VI. CREATION OF NEW PUBLIC ROADS

A) REQUIREMENTS FOR PUBLIC IMPROVEMENTS

1) GENERAL

Road and drainage improvements are conditioned through the development review process, this Ordinance, and other County policies adopted by the Board of County Commissioners. No road, bridge, drainage or utility construction, within or affecting public rights-of-way and County easements, shall commence prior to obtaining a permit from the Road Department approving the construction plans (Exhibit 4). Designs submitted shall be stamped by a Registered Professional Engineer licensed to practice within the State of Oregon.

Design of the public improvement shall be in conformance with the specifications of this section, the standard drawings contained in Section VII, the Oregon Department of Transportation Standard Specifications for Highway Construction and Oregon Department of Transportation Standard Plans, in preferential order. The Standard Drawings of Section VII may be periodically revised by the Public Works Director.

Regardless of any approval or acceptance by the County, the applicant shall be responsible to correct any defect in the road, drainage, or related facilities discovered within 2 years of final acceptance of the improvements.

All roads within the Urban Growth Boundary of a city shall comply with these standards as well as the standards required by Urban Growth Boundary management agreements between the city and the County.

B) SUBMITTAL REQUIREMENTS

1) GENERAL

Complete plans for all proposed improvements within or affecting public rights of way shall be submitted to the Public Works Director for approval. Submittal requirements consist of design plans, grading plans , erosion control plans , drainage calculations and other information as required by the Public Works Director of Columbia County.

2) DESIGN PLAN FORMAT

Vicinity Maps shall be located on the first sheet of all plans showing the location of the project in relation to the nearest major street intersection.

The location and elevation of a National Geodetic Survey, United States Geological Survey, State Highway, or Columbia County bench mark shall be shown. No other datum shall be used without permission of the County Surveyor. Temporary bench marks shall be shown on the plans.

A title block shall appear on each sheet of the plan set. The title block shall include the names of the project, the engineering firm, the owner and the sheet title.

The seal of the Registered Professional Engineer responsible for preparation of the plans shall appear on each sheet.

The description and date of all revisions to the plans shall be shown on each revised sheet, and shall be approved and dated by a Registered Professional Engineer as evidenced by signature or initial.

3) PLAN VIEW

Plan views shall show the following:

All plan view sheets shall include a north arrow oriented to the top or left side of the page. All plan views shall be drawn to a scale of 1 inch equals 50 feet.

Right-of-way, property, tract, and easement lines.

Subdivision name, lot numbers, street names and other identifying labels. Street names are subject to the approval of the County.

Location and stationing of existing and proposed street centerlines and curb faces.

Horizontal curve data of street centerlines and curb returns including radii, lengths, and central angles.

Vegetation in conflict with the construction or operation of the street and drainage facilities.

Top of cut and top of fill lines and respective slopes. Location and size of drainage facilities, including ditches and culverts.

Match lines with sheet number references.

Sidewalk ramp locations.

Centerline stationing of all intersecting streets.

Location and description of existing survey monuments, including but not limited to, section corners, quarter corners and donation land claim corners.

All existing and proposed utility locations and drainage facilities.

Location and type of signs, delineations, lane markings.

Legend.

Developer's name, address and phone number.

4) PROFILE VIEW

Profile Views shall show the following:

Stationing, elevations, vertical curve data and grades for center of streets and top of curbs. Where curbs are not to be constructed, centerline of street and ditch inverts shall be shown.

Original ground along the center line.

Centerline of existing streets for a distance of at least 100 feet each way from intersections with proposed streets.

All proposed drainage facilities, size, slopes, materials, bedding and backfill.

Existing drainage facilities, including off-site facilities, upstream and downstream that affect the design (e.g., downstream restrictions that back water on to project site).

All existing and proposed utility locations.

5) TYPICAL CROSS SECTION

Typical cross sections shall show the base design, curbs and gutters or ditch lines, rights-of-way, drainage facilities, utilities, fill slopes, and cut slopes.

6) DRAINAGE CALCULATIONS

Drainage calculations shall be presented in a clear,

concise and complete manner. These calculations shall address all runoff into the drainage system. Areas contributing flow to each inlet must be computed separately and each inlet with contributing area shall be designated and shown on an accompanying contour map work sheet.

Downstream calculations shall be made to determine the affect on downstream facilities to such a point at which the increase in stormwater is determined by the engineer to be insignificant. The applicant shall be responsible to increase the size of all downstream drainage facilities that are determined to be inadequate.

Initial time of concentration calculation with assumptions listed and charts or monographs used shall also be included with drainage calculations.

7) OTHER REQUIREMENTS

Other information to be shown on the construction drawings or the other submittals include:

The design elements such as:

(1) Street classification;
(2) Design speed;
(3) Superelevation;
(4) Average Daily Traffic (ADT) or Design Hourly Volume (DHV).

Structural construction plans and the necessary calculations shall be submitted for proposed structures (i.e., walls, box culverts, bridges, etc.).

Any additional information that the County deems necessary.

8) REVIEW PROCEDURE

Two sets of complete plans and supporting documentation shall be submitted for a cursory review. This review is to check that all the required information has been submitted. The required information includes drainage calculations, and a list of requested variances from these Road Standards. If the submittal is adequate, a detailed review will begin based on a first-in, first-out approach. If the submittal is not complete, notification will be given by the County to the private engineer specifying what is needed. This initial review of the construction drawings shall typically be completed within 30 days following submission of the drawings. Variances to the specifications will require additional review time.

Upon completion of the detailed review by the County, the County will return 1 set of plans with "Red Line" comments and calculations. After the private engineer has completed all revisions, 2 revised plans and the original "Red Line" plans shall be returned to the County for approval. If approved, 1 set will be returned and stamped approved by the County. This review of the resubmitted drawings shall be completed within 30 days of receipt of the revised drawings. County approval does not relieve the applicant of complete responsibility for the adequacy of the design submitted.

Plan review priority will be given to plans submitted for final review. This plan review and approval is valid for 2 years from the date of the approval stamp. Extensions can be made as part of the Development Permit extension process. See the Columbia County Community Development Code for requirements for permit extensions.

9) AS-BUILT DRAWINGS

Following the completion of construction and inspection approval by the County, a complete set of as-built drawings shall be submitted. Drawings shall describe any and all revisions to the previously approved construction plans. The engineer shall submit the as-built drawings on 3 mil minimum thickness mylar. On the first page of the drawings, the developer's engineer shall make the following statement and affix his/her stamp adjacent thereto: *"I hereby affix my seal to certify that these improvements have been inspected and constructed in conformance with these plans as approved by the Public Works Director and the general specifications adopted by the Columbia County Road Department."*

C) ROAD REQUIREMENTS

1) PRIVATELY MAINTAINED ROADS WITHIN PUBLIC RIGHTS-OF-WAY

The maintenance of roads within public rights-of-way will remain the responsibility of adjacent property owners until such time as the road has been constructed to county standards and accepted as a "County Road" by the Board of Commissioners.

2) ACCESS

Access to County and Public Roads shall conform to the Columbia County Access/Approach Road Ordinance, or as modified by UGB Management Agreements. An access approach permit must be obtained from the Columbia county Road Department prior to the construction of any access approach to any county road, public road under the jurisdiction of the county, or private road. An

access approach permit is also required prior to obtaining a building permit from the Land Development Services office.

An inspection form/permit is also required from the appropriate fire district official (or Oregon State Board of Forestry) for approval of a driveway prior to obtaining a building permit from the Columbia County Land Development Services Department.

When partitions or subdivisions abut on an existing or proposed arterial road, the County may require limited access to the arterial by construction of frontage roads or other local access roads.

3) WIDTH

Drawings I and II are a summary of road width standards by the functional classification of the road. It should be noted that public utility easements beyond the right-of-way are required in some instances. The preliminary approval given for the public improvement should indicate the classification of road required.

4) RIGHT-OF-WAY

Right-of-way may be needed in addition to that shown in Drawings I and II to accommodate the increased number of lanes at intersections, required cut and fill slopes, for utilities, or future bike routes.

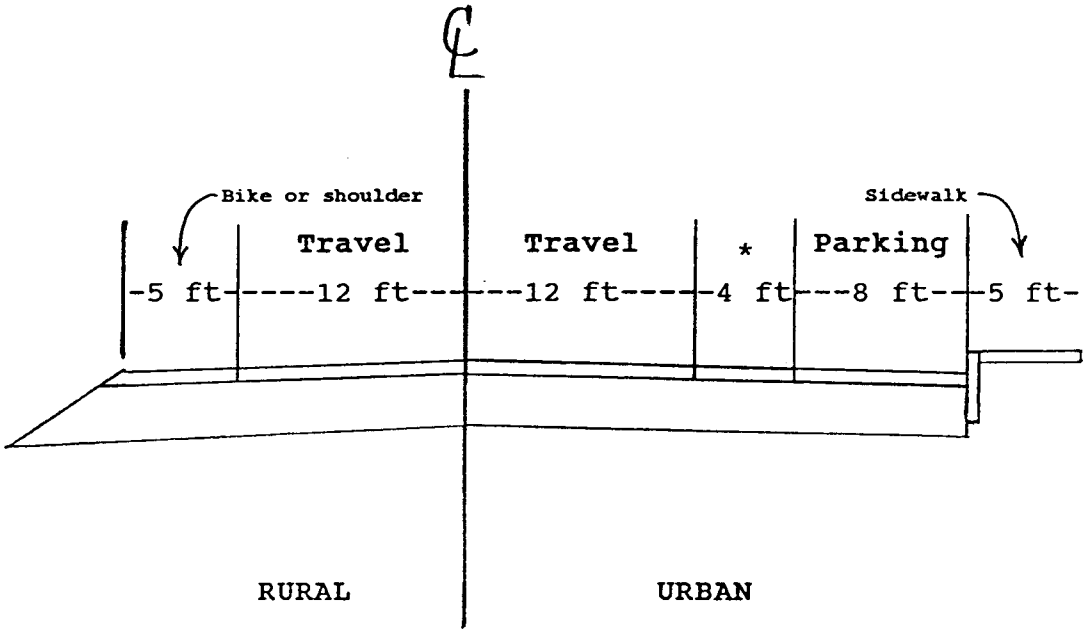
5) DESIGN SPEED

The minimum design speed for each road classification shall be as shown in Drawings I and II.

DRAWING I

ARTERIAL ROAD

TYPICAL CROSS SECTION



Superelevation = 6% max

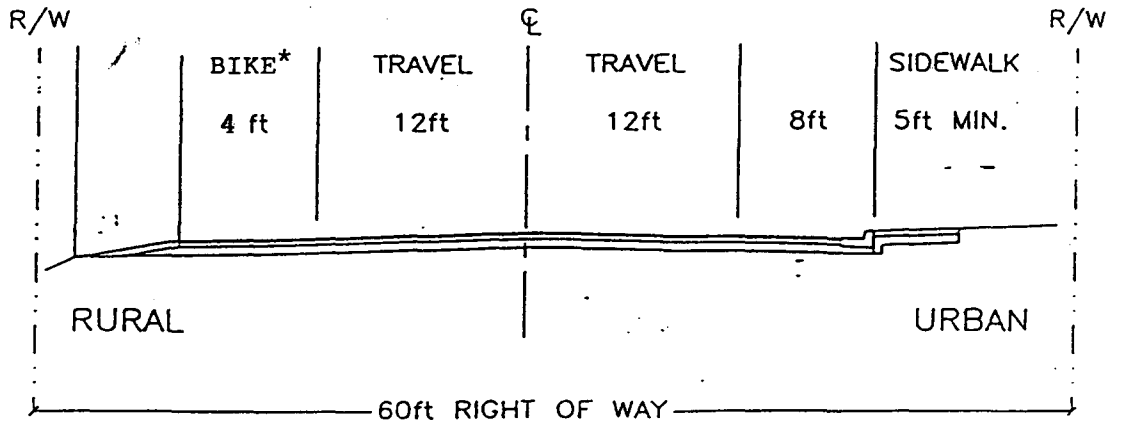
Superelevation = 4% max

Right-of-Way = 80 ft minimum
Design Speed = 45 mph
Profile Grade = 8% maximum
Fill slope = 2 : 1
Cut Slope = 1½ : 1
A.C. Depth = 4 inches

* Bike Lane if Designated

DRAWING II

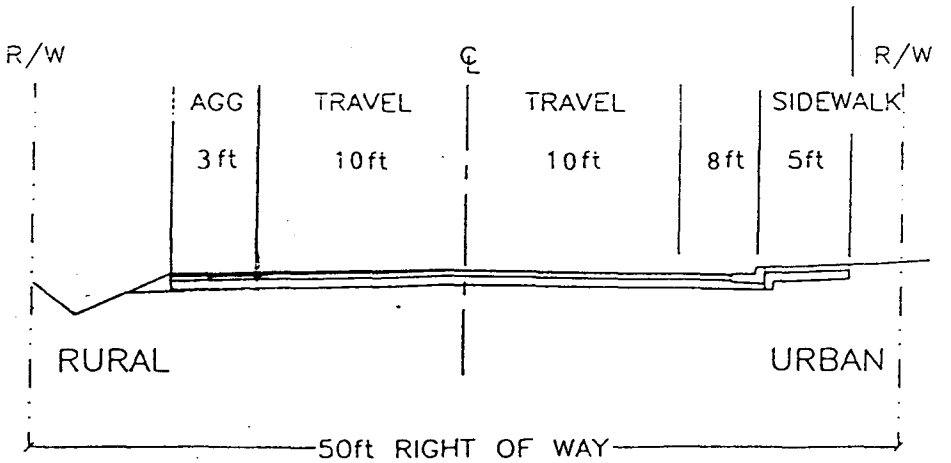
COLLECTOR ROAD



DESIGN SPEED 35 MPH

MAXIMUM GRADE = 10 %
MAXIMUM SUPERELEVATION = 6%
* AGGREGATE IF BIKE LANE NOT DESIGNATED

LOCAL ROAD



DESIGN SPEED 25 MPH

MAXIMUM GRADE = 12%
MAXIMUM SUPERELEVATION = 4%

COLUMBIA COUNTY	
COLLECTOR ROAD LOCAL ROAD ROAD STANDARDS	
DATE JAN. 1996	SHEET NO. 1–2

2) DESIGN EXAMPLE

A.C. STRUCTURAL SECTIONS EXAMPLE (ODOT METHOD)

FIND: STRUCTURAL SECTION (Asphaltic Concrete)

GIVEN: 24 HOUR TRAFFIC MIX (90-2 axle trucks, 45-3 axle trucks, 5-4 axle trucks, 90-5 axle trucks, 0-6 axle trucks, 25 buses)

R = 6 (ODOT Method)

STEP I. Complete the traffic analysis worksheet, Figure I.

STEP II. TC = 9.2 (from Step I).

STEP III. Go to Table II, with R = 6, and TC = 9.2, find CBE = 31.8".

STEP IV. Using CBE factors from Table II, go to CBE factors Table II and find that:

Alternative I

4" "AC" x 2 =	8.0" CBE
2" 3/4"-0 x 0.8 =	1.6" CBE
13" CTB x 1.8 =	23.4" CBE
	33.0" CBE

or we find an alternative structural section could be:

Alternative II

8" "AC" x 2 =	16.0" CBE
2" 3/4"-0 x 0.8 =	1.6" CBE
18" 2"-0 x 0.8 =	14.4" CBE
	32.0" CBE

FIGURE I - TRAFFIC ANALYSIS WORK SHEET

PRESENT ADT
PRESENT NUMBER OF:
- 2 Axle trucks _____
- 3 Axle trucks _____
- 4 Axle trucks _____
- Buses or garbage trucks _____
- 5 Axle trucks _____
- 6 Axle trucks _____

STREET _____
FROM _____
TO _____
D = BxC
E = $\frac{B+D}{2}$
F = One-Way Annual
G = ExF

A	B	C	D	E	F	G
2		1.48			36.5	
3		1.48			119.5	
4		1.48			157.0	
5		1.48			296.0	
6		1.48			325.0	
Buses		1.48			540.0	
					TOTAL =	

TOTAL - AVG. ANNUAL 18 Kip EAL = _____ = TOTAL
18 Kip EAL/day = _____ = TOTAL ÷ 365
20 Year 18 Kip EAL = _____ = TOTAL x 20
Traffic Coefficient, TC = _____

A = Number of axles per truck
B = Number of Trucks

$$TC = 9x \left[\left(\frac{20\ Year\ 18Kip\ EAL}{1,000,000}\right)^{0.119}\right]$$

TABLE II - CRUSHED BASE EQUIVALENT ALL ROADS

TRAFFIC COEFFICIENT	R=4 MINIMUM "CBE" REQUIREMENT	R=8 MINIMUM "CBE" REQUIREMENT	R=12 MINIMUM "CBE" REQUIREMENT	R=18 MINIMUM "CBE" REQUIREMENT	R=22 MINIMUM "CBE" REQUIREMENT	R=26 MINIMUM "CBE" REQUIREMENT	R=30 MINIMUM "CBE" REQUIREMENT
12.0-13.0	42.5"	41.0"	39.0"	36.5"	34.5"	33.0"	31.0"
11.0-12.0	39.0	37.5"	36.0"	33.5"	32.0"	32.0"	28.5"
10.0-11.0	36.0"	34.5"	33.0"	30.5"	29.0"	27.5"	26.0"
9.0-10.0	32.5"	31.0"	29.5"	27.5"	26.5"	25.0"	24.0"
8.0-9.0	29.0"	27.5"	26.5"	24.5"	23.5"	22.5"	21.0"
7.0-8.0	25.5"	24.5"	23.5"	22.0"	21.0"	20.0"	18.5"
6.0-7.0	22.0"	21.0"	20.0"	19.0"	18.0"	17.0"	16.0"
4.8-6.0	18.5"	17.5"	17.0"	15.5"	15.0"	14.0"	13.5"
Below 4.8	16.5"	15.5"	15.0"	14.0"	13.5"	12.5"	12.0"

R = R Value by AASHTO 190

CBE Factors

1.0"	Asphaltic Concrete Wearing Surface or Base	=	2.0"	Aggregate Base
1.0"	Emulsion Treated Base	=	2.0"	Aggregate Base
1.0"	Concrete Treated Base	=	1.8"	Aggregate Base
1.0"	3/4"-0 or 2"-0	=	.8"	Aggregate Base

Use fabric mat where moisture is present in the subgrade, or use fabric mat plus excavate an additional 12" and replace with rock for unusually wet subgrade conditions.

TABLE III - DESIGN SPEED/CENTERLINE RADIUS

Design Speed (MPH)	(e) 2%	(e) 4%	(e) 6%
25	220'	205'	185'
30	325'	300'	275'
35	455'	420'	380'
40	610'	560'	510'
45	795'	730'	660'
50	1010'	925'	835'
55	1300'	1190'	1060'
60	1655'	1500'	1335'

NOTES:

For Table III - right-of-way runoff shall be controlled to prevent concentrated cross flow in superelevated sections.

Urban curves should be designed for a maximum superelevation rate of 0.04. (See AASHTO Policy on Geometric Design of Highways and Streets.)

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3) PORTLAND CEMENT CONCRETE STRUCTURES

Design portland cement concrete structures using the guidelines and requirements of the American Association of State Highway and Transportation Officials design procedures.

Use a twenty 20 year design period.

c) HORIZONTAL ALIGNMENT

Alignments shall meet the following requirements:

Centerline alignment of improvements should be parallel to the centerline of the right-of-way.

Centerline of a proposed street extension shall be aligned

with the existing street centerline.

Horizontal curves in alignments shall meet the minimum radius requirements as shown in Table III.

TABLE IV -/DESIGN CONTROLS FOR CREST VERTICAL CURVES BASED ON STOPPING SIGHT DISTANCE

DESIGN SPEED	K
25	20 - 20
30	30 - 30
35	50.0
40	80.0
45	120.0
50	160.0
55	220.0

L = K x A

A = Algebraic Difference in grades, percent.
L = Length of vertical curve, feet.

TABLE V - DESIGN CONTROLS FOR SAG VERTICAL CURVES BASED ON STOPPING SIGHT DISTANCE

DESIGN SPEED*	K
25	30 - 30
30	40 - 40
35	50 - 50
40	70.0
45	90.0
50	110.0
55	130.0

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TABLE VI -

SIGHT DISTANCE AND VERTICAL CURVE STANDARDS
FOR WET PAVEMENT

Speed of traffic of intersecting roadway (85th percentile speed)	Preferred Intersection Sight Distance	Minimum Stopping Sight Distance	K Values		F Values
			Crest Curve	Sag	Friction Coefficient
20	200	125	10	20	0.39
25	250	150	20	30	0.37
30	300	200	30	40	0.35
35	350	250	50	50	0.33
40	400	325	80	70	0.32
45	450	400	120	90	0.31
50	500	475	160	110	0.30
55	550	550	220	130	0.29

Where the grade is not level, the minimum stopping sight distance shall be determined by the following formula:

$$SSD = 3.68V + \frac{V^2}{30(F+g)}$$

V = Traffic speed (mph) 85th percentile
g = grade, + for uphill, - for downhill
F = coefficient of friction for wet pavement

d) VERTICAL ALIGNMENT

Alignments shall meet the following requirements:

Minimum tangent street gradients shall be one-half (0.5) percent along the crown and curb.

Maximum street gradients shall be 12 percent for local roads, and 10 percent for collectors and 8 percent for arterials.

Roads intended to be posted with a stop sign, shall provide a landing averaging 3 percent grade or less. Landings are that portion of the street within 20 feet of the edge of the intersecting street at full improvement.

Grade changes of more than 2 percent shall be accomplished with vertical curves. Grade changes shall not be closer than 100 feet.

Street grades, intersections and superelevation transitions shall be designed to not allow concentrations of stormwater to flow over the pavement.

Roads intersected by roads not constructed to full improved standards shall be designed to match both present and future vertical alignments of the intersecting roads. The requirements of this manual shall be met for both present and future conditions.

Vertical curves shall conform to the values found in Tables IV and V.

Slope easements shall be dedicated or obtained for the purposes of grading outside of the rights-of-way.

e) INTERSECTIONS

The following specify the minimum requirements for intersections:

The interior angle at intersecting streets shall be kept as near to 90 degrees as possible and in no case shall it be less than 75 degrees. A tangent section shall be carried a minimum of 25 feet each side of intersecting right-of-way lines.

Edge of pavement or curb radii at intersections shall be as shown in Table VII for the various function classifications.

Sidewalk access ramps shall be provided at all corners of all intersections, regardless of curb type, and shall conform to Standard Drawing CS-306.

TABLE VII - TURNING RADII (FEET)

Edge of Pavement/Curb - Minimums*

Street Classification	Maj/Min Arterial Street	Collector	Local Street
Major/Minor Arterial Street	50	35	20
Collector	35	30	20
Local Street	20	20	20

* If bike lane or on-street parking exists, above radii may be reduced by 10 feet.

f) CUL-DE-SACS, TURNAROUNDS

The following specifies the minimum requirements for cul-de-sacs, and turnaround areas.

Cul-de-sacs, and turnaround areas shall be allowed only on local and private roads.

The minimum curb radius for cul-de-sac bulbs shall be 45 feet.

Cul-de-sacs, and turnaround areas shall have a six (6) foot public utility easement or right-of-way outside the pavement or sidewalk.

Optional turnaround shall be as shown in drawing TII.

The minimum curb radius for transitions into cul-de-sac bulbs shall be 25 feet.

g) SIGHT DISTANCE

The sight distance requirements for intersections shall be 10 times the 85th percentile speed of the intersecting street (35 mph traffic speed requires 350 feet of sight distance).

h) ACCESS APPROACHES

The following specifies the minimum requirements for access

approaches:

Access approaches shall conform to Standard Drawings DW-200 through DW-205.

Each access approach must be approved by a separate access approach permit and the access approach Section III of these standards.

Concentrated surface runoff shall not be allowed to flow over driveways, or sidewalks, or roads.

All commercial and industrial driveways shall be constructed to standards set by the Director of Public Works on a site specific basis so as to support the anticipated traffic upon complete development of the area.

i) CURBS AND GRADING

The following specifies the requirements for curbs and cross-slope grading for roads:

Urban roads shall include curbs on both sides.

Rural roads shall have shoulders adjacent to the road at a 2-1/2 percent cross-slope or super rate, whichever is greater, and roadside ditches each side of the shoulders with a minimum side-slope of 2 to 1. Ditches shall be of depth of at least 6 inches below the road base material.

Grading outside the improved areas shall be as follows:

Roads shall be graded no steeper than one and 1-1/2 to 1 cut slope or 2 to 1 fill slope.

Flatter slopes are preferred and may be required by the Road Department if soils are unstable. Slopes exceeding 5 feet in height shall be stabilized by seeding or rocking or mulching.

Retaining walls shall be used only if fill or cut slopes cannot be constructed on property within the right-of-way or property owned by the developer.

Cross-slope of the typical street section shall be a 2 percent crown.

j) SIDEWALKS

The following specifies the requirements for sidewalks:

Sidewalks shall be constructed according to Standard Drawing CS-305.

Where objects within a sidewalk are approved by the Public Works Director to remain, the walk shall be widened to provide clearance equal to the required sidewalk width.

k) GUARDRAILS

The following specifies the minimum requirements for the location and type of guardrails:

ODOT Standard Guardrail Type IIA (Drawing 2126) shall be placed along all sections of new road construction where the fill slope is greater than 10 feet high, within 10 feet of the edge of the traveled surface and steeper than 1½ to 1 or at other locations as required by the County based on information found in the current edition of the AASHTO publication, GUIDE FOR SELECTING, LOCATING, AND DESIGNING TRAFFIC BARRIERS.

Guardrails shall also be required for a distance of 40 feet from each corner of all bridges.

l) TRANSITIONS

Street width transitions from a narrower width to a wider width shall be designed with a 3 to 1 taper. Delineators, as approved by the County, shall be installed to define the configuration.

Street width transitions from a wider width to a narrower width, the length of transition taper shall be determined as follows:

$$L = S \times W$$

Where L = minimum length of taper (ft.)
S = Design speed (MPH)
W = EP to EP offset width

Delineators, as approved by the County, may be installed to define the configuration. Maximum spacing of delineators shall be the numerical value of the design speed, in feet (i.e. 35 foot spacing for 35 MPH).

m) SIGNS

Road signs shall be installed in compliance with the Manual of Uniform Traffic Control Devices.

n) DELINEATION

1) Consistency of Installation of Delineation

Both for the purpose of consistency and to avoid

diminishing effectiveness due to overuse, delineation shall be installed in accordance with the following hierarchy:

(1) Painted yellow centerline

(2) Painted white "fog" lines

(3) Turn and curve warning signs, with or without advisory speed plates

(4) Delineators (reflectors mounted on posts)

(5) Raised reflective pavement markers

(6) Large arrow signs

(7) Chevron alignment signs

Items (1), (2), (4), and (5) may be used on both tangents and horizontal curves whereas Items (3), (6), and (7) may be used only on horizontal curves.

Items (1), (2), and (5) cannot be installed on gravel roads.

2) Selection of Delineation

The selection of delineation to be installed at a particular location shall be based on the hierarchy listed above, the results of an engineering study and the following warrants:

a) Painted yellow centerlines and painted white "fog" lines constitute the standard delineation for paved roads and other types of delineation shall supplement rather than replace these painted lines.

b) Turn and Curve Warning Signs and Advisory Speed Plates

(1) The turn sign is intended for use where an engineering study shows that the recommended speed on a turn is 30 mph or less and is 10 mph less than the legal speed limit.

(2) The curve sign is intended for use where an engineering study shows that the recommended speed on a turn is greater than 30 mph and is 10 mph less than the

the legal speed limit.

(3) The advisory speed plate is intended to supplement the turn and curve signs to give additional warning. It shall not be used alone. It shall show the maximum speed recommenced by an engineering study.

c) Delineators (Reflectors Mounted on Posts)

(1) Delineators shall be installed in accordance with Table VIII:

TABLE VIII

DELINEATOR WARRANTS		
Traffic Volume (ADT)	Road Classification	Install Delineators
0-500	Local	Only in special cases where justified by an engineering study
500-1000	Collector	On curves with a degree of curvature greater than 12 degrees
1000 or more	Arterial	On curves with a degree of curvature greater than 6 degrees

(a) Delineators should be installed only on curves with a central angle of 20 degrees or greater.

(b) Delineators may be installed on curves when raised reflective pavement markers alone have been found to be inadequate. Such situations may occur where a crest vertical curve blocks the driver's view of the pavement markers within the safe stopping sight distance or where the need for additional advance warning is demonstrated by the occurrence of accidents.

(c) Delineators shall not be installed within any urban growth boundary.

(2) Delineators on horizontal curves shall be spaced in accordance with Table IX:

TABLE IX

DELINEATOR SPACING ON HORIZONTAL CURVES

Degree of Curve	Spacing on Curve-feet	Spacing in Advance of Curve-feet	
		First-Space	Second-Space
6	120	200	350
7-8	100	180	300
9-10	90	160	270
11-12	80	140	240
13-18	70	130	210
19-25	60	110	180
26-up	50	100	150

(a) For curves falling between the values listed, use the spacing given for the next sharper curve.

(b) To clear driveways, crossroads, etc., or for required adjustments at ramps and at intersections, either vary placement of that delineator up to ⅛ of spacing shown, or if that will not work, eliminate that delineator.

(c) On curves with central angles greater than 40 degrees, installation of delineators should be terminated at the location where deflection reaches 40 degrees.

(3) The Public Works Director shall be consulted on the installation of delineators on substandard roadway sections, particularly where ditches are narrow and where delineators would hamper maintenance operations.

(4) Where warranted, delineators should be installed on both sides of horizontal curves with white reflective sheeting or reflectors installed on the side of the delineator visible to the driver's right.

(5) The use of large arrow signs or chevron signs should be considered on all curves where the degree of curvature is greater than 30 degrees.

(d) Raised Reflective Pavement Markers

(1) Raised reflective pavement markers shall be installed only in special situations where justified by an engineering study.

(2) Pavement markers shall be spaced at the following intervals:

(a) Rural areas: 80 feet apart on tangents and 40 feet apart on curves.

(b) Urban areas: 40 feet apart on tangents and curves.

(3) Where pavement markers are to be installed only on a curve, markers shall also be installed on the approach tangents for a distance of 400 feet in each direction from the curve. On these tangents, the marker spacing shall be the standard 80 feet.

(4) Pavement markers shall not be installed in areas where snow removal operations are expected to be necessary. In the absence of site-specific records, markers shall not be installed at elevations greater than 800 feet above mean sea level.

(e) Large Arrow Sign

A large arrow sign is intended to be used to give notice of a sharp change in roadway alignment. It should be used to mark curves that have a high accident history where raised reflective pavement markers or delineators do not provide adequate warning to motorists. The large arrow sign shall be erected on the outside of the curve in line with and at right angles to approaching traffic. It should be visible for at least 500 feet.

(f) Chevron Alignment Sign

The chevron alignment sign may be used as an alternate or supplement to delineators and the large arrow sign. The chevron alignment sign is intended to be used to give notice of a sharp change in roadway alignment and to provide additional emphasis and guidance for vehicle operators. Chevron alignment signs are normally installed in groups of three of more with spacing such that drivers always have two in view as they proceed around the curve. Chevron alignment signs are installed on the outside of a curve at right angles to approaching traffic and the first two should be visible for at least 500 feet.

o) BRIDGES

All vehicular bridges on public roads shall be designed to carry at least HS 25 vehicle loading, plus impact. (See Standard Drawing No. HS 25.)

Structural and geometric design of bridges, including width, shall be in accordance with the current standards in use by ODOT. These include, but are not limited to, Standard Specifications for Highway Bridges (AASHTO). Minimum bridge width shall normally be equal to the total width of the travel lanes plus the shoulders but in no case shall be less than 28 feet.

p) UTILITIES

Utilities shall be located outside of the paved road to avoid future cuts in paved roads. On all phased (interim) road improvements, the necessary utilities shall be stubbed across the interim improvement to assure cuts are not necessary when the road is expanded to its full width.

Underground utilities intended to provide direct service to adjacent properties with future connections shall not be located in the full-width paved section of a street to be constructed. If all service connections are installed and extended beyond the full-width section prior to paving the street, underground utilities can be located in the paved section. Valves and manholes shall not be located in any pavements.

Underground utilities being constructed along existing paved streets shall not be located under the existing pavement

unless approved by the Road Department. Underground util. that must cross an existing paved street shall not be installed by any method which cuts the pavement, unless approved by the County.

Underground utilities shall be buried a minimum depth of 30 inches, as measured from finished grade to top of utility. Utilities in ditch lines shall be located 30 inches below ditch grade.

Street lights shall be located as required to provide proper illumination, but shall not physically or visually interfere with vehicle or pedestrian traffic.

3) DRAINAGE DESIGN

a) GENERAL

The following facility design requirements are intended to protect the public health, safety and welfare from damage due to flooding. Provisions must be made to provide for surface drainage on and crossing the development. A specific level of protection from all damage is encompassed in this chapter. Beyond that level of protection, additional measures are specified which should minimize damage.

Provisions must be made for gravity drainage of roofs and foundation drains for new homes and offices. In urban developments, these drains shall be piped to the street gutter or directly to the storm drain system. The connection to the street gutter must be through a 3 inch plastic pipe set in the curb during construction or cut through an existing curb, see Standard Drawings CS-300 and CS-301.

These requirements shall apply to all storm drainage facilities in existing and proposed County Road rights-of-way, public road rights-of-way, public drainage easements and tracts of common ownership in unincorporated areas. Storm drainage systems include, but are not limited to: inlets, pipes, ditches, creeks, rivers and runoff detention facilities.

Within public rights-of-way, where there are no curbs, there shall be culverts placed under driveways to provide for drainage as needed. The location, type and size of the culvert shall be specified by the Director of Public Works. Minimum diameter culvert shall be 12 inches and minimum length shall be 30 feet.

Prior to work within a wetland or waterway under the jurisdiction of the State of Oregon, developers of property are advised to consult with the Division of State Lands and the Oregon Dept. Of Fish and Wildlife for permitting requirements.

b) SYSTEM COMPONENTS

1) CATCH BASINS, CURB INLETS AND GUTTER INLETS

The spacing between catch basins and curb or gutter inlets shall be as required from the hydraulic design. For all other roads, gutter flow shall not run in the travel lane or deeper than 4 inches against a curb. Catch basins and gutter inlets shall be of sufficient size to accept the inflows without backing up water on the street.

Catch basins with curb inlets or gutter inlets shall be provided just prior to curb returns on streets with a centerline gradient of 3 percent or more and a street gutter drainage run of 100 feet or more.

Minimum depth shall be pipe diameter plus 12 inches.

Catch basins with curb inlets, either standard or oversize, shall be used on all streets with curbs or sidewalks.

Catch basins with curb inlets or gutter inlets shall be installed at the low point of all sag vertical curves in roads.

2) PIPES AND CULVERTS

Tongue and groove joints are preferred and shall be used when commercially available in the size required. Joints used shall meet the manufacturer recommendations.

All pipe and culvert type shall be as required by size, loading, bedding and trench conditions.

Minimum cross culvert diameter shall be 12". Minimum storm drain diameter shall be 10 inches.

No curved storm drain pipes shall be allowed by joint displacement or deflection if it results in a joint that allows the adjacent soil material to enter the pipe. Joints with rubber gaskets shall be used for all curved storm drains. Minimum radii shall be as shown in Table XIX.

All pipe and culvert outlets with exit velocities in excess of 4 feet per second shall be examined with respect to soil type to guarantee adequate erosion control. Where grades require, all end pipes shall be supported by tie downs, end walls or aprons, etc., to prevent the separation and dislodging of pipe sections.

3) MANHOLES

Manholes shall have a maximum spacing such that no pipe has a continuous run of 400 feet without access from open end pipe or manhole.

Manholes, shall be required at, but not limited to, the following locations:

Abrupt change in vertical grade or horizontal alignment of storm drain pipes.

Change in size or abrupt change in elevation of storm drain pipes.

Uppermost extent of storm pipe not open (daylighted) to receive ditch or other open conveyance flows. Cleanouts are not allowed in this situation.

Manholes or catch basins with pipe horizontal alignment changes of more than 30 degrees in angle shall have the outlet pipe invert at least two-tenths (0.20) of a foot in elevation lower than all inflow pipe inverts, in addition to the normal grade crossing the manhole.

Manholes shall have two hole lids; in some locations, tamper proof lids may be required. Heavy duty frames and covers shall be used on all manholes.

Manholes and catch basins deeper than 4.0 feet, measured from top of frame to flowline, shall have steps installed.

Offset manholes shall be used with pipes larger than 36 inches.

4) DITCHES AND CHANNELS

Proposed roadside ditches shall be properly sized to pass all required flows, have a maximum depth of no more than 3 feet as measured from the shoulder of the road, side slopes no steeper than 2 to 1 and have a minimum flow velocity of 3 feet per second when flowing full. All other ditches shall be properly sized to pass all required flows but are not limited to the

geometric restrictions of roadside ditches. Any proposed roadside ditch improvement that does not meet this requirement above shall be piped.

All proposed or modified channels shall have adequate erosion control provisions to prevent damage to the shoulder of the adjacent road or the water course channel. Side slopes no steeper than 2 to 1 will be allowed unless preapproved by the public works director.

No protruding pipes, culverts or other structures which reduce or hinder the flow characteristics of the ditch channel or creek will be allowed.

5) STANDARD DRAWINGS

Drainage structures shall conform to the applicable Standard Drawings in this Manual. Materials for all structures shall be as specified on the Standard Drawings. Allowable materials for pipes and culverts are specified in the HYDRAULICS section of this chapter.

c) HYDROLOGY

The following specifies the minimum requirements for the hydrologic criteria necessary for design of storm drains and culverts:

1) Methodology

The Rational Method (Q=CIA) is the standard method for calculations related to the peak discharge and other related hydrologic information for drainages of less than 400 acres. For reference to the concepts and theories of the Rational Method, see "The American Society of Civil Engineers", Design and Construction of Sanitary and Storm Sewers or others. If other hydrologic methods are used, calibration or comparison to the Rational Method is required prior to acceptance by the County.

Drainage Basin Areas (A)

The drainage area used in the design or analysis of storm drainage facilities shall include all areas that are or will be tributary (both on and off the project site) to the location under consideration.

Runoff Coefficients (C)

The runoff coefficients used in the design or analysis of storm drainage facilities shall vary depending on existing land uses and the maximum potential zoning of all land tributary to the location under consideration. Table VII shows minimum acceptable values for the coefficients. The composite runoff coefficients shall be the acceptable form and standard for this parameter.

In some instances, the use of individual characteristic runoff coefficients is more appropriate than composite coefficients. Project-specific composite coefficients can be calculated from an area-weighted-average basis using characteristic coefficients. Table VIII shows minimum acceptable values for the coefficients. The characteristic runoffs coefficients shall only be used when required by the County.

2) Rainfall Intensity (I)

The rainfall intensity used in the design and analysis of storm drainage facilities shall vary depending on the time of concentration for the drainage basin that is

tributary to the location under consideration. Tables XII and XIII show a tabular representation of the rainfall intensities for the 2, 5, 10, 25, 50 and 100 year storm events as a function of time of concentration. Interpolate for values not shown.

TABLE X - COMPOSITE RUNOFF COEFFICIENT CHART

Existing Land Use or Maximum Potential Zoning		Values of coefficient, C		
		Average Gradient of Terrain		
Use	Zone*	Less than 2%	2% to 7%	More than 7%
Commercial or Industrial	4	0.70	0.80	0.90
Multiple Family	3	0.60	0.65	0.70
Duplexes, Single Family	2	0.50	0.55	0.60
Single Family & Schools	1	0.40	0.45	0.50
Parks, golf courses, Agricultural or undeveloped	5	0.20	0.25	0.30

* These are to be used as a guide in evaluating undeveloped land based on current zoning and where no information in available defining a proposed development.

ZONE	PRIMARY LAND USE DISTRICT	
1	R-5	(Residential 5 units per acre)
1	R-6	(Residential 6 units per acre)
2	R-9	(Residential 9 units per acre)
3	R-15	(Residential 15 units per acre)
3	R-24	(Residential 24 units per acre)
3	R-25	(Residential 25 units per acre)
4	NC	Neighborhood Commercial
4	CBD	Community Business District
4	GC	General Commercial
4	OC	Office Commercial
4	IND	Industrial
2	INS	Institutional
5		Undeveloped, Rural
4	SID	Special Industrial District

TABLE XI - CHARACTERISTIC RUNOFF COEFFICIENT CHART

Land Characteristic	Values of coefficient, C		
	Average Gradient of Terrain		
	Less than 2%	2% to 7%	More than 7%
Asphalt or concrete	0.85	0.90	0.95
Roofing	0.85	0.90	0.95
Grassy surface	0.20	0.25	0.30
Bare soil	0.30	0.35	0.40

TABLE XII

RAINFALL INTENSITIES FOR NORTH COLUMBIA COUNTY

TIME OF CONCENTRATION (MIN)	Rainfall Intensity (inches/hr)					
	STORM EVENT - YEAR/(PROBABILITY)					
	2 (50%)	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
0	2.50	3.30	3.80	4.20	5.00	5.50
5	2.50	3.30	3.80	4.20	5.00	5.50
10	1.50	2.20	2.80	3.25	3.80	4.30
15	1.25	1.80	2.20	2.60	3.10	3.50
20	1.00	1.40	1.75	2.10	2.50	2.80
30	0.80	1.10	1.30	1.60	1.80	2.10
40	0.65	0.95	1.10	1.35	1.55	1.80
50	0.55	0.80	0.95	1.15	1.30	1.55
70	0.50	0.70	0.85	1.00	1.15	1.30
100	0.45	0.60	0.75	0.87	1.00	1.10
180 or more	0.40	0.50	0.60	0.75	0.90	0.95

North Columbia County is that area northerly of Nicolai, Anlicker, Meissner, Apiary, Highways 47 and 202

TABLE XIII

RAINFALL INTENSITIES FOR SOUTH COLUMBIA COUNTY

Rainfall Intensity (inches/hr)

TIME OF CONCENTRATION (MIN)	STORM EVENT - YEAR/(PROBABILITY)					
	2 (50%)	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
0	1.90	2.50	3.00	3.40	4.00	4.50
5	1.90	2.50	3.00	3.40	4.00	4.50
10	1.30	1.70	2.20	2.50	3.00	3.50
15	1.10	1.40	1.80	2.10	2.50	2.90
20	0.90	1.20	1.50	1.80	2.10	2.40
30	0.75	0.95	1.20	1.40	1.65	1.90
40	0.60	0.75	1.00	1.15	1.30	1.60
50	0.55	0.70	0.82	1.00	1.15	1.35
70	0.45	0.55	0.70	0.82	0.95	1.10
100	0.40	0.45	0.55	0.67	0.75	0.90
180 or more	0.35	0.40	0.50	0.60	0.70	0.85

South Columbia County is that area southerly of Nicolai, Anlicker, Meissner, Apiary, Hwy 47, and Highway 202.

TABLE XIV

OVERLAND FLOW TRAVEL TIME OF CONCENTRATION

(MIN)

LENGTH OF OVERLAND FLOW (FT)	AVERAGE GRADIENT OF TERRAIN														
	1% or less			2%			4%			7%			10% or more		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
50	11	6.5	4	10	5.5	3	8.5	4	2	7.5	3.5	2	7	3	2
100	15	8.5	5	13	7.5	4	11.5	6.5	3	10	5.5	2	9	5	2
200	20	11	6	17	9.5	5	15	8.5	4	12	7.5	3	13	7	2
300	23	13	7	20	11.5	6	18	10.0	5	16	9	4	14	8	3
400	16	15	8	22	12.5	6.5	20	11.0	6	18	10	5	16	9	4
500	28	16	9	24	14.0	7.0	22	12.5	6.5	19	11	6	18	10	5
700	33	18	10	28	16.0	8.0	25	14.0	7.5	22	12	6.5	20	11	6

This table is to be used for Sheet Flow conditions only.

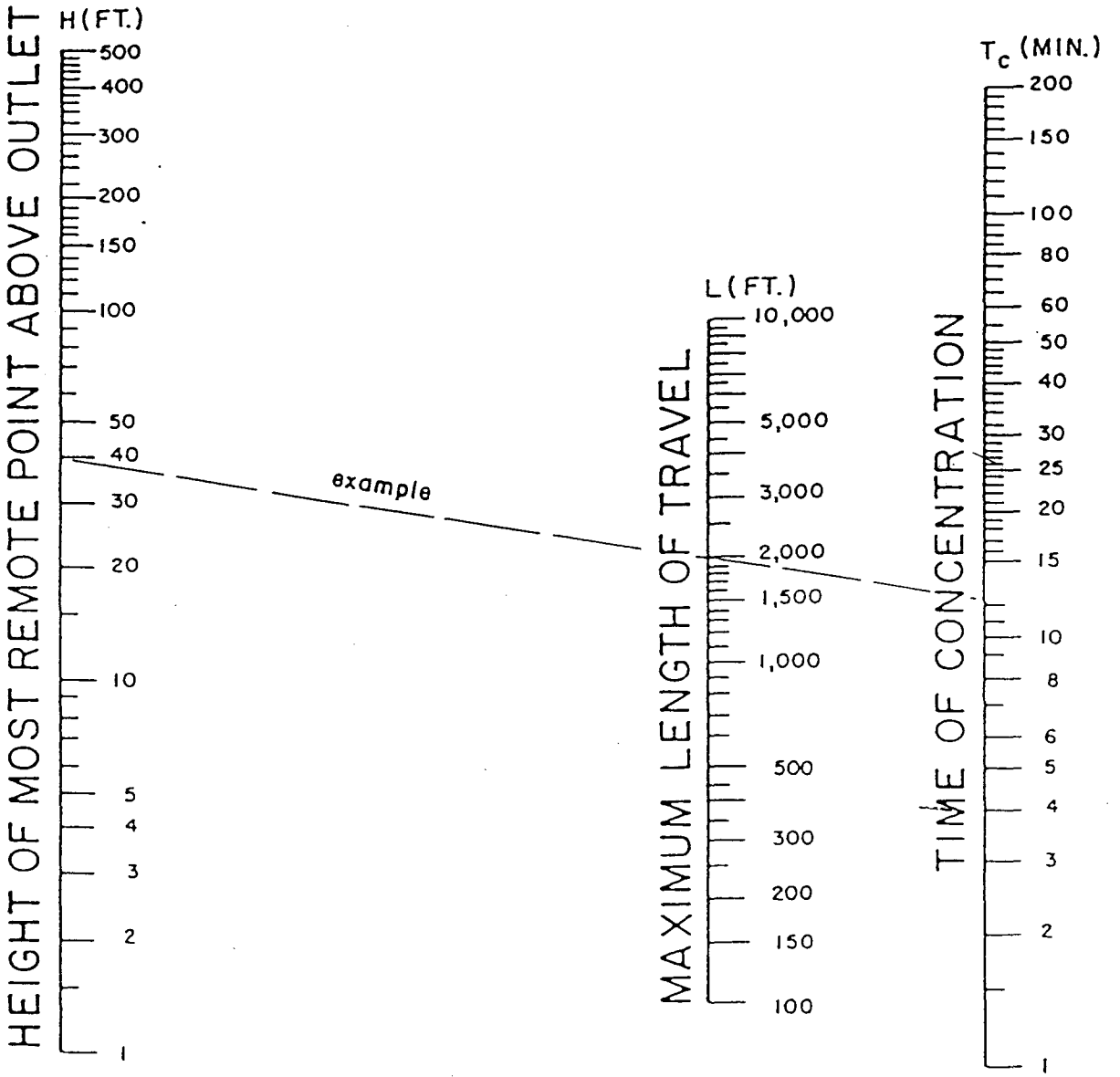
SURFACE TYPE:

A Grassy
B Bare Soil
C Rooftop/Paved

FIGURE II

TIME OF CONCENTRATION

NOTE: USE NOMOGRAPH T_c FOR NATURAL BASINS WITH WELL DEFINED CHANNELS.



KIRPICH, P.Z., "TIME OF CONCENTRATION OF SMALL AGRICULTURAL WATERSHEDS", CIVIL ENGINEERING, 29, 60, 1959.

The time of concentration shall be calculated as the time required for all portions of the drainage basin to contribute to the location under consideration assuming the most extensive land use possible. This time is the addition of the travel time for overland flow from the most remote part of the drainage basin to the headwaters of the conveyance system. For drainage basins not yet fully developed, the anticipated conveyance system must be incorporated to generate the shortest possible time of concentration.

Table XI shows the acceptable values for the overland flow travel time. For residential developments use the nominal travel time of 10 minutes from roof to gutter or use Table XIV; whichever is less.

Figure II may be used to compute time of concentration in rural areas (ref. Table X).

The travel time in a conveyance system shall be based on the full-flow velocity of the conveyance facilities.

The benefits of upstream detention systems shall not be accounted for in determining the time of concentration for any storm drain system.

3) Design Event

The following specifies the design event for sizing storm drainage facilities:

All conveyance components (such as catch basins, curb inlets, manholes, pipes, culverts, ditch inlets, ditches, swales, etc.) shall be designed to provide a level of protection from all damages due to flooding for a 25 year event. Beyond this level of protection, additional measures shall be designed to minimize the potential damage incurred as stated under HYDRAULICS.

Design flows shall be based on the maximum runoff created by existing land uses, the maximum potential zoning (according to the Comprehensive Plan) or a combination thereof.

d) HYDRAULICS

1) GENERAL

The following specifies the minimum requirements for various hydraulic criteria necessary for the design and construction of storm drains:

All conveyance components shall be designed to provide a level of protection from all damage due to flooding for the 25 year storm event. Hydraulically, "a level of protection from all damage due to flooding" means that all surface runoff waters must pass through a conveyance system without flooding streets, rights-of-way, public and private property and other items of value not normally publicly acceptable to be flooded. Surcharge in below-ground facilities shall be allowed provided that it will not cause surface flooding. Surcharge in below-ground facilities shall not be allowed if it will cause subsurface seepage flooding in any portion of a habitable structure, including the below-floor crawl spaces.

Beyond the level of protection stated above, additional measures must be designed to minimize the potential damage incurred for more intense rainfall. Hydraulically, "additional measures must be designed to minimize the potential damage incurred" means that surface runoff may surcharge the flood and cause damage, but this damage must be minimized as far as practicable. This level of minimization shall include making all attempts, as far as practicable, to reduce potential damage due to flooding in regards to loss of life, public safety, public and private property, structures and other items of value. Methods to minimize potential damage may include, but are not limited to, site grading, overflow structures (such as ditches), etc.

The benefits of upstream detention systems shall not be accounted for in designing a conveyance system.

2) IMPACT CONSIDERATIONS

Overall System Design Considerations.

Improvement projects shall address more than just the on-site drainage concerns. The off-site concerns, both upstream and downstream of a project, are critical to the development of proper improvements. The requirements in this section address most of those concerns.

Impacts on Upstream Off-site Property.

Modifications to the existing on-site storm drainage facilities shall not restrict flows creating backwater onto off-site property to levels greater than the existing situation.

Impacts on Downstream Off-site Property.

Proposed storm drainage facility modifications shall not

move the location of the runoff's outflow without executing properly recorded agreements with all affected downstream property owners.

Proposed concentration of outflows shall not be allowed without executing properly recorded agreements with all affected property owners between the release point and an existing defined receiving conveyance facility such as a pipe, culvert, ditch, creek, river, etc.

Agreements described above shall include, but are not limited to, execution of the proper easements in favor of the public and construction of conveyance facilities satisfactory to all property owners and the County.

Siltation of receiving streams due to construction of streets, drainage facilities and other utilities shall be prevented through the use of temporary on-site siltation detention systems. Such systems shall be subject to County approval. Erosion control plans and details may be required by the County as part of regular plan submittal.

Upstream Impacts of On-site Property.

Storm drainage facilities shall be designed and constructed to accommodate all flows generated from upstream off-site property (assuming no upstream detention) for the most extensive land-use possible, be it the existing land-use, the maximum potential zoning of the off-site property or a combination thereof.

Downstream Impact of On-site Property.

The design of storm drainage facilities shall take into account the impact of downstream restrictions on the project site. These restrictions that create on-site backwater shall either be removed by the development or their impact incorporated into the on-site design.

3) FLOW CAPACITIES

The following describes the detailed procedures required for the calculation of flow capacities of drainage facilities. This section also specifies the capacities for most common hydraulic components. If hydraulic components other than those discussed in this section are proposed or encountered, the method of hydraulic calculations shall be subject to County approval. If other methods of hydraulic calculations are used for components discussed in this section, calibration or comparison to the methods in this section is required

prior to acceptance by the County.

The maximum acceptable intake flowrate for catch basins, curb inlets and gutter inlets shall be as shown in Table XII.

The maximum acceptable intake flowrate for area drains shall be as shown in Table XIII.

Pipes and Culverts

For inlet control, pipe and culvert capacities shall be shown in Table XV. This inlet control table assumes worst case entrance condition. For various improved entrances, the Oregon State Highway Division, Hydraulics Manual is acceptable for capacity determinations.

For outlet control, Manning's Formula with proper consideration for entrance, exit and other minor losses shall be the accepted method of calculation. See Table XIV for the acceptable values of Manning's "n" and minor loss coefficients.

Ditches and Creeks (open channels)

For inlet control (upstream control), flow depths and elevations shall be based on critical depth calculations.

For outlet control (downstream control), the Standard Step Method using Manning's Formula with proper consideration for entrance, exit, contraction, expansion and other minor losses shall be the accepted method for calculating flow elevation profiles. See Table XIV for the acceptable values of Manning's "n" and minor loss coefficients.

TABLE XV - CATCH BASIN & CURB INLET CAPACITIES

Structure Style	Maximum Allowable Intake Flowrate (cfs) Centerline Street Gradient (%)		
	0 (SAG)	Less than 6	6 or more
* Standard Catch Basin w/pavement taper	N/A	3.0	N/A
* Oversize Catch Basin w/pavement taper	8.0	4.5	N/A
Standard Curb Inlet w/pavement taper	N/A	3.5	2.5
Oversize Curb Inlet w/pavement taper	8.0	5.0	3.5
Gutter Inlet 2 1/2A w/pavement taper 2 ½"	4.2	N/A	N/A
Gutter Inlet 4A w/pavement taper 2 ½"	6.7	N/A	N/A

N/A - Not allowed in this situation.

* - Not allowed on streets with curbs.

TABLE XVI - AREA DRAIN, TYPE II CAPACITIES

	Grate Angle 30°									
Hydraulic Head (ft.)*	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Flowrates CFS	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

* Measured from bottom of grate to headwater.

TABLE XVII - FRICTION AND MINOR LOSS COEFFICIENTS

Friction Coefficients

Conveyance Facility	Manning's n (FT1/6)
Concrete Pipe	0.012
Polyvinyl Chloride (PVC) pipe	0.008
Corrugated Polyethylene (CPE) pipe	0.026
Ductile or cast iron	0.014
Corrugated aluminum or steel pipe	
Annular (2-2/3" x ½")	0.025
Helical (2-2/3" x ½")	
not full flow	0.025
10", 12" flowing full	0.013
18" flowing full	0.015
24" flowing full	0.017
36" flowing full	0.019
48" flowing full	0.021
54" flowing full	0.022
Annular (3" x 1")	0.025
Helical (3" x 1")	
not full flow	0.025
36" flowing full	0.020
48" flowing full	0.020
54" flowing full	0.021
60" flowing full	0.021
66" flowing full	0.021
72" flowing full	0.022
Fully paved	0.012
Earth ditches; straight, uniform, clean	0.025
Earth ditches; rough, grass	0.035
Stream channels; fine gravel, straight grass	0.030
Stream channels; course gravel, straight, clean banks	0.035
Stream channels; fine gravel, slightly winding, grass	0.045
Stream channels; fine gravel, slightly winding, weeds	0.048
Stream channels; fine gravel, slightly winding, obstructions	0.055
Stream channels; obstructed, very winding	0.080

For overbank flooding and other characteristics refer to
Ven Te Chow's, Open-Channel Hydraulics

TABLE XVII - FRICTION AND MINOR LOSS COEFFICIENTS (CONTINUED)

Minor loss coefficients

Situation	k-factor
Pipes:	
Entrance	0.5
Exit	1.0
Expansion	1.0
Contractions	0.5
10° bends	0.04
20° bends	0.10
30° bends	0.15
45° bends	0.25
60° bends	0.35
90° bends	0.50
Open channel:	
Abrupt contractions	0.6
Abrupt expansions	0.8
Gradual contractions	0.1
Gradual expansions	0.3
Abrupt direction changes	0.4
Gradual directions changes	0.2

TABLE XVIII - PIPE/CULVERT CAPACITIES FOR INLET CONTROL

Flowrates, Q (cfs)

Hydraulic Head (feet)*	Diameter (in)							
	10	12	15	18	21	24	27	30
1.00	2.1	2.4	-	-	-	-	-	-
1.25	2.4	3.3	4.2	-	-	-	-	-
1.50	2.7	3.8	5.5	6.7	-	-	-	-
1.75	3.0	4.2	6.3	8.5	9.8	-	-	-
2.00	3.3	4.6	6.9	9.5	12.3	13.6	-	-
2.25	3.6	5.0	7.5	10.4	13.6	16.9	18.3	-
2.50	3.8	5.3	8.1	11.2	14.8	18.5	21.5	23.8
3.00	4.2	6.0	9.1	12.8	16.9	21.4	26.2	31.2
3.50	4.6	6.5	10.0	14.1	18.8	23.9	29.5	35.4
4.00	5.0	7.1	10.8	15.3	20.5	26.2	32.4	39.2
4.50	5.3	7.6	11.6	16.5	22.0	28.3	35.1	42.6
5.00	5.6	8.0	12.4	18.5	23.5	30.2	37.7	45.7
6.00	6.2	8.9	13.7	19.5	26.2	33.8	42.2	51.5
7.00	6.7	9.6	14.9	21.3	28.6	37.0	46.4	56.6
8.00	7.2	10.4	16.0	22.9	30.9	40.0	50.2	61.4
9.00	7.7	11.0	17.1	24.4	33.0	42.8	53.7	65.8
10.00	8.1	11.6	18.1	25.9	35.0	45.4	57.0	69.9
12.00	8.9	12.8	19.9	28.5	38.6	50.1	63.1	77.4
14.00	10.1	14.4	22.4	32.1	43.5	56.6	71.3	87.6

*Measured from invert to headwater.

TABLE XVIII - PIPE/CULVERT CAPACITIES FOR INLET CONTROL (CONTINUED)

Hydraulic Head (feet)*	Flowrates, Q (cfs) Diameter (in)						
	36	42	48	54	60	66	72
3.00	37.6	-	-	-	-	-	-
3.50	48.1	55.3	-	-	-	-	-
4.00	53.8	69.4	77.2	-	-	-	-
4.50	58.9	76.8	95.6	104	-	-	-
5.00	63.6	83.5	105	127.0	135.0	-	-
5.50	68.0	89.7	113	138	159	171	-
6.00	72.2	95.4	121	148	177	177	201
7.00	79.8	106	135	167	200	236	272
8.00	86.7	116	148	184	222	262	304
10.00	99.2	133	171	213	259	308	360
12.00	110	148	191	239	391	348	408
15.00	125	169	218	273	334	400	471

*Measured from invert to headwater.

TABLE XIX - TONGUE & GROOVE PIPE ON CURVED ALIGNMENT

Pipe Diameter in Inches	**MINIMUM RADIUS OF CURVATURE in FEET									
	*Length of pipe Section - in FEET									
	3 ½	4	6 ½	7 ½	8					
10	128									
12	149		277							
15		208		390						
18		245		460	121					
21		283		530	160	176	192			
24		320		600	195	215	234	254	273	292	311
27		357			230	253	276	299	322	346	369
30		395			265	292	318	345	371	398	425
36		469			300	330	360	390	420	450	480
42		560			335		402		469		536
48		635			370		444		518		592

NOTE: **1. Table is based on a maximum joint deflection of ⅜ inch.
*2. Check with Manufacturer on pipe lengths available.
3. Table is based on R=32xDxL as derived by CPAV Bulletin U-11 and Supplement of 4/15/69. R=min radius, in feet D=pipe o.d., in feet L=pipe section, in feet.

4) MATERIALS

Pipes and culverts may be constructed of the following materials:

- concrete
- asphalt coated corrugated steel
- ADS
- polymer coated corrugated steel
- corrugated aluminum
- polyvinyl chloride
- corrugated polyethylene
- plastic or polyvinyl chloride
- ductile iron/steel/aluminum

The material used shall be adequate to carry anticipated dead and live loads within deflection limits specified by the manufacturer. All pipes and culverts shall have a minimum design service life of 75 years based on manufacturer recommendations and be per the applicable ASTM (American Society of Testing Materials) standards. All pipes and culverts shall be strong enough to withstand the stresses created by cleaning equipment. Installation techniques shall be documented and follow manufacturers recommendations.

Pipes of different metals shall be connected together properly to avoid damaging chemical interaction between the two metals.

5) MISCELLANEOUS DRAINAGE REQUIREMENTS

All portions of the storm drainage system shall preferably be located in rights-of-way, but if necessary, may be located in easements or common tracts.

All common tracts for open drainage facilities such as ditches and creeks shall be 10 feet wider than the width necessary to carry the flows of a 10 year storm. This additional width shall be on one side only, be usable for maintenance equipment and have adequate access to a right-of-way.

Easements and Common Tracts that are not straight shall

provide space at the corners adequate to allow maintenance vehicles to negotiate the required turns.

E. SURVEYING

1) GENERAL

This document, Section 105 of the APWA specifications and ORS 209.140-150, define the requirements for protection of existing survey monuments during any construction and setting new survey monuments following construction of new streets and roads.

2) EXISTING SURVEY MONUMENTS

Whenever an existing section corner, quarter corner or donation land claim corner monument or accessory, appears to be in danger of damage or destruction by construction, the County Surveyor shall be notified in writing, not less than 10 working days prior to construction. The County Surveyor shall reference the monument prior to construction and replace it following construction. The County Surveyor shall be reimbursed for all expenses from said replacement by the party responsible for the construction.

As per ORS 209.150, no person shall willfully or negligently remove, destroy or deface <u>any existing survey monument</u>. If damage cannot be avoided, the monument shall be referenced and replaced , under the direction of a Registered Professional Land Surveyor, according to state law. A copy of the field notes referencing such monuments shall be provided to the County Surveyor. Failure to comply with this provision is subject to penalty according to ORS 209.990.

3) NEW SURVEY MONUMENTS

Centerline monuments, as shown on Standard Drawing M-404, shall be installed at all centerline intersections of streets (including intersections with existing streets), P.C.'s and P.T.'s of each curve, beginning and end of each road, and at all centers of cul-de-sacs and turnarounds or as required by the County Surveyor to sufficiently monument the right-of-way. Monuments shall be set by a registered Professional Land Surveyor or by the County, at the option of the County. If monuments are set by a registered Professional Land Surveyor, they shall file a record of survey complying with ORS 209.250 and any additional requirements set forth by the County Surveyor. If a monument box is used, or required to be used by the County, it shall not be less than eight (8) inches inside diameter and shall be approved by the County Surveyor before its installation.

F) STRUCTURAL DESIGN

1) GENERAL

Structures not included in the Standard Drawings of this document shall be designed and constructed in accordance with the requirements of the Structural Design Section of the Oregon State Highway Division of ODOT. These Standards are referenced in ODOT's BRIDGE DESIGN MANUAL AND ACCOMPANYING STANDARD DRAWING, STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, and STANDARD DRAWINGS FOR DESIGN AND CONSTRUCTION.

The project special provisions shall specify the APWA or ODOT requirements for bridges and other structures that apply to the specific project.

G) DESIGN MODIFICATIONS

1) GENERAL - REQUEST TO MODIFY SPECIFICATIONS/STANDARDS

To seek approval, non-compliant specifications/standards must be sent through the following process. It is to be noted that if the requested modification involves public safety, the County will rule in the direction of safety.

2) MODIFICATION PROCESS

a) SUBMITTAL

Requests to modify shall be submitted in writing to the County Public Works Director on the application form (Exhibit 5). This written request shall state the desired modification(s), the reason(s) for the request(s) and a comparison between the specification(s) or standard(s) and the modification(s) as far as performance, etc.

Any modification or variance of these standards should be documented and reference nationally accepted specifications/standards. The use thereof shall not compromise public safety or the intent of the County's standards.

b) REVIEW

The request to modify shall be reviewed by the County Public Works Director, County Counsel, Land Development Services Staff, and appropriate Fire Services Officer. The Public Works Director shall make a report to the Board of County Commissioners, who shall make one of the following decisions:

Approve as is,

Approve with changes, or

Deny with an explanation.

Approval of a request shall not constitute a precedent.

c) CRITERIA FOR MODIFICATION OF SPECIFICATIONS/ STANDARDS

The County Public Works Director may grant a minor modification to the adopted specifications or standards, without requiring the process of steps a and b above, when any one of the following conditions are met:

The specification or standard does not apply in the particular application.

Topography, right-of-way or other geographic conditions impose an economic hardship on the applicant and an equivalent alternative which can accomplish the same design is available.

A minor change to a specification or standard is required to address a specific design or construction problem, which, if not enacted, will result in an undue hardship.

Minor modifications include modifications to the requirement for plan submittals, cut or fill slopes, minor shoulder narrowing if other delineation is provided, and alternative drainage facilities and designs. Major modifications not subject to appeal by the Public Works Director include pavement width, design speed, grade, engineering requirements, right of way, or drainage capacity.

H) CONSTRUCTION SPECIFICATION

1) MATERIALS AND CONSTRUCTION

All materials and construction shall comply with the current version of ODOT Standard Specifications for Highway Construction unless otherwise specified herein.

2) CONSTRUCTION INSPECTION

a) GENERAL

All public construction falling under the jurisdiction of the County shall be inspected by an Oregon Registered Professional Engineer or a qualified individual under the supervision of an Oregon Registered Professional Engineer. The Road Department will not authorize work to begin on public roads without designation of an inspecting engineer by the owner, developer, or the County.

If the owner or developer does not designate an inspecting engineer, the County shall do so, selecting from a current list of engineers who have indicated their desire to perform such services. All inspection costs, including required testing, shall be paid by the owner or developer directly through service contracts or agreements. The County will require inspection costs be included in the bond or contract assurances as a percent of the total construction costs and in accordance with prevailing professional fee schedules.

An engineer whose firm, or any member of the firm, has a corporate, partnership or any form of real property interest in the development for which the improvements are required, cannot be designated inspecting engineer. The inspecting engineer's relationship to the project must be solely that of a professional service nature.

It shall be the policy of the County not to provide full inspection services for non-public funded public improvements. However, the County may perform limited inspection services upon request, if the project scale is such that the retention of a private inspecting engineer is not warranted. These inspecting requirements are not applicable to individual sidewalk, driveway or utility permits.

b) COUNTY ACTIVITIES

Inspecting services provided by the County shall include:

1) Liaison between the inspecting engineer and the County;

2) Monitoring of work progress and performance testing as deemed desirable;

3) The performance of administrative and coordinative activities as required to support the processing and completion of the project; and

4) The issuance of stop work orders upon notifying the inspection engineer of the County's intention to do so.

c) INSPECTING ENGINEER'S ACTIVITIES

The following minimum activities are required of the designated inspecting engineer:

1)* Execute a form accepting responsibility;

2) Maintain a project log book which contains at least the following information:

A. Job number and name of engineer and designees;
B. Date and time of site visits;
C. Weather conditions, including temperature;
D. A description of construction activities;
E. Statements of directions to change plans, specifications, stop work, reject materials or other work quality actions;
F. Public agency contacts which result in plan changes or other significant actions;
G. Perceived problems and action taken;
H. General remarks;
I. Final and staged inspections;
J. Record all material, soil and compact tests.

3) The inspecting engineer shall obtain and use a copy of County-approved construction plans and specifications;

4) Review and approve all pipe, aggregate, concrete, A.C. and other materials to ensure their compliance with County standards;

5)* Approve all plan or specification changes in writing and obtain County approval;

6) Monitor and concur in construction activities to ensure end products meet County specifications;

7) Perform or have performed material, composition and other tests required to ensure County specifications are met;

8) Periodically check that curb, storm sewer work and pavement and detention pond grades are in accordance with adopted plans;

9) For pavement construction, perform the following stage inspections and record date of each:

   A. Curbs are built to line and grade;
   B. Subgrade meets grade and compaction specifications;
   C. Base rock meets grade and compaction specifications;
   D. Leveling course meets grade and compaction specifications; and
   E. Wearing course meets grade and compaction specifications. The County shall be given 24 hour notice of impending stage inspections.

10)* Periodically certify to the County the amount of work completed to enable release of monies or a reduction of assurance amount.

11) File a completion report which contains:
   A. The original of the project completion certification;
   B. A complete copy of the log book initialed by the inspecting engineer;
   C. A complete set of as-built plans; and
   D. The results of material tests, compaction tests and soil analysis as detailed in the log book.

12) Call to the County's attention within two (2) working days all plan changes, material changes, stop work orders or errors or omissions in the approved plans or specifications.

* The inspecting engineer of record must be registered to practice engineering in the State of Oregon. He must personally perform all activities marked by an (*) and must supervise all individuals performing delegated activities. Material testing not performed by the inspection engineer must be accomplished by a recognized testing firm or another registered engineer.

3) AS-BUILT DRAWINGS

a) GENERAL

Following completion of construction and approval by the County, 2 sets of as-built drawings shall be submitted for preliminary review. Drawings shall describe any and all revisions to the previously approved construction plans. If this submittal is acceptable, the engineer shall submit the as-built drawings on 3 mil minimum thickness mylar or a print of contract quality suitable for reproducing and microfilming. If the first submittal was not acceptable, the County will give the engineer notice of what is required for re-submittal.

4) ACCEPTANCE OF IMPROVEMENTS

The County may accept the improvements upon recommendation of the Public Works Director only after the applicant has submitted a letter to the Board requesting the County to accept the improvements and that the improvements have been built to County standards and approved construction drawings.