

CITY OF TROY DEVELOPMENT/ENGINEERING STANDARDS

The development standards as herein presented are intended to provide a sound but reasonable basis for design of public improvements, and private improvements affecting the public, in the City of Troy. These improvements include sanitary sewers, storm sewers, water mains, detention basins, grading and rear yard drainage, paving, soil erosion and sedimentation control, site improvement plans and sidewalks. They are not intended as a substitute for sound engineering judgment. These Development Standards incorporate the City of Troy Standard Details and the City of Troy specifications. The Standards may not apply to all conditions, and alternate solutions shall be permitted as approved by the City Engineer.

SECTION	SUBJECT
A-1 — A-5	General
B-1 — B-4	Sanitary Sewers
C-1 — C-7	Storm Sewers
D-1 — D-7	Water Mains
E-1 — E-4	Detention Basins
F-1 — F5	Grading and Rear Yard Drainage
G-1 — G-6	Paving, Sidewalk and Driveway Approaches
H-1 — H-4	Widening Lanes
I-1 — I-7	Soil Erosion and Sedimentation Control
J-1 — J-6	Fees

CITY OF TROY DEVELOPMENT/ENGINEERING STANDARDS

A. General

1. Complete improvement plans bearing the seal of a Professional Engineer licensed in the State of Michigan shall be submitted prior to review and approval of any portion thereof.
2. A certified boundary survey of the site, prepared and sealed by a Professional Surveyor licensed in the State of Michigan, or a copy of the computed plat shall be submitted with the engineering drawings.

Chapter 39 – Section 03.43.01 – (6)
Chapter 41 – Section

3. Plans submitted shall be twenty-four (24) inch by thirty-six (36) inch prints using blue or black lines, and shall be neatly and accurately prepared. Judgment should be exercised in the design, layout, and the presentation of proposed improvements.
4. For projects or subdivisions having more than one sheet of plans, a general plan having a scale of one (1) inch = 100 feet shall be provided showing the overall project or subdivision and indicating the size and location of all improvements shown in the detailed plans. Street names, street and easement widths, lot lines, lot dimensions, lot numbers and ownership shall be shown on all plans.

Utilities shall be located in accordance with the City standards. Side or rear lot easements shall have a minimum total width of twenty (20) feet. Utilities in easements shall be kept at least three (3) feet away from side or rear lot lines. Utilities shall be parallel to lot lines. Generally, utilities shall be constructed in the road right-of-way, or in easements adjacent to the road right-of-way, and shall not be located under existing or proposed pavement.

5. Grading plans are required for all developments. Refer to Section F, “Grading and Rear Yard Drainage”, for specific requirements.
6. Engineering plans having a scale of one (1) inch = fifty (50) feet horizontal, and one (1) inch = five (5) feet vertical, shall be provided. Sanitary sewer and water main shall be shown on the same sheet. Plan and profile views are required on all sanitary sewers. Profile views must be located below the plan view.

Plan view is required on all water mains. A profile view of water mains is required only on sixteen (16) inch and larger mains or when unusual ground contours occur. Profile views must be located below the plan view.

Storm sewer and pavement shall be shown on the same sheets. Plan and profile views are necessary for all storm sewers.

A plan view with centerline stationing shown is necessary on all paving. Show top-of-curb line on profile. In the profile view, all crossings of utilities must be shown. When a water main crosses a sewer, indicate an invert elevation for the water main.

Minimum vertical clearance between utilities shall be one (1) foot. Sand backfill, compacted to at least ninety-five (95) percent of maximum unit weight, is required between utilities. Only one (1) plan and profile view per page will be accepted.

7. Profiles of sewers shall indicate the size, class of pipe, class of bedding, top elevations of all manholes, length between manholes and slope of pipe, and shall indicate the existing and proposed ground elevations above the route of the sewer.

The inverts of all sewers shall be given at manholes. The location of compacted porous backfill required shall be indicated on the plan and profile.

8. Elevations shall be on NAVD 88 datum. Permanent bench marks for the work shall be indicated on the plans.
9. 100-year flood boundary contour elevations from the Federal Emergency Management Agency (F.E.M.A.) maps shall be indicated on the plans.
10. Any areas that are considered to be "wetlands" as defined by the Michigan Department of Environmental Quality (M.D.E.Q.) shall be indicated on the plans. No improvements will be allowed in wetlands unless the M.D.E.Q. issues a permit, or a letter of "No Authority", for such improvements.
11. Finished grade shall be indicated for all structures.
12. A Tree Preservation Plan in accordance with the City of Troy Landscape Design and Tree Preservation Standards shall be submitted to the Parks and Recreation Department for review and approval, prior to the application for preliminary site plan approval for sites and with the tentative preliminary plat for subdivisions. This requirement may be waived, by the Superintendent of Parks or his designee, in those instances where the Architectural Survey and/or other written information provided by the applicant demonstrates that the nature of the site is such that a Tree Preservation Plan would not be applicable, or would serve no practical purpose.

Landscape Design and Tree Preservation Standards adopted 9-15-75 by City Council resolution No. 75-829; Revised 1-31-77 by City Council Resolution No. 77-88; Revised 11-3-86 by City Council Resolution No. 86-1148; Revised 3-16-87 by City Council Resolution No. 87-301.

13. Plans for Landscaping or tree planting required by any City Ordinance or City Standard, relating to such items as greenbelts, street islands, detention basins, or landscape and open space areas, shall conform to the City of Troy Landscape Design and Tree Preservation Standards and shall be submitted to the Parks and Recreation Department for review and approval prior to the application for final site approval for sites.

Chapter 39 – Section 03.43.03-(4) and 4.04(B)(E)(H)

14. All new grass areas that are required in the public right-of-way, by any City Ordinance or City Standard, and all existing grass areas that are disturbed by construction, shall be established or restored in conformance with the City of Troy Standard Specification for Turf Restoration
15. Street names shall be approved by the City. They shall not contain more than thirteen letters. All street name and traffic control signs in public Right-Of-Ways are installed by the City, and the developer shall pay the cost of these signs.

Chapter 2 – Section 12-C

16. The consulting engineer shall forward plans, for approval, to any public utility and any Federal, State, County, or other City agency whose facilities or right-of-way may be affected by the proposed construction.
17. For subdivisions, prior to Final Plat Approval, the following item or items must be furnished to the City:
 - a) A reproducible copy of the Final Plat, on Mylar (minimum of three (3) mils thick).
 - b) A computerized copy of the final plat, accurately produced by precision input in Microstation format with a file extension of .DGN, or in a generic .DXF format CAD file, with a file extension of .DXF, on a compact disk (CD) formatted to be compatible with the Microsoft Windows system.
18. For all developments, prior to design approval, a computerized copy of all final approved design drawings shall be furnished to the City in the same format as described in Item 17 above.
19. Contracts for all improvements shall be submitted to the City Engineer for approval prior to the start of construction.

20. For all developments, one (1) Mylar copy, a minimum of three (3) sets, of all as-built drawings for sanitary sewers, storm sewers, water mains, detention basins, paving and grading shall be provided by the developer within six (6) months of the completion of these improvements. A computerized copy of all as-built drawings shall be furnished to the City, in the same format as described in item 17 above.
21. The following plans for subdivisions must be submitted for City use after final approval and prior to the pre-construction meeting:
 - a) Eight (8) complete sets
 - b) Three (3) grading plans

Complete sets shall include all applicable detail sheets.

22. All public improvements must be staked under the supervision of a Professional Engineer or Professional Surveyor licensed in the State of Michigan according to the latest approved plans. All plans used by the contractor for construction must be stamped "APPROVED FOR CONSTRUCTION" by the City Engineer.
23. Proposed improvements must conform to the various master utility and thoroughfare plans of the City. Copies of these plans may be reviewed at the Troy Public Library, the Engineering Department or the Planning Department. Copies of these plans may be purchased through the City Clerk's office.
24. Where a project lies within an area or system under jurisdiction of the County, the State or the Federal Government, the standards and requirements of the respective agencies are generally adopted by the City. Where conflict arises, the higher standard applies, subject to interpretation by the City.
25. For subdivisions, a temporary construction access road shall be constructed to a major road to avoid construction traffic on existing residential streets. All new residential streets shall be barricaded and blocked at connections to existing residential streets to prevent construction traffic from using existing residential streets. The developer shall extend every possible effort to secure easements for access roads through private property, where necessary. The temporary construction access road shall remain in service until eighty (80) percent of the homes in the subdivision have been granted certificates of occupancy.

The Public Works Director will make the final decision as to when the barricades can be removed to allow access to new subdivision streets from existing residential streets.

When it is impossible to construct an access road, the developer shall make an escrow deposit for the repair of damage to existing residential streets used for access and a cash deposit for the cleaning and maintenance of existing residential streets used for access, as required by Section I. This cash deposit will be held until all of the subdivision improvements have been granted final approval and accepted by the City.

26. No person shall track mud onto any public roadway and shall cease working until weather conditions improve or shall make provisions to remove mud from the tires and tracks of his equipment prior to entering the public roadway. If mud is accidentally tracked onto a public roadway, it shall be removed immediately and immediate measures shall be taken to prevent a second occurrence. If any person fails to remove mud from the public roadway, the City can perform the work with all costs charged to the person.

Chapter 106 – Section 5.55 - 3, 4 & 5

27. The City reserves the right to revise the Development/Engineering Standards and Standard Construction Specifications at any time and to require that such revised Development/Engineering Standards or construction Specifications be incorporated into the work at any time prior to final design submittal.

The City Engineer reserves the right to revise or correct any plans, that have been “approved for construction”, due to errors, omissions or for unforeseen field conditions and to require that such revisions and corrections be incorporated into the work at any time prior to final acceptance of the work.

28. All persons performing work under permits issued by the City of Troy shall not enter upon private property for any purpose without first obtaining written permission from the property owner and giving evidence of same to the City.
29. All persons shall be responsible for the preservation of all public property, trees, monuments, etc., along, within, and adjacent to the street and/or Right-Of-Way, and shall use every precaution necessary to prevent damage or injury thereto. All persons shall use suitable precautions to prevent damage to pipes, conduits, and other underground structures and shall protect carefully from disturbance or damage, all monuments and property markers until the engineer or an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

B. Sanitary Sewers

1. Submittal Procedure

For City approval of sanitary sewer systems the applicant shall furnish the Engineering Department two (2) complete sets of the sanitary sewer plans. The City Engineer shall review the plans for conformity to the standards set forth herein, and certify that they are consistent with the overall utility plans of the City, after which he will return a letter of review with appropriate comments. The applicant, after making any changes requested, shall submit two (2) sets of the revised plans to the Engineering Department for final approval. After approval by the City, six (6) sets of plans, and a completed permit application for Wastewater Systems must be submitted. The City Engineer will transmit the six (6) sets of approved plans to the appropriate county agency. The county agency will transmit the plans to the Michigan Department of 'Environmental Quality (MDEQ) for approval and a construction permit. An approved copy will be returned to the applicant via the MDEQ.

2. Requirements

- a) Prior to starting any sanitary sewer design, the applicant is encouraged to make use of maps and information available at the City offices.

It shall be the responsibility of the applicant to field check and verify utility locations provided by the City.

- b) The following table of minimum slopes for sanitary sewers shall be adhered to:

Size and Minimum Slope

eight (8) inches @ 0.40 percent
ten (10) inches @ 0.30 percent
twelve (12) inches @ 0.22 percent
fifteen (15) inches @ 0.15 percent
eighteen (18) inches @ 0.12 percent
twenty-one (21) inches @0.10 percent

NOTE: The minimum allowable size of a public sanitary sewer is eight (8) inches in diameter. The last upstream run of sewer must be at a grade of 0.60 percent or greater. If more than one building is to be served by a sanitary sewer line, an eight (8) inch minimum size public sewer must be built.

- c) Sewer pipe shall be placed on Class "B" bedding or better, as indicated on the sewer detail sheet.

- d) Service leads installed with the lateral sewer shall be a minimum of six (6) inches in diameter. Each structure shall have a separate individual sanitary service lead connected to a public sanitary sewer.
- e) Sanitary sewer manholes shall not exceed the spacing listed below:

<u>Diameter of Sewer</u>	<u>Maximum Manhole Spacing</u>
Fifteen (15) inch or less	400 feet
Eighteen (18) inches and larger	500 feet

Sanitary sewers may be placed in an easement in front of the lot. The sewer must be within five (5) feet of the right-of-way line. In general, sanitary sewers **will not** be approved in the rear lot easement.

Sanitary sewer manholes must be watertight and shall be pre-cast sections with modified grooved tongue joints with rubber gaskets, conforming to A.S.T.M. Designation C-478.

- f) The following information shall be indicated on the sanitary sewer profile:
 1. Length of run between manholes.
 2. Type of pipe between manholes.
 3. Class of pipe between manholes.
 4. Size and slope of sewer between manholes.
 5. Class of bedding.
 6. Top elevation of all manholes.
 7. Existing and proposed ground elevation above the route of the sewer.
 8. A logical numbering system for manholes shall be included.
 9. Invert elevations of all sewers at manholes.
 10. Locations and limits of sand backfill where required.
 11. Locations and elevations of crossings with other utilities.
- g) Provide a minimum depth from top of curb (or road centerline if uncurbed) to the top of any sanitary sewer of eight and one-half (8-1/2) feet at local control points, or a minimum of nine (9) feet at locations where the sewer grade is parallel to the road grade. The sewer shall be deep enough to serve, by gravity, a standard depth basement.
- h) Allowable type of sewer pipe shall be as follows:
 1. Extra strength vitrified clay sewer pipe shall conform to the current adopted A.S.T.M. specification for reinforced concrete pipe; C-700. This pipe is to be used only for industrial zones.

2. Reinforced concrete sewer pipe shall conform to the current adopted A.S.T.M. specification for reinforced concrete pipe; C-76, Class IV or Class V, as required. The "wall B" or "wall C" specification shall be used.
 3. ABS or PVC composite sewer piping shall conform to A.S.T.M. Designation D-2680 with type SC joints.
- (i) Sanitary sewer leads shall only be constructed of PVC or ABS solid wall pipe, Schedule 40 of SDR 23.5, except in industrial zones where the lead shall be constructed of extra strength vitrified clay pipe as described above.
 - (j) Sanitary sewer shall be placed on the opposite side of the street from the water main, and shall have a horizontal separation of at least ten (10) feet.
 - (k) Pre-cast drop connections are required at manholes where the outlet pipe is 18 inches or more below the inlet pipe.
 - (l) Where conditions require tunneling or boring, consult the City Engineer for specific requirements. These conditions may include road crossings, trees, shrubs, structures or other utilities. Where sanitary sewers or sanitary sewer leads cross improved roads of any type, the pipe shall normally be installed by tunneling or boring.
 - (m) Where the developer must extend the sanitary sewer from off-site, the developer shall extend sanitary sewer leads to the property line of all adjacent property on both sides of the right-of-way the entire length of the off-site sanitary sewer installation except on major thoroughfares. When the sanitary sewer installation is on a major thoroughfare, the developer shall extend the sanitary sewer leads to the property line of all adjacent property on the same side of the roadway as the sanitary sewer. The City will reimburse the developer for the cost of sanitary sewer leads serving properties owned by others at prevailing costs as determined by the City Engineer.
 - (n) The developer shall prove that sanitary sewers, eight (8) inches in diameter and over, have been properly installed and cleaned, by performing a television inspection of the entire installation and recording the results on **digital video disk (DVD)** for submission to and approval by the City.

To preclude the possibility of tampering or editing in any manner, the DVD must, by electronic means, display continuously and simultaneously generated transparent digital information to include the date and time of recording and the distance in feet from the starting manhole. The date shall include the month, day and year; for example, 05/27/92.

The time shall consist of hours, minutes and seconds separated by colons; for example, 10:35:18. The distance from the starting manhole shall be displayed

in tenths of a foot; for example, 22.6. This information shall appear in an upper corner of the viewing screen, where it will not interfere with viewing the sewer pipe.

The television inspection shall also include a written report which includes all wye locations with respect to a manhole and shall also include a description and location of all defects in the sewer such as cracked or failing pipe, defective joints, points of infiltration, misalignment in line or grade, etc.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

C. Storm Sewers

1. Submittal Procedure

For City approval of storm sewer systems, the applicant shall furnish the Engineering Department two sets of the storm sewer plans. Detailed storm sewer design computation, and the drainage area map showing the various areas contributing to the points of inlet, shall be provided. The City Engineer shall review the plans for conformity to the standards set forth herein, and certify that they are consistent with the overall utility plans of the City, after which he will return a letter of review with appropriate comments. The applicants, after making any requested changes, shall submit two (2) sets of revised plans to the Engineering Department for final approval. After approval by the City, the applicant shall obtain approval of the Road Commission for Oakland County (R.C.O.C.), the Oakland County Drain Commissioner (O.C.D.C.), the Michigan Department of Transportation (M.D.O.T.) or any other agency where applicable. After approval by the City, a detailed estimate of cost must be submitted.

Chapter 41 – Section 3.02-B and 4.07-A

2. Design Standards

- a) The “rational formula” for computing storm water flows ($Q=CIA$) shall be used to design storm drainage systems capable of carrying a ten (10) year intensity rainfall. Intensity (I) shall be equivalent to $I=175/T+25$ where T is generally twenty (20) minutes for residential areas and fifteen (15) minutes for high runoff areas.

The following minimum values for “C” shall be used:

Zoning	Run-off Coefficient “C”	Assumed Average Imperviousness
R-1T, CR-1	0.54	60 percent
R-2	0.45	50 percent
RM, RN-1	0.54 – 0.81	60 percent – 90 percent
RM-2, RM-3	0.81	90 percent
O-1, OSC, O-M	0.81	90 percent
B-1, B-2, B-3	0.81	90 percent
H-S, P-1	0.81	90 percent
M-1, R-C	0.81	90 percent

Single-family detached residential runoff coefficients:

Zoning	Entire Lot	Front Lot	Rear Only
R-1A	0.30	0.39	0.24
R-1B	0.32	0.40	0.24
R-1C	0.32	0.40	0.26
R-1D	0.35	0.40	0.27
R-1E	0.36	0.42	0.29
R-1A* thru R-1D	0.35	0.44	0.27

*For areas with lot sizes reduced according to the open-space option (see Zoning Ordinance)

Other values of the runoff coefficient may be used or required at the discretion of the City Engineer for such areas as parks and open spaces or unusual sites. Generally, 0.90 should be used for hard surfaces and 0.15 for lawn areas.

- b) Sufficient capacity shall be provided in the storm sewer system to take fully developed upstream drainage into the system.

When a storm sewer is designed to provide capacity for developed upstream areas, the hydraulic gradient shall remain in the pipe. A clear twenty (20) foot wide easement shall be given to the City.

If a storm sewer is designed to take on-site drainage only, the hydraulic gradient must be no higher than one (1) foot below ground. When the hydraulic gradient is above the top of the sewer pipe, the design elevation of the hydraulic gradient shall be indicated on the profile at each manhole.

For non-residential areas, before storm water is outletted to a public storm sewer, it must be treated in an approved manner to remove sediment, grease, oil and any other pollutants the City Engineer may deem necessary.

- c) Manholes shall be located at:

1. Angles in the main sewer
2. Points where the size of the sewer changes
3. Points where the grade of the sewer changes
4. The junction of sewer lines
5. Street intersections or other points where catch basins or inlets are to be connected.

- d) Manhole spacing for storm sewers shall be as follows:

Diameter of Sewer	Maximum Manhole Spacing
12 inches – 18 inches	400 feet
21 inches – 30 inches	450 feet
36 inches – 42 inches	500 feet
48 inches	550 feet
54 inches – 60 inches	600 feet
66 inches – 72 inches	650 feet
6 feet, 6 inches and larger	800 feet

NOTE: Height of “Lo Head” pipe shall be used as the criterion for manhole spacing. The minimum size of a public storm sewer is twelve (12) inches in diameter.

Generally, catch basins shall not be constructed over a storm sewer to replace manholes. Storm manholes may have catch basin covers if there is a sump at the manhole bottom, when approved by the City Engineer.

Curved sewer is allowed in sizes thirty-six (36) inches and larger provided that, where joints are deflected, modified grooved tongue with rubber joints will be required.

- e) The following information shall be indicated on the storm sewer profile:

1. Length of run between manholes.
2. Type and class of pipe between manholes.
3. Size and slope of sewer between manholes.
4. Class of bedding.
5. Rim elevation of all manholes.
6. Top of curb line.
7. Top of curb elevations at 100 foot stations.
8. Existing and proposed ground elevations above the route of the sewer.
9. A logical numbering system for manholes shall be included.
10. Invert elevations of all sewer at manholes.
11. Locations and limits of sand backfill, where required.
12. Locations and elevations of crossing with other utilities.
13. Hydraulic gradient

- f) The following table of minimum slopes for storm sewers shall be adhered to:

Size and Minimum Slope

12 inches @ 0.32 percent
15 inches @ 0.24 percent
18 inches @ 0.18 percent
21 inches @ 0.14 percent
24 inches @ 0.12 percent
27 inches @ 0.10 percent
30 inches @ 0.09 percent
36 inches @ 0.07 percent
42 inches @ 0.06 percent
48 inches @ 0.05 percent
54 inches @ 0.04 percent
60 inches @ 0.036 percent
66 inches @ 0.032 percent
72 inches @ 0.028 percent

The minimum velocity may not be less than two and one-half (2-1/2) feet per second in a pipe flowing full. The maximum desired velocity in storm sewers is ten (10) feet per second. Velocity up to fifteen (15) f.p.s. may be allowed for cases of unusual terrain. The contents of a larger pipe will never be discharged into a smaller line even though the slope may be steeper for the smaller. This principle does not apply, however, to a restricted opening or discharge.

- g) Where possible provide a minimum of three (3) feet of cover from the top of curb (or road centerline) to the top of any storm sewer.

If cover is less than three (3) feet, use C-76, Class IV for twenty-four (24) inch and smaller pipe, and C-76, Class II for larger pipe. C-76, Class IV pipe shall be used for all cross-drains between pavement inlets and catch basins, including the leads to the manhole. Cross-drains will have pea gravel bedding and shall be backfilled to finished sub-grade with pea gravel.

For subdivisions, storm sewers shall be located in the public road right-of-way or in easements adjacent to the public road right-of-way.

Storm sewers shall not be located in rear yards except in unusual circumstances with the permission of the City Engineer. When storm sewers are allowed in rear yards, a parallel rear yard drainage system, as described in Section K, shall be required.

- h) A pre-fabricated bar screen shall be used on all storm sewer openings twelve (12) inches in diameter and larger. The bar screens will be constructed according to an approved separate enlarged detail to be provided in the drawings and shall be designed to be sturdy, permanent, easily maintained, non-clogging and shall have clear openings of no more than five (5) inches.
- i) In general, catch basins shall be located as follows:
 - 1. At the radius return of street intersections. When drainage is required to go around corners, 150 feet maximum distance along the street between a high point and a corner catch basin is allowed.
 - 2. At all low points in street
 - 3. Such that there is a maximum pavement area per structure as follows:
 - (a) 12,000 square feet for a catch basin or inlet at a low point; and
 - (b) 7,000 square feet for a relief basin
 - 4. Such that, where a low point exists in the gutter line, no more than two (2) relief basins shall be used in either direction in advance of the low point, i.e., four (4) relief basins would be possible. When a total of two (2) or more relief basins are used in such a system, a double catch basin will be placed at the low point.
 - 5. At all pavement catch basins and inlets, twenty (20) lineal feet of six (6) inch perforated or slotted pipe shall be constructed in back of curb line in each direction, backfilled with pea gravel.

The perforated pipe shall be Smooth-Wall PVC Plastic Underdrain with 3/16 inch to 3/8 inch perforations, A.S.T.M. F-758. The slotted pipe shall be PVC corrugated sewer pipe, A.S.T.M. F-949 with slotted perforations of 1.90 square inches per foot of pipe length.
- j) Rear yard underdrain systems shall be installed in all residential developments. See Section F, "Grading and Rear Yard Drainage" for details.
- k) The inlet end of culverts and storm drains shall have a properly designed inlet structure, head wall or flared end section, as approved by the City Engineer. Culverts and storm drain outlets shall also have headwalls or flared end section, with necessary erosion control.

- l) Sub-soil drainage systems, with sump pumps or gravity drains, must discharge to a drainage structure connected to an underground public rear yard drain or an approved alternate storm drain.
- m) A minimum three (3) inch diameter storm sewer lead for sump pump discharge shall be constructed to each lot in a new subdivision from the rear yard underdrain. The sump pump lead may be constructed from another storm sewer, which must be provided when the rear yard drain has been waived. The lead shall be constructed at a minimum one (1) percent grade.
- n) Improved open drains may be permitted upon special circumstances, with Engineering Department approval.

- 1. A permit must be obtained from Oakland County Drain Commissioner for all connections to county drains. Plans shall conform to all current requirements of federal and state law pertaining to flood plain determination, stream crossing requirements and other statutes relating to waterways.
- 2. Open drains shall have side slopes no steeper than six (6) horizontal to one (1) vertical, where such slopes abut the development being proposed.

Four (4) to one (1) slopes, with four (4) foot chain link fencing, may be considered, with the approval of the City Manager, along a development boundary (submit fence specifications).

An easement of at least thirty (30) feet wider than the widest point from top of bank to top of bank is to be recorded on the plat and/or dedicated.

- 3. Adequate culverts are required at all roads crossing a drain. Minimum length of culvert is sixty (60) feet. End section, curtain walls and energy deflectors shall not be considered as part of this minimum length.

A curtain wall and/or energy deflector is required under all culvert ends.

Sidewalks, where required, must be installed across the entire easement before final acceptance of the work. Six (6) inch thick unreinforced concrete riprap is required on all slopes at culvert crossings.

This riprap must be anchored by a footer a minimum of two (2) feet deep to prevent washing away during high water periods.

- 4. Open drains must have slope protection (riprap) at bends with a radius of 500 feet or less and at other points designated by the City Engineer.

5. The drain bottom and slopes, to the hydraulic gradient line, must be sodded and staked in place. The remainder of the easement may be seeded. The City will not accept the work until all turf is established in accordance with the Standard Specifications for Turf Restoration.
- o) Pipe for storm sewers shall be reinforced concrete pipe conforming to A.S.T.M. Designation C-76, Classes III, IV or V. The wall "B" specifications shall be required. Elliptical reinforcement will not be permitted in thirty-six (36) inch pipe or larger.

Allowable joints:

1. Thirty (30) inch diameter pipe and smaller shall be modified grooved tongue with rubber gasket conforming to A.S.T.M. Designation C-361.
2. Sizes over thirty (30) inches shall be rubber gasket wrap or A.S.T.M. Designation C-361.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

D. Water Mains

1. Submittal Procedure

For City approval of water main systems, the applicant shall furnish the Engineering Department two (2) sets of water main plans. The City Engineer shall review the plans for conformity to the standards set forth herein, and certify that they are consistent with the overall utility plans of the City, after which he will return a letter of review with appropriate comments. The applicant, after making any changes requested, shall submit two (2) sets of the revised plans to the Engineering Department for approval. After approval by the City, nine sets of plans, and detailed estimate of cost must be submitted. The City Engineer will transmit eight (8) copies to the City of Detroit for approval. After the City of Detroit approval has been obtained, they will be forwarded to the Michigan Department of Public Health for a construction permit. An approved copy will be returned to the applicant via the Michigan Department of Public Health.

Chapter 41 – Section 3.02-B and 4.07-D

2. Requirements

- a) Prior to starting any water main design, the applicant is encouraged to arrange a meeting with the Engineering Department, to include the Superintendent of Water and the Fire Marshal, to discuss specific fire protection needs. Public water mains are required for fire protection purposes. Fire protection lines must be sized to provide the necessary flows in accordance with the International Fire Code – Fire Flow Requirements for Buildings as amended and as described in Section D3 of this standard.
- b) Eight (8)-inch minimum diameter mains will be installed in single family residential areas.
- c) Twelve (12) inch mains are considered to be the minimum size in commercial, office, industrial, mercantile, assembly and multiple family residential areas.
- d) All single hydrant leads longer than sixty (60) feet must be eight (8) inches, and shall be valved as a dead-end main.
- e) When approved by the fire official, eight (8) inch water main may be permitted in a looped system of 1,500 feet or less where buildings are equipped throughout with an automatic fire sprinkler system.

- f) At all open drain crossings, a separate enlarged scale view is required. A six (6) foot minimum clearance between the bottom of the drain and the top of the water main is required.
- g) Profile view is required for sixteen (16) inches and larger water mains, and for other smaller sizes when determined necessary by the City Engineer. Water mains shall be kept on one side of the street for the entire length of the street (parking is prohibited on the water main side of the street). Water mains shall not be located under pavement or under cul-de-sacs but shall "wrap" the cul-de-sac and terminate at the center of the property, at the base of the cul-de-sac on the opposite side.
- h) Gate valves shall be spaced not to exceed 800 feet intervals on distribution lines. They shall be spaced such that not more than four valves need to be turned off to isolate any section of the water main. The Superintendent of the Water and Sewer Department can require inserting valves to be installed on existing water mains wherever deemed necessary.
- i) Sufficient valves shall be placed such that not more than twenty-four (24) homes and not more than one hydrant shall be out of service within such section of water main, which can be so isolated.
- j) Where possible, gate valves shall be located at street intersection five (5) feet from the intersecting street right-of-way line. All dead-end mains must be valved at the tee. Gate valves shall not be located under roadway pavement, sidewalks, or driveway approaches.
- k) Hydrants shall be installed at the ends of all dead-end water mains that are not to be extended in the future. When near a street intersection, hydrants shall be located twenty-five (25) feet from the intersecting street right-of-way line. In other areas, hydrants shall be located at the end of the water main after wrapping the cul-de-sac as described in paragraph g) above.
- l) When connecting to an existing water main, a tapping sleeve and gate valve in well will be required unless connection to the existing main can be made without interrupting service on the main.
- m) The plans shall indicate the finish grades of all hydrants and gate well rims.
- n) The Michigan State Health Department requires that all water mains be located so as to provide a minimum of ten (10) feet horizontal clearance between the nearest edge of the water main and the nearest edge of any sanitary or storm sewer.

- o) A minimum vertical clearance of eighteen (18) inches shall be maintained between the bottom of any water main and the top of any sanitary sewer, or any other utility, crossing under the water main. A vertical clearance of less than eighteen (18) inches, or the crossing of a sewer over a water main, will require encasement of the sewer or special measures be taken to prevent contamination of the water supply.
- p) Tapping of pre-stressed concrete cylinder pipe or embedded cylinder pipe shall be done in compliance with the manufacturer's recommendations, and with details prepared by the City Engineer.
- q) Where conditions require tunneling or boring, consult the City Engineer for specific requirements. These conditions may include road crossings, trees, shrubs, structures or other utilities. Where water mains cross improved roads of any type, the pipe shall normally be installed by tunneling or boring.
- r) Fire hydrants located in areas of vehicular movement shall be protected by four (4) steel posts, as shown on the standard detail sheet for water mains.

3. Fire Flow Requirements for Buildings

- a) The procedure for determining fire flow requirements for buildings or portions of buildings shall be in accordance with this section.
- b) For the purpose of this section, certain terms are defined as follows:
 - * Fire Area: The floor area, in square feet, used to determine the required fire flow.
 - * Fire Flow: The flow rate of a water supply, measured at 20 psi (137.9 kPa) residual pressure, that is available for fire fighting.
- c) The fire official is authorized to increase the fire flow requirements where conditions indicate an unusual susceptibility to group fires or conflagrations. An increase shall not be more than twice that required for the building under consideration.
- d) The fire area shall be the total floor area of all floor levels within the exterior walls, and under the horizontal projections of the roof of a building, except as modified in paragraph e) of this section.
- e) Portions of buildings that are separated by one or more firewalls constructed in accordance with the Building Code, without openings and provided with a thirty (30)-inch (762 mm) parapet, are allowed to be considered as separate fire areas.

- f) The fire area of buildings constructed of Type I and Type II construction shall be determined by the area of the largest floor.
 - * Exception: The fire area for open parking garages shall be determined by the area of the largest floor.
- g) The minimum fire flow requirements for one- and two-family dwellings having a fire area which does not exceed 3,600 square feet (344.5m²) shall be 1,000 gallons per minute (3785.4L/min.). Fire flow and flow duration for dwellings having a fire area in excess of 3,600 square feet (344.5 m²) shall not be less than that specified in the accompanying table.
 - * Exception: A reduction in required flow of up to 50 percent, as approved by the fire official, is allowed when the building is provided with an approved automatic sprinkler system.
- h) The minimum fire flow duration for buildings other than one- and two-family dwellings shall be as specified in the accompanying table.
 - * Exception: A reduction in required fire flow of up to 75 percent, as approved by the fire official, is allowed when the building is provided with an approved automatic sprinkler system. The resulting fire flow shall not be less than 1,500 gallons per minute (5677.5 L/min.).

4. Fire Hydrant Locations and Distributions

- a) Fire hydrants shall be located in accordance with the International Fire Code – Fire Hydrant Locations and Distribution as amended and as described in Section D4 of this standard. In addition, fire hydrants must be located at least twenty-five (25) feet from any exterior wall of any masonry building, and at least fifty (50) feet from any exterior wall of frame or equivalent construction, including brick and stone veneer.
- b) Fire hydrants shall be provided along required fire apparatus access roads and adjacent public streets.
- c) The minimum number of fire hydrants available to a building shall not be less than that listed in the accompanying table. The number of fire hydrants available to a complex or subdivision shall not be less than that determined by spacing requirements in the accompanying table when applied to fire apparatus access roads and perimeter public streets from which fire fighting operations could be conducted.

- d) Existing fire hydrants on public streets are allowed to be considered available. Existing fire hydrants on adjacent properties shall not be considered available unless fire apparatus access roads extend between properties and easements are established to prevent obstruction of such roads.
- e) The average spacing between fire hydrants shall not exceed that listed in the accompanying table. Regardless of the average spacing, fire hydrants shall be located such that all points on streets and access roads adjacent to a building are within the distances listed in the accompanying table.
 - * Exception: The fire official is authorized to accept a deficiency of up to 10 percent where existing fire hydrants provide all or a portion of the required fire hydrant service.
- f) High density and high-rise developments shall be provided with sufficient valves and hydrants so located as to provide emergency exterior fire coverage in case of water main breaks.
- g) There shall be a fire hydrant located within 100 feet of any building standpipe Fire Department connection unless the building is equipped with a complete automatic fire sprinkler system.
- h) Any domestic or fire sprinkler line, three (3) inch diameter or larger, shall have a gate valve in well constructed near the connection to the public water main.
- i) All public mains must be centered in clear twenty (20) foot wide easements given to the City. Written descriptions of the easements must be prepared by a Licensed Professional Engineer or Professional Surveyor on City of Troy standard easement forms. After plan approval, the consulting engineer shall supply a written, detailed estimate of cost for the water main. All public water mains require Michigan Department of Health Construction Permits and City of Detroit Water and Sewerage Department permits.
- j) regardless of the average spacing, fire hydrants shall be located such that all points on streets and access roads adjacent to a building are within the distances listed in the accompanying table.

MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION TABLE

FIRE AREA (square feet)					FIRE FLOW (gallons per minute) ^b	FLOW DURATION (hours)
TYPE IA & IB ^a	TYPE IIA & IIIA ^a	TYPE IV AND V-A ^a	TYPE IIB & IIIB ^a	TYPE V-B ^a		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
"	"	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
"	"	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
"	"	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
"	"	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
"	"	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
"	"	167,901-179,400	121,301-129,600	74,601-79,800	7,500	
"	"	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
"	"	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

For **SI**: 1 square foot = 0.0929 m², 1 gallon per minute = 3.785 L/m

^a Types of construction are based upon the Building Code.

^b Measured at 20 psi (137.9 kPa).

NUMBER AND DISTRIBUTION OF FIRE HYDRANTS

FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NO. OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS ^{a,b,c} (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT ^d
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more ^e	200	120

For **SI**: 1 gallon per minute = 3.785 L/m, 1 foot = 304.8 mm

^a Reduce by 100 feet (30,480 mm) for dead-end streets or roads.

^b Where streets are provided with median dividers which can be crossed by firefighters pulling hose lines, or arterial streets are provided with four or more traffic lanes and have a traffic count of more than 30,000 vehicles per day, hydrant spacing shall average 500 feet (152.4 m) on each side of the street and be arranged on an alternating basis up to a fire-flow requirement of 7,000 gallons per minute (26,495 L/min.) and 400 feet (122 m) for higher fire-flow requirements.

^c Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at spacing not to exceed 1,000 feet (305 m) to provide for transportation hazards.

^d Reduce by 50 feet (15,240 mm) for dead-end streets or roads.

^e One hydrant for each 1,000 gallons per minute (3,785 L/min.) or fraction thereof.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

E. Detention Basins

1. Submittal Procedure

For City approval of detention basins, the applicant shall furnish the Engineering Department two (2) sets of detention basin plans and one (1) set of detention calculations. The City Engineer shall review the plans for conformity to the standards set forth herein, and certify that they are consistent with the overall utility plans of the City, after which he will return a letter of review with appropriate comments. The applicant, after making any requested changes, shall submit two (2) sets of the revised plans to the Engineering Department for final approval. The applicant may be required to obtain approval of the Oakland County Drain Commissioner (O.C.D.C.), the Road Commission for Oakland County (R.C.O.C.) or the Michigan Department of Transportation (M.D.O.T.) where the outlet discharges to facilities under their jurisdiction. After approval by the City Engineer, a detailed cost estimate must be submitted.

Chapter 41 – Section 3.02-B and Section 4.07-A

2. Requirements

- a) Storm water detention is necessary for all developments in the City.
- b) Detention basins shall be designed to detain storm water for the developed site. The applicant is not required to detain water from off-site areas in the drainage district.
- c) Detention basins shall be designed to store storm water from a 25-year frequency rainfall over the developed area of the site in commercial, industrial, office and high-rise residential area.

The O.C.D.C. method entitled “A Simple Method For Retention Basin Design” Water and Sewer Works 12/73, may be utilized to determine the amount of detention required. Copies of this method are available from the Engineering Department.

- d) For all developments, the basin shall be designed to store all storm water runoff, from a twenty five (25) year frequency rainfall, in excess of agricultural runoff; a rule of thumb for determining agricultural runoff is 0.10 to 0.20 cfs per acre dependent on slope, ground cover, and soil type.

- e) For residential developments, all detention basins shall be unfenced with side slopes no steeper than one (1) vertical on six (6) horizontal, with a three (3) foot minimum flat shoulder between the top of slope and the property line.

The property on which the detention basin is located shall be deeded to the City.

- f) For all other developments, other than residential developments, all open detention basins having side slopes steeper than one (1) vertical on six (6) horizontal shall be fenced, except where their design is an integral part of the landscape, and where the City Manager determines that depth and location are not hazardous. The maximum side slopes of the basins shall be one (1) vertical on four (4) horizontal, with a three (3) foot minimum flat shoulder between the top of the slope and the fence.

Where required, fences shall be six (6) feet high chain link with a black PVC coating. Gates shall be provided that are 12 feet wide with a double opening. Detailed specifications must be submitted for approval. Alternate types of fencing may be permitted, for aesthetic purposes, subject to the approval of the City Manager.

Basins designed as an integral part of the landscape may vary from this requirement, with approval of the City Manager. Detention basins, which would require fencing, will not be located within yard set-back areas adjacent to public thoroughfares. Detention basins specifically designed architecturally and aesthetically for a location within such yard set-back areas shall be approved as to their concept and location by the Planning Department, before Engineering Review.

Alternate detention options may be considered at the discretion of the City Engineer, parking lot storage, six (6) inches maximum depth and/or underground storage. Either method requires treatment of the storm water before discharge from the site. Treatment to address sediment, greases, oils and other pollutants deemed necessary by the City Engineer.

- g) Earthen detention basins, except those designed to have a permanent body of water, shall have a natural cobblestone cunette constructed from each inlet to the outlet. The cobblestone cunette shall be a minimum of 6' wide constructed of a geo-textile fabric. The cunette shall have a minimum slope of 1%. Where a permanent body of water is incorporated in the detention system design, a constant adequate source of fresh water shall be provided. A pumped well system shall be provided, if necessary.
- h) The entire detention basin must be seeded or sodded except below the water line for detention basins designed to have a permanent body of water. The

City will not accept the basin until turf is established in accordance with the Standard Specifications for Turf Restoration.

- i) All pipes entering a detention basin shall have an end section with bar screen at the end of the pipe and 6'-12" natural cobblestone riprap. The minimum width of the riprap shall be twice the outside diameter of the pipe. The riprap shall extend from bottom of the basin to the top of the slope.
- j) The outlet pipe, from the detention basin to an approved outlet, shall be designed for a ten (10) year intensity rainfall in conformance with Section C. The outlet pipe, from the detention basin, shall be restricted to allow only the agricultural run-off, as defined in Section E.2.d, to discharge to the outlet.
- k) An overflow system must be provided. Where possible, an overflow structure shall be designed to outlet into an adequately sized storm sewer. There are two (2) possible alternate methods: 1) Using an overflow pipe; the invert elevation of this pipe shall be above the maximum storage elevation of the basin and 2) a low point overflow; the low point of the basin shall be set at an elevation no lower than the maximum storage elevation of the basin.

The overflow shall have riprap adequate to prevent scour. The overflow must be designed so as to not flood adjacent properties, and the back-water elevation must be no higher than one (1) foot below the lowest ground elevation of the developed area.

- l) Detention basins that are gravity drained into an open drain must have the outlet pipe invert above the normal water level of the drain.
- m) In cases where the drain outlet for the detention basin is not deep enough to completely de-water the basin, pumps must be installed.

The pumps shall be installed in duplicate with each pump capable of handling the flow.

For basins with pumped outlets, a silt trap and bar screen shall precede the outlet line from the detention basin. The screen clear opening shall be two (2) inches maximum.

Design shall be based on Standard Plans for Detention Pond De-Watering Pump Station, Sheets 1 & 2 adopted by the City of Troy and on file at the Troy Engineering office.

Pump controls shall be designed in a manner to assure that the water level in the receiving stream shall not create flooding to adjacent properties.

Complete specifications for the pumps and controls and performance curves for the pumps called for must be submitted to the City Engineer for approval. Two (2) operation manuals shall be provided by the Manufacturer.

The Building Department requires a building permit for all electrical work and for concrete structures.

The pump house and all gates to the detention basin shall be locked at all times. It shall be the owner's responsibility to provide a lock and keys necessary to insure that the basin is closed until final acceptance by the City.

- n) For all new residential subdivision plats, the property the detention basin is located upon must be deeded to the City. A non-refundable cash fee for public detention basin maintenance and landscaping is required.
- o) Access must be provided to all public detention basins. Drive approaches in the public street Right-Of-Way shall be provided in accordance with these Development Standards, Section G. Access drives outside of road Right-Of-Way shall consist of twelve (12) feet wide, three (3) inch thick bituminous pavement on an eight (8) inch, 22A aggregate base, or as an alternate shall consist of six (6) inch thick concrete pavement and shall be located within a fourteen (14) feet wide easement or property deeded to the City.

All gates constructed directly in front of a paved roadway are to have an end of roadway marker (ER-1) and a "road ends" sign (W-14-2-a) securely fastened to the gate. High intensity reflectorized Scotchlite on .080 aluminum is the required sign material.

CITY OF TROY DEVELOPMENT/ENGINEERING STANDARDS

F. Grading and Rear Yard Drainage

1. Submittal Procedure

For City approval of grading and rear yard drainage, the applicant shall furnish the Engineering Department two (2) grading and rear yard drainage plans. The City Engineer shall review the plans for conformity to the standards set forth herein, after which he will return a letter of review with appropriate comments. The applicant, after making changes requested, shall submit two (2) revised plans to the Engineering Department for final approval. After approval by the City, a detailed estimate of cost must be submitted.

Chapter 41 – Section 3.02-B and Section 4.07-B

2. Requirements

A grading plan is required for all developments. Rear yard storm drainage systems are required for all residential projects.

- a) A residential development grading plan provides all necessary information for the building contractor to establish the house grades and finish grade the lots so that good drainage is provided for both the proposed development and all surrounding property. Specific items to be included are:
 - 1. List benchmark descriptions and elevations to be used for the development. These benchmarks must not be disturbed during construction. In non-residential areas each site must have storm drainage provided to it and will be required to have internal drainage.
 - 2. The practical scale for residential subdivision grade plans is one (1) inch = 50 feet. This scale requires repetitive labeling to be kept to a minimum and lettering to be small and neat.
 - 3. The grades of existing adjacent houses, buildings, drainage structures and streets shall be shown. The grades of existing adjacent ground and yards shall be shown on a twenty-five (25) feet grid pattern for fifty (50) feet from the property line. The drainage pattern of all adjacent existing land shall be indicated.
 - 4. The grading plan shall be designed to ensure that if a failure occurs in the storm system, water will drain away in overland swales without flooding houses.

5. Show proposed house grade and top of curb grade at the center of each lot to hundredths of a foot. Place house grades within the plan view of the typical house to be built in this development. Front yard setbacks shall be drawn to scale.

If the typical house plan is not known, the proposed house should be drawn as a rectangle of the approximate size.

6. The finish grade of the house shall meet the following conditions:
 - a) Finish grade shall normally be no lower than four (4) percent of the minimum setback distance above the sidewalk at the center of the lot.
 - b) Finish grade on lots with rear to front drainage shall be no lower than one (1) foot above the highest sidewalk elevation.
 - c) Finish grade shall be no less than four (4) feet above the established ground water table.
 - d) Finish grade shall be compatible with the grades of surrounding existing houses, yards and with the existing ground at the proposed house. Basement excavation and roadway excavation shall be removed from the site, if necessary.
7. Show proposed sidewalk grades at all lot lines, to hundredths of a foot. Sidewalk grades are to be 0.5 feet above top of curb except at major roads where they shall be 0.8 feet above top of curb or centerline.
8. Rear yard drainage is required in all residential developments. Upon receiving a recommendation from the City Engineer based on topographic considerations, the City Manager may waive this requirement.
9. Indicate rear yard catch basins. Show the proposed rim elevation to hundredths of a foot. Catch basins are required to be at a lot corner and the catch basin grade shall be the only grade shown at that corner.
10. Indicate perforated plastic rear yard underdrains and sump pump leads where they are called for in the storm sewer plans. Use different symbols for plastic underdrains and concrete storm sewer on the plans. Rear yard storm drainage requirements are given under b) of this section.
11. All existing and proposed ground grades are to be in tenths of a foot.
12. Show proposed ground grades at all remaining lot corners.

13. Rear yard swales shall be no longer than two (2) lots wide before being intercepted by a catch basin and shall have a minimum grade of one (1) percent. There will be a catch basin located on every other lot corner.
14. Rear yard swales more than one (1) lot long must not be graded straight down to a street without being intercepted by a standard four (4) foot diameter catch basin and a low point shall be established outside of the road right-of-way.
15. All low points shall have a standard four (4) foot diameter catch basin. Rear yard underdrain runs from low points must be twelve (12) inches or more in diameter.
16. Show both existing and proposed ground grades at lot corners around the subdivision perimeter boundaries. The proposed grades should be equal to or lower than existing ground grades. If these grades must be higher than existing ground, an intercepting ridge a minimum of 0.5 feet high may be required.
17. Show the proposed side yard swale elevation between all houses. This elevation must be a minimum of 0.5 feet below the lower adjacent house grade. The side yard swale must have minimum slope of one (1) percent to the front and rear.
18. Where topography prevents rear yard drainage from being practical, rear to front, rear to side drainage or an approved alternative may drain only the specific lot in question. Other bordering lots are not to drain across this lot. Lots with rear to front drainage must have side swales shown around the house with swale grades of two (2) percent or more. The following swale elevations must be shown:
 - a) The high point of the swale(s), located generally behind the house, a minimum of fifteen (15) feet from the house and 0.5 feet below the house grade.
 - b) The side swale elevation located even with the back of the house.
 - c) The side swale elevation located even with the front of the house.
19. General direction of flow of the rear yard drainage and swales must be indicated with arrows. Swales need not be otherwise labeled. Arrows need not be drawn for front yards with standard house to street drainage.
20. Additional grades shall be shown under special conditions as required by the City Engineer.

21. Show lot number, tax identification number (if known) and all lot dimensions.
- b) Non residential plans should give proposed grades at all high points, grade-breaks and low points. It should show existing and proposed grades around the perimeter of the site and site corners. The proposed exterior grades at building corners and the proposed finish floor elevation shall be shown to hundredths of a foot.

All building grades shall be established such that there is a positive drainage from the building to the designated drainage course. The perimeter grades shall remain the same or be lower than existing grades, unless tributary drainage is provided for by extending the storm sewer and installing catch basins at the property line or by otherwise providing for the positive drainage of all adjacent property. The site grading shall not create drainage problems or make existing drainage problems worse on adjacent property.

c) Rear Yard Storm Drainage Systems and Footing Drain Outlets

The following details and specifications will be required in all residential developments.

1. An underdrain will be located in a drainage easement provided along the rear and side lot lines as necessary. This easement shall give access to every lot and will total not less than twelve (12) feet wide. Rear yard underdrains shall be located three (3) feet from the rear property line.

While abutting unplatted property, underdrains shall be located six (6) feet from the rear property line. Rear yard underdrains shall completely traverse every lot except the last lot of an underdrain run, in which case the underdrain shall extend across the lot to ten (10) feet from the far lot line.

2. Rear yard underdrains shall consist of the following:
 - (a) Rear yard underdrains, upstream of a low point, shall consist of an eight (8) inch (minimum) diameter, perforated or slotted P.V.C. pipe with smooth interior. Perforated underdrain shall be smooth wall P.V.C., A.S.T.M. F-758, Type PS 46, with 3/16 inch to 3/8 inch diameter perforations. Slotted underdrain shall be P.V.C. corrugated with smooth interior, A.S.T.M. F-949, with slotted perforations of 1.90 to 2.00 square inches per foot of pipe length. Eight (8) inch underdrain shall be laid at a minimum slope of 0.40 percent.
 - (b) Rear yard underdrains, downstream of a low point, shall consist of a twelve (12) inch minimum diameter pipe. Twelve (12) inch to eighteen (18) inch diameter pipe shall be P.V.C. corrugated with smooth interior, A.S.T.M. F-949, with slotted perforations of 1.90 to 2.00 square inches per foot of pipe length.

Twelve (12) inch underdrain shall be laid at a minimum slope of 0.32 percent. Underdrains over eighteen (18) inches diameter shall be reinforced concrete pipe, A.S.T.M. C-76.

- (c) Underdrain joints shall be plain.
- (d) Underdrain trenches shall have a minimum depth of three (3) feet, a minimum width of twelve (12) inches and a maximum width of ten (10) inches greater than the inside pipe diameter and shall be backfilled with pea gravel to the finished grade.
- (e) As a part of the rear yard underdrain system, a three (3) inch sump pump lead shall be connected to the catch basin and extended to the easement line in the direction of the house to be served, and capped.

Minimum depth shall be two and one-half (2 ½) feet, maximum depth shall be three (3) feet. Sump pump leads shall be provided for all proposed new homes in the development and for all homes on adjacent property that do not have a sump pump outlet.

Sump pump leads shall be (3) inch P.V.C., A.S.T.M. D-2729 with solvent cement joints.

- 3. Catch Basins shall be located:
 - a) At all bends of thirty (30) degrees or greater.
 - b) At low points.
 - c) At every other lot corner, sump pump leads from all proposed new homes must connect to a catch basin.
- 4. The rear yard catch basin's will be a standard three (3) foot reinforced concrete catch basin with a minimum twenty-four (24) inch sump. The catch basin cover shall be E.J.I.W. No. 1000 with Type N Grate or approved equal.
- 5. No rear yard storm drainage shall be constructed until the storm sewer system is completed and until the rear yard mass grading is completed and approved.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

G. Paving, Sidewalk and Driveway Approaches

1. Submittal Procedure

For City approval of paving plans, the applicant shall furnish the Engineering Department two (2) sets of paving plans. The City Engineer shall review the plans for conformity to the standards set forth herein, and certify that they are consistent with the overall utility plans of the City, after which he will return a letter of review with comments. The applicant, after making any changes requested, shall submit two (2) sets of the revised plans to the Engineering Department for final approval. After approval of the plans by the City, the applicant shall obtain approval of the Road Commission for Oakland County, Oakland County Drain Commissioner, the Michigan Department of Transportation or any other agency where applicable. After approval by the City, a detailed estimate of cost must be submitted.

Chapter 33 – Section 4.16

Chapter 34

Chapter 41 – Section 3.02-B, Section 4.00, 4.05 and 4.06

2. Requirements

a) Paving width and thickness shall conform to the following requirements:

Zoning	Width (B-C to B-C)	Thickness of P.C. Concrete
Single & Two Family Residential	Thirty-six (36) foot min. collector Twenty-eight (28) foot min. local	Seven (7) inch on four (4) inch 21AA gravel base
Multiple Family Residential	Thirty-six (36) foot min. collector Twenty-eight (28) foot min. local	Seven (7) inch on four (4) inch 21AA gravel base
Office	Thirty-six (36) foot minimum	Eight (8) inch on six (6) inch 21AA gravel base
Commercial	Thirty-six (36) foot minimum	Eight (8) inch on six (6) inch 21AA gravel base
Industrial	Thirty-six (36) foot minimum	Eight (8) inch on six (6) inch 21AA gravel base
Major Roads	Varies	Nine (9) inch on four (4) inch 21AA gravel base & eight (8) inch Glass II granular material

The minimum outside pavement radius of cul-de-sacs in industrial areas shall be sixty-five(65) feet. In all other areas the minimum radius shall be forty-four (44) feet.

Eyebrows at corners shall have outside pavement radius a minimum of eighty (80) feet for industrial and fifty-four (54) feet in residential subdivisions.

When boulevard sections are used at the entrance to a subdivision, the right-of-way must be 100'; the minimum pavement widths shall be twenty-four (24) feet, minimum island width shall be twenty (20) feet distance from the right-of-way to back of curb shall be sixteen (16) feet, minimum island length shall be 100 feet and the minimum length of taper between boulevard section and the undivided pavement shall be 150 feet. The nose of the median shall be offset at least eight (8) feet from the edge of the pavement of the intersecting street.

Where a new development borders an existing gravel local public road/or when a new street is proposed to be opened, and accepted for maintenance by the City, within a previously platted area or within an acreage parcel, a twenty-eight (28) foot wide concrete pavement with integral curbs and enclosed storm drains shall be constructed. Nine (9) inch thick deep strength asphalt pavement with concrete curb and gutter may be substituted as an alternative to concrete pavement with the approval of the City Engineer.

Other alternative paving and drainage designs may be submitted to the City Manager for his consideration, following review and recommendation by the City Engineer, in limited areas where such alternative paving and drainage designs would be more consistent with the character and construction of existing paving and drainage facilities in the area. Such alternative paving and drainage facilities shall only be acceptable in those instances where the City Manager finds that the proposed design will provide an acceptable level of serviceability, ease of maintenance, and facility life, consistent with public paving and drainage facilities in similar areas, elsewhere in the City.

b) Sidewalk width and thickness shall conform to the following requirements:

1. Thickness: All public sidewalks shall be not less than four (4) inches thick and not less than six (6) inches thick across any residential driveway and not less than eight (8) inches thick across any commercial or industrial driveway. All residential driveway approaches shall be not less than six (6) inches thick. All commercial industrial driveway approaches shall be not less than eight (8) inches thick. Sidewalk ramps shall be four (4) inches thick except the first slab adjacent to a roadway shall be six (6) inches thick.

Width: All public sidewalks shall be not less than five (5) feet wide except those sidewalks identified to be a minimum of eight (8) feet in width on any plan for the area as adopted or accepted by the City Council. In general, eight (8) foot sidewalk shall be provided on both sides of all major roads in conjunction with related construction, across all major thoroughfare frontages unless modified to a lesser width by the City Manager. Driveway approaches shall be of the size shown on the attached detail drawing.

- c) The minimum pavement grade for concrete is 0.60 percent. A grade in excess of six (6) percent will not be allowed. Vertical curves are necessary when a change in grade of 1.50 percent or more occurs. The minimum length of vertical curve shall be 100 feet.

(Chapter 41)

- d) The pavement profile view must include:
 - 1. Elevations at top of curb, or at centerline if not curbed.
 - 2. Existing ground elevations at the center of the right-of-way, and at other locations as required by the City Engineer.
 - 3. Station and elevations of all high points, low points, grade-breaks, curb returns intersecting property lines and necessary information at vertical curves.
 - 4. Top of curb (or centerline) elevations at each station. Grade in vertical curves must be indicated at twenty-five (25) foot intervals.
 - 5. The station and top of curb grade of all pavement catch basins and inlets.
- e) The pavement radius at all intersections of non-major roads shall be a minimum of twenty (20) feet. Allow for a minimum of 0.4 foot drop in elevation around the curb return for twenty (20) foot radius. For larger radii, a proportionately greater amount of fall must be provided.
- f) At intersections with roads under the jurisdiction of Michigan Department of Transportation or Road Commission for Oakland County, their requirements shall be met. Passing lanes and deceleration lanes are required at all entrances to major roads per Section H.
- g) All horizontal curves shall be consecutively numbered and indicated in the plan view. Curve data shall be given for the respective curve on the same sheet as it occurs.
- h) Finish grade of all structures shall be indicated in the plan view.
- i) Catch basins shall be located as detailed in Section C, Storm Sewers 2i.
- j) The minimum outside curb grade for centerline radius of less than 275 feet shall be 0.50 percent.
- k) All pavement in residential areas shall have four (4) inch mountable curbs 18 inches wide (30" curb; gutter). All island curbs shall have six (6) inch roll curbs.

- l) Major roads shall have six (6) inch minimum roll curbs. A five (5) foot transition area is required where the curb changes from six (6) inch roll to four (4) inch mountable.
- m) At entrances onto major roads, drop the curb to a height of one (1) inch (MDOT detail "m").
- n) Show a detail of all intersections, eyebrows, and cul-de-sacs. The detail shall show jointing and detailed grades. Maximum scale of the detail shall be one (1) inch = thirty (30) feet. On intersections where jointing is shown on the pavement Standard Detail sheet and where grades are completely determined by additional notes on the plans, separate detail need not be shown.
- o) At the end of a street that may be extended in the future, indicate a one (1) foot end header, barricade and signs as required in Item E, 2-o.
- p) The spacing of catch basins and inlets on twenty-eight (28) foot streets shall be twenty-three and one-half (23.5) feet from center of catch basin to center of inlet. A typical detail showing spacing of catch basin and inlets on other than twenty-eight (28) foot wide pavement should be shown on the plans.
- q) Underdrains shall be placed as specified in Item C, Storm Sewers, Section 2, I-5, and at other locations determined by the City Engineer.
- r) Access roads shall be eighteen (18) feet wide minimum and consist of six (6) inches of crushed concrete and three (3) inches of 21AA aggregate and capped with three (3) inches of bituminous mix.
- s) Sidewalk ramps shall conform to the current ADA Standards. Refer to detail at the end of this Section.
- t) Emergency vehicle access (EVA) shall conform to the details at the end of this Section.

3. Materials

- a) Cement: All cement used in sidewalk and driveway approach construction shall be Air Entraining Portland Cement, Type I – A, A.S.T.M. Designation C – 150.
- b) Aggregates: Aggregates, 2NS Natural Sand and Gap Coarse Aggregate, shall meet all requirements of the current Michigan Department of Transportation Standard Specifications for Constructional Laboratory test reports conforming to ASTM C295 and potential reactivity with alkalines may also be required.

- c) Water: Water used in concrete shall be clean, free from oil, acids, strong alkalines or vegetable matter. If City water is used in the concrete, all necessary permits shall be obtained from the City Water Department.
- d) Expansion Joints: Expansion joints, shall be constructed using preformed expansion joint filler, A.S.T.M. D-1751, not less than one-half (1/2) inch thick, the length shall be equal to the width of the slab and the depth equal to the thickness of the thickest slab.

One-half (1/2) inch expansion joints shall also be constructed wherever a sidewalk abuts a driveway approach and wherever sidewalk thickness changes. One (1) inch expansion joints shall be constructed wherever sidewalk ramps or driveway approaches abut a concrete road or curb.

- e) Curing Compound: The curing compound shall be white membrane type A.S.T.M. C-309, Type 2, Class B Vehicle. It shall retain at least ninety-three (93) percent of the moisture for a period of three days when tested according to A.S.T.M. Specifications Designated C-156.

4. Concrete

- a) Mix Composition: Concrete shall be M.D.O.T. Grade 35P. The concrete mix proportion shall be one (1) part cement, one and one-half (1 ½) parts fine aggregate and two (2) parts coarse aggregate measured by volume with a maximum of six (6) gallons of water per sack of cement. The water content may be reduced in proportion with the amount of water contained in the aggregates. Maximum slump of the mixture shall be three (3) inches. Concrete shall attain a minimum compressive strength of 3,500 p.s.i. after twenty-eight (28) days.
- b) Cement Content: The concrete shall contain not less than six (6) standard ninety-four (94) pound bags of cement per cubic yard.
- c) Air Content: The total air entrained in the concrete shall be six and one-half (6 ½) percent plus or minus one and one-half (1 ½) percent.
- d) Mix Design: A mix design in accordance with the Michigan Department of Transportation Standard Specifications for Construction must be submitted and approved by the City Engineer.
- e) Mixing Cement: The materials shall be mixed in an approved mixing device for at least one and one-half (1 ½) minutes prior to placing the concrete. Re-tempered concrete will not be permitted.

- f) Transit Mixed Concrete: All transit mix concrete suppliers must be approved by the City. The contractor must furnish the inspector a ticket for each load of transit mix delivered, properly signed by the transit plant inspector, showing all required information, including water content, cement content and time truck left plant. Absolutely no water shall be added to the transit mixer, after leaving the plant, without approval of the inspector. Any water added shall be noted on the ticket.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

H. Widening Lanes

1. Any property which will contribute traffic flow on the public thoroughfare system by land use change, new or existing street and drive improvements or on-site development, shall be required to provide for this traffic in an approved manner. The following standards will be applied to determine the appropriate improvement;

- a) Standards for two (2) Lane Highways:

1. Right Turn Lanes, Two (2) Lane Highways

Right turn deceleration lanes will be installed on the major thoroughfare at the intersection of all new streets required as a part of any development. New streets shall, by definition, include constructing a roadway within existing right of way where no roadway surface now exists.

Chapter 41 – Section 4.05-F

Right turn deceleration lanes will be installed on the major thoroughfare at the intersection of driveways for all developments, other than one family and two family residential developments, when the peak hour entering trips generated by the site during the street peak hour are equal to or greater than twenty (20) as contained in the table of current INSTITUTE OF TRANSPORTATION ENGINEERS (I.T.E.) Trip Generation Rates.

2. Left turn Passing Lanes, Two (2) Lane Highways

Left turn passing lanes will be installed on the major thoroughfare at the intersection of all new streets required as a part of any development. New streets shall, by definition, include constructing a roadway within existing right of way where no roadway surface now exists.

Chapter 41 – Section 4.05-F

Left turn passing lanes will be installed on the major thoroughfare at intersection of driveways for all developments, other than one family and two family residential developments, when the site generated left turns into the site during the street peak hour are equal to or greater than twenty (20) as contained in the table of current INSTITUTE OF TRANSPORTATION ENGINEERS (I.T.E.) Trip Generation Rates. A passing lane will also be required when the left turns into the site are equal to or greater than ten (10) during the peak hour of the generator and the daily traffic volume exceeds 10,000.

b) Standards for Highways of Four (4) or Five (5) Lanes:

Rev. 3-3-97

Right turn deceleration lanes will be installed on the major thoroughfare at the intersection of all new streets (public and private) required as a part of any development.

New streets shall, by definition, include constructing a roadway within existing right of way where no roadway surface now exists.

Chapter 41 – Section 4.05-F

Rev. 3-3-97

Right turn deceleration lanes will be installed on major thoroughfares having four (4) or five (5) lanes of pavement at the intersection of driveways for all developments, when the peak hour entering trips generated by the site during the street peak hour are equal to or greater than twenty (20) as contained in the trip table of the current INSTITUTE OF TRANSPORTATION ENGINEERS (I.T.E.) Trip Generation Rates.

c) Standards for Highways of Six (6) or More Through Lanes:

Rev. 3-3-97

Right turn deceleration lanes will be installed on major thoroughfares having six (6) or more through lanes of pavement at the intersection of driveways for all developments, when the peak hour entering trips generated by the site during the street peak hour are equal to or greater than two hundred (200) as contained in the trip table of the current INSTITUTE OF TRANSPORTATION ENGINEERS (I.T.E.) generation Rates.

2. Sites at Locations Having Limited Right-of Way:

a) In a situation where sufficient public right-of-way does not exist for construction of standard deceleration lanes or passing lanes, the owner or builder will:

1. Complete the improvement in the configuration complying hereto so as to accommodate traffic, said improvement to be treated as an extension of the private driveway and situated in part or entirely, upon private property;

or

2. Dedicate right-of-way to the City sufficient to accommodate the improvement that will be constructed at the cost of the developer in a configuration complying hereto.

- b) In situations where required improvements extend beyond the ownership of the subject site(s) and public right-of-way is insufficient, the owner will deposit the cost of providing these lanes with the City Treasurer. These funds will be used at a later date when right-of-way becomes available to place the required lanes.

As an alternative, these funds may be used at a later date as a contribution toward a larger project. If deemed appropriate by the City Manager and City Assessor, a recordable agreement to be in favor of a future special assessment project for road improvements may be substituted for the cash deposit.

- 3. Required improvements to the thoroughfare system may include ultimate alignment, widening lanes, turning lanes, passing lanes, realigned pavements, base drainage, storm drainage, signing and all other items necessary to the construction of a durable pavement.
- 4. Required improvements may be caused to extend beyond the limits of the site of developing property in order to provide both capacity and safety.
- 5. The City Manager or his designee may require improvements to precede site development where construction traffic would be detrimental to the capacity of the street and detrimental to the safety of the traveling public.
- 6. Site improvement plans are to be submitted to the Engineering Department illustrating the following:
 - a) All improvements required by these Standards.
 - b) Proposed treatment of drive entrances and exits to and from public streets and highways that comply with the attached typical drawing of deceleration and passing lanes (see Page H-4).
 - c) Public right-of-way throughout the extension of proposed improvements and that proposed for dedication, if any.
- 7. Concrete shall be used for widening lanes if the existing pavement is concrete or concrete with a bituminous overlay.
- 8. Full depth asphalt pavement may be used in other locations with the approval of the City Engineer.
- 9. These requirements apply to all thoroughfares within the corporate limits of the City of Troy.
- 10. The current Institute of Transportation Engineers (I.T.E.) Trip Generation Rates will be used for purposes of Calculating trips for proposed site.

CITY OF TROY DEVELOPMENT/ENGINEERING STANDARDS

I. Soil Erosion and Sedimentation Control Plan

Public Act 451, 1994; amended 2001, and Chapter 86

1. Submittal Procedure

For City approval of soil erosion and sedimentation control plans, the applicant shall furnish the Engineering Department one complete set of the plans, a detailed estimate of cost and a Soil Erosion Permit application and pay the engineering plan review fee. The City Engineer shall review the plans for conformity to standards herein and return a letter of review with required changes to the applicant. The applicant, after making any required changes, shall submit one (1) complete set of revised plans to the engineer for final approval. Upon approval by the City, the applicant shall submit three (3) sets of plans, pay all necessary engineering inspection fees and provide the necessary bonds or escrow deposits. **Applying for a permit is required for any earth change activity, regardless of size or location.**

2. Plan Requirements

The plan to accompany an application for a permit under Chapter 86, City of Troy Ordinances shall contain the following data on sheets twenty-four (24) inches by thirty-six (36) inches.

- a) The seal of a Michigan Licensed Architect, Landscape Architect or Surveyor who prepared the plans.
- b) Topographic plan, scale one (1) inch = 100 feet, to 100 feet beyond site boundaries showing:
 1. Existing ground elevations, with either two (2) feet contour interval or spot elevations on a fifty (50) foot grid.
 2. Existing structures and significant features including trees four (4) inches in diameter or larger, existing ground cover, extent and condition.
 3. Existing drainage and soil information.
 4. All Lakes or Streams within five hundred (500) feet of site boundaries.
 5. Legal description of site boundaries and tax parcel number.

c) Erosion and sedimentation control plan will include the following:

1. Location map showing section number and major thoroughfares.
2. Lot number, parcel dimensions, and adjoining right-of-way (existing and proposed), and street names.
3. North arrow and scale.
4. Name, address, and telephone number of the owner and engineer/architect, if applicable.
5. Distance to lakes, streams, or wetlands.
6. Dominant existing land features; i.e., grass, brush, trees, etc.
7. Accurate legal description of property, including total acreage, sidwell number(s), and bearing and distances of property lines.
8. Description and limits of earth disruption.
9. Timing and sequence of earth change (calendar and/or narrative).
10. Proposed contour interval and slope description.
11. Permanent land cover; i.e., grass, brush, etc.
12. Statement on the site plan stating who is responsible for maintenance and that "soil erosion controls will be maintained weekly and after every storm event."
13. Show all proposed soil erosion; sedimentation control measures, including staging limits

3. Design Standards

a) Definitions in Usage of these design standards:

1. Erosion: The process by which the land surface is worn away by action of wind, water, ice, or gravity. Accelerated erosion resulting from works of man is to be controlled.
2. Sediment: Soil or other earth cover transported or deposited as a result of erosion.

3. Waterway: Any natural or man-made drainage course in which waters flow in a definite direction either continuously or intermittently, including ditches, streams, ponds, lakes, rivers, storm sewers, and structures or areas adjacent which are subject to flooding.
4. Overland Erosion: erosion which occurs on denuded slopes above natural waterways as a result of rain splash and runoff. This starts as sheet erosion, develops into small rills and finally into gullies.
5. Stream Channel Erosion: Erosion which occurs in intermittent or continuous waterways along the banks or in the bed of the waterway.
6. Wind Erosion: Erosion which occurs on denuded areas by actions of wind to cause dust hazards to traffic and structures.
7. Piping: The flow of water along the outside of a pipe or inlet causing failure of the structure through erosion.
8. Universal Soil Loss Equation: A method of estimated annual loss of soil by erosion, developed by the U.S. Department of Agriculture Research Service. See text below for further explanation.

b) Soil Erosion and Sedimentation Control Measures:

1. Temporary Sedimentation Basins.

The surface area of a temporary sedimentation basin shall be determined by the following:

Let A_b	=	surface area of basin
C	=	run-off coefficient
A	=	contributing area, acres
t	=	time of concentration

Then:

$$A_b = (415.57)C(A)[72/(t+25)]$$

In this method, $I=72/(t+25)$, for the year rainfall intensity. Any depth may be used; but the deeper the basin, the less frequent clean-up may be required.

2. Special grading practices include:
 - a) Preserving natural vegetative cover to guard critical areas, in strips, contours, or areas. This includes the use of vegetative buffers.
 - b) Staging – grade only where necessary for work to be done in a short time, maximum thirty (30) days.
 - c) Surface roughening or scarification or contour ditching before impending rainstorms, on critical slopes.
3. Diversion structures, (usually temporary) but can be permanent consist of:
 - a) Soil or Gravel Interceptor Dikes: Gravel dikes are used to protect drainage inlets and catch basins from sediment. Soil dikes are used in roadways or ditches. If a soil dike is used, the soil must be sodded.
 - b) Diversion Dikes or Ditches: These collect runoff and channel it away from an erodible soil surface to a safe disposal area usually on-site, or off-site if no sediment is being transported. Diversion ditches are used on natural hillsides where the fill soil for a dike is not available or would not hold. A “top-of-cut” diversion ditch is used in highway construction. Caution must be used to avoid a slide that might occur on a poorly maintained hillside diversion ditch.
 - c) A level spreader might be required when run-off is too voluminous to be disposed of directly onto areas protected by vegetation or non-erodible material. The level spreader diffuses concentrated run-off, changing it to non-erosive sheet flow.
4. Energy Dissipaters-sometimes called check dams, along a channel or at its outlet, for the purpose of slowing water velocity and preventing erosion. Examples are riprap sections, blankets of crushed rock, small log dams held in place by stakes.
5. Sediment Traps – or silt traps, can be excavated or they can be made of sandbags or stone. They are usually temporary. Silt traps are used effectively when placed as barricades or check dams across a ditch at intervals to slow water velocity and to allow silt to settle, or when placed as a perimeter around a site to arrest any silt being transported by run-off. To prevent piping, the barricade should be laid in a small ditch about six (6) inches deep, with soil packed at its base. An excavated silt trap is placed where it can intercept and detain water in a waterway. The settled silt and sediment must be removed systematically for the life of the trap. Proper maintenance is necessary.

6. Permanent Sediment Basins.

For a permanent basin, the size and silt removed time periods should be determined by the Universal Soil Loss Formula, this equation is expressed as follows:

$A = RKLSCP$, where:

A = Annual soil loss due to sheet and rill erosion in tons

In the Troy area, the factors are:

R = Rainfall Erosion Index = 100

K = Soil Erodibility Factor, varying according to soil type between .17 and .50 (.17 for sand soil, .50 for clayey loams)

LS = Length and steepness of Slope Factor (See Table 1 – Slope Effect Chart, i.e., for 100 foot slope at ten (10) percent, LS = 1.4)

C = One (1) for fallow ground during construction

C = .006 for well established grass or legume cover

C = .12 for weeds and wild grass cover

P = One (1) during construction

P = .5 for large garden or crops

- a) A dry sediment basin is designed to impound run-off for a comparatively short time, still long enough to allow sediment to settle, during rainfall. It is completely drained by a perforated metal riser pipe that releases water at a controlled rate.
- b) Wet sediment basins or ponds are used when necessary to dam waterways in order to trap sediment. They may be coordinated or combined with recreational ponds.
- c) Both types of basins must be designed for the site by a licensed engineer. An earthen dam requires an impervious core, protection from piping conditions and proper compacting and planting for stabilization of surface.
- d) As a guide, 400 cubic feet per acre sediment capacity will require desilting once every six (6) months under average Troy conditions.

7. Vegetative Stabilization

- a) Temporary – those annual or perennial grasses, legumes or vines which grow rapidly and abundantly enough to protect the area for less than one (1) year. Good temporary seeding combinations, with quantity per acre, are given in the Michigan Department of Environmental Quality's Guidebook of Best Management Practice for Michigan Watersheds.

Examples for the Troy vicinity (per 1,000 square feet) are:

April 1 to Aug. – Spring Oats or Barley [two (2) lbs] or Domestic Rye Grass [one-half (1/2) lb]

June 1 to July 31 – Sudan Grass [one (1) lb]

Aug. 1 to Oct. 15 – Rye [three (3) lbs] or

Perennial Rye Grass [one-half (1/2) lb]

Mulching:

Immediately after seeding, mulch all critical areas (slopes steeper than 4:1, unstable soils, or heavy clay soil) with a suitable mulch material. An example is unweathered small grain straw or hay spread uniformly at the rate of one and one-half (1 ½) to two (2) tons per acre or 100 lbs [two (2) to three (3) bales] per 1,000 square feet. Anchor the mulch with nets, stakes, mechanical crimping or other means to prevent it from blowing away.

- b) Permanent

Hardy annual grasses, vines, legumes and shrubs, or sodding provide good permanent vegetative cover.

Sod may be laid between May 1 and about October 20, except that between June 30 and September 01, it must have adequate watering or irrigation available at least three (3) days weekly. Permanent seeding mixtures, application rates and seasonal limitations shall be in accordance with the City of Troy Standard Detail Sheet for Soil Erosion.

8. Maximum velocities of water flow in open channels will be designed to be:

1.5 fps on sandy soils

2.5 fps on bare channels other than sandy soils

4.0 fps on seeded permanent vegetation

6.0 fps on sodded vegetation

Raised banks or levees will be four (4) feet minimum width at the top. They will be constructed of suitable soil with an impervious core. Soil will be compacted in six (6) inch layers to 100 percent maximum density at the core, and six (6) to twelve (12) inch layers to at least eighty (80) percent maximum density in the remainder of the embankment. Density will be determined by current ASTM D-698 method of compaction testing. The surface will be loosened for a depth of about twelve (12) inches and sodded, or covered with four (4) inches of topsoil and seeded with minimum delay after final grading.

**CITY OF TROY
DEVELOPMENT/ENGINEERING STANDARDS**

J. Fees

Preceding final approval of engineering plans for subdivisions, site condos, commercial or other development, a detailed estimate of costs for all water main, sanitary sewer, paving, grading, drainage improvements, and soil erosion control measures (where applicable) and any other site improvements regardless of whether private or public, must be submitted for all municipal improvements.

At the time of submittal of plans for the proposed project improvements, the Developer shall make a deposit for review of such equal to 1.1 percent of the estimated cost of the improvements. This deposit for review shall be deducted from the Engineering Review and Inspection Fee when that fee is paid.

The following approximate deposit for single-family residential subdivisions may be made for Engineering review in lieu of the estimate:

Zoning	Estimated Review Deposit Per Lot
R-1A	\$140.00
R-1B	120.00
R-1C	100.00
R-1D	80.00
R-1E	60.00

1. At the time of final preliminary approval of subdivision plats and final approval by the City Council of other sites, the following cash payments must be on deposit with the City:

Chapter 41 - Section 4.00-D

- a) Engineering Review and Inspection according to the following schedule, or as revised on approval of City Council for all public improvements associated with site development:

Review and Inspection Cost of Improvements (Thousands)	Engineering Fee as a Percent of Improvement Cost
0 to 100	8.10
100 to 120	8.02
120 to 140	7.94
140 to 180	7.77
180 to 220	7.61

**Review and Inspection
Cost of Improvements
(Thousands)**

**Engineering Fee as a Percent of
Improvement Cost**

220 to 280	7.49
280 to 340	7.33
340 to 400	7.25
400 to 500	7.12
500 to 600	6.99
600 to 700	6.91
700 to 800	6.87
800 to 900	6.74
Over 900	6.70

- b) The above fee schedule includes inspection fees for up to ten hours per day during normal work days. An additional overtime fee will be charged for all inspection provided in excess of ten hours during normal work days and for all Saturday, Sunday or Holiday inspection provided, at the inspector's actual overtime cost to the City. No final acceptance of any development or improvement will be made until all overtime charges have been paid by the developer. This fee is not refundable
- c) An engineering review fee of 2.0% of the construction cost for all private site improvements including but not limited to walls, berms, paving, grading, drainage improvements, sewer and water leads, sidewalks, and any other site improvements excluding landscaping and building structures must be deposited with plan submittal. This fee is non-refundable.
- d) A site grading and drainage review fee of \$65 per single family home site must be deposited with plan submittal. This fee is non-refundable.
- e) Sidewalk closures at intersections and those sidewalks required in Section 4.06 C of the Subdivision Control Ordinance at three (3) dollars per square foot of sidewalk shall be deposited. This fee is refundable when the developer performs the work. See t) of this section.
- f) Sidewalk and fencing for public walkways or crosswalks at current estimated prices. This fee is refundable when the developer performs the work. See item t) of this section.

- g) Water main testing and chlorination is done by the City's Department of Water and Sewers. The fee for this service is as follows:

Length of Water Main In Linear Feet:	Testing and Chlorination Fee:
1 to 1,000	\$650.00
1,001 to 2,000	\$650.00 + \$0.31 per L.F. over 1,000 feet
2,001 & over	\$960.00 + \$0.24 per L.F. over 2,000 feet

An additional fee shall be charged whenever testing fails after two attempts. This fee is not refundable.

- h) Street name and traffic signs are installed in public right-of-ways by the Public Works Department at all locations. The cost is estimated at current prices. This fee is not refundable.
- i) Street island improvements will be constructed by the Parks and Recreation Department at a cost of one dollar and forty-six cents (\$1.46) per square foot of island.
- Up to eighty-five (85) percent of this fee is refundable if the Developer performs the work. See item u) of this section.
- j) Material and construction testing fees in the amount of one and one-half (1½) percent of the construction cost. This fee is not refundable.
- k) Landscaping and screen planting of non-access green belt easements with berm at a cost of eighteen (18) dollars per lineal foot. Up to eighty-five (85) percent of this fee is refundable if the Developer performs the work. See item u) of this section.
- l) Landscaping and screen planting of non-access green belt easements without berm at a cost of twenty-six (26) dollars per lineal foot. Up to eighty-five (85) percent of this fee is refundable if the Developer performs the work. See item u) of this section.
- m) Landscaping and screen planting of detention basins at a cost of eleven (11) dollars per lineal foot around the perimeter of the basin. Up to eighty-five (85) percent of this fee is refundable if the Developer performs the work. See item u) of this section.
- n) Maintenance of detention basins at a cost of 1,000 dollars per acre of basin area multiplied by 20 for a gravity outlet; 2,000 dollars per acre of basin area multiplied by 20 for a gravity outlet wet pond; and at 2,725 dollars per acre of basin area, multiplied by 20 for a pumped outlet. This fee is not refundable.

- o) Topsoil, seed, fertilizer and mulch of right-of-way areas adjacent to major roads, secondary roads, detention basins, outlots, open space, park areas, walkways or any other right-of-way or easement area where grass will not be installed by a property owner, at a cost of three (3) dollars and seventy (70) cents per square yard. Up to eighty-five (85) percent of this fee is refundable if the Developer performs the work. See item u) of this section.
- p) Soil erosion and sedimentation control permit cost at a rate of .25 percent for the first 400,000 dollars of total improvement costs and at a rate of .10 percent for any total improvement costs over 400,000 dollars. This fee is not refundable.
- q) Park review fee at a cost of 100 dollars per acre. This fee is not refundable.
- r) Cleaning, dust control and maintenance of any existing public streets used for construction access at a cost of 200 dollars per lot or a minimum of 2,000 dollars or a maximum of 10,000 dollars. The unused portion of the fee is refundable when all of the subdivision improvements have been granted final approval and accepted by the City.
- s) Wetland mitigation cash deposit in the amount of \$60,000 – 1 acre, when applicable, to ensure viability of mitigation area. Refundable after acceptance by the City.
- t) Other payments as required under Section 4.00 D.2 of the Subdivision Control Ordinance, Chapter 41.
- u) Items e) and f) of this section are to be performed by the Developer in conformance with the Development Standards. The cash fee is refundable when the work has been inspected and accepted by all necessary City departments.
- v) Items i) k) l) m) and o) of this section are normally performed by the City of Troy, Parks and Recreation Department and the cash fee is not refundable. The Developer may elect to perform this work by preparing a plan for the improvement that conforms to the City of Troy Landscape Design and Tree Preservation Standards, and submitting the plan to the Parks and Recreation Department for review and approval.

When the homes adjacent to the work are all occupied, and the work has been inspected and approved by the Parks and Recreation Department, eighty-five (85) percent of the cash fee can be refunded by the Parks and Recreation Department. Fifteen (15) percent of the cash fee will be retained by the City.

- w) A non-refundable Street Tree Fee for the City to plant trees in greenbelt areas within the road right-of-way, between residential property lines and edge of abutting roads, in accordance with the following schedule.

Zoning District	Street Tree Fee Per Lot
R-1A	\$800
R-1B	\$700
R-1C	\$600
R-1D	\$500
R-1E	\$400

The Street Tree Fee shall be collected by the Building Department upon application for building permit. If trees are not wanted, a property owner can decline them and no trees will be planted, however; the Street Tree Fee is not refundable.

2. The Developer shall be required to deposit with the City Clerk, cash, certified check, certificate of deposit, irrevocable bank letter of credit or performance bond subject to the provisions in Section 3, whichever the Developer selects, in an amount sufficient to guarantee:
 - a) The construction of all required improvements.
 - b) The placement or replacement, after construction of improvements, of all lot corner irons and monuments.
 - c) Sidewalks on major thoroughfares and secondary streets right-of-way, sidewalks adjacent to detention basins, outlots and open space areas when abutting an improved street within the subdivision.
 - d) The installation of a street light at intersections with major thoroughfares.
 - e) Any improvements required to parking area or open space.
 - f) Soil erosion control measures.
 - g) Construction, removal and restoration of temporary construction access road.
 - h) Repair of any damage done to existing public streets used for construction access. The amount deposited shall be at a rate of 600 dollars per lot, with a minimum of 6,000 dollars and a maximum of 50,000 dollars.

The unused portion of this deposit will be released when all of the subdivision improvements have been granted final approval and accepted by the City.

This deposit must be made at the same time as cash payments are required.

The final release of escrow deposits will be made only after the improvement has been inspected and accepted by all necessary City departments. A three (3) year maintenance bond in the amount of thirty-five (35) percent of the construction

costs must be supplied to the City prior to acceptance of the improvements and the final release of escrow deposits.

3. If the developer chooses to satisfy the foregoing requirement with an irrevocable bank letter of credit, certificate of deposit or performance bond, the developer shall be required to deposit with the City Clerk, cash in the amount of 10% of the escrow amount as determined under the foregoing Section 2, items a-h. This cash deposit shall be in addition to the irrevocable bank letter of credit, certificate of deposit or performance bond for 100% of the estimated costs of all required improvements. The cash deposit shall guarantee completion of all punch list and/or right-of-way restoration items. The City reserves the right to complete the aforementioned items with City and/or contract forces and deduct all costs from this deposit should the developer fail to complete the work within two (2) years of the start of work by the developer. Final release of any remaining cash deposit will be made only after all necessary City departments have accepted all improvements. The City reserves the right to use the 10% cash deposit as payment for the completion of all outstanding work when the developer has been notified by certified mail of the outstanding items and has failed to complete them within 30 days from the date of notification.