CITY OF POWELL
STORMWATER
MANAGEMENT POLICY

OCTOBER 2005

STORMWATER MANAGEMENT POLICY

The purpose of this policy is to standardize and clarify the way in which drainage reports should be submitted to the City of Powell for review. Having a standardized process will decrease design and review time. This policy is not designed to circumvent the engineer's judgment in these matters. There are special circumstances in which the literal application of this policy will result in an impractical design. For these special circumstances the design engineer is encouraged to discuss these alternatives with the City Engineer.

A drainage report shall be required for all commercial developments and subdivisions. All drainage plans must be prepared and stamped by a professional engineer licensed in the State of Wyoming.

In general, technical information, procedures, approach and methodology from the Urban Storm Drainage Criteria Manual[1] distributed by the Urban Drainage and Flood Control District shall be used if not specifically covered in this policy.

1. A drainage report will be required with the following minimum information:

   1.1 A map with a scale of not less than 1"=50' showing proposed contours with a one foot interval. Any site less than 0.25 acres may be depicted using spot elevations.

   1.2 The map should also show any drainage features or physical features on the site both proposed and existing. The map should also include identification of various surfaces indicated in the drainage report, drainage basins and the area of each surface and basin. Details of proposed drainage structures should also be included as well as pertinent dimensions and profiles of drainage facilities.

   1.3 A report with calculations and written comments determining runoff quantities, storage requirements, infiltration information, routing information, inlet capacities, pipe capacities, detention facility capacities and any other information pertinent to the design.

   1.4. A storm drainage facility maintenance plan. The plan shall at a minimum:

      1.4.1 Identify ownership of all facilities.

      1.4.2 Establish a maintenance schedule for activities necessary to keep the system operational and at the designed efficiency.

      1.4.3 Identify the responsible party in charge of the specific maintenance duties.

2. Estimation of Runoff.

   2.1 The rational method shall be used for determination of peak runoff for areas less than 160 acres with the following assumptions inherent in the method:

      2.1.1 Rainfall occurs at a constant rate.

      2.1.2 The peak runoff occurs when the entire drainage area is contributing to surface runoff, at t_c.

      2.1.3 The recurrence interval of the peak flow is the same as for the design storm.

      2.1.4 The runoff coefficient is constant.

      2.1.5 The rainfall is spatially uniform over the drainage area.

2.2 The rational formula is:

$Q=CIA$

Where:
Q=peak runoff rate
C=runoff coefficient
I=rainfall intensity
A=area contributing to the runoff

2.2.1 Please refer to Appendix A for rainfall intensity for various reoccurrence intervals and storm durations. The design storm for all facilities shall be the 10 year, 2 hour storm unless otherwise noted.

2.2.2 The runoff coefficients given in Appendix B are recommended for design. These are reproduced from the Urban Storm Drainage Criteria Manual[1] by permission of the Urban Drainage and Flood Control District and are for semi-arid climates.

2.2.3 The time of concentration is the time it would take for water to flow from the most remote point in the drainage basin to the point in question. This may consist of overland flow time and gutter flow time.

2.2.3.1 Overland flow time may be estimated using either the nomograph or chart located in Appendix C.

2.2.3.2 Gutter flow time may be estimated using either the Manning Equation:

$$V=\frac{1.49}{n}*R^{2/3} * S^{1/2}$$

Where:
V=flow velocity
R=Hydraulic Radius=A/P
S=channel slope in ft./ft.
N=manning roughness coefficient-App. D

or the chart located in Appendix E

A minimum time of 5 minutes shall be used for a combined time of concentration.

2.3 Runoff volumes shall be determined using the modified rational method. Please reference the Civil Engineering Reference Manual for the PE Exam Seventh Edition [2] , page 20-20 for a description of this method.

3. Drainage Systems and Facilities.

3.1 All storm drainage systems shall be designed and constructed to handle not only drainage from the proposed site, but must also take into consideration land areas currently draining onto it.

3.2 Individual design storm requirements from this policy do not preclude engineer from analyzing other storm events to determine worst case scenarios based upon type of drainage facility chosen by the engineer.

3.3 Drainage pipes.

3.3.1 All drainage pipes shall be designed and constructed based upon flows from a 10 year, 2 hour design storm for the contributing watershed basin.

3.3.2 All pipe shall be reinforced concrete pipe (RCP) Class IV unless conditions warrant Class V RCP, or high density polyethylene (HDPE) pipe. Concrete pipes shall be joined with full Portland cement mortar joints in cases where the pipe is expected to be under pressure flow during design conditions. Rubber gasketed pipe may be used in place of full Portland cement mortar joints otherwise ungasketed pipe may be used. Where excessive groundwater is encountered or poor drainage is anticipated, the City Engineer may require that suitable under drains be installed prior to the placement of the sub-base course or pavement.

3.3.3 Other pipes may be used with written permission from the City Engineer.

3.3.4 The minimum pipe size shall be fifteen inches for public improvements and twelve inches for any private, commercial or industrial development. Pipe capacity shall be computed using the Manning Equation. Please see Appendix D for n values.

3.3.5 The minimum grade of all pipes shall be 0.003 feet per foot.

3.3.6 The Hydraulic Grade Line of a storm sewer system shall not be higher than one (1) foot below the ground surface at any point.

3.3.7 Culverts shall be constructed with corrugated metal pipe or approved equivalent. Please see FHWA Hydraulic Design of Highway Culverts[3] for design information.

3.4 Catch Basins.

3.4.1 All catch basins shall be designed and constructed based upon flows from a 10 year, 2 hour design storm for the contributing watershed basin.

3.4.2 The maximum distance from the roadway summit to the first catch basin shall shall be 400 feet. The maximum distance between catch basins and manholes in a storm drain system shall be 400 feet.

3.4.3 Catch basins shall be spaced so that the width of the flow in gutters, as determined by gutter flow analysis, shall not exceed ten (10) feet.

3.4.4 Catch basins shall be used in sags when warranted by the gutter flow analysis.

3.4.5 On steep grades, distances between catch basins shall be determined by gutter flow analysis and catch basin capacity analysis. In no case should the water carried in the street extend to more than one lane of traffic.

3.4.6 Inlets shall be open curb type with a grate and shall be bicycle safe. (See Appendix F)

3.5 Detention basins, retention basis, dry wells, percolation trenches and special structures.

3.5.1 Detention Basins shall be defined as any facility designed to hold water for a specified amount of time and release the water at a specified rate.

3.5.2 All detention basins shall be designed and constructed based upon flows and volumes from a 10 year, 2 hour design storm for the contributing watershed base.

3.5.3 To minimize any increase in storm water runoff from a site, storm water detention basins, dry wells or percolation trenches shall be required for all new developments unless specifically waived by the City Engineer or unless sufficient capacity is available in a storm sewer and the developer is willing to extend storm sewer to this location. The effect of the storm water detention on the timing of runoff shall also be considered in the evaluation of flooding potential downstream. Storm water detention basins shall be designed to maximize recharge to ground water. Design of such facilities shall be performed within the following guidelines:

3.5.3.1 Detention basins shall be designed to reduce the peak rate of discharge to the level of the peak rate of discharge before development.

3.5.3.2 Detention basins shall be designed to reduce the volume of storm water discharge to the volume released before development.

3.5.3.3 An emergency spillway shall be provided to pass the discharge from a 100 year storm. Rip rap shall be used on all spillways and designed in such a manner as to attenuate the overflow ensuring it is not a point discharge.

3.5.3.4 When the potential exists for major property damage in conjunction with a detention basin failure, the 100 year, 2 hour design storm should be used for all design considerations related to the facility.

3.5.3.5 Detention basins shall be designed to empty within 24 hours after a design storm with no more than 50% of the runoff being released within the first 12 hours and have a minimum freeboard of one (1) foot.

3.5.3.6 Detention basins located in areas that can be accessed by the public shall have a maximum water depth of 1.5' and provide a minimum of one (1) foot freeboard. Detention basins designed to be deeper than this should be placed in remote locations and be fenced.

3.5.3.7 Detention basins serving multiple lots shall be owned and maintained by a Homeowners or Property Owners Association.

3.5.3.8 Basin slopes shall be 3:1 or flatter.

3.5.3.9 The detention basin shall be designed as a sedimentation basin for use during and after construction.

3.5.4 Dry wells and percolation trenches shall be designed and constructed based upon flows and volumes from a 25 year, 2 hour design storm for the contributing watershed basin. The permeability of the soil shall be measured to determine the rate at which water flows through the soil. A letter shall be submitted to the Wyoming Department of Environmental Quality according to "permit by rule" Section 8 of Chapter 16 Class V injection well rules. (See Appendix I)

3.5.5 Retention basins.

3.5.5.1 Retention basins shall be designed as any facility designed to hold Water indefinitely with no identified means of discharge not including an emergency spillway.

3.5.5.2 Retention basins shall be designed and constructed based upon flows and volumes from a 100 year, 2 hour design storm for all design considerations related to the facility and shall take into account the entire watershed in which the basin is to be constructed. A complete hydrogeologic study shall be required to ascertain the exact field conditions under and around the basin.

3.5.6 Special structures.

3.5.6.1 Bridges, box culverts, deep manholes and other special structures shall be designed in accordance with good engineering practice acceptable to the City Engineer. Bridges and box culverts shall be designed to the full width of the right-of-way.

4. In commercial construction where the entire site is less than 7000 sf and all of the storm water will be graded to remain on site regardless of historic drainage patterns please refer to Appendix G for drainage options. These options may be exercised only when eligible with the following restrictions:

4.1 Dry wells may be utilized according to Appendix G, installed according to specifications provided in this policy (please see Appendix H) and manufacturer's instructions.

4.2 Percolation trenches may be utilized according to Appendix G filled with 2" minus uniformly graded drain gravel using Amoco 4547, a non-woven geotextile, installed according to the specifications provided in this policy (please see Appendix H) and and manufacturer's instructions. A 6" perforated pipe and inlet box must be utilized to "inject" the storm water into the percolation trench if storm water is anything other than overland flow.

4.3 A drainage and grading plan must be provided showing placement, types, specifications and sizes of drainage facilities. This plan must indicate the direction of drainage with flow arrows showing all drainage will remain on site and must include a disturbed area calculation that includes at a minimum the building, the parking lot and all landscaped areas.

4.4 A percolation test must be performed in order to confirm drainage characteristics of the soil located on the site according to the following: a pit measuring 1' diameter by 14" deep must be dug and filled with water. The date, weather conditions, time the pit was filled and the time the pit emptied must be recorded and presented with the drainage plans.

4.5 All facilities must be constructed as provided in this policy.

4.6 All other components of this policy must be followed.

5. Drainage easements, flowage rights, and indemnification agreements shall be furnished by the developer, in a form satisfactory to the City Attorney, in the name of the City of Powell, where they may be required to install or maintain drainage installation outside roadway limits, including ditches where necessary, and to hold harmless the City of Powell from any future damage from storm water runoff. Such easements shall be a minimum of 15 feet in width.

6. Any proposed change or revision in the drainage system as shown on the approved plans plans shall be submitted to and approved by the City Engineer in advance of construction.

7. Where a subdivision of land proposes building lots on an existing town road, or where the tract of land to be subdivided presently receives storm water drainage from an existing town road or from a watercourse, it will be the responsibility of the developer to provide, by piping, an adequate storm water drainage system suitable to give the existing town street and adjacent lots of the proposed subdivision proper drainage.

8. According to Best Management Practices, storm water management devices shall be shown on the drainage plan or on a sedimentation and erosion control plan. These devices shall be provided during construction for new commercial sites and subdivisions in excess of 14,000 sf., modifications to existing commercial sites and subdivisions in excess 14,000 sf or as the City Engineer deems necessary unless during the city's review the applicant's engineer can show, due to site specific conditions, they are not needed. These devices shall provide erosion control during the construction process. These devices are to include but are not limited to the following: anti-tracking pads, siltation fabric, hay bales and/or "sediment logs.".

For commercial sites and subdivisions in excess of 0.5 ac., when regulated by the state or as deemed necessary by the City Engineer. The developer shall provide devices for management of petroleum products in storm water runoff.

9. A drainage certification letter will be required when construction is complete certifying the drainage improvements have been constructed in accordance with the approved plans. If the improvements have not been constructed according to the approved plans, the modifications will need to be outlined and the drainage reapproved. This letter must be prepared and stamped by a professional engineer licensed in the State of Wyoming. When a site qualifies for the commercial construction option outlined in number 4, the general contractor listed on the building permit will need to certify that the drainage improvements have been constructed in accordance with the approved plans and in accordance with the stipulations outlined in the storm water management policy before receiving Certificate of Occupancy.

10. Please be aware the State of Wyoming Department of Environmental Quality requires a letter to be submitted according to "permit by rule" Section 8, Chapter 16 Class V injection well rules when a new injection well is being constructed. A form is enclosed for your use as a minimum amount of information required but not a guarantee for acceptance by the State. Please see Appendix 1.

REFERENCES

1. Wright-McLaughlin Engineers. Urban storm drainage criteria manual. Denver, CO.: Urban Drainage and Flood Control District; 1990.

2. Lindeburg, M. R. Civil engineering reference manual for the PE exam seventh edition. Belmont, CA.: Professional Publications, Inc.; 1999.

3. U.S. Department of Transportation Federal Highway Administration. Hydraulic design of Highway culverts, second addition, report number FHWA-NHI-01-020 HDS No. 5. Springfield, Va.; National Technical Information Service; 2001.

APPENDIX A

PRECIPITATION (IN)

	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
5 MIN	0.14	0.19	0.25	0.33	0.40	0.48
10 MIN	0.21	0.29	0.39	0.52	0.63	0.74
15 MIN	0.27	0.37	0.50	0.66	0.79	0.94
30 MIN	0.37	0.51	0.69	0.91	1.10	1.30
1 HR	0.47	0.65	0.87	1.15	1.39	1.65
2 HR	0.53	0.74	0.95	1.23	1.44	1.68
3 HR	0.59	0.81	1.02	1.30	1.49	1.71
6 HR	0.72	1.00	1.19	1.48	1.60	1.79
12 HR	0.88	1.20	1.39	1.64	1.78	1.99
24 HR	1.04	1.39	1.58	1.80	1.95	2.19

INTENSITY (IN/HR)

	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR
5 MIN	1.64	2.26	3.03	4.00	4.84	5.73
10 MIN	1.27	1.76	2.35	3.11	3.75	4.45
15 MIN	1.08	1.48	1.98	2.62	3.17	3.76
30 MIN	0.75	1.03	1.37	1.82	2.20	2.60
1 HR	0.47	0.65	0.87	1.15	1.39	1.65
2 HR	0.27	0.37	0.48	0.62	0.72	0.84
3 HR	0.20	0.27	0.34	0.43	0.50	0.57
6 HR	0.12	0.17	0.20	0.25	0.27	0.30
12 HR	0.07	0.10	0.12	0.14	0.15	0.17
24 HR	0.04	0.06	0.07	0.08	0.08	0.09

Developed from NOAA Atlas 2, Precipitation-Frequency Analysis
of the Western United States, 1973

APPENDIX B

Recommended runoff coefficients taken from the Urban Storm Drainage Criteria Manual by permission of the Urban Drainage and Flood Control District.

Land Use or Surface Characteristics	Frequency 10yr	100yr
Business:		
Commercial Areas	0.88	0.89
Neighborhood Areas	0.70	0.80
Residential:		
Single-Family	0.50	0.60
Multi-Unit (detached)	0.60	0.70
Multi-Unit (attached)	0.70	0.80
½ Acre Lot or Larger	0.40	0.60
Apartments	0.70	0.80
Industrial:		
Light Areas	0.76	0.82
Heavy Areas	0.85	0.90
Parks, Cemeteries:	0.25	0.45
Playgrounds:	0.30	0.50
Schools:	0.60	0.70
Railroad Yard Areas:	0.35	0.45
Streets:		
Paved	0.90	0.93
Gravel (Packed)	0.50	0.60
Drive and Walks:	0.88	0.89
Roofs:	0.90	0.90
Lawns, Sandy Soil:	0.05	0.20
Lawns, Clayey Soil:	0.25	0.50

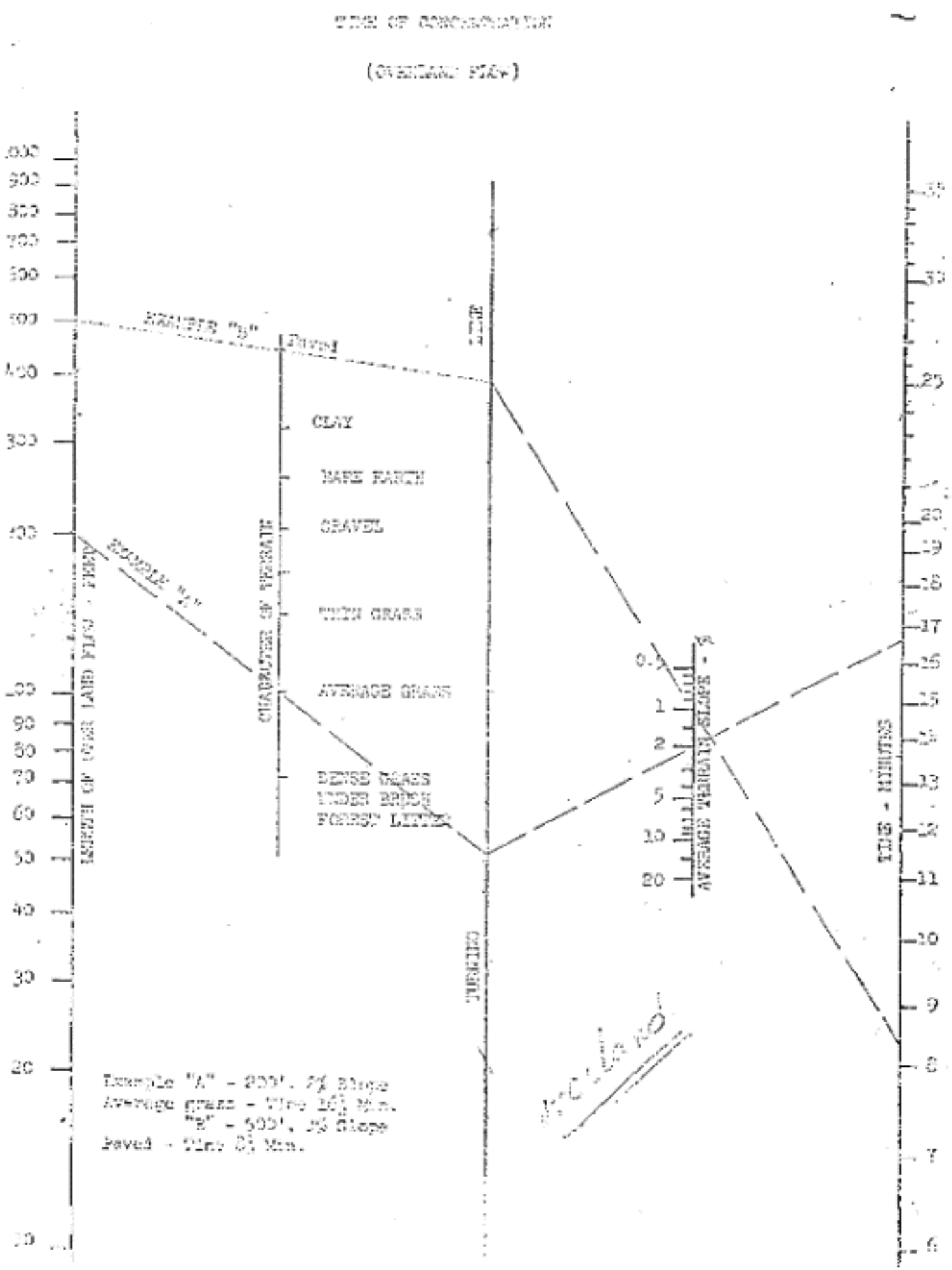
NOTE: These Rational Formula coefficients may not be valid for large basins. Other values should be determined using good engineering judgment.

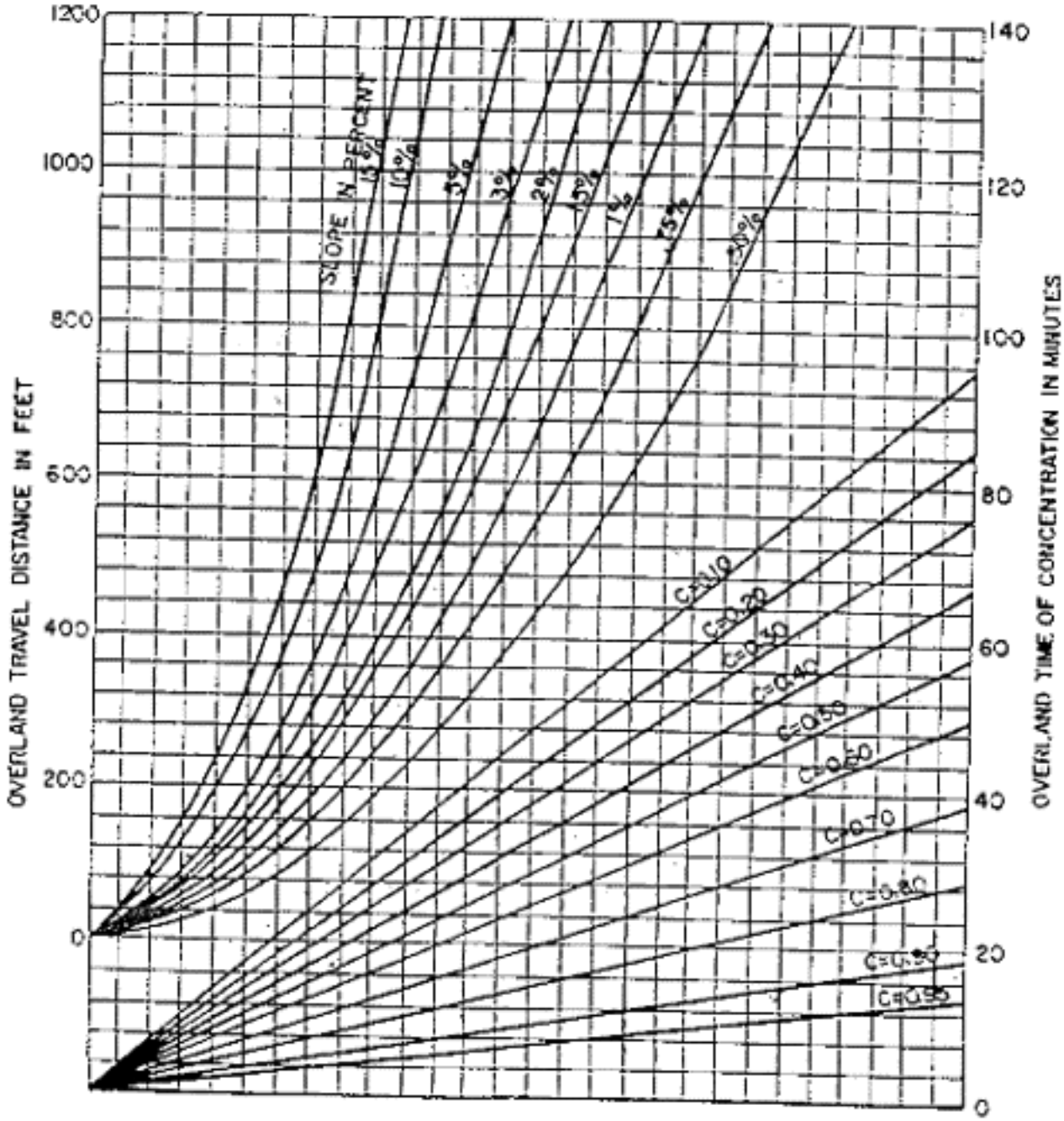
APPENDIX B

Runoff Coefficients for Rational Method

Surface		Value
Asphalt		0.70 – 0.95
Brick		0.70 – 0.85
Concrete		0.80 – 0.95
Well Drained Lawn	Flat <2%	0.05 – 0.10
	Average 2% - 7%	0.10 – 0.15
	Steep >7%	0.15 – 0.20
Poorly Drained Lawn	Flat <2%	0.13 0.17
	Average 2% - 7%	0.18 – 0.22
	Steep >7%	0.25 – 0.35
Unimproved Areas		0.10 – 0.30

Other values should be determined using good engineering judgment.


TIME OF CONCENTRATION
(OVERLAND FLOW)
LENGTH OF OVER LAND FLOW - FEET
RUNOFF "C"
CHARACTER OF SURFACE
CLAY
BARE EARTH
GRAVEL
THIN GRASS
AVERAGE GRASS
DENSE GRASS
WOODS BRUSH
FOREST LITTER
AVERAGE OVERLAND SLOPE - %
TIME - MINUTES
Example "A" - 200', 2% Slope
Average grass - Time 26½ Min.
"B" - 500', 3% Slope
Paved - Time 8½ Min.

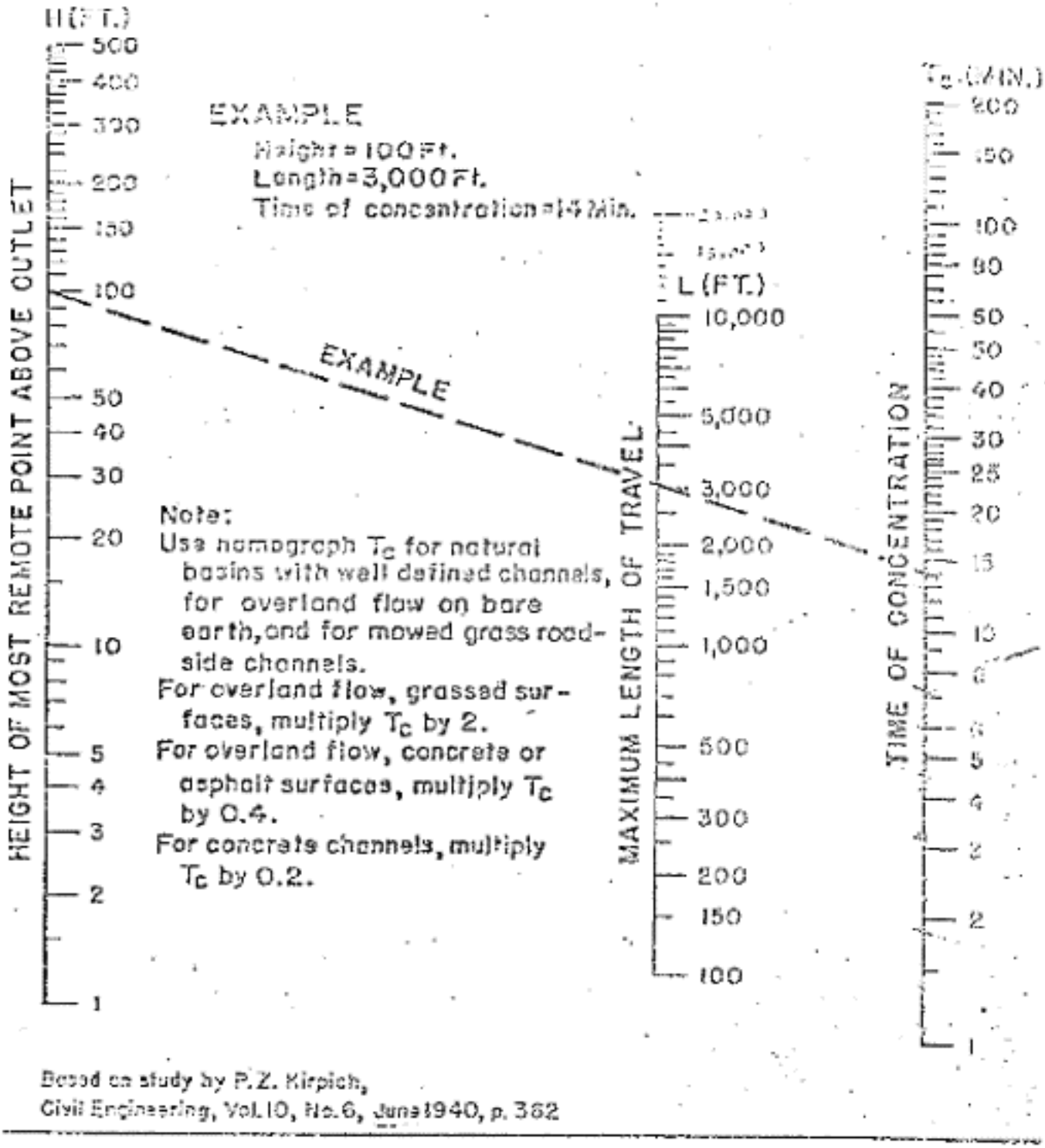

OVERLAND TRAVEL DISTANCE IN FEET
OVERLAND TIME OF CONCENTRATION IN MINUTES
SLOPE IN PERCENT
15%
10%
5%
3%
2%
1%
C=0.10
C=0.20
C=0.30
C=0.40
C=0.50
C=0.60
C=0.70
C=0.80
C=0.90
C=0.95
0
200
400
600
800
1000
1200
0
20
40
60
80
100
120
140

APPENDIX D

Manning's Roughness Coefficient

Channel Material	n Value
PVC pipe	0.009
Concrete	0.013
Corrugated Metal Pipe	0.024
High Density Polyethylene Pipe	0.010
Smooth Earth	0.018
Natural Channels, good condition	0.025
Natural Channels, with stones and weeds	0.035
Rip Rap Channels	0.40-0.45

Other values should be determined using good engineering judgment.



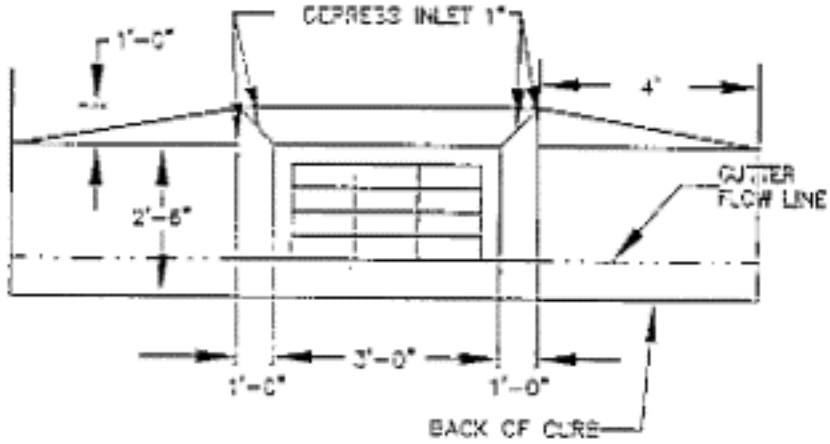
Based on study by P.Z. Kirpich,
Civil Engineering, Vol.10, No.6, June 1940, p. 362

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

FIG. A-6-1

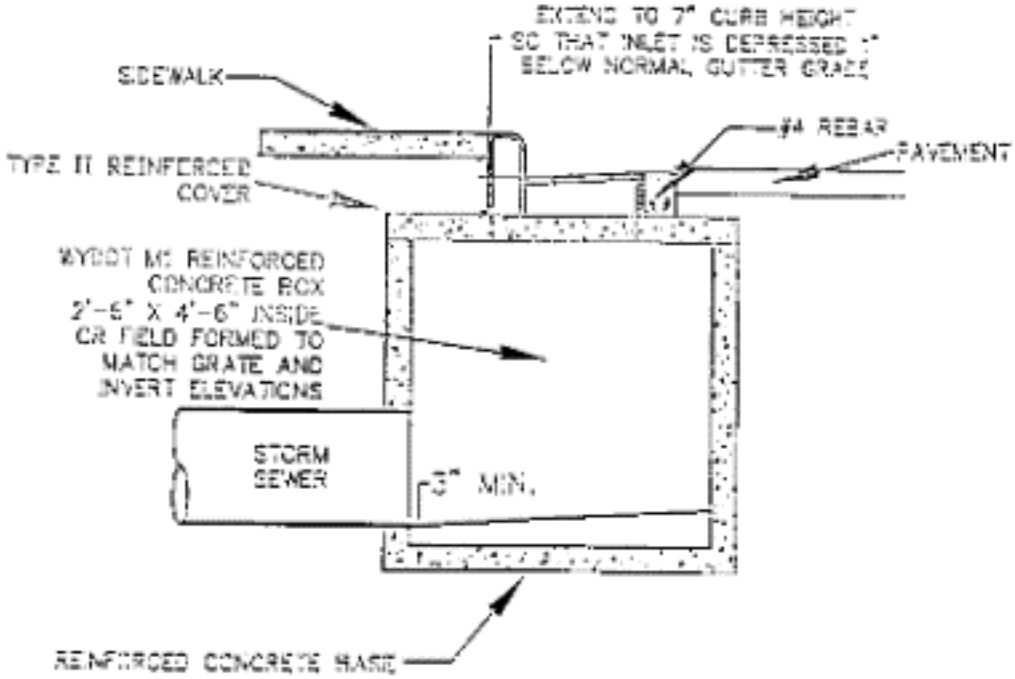
CATCH BASIN PLAN VIEW AT GUTTER FLOW

NOT TO SCALE

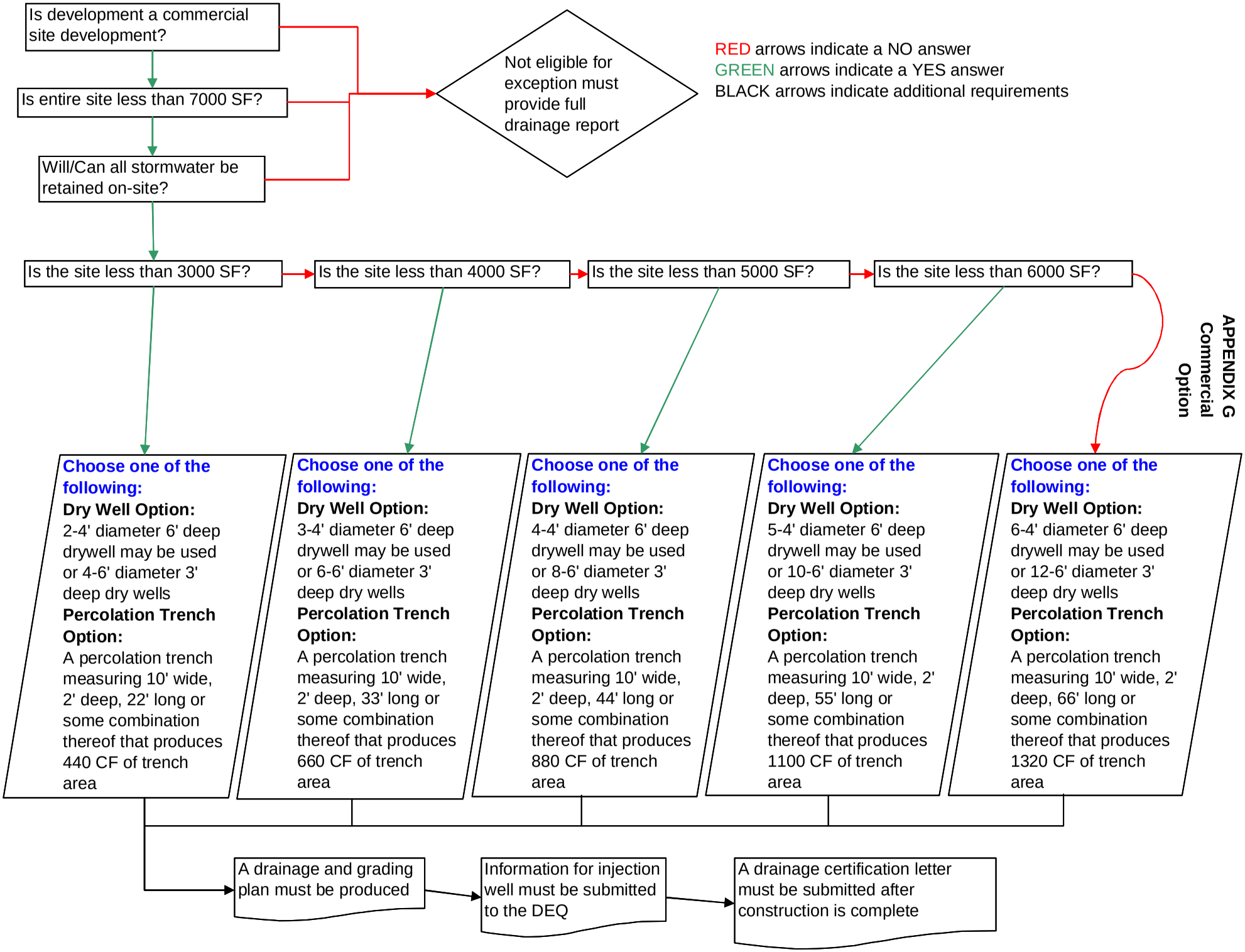


CATCH BASIN PROFILE

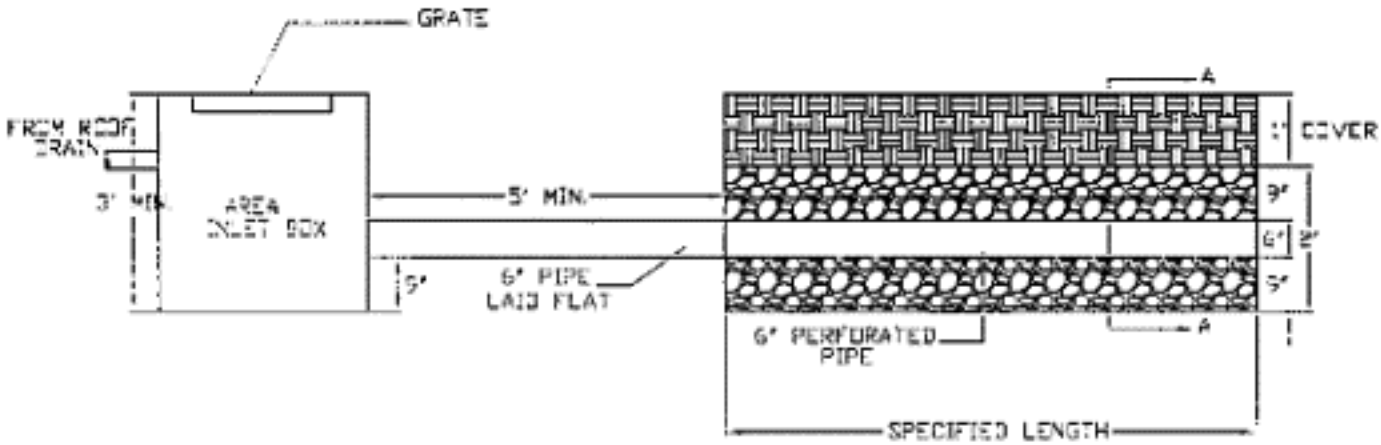
NOT TO SCALE

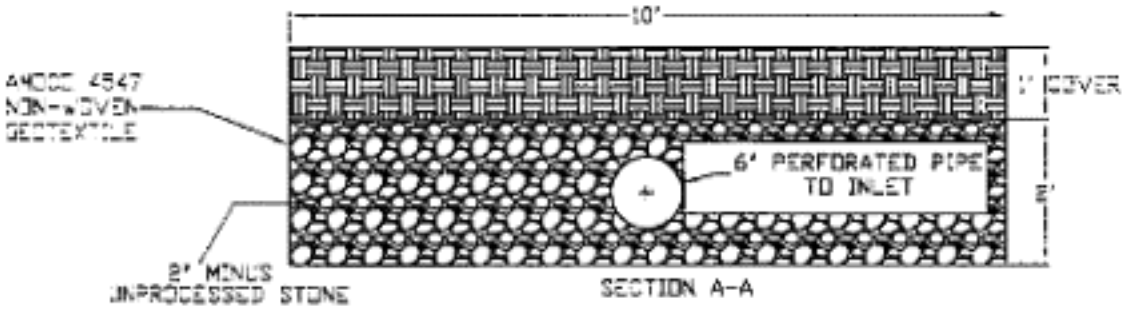


NOTE: 1. ALL FIELD CAST CONCRETE BOX SHALL BE REINFORCED WITH #4 REBAR SIMILAR TO STORM SEWER CHARGION STRUCTURE DETAIL.

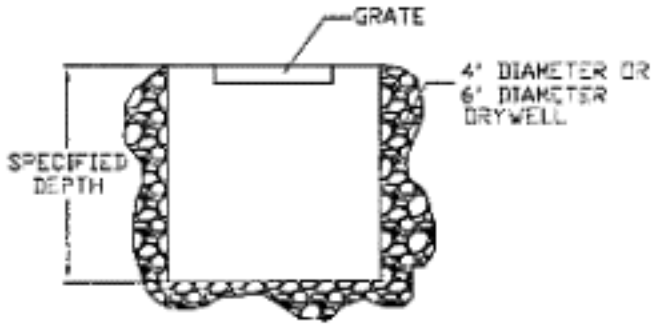

Is development a commercial site development?
Is entire site less than 7000 SF?
Will/Can all stormwater be retained on-site?
Not eligible for exception must provide full drainage report
RED arrows indicate a NO answer
GREEN arrows indicate a YES answer
BLACK arrows indicate additional requirements
Is the site less than 3000 SF?
Is the site less than 4000 SF?
Is the site less than 5000 SF?
Is the site less than 6000 SF?
APPENDIX G
Commercial
Option
Choose one of the following:
Dry Well Option:
2-4' diameter 6' deep drywell may be used or 4-6' diameter 3' deep dry wells
Percolation Trench Option:
A percolation trench measuring 10' wide, 2' deep, 22' long or some combination thereof that produces 440 CF of trench area
Choose one of the following:
Dry Well Option:
3-4' diameter 6' deep drywell may be used or 6-6' diameter 3' deep dry wells
Percolation Trench Option:
A percolation trench measuring 10' wide, 2' deep, 33' long or some combination thereof that produces 660 CF of trench area
Choose one of the following:
Dry Well Option:
4-4' diameter 6' deep drywell may be used or 8-6' diameter 3' deep dry wells
Percolation Trench Option:
A percolation trench measuring 10' wide, 2' deep, 44' long or some combination thereof that produces 880 CF of trench area
Choose one of the following:
Dry Well Option:
5-4' diameter 6' deep drywell may be used or 10-6' diameter 3' deep dry wells
Percolation Trench Option:
A percolation trench measuring 10' wide, 2' deep, 55' long or some combination thereof that produces 1100 CF of trench area
Choose one of the following:
Dry Well Option:
6-4' diameter 6' deep drywell may be used or 12-6' diameter 3' deep dry wells
Percolation Trench Option:
A percolation trench measuring 10' wide, 2' deep, 66' long or some combination thereof that produces 1320 CF of trench area
A drainage and grading plan must be produced
Information for injection well must be submitted to the DEQ
A drainage certification letter must be submitted after construction is complete

APPENDIX H





PERC TRENCH



DRYWELL

N.T.S.

APPENDIX I

INFORMATION PACKAGE
FOR
EXAMPLE

1.Company:_____ Operator:_____

_____ _____

_____ _____

Physical Address of Property: _____

_____

2. Legal Description: ie. Lot 55 of Cedarwood Subdivision, Powell, WY, T.55N., R.99W. Park County.

3.System Description: ie. Percolation tench located in Lot 55, Cedarwood Subdivision, Powell, WY., T.55N., R.99W., Park County.

4. Type of Injected Fluid:
Capacity of System:_____

Depth of Injection Zone:_____

Operation: Continuous

5. Violations: As defined in Chapter 16, Section 8 (a), (iii) – "Chemical, bacteriological, radiological additives, hazardous substances, or toxic substances additives shall not be mixed in the injected fluid at any time during use of the water, prior to injection or during injection…."

5. Reporting:
   a. Call WDEQ (1-307-777-7781) within 24 hours of the time that the operator becomes aware of violation.
   b. Submit written report to WDEQ, 122 West 25th Street, Herschler Building, Cheyenne, WY., 82002 within seven (7) days of the telephone report detailing steps which have been taken and will be taken to eliminate the violation.

APPENDIX I

INFORMATION PACKAGE
FOR

_____

1.Company:_____ Operator:_____

_____ _____

_____ _____

Physical Address of Property: _____

_____

2. Legal Description: _____

_____

3. System Description: _____

_____

4. Type of Injected Fluid:
Capacity of System:_____

Depth of Injection Zone:_____

Operation: Continuous

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