

Section 1700.01 Stormwater Pollution Prevention and Erosion Control

(a) GENERAL PROVISIONS

(1) Purpose

- a. The purpose and objectives of this Section are as follows:
 1. To maintain and improve the quality of water impacted by the storm drainage system within the City of Bentonville.
 2. To prevent the discharge of contaminated stormwater runoff and illicit discharges from industrial, commercial, residential, and construction sites into the storm drainage system or other property within the City of Bentonville.
 3. To promote public awareness of the hazards involved in the improper discharge of trash, yard waste, lawn chemicals, pet waste, wastewater, oil, petroleum products, cleaning products, paint products, hazardous waste, sediment and other pollutants into the storm drainage system.
 4. To encourage recycling of used motor oil and safe disposal of other hazardous consumer products.
 5. To facilitate compliance with Federal and State standards and permits issued by ADEQ to operators of construction sites within the City.
 6. To enable the City to comply with all Federal and State laws and regulations applicable to the National Pollutant Discharge Elimination System (NPDES) permitting requirements for storm water discharges.

(2) Responsibility of Administration

- a. The City Official shall administer, implement, and enforce the provisions of this Section. Any powers granted or duties imposed upon the City Official may be delegated in writing by the City Official to persons or entities acting in the beneficial interest of or in the employ of the City.

(3) Definitions The following words, terms and phrases, when used in this section, shall have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

- a. ADEQ: Arkansas Department of Energy and Environment Division of Environmental Quality.
- b. Best Management Practices (BMP's): a technique or series of techniques which, when used in an erosion and sedimentation control plan, is proven to be effective in controlling construction-related runoff, erosion and sedimentation.

- c. City: the City of Bentonville, Arkansas
- d. City Official: is the Mayor of Bentonville, Arkansas, or duly authorized representatives designated by the Mayor.
- e. Commercial: pertaining to any business, trade, industry, or other activity engaged in for profit.
- f. Construction Site: any location where construction activity occurs including land disturbing activities.
- g. Contaminated: containing harmful quantities of pollutants.
- h. Contractor: any person or firm performing or managing construction work at a construction site, including any construction manager, general contractor or subcontractor. Also includes, but is not limited to land disturbing activity, paving, building, plumbing, mechanical, electrical or landscaping contractors, and material suppliers delivering materials to the site.
- i. Discharge: any addition or release of any pollutant, stormwater or any other substance whatsoever into the storm drainage system.
- j. Discharger: any person who causes, allows, permits, or is otherwise responsible for, a discharge, including, without limitation, any owner of a construction site or industrial facility.
- k. Domestic Sewage: sewage origination primarily from kitchen, bathroom and laundry sources, including waste from food preparation, dishwashing, garbage grinding, toilets, baths, showers and sinks.
- l. EPA: Environmental Protection Agency.
- m. Erosion: the wearing away of the ground surface as a result of the movement of wind, water, gravity, or ice.
- n. Final Stabilization: All soil disturbing activities at the site have been completed and either of the two following criteria are met:
 - 1. Uniform, evenly distributed, and without large bare areas perennial vegetative cover with a density of 80 percent of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures, or
 - 2. Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.
- o. Garbage: means decaying or rotting animal and vegetable waste materials from the handling, preparation, cooking, or consumption of food, including waste materials from markets, storage facilities, and the handling and sale of produce and other food products.
- p. Groundwater: any water residing below the surface of the ground or percolation into or out of the ground.
- q. Harmful Quantity: the amount of any substance that the City Official determines will cause an adverse impact to storm drainage system or will contribute to the failure of the City to meet the water quality based

requirements of the NPDES permit for discharges from the MS4.

- r. Hazardous Substance: any substance identified or listed as a hazardous waste by the EPA pursuant to current regulations.
- s. Household Hazardous Waste (HHW): any material generated in a household (including single and multiple residences) that would be classified as hazardous.
- t. Illicit Discharge: means any discharge to the storm drainage system that is prohibited.
- u. Illicit Connection: any drain or conveyance, whether on the surface or subsurface, which allows an illicit discharge to enter the storm drainage system.
- v. Industrial Waste: (or commercial waste) any wastes produced as a by-product of any industrial, institutional or commercial process or operation, other than domestic sewage.
- w. Land Disturbing Activity - any use of land by any person in residential, industrial, educational, institutional, or commercial development, highway and road construction and maintenance that results in a change in the natural cover or topography and that may cause or contribute to sedimentation. These activities include removal of vegetation, disturbance of soils, installation of BMPs, stockpiles, access roads, material lay down areas, offices, storage areas, changes to the contouring, surface drainage pattern, slope characteristics, utility work, excavation, or fill.
- x. Larger Common Plan: A contiguous area where multiple separate and distinct construction activities are occurring under one plan.
- y. Low impact development: A system and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat.
- z. Mechanical Fluid: any fluid used in the operation and maintenance of machinery, vehicles and any other equipment, including lubricants, antifreeze, petroleum products, oil and fuel.
- aa. Mobile Commercial Cosmetic Cleaning (or mobile washing): power washing, steam cleaning, and any other method of mobile cosmetic cleaning, of vehicles and/or exterior surfaces, engaged in for commercial purposes or related to a commercial activity.
- bb. Municipal Separate Storm Sewer System (MS4): the system of conveyances, including roads, streets, curbs, gutters, ditches, inlets, drains, catch basins, pipes, tunnels, culverts, channels, detention basins and ponds owned and operated by the City and designed or used for collection or conveying stormwater, and not used for collecting or conveying sanitary sewage.
- cc. Non-stormwater discharges: septic systems, sanitary sewers and others; industrial NPDES discharges, urban return flows, water diversions, runoff from confined animal feeding lots.

- dd. NPDES: the National Pollutant Discharge Elimination System.
- ee. NPDES Permit: a permit issued by EPA and or ADEQ that authorizes the discharge of pollutants to Waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.
- ff. NOI: Notice of Intent
- gg. NOT: Notice of Termination
- hh. Notice of Violation: a written notice detailing any violations of this Section and any action expected of the violators.
- ii. Oil: any kind of oil in any form, including, but not limited to: petroleum, fuel oil, crude oil, synthetic oil, motor oil, cooking oil, grease, sludge, oil refuse, and oil mixed with waste.
- jj. Owner: the person who owns a facility, part of a facility, or land.
- kk. Person: any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns, including all federal, state, local governmental entities, joint venture, public or private corporation, commission, board, public or private institution, utility, cooperative, and interstate body.
- ll. Permittee: the applicant in whose name a valid permit is duly issued pursuant to this section and his/her agents, employees and others acting under his/her supervision or control.
- mm. Operator: for the purpose of this ordinance, means any person (an individual, association, partnership, corporation, municipality, state or federal agency) who has the primary management and ultimate decision-making responsibility over the operation of a facility or activity. The operator is responsible for ensuring compliance with all applicable environmental regulations and conditions. In addition, for purposes of this ordinance, “owner” refers to the party that owns the structure being built. Ownership of the land where construction is occurring does not necessarily imply the property owner is an operator (e.g., a landowner whose property is being disturbed by construction of a gas pipeline or a landowner who allows a mining company to remove dirt, shale, clay, sand, gravel, etc. from a portion of his property). Likewise, if the erection of a structure has been contracted for, but possession of the title or lease to the land or structure is not to occur until after construction, the would-be owner may not be considered an operator (e.g., having a house built by a residential homebuilder).
- nn. Pesticide: a substance or mixture of substances intended to prevent, destroy, repel or migrate any pest.
- oo. Pet Waste (or animal waste): excrement and other waste from domestic animals.
- pp. Petroleum Product: a product that is obtained from distilling and processing crude oil and that is capable of being used as a fuel or lubricant in a motor

vehicle or aircraft, including motor oil, motor gasoline, gasohol, other alcohol blended fuels, aviation gasoline, kerosene, distillate fuel oil, and #1 and #2 diesel.

- qq. Pollutant: any substance attributable to water pollution, including but not limited to rubbish, garbage, solid waste, litter, debris, yard waste, pesticides, herbicides, fertilizers, pet waste, animal waste, domestic sewage, industrial waste, sanitary sewage, wastewater, septic tank waste, mechanical fluid, oil, motor oil, used oil, greases, petroleum products, antifreeze, surfactants, solvents, detergents, cleaning agents, paint, heavy metals, toxins, household hazardous waste, small quantity generator waste, hazardous substances, hazardous waste, soil and sediment.
- rr. Pollution: the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water that renders the water harmful, detrimental, or injurious to humans, animal life, plant life, property, or public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.
- ss. Potable Water: water that has been treated to drinking water standards and is safe for human consumption.
- tt. Private Drainage System: all privately or publicly owned ground, surfaces, structures or systems, excluding the MS4, that contribute to or convey stormwater, including but not limited to, roofs, gutters, downspouts, lawns, driveways, pavement, roads, streets, curbs, gutters, ditches, inlets, drains, catch basins, pipes, tunnels, culverts, channels, detention basins, ponds, draws, swales, streams and any ground surface.
- uu. Public Infrastructure Improvement Plans (PIIP): engineering drawings subject to approval by the City Official for the construction of public improvements.
- vv. Qualified Person: a person who possesses the required certification, license, or appropriate competence, skills, and ability as demonstrated by sufficient education, training, and/or experience to perform a specific activity in a timely and complete manner consistent with the regulatory requirements and generally accepted industry standards for such activity.
- ww. Release: to dump, spill, leak, pump, pour, emit, empty, inject, leach, dispose or otherwise introduce into the storm drainage system.
- xx. Rubbish: non-putrescible solid waste, excluding ashes, which consist of: (a) combustible waste materials, including paper, rags, cartons, wood, excelsior, furniture, rubber, plastics, yard trimmings, leaves, and similar materials; and (b) noncombustible waste materials, including glass, crockery, tin cans, aluminum cans, metal furniture, and similar materials that do not burn at ordinary incinerator temperatures (1600 to 1800 degrees Fahrenheit).
- yy. Sanitary Sewage: the domestic sewage and/or industrial waste that are discharged into the City sanitary sewer system and passes through the sanitary sewer system to a sewage treatment plant for treatment.

- zz. Sanitary Sewer: the system of pipes, conduits, and other conveyances which carry industrial waste and domestic sewage from residential dwellings, commercial buildings, industrial and manufacturing facilities, and institutions, whether treated or untreated, to a sewage treatment plant (and to which stormwater, surface water, and groundwater are not intentionally admitted).
- aaa. Sediment: soil (or mud) that has been disturbed or eroded and transported naturally by water, wind or gravity, or mechanically by any person.
- bbb. Sedimentation: the deposition of sediment.
- ccc. Septic Tank Waste: any domestic sewage from holding tanks such as vessels, chemical toilets, campers, trailers, septic tanks and aerated tanks.
- ddd. Site: the land or water area where any facility or activity is physically located or conducted, including adjacent land used in connection with the facility or activity.
- eee. Solid Waste: any garbage, rubbish, refuse and other discarded material, including solid, liquid, semisolid, or contained gaseous material, resulting from industrial, municipal, commercial, construction, mining or agricultural operations, and residential, community and institutional activities.
- fff. State: the State of Arkansas.
- ggg. Storm Drainage System: all surfaces, structures and systems that contribute to or convey stormwater, including private drainage systems, the MS4, surface water, groundwater, Waters of the State and Waters of the United States.
- hhh. Stormwater: runoff resulting from precipitation.
- iii. Stormwater Pollution Prevention Plan (SWPPP): a document that describes the Best Management Practices to be implemented at a site, to prevent or reduce the discharge of pollutants. It includes narrative, plan set, specifications, and other associated documents. Subdivision Development: includes activities associated with the platting of any parcel of land into two or more lots and includes all construction activity taking place thereon.
- jjj. Surface Water: water bodies and any water temporarily residing on the surface of the ground, including oceans, lakes, reservoirs, rivers, ponds, streams, puddles, channelized flow and runoff.
- kkk. TMDL: Total Maximum Daily Load
- lll. Track Out – The mud, soil, rock, or other debris that gets carried out of a construction site or area covered by a SWPPP.
- mmm. Uncontaminated: not containing harmful quantities of pollutants.
- nnn. Used Oil (or Used Motor Oil): any oil that as a result of use, storage, or handling, has become unsuitable for its original purpose because of impurities or the loss of original properties.

- ooo. Utility Agency: private utility companies, City departments or contractors working for private utility companies or City departments, engaged in the construction or maintenance of utility distribution lines and services, including water, sanitary sewer, storm sewer, electric, and gas, telephone, television and communication services.
- ppp. Wastewater: any water or other liquid, other than uncontaminated stormwater, discharged from a facility.
- qqq. Water of the State (or water): any groundwater, percolating or otherwise, lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, inside the territorial limits of the State, and all other bodies of surface water, natural or artificial, navigable or non-navigable, and including the beds and banks of all water courses and bodies of surface water, that are wholly or partially inside or bordering the State or inside the jurisdiction to the State.
- rrr. Water Quality Standard: the designation of a body or segment of surface water in the State for desirable uses and the narrative and numerical criteria deemed by State or Federal regulatory standards to be necessary to protect these uses.
- sss. Waters of the United States: all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and the flow of the tide; all interstate waters, including interstate wetlands; all other waters the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the United States under this definition; all tributaries of waters identified in this definition; all wetlands adjacent to water identified in this definition; and any waters within the federal definition of "Waters of the United States" at 40 CFR Section 122.2; but not including any waste treatment systems, treatment ponds, or lagoons designed to meet the requirements of the Federal Clean Water Act.
- ttt. Wetlands: an area that is regularly saturated by surface or groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include: swamps, bogs, fens, marshes, and estuaries.
- uuu. Yard Waste: leaves, grass clippings, tree limbs, or brush that result from landscaping, gardening, or yard maintenance.

(b) PROHIBITIONS AND REQUIREMENTS

(1) Prohibitions

- a. No person shall release or cause to be released into the storm drainage system any discharge that is not composed entirely of uncontaminated stormwater, except as allowed herein. Common stormwater contaminants include trash, yard waste, lawn chemicals, pet waste, waste water, oil,

petroleum products, cleaning products, paint products, hazardous waste, and sediment.

- b. Any discharge shall be prohibited by this Section if the discharge in question has been determined to be a source of pollutants to the storm drainage system.
- c. The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited. This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.
- d. No person shall connect a line conveying sanitary sewage, domestic sewage or industrial waste, to the storm drainage system, or allow such a connection to continue.
- e. No person shall maliciously destroy or interfere with BMP's implemented pursuant to this Chapter.
- f. No person shall cause or allow Illicit Discharges including but not limited to:
 - 1. **Minimization of Irrigation Runoff.** A discharge of irrigation water that is of sufficient quantity to cause a concentrated flow in the storm drainage system is prohibited. Irrigation systems shall be managed to reduce the discharge of water from a site.
 - 2. **Cleaning of Paved Surfaces Required.** The owner of any paved parking lot, street or drive shall clean the pavement as required to prevent the buildup and discharge of pollutants. The visible buildup of mechanical fluid, waste materials, sediment or debris is a violation of this ordinance. Paved surfaces shall be cleaned by dry sweeping, wet vacuum sweeping, collection and treatment of wash water or other methods in compliance with this Code.
 - 3. **Maintenance of Equipment.** Any leak or spill related to equipment maintenance in an outdoor, uncovered area shall be contained to prevent the potential release of pollutants. Vehicles, machinery and equipment-must be maintained to reduce leaking fluids.
 - 4. **Materials Storage.** In addition to other requirements of this Code, materials shall be stored to prevent the potential release of pollutants. The uncovered, outdoor storage of unsealed containers of hazardous substances is prohibited.
 - 5. **Pesticides, Herbicides and Fertilizers.** Pesticides, herbicides and fertilizers shall be applied in accordance with manufacturer recommendations and applicable laws. Excessive application shall be avoided. Limit the use of phosphorus in the Town Branch Watershed
 - 6. **Prohibition on use of pesticides and fungicides banned from manufacture.** Use of any pesticide, herbicide or fungicide, the

manufacture of which has been either voluntarily discontinued or prohibited by the Environmental Protection Agency, or any Federal, State or City regulation is prohibited.

7. Release Reporting and Cleanup. Any person responsible for a known or suspected release of materials which are resulting in or may result in illicit discharges to the storm drainage system shall take all necessary steps to ensure the discovery, containment, abatement and cleanup of such release. In the event of such a release of a hazardous material, said person shall comply with all state, federal, and local laws requiring reporting, cleanup, containment, and any other appropriate remedial action in response to the release. In the event of such a release of hazardous materials, said person shall notify the City Stormwater Control Inspector no later than 3:30 p.m. of the next business day and fill out a Spill Report form and submit it to the City of Bentonville within 5 business days.
8. Hyperchlorinated water.

(2) Exemptions. The following non-stormwater discharges are deemed acceptable and not a violation of this Section:

- a. Firefighting activities
- b. Fire hydrant flushing
- c. Water used to wash vehicles (where detergents or other chemicals are not used) or to control dust
- d. Potable water sources including uncontaminated waterline flushing
- e. Landscape Irrigation
- f. Routine external building wash down which does not use detergents or other chemicals;
- g. Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled materials have been removed) and where detergents or other chemicals are not used;
- h. Uncontaminated air conditioning compressor condensate
- i. Uncontaminated springs, excavation dewatering and groundwater
- j. Foundation or footing drains where flows are not contaminated with process materials such as solvents.

(c) **STORMWATER DISCHARGES FROM CONSTRUCTION ACTIVITY.**

(1) Scope and Exclusions

- a. Geographical Scope of Regulated Land-Disturbing Activity. This ordinance shall apply to land-disturbing activity within the territorial jurisdiction of the City of Bentonville and to the extraterritorial jurisdiction

as allowed by agreement between local governments, the extent of annexation or other appropriate legal instrument or law.

- b. Exclusions from Regulated Land-Disturbing Activity. Notwithstanding the general applicability of this ordinance to all land-disturbing activity, this ordinance shall not apply to the following types of land-disturbing activity:
 1. Activities, including the production and activities relating or incidental to the production of crops, grains, fruits, vegetables, ornamental and flowering plants, dairy, livestock, poultry, and all other forms of agriculture undertaken on agricultural land for the production of plants and animals useful to man, including, but not limited to:
 - i. Forage and sod crops, grain and feed crops, tobacco, cotton, and peanuts.
 - ii. Dairy animals and dairy products.
 - iii. Poultry and poultry products.
 - iv. Livestock, including beef cattle, llamas, sheep, swine, horses, ponies, mules, and goats.
 - v. Bees and apiary products.
 - vi. Fur producing animals.
 - vii. Mulch, ornamental plants, and other horticultural products. For purposes of this section, "mulch" means substances composed primarily of plant remains or mixtures of such substances.
 2. An Activity undertaken on forestland for the production and harvesting of timber and timber products and conducted in accordance with Arkansas best management practices for forestry. If land-disturbing activity undertaken on forestland for the production and harvesting of timber and timber products is not conducted in accordance with approved state forest best management practices, the provisions of this ordinance shall apply to such activity and any related land-disturbing activity on the tract.
 3. An activity which is essential to protect human life during an emergency.
- c. Plan Approval Requirement for Land-Disturbing Activity. No person shall undertake any land-disturbing activity subject to this ordinance without first obtaining the appropriate plan approval from the City of Bentonville.

- d. Protection of Property - Persons conducting land-disturbing activity shall take all reasonable measures to protect all public and private property from damage caused by such activity.
- e. Authorization to Adopt and Impose Best Management Practices. The City hereby adopts the “STORMWATER POLLUTION PREVENTION, GRADING, AND EROSION CONTROL Best Management Practices Manual” for any activity, operation, or facility, which may cause a discharge of pollutants to the storm drainage system. This document is available on the City website in the Stormwater Section. Where specific BMP's are required, every person undertaking such activity or operation, or owning or operating such facility shall implement and maintain these BMP's at their own expense.

(2) General Requirements for Land Disturbing Activities.

- a. All sites:
 - 1. The owner, permittee, or operator of a construction site that includes land disturbing activity shall be responsible for compliance with the requirements of this ordinance and other applicable federal and state rules.
 - 2. Erosion and Sediment Control. Best Management Practices shall be implemented to prevent the release of sediment from construction sites. Disturbed areas shall be minimized, disturbed soil shall be managed and construction site entrances shall be maintained.
 - 3. Track out is not allowed. It must be removed immediately if it exists.
 - 4. Temporary vegetation or other measure to control erosion must be placed in areas that will be inactive more than 14 days.
 - 5. Final stabilization must be in place prior to certificate of occupancy.
- b. Sites larger than 1 acre of land disturbing activity (In addition to Item a. above):
 - 1. The area disturbed shall be assumed to include the entire property or platted area unless all applicable plans specifically exclude certain areas from disturbance. Areas excluded from disturbance shall be noted on the plans and protected in the field.
 - 2. For sites subject to plan review by any City Division or Department, the plan will not be released for land disturbing activity until an approved SWPPP has been obtained, preconstruction meeting occurred, plans stamped, and BMPs installed and approved.
 - 3. A review of the SWPPP submitted for the site will be completed and notification will be given of either an approval of the SWPPP or a request for revisions will be made.

4. The owner, developer, and permittee (where applicable) bear the responsibility for implementation of the SWPPP no later than the preconstruction meeting
 5. During the development of a site, the person conducting the land-disturbing activity shall install and maintain all temporary and permanent erosion and sedimentation control measures as required by the approved plan or any provision of this Ordinance, or any order adopted pursuant to this ordinance.
 6. Whenever the City of Bentonville, determines that accelerated erosion and sedimentation continues despite the installation of BMPs, they shall direct the person conducting the land-disturbing activity to take additional protective action necessary to achieve compliance with the conditions specified in this ordinance.
 7. A Rain gauge is required to be on site to provide rainfall data.
- c. Larger than 5 acre land disturbing activity (In addition to Items a. and b. above):
1. The NOI shall be included in the approved SWPPP and kept on site in a dry and reasonably secure location before land disturbance begins. Documents related to SWPPP compliance shall be kept at the same location as SWPPP.
 2. An approved NOI received from ADEQ for the project shall be provided and posted in public view on the job site. This posting shall be posted at the entrance of the job site at all times. This can be a photocopy of the original. Posting shall be of material that will sustain the length of the permit.
 3. Self-Inspections: A copy of the SWPPP self-inspection shall be emailed to SWPPPSelfInspection@bentonvillear.com. The Operator or duly authorized person shall perform an inspection of the area covered by the plan after each phase of the plan has been completed and after establishment of temporary ground cover. Follow state and federal inspection frequency. The person who performs the inspection shall maintain and make available a record of the inspection at the site of the land-disturbing activity during normal business hours. The record shall set out any deviation from the approved SWPPP, identify any measures that may be required to correct the deviation, and document the completion of those measures. The record shall be maintained until permanent ground cover has been established as required by the approved SWPPP and Notice of Termination has been filed. The self-inspection reports for the job site shall be at the same location as NOI. If another type of inspection form is used, it must at a minimum contain all of the items as the State approved form. Inspections are required after final inspection until NOT is achieved. City must be notified of

NOT on all sites subject to this ordinance.

- i. The inspection shall be performed during or after each of the following phases of the plan;
 - a) initial installation of erosion and sediment control measures;
 - b) removal of existing ground cover;
 - c) completion of any grading that requires ground cover;
 - d) completion of all land-disturbing activity, construction, or development, including permanent ground cover establishment and removal of all temporary measures.
 - e) When there is a transfer of ownership or control of the tract of land where the erosion and sedimentation control plan has been approved and work has begun. The new owner or person in control shall conduct and document inspections until the project is permanently stabilized.
 - f) Document start and end dates on inspection reports or on SWPPP plans.
 - ii. If project Operator changes, a transfer of plans shall occur. Submit written request for the transfer of the SWPPP. The SWPPP holder shall comply with all terms and conditions of the plan until such time the plan is transferred.
- d. Sites covered by a Large Scale Development, Plat, Public Infrastructure Improvement Project, or Grading Permit. (In addition to Items a. , b., or c. above as applicable)
 1. Before land disturbing activity can begin, the Permittee shall have a pre-construction meeting with the City of Bentonville to review the approved plans and discuss construction sequencing for the site. Residential lots are not required to have a pre-construction meeting unless specifically requested by the City Engineer. No person shall initiate land-disturbing activity until after the pre-construction meeting has been held and approved. The Owner or Permittee will ensure the proper installation of BMPs as required in the SWPPP.
- (3) Stormwater Pollution Prevention Plans. Preparation and implementation of Stormwater Pollution Prevention Plans for construction activity shall comply with the following:
- a. SWPPP Drawings General Requirements. At a minimum the following shall be provided on the SWPPP drawings.
 1. Name, address, email, and phone number of the applicant, owner,

- operator, and permittee of the construction site on the cover sheet.
2. The existing and proposed topography of the site shown at a 1' contour interval over the entire site and offsite as need to show off site drainage sources and impacts.
 3. The site's property limits shown in true location with respect to the plan's topographic information.
 4. The proposed limits of land disturbing activities.
 5. All land-disturbing activity is to be planned and conducted to prevent off-site sedimentation and damage.
 6. Identify FIRM panel. Appropriate and applicable information from the Federal Emergency Management Agency (FEMA) flood maps and federal and state protected wetland maps.
 7. A site specific sequence of construction shall be contained on the SWPPP describing the relationship between the implementation and maintenance of sediment controls, including permanent and temporary stabilization and the various stages of land disturbing activity and construction. The specifications for the sequence shall be site specific and take into account seasonal variations.
 8. Provide pollution prevention notes
- b. Design and Performance Standards
1. SWPPP documents shall be developed according to Federal, State and Local laws including this ordinance.
 2. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.
 3. Erosion and sedimentation control measures, structures, and devices shall be planned, designed, and constructed to provide protection from the calculated maximum peak rate of runoff from the 25-year storm.
 4. Discharge rates from the site shall not exceed the pre-developed rate for all rainfall events.
 5. There shall be no right angle turns of water without adequate protection.
 6. Surface water runoff originating upgrade of exposed areas should be controlled to reduce erosion and sediment loss during the period of exposure.
 7. Plans shall be designed so that any increase in velocity of stormwater runoff resulting from a land-disturbing activity will not result in accelerated erosion of the receiving stormwater conveyance or at the point of discharge. Plans shall include measures to prevent accelerated erosion within the project boundary and at the point of discharge.

8. The construction-phase erosion (such as site stabilization) and sediment controls (such as check dams) should be designed to retain sediment on-site.
9. A site does not qualify for Notice of Termination when construction activity inside a structure such as material storage, cleaning, painting, trash, equipment/material delivery, caulking, tile, sealants, sheetrock etc. is ongoing.
10. If adverse weather prevents a stormwater inspection within 24hrs of the regulated storm event, then document the beginning and end date of the adverse weather condition and complete an inspection report as soon as it is safe.
11. Do not put stockpiles within 75' of neighboring structures, in prevailing wind direction, and keep under 12 feet high.
12. Sanitary wastes including portable toilets are to be kept a minimum of 25 feet from stormwater drainage structure.
13. No short circuiting of stormwater basin.
14. 80% density of permanent vegetation on entire site is required before final inspection regardless of season.
15. All BMPs must be within the SWPPP approved acreage limits.
16. Stormwater drain outfalls must terminate 25' from top of bank of Water of the State. If not feasible, city engineer approval of maximum extent practicable is required.
17. Waste Disposal. Solid waste, industrial waste, yard waste and any other pollutants or waste on any construction site shall be controlled through the use of Best Management Practices. Waste or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waste that may blow, wash or otherwise be released from the site is prohibited.
18. Concrete. Ready-mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying ready-mixed concrete, shall be contained on construction sites for proper disposal. Release of these materials is prohibited.
19. The entire post construction storm drainage system shall be cleaned, repaired, and maintained to as new condition.
20. Avoid increases in surface runoff volume and velocity by including measures to promote infiltration to compensate for increased runoff from areas rendered impervious
21. Avoid increases in storm water discharge velocities by using vegetated or roughened swales and waterways in place of closed drains and high velocity paved sections.

22. Provide energy dissipaters at outlets of storm drainage facilities to reduce flow velocities to the point of discharge.
23. Protect watercourses subject to accelerated erosion by improving cross sections and/or providing erosion-resistant lining
24. Upgrade or replace the receiving device structure, or watercourse such that it will receive and conduct the flow to a point where it is no longer subject to degradation from the increased rate of flow or increased velocity.

(4) Execution

a. General

1. SWPPP The subsequent owner of an individual lot bears the responsibility for continued implementation of the approved SWPPP for all construction activity within or related to the individual lot, excluding construction managed by utility agencies.
2. Graded Slopes and Fills. The angle for graded slopes and fills shall be no greater than the angle that can be retained by vegetative cover or other adequate erosion control devices or structures. In any event, slopes left exposed shall, within 21 calendar days of completion of any phase of grading, be planted or otherwise provided with temporary or permanent ground cover, devices, or structures sufficient to restrain erosion. The angle for graded slopes and fills must be demonstrated to be stable. Stable is the condition where the soil remains in its original configuration, with or without mechanical constraints.
3. Ground Cover. Provide a permanent ground cover sufficient to restrain erosion after completion of land disturbance.
4. Preparation
 - i. The SWPPP shall be prepared under the direction of a qualified person.
 - ii. The SWPPP shall provide a 24 hour contact name, address and phone number of the project owner for purposes of correspondence and enforcement.
 - iii. The SWPPP shall identify existing natural resources such as streams, forest cover and other established vegetative cover.
 - iv. The SWPPP shall specify and provide detail for all BMP's necessary to meet the requirements of this ordinance, including any applicable BMP's that have been adopted and imposed by the City.
 - v. The SWPPP shall specify when each BMP will be installed, and for how long it will be maintained within the construction sequence. Multiple plans may be required for

major phases of construction such as rough grading, building construction and final grading.

- vi. The SWPPP shall delineate all anticipated disturbed areas and specify the vegetative cover that must be established in those areas to achieve final stabilization.

5. Implementation

- i. BMP's shall be installed and maintained by qualified persons or persons who possess the required stormwater training from the City.
- ii. The owner, contractor, or permittee shall have a person capable of reading and thoroughly understanding the plans, specifications and requirements for the type of work being performed. The person shall have full authority to issue orders or direction to employees working on site, without delay and to promptly supply such materials, labor, equipment, tools, and incidentals as may be required to complete the work in a proper manner.
- iii. The owner/developer or their representative shall inspect all BMP's every 14 calendar days and within 24 hours after a rainfall of one quarter of an inch or more as measured at the site. A commercial rain gauge, appropriately installed and capable of accurate site rainfall measurements must be maintained onsite and rainfall events documented. If sediment escapes the construction site, off-site accumulations of sediment shall be removed at a frequency sufficient to minimize off-site impacts. This permit does not give the authority to trespass onto other property; therefore this condition should be carried out along with the permission of neighboring land owners to remove sediment.
- iv. Sediment shall be removed from sediment traps (if used, please specify what type) or sedimentation ponds when design capacity has been reduced by 50%.
- v. Silt fence must be cleaned when greater than 25% capacity has been exceeded.
- vi. Species of perennial grasses suitable for local climate and soil conditions are required to be planted to meet standards for permanent groundcover within 14 days of the completion of work in an area.
- vii. Prior to entering a construction site or subdivision development, utility agencies shall have obtained from the owner a copy of any SWPPP's for the project. Utility agencies shall develop and implement BMP's to prevent the release of pollutants from utility construction. Disturbed areas shall be minimized, disturbed soil shall be managed

and construction site entrances shall be managed to prevent sediment tracking. Excessive sediment tracked onto public streets shall be removed immediately. Any disturbance to BMP's resulting from utility construction shall be repaired immediately by the utility company.

- viii. Any change to the sequence of construction will require an additional review and approval by the City. Work performed varying from the approved sequence of construction is a violation of this ordinance.
- ix. Required Revisions: After approving a SWPPP, if the City of Bentonville, either upon review of such SWPPP or on inspection of the job site, determines that a significant risk of accelerated erosion or off-site sedimentation exists, the City of Bentonville shall require a revised SWPPP. Pending the preparation of the revised SWPPP, work shall cease or shall continue under conditions outlined by the appropriate authority. If following commencement of a land-disturbing activity pursuant to an approved SWPPP, the City of Bentonville determines that the SWPPP is inadequate to meet the requirements of this ordinance, the City of Bentonville may require any revision of the SWPPP that is necessary to comply with this ordinance. Contractors shall add and improve BMPs to prevent offsite conditions, but not ones that will change the flow unless there is an emergency condition. Changes to redirect or increase/decrease flow shall have written design engineer approval. Contractors shall implement the SWPPP and make changes only when erosion control measures are not effective in preventing significant impacts to Waters of the State or offsite. Contractors shall not revise the SWPPP before construction has initiated without approval from the City of Bentonville.
- x. Amendment to a SWPPP. Applications for amendment of a SWPPP may be made at any time under the same conditions as the original application. Until such time as said amendment is approved by the City of Bentonville, the land-disturbing activity shall not proceed except in accordance with the SWPPP as originally approved. If more than an additional acre is to be disturbed, notification of the City of Bentonville is required with the appropriate State permitting documentation.

(d) ENFORCEMENT PERSONNEL AUTHORIZED.

- (1) The City Engineer shall have the power to issue Notices of Violations, citations and implement other enforcement actions under this ordinance as provided by the

City of Bentonville.

(2) Right of Entry and Sampling

- a. Whenever an authorized enforcement person has cause to believe that there exists, or potentially exists, in or upon any premises any condition which constitutes a violation of this ordinance, the enforcement person shall have the right to enter the premises at any reasonable time to determine if the discharger is complying with all requirements of this ordinance. In the event that the owner or occupant refuses entry after a request to enter has been made, the City is hereby empowered to seek assistance from a court of competent jurisdiction in obtaining such entry.
- b. The City Engineer shall have the right to cause to be set up on the property of any discharger to the storm drainage system such devices that are necessary to conduct sampling of discharges. If such devices are required the cost will be covered by the Owner, Operator, or Permittee.

(3) Enforcement Procedures. This policy establishes a formal enforcement procedure to be followed by the City of Bentonville when enforcement action is necessary on sites that do not comply with the City's Storm water Pollution Prevention, and Erosion Control Ordinance. Enforcement cases can be generated in any of three ways: (1) through the construction review process; (2) through complaints from individuals or groups; and (3) through referrals from City/State agencies. Procedures to be followed for the issuance of a Notice of Violation or Compliance Review (see Actions below):

- a. Construction Review. Every effort is made to use the Construction Review process to correct deficiencies in site compliance whenever possible. Should that process fail to achieve expected results or the site reviewer feels that a violation is serious enough to warrant enforcement action, the following procedures shall be followed:
- b. Submissions from the General Public. Members of the General Public may submit information pertaining to this ordinance to the City of Bentonville, Engineering Department. The City Engineer will consider such submissions as they pertain to the implementation and enforcement of this ordinance and will provide written or verbal response to the person submitting the information.
- c. Referrals from other agencies. Referrals from other agencies will be referred directly to the City Engineer. At this point the City Engineer working with the referral agency will determine if enforcement actions are warranted and if proper documentation has been obtained. If a determination is made that action is required, the enforcement process will be set into motion.
- d. Actions
 1. Notice of Violation: If site deficiencies are noted, the Permittee or their on-site representative shall be given a Notice of Violation. The Notice of Violation shall be specific as to the noted violation(s), corrective measures to be taken, and time frame

allowed completing the work.

2. Compliance Review: At the end of the time period specified above, a follow-up site inspection shall take place to determine whether compliance has been achieved.

e. Depending on that determination, the following actions may occur:

1. Site Violations Corrected: If all previous site violations have been corrected, the City Engineer shall issue an inspection report stating that fact and the site shall be returned to a normal Construction Review status.
2. Previous Violations Not Corrected: If previously noted Violations have not been satisfactorily corrected, the further actions may be initiated as outlined in the following section.

- a) Cases received by the City Engineer will be handled on a first come first served basis. All enforcement actions will be initiated by a site inspection to verify site conditions that caused the case to be referred. If conditions have been corrected or do not exist as stated in the referral, the case will be returned to file for documentation and reporting purposes. If conditions exist as stated in the referral, enforcement actions will proceed.

3. Once site conditions have been verified and the site is determined to be in a state of non-compliance, two avenues of enforcement can be pursued, one for the infrequent offender and one for the frequent offender.

- a) Infrequent Offender. If a Permittee being reviewed for the first time or it has been at least 3 years since the last Notice of Violation (36 months has elapsed since last violation), Notice of Violation will be issued to the Permittee informing them they are not in compliance with the City's Stormwater Pollution Prevention and Erosion Control Ordinance, the steps needed to be taken to get into compliance, and that they have an established time frame to complete the work. At the end of the period a re-inspection will be conducted to check for compliance. If all corrective actions has been satisfactorily completed the case will be returned to file for documentation and reporting purposes. If the work has not been satisfactorily completed within the established time frame, citation will be issued to the Permittee.

- b) Frequent Offender. If a Permittee has been cited for a violation three or more times in the preceding 36

months they will be considered repeat offenders. Repeat offenders will be issued a Stop Work Order upon verification of non-compliance with the City's Storm water Pollution Prevention and Erosion Control Ordinance and the corrective actions to be taken to get into compliance along with an established time frame to complete the work. At the end of the period a re-inspection shall be conducted to check for compliance. If all work has been satisfactorily completed the case will be returned to file for documentation and reporting purposes. If the work has not been satisfactorily completed within the established time frame, a citation shall be issued to the Permittee.

(4) Enforcement Options for Notice of Violation

- a. The City Engineer may issue a Stop Work Order to any persons violating any provision of the City's Stormwater Pollution Prevention, Erosion Control Ordinance by ordering that all site work stop except that necessary to comply with any administrative order.
 1. The City Engineer has primary responsibility for the administration and enforcement of this Stop Work Order.
 2. Representatives of the Transportation Engineering Department, the City Engineer and Code Enforcement Officers may serve as the City's designee, with full authority to enforce all municipal infraction provisions of this Chapter.
 3. In addition to all other means of enforcement provided for by law and in this Chapter, the Transportation Director, City Engineer, Stormwater Inspector, Code Enforcement officers, or police officers may issue a "stop work order" to any person who violates any provision of this Chapter. A stop work order also may be issued on the basis of information received setting forth the facts of the alleged violation.
 4. Any person who receives such a stop work order shall immediately cease the activity that constitutes the violation. The person shall comply with all terms and conditions imposed by the person issuing the order before the activity may resume.
 5. A person who receives a stop work order may appeal the issuance of the stop work order to the City Council within 10 days after the issuance of the stop work order.
 6. If there has not been an appeal of the Stop Work Order made to the City Council within the designated 10 days of issuance of the stop work order and no reasonable attempt has been made to rectify the violation within 21 days of issuance of the stop work order, the City Engineer shall impose a fine in accordance with the schedule of

finest found in Item (7) of this Section.

- b. City Engineer may initiate penalties as stipulated herein. Complete information concerning enforcement and penalties is described below.
- c. Appeal Process.
 - 1. Any violation notice issued pursuant to this chapter may be appealed in writing to the City Council within 10 days of the date of the violation notice.
 - 2. Any party aggrieved by the decision of the City Engineer denying a waiver or a variance of the requirements of this chapter may appeal such decision to the City Council, in writing, within 10 days of the date of the written denial.
 - 3. An appeal to the City Council pursuant to this section is a prerequisite to any court action by the aggrieved party.

(5) Action without Prior Notice. Any person who violated a prohibition or fails to meet a requirement of this Chapter will be subject, without prior notice, to one or more of the enforcement actions, when attempts to contact the person have failed and the enforcement actions are necessary to stop an actual or threatened discharge which presents or may present imminent danger to the environment, or to the health or welfare of persons, or to the storm drainage system.

(6) Criminal Penalties. The violation of any provision of this ordinance shall be deemed a municipal offense. Any person in violation this ordinance shall, upon an adjudication of guilt or a plea of no contest, be fined according to the schedule of fines for each separate day on which a violation is committed or continues shall constitute a separate offense. Other Legal Action. Notwithstanding any other remedies or procedures available to the City, if any person discharges into the storm drainage system in a manner that is contrary to the provisions of this ordinance, an Attorney acting on behalf of the City may commence an action for appropriate legal and equitable relief including damages and costs in any court of competent jurisdiction. The Attorney may seek a preliminary or permanent injunction or both which restrains or compels the activities on the part of the discharger.

(7) Violations/Schedule of Fines. A violation of any of the foregoing provisions shall be punished in accord with the following schedule of fines per violation: First Offense - \$500.00; Second Offense - \$1,000.00; Third Offense - \$2,000.00; Fourth and Subsequent Offenses - \$4,000.00

(e) TERMINATION

(1) Upon completion of construction activities a copy of the Notice of Termination filed with ADEQ shall be filed with the City Engineer indicating compliance with the provisions of this ordinance.

(f) MAINTENANCE OF STORMWATER FACILITIES

(1) Maintenance Responsibility. Those stormwater management systems approved in

compliance with this chapter that will function as an integral part of the system maintained by the city shall be dedicated to the city. All areas and/or structures to be dedicated to the city must be dedicated by plat or separate instrument and accepted by action of the City Council. All stormwater management systems accepted as dedications by the city shall be maintained by the city. Maintenance of all other stormwater management systems approved in compliance with this chapter shall be accomplished by the legal entity responsible for maintenance, which may include an approved entity as identified in the following:

- a. Local government-a county, municipality, municipal service taxing unit, special district, or other appropriate governmental unit;
- b. Special district-an active water control district, a drainage district, or a special assessment district;
- c. State or federal agency-an appropriate state or federal agency;
- d. Public entity-an officially franchised, licensed, or approved communication, water, sewer, electrical, stormwater, or other public utility;
- e. Developer or property owner-a developer or property owner who provides a bond or other assurance of continued financial capability to operate and maintain stormwater management systems and who executes a legal maintenance agreement with the city; or
- f. Property owner association-property owner associations able to comply with the following provisions:
 - g. The association provides a binding legal instrument through which it assumes full responsibility for stormwater management system operation and maintenance.
 - h. The association has sufficient powers to operate and maintain the system, establish rules, assess members, contract for services, exist perpetually and, if dissolved, to provide alternative operation and maintenance services.
 - i. The association can provide a bond or other assurances of financial capability to operate and maintain services.

(2) Post Construction Stormwater Maintenance

- a. Private Drainage System Maintenance. The owner of any private drainage system shall maintain the system to prevent or reduce the discharge of pollutants. This maintenance shall include, but is not limited to, sediment removal, bank erosion repairs, maintenance of vegetative cover, and removal of debris from pipes and structures.
- b. Open Drainage Channel Maintenance. Every person owning or occupying property through which an open drainage channel passes shall keep and maintain that part of the drainage channel within the property free of trash, debris, excessive vegetation, and other obstacles that would pollute, contaminate, or retard the flow of water through the drainage channel. In addition, the owner or occupant shall maintain existing privately owned

structures adjacent to a drainage channel, so that such structures will not become a hazard to the use, function, or physical integrity of the drainage channel.

Section 1700.02 Drainage Manual

(a) SUBMITTAL PROCEDURES

(1) GENERAL

- a. Engineering Department review of the proposed Drainage Plan shall include examination of the supporting calculations. Computations must be submitted either as a part of the Plans or on separate tabulations sheets convenient for review and use as a permanent record in order to speed review.
- b. All documents will be submitted through the electronic system used by the City Planning Department for project reviews.
- c. In order to minimize review time by the City Engineer's staff, all submittals shall include: (1) Title Sheet, (2) Master Site Plan, (3) Drainage Plan(s), (4) Right-of- Way Sheet, (S) Plan and Profile Sheet(s), (6) Standard and Special Detail Sheets, (7) Drainage Area Map, and (8) Calculations. Combining of the above items is allowed when legibility and readability is maintained.
- d. A written drainage report shall accompany the plan submittal. Examples of additional submittal requirements may include a grading permit, a stormwater pollution prevention plan, and erosion control plan
- e. The word "improvement" means the construction of public or private infrastructures, roadways, drainage, utilities, and buildings.
- f. On combination roadway-drainage projects, it is not the intent that completely separate storm drainage plans be prepared. Where the required details of the proposed storm drainage system can be adequately shown on the roadway plans without sacrificing clarity, the roadway plans will be sufficient. If a combined project submittal is made for review of only roadway or only storm drainage aspects of the project, this fact shall be clearly indicated in large, bold lettering on the Title Sheet.
- g. Plans and Specifications for storm drainage plans are to be signed and stamped by a professional engineer registered in the State of Arkansas. Because all plans, specifications, and calculations are retained by the City for use as permanent records, neatness, clarity and completeness are very important and lack of these qualities will be considered sufficient basis for submittal rejection.

- h. The suggested plan sheet size is 24" x 36" with all sheets in a given set of plans the same size. The Master Site Plan should include the overall scope of the project on one sheet regardless of the scale. Plan drawings will be prepared with a maximum horizontal scale of 1" = 50'. Profile drawings for storm sewers should be drawn to a suggested horizontal scale of 1" = 20' with a maximum scale of 1" = 50'; and a minimum vertical scale of 1" = 5'. Drainage ditch profiles should be drawn at the suggested horizontal scale of 1" = 20' with a maximum scale of 1" = 50'; and a minimum vertical scale of 1" = 5'. Special cases may warrant use of larger or smaller scale drawings for increased clarity or conciseness of the plans and may be used with prior permission of the City Engineer.
- i. Each sheet in a set of Plans shall contain a sheet number, the total number of sheets in the Plans, proper project identification and the date. Revised sheets submitted must contain a revision block with identifying notations and dates for revisions, and the revised areas must be clouded.

(2) TITLE SHEET

- a. Title shall include:
 - 1. The designation of the project, which includes the nature of the project, the name or title, city, and state.
 - 2. Index of sheets.
 - 3. Location maps showing project location in relation to streets, railroads, and physical features. The location map shall have a north arrow and appropriate scale.
 - 4. A project control bench mark identified as to the location and elevation.
 - 5. Horizontal and Vertical Datum:
 - 6. All drainage improvements in the City of Bentonville shall be tied to the City of Bentonville Survey Monumentation System based upon the State Plane Coordinate System, Arkansas North Zone using the North American Datum of 1983 (NAD 83). All information for newly constructed streets and roads at the time of approval shall be delivered to the City of Bentonville Engineering Department, georeferenced, in an AutoCAD compatible digital format for review and acceptance.
 - 7. All drainage construction shall use the above mentioned coordinate system and shall identify with monuments that were used for horizontal and vertical control. Elevation of controlling points shall be based on USGS NAVD 88 datum.

8. The name and address of the owner of the project and the engineer preparing the plans.
9. Engineer's seal.

(3) Drainage Plan

a. The Drainage Plan shall include:

1. North arrow and scale.
2. Legend of symbols, which will apply to all sheets.
3. Name of subdivision, if applicable, and all street names and an accurate tie to at least one quarter section corner. Unplatted tracts should have an accurate tie to at least one quarter section corner.
4. Boundary line or project area.
5. Location and description of existing major drainage and utility facilities within or adjacent to the project area.
6. Location and description (size, material, etc.) of major proposed drainage facilities, along with other proposed improvements.
7. Name and description (size, material, utility owner, etc.) of each utility within or adjacent to the project area.
8. If more than one sheet is required, a match line should be used to show continuation of coverage from one sheet to the next sheet. A key should be included to show the sheet's location in relation to the overall project.
9. The registration seal of the Engineer of Record shall be placed in a convenient place on each set of plans.
10. Elevations on profiles of sections or as indicated on plans shall have
11. U.S.G.S. data. At least one permanent bench mark in the vicinity of each project shall be noted on the first drawing of each project, and their location and elevation shall be clearly defined.
12. Horizontal and Vertical Datum:
13. All drainage improvements in the City of Bentonville shall be tied

to the City of Bentonville Survey Monumentation System based upon the State Plane Coordinate System, Arkansas North Zone using the North American Datum of 1983 (NAD 83). All information for newly constructed streets and roads at the time of approval shall be delivered to the City of Bentonville Engineering Department, georeferenced, in an AutoCAD compatible digital format for review and acceptance.

14. All drainage construction shall use the above mentioned coordinate system and shall identify with monuments that were used for horizontal and vertical control. Elevation of controlling points shall be based on USGS NAVD 88 datum.
15. The top of each page shall be either north or east. The stationing of street plans and profiles shall be from left to right and downstream to upstream in the case of channel improvement/construction projects unless approved by the City Engineer.
16. Each project shall show at least 100' of topography beyond the project limits. At least 100' of topography shall be shown in areas of channel flow at the property boundary. For sites one (1) acre or smaller, the project shall show at least 50' of topography beyond the project limits. City aerial topography can be used outside of the project limits. All existing topography and any proposed changes, including utilities, telephone installations, etc., shall be shown on the plans and profiles. An increase of distance beyond the project limits shall be provided if requested by the City Engineer.
17. Revisions to drawings shall be indicated above the title block in a revision block and shall show the nature of the revision and the date made. The revised area shall be clouded, unless the entire sheet is affected.
18. Utilizing the standard symbols for engineering plans, all existing utilities, telephone installations, sanitary and storm sewers, pavements, curbs, inlets, and culverts, etc., shall be shown with a broken line; proposed facilities with a solid line; land, lot, and property lines to be shown with a slightly lighter solid line. Easements shall be shown.
19. Lot lines and dimensions shall be shown where applicable.
20. All occupied buildings, whether in or out of a designated floodplain shall have the finished floor elevation a minimum of 12" above the land immediately surrounding the building.
21. It shall be understood that the requirements outlined in these standards are only minimum requirements and shall only be applied

when conditions, design criteria, and materials conform to the City Specifications and are normal and acceptable to the City Engineer. When unusual subsoil or drainage conditions are suspected, an investigation should be made and a special design prepared in line with good engineering practice.

(b) DETERMINATION OF STORM RUNOFF

(1) CITY OF BENTONVILLE DRAINAGE METHODS

- a. Three widely used methods include: The Rational Method, the Soil Conservation Service Technical Release - 55 Synthetic Hydrograph Method, and the use of the Corps of Engineers HEC-HMS computer programs. One of these three methods should be the basis of all drainage analysis in the City of Bentonville. If the design engineer proposes to use an alternative method, they first must obtain approval from the City Engineer. The City Engineer may request that the design engineer provide proof of applicability for the intended project. The area limits and/or ranges for the analysis methods are:
 1. Rational Method: Less than 10 Acres
 2. Modified Rational Method, SCS TR-55/TR-20 or NEC-1: 10 to 100 Acres or < 10 if required for detention analysis
 3. SCS TR-55
 4. Hydrograph Method Or HEC -HMS 100 to 2,000 Acres
 5. HEC-HMS Greater than 2,000 Acres or within Designated FEMA Flood Plain Areas
- b. Computer programs may be used in the satisfaction of the above minimum standards. The City Engineer may disallow any specific software about which there are concerns of the accuracy thereof, or which produce printed calculations that are inadequate to define the design process, or which are difficult to review.

(c) FLOW IN STORM DRAINS AND DRAINAGE APPURTENANCES

(1) GENERAL

- a. Hydraulically, storm drainage systems are conduits (open or closed) in which unsteady and non-uniform free flow exists. Storm drains accordingly are designed for open-channel flow to satisfy, as well as possible, the requirements for unsteady and non-uniform flow. Steady flow conditions may or may not be uniform.

(2) STORM SEWER DESIGN REQUIREMENTS

- a. A plan of the drainage area that ties to the City of Bentonville monumentation network, which is available on the City of Bentonville's GIS map at www.bentonvillear.com. Contours shall be a minimum of 1 foot, regardless of the plan scale. This plan shall include all proposed street, drainage, and grading improvements with flow quantities and direction at all critical points. All areas and subareas for drainage calculations shall be clearly distinguished.
- b. Complete hydraulic data showing all calculations. Computer generated computations and output are accepted and subject to review by City Engineer.
- c. A plan and profile of all proposed improvements at a scale of 1" = 20' to 1" = 50' horizontal and 1" = 5' vertical shall be submitted. This plan shall include the following: Location, sizes, flow line elevations and grades of pipes, channels, boxes, manholes and other structures drawn on standard plan-profiles; a list of the kind and quantities of materials; typical sections of all boxes and channels; location of property lines, street paving, sanitary sewers and other utilities; and standard installation details for all facilities.
- d. A field study of the downstream capacity is required of all drainage facilities and the effect of additional flow from the area to be improved shall be submitted. If the effect is to endanger property or life, the problem must be resolved before the plan will be given approval. Stormwater flow quantities in the street shall be shown at all street intersections and all inlet openings and locations where flow is removed from the streets. This shall include the hydraulic calculations for all inlet openings and street flow capacities. The street flow shall be limited according to Section (f), Flow in Streets.
- e. Any additional information deemed necessary by the City Engineer for an adequate consideration of the storm drainage effect on the City of Bentonville and surrounding areas must be submitted.

(3) REQUIREMENTS RELATIVE TO IMPROVEMENTS

- a. **DESIGN CRITERIA / STORM FREQUENCIES** All storm drains, roadway crossings, open channels, and other drainage ways shall be designed to convey the 25-year design storm. Emergency overflow for 100 year events shall be maintained. Design frequencies above are minimum requirements. It is the Engineer's responsibility to comply with state and federal regulations and guidelines. It is also the Engineer's responsibility to ensure storm sewer design will not adversely impact adjacent properties.

- b. **BRIDGES AND CULVERTS** Bridges or culverts shall be provided where streets or alleys cross water courses and shall be designed to accommodate a 100-year storm and meet Federal Emergency Management Agency (FEMA) regulations on FEMA regulated floodways or floodplains. The structure shall be designed in accordance with current Arkansas Department of Transportation specification materials and to carry a minimum H-20 loadings in any case. Where same structure is to be constructed in a location other than existing or proposed street right-of-way, H-10 loadings may be used.
- c. **CLOSED STORM SEWER** Closed storm sewers for all conditions shall be designed to accommodate a 25-year frequency storm, based on the drainage area involved. Same shall either be Reinforced Concrete Box culverts for minimum H-20 loadings on street right-of-way or H-10 loadings elsewhere, or Reinforced Concrete Pipe ASTM Class III when sufficient cover is provided or ASTM Class IV when less than one-foot under paving or less than two feet of cover.
- d. **MINIMUM VELOCITY** Storm drains should operate with velocities of flow sufficient to prevent excessive deposition of solid material; otherwise, objectionable clogging may result. The controlling velocity is near the bottom of conduits and considerably less than the mean velocity. Storm drains shall be designed to have a minimum velocity flowing full of 2.5 fps. Grades for closed storm sewers and open paved channels shall be designed so that the velocity shall not be less than 2.5 fps nor exceed 12 fps. All other structures such as junction boxes or inlets shall be in accordance with City standard drawings. The minimum slope for standard construction procedures shall be 0.50 percent when possible. This minimum slope shall not apply to underground detention systems. Any variance must be approved specifically in writing by the City Engineer.
- e. **OPEN DITCHES (EARTH CHANNELS)** Open earth ditches shall be designed to carry the 100-year frequency storm without encroaching on existing buildings, infrastructures, or improvements and must be contained within a dedicated drainage easement if carrying water from multiple properties. The 100-year water surface elevation must not be increased in conjunction with the ditch. Ditches shall have a gradient to keep the velocity within 1.5 to 5.0 feet per second in unpaved channels unless approved by City Engineer. Sod shall be required to within the banks unless approved by the City Engineer. Side slopes shall have a minimum slope ratio of 3:1 unless approved specifically in writing by the City Engineer. Designer's attention is directed to the fact that the Subdivision Ordinance prohibits encroachment of buildings and improvements on natural or designated drainage channels, or the channel's floodways. Floodplains are areas of land adjacent to an open channel (not in closed

storm sewers) that may flood during a 100-year rain. Such floodways and floodplains shall be indicated on drainage improvement plans and individual plot plans.

- f. **OPEN PAVED CHANNELS** Open paved channels are to be used where flow velocity exceeds 5 fps or channel grade is less than 1.00%, unless approved by the City Engineer. Open paved storm drainage channels shall be designed to carry a 100-year frequency storm without encroaching on existing buildings, infrastructures, or improvements. Such channels may be of different shapes according to existing conditions. The channel shall be of concrete with a minimum four-inch thickness paved to a point 1' above the 25-year storm depth. Six-inch minimum thickness is required where maintained by machinery. Thickness of concrete and amount of reinforcing steel shall depend upon conditions at site and size of channel. Gabion or riprap lined channels may be used in place of paved channels where approved by the City Engineer. Channels dedicated to the City of Bentonville shall be designed to be cleaned by mechanical means. Below are the design requirements for these types of channels:
1. Channel Type – Trapezoidal
 2. Bottom Width (min.) – six (6) feet
 3. Concrete Thickness (min.) – six (6) inches
 4. Concrete Strength (min) – 3500 psi
 5. Side Slopes – 3:1 of flatter
 6. Weep Holes – every 75 sf along the channel bottom (2")
 7. Class 7 Base Course – six (6) inches compacted to 95%
 8. Subgrade – design engineer responsible for design.
 9. Reinforcing steel – design engineer responsible for design.
 10. Easements – the channel shall be contained within a drainage easement and access to the channel shall be provided through the use of the drainage easement. Access shall be off of a public street or other means of access as approved by the City Engineer.

g. **FULL OR PART FULL FLOW IN STORM DRAINS**

h. **GENERAL**

1. There are several general rules to be observed when designing storm sewer runs. When followed, they will tend to alleviate or eliminate the common mistakes made in storm sewer design. These rules are as follow:
 - i. Select pipe size and slope so that the velocity of flow will increase progressively, or at least will not appreciably decrease at inlets, bends or other changes in geometry or configuration. An 18" pipe diameter is the minimum acceptable pipe diameter in the City ROW, or if the City will maintain the pipe. Where used, arch pipe sizes shall be

hydraulically equivalent to the round pipe size.

- ii. Do not discharge the contents of a larger pipe into a smaller one, even though the capacity of the smaller pipe may be greater due to steeper slope.
- iii. At changes in pipe sizes, match the soffits or crown of the two pipes at the same level rather than matching the flow lines.
- iv. Conduits are to be checked at the time of their design with reference to critical slope. If the slope of the line is greater than critical slope, the unit will likely be operating under entrance control instead of the originally assumed normal flow. Conduit slopes should be kept below critical slope if at all possible. This also removes the possibility of a hydraulic jump within the line.

i. PIPE FLOW DESIGN

1. Pipe flow design shall be accomplished using currently available software or manually calculated using standard engineering practices as approved by the City Engineer.

j. ROUGHNESS COEFFICIENTS

1. Roughness coefficients for storm drains shall be based on manufactures recommendations and standard engineering practice.

k. MANHOLE LOCATIONS

1. Manholes or maintenance access ports will be required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two or more sewers. A manhole may be required at the beginning and/or at the end of a curved section of storm sewer. The maximum spacing between manholes for various pipe sizes shall be in accordance with the Chart below. The required manhole size shall be as follows: 18" – 24" pipe ID 48" minimum interior dimension. 27" – 36" pipe ID 60" minimum interior dimension. Greater than 36" minimum interior dimension 60" or greater to accommodate all pipe with adequate sidewall to support load. A manhole is required every 500 linear foot of pipe.
2. Connections will be made by inlet or junction boxes
3. Minor head losses need to be included in the design.

l. UTILITIES

1. In the design of a storm drainage system, the Engineer is frequently confronted with the problem of grade conflict between the proposed storm drain and existing utilities, such as water, gas, sanitary sewer,

- electric, and communication lines.
2. When conflicts arise between a proposed drainage system and utility system, the owner of the utility system shall be contacted and made aware of the conflict. Any adjustments necessary to the drainage system or the utility can then be determined.
 3. Due to the difficulty and expense to the public with regard to hand cleaning, clearing, and other ditch maintenance, the following ditch requirements are specified to expedite small equipment cleaning and access to drainage easements and ditches:
 - i. Manholes are not allowed in drainage ditches, unless approved by the City Engineer.
 - ii. Access easements shall be required every 600 feet. Access to be provided from public street to drainage facility.
 - iii. Utility crossings above the channel flow line shall not be allowed unless approved specifically in writing by the City Engineer.
 - iv. Utilities shall not be located beneath a concrete ditch bottom except at crossings.
 - v. Utilities shall have a vertical separation from storm sewer lines of at least 8 inches (O.D. to O.D., unless greater separation is required by the utility).
 - vi. Minimum drainage easement width shall be 20 feet.
 - vii. Minimum Access Easement width shall be 20 feet.

(d) CULVERT HYDRAULICS

(1) GENERAL

- a. The function of a drainage culvert is to pass the design storm flow under a roadway or railroad without causing excessive backwater and without creating excessive downstream velocities. Culvert flow may be separated into two major types of flow - inlet or outlet control. Under inlet control, the cross sectional area of the barrel, the shape of the inlet and the amount of ponding (headwater) at the inlet are primary design considerations. Outlet control is dependent upon the depth of water in the outlet channel (tailwater), the slope of the barrel, type of culvert material and length of the barrel.

(2) INLET CONTROL

- a. The size of a culvert operating with inlet control is determined by the size and shape of the inlet and the depth of ponding allowable (headwater) between the flow line elevation of a culvert and the elevation of a finished grade surface or surrounding buildings and facilities. Factors not effecting inlet control design are the barrel roughness, slope and length and depth of the tailwater. The headwater (HW) depth for a culvert of a given diameter or

height (D) where a discharge is given can be determined by obtaining the HW/D value from current Hydraulic Design Series #5, FHWA. A desirable maximum headwater for a culvert should not be greater than the diameter or height plus 2'. The elevation of adjacent facilities (i.e., buildings, etc.) must be reviewed for flooding.

(3) OUTLET CONTROL

- a. A culvert will operate under outlet control when the depth of the tailwater, the length, the slope or roughness of the culvert barrel act as the control on the quantity of water able to pass through a given culvert. Energy head required for a culvert to operate under outlet control is comprised of velocity head (H_v), entrance loss (H_e) and friction loss (H_f). This energy head (H) is obtained from current Hydraulic Design Series #5, FHWA.
- b. The maximum desirable headwater depth for culverts operating under outlet control shall be the same as described in this section.
- c. Computer generated computations and output are accepted and subject to review by City Engineer.

(4) HEADWALLS AND ENDWALLS

a. GENERAL

1. The normal functions of properly designed headwalls and end walls are to anchor the culvert, to prevent movement due to the lateral pressures, to control erosion and scour resulting from excessive velocities and turbulence, and to prevent adjacent soil from sloughing into the waterway opening. Headwalls shall be constructed of reinforced concrete and may either be straight parallel headwalls, flared headwalls, or warped headwalls with or without aprons as may be required by site conditions. Multi-barrel culvert crossings of roadways at an angle of 15° or greater shall be accompanied by adequate inlet and outlet control sections.

(5) CONDITIONS AT ENTRANCE

- a. It is important to recognize that the operational characteristics of a culvert may be completely changed by the shape or condition at the inlet or entrance. Design of culverts involve consideration of energy losses that occur at the entrance.
- b. In general, the following guidelines should be used in the selection of the type of headwalls or endwalls.
 1. Straight/Parallel Headwalls and Endwalls
 2. Approach velocities are low (below 6 feet per sec.).
 3. Backwater pools may be permitted.
 4. Approach channel is undefined.
 5. Ample right-of-way or easement is available.
- c. Flared Headwall and Endwall:

1. Channel is well defined.
 2. Approach velocities are between 6 and 10 feet per second.
 3. Medium amounts of debris exists.
 4. The wings of flared walls should be located with respect to the direction of the approaching flow instead of the culvert axis.
- d. Warped Headwall and Endwall:
1. Channel is well defined and concrete lined.
 2. Approach velocities are between 8 and 20 feet per second.
 3. Medium amounts of debris exists.
- e. These headwalls are effective with drop down aprons to accelerate flow through the culvert, and are effective for transitioning flow from closed conduit flow to open channel flow. This type of headwall should be used only where the drainage structure is large and right-of-way or easement is limited.

(6) CULVERT DISCHARGE VELOCITIES

- a. The velocity of discharge from culverts should be limited as shown below. Consideration must be given to the effect of high velocities, eddies, or other turbulence on the natural channel, downstream property, and roadway embankment.
1. Bare Earth (Only when adjacent to undeveloped areas) 2 FPS
 2. Sodded Earth 5 FPS
 3. Paved or Riprap Apron 15 FPS
 4. Rock 15 FPS
 5. Other As approved by City Engineer

(7) ENERGY DISSIPATERS

- a. Energy dissipaters are used to dissipate excessive kinetic energy in flowing water that could promote erosion. An effective energy dissipater must be able to retard the flow of fast moving water without damage to the structure or to the channel below the structure.
- b. Impact-type energy dissipaters direct the water into an obstruction that diverts the flow in many directions and in this manner dissipates the energy in the flow. Baffled outlets and baffled aprons are two (2) impact- type energy dissipaters.
- c. Other energy dissipaters use the hydraulic jump to dissipate the excess head. In this type of structure, water flowing at a higher than critical velocity is forced into a hydraulic jump, and energy is dissipated in the resulting turbulence. Stilling basins are this type of dissipater, where energy is diffused as flow plunges into a pool of water.
- d. Generally, the impact-type of energy dissipater is considered to be more

efficient than the hydraulic jump-type. Also the impact-type energy dissipater results in smaller and more economical structures.

- e. The design of energy dissipaters is based on HEC 14.

(8) CULVERT TYPES AND SIZES

- a. The permissible types of culverts under all roadways and embankments are reinforced concrete box, round, or elliptical concrete pipe or pipe arch.
- b. The minimum size of pipe for all culverts shall be 18" or the equivalent sized elliptical pipe or arch pipe. Box culverts may be constructed in sizes equal to or larger than 3' x 2' (width versus height), except as approved by the City Engineer.
- c. If material other than reinforced concrete pipe is to be used, it shall be approved by the City Engineer.
- d. Precast or poured in place concrete aprons may be used in lieu of headwalls to improve the hydraulic capabilities of the culverts. Plastic and HDPE end sections are prohibited.

(9) FILL HEIGHTS AND BEDDING

- a. The minimum cover over any culvert or box culvert shall be 18", or a minimum of 6" from the bottom of the pavement subgrade, unless approved by City Engineer. Minimum cover less than these values shall be fully justified in writing and approved by the City Engineer prior to proceeding with final plans. Maximum fill heights shall be based on pipe manufacturer's recommendations. Box culverts shall be structurally designed to accommodate earth and live load to be imposed upon the culvert. Refer to the Arkansas Department of Transportation Standard Plans for Typical Box Culvert Designs. When installed within public right-of-ways, all culverts shall be capable of withstanding minimum H-20 loading.
- b. Where culverts under railroad facilities are necessary, the designer shall obtain approval from the affected railroad.

(10) CULVERT DESIGN PROCEDURE:

- a. Computer generated computations and output are accepted and subject to review by City Engineer.

(e) STORMWATER DETENTION

(1) GENERAL

- a. Stormwater runoff and the velocity of discharge are considerably increased through development and growth of the City. Prior to the development of land, surface conditions provide a high percentage of permeability and a

longer time of concentration. With the construction of buildings, parking lots, etc., permeability and the time of concentration are significantly decreased. These modifications may create harmful effects on properties downstream.

- b. Criteria for differential runoff and detention guidelines are set out below to attempt to decrease the possible effects of development on downstream properties due to increased runoff.
- c. Downstream Conditions: A field study of the downstream capacity of all drainage facilities and the effects from the area to be improved shall be submitted which includes an area equal to twenty (20) times the project area or one-half (1/2) mile minimum distance along the drainage path.
- d. No increase in peak flow discharge from the one hundred (100) year precipitation event down to and including the two (2) year event or release rates from the site prior to the peak discharge shall be allowed into areas within the City of Bentonville, Arkansas, or the city's planning jurisdiction.
- e. An acceptable solution must be presented to the Planning Commission as a part of the PROJECT DRAINAGE PLAN, which may include detention design and/or other on-site and/or off-site improvements as required to meet the intent of these regulations and have no negative impact on adjacent property or watersheds. Staff will need to review and concur with the proposal before submission to Planning Commission.

(2) VOLUME OF DETENTION

- a. Volume of detention for basins with total drainage areas of less than 25 acres may be evaluated by the "Modified Rational Hydrograph Method".
- b. For basins with total drainage areas larger than 25 acres, the City Engineer retains the right to require submittal of proposed method of evaluation for the sizing of the retention basin or detention basin. The method will be evaluated for a professional acceptance, applicability, and reliability by the City Engineer.

(3) DESIGN CRITERIA

- a. Stormwater detention ponds shall be designed to limit the post-developed hydrograph to less than the pre-developed hydrograph prior to the peak and the peak stormwater discharge rate of the 2, 10, 25, 50, and 100 year storm frequencies after development to predevelopment rates.

(4) METHOD OF DETENTION

- a. The following conditions and limitations shall be observed in selection and

use of the method of detention:

(5) GENERAL LOCATION

- a. Detention facilities shall be located within the parcel limits of the project under consideration. No detention or ponding will be permitted within public road right-of-ways.

(6) DRY RESERVOIRS

- a. Wet weather ponds or dry reservoirs shall be designed with proper safety, stability, and ease of maintenance facilities, and shall not exceed eight (8) feet in depth. Maximum side slopes for grass reservoirs shall not exceed one (1) foot vertical for three (3) feet horizontal (3:1) unless adequate measures are included to provide for the above noted features. In no case shall the limits of maximum ponding elevation be closer than twenty (20) feet horizontally from any building and less than one and a half (1.5) feet vertically below the lowest sill or floor elevation. The entire reservoir area shall be sodded as required prior to final inspection approval or issuance of certificate of occupancy. The reservoir area shall include bottom, all side slopes (interior and exterior), and top of berm/embankment. Any area susceptible to, or designed as, overflow by higher design intensity rainfall shall be sodded or paved depending upon the outflow velocity. Concrete trickle channel shall be constructed from all inlets into pond to discharge. Detention Facilities will be designed to have one (1) foot of freeboard from the 100 yr water surface elevation

(7) DETENTION IN OPEN CHANNELS

- a. Open channels may be used as detention areas provided that the limits of the maximum ponding elevation are not closer than twenty (20) feet horizontally from any buildings, and not less than one and a half (1.5) feet below the lowest sill or floor elevation of any building. No ponding will be permitted within public road right-of-way unless approval is given in writing by the City Engineer. Maximum depth of detention in open channels shall be four (4) feet. Minimum flow line grade shall be 1.0 percent for grass or untreated bottoms or 0.5 percent for paved channels.
- b. For trapezoidal sections, the maximum side slopes of the channel used for detention shall not exceed one (1) foot vertical for three (3) feet horizontal (3:1). For design of other typical channel sections, the features of safety, stability, and ease of maintenance shall be considered in the design.
- c. Unless concrete lined, the entire reservoir area of the open channel shall be sodded as required in the original design. The hydraulic or water surface elevations resulting from channel detention shall not negatively adjoining

properties.

(8) PERMANENT LAKES OR RETENTION PONDS/WET PONDS

- a. Permanent lakes with fluctuating volume controls may be used as detention areas provided that the limits of maximum ponding elevations are no less than one and a half (1.5) feet below the lowest sill or floor elevation of any building.
- b. Maximum side slopes for the fluctuating area of permanent lakes shall be one (1) foot vertical to three (3) feet horizontal (3:1) unless provisions are included for safety, stability, and ease of maintenance.
- c. Special consideration such as fencing, shoreline slope, depth of water, and abrupt change of grade in inundated areas of two (2) feet or more depth, etc., shall be given to the safety of small children and the public in design of permanent lakes in residential areas.
- d. The entire fluctuating area of the permanent reservoir shall be sodded. Also, calculations must be provided to ensure adequate "live storage" is provided for the 100 year storm. Any area susceptible to or designed as overflow by higher design intensity rainfall (100-year frequency) shall be sodded or paved, depending on the design velocities. An analysis shall be furnished of any proposed earthen dam construction soil. A boring of the foundation for the earthen dam may be requested by the City Engineer. Earthen dam structures shall be designed by a Professional Engineer.
- e. Aeration devices required for lakes/ponds less than 10-acre water surface area.

(9) PARKING LOTS

- a. Detention is permitted in parking lots to maximum depths of 12 inches. In no case should the maximum limits of ponding be designed closer than twenty (20) feet from a building.
- b. The minimum freeboard and the maximum ponding elevation to the lowest sill or floor elevation shall be three (3.0) feet for the 100 year precipitation event.

(10) OTHER METHODS

- a. Underground detention is acceptable if design conditions warrant. Parking lots and associated curb and gutter is to serve as the overflow and/or freeboard area. Freeboard is used to account for issues such as sedimentation, clogged discharge, factor of safety, etc. If a parking lot or overflow area is available on site, there is no need for additional storage. If

a parking lot or overflow area is not available on site, and/or any overflow would immediately discharge to adjacent property, extra storage/volume should be provided (designed for 105% of the design capacity).

(11) CONTROL STRUCTURES

- a. Detention facilities shall be provided with effective control structures. Plan view and sections of the structure with adequate details shall be included in Plans.
- b. The structure selected shall have documented evidence that it will control the 2, 10, 25, 50, and 100 year storms.
- c. The overflow opening or spillway shall be designed to accept the total peak runoff of the improved tributary area. Conveyance for any off-site drainage shall also be provided for.

(12) DISCHARGE SYSTEMS

- a. For site-specific runoff, the effectiveness of local detention structures can be acknowledged in the design of any on-site downstream drainage facilities assuming that the detention facilities comply with all criteria and that they are properly constructed and maintained.
- b. In the case of regional detention basins, sizing of the system below the control structure shall be for the total improved peak runoff tributary to the structure with no allowance for detention unless approved in writing by the City Engineer.
- c. In the event the Engineer desires to incorporate the flow reduction benefits of existing upstream detention ponds, the following field investigations and hydrologic analysis will be required: (Please note that under no circumstances will the previously approved construction plans of the upstream pond suffice as an adequate analysis. While the responsibility of the individual site or subdivision plans rests with the Engineer of Record, any subsequent engineering analysis must assure that all the incorporated ponds work collectively.)
 - 1. A field survey of the existing physical characteristics of both the outlet structure and ponding volume. Any departure from the original engineer's design must be accounted for. If a dual use for the detention pond exists, (e.g., storage of equipment), then this too should be accounted for.
 - 2. A comprehensive hydrologic analysis which simulates the attenuation of the contributing area ponds. This should not be limited to a linear additive analysis, but rather a network of hydrographs which considers incremental timing of discharge and potential coincidence of outlet peaks.

(13) EASEMENTS

- a. Easements shall be provided in Plans for detention facilities.
- b. Easements shall be dedicated in conjunction with platting of subject

property, or by separate document in the case of existing platted property. In either case, document to be approved by City Engineer prior to execution.

- c. All detention and retention facilities within a subdivision shall be shown on the final plat as an individual lot and said lot shall be a drainage easement to allow for access to outfall structure by the City.
- d. Access to the detention facility shall be provided by a minimum 20' wide unobstructed drainage/access easement between public street and facility when the facility and associated easement is not located adjacent to a public right-of-way.
- e. A detention facility located on an individual commercial development does not require a drainage easement unless the detention is shared or located off-site. In this case, the detention facility shall be enclosed within a drainage easement along with necessary access easement.

(14) MAINTENANCE

- a. Basins, when mandatory, are to be built in conjunction with the storm sewer installation and grading. Since these facilities are intended to control increased runoff, they must be partially or fully operational within 14 days after the initial clearing of vegetation.
- b. A maintenance plan shall be prepared for all ponds and other stormwater storage structures.
- c. Silt and debris connected with early construction shall be removed periodically from the detention area and control structure in order to maintain close to full storage capacity. Common maintenance includes trash and sediment removal, erosion repairs, vegetation, outlet protection, or as required by City Engineer.
- d. The responsibility of maintenance of detention facilities in residential subdivision projects shall remain with the developer, property owner, or POA.
- e. The responsibility of maintenance of stormwater storage structures facilities in commercial developments shall be the responsibility of the property owner.
- f. Regarding the responsibility of maintenance for detention facilities, if the Developer, property owner, or POA fail to provide a reasonable degree of maintenance and the detention facilities become inoperative or ineffective, the City of Bentonville, Arkansas, may perform remedial work and assess the owner the cost of repair and maintenance. The responsibility of maintenance of the stormwater storage structures facilities and single lot development projects shall remain with the general contractor until final inspection of the development is performed and approved, and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention facilities shall be vested with the owner of the detention pond.

(f) VI - FLOW IN STREETS

(1) GENERAL

- a. The location and type of inlets and permissible flow of water in the streets should be related to the extent and frequency of interference to traffic and the likelihood of flood damage to surrounding property. Interference to traffic is regulated by design limits on the spread of water into traffic lanes, especially in regard to arterials.

(2) INTERFERENCE DUE TO FLOW IN STREETS

- a. Design flow depths shall not exceed 6”.

(3) INTERFERENCE DUE TO PONDING

- a. Ponding depths shall be limited to 9”

(4) INTERFERENCE DUE TO WATER FLOWING ACROSS TRAFFIC LANE OR INTERSECTION

- a. Inlets need to be located to eliminate water flowing across traffic lanes. This includes where there are changes in cross slope or superelevation.

(5) PERMISSIBLE SPREAD OF WATER

- a. Inlets shall be spaced at such an interval to provide gutter spread of less than one half the lane width adjacent to the gutter.

(6) ALL ROADS

- a. Gutter depressions are not allowed. The design storm will have a 25 year return frequency. A design storm of 100-year frequency must be accommodated within the limits of the street right-of-way unless approved in writing by City Engineer.

(7) BYPASS FLOW

- a. Flow bypassing each inlet of 20% must be included in the total gutter flow to the next inlet downstream.

(8) MINIMUM AND MAXIMUM VELOCITIES

- a. To ensure cleaning velocities at very low flows, the gutter shall have a minimum slope of 0.01 feet per foot (1.00%, unless otherwise approved by City Engineer). The maximum velocity of curb flow shall be 10 feet per second. Along sharp horizontal curves, peak flows tend to jump behind the curb line at driveways and other curb breaks. Water running behind the curb

line can result in considerable damage due to erosion and flooding. In a gutter where the slope is greater than 0.10 feet per foot (10%) and the radius is 400 feet or less, design depth of flow shall not exceed 4 inches at the curb.

(g) STORM DRAIN INLETS

(1) GENERAL

- a. The primary purpose of storm drain inlets is to intercept excess surface runoff and deposit it in a drainage system, thereby reducing the possibility of surface flooding.
- b. The most common location for inlets is in streets which collect and channelize surface flow making it convenient to intercept. Because the primary purpose of streets is to carry vehicular traffic, bikes, and pedestrians, inlets must be designed so as not to conflict with that purpose.
- c. The following guidelines shall be used in the design of inlets to be located in streets:
 1. Depressed inlets are not allowed.
 2. When recessed inlets are used, they shall not interfere with the intended use of the sidewalk.
 3. The capacity of a recessed inlet on grade shall be calculated the same as the capacity of a similar unrecessed inlet.
 4. Design and location of inlets shall be pedestrian and bicycle safe.
 5. Inlet design and location must be compatible with the criteria established in Section c of this manual.
 6. Grate inlets adjacent to a curb must be a combination inlet.

(2) CLASSIFICATION

- a. Inlets are classified into three major groups, mainly: Inlets in sumps (Type A), and inlets on grade without gutter depression (Type B). Each of the two major classes include several varieties. The following are presented herein and are likely to find reasonable wide use.
- b. Inlets in Sumps
 1. Curb opening Type A-1 Type A-2 Type A-3 Type A-4 Type A-5

2. Grate
3. Combination (Grate & Curb Opening)
4. Drop (Grate Covering) Type B-1 Type B-2 Type B-3

c. Inlets on Grade

1. Curb Opening
2. Grate
3. Combination (Grate & Curb Opening)

d. Recessed inlets are identified by the suffix (R), (i.e.: A-1 (R)).

(3) INLETS IN SUMPS

- a. Inlets in sumps are inlets placed in low points of surface drainage areas to relieve ponding. The capacity of inlets in sumps must be known in order to determine the depth and width of ponding for a given discharge. The charts in this section may be used in the design of any inlet in a sump, regardless of its depth of depression.

(4) CURB OPENING INLETS AND DROP INLETS (TYPE A-1 and A-4)

- a. Unsubmerged curb opening inlets (Type A-1) and drop inlets (Type A-4) in a sump at low points are considered to function as rectangular weirs with
- b. Grate inlets in sumps have a tendency to clog when flows carry debris such as leaves and papers. Clogging shall be taken into consideration when calculating grate inlet capacity.

(5) COMBINATION INLETS (TYPE A-3)

- a. The capacity of a combined inlet type A-3 consisting of a grate and curb opening inlet in a sump shall be considered to be the sum of the capacities. When the capacity of the gutter is not exceeded, the grate inlet accepts the major portion of the flow.

(6) INLETS ON GRADE WITHOUT GUTTER DEPRESSION

a. CURB OPENING INLETS (UNDEPRESSED: TYPE B-1)

1. The capacity of the curb inlet, like any weir depends upon the head and length of the overfall. In the case of an undepressed curb opening inlet, the head at the upstream end of the opening is the depth of flow in the gutter. In streets where grades are greater than one percent (1%), the Velocities are high and the depths of flow are

usually small, as there is little time to develop cross flow into the curb openings. Therefore, undepressed inlets are inefficient when used in streets of appreciable slope, but may be used satisfactorily where the grade is low and the crown slope high or the gutter channelized. Undepressed inlets do not interfere with traffic and usually are not susceptible to clogging. Inlets on grade should be designed and spaced so that 20 to 40 percent of gutter flow reaching each inlet will carry over to the next inlet downstream, provided the water carry-over does not inconvenience pedestrian or vehicular traffic.

b. GRATE INLETS ON GRADE (UNDEPRESSED: TYPE B-2)

1. Undepressed grate inlets on grade have a greater hydraulic capacity than curb inlets of the same length so long as they remain unclogged. Undepressed inlets on grade are inefficient in comparison to grate inlets in sumps. For flow capacity through grade inlets, the Engineer should refer to Federal Highway publication HEC 12 or refer to appropriate vendor catalog. Grate inlets should be designed and spaced so that 20 to 40 percent of the gutter flow reaching each inlet will carry over to the next downstream inlet, provided the carry-over does not inconvenience pedestrian or vehicular traffic.
2. Grates shall be certified by the manufacturer as bicycle-safe.
3. Vane grate inlets are the recommended grates for best hydraulic capacity and should be the first grate type considered on any project. Clogging shall be taken into consideration when calculating grate inlet capacity.

c. COMBINATION INLETS ON GRADE (UNDEPRESSED: TYPE B-3)

1. The interception capacity of a combination inlet consisting of a curb opening and grate placed side-by-side, is not appreciably greater than that of the grate alone. Capacity is computed by neglecting the curb opening. A combination inlet is sometimes used with the curb opening or a part of the curb opening placed upstream of the grate. The curb opening in such an installation intercepts debris which might otherwise clog the grate and has been termed a "sweeper" by some. A combination inlet with a curb opening upstream of the grate has an interception capacity equal to the sum of the two inlets, except that the frontal flow and thus the interception capacity of the grate is reduced by interception by the curb opening.
2. The capacity of a Type B-3 inlet without extensions shall be considered the same as the capacity of a Type B-2 inlet

(h) STORM SEWER DESIGN

(1) GENERAL

- a. All storm drains shall be designed by the application of the Manning equation. In the preparation of hydraulic designs, a thorough investigation shall be made of all existing waterways and drainage structures along with their performance.
- b. The design of the storm drainage systems should be governed by the following six conditions:
 1. The system must accommodate all surface runoff resulting from selected design storm without serious damage to physical facilities or substantial interruptions of normal traffic.
 2. Runoff resulting from storms exceeding the design storm must be anticipated and disposed of with minimum damage to physical facilities and minimum interruption of normal traffic.
 3. The storm drainage system must have a maximum reliability of operation.
 4. The construction cost of the system must be reasonable with relationship to the importance of the facilities it protects.
 5. The storm drainage system must require minimum maintenance and must be accessible for maintenance operations.
 6. The storm drainage system must be adaptable to future expansion with minimal additional costs.
 7. Storm drains must terminate 25' from a water of the State and 50 feet from Water of State with TMDL or exceptions approved by City Engineer.

(2) PRELIMINARY DESIGN CONSIDERATIONS

- a. All drainage improvements in the City of Bentonville shall be tied to the City of Bentonville Survey Monumentation System based upon the State Plane Coordinate System, Arkansas North Zone using the North American Datum of 1983 (NAD 83). All information for newly constructed streets and roads at the time of approval shall be delivered to the City of Bentonville Engineering Department, georeferenced, in an AutoCAD compatible digital format for review and acceptance.
- b. All drainage construction shall use the above mentioned coordinate system and shall identify with monuments that were used for horizontal and vertical control. Elevation of controlling points shall be based on USGS NAVD 88 datum.

(3) STORM SEWER SYSTEM

- a. After the computation of the quantity of runoff entering each inlet, the storm sewer system required to carry the runoff is designed

(4) STORM SEWER PIPE

- a. The ground line profile is now used in conjunction with the previous runoff calculations. The maximum elevation of the hydraulic gradient is below the ground surface. When this tentative gradient is set and the design discharge is determined, a Manning flow chart may be used to determine the pipe and velocity.

(5) JUNCTIONS, INLETS, AND MANHOLES

- a. Determine the hydraulic gradient elevation at the upstream end and downstream end of the pipe section in question. The elevation of the hydraulic gradient of the upstream end of the pipe is equal to the elevation of the downstream (hydraulic gradient) plus the product of the length of the pipe and the friction slope.
- b. Determine the velocity of flow for incoming pipe (main line) at junction, inlet or manhole at design point.
- c. All information shall be recorded on the Plans or in tabular form convenient for review.

(6) PROPORTIONING STORM SEWER PIPES.

- a. Computer generated computations and output are accepted and subject to review by City Engineer.

(7) HYDRAULIC GRADE LINE

- a. The final step in designing a storm sewer is to check the Hydraulic Grade Line (HGL). Computing the HGL will determine the elevation under design conditions to which water will rise in various inlets, manholes, junctions, and etc.
- b. In conditions where tailwater is present the starting HGL of the stormwater system shall be the water surface elevation at that event.
- c. Computer generated computations and output are accepted and subject to review by City Engineer.

(i) OPEN CHANNEL FLOW

(1) GENERAL

- a. Open channels for use in the major drainage system have significant advantage in regard to cost, capacity, multiple use for recreational and aesthetic purposes, and potential for detention storage. Disadvantages include right-of-way needs and maintenance costs. Careful planning and design are needed to minimize the disadvantages, and to increase the benefits.
- b. Open channels may be used in lieu of storm sewers to convey storm runoff where:
 1. Sufficient right-of-way is available;
 2. Sufficient cover for storm sewers is not available;
 3. To maintain compatibility with existing or proposed developments; and
 4. A 10' right-of-way or permanent easement should be provided adjacent to open channels to allow entry of maintenance vehicles.

(2) DESIGN CRITERIA

- a. Open channels shall be designed to the following criteria:
- b. Channel shall carry the 25 year storm minimum with free board.
- c. Channel or adjacent public drainage easement, floodway, etc., shall be capable of carrying the 100 year storm.
- d. When open channel flow velocity exceeds 5 fps, the channel shall be paved to a point 1 foot above the design water surface or other forms of stabilization shall be used.

(3) CHANNEL CROSS SECTIONS

- a. The channel shape may be almost any type suitable to the location and to the environmental conditions. Often the shape can be chosen to suit open space and recreational needs to create additional benefits.
- b. Side Slope
 1. Except in horizontal curves, the flatter the side slope, the better. Normally, slopes shall be no steeper than 3 horizontal:1 vertical (3.1), which is also the practical limit for mowing equipment, unless approved in writing by City Engineer.
 2. Rock or concrete lined channels or those that for other reasons do not require slope maintenance may have slopes as steep as 1-1/2 horizontal:1 vertical (1.5:1), or rectangular vertical if walls are structurally designed, unless approved in writing by City Engineer.
- c. Depth

1. Deep channels are difficult to maintain and can be hazardous. Constructed channels should, therefore, be as shallow as practical, and they shall not exceed 4 feet unless approved in writing by City Engineer.
- d. Bottom Width
1. Channels with narrow bottoms are difficult to maintain and are conducive to high velocities during high flows. It is desirable to design open channels such that the bottom width is at least twice the depth unless approved in writing by City Engineer.
- e. Bend Radius
1. Twenty-five (25) feet or ten (10) times the bottom width, whichever is larger, is the minimum bend radius required for open channels.
- f. Trickle Channels
1. The low flows, and sometimes base flows, from urban areas must be given specific attention. If erosion of the bottom of the channel appears to be a problem, low flows shall be carried in a paved trickle channel which has a capacity of 5.0 percent of the design peak flow. Care must be taken to ensure that low flows enter the trickle channel without the attendant problem of the flow paralleling the trickle channel. Concrete trickle channels are required when channel slope is less than 1%. Concrete channels shall have a flat bottom width of 6' to allow for maintenance.
- g. Freeboard
1. For channels with flow at high velocities, surface roughness, wave action, air bulking, and splash and spray are quite erosive along the top of the flow. Freeboard height should be chosen to provide a suitable safety margin. The height of freeboard should be a minimum of 1-foot for velocities up to 8 FPS and 2' for velocities over 8 FPS or provide an additional capacity of approximately one-third of the design flow.
- h. Connections
1. Connections at the junction of two or more open channels shall be smooth. Pipe and box culvert or sewers entering an open channel will not be permitted to project into the normal channel section, nor will they be permitted to enter an open channel at an angle which would direct flow from the culvert or sewer upstream in the channel.
- i. Hydrostatic pressures must be considered in the design of channels to resist

uplift forces from groundwater and shallow surface flow.

(4) CHANNEL DROP

- a. The use of channel drops permits adjustment of channel gradients which are too steep for the design conditions. In urban drainage work, it is often desirable to use several low head drops in lieu of a few higher drops.
- b. The use of sloped drops will generally result in lower installation cost. Sloped drops can easily be designed to fit the channel topography.
- c. Sloped drops shall have roughened faces and shall be no steeper than 2:1. They shall be adequately protected from scour, and shall not cause an upstream water surface drop which will result in high velocities upstream. Side cutting just downstream from the drop is a common problem which must be protected against.
- d. The length of the drop (L) will depend upon the hydraulic characteristics of the channel and drop. For a Q of 30 cubic feet per second/feet, L would be about 15 feet, that is, about 1/2 of the Q value. The L should not be less than 10 feet, even for low Q values. In addition, follow-up riprapping will often be necessary at most drops to more fully protect the banks and channel bottom. The criteria given is minimal, based on the philosophy that it's less costly to initially under protect with riprap, and to place additional protection after erosional tendencies are determined in the field. Project approvals are to be based on provisions for such follow-up construction.

(5) BAFFLE CHUTES

- a. Baffle chutes are used to dissipate the energy in the flow at a larger drop. They require no tailwater to be effective. They are useful where the water surface upstream is held at a higher elevation to provide head for filling a side storage pond during peak flows.
- b. Baffle chutes are used in channels where water is to be lowered from one level to another. The baffle piers present undue acceleration of the flow as it passes down the chute. Since the flow velocities entering the downstream channel are low, no stilling basin is needed. The chute, on a 2:1 slope or flatter, may be designed to discharge up to 60 CFS per foot of width, and the drop may be as high as structurally feasible. The lower end of the chute is constructed to below stream bed level and backfilled as necessary. Degradation of the streambed does not, therefore, adversely affect the performance of the structure. In urban drainage design, the lower end should be protected from the scouring action.

(6) STRUCTURAL AESTHETICS

- a. The use of hydrologic structures in the urban environment requires an

approach not encountered elsewhere in the design of such structures. The appearance of these structures is very important. The treatment of the exterior should not be considered of minor importance. Appearance must be an integral part of the design.

- b. Parks. It must be remembered that structures are often the only above-ground indication of the underground works involved in an expensive project. Furthermore, parks and green belts may later be developed in the area in which the structure will play a dominant environmental role.
- c. Play Areas: An additional consideration is that the drainage structures offer excellent opportunities for neighborhood children to play. It is almost impossible to make drainage works inaccessible to children, and therefore, what is constructed should be made as safe as is reasonably possible. Safety hazards should be minimized and vertical drops protected with decorative fencing or rails.
- d. Concrete Surface Treatment: The use of textured concrete presents a pleasing appearance and removes form marks. Exposed aggregate concrete is also attractive but may require special control of aggregate used in the concrete.

(7) CHANNEL LINING DESIGN

- a. All channels must be lined.
- b. TEMPORARY LININGS
 - 1. Temporary linings are flexible coverings used to protect a channel until permanent vegetation can be established using seeding. For the most part, the materials used are biodegradable. Listed below are some of the temporary linings that can be used, which are established in the charts for this section. Among the factors which should be known in order to use these are hydraulic radius, soil condition, and channel slope.
 - i. Jute Matting
 - ii. Wood Fiber
- c. GRASS LININGS
 - 1. Grass linings need to be designed based on seasonal changes during installation and will need a temporary lining until vegetation is established.
- d. ROCK RIPRAP
 - 1. When rock riprap is used, the need for an underlying filter material must be evaluated. The filter material may be either a granular blanket or plastic filter cloth. All rip-rap shall include concrete slurry to increase stability and minimize vegetative growth.
- e. CONCRETE
 - 1. Concrete lined channels provide high capacities, but also have high outlet velocities so erosion problems become evident and must be dealt with. Maximum velocity of concrete lined channel shall be 10

fps unless otherwise approved in writing by City Engineer.

f. OTHER LINING OPTIONS

1. Other lining options shall be reviewed on a case by case basis and approved by the City Engineer.

(J) STORMWATER RUN-OFF FOR IMPERVIOUS AREAS

- (1) Requirement. All development not subject to Large Scale Development or Preliminary Plat must mitigate stormwater run-off of all impervious areas. All stormwater must be directed to a stormwater collection system. If new impervious areas cannot be directed to a stormwater collection system, each new impervious area shall be mitigated at a rate of 0.2 cubic ft. of storage for each 1 sq. ft. of impervious area. Mitigation techniques must be the Low Impact Development practices listed here with their corresponding detention credits or other techniques as approved by the City Engineer:
 - a. Redirect downspouts - 0.05 cubic ft. for each 1 sq. ft. of roof that is redirected
 - b. Rain barrels / cisterns - 100% of the volume of the structure
 - c. Rain gardens - 20% of the volume of the rain garden
 - d. Porous pavers - 40% of the volume of the rock under the pavers + 0.10 cubic ft. for each 1 sq. ft. of pavers
 - e. Green roofs - .20 cubic ft. for each 1 sq. ft. of roof
 - f. Terraced landscape - 40% of the volume of the terrace
- (2) Waiver requests. The property owner or developer may request a waiver of run-off mitigation requirements from the Planning Commission in accordance with the Land Development Code Sec. 300.04 Waivers. The Planning Commission shall grant waivers only upon a review and consideration of the following review criteria.
 - a. Staff support of the waiver.
 - b. Sufficient documentation showing that the increased impervious area will not increase flows off-site or cause negative impacts.
 - c. Sufficient documentation that flows are already accounted for in an existing system that is functioning as designed.
- (3) Replacement and maintenance. Property owners are responsible for maintenance and replacement of the stormwater run-off mitigation practices required by this section.

DRAINAGE DESIGN CHECKLIST CITY OF BENTONVILLE, ARKANSAS
REVISION NO. DATE:

- (a) PROJECT TITLE AND DATE
- (b) PROJECT LOCATION MAP
- (c) PROJECT DESCRIPTION
- (d) NAME OF OWNER AND ENGINEER — With addresses and telephone numbers.
- (e) SITE AREA — Within a 1 mile radius.
- (f) DRAINAGE DESIGN CHECKLIST – Must be filled out completely and sealed. Failure to include as directed will be considered an incomplete submittal.
- (g) DRAINAGE MAPS – Figures presenting significant hydrologic and hydraulic computation parameters. Topographic data must be shown on the maps and must extend a minimum of 100 feet beyond the property line or to the extents of any analyzed offsite drainage areas.
- (h) Pre- and Post- Development Maps showing basin areas with hydrologic parameters labeled for each basin (including offsite drainage areas), including basin area, time of concentration with the longest flowpath used for this determination, and loss method values (Curve Number, Rational C value, etc.). Additionally, provide a boxed note at each storm sewer outlet and/or study point that lists the 10-year, 25-year and 100-year flowrate (Q) and velocity (V).
- (i) Inlet Area Maps showing the type of inlet, size, opening length, and/or end treatment, in addition to the hydrologic parameters listed above.
- (j) UPSTREAM AND DOWNSTREAM DRAINAGE - Brief description of the drainage path from the proposed site shown on a 1" = 200' minimum scale, 1' contour topographic map.
- (k) AREA DRAINAGE PROBLEMS
- (l) ANALYSIS OF TEMPORARY PONDS AND DRAINAGE FEATURES – Include complete calculations and description of temporary water and erosion control measures such as sedimentation ponds, diversion ditches, and other alterations to existing drainage patterns during construction.
- (m) HYDROLOGIC COMPUTATIONS - Include complete runoff computations for the design frequency storm specified in the Manual for each specific type drainage system Modeling Software: Version:
- (n) OPEN CHANNEL FLOW DESIGN - Include computations for normal depth and velocity Modeling Software: Version:
- (o) PAVEMENT DRAINAGE DESIGN - Include width of spread for design flow. Show flow in gutter for Qtr and Q1 in plan view. Modeling Software Version:
- (p) CULVERT DESIGN - Include all computations and check for inlet/outlet control (Modeling Software: Version:
- (q) STORM SEWER INLET DESIGN - Include all computations Modeling Software: Version:
- (r) STORM SEWER DESIGN - Include all computations and profiles. Modeling Software: Version:
- (s) STORMWATER DETENTION DESIGN - Include the following computations and backup/support data:
 - (1) SUMMARY OF RUNOFF - A figure with minimum 2, 10, 25, 50, and 100 year storm flow comparisons for existing and proposed conditions and detention volumes required if applicable - Also describe method used for determining stormwater runoff flows.
 - (2) RECOMMENDATIONS/SUMMARY - Description of any drainage improvements to be

made to the site - Also, the following backup/support data:

- a. Runoff coefficient/RCN computations (existing and proposed conditions)
 - b. Complete runoff computations for the 2, 10, 25, 50, and 100-year storms (existing and proposed conditions)
 - c. Detention basin size requirement computations
 - d. Release structure design computations (include release rate computations for the 2, 10, 25, 50, and 100 year storms)
 - e. Stage-Storage and Stage-Discharge curves for the detention facility
- (t) OUTLET AND ENERGY DISSIPATION DESIGN – Include all computations for exit velocity and energy dissipation.
- (u) DESIGN STORM DESIGNATED BY QXX = and design flow rate for each street crossing or drainage structure
- (v) This check list needs to be Signed and Sealed by the Professional Engineer for all submittal and resubmittals of the drainage design.