

Section 500 Engineering Design Requirements

501 General

501.01 Lots

A. Configuration

Side lines of lots shall be perpendicular to the right of way, or radial to curved street lines where feasible. Double frontage or reverse front lots should be avoided except where their use will produce definite advantages in meeting special situations in relation to topography, features or will allow for proper land use

B. Access

Every lot shall have frontage on or that abuts a Right-of-way dedicated for mutual access on a hard surface street.

C. Dimensions

Lot dimensions, yard, building setback lines, and lot area shall conform to the requirements of the Zoning Ordinance and shall conform to the Oklahoma Department of Environmental Quality (ODEQ) requirements for the intended water and sewer service system.

D. Cul-De-Sac and Curved Frontage Lots

For this determination the width of cul-de-sac lots or lots on street curves shall be defined as the length of the tangent line drawn at the midpoint of the building line are on the lot as shown in the Appendix.

501.01.1 Frontage Requirement Determination

E. Flag Lots

Flag lots are not allowed within a platted subdivision or lot split unless included in a specific variance request or approved through special exception by the Board of Adjustments. Flag lots may be allowed in certain circumstances where access is limited by topography or other circumstances where a hardship exists. Flag lots must meet the following requirements:

- a) The “pole” must have minimum of thirty (30) of frontage on a dedicated public road or street.
- b) The acreage with the “flag” portion of the lot must meet the minimum lot size requirements without considering the “pole” area.

- c) Setback requirements for front setbacks must be counted only from the front edge of the “flag” portion without considering any of the “pole”. Front setback requirements may also be required by the Planning Director from the “pole” or an extension of the alignment of the “pole”.

501.02 Easements

A. Utility Easements

- a) Utility easements shall be of a minimum width of twenty (20) feet, ten (10) feet on each side of all rear lot lines, or width as specified by the utility company, and when necessary on other lot lines, for poles, wires, conduits, sanitary sewers, gas, water, power, and other utility lines.
- b) When an easement of twenty (20) feet in width is not provided, the minimum width of the easement shall be fifteen (15) feet, or as required by the County Engineer.
- c) A minimum of twenty (20) feet utility easement shall be provided adjacent to public right-of-way dedication, or as required by the County Engineer.
- d) A perimeter easement of seventeen and a half (17.5) feet shall be provided, or as required by the County Engineer.
- e) Easements shall be maintained free of buildings, appurtenances, or other structures or improvements, which would prevent access for maintenance and service of utilities.

B. Drainage Easements

- a) Suitable drainage easements shall be provided for all overland drainage flow from the one hundred (100) year storm event.
- b) Drainage easements shall be maintained free of buildings fences, appurtenances or structures. Subdivision covenants shall also contain these requirements.
- c) Public drainage easements shall be provided for all detention facilities and drainage ways. The covenants shall explicitly state who shall be responsible to maintain detention facilities. Wagoner County will not maintain any detention facilities.

501.03 Block Length Requirements

The lengths, width and shapes of blocks shall be determined in accordance with the following:

- a) Zoning requirements applicable to lot sizes and dimensions.
- b) Needs for convenient access, circulation, control and safety of street traffic.
- c) Limitations and opportunities of topography and physical features within and adjacent to the development.
- d) Blocks for residential use shall not be longer than one thousand eight hundred (1,800) feet, measured along the centerline of the abutting streets. When blocks exceed one thousand two hundred (1,200) feet in length, a perpendicular dedicated right-of-way not less than ten (10) feet in width and a paved crosswalk of not less than four (4) feet in width may be required.
- e) Blocks used for residential purposes should be of sufficient width to allow for two (2) tiers of lots of appropriate depth, except where adjacent to major streets, limited access highways, railroads, waterways, or when prevented by topographical conditions.
- f) Blocks intended for business and industrial use should be of a width and depth suitable for the intended use, with due allowance for off-street parking and loading facilities.

501.04 Building Lines

Building lines shall be shown on all plats for the intended use as follows:

- a) Where an official building setback line has been established by the Board of County Commissioners, the setback line on the plat shall not be in front of such line.
- b) Where a Planned Unit Development has been approved under the provisions of the zoning regulations, any setback lines established therein shall be recognized on the plat.

- c) A front yard setback shall be provided on every lot as required by the zoning regulations.
- d) All corner lots shall have building setback lines as required by the zoning regulations.
- e) All buildings shall be setback from interior side lines as required by the zoning regulations.
- f) Where the average natural slope of the first fifty (50) feet of any lot exceeds twenty (20) percent, the Planning Commission may appropriately reduce the building lines required under this section.

501.05 Driveways

Driveways shall conform to the following:

- a) Residential lots with area less than 0.34 acre shall have an asphalt or concrete driveway.
- b) Commercial and industrial driveways and customer parking areas shall be asphalt or concrete or an approved hard surface dust free material.
- c) All existing improvements including sidewalks, curb, gutter and streets damaged or removed by the driveway construction shall be required or replaced to existing alignments and grades. All concrete or asphalt removal shall be saw cut.
- d) Driveways on the same property shall have a minimum separation of twenty five (25) feet.
- e) All driveway location and separation requirements are measured from the end of the radius returns.
- f) Residential driveways shall have minimum width of twelve (12) feet and a maximum width of thirty (30) feet.
- g) No portion of a driveway shall be closer than two (2) feet to a property line for residential use or nine (9) feet for commercial use.

- h) Maximum industrial and commercial driveway width is forty (40) feet.
- i) Minimum driveway return radius is ten (10) feet for residential and fifteen (15) feet for commercial or industrial.
- j) In relation to nearby intersections, residential driveways shall have no portion of the driveway within twenty (20) feet of a residential or collector street or fifty (50) of an arterial street.
- k) In relation to nearby intersections, commercial and industrial driveways have no portion of a driveway within twenty-five (25) feet of a residential or collector street or seventy-five (75) feet of an arterial street.
- l) The edge of the driving lane of a driveway shall be no closer than five (5) feet from a utility pole, fire hydrant, and drainage inlet or any other above ground utility structure and shall be outside any water and sewer lines and appurtenances.
- m) One driveway may serve two (2) properties if the required joint or "mutual access" easement has been recorded. The minimum driveway width in this case is eighteen (18) feet.

501.06 Alleys

Alleys, if required, shall conform to the following:

- a) Unless provisions are made for utility easements, emergency access and service access, alleys shall be provided in commercial and industrial districts at the rear of all lots regardless of frontage on a major street.
- b) Alleys serving commercial and industrial areas shall not be less than thirty (30) feet in width and shall be paved the full width.
- c) Alleys may be required in Multi-Family Districts by the Planning Commission after review and recommendation by the Planning Director or Engineering Department for efficient solid waste collection, more effective police and fire protection or for more efficient provision of service access and maintenance of utilities. Alleys serving Multi-Family Districts shall not be less than twenty (20) feet in width and paved for the full width.

- d) Alleys are not required in Residential Subdivisions, but when provided shall not be less than twenty (20) feet in width and paved for the full width.
- e) Alley intersections and sharp changes in alignment shall be avoided, but where necessary, corners shall have a radius sufficient to permit safe vehicular movements as determined by the Engineering Department.
- f) Dead-end alleys shall be avoided where possible, but if unavoidable shall be provided with adequate turnaround facilities at the dead-end as determined by the Engineering Department.

502 Street Design Criteria

502.01 General

The general alignment of the streets shall discourage the use of local streets, excluding collectors, to through traffic. Streets shall be looped whenever possible.

The street alignments shall provide for the appropriate connection to existing streets and shall stub-out or project to surrounding undeveloped tracts of property. Stub outs shall be required, at the discretion of the County.

A subdivision shall have two routes of access to a section line road, or one route of access with additional planned route(s) of access through future development as approved by the Planning Commission and Board of County Commissioners.

502.02 Street and Subdivision Names

- a) No street name shall be used which will duplicate or be confused with the name of existing streets.
- b) Street names and addresses shall be referred to the Wagoner County 911 Addressing for recommendations and are subject to the approval of the Board of County Commissioners.
- c) Subdivision names shall not duplicate existing subdivisions of record and shall be reviewed by the Planning Director and are subject to the approval of the Board of County Commissioners.
- d) Signs indicating street names must be in place at all intersections prior to approval of the final plat.

502.03 Access and Limits of No Access

- a) In commercial and industrial subdivisions, specifically designated “one-way turn only” access may be required in the direction of the adjacent lane at a minimum distance of three hundred (300) feet between major street intersections or a minimum distance of three hundred (300) feet between each access point.
- b) Commercial and industrial subdivisions should have access to a major or commercial street, and may have access to a collector street, if traffic conditions determined by the Planning Commission warrant, but shall not have access to a residential street.
- c) To assure traffic safety, appropriate non-access provisions shall be designated and dimensioned along all abutting streets in all commercial and industrial subdivision, and along all major streets in residential subdivisions. A description of such non-access provisions shall appear in the plat.
- d) Access to property occurring within the minimum distance prescribed for major street access, six hundred (600) feet, shall only be by the closest service or frontage road entrance onto the major street.
- e) In residential subdivisions, individual driveways will be located on each lot to avoid direct vehicular access to or from any expressway, thoroughfare, or major street. Driveways should be located to enable direct access primarily to or from a minor street, or, if necessary, to the collector streets which serve as feeders to or distributors from the major streets. Limits of non-access shall be designated on the plat.
- f) Additional Limits of No Access must be provided if requested by the County.
- g) Multiple points of access are encouraged and shall be achieved if possible.

502.04 Roadway Drainage System Determination

A. Curb and Gutter

Subdivisions in which the smallest lot width, excluding cul-de-sac lots, is equal or less than one hundred and thirty (130) feet shall utilize curb and gutter streets. Curb and gutter may be required for subdivision where the lot area is less than 0.34 acre as determined by Planning and Zoning or the County Engineer. The district's Commissioner may allow for a variance in rural communities.

B. Borrow Ditch

Subdivisions with the lot width in excess of one hundred and thirty (130) feet may utilize streets with borrow ditch drainage systems.

502.05 Right of Way Widths Dedication

The minimum street right-of-way requirements are as follows, and shall be dedicated as follows:

Primary/Principal Arterial	120 feet minimum
Secondary/Minor Arterial	100 feet minimum
Commercial/Industrial Collector	80 feet minimum
Commercial/Industrial Street	80 feet minimum
Residential Collector	60 feet minimum
Residential/Local Street	60 feet minimum

*This requirement may be reduced to fifty (50) feet for curb and gutter streets.

The right-of-way dedications shall include full width dedication for all streets with the exception of Primary and Secondary Arterials in which case half-width dedication to the Section Line is required when the development lies only within one particular Section of land. If a Reserve Area falls within a right-of-way (e.g. Entrance Island), the Reserve Area must be contained in a roadway easement. The County shall have no liability for any damage to any private improvements occasioned by the maintenance or reconstruction of utilities or infrastructure located in the Reserve Area.

502.06 Design Speed

Speed shall be twenty five (25) miles per hour on all residential streets and thirty (30) miles per hour on all collector streets, or as otherwise approved by the Planning Commission or Board of County Commissioners.

502.07 Street Geometry

- a) Minimum Centerline Radius

<u>Street Classification</u>	<u>Min. Centerline Radius</u>
Arterial	500 feet
Commercial/Industrial	500 feet
Residential Collector	270 feet
Local Residential	150 feet

b) Minimum Centerline Tangent

<u>Street Classification</u>	<u>Min. Centerline Tangent</u>
Arterial	200 feet
Commercial/Industrial	200 feet
Residential Collector	100 feet
Local Residential	100 feet

c) Minimum Intersection Return Radius

<u>Street Classification</u>	<u>Min. Intersection Return Radius</u>
Arterial	40 feet
Commercial/Industrial	40 feet
Residential Collector	30 feet
Local Residential	25 feet

502.08 Cul-De-Sac

The entrance to the cul-de-sac shall be considered the intersection leading into the cul-de-sac from an existing through street or planned through street as approved by the Planning Commission and Board of County Commissioners. For residential subdivision with lots having an area greater than 0.34 acre, the cul-de-sacs shall not exceed one thousand (1,000) feet in length, for the other subdivisions with smaller lots, a maximum length shall not exceed five hundred (500) feet, as measured from the entrance to the center of the cul-de-sac shall have a minimum radius at the property line of not less than fifty (50) feet.

502.09 Intersections

- a) Streets shall be designed to intersect at right angles as permitted by topography or other limiting factors.

- b) Street intersections shall be as nearly at right angles as possible, and no intersection shall be at an angle of less than eighty (<80) degrees. Detailed designs of intersections may be required. Street jogs with centerline offsets of less than one hundred fifty (150) feet shall not be permitted.

- c) Sight Distance Triangles shall be considered and maintained in accordance with the Zoning Ordinances.
- d) No more than two (2) streets shall intersect at any one point.

502.10 Street Grades

- a) The minimum street grade for all streets shall be five tenths percent (0.5%) and the maximum street grade shall not exceed the following:

<u>Street Type</u>	<u>Grade</u>
Primary Arterial	5%
Secondary Arterial	7%
Local Residential	10%

- b) The maximum driveway grade, from the street right-of-way to the building line shall not exceed fourteen percent (14%).
- c) If the algebraic difference between two intersecting grades is greater than five tenths percent (0.5%), the change in grade shall be connected by vertical curves and designed for safe stopping sight distances as determined by the County Engineer.
- d) The grade of a residential street when intersecting an arterial street shall not exceed three percent (3%) within a distance of fifty (50) feet measured from the radius points. The maximum grade of residential streets at intersections shall be four percent (4%) within a distance of fifty (50) feet measured from the radius points.
- e) Street grades shall be established in such a manner to avoid excessive grading or removal of tree growth, and shall otherwise be in accordance with these engineering design requirements.
- f) In those cases where topography or other physical features dictate, a modification of required street grades may be approved by the County Engineer.

502.11 Paving Materials and Street Design

A geotechnical report is required to determine the subgrade treatment requirements and to evaluate the pavement section requirements. The minimum compaction of the subgrade and base shall be ninety five percent (95%) standard proctor density. The

subgrade shall have a minimum Plasticity Index (P.I.) Index less than ten (P.I.<10) or be modified as approved by the County.

The street cross-section shall meet the minimum requirements shown in the Standard Drawings. An alternate paving section may be required, or would be considered upon request, based on a geotechnical engineering report of representative areas in the subdivision.

503 Street Drainage and Storm Sewer Criteria

503.01 General

For the one-hundred (100) year frequency storm with curb and gutter streets:

- a) Arterial Streets – shall have two driving lanes of traffic open and clear of water.
- b) Collector Streets – shall have one driving lane open and clear of water.
- c) Residential Streets – the depth of flow shall not exceed curb height and may spread to the crown of the street.

Where no curb exists, storm water encroachment from the one hundred (100) year storm shall not extend past the street right-of-way or adjacent drainage easement.

503.02 Paving Sump Locations

The water depth shall not extend twelve (12) inches above the top of the grate for the one hundred (100) year frequency storm. But in no case shall the one hundred (100) year flow extend past the right-of-way or adjacent drainage easement.

Where sump locations are used, a permanent overflow route shall be contained in a dedicated drainage easement providing an emergency bypass in case of blockage or overflow of the sump inlets.

503.03 Underground Storm Sewers

- a) The plans shall show the systems in plan and profile view. The plans must include flow-lines, pipe size and material, existing and proposed grade, pipe slope, energy grade line, hydraulic grade line, discharge and velocity for each segment of pipe.

- b) Storm sewers shall be constructed from reinforced concrete pipe (RCP), high-density polyethylene (HDPE) or coated metal alloy as approved by the County Engineer. HDPE shall have a minimum of twenty four (24) inches of cover under streets.
- c) The minimum storm sewer size shall be eighteen (18) inches diameter.
- d) No storm sewer pipe shall be installed downstream having a diameter smaller than the storm sewer pipe it is receiving water from.
- e) The maximum inlet spacing shall be five hundred (500) feet.
- f) Storm sewer construction shall meet the latest edition of Oklahoma Department of Transportation (ODOT) specifications subject to the approval of the County Engineer.

Structures (manholes, inlets, etc.) must be of concrete construction; masonry shall not be allowed. HDPE may be proposed for a project and is subject to approval by the County Engineer.

504 Culverts and Borrow Ditches

504.01 Roadway Culverts

Material shall be smooth steel pipe, reinforced concrete pipe (RCP), reinforced concrete box (RCB) or High Density Polyethylene (HDPE). HDPE culverts may be used if there is at least twenty four (24) inches of cover.

All culverts shall have ODOT Standard Sloped Concrete End Sections or ODOT Standard Headwalls. Alternative headwalls and/or end sections must be submitted as part of the construction plans, reviewed, and approved by the County prior to installation. All roadway culverts shall be a minimum of eighteen (18) inch diameter. Energy dissipaters shall be provided as required.

The minimum design frequency storm for all culverts shall be the one hundred (100) year storm.

504.02 Driveway Culverts

Culverts shall consist of smooth steel pipes, RCP, or corrugated metal pipe (CGMP). Driveway culverts may be HDPE or PVC only with at least twelve (12) inches of cover or

if the driveway is concrete and is at least four (4) inches thick. All driveway culverts shall have ODOT Standard Slope Concrete End Sections. Alternative headwalls and/or end sections must be submitted as part of the construction plans, reviewed, and approved by the County prior to installation. Headwalls or sloped concrete end sections are NOT required if the culvert pipe is RCP or smooth steel pipe having sufficient wall thickness that prevents collapsing.

504.03 Borrow Ditches

Borrow ditches shall meet the following standards:

- a) Be a minimum of two (2) feet in depth measured from the top of the street subgrade to the bottom of the ditch.
- b) The velocity of the water in the ditch shall not exceed six (6) feet per second, if the velocity of the water in the ditch exceeds six (6) feet per second, the ditch shall be lined with concrete or other such materials to prevent erosion.
- c) Unlined ditches shall utilize the appropriate erosion and sediment control measures per these subdivision regulations.
- d) Where a private drive crosses a borrow ditch, the subdivider's engineer shall determine the minimum required diameter of the culvert which shall be shown on the face of the Preliminary Plat and recorded on the face of the Final Plat drawing. A minimum of a twelve (12) inch diameter culvert pipe shall be required for each such drive.
- e) Borrow ditches shall have a minimum fore-slope and back-slope of 3:1, shall be backfilled with a minimum of four (4) inches of topsoil, seeded or slab sodded. At a minimum, the bottom of the bar ditch must be contained in the right-of-way dedication.

505 Drainage Design Requirements

505.01 General

- a) The storm water drainage system shall be designed to receive and pass the runoff from a one hundred (100) year frequency rainstorm within dedicated easements or public right-of-way under full urbanization. The entire flow shall be contained in an approved storm water drainage system. The storm water

drainage system shall consist of street flow, storm sewers, ditches, channels, drainage ways and detention facilities.

- b) The building pad elevation on every lot shall be minimum of two (2) feet above the one hundred (100) year floodplain elevation or the flood elevation due to any localized drainage or localized flooding. This elevation shall be the minimum elevation for the finished floor of any structure on the lot and this elevation shall be noted and labeled on each lot on the face of the subdivision drainage plans.
- c) Floodplain development must be in accordance with the Floodplain Development Permit as issued by the Floodplain Manager and required by the Zoning Regulations.
- d) The development shall not increase the one hundred (100) year flood plain elevation or modify the existing flood plain boundaries that exist on the latest publication of the Flood Insurance Rate Map (FIRM) unless the appropriate map revisions/amendments are approved by FEMA (e.g. Letter of Map Revision LOMR, or Letter of Map Amendment, LOMA). The subdivider shall have full responsibility for obtaining any such map revisions/amendments.
- e) The runoff rate and velocity from any development shall not exceed the predevelopment conditions which shall be demonstrated by analyzing the runoff from the year, five (5) year, ten (10) year, twenty-five (25) year, fifty (50) year and the one hundred (100) year rainfall frequency events. The post development runoff shall incorporate detention facilities and drainage patterns in the calculations.
- f) The development shall not adversely impact adjacent properties in the modification of drainage patterns to and from adjacent properties. Protection of unprotected or adjacent property from incremental flows, changes in drainage patterns or point discharges shall be provided. Such flows shall not be directed across unprotected or adjacent properties unless the appropriate easements and proper storm water drainage systems are provided to convey flows to an adequate drainage conveyance system as approved by the County Engineer.

505.02 Construction in the Regulatory Floodplain

- a) Any construction in the floodplain shall not increase the base flood elevation in the regulatory floodplain.

- b) The one hundred (100) year Base Flood Elevation (BFE) must be determined through backwater analysis. HEC-RAS or other FEMA approved model shall be utilized for the backwater analysis.
- c) The simulation results shall be submitted to the County to document the BFE and demonstrate the project has no adverse impact.
- d) Any floodplain modifications shall require approval by the County and the appropriate FIRM modifications by FEMA.

505.03 Storm water Runoff Calculations

Approved methods of storm water runoff analysis are shown in Table 505.03-1. Methods of analysis other than the ones listed here may be utilized with the approval by the County Engineer.

Table 505.03-1 Approved Methods of Hydrologic Analysis

Method of Analysis	Application		Minimum Drainage Area	Maximum Drainage Area
	Peak Q	Volume Calculations		
Rational Method	Yes	No	~0	200
NRCS (SCS) Method	Yes	Yes	~0	2000

A. Rational Method

Rational Method may be used to determine required design flows for culverts or channels with drainage areas less than the maximum drainage area allowed in Section 505.03.

The recommended ranges of C values are shown in Table 505.03-2. Coefficient values selected from the range available shall be consistent with the urbanized percent imperviousness (i.e. minimum percent imperviousness requires minimum runoff coefficient value). Also, for flat slopes and permeable soils, use the lower values. For steep slopes and impermeable soils use the higher values.

Table 505.03-2 Runoff Coefficients

Land Use of Surface Characteristic	Percent Impervious	Runoff Coefficients
BUSINESS		
Commercial Areas	70 to 95	0.70 to 0.95
Neighborhood Areas	60 to 80	0.60 to 0.80
RESIDENTIAL		
Single Family	35 to 50	0.30 to 0.50
Multi-Unit (detached)	45 to 55	0.40 to 0.60
Multi-Unit (attached)	65 to 75	0.60 to 0.75
½ Acres or larger lot	30 to 45	0.25 to 0.40
Apartments	65 to 75	0.50 to 0.70
INDUSTRIAL		
Light Uses	70 to 80	0.50 to 0.80
Heavy Uses	80 to 90	0.60 to 0.90
PARKS, CEMETERIES	4 to 8	0.10 to 0.25
PLAYGROUNDS	40 to 60	0.50 to 0.60
RAILROAD YARDS	35 to 45	0.20 to 0.35
UNDEVELOPED AREAS		
Cultivated	30 to 70	0.35 to 0.60
Pasture	20 to 60	0.25 to 0.50
Woodland	5 to 40	0.10 to 0.40
Offsite flow analysis (land use not defined)	35 to 55	0.45 to 0.65
STREETS:		
Paved	90 to 100	0.80 to 0.90
Gravel	50 to 70	0.55 to 0.65
DRIVES AND WALKS	90 to 100	0.80 to 0.90
ROOFS	85 to 95	0.80 to 0.90
LAWNS		
Sandy Soils	5 to 10	0.10 to 0.20
Clayey Soils	10 to 30	0.13 to 0.35

The intensity (I) is the average rainfall rate in inches per hour for the period of maximum rainfall of a given frequency having duration equal to the time of concentration.

B. NRCS (SCS) Unit Hydrograph Method

All drainage areas over sixty (60) acres and calculations for detention volume require a hydrograph method to determine peak runoff rates. Other hydrograph techniques can be utilized upon approval from the County Engineer.

The Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS) method is presented in detail in Section 4 of the *U.S. Department of Agriculture Soil Conservation Service Engineering Handbook and Model Drainage Manual*, American Association of State Highway and Transportation Officials, 1991. The SCS computer program TR-20 or the U. S Army Corps of Engineers computer program HEC-HMS are acceptable ways of utilizing the SCS methodology.

The NRCS/SCS publication Technical Release 55 (TR-55) *Urban Hydrology for Small Watersheds* should be used to establish the required precipitation runoff and time parameters. This includes the NRCS/SCS Runoff Curve Number and the Time of Concentration and Lag Time calculations.

Rainfall data to be used for projects in Wagoner County is listed in Table 505.03-4. This data was compiled from the *U.S. Weather Bureau Technical Paper No. 40 and Hydro-35*.

Table 505.03-4 Wagoner County Rainfall Data

DURATION	Frequency (Return Period)						
	1-Year	2-Year	5-Year	10-Year	50-Year	100-Year	500-Year
5-Minute	0.40	0.48	0.56	0.62	0.79	0.86	1.01
10-Minute	0.71	0.84	0.99	1.11	1.41	1.54	1.83
15-Minute	0.84	1.01	1.20	1.34	1.70	1.86	2.23
30-Minute	1.14	1.40	1.73	1.96	2.55	2.81	3.39
1-Hour	1.44	1.81	2.28	2.60	3.44	3.80	4.58
2-Hour	1.70	2.13	2.80	3.30	4.44	5.00	6.12
3-Hour	1.87	2.28	3.13	3.63	4.83	5.43	6.60
6-Hour	2.19	2.71	3.64	4.30	5.71	6.40	7.80
12-Hour	2.63	3.23	4.31	5.10	6.71	7.55	9.20
24-Hour	3.00	3.75	5.15	5.88	7.78	8.75	10.68

506 Storm Water Detention Facilities

506.01 General

The runoff from any development shall not exceed the pre-development condition which shall be demonstrated by analyzing the runoff from the five (5) year, ten (10) year, twenty-five (25) year, fifty (50) year and the one hundred (100) year rainfall frequency events.

The pre-development condition is the runoff pattern, rate, and velocity prior to the construction of the development. The pre-development curve number is generally less than the post development curve number. Soil covers that produce a curve number that is higher in the pre-development condition must be approved by the County Engineer. The post-development condition with detention is the runoff pattern, rate, and velocity after construction of the development, which includes incorporating any storm water detention facilities into the development.

506.02 Storm Water Detention Report

The report shall be submitted to the County to explain and support how each item in these Criteria are met. The report shall be formatted to sequentially answer each Criteria item. Any deviation from the Criteria shall be noted on the plans and explained in the report.

All calculations for detention facilities shall be submitted for review by the County. Submittals shall include hydrographs, outflow rate and velocity, and stage-discharge relationship through the facility. Detention facilities may be located in the regulatory floodplain as approved by the floodplain administrator.

506.03 Hydrologic Analysis Criteria

- a) Precipitation – The total cumulative precipitation may be incrementally arranged using the NRCS Type II Rainfall Distribution Pattern.
- b) Infiltration/Excess Runoff – The excess precipitation/runoff will be calculated using the NRCS Curve Number Technique as described in the NRCS TR-55 Publication.
- c) Hydrograph Construction – The Hydrograph may be constructed using the NRCS Unit Hydrograph Method. Other methods may be utilized as approved by the County Engineer.

- d) Routing – Flows through detention ponds, both existing and proposed, should be routed using level pool or Modified Puls routing. Channel routing should generally be accomplished with Lag Routing or Kinematic Wave Routing. If there is sufficient floodplain storage to warrant, a diffusive routing technique may be utilized upon approval of the County Engineer.
- e) Simulation – The Hydrologic Model must be simulated for a twenty four (24) hour storm duration event. The maximum time step is five (5) minutes or thirty percent (30%) of the shortest lag time in the model, whichever is less.

506.04 Additional Detention for Downstream Development

- a) Additional detention storage, in excess of the required storage for the development, can be provided to satisfy the detention requirements for a tract of land downstream of the detention facility.
- b) This detention will be allowed provided the detention facility is constructed prior to the development of the downstream tract.
- c) A map showing the specified tract of land included in the detention facility volume shall be submitted. This shall be clearly documented in the Storm Water Detention Report.

506.05 Access to Detention Facilities

An access way, a minimum of fifteen (15) feet wide, shall be provided to and into all detention facilities from a public right-of-way. Access may be provided by frontage on a right-of-way or by an access easement to the detention facility. The access road shall have a maximum grade of fifteen percent (15%).

506.06 Slope and Depth Requirements for Detention Facilities

- a) Side slopes on detention facilities shall not be steeper than four to one (4:1), horizontal run to vertical rise.
- b) The bottom slope of a dry detention facility shall have a minimum slope of one percent (1%) across grass surfaces and a minimum slope of five tenths percent (0.5%) across paved surfaces.
- c) The standing water depth of the permanent pool of a wet detention facility shall be a minimum of four (4) feet deep.

506.07 Outlet Structure

All detention facilities shall have a defined spillway. The spillway shall be designed to pass the five hundred (500) year flood event with a minimum of one (1) foot of freeboard.

The plan shall show the spillway elevation, the one hundred (100) year and five hundred (500) year water surface elevation, and the minimum top of embankment.

506.08 Energy Dissipaters

Energy dissipation devices shall be installed at the outlet of the detention facility, and shall be detailed in the plans.

506.09 Erosion Protection and Sediment Control

All disturbed earth surfaces, including the detention facility, shall require the appropriate soil stabilization, erosion and sediment control methods in accordance with these subdivision regulations. These methods shall provide for the establishment or re-establishment of permanent vegetation on the detention facility.

506.10 Maintenance

Maintenance of the detention facility shall remain with the owner of the property as required by these subdivision regulations. The covenants shall explicitly state who shall be responsible to maintain detention facilities. Wagoner County will not maintain any detention facilities.

507 Open Channel Design Criteria

507.01 General

Channels shall be designed in accordance with sound engineering principles. The design water surface elevation shall be contained in the channel bank section. All open channels shall be provided with a minimum of one (1) foot of freeboard above normal depth from a one hundred (100) year frequency rainstorm.

507.02 Lined Channels

- a) All engineered channels shall be lined. The lining may be grass, riprap, concrete, or other erosion resistant materials.

- b) Trapezoidal channels shall have a minimum bottom width of two (2) feet. For sodded or grass lined sections the side slopes shall not be steeper than 4:1. For concrete or rock lined sections a side slope of 2:1 is acceptable.

- c) Rectangular channels require approval of the County Engineer. All rectangular channels will be concrete lined and may be stipulated to be fully enclosed.
- d) Low flow or “trickle” channels will be provided when required, to control erosion, and at the request of the County Engineer.
- e) Concrete channels shall have a minimum longitudinal slope of two tenths percent (0.2%), and grass lined channels shall have a minimum longitudinal slope of five tenths percent (0.5%). The minimum velocity to avoid sedimentation must be considered as part of channel slope design. Concrete channels must maintain a minimum velocity of two and five tenths (2.5) feet per second.
- f) The velocity of the water in the channel shall not exceed six (6) feet per second. If the velocity of the water in the ditch exceeds six (6) feet per second, the channel shall be lined with concrete or other such materials to prevent erosion.
- g) Proper erosion and sediment control methods shall be used for all disturbed areas in accordance with these subdivision regulations. These methods shall provide for the establishment of permanent vegetation.

507.03 Manning’s Friction Factor Values

Manning’s equation for the calculations of channel characteristics is acceptable. The friction factor (N) utilized for channel design is summarized in Table 507.03-1 for natural channels and Table 507.03-2 for lined channels. The source for this table is *Open Channel Hydraulics*, by V.T Chow, circa 1959.

For lined channels a high end value should be used for capacity determination. To estimate flow velocity, a low end Manning’s Value should be utilized. Additionally, the future growth, vegetation and natural maturation process of the channel should be anticipated.

Table 507.03-1 Manning's Fiction Factor for Natural Streams – Main Channels

Type of Channel and Description	Minimum	Normal	Maximum
Natural Streams			
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as “d” but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150

Table 507.03-2 Manning's Friction Factor for Natural Streams – Floodplains

2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees	0.040	0.060	0.080
3. Medium to dense brush	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Heavy stand of timber, few down trees, Little undergrowth, flow below branches	0.080	0.100	0.120
3. Same as above, but with flow into branches	0.100	0.120	0.160
4. Dense willows, summer, straight	0.110	0.150	0.200

Table 507.03-3 Manning's Friction Factor for Lined Channels

Type of Channel and Description	Minimum	Normal	Maximum
Lined or Built-Up Channels			
1. Concrete			
a. Trowel Finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
2. Concrete bottom float finished with sides of:			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035

507.04 Natural Channels

Natural channels shall be privately maintained and contained in a drainage easement or reserve area.

508 Erosion Protection and Sediment Control

508.01 General

In order to minimize erosion and sedimentation damage to properties, drainage facilities, or other improvements, the subdivider shall provide appropriate soil stabilization and sediment control measures.

These measures shall allow for permanent vegetation to become established and shall prevent sediment deposition on adjacent properties or within the storm water drainage system.

The subdivider shall be responsible to install and maintain all soil stabilization; erosion control and sedimentation control measures and shall remove and dispose of any deposited sediment or repair erosion damage as required by the County.

Building permits for a portion or the entirety of a subdivision may be suspended for the enforcement and correction of erosion and sediment control measures including revegetation.

The subdivider is responsible for all applicable storm water discharge and wetlands permitting.

508.02 Storm Water Pollution Prevention Plan

The Storm Water Pollution Prevention Plan (SWP3) and report shall be included in the submission of the construction plans. The Report shall include a copy of the Notice of Intent and General Permit OKR10 – “*Stormwater Discharges from Construction Activities within the State of Oklahoma*” as issued by the Oklahoma Department of Environmental Quality. Additionally, the report should address all aspects of pollution control as outlined in the OKR10 document. The specific soil stabilization, erosion control and sediment control methods to be utilized are interdependent and shall be approved by the County Engineer on a project-specific basis.

508.03 Soil Stabilization Methods

Approved methods include sod placement, seeding, hydromulching, hydroseeding, geotextiles, erosion control blankets/mats or other methods as approved by the County Engineer.

508.04 Sediment Control Methods

Approved methods include silt fence, sediment basin/trap, check dam, fiber rolls, gravel/sand bags, straw bale barriers, stabilized construction entrances, truck washdown areas or other methods as approved by the County Engineer.

508.05 Clean Water Act 404 Permits

Applicants are responsible to contact the U.S. Army Corps of Engineers regarding Section 404 of the Clean Waters Act.

509 Water Supply and Fire Protection

509.01 General

Water supply systems shall be approved by ODEQ and the water provider. Where applicable, water systems should meet the requirements of ODEQ standards for “systems that provide fire protection”. Proposed residential and commercial plats should address fire protection for the proposed development.

510 Sewage and Wastewater Disposal

510.01 General

Sewage and wastewater disposal systems shall be approved by ODEQ and the utility provider as applicable.

Private and individual on-site disposal systems must be approved by ODEQ.