**	**t_c (min)**	**i_t (in/hr)**
N	0.74	307	0.33
S	0.74	431	0.28
V	0.74	503	0.26
100-Year Post-Development			
Subbasin	**i (in/hr)**	**t_c (min)**	**i_t (in/hr)**
N	1.1	228	0.57
S	1.1	234	0.56
V	1.1	365	0.45

NORTH & CENTRAL MONTEREY COUNTY TWO YEAR ONE HOUR RAINFALL INTENSITIES CHART SCALE: 1" = 5.5 MILES



NOTE:

1. Intensities for particular location in the Southern part of the County available from County Surveyors Office.
2. Conversion Factors:
   Intensity of a 10-year design storm equals 2-year design storm times 1.48
   Intensity of a 25-year design storm equals 2-year design storm times 1.73
   Intensity of a 50-year design storm equals 2-year design storm times 1.92
   Intensity of a 100-year design storm equals 2-year design storm times 2.22
3. The maximum intensity (I_t) for storms of various in duration is determined by the formula: $I_t = 7.75i/\sqrt{t}$ in which variables are as follows:
   I_t = maximum intensity of storm of t minutes duration
   i = one hour rainfall intensity from above chart and note 2
   t = time in minutes shortest time it takes storm runoff to flow from farthest point in the drainage area to the point in question
4. **Example:** Find maximum intensity of 20 minute storm in Chualar, expected to occur on the average of once in 25 years.
   Solution: From chart 0.3/hr intensity for 2-year design storm.
   From note 2, 0.3 times 1.73 equals 0.52"/hr the maximum intensity of a 25-year one hour design storm.
   From note 3, $I_t = 7.75i/\sqrt{t} = (7.75)(0.52)/\sqrt{20} = 0.90$"/hr. Therefore, the maximum 20 minute intensity of a storm that on the average would occur once every 25 years would be 0.90"/hr.

MONTEREY COUNTY	DEPT. OF PUBLIC WORKS
STANDARD DETAILS RAINFALL INTENSITIES CHART	
APPROVED [signature]	DATE 10-24-77
REVISED / DATE	PLATE NO 25

PARAISO SPRINGS RESORT

Rational Method

Q = KCitA   K = 1 for US customary units

	C	Notes
10-yr Pre	0.41	10-yr forest/woodland; steep, over 7%
100-yr Post	0.95	100-yr Asphaltic
	0.53	100-yr Fair condition (grass over 50% to 75% of the area); steep, over 7%

Table 15.2.3 (Mays, 2001)

10-Year Pre-Development

Subbasin	C	i_t (in/hr)	A (acres)	Q (cfs)
N	0.41	0.33	17.50	2.35
S	0.41	0.28	17.83	2.02
V	0.41	0.26	44.24	4.64
				9.00

100-Year Post-Development

Subbasin	% Impervious	Weighted C
N	50%	0.74
S	43%	0.71
V	23%	0.63

C = % Impervious * 0.95 + (1 - % Impervious) * 0.53

Sub Basin	C	i_t (in/hr)	A (acres)	Q (cfs)
N	0.74	0.57	17.50	7.34
S	0.71	0.56	17.83	7.06
V	0.63	0.45	44.24	12.38
				26.77

Table 15.2.2 Technical Items and Limitations to Consider in Storm Sewer Design (*continued*)

Minimum size of pipe	12–24 in (0.3–0.6 m)
Vertical alignment at manholes:	
Different size pipe	Match crown of pipe or 80 to 85% depth lines
Same size pipe	Minimum of 0.1–0.2 ft (0.03–0.06 m) in invert drop
Minimum depth of soil cover	12–24 in (0.3–0.6 m)
Final hydraulic design	Check design for surcharge and junction losses by using backwater analysis
Location of inlets	In street where the allowable gutter flow capacity is exceeded

Source: Urbonas and Roesner (1993).

15.2.2 Rational Method Design

From an engineering viewpoint the design can be divided into two main aspects: runoff prediction and pipe sizing. The rational method, which can be traced back to the mid-nineteenth century, is still probably the most popular method used for the design of storm sewers (Yen and Akan, 1999). Although criticisms have been raised of its adequacy, and several other more advanced methods have been proposed, the rational method, because of its simplicity, is still in continued use for sewer design when high accuracy of runoff rate is not essential.

Using the rational method, the storm runoff peak is estimated by the rational formula

$$Q = KCiA \tag{15.2.1}$$

where the peak runoff rate Q is in ft³/s (m³/s), K is 1.0 in U.S. customary units (0.28 for SI units), C is the runoff coefficient (Table 15.2.3), i is the average rainfall intensity in in/hr (mm/hr) from intensity-duration frequency relationships for a specific return period and duration t_c in min, and A is the area of the tributary drainage area in acres (km²). The duration is taken as the time of concentration t_c of the drainage area.

Table 15.2.3 Runoff Coefficients for Use in the Rational Method

	Return Period (years)						
Character of Surface	2	5	10	25	50	100	500
Developed							
Asphaltic	0.73	0.77	0.81	0.86	0.90	0.95	1.00
Concrete/roof	0.75	0.80	0.83	0.88	0.92	0.97	1.00
Grass areas (lawns, parks, etc.)							
Poor condition (grass cover less than 50% of the area)							
Flat, 0–2%	0.32	0.34	0.37	0.40	0.44	0.47	0.58
Average, 2–7%	0.37	0.40	0.43	0.46	0.49	0.53	0.61
Steep, over 7%	0.40	0.43	0.45	0.49	0.52	0.55	0.62
Fair condition (grass cover 50% to 75% of the area)							
Flat, 0–2%	0.25	0.28	0.30	0.34	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.49	0.53	0.60
Good condition (grass cover larger than 75% of the area)							
Flat, 0–2%	0.21	0.23	0.25	0.29	0.32	0.36	0.49
Average, 2–7%	0.29	0.32	0.35	0.39	0.42	0.46	0.56
Steep, over 7%	0.34	0.37	0.40	0.44	0.47	0.51	0.58

Table 15.2.3 Runoff Coefficients for Use in the Rational Method (*continued*)

Character of Surface	Return Period (years)						
	2	5	10	25	50	100	500
Undeveloped							
Cultivated land							
Flat, 0–2%	0.31	0.34	0.36	0.40	0.43	0.47	0.57
Average, 2–7%	0.35	0.38	0.41	0.44	0.48	0.51	0.60
Steep, over 7%	0.39	0.42	0.44	0.48	0.51	0.54	0.61
Pasture/range							
Flat, 0–2%	0.25	0.28	0.30	0.34	0.37	0.41	0.53
Average, 2–7%	0.33	0.36	0.38	0.42	0.45	0.49	0.58
Steep, over 7%	0.37	0.40	0.42	0.46	0.49	0.53	0.60
Forest/woodlands							
Flat, 0–2%	0.20	0.25	0.28	0.31	0.35	0.39	0.48
Average, 2–7%	0.31	0.34	0.26	0.40	0.43	0.47	0.56
Steep, over 7%	0.35	0.39	0.41	0.45	0.48	0.52	0.58

Note: The values in the table are the standards used by the City of Austin, Texas.

Source: Chow, Maidment, and Mays (1988).

In urban areas, the drainage area usually consists of subareas or subcatchments of substantially different surface characteristics. As a result, a composite analysis is required that must take into account the various surface characteristics. The areas of the subcatchments are denoted by A_j and the runoff coefficients for each subcatchment are denoted by C_j. Then the peak runoff is computed using the following form of the rational formula:

$$Q = Ki\sum_{j=1}^{m} C_j A_j \tag{15.2.2}$$

where m is the number of subcatchments drained by a sewer.

The *rainfall intensity* i is the average rainfall rate considered for a particular drainage basin or subbasin. The intensity is selected on the basis of design rainfall duration and design frequency of occurrence. The design duration is equal to the time of concentration for the drainage area under consideration. The frequency of occurrence is a statistical variable that is established by design standards or chosen by the engineer as a design parameter.

The *time of concentration* t_c used in the rational method is the time associated with the peak runoff from the watershed to the point of interest. Runoff from a watershed usually reaches a peak at the time when the entire watershed is contributing; in this case, the time of concentration is the time for a drop of water to flow from the remotest point in the watershed to the point of interest. Runoff may reach a peak prior to the time the entire watershed is contributing. A trial-and-error procedure can be used to determine the critical time of concentration. The time of concentration to any point in a storm drainage system is the sum of the inlet time t_0 and the flow time t_f in the upstream sewers connected to the catchment, that is,

$$t_c = t_0 + t_f \tag{15.2.3}$$

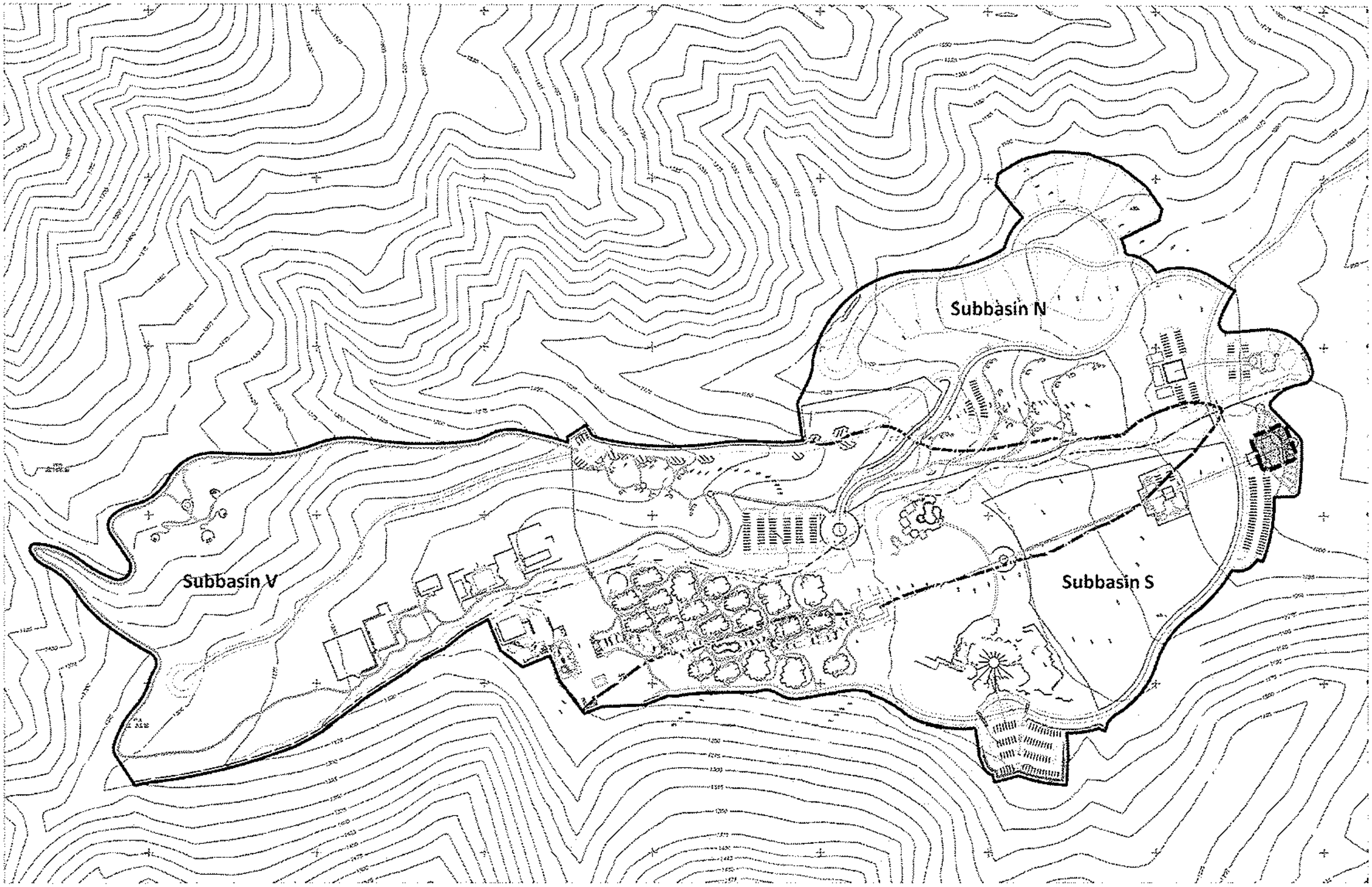
where the flow time is

$$t_f = \sum \frac{L_j}{V_j} \tag{15.2.4}$$

where L_j is the length of the jth pipe along the flow path in ft (m) and V_j is the average flow velocity in the pipe in ft/s (m/s). The inlet time t_0 is the longest time of overland flow of water in a catchment to reach the storm sewer inlet draining the catchment.

PARAISO SPRINGS RESORT					
Runoff Rates and Volumes					
Return Period	**Q (cfs)**	**Q (CF/hr)**	**2 hour (CF)**	**2 hour (MG)**	**2 hour (ac-ft)**
100-Year Post-Development	26.77	96,370	192,739	1.44	4.42
10-Year Pre-Development	9.00	32,411	64,822	0.48	1.49
Difference	**17.77**	**63,959**	**127,917**	**0.96**	**2.94**

Attachment 3
Project Site Map and Subbasin Delineation



North
NOT TO SCALE

Potential On-site Detention Basin

ATTACHMENT 3
Project Site Map and Subbasin Delineation

CH2MHILL

Attachment 4
Proposed Developed Area Calculations

CH2MHILL.

Job Name: Paraiso Springs Resort
Subject: Proposed Developed Areas

Job No. 434834.03
Sheet No. 1 of 4
Date 5/1/2012
Computed By M. Burns
Checked By

Subbasin N

4-plex condos	10 condos x 2,800 SF = 28,000 SF
Paths	1,420 SF
Roads	25' wide x (1,450' + 4,450') long = 147,500 SF
Parking	3,000 SF + 10,000 SF = 13,000 SF
Homes	180,000 SF
Misc buildings	9,200 SF + 5,200 SF = 14,400 SF
TOTAL	28,000 + 1420 + 147,500 + 13,000 + 180,000 + 14,400
	= 384,320 SF

CH2MHILL.

Job No. 434834.03

Sheet No. 2 of 4

Date 5/1/2012

Job Name Paraiso Springs Resort

Subject Proposed Developed Areas

Computed By

Checked By

Subbasin S

Parking	27,800 SF + 13,500 SF + 17,300 SF = 58,600 SF
Roads	25' wide x (430' + 1,200' + 185' + 800') long = 65,375 SF
Paths	3,000 SF
Misc. walkways	6' wide x 1,300' long = 7,800 SF
Bungalows	10 bungalows x 1,700 SF = 17,000 SF
Misc. buildings	15,300 SF + 132,500 SF + 12,800 SF + 20,300 SF = 180,900 SF
TOTAL	58,600 + 65,375 + 3,000 + 7,800 + 17,000 + 180,900 = 332,675 SF

CH2MHILL.

Job No. 434834.03

Sheet No. 3 of 4

Job Name Paraiso Springs Resort

Date 5/1/2012

Subject Proposed Developed Areas

Computed By M.Burns

Checked By

Subbasin V

Paths	6' wide x (1,900' + 8,100' + 3,500') long + 1,000 SF = 82,000 SF
Roads	25' wide x 1,550' long + 1,900 SF = 40,650 SF
Parking	13,800 SF + 29,000 SF = 42,800 SF
Pools	3,600 SF
4-Plex Condos	20 condos x 2,800 SF = 56,000 SF
Bungalows	16 bungalows x 1700 SF = 27,200 SF
Misc buildings	1,520 SF + 35,100 SF + 85,700 SF + 38,500 SF + 26,700 SF + 5,350 SF = 192,850 SF
TOTAL	82,000 + 40,650 + 42,800 + 3,600 + 56,000 + 27,200 + 192,850 = 445,100 SF

CH2MHILL.

Job Name: Paraiso Springs Resort

Subject: Proposed Developed Areas

Job No. 434834.03

Date 5/1/2012

Computed By M. Burns

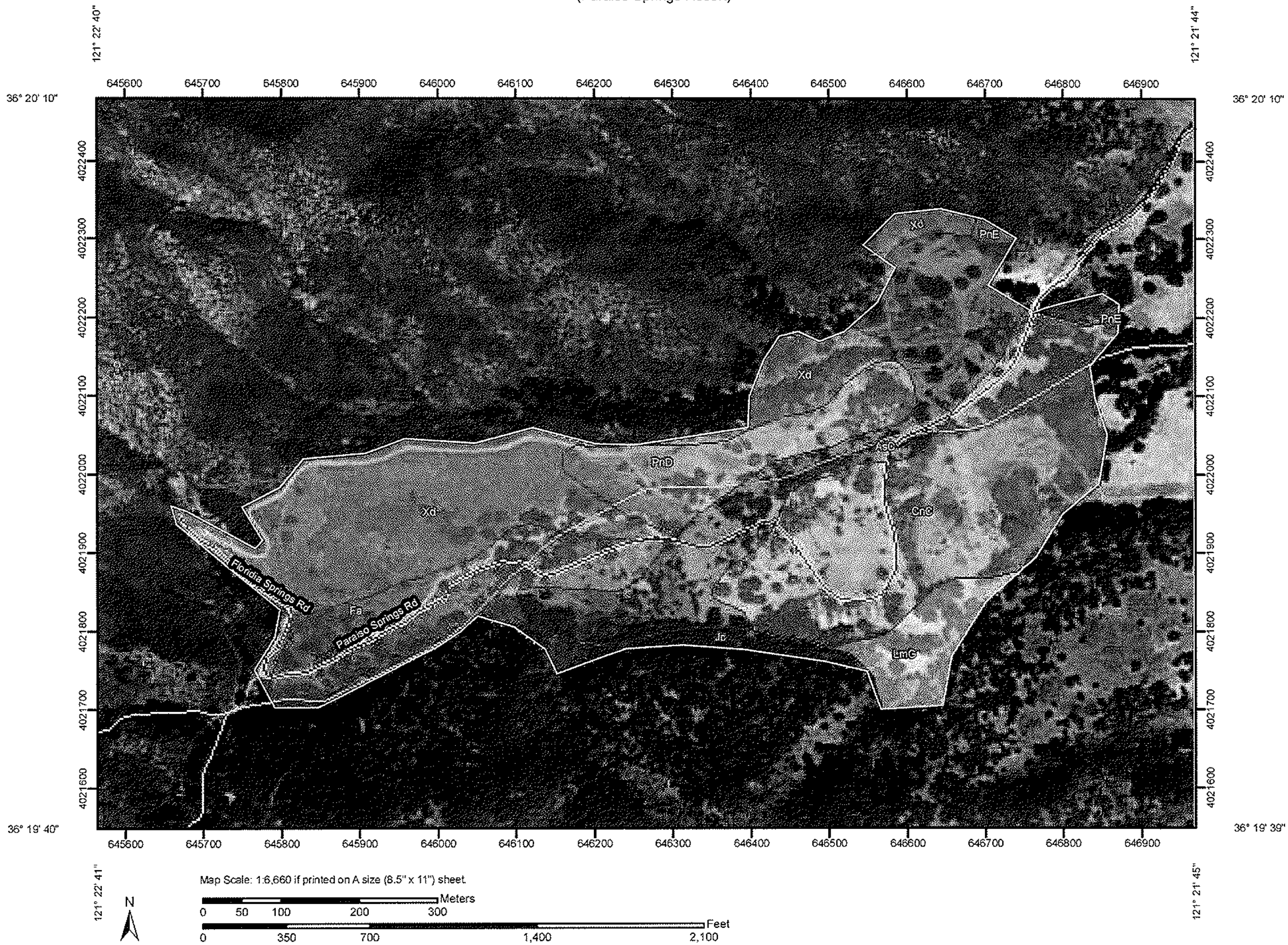
Checked By

Subbasin	Proposed Developed Areas*
N	384,320 SF
S	332,675 SF
V	445,100 SF
TOTAL	1,162,095 SF

*Proposed developed areas calculated based on the Paraiso Springs Resort Vesting Tenative Map dated Nov 11, 2009.

Attachment 5
Web Soil Survey 2.3 Output for the Project Site

Hydrologic Soil Group—Monterey County, California
(Paraiso Springs Resort)



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:6,660 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Monterey County, California
Survey Area Data: Version 9, Apr 14, 2009

Date(s) aerial images were photographed: 6/13/2005; 6/28/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Monterey County, California (CA053)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AsC	Arroyo Seco gravelly sandy loam, 5 to 9 percent slopes	B	17.8	19.3%
CnC	Cropley silty clay, 2 to 9 percent slopes	D	25.3	27.5%
Fa	Fluvents, stony	A	11.0	11.9%
Jc	Junipero-Sur complex	B	2.6	2.8%
LmG	Los Osos clay loam, 50 to 75 percent slopes	C	4.1	4.5%
PnD	Placentia sandy loam, 9 to 15 percent slopes	D	8.0	8.7%
PnE	Placentia sandy loam, 15 to 30 percent slopes	D	0.4	0.4%
Xd	Xerorthents, dissected	D	23.0	24.9%
Totals for Area of Interest			**92.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Attachment 6
Composite Curve Number Calculations

CH2MHILL.

Job Name Paraiso Springs Resort

Subject Composite CN Calculations

Job No. 434843.03

Sheet No. 1 of 4

Date 5/2/2012

Computed By M Burns

Checked By

Subbasin	Hydrologic Soil Group*	Percentage of Area*
N	B	50%
	D	50%
S	B	25%
	C	25%
	D	50%
V	A	25%
	B	25%
	D	50%

* Hydrologic Soil group and percentage for each subbasin were determined using site specific mapping available through the NRCS Web Soil Survey (accessed 5/2/2012).

CH2MHILL.

Job Name: Paraiso Springs Resort	Job No. 434843.03
Subject: Composite CN Calculations	Sheet No. 2 of 4
	Date 5/2/2012
	Computed By M Burns
	Checked By

Pre-Development, All Subbasins

Cover = Forestland — grass or orchards — evergreens or deciduous, Table 8.7.3 (Mays, 2001), Good condition

Hydrologic Soil Group	Curve Number, CN
A	32
B	58
C	72
D	79

Subbasin	Composite CN Calculation
N	0.50 x 58 + 0.50 x 79 = 68.5 use 69
S	0.25 x 58 + 0.25 x 72 + 0.50 x 79 = 72
V	0.25 x 32 + 0.25 x 58 + 0.50 x 79 = 62

CH2MHILL.

Job No. 434843.03
Sheet No. 3 of 4
Date 5/2/2012
Computed By M. Burns
Checked By

Job Name Paraiso Springs Resort
Subject Composite CN Calculations

Post-Development, Subbasin N

50% impervious — Assumes all developed areas within the Subbasin are impervious

Cover = average of Row houses, town houses, and residential with lot size of 1/8 acre or less (65% impervious) and Residential with average lot size of 1/4 acre (38% impervious) for an average of 51.5% impervious, Table 8.7.3 (Mays, 2001)

Hydrologic Soil Group	Average CN
A	$1/2(77+61) = 69$
B	$1/2(85+75) = 80$
C	$1/2(90+83) = 86.5$ use 87
D	$1/2(92+87) = 89.5$ use 90

Composite CN $= 0.50 \times 80 + 0.50 \times 90 = 85$

Post-Development, Subbasin S

43% impervious — Assumes all developed areas within the Subbasin are impervious

cover = same as used for Subbasin N

Composite CN $= 0.25 \times 80 + 0.25 \times 87 + 0.50 \times 90 = 86.75$
use 87

CH2MHILL.

Job Name Paraiso Springs Resort

Subject Composite CN Calculations

Job No. 434843.03

Sheet No. 4 of 4

Date 5/2/2012

Computed By M. Burns

Checked By

Post-Development, Subbasin V

23% impervious — Assumes all developed areas are impervious

Cover = Residential with an average lot size of 1/2 acre (25% impervious), Table 8.7.3 (Mays, 2001)

Hydrologic Soil Group	CN
A	54
B	70
C	80
D	85

Composite CN = $0.25 \times 54 + 0.25 \times 70 + 0.50 \times 85 = 73.5$

use 74

The values of *CN* for various land uses on these soil types are given in Table 8.7.3. For a watershed made up of several soil types and land uses, a composite *CN* can be calculated.

Minimum infiltration rates for the various soil groups are:

Group	*Minimum Infiltration Rate (in/hr)*
A	0.30 – 0.45
B	0.15 – 0.30
C	0 – 0.05

Table 8.7.3 Runoff Curve Numbers (Average Watershed Condition, $I_a = 0.2S$)

Land Use Description		Average % impervious[b]	Curve Numbers for Hydrologic Soil Group A	B	C	D
Fully developed urban areas[a] (vegetation established)						
Lawns, open spaces, parks, golf courses, cemeteries, etc.						
Good condition; grass cover on 75% or more of the area			39	61	74	80
Fair condition; grass cover on 50% to 75% of the area			49	69	79	84
Poor condition; grass cover on 50% or less of the area			68	79	86	89
Paved parking lots, roofs, driveways, etc.			98	98	98	98
Streets and roads						
Paved with curbs and storm sewers			98	98	98	98
Gravel			76	85	89	91
Dirt			72	82	87	89
Paved with open ditches			83	89	92	93
Commercial and business areas		85	89	92	94	95
Industrial districts		72	81	88	91	93
Row houses, town houses, and residential with lot sizes 1/8 acre or less		65	77	85	90	92
Residential: average lot size						
1/4 acre		38	61	75	83	87
1/3 acre		30	57	72	81	86
1/2 acre		25	54	70	80	85
1 acre		20	51	68	79	84
2 acre		12	46	65	77	82
Developing urban areas[c] (no vegetation established)						
Newly graded area			77	86	91	94
Cover: Land Use	**Cover: Treatment of Practice**	**Hydrologic Condition[d]**				
Cultivated agricultural land						
Fallow	Straight row		77	86	91	94
	Conservation tillage	Poor	76	85	90	93
	Conservation tillage	Good	74	83	88	90
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Conservation tillage	Poor	71	80	87	90
	Conservation tillage	Good	64	75	82	85

Table 8.7.3 Runoff Curve Numbers (*continued*)

Cover		Hydrologic Condition[d]	Curve Numbers for Hydrologic Soil Group			
Land Use	Treatment of Practice		A	B	C	D
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and conservation	Poor	69	78	83	87
	tillage	Good	64	74	81	85
	Contoured and terraces	Poor	66	74	80	82
	Contoured and terraces	Good	62	71	78	81
	Contoured and terraces	Poor	65	73	79	81
	and conservation tillage	Good	61	70	77	80
Small grain	Straight row	Poor	65	76	84	88
	Straight row	Good	63	75	83	87
	Conservation tillage	Poor	64	75	83	86
	Conservation tillage	Good	60	72	80	84
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured and conservation	Poor	62	73	81	84
	tillage	Good	60	72	80	83
	Contoured and terraces	Poor	61	72	79	82
	Contoured and terraces	Good	59	70	78	81
	Contoured and terraces	Poor	60	71	78	81
	and conservation tillage	Good	58	69	77	80
Close-seeded	Straight row	Poor	66	77	85	89
legumes or	Straight row	Good	58	72	81	85
rotation meadow[e]	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured and terraces	Poor	63	73	80	83
	Contoured and terraces	Good	51	67	76	80
Noncultivated agricultural						
land Pasture or range	No mechanical treatment	Poor	68	79	86	89
	No mechanical treatment	Fair	49	69	79	84
	No mechanical treatment	Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		—	30	58	71	78
Forestland—grass or		Poor	55	73	82	86
orchards—evergreen or		Fair	44	65	76	82
deciduous		Good	32	58	72	79
Brush		Poor	48	67	77	83
		Good	20	48	65	73
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		—	59	74	82	86
Forest–range						
Herbaceous		Poor		79	86	92
		Fair		71	80	89
		Good		61	74	84

Table 8.7.3 Runoff Curve Numbers (*continued*)

Cover		Hydrologic Condition[d]	Curve Numbers for Hydrologic Soil Group			
Land Use	Treatment of Practice		A	B	C	D
Oak–aspen		Poor		65	74	
		Fair		47	57	
		Good		30	41	
Juniper–grass		Poor		72	83	
		Fair		58	73	
		Good		41	61	
Sage–grass		Poor		67	80	
		Fair		50	63	
		Good		35	48	

[a] For land uses with impervious areas, curve numbers are computed assuming that 100% of runoff from impervious areas is directly connected to the drainage system. Pervious areas (lawn) are considered to be equivalent to lawns in good condition and the impervious areas have a *CN* of 98.

[b] Includes paved streets.

[c] Use for the design of temporary measures during grading and construction. Impervious area percent for urban areas under development vary considerably. The user will determine the percent impervious. Then using the newly graded area *CN* and Figure 8.7.1*a* or *b*, the composite *CN* can be computed for any degree of development.

[d] For conservation tillage poor hydrologic condition, 5% to 20% of the surface is covered with residue (less than 750-lb/acre row crops or 300-lb/acre small grain).

For conservation tillage good hydrologic condition, more than 20% of the surface is covered with residue (greater than 750-lb/acre row crops or 300-lb/acre small grain).

[e] Close-drilled or broadcast.

For noncultivated agricultural land:
Poor hydrologic condition has less than 25% ground cover density.
Fair hydrologic condition has between 25% and 50% ground cover density.
Good hydrologic condition has more than 50% ground cover density.

For forest–range:
Poor hydrologic condition has less than 30% ground cover density.
Fair hydrologic condition has between 30% and 70% ground cover density.
Good hydrologic condition has more than 70% ground cover density.

Source: U.S. Department of Agriculture Soil Conservation Service (1986).

8.7.3 Curve Numbers

Table 8.7.3 gives the curve numbers for average watershed conditions, $I_a = 0.2S$, and antecedent moisture condition II. For watersheds consisting of several subcatchments with different *CN*s, the area-averaged composite *CN* can be computed for the entire watershed. This analysis assumes that the impervious areas are directly connected to the watershed drainage system (Figure 8.7.1*a*). If the percent imperviousness is different from the value listed in Table 8.7.3 or if the impervious areas are not directly connected, then Figures 8.7.1*a* or *b*, respectively can be used. The pervious *CN* used in these figures is equivalent to the open-space *CN* in Table 8.7.3. If the total impervious area is less than 30 percent, Figure 8.7.1*b* is used to obtain a composite *CN*. For natural desert landscaping and newly graded areas, Table 8.7.3 gives only the *CN*s for pervious areas.