TITeL MC-15
DEPARTMENT OF PUBLIC WORKS AND WASTE MANAGEMENT
COUNTY OF MAUI

CHAPTER 4

RULES FOR THE DESIGN OF
STORM DRAINAGE FACILITIES
IN THE COUNTY OF MAUI

SUMMARY

1. Chapter 4, entitled "Rules For The Design
Of Storm Drainage Facilities In The County of Maui", is
hereby adopted to read as follows:

"TITeL MC-15
DEPARTMENT OF PUBLIC WORKS AND WASTE MANAGEMENT

SUBTITLE 01

CHAPTER 4

RULES FOR THE DESIGN OF
STORM DRAINAGE FACILITIES
IN THE COUNTY OF MAUI"
GENERAL PROVISIONS

§15-04-01 Title
§15-04-02 Authority
§15-04-03 Purpose
§15-04-04 Definitions
§15-04-05 Hydrologic criteria
§15-04-06 Design standards
§15-04-07 Severability
§15-04-08 Appendix - reference tables and charts

§15-04-01 Title. The rules in this Title shall be known as the "Rules For The Design of Storm Drainage Facilities in the County of Maui". [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-02 Authority. The rules herein are established pursuant to the provisions of Sections 46.15(13) and 46.15(14), Hawaii Revised Statutes, and Section 18.20.130A, Maui County Code. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-03 Purpose. These rules govern the design of storm drainage facilities in the County of Maui. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-04 Definitions. For the purpose of these rules, unless it is plainly evident from the context that a different meaning is intended, certain words and phrases used herein are defined as follows:

"Detention facilities" means temporarily impound runoff to control runoff rates.

"Director" means the Director of Public Works and Waste Management.

"Infiltration facilities" means facilities, such as, infiltration basins, retention basins and porous pavements, which rely on absorption of runoff.
"Injection wells" are wells that dispose runoff into the subsurface and shall be in conformance with applicable State Department of Health Underground Injection Control (UIC) Rules.

"Sumps" mean either detention facilities or infiltration facilities. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-05 Hydrologic criteria.

Recurrence interval.
(a) For drainage areas of 100 acres or less, Tm (recurrence interval) = 10 year based on 1 hour storm, unless otherwise specified.
(b) For drainage areas of 100 acres or less with sump, or tailwater effect, Tm (recurrence interval) = 50 year based on 1 hour storm.
(c) For the design of roadway culverts and bridges with drainage areas less than 100 acres, Tm (recurrence interval) = 50 year based on 1 hour storm.
(d) For drainage areas greater than 100 acres and all streams, the Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service) hydrograph method shall be used, Tm (recurrence interval) = 100 year based on 24 hour storm.
(e) Retention and Detention Basins: Tm (recurrence interval) = 50 year based on 1 hour storm for drainage areas 100 acres or less.
   Tm (recurrence interval) = 100 year based on 24 hour storm for drainage areas more than 100 acres.
(f) When a drainage area of less than 100 acres contributes to a major stream or channel with a total drainage area greater than 100 acres, the contributory drainage system shall be designed for 10 year or 50 year storm, whichever is applicable.

Runoff Quantity.
(a) Rational Method: For drainage areas of 100 acres or less, the rational method along with the accompanying reference tables and charts, or latest revision thereof, shall be used. The formula \( Q = CIA \) may be used to determine quantities of flow rate, in which:
   \( Q \) = flow rate in cubic feet per second;
   \( C \) = runoff coefficient;
I = rainfall intensity in inches per hour for a duration equal to the time of concentration; and
A = drainage area in acres.

(b) Runoff Coefficient (C):
(1) For Off-site Areas - The "C" value shall be determined from Table No. 1 and based on the current use of the drainage area. For distinctive composite drainage areas, a weighted value of runoff coefficient shall be used.

(2) For On-site Areas - Composite areas shall be designated and a weighted value of runoff coefficient shall be determined using the runoff coefficient from Table 1 or 2, whichever is higher. Minimum runoff coefficients for built-up areas are noted in Table 3.

(c) Time of Concentration (Tc)
(1) Determine overland flow time from Plate 1 generally for paved, bare soil and grassed areas.

(2) Determine flow time over small agricultural areas with well-defined divides and drainage channels from Plate 3.
   (A) Use upper curve for well-forested areas representing:
       \[ Tc = 0.0136K^{0.77} \]
   (B) Use lower curve for areas with little or no cover, representing:
       \[ Tc = 0.0078K^{0.77} \]

(3) To verify the time of concentration, divide the estimated longest route of runoff by the appropriate runoff velocity from Table 4.

(4) Tc for flows in uniform channels and in culverts shall be computed by length of run divided by computed velocity.

(d) Rainfall Intensity (I) - The design rainfall intensity of a drainage area shall be determined by the following procedure:

(1) Select the appropriate 1-hour rainfall value from Plates 4 to 9 for the design recurrence interval for each individual island.

(2) Enter Plate 2 with the 1-hour rainfall value and the required time of concentration. Obtain the design rainfall intensity in inches per hour.
Natural Resources Conservation Service (NRCS) Method, Hydrograph Analysis

(a) For drainage areas greater than 100 acres and all streams, the Natural Resources Conservation Service method shall be used.

(b) The procedure for computing the peak flows and plotting the hydrographs shall be as outlined in the NRCS, National Engineering Handbook, Section 4, Hydrology, Supplement, or latest revision thereof or Erosion and Sediment Control Guide for Hawaii, NRCS, March 1981, or latest revision thereof.

(c) The NRCS computer program TR55 or TR20 may be used in lieu of the NRCS hydrograph analysis.

Federal Emergency Management Agency (FEMA)

Federal Emergency Management Agency (FEMA) storm flows shall be the minimum storm flow in drainage basins where flows have been determined in the "Flood Insurance Study," Maui County. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-06  Design Standards  (a) General Conditions: The design and capacity of a drainage system shall be based on the following conditions:

(1) The drainage system shall dispose the design storm runoff and subsurface water without damage to street facilities, structures or ground and cause no serious interruption of normal vehicular traffic, and in a manner that will not adversely affect downstream and adjoining properties.

(2) System must have maximum reliability of operation with minimum maintenance and upkeep requirements.

(3) If applicable, system must be adaptable to future expansion.

(4) Where sump conditions exist; a safety measure such as an overflow swale shall be provided to prevent flooding of adjacent lots in the event the design capacity of the closed conduit is exceeded.
(5) In general, natural gullies, waterways, streams and tributaries shall not be replaced with a closed system except at roadway crossings. For natural drainageways with contributory areas greater than 100 acres, the engineer shall determine, dimension and designate the 100 year flooded width as a drainage reserve in the drainage report and on the final subdivision map, if applicable.

(6) Roadway culverts and bridges shall be designed to pass the design flow as determined by this design criteria. Under open channel hydraulic analysis the minimum freeboard shall be as specified in the design criteria for open channels. Multiple span road crossings (bridges) shall have minimum clear spans of 30-feet, unless otherwise permitted by the Director. Where possible, the roadway shall be designed to form a sag vertical curve with a low point at the waterway crossing with minimum grades to confine and control overflow at the crossing.

(7) In general, outlets for enclosed drains emptying into open channels shall be designed to point downstream at an angle of 45 degrees. Junctions of open channels shall be designed to flow as nearly parallel as possible.

(8) Outlet velocities of storm waters leaving culverts and channels shall not exceed existing drainage velocities when entering existing drainage ways.

(9) Subsurface drains may be installed when approved by the Director, provided no ground water is encountered or will be encountered during wet weather.

(10) In areas where existing drainage systems are inadequate, the existing system shall be upgraded to handle runoff from the new project area or a new system shall be provided to connect to an adequate outlet. When there is no existing drainage system or adequate outlet to connect to, the additional runoff generated by the development may be retained on-site in a temporary retention basin with the following design conditions:
(A) Storage volume of an infiltration basin, infiltration trench piping, or retention basin shall equal at least the total additional runoff volume for the appropriate storm intensity.

(B) Soil percolation shall not be used in satisfying required storage volumes.

(C) Fifty percent (50%) of voids within the rock envelope for subsurface drains may be used in satisfying required storage volume provided that filter fabric is installed around the subsurface pipe and at the interface of the rock envelope and soil.

(D) Sumps, detention and retention facilities will remain private.

(E) Detention or retention ponds with embankment heights equal to or in excess of 25 feet or with storage capacity equal to or in excess of 50 acre-feet shall conform to all state and federal requirements relative to dams.

(11) Flooded widths shall not be more than the following for the appropriate design storm:

(A) 8 feet for all curbed streets.

(B) No portion of the pavement shall be flooded for non-curbed streets. All storm runoff shall be confined to the roadway shoulder swale.

(12) Provide spillway or other devices that will direct overflow for design storms to an appropriate drainage channel or drainage system to assure that there will be no adverse effects on downstream or adjacent properties.

(13) Additional storm runoff from a new development shall be disposed of at an appropriate drainage outlet or drainage system so as not to create any additional adverse effects to adjacent or downstream properties.

(14) Off-site flows may be passed safely through a development provided there are no additional adverse effects resulting from the new development to adjacent and downstream properties.
(15) All new structures shall have either:
   (A) The lowest floor or lowest opening be at least one foot above the crown of the nearest street or above the highest grade adjacent to the structure; or
   (B) The site plan ensure that new structures are protected from local drainage problems.

(b) Drainage system
(1) Closed Conduits:
   (A) Freeboard and Hydraulic Grade Line (HGL) unless otherwise authorize by the Director:
      i. 1' freeboard within drainage structures.
      ii. HGL shall not be less than 1' below finish ground elevation.
   (B) Minimum Pipe Sizes Within County Right-of-Way:
      i. 18" diameter for lateral not exceeding 50 feet in length connecting drainage structures to main line.
      ii. 24" diameter for main trunk line

(C) Materials and "n" Values:
   i. Concrete Pipe n=0.013
   ii. *High Density Polyethylene Pipe (HDPE) n=0.013
   iii. *Corrugated Aluminum Pipe (CAP) and *Corrugated Galvanized Metal Pipe (CMP), annular (1/2 X 2 2/3 corrugation, All sizes):
        Unpaved n=0.024
        25% paved invert n=0.021
        Lower 50% Paved n=0.018
        100% Paved n=0.013
   iv. Helical *CAP and *CSP (1/2 X 2 2/3 corrugation):
        18" n=0.014
        24" n=0.017
        30" n=0.018
        36" to 48" n=0.020
        54" and larger n=0.021
   v. *Spiral Rib Pipe
        All sizes n=0.011

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*Shall be allowed only upon submittal of soil test, PH value, etc. to substantiate soil/effluent/pipe material compatibility and with written approval from the Director.

(2) Open Channels
(A) Freeboard: Freeboard shall be according to the U.S. Department of Interior Bureau of Reclamation's empirical formula,

Freeboard in feet = 2.000 + 0.025v^3 \sqrt{d}

where v is the velocity in feet per second and d is the flow depth in feet. Freeboard shall be provided at bends from the superelevated water surface.

(B) Material, "n" values and maximum velocities:

<table>
<thead>
<tr>
<th>Material</th>
<th>Manning n</th>
<th>Max. v (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete, trowel finish</td>
<td>0.013</td>
<td>no limitation</td>
</tr>
<tr>
<td>Concrete, form finish</td>
<td>0.015</td>
<td>no limitation</td>
</tr>
<tr>
<td>Gunite, good section</td>
<td>0.018</td>
<td>20</td>
</tr>
<tr>
<td>Gunite, wavy section</td>
<td>0.020</td>
<td>20</td>
</tr>
<tr>
<td>Grouted Rubble Paving (GRP)</td>
<td>0.025</td>
<td>20</td>
</tr>
<tr>
<td>Cement Rubble Masonry (CRM)</td>
<td>0.025</td>
<td>20</td>
</tr>
<tr>
<td>Rock, smooth, uniform</td>
<td>0.030</td>
<td>10</td>
</tr>
<tr>
<td>Rock, jagged, irregular</td>
<td>0.045</td>
<td>10</td>
</tr>
<tr>
<td>Earth, fairly uniform, grassed</td>
<td>0.035</td>
<td>5</td>
</tr>
</tbody>
</table>

(C) Channel rights-of-ways shall encompass the channel width and include sufficient width for maintenance.

(D) Special considerations shall be made for guard rails and fences, debris control structures, energy dissipators, etc.
(c) Drainage report: Three copies of a drainage report, when required, shall be submitted to the Land Use and Codes Administration for approval. The drainage report shall be sealed and signed by a professional civil engineer licensed to practice in the State of Hawaii and at a minimum, include the following:

(1) Hydrologic runoff computations
   (A) On-Site
      i. Existing Conditions
      ii. Developed Conditions
   (B) Off-Site
      i. Existing Conditions
      ii. Allowances for future conditions (if any).

(2) Hydraulic Analysis:
   (A) Catch Basins & Inlet Capacities.
   (B) Flooded Road Width.
   (C) Hydraulic Grade Line (HGL). The HGL shall be shown on the construction plans.

(3) Contributory drainage area maps and schematic drainage scheme.

(b) The chairperson and vice-chairperson shall have responsibilities and duties as prescribed in this chapter. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §1.16.040 Maui County Charter

§15-04-07 Severability. If any portion of the foregoing rules or the applicability thereof to any person, property or circumstance is held invalid for any reason, such invalidity shall not affect other provisions or applications which can be given effect without the invalid provision or application, and to this end these are declared to be severable. [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

§15-04-08 Appendix. Reference charts and tables attached hereto and made a part hereof." [Eff. 11/12/95] (Auth: §§46.15(13) and (14), Hawaii Revised Statutes) (Imp: §18.20.130A, Maui County Code)

CHARLES JENCKS
Its Director
Department of Public Works & Waste Management
County of Maui

APPROVED AS TO FORM AND LEGALITY:

LILLIAN B. KOLLER
Deputy Corporation Counsel
County of Maui

APPROVED this 14th day of July, 1995.

LINDA CROCKETT LINGLE
Mayor
County of Maui

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CERTIFICATION

I, CHARLES JENCKS, in my capacity as Director of Public Works and Waste Management, County of Maui, do hereby certify:

1. That the foregoing is a full, true and correct copy of the Rules of the Department of Public Works and Waste Management relating to the Rules for the Design of Storm Drainage Facilities in the County of Maui.

2. That the notice of public hearing on the foregoing Rules, which notice included the substance of such Rules, was published in the Maui News on June 12, 1995.

CHARLES JENCKS
Director, Department of Public Works and Waste Management
County of Maui

Received this 2nd day of November, 1995.

DARYL T. YAMAMOTO
County Clerk
County of Maui

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### Table 1

**GUIDE FOR THE DETERMINATION OF RUNOFF COEFFICIENTS FOR BUILT-UP AREAS**

<table>
<thead>
<tr>
<th>WATERSHED CHARACTERISTICS</th>
<th>EXTREME</th>
<th>HIGH</th>
<th>MODERATE</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>INfiltration</td>
<td>NEGLIGIBLE 0.20</td>
<td>SLOW 0.14</td>
<td>MEDIUM 0.07</td>
<td>HIGH 0.0</td>
</tr>
<tr>
<td>Relief</td>
<td>STEEP (&gt; 25%) 0.08</td>
<td>HILLY (15 - 25%) 0.06</td>
<td>ROLLING (5 - 15%) 0.03</td>
<td>FLAT (0 - 5%) 0.0</td>
</tr>
<tr>
<td>Vegetal Cover</td>
<td>NONE 0.07</td>
<td>POOR (&lt; 10%) 0.05</td>
<td>GOOD (10 - 50%) 0.03</td>
<td>HIGH (50 - 90%) 0.0</td>
</tr>
<tr>
<td>Development Type</td>
<td>INDUSTRIAL &amp; BUSINESS 0.55</td>
<td>HOTEL-APARTMENT 0.45</td>
<td>RESIDENTIAL 0.40</td>
<td>AGRICULTURAL 0.15</td>
</tr>
</tbody>
</table>

*NOTE: The design coefficient "c" must result from a total of the values for all four watershed characteristics of the site.*

### Table 2

**RUNOFF COEFFICIENTS**

<table>
<thead>
<tr>
<th>Type of Drainage Area</th>
<th>Runoff Coefficient C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business:</td>
<td></td>
</tr>
<tr>
<td>Downtown areas</td>
<td>0.95</td>
</tr>
<tr>
<td>Neighborhood areas</td>
<td>0.70</td>
</tr>
<tr>
<td>Residential:</td>
<td></td>
</tr>
<tr>
<td>Single-family areas</td>
<td>0.50</td>
</tr>
<tr>
<td>Multi-units, detached</td>
<td>0.60</td>
</tr>
<tr>
<td>Multi-units, attached</td>
<td>0.75</td>
</tr>
<tr>
<td>Suburban</td>
<td>0.40</td>
</tr>
<tr>
<td>Apartment dwelling areas</td>
<td>0.70</td>
</tr>
<tr>
<td>Industrial:</td>
<td></td>
</tr>
<tr>
<td>Light areas</td>
<td>0.80</td>
</tr>
<tr>
<td>Heavy areas</td>
<td>0.90</td>
</tr>
<tr>
<td>Parks, cemeteries</td>
<td>0.25</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>0.35</td>
</tr>
<tr>
<td>Railroad-yard areas</td>
<td>0.40</td>
</tr>
<tr>
<td>Unimproved areas</td>
<td>0.30</td>
</tr>
<tr>
<td>Streets:</td>
<td></td>
</tr>
<tr>
<td>Asphalitic</td>
<td>0.95</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.95</td>
</tr>
<tr>
<td>Brick</td>
<td>0.85</td>
</tr>
<tr>
<td>Drive and walks</td>
<td>0.85</td>
</tr>
<tr>
<td>Roofs</td>
<td>0.95</td>
</tr>
<tr>
<td>Lawns:</td>
<td></td>
</tr>
<tr>
<td>Sandy, soil, flat, 2%</td>
<td>0.10</td>
</tr>
<tr>
<td>Sandy, soil, avg., 2-7%</td>
<td>0.15</td>
</tr>
<tr>
<td>Sandy, soil, steep, 7%</td>
<td>0.20</td>
</tr>
<tr>
<td>Heavy soil, flat, 2%</td>
<td>0.17</td>
</tr>
<tr>
<td>Heavy soil, avg., 2-7%</td>
<td>0.22</td>
</tr>
<tr>
<td>Heavy soil, steep, 7%</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Table 3

MINIMUM RUNOFF COEFFICIENTS FOR BUILT-UP AREAS

<table>
<thead>
<tr>
<th>AREA TYPE</th>
<th>COEFFICIENT RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Areas</td>
<td>C = 0.55 to 0.70</td>
</tr>
<tr>
<td>Hotel-Apartment Areas</td>
<td>C = 0.70 to 0.90</td>
</tr>
<tr>
<td>Business Areas</td>
<td>C = 0.80 to 0.90</td>
</tr>
<tr>
<td>Industrial Areas</td>
<td>C = 0.80 to 0.90</td>
</tr>
</tbody>
</table>

*The type of soil, the type of open space and ground cover and the slope of the ground shall be considered in arriving at reasonable and acceptable runoff coefficients.*

Table 4

APPROXIMATE AVERAGE VELOCITIES OF RUNOFF FOR CALCULATING TIME OF CONCENTRATION

<table>
<thead>
<tr>
<th>TYPE OF FLOW</th>
<th>VELOCITY IN FPS FOR SLOPES (in percent) INDICATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overland Flow:</td>
<td>0-3% 4-7% 8-11% 12-15%</td>
</tr>
<tr>
<td>Woodlands</td>
<td>1.0 2.0 3.0 3.5</td>
</tr>
<tr>
<td>Pastures</td>
<td>1.5 3.0 4.0 4.5</td>
</tr>
<tr>
<td>Cultivated</td>
<td>2.0 4.0 5.0 6.0</td>
</tr>
<tr>
<td>Pavements</td>
<td>5.0 12.0 15.0 18.0</td>
</tr>
</tbody>
</table>

*Open Channel Flow:*

<table>
<thead>
<tr>
<th>Description</th>
<th>Velocity Calculation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Channels</td>
<td>Determine Velocity by Manning’s Formula</td>
</tr>
</tbody>
</table>
| Natural Channel* (not well defined) | 1.0 3.0 5.0 8.0 | *These values vary with the channel size and other conditions so that the ones given are the averages of a wide range. Wherever possible, more accurate determinations should be made for particular conditions by Manning’s formula.
\[ L = \text{Maximum length of travel in feet} \]
\[ H = \text{Difference in elevation between most remote point and outlet in feet.} \]
\[ S = \text{Slope } \frac{H}{L} \]
\[ K = \sqrt[3]{\frac{L}{S}} = \sqrt[3]{\frac{L}{H}} \]

Use upper curve for well forested areas.
Use lower curve for areas with little or no cover.

SOURCE: CITY PLANNING COMMISSION
Graph from Hunter Rouse Engineering Hydraulics

**Plate 3**

Time of Concentration
(OF SMALL AGRICULTURAL DRAINAGE BASIN)