CITY UTILITIES
DESIGN STANDARDS MANUAL

CITY UTILITIES

WATER THAT WORKS

June 2024

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CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 1 General Requirements

Book 1

General Requirements (GR)

GR1 Acronyms and Definitions

GR1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the General Requirements Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

GR1.02 Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACHD	Allen County Highway Department
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AEP	American Electric Power Company
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	ASTM International (formerly American Society of Testing and Materials)
CBR	California Bearing Ratio
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980 (commonly known as Superfund)
CITY	City of Fort Wayne, Indiana
CSI	Construction Specifications Institute
CTC	Conforms to Contract
CUE	City Utilities Engineering
DBH	Tree Diameter at Breast Height
DPS	Department of Planning Services
DVS	Development Services
ERU	Equivalent Residential Units
FEMA	Federal Emergency Management Agency
FGCC	Federal Geodetic Control Committee
FIRM	Flood Insurance Rate Maps
GIS	Geographic Information System

GPS	Global Positioning System
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IESNA	Illuminating Engineering Society of North America
IMUTCD	Indiana Manual on Uniform Traffic Control Devices
IN83-EF	Indiana State Plane, East Zone, US (Survey) Foot on NAD83 datum
INDOT	Indiana Department of Transportation
LCC	Life Cycle Cost
LS	Land Surveyor
MF04	Master Format 2004
NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration
PDF	Portable Document Format
PE	Professional Engineer
PSA	Professional Services Agreement
RPR	Resident Project Representative
SWPPP	Stormwater Pollution Prevention Plan
TBM	Temporary Bench Marks
TCP	Temporary Project Control Points
TES	Transportation Engineering Services
W	Watt

GR1.03 Definitions

Book	Organizational grouping of utility design standards by topic. These Books consist of General Requirements, CADD, Stormwater, Sanitary Sewer, Water and Materials.
Capital Projects	Projects to improve City Utilities infrastructure which are typically designed and constructed under the management of City Utilities Engineering.
City	The City of Fort Wayne, Indiana.

City Utilities	The department of the City of Fort Wayne that manages the stormwater, wastewater and water utilities.
City Utilities Engineering	The division within City Utilities that develops City Utility Engineering Standards, manages City Utilities Projects, and performs planning and system analysis for the stormwater, wastewater and water utilities.
City Utilities Projects	Publicly funded projects that improve the stormwater, wastewater, and water utilities and are under direction of City Utilities Engineering
City Utilities Design Standards Manual	A document that provides guidance and requirements for the planning, design, and construction of stormwater, wastewater, and water utility infrastructure.
Development Services (DVS)	The division within the department of City Utilities that oversees non-capital projects.
Easement	A right to occupy, access or otherwise utilize the real property of another for a specifically defined use.
Equivalent Residential Unit (ERU)	An accepted average unit of measure that is consumed or discharged from a typical full-time single-family residence for Water and Sewer. For Stormwater an ERU equals 7,667 gallons per month.
Non-Capital Project	Variety of projects managed by Development Services whose primary funding source is not City Utilities. Typical projects include, but not limited to private infrastructure, development, redevelopment, and septic tank elimination projects.
Program Manager	A senior staff member of City Utilities with designated authorities and responsibilities specific to their field of discipline.
Project Manager	A staff member of City Utilities responsible for the management and coordination of activities required for the completion of a project owned by or affecting City Utilities.
Project Manual	A collection of written construction documents and project requirements which typically includes; bidding requirements, contract forms and supplements, contract conditions, and specifications.
Project Record Documents	Include construction submittals, record drawings, record specifications, addenda, contract modifications, photographs, start-up logs, test reports, certifications, coordinates, models, GPS data and other documents which are assembled by the contractor.
Standards	Fort Wayne City Utilities Design Standards Manual. The requirements for the design and construction of utilities within Fort Wayne's jurisdiction.

<u>**Transportation Engineering Services**</u> A department of the City of Fort Wayne that provides engineering support, design and construction management for the transportation system.

Book 1

General Requirements (GR)

GR2 Introduction

GR2.01 Purpose

The City Utilities Design Standards Manual (Standards) is a guide for the planning, design, and construction of stormwater and sanitary sewer collection systems, water distribution systems and facilities, and associated activities for City Utilities. Guidelines, basic design criteria, standards, and mapping are presented in the Standards.

The intent of the Standards is twofold: to present design basics and to present general submittal requirements. The Standards present detailed design methods and comprehensive design guidelines. There is discussion on intent and various computation worksheets to assist in infrastructure design for City Utilities Engineering (CUE) design staff and professional design consultants.

In general, the Standards:

- enumerate general design standards that have been either commissioned or authorized by local and state agencies to facilitate City Utility’s compliance with local, state and federal regulations;
- identifies submittal requirements and procedures for the review of infrastructure projects;
- serves as a reference document for City Utilities Engineering design staff, professional design consultants, and private developers to define review procedures and requirements; thus facilitating the approval of infrastructure projects;
- identifies and provides standards for the construction and installation of stormwater, sanitary sewer, and water distribution systems; and
- was created to provide uniformity in design and construction of projects within the City Utilities service area. This is important to ensure completed projects are easily maintainable, are reliable and durable, and ultimately meet the needs of the public as well as the City.

GR2.02 City Utilities

City Utilities departments or groups that are responsible for management of design and construction, review and approval of plans, and mapping are referred to throughout the Standards as follows:

- City Utilities Engineering (CUE),
- Development Services (DVS), and
- Geographic Information Systems (GIS).

1. **City Utilities Engineering (CUE)**

   CUE plans for City-sponsored infrastructure improvements, conducts system studies and analysis, and manages and performs design and construction services in the following main program management areas:

   - stormwater collection and quality
   - sewer repair/replacement/rehabilitation
   - sewer capacity and combined sewer capacity
   - sewage treatment/plant engineering
   - water distribution capacity
   - water distribution repair/replacement/rehabilitation
   - construction inspection, construction management, and contract management services

2. **Development Services (DVS)**

   DVS is the primary provider of services for plan review and approval of private development utility work within the City Utilities Service Area. Plan review includes, but is not limited to: stormwater infrastructure and associated detention facilities, sanitary sewer facilities, and water distribution facilities.

   DVS is the primary administrator of private project permits within the City Utilities Service Area. Permitting is discussed in Chapter GR4 – Contracts, Fees, and Permits.

3. **Geographic Information Systems (GIS)**

   GIS is responsible for maintaining and updating all electronic information pertaining to the Fort Wayne infrastructure system. GIS also develops and makes available GIS interfaces, portals and tools such as the public-facing GIS Interactive Map. GIS can also provide existing GIS data, apps, maps, dashboards and analysis that may be required for project drawings and design.

GR2.03 Description and Use of the Standards

The Standards identifies requirements to be used in the planning, design, permitting, and construction of projects within City Utilities Service Area.

The Standards is not intended to serve as a step-by-step design procedure nor can it address every situation that may arise. The application of sound engineering principles and judgment combined with the information contained herein are necessary to complete the planning, design, and preparation of related construction documents for stormwater, wastewater, and potable water projects.

Adherence to these standards does not eliminate the need to comply with other applicable City, County, State and Federal ordinances and regulations.

The provisions of the Standards shall be deemed as additional requirements to minimum standards required by other applicable ordinances and standards. In the case of conflicting requirements, the most restrictive shall apply.

GR2.04 Structure of the Design Manual

The Standards contains six Books and is structured as follows:

Book 1: General Requirements - Outlines City Utilities general policies for coordination, approval procedures, preparation of drawings and accompanying documents, and basic design criteria associated with stormwater, sanitary sewer, and potable water improvement projects.

Book 2: Stormwater - Outlines stormwater standards and policies for the design of stormwater facilities.

Book 3: Sanitary - Outlines standards and policies for the design of sanitary sewers and sanitary lift stations.

Book 4: Water - Outlines standards and policies for the design of potable water distribution systems.

Book 5: Materials - Outlines approved construction materials for use on stormwater, sanitary, or water projects.

Book 6: CADD Standards - Outlines drawing requirements and details for use on stormwater, sanitary sewer and water projects.

GR2.05 Updates to the Manual

The Standards is intended to be a dynamic document. As design criteria and technology evolves, the Standards will require revisions and improvements. As changes are made, supplements or revisions will be posted and updated at the City Utilities website, **utilities.cityoffortwayne.org/contractors-engineers-developers/design-standards-manual**.

GR2.06 Enforcement of Standards & Penalties

Failure to comply with requirements set forth in the Standards may result in rejection of design or construction work by City Utilities and/or the Board of Public Works

GR2.07 Topics Not Included

Topics not included in the Standards, that are within the jurisdiction of City Utilities include:

- Wastewater treatment and storage
- Water treatment, pumping, and storage
- City Utilities master specifications
- Procedures internal to City Utilities departments
- Contract and Agreement procurement

GR2.08 Other Resource Documents

External documents, standards, and manuals that were used as references in the development of the Standards include, but are not limited to, the following:

- “Draft” Storm Water Design and Specification Manual, Green Infrastructure Supplemental Storm Water Document,
- Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Wastewater Facilities, latest edition. (Also referred to as Ten State Standards for Wastewater Facilities);
- Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Water Works, latest edition. (Referred to as Ten State Standards for Water Works);
- Indiana Department of Environmental Management (IDEM) Regulations including Title 327 of the Indiana Administrative Code (327 IAC);
- Indiana Department of Natural Resources (IDNR) Storm Water Quality Manual;
- Indiana Department of Transportation (INDOT) Standard specifications, latest edition,
- American Association of State Highway and Transportation Officials (AASHTO) A Policy of Geometric Design of Highway and Streets, latest edition;
- American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide, latest edition;
- Indiana Manual on Uniform Traffic Control Devises (IMUTCD), latest edition;
- Fort Wayne Water Pollution Control Utility (Wastewater Utility) General Rules and Regulations
- Fort Wayne Water Utilities General Rules and Regulations
- Fort Wayne Stormwater Utility General Rule and Regulations
- Indiana State Standards for Energy Conservation Codes, and
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) ASHRAE Standard 90.1-2007.
- United States National CAD Standard, version 5.

Book 1

General Requirements (GR)

GR3 Variances

GR3.01 Purpose

This Chapter outlines the requirements, processes, and procedures for acquiring variances from the City design standards.

Variances from the City Utilities Design Standards Manual (Standards) shall be considered on a project-by-project basis. A variance may be granted if an applicant makes a substantial showing that:

- the design standard is infeasible or unreasonably burdensome;
- an alternative plan submitted by the applicant will achieve the same objective and purpose as compliance with the minimum requirements contained in the Standards;
- the alternative plan will not increase the direct annual and/or life cycle cost of operation and/or maintenance to the City; and
- the alternative plan does not violate any other permits, statutes, or regulatory requirements.

Cost to the applicant shall not be the sole factor used to determine whether the design standards are infeasible or unreasonably burdensome.

The variance requirements, processes and procedures in this chapter supersede all variance requirements, processes and procedures that may be included in other Books and/or Chapters of the Standards.

GR3.02 Authority to Approve Variances

The Senior Engineer for each of the fields of discipline (e.g. stormwater, sanitary and water) with the recommendation of the Project Manager for CUE and the Development Services Manager (DVS) or Program Manager, has the authority to modify or waive any requirement found in the Standards. The Senior Engineer for each of the fields of discipline may delegate approval authority to the DVS Program Manager

GR3.03 Types of Variances

There are two types of variances: Technical and Material. The requirements of Section 3.01 apply to both types of variances using the procedures described in Sections 3.04 Technical Variance Procedures and Section 3.06 Material Variance Procedures.

1. Technical Variance

   A Technical Variance applies to deviations from the process and/or requirements of General Requirements, Stormwater, Sanitary and/or Water Books of the Standards.

2. Material Variance

   A Material Variance applies to deviations from the standard design materials as required by the Materials Book of the Standards.

GR3.04 Technical Variance Procedures

Variances for deviations from the General Requirements, Stormwater, Sanitary Sewer, and/or Water Standards shall use the following procedure. This procedure is graphically represented in **Exhibit GR3-1**.

1. Variance Request Form.

   All variance applications shall be made using the Variance Request Form (**Exhibit GR3-2**). The form must be fully completed and include all attachments to substantiate and demonstrate the requirements of Section 3.01. The form must be sealed by a Professional Engineer licensed in the State of Indiana.

2. Variance Application.

   A. DVS Projects

      Variance applications shall be submitted to DVS as part of a standard submittal package.

      - Development Submittal packages must include completed Variance Request Forms.
      - It is the responsibility of the applicant to understand the requirements of the City Utilities design standards and to know if a variance is required.
      - Where review of the submittal package identifies that a variance is needed, the applicant will be notified through the review comment process. The timely submittal of the variance request is encouraged to avoid delays in the issuance of permits.

   B. CUE Projects

      Variance applications shall be submitted to the Project Manager of that project.

      - It is the responsibility of the design engineer to understand the requirements of the City Utilities design standards and to know if a variance is required.

3. Variance Decision.

   A. DVS projects,

      - Variance requests submitted as part of a standard submittal package will be responded to within the timeframes established for review by DVS. Responses include approvals, denials or the need for additional review time.
      - Variance requests submitted as part of a standard submittal package that are incomplete will be returned for additional information. When the additional information is received, the request will be decided upon within fourteen (14) calendar days.
      - Variance requests received outside the standard submittal package will be decided upon within fourteen (14) calendar days. Incomplete variance requests will have the process suspended and the request returned for additional information. After the completed application is submitted, the review time will resume, beginning with the time remaining at the point of suspension.
      - The Senior Engineer for each CUE field of discipline will reply in writing to the applicant within the timetables listed in this section.

   B. CUE projects,

      - The Senior Engineer for each CUE field of discipline will respond in writing with a decision on the variance request within fourteen (14) calendar days from receipt of the variance request by the Project Manager.
      - In the event the application is not complete, it will be returned to the applicant and the application time will be suspended. After the completed application is submitted, the review time will resume, beginning with the time remaining at the point of suspension.

GR3.05 Technical Variance Appeals

Any person affected by the exercise of the discretionary authority delegated by Section 3.04, including a decision to deny or partially deny a variance, and who objects to the decision made is entitled to appeal the decision. The appeal procedure is as follows.

1. Appeal Filing

   The appeal of denied or partially denied variance decision shall be filed with the Deputy Director of CUE in writing within twenty-one (21) calendar days following the date of the decision.

2. Appeal Review

   Within thirty (30) calendar days of the appeal submittal, the Deputy Director of CUE shall make a final ruling on the variance request. The applicant can request an in-person meeting with the Deputy Director as part of the appeal process. The decision of the Deputy Director will be provided directly to the applicant and to the CUE or DVS Manager.

GR3.06 Materials Variance Procedures

Variances for deviations from the Materials Standards shall use the following procedure:

1. Variance Request Form

   All variance applications shall be made using the Variance Request Form (**Exhibit GR3-2**). The form must be fully completed and include all attachments to substantiate and demonstrate the requirements of Section 3.01.

2. Variance Application

   1. DVS Projects

      Variance applications shall be submitted to DVS.

   2. CUE Projects

      Variance applications shall be submitted to the CUE Project Manager of that project.

3. Variance Decision.

   The Senior Engineer for each CUE field of discipline will respond in writing with an estimate of the time required to review the request. The required time will be determined on a case-by-case basis.

   Materials variance requests for new materials may be required to go through the City Utilities New Products Committee before a decision is made. The review requirements will be determined on a case-by-case basis depending on the complexity of the request. All costs associated with the New Products Committee review are the responsibility of the applicant.

GR3.07 Material Variance Appeals

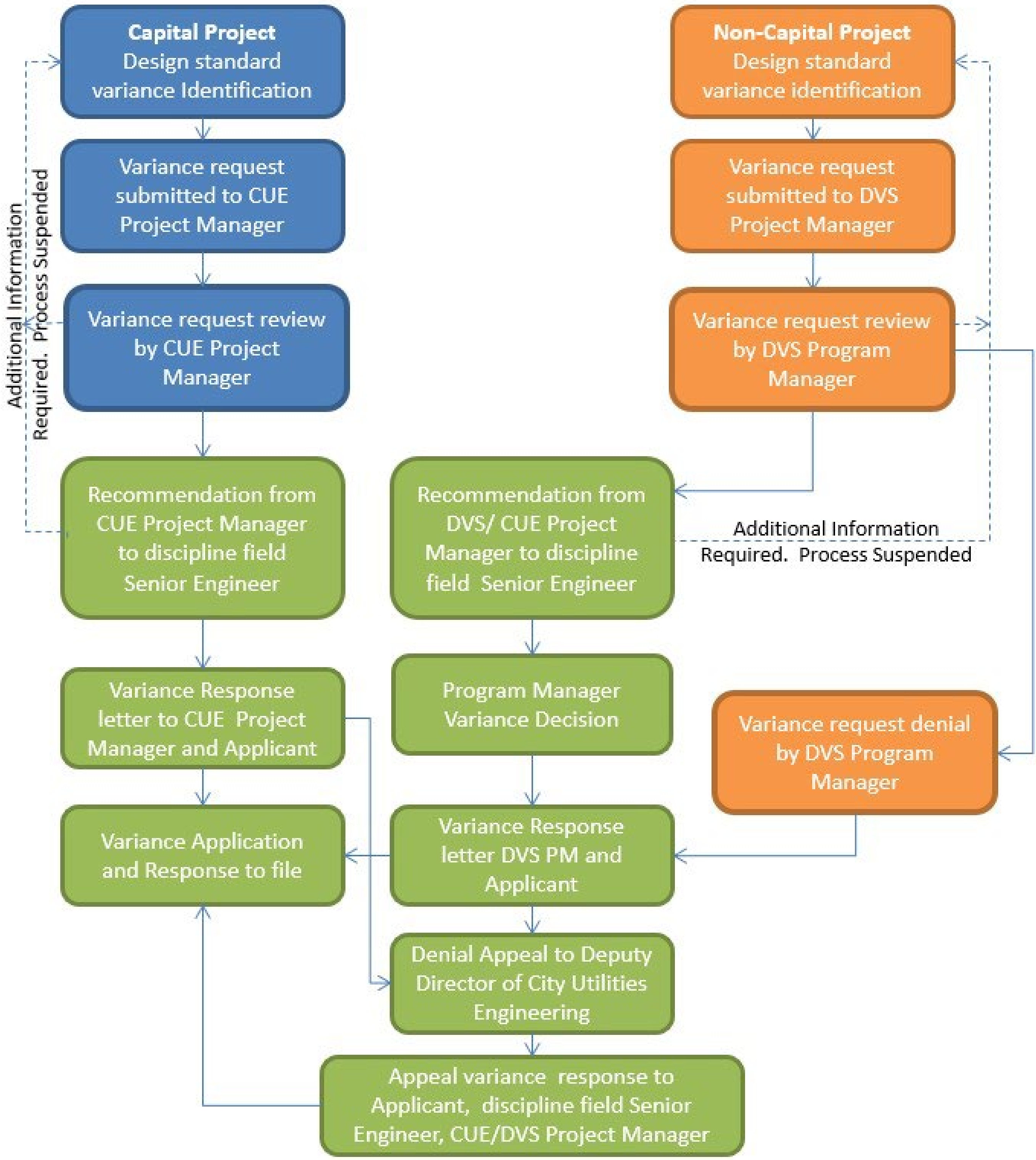
Any person affected by the exercise of the discretionary authority delegated by Section 3.06, including a decision to deny or partially deny a variance, and who objects to the decision made is entitled to appeal the decision. The appeal procedure is as follows.

1. Appeal Filing

   The appeal of denied or partially denied variance decision shall be filed with the Deputy Director of CUE in writing within twenty-one (21) calendar days following the date of the decision.

2. Appeal Review

   Within thirty (30) calendar days of the appeal submittal, the Deputy Director of CUE will make a final ruling on the variance request. The applicant can request an in-person meeting with the Deputy Director of City Utilities Engineering as part of the appeal process. The decision of the Deputy Director of City Utilities Engineering will be provided directly to the applicant and to the CUE/DVS Project Manager.


Capital Project
Design standard variance Identification
Variance request submitted to CUE Project Manager
Variance request review by CUE Project Manager
Additional Information Required. Process Suspended
Recommendation from CUE Project Manager to discipline field Senior Engineer
Variance Response letter to CUE Project Manager and Applicant
Variance Application and Response to file
Non-Capital Project
Design standard variance identification
Variance request submitted to DVS Project Manager
Variance request review by DVS Program Manager
Recommendation from DVS/ CUE Project Manager to discipline field Senior Engineer
Additional Information Required. Process Suspended
Program Manager Variance Decision
Variance request denial by DVS Program Manager
Variance Response letter DVS PM and Applicant
Denial Appeal to Deputy Director of City Utilities Engineering
Appeal variance response to Applicant, discipline field Senior Engineer, CUE/DVS Project Manager

Project Name:		
Work Order/DVS Number:		
Date:		
I hereby certify that the data and information provided is accurate and correct to the best of my knowledge (affix PE seal and sign)		
Design Standards Book		
Design Standards Chapter		
Design Standards Section		
Description of infeasible and/or unreasonably burdensome design standard.		
Description of the alternative and how it will achieve the same objective as the standard. Attach drawings, specification sheets, manufacturer cut sheets, etc.		
Estimate of life cycle costs, including construction cost, for complying with the standard and for the proposed variance.		
Does the alternative comply with all other City of Fort Wayne, local, state and federal requirements? Explain.		
Reviewer:		
Decision:		
Supporting Comments (Optional):		

Book 1

General Requirements (GR)

GR4 Contracts, Fees, and Permits

GR4.01 Purpose

This Chapter provides information on the contract requirements, fees, and permitting that pertain to stormwater and/or, sanitary sewer collection systems and/or water distribution systems within the City Utilities Service Area. General requirements are provided for permitting by City Utilities. Guidance and reference to permits required by other regulatory agencies (county, state, federal, etc.) is provided for information, however, it is not intended to be an exhaustive listing.

GR4.02 Developer Contracts

Prior to a private developer extending a public storm sewer, sanitary sewer, or water system, the developer shall be required to enter into a public utility extension contract with City Utilities. Copies of the standard contract documents are available from Development Services (DVS) upon request. All public main extension contracts are subject to the rules and regulations of the Indiana Utility Regulatory Commission and City Utilities. DVS shall be consulted for contract questions.

Unless a waiver is granted by Development Services (DVS), all new development projects proposing to use City Utilities for sanitary sewer service must include provisions for water main extensions and water service from City Utilities.

GR4.03 Fees

Permit application fees for local, state, and federal permits will be determined by the respective agency at the time of permit application.

GR4.04 Permit Responsibility

For DVS Projects, all applicable permits shall be obtained before starting construction. Copies of permits shall be provided as required or requested by DVS.

For CUE Projects, permitting responsibility involves the design engineer, CUE and/or the contractor.

Where required, all permits for work within the public right-of-way shall be obtained.

GR4.05 Permit Compliance with Other Standards

Compliance with Other Standards and Regulations

Adherence to these standards does not eliminate the need to comply with other applicable City, County, State and Federal ordinances and regulations. These may include, but are not limited to:

- Submission and approval of preliminary and final subdivision plats
- Construction in a Floodway permits, including any required by Department of Planning Services (DPS)
- IDEM permits (IDEM or City issued) for sanitary and water facilities construction
- Indiana Department of Natural Resources (IDNR) permits
- Army Corps of Engineers permits
- Allen County Drainage Board permits
- Indiana Department of Transportation (INDOT) permits
- Road right-of-way and building and zoning permits (City or County)
- Construction inspections
- Appeals and similar matters

GR4.06 DVS Permits

Permits required by private development for City Utilities are administered by DVS. These permits are listed in **Exhibit GR4-1**.

1. Application Forms

   The permit application forms are available from DVS. The Local Unit Construction Permit application for Potable Water is provided in **Exhibit GR4-2**. Permit application forms for local sanitary sewer construction are provided in **Exhibit GR4-3**, **Exhibit GR4-4**, and **Exhibit GR4-5**.

2. Exemptions

   There are no exemptions to the permitting requirements.

3. Expiration of Permits

   Permit expiration information is specific to each permit. Review the permit and/or contact DVS for additional information.

4. Changes to Application Information

   For any changes to information on a permit application, contact DVS before the start of construction.

DVS will review the applications and submittals for compliance with local requirements as defined by this manual. To this end, outside consultants may be utilized. DVS will also, as applicable, review for state requirements. Projects that are found to be deficient will require revisions. DVS or the reviewing consultant will notify the design professional in writing how the project is deficient.

The design professional will have 180 days to submit revisions. Projects that are not resubmitted within 180 days may be required to restart the application process.

The revision submittal (2^{nd} Submittal) shall include an itemized cover letter. This letter shall identify how the design professional addressed the noted deficiencies from the review. It shall also identify any major revisions that may have occurred. (I.E. added or deleted a drive access, changed the building footprint…)

DVS or their representative will review the 2nd submittal. If additional deficiencies are discovered or were not adequately addressed, the design professional will again be notified of deficiencies in writing.

The design professional shall again submit (3^{rd} Submittal) the revisions with an itemized cover letter. If this submittal is also found to be deficient, the applicant will be charged for all cost incurred beginning with the third review and all subsequent reviews. This cost will be as noted in fees and charges table and can be found in the DVS Office.

A site plan checklist has been provided for reference as **Exhibit GR4-6**.

GR4.07 Other Permits

Projects may require permits that are obtained from regulatory agencies other than City Utilities.

For DVS Projects, all plan changes required by other agency permits shall be submitted to DVS for approval. Additional review may be required.

For CUE Projects, all plan changes required by other agencies shall be submitted to the project manager.

While not intended to be complete or all inclusive, permits typically required by other agencies for storm water and/or sanitary sewer collection systems and/or potable water distribution system are listed in **Exhibit GR4-7**.

PERMIT	WHEN REQUIRED	SUBMITTAL REQUIREMENTS
Storm Water Pollution Prevention Plan (SWPPP)	Grading, demolition and/or construction, separately or together, where land disturbing activity will be in excess of statutory minimums.	Application to City Utilities Development Services, by project owner and project engineer or registered land surveyor.
Water Service Line Tap **Sanitary Sewer Service Tap**	Any new service connection to a City water or sanitary sewer main. Fees apply.	Application to City Utilities Development Services, by property owner or contractor.
Water Service Line Temporary Disconnect	Building demolition where service will be used for future building. Fees apply.	Application to City Utilities Development Services, by property owner or contractor.
Water Service Line Permanent Disconnect	Building demolition where service will not be used for future building. Fees apply.	Application to City Utilities Development Services, by property owner or contractor.
Sanitary Sewer Service Disconnect	Building demolition where service will or will not be used for future building. Work must be performed by City-licensed sanitary sewer contractor. Fees apply.	Application to City Utilities Development Services, by property owner or contractor.
Special Use	New sanitary sewer or storm sewer connection to a manhole, inlet or catch basin on a City sanitary, storm or combination sewer. Work must be performed by City-licensed sewer contractor. Fees apply.	Application to City Utilities Development Services, by property owner or contractor.
Industrial Pretreatment	When a discharge to the City's wastewater system may contain toxins in excess of the limits specified in Ft. Wayne Code of Ordinances § 51.033. Fees apply.	Application to City Utilities Development Services, by project owner.
Sanitary Sewer Main Construction	Local permit in lieu of IDEM permit for construction of public or private sanitary sewer main ≥2 in. dia. Fees apply.	Application to City Utilities Development Services, by licensed engineer.
Water Main Construction	Construction of public water main. Fees apply.	Application to City Utilities Development Services, by licensed engineer. Notice of Intent to IDEM.

LOCAL UNIT CONSTRUCTION PERMIT APPLICATION - POTABLE WATER

Fort Wayne City Utilities

Development Services

1. Name of project	
2. Location of project(nearest public intersection)	
3. Quarter section, section, township and range of the approximate center of development	
4. Brief description of project (including length and type of water main)	
5. Maximum number of proposed service connections to the water main(s)	
6. Numerical count of type of connections to the main(s) (A) Residential (B) Commercial (C) Industrial	
7. Certification by Design Engineer I hereby certify that I am familiar with the information contained in this application and that to the best of my knowledge and belief, such information is true, complete and accurate. Signature of Engineer ____	
8. Date Signed	12. PE Seal
9. Name of Engineering Firm	
10. Telephone Number	
11. Address of Engineering Firm	

LOCAL UNIT CONSTRUCTION PERMIT APPLICATION - SANITARY SEWER

Fort Wayne City Utilities

Development Services

1. Name of project	
2. Location of project (nearest public intersection)	
3. Quarter section, section, township and range of the approximate center of development	
4. Brief description of project (including length and type of sewer main)	
5. Average flow in gallons per day (GPD)	
6. Numerical count of type of connections to the main(s) (A) Residential (B) Commercial (C) Industrial	
7. Certification by Design Engineer I hereby certify that I am familiar with the information contained in this application and that to the best of my knowledge and belief, such information is true, complete and accurate. Signature of Engineer ____________________________	
8. Date Signed	12. PE Seal
9. Name of Design Firm	
10. Address	
11. Telephone	

Submit the following with this application:

13. An 8 1/2 x 11 in. site plan

14. Sanitary Sewer Design Summary (Exhibit GR4-4)

15. Certification of Registered Professional Engineer (Exhibit GR5-5)

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit GR4-4 Sanitary Sewer Design Summary Part of State Form 53159 (R7 / 2-20) Version: April 2022 — **Fillable Version**

COLLECTION SYSTEM DESIGN SUMMARY

Design Flow – Refer to 327 IAC 3-6-11 for Design Flow Rate Requirements

Description of Units Served		Design Flow Per Unit	Number of Units	Unit Design Flow
Example: Single family homes		*310 gpd/unit*	*30*	*9,300 gpd*
		(gpd/unit)		gpd
		(gpd/unit)		gpd
		(gpd/unit)		gpd
		(gpd/unit)		gpd
		(gpd/unit)		gpd
		Average Design Flow		gpd
Peaking Factor		**Peak Design Flow**		gpd

Gravity Sewer Pipe ☐ Applicable ☐ Not Applicable

Length	Diameter	Material	ASTM or AWWA Standard	SDR or DR	Pressure Class (psi)	Installation Method
Example: 1,525 ft	*8-inch*	*PVC*	*ASTM D3034*	*SDR-35*	*N/A*	*Open Cut*
ft	in					
ft	in					
ft	in					
ft	in					
ft	in					

Force Main Pipe and Low Pressure Sewer ☐ Applicable ☐ Not Applicable

Length	Diameter	Material	ASTM or AWWA Standard	SDR or DR	Pressure Class (psi)	Installation Method
Example: 1,525 ft	*8-inch*	*PVC*	*ASTM D2241*	*SDR-21*	*200 psi*	*Open Cut*
ft	in					
ft	in					
ft	in					
ft	in					
ft	in					

Connection Location(s)

Example: The proposed sanitary sewer shall connect to an existing 8-inch sewer located approximately 10 ft north and 10 ft west of the intersection of Main Street and Park Avenue and to an existing lift station located approximately 20 ft southeast of the intersection of Oak Lane and Maple Drive.

The proposed shall connect to located .

Inspection / Maintenance

Inspection during construction will be provided by	
Maintenance after completion will be provided by	

Wastewater Treatment

Wastewater treatment will be provided by	

Lift Station ☐ Applicable ☐ Not Applicable

1. Location:
2. Type of pump (example: submersible, dry pit):

3.	Number of pumps:
4.	Constant or variable speed:
5.	Design pump rage (gmp) and TDH (ft):
6.	Operating volume of the wet well (gal):
7.	Average detention time in the wet well (min):
8.	Type of standby power/pump provisions:
9.	Type of alarm:
10.	Additional Information:

Low Pressure Sewer Grinder Pump Station	☐ Applicable ☐ Not Applicable
1. Number of Stations: simplex duplex triplex	
2. Number of residential connections per simplex station (two maximum):	
3. Design pump rate (gpm) at maximum TDH (ft):	
4. Type of alarm:	
5. Privately or utility owned and maintained:	
6. Additional information:	

Vacuum Pump Station	☐ Applicable ☐ Not Applicable
1. Location:	
2. Total volume of vacuum tank (gal):	
3. Operating volume of the vacuum tank (gal):	
4. Number and size (HP) of vacuum pumps:	
5. Number and type of sewage pumps:	
6. Constant or variable speed:	
7. Design pump rage (gpm) and TDH (ft):	
8. Type of standby power/pump provisions:	
9. Type of alarm:	
10. Additional information:	

Certification Seal, Signature, and Date	
Printed Name of Engineer or Land Surveyor	
Signature	Date Signed *(month / day / year)* / /

A factor of four (4) is prescribed by 327 IAC 3-6-11. However, an alternative peaking factor may be justified by other means (327 IAC 3-6-32) or as provided by Ten State Standards 11.243: **Peaking Factor = (18 + √P) / (4 + √P)**, where P = population in thousands.

Provide pump and system curves and design calculations for TDH. If connecting to an existing force main, provide upstream lift station pump curves and describe how the proposed flow will affectthe lift station performance during simultaneous operation.

For small diameter low-pressure sanitary sewer systems, provide a spreadsheet that includes the maximum expected simultaneous operation of the proposed grinder pumps, maximum expected flow (gpm)and fluid velocity (ft/sec), static head and accumulated friction loss, and expected accumulated total dynamic head (TDH).

The average detention time in the wet well (cycle time between pump on/off settings) should be between 5 and 30 minutes. The cycle time may be calculated from the following equation: **Cycle Time = (V / (D -Q)) + (V/ Q)**, whereD = discharge flow rate out of the wet well (design pump rate) in gpm, Q = inflow rate into wet well (average design flow) in gpm, and V = operating volume of wet well (between pump on/off settings) in gallons.

CERTIFICATION OF REGISTERED PROFESSIONAL ENGINEER OR LAND SURVEYOR

This form must be filled-out in its entirety with no alterations.

Name of Applicant:	
Name of Applicant Representative:	
Name of Project:	

CERTIFICATION

I, ___________________________________, representing the project applicant, in my capacity as a

(Name of Individual)

registered professional ____________________________________ , __________________________________

(Engineer or Land Surveyor) (Indiana registration number)

certify the following under penalty of law: The design of this project has been performed under my direction or supervision to assure conformance with 327 IAC 3 and the plans and specifications require the construction of said project to be performed in conformance with 327 IAC 3-6. The peak daily flow rates, in accordance with 327 IAC 3-6-11 generated from within the specific area that will be collected by the proposed collection system that is the subject of the application, plans, and specifications (when functioning as designed and properly installed), will not cause overflowing or bypassing in the same specific area serviced by the proposed collection system other than from NPDES authorized discharge points. The proposed collection system does not include new combined sewers (serving new areas) or a combined sewer extension to existing combined sewers. The sewer at the point of connection is physically in existence and operational. Based upon information provided by the owner of the Wastewater System, the ability for this collection system to comply with 327 IAC 3 is not contingent on downstream water pollution/control facility construction that has not been completed and put into operation. The design of the proposed project meets applicable local rules or laws, regulations and ordinances. The information submitted is true, accurate, and complete, to the best of my knowledge and belief. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Average Design Flow (*gallons per day*)	
Peak Design Flow (*gallons per day*)	
Owner of Receiving Collection System	
Name of Wastewater Treatment Plant	
Signature	Date Signed *(month / day / year)* / /

(Please refer to IC 13-30-10 for penalties for submission of false information)

City Utilities has developed a fillable checklist for the following routing types:

- Primary Development Plan
- Primary Development Plat
- Secondary Development Plan
- Secondary Development Plat
- SITE
- SFR
- SWIM
- Remodel
- Driveway
- Parking Lot

The checklist is available by clicking on ‘Fillable Version’ above or by visiting **utilities.cityoffortwayne.org/contractors-engineers-developers/design-standards-manual**.

PERMIT	ADMINISTERED BY:	CONTACT INFORMATION	WHEN REQUIRED
Improvement Location Permit (ILP)	Allen County Department of Planning Services (DPS)	Citizens Square 200 East Berry Street, Suite 150 (260) 449-7607	New Construction of a Building
Certificate of Compliance	Allen County DPS	Citizens Square 200 East Berry Street, Suite 150 (260) 449-7607	New Construction of a Building
Parking Lot Permit	Allen County DPS	Citizens Square 200 East Berry Street, Suite 150 (260) 449-7607	New Construction of a parking lot within City of Fort Wayne Limits
Driveway Permit	Fort Wayne Right-of-Way Department	Citizens Square 200 East Berry Street, Suite 210 (260) 427-6155	New Construction of a driveway connecting to or within CFW public right-of-way.
Right-of-Way Permit for State and Federal Road	Indiana Department of Transportation (INDOT)	5333 Hatfield Road Fort Wayne, IN 46808 (866) 227-3555	New Construction of a driveway connecting to or with State or Federal right-of-way
Right-of-Way Permit for County Roads	Allen County Highway Department	Citizens Square 200 East Berry Street, Suite 280 (260) 449-7369	New Construction and placement of infrastructure (water mains, sanitary, storm, utility) within County right-of-way.
Right-of-Way for City Streets	Fort Wayne Right-of-Way Department	Citizens Square 200 East Berry Street, Suite 210 (260) 427-6155	New Construction and placement of infrastructure (water mains, sanitary, storm, utility) within City right-of-way.
Building Permit	Allen County Building Department	Citizens Square 200 East Berry Street, Suite 180 (260) 449-7131	New Building
Construction in a Floodway	Indiana Department of Natural Resources (IDNR) Division of Water	402 West Washington Street Room W264 Indianapolis, IN 46204 (317) 232-4160 or (877) 928-3755	See Indiana Administrative Code Article 10 Flood Plain Management
Railroad Right-of-Way Crossing	Allen County DPS and Railroad Company - Norfolk Southern - CSX	Contact Railroad Owner	Crossing a railroad or withing right-of-way with placement of infrastructure
Wetlands	U.S. Army Corps of Engineers and Indiana Department of Environmental Management	Louisville District P.O. Box 59 Louisville, KY 40401 (502) 315-6733	See Indiana Administrative Code Article 10 Flood Plain Management

*Note: This is not a comprehensive list.

Book 1

General Requirements (GR)

GR5 Project Coordination

GR5.01 Purpose

The purpose of this Chapter is to:

- Ensure consistent project development by defining necessary criteria for compliance during the design process including the preparation of construction documents of proposed improvements to stormwater and/or sanitary sewer collection systems, and/or water distribution system facilities for approval by City Utilities (CUE and/or DVS).
- Supplement the project development criteria and requirements of other City departments and other local, state, and federal agencies.
- Provide direction for preparation of opinions of capital, operation, and maintenance costs.

Information provided in this Chapter does not relieve the design engineer from adhering to proper engineering practices, applicable codes, etc.

Where project development criteria from different sources are in conflict with another, the discrepancy shall be discussed and resolved with the CUE Project Manager or the DVS Program Manager.

GR5.02 Services Offered by DVS

1. Information

   In most cases, DVS can make available City GIS maps, record drawings, ordinances, rules and regulations, studies, and facility plans.

2. Conceptual Review

   The need for conceptual review will be determined on a case-by-case basis, usually based on the project description. It may not always be a formal process and could occur with a simple discussion with the DVS Project Manager for compliance with the City's requirements. Construction drawings may be submitted to DVS to review readiness prior to a formal submittal.

   When required and upon the submittal of sufficient basic information, the DVS Project Manager will review the request.

3. Construction Drawings Approval

   The DVS Program Manager will review construction drawings for adherence to the Standards as well as conformance with other City standards and specifications. If the submittals are incomplete or are not in compliance with

City standards, the construction drawings will be returned for incorporation of required revisions to the design for resubmittal. When the construction drawings are in compliance, DVS will stamp the plans “Approved” and prepare developer public utility extension contracts and/or other appropriate documents as required.

GR5.03 Coordination with Other City Departments

During the design process, the stormwater and/or sanitary sewer collection systems, and/or potable water distribution system project may also require reviews and/or permits to be issued by other City departments.

- CUE Projects

  The CUE Project Manager shall confirm who is responsible for the routing of the construction drawings to other City Departments, prior to the first CUE project design submittal. Approval from all other City departments will be coordinated with the CUE Project Manager.

- DVS Projects

  Coordination with other City departments starts at the planning stage of the project and continues throughout the entire project submittal stage.

GR5.04 Environmental Assessment

The following environmental factors shall be assessed to delineate a basis for selecting one alternative over another during all stages of project coordination:

- wetlands,
- wildlife habitat,
- historic properties,
- noise,
- water quality,
- trails,
- hazardous materials,
- Karst topography,
- air quality,
- floodplain,
- public parks, and
- contaminated materials.

This list is not all inclusive, and does not relieve design engineer of the responsibility to evaluate other items necessary to justify final design recommendations.

GR5.05 Sustainable Infrastructure Design and Implementation

In an effort to reduce the peak hydraulic and pollutant load during wet weather events and the ever-increasing regulatory control of stormwater management, City Utilities encourages the use of designs that promote ground infiltration, filtering, evaporation, and detention of runoff close to its source.

Nature based design, low impact development, and green infrastructure are approaches to land development that use various land planning techniques, design practices and technologies to simultaneously conserve and protect natural resource systems. It is an innovative multi-step stormwater management approach that 1) utilizes thoughtful site planning to minimize negative impacts and implement natural systems in a synergistic, positive way, 2) capitalizes on existing site features to manage stormwater and reduce soil disturbance, and 3) manages rainfall at its source using integrated and distributed micro-scale storm water practices.

These innovative practices are more beneficial in the long term for the City and its citizens, and have been generally found to provide cleaner water, enhanced water supplies, cleaner air, reduced urban temperatures, increased energy efficiency, infrastructure cost savings, and community benefits (quality of life).

Nature based design techniques are also beneficial to developers to help reduce imperviousness surfaces and potentially reduce the volume of water they must manage for quality. The reduction to the curve number at any development can reduce runoff, ultimately, reducing the overall cost of development.

Examples of thoughtful site planning include: the preservation/protection of environmentally sensitive site features such as riparian buffers, wetlands, undeveloped land, steep slopes, trees, flood plains, woodlands, and highly permeable soils.

Examples of integrated and distributed micro-scale storm water practices: bioretention, permeable pavers, flow through planters, disconnected downspouts, rain barrels, and green roofs, among others. Ultimately, natural hydrologic functions such as storage, infiltration, evaporation, transpiration, and groundwater recharge are used to their fullest potential to help minimize the amount of storm water runoff that must be managed. This helps users to control pollutants, reduce runoff volume, manage runoff timing, and address other ecological concerns.

The items listed below should be considered during design and may result in a stormwater utility fee credit for the project and/or partnership opportunities with City Utilities. These nature-based solutions should be coordinated with City Utilities Development Services during the planning process.

1. Return developed land to a condition that supports natural hydrology.
2. Preserve sites of high ecological value
    a. Avoid developing or disturbing 100% of areas of high ecological value located on site.

3. Preserve undeveloped land
    a. Preserve as much of the undeveloped area of the project site as possible.
4. Manage stormwater to a higher level of control
    a. Control stormwater for a higher design storm standard and reduce discharge rates and water quality impacts during the wet weather event.
5. Enhance functional habitats
    a. Identify existing habitat types on or near the project site and enhance existing terrestrial habitats.
6. Enhance wetland and surface water functions
    a. Restore any previously degraded wetland and/or surface water functions.

One of many tools to assist in sustainable design Is the Institute for Sustainable Infrastructure's Envision framework. More information can be found at sustainableinfrastructure.org/envision/about/.

GR5.06 Utility Coordination

The design of all projects shall be researched and coordinated with all utilities and/or appropriate agencies actively involved in the provision of services within the proposed project area.

Utility coordination efforts/responsibilities for City Utilities projects shall include, but are not necessarily limited to the following:

- Obtain, examine, and evaluate current public and private utility records for information needed in project planning and design;
- Identify and evaluate potential conflicts with other proposed projects in the immediate area;
- Research City's available documents pertaining to existing stormwater and sanitary sewer collection systems, potable water distribution system, and transportation facilities in the vicinity of the proposed project including: existing mapping, record drawings, City and County GIS data, and other pertinent information;
- Obtain maps of regulated drains from the County Surveyor's Office;
- Obtain plat information from the Allen County Recorder's Office;
- Request in-field location of facilities prior to surveying by calling 811 or 1-800-382-5544.
- Verify location of underground infrastructure with the appropriate private utility companies after surveying; and

- For subsurface utility engineering verification, refer to **Chapter GR8 – Subsurface Investigation**.

GR5.07 General Submittal Requirements

For most City Utilities Engineering projects, the design will be developed in four submittal stages, each of which requires approval from the Project Manager to proceed to the next stage. Some projects may not require all four submittal stages. The CUE Project Manager shall agree before any of the submittal stages are omitted.

For DVS projects, plans are normally submitted to the Department of Planning Services (DPS), which then delivers the plans to the appropriate City departments and agencies for review and approval. With prior approval from DVS, Stormwater Pollution Prevention Plans (SWPPP) may be submitted directly to DVS prior to submittal of the plans to the DPS.

At a minimum, all submittals shall be in conformance with the criteria for project design development and submittals outlined in the Standards.

GR5.08 Professional Certification

For all CUE Projects, the design engineer shall be responsible to confirm that all criteria and standards are implemented accurately in the preparation of project documents. For the final design submittal, all plans are to be certified by an Indiana licensed Professional Engineer in accordance with the requirements set forth by the Indiana State Board of Registration for Professional Engineers Statute and Board Rules and the Indiana Code.

Plans for all DVS Projects shall be certified as follows:

- For a potable water construction permit, a licensed Professional Engineer shall prepare the plans and submit them to City Utilities for review;
- For a local sanitary sewer construction permit, a licensed Professional Engineer shall prepare the plans and submit them to City Utilities for review;
- A Professional Surveyor shall certify the survey for all projects;
- SWPPP shall bear the certification of a licensed Professional Engineer or a Professional Surveyor.
- For stormwater collection system design plans, the DVS Project Manager will determine the appropriate/acceptable professional certification.

GR5.09 Review and Approval Process

1. CUE Projects

   The design drawings will be reviewed at the completion of each design phase by the project manager and other departments within the City affected by and/or having jurisdiction over various components of the project. Design drawings shall be submitted to the project manager who will coordinate the review process. The project manager will compile the review comments and submit them to the design engineer at the specific design submittal review meeting for integration into the project. All comments shall be reconciled and resolutions documented appropriately. The review and approval process will vary depending on the project schedule.

2. DVS Projects

   Design drawings shall be submitted to the DPS for review unless otherwise directed. DPS will route plans to DVS. All DVS review comments will be provided directly to applicant for resolution and re-submittal. All changes requested by DVS upon review shall be incorporated and addressed before design approval is granted for the project.

GR5.10 Opinions of Probable Project Cost for CUE Projects

A detailed cost estimate of the probable cost of construction for the project shall be provided with each design submittal. The cost estimate shall reflect the design engineer's best estimate of the probable cost to construct the project described by the drawings and technical specifications. Cost estimates should be based on the same drawings and specifications provided to the CUE Project Manager for review.

A review of the market conditions in the applicable geographic area shall be made when preparing each cost estimate. The following factors shall be considered in preparing each cost estimate:

- the effect of project costs on bidding competition,
- seasonal conditions,
- job site conditions,
- area productivity,
- material cost and availability,
- labor costs, and
- optimum methods of construction.

The final project cost methods of measurements and units shall comply with the Construction Specifications Institute (CSI) Master Format (MF04) technical specifications prepared for the project. The City has developed templates for many general technical specifications. A list of available MF04 technical specification and templates are part of the City website at **utilities.cityoffortwayne.org/contractors-engineers-developers/master-specifications**.

GR5.11 Life Cycle Cost (LCC)

The CUE Project Manager will determine the necessity of developing a life cycle cost (LCC) analysis for each project. The LCC analysis content includes interest rate, miscellaneous cost elements, etc.; and shall be discussed with the CUE Project Manager prior to the development of any LCC analysis.

A LCC analysis shall be conducted to compare and evaluate the different alternatives considered. Using the LCC economic model provides better assessment of long-term cost effectiveness of projects compared to only using the initial cost of design and construction in making decisions. For best results, the LCC analysis requires that the objectives of the project be clearly defined, assumptions about future conditions be clearly stated, and all reasonable means of accomplishing the defined objectives be evaluated. **Exhibit GR5-1** provides a sample calculation for a LCC analysis report.

For analysis of sewer collection system options, refer to **Chapter GR11 – Life Cycle Cost Analysis**.

GR5.12 American with Disabilities Act Accessibility Guidelines (ADAAG)

The design of projects shall include provisions to replace concrete sidewalks and curb ramps adjacent to and affected by the construction of the proposed project with new sidewalk ramps at street intersections, in conformance with ADAAG, latest edition.

During the design phase, the CUE Engineer will be coordinating projects with other City departments. As a result of this coordination, installation of ADA ramps may be required to be added in locations not directly impacted by the proposed project. In this case, the project drawings shall include design and installation details required for the additional requested ramps.

GR5.13 Pedestrian Facilities in the Public Rights-Of Way Accessibility Guidelines (PROWAG)

The design of projects shall include provisions to improve or maintain pedestrian access routes, and reduce various constraints posed by space limitations. The guidelines apply to permanent, as well as, temporary facilities. When the proposed construction project is altering the existing right-of-way, restore the affected area, in conformance with PROWAG, latest edition.

Example: The City of Fort Wayne needs an additional supply of water from the St. Joseph River. The engineer has selected two plans for comparison:

Gravity Plan: Divert water at a point ten miles up the St. Joseph River and carry it through a pipeline by gravity to the water plant.

Pumping Plan: Divert water at a point near the water plant and pump it through 2 miles of pipeline to the plant. The pumping plant can be built in two stages, with half capacity installed initially and the other half ten years later.

Use a 40-year analysis period and 8% interest. Salvage values can be ignored. During the first ten years, the average use of water will be less than during the remaining 30 years. Costs are as follows.

	Gravity	Pumping
Initial investment	$2,800,000	$1,600,000
Additional investment in tenth year	$0	$200,000
Operation, maintenance, replacements	$10,000/yr	$30,000/yr
Power cost (average first 10 years)	$0	$60,000/yr
Power cost (average next 30 years)	$0	$100,000/yr

Select the more economical plan.

Factor Table for I= 8%												
n		***F/P***		***P/F***		***A/F***		***A/P***		***F/A***		***P/A***		***A/G***
40		21.725		0.0460		0.0039		0.0839		259.057		11.925		10.570

Sample Calculations:

Since we have a 40-year analysis period, the problem may be solved by any of the exact analysis techniques. An annual cash flow analysis would appear to require the least calculations.

Gravity Plan

Initial Investment	=$2,800,000 (A/P, 8%, 40)	
	= $2,800,000 (0.0839) =	$234,920
Operation, Maintenance, & Replacements		$10,000
	Equivalent Uniform Annual Cost (EUAC) for Gravity Plan=	*$244,920*

Pumping Plan

Initial Investment	=$1,600,000 (A/P, 8%, 40)	
	=$1,600,000 (0.0839)=	$134,240
Annual Power Cost		$60,000
Additional Power Cost last 30 yrs	=$60,000 (F/A, 8%, 30)(A/F, 8%, 40)	
	=$60,000 (113.283)(0.0039) =	$26,509
Additional Investment in 10th Year	=$200,000 (P/F, 8%, 10)(A/F, 8%, 40)	
	=$200,000 (0.4632)(0.0839) =	$7,770
Operation, maintenance & replacements		$30,000
	Equivalent Uniform Annual Cost (EUAC) for Pumping Plan=	*$258,519*

For a minimum Equivalent Uniform Annual Cost (EUAC), choose Gravity Plan

i = Interest rate per interest period.

n = Number of interest periods

P = A present sum of money

F = A future sum of money. The future sum ***F*** is an amount, ***n*** interest periods from the present, that is equivalent to ***P*** with interest rate ***i***.

A = An end-of-period cash receipt or disbursement in a uniform series continuing for ***n*** periods, the entire series equivalent to ***P*** or ***F*** at interest rate ***i***.

G = A uniform arithmetic gradient representing a period-by-period increase in payments or disbursements.

Book 1

General Requirements (GR)

GR6 Surveying

GR6.01 Purpose

This Chapter discusses the various tasks associated with field surveys required for the design, construction, and approval of City Utilities projects. Projects requiring CUE approval and/or acceptance of constructed facilities should also follow these guidelines, unless otherwise instructed. Design engineers and survey crew chiefs should familiarize themselves with this and all other chapters of these Standards prior to commencing any field survey effort. Familiarity with the requirements will enable the field survey crew to efficiently obtain the necessary field information for design and construction and minimize the occurrence of unnecessary activities.

GR6.02 General

The members of the survey crew are normally the first project representatives to come in contact with the property owners/residents along the route of the proposed project. It is imperative, therefore, that the survey crew conduct themselves properly, both on the project site and in the surrounding community.

Proposed work should be explained to the affected property owners/residents and to the public, insofar as necessary. The survey crew should carefully refrain from outlining any specific plans or policies which might be misconstrued by individual property owners. If approached, the survey crew should not convey any project specific information to the property owners. If a citizen has project specific questions, they should be referred to the CUE project manager assigned to the project.

The survey crew shall be courteous at all times when interacting with the public and the crew members shall maintain a record of the names of owners/residents with whom they converse. During these conversations, survey crew should inquire as to the location of survey corners or monuments located on the property.

GR6.03 Survey Notification

Notification to property owners/residents is required when the survey crew must gain access to private property. The entity conducting the survey shall be responsible for the notifications. The survey notification procedure shall be as follows:

- generate a list of property owners who are within the project, adjacent to the project, and/or have lands that have to be accessible to the Professional Surveyor;

- complete a Surveying and Inspection Notice, form provided in Exhibit GR6-1;
- submit property owner list and a copy of the Survey and Inspection Notice to the Project Manager; and
- survey crew(s) shall maintain copies of Survey and Inspection Notice and Property Owner list with them when working in the field.

GR6.04 Damage

Damage to public and private property resulting from the activities of survey crews are the sole responsibility of the entity providing the service. City Utilities assumes no responsibility for damage to public or private property during contracted field activities.

GR6.05 Horizontal and Vertical Control

Project control shall be established by setting temporary project control points with coordinates (horizontal and vertical). The temporary project control points shall be tied to either field located and verified property monuments or documented control points such as section corners, subdivision corners, control points established during route surveys, or other control points previously documented by City Utilities.

1. U.S. Survey Foot

   All references to “foot” or “feet” in this Chapter shall mean US Survey Foot, which is the basis for the Indiana State Plane system.

2. Trees

   Trees are not to be used for surveying purposes except in remote areas where there is no practical alternative. No spikes, nails, etc., are to be driven into a tree. Trees shall not be “blazed” under any circumstances and only water-based paint may be used if it is necessary to mark a tree.

3. Guidelines

   Horizontal and vertical control shall be established according to the guidelines defined by the following publications:

   - Federal Geodetic Control Committee (FGCC), Standards and Specifications for Geodetic Control Networks;
   - NOAA Technical Report NOS 88 NGS 19, Horizontal Control;
   - NOAA Manual NOS NGS 3, Geodetic Leveling;
   - FGCC, Geometric Geodetic Accuracy Standards and Specifications Using GPS Relative Positioning Techniques (or its subsequent revisions); and
   - The Route Surveying Portion of Rule 12 as defined in Title 865 IAC 1-12-12 thru 1-12-26.

4. Datum

   All control shall be related to existing monuments that have been approved by City Utilities and shall reference the appropriate datum as indicated below.

   - Horizontal control shall be referenced to the North American Datum of 1983, Indiana State Plane, East Zone, US (Survey) Foot (IN83-EF).
   - Vertical control shall be referenced to North American Vertical Datum of 1988 (NAVD 88) unless otherwise requested.

5. Location Witness

   All project horizontal control points, temporary or permanent, shall be witnessed to the nearest one-hundredth of a foot, at three or more exactly definable points on permanent structures with no reference being more than one hundred feet from the control point. If no permanent structures are nearby, two or more exactly definable points are to be set and occupied for measurement of angle and distance from each other to the control point. Each line of sight is to have an exactly definable back sight.

   Permanent monuments placed during the survey process shall be individually documented using the Data Control Card form presented in **Exhibit GR6-2**. Temporary control points and bench marks shall be documented in the format shown in **Exhibit GR6-3**. Documentation for each monument or control point, whether permanent or temporary, shall be submitted to the Project Manager during the submittal of final plans or drawings.

   All bench marks are to be exactly defined and shall be referenced to the survey project control points in addition to other field references such as addresses, etc., in field notes, plans and any other pertinent documents submitted.

6. Vandalized Survey Project Points and Bench Marks

   The City will not assume responsibility for any damage done to project control points and bench marks until after the survey has been accepted. Any damage done to those points up to that time will be repaired or replaced by the Professional Surveyor at the Professional Surveyor's expense, if the vandalized points have not been properly field referenced before the occurrence of damage.

7. Degree of Accuracy

   Horizontal surveys will adhere to Third Order, Class I specifications, except that adjustments may be made by either the Least Squares or Compass Rule Method. Vertical control will adhere to Third Order specifications, except that the error of closure will be equal to or exceed Second Order, Class II requirements. The specified criteria for surveys may vary according to their purpose. All surveys are subject to conform to Title 865 IAC 1-12-22.

   The instruments used shall meet the specifications indicated in these guidelines or in following articles. All instruments shall be certified to

National Institute of Standards and Technology standards and manufacturer's specifications. Certification shall be performed by the previously mentioned institute, the instrument manufacturer or a certified instrument repairs facility.

8. Control Points

   Control points used for the completion of surveys may be existing or recorded monuments, or temporary control points set specifically for the project. The following articles outline the requirements for control points.

   a. Temporary Project Control Points and Temporary Bench Marks

      Temporary Project Control Points (TCPs) and Temporary Bench Marks (TBMs) are distinct from horizontal and vertical control monuments. TCPs may consist of, but are not limited to the following:

      - a 2-inch minimum masonry nail in pavement
      - a metal tack in a 1-inch x 2-inch wooden hub
      - iron rebar or pipe

      TBMs shall be established at a maximum of 500-feet and shall be located within a public easement or right-of-way. Acceptable TBMs include, but are not limited to, the following:

      - a 2-inch minimum masonry nail in pavement
      - a bolt on a fire hydrant which is not used for operation of the hydrant
      - a painted or etched box or "x" in a curb, sidewalk, or other concrete structure

   b. Documented Control Point Placement

      There shall be a minimum of two horizontal control points. All horizontal control shall be located within the easement or public right-of-way. Each monument shall be placed to avoid movement caused by construction or other activities. Each and every horizontal control monument shall also be a vertical control and shall be set per Title 865 IAC 1-12-24(1) on all projects.

      Vertical control monuments shall be placed similarly to horizontal control monuments at maximum intervals of 500-feet. When horizontal-vertical control monuments are also set, they shall be considered vertical control monuments. For projects less than 1,000-feet in length, the requirements for the placement of horizontal and vertical control shall be as directed by the project manager, and shall conform to Title 865 IAC 1-12-24(1).

   c. Documented Control Point Monumentation

      Monumentation of documented horizontal and vertical control shall meet or exceed the requirements of Title 865 IAC 1-12-24 (2 through 6). Standard permanent vertical control of bench marks, consisting of a 3½-inch diameter, or larger, domed disk set in the top of a 12-inch x

36-inch poured concrete post shall be used when vertical control monuments are specifically requested.

d. Documented Control Point Horizontal and Vertical Control Approval

When the final control work has been completed and checked, all computations shall be prepared on 8.5 inch x 11 inch sheets and shall be submitted to the Project Manager for review and approval.

The computations shall be indexed and bound in a neat and orderly manner, along with hard copies and electronic files of the actual field notes and all related drawings. If the horizontal traverse has been closed on a computer, the appropriate computer run showing any unadjusted data shall also be submitted.

Computations shall be submitted and stamped by a registered Professional Surveyor in the State of Indiana attesting to the accuracy of the survey.

e. Documented Control Point Horizontal and Vertical Control Map (Route Survey Plat)

A horizontal and vertical control map, otherwise known as a route survey plat; as shown in **Exhibit GR6-4** is required for all surveys completed for sanitary sewer projects, major stormwater projects, and potable water main projects, as designated by the project manager. Each route survey plat shall be prepared on a standard plan sheet and shall be included in the final plans. The final route survey plat shall include final stations, station equations, all curve data, and the final location and description of bench marks.

Horizontal control and vertical control information placed on the route survey plat shall be in accordance with Title 865 IAC 1-12-23, "Publication of Route Survey Results". The plat shall be submitted to the Allen County Recorder's Office and shall conform to the requirements and specifications of the Allen County Recorder. Required horizontal information includes:

- angles at all baseline points of intersection and ties to available acceptable monuments
- bearings and distances on the final project centerlines and available baselines
- angles and stations with adjacent projects
- final coordinates (State plane or assumed)
- all bearings, coordinates, angles, and point designations on baselines in the design segment
- source of horizontal control
- any and all monuments marking the Public Land Surveying System as can be recovered with reasonable efforts
- any and all monuments marking subdivided lots, centerline control, and public project centerlines or baselines.

Vertical information to be shown includes:

- new bench marks - their designations, locations, descriptions and elevations
- USGS, City or County bench marks - their designations, elevations and locations
- source of vertical control

f. Drawings and Field Notes of Desired Survey Locations

Survey drawings for all CUE Projects shall be provided to the Project Manager. All control points, bench marks, and topographic features shall be clearly identified.

GR6.06 Requirements for Survey Information and Data Collection

Requirements for survey information and data collection for CUE Projects have been developed to accurately define and assess the areas to be impacted by proposed projects. The following articles discuss the criteria governing survey information and data collection. A Surveying Scope Checklist for Design Surveys form is provided in **Exhibit GR6-5** to assist in determining the project-specific requirements of each survey.

1. Area to be Surveyed

Prior to the initiation of field activities, the development of the project area to be surveyed shall be coordinated with the Project Manager. Survey corridors and routes shall be developed specifically for each project. The corridor defined for surveys shall be sufficient in size to identify all physical characteristics of the project's topography.

Each survey shall include a sufficient number of shots, located approximately 10 to 20-feet, outside the existing right-of-way or survey corridor to assess the impacts of proposed limits on adjacent areas. Due to the varying requirements for each survey, the location of survey points outside the proposed survey corridor shall be coordinated with the project manager.

2. Physical Features to be Identified

All topography and physical features critical to the design of and potentially affected by the improvement shall be located and recorded in the field notes. The requirements for the location of man-made and natural physical features on the proposed survey shall always be discussed with the Project Manager prior to mobilization of field activities. Plan view requirements specific for Stormwater, Sanitary Sewer and Water are provided in their respective Books in the Standards.

Topography generated from aerial photography shall be identified and field checked for any errors or omissions. Omitted topography shall be located by field survey and appropriately recorded. This work is the specific responsibility of the engineer or Professional Surveyor, even though the aerial photography may have been provided from other sources. All topography within the proposed project construction limits and/or easements and rights-of-way shall be field located.

3. Survey Information Needed for Trees

   Unless otherwise directed, the following information shall be provided for trees within the proposed survey boundaries.

   - Species of Tree (Use the Audubon Society Field Guide to North American Trees, Eastern Region)
   - Size (DBH - Diameter at Breast Height)
   - Dripline (Diameter)
   - Location:
     - All trees 6-inches in diameter or greater and within 30-feet of the centerline of the pipe or 30-feet outside the toe of slope of ditches shall be located and the species given.
     - All trees less than 6-inches in diameter shall be located and species given, when within an existing or proposed sewer, water or drainage easement.
     - When trees are grouped together at a very close interval, locate the approximate limits of the grouping and list the most dominant species, average DBH, and approximate drip line of the group.

4. Field Profile Requirements

   All field topography and profile activities shall conform to Title 865 IAC 1-12. Profile elevations shall be determined along stormwater sewers, sanitary sewers, potable water mains, and/or through drainage systems. Survey points to support the generation of profiles are to be collected at intervals of 25-feet nominally, where possible; at intervals of 50-feet nominally on paved streets, and at all intermediate breaks. Profiles shall delineate existing structures, roads, streams, etc. Elevations shall be established to the nearest one-tenth of a foot on natural terrain and to one-hundredth of a foot on artificial surfaces.

5. Cross sections

   Cross sections shall be generated at 50-foot intervals and as needed at critical locations when it is necessary to determine what effect open cuts or trenching might have on other facilities such as structures, utilities, pavements, fences, trees, or landscaping. Survey points are to be taken to support the generation of the cross sections. Sufficient original ground elevations shall be determined to establish the slopes necessary to adequately serve the property. The project manager may modify these requirements to suit specific projects.

6. Subsurface and Overhead Utilities

   All publicly and privately owned subsurface and overhead utilities affected by the proposed project shall be located and identified by the field survey and by use of maps supplied by the utilities. Locations, elevations, and other pertinent data as may be required for possible relocation or adjustment shall be secured for all such utilities to the limits of information currently available.

The survey crew shall request that the underground utilities be marked by calling the Indiana Underground Plant Protection Services (IUPPS) Indiana811). The ticket number for the locate request shall be documented and submitted with the plans. The utility members notified by the request shall also be documented.

All sewer manhole structures within the survey corridor shall be surveyed. The next structures upstream/downstream from the survey corridor shall also be surveyed. A Structure Data Sheet, form in **Exhibit GR6-6**, shall be completed for each structure. Manholes are considered confined spaces per OSHA and shall only be entered with the appropriate procedures and personnel.

Overhead power lines shall be accurately located within the survey corridor. The sag elevation of the overhead lines between poles shall be documented.

7. Summary of Topographic Survey Elements

   Complete topographic survey data along proposed project corridor, including the natural and man-made features of the land, as well as its elevations. Facilities to be located shall include, but are not be limited to:

   - sanitary and storm sewer manhole rim and invert elevations
   - stormwater inlet and catch basin rim and invert elevations
   - water valves, valve vaults and hydrants
   - power poles and supports
   - electrical vaults
   - traffic signal equipment
   - utility locations as marked by IUPPS Indiana811

   Data from all utility locates marked on the site from IUPPS Indiana811 shall include horizontal locations and depths where available. The IUPPS Indiana811 service shall be notified at least 48 hours prior to any necessity for verification of location, size, and material of utilities.

   All sewer structures shall be sketched and structure data details provided to show pipe size, Identification number, flow direction, and invert elevation, and be referenced to the horizontal notes with a reference point.

   Record the location of all existing natural and man-made features such as bridges, rivers, ponds, trees, landscaping, driveways, edge of pavements, curb and gutters, sidewalks, edge of buildings, fences, signs, guardrails, street lights, existing top of bank and toe of slope, etc.

   Curved features, such as a curved roadway, shall have sufficient points collected in the field to accurately depict the field condition on the base plan.

Establish and reference the design/construction centerline for all roads affected by the project.

For additional information about facilities to be located in the field refer to the checklist provided in **Exhibit GR6-5**.

At least two (2) horizontal control points will be necessary for projects 500-feet or less in length. The distance between referenced control points shall not exceed 1,000-foot intervals for projects greater than 500-feet long.

Control points shall be semi-permanent in nature (PK nails, RR spikes, hardwood hubs, iron rods, etc.) and be witnessed to at least three permanent objects.

All projects shall be tied to the same vertical datum, North American Vertical Datum of 1988 (NAVD 88) as the current FEMA Flood Insurance Rate Maps (FIRM).

Horizontal datum coordinates shall be in the North American Datum of 1983 (NAD83), Indiana State Plane, East Zone, US (Survey) Foot (IN83-EF) coordinate system.

Each project shall have at least one (1) temporary bench mark for projects 500-feet or less in length for vertical control. The spacing of temporary bench marks shall not exceed 500-feet for projects with a length greater than 500-feet.

Notes relating to vertical positions shall include data on all bench marks established and provide reference to the source of the control. Bench marks shall be described and/or sketched to ensure proper identification. Elevation notes shall also include a periodic check from bench mark control to traverse points to ensure the data collector is recording accurate elevations.

Establish property ownership/addresses and apparent property lines for right-of-way.

Provide sufficient control for the contractor to layout the proposed work.

All ground features pertinent to the required end product shall be collected as part of the field effort.

If using Civil 3D or an equivalent CADD Software, point symbols, descriptions, scales, layers, and other point properties may be set and automated utilizing Description Key Sets, Point Codes, Line Codes and Survey Prefixes. See **Exhibit GR6-7** for examples.

CUE may provide Description Key Sets, Point Codes, Line Codes and Survey Prefixes within electronic files and/or within Civil 3D drawing (DWT) templates. Unless otherwise instructed, each company or surveyor may modify the Point Codes and Line Codes to match their company standard as long as other point, survey figure and linework requirements within this chapter and all Book 6: CADD Standards are met.

Points shall be systematically collected in the field and addressed in CADD drawings and plans as follows:

- Points shall be described by an appropriate description and receive a point symbol, number and elevation. See **Exhibit GR6-7** for point description examples. If a point requires a more extensive description for clarity, the additional description shall be added.
- Points shall use approved symbols per Book 6: CADD Standards, Chapter CADD7 Symbols and other chapters of the CADD Standards and shall be scaled appropriately within Project CADD drawings and Project plans. Point symbols and scales may be specified and configured within CUE CADD (DWT) templates.
- Point information such as, but not limited to, point symbol, point number, point description, and point elevation shall be placed on required CADD Layers per Book 6: CADD Standards, Chapter CADD6 Layers and shall conform to requirements in other chapters of the CADD Standards. Point information and symbol layers may be specified and configured within CUE CADD (DWT) templates.

Most building dimensions and other data and comments that cannot be recorded in an electronic field book shall be noted as a sketch in a field book. While the sketches will not require the minute dimensions and detail once necessary for a manual survey, they should be explicit enough so that the design engineer can orient position on the electronic drawing and complete the topographic map/base plan.

Building footprints shall include overhangs and cantilevered improvements.

After the topographical field survey is completed, the recorded data shall be processed using a compatible software package and drafting standards approved by the City to create the topographic map/base plan.

Apparent property corners located in the field shall be shown on the base plan. Owner's names, addresses, and deed references shall be shown along with approximate property lines pertinent to the project. Layout data is to be shown on the base plan indicating the coordinates, bearing, distances and stations between changes in geometry of the alignment.

All coordinate values shall be to four (4) decimal places, linear values and elevations shall be to two (2) decimal places, and direction bearings shall be to the second.

GR6.07 Special Surveys and Topographical Information

1. Property Surveys

   Surveys covered by the requirements of this article include: route, original, and retracement surveys.

   Where the relationship of the project's location and adjacent property line is critical, the location of the existing property line and other boundaries shall be established by a property survey sufficient to define the easement. All property surveys shall comply with the "Minimum Standards for Competent Practice for Land Surveying in Indiana" and Title 865 IAC 1-12. Plats and descriptions for easements shall conform to the requirements defined in [Chapter GR7 – Easements].

2. Railroad and Highway Surveys

   When the centerline of a proposed linear project such as sewer or a water main crosses a railroad or highway, all existing and proposed railroad tracks, roadways, and affected structures shall be tied to the centerline of the proposed project. The topography data shall be collected on both sides of the proposed crossing to the extent required by the affected reviewing agencies.

   a. Railroads

      Information for railroads shall include, but not be limited to, the following:

      - top of rails - 300 feet minimum in either direction to be located horizontally and vertically at 50-foot intervals
      - angle between centerline of tracks and centerline of improvement
      - name and address of railroad company
      - location of railroad rights-of-way and easements (source of record where possible)
      - horizontal information relative to transmission lines, such as telephone or electric (when possible)
      - stations on the centerline of each track
      - mile post locations, measured from centerline crossing

      Permission to be on the railroad right-of-way shall be secured from the railroad company prior to entering the right-of-way. Trespassing on railroad right-of-way is a Class D felony. City will not be responsible for any violations or resulting penalties associated with trespassing on railroad property.

   b. Highways (INDOT Controlled Roadways).

      Information for highways shall include, but may not be limited to, the following:

      - station on centerline of highway and each edge of pavement, or front face of curb, as may be appropriate
      - angle between centerline of highway and centerline of improvement
      - location of highway rights-of-way and easements (source of record where possible)
      - location of any crossings, or parallel utilities, or drainage structures which may be in conflict with the improvement construction
      - number and width of lanes and the type and condition of the surface

Additional information relative to requirements in the vicinity of railroads and highways may be required on a project specific basis.

GR6.08 Deliverables and Submittals

All required deliverables and submittals, as indicated in the project scope, shall be submitted to City Utilities in conformance to the applicable requirements of the Standards.

GR6.09 Construction Staking

The staking of all baselines, control points, monuments, and all other items associated with the plans for proposed project construction shall be the responsibility of the contractor to perform prior to the initiation of construction. CUE will provide the contractor with the necessary information for reinstating control points and baselines for the project in the field. The staking of all proposed work shall comply with Title 865 IAC. Specific items that shall be staked and identified in the field prior to construction activities include all proposed permanent and temporary easements and project control points and monuments.

(Copy & Paste text below into Consultant's Letter Head and modify with project information)

Property Owner's Name
Property Owner's Street Address
Property Owner's City, State, Zip

Re: Project Name

Dear Property Owner:

The City of Fort Wayne has retained (Firm Name) to prepare a topographic survey for a (sewer/water/storm) project on (Location). The purpose of this project is to (Reason for Project (i.e. increase capacity, improve drainage, increase pressure, etc.…)).

Our information indicated that you either own or occupy property near this proposed (Location) project. Our employees will be conducting a survey of the project area in the near future. The majority of the work will be within existing City street right-of-ways or utility easements, but it may be necessary for them to come onto your property to complete this work. Entry onto your property will be kept to a minimum. They will show you their identification, at your request. If the property is occupied by someone else, please let them know that a survey crew could be on the property. If you have sold the property, please let me know so I can properly notify them.

The survey work will include gathering detailed mapping information for the project area including the location of features such as roads, existing utilities, buildings, trees, fences, and drives, and obtaining ground elevations. The survey is needed for the proper planning and design of this project.

Please be assured it is our sincerest desire to cause you as little inconvenience as possible during this survey. If any problems do occur, please contact our field crew or me.

Very truly yours,

____
Survey Department Manager Name

(Consultant/Designer Firm Name, Address and contact information)

FORT WAYNE CITY UTILITIES

CONTROL DATA

NO. OF STATION ____________________
ELEVATION OF STATION ____________________
DATE STATION ESTABLISHED ____________________

Horizontal Datum
(1983 Indiana State Plane, East Zone, US Foot, IN83-EF)

N-Coordinate	E-Coordinate
1239123.1234	287912.5678

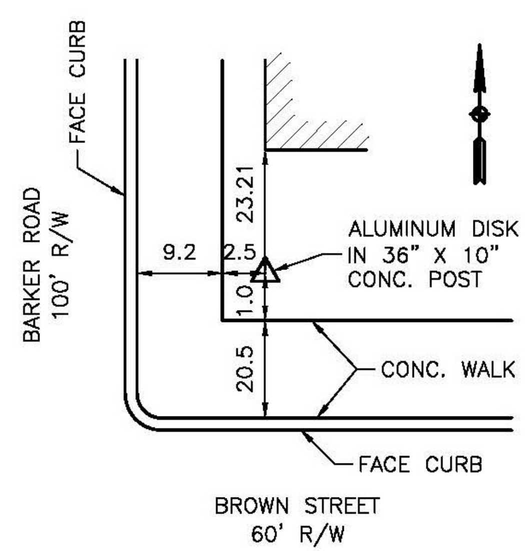
Grid Distance and North Azimuth to Objects Observed		
Object	Grid Distance – Ft.	North Azimuth
29 X FB	1321.48	218° 15' 33"
TRY	AND MAKE OBSERVATION >	100'

DESCRIPTION AND REFERENCES:

Monument is aluminum disk set on a concrete post 36" x 10" flush with the ground.

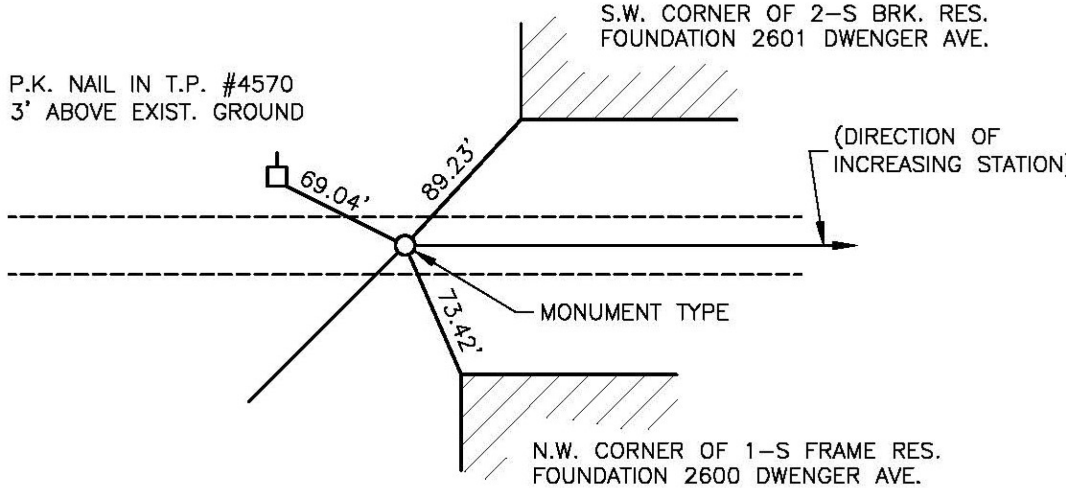
To reach station from Intersection Brown Street and Barker Road, City of Fort Wayne, County of Allen, proceed 21.5' north of north face curb of Brown Street and 11.7' east of east face curb of Barker Road to aluminum disk set in concrete post.

SKETCH



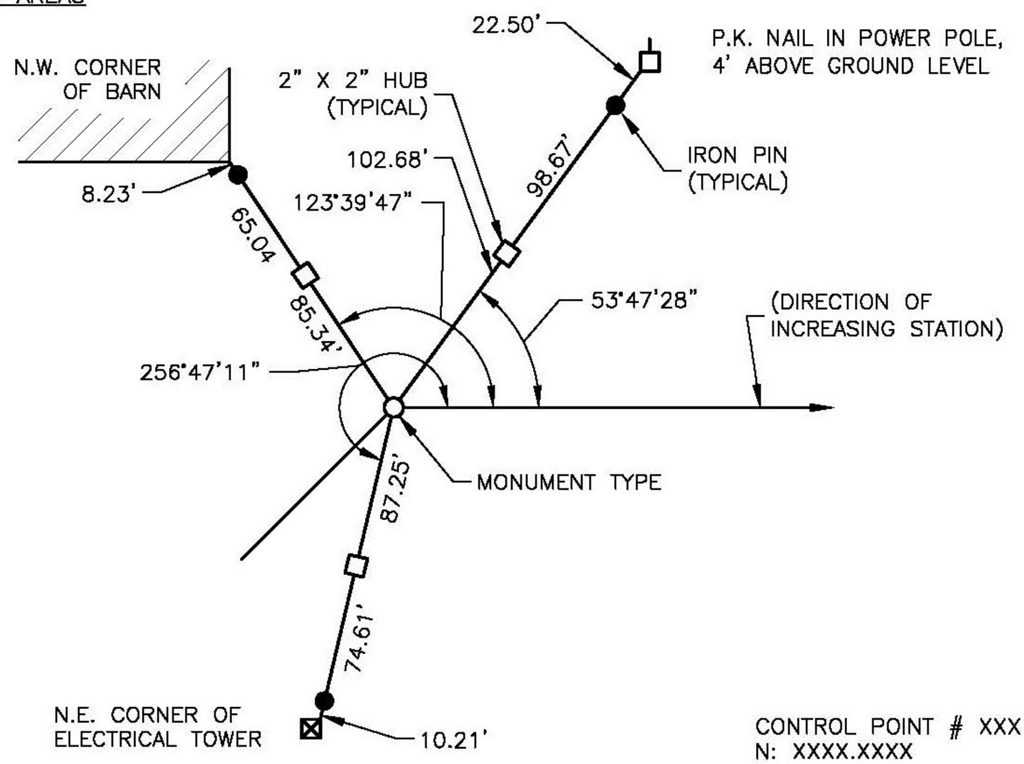
	City Utilities Design Standards Manual	Exhibit GR6-3 Temporary Control Point and Benchmark References
CITY UTILITIES WATER THAT WORKS		Version: February 28, 2013 Scale: N.T.S.

DEVELOPED AREAS



CONTROL POINT # XXX
N: XXXX.XXXX
E: XXXX.XXXX

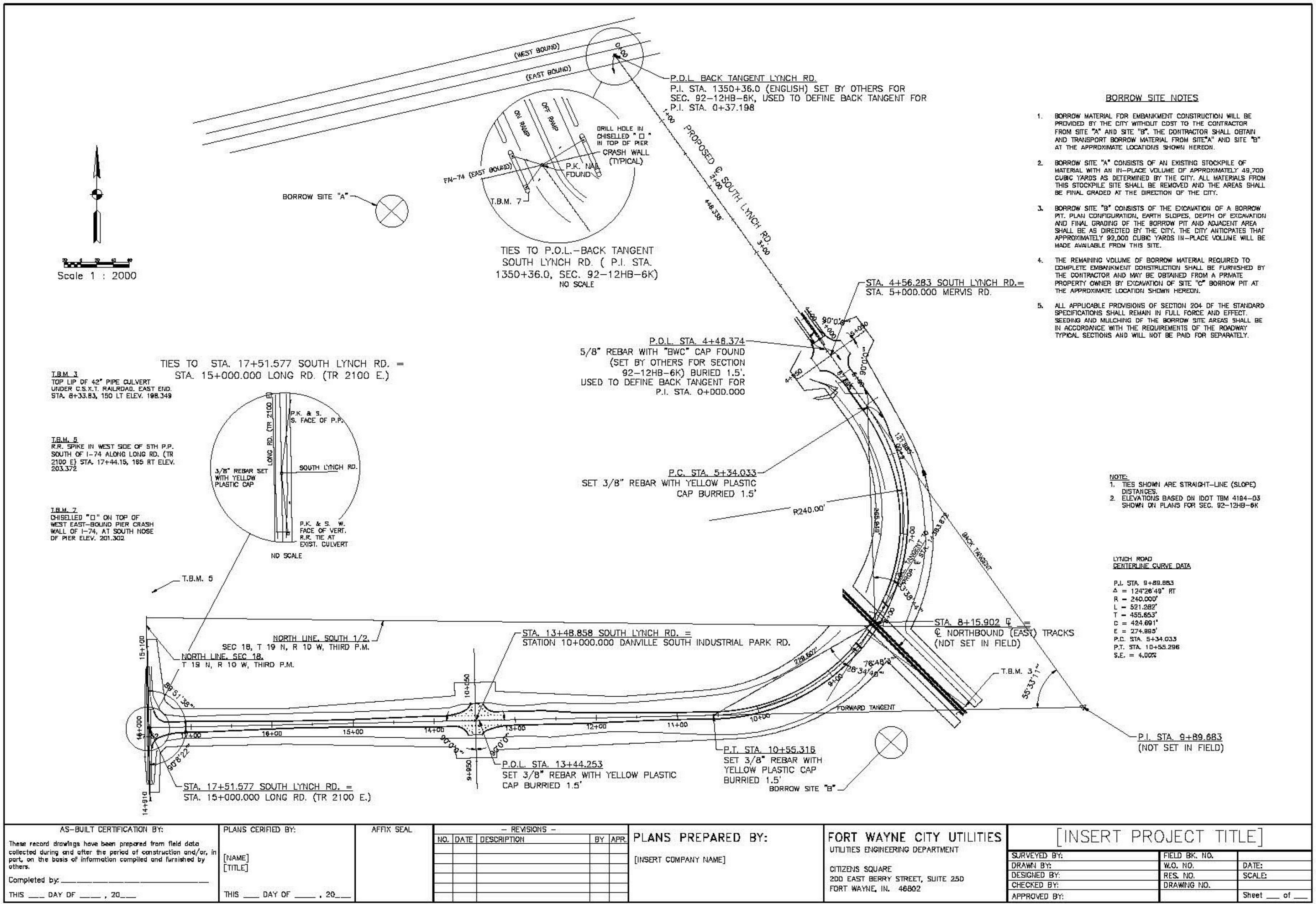
UNDEVELOPED AREAS



CONTROL POINT # XXX
N: XXXX.XXXX
E: XXXX.XXXX

Exhibit GR6-4 Horizontal and Vertical Control Map

Version: February 28, 2013
Scale: N.T.S.



1. GENERAL PROJECT INFORMATION

Project Name: ____

Project Description: ____

____

____

Project Location (Attach Map): ____

____

____

2. HORIZONTAL AND VERTICAL CONTROL

Where are improvements located? (Circle All Applicable) *Public ROW* *Existing Easements* *Proposed Easements*

Horizontal datum required: North American Datum of 1983, *Indiana States Plane, East Zone, US Foot (IN83-EF)*

What vertical datum is required? (Circle one) *North American Vertical Datum of 1988* *Match Existing Project* ____________________

National Geodetic Vertical Datum of 1929

3. AREA TO BE SURVEYED

_____ Survey Corridor as defined on the attached map

____ Other: ____

____

____

4. PLANIMETRIC FEATURES TO BE IDENTIFIED

Boundary Lines

___ Property Lines

___ Lot Lines

___ Right-of-Way Lines

___ Easement Lines ____ as Originally Platted (Deed Book and Pg. Number) ____ per Title Search/Property Deed

___ Other: ________________________________

Synthetic Improvements (Check): _____ **ALL ITEMS BELOW located within the survey limits area.**

_____	Streets	_____	Names	_____	Pavement Markings		
_____	Signals	_____	Types	_____	Material		
_____	Curbs	_____	Types	_____	Material		
_____	Signs	_____	Types	_____	Material		
_____	Driveways	_____	Types	_____	Material		
_____	Pipe End Sections	_____	Types	_____	Sizes	_____	Material
_____	Buildings	_____	House Numbers	_____	Property Owners' Names		
_____	Walks	_____	Material	_____	Steps	_____	Material
_____	Parking Lots	_____	Material	_____	Pavement Markings/Striping		

4. PLANIMETRIC FEATURES TO BE IDENTIFIED (CONTINUED)

Synthetic Improvements (Continued) ____ **ALL ITEMS BELOW located within the survey limits area.**

______ Head or Retaining Walls (Top & bottom) ______ Length/Width/Height ______ Material ______ Thickness
______ Bridges or Culverts ______ Sizes ______ Material
______ Fences ______ Material ______ Height
______ Other: ______________________

Landscaping ___ **ALL ITEMS BELOW located within the survey limits area.**

______ Trees ______ Types ______ Sizes (Drip line & Diameter at Breast Height (DBH))
(All Trees with DBH of _____" and greater)
______ Shrubs ______ Types ______ Sizes
______ Gardens
______ Timbers ______ Types
______ Decorative Stone or Rock
______ Ponds, Lakes
______ Creeks, Streams, Ditches, or Rivers (Centerlines, Top of Banks, Bottom of Banks)
______ Bricks ______ Types ______ Sizes

Utility Appurtenances (Check) All utilities shall be field located and marked prior to survey

______ **ALL ITEMS BELOW located withing the survey limits area.**
______ All Sewer Structures (Structure Data Sheet, shall be completed for each sewer structure)
______ Towers ______ ID Number ______ Owned By
______ Poles ______ ID Number ______ Owned By ______ # Transformers ______ Street Lights
______ Pedestals ______ Sizes ______ Owned By
______ Manhole Covers ______ Sizes ______ Material
______ Vault Lids ______ Sizes ____ Material
______ Valve Box Covers ______ Sizes ____ Material
______ Meter Box/Vault Covers ______ Sizes ____ Material
______ Service Box Covers______ Sizes ____ Material
______ Cleanouts ______ Sizes ____ Material
______ Fire Hydrants
______ All Underground Utility Lines______ Utility ______ Sizes
______ All Overhead Utility Lines ______ Utility
______ Other: ______________________

Miscellaneous ______ **ALL ITEMS BELOW located withing the survey limits area.**

______ Soundings and Borings ______ Pavement Cores ______ Rock Soundings
______ Wet Delineation Flags
______ High Water Marks
______ Utility Pot Holes
______ Other: ______________

5. TOPOGRAPHIC INFORMATION REQUIRED

______ Survey Line Profile at _____ Foot Intervals (NTS: Typically leave blank)
______ Cross Sections at _______ Foot Intervals
______ Ground Elevations at ______ Foot square grid (NTS: Typically 50')
______ Pavement Elevations at ______ Foot square grid (NTS: Typically 50')
______ Basement Elevations _______ Basement Elevation Certification
______ Finished Floor Elevations _____Lowest Opening Elevation
______ All Sewer Structures (Including all information on Exhibit GR6-6 (Structure Data Sheets))
__X__ All Sewer Pipe Ends (Inverts at Upstream and Downstream Structures including those outside survey area)

5. TOPOGRAPHIC INFORMATION REQUIRED (CONTINUED)

_____ Overhead Utility Line Elevations
_____ Overhead Clearance Elevations
_____ Drive Elevations
_____ Flood Grade Elevations
_____ Garage Floor Elevations
_____ Private Walk, Steps, and Entranceway Elevations ______ADA Accesses Detailed
_____ Center Line of Ditch Elevations
_____ Top of Bank - Toe of Slope Elevations
_____ River/Ditch Cross-Sections at _____ intervals _____As identified on Attached Map
_____ Water Surface Elevation _____Apparent High Water Elevation

6. SPECIAL SURVEYS (All Special Surveys need defined in specs or removed from this list.)

_____ Property _____Original _____Retracement
_____ Railroad
_____ Highway
_____ ALTA Boundary Survey (Table A Items Attached)
_____ Location Control Route Survey Plat (Easement Acquisitions)
_____ Record Drawing Survey
_____ Other___________________________

7. DELIVERABLES

All deliverables and submittals shall be submitted to Fort Wayne City Utilities Engineering and shall conform to all pertinent sections of the City Utilities Design Standards Manual as well as to all other requirements specified. Examples from the City Utilities Design Standards Manual include, but are not limited to, Section GR6 (General Requirements Surveying) and all sections (CADD1 – CADD8) of the CADD Standards.

CITY UTILITIES WATER THAT WORKS	City Utilities Design Standards Manual	Exhibit GR6-6 Structure Data Sheet
		Version: June 2024 Fillable Version Scale: N.T.S.

STRUCTURE DATA SHEET

Date: ______________________ Weather: ____

Crew: ____ Firm Name: ______________________________________

Project Description/No: ____

Topo Point No: __________________________________ City Structure ID:________________________ (Ex. N02 134)

Sewer Type: Sanitary Storm Combo Unknown Casting Type: Solid Flat Open Gate Curb Beehive

Structure Size (in.):____________________ Cone Size (in.): ____________________

MH Material: Pre-Cast Brick In-Place Conc. Other Structure Shape: Round Square Rectangle Oval

N:______________________ E:____________________ Rim Elev.:_____________________________

Pipe Material Types: PVC = Poly-Vinyl-Chloride, VCP = Vit. Clay, RCP = Concrete, CMP = Corr. Metal, Fe = Iron, D.I. = Ductile Iron, HDPE = High-Density Polyethylene, PP = Polypropylene, BR = Brick

North

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

ADDITIONAL SKETCH
(Please also sketch shape and location of lid/grate)

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Clock Pos.:___________
Pipe Dia.: ____________
Material: ____________
Drop: ______________
Inv. Elevation: ________
Flow Depth: _________
Conn. To: ____________

Observations:

1. Presence of Roots? Y N Severity: Minor Presence Obstructing Flow
2. Flow Conditions: Laminar (Uniform) Turbulent (Non-Uniform)
3. Evidence of Sewer Surcharge: Y N Depth of Surcharge (Above Invert): ____________________
4. Active Infiltration? Y N Evidence of Infiltration? Y N Describe: _________________________________
5. Debris in Structure? Y N Describe: ____
6. Sediment in Structure? Y N Depth_____________ Describe: _____________________________________
7. Photo Number: ____
8. Overall Structure Condition: New Good Poor ____
9. Other Notes: ____

Line Codes	Description
BKL	Breakline
BLD	Building
BOC	Back of Curb
BR	Edge of Brush Row
BRICK	Brick
BOW	Back of Walk
BRUSH	Brush Line
CATV	Cable TV
CL	Centerline
CLD	Centerline of Ditch
CONC	Concrete
DITCH	Ditch
DRA	Drive Asphalt
DRC	Drive Concrete
DRS	Drive Stone
EB	Edge of Brush Line
EC	Edge of Concrete
EP	Edge of Pavement
ES	Edge of Stone
EOW	Edge of Water
FCL	Fenceline Chainlink
FCW	Fenceline Wood
FCV	Fenceline Vynil
FOC	Face of Curb
FL	Fence Line
FOW	Face of Walk
HEDGE	Hedge Row
HR	Hand Rail
Gate	Fence Gate
GL	Gutter line
GR	Guard Rail - Face
GS	Gas Line
HW	Head Wall
LS	Edge of Landscaping
OHE	Overhead Electric Lines
OHC	Overhead Communication Lines
PM	Pavement Stripes (Provide Description)
RR	Center of each railroad rail
RRT	Railroad Ties/Landscaping Timbers
RW	Top of Exposed face of Retaining Wall
SWA	Sidewalk Asphalt
SWB	Sidewalk Brick
SWC	Sidewalk Concrete
TB	Top of Bank
TL	Tree Line
TOE	Toe of Slope
UGCL	Underground Communication Lines
UGFO	Underground Fiber Lines
UGEL	Underground Electric Lines
WDL	Edge of Woods Line
WL	Water Line

Point Codes	Descriptions
ACU	Air Conditioning Unit
ADRV	Asphalt Drive
ANC	Guy Anchor Wire – Single
ANT	Satellite Dish
ASPH	Asphalt Surface Label/Elevation (Small X)
AXLE	Axle
BB	Sign Single Post
BEEHIVE	Beehive Inlet Round
BH	Beehive Inlet Round
BKLN	Breakline
BLDG	Building
BM	Benchmark (Provide Description)
BO	Blow-off
BOC	Back of Curb
BOL	Bollard
BOLT	TPN
BOULDER	Boulder
BOWA	Back of Walk - Ashpalt
BOWB	Back of Walk - Brick
BOWC	Back of Walk - Concrete
BRG	BRG
BRICK	Brick
BRUSH	Brush
BUSH2, BUSH3…	Bush (# = Width of Drip Line to the Nearest Foot)
CATV	Cable TV
CATVPED	Cable TV Pedestal
CB	Catch Basin
CBMH	Communication Manhole
CDRV	Concrete Drive
CES	Concrete End Section
CL	Centerline
CL#	Centerline
CLD*	Drive Centerline
COL	Box
CONC	Concrete Surface Label/Elevation
CO	Clean-Out
CP	Control Point (Provide Description)
CRBOX	Water Curb Stop
CTDL	Drive Centerline
CX	Chiseled X
DD*	Deciduous Tree
DIR*	Dir
DS	Downspout
EM	Electric Meter
EMH	Electric Manhole
EP	Edge of Pavement
EPED	Electric Pedestal
ETRANS	Electric Transformer
FCO	Face of Curb
FF	Finished Floor
FH	Fire Hydrant
FP	Flag Pole

GM	Gas Meter
GMK	Gas Line Marker
GV	Gas Valve
GCS	Gas Curb Stop
HDW	Headwall
ICC	Inlet Curb Cast
IN	Inlet
INV	Invert
IP	Iron Pipe Found
LP	Light Pole
MB	Mailbox
MAG	Mag Nail
MH	Manhole
MW	Monitoring Well
OHE	Ovehead Electric
PK	PK Nail
PMTR	Parking Meter
POST	Post (Provide Description)
PWP	Power Pole
RR	Riprap
SB	Soil Boring/Rock Sounding
SMH	Sanitary Manhole
SN	Sign (Provide Description)
SPK	Sprinkler Head
STMH	Storm Manhole
STAP	Stand Pipe
TBM	Temporary Bench Mark
TMA	Traffic Mast Arm Pole
TMH	Telephone Manhole
TP	Telephone Pole
TPED	Telephone Pedestal
TRMH	Traffic Manhole
WELL	Water Well
WM	Water Meter
WV	Water Valve
WS	Water Service
YL	Yard Light

Book 1

General Requirements (GR)

GR7 Easements

GR7.01 Purpose

All sanitary and stormwater collection systems and water distribution systems that are to be publicly owned, operated, and/or maintained shall be constructed in the public right-of-way, easements, or on property owned by City Utilities. No approval will be given for construction of, or improvements to, any City Utilities infrastructure without provisions for suitable permanent easement or right-of-way.

This Chapter outlines easement requirements. Easement requirements shall be discussed with City Utilities' staff during the planning stage of every project, which is when the easement acquisition process for each project will be defined. Easement locations, sizes and limits shall be determined as early as possible.

GR7.02 Existing Easements

Existing easements shall be shown on the construction plans. The plans shall include:

- The location, dimensions, and specified use of each existing easement
- The recording information of the existing easement, including the document number or the book and page number of the existing easement as found in the Allen County Recorder's Office

An existing easement that is an exclusive use easement for gas, electric, or other non-City owned utility does not permit the construction of a sanitary or stormwater collection system or a potable water distribution system. In such a case, City Utilities will have to acquire a new easement signed by the property owner and the beneficiary of the existing exclusive use easement.

Special attention shall be given to the type of easement. Some existing easements are specifically for stormwater drainage, potable water, sanitary sewer, or any combination thereof. Such easements can only be utilized for the use specified. For example, a sanitary sewer cannot be placed in an easement specified as a stormwater drainage easement. In such an instance, a new sanitary sewer easement shall be acquired and noted on the construction plans in the same manner as any other new easement.

Recording information for existing easements such as document number or book and page number shall be shown in the "remarks" column on the Property Acquisition Summary Sheet.

GR7.03 Types of Interest in Real Property for City Utilities Projects

The following terms apply to acquiring interest(s) in real property for the purposes of constructing, operating, and maintaining stormwater drainage, sanitary sewer, wastewater treatment, and potable water facilities.

1. Fee Simple Title

   Fee simple title is ownership of the land. There can be encumbrances to fee simple title such as easements, zoning, and other limitations on use. Fee simple title is usually established by a recorded deed.

   For the purpose of constructing major aboveground structures, City Utilities will normally acquire the property in fee simple title. Examples of projects that require fee simple title are pumping stations, wastewater treatment plant sites, potable water production facilities, major detention basins, and other miscellaneous projects of similar scope.

2. Sanitary Sewer, Stormwater Drainage, and Potable Water Permanent Easements

   A permanent easement is a permanent interest in real property that allows the privilege of a specific and limited use of real property owned by someone else. A recorded easement, whether dedicated on a subdivision plat or in an easement agreement, will generally remain an encumbrance on the land regardless of any change in ownership of the underlying property. An easement can generally only be terminated by the grantee. The most common way that an easement terminates is by its own terms, usually by passage of a particular amount of time. Merger of Title, when the grantee purchases the land on which the grantee has an easement, also terminates an easement.

   For the purpose of sanitary and stormwater collection systems and potable water distribution systems, City Utilities will acquire a permanent easement. The easement shall grant the right to construct, operate, and maintain City Utilities systems within the limits of the defined area. These easements shall be designated “Utility Easements” unless otherwise determined that they should be specific to “Sanitary Sewer, Stormwater Drainage, and/or Potable Water Easement”.

   A permanent easement shall not be designed to include any portion of an existing or proposed permanent structure, unless City Utilities decides otherwise on a case-by-case basis. A property owner generally is restricted from constructing any improvements within the limits of an easement which might interfere with the privileges granted by the easement.

3. Overland Flow Drainage Easement

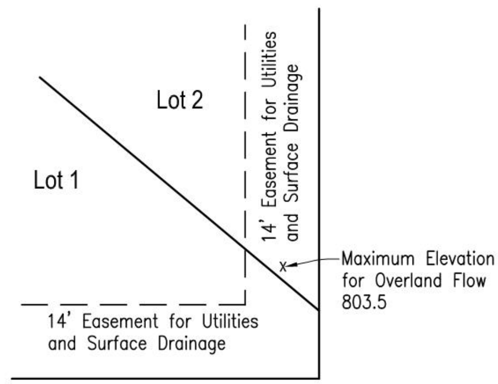
   Stormwater management plans require easements for overland drainage paths. These easements may not have obvious infrastructure such as pipes or ditches and may be only for general grading and/or preserving existing overland drainage patterns. The intent is to define a dedicated location for overland flow paths. The overland flow drainage easements are required for two different applications.

a. Emergency Overland Flow Easement

An Emergency Overland Flow Easement can be easement can be multi use. It can include the construction and maintenance rights of the typical development utilities (I.E., cable, electric, gas).

Emergency overland Flow Paths shall be shown on subdivision plats. The maximum elevation and location for a watershed break shall be identified and the location of the maximum elevation shall be noted. If the easement is a stand-alone document, the maximum elevation and location shall be on the attached easement plat. See Figure GR7.1 for reference.

Figure GR7.1 Sample Emergency Overland Flow Path



Emergency overland drainage easements will prohibit obstructions such as:

- Houses, garages and other building structures.
- Hedges and similar dense vegetation above the typically lawn height.
- Privacy and screening fences.
- Elevated landscaping or garden beds.
- General lawn regrading that is not in compliance with the vertical design profiles.

b. Surface Drainage Easements

Surface drainage easements in residential areas are typically in rear yards and sometimes in side yards. These easements are generally for drainage swales that are designed to be part of the stormwater system for an area. The surface drainage easement grants the city access to regrade the swale (typically back to original design) or install and maintain a subdrain if necessary. The city is the beneficiary of these easements.

Surface drainage easements will prohibit grading and obstructions such as:

- Houses, garages and other building structures.

- Hedges and similar dense vegetation above the typically lawn height.
- Privacy and screening fences.
- Elevated landscaping or garden beds.
- General lawn regrading that is not in compliance with the vertical design profiles.

Often, the surface drainage easement will be coincident with a dedicated utility easement. The permitted use of the easement must be conspicuous and cannot be assumed as interchangeable.

4. Temporary Construction Easement

A temporary construction easement is a temporary interest in real property that allows the privilege of a specific and limited use of real property owned by someone else, for activities associated with the act of construction. Temporary construction easements generally terminate on a specific date or after the completion of a particular accomplishment or action.

A temporary construction easement will be required if the activities associated with the construction process cannot be completed within the confines of the permanent easement or within the right-of-way. These activities may include activities such as structure removal, ingress/egress of construction equipment and materials, stockpiling, grade adjustment, and other miscellaneous tasks.

Temporary construction easement lines may be drawn through permanent structures; however, the contract documents shall contain language which clearly indicates that all such permanent structures shall not be disturbed during construction.

GR7.04 Easement Widths

Whenever possible, the total easement width, permanent plus temporary, shall be sufficient to permit the Contractor to have flexibility in the method of construction. The perpetual easement must also allow for future maintenance activities. However, the easement shall not encumber more land than reasonably necessary.

1. Utility, Sanitary Sewer, Stormwater Drainage, and Potable Water Permanent Easements

Standard minimum widths of permanent easements for underground piping are provided in Figure GR7.2. In no case shall these standards be a substitute for sound engineering judgment. Lesser easement widths may be allowed upon approval of such widths by City Utilities. Justification for the lesser easement widths shall be provided.

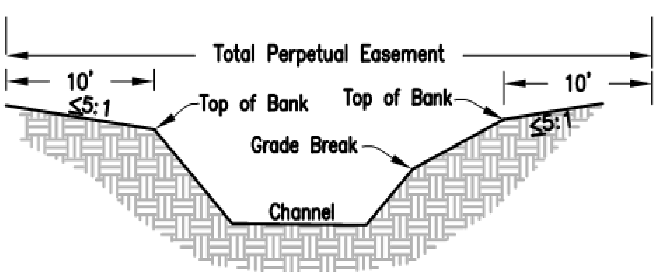
Figure GR7.2 Minimum Easement Widths

Diameter of Underground Utility Diameter	Standard Minimum Easement Width for Depths <18’				
Size of Pipe	**Permanent – Stand Alone Easement**	**Permanent – Adjacent to R/W**	**Temporary**	**Total-Stand Alone**	**Total – Parallel to R/W**
3" – 8" Water Mains, Water Services, Sewer Force Mains	20’	10’	15’ on each non R/W side	50’	25’
12" – 24" Water Mains, Sewer Force Mains	20’	15’	15’ on each non R/W side	50’	30’
8" – 12" Gravity Sewers and Sewer Services	20’	20’	15’ on each non R/W side	50’	35’
15" - 48" Gravity Sewers & Water Mains 30" to 48"	20’	20’	20’ on each non R/W side	60’	40’
54" - 72" Gravity Sewers & Water Mains 54" & larger	25’	25’	25’ on each non R/W side	75’	50’
84" and larger Gravity Sewers	30’	30’	30’ on each non R/W side	90’	60’

Diameter of Underground Utility Diameter	Standard Minimum Easement Width for Depths >18’				
Size of Pipe	**Permanent – Stand Alone Easement**	**Permanent – Adjacent to R/W**	**Temporary**	**Total-Stand Alone**	**Total – Parallel to R/W**
8" – 12" Gravity Sewers and Service Connections	30’	30’	15’ on each non R/W side	60’	45’
15" - 48" Gravity Sewers	30’	30’	25’ on each non R/W side	80’	55’
54" - 72" Gravity Sewers	30’	30’	30’ on each non R/W side	90’	60’
84" and larger Gravity Sewers	40’	40’	30’ on each non R/W side	100’	70’

2. Overland Flow Perpetual Easements

Figure GR7.3 Sample Cross Section of a Perpetual Easement



Easements for overland flow conveyances shall be based upon the top of bank. The easement shall encompass the entire channel/swale plus 10 feet beyond the top of bank. This 10 feet beyond the top of bank shall have a cross grade less than or equal to 5:1. It is intended for maintenance vehicles to safely access the channel/swale.

3. Emergency Overland Flow Path Easements

   The easement for an emergency overland flow path shall be at least 14 feet in width. A wider easement should be considered if the sub-watershed is larger than 3 acres or otherwise part of a complicated overall watershed. The footprint of the 100-year emergency overland flow shall be maintained with the easement.

GR7.05 Construction Plan Requirements

The construction plans shall show:

- the locations and dimensions of all proposed and existing permanent and temporary easements, including information required under SectionGR7.02 herein
- that the proposed facilities or utilities will be within easements
- the parcels burdened by the proposed construction and the parcels adjacent to the parcels burdened by the proposed construction, including:
  - property owners' names and property address
  - document number or book and page number of last deed of record of the parcels
  - lot number of parcel

GR7.06 Easement Description Criteria

Easement descriptions prepared for City Utilities are to be consistent in general appearance and information provided. A Sample Easement Description is attached in **Exhibit GR7-1**.

1. General Description Elements

   Easement legal descriptions are no different from legal descriptions used for fee simple documents. The same basic requirements and elements are required. Legal descriptions are to be prepared by an Indiana registered Professional Surveyor or an attorney. There are two general types of legal descriptions that may be used for City Utilities projects: the aliquot part of a parcel and the perimeter description.

   Every legal description will have three basic parts:

   - Caption
   - Body
   - Certification

   The caption is the opening clause of the legal description. It states the general locality, reference documents associated with the description, county and state of the parcel. The caption for an easement legal description shall be identical to the caption in the easement grantor's deed description to the extent applicable.

The body shall include a legal description that states the area encumbered by the easement. This shall be given in square feet to the nearest whole number or to the nearest one-thousandth of an acre. The body shall utilize the same qualifying calls and bounding calls as are found in the easement grantor's last deed of record as much as practical.

A line shall be added below the body that identifies the tax identification number for the underlying parcel.

The certification shall state who prepared the description, the patron of the description, and a date. The Professional Surveyor's signature and seal shall be included.

2. When Multiple Descriptions are Required

   A legal description is required for each parcel that has a unique tax parcel number according to the Allen County Assessor's Office. The parent parcel's tax number shall be stated somewhere on the description document.

3. Aliquot Descriptions

   A common method for describing an easement within a platted area of the City is to utilize the aliquot description method. This is sometimes referred to as the "OF" description. This method defines the location of the easement based on the existing boundary of the grantor's parcel and defines a width of the easement. An example is "The North xx feet of Lot yy of John's Subdivision." These types of descriptions require the easement to be parallel to a lot line or right-of-way.

   The aliquot description shall only be used when the grantor's deed description is a lot or parcel defined by a plat. An aliquot description that refers back to a metes-and-bounds or perimeter description defined in a recorded deed is not acceptable. For instance, the "north xx number of feet of the grantor's lands described in Document #xxx" is not acceptable.

4. Perimeter Descriptions

   The other acceptable description method is a perimeter description. A perimeter description will describe each course segment around the perimeter of a parcel. This results in a geometric figure that closes mathematically. Perimeter descriptions are also called metes-and- bounds descriptions, although this is an incorrect moniker.

   The perimeter description will require a Point of Beginning and, if necessary, a "Point of Commencement". The description for the easement shall commence at the same point as the "Point of Commencement" identified in the easement grantor's deed. The proposed easement description shall follow the grantor's commencement courses and deed perimeter until it intersects a perimeter point of the easement description. This will be the "Point of Beginning". The clause "true point of beginning" is not acceptable.

   The perimeter description courses are to be consistent with the distances and directions shown on the easement plat, see **Exhibit GR7-2** for a Sample

Sanitary Sewer, Stormwater Drainage and Potable Water Easement Plat. The easement description is to utilize as many qualifying clauses as practical to insure conformity with the grantor's deed description. The easement description shall follow the easement perimeter in a clockwise motion.

A perimeter description shall only be used when the proposed easement is not parallel to an existing lot line, or if the grantor's deed description is not a lot or parcel defined by a plat. Per Title 865 Indiana Administrative Code (IAC), Rule 12, a boundary land survey or a location control route survey plat is required for a perimeter description. An easement plat, per **Exhibit GR7-2**, can be utilized to these ends if it meets the requirements per Title 865 Indiana Administrative Code (IAC), Rule 12. This includes but is not limited to setting monument corners and providing a Professional Surveyor's report that is consistent with said requirements.

GR7.07 Easement Plat Criteria

Easement plats are graphical representations of the easement legal descriptions. They allow the grantors to see the easement in relation to their parcel lines.

1. General Requirements

   Easement plats shall be prepared for each parcel on which a permanent and/or temporary easement shall be acquired. A single easement plat can be utilized for several contiguous parcels having the same owner that have different tax parcel numbers. The phrase "Sanitary Sewer, Stormwater Drainage, "Utility", and Potable Water Easement" shall be used on all easement plats. Easement plats shall:

   - have the title block in the lower right corner of the plat and the Professional Surveyor's certification and seal in the lower left corner; other formats may be approved by City Utilities on a case-by-case basis
   - have the easement limits hatched for clarity; temporary and permanent easements shall be hatched in dissimilar manner so as to easily distinguish between easement types
   - have a clear indication of the information taken from deeds and/or plats as well as information that was from calculated or measured sources
   - have a statement to define the basis of bearings, which can be an established horizontal datum or an assumed north
   - have the proper depiction of the different line types and widths for parcel lines, permanent easements, temporary easements, etc.
   - have the street address, parcel Owner's name, tax parcel number and document number or book and page number of the last deed of record for the affected parcel
   - show existing easements with specific uses labeled and the recording information of the easements;
   - show all dimensions to the nearest one-hundredth of a foot;

- show angles or bearings to the nearest second
- have the easement area(s) stated, with permanent and temporary easements stated separately; the easement area on a small residential lot shall be shown in square feet and the easement area for a larger area (generally more than 1 acre) shall be shown in acres
- show existing encroachments to proposed easements
- comply with Title 865 IAC 1-12-25

2. Release of Easement

City Utilities will determine if it is necessary to release an existing easement. City Utilities will handle the paperwork involved with releasing an easement. A sample Release of Easement Plat is provided in **Exhibit GR7-3**.

GR7.08 Easements on Railroad Rights-of-Way

Whenever possible, utilities shall avoid crossing underneath railroad tracks or into railroad rights-of-way. Most railroad companies will make the utility company sign a quitclaim grant of occupancy (license agreement) and charge a fee.

GR7.09 Easement Encroachments

An encroachment into an easement is an intrusion onto an easement by a building or another improvement that hinders, jeopardizes, or precludes the intended purpose of the easement. Encroachments in easements shall be clearly identified on the construction plans. An Easement Encroachment Agreement may be required and shall be discussed with City Utilities.

1. Easement Encroachment Agreements

The plat and description(s) required for an easement encroachment agreement shall meet the same requirements as stated for an easement acquisition. In addition, it shall include sufficient information to clearly identify the encroachments. A Sample Easement Encroachment Plat is provided in **Exhibit GR7-4**.

GR7.10 Execution of Easement Documents

The required easement plats and descriptions for CUE Projects shall be submitted to the Project Manager. The Project Manager will provide the front end documents, including easement agreements, encroachment agreements, release forms, and quitclaim forms. City Utilities will be responsible for getting the documents executed and recorded.

1. Easement Document Submittals

The submittal process for the easements shall be as follows.

- Once the easement requirements have been defined, one set of preliminary easement plats and descriptions shall be submitted.
- After the preliminary easement plats and descriptions have been approved, one set of final easement plats and descriptions shall be

submitted along with the proper certificates. The final easement plats and descriptions submitted shall contain a Professional Surveyor's original stamp, signature and date.

If City Utilities makes any changes or modifications to the plans after the easement plat(s) and description(s) are prepared, the Professional Surveyor will receive a copy of the revised sheets. If changes or revisions are necessary to the easement documents, the Professional Surveyor shall make the necessary revisions and resubmit the documents as previously described.

GR7.11 Property Acquisition Summary Sheet

Any project that requires acquisition of an easement will require a Property Acquisition Summary Sheet. The specific data to be shown on the Property Acquisition Summary Sheet is presented in the following paragraphs.

1. Parcel Numbers

   Parcel numbers shall be assigned to each parcel of property to be acquired and shown on the plans. "Parcel 1" shall be assigned to the first parcel, and the remaining parcels shall be numbered consecutively from the beginning to the end of the project.

   Parcel numbers shall not be changed after submission of the final easement plats. If it is determined that acquisition from any parcel will not be required, that number shall be removed from the plans and the notation "NOT USED" shall be placed in the owner's block on the Property Acquisition Summary Sheet.

   Parcel numbers for property acquired for temporary easement shall also be numbered consecutively with normal parcel numbers, except that the letter "C" shall precede the number.

2. Owner's Name

   The Property Acquisition Summary Sheet shall provide the owner's name(s) per the last deed of record.

3. Property Address

   The address of the property served shall be shown. If the owner's tax mailing address differs from that of the parcel affected, the owner's tax mailing address shall be shown in the remarks column.

4. Sheet Number

   The sheet number is the number assigned to the plan sheet on which the particular parcel is shown. Some parcels will appear on more than one plan sheet, in which case all sheet numbers shall be included.

5. Source of Title

   This column shall show the Allen County Recorder's Office document number or deed book and page number of the parcel or such other evidence of title information as may be available.

6. Area of Easements

   The area required for permanent easement shall be shown in square feet or acres in the column designated “Sewer and Stormwater Drainage Easement”. The area required for temporary construction easement shall be shown in square feet or acres in the designated column. Areas shall be shown to the nearest square foot or one-thousandth of an acre as appropriate.

7. Remarks

   Additional comments shall be placed in the remarks column of the Property Acquisition Summary sheet.

8. Easement Document Number

   City Utilities will place the Allen County Recorder’s Office document number of the recorded easement in the last column of the Property Acquisition Summary sheet.

Exhibit "A"

Easement Description

A part of the Northeast Quarter of Section 22, Township 31 North, Range 12 East, in Allen County, Indiana, and being a part of the parcel described in Document #206062980 in the Allen County Recorder's Office, described as:

Commence at an iron pin found at the Northeast corner of the Plat of Interstate Industrial Park, Section "D" as recorded in Plat Book 30, page 1, in the Office of the Recorder of said Allen County, thence South 87 degrees 15 minutes West (North 90 degrees 00 minutes West plat) along the North line of said Section "D", a distance of 52.9 feet to the Easternmost corner of Interstate Industrial Park, Section "I" as recorded in Plat Book 32, page 146, as situated in the centerline of the Spy Run Creek; thence Northwesterly along the Easterly lines of said Section "I" and the centerline of the Spy Run Creek as follows:

thence North 50 degrees 03 minutes West, a distance of 162.7 feet;
thence North 43 degrees 21 minutes West, a distance of 93.1 feet;
thence North 32 degrees 05 minutes West, a distance of 91.7 feet;
thence North 51 degrees 49 minutes West, a distance of 89.7 feet;
thence North 62 degrees 13 minutes West, a distance of 103.1 feet;
thence North 69 degrees 51 minutes West, a distance of 123.9 feet;

thence North 60 degrees 15 minutes West, a distance of 33.3 feet to the North line of the South One-half of the Northwest Quarter of said Section 22, being also the Northeast corner of said Section "I" and the Southeast corner of a 0.560 acre tract of land as recorded in Document #72-7276;

thence continuing Northwesterly along the centerline of said Spy Run Creek, North 38 degrees 01 minute West, a distance of 42.7 feet to the South 125 foot limited access right-of-way line of said Interstate Highway No. 69;

thence North 87 degrees 15 minutes 18 seconds East along said right-of-way line, a distance of 813.07 feet to an iron pin found in concrete at Plan Station 508+00 of Indiana State Highway Commission Plans dated 1958, Project Number I-69-4(3)109;

thence continue along said Highway right-of-way North 85 degrees 59 minutes 01 second East, a distance of 137.09;

thence South 01 degree 00 minutes 11 seconds East, a distance of 92.58 feet to the Point of ***Beginning;***

thence North 88 degrees 59 minutes 43 seconds East, a distance of 190.40 feet to a point of curvature;

thence 210.78 feet along an arc to the right with a radius of 400 feet, said arc having a long chord bearing of South 75 degrees 54 minutes 31 seconds East with a long chord length of 208.35 feet to a point of tangency;

thence South 60 degrees 48 minutes 44 seconds East on a line parallel with and 40.00 feet south of a northeasterly line of the parcel described in Document #206062980, a distance of 507.47 feet to a easterly line of said parcel;

thence South 28 degrees 55 minutes 46 seconds West on said easterly line, a distance of 20.00 feet;

thence North 60 degrees 48 minutes 44 seconds West on a line parallel with and 60.00 feet south of said northeasterly line, a distance of 507.56 feet to a point of curvature;

thence 200.25 feet along an arc to the left with a radius of 380 feet, said arc having a long chord bearing of North 75 degrees 54 minutes 31 seconds West with a long chord length of 197.94 feet; thence South 88 degrees 59 minutes 43 seconds West, a distance of 190.40 feet;

thence North 01 degrees 00 minutes 11 seconds West, a distance of 20.00 feet to the point of beginning, containing 0.415 acres, more or less.

Part of Parent Parcel 02-07-22-251-001.000-073

This description was prepared for the City of Fort Wayne by (Company xxx) and certified by Jane Doe, Indiana Registered Land Surveyor, License No. xxx.

________________________________(Date)____

Jane Doe, LS

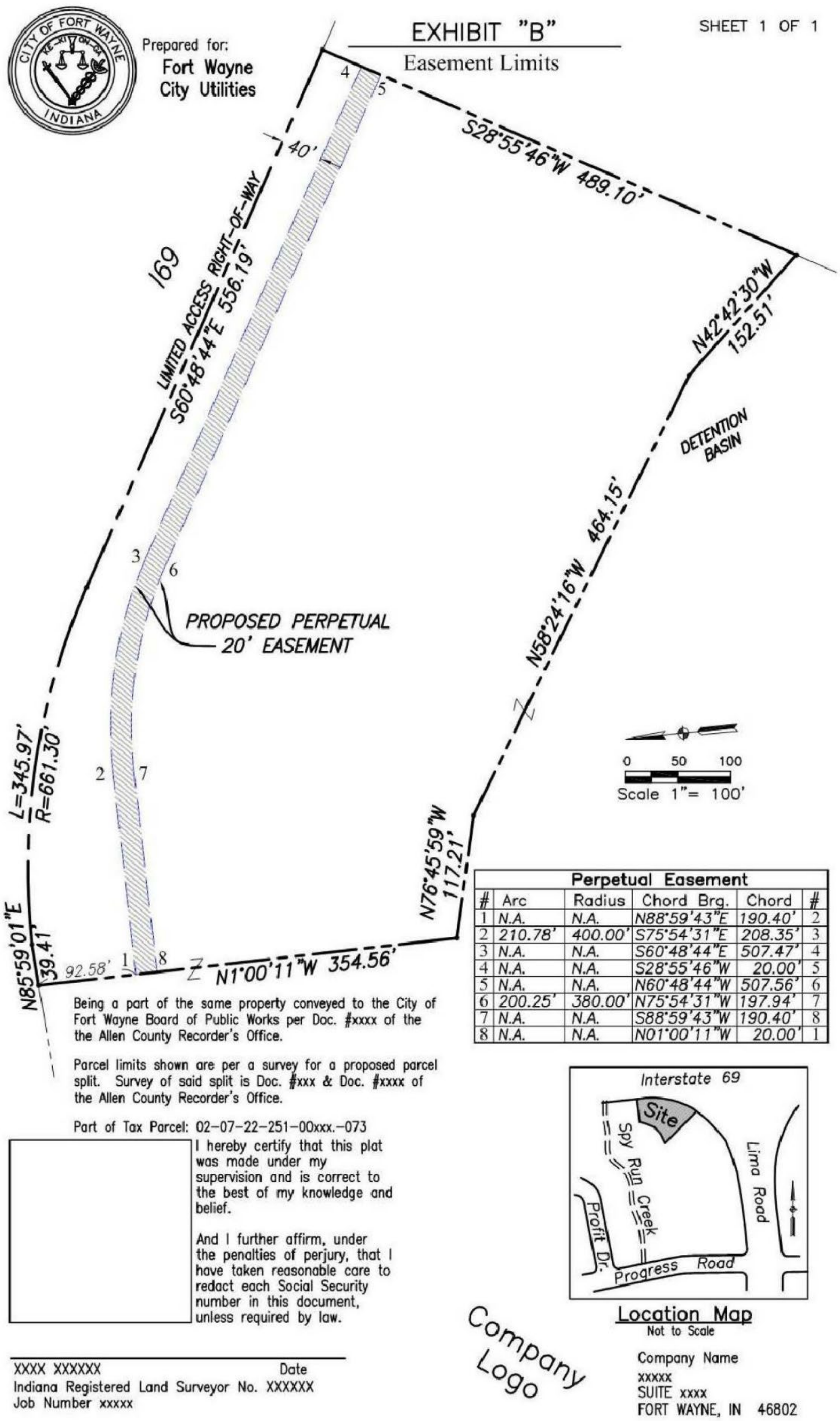
Exhibit "A"

Easement Description

A part of Lots 114 through 118, consecutively, of the "Original Plat of the City of Ft. Wayne, Indiana" as recorded in Plat Book xx, Page xx of the Allen County Recorder's Office, described as:

The north 20 feet of the said Lots 114 through 188, consecutively, said distances being measured from and parallel with the north line of the said lots, containing xxx square feet, more or less.

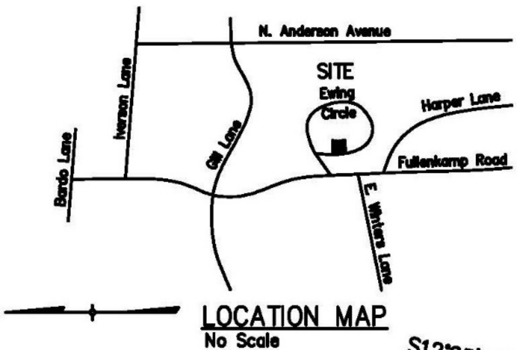
Part of Parent Parcel 02-12-02-432-001.000-074



Perpetual Easement

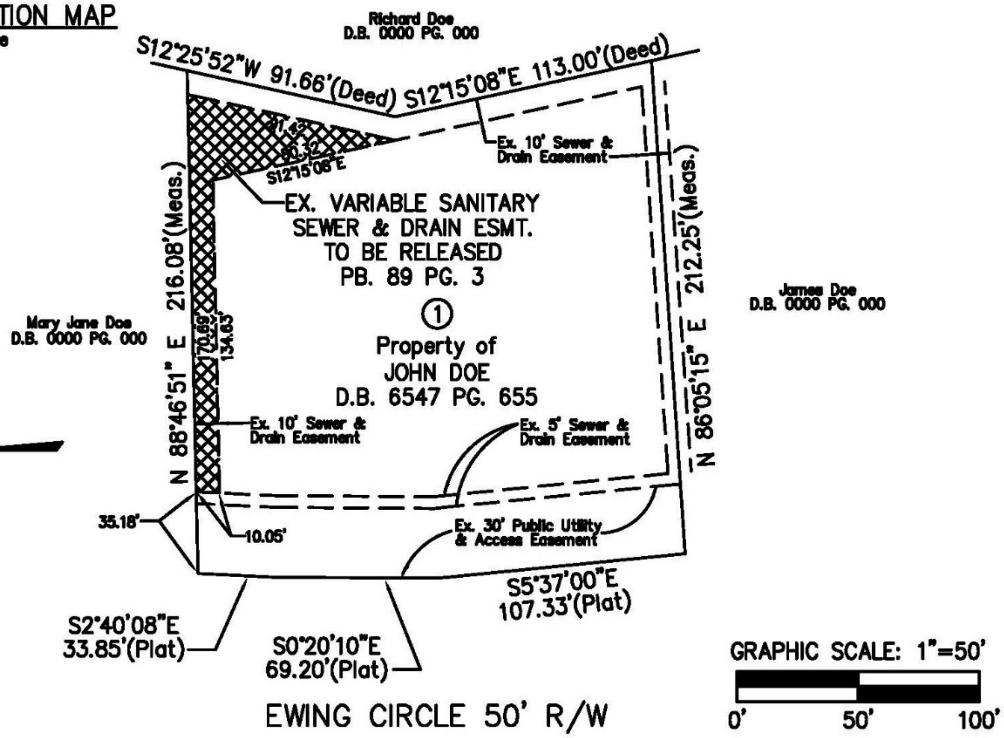
#	Arc	Radius	Chord Brg.	Chord	#
1	N.A.	N.A.	N88°59'43"E	190.40'	2
2	210.78'	400.00'	S75°54'31"E	208.35'	3
3	N.A.	N.A.	S60°48'44"E	507.47'	4
4	N.A.	N.A.	S28°55'46"W	20.00'	5
5	N.A.	N.A.	N60°48'44"W	507.56'	6
6	200.25'	380.00'	N75°54'31"W	197.94'	7
7	N.A.	N.A.	S88°59'43"W	190.40'	8
8	N.A.	N.A.	N01°00'11"W	20.00'	1

City Utilities — Water That Works	City Utilities Design Standards Manual	Exhibit GR7-3 Sample Release of Easement Plat
		Version: October 20, 2011



EASEMENT RELEASE DATA

POINT #	BEARING	DISTANCE	TO POINT #
101	S 12°25'52"W	91.42'	102
102	N 12°15'08"W	80.32'	103
103	S 88° 46'51"W	134.63'	104
104	N 2°40'08"W	10.5'	105
105	N 88°46'51"E	170.69'	101



LEGEND

Area to be released = 3,075 Sq.Ft.

All lot dimensions are per deed of record.

The reference meridian used on this plat to determine the directions of survey lines was based on the deed bearing of the NORTH line of the tract, which is on Tax Map 35 Lot 3.

LAND SURVEYOR'S STAMP

I hereby certify that this plat was made under my supervision and is correct to the best of my knowledge and belief. Distances as shown on this plat have not been adjusted for ____ . This easement Plat meets or exceeds the minimum standards of governing authorities.

LAND SURVEYOR'S SIGNATURE Surveyor

Being a part of the same property conveyed to the GRANTOR by deed dated AUGUST 23, 1970, recorded in Deed Book 6547, Page 655, in the office of the Allen County Recorder.

SAMPLE ENGINEERING COMPANY & ADDRESS

EASEMENT OF ENCROACHMENT

Property of
JOHN DOE
1 EXAMPLE COURT
FORT WAYNE, IN 46208

Property of
JANE DOE
1 SAMPLE COURT
FORT WAYNE, IN 46205

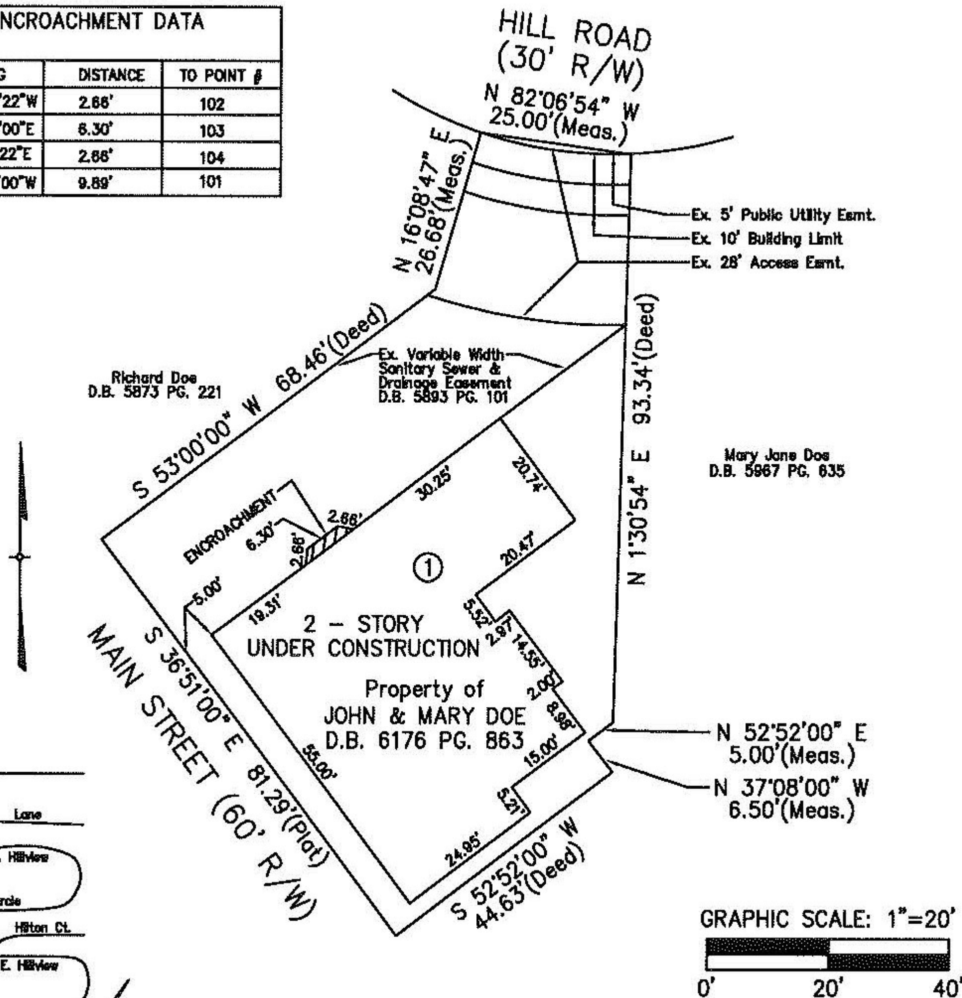
Parcel No. ____________ Record No. ____________

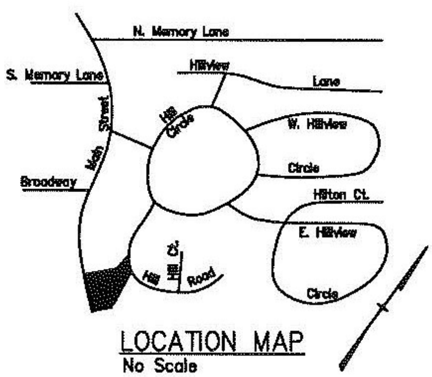
Date ____________

Sheet of

EASEMENT ENCROACHMENT DATA

POINT #	BEARING	DISTANCE	TO POINT #
101	N 79°26'22"W	2.66'	102
102	N 53°00'00"E	6.30'	103
103	S 79°26'22"E	2.66'	104
104	S 53 00'00"W	9.89'	101





LOCATION MAP
No Scale

LEGEND

Area of Encroachment 16.24 Sq.Ft.

All lot dimensions are per deed of record.

The reference meridian used on this plat to determine the directions of survey lines was based on the deed bearing of the NORTH line of the tract, which is on Tax Map 69G Lot 187.

Being a part of the same property conveyed to the Grantor by deed dated AUGUST 2, 1965, recorded in Deed Book 6175, Page 863, in the office of the Allen County Recorder.

SAMPLE ENGINEERING
COMPANY
&
ADDRESS

EASEMENT OF ENCROACHMENT

Property of
JONH DOE
1 EXAMPLE COURT
FORT WAYNE, IN 46208

Property of
JANE DOE
1 SAMPLE LANE
FORT WAYNE, IN 46205

LAND SURVEYOR'S STAMP

I hereby certify that this plat was made under my supervision and is correct to the best of my knowledge and belief. Distances as shown on this plat have not been adjusted for ____ . This easement Plat meets or exceeds the minimum standards of governing authorities.

LAND SURVEYOR'S SIGNATURE ____ Surveyor

Parcel No. ____ Record No. ____

Date ____

Sheet ____ of ____

Book 1

General Requirements (GR)

GR8 Subsurface Investigations

GR8.01 Purpose

This Chapter establishes the standards for performing subsurface investigations for CUE Projects. Although not required for all DVS Projects, subsurface investigations may be required for project approval on a case-by-case basis.

This Chapter covers the following:

- geotechnical borings
- pavement cores
- pot-holing/daylighting
- soil infiltration testing

A Subsurface Investigation Scope Checklist form is found in **Exhibit GR8-1**.

Reasons for performing subsurface investigations include, but are not limited to the following:

- determining the subsurface profile and properties (texture, moisture content, density, shear strength, compressibility, etc.) of soil and bedrock materials
- detecting subsurface contamination
- investigating the subsurface conditions for trenchless technology; the composition and nature of materials at underground crossings are needed to establish the conditions (soft ground, hard ground, or mixed face tunneling) and determine the appropriate construction method
- providing information regarding groundwater including seasonal high groundwater tables
- determining pavement section makeup, layer thicknesses and condition by performing pavement cores
- determining depth and vertical location of existing utilities by performing pothole utility locates
- determining soil permeability for the purpose of determining the suitability of green stormwater infrastructure
- determining the need for underdrain systems by performing soil infiltration testing

Soil investigation and evaluation shall be conducted under supervision of soil scientists, engineers, professional geologists, or other qualified professionals and technicians.

GR8.02 Right of Access

When the subsurface investigation requires access to public or private property, the landowner shall be first contacted, the work described, and permission to enter obtained.

A Sample Right of Access Agreement is found in **Exhibit GR8-2**.

GR8.03 Protection of Underground Structures and Utilities

Protection of underground structures and utilities shall be a priority, and include the following:

- Prior to subsurface investigation and sampling, Indiana 811 or 1-800-382-5544 shall be called and a request to mark the locations of existing underground facilities shall be made; non-Indiana 811 utilities shall be notified for location services as well
- A minimum notice of 48-hours shall be provided
- Confirmation numbers shall be documented so that a record of the request is available
- Subsurface investigation shall not begin until clearance has been provided or notification has been received that all underground utility lines are marked

It may be necessary to employ the property owner's assistance and knowledge of service lines, underground storage tanks, septic tank facilities, geothermal systems, water wells, and/or use visible surface features, such as meter vaults, shut-off valves, etc. to estimate the locations of underground facilities.

If there is any reason to believe that an underground facility exists in an area to be bored for samples and its location cannot be determined with reasonable accuracy, then that boring(s) shall not be advanced.

GR8.04 Safety

As with all field work and testing, compliance with all applicable OSHA regulations and local guidelines related to earthwork and excavation is required. Excavations shall never be left unsecured or unmarked, and all applicable authorities shall be notified prior to any work.

GR8.05 Restoration

Restoration shall include:

- backfilling and compaction of the boring, pavement core, potholing site, soil infiltration test site, or test pit; and
- surface restoration to pre-existing condition as required by the governing authority having jurisdiction at the restoration site.

GR8.06 Geotechnical Borings

1. Methods and Equipment

   In general, all soil test borings shall be performed in accordance with ASTM D 1686 “Standard Method for Penetration Test and Split Barrel Sampling of Soils”. Split-barrel (split-spoon) samples shall be taken at five foot depth intervals and at changes in strata. When undisturbed samples in clay soils are required (for example, when shear strength determinations are needed), samples shall be obtained in accordance with ASTM D 1587 “Standard Practice for Thin-Walled Tube Sampling of Soils”.

   Rock core drilling shall be performed in accordance with ASTM D 2113 “Standard Practice for Diamond Core Drilling for Site Investigation”, except that wire line drilling will be permitted. The diameter of the rock core shall not be less than 2 ⅛-inches.

2. Location, Frequency and Depth Requirements for Soundings and Borings

   Rock soundings shall be performed at intervals of 50-feet where rock is encountered and reduced to 100-feet intervals where rock is not encountered along the proposed alignment. The soundings shall be advanced to a maximum depth which corresponds to one foot below the invert elevation, or to auger refusal, whichever occurs first. The requirements for rock soundings may be waived by City Utilities in areas where the bedrock surface is known to be deeper than proposed excavation depths.

   When required, soil test borings shall be drilled at approximate intervals of 500-feet and shall be terminated 4-feet below the invert elevation, or at auger refusal, whichever occurs first. If bedrock occurs higher than the invert elevation, rock core drilling shall extend the boring to 2-feet below the invert elevation.

   Whenever possible, the boring plan shall be developed to position test borings at locations of special interest. For example, test borings should be sited at the deepest excavation or where the open trench may affect existing buildings or major utilities. Borings shall be drilled at the access pits or shafts or tunnels. If access is available, intermediate borings along the alignment shall be drilled at 100-foot intervals. For large structures the number of borings needed may vary based on the number and layout of the individual facilities.

3. Laboratory Analyses

   Representative split-barrel (split-spoon) samples shall be analyzed for the following:

   - Atterberg limits (ASTM D 4318)
   - particle size distribution (ASTM D 422)
   - specific gravity (ASTM D 854)
   - moisture content (ASTM D 2216)

The samples shall then be classified in accordance with ASTM D 2487 “Test Method for Classification of Soils for Engineering Purposes”. Representative samples of soil materials which are to be placed and compacted to controlled moisture-density conditions shall be subjected to Standard Proctor moisture-density tests (ASTM D 698) to determine the maximum dry density and optimum moisture content. Additionally, for any projects requiring pavement design, representative samples of proposed subgrade soils shall be subjected to laboratory California Bearing Ratio (CBR)Tests (ASTM D 1883) to provide design values for the CBR or Resilient Modulus.

When shear strength parameters are required for geotechnical analyses, these parameters shall be determined as follows:

- the shear strength for non-cohesive materials (Sand and sand-gravel mixtures) shall be measured in accordance with ASTM D 3080 “Standard Test Method for Direct Shear Test of Soils under Consolidated-Drained Conditions”
- the undrained shear strength for cohesive soils (clays) shall be measured in accordance with ASTM D 2166 “Standard Test Method for Unconfined Compressive Strength of Cohesive Soil”
- the drained shear strength for cohesive soils shall be measured in accordance with ASTM D 4767 “Standard Test Method for Consolidated-Undrained Triaxial Compression Test on Cohesive Soils”

4. Report Development and Drafting

Reports of geotechnical investigations shall include the following.

- Discussion of the Project

  The site description shall include discussions of site topography, site drainage characteristics, existing improvements, etc.

- General Site Conditions

  Site conditions shall include a site geology description of underlying soil types and rock formations. Other geologic features such as faults or susceptibility to sinkholes shall also be included.

- Scope of Services

  Description of scope shall also be provided, and shall include a description of the drilling, sampling and laboratory analysis programs.

- Results of the Investigation

  The results of the investigation shall include information such as descriptions of soil types, depths, the presence of groundwater, soil classifications, a soil stratum profile, etc. Descriptions of rock cores shall note the presence of joints, voids, recovery ratios and rock quality designation values. References to site locations shall also be included. In addition, any engineering analysis performed (slope stability, settlement, etc.) shall be discussed.

- Conclusions and recommendations relative to the proposed design and construction shall be provided.

The following geotechnical investigation data shall be shown in plan and profile on a drawing(s) included in the geotechnical report:

- boring locations, including coordinates in NAD83/IN-EF and NAVD88 datums and coordinate systems
- graphical boring logs,
- sounding systems,
- penetration test blowcounts,
- unconfined compressive strengths,
- natural moisture contents, and
- groundwater elevations in NAVD88 datum

GR8.07 Pavement Cores

Some projects may require pavement cores to determine pavement section makeup and layer thicknesses for pavement patching and restoration. For CUE Projects that are within the City street right-of-way, a request for pavement cores shall be given to the City Transportation Engineering Services (TES). Other pavement cores will be coordinated through the respective jurisdictional entity, such as the County Highway Department or INDOT.

The pavement core report shall consist of the following items:

- location description
- Pavement core coordinates in NAD83/IN-EF and NAVD88 datums and coordinate systems
- When requested, elevation of pavement at the core.
- core section dimensions for the different material composition such as asphalt, concrete, stone
- subgrade material
- photograph

A sample Pavement Core Report Log Sheet is provided in **Exhibit GR8-3**.

GR8.08 Potholing/Daylighting

Potholing is a preferred method to visually confirm the location and depth of underground utilities. Potholing shall be performed using non-destructive vacuum excavation equipment, through small holes (8 to 12-inches) at the surface. The holes shall be backfilled and the surface replaced to pre-existing condition.

1. Standard Guidelines

   All aspects of the subsurface utility engineering shall be in accordance with ASCE Standard 38-02 “Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data”.

2. Potholing Report

   Potholing reports shall include:

   - location description of test hole
   - Pothole coordinates in NAD83/IN-EF and NAVD88 datums and coordinate systems
   - type of utility
   - material of utility
   - size of utility (diameter)
   - depth of utility from surface
   - Elevation (when available) in NAVD88 datum

GR8.09 Soil Infiltration Testing

Soil infiltration testing shall be done to determine suitability of a specific site for infiltration facilities.

For reference, a Hydrologic Soil Group Map for Allen County is provided in **Exhibit GR8-4**.

1. Test pits (deep holes) for Infiltration Testing

   A test pit (deep hole) allows visual observation of the soil horizons and overall soil conditions both horizontally and vertically:

   It is important that the test pit provide information related to conditions at the specified elevation or depth.

   A test pit (deep hole) consists of an excavated trench, excavated to a specified elevation or depth, or until bedrock or fully saturated conditions are encountered. The trench shall be benched at a depth of 2 to 3-feet for access and/or infiltration testing. At each test pit, the following conditions shall be noted and described: (Depth measurements shall be described as depth below the ground surface.)

   - soil horizons (upper and lower boundary)
   - soil texture, structure, and color for each horizon
   - color patterns (mottling) and observed depth
   - depth to water table
   - depth to bedrock
   - observance of pores or roots (size, depth)
   - estimated type and percent coarse fragments
   - hardpan or limiting layers

- strike and dip of horizons (especially lateral direction of flow at limiting layers)
- additional comments or observations

A sample Soil Test Pit Log Sheet, provided in **Exhibit GR8-5**, may be used for documenting each test pit. Following testing, the test pits shall be refilled with the original soil and the topsoil replaced.

2. Acquiring Design Infiltration Rate from Infiltration Testing

A variety of field tests exist for determining the infiltration capacity of a soil. Laboratory tests are not recommended, as a homogeneous laboratory sample does not represent field conditions. Infiltration tests shall be conducted in the field. Infiltration tests shall not be conducted in the rain, within 24 hours of significant rainfall events (>0.5-inches), or when the temperature is below freezing. At least one test shall be conducted at the specified elevation or depth, and a minimum of two tests per test pit are recommended. Personnel conducting infiltration tests shall be prepared to adjust test locations and depths depending on observed conditions.

Methodologies discussed in this protocol include:

- double-ring infiltrometer tests
- percolation tests (such as for onsite wastewater systems)

There are differences between the two methods. A double-ring infiltrometer test estimates the vertical movement of water through the bottom of the test area. The outer ring helps to reduce the lateral movement of water in the soil from the inner ring. A percolation test allows water movement through both the bottom and sides of the test area. For this reason, the measured rate of water level drop in a percolation test shall be adjusted to represent the discharge that is occurring on both the bottom and sides of the percolation test hole. Other testing methodologies and standards that are available but not discussed in detail in this protocol include (but are not limited to):

- constant head double-ring infiltrometer
- testing as described in the Maryland Stormwater Manual Appendix D.1, using 5-inch diameter casing
- ASTM 2003 Volume 4.08, Soil and Rock (I): Designation D 3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using a Double-Ring Infiltrometer
- ASTM 2002 Volume 4.09, Soil and Rock (II): Designation D 5093-90, Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring
- Guelph permeameter
- constant head permeameter (Amoozemeter)

3. Methodology for Double-Ring Infiltrometer Field Test

   A double-ring infiltrometer consists of two concentric metal rings. The rings are driven into the ground and filled with water. The outer ring helps to prevent divergent flow. The drop-in water level or volume in the inner ring is used to calculate an infiltration rate. The infiltration rate is the amount of water per surface area and time unit which penetrates the soils. The diameter of the inner ring shall be approximately 50-70 percent of the diameter of the outer ring, with a minimum inner ring size of four inches.

4. Equipment for Double-Ring Infiltrometer Test

   - two concentric cylinder rings 6 inches or greater in height; inner ring diameter equal to 50-70 percent of outer ring diameter, (i.e., an 8-inch ring and a 12-inch ring)
   - water supply
   - stopwatch or timer
   - ruler or metal measuring tape
   - flat wooden board for driving cylinders uniformly into soil
   - rubber mallet
   - log sheets for recording data

5. Procedure for Double-Ring Infiltrometer Test

   - Prepare level testing area.
   - Set outer ring in place; place flat board on ring and drive ring into soil to a minimum depth of 2-inches.
   - Place inner ring in center of outer ring; place flat board on ring and drive ring into soil a minimum of 2-inches. The bottom rim of both rings shall be at the same level.
   - Presoak the test area immediately prior to testing. Fill both rings with water to water level indicator mark or rim at 30-minute intervals for one hour. The minimum water depth shall be four inches. The drop in the water level during the last 30-minutes of the presoaking period shall be applied to the following standard to determine the time interval between readings:
   - If water level drop is 2-inches or more, use 10-minute measurement intervals.
   - If water level drop is less than 2-inches, use 30-minute measurement intervals.
   - Obtain a reading of the drop in water level in the center ring at appropriate time intervals. After each reading, refill both rings to water level indicator mark or rim. Measurement to the water level in the center ring shall be made from a fixed reference point and shall continue at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼ -inch or

less of drop between the highest and lowest readings of four consecutive readings.

- The drop that occurs in the center ring during the final period or the average stabilized rate, expressed as inches per hour, shall represent the infiltration rate for that test location.

6. Methodology for Percolation Test

   Equipment for Percolation Test

   - post hole digger or auger
   - water supply
   - stopwatch or timer
   - ruler or metal measuring tape
   - log sheets for recording data
   - knife blade or sharp-pointed instrument (for soil scarification),
   - course sand or fine gravel
   - object for fixed-reference point during measurement (nail, toothpick, etc.)

7. Procedure for Percolation Test

   - Prepare level testing area.
   - Prepare hole having a uniform diameter of 6 to 10-inches and a depth of 8 to 12-inches. The bottom and sides of the hole shall be scarified with a knife blade or sharp-pointed instrument to completely remove any smeared soil surfaces and to provide a natural soil interface into which water may percolate. Loose material shall be removed from the hole.
   - (Optional) 2-inches of coarse sand or fine gravel may be placed in the bottom of the hole to protect the soil from scouring and clogging of the pores.
   - Presoak test holes immediately prior to testing. Water shall be placed in the hole to a minimum depth of six inches over the bottom and readjusted every 30-minute for one hour.
   - The drop in the water level during the last 30-minutes of the final presoaking period shall be applied to the following standard to determine the time interval between readings for each percolation hole:
     - If water remains in the hole, the interval for readings during the percolation test shall be 30-minutes.
     - If no water remains in the hole, the interval for readings during the percolation test may be reduced to 10-minutes.
   - After the final presoaking period, water in the hole shall again be adjusted to a minimum depth of 6-inches and readjusted when necessary after each reading. A nail or marker shall be placed at a

fixed reference point to indicate the water refill level. The water level depth and hole diameter shall be recorded.

- Measurement to the water level in the individual percolation holes shall be made from a fixed reference point and shall continue at the interval determined from the previous step for each individual percolation hole until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼-inch or less of drop between the highest and lowest readings of four consecutive readings.
- The drop that occurs in the percolation hole during the final period, expressed as inches per hour, shall represent the percolation rate for that test location.
- The average measured rate shall be adjusted to account for the discharge of water from both the sides and bottom of the hole and to develop a representative infiltration rate. The average/ final percolation rate shall be adjusted for each percolation test according to the following formula:

$$\text{Infiltration Rate} = \frac{\text{Percolation Rate}}{\text{Reduction Factor}}$$

Where the Reduction Factor is given by:

$$R_f = \frac{(2d_1 - \Delta d)}{DIA} + 1$$

With:

R_f= Reduction factor

d_1 = Initial Water Depth (in.)

Δd = Average Water level Drop (in.)

DIA = Diameter of the Pecolation Hole (in.)

The percolation rate is simply divided by the reduction factor as calculated above to yield the representative infiltration rate. An example of this calculation is shown in Figure GR8.1. In most cases, the reduction factor varies from about two to four depending on the percolation hole dimensions and water level drop – wider and shallower tests have lower reduction factors because proportionately less water exfiltrates through the sides.

Note: The area reduction factor accounts for the exfiltration occurring through the sides of percolation hole. It assumes that the percolation rate is affected by the depth of water in the hole and that the percolating surface of the hole is in uniform soil. If there are significant problems with either of these assumptions then other adjustments may be necessary.

Figure GR8.1 Sample Percolation Rate Adjustments

Perc. Hole Diameter (in.)	Initial Water Depth, D_1 (in.)	Ave./Final Water Level Drop, Δd (in.)	Reduction Factor, R_f
6	6	0.1 0.5 2.5	3 2.9 2.6
	8	0.1 0.5 2.5	3.7 3.6 3.3
	10	0.1 0.5 2.5	4.3 4.3 3.9
8	6	0.1 0.5 2.5	2.5 2.4 2.2
	8	0.1 0.5 2.5	3 2.9 2.7
	10	0.1 0.5 2.5	3.5 3.4 3.2
10	6	0.1 0.5 2.5	2.2 2.2 2
	8	0.1 0.5 2.5	2.6 2.6 2.4
	10	0.1 0.5 2.5	3 3 2.8

8. Hotspot Investigation Procedures (For Preliminary Planning)

   This policy is intended to encourage infiltration on most sites while addressing potential contamination of groundwater and surface water caused by infiltration on sites with contaminated soils.

   - Determine the prior land use at the site to be developed, and review any data on soil or groundwater quality.
   - For larger development sites, a formal Phase I site assessment is often required by the lender in order to determine if any environmental hazard exists on the site. A determination of prior land use is part of this assessment.
   - On sites where a formal Phase I is not conducted, methods to determine prior land use may include a title search, aerial photographs, soil surveys, topographic maps, city and state regulatory databases, and a review of state and local records.

- Determine the potential for contamination based on available data and prior land use. The following land uses are considered to have a potential for contaminated soil which may adversely affect the quality of groundwater discharging to surface water. Infiltration is prohibited on these sites unless the applicant can show that there is no potential for contaminant migration due to infiltration.
- sites designated as CERCLA (Superfund) sites
- auto recycler facilities and junk yards
- commercial laundry and dry cleaning
- commercial nurseries
- vehicle fueling stations, service and maintenance areas
- toxic chemical manufacturing and storage
- petroleum storage and refining
- public works storage areas
- Airports and deicing facilities, railroads and rail yards, marinas and ports
- heavy manufacturing and power generation
- metal production, plating and engraving operations
- landfills and hazardous waste material disposal
- sites on subsurface material such as fly ash known to contain mobile heavy metals and toxins

For sites that do not qualify as hotspots, proceed with design of infiltration facilities including pre-treatment. For hotspots, proceed with design of water quality treatment facilities.

SUBSURFACE INVESTIGATION SCOPE CHECKLIST

General Project Information

Project Name: ____

Project Description: ____

____

Project Location (attach map): ____

Purpose of Investigation (check all that apply):

____ To establish bedrock depth.

____ To determine the subsurface properties (texture, moisture content, density, shear strength, compressibility, etc.).

____ To investigate the subsurface conditions at tunneling or boring and jacking sites.

____ To provide information regarding groundwater for contractor's dewatering plan.

____ To determine pavement section makeup, layer thickness and condition. (Pavement Cores)

____ California Bearing Ratio (CBR) test for subgrade soils.

____ Potholing to visually confirm location and depth of utilities.

____ Soil Infiltration Testing for Green Infrastructure Design.

____ Detect Subsurface Contamination.

____ Other ____

Location, Frequency and Depth for Soundings and Borings:

____ Soil borings required – per General Requirements, Chapter GR8, GR8.06.1

____ Rock borings required – per General Requirements, Chapter GR8, GR8.06.2

____ Prepare layout plan for borings based on design routing – Approval required by Project Manager

____ Other ____

Report:

____ Subsurface Investigation Report – per General Requirements, Chapter GR8 – Subsurface Investigations

____ Other ____

RIGHT OF ACCESS AGREEMENT

This Right of Access Agreement ("Agreement") is made and entered into by ____________________________________ ["Landowner(s)"] and the City of Fort Wayne, ("City").

RECITALS

A. Landowner(s) is/are the owner(s) of the real estate described in Exhibit "A" attached hereto and by this reference incorporated herein for all purposes ("Real Estate").

B. City desires to utilize the Real Estate to perform the activities which are described in Exhibit "B" attached hereto, and by this reference incorporated herein for all purposes ("Work").

C. Landowner(s) have no objection to the City performing the Work.

D. Landowner(s) and the City agree that it is mutually beneficial for the City to perform the Work at this time, and the Work may begin any time after this Agreement is fully executed by the Landowner(s) and the City.

AGREEMENT

NOW, THEREFORE, in consideration of the above representations, mutual benefits, promises, the City and Landowner(s) agree as follows:

1. The Recitals set forth above are hereby incorporated into this Agreement as though set forth within the numbered paragraphs following.
2. Landowner(s) grant the City a right of access within, on, and across the Real Estate to provide for the completion of the Work described in Exhibit "B".
3. This right of access shall be effective when fully executed by the Landowner(s) and the City.

STATE OF INDIANA)
) SS:
COUNTY OF ALLEN)

Before me, a Notary Public in and for the State of Indiana, personally appeared ____________________________, Fort Wayne City Utilities who acknowledged the execution of the foregoing Right of Access Agreement.

Witness my hand and seal this ______ day of ______________________, 20____.

____________________________	____
My commission expires:	Signature
____________________________	____
County of Residence:	Printed

LANDOWNER(S)

By: ____

Printed: ____________________________________

By: ____

Printed: ____________________________________

STATE OF INDIANA)
) SS:
COUNTY OF ALLEN)

Before me, a Notary Public in and for State of Indiana, personally appeared _______________________________________ and ___________________________________ who acknowledged the execution of the foregoing Right of Access Agreement.

Witness my hand and Notary Seal this ______ day of ___________________________, 20_____.

____________________________ ____

My commission expires: Signature

____________________________ ____

County of Residence: Printed

PAVEMENT CORE REPORT LOG SHEET

Date ___________________________________

Test No. ___________________________

Work Order No. _________________________

Street ____

B. to B. Width ___________________________

Location Address ______________________________________

Nearest Intersection _____________________

Distance From Centerline _______________________________

Station _________________________________

Retain Core Yes ________ No _________

Photograph Obtained ____________________

Dimension Core Section:

Asphalt _____ in. Conc. _____ in. Stone _____ in. Other _____ in.

Northing ____________________

Easting ______________________

Elevation __________________________________

Sub-Grade Type ____

Core P.S.I. Test ____

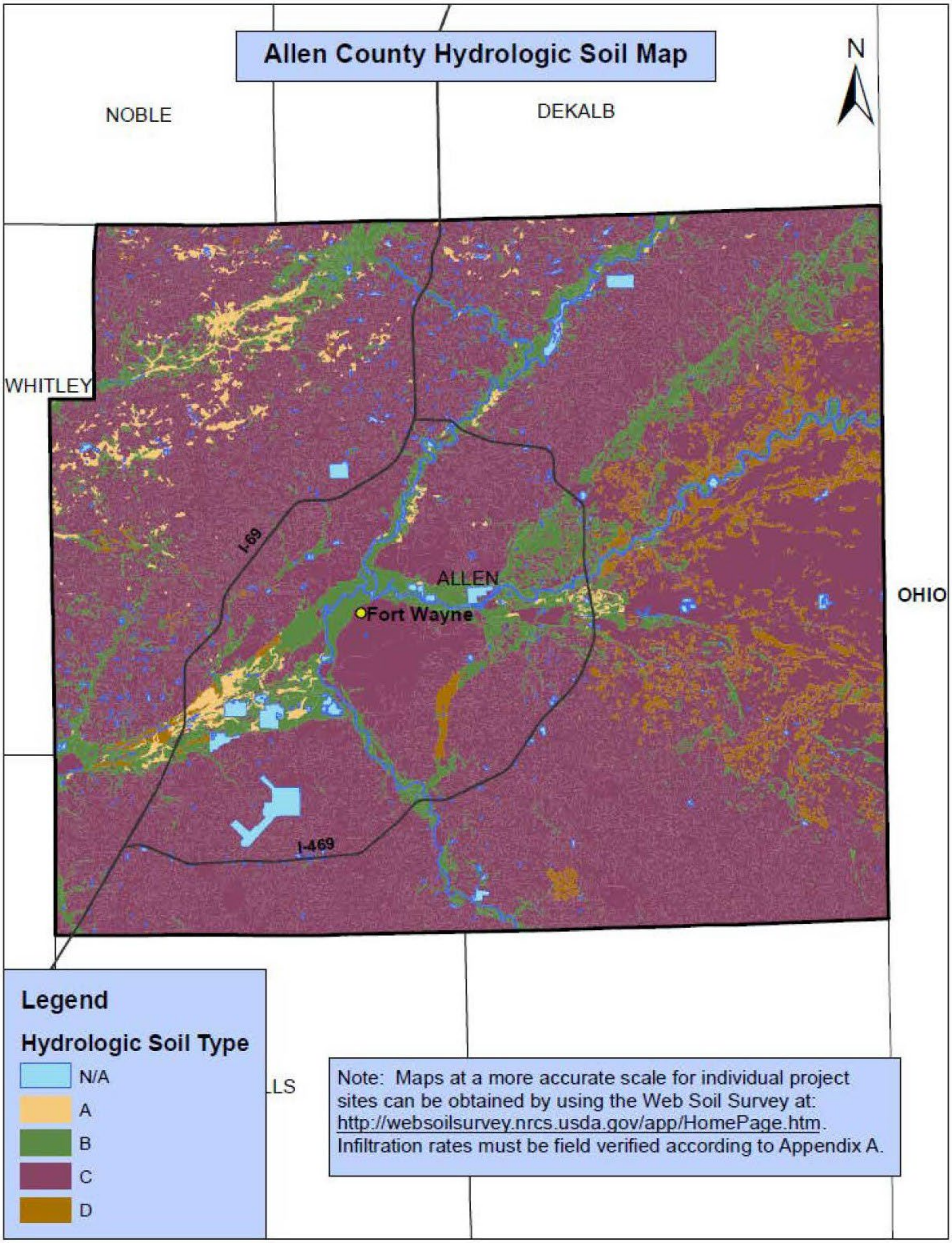
Remarks ____

____

____

Sketch:

HYDROLOGIC SOIL GROUP MAP



Note: Maps at a more accurate scale for individual project sites can be obtained by using the Web Soil Survey at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm. Infiltration rates must be field verified according to Appendix A.

SOIL TEST PIT LOG SHEET

Soil Test Pit Log Sheet

Project: ______________________________ **Date:** ________________________

Name: ______________________________ **Soil Series:** ________________________

Location: ______________________________ **Other:** ________________________

Test Pit # ______________________________

Horizon	Depth (In.)	Color	Redox Features	Texture	Notes (if applicable)	Boundary

NOTES:

REDOX FEATURES

Abundance

Few ....<2%
Common ..2-20%
Many ....>20%

Contrast

faint
hue & chroma of matrix and redox are closely related.

distinct
matrix & redox features vary 1 -2 units of hue and several unites of chroma & value.

prominent
Matrix & redox features vary several units in hue, value & chroma

COARSE FRAGMENTS (% of profile)

15-35%	**35-65%**	**>65%**
gravelly	very gravelly	extremely gravelly
channery	very channery	extremely channery
cobbly	very cobbly	extremely cobbly
flaggy	very flaggy	extremely flaggy
stony	very stony	extremely stony

BOUNDARY

Distinctness

abrupt...<1” (thick) *gradual*...2.5 - 5”
clear......1 - 2.5” *diffuse*....>5

Topography

smooth - boundary is nearly level
wavy - pockets with width > than depth
irregular - pockets with depth > than width

HORIZONS

O - organic layers of decaying plant and animal tissue (must be greater than 12-18% organic carbon, excluding live roots).

A (topsoil) - mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material.

B (subsoil) - mineral horizon with evidence of pedogenesis or Illuviation (movement into the horizon).

C (substratum) - the un-weathered geologic material the soil formed in. Shows little or no sign of soil formation.

E - mineral horizon which the main feature is loss of silicate clay, iron, aluminum. Must be underlain by a B (alluvial) horizon.

Book 1

General Requirements (GR)

GR9 Energy Efficient Light Standards

GR9.01 Purpose

The City is committed to the efficient, cost effective and environmentally responsible use of energy throughout all of its facilities. City Utilities promotes energy efficiency by implementing cost effective lighting projects that will maintain or improve the quality of the work environment, optimize service reliability, increase productivity, reduce carbon footprint, maintain or improve energy consumption and cost, and enhance the safety of our workplace.

In keeping with the City's Utility Energy Policy, City Utilities has adopted the Indiana State Standards for Energy Conservation Codes for all lighting improvements and new construction to the City Utilities facilities, including: lift stations, pump stations, maintenance facilities, water treatment plants, wastewater treatment plants, and offices. The purpose of this Chapter is to outline these requirements as they pertain to City Utilities facilities and projects.

GR9.02 Requirements

The replacement of existing lighting systems or the addition of new lighting systems in any building space shall comply with the light power density (LPD) requirements of ASHRAE Standards 90.1-2007 Section 9 applicable to that space. Any new control devices as a direct replacement of existing control devices shall comply with the specific requirements of Section 9.4.1.2(b).

(ASHRAE Standard 90.1-2007 Section 9.1.2)

Exceptions

- emergency lighting that is automatically off during normal building operation
- lighting that is specifically designed as required by a health or life safety statute, ordinance, or regulation

(ASHRAE Standard 90.1-2007 Section 9.1.1)

GR9.03 Fixture Requirements

Low bay fluorescent fixtures shall use lamps 28-W or less.

Fluorescent lamps shall be low mercury as defined by a maximum allowable of 3.5-mg of mercury per 4-foot lamp.

All florescent ballasts shall be programmed-start. Rapid-start ballasts and instant start ballasts shall not be allowed for florescent fixtures.

Programmed- start fluorescent ballasts delay the heating of the lamp when it is started. This ballast increases the lamp life and also operates the lamp at a slightly lower input wattage than rapid start ballasts. However, the input wattage is slightly higher than instant-start ballasts. Some manufacturers are discontinuing the rapid-start ballast and replacing them with programmed-start. Use programmed- start fluorescent ballasts in areas controlled with occupancy sensors. Figure GR9.1 outlines the pros and cons for each lamp starting type. (5-4.2.3 Department of Defense – Design: Interior, Exterior Lighting and Controls).

Figure GR9.1 Lamp Starting Type Comparisons

Starting Type	Pros	Cons
Rapid-start A separate circuit simultaneously heats lamp electrodes when arc power is applied	Longer lamp life than instant-start in most applications.	Usually involves a series connection of lamps. Lower overall lamp/ballast system efficacy.
Instant-start Lamp electrodes are not preheated before applying a high voltage to start lamp arc.	Inexpensive, high efficacy system. Parallel lamp circuits permit continued operation of all working lamps when a lamp fails. Low temperature starting.	Can shorten lamp life if lamp is switched on and off frequently.
Programmed-start Lamp electrodes are heated before applying arc power.	Results in long lamp life under any switching frequency. High efficacy. Improved lamp life with short duty cycles	More expensive and less common than instant-start.

From: IESNA LEM-3-07 Table 8, pg 28

All fixtures shall have lenses to protect the reflectors from dirt.

Fixtures in areas exposed to moisture shall be rated for wet environments and mounted either off the wall with a bracket or from the ceiling. The fixture shall be aluminum, stainless steel, or shall have all other metal parts treated with a cured protector. Fixtures in areas exposed to harsh or corrosive environments shall be stainless steel and epoxy coated.

It is recommended that all interior fixtures have a receptacle plug and be removable for maintenance.

GR9.04 Space Control

Each space enclosed by ceiling height partitions shall have at least one control device to independently control the general lighting within the space. Each manual device shall be readily accessible and located so the occupants can see the controlled lighting.

- A control device shall be installed that automatically turns lighting off within 30-minutes of all occupants leaving a space.
- For all other spaces, each control device shall be activated either manually by an occupant or automatically sensing an occupant. Each control device shall control a maximum of 2500-square feet area for a space of 10,000-

square feet or less and a maximum of 10,000-square feet area for a space greater than 10,000-square feet and be capable of overriding any time-of-day scheduled shutoff control for no more than four hours.

(ASHRAE *Standard 90.1-2007* Section 9.4.1.2)

GR9.05 Lighting Control

Automatic Lighting Shutoff – Interior lighting in buildings larger than 5000-square feet shall be controlled with an automatic control device to shut off building lighting in all spaces. This automatic control device shall function on either:

- a scheduled basis using a time-of-day operated control device that turns lighting off at specific programmed times ; an independent program schedule shall be provided for areas of no more than 25,000-square feet but no more than one floor,
- an occupant sensor that shall turn lighting off within 30-minutes of an occupant leaving a space, or
- a signal from another control or alarm system that indicates the area is unoccupied.

There are two types of occupancy sensors to choose from. The decision will depend on the situation in which the occupancy sensor and light fixtures are being installed.

- Passive infrared sensors detect the difference in heat between a human and the surroundings. Because of this, the sensor must be able to “see” the entire space and any obstruction such as partitions, shelves, or cabinets will block detection. Changes in ambient temperature will also reduce the effectiveness of infrared sensors. (5-5.1.3 Department of Defense – Design: Interior, Exterior Lighting and Controls)
- Ultrasonic technology relies on high frequency sound waves to detect movement in the space. This movement could be a person moving, or air movement created by a person’s activity. This type of sensor is therefore appropriate for spaces that have partitions such as restrooms or open office areas. Such sensors need to be located so that they do not sense the “false-occupancy” of an air vent or a passer-by in an adjacent space. (5-5.1.4 Department of Defense – Design: Interior, Exterior Lighting and Controls)

Daylight automatic shut off is recommended for non-task-dominant rooms such pump rooms with ample windows, hallways with windows, and storage/warehouse with windows.

Daylight dimming is recommended for task dominant rooms such as control rooms and offices.

(ASHRAE *Standard 90.1-2007* Section 9.4.1.1)

GR9.06 Lighting Power Densities – Space-by-Space Method

Lighting power densities (LPD), including ballast shall not surpass the following unless the Utilities Energy Manager gives approval. Special consideration will be given for spaces rated as Class I Division I, hazardous location.

- Low Bay (<25-ft Floor to Ceiling Height) 1.2 (LPD, W/ft2)
- High Bay (> or = 25-ft Floor to Ceiling Height) 1.7 (LPD, W/ft2)
- Detailed Operations 2.1 (LPD, W/ft2)
- Equipment Room 1.2 (LPD, W/ft2)
- Control Room 0.5 (LPD, W/ft2)
- Corridor/Transition 0.5 (LPD, W/ft2)

Example:

If a room is 33-feet by 34-feet and is less than 25-feet high and the installer wants to use 6 lamp T8 28-W fixtures then the calculation to find the MAXIMUM number of fixtures is as follows:

$$33ft \times 34ft = 1122ft^2$$

$$1122ft^2 \times 1.2\frac{W}{ft^2} = 1346.4W$$

$$1346.4W \div 28W = 48\ T8\ Lamps$$

$$48\ Lamps\ \div 6\ Lamps\ per\ Fixture = \boldsymbol{8\ Six\ Lamp\ T8\ Fixtures}$$

*Power Density also includes ballast losses so that needs to be included in lamp wattage.

(ASHRAE Standard 90.1-2007 Section 9.6.1)

GR9.07 Exit Signs

Internally illuminated exit signs shall not exceed 5-W per face.

LED emergency exit signs are recommended.

(ASHRAE *Standard 90.1-2007* Section 9.4.3)

GR9.08 Exterior Lighting Control

Lighting for all exterior applications not exempted in Section GR9.02 shall have automatic controls capable of turning off exterior lighting when sufficient daylight is available or when the lighting is not required during nighttime hours. Lighting not designated for dusk-to-dawn operation shall be controlled by either:

- a combination of a photosensor and a time switch (preferred), or
- an astronomic time switch.

See Figure GR9.2 for lighting power density requirements. (ASHRAE *Standard 90.1-2007* Section 9.4.1.3)

Figure GR9.2 Lighting Power Densities for Building Exteriors

Uncover Open Areas		
	Parking lots & drives	0.15 W/Sq Ft
Building grounds		
	Walkways less than 10 ft wide	1.0 W/linear Ft
	Walkways greater than 10 ft wide	0.2 W/Sq Ft
	Plaza areas	0.2 W/Sq Ft
	Special feature areas	0.2 W/Sq Ft
	Stairways	1.0 W/Sq Ft
Building Entrances and Exits		
	Main entries	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width
Canopies and overhangs		
	Canopies (free standing and attached and overhangs)	1.25 W/Sq Ft

(ASHRAE *Standard 90.1-2007* Table 9.4.5)

GR9.09 Records of Fixture Replacement or Additions

All fixture replacement, additional lighting, and lighting controls that are changed or added shall be recorded and reported to the Utilities Energy Manager.

Book 1

General Requirements (GR)

GR10 Final Record Drawings

GR10.01 Purpose

This Chapter establishes the procedures for maintaining and submitting record drawings so that City has a final record which correctly depicts infrastructure as constructed. Refer to **Chapter CADD3 – Submittals** for information on how to produce Record Drawings electronically.

GR10.02 Documentation and Approval Process

1. CUE Projects

   A set of project drawings designated specifically for recording changes and deviations from the original project drawings shall be maintained throughout construction. The requirements for record drawings shall be described in each project manual based on the requirements of this section.

   Record drawings will be produced based on the record of work provided by the contractor and Resident Project Representative (RPR) to CUE. **Exhibit GR10-1** and **Exhibit GR10-2** show sample record drawings. The following procedures will be followed.

   - CUE will notify the design engineer that a particular project is ready for record drawings and provide the field records from the contractor and the RPR.
   - Design Engineer shall prepare draft record drawings.
   - The completed draft record drawings will be reviewed by CUE for verification of information. A full-size hard copy and PDF of the draft record drawings shall be submitted. The draft record drawings will either be accepted as record drawings or rejected and the design engineer will be required to correct and resubmit the draft record drawings.
   - Once the draft record drawings have been approved by CUE for the project, final record drawings shall be submitted to CUE as one (1) full size hard copy and PDF. The electronic CAD (DWG) version of the record drawings shall also be submitted to CUE. File formats shall follow Book 6: CADD Standards.

2. DVS Projects

   A record of all work from the construction drawings shall be made upon completion of each project to generate record drawings. **Exhibit GR10-1** and **Exhibit GR10-2** provide Sample Record Drawings. Record drawings shall be generated by drawing a line through the original design information and adding the as-constructed data to the original plans using red ink. Therefore, the record drawings shall show the original design information and the as-constructed information, which shall include, but not be limited to, features such as detention basins, topographical information, drawings added to the original plan set, and revised and new calculations based upon modifications.

DVS will notify the applicant when the project is ready for record drawings. The applicant shall then prepare the draft record drawings. Based on DVS review, the draft record drawings will either be accepted as record drawings or rejected and the applicant will be required to resubmit revised draft record drawings.

Record drawings shall be submitted to DVS in PDF.

GR10.03 Drawing Information

1. CUE Projects

   All as-constructed work shall be shown and clouded, preferably in red. Original drawing information shall under no circumstances be erased. Supplemental information collected during construction shall be added to the drawings. Examples of supplemental information include tap locations, utility locations and information, field observations, etc. As- constructed work shall be noted as follows.

   a. As-constructed Work Differs from Original Drawings

      Where the as-constructed work differs from the original drawings, a line will be marked through the original information. The as-constructed information shall appear adjacent to the original design information and a cloud shall be placed around the as-constructed information.

   b. As-constructed Work Matches Original Drawings

      Where the as-constructed information matches original design information, the as-constructed information will appear adjacent to the original information and shall have a cloud placed around it.

2. DVS Projects

   All as-constructed work shall be shown and clouded, preferably in red. Original drawing information shall under no circumstances be erased. As-constructed work shall be noted as follows:

   a. As-constructed Work Differs from Original Drawings

      Where the as-constructed work differs from the original approved drawings, a line will be marked through the original design information, and the revised as-constructed information shall appear adjacent to the original drawing information, and a cloud placed around the revised as-constructed information.

b. As-constructed Work Matches Original Drawings

Where the as-constructed work matches the original approved drawings, the recorded information shall appear adjacent to the original approved drawing information and have a cloud placed around it.

GR10.04 Drawing Requirements

The requirements of this section apply to all projects.

1. Survey Datum

   Horizontal control shall be referenced to the North American Datum of 1983 (NAD83), Indiana State Plane Coordinate System, East Zone (US Survey) Foot (IN83-EF).

   Vertical control shall be referenced to the National Geodetic Vertical Datum 1988 (NAVD 88).

2. Survey Accuracy

   For hard structures horizontal measurements and vertical elevations shall be recorded to 0.01 feet, with accuracy to 0.05 feet.

   For earthen structures, horizontal measurements and vertical elevations shall be recorded to 0.1 feet, with accuracy to 0.25 feet.

3. Record Drawings Content

   The following items, at a minimum, shall be included in the record drawings.

   a. Alignment

      Horizontal location shall be noted for features including, but not limited to:

      - manholes
      - cleanouts
      - catch basins and/or surface inlets
      - headwalls
      - retaining walls
      - slope protection
      - channel linings
      - water main and appurtenances (as required by DVS and/or CUE)
      - miscellaneous structures
      - stormwater basins
      - swales and ditches

   b. Elevation

      Elevations shall be noted for features including but not limited to:

- inverts of overflows
- rims
- surface inlet grate rims and top of curb
- flow lines
- structures (all pipe elevations)
- outlets and spillways

c. Stormwater Basin Volumes

Original and as-constructed stormwater basin volumes shall be included on the record drawings.

d. Pipe Characteristics

Pipe sizes, lengths, slopes and pipe angles at structures shall be included on record drawings.

e. Materials

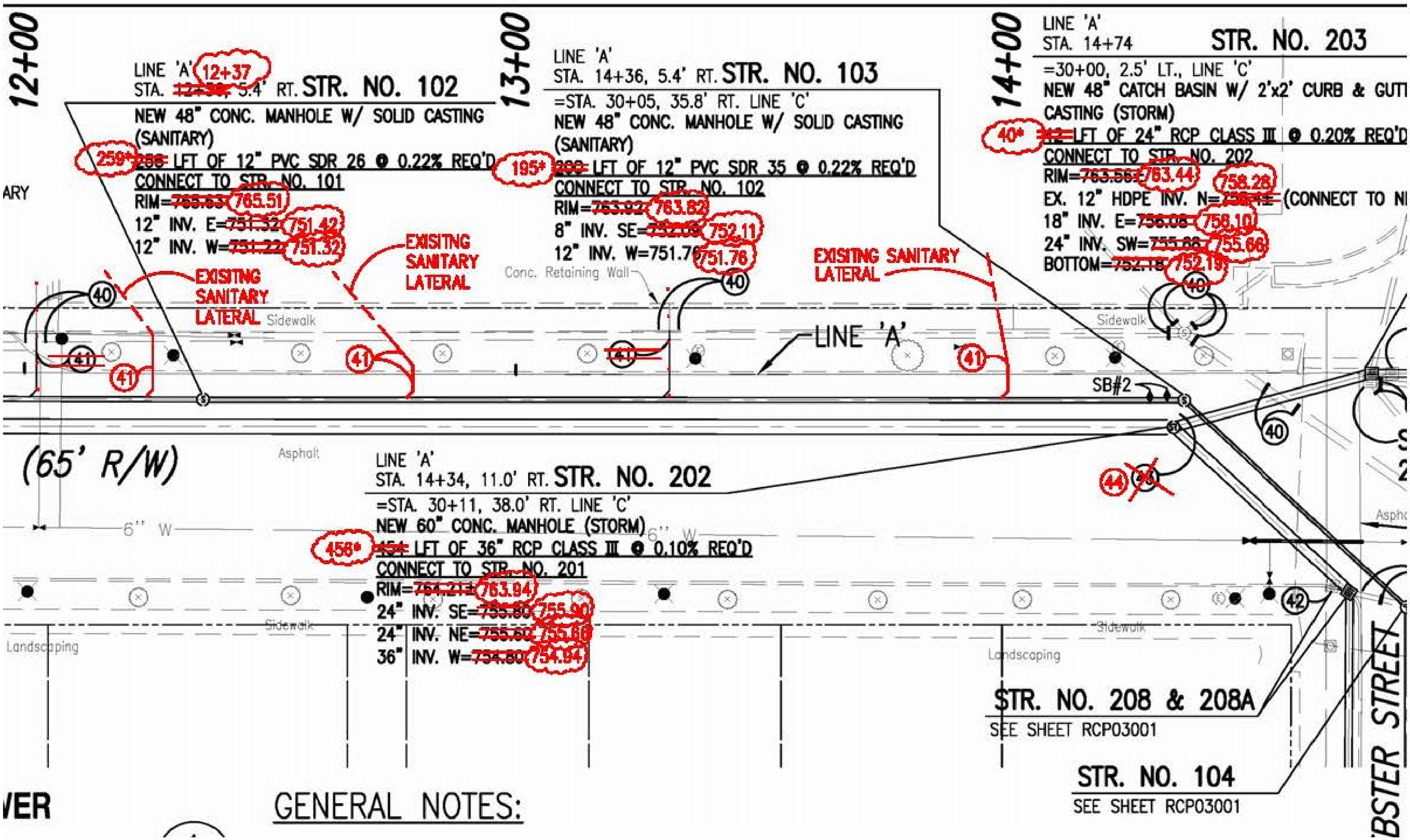
Materials for all work shall be included on record drawings.

f. General Record Drawing Requirements

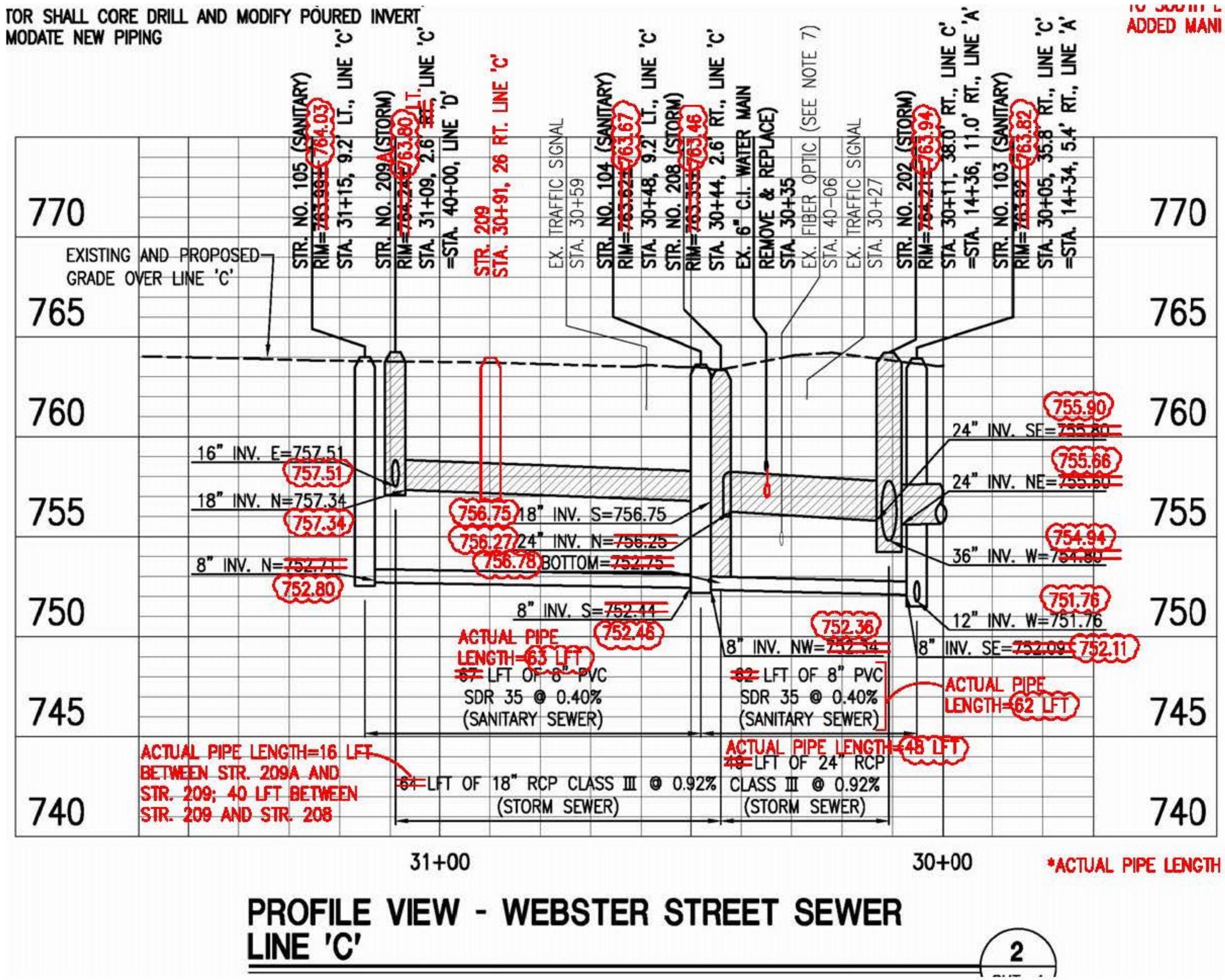
In general, the following shall apply:

- The surveyor or engineer shall seal and sign all drawing sheets.
- Any unverified data shall show +/- thereby indicating the information has not been verified.
- The record drawing shall be clearly dated.

City Utilities Design Standards Manual	Exhibit GR10-1 Record Drawing Sample 01
	Version: August 29, 2012



CITY UTILITIES WATER THAT WORKS	City Utilities Design Standards Manual	Exhibit GR10-2 Record Drawing Sample 02
		Version: August 29, 2012



Book 1

General Requirements (GR)

GR11 Life Cycle Cost Analysis

GR11.01 Purpose

The purpose of this Chapter is to provide a standardized basis of analysis for consistent 20-year life cycle cost analysis of gravity sewers, lift stations, and low-pressure sewer systems. For further details related to the life cycle cost evaluation and project examples with worksheets, refer to the document entitled **20 Year Lifecycle Evaluation** dated May 16, 2013.

City Utilities will determine the appropriateness to develop a life cycle cost (LCC) analysis for particular projects. The LCC analysis content, interest rate, miscellaneous cost elements, etc. shall be discussed with City Utilities prior to starting the development of the engineering cost analysis.

It is the intent that the 20-Year Life Cycle Cost Summary Excel worksheets included in **Appendix A** and **Appendix B** of this document be used to complete 20-year life cycle evaluations. However, other methods may be used to evaluate the LCC. The information included in the worksheets shall be considered “typical” for City Utilities sanitary collection systems.

GR11.02 Life Cycle Cost Methodology

1. Present Worth Analysis

   The purpose of a life cycle cost analysis is to evaluate all of the present and future costs to construct and maintain a facility over its life.

   The worksheet model considers four different future cost components:

   - Future construction costs to replace equipment or capital upgrades
   - Annual utility expenditures to operate the lift stations and/or low-pressure systems
   - Labor expenses related to annual maintenance, cleaning, or at the time of expected repair and replacement schedules for the facility
   - Remaining salvage or residual value at the end of 20 years, assuming the assets all have 40-year useful lives

2. Inflation and Discount Rates

   The Consumer Price Index (CPI) measures the cost of living increases for all urban consumers from year to year. The average annual compounded increase in CPI will be different for different time periods. The past five years average annual rate of inflation was used for the Life Cycle Cost Analysis.

3. Construction Costs Data Sources

   Typical initial construction costs for gravity sewers, lift stations, and low-pressure sewer systems in the worksheets are costs that were developed based upon average installed costs from public sector projects from recent years.

4. Operation and Maintenance Data Source

   Operation and maintenance (O&M) costs for lift station O&M, gravity sewer O&M, and low pressure sewer system O&M are provided in **Appendix A** and **Appendix B**.

5. Salvage Value

   The following items will have a 40-year design life:

   - Gravity Sewers
   - Lift Station Structures
   - Force Mains
   - Grinder Pump Station Basins

   The salvage value of the items above is considered to be zero at the end of the 40-year design life. However, since the worksheet is for a 20-year life cycle, each of these items will include a salvage value. The salvage value will be the remaining value at the end of the 20-year period, assuming 40-year straight-line depreciation of the asset.

6. Life Cycle Cost Computations

   A timeline of estimated initial and future costs is calculated in **Appendix A** and **Appendix B**.

   After all costs are converted to year 2010 costs, the costs are inflated to convert them to current year dollars at the time of construction (the current year is referred to as “Year X” in the worksheets).

7. Fixed Worksheet Cell Values

   - Construction Inflation (5-year ENR Cost Index)
   - Yearly Power Cost Increase
   - Yearly Labor Cost Increase
   - Discount Rate (5-year CPI)

GR11.03 Gravity Sewer Option – Life Cycle Analysis

1. Design Life

   Assume the design life of the gravity sewer will be 40 years and residual/salvage values will be calculated accordingly.

2. Initial Construction

   Gravity Sewer: All gravity sewer construction costs will be considered the same regardless of the property on which construction is proposed. The cost per linear foot of initial construction of gravity sewer includes but is not limited to the following:

- Pipe Materials
- Manholes
- Excavation
- Backfill
- Pavement
- Pavement Subbase

Oversizing: An oversizing cost can be added as a lump sum to the gravity sewer construction section. It should be added to the miscellaneous construction cost.

Land: It has been assumed that all sewers are located within the right-of-way, therefore, no easement acquisition nor property purchase is included in the Gravity Sewer Option LCC worksheets. If land acquisition or easements are required, these costs may be added as a lump sum in the Gravity Sewer Construction Cost worksheet as a miscellaneous cost.

3. Operation and Maintenance

Cleaning and Inspecting: A unit cost per foot to clean and inspect sanitary sewers has been input into the 20-year LCC worksheets.

Maintenance: This cost is included with cleaning and inspecting, therefore, no separate cost has been included in the worksheets for maintenance.

Replacement: Since the life expectancy of gravity sewer is considered to be 40 years, replacement is not considered in this analysis.

Rehabilitation: Since the life expectancy of gravity sewer is considered to be 40 years, rehabilitation is not considered in this analysis.

4. Salvage Value

Since the design life of gravity sewers is estimated at 40 years, gravity sewers will have a residual/salvage value at the end of the 20-year life cycle.

GR11.04 Lift Station Option – Life Cycle Analysis

1. Design Life and Replacement Schedules

Design Life:

- Lift Stations Structure: 40 years
- Pumps and Controls: 20 years
- Motors: 10 years
- Impellers: 7 years
- Valves: 25 years
- Force Main: 40 years

Replacement Schedules:

- Lift Station Structure: Not required; a salvage value at the end of 20 years will be included.
- Pumps and Controls: Replacement required at Year 20.
- Motors: Repair/replacement at Year 10; this cost is included in the Yearly Maintenance Cost because it is not a capital cost.
- Impellers: Repair/replacement at Year 7 and Year 14; this cost is included in the Yearly Maintenance Cost because it is not a capital cost.
- Valves: Not required; a salvage value at the end of 20 years will be included.
- Force Main: Not required; a salvage value at the end of 20 years will be included.

2. Initial Construction

Gravity Sewer: For gravity sewer on the development to convey flow to the lift station, use the separate table for the Lift Station Option in the Gravity Sewer Worksheet.

Pumps, Wet Well, and Valve Vault (Installed): A lump sum cost is included in the Lift Station Construction Cost worksheet.

Electrical Feed to Site: **Appendix A** and **Appendix B** assumes that three-phase power is available at the lift station site. If this is not the case, $25,000 (cost to bring three-phase power one-quarter mile to the site) should be input in the “miscellaneous” line of the 20-Year Life Cycle Cost Summary worksheet.

Force Main: The Lift Station Construction Cost worksheet includes typical installation costs for 4-inch through 10-inch force mains. Installation by open-cut method using Class 200/SDR-21 PVC pipe material has been assumed. HDPE and ductile iron are acceptable. Confirm the unit cost of pipe material; this can be adjusted by inputting material unit cost per linear foot in **Appendix A** and **Appendix B**.

Land: For “private development”, the typical lift station foot print is small and has been considered as negligible, therefore, no land cost is included. For “public projects” a lump sum cost has been included in **Appendix A** and **Appendix B**.

Site Work: Included in the unit cost for lift stations.

SCADA (Supervisory Control And Data Acquisition): Costs included in Pumps, Wet Well, and Valve Vault (Installed). City Utilities should be consulted to determine if the SCADA requirements have been updated such that re-evaluation of the typical costs provided in **Appendix A** and **Appendix B** is required.

Communications: Current City Standards include a radio and antennae pole or telephone service compatible with the City’s SCADA communication network. This equipment cost is included in Pumps, Wet Well, and Valve Vault (Installed).

3. Operation and Maintenance

   Subcategories of O&M costs are as follows:

   Corrective Maintenance (CM):

   - Mechanical and electrical labor and repair parts

   Preventative Maintenance (PM):

   - Regular and systematic inspection
   - Replacement of worn parts, materials, and systems
   - Cleaning

   Routine Maintenance:

   - Response to alarms
   - Bi-weekly inspections
   - Cleaning wet well and floats
   - Exercising valves
   - Lubricating valves and equipment
   - Site maintenance

   Capital Improvements: These are intermittent major expenditures associated with normal equipment wear. The total costs of these combined replacements exceed $25,000 and are assumed to occur at Year 20.

   Lift Station O&M:

   The costs include corrective maintenance, preventative maintenance and routine maintenance. They do not include capital improvements and power costs. Two different lift station annual O&M costs were used; one for lift stations 20-horsepower and under and one for lift stations larger than 20-horsepower.

4. Power Usage

   Typical power requirements expressed in dollars per year are automatically calculated for a single pump horsepower in **Appendix A** and **Appendix B**.

5. Communications

   If a monthly phone service fee is required for SCADA instead of the standard radio and antennae pole, a yearly service fee has been entered in **Appendix A** and **Appendix B**.

GR11.05 Low Pressure Sewer Option – Life Cycle Analysis – Septic Elimination ONLY

1. Design Life and Replacement Schedules

   Design Life:

   - Grinder Pump Station Structure: 40 years

- Grinder Pumps: 10 years
- Controls: 20 years
- Low pressure force main piping: 40 years
- Air Release Valves: 15 years

Replacement Schedule:

- Grinder Pump Station Structure: Not required; a salvage value at the end of 20 years will be included.
- Grinder Pumps: Repair/replacement at Year 10; this cost is included in the yearly maintenance cost.
- Controls: Replacement required at Year 20.
- Air Release Valves: Repair/replacement required at Year 15.
- Force Main: Not required; salvage value of entire low-pressure system is included at the end of 20 years.

2. Initial Construction

Grinder Pump Stations: A cost for simplex stations has been entered in the worksheet.

Electrical Feed To Sites: A cost for power feed from home to grinder pump station has been entered in the worksheet.

Low Pressure Force Main: The Grinder Station Construction worksheet in **Appendix B** includes typical installation costs for 1.25-inch through 4-inch DR-11 HDPE pipe material. Confirm the unit cost of pipe material; this can be adjusted by inputting material unit cost per linear foot in the worksheet.

Land: Assumed that low pressure sewer force main will be located within right-of-way, therefore, no land or easement costs.

3. Operation and Maintenance

Grinder Pump Stations O&M: A yearly grinder station maintenance cost per pump has been entered in **Appendix B**.

Electrical O&M: A replacement cost, to occur at the end of year 20 for the control panel including material and installation has been entered in **Appendix B**.

Low Pressure Sewer O&M: A yearly maintenance cost for cleaning low pressure sewer has been entered in **Appendix B**.

Air Release Valves: A unit cost for replacement at Year 15 has been entered in **Appendix B**.

4. Power Usage

The approximate power cost to operate a grinder pump station is $24 per year per pump station. This cost will be incurred by the homeowner. The present worth value of power for the grinder pump stations is calculated in the worksheet, however, this cost is not included in the overall “20-Year Life Cycle Cost” of the Low Pressure Sewer Option in **Appendix B**.

CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 2 Stormwater

Book 2

Stormwater (SW)

SW1 Acronyms and Definitions

SW1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the Stormwater Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

SW1.02 Acronyms

ANSI	American National Standards Institute
ASTM	ASTM International (formerly American Society of Testing and Materials)
BFE	Base Flood Elevation
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980 (commonly known as Superfund)
CFS	Cubic Feet per Second
CMP	Corrugated Metal Pipe
CN	Curve Number
CSI	Construction Specifications Institute
CUE	City Utilities Engineering
DIP	Ductile Iron Pipe
DPS	Department of Planning Services
DSM	Department of Stormwater Management
DVS	Development Services
EGL	Energy Grade Line
FEMA	Federal Emergency Management Agency
FFE	Finished Floor Elevation
FHWA	Federal Highway Administration
FPG	Flood Protection Grade
GI	Green Infrastructure
GIS	Geographic Information System
GPS	Global Positioning System
HEC-RAS	Hydraulic Engineering Centers River Analysis System

HDPE High Density Polyethylene

HEP Horizontal Elliptical Pipe

HGL Hydraulic Grade Line

IAC Indiana Administrative Code

IDEM Indiana Department of Environmental Management

IDF Intensity-Duration-Frequency

IDNR Indiana Department of Natural Resources

INDOT Indiana Department of Transportation

LID Low Impact Development

LS Registered Land Surveyor

MF04 Master Format 2004

MS4 Municipal Separate Storm Sewer Systems

NASSCO National Association of Sewer Service Companies

NAD 83 North American Datum of 1983

NAVD North American Vertical Datum

NAVD 88 North American Vertical Datum of 1988

NGVD29 National Geodetic Vertical Datum of 1929

NOAA National Oceanic and Atmospheric Administration

NOC Notice of Compliance

NOI Notice of Intent

NOT Notice of Termination

NOV Notice of Violation

NPDES National Pollutant Discharge Elimination System

NRCS National Resources Conservation Service

OD Outside Diameter

O&M Operations and Maintenance

OSHA Occupational Safety and Health Administration

PACP Pipeline Assessment Certification Program

PDF Portable Document Format

PE Professional Engineer

PC-SWP3 Post-construction Stormwater Pollution Prevention Plan

PP Poly Propylene

PSI Pounds per Square Inch

PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
ROW	Right-of-Way
RPR	Resident Project Representative
SCS	Soil Conservation Science or Soil Conservation Service
SMP	Stormwater Management Plan
SW	Stormwater
SWP3	Stormwater Pollution Prevention Plan
SWQMP	Stormwater Quality Management Plan
TBM	Temporary Bench Mark
TCP	Temporary Project Control Points
TR	Technical Release
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
VEP	Vertical Elliptical Pipe
WQCR	Water Quality Characterization Report
WQv	Water Quality Volume

SW1.03 Definitions

Armor	A surface treatment to protect a slope from erosive energies.
Backfill	Earth and/or other material used to replace material removed from trenches or other excavations during construction activities. The backfill lies above the pipe bedding.
Base Flood Elevation	The water surface elevation for the 1% annual chance storm event (100-year).
Best Management Practice	Structural and/or non-structural controls that temporarily store or treat stormwater runoff to reduce flooding, improve water quality and provide other benefits
Bioretention	An engineered landscape feature appearing as shallow depressions and vegetated with plant species adapted to occasional inundation.
Bioswale (Water Quality Swale)	An engineered swale designed to remove silt and other pollutants by retaining or maximizing the travel time of stormwater runoff during smaller rainfall events for water quality and conveying the runoff during larger rainfall events to a stormwater storage feature. The swale needs to be vegetated

with species that tolerate inundation for extended periods. Also referred to as water quality swale.

Book Organizational grouping of utility design standards by topic. These Books consist of General Requirements, CADD, Stormwater, Sanitary Sewer, Water and Materials.

Bridge A structure having an opening of more than 20 feet between faces of abutments or spring lines of arches, measured along the centerline of a roadway.

Catch Basin A structure designed with a sump below the invert to catch debris and sediment from runoff that enters the stormwater system.

Channel A portion of a natural or artificial watercourse that periodically or continuously contains surface water, groundwater or stormwater runoff, or which forms a connecting link between two bodies of water, having a defined bed and banks that serve to contain water.

City The City of Fort Wayne, Indiana.

City Utilities The department of the City of Fort Wayne that manages the stormwater, wastewater and water utilities.

City Utilities Engineering The division within City Utilities that develops City Utility Engineering Standards, manages City Utilities Projects, and performs planning and system analysis for the stormwater, wastewater and water utilities.

City Utilities Projects Publicly funded projects that improve the stormwater, wastewater, and water utilities and are under direction of City Utilities Engineering.

City Utilities Design Standards Manual A document that provides guidance and requirements for the planning, design, and construction of stormwater, wastewater, and water utility infrastructure.

Combined or Combination Sewer Pipe or conduit that conveys sanitary sewage at all times and is designed to also collect and convey stormwater runoff during wet weather.

Conveyance Any structural method for transferring stormwater runoff between at least two points. This includes piping, ditches, swales, curbs, gutters, catch basins, channels, storm drains, culverts, small structures, bridges, and roadways.

Culvert A structure having an opening of less than 10 feet in width between faces of abutments or spring lines of arches, measured along the centerline of a roadway.

Design Storm A rainfall event of specified size and return frequency that is used to calculate the runoff volume and peak discharge rate for a stormwater management facility.

Detention	The temporary storage of stormwater runoff in a basin, pond or other structure to control the peak discharge rates by holding the stormwater for a lengthened period of time, and which provides some gravity settling of particulates.
Detention Basin	A facility constructed or modified to restrict the flow of storm water to a prescribed maximum rate, and to detain concurrently the excess waters that accumulate behind the outlet.
Detention Facility	A facility that stores stormwater and releases it at a controlled rate into a stormwater conveyance system.
Developer	Any landowner, agent of such landowner or tenant with the permission of such landowner, who makes or causes to be made a subdivision of land, or a land development or redevelopment.
Development	The improvement of one lot or two or more contiguous lots, tracts or parcels of land by means of or for the purpose of streets, common areas, leaseholds, condominiums, building groups or other features.
Development Services (DVS)	The division within the department of City Utilities that oversees non-capital projects.
Discharge	Stormwater runoff from land and impervious areas such as streets, parking lots, sidewalks and building rooftops that is collected in stormwater management facilities and directed to a specific point.
Discharge Point	A location where stormwater runoff from the impervious surface on a property, within a development, sub-watershed or watershed leaves the area where it has been generated and enters a stormwater management facility or waterway.
Ditch	A man-made, open watercourse in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters flow either continuously or intermittently.
Drain	Relative to stormwater, any sewer, tile, ditch, stream or other stormwater runoff conveyance channel or conduit.
Drainage	The conveyance of excess surface water, groundwater, or stormwater runoff from land by means of natural or man-made ditches, drains or other stormwater management systems or components.
Easement	A right to occupy, access or otherwise utilize the real property of another for a specifically defined use.
Emergency Overflow (Spillway)	An engineered outfall or spillway that provides a nondestructive release point if a basin exceeds its design capacity.
Engineer	The design professional licensed by the state and ultimately responsible for the design of a project.

Evapotranspiration	The natural processes that releases moisture into the atmosphere by way of evaporation and plant transpiration.
Flood Protection Grade	The base flood elevation plus 2 feet.
Forebay	A pool of water used to collect sediment and debris before the stormwater reaches a detention basin or green infrastructure facility.
Freeboard	An additional depth regarded as a safety factor between the peak design water elevation and the top of a basin's berm.
Gradually-Varied Flow	Non-uniform flows in which the depth and velocity change gradually in the direction of flow.
Green Infrastructure	Engineered features that utilize the natural processes provided by vegetation and soils to manage the quantity and quality of stormwater runoff.
Hydrograph	Graph of the time distribution of runoff from a watershed.
Hydrograph Method	A method of calculating runoff and discharges based on a mathematical simulation, also referred to as the SCS or TR20 method.
Impervious Surface/Area	Area that has been paved and/or covered with buildings and materials which include, but are not limited to: concrete, asphalt, rooftop, blacktop, gravel or stone, such that the infiltration of water into the soil is prevented. Excluded from this definition are undisturbed land, lawns and fields.
Infiltration	A complex process of allowing stormwater runoff to penetrate the ground surface and flow through the upper soil surface.
Inlet	An opening into a stormwater drainage system for the entrance of surface storm water runoff, more completely described as a storm drain inlet.
Inline Stormwater Detention	A stormwater storage area created within the limits of an open channel or other stormwater conveyance system.
Invasive Species	A species that is introduced to an environment, becomes overpopulated and harms its new environment, adversely affecting habitats, bioregions, causing ecological, environmental, and/or economic damage.
Land Disturbing Activities	Any land alterations or disturbances that may result in soil erosion, sedimentation, or change in runoff including, but not limited to, construction traffic, removal of ground cover, grading, excavating, and filling of land.
Leveler	A structure or grading feature used to ensure surface water enters an area as sheet flow.
Low Impact Development	Land development that utilizes natural processes and minimizes impervious surfaces to manage stormwater as close to its source

as possible and treats stormwater as a resource rather than a waste product.

Maintenance Ledge A relatively flat surface to allow maintenance vehicles access around basins and green infrastructure.

Manhole Confined space that provides access to a sewer.

Micro Model A hydrograph modeling technique that incorporates the detention volumes of each green infrastructure feature as interconnected basins.

Micro Pool A small permanently wet pool directly upstream of the outfall of a green infrastructure feature to reduce resuspension of solids and guard against vegetation encroachment towards the outlet.

Micro Watershed The watershed associated with an individual green infrastructure feature as it relates to utilizing a micro model.

Municipal Separate Storm Sewer System(MS4) Stormwater management system that is located inside the Fort Wayne City limits that is designed and intended to collect and convey only stormwater runoff and other clear water, that is not a combined sewer, that is not part of a publicly-owned treatment works (“POTW”) and discharges to waters of the United States.

Natural Buffer Undisturbed area adjacent to or surrounding surface waters within which construction activity is restricted.

New Development Construction of roads, house and/or other structures and related infrastructure on vacant or nearly vacant land.

Non-Structural BMP Practices that control and reduce pollutants at their source without the use of a proprietary water quality unit.

Operations and Maintenance Manual Documents that identify the post-construction SWP3 features with instructions for the inspection and maintenance of the features.

Outfall The point, location, or structure where a pipe or open drain discharges to a receiving body of water.

Outlet An opening through which water is discharged.

Owner Any individual, partnership, firm, corporation or other entity that is initiating and financially responsible for a project.

Overland Flow Path A designated area of land on a plat that can serve as a conductor of surface water runoff when capacity has been exceeded, typically during wet weather events. Overland flow paths are typically located within an established easement.

Peak Release Rate The maximum flow rate that can be discharged from a site for a given storm event.

Permeable Pavement A specially designed pavement system that allows water to infiltrate through the surface and into the subbase.

Permit	Clearance to perform specific work under specific conditions at specific locations.
Post-Construction Stormwater Pollution Prevention Plan	Calculations, reports, drawings and O&M manuals that define how the stormwater quality imperative will be achieved and maintained on the site after construction activities are complete.
Primary Outfall	The structure that controls the discharge rate of stormwater from a detention facility associated with the on-site flows or the smaller storm events.
Private Stormwater System	A system owned, operated, and maintained by a private entity.
Proprietary Water Quality Unit	A patented stormwater structure that is used to achieve the stormwater quality imperative by collecting the pollutants within the structure.
Rainwater Harvesting	The collection and temporary storage of runoff for future on-site use.
Rainfall Intensity	The measure of the amount of rain that falls over time.
Redevelopment	The construction of roads, house and/or other structures and infrastructure on land where previous impervious improvements are removed or are partially removed.
Reduced Runoff Method	A design and calculation method for sizing the stormwater quality features and detention facilities to contain the first 1-inch rainfall on-site with a zero discharge.
Retention	The holding of stormwater runoff in a constructed basin or pond or in a natural body of water without release except by means of evaporation, infiltration or emergency bypass.
Run-off	Water that originates during a precipitation event and flows over the land rather than infiltrating into the ground or evaporating.
Riparian	Of, on, or pertaining to the banks of a stream, river, or pond.
Safety Ledge	A plateau around the perimeter of a wet basin that is 12 inches to 18 inches below the normal water's surface.
Secondary Outfall	The release outfall of a basin that is associated with the off-site flows that are being routed through a basin or the auxiliary release from a basin when two-stage outfalls are utilized for larger storm events.
Sediment	Solid material (both mineral and organic) that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface.
Sedimentation	The settling and accumulation of unconsolidated sediment carried by stormwater run-off.

Sediment Basin A pond built with appropriate control structures to capture sediment that are washed off during or after rainstorms or other runoff events to protect the water quality of nearby bodies of water.

Small Structure A structure having an opening of more than 10 feet and less than 20 feet in width between faces of abutments or spring lines of arches, measured along the centerline of a roadway.

Soil The unconsolidated mineral and organic material on the surface of the earth that serves as the natural medium for the growth of plants.

Springline The horizontal centerline of a conduit or sewer pipe

Standards Fort Wayne City Utilities Design Standards Manual. The requirements for the design and construction of utilities within Fort Wayne's jurisdiction.

Storm Sewer A sewer designed or intended to convey only stormwater, surface runoff, and drainage, and not intended to receive or convey sanitary sewage and industrial wastes other than unpolluted cooling water. The portion of a sewer intended to carry stormwater only, which begins at the grating or opening where water enters said sewer, continues through the sewer and any other conduits, to the outlet structure where water enters a channel, natural watercourse or combined sewer.

Stormwater Any flow resulting from any form of natural precipitation.

Stormwater Basin Control Structure The structure that releases the runoff from a stormwater detention facility at a defined rate.

Stormwater Inspection and Maintenance Agreement An agreement between an owner and the Stormwater Utility that outlines the owner's maintenance obligations for private stormwater management facilities.

Stormwater Management Plan The calculations, reports and drawings that define how stormwater will be collected, treated for water quality, stored and released from a development.

Stormwater Management Report A report that includes a narrative that explains how stormwater run-off will be collected, treated, stored and released. It will also include the appropriate calculations.

Stormwater Pollution Prevention Plan A plan developed to minimize the impact of stormwater pollutants resulting from construction activities.

Stormwater Pretreatment A component of a stormwater quality plan that captures larger particles and debris before the stormwater enters a green infrastructure feature.

Stormwater Quality Imperative The stormwater quality goals defined in these standards.

Stormwater Quality Measure Practice, or a combination of practices, to control or minimize pollutants associated with stormwater run-off.

Stormwater Quality Volume	The volume of runoff to be retained in a green infrastructure feature to achieve the stormwater quality imperative. Also referred to as water quality volume.
Stormwater System	All of the structures and features associated with the collection, conveyance, storage and water quality treatment of stormwater.
Surcharge	The overloading of a stormwater conveyance to a point at which stormwater is backing up and possibly discharging at the lowest opening of the stormwater system.
Swale	An overland open channel intended to carry small amounts of stormwater runoff at a shallow depth.
Time of Concentration	The time needed for runoff to flow from the most hydrodynamically remote point in a watershed to the watershed outfall.
Total Suspended Solids	The soil and other particles found in stormwater runoff that is associated with water quality. These particles are typically a function of the runoff's velocity.
Trained Individual	An individual who is trained and experienced in the principles of stormwater quality, including erosion and sediment control as may be demonstrated by completion of coursework, state registration, professional certification, or annual training that enable the individual to make judgments regarding stormwater management, treatment, and monitoring.
Underground Detention	Subsurface structures for the sole purpose of storing stormwater.
Undeveloped	The condition of real property unaltered by the construction or addition to such property of any impervious surfaces or physical improvements that change the hydrology of the property from its natural state.
Vegetated Filter Strip	A vegetated pretreatment area where plants slow runoff and remove some of the larger particles and debris.
Volume Based Method	A design and calculation method for sizing "end of pipe" stormwater quality features to achieve the stormwater quality imperative.
Watershed	An area of land from which all water drains to a common point.
Water Body	Any accumulation of water, surface, or underground, natural or artificial, excluding water features designed and designated as water pollution control facilities.
Wetland	A land area that is saturated with water for an extended period such that the soils develop hydric soil characteristics that favor the growth of hygrophyte plant species.
Work	All the activities to be done in accordance with the approved plans and specifications.

Book 2

Stormwater (SW)

SW2 Introduction

SW2.01 Purpose

The purpose of this Chapter is to provide an introduction to how the Stormwater Book is presented. The purpose of the Stormwater Book of the City Utilities Design Standards Manual is to ensure that stormwater facilities constructed under the jurisdiction of City Utilities provide the level of service necessary to

- Protect the health and welfare of residents
- Comply with local, state and federal laws
- Protect public and private property from unnecessary damage
- Protect the environment from pollutants transported by rainfall
- Ensure operability and maintainability of public stormwater systems

The Standards establishes the minimum requirements for the design and construction of stormwater systems that will be owned, operated and/or maintained by the City of Fort Wayne.

SW2.02 Applicability

The Standards applies to all projects that result in stormwater systems that are owned, operated and/or maintained by the City of Fort Wayne. Stormwater systems include, but are not limited to:

- Storm sewers including manholes, inlets and catch basins
- Culverts
- Open channels
- Crossings
- Detention and retention basins
- Water quality facilities

For private stormwater facilities, which are wholly owned, operated, and maintained by a private entity, these Standards constitute best management practices. Incorporation of these standards is required.

SW2.03 Variance from Standards

Variance from the Standards may be granted under specific conditions. Refer to Chapter GR3 – Variances of the General Requirements book for the variance procedures and requirements.

SW2.04 Organization of Stormwater Standards

The Standards contains the process, procedures, and technical requirements needed to comply with the City of Fort Wayne stormwater regulation. Chapter SW4 – Special Discharges outlines requirements for unique stormwater flows and non-stormwater flows for all projects.

The remaining chapters are dedicated to key stormwater topics. Each chapter contains technical requirements including, but not limited to:

- Allowable design approaches (methods, equations)
- Minimum allowable sizing
- Implementation limitations
- Criteria for submittal
- Minimum geometry requirements

SW2.05 Stormwater Materials

Allowable materials and minimum requirements for use are provided in the Materials book of the City Utilities Design Standards Manual. Relevant Chapters include:

- Chapter MA2 – Introduction
- Chapter MA3 – Certification of Materials
- Chapter MA4 – Common Materials and Testing Requirements
- Chapter MA5 – Stormwater Materials and Testing Requirements

SW2.06 Stormwater Specifications

City Utilities maintains a library of Master Specification for use on public projects and that may be used on private projects. Specifications are available via the City's website at

utilities.cityoffortwayne.org/contractors-engineers-developers/master-specifications

The Master Specifications have been developed to support the requirements established in this manual. The Master Specifications are provided as a service to design engineers and do not waive the engineer's responsibility or liability for the site-specific design of the stormwater system.

Book 2

Stormwater (SW)

SW3 Drawings and Submittals

SW3.01 Purpose

The purpose of this Chapter is to outline the minimum drawing and submittal requirements for proposed stormwater improvements. These requirements are intended to supplement Chapter 53 of the Fort Wayne Code of Ordinances and the Fort Wayne Water Pollution Control Utility General Rules and Regulations.

SW3.02 Stormwater Management Submittal Requirements

The stormwater management plan requires several elements to be considered complete. These are:

- Minimum plan sheet elements
- Stormwater Management Report
- Operations and Maintenance Manual (O&M)

1. Minimum Plan Sheet Elements

   All of the following design criteria must be present within a project's construction plan sheets and/or specifications.

   a. The existing conditions. It needs to be a composite of a topographic survey and a boundary survey. The topographic portion will identify the existing surface flow patterns and impervious surfaces. The boundary portion will identify ownership and easement rights. **Exhibit GR4-6** identifies the minimum requirements for the existing conditions included in Stormwater Management Submittals.

      The existing conditions sheet shall also meet the requirements of IDEM CSGP.

   b. The proposed grading plan. It needs to show sufficient detail to illustrate that the proposed contours and spot elevations will blend into the adjacent off-site grades without causing off-site drainage obstructions or pockets of standing water. It should also show:

      - the on-site swales with slopes
      - the flood protection grades and the areas affected by them
      - the finished floor or building pad elevation of each lot and/or building
      - location of inlets and storm structures with surface elevation (rim) shown
      - proposed spot elevations or contours to identify the drainage pattern between lots and structures

- the intended overland flow paths between sub-sheds to the basin or outfall as applicable
- the peak elevations between sub-sheds that define overland flow paths
- the proposed easements associated with surface drainage and overland flow paths
- the location of flood zone delineations

The proposed grading plan sheet shall also meet the requirements of IDEM CSGP.

c. The proposed stormwater infrastructure. The plans need to show:

- pipe sizes
- materials
- structure types and sizes
- bedding and backfill requirements
- rim elevations (at flow line)
- invert elevations
- special discharges discharge location
- water lines and sanitary sewers
- elevation labels at potential crossing conflicts
- profiles are required for storm sewers that will become public
- profiles may be required for private storm sewer on complicated projects
- existing and proposed easements
- overland flow path between the sub-watersheds
- Coordinates for the storm structures and the emergency overflow. Theses coordinates shall be State Plane (NAD'83) or Indiana Geospatial Coordinate System for Allen County
- Individual lot drainage plan for each lot of the development, including common areas or community property. Show all swales and open channels (existing or proposed)

d. The proposed detention basin plan, if applicable. This is often a part of the grading plan. The plans for detention basins need to show:

- proposed contours
- label grades to clearly identify the basin's side slopes
- label the berm width
- longitudinal slope of the bottom of the basin
- detail of the outfall structure
- maintenance and safety ledges as necessary
- pipe outfalls
- emergency overflow and detail thereof

- proposed cross sections in each direction (longitudinal and latitudinal)
- Coordinates for the basin outfall structure and the emergency overflow. These coordinates shall be State Plane (NAD'83) or Indiana Geospatial Coordinate System for Allen County.

e. The post construction SWP3 (PC-SWP3). A sheet uniquely dedicated to the PC-SWP3 must be provided. The sheet needs to show:

- all post-construction water quality features
- water quality features need to be clearly labeled and dimensioned as applicable
- a detail for each water quality feature
- a pollutants of concern table (This can be in the O&M or on the PC-SWP3 sheet.)
- Coordinates for the post-construction water quality features. these coordinates shall be State Plane (NAD'83) or Indiana Geospatial Coordinate System for Allen County. The coordinates shall be to the empirical center of each water quality feature.

The post-construction SWP3 sheet shall also meet the requirements of IDEM CSGP.

2. Stormwater Management Report

The stormwater management report needs to include a narrative and all of the necessary supporting documents and calculations. The stormwater management report needs to include, as applicable:

- A narrative explaining the project's overall drainage plan.
- Documentation of discharge location for Special Discharges.
- A completed **Exhibit SW11-12** "Detention Facility Design Summary" for each stormwater storage facility.
- A pre and post watershed map of the overall project with the sub-basins identified.
- A "stage-volume" table or graph for detention facilities.
- A "stage-discharge" table or graph for detention facilities.
- Documentation of any composite Curve Number or weighted Run-off Coefficient calculations.
- Documentation of the drainage model inputs.
- Documentation of Routing Calculations that includes the peak inflow into the basin, the peak discharge from the basin and the peak water surface level. The Routing Calculation documents can be summaries that are produced by the routing software.
- Documentation of Water Quality Volume Calculations that include impacts for 2 year event and 100 year event.
- Documentation of the sizing calculations for the PC-SWP3 features.

- The emergency overflow calculations.
- A table showing pre and post impervious service calculations.

Stormwater Management Reports for multi-lot developments shall include a Lot Plan for each potential sell-off. The purpose of the Lot Plan is to clearly identify aspects of the overall development's stormwater plan that relay specifically to a lot. This is applicable to commercial or residential developments. The Lot Plans shall:

- Identify the elevation of the proposed finished floor or building pad.
- Identify the elevations of the swales on or adjacent to the lot.
- Identify the storm structure(s) that are dedicated connection points for any potentially proposed storm sewer.
- Show easements associated with the overall development that apply to the individual lot.
- Identify any flood protection grades.
- Identify where sump pumps or other special discharges from individual lots are to drain.
- Identify stormwater flow path from each lot and where it is designed to drain.

3. Operations and Maintenance Manual (O&M)

   All projects with post-construction water quality features require an O&M. The O&M will identify the site's water quality features and how the owner is to maintain them. It should include:

   - the discharge location for special discharges
   - an introductory paragraph or page that states all water quality features are to be maintained in perpetuity
   - a statement that the City has a right to enter the property and inspect the water quality features
   - a requirement for the owner to keep a log of inspections and maintenance
   - an exhibit map that clearly identifies the location of all the water quality features
   - a table that identifies the inspection schedule for the individual water quality features
   - a narrative defining what the inspections should include and how to address any deficiencies for each water quality feature
   - a user-friendly inspection and maintenance log form for a layperson's use

SW3.03 Erosion Control Submittal Requirements

As an MS4, the City of Fort Wayne reviews erosion control submittals as part of the IDEM CSGP process. The approval from the City is part of IDEM's Notice of Intent submittal requirements. The termination from the City is part of IDEM's

Notice of Termination requirements. See **Chapter SW12 – Stormwater Pollution Prevention Plan (SWP3)** for more information.

Book 2

Stormwater (SW)

SW4 Special Discharges

SW4.01 Purpose

Special discharges are a general classification for atypical issues related to stormwater management systems. They are issues beyond the typical surface runoff and resulting stormwater management facilities. This chapter is intended to provide some guidance for these atypical issues.

Stormwater rules, regulations, and policies are established at the federal, state and local level. The City of Fort Wayne's responsibility is to implement these federal and state mandates. **The Fort Wayne Stormwater Utility – General Rules and Regulations** govern stormwater management practices defined in this manual. The City of Fort Wayne ordinance for stormwater management is found under Title V: Public Works Chapter 53: Stormwater Management. Ordinances can be accessed through the City's website at **http://www.cityoffortwayne.org/city-code.html**.

SW4.02 Projects with only Combined Sewer Access

Some areas within the City only have access to combined sewer systems. Developments in these areas are required to have systems that keep the on-site sanitary sewer and on-site storm sewer separated. It is assumed a sewer separation project will occur in the future.

Developments in combined sewer areas are required to follow stormwater standards for stormwater management in discharge rates and post construction water quality measures. The allowable discharge rate into a combined sewer may be reduced if the existing sewer has insufficient capacity.

Developments in combined sewer areas are required to connect to the sanitary and storm sewer system if the separate system is within the right-of-way adjacent to the project area.

SW4.03 Curb Drains

Curb Drains are drainage discharges onto streets, walks, drives or similarly used surfaces. **These discharges are prohibited** (Section 99.020 of the City of Fort Wayne Code of Ordinances (the "Code"). The discharges can result in ice, algae growth or other public nuisance that can endanger life, limb and/or property of others. Design should account for this issue and provide appropriate stormwater facilities to prevent.

SW4.04 Downspouts

Downspouts convey a significant amount of runoff from roof tops. It is assumed to be from precipitation. It is also assumed to be clean except for any pollutants associated with stormwater flowing across the roofs and building faces. Downspouts associated with residential use will have different requirements than other building uses.

The downspout discharge shall include an adequate energy dissipater and drainage path to a storm water management system. The downspouts shall not discharge directly onto a street, sidewalk or trail. The identified discharge locations shall be a minimum of five (5) feet from the any neighboring building foundation and at least two (2) feet from the parcel line of an adjacent property or right of way.

Stormwater runoff may be discharged to a public stormwater management system, or a private stormwater management system.

Downspouts may discharge to underdrains if the underdrain has been designed, sized, and reviewed and approved by Development Services.

In the case of new development where private stormwater laterals have been provided for each building, downspouts may be connected to the private lateral.

In combined sewer areas, downspouts should discharge on the surface. There should be no direct connection to the combined sewer. If the downspouts cannot discharge to the ground without creating a nuisance, refer to **Fort Wayne Stormwater Utility – General Rules and Regulations**.

1. Non-residential Downspouts

   "Non-residential" as it relates to downspouts, is any structure not defined as residential above. This includes apartments, commercial buildings and industrial structures.

   Non-residential downspouts may tie into a private storm sewer (**Section SW6.11 – Private Storm Sewers**). The flow from the downspouts must be directed to the post-construction water quality measures and detention as required for the site.

   Non-residential downspouts can be discharged at grade. The plans shall identify those discharge locations. The discharge locations shall be included in the O&M manual.

2. Residential Downspouts

   "Residential" as it relates to downspouts, is a single family or duplex structure. It is a free-standing structure. It can be a house, a condominium or villa. This classification includes small accessory structures such as sheds and detached garages.

   Residential downspouts shall discharge at grade. They shall utilize a splash block or similar energy dissipater. The discharge point can be:

   a. on the property they serve.

b. onto a neighborhood common area with the written consent of the neighborhood association. This assumes the property is adjacent the common area (detention/retention area). These discharges must comply with any recorded covenants, restrictions, and/or other applicable neighborhood requirements.

c. into a private stormwater management system.

The flow from the downspouts must be in accordance with the overall drainage plan for the development. This requires the flows to eventually get into the overall development's post-construction water quality measures and detention facilities.

Downspouts shall not discharge in a manner that creates an adverse impact on an adjacent property. Surface discharges shall be located a minimum of five (5) feet from the any neighboring building foundation and not closer than two (2) feet from the property line or right of way.

The downspouts shall not discharge directly onto a street, sidewalk or trail. **Residential downspouts are prohibited from connecting directly into a public storm sewer system. Connections into the combined sewer system and separate sanitary system are prohibited.**

Development plans shall identify the discharge location for downspouts from each lot/structure. The location of the discharges shall be included in the O&M manual and the restrictive covenants, if applicable. The location can be the general building envelope limits with flow arrows for lots with unknown building footprints. (residential lots of a subdivisions)

In developments where private laterals have been provided for each building, downspouts may be connected to the private lateral.

Requirements for downspouts are defined in the **Fort Wayne Stormwater Utility – General Rules and Regulations**.

SW4.05 Sump Pumps

Storm water sump pumps are exclusively intended for discharging clear, uncontaminated water. This water is from foundation drains and uncontaminated ground water infiltration. Sump pumps and their discharge shall be included in the overall project's stormwater management design. The discharge location options are surface and sewer.

1. Surface Discharges

   Surface discharges for sump pumps are typically associated with new residential projects. The site designer shall identify the surface discharge locations of all storm water sump pumps for each building or lot of the development. These should be indicated on the plans. The discharge location for each lot or building shall be included in the O&M manual and the restrictive covenants (directly or by reference to the O&M).

   The sump pump surface discharge locations shall:

(a) include an adequate energy dissipater

(b) include a defined drainage path to the storm water management system

(c) feature appropriate design slopes, where freely discharged to eliminate ponding water.

(d) discharge onto the ground of the owner of the property

(e) not discharge or flow across a street, sidewalk or trail

(f) not direct flow onto an adjacent property outside of a dedicated easement

(g) not discharge in a manner that creates a nuisance.

The identified discharge locations shall be a minimum of five (5) feet away from a neighboring building foundation and not closer than two (2) feet from the property line or right-of-way.

2. Discharges into Proposed On-site Stormwater Infrastructure

Sump pump discharges into on-site stormwater infrastructure are generally associated with new developments. This infrastructure is designed specifically for the proposed conditions. It shall be a private stormwater system.

Stormwater management plans for a new development shall include the following as it relates to sump pump discharges.

(a) The sump pump(s) discharge locations shall be into an on-site private storm sewer structure.

(b) The storm sewer shall be sized to include any applicable traditional surface flows plus the peak discharge from the sump pumps. The peak discharge rate ($Q_{sump\ pump}$) from the sump pump shall be provided in the stormwater calculations. The peak for systems with multiple pumps shall assume all pumps are on. The sump pump flow ($Q_{sump\ pump}$) shall be added to the surface drainage flow ($Q_{surface}$). The sum of the flows will determine the storm sewer capacity requirements.

$$(Q_{sump\ pump}) + (Q_{surface}) = \text{Required Pipe Capacity}$$

(c) The O&M shall identify the sump pump discharge point(s).

(d) The sump pump flows are not required to be included in basin or stormwater quality sizing. However, it is suggested the designer consider the impacts if the site has significant ground water concerns.

(e) The City may require additional information as part of the design submittal such as soil borings or other geotechnical information if ground water is a suspected concern.

3. Discharges into Sewers

Discharges into stormwater or combined sewers are typically redevelopment or in-fill type projects and will typically only be allowed directly for non-residential connections. The designer shall identify the desired receiving sewer structure. All requests for connections to any public sewer structure shall be approved by the City. Sump pumps may be approved to connect clearwater discharges to a combined sewer system if no other option exists.

The peak discharge rate from the sump pump shall be provided in the stormwater calculations. The peak for systems with multiple pumps shall assume all pumps are on. The designer shall prove the sump pump will not overtax the existing sewer system during the peak flow of the 10-year event.
The average monthly flow from the sump pump will be converted to an average equivalent ERUs (Equivalent Residential Units). An ERU is 7,667 gallons per month. The cost for the average monthly equivalent of ERUs will be added to the customer's bill each month. The minimum ERU quantity for any sump pump is three (3) ERU. The calculation is:

Total Pump Discharge for the year ÷ 12 months = Average Monthly Flow

Average Monthly Flow ÷ 7,667 gallons = Monthly Equivalent of ERUs

Monthly Equivalent of ERUs x ERU Billing Rate = Cost to Customer

A sump pump's discharge capacity shall be included in the calculation of a properties sewer Area Connection Fee and will be calculated as follows. The design point on the sump pump discharge curve or calculated flow rate provided by an engineer for an approved sump pump connection to a combined sewer will be converted into an ERU by dividing the flow rate by a Peak Factor of 4. *This calculation may also be used for establishing a flat rate billing fee for any sump pump connection to a sewer discovered that is not approved by the City*.

The City's review evaluation of sump pump discharges into a sewer requires some minimum research and submittal documentation. This includes:

- Research of past complaints to the City of basement backups (by City)
- Research of past complaints to the City of street flooding (by City)
- Soil borings and other geotechnical information if a shallow water table is suspected (by Owner or Design consultant)

Requirements for sump pumps are defined in the **Fort Wayne Stormwater Utility – General Rules and Regulations**.

SW4.06 Geothermal Heating and Cooling Systems

Requirements associated with discharges from geothermal heating and cooling systems are governed by **Fort Wayne Stormwater Utility – General Rules and Regulations**.

1. Locations of Geothermal Systems

   No portion of a geothermal system may cross a swale, ditch, stream, pond, lake, regulated drain, storm sewer, sanitary or combined sewer or potable water line that is part of a public system unless the project owner has received prior written approval from the City or easement holder.

   A geothermal system may be installed in or under a private stormwater basin. The geothermal system shall be included in the design of the basin as applicable. The installation must be approved by the owner of the basin (community associations) if in a common area or otherwise off-site. Geothermal systems can also be a part of basins that are not part of a stormwater management system (decorative basins).

2. Residential Geothermal Systems

   Residential geothermal systems shall be closed-loop or modified closed-loop systems as defined by General Rules and Regulations. No new open loop geothermal systems will be allowed to discharge to the public sewer systems. Existing residential open-loop geothermal heating and/or cooling systems may not discharge groundwater into a public sanitary or combined sewer.

   All piping and outfall structures of a geothermal system will be the responsibility of the system's owner. It will be their responsibility to professionally install, operate, maintain, repair and replace system components as necessary.

3. Non-residential Geothermal Systems

   Non-residential geothermal systems are permitted as open or closed loop systems. Open loop geothermal systems shall not discharge to a sanitary sewer. Storm and combined sewer systems can be considered as discharge locations. This assumes the effluent is "clean" water that is suitable for the storm sewer.

   The City's review evaluation of geothermal discharges into a storm or combined sewer requires some minimum research and submittal documentation. This includes:

   - Research of past complaints to the City of basement backups (by City)
   - Research of past complaints to the City of street flooding (by City)
   - Soil borings and other geotechnical information if a shallow water table is suspected (by Owner or Design consultant)

   Open-loop geothermal systems may discharge as follows:

   a. The system may connect directly to a public storm sewer (or combined sewer as circumstances require). All piping and other appurtenances necessary to connect to the approved discharge point will be the responsibility of the geothermal system owner for operation, maintenance, repair, and replacement as necessary. The design calculations shall show the sewer has adequate capacity during the 10-

year event including the geothermal discharge. Connection to a public storm sewer or combined sewer shall be metered. The owner of the geothermal system will be charged in accordance with said data as outlined in the General Rules and Regulations and Stormwater Utility Rates and Charges.
The average monthly flow from the geothermal system will be converted to an average equivalent ERUs (Equivalent Residential Units). An ERU is 7,667 gallons per month. The cost for the average monthly equivalent of ERUs will be added to the customer's bill each month. The minimum ERU quantity for any geothermal system is three (3) ERU. The calculation is:

Total Pump Discharge for the year ÷ 12 months = Average Monthly Flow

Average Monthly Flow ÷ 7,667 gallons = Monthly Equivalent of ERUs

Monthly Equivalent of ERUs x ERU Billing Rate = Cost to Customer

A geothermal system's discharge capacity shall be included in the calculation of a properties sewer Area Connection Fee and will be calculated as follows. The design point on the geothermal system discharge curve or calculated flow rate provided by an engineer for an approved geothermal system connection to a combined sewer will be converted into an ERU by dividing the flow rate by a Peak Factor of 4. *This calculation may also be used for establishing a flat rate billing fee for any geothermal system connection to a sewer discovered that is not approved by the City*.

b. The system may discharge directly into the ground through an injection well.
c. The system may discharge directly into the Maumee, St. Mary's or St. Joseph Rivers with proper permits and necessary approvals.
d. The system may discharge directly into a regulated surface drain with the proper permits and necessary approvals.
e. The system may discharge to a privately owned and maintained detention or retention basin system. The system shall include the discharges from the geothermal system within the design of detention/retention system. The design shall be approved by the City. The system's discharge shall not violate any covenants, restrictions, or other applicable neighborhood requirements.

Geothermal discharges shall not have excessive thermal characteristics upon release. Water with significant temperature gradients from the ambient surrounds can have negative impacts on the ecosystem. An open looped system discharging into a river, stream, lake, or other surface body of water shall discharge into a forebay or similar feature to alleviate thermal differences.

SW4.07 Swimming Pools, Chlorinated Water, and other Chemically Treated Water

Requirements for discharges from these types of bulk water sources are governed by the **Fort Wayne Stormwater Utility – General Rules and Regulations**.

SW4.08 Interactive Water Fountains

Requirements for discharges from these water sources are governed by the **Fort Wayne Stormwater Utility – General Rules and Regulations**.

SW4.09 Floor Drains

Floor drains are susceptible to contamination. Therefore, floor drains shall be connected to a sanitary or combined sewer. Backflow preventors are recommended.

SW4.10 Solid Waste and Dumpster Pads

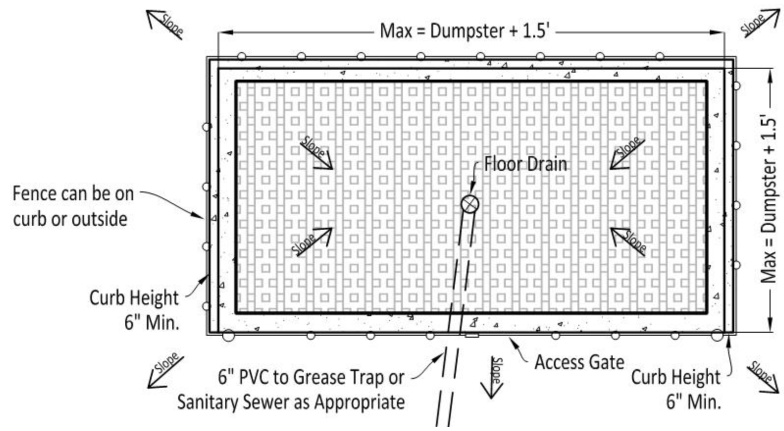
Dumpsters for solid waste collection and garbage compactors are a unique concern. Fluids that leak from the solid waste are considered grey water. It shall be sent to the sanitary or combined sewer. Direct precipitation shall be directed away from the solid waste. The precipitation that does not have contact with the solid waste shall be directed to a stormwater management system.

Permanent dumpsters shall have a dedicated location. The dedicated location will require a dumpster pad. The pad shall be:

1. concrete.
2. curbed on three sides to contain effluent from leaking dumpsters.
3. sized for the dumpster. The pad's dimensions shall not exceed those of the dumpster by more than 1.5 feet in any direction.
4. sloped to a floor drain. This drain shall connect to a grease trap when available on site. It shall connect to a sanitary sewer tap if a grease trap is not available. See **Section SA6.07 – Building Sewer Appurtenances** for requirements of grease traps.
5. elevated and designed such that runoff from the adjacent land does not cross the pad.

See Figure SW4.1 for general dumpster pad requirements.

Figure SW4.1 Map for Dumpster Pad



Permanent dumpster locations shall be fenced. The fence shall provide a degree of protection from wind driven precipitation. The voids in the fence shall be approximately 15% or less of the surface area. Chain-link fences can meet the requirement with a privacy fence weave or privacy screen with a privacy blockage rating of 85% or higher. Wood, PVC and other fence materials shall also meet the said 15% void surface area requirements (I.E. space between wood slats). The fence shall be located so the precipitation from the surface area of the fence drips away from the dumpster pad.

Garbage compactors shall abide by the same requirements to the extent possible. Cardboard balers are exempt from the dumpster pad requirements.

Temporary dumpsters for demolition debris, construction debris and similar uses do not require the same elements. The site operators will be response for keeping liquid materials out of the dumpsters. Temporary dumpsters shall not be placed over or immediately adjacent to stormwater inlets or overland conveyance paths. They shall be placed to prevent surface flow obstructions.

SW4.11 Loading Docks and Similar Vehicle Access

Loading docks and similar access points to a building are stormwater challenges unique onto themselves. This includes managing the stormwater quality and the increased risk of illicit discharges.

All inlets within a sunken loading dock shall be a trapped structure (catch basin or trench drain). This shall be incorporated into the site's stormwater management plan. Stormwater from the loading docks shall be directed into a post-construction water quality feature beyond the trapped catch basin and to the basin as applicable.

SW4.12 Fueling Stations and Hazardous Liquid Storage

Spills are inevitable wherever liquids are handled or dispensed. Containment measures shall be passive for small spills. Site operators shall have procedures for large spills.

1. All areas that will be dispensing fuel or other hazardous liquids shall drain to an on-site drainage system. This system shall include an oil and grease separator. All on-site areas with a potential for a hazardous liquid spill shall drain to the separator. The oil and grease separator shall be sized and maintained appropriately.
2. Areas that store hazardous liquids shall be contained. The water shed area of the storage shall be minimized. These storage areas shall drain to an inlet. This inlet or the system of inlets shall capture minor spills of the hazardous liquids. This may be through an oil and grease separator or another grey infrastructure as appropriate for the liquids of concern.
3. Performance based water quality features are not acceptable for treating hydrocarbons or other hazardous liquids.
4. New and replacement retail gasoline outlets and MS4-owned fueling areas, regardless of size are required to install appropriate measures to reduce lead, copper, zinc, and polyaromatic hydrocarbons in stormwater run-off.
5. Adverse incidents (including spills and leaks) that reach any surface water of the state shall be monitored for, identified, and reported to IDEM. When any adverse incidents are observed or is made aware of any permit noncompliance that may have resulted from a discharge from the permitted facility, IDEM Spill Line at (888) 233-7745 or (317) 233-7745 shall be notified.

SW4.13 Industrial Sites

Stormwater quality for many industrial sites are governed by 327 IAC 15-6 (Rule 6). It is the operator’s responsibility to identify their site as a Rule 6 industry. Some of the uses govern by Rule 6 include:

- Industrial Plant Yards
- Refuse Sites
- Material Handling Sites
- Outdoor Manufacturing or Material Storage

The runoff associated with these sites is inherently “dirty”. Performance based stormwater quality features are not appropriate unless explicitly allowed by Rule 6.

Rule 6 requires an Operations and Maintenance Manual (O&M) for these sites. The O&M shall require the City’s Stormwater Maintenance Department be notified of a spill in addition to any state and local agency requirements.

SW4.14 Garages and Parking Structures

Garages and parking structures require special consideration.

Garages are defined as an enclosed or partially enclosed building. Its intended use is for the storage and/or maintenance activities for a small number of vehicles. Garages are typically a single level building at grade.

Parking Structures are typically open sided. They are generally called parking garages. They can be multilevel and may include sub-terrain levels. They are intended to provide parking for numerous vehicles. A single level of a larger building dedicated to the parking of numerous vehicles will be considered a parking structure.

Floor drains from all garages and parking structures are prohibited from discharging into storm sewers or surface drainage facilities. It shall be discharged into sanitary sewer or combination sewer as applicable. The flows into sanitary sewer or combined sewer shall be metered. This applies to all garages including those associated with residential use.

Book 2

Stormwater (SW)

SW5 Hydrology

SW5.01 Purpose

This Chapter provides design policies which shall be used during a hydrologic analysis performed within the City of Fort Wayne's stormwater jurisdiction.

SW5.02 Rainfall

The probability that a storm event of a certain magnitude will occur in any given year is expressed in terms of event frequency and return period. The frequency, or exceedance probability, is a measure of how often a specific rainfall event will be equaled or exceeded. For specific storm durations, a rainfall intensity exists that corresponds to a given frequency. The intensity-duration-frequency (IDF) curve provided in Figure SW5.1 illustrates the average rainfall intensities corresponding to a particular storm frequency for various storm durations. Figures SW5.2 and SW5.3 contain frequency and duration of events based on rainfall intensity and rainfall depth, respectively. The most recent precipitation data can be found at http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=in. Select station FORT WAYNE WSO AP (12-3037).

Figure SW5.1 Intensity-Duration-Frequency Curves for the City of Fort Wayne
Source: NOAA Atlas 14, Volume 2, Version 3, 2017

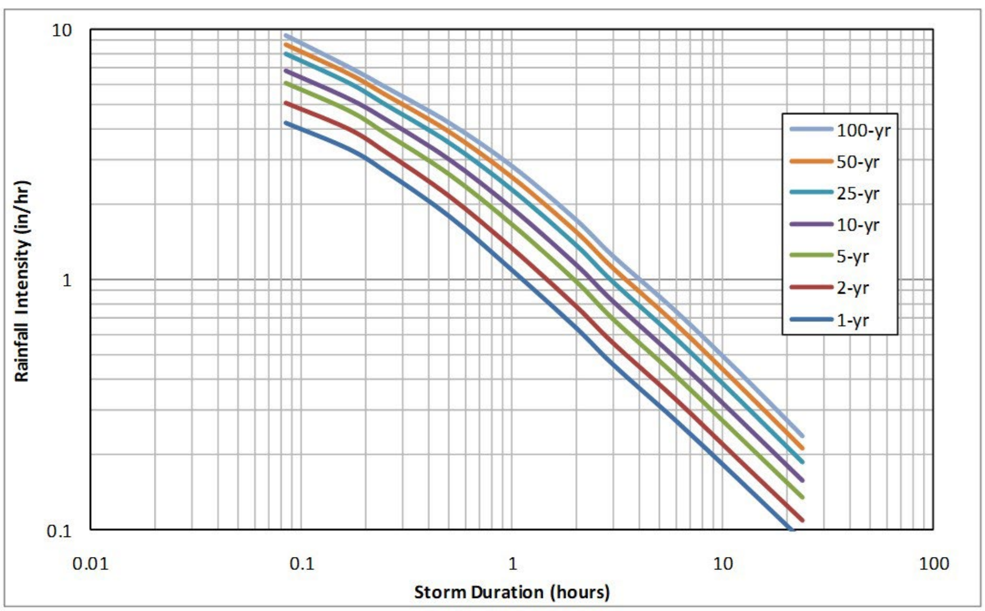


Figure SW5.2 Intensity-Duration-Frequency

Hours	Minutes	Return Frequency - Rainfall Intensity (in/hr)						
		1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0.08	5 *	4.2	5.04	6.12	6.84	7.92	8.64	9.48
0.17	10	3.3	3.96	4.74	5.28	6.06	6.6	7.08
0.25	15	2.68	3.2	3.84	4.36	4.96	5.44	5.88
0.5	30	1.78	2.14	2.64	3.02	3.5	3.88	4.24
1	60	1.08	1.32	1.66	1.92	2.27	2.55	2.84
2	120	0.64	0.78	0.99	1.15	1.38	1.56	1.75
3	180	0.46	0.56	0.7	0.82	0.98	1.11	1.25
6	360	0.27	0.33	0.41	0.48	0.58	0.66	0.75
12	720	0.16	0.19	0.24	0.28	0.33	0.38	0.43
24	1440	0.09	0.11	0.14	0.16	0.19	0.21	0.24

*Minimum time of concentration (T_c)

Figure SW5.3 Depth-Duration-Frequency

Hours	Minutes	Return Frequency - Rainfall Depth (in)						
		1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0.08	5 *	0.35	0.42	0.51	0.57	0.66	0.72	0.79
0.17	10	0.55	0.66	0.79	0.88	1.01	1.1	1.18
0.25	15	0.67	0.8	0.96	1.09	1.24	1.36	1.47
0.5	30	0.89	1.07	1.32	1.51	1.75	1.94	2.12
1	60	1.08	1.32	1.66	1.92	2.27	2.55	2.84
2	120	1.28	1.56	1.98	2.3	2.75	3.11	3.49
3	180	1.37	1.67	2.1	2.46	2.94	3.34	3.75
6	360	1.63	1.98	2.48	2.9	3.49	3.98	4.5
12	720	1.89	2.27	2.84	3.32	3.99	4.54	5.14
24	1440	2.17	2.61	3.25	3.77	4.5	5.1	5.72

*Minimum time of concentration (T_c)

1. Rainfall Distributions

   The Huff rainfall distribution most accurately reflects rainfall conditions in Fort Wayne. To use the Huff distribution, the Designer specifies the total depth of rainfall, the duration, and the proper quartile. The distribution for each of the quartiles is provided in Figure SW5.4. Storm distributions for hydrograph computation are determined by applying the appropriate Huff Distribution for the following conditions:

<u>Storm Duration</u>	<u>Distribution</u>
≤ 6 hours Duration	Huff 1st Quartile
6 hours < Duration ≤ 12 hours	Huff 2nd Quartile
12 hours < Duration ≤ 24 hours	Huff 3rd Quartile
> 24 hours Duration	Huff 4th Quartile

Figure SW5.4. Huff Rainfall Distribution

	Cumulative storm rainfall (%) for given storm type			
Cumulative storm time (%)	**First Quartile**	**Second Quartile**	**Third Quartile**	**Fourth Quartile**
5	16	3	3	2
10	33	8	6	5
15	43	12	9	8
20	52	16	12	10
25	60	22	15	13
30	66	29	19	16
35	71	39	23	19
40	75	51	27	22
45	79	62	32	25
50	82	70	38	28
55	84	76	45	32
60	86	81	57	35
65	88	85	70	39
70	90	88	79	45
75	92	91	85	51
80	94	93	89	59
85	96	95	92	72
90	97	97	95	84
95	98	98	97	92

Source: Bulletin 71, “Rainfall Frequency Atlas of the Midwest”, 1992

See the **Huff Distribution Design Resource** for additional design guidance.

2. Design Storm Frequencies

   The design storm frequency is the basis for all hydrologic computations. Selection of the design storm shall conform to the criteria set forth within the appropriate section dedicated to each drainage system type provided in this manual. The Designer shall run the appropriate return frequency storm(s) for the full range of durations (5 minute through 24 hours). Refer to Figure SW5.5 for a summary of the design storm frequency requirements.

Figure SW5.5 Acceptable Runoff Generation Methods

Stormwater Facility Type	Design Requirements
Storm Sewers (SW6)	Refer to **Chapter SW6 – Storm Sewers**
Inlets/Outlets (SW7)	Refer to **Chapter SW7 – Inlets/Outlets**
Culverts/Small Structures/Bridges (SW8)	Refer to **Chapter SW8 - Culverts/Small Structures/Bridges**
Open Channels (SW9)	Refer to **Chapter SW9 – Open Channels**
Stormwater Management (SW11)	Refer to **Chapter SW11 – Stormwater Management**

SW5.03 Runoff

Proper calculation of runoff is critical to proper planning and sizing of storm drainage facilities. This section identifies the methodology to be used for determining the storm runoff design peaks and hydrograph generation for preparation of storm drainage studies, plans, and facility designs.

1. Time of Concentration Calculation

   Time of Concentration (T_c) is the amount of time it takes for the most hydraulically distant point in the watershed to contribute flow. T_c influences the shape of the runoff hydrograph and has two components:

   $$T_c = T_s + T_{sc} + T_o$$

   where:

   T_c = time of concentration, hours

   T_s = travel time for sheet flow, hours

   T_{sc} = travel time of shallow concentrated flow, hours

   T_o = travel time for open channel flow, hours

   Sheet Flow is flow over plane surfaces and usually occurs in the headwaters of a stream near the ridgeline that defines the watershed boundary. Typically, sheet flow occurs for no more than 100 feet before transitioning to shallow concentrated flow.

   Shallow concentrated flow occurs from collecting into swales, small rills, and gullies after traveling approximately 100 feet as sheet flow.

   Open channel flow includes flow through structures such as swales, ditches, storm sewers, and tiles that are not flowing full.

   The minimum time of concentration for all computations shall be 5 minutes. Technical Release 55 (TR-55, June 1986) Chapter 3 provides the procedure for calculating T_c. Refer to **Exhibit SW5-1** for the T_c worksheet.

   See the **Time of Concentration Design Resource** for additional storm sewer design guidance.

2. Peak Flow Calculations

   Peak flow calculations represent the first level of runoff analysis. This analysis is used to determine the maximum flow rate at a given point resulting from a storm event. Peak flow analysis is sufficient to design storm sewers and culverts whose purpose is only to convey runoff. As indicated in Figure SW5.6, the Rational and Graphical Peak Discharge Methods are approved peak flow calculation methods for use in Fort Wayne.

A. Rational Method

The Rational Method can be used to compute peak flows for watershed areas less than twenty (20) acres. This method assumes that all rainfall abstractions are represented by a single runoff coefficient, C. Where distinctive land use features are known, use of an area weighted C factor is required. The Rational Method equation is:

$$Q = CiA$$

Where:

Q = Runoff (cfs)

i = Rainfall intensity (in/hr, see Figure SW5.2)

A = Drainage area (acres)

C = Runoff coefficient (see **Exhibit SW5-2**)

Using the Rational Method assumes:

- The rainfall intensity is uniform over the entire watershed during the entire storm duration.
- The storm duration is equal to Tc.
- The Tc is the time required for the runoff from the most remote part of the watershed to reach the point under design.

B. Graphical Peak Discharge Method - (TR-55)

The Graphical Peak Discharge Method uses the runoff curve number (CN), where CN > 40. This number is a function of soil type and land use. For details on using the NRCS (SCS) procedure refer to **TR-55, June 1986**. This method is implemented by first applying the following equations to calculate the runoff depth:

$$Q = (P-0.2*S)^2/(P+0.8*S) \text{ and } S=(1000/CN)-10$$

Where:

Q = Runoff depth (in)

P = Rainfall depth (in, see Figure SW5.3)

S = Retention (in)

CN = Curve number (see **Exhibit SW5-3** & **Exhibit SW5-4**)

Peak discharge is estimated as:

$$q_p = q_u * A * Q * F_p$$

Where:

q_p =Peak flow rate (cfs)

q_u = Unit peak flow rate (cfs/mi^2 per inch of runoff, refer to TR-55)

A =Drainage area (mi^2)

Q = Runoff depth calculated from previous equation (in)

Fp = Pond and swamp adjustment factor

= 1 if there are no ponds or swamps

3. Hydrograph Generation Methods

A hydrograph represents runoff flow as it varies over time at a particular location. The area under the hydrograph represents the total volume of runoff. As opposed to peak rate of runoff, the hydrograph accounts for the variation in volume and flow rate over the duration of the of the storm event. Hydrographs are necessary to assess the effects of stormwater detention/retention facilities. Hydrographs are also necessary for assessing the effects of combining runoff from two or more subcatchments discharging to a common location in complex drainage areas with multiple subcatchments.

Hydrologic modeling software or the Tabular Hydrograph Method listed in Figure SW5.5 are approved methods for hydrograph generation. Designers are responsible for understanding the limitations and correct application of modeling software used for hydrograph generation. For details on the Tabular Hydrograph Method refer to TR-55, June 1986. In some cases detailed hydrologic studies may have been completed for the area of interest and can be used with approval from City Utilities.

Figure SW5.6 Acceptable Runoff Generation Methods

Peak Flow Calculation Methods	**Application Criteria**
Rational Method	Drainage Areas < 20 acres
Graphical Peak Discharge Method	1. Applicable to drainage areas of all sizes 2. Drainage area must be hydrologically homogeneous (i.e. describable by one CN) 3. CN > 40 4. 0.1 hrs. < T_c < 10 hrs. 5. Drainage area can have only one main stream, or if more, the branches must have nearly equal T_c’s. 6. For use with 24 hour storm rainfall depths
Hydrograph Generation Method	**Application Criteria**
Tabular Hydrograph Method	1. Applicable to drainage areas of all sizes 2. Divide drainage area in subbasins that have a reasonably homogeneous CN and one main channel 3. For use with 24-hour storm rainfall depths 4. T_c < 2 hrs.
TR-20 *(preferred)*	Used to generate and route runoff hydrographs. Output consists of peaks and/or hydrographs. TR-20 develops hydrographs from rainfall using the dimensionless unit hydrograph, drainage area, time of concentration, and SCS curve number.
HEC-HMS (HEC-1) *(preferred)*	Provides a variety of options for simulating precipitation-runoff process.
WinTR-55	Uses the TR-20 model for hydrograph generation and routing. Provides a variety of options for defining precipitation, land use, and dimensionless unit hydrograph. Not as comprehensive as TR-20.
Unit Hydrograph	For gauged watershed – rainfall and runoff records can be used to generate a site-specific unit hydrograph. For ungauged watersheds – synthetic unit hydrographs may be used, such as NRCS, Clark, and Snyder.
EPA SWMM	Used to route and combine hydrographs for sub-catchments. Appropriate for use in more complex basins.
Published Hydrologic Information	May be used where Fort Wayne and/or State have developed detailed hydrologic studies appropriate for use in the study area.

SW5.04 Offsite Hydrologic Analysis

The design of stormwater facilities shall consider and accommodate the storm runoff from watersheds upstream to the drainage area(s) being analyzed as indicated in Figure SW5.7. Investigation of facilities downstream of the boundaries of the project area is a required part of the design process.

Figure SW5.7 Assumptions for Onsite and Offsite Storm Flow Analysis

Analysis Type	Requirements for Use in Fort Wayne
Onsite Analysis	The proposed fully developed land use plan shall be used to determine runoff coefficients. Changes in flow patterns (from undeveloped site conditions) caused by the proposed development shall be considered. The proposed lot grading shall be used to calculate the time of concentration or the runoff calculation parameters.
Offsite Analysis	Upstream drainage areas shall be considered developed for analysis of onsite stormwater facilities. Where the offsite area is fully or partially undeveloped, the runoff shall be calculated assuming the basin is fully developed. Fully developed land use parameters (i.e., C and CN) shall be based on current zoning. Downstream analysis of the impacts of drainage improvements shall be completed to a point in the receiving watercourse where an increase in the stage of the receiving stream during the design storm is less than or equal to 0.14 feet (0.14’).

SW5.05 Consistency of Watersheds

The consistent quantity of area and discharge location of established watersheds is required. This allows the City to maintain the existing stormwater conveyance systems and plan for growth accordingly. Keeping consistent watersheds within the river shed areas is also an established management tool at the state and federal levels. It is especially critical for the Great Lakes as it relates to water quantity and quality.

1. Storm Sewer and Surface Conveyance Watersheds

   The City of Fort Wayne requires the areas of watersheds to remain consistent in size. For the purpose of this goal, a consistency of a watershed means the outfall from a proposed project is within the same storm lateral or surface conveyance and contains the same quantity of area as the pre-construction conditions. The outfall can connect at a different point. However, the site’s discharge shall contribute to the same lateral or surface conveyance as the pre-construction conditions.

   Occasionally, a project’s pre-construction conditions will drain into two or more watersheds. The areas contributing to the different watershed shall remain consistent between the pre- and post-construction conditions. Consistent is defined as being with 3% of the project’s pre-construction watershed areas.

   The allowable justifications for changing the net areas to a storm sewer lateral or surface conveyance watershed includes:

1. The existing conveyance system is inadequate and the overall storm system is improved by a change in the watershed limits.
2. The change in area is considered irrelevant by the City of Fort Wayne (i.e., the storm laterals outfall in the same location and have excessive capacities).
3. The change will direct run-off to a storm system and away from a combined sewer.

The designer must contact development services (DVS) prior to sending flow to a different watershed. All such deviations that change quantity of area or discharge location of the pre-construction watersheds shall go through the Variance Process to seek approval.

2. River Watersheds Basins

Changing the area contributing to an individual river's watershed basin is prohibited. The location of the discharge point into the river's watershed can be moved. However, the rainwater that falls within a river's watershed in the pre-construction conditions shall remain in that river's basin.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SW5-1 Time of Concentration Worksheet
		Version: June 2024 Fillable Version

Project ______________________ By______________________ Date __________

Location ______________________ Checked______________________ Date __________

Circle one: Existing Proposed

NOTES: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

	Units	Segment 1	Segment 2	Total
Overland (Sheet) flow (Applicable as part of T_c computation only) Segment ID				
1. Surface description : paved or unpaved				
2. Manning's roughness coeff., n				
3. Flow Length, L (total L ≤ 300 for unpaved, L ≤ 100 for paved)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. Calculate $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$	hr		+	=
Shallow concentrated flow Segment ID				
7. Surface description: paved or unpaved				
8. Flow length, L	ft			
9. Watercourse slope, s	ft/ft			
10. Average velocity, $V_{unpaved}=16.1345(s)^{0.5}$, or $V_{paved}=20.3282(s)^{0.5}$	ft/s			
11. Calculate $T_t = \frac{L}{3600\ V}$	hr		+	=
Channel flow Segment ID				
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Calculate Hydraulic radius, $r_H = \frac{a}{p_w}$	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n (Exhibit 205.3.1)				
17. Calculate $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$	ft/s			
18. Flow length, L	ft			
19. Calculate $T_t = \frac{L}{3600\ V}$	hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			

Hydrological Soil Group****		A			B			C			D			
Land Slope		0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	Percent-Impervious Surface*
Land Use	RF** (yrs)													
Commercial	5&10	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	70 - 95
	50	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	
	100	.98	.98	.98	.98	.98	.98	.98	.98	.98	.98	.98	.98	
Industrial	5&10	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	65 - 90
	50	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	
	100	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	.95	
High Density Residential (<12,000 sf)	5&10	.55	.57	.58	.56	.58	.60	.58	.60	.62	.60	.62	.65	40 - 60
	50	.62	.64	.66	.63	.66	.68	.66	.68	.70	.68	.70	.73	
	100	.65	.67	.69	.66	.69	.71	.69	.71	.74	.71	.74	.77	
Medium Density Residential (12,000 to 1/2 acre)	5&10	.31	.35	.38	.33	.37	.40	.38	.40	.45	.40	.45	.50	15 – 30***
	50	.35	.40	.43	.37	.42	.45	.43	.45	.51	.45	.51	.57	
	100	.37	.42	.45	.39	.44	.47	.45	.47	.54	.47	.54	.60	
Low Density Residential (> 1/2 acre)	5&10	.20	.25	.28	.23	.27	.30	.28	.30	.38	.30	.34	.43	5 - 15
	50	.23	.28	.32	.26	.31	.34	.32	.34	.43	.34	.38	.49	
	100	.24	.29	.34	.27	.33	.36	.34	.36	.45	.36	.40	.51	
Agricult. And Other Open Land	5&10	.14	.18	.20	.16	.20	.25	.20	.22	.30	.22	.28	.38	less than 5
	50	.16	.20	.23	.18	.23	.28	.23	.25	.34	.25	.32	.43	
	100	.17	.21	.24	.19	.24	.29	.24	.26	.36	.26	.34	.45	

* Average range of percent-impervious surface expected for designated land-use condition.
** Design storm return frequency in years.
*** Where percent-impervious surface ranges between 30 and 40 percent (e.g., 35%) interpolate runoff coefficient between values given.
**** Hydrologic soil group for a particular type of soil may be obtained from the “Soil Survey of Allen County” by the U.S.D.A.’s Soil Conservation Service or the “Master Plan for Storm Drainage”, by the Three Rivers Coordinating Council, April 1972.

NOTE: Calculated “C” factors based upon actual conditions may be used.

Cover Description Cover Type and Hydrologic Condition	Average Percent Impervious Area	Curve Numbers for Hydrologic Soil Group A	B	C	D
Fully Developed Urban Areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc):					
Poor Condition (grass cover <50%)		68	79	86	89
Fair Condition (grass cover 50% to 75%)		49	69	79	84
Good Condition (grass cover >75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1 to 2 inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential district by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)		77	86	91	94
Idle lands					

Cover Description	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
Cover Type		A	B	C	D
Pasture, grassland, or range - continuous forage for grazing.	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow - continuous grass, protected from grazing and generally mowed for hay	– –	30	58	71	78
Brush - brush-weed-grass mixture with brush the major element.	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods - grass combination (orchard or tree farm).	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads - buildings, lanes, driveways, and surrounding lots	– –	59	74	82	86

Book 2

Stormwater (SW)

SW6 Storm Sewers

SW6.01 Purpose

The purpose of this Chapter is to establish the minimum standards and technical design criteria for all storm sewers in regard to hydrology, size, and alignment within the City of Fort Wayne. The primary function of storm sewer systems is to collect excess stormwater from street gutters, convey the excess stormwater through storm sewers and along the street right-of-way, and discharge it into a detention basin, water quality best management practice (BMP) or the nearest receiving water body (FHWA 1996). The design of storm sewers presented in this section relies on fundamental hydrologic and hydraulic design concepts. Designers should refer to **Chapter SW5 – Hydrology**, **Chapter SW7 – Inlets/Outlets**, **Chapter SW8 – Culverts/Small Structures/Bridges**, and **Chapter SW9 – Open Channels** for additional design methodology.

SW6.02 Design Storms

Two design storms shall be considered for sizing storm sewers: the minor (10-year) storm and the major (100-year) storm. Refer to **Chapter SW5 – Hydrology** for appropriate hydrologic design methods. In each case, storm sewers shall be sized to carry the portion of the runoff that cannot be conveyed on the surface, as dictated by the available capacity in streets and swales during these two events. Designers shall ensure that storms in excess of pipe design flows can be safely conveyed through a development without damaging structures or flooding major roadways.

Designers shall refer to **Chapter SW7 – Inlets/Outlets** for design guidance on inlet spacing.

The hydraulic grade line (HGL) shall not exceed the crown of the pipe by more than five percent (5%) of the diameter of the pipe for the design storm.

1. Minor Event Design Storm

   At a minimum, all storm sewers shall be designed to convey the peak flow for the minor storm (10-year storm event).

2. Major Event Design Storm

   The storm sewer system shall be sized to convey the major storm (100-year storm event) if any of the following conditions are met:

   a) The street capacity for the major storm is exceeded; especially where the grade slopes down behind the curb and the major storm capacity is limited to the height of the curb.

b) The major storm flows split off in an undesired direction (e.g. flow splits at intersections).

c) The storm sewer system is accepting flow from an upstream storm sewer system or branch that is designed for the major storm.

d) Regional storm sewers are designed for the major storm.

e) The storm sewers must convey un-detained flows to a regional detention basin if an overland flow path to the basin is not available.

SW6.03 Alignment Criteria

All storm sewers shall be constructed with a straight alignment between manholes. Sound engineering judgment shall be utilized when determining locations for stormwater systems. Existing easements and rights-of-way shall be utilized if possible. Service needs of both the present service area and future service areas should be thoroughly evaluated. Figure SW6.1 provides the minimum horizontal and vertical alignment criteria.

Figure SW6.1 Horizontal and Vertical Alignment Criteria

Alignment of Storm Sewer Relative to:	Alignment		Comment
	Minimum Vertical Clearance	Minimum Horizontal Clearance	
Water Main	18 inches	10 feet	The distance shall be measured edge to edge. Approval from City Utilities will be required for lesser clearances
Building Structure or Foundation	-	10 feet (@ depth of less than 10 feet) 15 feet (@ depth of greater than 10 feet)	
Cover	-	-	Minimum cover depends upon the pipe size type and class (see **Chapter MA5 – Stormwater Materials and Testing Requirements**), and the soil bedding condition. The storm sewer grade shall be such that a minimum cover is maintained to withstand loading on the pipe.

1. Placement in Existing Rights-of-Way and Easements

   For storm sewers located within existing or proposed street right–of-way, the preferred placement should be as shown on Standard Drawing **BS-1**.

   In areas of concrete pavement, consideration shall be given to placing the storm sewer in a location such that when saw-cut, an edge of the pavement to be removed would coincide with an existing construction joint resulting in the need to only saw-cut one side of the pavement. Manhole structures shall be either completely outside the pavement or completely inside the pavement. The existence of curbs or proposals of future curb and gutter shall be taken into account when evaluating the benefit of reducing the number of manholes in curved streets.

2. Minimum Distance from Water Lines

   Storm sewers shall be laid at least the vertical and horizontal distance listed in Figure SW6.1. The distance shall be measured from outside edge of pipe to outside edge of pipe.

   In instances where it is not possible to maintain the minimum horizontal alignment, City Utilities may allow deviation on a case-by-case basis. This deviation may allow installation of the storm sewer closer to the water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18” above the top of the storm sewer.

   When proper separation as described above is not possible, the water main shall be HDPE and storm sewer must be appropriate pressure-rated pipe material from structure to structure, complying with the water supply standards outlined in **Chapter MA5 – Stormwater Materials and Testing Requirements** and **Chapter MA7 – Water Materials and Testing Requirements.** In all instances when separation cannot be maintained, City Utilities shall be consulted for guidance and approval.

   See **Section W5.04 – Vertical Alignment** for minimum coverage depth for water mains.

3. Minimum Distance from Additional Utilities

   All plans shall show the location of both underground and overhead utilities (existing and proposed). The location of the utilities shall be derived from the best information available. Each utility company shall receive a set of plans prior to final submittal on which they may note changes or additions to utility information. The adequacy of the separation of the storm sewer and other utilities shall be determined by both the appropriate utility company and the design engineer. Any necessary relocation shall be closely coordinated with the respective utility company.

SW6.04 Hydraulic Design

Storm sewers are designed to have capacity that meets or exceeds the design discharge (peak flow rate) as determined using the Rational Method (**Chapter SW5 – Hydrology**). Hydraulic computations are then performed to determine the capacity of storm sewer systems. Refer to Urban Drainage Design Manual Hydraulic Engineering Circular 22, 3rd Edition Chapter 7 for more technical detail on design methodology for storm sewer hydraulic design. As site conditions allow, the rate at which water flows through the storm sewer system and MS4 conveyances shall be regulated to reduce outfall scouring and stream bank erosion.

1. Flow Equations and Storm Sewer Sizing

   Storm sewer flow is usually unsteady and non-uniform, but for design purposes it is assumed to be steady and uniform at the peak flow rate. Manning's equation is utilized (see **STSD Calculations Design Resource**), which can be stated as:

   $$Q = 1.49/n\ AR_h^{2/3}S_f^{1/2}$$

   Where:

   Q = flow rate (cfs)

   n = Manning's Roughness Coefficient, **Exhibit SW6-1** a coefficient of 0.013 shall be used unless authorized by the City.

   A = flow area (ft^2)

   R_h = hydraulic radius (ft), defined as flow area, A, in square feet divided by wetted perimeter, (P_w) in feet

   S_f = friction slope (equal to storm sewer slope for uniform flow) (ft/ft)

   Initially storm sewers can be sized to flow just full (i.e., as open channels using nearly the full capacity of the pipe). For circular pipes,

   $$D_r = (2.16 * nQ_p/\sqrt{S_o})^{3/8}$$

   In which D_r is the minimum size pipe required to convey the peak design flow and Q_p is the peak design flow.

   The typical process for sizing storm sewers proceeds as follows:

   a) Use the Rational equation to calculate peak flow rate for design storm event.

   b) Size storm sewer using Manning's equation assuming uniform, steady flow at the peak.

   c) Check proposed storm sewer sizes using the energy equation by accounting for head losses.

   d) If surcharging occurs at manholes or inlets, increase storm sewer size and repeat process.

2. Hydraulic Grade Line

   The hydraulic grade line (HGL) in newly constructed storm sewers shall not exceed the crown of the pipe by more than five percent (5%) of the diameter of the pipe for the minor storm (or the major storm if the storm sewer is designed to convey that flow). If an exception is requested, the HGL shall be determined by starting at the downstream end of the proposed drainage system using the maximum water surface elevation experienced for the design period. Tailwater shall be included in the analysis. For these exceptions, design calculations shall be provided where the HGL exceeds the crown of the pipe.

Sound engineering judgment shall be used to account for the HGL in storm sewers affected by storm events exceeding the design storm event.

3. Headlosses

Energy losses in pipes, structures, and appurtenances shall be taken into account in all designs, including:

a. Pipe Friction Losses

The headloss due to friction in a pipe is computed as follows:

$$H_f = [V^2\, n^2\, L]/[(2.21)(R_h)^{4/3}]$$

Where:

H_f = Friction loss, ft

V = Velocity, ft/s

n = Manning's Roughness Coefficient (See **Exhibit SW6-1**)

L = Length of pipe, ft

R_h = Hydraulic radius of pipe, ft

b. Structure and Appurtenance Losses

Local losses in structures and appurtenances shall be computed as follows:

$$H_L = K(V^2/2g)$$

Where:

H_L = Headloss in structure, ft

K = Headloss coefficient

V = Velocity, ft/s

g = Acceleration of gravity, 32.2 ft/s^2

Values for K may be obtained using the following Figure:

Figure SW6.2 Headloss Coefficients

Structure Type	K
90-degree bend	0.4
45-degree bend	0.32
Straight Through	0.05

Values for other bends may be derived through linear interpolation.

c. Exit Losses

For sudden expansion at storm drain outlet, the exit loss is:

$$H_o = 1.0\ [(V_o^2/2g) - (V_d^2/2g)]$$

Where:

V_o = Average outlet velocity

V_d = Channel velocity downstream of outlet in the direction of the pipe flow

g = Acceleration due to gravity (32.2 ft/s^2)

4. Velocity

The velocity in newly designed storm sewer systems shall not be less than 2.5 ft/s and no greater than 6 ft/s. This velocity shall be based on full flow, gravity conditions.

5. Slopes

The minimum slope for storm sewers less than 48” in diameter shall be such that minimum velocities can be achieved. The minimum slope for storm drains with diameters of 48” or greater shall be 0.001 ft/ft.

The minimum slope for some standard size pipes with an n value of 0.013 and a velocity of 2.5 feet per second:

Figure SW6.3 Minimum Pipe Slopes

Pipe Size	Min. Slope
12”	0.30%
15”	0.22%
18”	0.18%
24”	0.12%
30”	0.09%
36”	0.07%

SW6.05 Construction Materials

Construction materials must be in accordance with Chapter MA5 – Stormwater Materials and Testing Requirements.

SW6.06 Pipe Size

The minimum pipe diameter for storm sewers, with the exception of perforated underdrains shall be 12”. Perforated underdrains for use in poorly drained and flat drainage areas shall have a minimum diameter of 6”.

The minimum diameter of a culvert crossing a public roadway shall be 15 inches.

SW6.07 Manholes

1. Manholes shall be located at the following locations:
   - Where dictated by spacing requirements
   - Storm sewer junctions
   - Transitions in alignment
   - Transitions in grade
   - Transitions in pipe diameter
   - Transitions in material
2. Spacing

   Manholes shall be placed at the intervals provided in Figure SW6.4.

Figure SW6.4 Maximum Manhole Spacing Intervals

Pipe Diameter	Maximum Distance
12" - 15"	400'
18" - 30"	500'
33" and greater	600'

3. Manhole Diameter

   Online manhole sizing calculators are also available as a guideline, but designer should be aware of minimum reinforcing requirements between the pipes. More detailed information is provided in Section SA7.02 — Manholes.

Figure SW6.5 Manhole Maximum Allowable Pipe Diameter

Minimum Manhole Diameter	Maximum Pipe Size Straight Through and up to 45° angle			Maximum Pipe Size 45° to 90° angle		
	RCP	HDPE	PVC	RCP	HDPE	PVC
48”	18”	18”	24”	18”	18”	24”
60”	36”	36”	36”	24”	24”	27”
72”	42”	42”	48”	36”	36”	42”
84”	54”	54”	60”	42”	42”	48”
96”	60”	60”	66”	48”	48”	54”

Additional Manhole requirements based on diameter include:

- For flexible pipe in sizes less than 36 inches (36”) or rigid pipe less than thirty inches (30”) in diameter, a compression connector or resilient connector per ASTM C923 shall be installed.
- For all materials, pipe sizes 36 inches (36”) and larger, seep ring and non-shrink grout shall be installed.

All manholes must have sufficient wall between pipe openings to meet the following criteria:

- For circular structures, the minimum distance allowed between precast holes shall be six inches (6”).
- For rectangular structures such as junction chambers, where pipe is to be installed in adjacent walls, a minimum of six inches (6”) of wall as measured from the interior corner is required on each side of the pipe beyond the precast opening for the pipe. This rule is not applicable for structures which have pipe installed in opposite walls or where one outlet pipe is utilized.

4. Transitions in Alignment

   Changes in direction of flow (internal angles between pipes) less than 90 degrees (90^{o}) are not allowed due to hydraulic losses.

5. Transitions in Grade

   For all manhole and junction chamber structures with equal diameter influent and effluent pipes, a minimum 0.10 foot (0.1 ‘) drop between the inverts of the influent and effluent pipes shall be maintained to offset losses experienced at manhole structures. For change in direction 45 degrees to 90 degrees, a minimum 0.20 foot drop shall be maintained.

   The flow channel through a manhole shall be made to conform in shape, and slope to that of connecting sewers.

6. Transitions in Pipe Diameter

   Storm sewer pipe size changes are only allowed at manhole and junction chamber structures. Drop between the influent and effluent pipes of different diameters shall be sufficient to maintain the energy gradient. The influent and effluent pipes with different diameters shall be connected to manholes and junction chamber structures according to the criteria in Figure SW6.6.

Figure SW6.6 Diameter Change Criteria

Diameter	Criteria
24 inch (24”) or less	1. When increasing pipe diameter by six inches (6”) or less, crown elevations at the centerline of manhole shall match. 2. When increasing pipe diameter by more than six inches (6”), the springlines of the pipes at the centerline of the manhole shall match.
Greater than 24 inch (24”)	1. Begin design by matching crowns at centerline of manhole and evaluate energy grade line (EGL) of upstream and downstream segments. EGL shall not increase in downstream segment. 2. If EGL of downstream segment lies below EGL of upstream segment, the downstream sewer may be raised by two-thirds the difference between the upstream and downstream EGLs.

7. Bench

   A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench shall be sloped no less than ½ inch per foot (4%). No manhole pipe shall discharge onto the surface of the bench.

8. Adjustment Rings

   At least one adjustment ring is required on all structures. Riser rings shall have a minimum thickness of 3 inches and a maximum thickness of 6 inches. A 6 inch adjustment ring shall be used when lowering of a manhole rim is not anticipated. No more than two adjustment rings shall be used to adjust for 12 inch. Bricks are not acceptable.

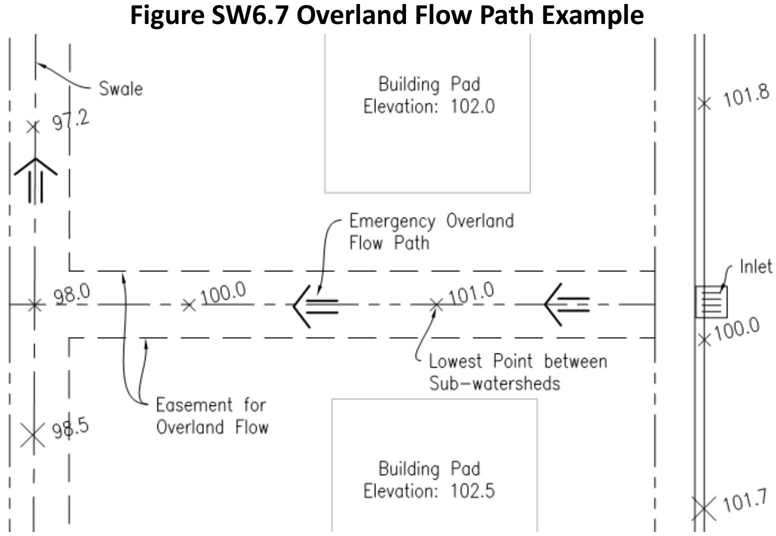
SW6.08 Storm Sewer Laterals

Storm sewer laterals shall intersect at manholes. Blind connections are prohibited.

SW6.09 Overland Flow Paths

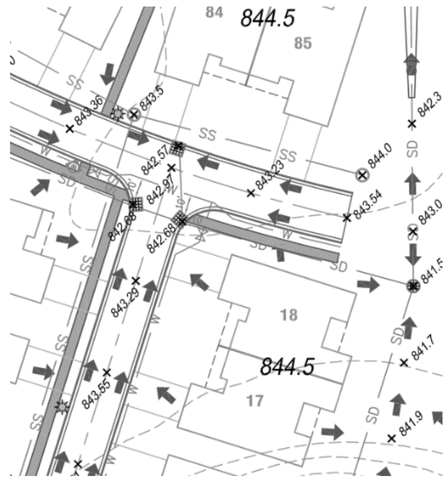
Storm sewer systems are prone to clogging, overloading, or other forms of failure. Designs shall include the designation of an overland flow path. This path shall delineate the overland route for each structure's sub-watershed to the detention basin or offsite relief discharge as appropriate. This path shall be within right-of-ways or easements. The overland flow path shall be at least 1.0 foot lower than the lowest building pad in the sub-watershed and at least 2.0 feet below the base flood elevation (BFE) identified on the plat. In all lots, a flood protection grade shall be identified on the plat and restrictive covenants for each sub-watershed.

Figure SW6.7 Overland Flow Path Example



SW6.10 Construction Phasing and Sequencing Considerations

Figure SW6.8 Surface Drainage Plan Example



Storm sewer and general drainage have large impacts upon construction sequencing and development phasing. Typically, a project is designed for an entire site. Any phasing needs to be planned as a “stand alone development”. There cannot be temporary drainage issues that will be addressed at a later phase. Some of the common issues that must be considered between phasing or general construction sequencing include:

1. The temporary termination of impervious surfaces shall drain to a storm sewer. Streets and drives shall terminate at the inlet locations or drain back into the phase being constructed. Impervious surfaces shall not surface drain onto a future phase of the project.

2. Swale and other overland flow requirements shall be completed to an adequate outfall. The surface drainage plan for a phased development shall not require flow paths to be altered from the master plan. The storm sewer or other outfall location identified on the master plan shall be constructed concurrently as the phased or sequenced construction.

3. Knockouts are the preferred method for sequencing future storm sewer connections. A stubbed section of pipe for future extensions is susceptible to having an incorrect slope or alignment. It is also a potential source for soil and other partials to enter the system.

SW6.11 Private Storm Sewers

Some storm sewer is installed uniquely for the development of a single landowner. It is most often associated with commercial and industrial site development. This will remain a private storm sewer. The landowner will be responsible for the construction and maintenance of the system.

Private storm sewer systems shall abide by the design and construction requirements of a public storm sewer.

SW6.12 Non-Gravity Flow Stormwater Systems

Stormwater facilities are to be gravity flow. Facilities designed to include pumps or mechanized equipment such as gates will be allowed only through the variance process described in General Requirements, **Chapter GR3 – Variances**.

SW6.13 Stormwater Design Considerations

The proposed stormwater design shall account for the capture and collection of stormwater runoff from the entire site. Stormwater runoff in parking lots must be captured and managed and shall not drain out to the street. Sheet flow from the site to the public right-of-way, over the sidewalk, and / or public stormwater system is prohibited.

Dead end streets shall not drain into the adjacent properties. The street design should account stormwater capture and conveyance.

SW6.14 Crossings

Stormwater Pipe Criteria Crossing Considerations:

1. Railroad Crossings

    When a railroad is crossed, a copy of the railroad crossing application and proof of approval from the respective railroad entity shall be submitted to City Utilities. The specifications and precautionary measures required by the respective railroad officials shall be followed. In the absence of specific railroad requirements, the following general criteria shall apply:

    - Storm sewers shall cross tracks at an angle as close as possible to 90 degrees (90°). The crossing angle shall never be less than 45 degrees (45°).
    - Stormwater mains crossing beneath railroad tracks shall be constructed in bored and jacked casings.
    - Casing pipe under railroad tracks and across railroad rights-of-way shall extend to a point a minimum distance of 25-feet from the centerline of the outside track or the right-of-way line, whichever occurs first and a minimum of 5-feet beyond the top of ditch bank within the railroad right-of-way.
    - Stormwater mains laid longitudinally along railroad rights-of-way shall be located as far as practical from the tracks. If the storm sewer is located within 25-feet of the centerline of any track, the storm sewer shall be encased or shall be of a special design as approved by City Utilities Engineering.
    - Casings under tracks and across railroad rights-of-way shall be a minimum of four 4-feet deep as measured from the bottom of the track rail to the top of the casing pipe.

    A railroad crossing drawing including a plan and profile view shall be submitted to both City Utilities Engineering and the appropriate railroad company for review and approval. **Exhibit SA5-2** and **Exhibit SA5-3** show examples of plan and profile views, respectively. The following items shall be included on the drawing: relationship between the proposed storm sewer and the railroad, angle of crossing, location of utilities, original survey station of the railroad (when available), right-of-way lines, limits of boring or casing liner, topography, and general layout. The profile shall clearly show the storm sewer in relation to both the tracks and existing ground elevations. Boring limits by station, storm sewer line soundings and borings, and other pertinent information shall be included on the drawings.

2. Highway Crossings

   When any highway is crossed, a copy of the highway crossing application and proof of approval from the respective highway entity shall be submitted to City Utilities. The specifications and precautionary measures required by the respective highway officials shall be followed. In the absence of specific highway requirements, the following general criteria shall apply:

   - Stormwater sewers shall cross the roadway at an angle as close as possible to 90 degrees (90°). The crossing angle shall never be less than 45 degrees (45°).
   - Stormwater mains crossing beneath the highway shall be constructed in bored and jacked casings.
   - Storm sewers shall not be placed under roadway bridges where the possibility of restricting the required waterway area or where a possibility of compromising the structural integrity of bridge foundations exists.
   - Pipes crossing beneath highways shall be installed by jack and bore method with a casing pipe, tunneling method or micro-tunneling method.
   - Borings under highways shall have a minimum depth of cover of 3-feet as measured from the surface elevation to the top of the casing. The top of the casing shall not be above the invert of existing or proposed ditches.
   - Borings under highways shall extend a minimum of 10-feet (measured perpendicularly) outside the outer edge of existing pavement or to the toe of slope when the roadway is on fill and the toe of slope exceeds the outside of pavement requirement of 10-feet.
   - Stormwater mains laid longitudinally along highway rights-of-way shall be located a sufficient distance outside of the existing edge of pavement to ensure worker and motorist safety during construction.
   - Stormwater mains laid outside of pavement but inside of roadway right-of-way shall have a minimum depth of cover of 4- feet.

Roadway crossing construction may require approval and/or permitting from the agency having jurisdiction over the roadway. Each public agency may have design criteria which must be complied with for permitting. For additional information on permitting refer to **Chapter GR4 – Contracts, Fees, and Permits**.

SW6.15 Checklists and Design Aids

All of the design criteria in this chapter must be followed. Several key considerations that the designer must take care to address include:

- Design the HGL not to exceed the pipe's crown more than five percent (5%) of the diameter of the pipe for the design storm.
- Account for all losses in the EGL and HGL calculations including pipe friction, manhole, junction, and outlet losses.
- Provide adequate erosion protection at the outlet of all sewers.
- Provide cross sections for riprap protection.
- Check for minimum pipe cover and clearance with utilities.
- Non-gravity flow systems should only be considered as a last option.

Exhibit SW6-1 Values of Manning's Roughness Coefficient, *n*

	Manning's n Range
I. Closed Conduits:	
A. Concrete Pipe	0.013
B. Corrugated-metal pipe or pipe arch	
1. 2_ by ½-in. Corrugation (riveted pipe):	
a. Plain of fully coated	0.024
b. Paved invert (range values are for 25 and 50 percent of circumference paved):	
(1) Flow full depth	0.021-0.018
(2) Flow .8 depth	0.021-0.016
(3) Flow .6 depth	0.019-0.013
2. 2_ by ½-in. helical corrugation	0.022
3. 2_ by ½-in. annular corrugation	
a. 15 in. to 36 in	0.025
b. 42 in. to 96 in	0.024
4. 3 by 1 in. corrugation.	0.027
5. 5 by 1 in. corrugation	0.025
C. Structural plate pipe or pipe arch	
1. 6 by 2 in. corrugation	0.033
2. 9 by 21/2 in. corrugation	0.035
D. Ductile Iron Pipe	0.012
E. Smooth High Density Polyethylene (HDPE)	0.012
F. Smooth-lined interior Polyvinyl Chloride (PVC)	0.012
II. Open Channels, lined (straight alignment):	
A. Concrete with surfaces as indicated:	
1. Formed, no finishes	0.013-0.017
2. Trowel finish	0.012-0.014
3. Float finish	0.013-0.015
4. Float finish	0.015-0.017
5. Gunite, good section	0.016-0.019
6. Gunite, wavy section	0.019-0.022
B. Concrete, bottom float finished, sides as indicated:	
1. Dressed stone in mortar	0.015-0.017
2. Random stone in mortar	0.017-0.020
3. Cement rubble masonry	0.020-0.025
4. Cement rubble masonry, plastered	0.016-0.020
5. Dry rubble (rip rap)	0.020-0.030
C. Gravel Bottom, sides as indicated:	
1. Formed concrete	0.017-0.020
2. Random stone in mortar	0.020-0.023
3. Dry rubble (rip rap).	0.014-0.017
III. Open Channels, (straight alignment, natural lining):	
A. Earth, uniform section:	
1. Clean, recently completed.	0.016-0.018
2. Clean, after weathering	0.018-0.020
3. With short grass, few weeds	0.022-0.027
4. In gravelly soil, uniform section, clean	0.022-0.025
B. Earth, fairly uniform section:	
1. No vegetation	0.022-0.026
2. Grass, some weeds	0.025-0.030
3. Dense weeds or aquatic plants in deep channels	0.030-0.036
4. Sides clean, gravel bottom	0.025-0.030
5. Sides clean, cobble bottom	0.030-0.040
C. Channels not maintained, weeds and brush uncut:	
1. Dense weeds, high as flow depth	0.06-0.13
2. Clean bottom, brush on sides	0.05-0.06
3. Clean bottom, brush on sides, highest stage of flow	0.07-0.11
4. Dense brush, high stage	0.10-0.14
IV. Street and Expressway Gutters:	
A. Concrete gutter, troweled finish	0.013
B. Asphalt pavement:	
1. Smooth texture	0.013
2. Rough texture	0.016
C. Concrete gutter with asphalt pavement:	
1. Smooth	0.013
2. Rough	0.015
D. Concrete pavement:	
1. Float finish	0.014
2. Broom finish	0.016
E. For gutters with small slope, where sediment may accumulate, increase above values by	0.002
V. Natural Stream Channels:	
A. Minor streams (surface width at flood stage less than 100 ft.):	
1. Fairly regular section:	
a. Some grass and weeds, little or no brush	0.030-0.035
b. Dense growth of weeds, depth of flow materially greater than weed height	0.035-0.06
c. Some weeds, light brush on banks	0.035-0.06
d. Some weeds, heavy brush on banks	0.05-0.07
e. Some weeds, dense willows on banks	0.06-0.08
f. For trees within channel, with branches submerged at high stage, increase all above values by	0.01-0.02
2. Irregular sections, with pools, slight channel meander: Increase values given in 1 a-e about	0.01-0.02
VI. Sheet Flow (for use in time of concentration calculations only):	
A. Paved Surfaces	
1. Smooth Surfaces (concrete, asphalt, gravel, or bare soil)	0.011
B. Unpaved Surfaces	
1. Fallow (no residue)	0.05
2. Cultivated Soils	
a. Cover < 20%	0.06
b. Cover > 20%	0.17
3. Grass	
a. Short grass, prairie	0.15
b. Dense grass	0.24
c. Bermuda grass	0.41
d. Range	0.13
4. Woods	
a. Light underbrush	0.04
b. Dense underbrush	0.80

Book 2

Stormwater (SW)

SW7 Inlets/Outlets

SW7.01 Purpose

The purpose of this Chapter is to establish a basis for inlet design utilizing City of Fort Wayne standard inlets and castings.

Stormwater inlets are a vital component of the urban stormwater collection and conveyance system. Inlets intercept excess stormwater from streets and developed areas and transition surface flow into storm sewers.

Proper inlet design includes both the proper inlet hydraulic capacity and appropriate inlet placement.

Methods for determination of stormwater runoff are presented in the **Chapter SW5 – Hydrology**.

SW7.02 Inlet Use by Grates

There are numerous grate options for inlets. The majority fall into three categories based on placement:

1. Curb and Gutter
2. Pavement and Alley
3. Swale and Grass

All inlets placed in a curb and gutter situation shall have a combination inlet frame, grate, and curb box. A rolled curb casting is prohibited. Rolled curb shall be transitioned to the curb box per Standard Drawing **SW-7-4**.

The proper orientation a vane grate is important to maximize its capacity. The vanes shall be orientated to direct the flow down the face of the vane. An inlet is in a sump or sag condition when the gutter profile is contributing to the inlet from both sides. It requires a bidirectional vane grate.

Vane grates have greater capacity than flat grates, tend to be bicycle friendly, and shall only be used for steep slopes. See **Exhibit SW7-1 Inlet Capacity of Certain Gates** for detailed design guidance charts to aid in the selection of different types of inlets and grates.

An inlet can also be in a continuous grade situation. The gutter profile is contributing from only one direction. The gutter profile continues downward after the inlet. It requires a monodirectional vane grate.

Pavement and alley inlets are in areas of impervious surface but without a curb. These are most often in parking lots or pavement with inversed crowns. The City's details identify these as "alley castings".

Inlets with alley castings shall have an ADA compliant grate if within an anticipated accessible route. An accessible route would be a sidewalk, trail, crosswalk or as otherwise defined by the American Disabilities Act. Alley casting are appropriate for stone covered parking areas.

Inlets in swales and pervious surfaces with vegetative cover have inherent challenges. The grates are prone to clogging from lawn clippings, leaves and other lawn waste. These inlets shall have a beehive (domed) grate. Flat grates are prohibited in areas of vegetative cover.

Drainage structures within the public right-of-way or easements with impervious public trails shall drain the subbase of the pavement. Subdrains shall be stubbed out of the drainage structures. The subdrains shall extend at least 5 feet from the wall of the inlet. Curbed road sections shall include a curb drain. (Standard Drawing SW-2 Curb Drain).

The standard inlets permitted for use in Fort Wayne and their intended application (placement) are provided in **Exhibit SW7-2**. Standard casting types are provided for each structure type.

SW7.03 Gutter Flow

The capacity of gutter flow in curbed pavement helps determine proper inlet casting and inlet spacing designs. Many factors affect the flow capacity of gutters. These factors work together to provide a safe limit on stormwater encroachment into driving lanes and parking areas.

The flow within a street gutter is defined by:

Gutter Flow Equation (Modified Manning's Equation)

$$Q = 0.56\,(S_x^{1.67}\,S_L^{0.50}\,T^{2.67})/n$$

Where:

Q = Flow, (cfs)

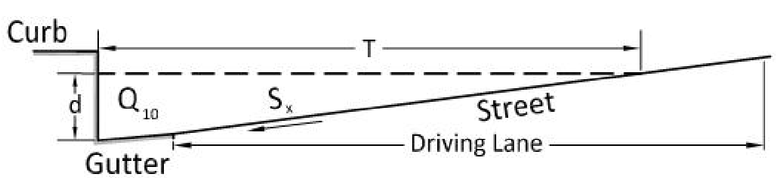
S_x = pavement cross slope, (ft/ft)

S_L = average longitudinal slope of gutter, (ft/ft)

T = top width of flow extending from face of curb to street, (ft)

n = Manning's roughness coefficient

Figure SW7.1 Gutter Cross Section



Note that "T", the top width of the flow, is inclusive of the gutter. The encroachment into the driving lane is the top width of flow minus the gutter width.

The gutter flow capacity equation will be utilized for both square curbs and rolled curbs. The capacity difference will be considered insignificant.

Figure SW7.2 may be used in lieu of separate calculations unless the actual street design is not represented by the assumptions listed. The roughness coefficient n=0.016 is based on an asphalt street.

Figure SW7.2 Gutter Flow Capacity

n = 0.016	**GUTTER FLOW, Q (cfs) at S_x 2.0%**									
Longitudinal Gutter Slope, S_L (%)	Flow Width from Curb, T (ft)	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
	Depth of Gutter Flow, d (ft)	0.08	0.09	0.10	0.13	0.14	0.15	0.16	0.45	0.50
0.50		0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.9
0.75		0.2	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.1
1.0		0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.3
1.5		0.3	0.3	0.5	0.6	0.7	0.9	1.1	1.4	1.6
2.0		0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.6	1.9
2.5		0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1
3.0		0.4	0.5	0.6	0.8	1.1	1.3	1.6	1.9	2.3
3.5		0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.1	2.5
4.0		0.4	0.6	0.7	1.0	1.2	1.5	1.8	2.2	2.6
4.5		0.4	0.6	0.8	1.0	1.3	1.6	1.9	2.3	2.8
5.0		0.5	0.6	0.8	1.1	1.4	1.7	2.1	2.5	2.9

The allowable flow within a street gutter is governed by the top width (T) and the flow depth (d). The maximum allowable for these variables are dependent upon the street width and classification. These maximums are shown in Figure SW7.3 for the minor storm event (10-year event) and Figure SW7.4 for the major storm event (100-year event).

Figure SW7.3 Allowable Extents of Minor Storm Runoff in Streets

Street Classification	**Maximum Driving Lane Encroachment**	**Driving Lane Width (Excluding gutter or curb) (ft)**	**Maximum Width into Driving Lane T_{max} (ft)**	**Maximum Depth in Gutter Flow d (ft)**
Local	No curb overtopping. ½ Driving Lane	10	5.0	0.12
		12	6.0	0.16
		14	7.0	0.18
Collector (< 45 mph)	No curb overtopping. Maximum 6 feet Maximum Depth a Function of Cross-Slope	10	5.0	0.15
		12	6.0	0.18
		14	6.0	0.18
Arterial & Collector (> 45 mph)	No curb overtopping. Maximum 4 Feet	10	4.0	0.12
		12	4.0	0.12
		14	4.0	0.12

Figure SW7.4 Allowable Extents of Major Storm Runoff in Streets

Street Classification	Maximum Depth and Inundated Area
Local and Collector	The maximum Depth of water: 1. shall not exceed 2-inches above the top of curb and, 2. shall not reduce the localized Flood Protection Grade to less than 12-inches. (Whichever is more restrictive)
Arterial	The maximum Depth of water: 1. shall not exceed the top of the curb, 2. shall not reduce the localized Flood Protection Grade to less than 12-inches, 3. shall not exceed the street crown

SW7.04 Street Inlet Hydraulic Capacity

The hydraulic capacity of inlets within the street is a function of the gutter profile and the grate.

The following sections include design considerations for the two potential street inlet configurations.

1. Sump Condition

   Inlets in depressions or sumps function like weirs for shallow flow. As the depth of stormwater increases the inlets begin to function like an orifice. Exhibit SW7.01 identifies the capacity of some grates in sump conditions.

   Assumptions:

   - Weir flow assumed for water depths below 2”.
     Weir Equation:

     $Q_1 = 3.30 \times P \times d^{1.5}$

     Q_1 = Rate of flow into the inlet, cfs

     P = perimeter of grate, ft

     d = depth of water surface above inlet, ft

   - Orifice flow assumed for water depths above 4”
     Orifice Equation:

     $Q_1 = 4.81 \times A \times d^{0.5}$

     Q_1 = Rate of flow into the inlet, cos

     A= net open area of grate, ft

     d = depth of water surface above inlet, ft

   - Transition flows assumed between 2” and 4” water depth
   - Clogging reduces weir length by 50%
   - Clogging reduces free open area by 50%

2. Continuous Grade Condition

   Inlet Hydraulic Capacity on a continuous grade is designed as a function of depth of water flow in the street gutter and the inlet grate constant. The grate constant is determined empirically by the inlet manufacturer.

   Note that inlets shall be spaced so that allowable inlet capacity intercepts at least 75% of the gutter flow during the 10-year rainfall event.

   Inlet Capacity on a continuous grade Equation:

$$Q_i = K * d^{(5/3)}$$

   Q_i = Rate of flow into the inlet, cfs

   K = Inlet grate constant based on grade geometry and longitudinal and transverse slopes (provided by manufacturer)

   (Neenah inlet constants are utilized for comparable East Jordan grates)

   d = maximum depth of water surface above inlet, ft

   Continuous grade capacity curves only apply when street flow is at the maximum allowable depth. For lower gutter depths, the inlet interception rate will decrease.

   Exhibit SW7-1 graphically provides inlet capacities for various grates in sump and continuous grade conditions.

SW7.05 Inlet Placement

Inlets must be placed at each location where surface runoff flow should be interrupted and transitioned into stormwater collection system. Inlets can be placed in roadside ditches, grass or lined swales, parking, or pavement area depressions, and in roadway or parking area curb and gutters.

The following location requirements must be considered during the design of inlets.

1. In developed areas, inlets shall be in pavement or green space areas where surface runoff collects and transitions to storm sewer pipe flow.
2. Inlets shall be placed in grass or lined swales and open channels where concentrated flow transitions to storm sewer pipe flow.
3. Inlets shall be placed in all streets and roadway sags. For the 10-year design storm, the depth of ponded water at the inlet shall not exceed the values shown in Figure SW7.3. For the 100-year design storm, the depth of ponded water at the inlet shall not exceed the values shown in Figure SW7.4.
4. An emergency overland flow path shall be included at street and roadway sags in the event that the inlet or storm sewer is not functioning. The depth of ponded water at the inlet shall not exceed twelve inches (12”).
5. Depth of ponded water shall not exceed eight inches (8”) in private development parking areas

6. Depth of ponded water shall not exceed twenty-four inches (24”) in green space areas, except in areas used as detention.
7. In streets and roadways, inlets shall be placed immediately upstream of intersections, pedestrian walkways, and handicap ramps. Required inlets shall be placed not closer than two feet (2') from the upstream edge of walkways and handicap ramps. See Standard Drawing **SW-4** for placement of inlets at intersections.
8. In pedestrian traveled areas, install ADA compliant inlet grates and pick hole plugs.
9. In streets or roadways where opposing lanes are separated by a grass median or concrete center curb, inlets shall be placed upstream of a crossover.
10. On continuous roadway or street grades, inlet spacing is determined by limiting maximum width of gutter flow (T_{max}). Inlets shall be spaced to collect a minimum of 75 percent (75%) of the watershed design flow. Bypass flow, flow not intercepted by an individual inlet, shall not exceed 25 percent (25%). Bypass flow shall be considered when determining the location of the next downstream inlet. General inlet spacing on continuous grades is 300 feet to 600 feet (300' to 600') provided the T_{max} criteria are not exceeded. Exact spacing shall be computed by the designer. See Figure SW7.2 for allowable gutter flow spread (T_{max}).
11. Uniform inlet and casting types should be used on individual street and roadway projects. Uniformity limits confusion and misplacement of proper inlet types during construction.
12. Inlets in drives/driveways are prohibited on all new developments. Contact Development Services to discuss available options associated with inlets that are located in a proposed drive/driveways on existing developments.

SW7.06 Curb Turnouts

Curb turnouts are concrete gutters that drain a curbed road section to a side-ditch or final discharge location. Curb turnouts have inherent challenges when compared to a curbed inlet casting. These challenges include redirecting the water flow perpendicular to the curb, multiple discharge points and the need for a run-off conveyance system beyond the footprint of the road. The receiving conveyance system is an engineered swale. The overall road and drive geometrics must be conducive to use of a curb turnout.

Unlike inlet castings, curb turnouts reroute the water. They are only appropriate when certain conditions exist. These conditions include:

1. The road or drive curb shall have a longitudinal slope between 0.5% and 2.0%. The velocities of run-off in curbs with slopes greater than 2.0% are averse to the quantity of run-off redirected into the curb turnouts.
2. A minimum vertical distance of at least 2.0 feet is required from the street gutter line at the curb turnout to the toe of the swale. One foot or more of

freeboard is required between the water surface for the 100-year event in the swale and the street's gutter line.

3. The run-off quantity redirected into a curb turnout in a non-sag condition is approximately 0.25 cfs. This is based on the opening of the curb turnout acting as a 3-foot weir. A weir depth of 0.12 foot is assumed. (Depth of 0.12 foot assumes a gutter spread of 6 feet on a 2.0% cross-slope pavement.)
4. The run-off capacity of a curb turnout in a sag condition is approximately 1.2 cfs. A weir depth of 0.25 foot at the opening of the curb turnout is assumed. (Depth of 0.25 foot assumes a gutter spread of 12 feet on a 2.0% cross-slope pavement.)

Curb turnouts are poured in-place. They shall be constructed per Standard Drawings **SW-7-1** and **SW-7-3**. Because they are field constructed, they are subject to individual review and acceptance by the city. This includes as-builts of the curb slopes.

The concrete curb turnout shall be continued to the toe elevation of the swale (side-ditch). There shall be an energy dissipation measure at the bottom. The dissipation measure shall be a flat concrete pad or permanent turf reinforcement. This energy dissipator shall be extended up the opposite slope of the swale a minimum of 6 vertical inches. The application of riprap for the energy dissipation is discouraged. Riprap in the swale diminishes the flow capacity of the channel. Forebays are recommended downstream of the energy dissipation pad.

Curb turnouts are problematic in additional ways. These issues should be considered before utilization. They are:

1. Prone to being obstructed. Leaves and litter collect at the mouth of the turnout.
2. Snow and ice accumulations. Snowplows push the snow to the gutter of the streets. The snow and slush compacts and can create ice jams.
3. Vegetation maintenance. The concrete curb turnout down a mowed slope may be detrimental to a mower or require additional time for equipment to navigate.

SW7.07 Catch Basins

Catch basins are inlets that are sumped and trapped. A catch basin is sumped to allow solids to drop out of the flow. The trapped discharge prevents floatables from leaving the structure. A catch basin is a pretreatment measure for post construction water quality on site developments. There is no widely accepted data to define the percentage of total suspended solids removed by a catch basin.

Catch basins are most effective when utilized for draining street and parking lot pavement. They capture the heaviest sediment. The incidental hydrocarbons are trapped as floatables. They also capture the litter associated with the said pavement uses.

Catch basins shall not be utilized as a standalone best management practice (BMP), and are typically used as part of a treatment train.

A catch basin shall meet the following minimum standards:

1. Catch basin structures shall be placed in impervious surfaces with the appropriate grate to capture surface runoff.
2. The catch basin shall serve small water sheds that are dominantly impervious surfaces associated with streets and parking lots.
3. Catch basins for pipes 12-inches in diameter shall be at least 33-inches in diameter or square structures of at least 36-inches per side. This will provide access for a vac-truck to clean the structure periodically. Pipes larger than 15-inches in diameter shall require a 48-inch manhole.
4. Catch basins shall have a sump of at least 4 times the diameter of the structure’s effluent pipe.
5. The trap device can be a down-turned elbow or manufactured hood. The device shall extend a minimum of 6-inches below the invert of the effluent pipe. The maximum extension below the effluent pipe invert is 18-inches.
6. Catch basins shall have concrete bottoms. Catch basins are intended to capture pollutants and contaminants. Pervious bottoms would allow those pollutants and contaminants to migrate into the soil.
7. Catch basins require pre-approval for use in a public stormwater system.

The use of catch basins in largely pervious areas shall be limited. Vegetated swales draining to an inlet typically have low velocities. Therefore, the swales will accomplish most of the same results.

Catch basins require a regular inspection and maintenance process. Catch basins shall be conspicuously identified in the O&M. The inspection shall be at least twice a year and shall:

1. Document the floatables. Large floatables such as plastic bottles shall be removed with a net or similar technique that does not require entering the catch basin.
2. Document the presence of oil sheens and foam floating on the water’s surface. Small quantities can be removed with absorbent pads or similar proprietary products. Large quantities may require removal by a vac truck.
3. Document the depth of sediment in the structure. The sediment shall be removed when the storage depth of the sump is reduced by 50% or once every second year. Use a vac truck or similar method for the removal of the sediment. Catch basins shall be used when connecting to a combined sewer system. The trap will act as an odor control. This may include having an influent pipe into the structure. The use of a catch basin to control odor will allow for influent pipes into the structure. The head loss through the catch basin should be considered.

SW7.08 Outlets

Storm sewer outlets shall be designed to allow expansion of flow and reduction of velocity, to prevent erosion downstream, and to allow for proper construction and maintenance of cut or embankment slopes at the outlet.

A headwall or flared end section shall be provided at all pipe outlets. Flared end sections and headwalls shall have a toe wall extending a minimum of 18" below grade at their downstream end to prevent undercutting.

Scour and general perpetual erosion protection is required at outlets. Outlet protection design shall consider:

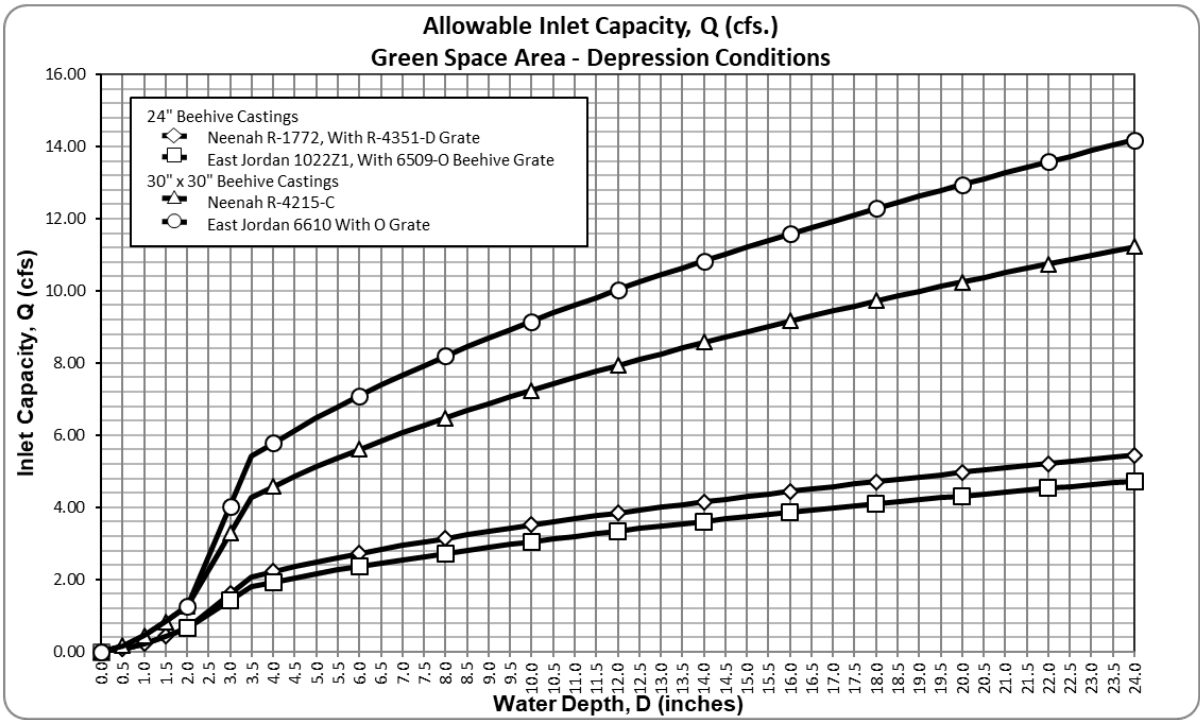
- Velocity of discharge
- Invert elevation of outlet
- Tailwater elevations
- Energy dissipation and erosion protection
- Orientation of outlet

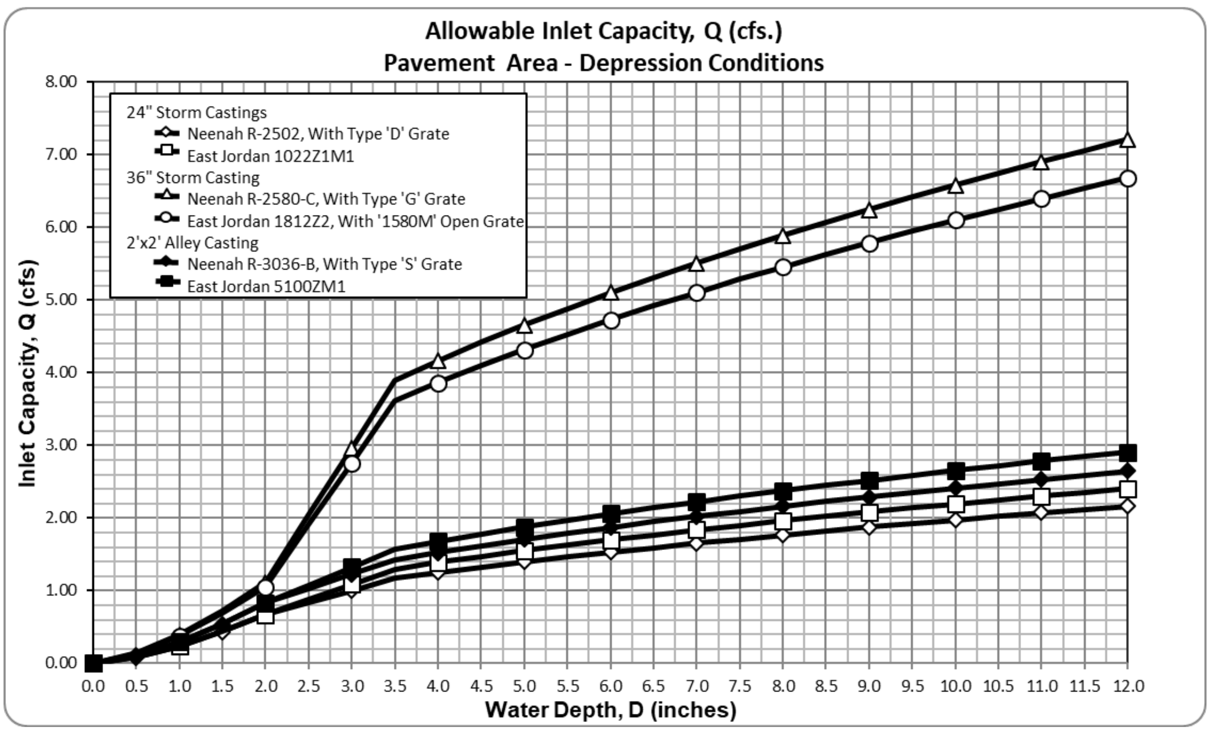
The invert of the storm sewer outlet shall be higher than the invert of the receiving drainage path at the outfall.

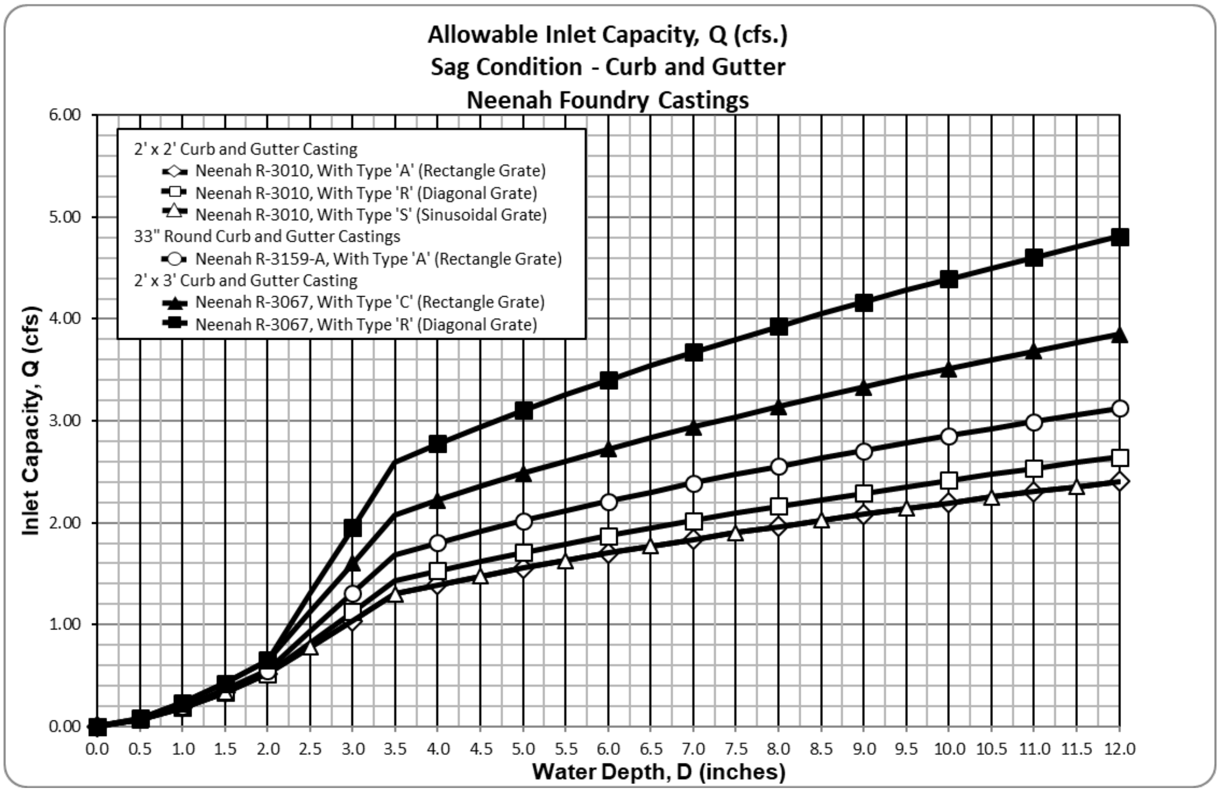
SW7.09 Trash Racks

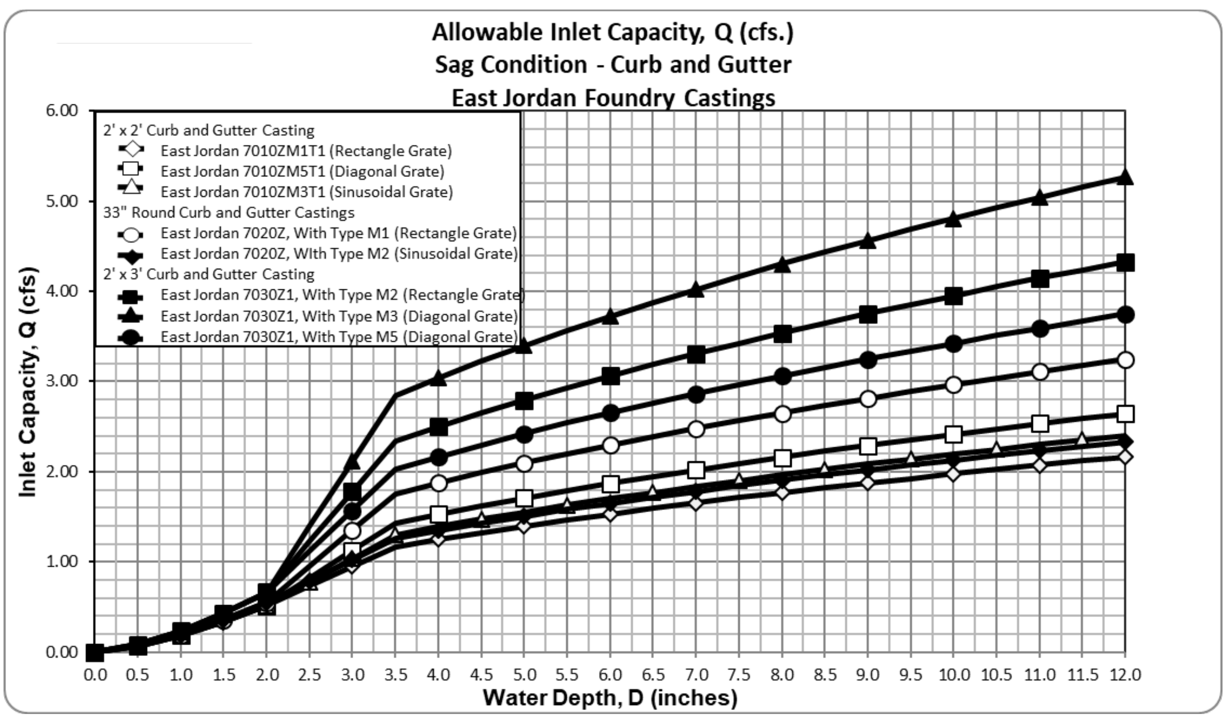
Trash racks should be considered for end treatment where inlet pipe clogging or downstream trash pollution is anticipated due to upstream land use activities. Trash racks on inlet pipes should be inclined bars instead of vertical bars to allow trash to slide up instead of clogging as trash and debris accumulate with flow entering the system. In general, trash racks shall not be used on culvert/ small structure/ bridge outlets.

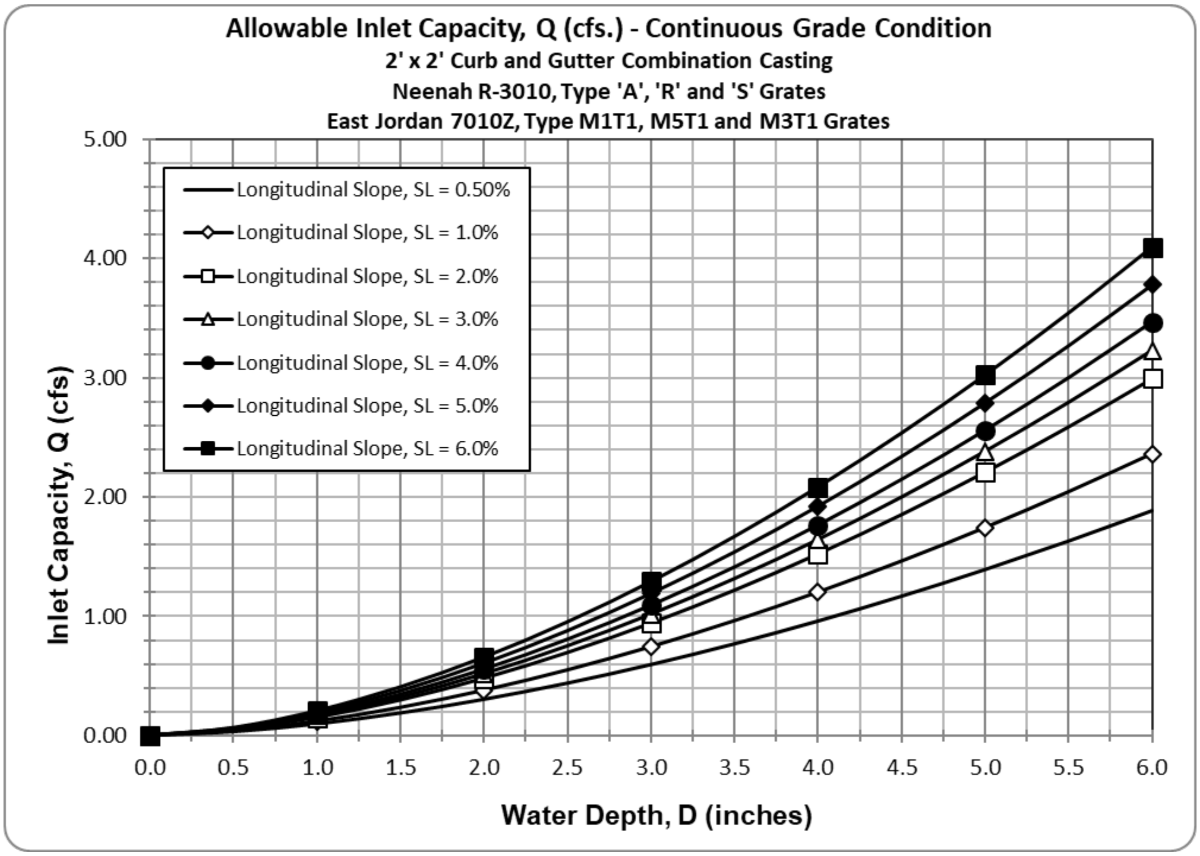
Trash racks may be warranted on inlet pipes and outlet pipes in areas where public safety is a concern. Trash racks with larger openings shall be included on inlet pipes and outlet pipes greater than 12” that connect directly to a closed storm sewer system.

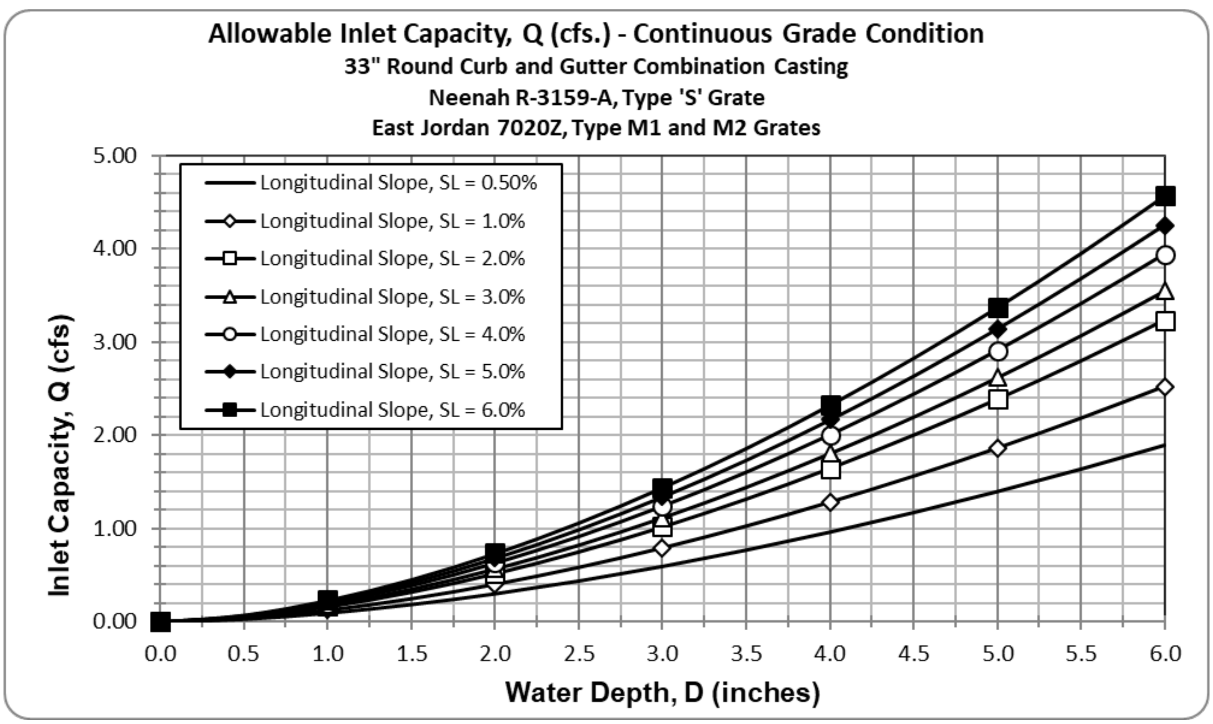

Allowable Inlet Capacity, Q (cfs.)
Green Space Area - Depression Conditions
24" Beehive Castings
Neenah R-1772, With R-4351-D Grate
East Jordan 1022Z1, With 6509-O Beehive Grate
30" x 30" Beehive Castings
Neenah R-4215-C
East Jordan 6610 With O Grate
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00


Allowable Inlet Capacity, Q (cfs.)
Pavement Area - Depression Conditions
24" Storm Castings
Neenah R-2502, With Type 'D' Grate
East Jordan 1022Z1M1
36" Storm Casting
Neenah R-2580-C, With Type 'G' Grate
East Jordan 1812Z2, With '1580M' Open Grate
2'x2' Alley Casting
Neenah R-3036-B, With Type 'S' Grate
East Jordan 5100ZM1
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00


Allowable Inlet Capacity, Q (cfs.)
Sag Condition - Curb and Gutter
Neenah Foundry Castings
2' x 2' Curb and Gutter Casting
Neenah R-3010, With Type 'A' (Rectangle Grate)
Neenah R-3010, With Type 'R' (Diagonal Grate)
Neenah R-3010, With Type 'S' (Sinusoidal Grate)
33" Round Curb and Gutter Castings
Neenah R-3159-A, With Type 'A' (Rectangle Grate)
2' x 3' Curb and Gutter Casting
Neenah R-3067, With Type 'C' (Rectangle Grate)
Neenah R-3067, With Type 'R' (Diagonal Grate)
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0


Allowable Inlet Capacity, Q (cfs.)
Sag Condition - Curb and Gutter
East Jordan Foundry Castings
2' x 2' Curb and Gutter Casting
East Jordan 7010ZM1T1 (Rectangle Grate)
East Jordan 7010ZM5T1 (Diagonal Grate)
East Jordan 7010ZM3T1 (Sinusoidal Grate)
33" Round Curb and Gutter Castings
East Jordan 7020Z, With Type M1 (Rectangle Grate)
East Jordan 7020Z, With Type M2 (Sinusoidal Grate)
2' x 3' Curb and Gutter Casting
East Jordan 7030Z1, With Type M2 (Rectangle Grate
East Jordan 7030Z1, With Type M3 (Diagonal Grate)
East Jordan 7030Z1, With Type M5 (Diagonal Grate)
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 12.0


Allowable Inlet Capacity, Q (cfs.) - Continuous Grade Condition
2' x 2' Curb and Gutter Combination Casting
Neenah R-3010, Type 'A', 'R' and 'S' Grates
East Jordan 7010Z, Type M1T1, M5T1 and M3T1 Grates
Longitudinal Slope, SL = 0.50%
Longitudinal Slope, SL = 1.0%
Longitudinal Slope, SL = 2.0%
Longitudinal Slope, SL = 3.0%
Longitudinal Slope, SL = 4.0%
Longitudinal Slope, SL = 5.0%
Longitudinal Slope, SL = 6.0%
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
1.00
2.00
3.00
4.00
5.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0


Allowable Inlet Capacity, Q (cfs.) - Continuous Grade Condition
33" Round Curb and Gutter Combination Casting
Neenah R-3159-A, Type 'S' Grate
East Jordan 7020Z, Type M1 and M2 Grates
Longitudinal Slope, SL = 0.50%
Longitudinal Slope, SL = 1.0%
Longitudinal Slope, SL = 2.0%
Longitudinal Slope, SL = 3.0%
Longitudinal Slope, SL = 4.0%
Longitudinal Slope, SL = 5.0%
Longitudinal Slope, SL = 6.0%
Inlet Capacity, Q (cfs)
Water Depth, D (inches)
0.00
1.00
2.00
3.00
4.00
5.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0

Casting DWG No.	Structure DWG No.	City Utilities Standard Stormwater Castings	Applications
24" Solid Storm Casting			
C-4-1	STR-30-1 STR-30-2 STR-30-3 STR-30-4	NEENAH: R-1772 EJW: 1022Z1	Not for accepting flow Valve in vault applications For manned/maintenance access
24" Watertight Storm Casting			
C-5-1 C-5-2	STR-30-1 STR-30-2 STR-30-3 STR-30-4	NEENAH: R-1772 EJW: 1022Z1PT	Can be bolted down to prevent waters entering or exiting Flood plain/ low lying areas for surcharge applications For manholes that are expected to be inundated/ overwhelmed
24" Storm Casting			
C-6-1	STR-30-1 STR-30-2 STR-30-3 STR-30-4	NEENAH: R-2502 EJW: 1022Z1M1 Approx. 130 & 140 SQ. IN OPEN AREA	M1 indicates open grate, open grate with the same dimensions as 1022Z series For area drainage (pavement, alley, grass) Suitable for flat areas Not for curb & gutter applications
24" Beehive Casting			
C-7-1	STR-30-1 STR-30-2 STR-30-3 STR-30-4	NEENAH: R-1772 W/ R-4351-D EJW: 1022Z1 W/6509-O Approx. 230 & 177 SQ. IN OPEN AREA	Effective for area drainage in grassy areas Exclusively used in grass or swale applications Beehive dome feature provides more open area under signifcant debris and leaf coverage conditions
30" x 30" Beehive Grate			
C-8-1 C-8-2	STR-31-1 STR-31-2	NEENAH: R-4215-C Approx. 475 SQ. IN OPEN AREA EJW: 6610-O Approx. 430 SQ. IN OPEN AREA	Effective for greater capacity area drainage in grassy areas Exclusively used in grass or swale applications, used for square structures Beehive dome feature provides more open area under signifcant debris and leaf coverage conditions
2' x2' Alley Casting			
C-9-1 C-9-2	STR-32-1	NEENAH: R-3036-B Approx. 158 SQ. IN OPEN AREA EJW: 5100ZM1 Approx. 175 SQ. IN OPEN AREA	Exclusively used for area drainage in pavement applications Sinusoidal openings provide more flexibility with flow entry. Sinusoidal openings are suitable for bicycle traffic and offer the best middle ground option between bar and vane grates.

Casting DWG No.	Structure DWG No.	City Utilities Standard Stormwater Castings	Applications
2' x2' Curb and Gutter Casting			
C-10-1 C-10-2	STR-32-1	NEENAH: R-3010 Approx. 144 SQ. IN OPEN AREA EJW: 7010ZM1T1 Approx. 130 SQ. IN OPEN AREA	Standard bar grate, suitable for bicycle traffic Smaller openings do not function as debris trap, large backside opening is for debris Most common in the country (comprises ≈75% of curb and gutter castings in the US)
C-10-3 C-10-4	STR-32-1	NEENAH: R-3010 Approx. 160 SQ. IN OPEN AREA EJW: 7010ZM5T1 Approx. 160 SQ. IN OPEN AREA	Diagonal grate design is utilized to pull water back toward curb as flow crosses openings. Ineffective at designed function. Poor performance in applications with increased slope Will not accept any water if installed in the wrong direction and orientation.
C-10-5 C-10-6	STR-32-1	NEENAH: R-3010 Approx. 144 SQ. IN OPEN AREA EJW: 7010ZM3T1 Approx. 140 SQ. IN OPEN AREA	Combines sinsoidal grate design with large backside opening for debris Sinusoidal openings provide more flexibility with flow entry. Sinusoidal openings are suitable for bicycle traffic and offer the best middle ground option between bar and vane grates.
2' x 3' Curb and Gutter Casting			
C-11-1 C-11-2	STR-32-2	NEENAH: R-3067 Approx. 230 SQ. IN OPEN AREA EJW: 7030Z1 Approx. 260 SQ. IN OPEN AREA	Larger size used for larger capacity with standard bar grate, suitable for bikes Smaller openings do not function as debris trap, large backside opening is for debris Most common in the country (comprises ≈75% of curb and gutter castings in the US)
2' x 3' Curb and Gutter Casting (Cont.)			
C-11-3 C-11-4 C-11-5	STR-32-2	NEENAH: R-3067 Approx. 282 SQ. IN OPEN AREA EJW: 7030Z1 Approx. 315 SQ. IN OPEN AREA EJW: 7030Z1 Approx. 225 SQ. IN OPEN AREA	Diagonal grate design with large backside opening. Diagonal design is utilized to pull water back toward curb as flow crosses openings. Ineffective at designed function. Poor performance in applications with increased slope Will not accept any water if installed in the wrong direction and orientation.

Casting DWG No.	Structure DWG No.	City Utilities Standard Stormwater Castings	Applications
2' x 3' Approach Casting			
C-11-6 C-11-7	STR-32-2	NEENAH: R-3290 Approx. 374.4 SQ. IN OPEN AREA EJW: 7034Z	Standard bar grate for depressed curb applications Features flat grate extension instead of barrier For driveway cut-ins and sidewalk termination to maintain trough of curb
33" Round Curb & Gutter Casting			
C-12-1	STR-31-3 STR-31-4	EJW: 7020Z Approx. 195 SQ. IN OPEN AREA	Standard bar grate style, bicyle friendly, and fits round structures while having square top Smaller openings do not function as debris trap, large backside opening is for debris Most common in the country (comprises ≈75% of curb and gutter castings in the US)
C-12-2 C-12-3	STR-31-3 STR-31-4	EJW: 7020Z Approx. 140 SQ. IN OPEN AREA NEENAH: R-3159-A Approx. 187 SQ. IN OPEN AREA	Combines sinsoidal grate design with large backside opening for debris. Fits rounds structures while having square top Sinusoidal openings provide more flexibility with flow entry. Sinusoidal openings are suitable for bicycle traffic and offer the best middle ground option between bar and vane grates.
36" Storm Casting			
C-13-1		NEENAH: R-2580-C EJW: 1812Z2 Approx. 432 & 468 SQ. IN OPEN AREA	Standard bar grate style, bicycle friendly, and fits round structures Small openings do not function as debris trap Most common in the country (comprises ≈75% of curb and gutter castings in the US)

Book 2

Stormwater (SW)

SW8 Culverts/Small Structures/Bridges

SW8.01 Purpose

A culvert/small structure/bridge is defined as a conduit for the conveyance of water under a roadway, railroad or other embankment. In addition to serving hydraulic functions, culverts/small structures/bridges must also carry overhead loads from traffic and other activities, thereby serving a structural function. Proper culvert/small structure/bridge design is essential because culverts/small structures/bridges often significantly influence upstream and downstream flood risks, floodplain management and public safety. The criteria presented in this Chapter shall be used in the design of culverts/small structures/bridges.

A culvert is a structure having an opening of less than 10 feet in width between faces of abutments or spring lines of arches, measured along the centerline of a roadway.

A small structure is a structure having an opening of more than 10 feet and less than 20 feet in width between faces of abutments or spring lines of arches, measured along the centerline of a roadway. Multiple barrel box culverts or multiple pipe culverts having an opening of more than 10 feet and less than 20 feet between the limits of the extreme openings are classed as small structures.

A bridge is a structure having an opening of more than 20 feet between faces of abutments or spring lines of arches, measured along the centerline of a roadway. Multiple barrel box culverts or multiple pipe culverts having an opening of more than 20 feet between the limits of the extreme openings are classed as bridges. *(Bridge Inspection Manual Definitions)*

Private driveways and their associated structures (culverts/small structures/bridges) are the responsibility of the property owner.

SW8.02 General Design

1. Federal Highway Administration

   The design of culverts/small structures/bridges shall conform to the methodology described in the *Hydraulic Design of Highway Culverts* published by the U.S. Department of Transportation's Federal Highway Administration Publication No. FHWA-NHI-01-020, September 2001 (Revised May 2005 or current edition) Available online at **https://www.fhwa.dot.gov/resources/pubstats/**

2. Indiana Department of Transportation

   The *Indiana Department of Transportation Design Manual 2013* or current edition provides valuable culvert/small structures/bridges design information. The Design Manual is available online at **https://www.in.gov/indot/design-manual/**

SW8.03 Hydraulic Design

1. Design Program

   The HY-8 program is the computerized implementation of FHWA culvert/small structures/bridges hydraulic approaches and protocols and shall be used for culvert/small structures/bridges design. Available online at **http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/**

2. Design Storm Event

   Drive culverts/small structures/bridges in roadside ditches shall meet the 50-year design. Culverts/small structures/bridges for road or embankment construction in all other channels shall meet the 100-year design.

3. Backwater

   Culverts/small structures/bridges shall not increase backwater elevations on upstream properties. Backwater shall be contained within existing banks of the upstream open channel.

   Refer to the link below for backwater calculations:

   https://dcd.kitsapgov.com/ordnances/Stormwater_HTML_20210902/Content/Appendices/HydrologicalModelMethods/ConveyancePipeBackwaterAnalysis.htm

   Refer to link below for design guidance on when backwater calculations shall be performed:

   Hydraulic Design of Highway Culverts - HDS-5 - Third Edition (dot.gov)

4. Overland Flow Routes

   Emergency overland flow routes shall be checked to assure that backwater resulting from a potentially blocked culvert/small structure/bridge or intense storm does not flood or damage property. If an emergency overland flow route is not available, culvert/small structure/bridge flow capacity shall be increased. Sound engineering judgment shall be applied in determining the potential extent of backwater damage and the necessary increase in culvert/small structure/bridge flow capacity.

5. Flow Velocity

   Both minimum and maximum flow velocities should be considered when designing a culvert/small structure/bridge. A minimum velocity of 3.0 feet/second when the culvert/small structure/bridge is flowing partially full is recommended to ensure a self-cleaning condition during partial depth flow. The maximum velocity should not exceed manufacturer recommendations. The maximum velocity should be consistent with channel stability requirements at the culvert/small structure/bridge outlet. The maximum allowable outlet velocity of culverts / small structures / and bridges, which discharge to an earthen channel, shall be 6 feet/second. As outlet velocities increase, the need for channel stabilization at the culvert/small structure/bridge outlet increases. If velocities exceed permissible velocities for the various types of nonstructural outlet lining material available, the installation of structural energy dissipators are required.

6. Minimum Diameter

   The minimum diameter for culverts/small structures/bridges crossing a public roadway shall be 15 inches (15”). The minimum diameter for private culverts/small structures/bridges shall be 12 inches (12”).

SW8.04 Sumped Culverts

Culverts/small structures/bridges shall be installed with inverts lower than adjacent channel flowline. Sound engineering judgment shall be applied to determine the depth of sumping. Sumping increases the base flow capacity, accommodates the future lowering of the channel, may increase the depth of cover, and in environmentally sensitive areas allows for a natural stream bottom in the culverts/small structures/bridges.

In channels with a base flow or normal pool, migration of aquatic species should be considered. Culverts/small structures/bridges should be sumped to maintain a base flow depth through the culvert/small structure/bridge equal to or greater than the adjacent channel base flow depth. Bottomless versions are not allowed.

SW8.05 Structural Design

1. Loading

   All culverts/small structures/bridges crossing a roadway shall be designed to withstand a minimum HS-20-44 loading as defined by the American Association of State Highway and Transportation Officials (AASHTO). Culverts/small structures/bridges crossing a railroad shall be designed to withstand an E-80 loading.

2. Installation Depth

   Refer to manufacturer specifications or recommendations for installation depth requirements.

   Minimum pipe diameters, classes and cover requirements are listed in **Chapter MA5 – Stormwater Materials and Testing Requirements**.

3. Bedding and Backfill

   Backfill classifications, materials, and methods of compaction shall be in accordance with City Utilities standards for projects inside of the City limits and in accordance with Allen County Highway standards outside the City limits unless special circumstances warrant otherwise.

A clay layer shall be added between the roadway drainage layer and the culvert/small structure/bridge to stop infiltration.

Bedding and Backfill standard details are located in **Chapter CADD8 – Standard Drawings**.

4. Floatation and Anchoring

   Pipe floatation can occur when the uplift (buoyancy) forces outside the pipe are greater than the downward weight forces on the pipe. This uplift force can be great enough to cause the pipe to bend and dislodge from the embankment. Large diameter, flexible material culverts/small structures/bridges are more vulnerable to floatation. Anchoring may be achieved using concrete end sections, ties to a concrete footer, or other similar means.

SW8.06 Culvert / Small Structure/ Bridge Length Design

Culvert / small structure/ bridge length design shall consider embankment width, installation depth and embankment slopes.

1. General

   Culvert/small structure/bridge length shall be designed to fit existing or design roadway front slopes. Roadway safety shall be considered for culvert/small structure/bridge replacement projects where roadway shoulders are narrow and embankment slopes are steep. Consideration should be given to widening shoulders and flattening slopes when practical.

2. The length for culverts/small structures/bridges or open-end pipe sections below a slope are based on the following calculation

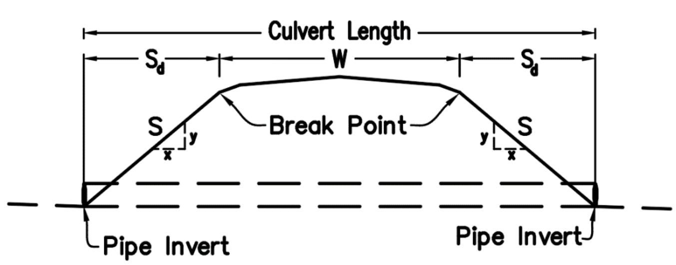
   $L_P = S_d$ (left) + W + S_d (right)

   L_P = Total crossing length

   S_d = Slope distance between shoulder break and invert of culvert/small structure/bridge or end treatment.

   W = Distance between left and right shoulder breaks.

Figure SW8.1 Culvert Length Diagram



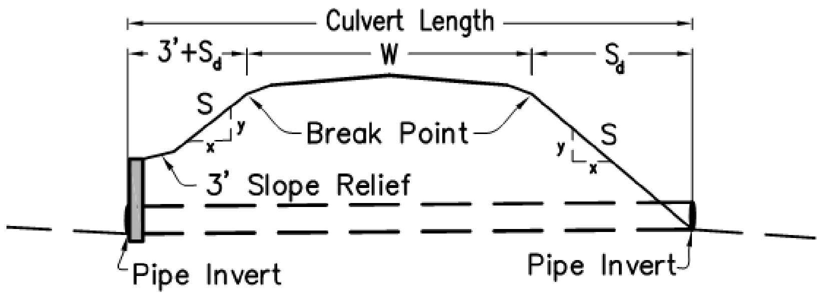
SW8.07 Headwalls

Typically, headwalls are used when the embankment slope cannot be maintained to the invert of the culvert/small structure/bridge or pipe outfall. Other uses of headwalls include maximizing the flow into the end of the culvert/small structure/bridge and scour protection from high velocity flows.

The length of the culvert/small structure/bridge may be limited by easement or right-of-way concerns. If the slope distance from the break point to the pipe invert exceeds the limits of the easements or right-of-way, a headwall can be considered. The headwall will be placed within the limits of the easement. It should include room for construction activities beyond the headwall. This can be a temporary construction easement.

A slope relief ledge of 3 feet shall be behind the headwall. This ledge shall have a maximum slope of 8%. This ledge will provide some recovery relief for maintenance activities of the slope.

Figure SW8.2 Culvert Headwall Diagram



The headwall may require wingwalls. Wingwalls are required when intersecting slopes at the headwall cannot be maintained. Wingwalls are also required if erosion is expected due to water velocities or soil conditions.

Headwalls and wingwalls are engineered for the soil conditions. The plans for these walls shall be certified by an engineer with the appropriate expertise. The design will be based on:

- Allowable soil bearing pressure
- Angle of friction between wingwall footing and foundation soil
- Angle of internal friction of the foundation soil
- Ultimate cohesion of foundation soil
- Ultimate adhesion between foundation soil and concrete

The vertical drop associated with headwalls and wingwalls is a hazard. The vertical drop is measured from the top of the wall to the flow line of the channel below it. Headwalls with vertical drops greater than 24” shall have a pedestrian rail for fall protection. Headwalls with vertical drops greater than 5.5 feet shall have a clear zone of at least 8 feet for roads with speed limits less than 50 miles per hour or a guardrail for vehicle protection. The clear zone shall increase per INDOT standards for speed limits greater than 49 miles per hour. The engineer certifying the headwall and wingwall plans shall comply with any safety requirements that exceed these requirements.

Toe walls are recommended for culvert/small structure/bridge design. Toe walls are low walls built at the bottom to prevent water under the culvert/small structure/bridge and undermining. Toe walls can cause an increase in uplift pressures.

SW8.08 Inlet and Outlet Configuration

All culverts / small structures / bridges, public and private, shall have end treatments such as prefabricated end sections, wingwalls and aprons, or headwalls at the inlet and the outlet. The design of end treatments shall consider public safety and erosion control.

1. Roadside Safety

   Roadside ditch culverts / small structures/ bridges for commercial and residential drives shall have sloped prefabricated end sections. Headwalls and wingwalls are not permitted.

2. Trash Racks

   Refer to the guidance on trash racks and their requirements in Section SW7.09 – Trash Racks.

3. Erosion Control

   Channel stabilization and erosion control measures shall be utilized at the inlet and outlet of a culvert/small structure/bridges. For INDOT guidance on different channel stabilization and erosion control measures shall be utilized based on different velocities see Figure SW8.3.

Figure SW8.3 Erosion Control Measure by Velocity

Erosion-Protection Method	Velocity, v (ft/s)
Revetment Riprap	≤ 6.5
Class 1 Riprap	6.5 < v < 10
Class 2 Riprap	10 ≤ v ≤ 13
Energy Dissipator	> 13

SW8.09 Environmental Considerations

Where fish migration is a concern, contact the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife for culvert design assistance.

SW8.10 Permitting

Culvert/small structure/bridge installation may require approval and/or permitting from federal, state, or local agencies. Early coordination regarding permitting and approval is recommended. Each public agency may have design criteria which must be complied with for permitting. For additional information on permitting refer to Chapter GR4 – Contracts, Fees, and Permits.

SW8.11 Culvert/small structure/bridge Materials

Culvert/small structure/bridge materials must be in accordance with **Chapter MA5 – Stormwater Materials and Testing Requirements**.

Book 2

Stormwater (SW)

SW9 Open Channels

SW9.01 Purpose

This Chapter provides information for the design of open channels for the conveyance of stormwater in the City of Fort Wayne. By definition an open channel is a conduit for the conveyance of liquids. Flow in an open channel is open to the atmosphere and driven by gravity. Open channels for the conveyance of stormwater can be natural or constructed.

1. Natural Channels

   Natural channels include rivers, streams, and natural intermittent drainage courses. Investigation and analysis of the capacity of existing natural channels using the United States Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS) is complex and time consuming. Alteration of a natural channel is also regulated and can require permits from the United States Army Corps of Engineers (USACOE), Indiana Department of Natural Resources (IDNR), and Indiana Department of Environmental Management (IDEM). Natural channels shall be regarded as receiving waters. Storm drainage design shall include detention for control of developed stormwater runoff peak flows thus avoiding the necessity of altering existing natural channels.

2. Natural Buffers along Water Bodies

   Natural buffers anchor the soil in place. They control sediment migration by slowing and capturing particles. These buffers are typically aesthetically pleasing to future land users. The CSGP requires natural buffers adjacent to waters of the state be maintained and preserved to promote infiltration and protection of the water resource when feasible.

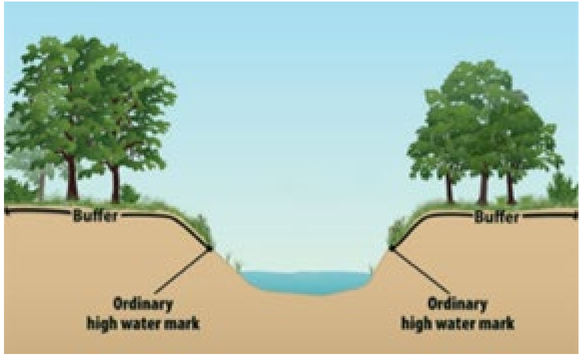
   The topographic survey shall delineate trees, shrubs and similar vegetation along all surface water courses or impoundments. These delineations will be a tool in determining if and where the limits of the natural buffer apply, see Figure SW9-1.

   The buffer shall be maintained and undisturbed when:

   a. Adjacent to a river, stream or name tributary

   b. Adjacent to a regulated or natural drain that has an existing natural buffer

Figure SW9.1 Natural Buffer



The natural buffer is required to be continuous for the frontage of the water body for the length of the project site. The minimum natural buffer width to be preserved is 50-feet if the width of the existing buffer is 50-feet or more. All existing buffers less than 50 feet in width shall be reestablished to 50 feet or maintained as is and an added equivalent of erosion and sediment controls to meet 50 feet buffer performance must be implemented

The width of the buffer is measured from the Ordinary High Water Mark (OHW). The buffer width shall parallel the OHM. These restrictions are to be clearly indicated on the drawings and in specifications.

There are allowable impacts into these buffers. These incursions into the buffers shall have the minimal impact necessary. These incursions include things such as stormwater discharges, surface water conveyances (swales) and pedestrian trails. Such incursions shall be planned and detailed.

3. Constructed Channels

   This chapter will consider the design of constructed open channels. Constructed channels include drainage ditches, roadside ditches, swales, bioswales and water quality treatment channels. New constructed channels can be excavated or existing constructed channels can be reconstructed as part of a new or altered storm drainage system. Alteration of existing constructed channels might require permits from Allen County Drainage Board, Allen County Department of Planning Services, USACOE, IDNR or IDEM.

   Swales are minor channels that are man-made. They are typically in the rear of yards or along a property line. In a subdivision, they may traverse several lots but are typically much shorter than a ditch. Swales may or may not be immediately identifiable on topographic map of two-foot contours. Swales typically outfall into a storm sewer inlet or detention basin.

SW9.02 Channel Geometrics

Open channels can be configured in a variety of shapes. Common shapes include:

1. V-Shaped Channels

   V-shaped open channels are used for roadside ditches or swales. V-shaped channels are not efficient for conveyance of high flows and are generally designed for collection of intermittent surface sheet flow.

2. Trapezoidal Channels

   A trapezoid is defined as a quadrilateral figure with two parallel sides. In the case of an open channel the channel bottom and top of water are regarded as parallel. Channels with rounded bottoms shall be treated as trapezoidal. The sides of an excavated trapezoidal channel are sloped to provide stability; channel slopes generally do not exceed 1.5 horizontal to 1 vertical (1.5:1).

   Channels can have uniform or variable bottom widths and side slopes. In developed or agricultural areas where land is premium, storm drainage channels are generally designed to be uniform and functional with minimum use of land.

   Two-stage open channels are designed with a low flow channel and at a higher elevation a wider second stage channel. Two-stage channels provide in channel storage and reduce flow velocity at higher flow rates.

3. Composite Channel

   Composite channels are designed with a low flow channel in combination with additional natural channel features. Composite channels can be utilized as stormwater quality best management practices, detention facilities, wildlife habitat, attractive landscape feature or a combination of the above.

   Composite channels may incorporate a low flow, meandering, variable width channel through constructed wetlands or open pools. The low flow channel may meander through a wider valley which can flood during higher flows. Composite channels can be used with a water control structure or multiple control structures which reduce flow velocity and provide storage during periods of high flow.

   Low flow channel and valley side slopes and bottom widths may vary to provide the appearance of a natural topography. Riparian vegetation may be planted for water quality treatment and to provide a naturally appearing landscape. Upland slopes can be planted with prairie grass mixes and native woody species.

SW9.03 Channel Side Slopes

Channel side slope design is dependent on several factors including soil stability, available land area for top of bank width, ease of maintenance and safety. Grass lined slopes shall not exceed 3 feet horizontal to 1 foot vertical (3:1). Slopes maintained by mowing should not exceed 4:1. Yard swale side slopes should not exceed 6:1 for ease of maintenance. Where side slopes are steeper than 3:1 armor or stabilization lining is required.

SW9.04 Channel Slope

Channel slope is the channel bottom gradient or profile grade defined as the ratio of elevation change over length. Channel slope is expressed as a percentage or a decimal.

Channel slopes vary due to existing topography and the design requirements of each storm drainage system.

The desirable minimum slope for open channels is 0.5 percent (.005 ft/ft). In areas of flat topography, the desirable 0.5 percent minimum slope is not always possible to achieve.

SW9.05 Channel Linings

Open channel bottoms and side slopes require stabilization measures to prevent scour and erosion. At minimum the peak flow rate from a 10-year storm shall be used to design armored linings for all channels. Acceptable methods of lining include grass or riparian vegetation, riprap or rock, concrete, or manufactured linings.

As site conditions allow, a vegetated filter strip of appropriate width shall be maintained along unvegetated swales and ditches.

1. Grass Lined Channels

   Grass is the most common method of channel stabilization in areas of flat topography. Grass or vegetation lining is permitted in channel bottoms with slopes not exceeding 3.0 percent or flows not exceeding 5 feet per second. Grass is permitted on channel side slopes not exceeding 3:1.

   Armor might be required in areas of grass lined channels where scour or erosion might occur. Areas which might require riprap or rock armor include storm sewer outlets, changes in bottom slope grade, bends in channel alignment, or areas where gullies might be formed inside slopes by concentrated flow entering a channel over the bank.

2. Riprap or Rock Lined Channels

   Riprap shall comply with Indiana Department of Transportation (INDOT) Revetment Riprap. INDOT Class 1 or class 2 Riprap may be used for energy dissipators.

   Riprap or rock lined channels are required where flow velocity might result in bottom or side slope erosion. Armor lining is required where channel bottom slope exceeds 3.0 percent or flow velocity exceeds 5 feet per second. Maximum slope for riprap lined channels shall not exceed 10.0 percent.

   Channel side slopes between 1.5:1 and 3:1 shall be riprap lined.

   Grouted riprap is prohibited.

3. Concrete Lined Channels

   Concrete lined channels are permitted only in areas where limited space due to existing development prohibits the construction of grass or riprap lined channels. Concrete lining shall also be used where channel bottom slope exceeds 10 percent or flow velocity exceeds 15 feet per second.

   Side slopes 1.5:1 or steeper shall have a concrete lining and the concrete lining shall be designed as a structural retaining wall. Concrete channel bottom and slopes shall be constructed with expansion and contraction joints to control cracking. Weepholes shall be installed along all channels with paved side slopes or retaining walls to relieve hydrostatic pressure from ground water.

Concrete channel lining shall be steel reinforced INDOT Class A concrete with a minimum thickness of 5 inches.

Concrete channel lining shall be designed with lugs where bottom slope exceeds 3 percent. INDOT Paved Side Ditch Cut-Off Wall and Lug Standard drawings are available on the Indiana Department of Transportation website: **https://www.in.gov/dot/div/contracts/standards/drawings/**

Allowed through variance process only.

4. Manufactured Linings

   Manufactured channel linings include concrete revetment, gabions and Reno mattresses, or turf reinforcement mats. Manufactured linings shall be designed and constructed according to the manufacturer's specifications.

SW9.06 Yard Swales

Yard swales are open channels that are intended to convey runoff from small watersheds. The contributing water shed is largely lawn or vegetated areas. They are typically in the rear of the lots. The flow path is typically less than 300 lineal feet. They terminate at storm inlets or stormwater outfalls. Yard swales shall not be obstructed.

Yards swales shall be:

1. Trapezoidal with a three feet bottom. V-shaped swale are acceptable if dictated by the existing conditions but should be avoided when possible.
2. Sloped between 1% and 5% are optimal. Yard swales sloped between 0.5% and 1.0% shall have an underdrain. Underdrains on yard swales are required to be a minimum of 6 in. Slopes less than 0.5% are prohibited. Yard swales with slopes greater than 5% may require special channel lining to limit erosion.
3. In an easement. Yard swales for individual properties that are contained on the property do not require an easement.
4. Designed to be dry after the storm event passes after 24-48 hours.

SW9.07 Easements

Drainage easements shall be provided for the maintenance or reconstruction of all public open channels. The width of the easement is a function of the conditions. For general open channels, the width shall extend at least 25 feet from the top of the bank on each side. See **Chapter GR7 – Easements** for more information.

SW9.08 Public Safety

Safety should be considered where an open channel presents a potentially dangerous situation to pedestrians or vehicular traffic. Guardrail or fencing may be required for the protection of the public.

SW9.09 General Design Requirements

The design requirements for an open channel include:

1. Design Storm

   Open channels and swales serving storm sewers and tributary flows from upstream watersheds shall be designed to convey runoff from a 100-year rainfall event. Open channels shall convey the 100-year event with 2 feet of freeboard to the top of the channel bank.

2. Channel Lining and Stability

   Channel lining shall be incorporated in the design to prevent scour and erosion and to assure stability of the channel. At minimum the peak flow from a 10-year design storm shall be used to design channel linings criteria for determining required channel lining type and design criteria are set forth in Figure SW9-2. Additional channel lining protection may be required beyond this based on review by Development Services.

3. Channel Slope (Gradient)

   The minimum gradient for open channels is 0.5 percent (.005 ft/ft). Swales with gradient less than 1.0 percent shall be served by an underdrain. Minimum underdrain size shall be 6 inches.

Figure SW9.2 Open Channel Parameters

Channel Lining	Maximum Channel Gradient		Maximum Flow Velocity (ft/sec)	Maximum Side Slope Hor:Vert
	Percent	ft/ft		
Grass	3	0.03	5	3:1
Riprap	10	0.1	15	1.5:1
Concrete	-	-	-	≤1.5:1
Manufactured Lining	*	*	*	*

*Per manufacturer's specifications

SW9.10 Hydraulic Design

1. Uniform Steady Flow Equations

   For the purposes of open channel design, flow is usually considered steady and uniform. Given steady, uniform flow or a reasonable approximate condition, Manning's equation can be used to calculate the capacity of a channel. Using this equation for gradually varied or rapidly varied flow will result in errors.

$$Q = (1.49/n)\, A R_h^{2/3} S_f^{1/2}$$

Where:

Q = flow rate (cfs)

n = Manning's Roughness Coefficient, **Exhibit SW6-1**

A = flow area (ft^2)

R_h = hydraulic radius (ft), defined as flow area, A, in square feet divided by wetted perimeter, (P_w) in feet

S_f = friction slope (equal to storm sewer slope for uniform flow) (ft/ft)

2. Flow Regime

A more detailed analysis of an open channel design might be required by City Utilities if there is concern regarding the flow regime. Flow regime describes the state of flow in an open channel. Critical flow represents the minimum specific energy for a given discharge. The flow depth at critical flow is considered critical depth. Designers must calculate critical depth to classify design flows in the open channel as supercritical or subcritical. To distinguish supercritical and subcritical flow, the Froude number (Fr), which represents the ratio of inertial forces to gravitational forces, is defined by the following equation:

$$F_r = \frac{v}{\left(\frac{g * A}{T}\right)^{0.5}}$$

Where:

F_r = Froude number

v = Mean velocity (ft/s)

g = Acceleration of gravity (32.2 ft/s^2)

A = Cross-sectional area of flow (ft)

T = Top width of flow (ft)

For flows near critical depth (Fr=1), small disturbances can cause changes in flow state and unexpected hydraulic jumps. Flow with a Froude number between 0.8 and 1.2 are unstable and must be avoided. Designers should seek to create open channels with subcritical flow. When flow in open channels is subcritical it is relatively easier to handle through bends and flow transitions. Supercritical flow has higher erosive power and hydraulic losses. Due to erosion potential, curves in an open channel with supercritical flow are not practical. A description of each flow regime is provided in Figure SW9-3.

Figure SW9-3 Flow Regime Classification

Flow Regime	Characteristics
$F_r > 1$ = Supercritical flow	Flow depth controlled by upstream influence usually critical depth. Characterized as shallow with high velocities and steeper slopes. Higher potential for erosion.
$F_r < 1$ = Subcritical flow	Flow depth controlled by downstream influence, usually a ponded area or larger downstream channel. Flow characterized as deep with lower velocities and mild slopes. This flow regime produces most stable open channels.
$F_r = 1$ = Critical flow	Minimum specific energy for a given discharge.

SW9.11 Permitting

Open channels are frequently constructed through low lying areas which may contain wetlands. Permitting may be required if wetlands are affected by construction. For additional information on permitting refer to **Chapter GR4 – Contracts, Fees, and Permits**.

Book 2

Stormwater (SW)

SW10 City Regulated Drains

SW10.01 Purpose

The purpose of this Chapter is to identify jurisdiction and processes for projects adjacent to regulated drains within the City limits. Regulated drains within the City's limits can be a county regulated drain or a City regulated drain. The appropriate permitting procedures are defined by the entity with jurisdiction.

SW10.02 Authority

Indiana Code 36-9-27-15 states regulated drains are under the jurisdiction of the county's drainage board. Therefore, the Allen County Drainage Board has default jurisdiction. However, the Allen County Drainage Board can agree to transfer the jurisdiction to the Fort Wayne Board of Stormwater Management.

1. The Allen County Drainage Board shall define the processes and requirements associated with projects within the right of way of the regulated drain. The Allen County Surveyor's Office is responsible for presenting petition projects to the Allen County Drainage Board.

   Common petition considerations that go to the Allen County Drainage Board include:

   - Consent for permanent structure within the regulated drainage right of way
   - Consent for permanent structure outfall within the regulated drain
   - Petition to establish a new regulated drain
   - Petition to remove obstruction
   - Petition to establish periodic maintenance.

2. The Fort Wayne Board of Stormwater Management (Board) has jurisdiction over City Regulated Drains. The City Utilities Stormwater Engineering Department (Stormwater Engineering) is responsible for presenting petitions to the Board.

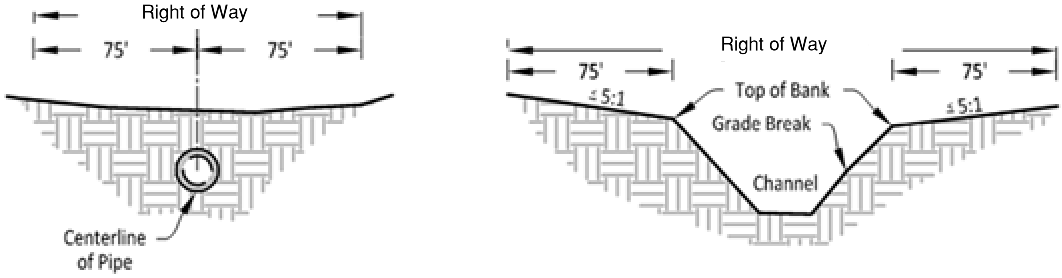
SW10.03 Right of Way Associated with a Regulated Drain

Indiana Code 36-9-27-33 establishes a right of way upon and over land laying within 75 feet of a regulated drain. The 75 feet is measured at right angles to:

- The centerline of a tiled drain (pipe) as shown in Figure SW10.1.

- The top of each bank of an open drain (ditch) as shown in Figure SW10.1. If the top bank is debatable, it shall be the point above the ordinary high water where the slope is equal to or less than 5:1.

Figure SW10.1 Right of Way Limits of Regulated Drain



Historically, some regulated drains were classified by the Allen County Drainage Board as Urban Drains. An urban drain will have a reduced right of way width. It will be the landowner's responsibility to recover the documentation of an urban drain classification from the minutes of the Allen County Drainage Board. The 75 foot right of way, as established by the Indiana Code, will prevail when there is no such documentation.

1. The right of way established by the Indiana Code places some restrictions upon the land. The owner is prohibited for placing permanent structures within the right of way without consent from the Board. Permanent structures shall include, but not be limited to:

   a. Buildings

   b. Fences

   c. Impervious drives and parking areas

   d. Trees, shrubs or other woody vegetation

   e. Earthen mounds

   f. Bridges

   g. Small Structures

   h. Culverts

   Temporary structures and improvements can be made within the right of way without the consent of the Board. Such temporary structures and improvements include but are not limited to:

   a. Agricultural crops (annuals)

   b. Gravel drives

   c. Gardens

   Placement of structures or plantings that interfere with proper operation and maintenance of public stormwater facilities or rights of way without the prior written consent of the Department of Stormwater Management are a violation of Rules and Regulations and are subject to enforcement actions.

2. Landscaping buffers, as required and defined by zoning ordinances, shall not be within the right of way. The landowner can petition to allow the landscaping buffer in the outer most 35 feet of the right of way as a permanent structure. Petitions to place landscaping buffers within the inner 40 feet of the right of way are discouraged.
3. The right of way associated with the regulated drain is for the activities and uses associated with the function of the drain. The right of way rights are limited to inspection, maintenance and stormwater, pipe or surface, outfalls associated with the stormwater conveyance function of the drain. Additional right of way rights such as trail construction, sanitary sewer construction or other rights are not established under a Regulated Drain right of way.

SW10.04 Petition for Permanent Structure within City Regulated Drain Right-of-Way

The Fort Wayne Board of Stormwater Management (Board) has jurisdiction over City Regulated Drains. The City Utilities Stormwater Engineering Department is responsible for presenting petitions to the Board. The Board will approve or deny the petitions.

Each petition consideration requires a basic evaluation by Stormwater Engineering prior to consideration by the Board. The evaluation will include reviewing the proposed petition for compliance with the Design Standards Manual. The basic minimum submittal for the petitions includes:

1. Consent for Permanent Structure within Right-of-Way
    - A completed and signed Fort Wayne Board of Stormwater Management “Petition for Consent to Allow a permanent Structure in the Right-of-way of a Regulated Drain” form. The said form is **Exhibit SW10-1**.
    - Copy of the last recorded deed of record
    - Boundary survey that was certified within the last 18 months
    - Certified plans for the improvements
    - Additional information as required to comply with the Design Standards Manual and necessary to obtain an Improvement Location Permit from the Planning Authority

SW10.05 Relocating, Reconstructing, and Vacating City Regulated Drains

For all other proposed work to regulated drains outside of permanent encroachments, including reconstruction, relocation, and vacation of a City regulated drain, Engineer shall contact City Utilities Development Services to discuss project and process.

FORT WAYNE BOARD OF STORMWATER MANAGEMENT

PETITION FOR CONSENT TO ALLOW A PERMANENT STRUCTURE IN THE RIGHT-OF-WAY OF A REGULATED DRAIN PURSUANT TO IND. CODE § 36-9-27-33

To the Fort Wayne Board of Stormwater Management ("Board"):

Pursuant to Ind. Code § 36-9-27-33, I/we hereby submit this Petition for Consent to Allow a Permanent Structure in the Right-of-Way of a Regulated Drain, and in support hereof, state as follows:

1. I/we am/are the owner(s) of a tract of land with a common address of ___________________________ and generally described as follows: **(include legal description, document number, and copy of latest deed)**

____

____

____

2. The regulated drain affected by this Petition is ____________________________________ (the "Subject Drain"). Drain # ___________.

3. Petitioner requests permission to have the following described structure erected or allowed to remain in the right-of-way of the above named regulated drain **(describe the proposed structure, e.g., house, driveway, deck, etc., and provide copies of plans showing the exact dimensions and proposed location of the structure)**

____

____

____

____

____

By submitting this Petition, Petitioner agrees to the following covenants, conditions, and restrictions:

1. **INDEMNITY**. Petitioner shall indemnify and hold harmless the Board, the City of Fort Wayne ("City"), the Fort Wayne City Utilities Stormwater Engineering Department ("Department"), and each of their respective directors, officers, agents, representatives, employees, successors and assigns from and against any liabilities, actions, demands, claims, losses, or damages, including reasonable attorney's fees, arising out of any injury or death to any person or damage to any property resulting from or in connection with the Petitioner's, or any of the Petitioner's agent's, contractor's, vendor's, or supplier's, use or occupancy of the right-of-way of the Subject Drain, the work performed in the right-of-way pursuant to this Petition, or the condition of any permanent structures installed in the right-of-way pursuant to this Petition.

2. **CONTROL OF PREMISES**. The Board shall retain control over the right-of-way of the Subject Drain and the Board, or its designated agents, representatives, or employees may enter into the same in accordance with Ind. Code § 36-9-27-33. The Board assumes no responsibility for any temporary or permanent structures placed in the right-of-way of the Subject Drain. Petitioner expressly relieves and discharges the Board and the Department from any and all liability for any loss, injury, or damage to person or property that may be sustained by reason of the placement of the structure in the right-of-way and waives the right to recover damages (whether in contract or in tort) for loss of or damage to the structure.

3. **REMOVAL OF STRUCTURE**. The Board, or its agents, representatives, employees, contractors, or others working at the Board's direction, may require removal of the structure as needed to gain access to the Subject Drain. Further, the Board may require removal of the structure if the structure does not conform in all material respects to the plans included as part of this Petition. Removal of the structure for either of the foregoing reasons will be at Petitioner's expense. Should Petitioner fail to remove the structure in a timely manner after written notice from the Board, the Board may cause the structure to be removed at Petitioner's expense.

4. **PERMITS**. The approval granted hereby is solely limited to approval of the placement of a permanent structure in the right-of-way of the Subject Drain. It in no way constitutes any other approval that may be required by any governmental entity under applicable law. Petitioner represents and warrants that it has obtained all of the legal permits and/or governmental approvals for its operation in and on, or use of, the right-of-way of the Subject Drain. Issuance of all required permits and governmental approvals is a condition of this approval. The indemnity provisions of Section 1 shall apply to any fines or other penalties that may be levied as a result of Petitioner's failure to procure all necessary permits and/or approvals.

5. **TERMINATION**. Failure to comply with the terms outlined herein may result in revocation of the approval granted hereby. The Board shall not be liable for any damages incurred by Petitioner as a result of a revocation of the approval to place a permanent structure in the right-of-way of the Subject Drain.

6. **INCORPORATION INTO APPROVAL RESOLUTION**. Petitioner acknowledges and agrees that the covenants, conditions, and restrictions set forth herein will be incorporated into any final Board resolution approving the Petitioner's request.

Petitioner(s)

________________________________	________________________________
Signature	Signature
________________________________	________________________________
Printed Name	Printed Name
________________________________	________________________________
Mailing Address	Mailing Address
________________________________	________________________________
City/State/Zip	City/State/Zip
________________________________	________________________________
Telephone (include area code)	Telephone (include area code)
________________________________	________________________________
Email	Email
________________________________	________________________________
Project address (if different from mailing address)	Project address (if different from mailing address)

____

Name of Engineer/Contractor

Book 2

Stormwater

SW11 Stormwater Management

SW11.01 Purpose

The purpose of this Chapter is to define the minimum requirements of stormwater management for new development and redevelopment projects. The stormwater management plan must address the quality and rate at which the stormwater leaves the site. The most successful stormwater management plan will retain all the runoff on site for the water quality storm event and have limited discharges during greater storm events. All development and redevelopment projects must comply with these standards.

The use of the generic term “basin” in this chapter will be synonymous with a stormwater detention or stormwater retention feature for the sole purpose of providing a storage volume associated with reducing the peak discharge. It can include traditional above ground detention basins and underground detention.

SW11.02 Stormwater Management Plans (SMP) for New Development

All new developments require a SMP. The SMP is a function of the existing site conditions, the amount of new impervious area constructed and the capacity of the existing stormwater infrastructure.

A major component of SMPs is detention and/or retention of stormwater. It impacts the stormwater quality and the discharge rates of a development site.

1. The stormwater volume retained on site during the water quality storm (1-inch rainfall) event is a leading variable in meeting the stormwater quality imperative. The City of Fort Wayne adopted a post-construction stormwater quality policy that requires a reduction of least 80% of the total suspended solids in the stormwater before it leaves the site. A zero discharge from a development for the 1-inch storm event satisfies the water quality imperative. Additional stormwater quality measure are required if a zero discharge is not feasible for the water quality rainfall event. A stormwater quality proprietary unit (proprietary unit) is an acceptable alternative to utilizing detention/retention for stormwater quality.
2. SMPs utilize basins during larger rainfall events to reduce the peak release rate of stormwater discharges from a site. The allowable peak release rate for new developments is the product of the total shed area of the new development per the release rate shown in Figure SW11.1.

Figure SW11.1 Peak Unit Discharge Rates for New Developments

Design Storm	Release Rates (cfs/acre)
100 year	0.18

For example, the 100-year release rate for a 10-acre site is 1.8 cfs. (10 acres x 0.18 cfs/acre = 1.8 cfs)

There are particular site situations when a peak release rate is not applicable. These site situations include, but are not limited to:

- The change in impervious area is less than 0.5 acres.
- The site drains to a regional detention basin that was adequately sized for the proposed development.
- The site is immediately adjacent to a river or major open channel.
- The site is with the 100-year floodplain.
- The site will discharge into the low end of an existing stormwater infrastructure system with that has sufficient capacity for a direct outfall from the new development.

A preliminary meeting should occur with City Utilities for all projects that propose stormwater release rates higher than those stated in Figure SW11.1. Exhibit SW11-1 outlines the process utilized to determine if a site is exempt from the peak discharge rate requirement.

New developments that are less than 2-acres require release rates less than 0.36 cfs. An orifice small enough to control a flow rate this low can be a maintenance issue. Contact City Utilities to establish possible alternatives. Potential options include water quality offsets, or a minimum 3-inch diameter orifice.

Storm-water quality measures will be required for sites that are less than 1-acre and need to receive a variance to release at a rate greater than those allowed by Figure SW11.1.

City Utilities may dictate a reduced peak release rate for watersheds with known drainage issues. A reduced release rate will be required when the receiving channel or storm sewer is inadequate to accommodate the proposed discharge.

City Utilities may require an overall watershed analysis, beyond the project's geographical limits, from the design consultant to determine the maximum allowable release rate for watersheds with known drainage issues.

SW11.03 Stormwater Management Plans (SMP) for Redevelopments

An SMP is also required for projects that include land disturbing activities associated with site renovations to an existing development or a redevelopment project. There are several scopes of projects that are considered redevelopment projects. Hard surface area will be based upon existing conditions per a boundary or topographic survey at the time of submittal to Development Services.

The definition for the scope of redevelopment is largely based on the footprint of areas disturbed down to bare earth.

1. Entire Sites reduced to Bare Soil

   Sites that demo most of the existing improvements to bare soil shall provide post-construction water quality plan as required for a new development. If the site is less than 0.5 acres, a post-construction water quality plan is encouraged. Examples of this redevelopment scope is the removal of a building or parking lot for a similar project.

2. Portions of the Site remain Undisturbed

   Some redevelopment projects have only a portion of the site being disturbed. The area being disturbed will be evaluated as a project independent of the undisturbed portion of the site. An increase of impervious surface greater than 0.5 acres will require post-construction water quality. The discharge rate from the disturbed site will be limited to 0.18 cfs per acre. The “disturbed site” will be the construction limits of the project.

   Examples of this redevelopment scope is a building addition or parking lot expansion. It typically is an increase of impervious surface that includes a portion of the site being reduced to bare soil.

3. Renovation or Repairs to an Existing Impervious Surface

   Redevelopments projects with scopes limited to renovations or repairs to the existing impervious surfaces will have limited impact on the stormwater. The project’s SWP needs to show there is practically no change to the runoff quantity or discharge point. Post-construction water quality is encouraged but not required.

   Examples of this redevelopment scope is the remodeling a building, building façade revisions or reconstruction of a parking lot. The area of the impervious surfaces is nearly unchanged.

4. Post-Construction Water Quality for Redevelopment

   All redevelopment projects are encouraged to implement post-construction water quality practices. Redevelopment projects that disturb more than 0.5 acres of bare soil are required to provide post-construction stormwater quality measures for the area within the construction limits. For example, if a 50-acre development is adding 2-acres of impervious area, the run-off from the 2-acres will require post-construction stormwater quality. **Exhibit SW11-2** shows an example of defining the areas that affect the required extents for post-construction water quality of a redevelopment project.

   The post-construction water quality and discharge rate requirements for each of these scopes of redevelopment will vary. Figure SW11.2 Requirement per Scope of Redevelopment is a table of the general requirements.

Figure SW11.2 Requirement per Scope of Redevelopment

Scope of Redevelopment	Water Quality	Discharge Rate
Site is > 0.5 acres and majority is demoed to bare soil	Required for all of site	Function of Existing Infrastructure*
Site is < 0.5 acres and majority is demoed to bare soil	Recommended	Function of Existing Infrastructure*
Impervious surface of site is increased by > 0.5 acres (additional building/parking)	Required for new impervious	0.18 cfs per acre for impacted on-site water shed
Impervious surface of site is increased by < 0.5 acres (additional building/parking)	Recommended	Function of Existing Infrastructure*
Renovations to existing impervious surface (resurfacing/repairing)	Recommended	No Change

* City Utilities input is required. The existing capacity of the system receiving the stormwater discharge from the site will impact the allowable discharge rate.

5. Stormwater Discharge for Redevelopment

   The discharge from redevelopment projects is a function of the increase of impervious surface and the capacity of the existing discharge. Generally, an increase in net impervious surface of 0.5 acres or less, will not require a controlled discharge rate. This is subject to approval by City Utilities based on the existing capacity of the outfall storm system.

   Increases greater than 0.5 acres of impervious surface will require a controlled discharge rate. Generally, the discharge rate for the 100-year event will be limited to 0.18 cfs per acre. The area will be based on the disturbed (construction) limits or as arranged with City Utilities. The discharge rate for the undisturbed areas of a redevelopment can remain unchanged.

   If the existing development has a stormwater detention facility and the improvements to the site will continue to drain to the detention facility, the detention facility shall be calibrated to meet the new conditions. This typically will include increasing the detention volume and may require modifications to the outfall control structure.

   When a new detention basin is required, there are two options for addressing release rates from the redevelopment project. Both options are dependent upon the downstream receiving channel having sufficient capacity to convey the new flows.

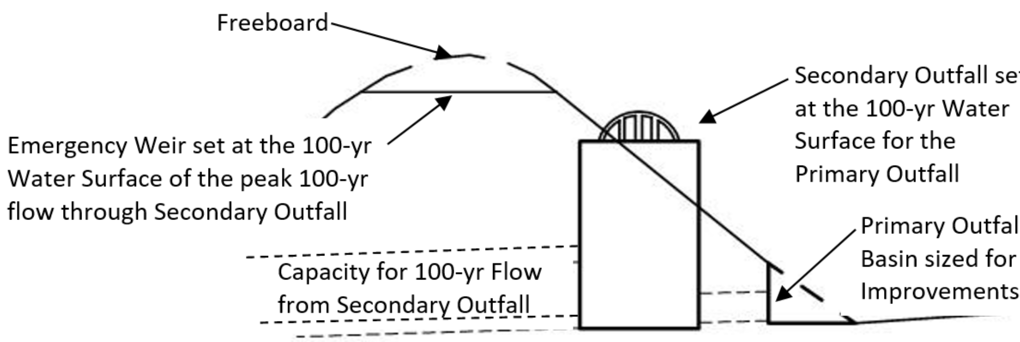
   <u>Option 1</u> - The flows from the existing impervious surfaces can be passed through the new basin. This will require a 2-stage outfall. The release rate for the primary outfall will be the product of the area within the project's construction limits at the rate stated in Figure SW11.2. This will define the required release rate and the stormwater volume of the basin for the primary outfall.

A second outfall will be set at the 100-year water elevation of the primary outfall. This second outfall must pass the peak 100-year flow from the existing site conditions that are outside of the proposed construction limits. The grade beam for the basin shall be at the peak 100-year water surface when the secondary outfall is passing the peak 100-year flow. Figure SW11-4 shows a sample of a 2-stage outfall configuration.

Figure SW11.3 Detention Basin Method for Passing Existing Runoff

Primary Outfall	Sized to release at 0.18 cfs per acre for the shed area of the disturbed construction limits	Set at the pool elevation of the water quality retention or the basin floor
Secondary Outfall	Sized to release the peak 100-year flow of the undisturbed watershed	Set at the 100-year water surface of the Primary Outfall

Figure SW11.4 – Sample 2-Stage Outfall Configuration



<u>Option 2</u> – The runoff from the existing impervious areas are routed around the new basin. The proposed project will follow the release rate as defined in Figure SW11.1 based on the new impervious areas and pervious areas draining to the new basin.

City Utilities may dictate a reduced peak release rate for watersheds with known drainage issues. A reduced release rate will be required when the receiving channel or storm sewer is inadequate to accommodate the proposed discharge.

City Utilities may require an overall watershed analysis, beyond the project's geographical limits, from the design consultant to determine the maximum allowable release rate for watersheds with known drainage issues.

Redevelopment projects with less than 2-acres of disturbed area require release rates less than 0.36 cfs. An orifice small enough to control a flow rate this low can be a maintenance issue. Contact City Utilities to establish possible alternatives. Storm-water quality measures will be required for sites that are less than 1-acre and need to receive a variance to release at a rate greater than those allowed by Figure SW11.1.

Most projects will impact right-of-way in one of two fashions. The first is most projects will have some type of existing right-of-way. Typically, it will have well established drainage patterns. The second situation is the creation of new right-of-way. This requires defining a new drainage plan.

1. Existing Right-of-way

   The improvements required within the existing right-of-way will vary greatly between projects. The extent of the improvements will directly affect the existing drainage patterns. The improvements can be classified into no impact, a drive only impact or lane improvements to an existing road.

   A project with no impact on the existing right-of-way will have extremely limited work within a right-of-way. Such projects will be:

   1. Site improvement projects with no work in or immediately adjacent to the right-of-way. (i.e., additions to existing buildings, parking lots…)
   2. Repairs or resurfacing to an existing drive.
   3. Utility extensions that are minor cuts through the right-of-way to a development site.

   Projects of no impact will not require drainage improvements to the existing right-of-way. The existing drainage patterns will remain unchanged. Minor erosion and sediment control will be required as appropriate.

   Projects with simple drive installations will require the perpetuation of the existing drainage patterns. A simple drive installation is defined as the installation of residential, commercial or industrial drive that is 28-feet, or less, in width. It may require a culvert and some minor grading to perpetuate the drainage pattern. There is no or a minimal increase of impervious surface draining to the right-of-way. This is limited to the new drive or turning radii. Stormwater detention is not required for the minimal increase in drainage to the existing right-of-way. Minor erosion and sediment control measures will be required.

   Projects that require acceleration/deacceleration lanes and/or turn lanes will have a substantial impact on the existing drainage pattern. The amount of impervious surface is increased. The improvements may result in the loss of the existing side ditch capacity. The runoff from the new impervious surface shall be directed to the stormwater detention facility to the extent practical. Runoff directed to a detention basin is required to meet the post-construction water quality requirements of the overall project.

2. Proposed Right-of-way

   Newly created right-of-way (newly platted right-of-way) must drain to a detention basin. The expansion of existing right-of-way for lane improvements shall drain to a detention facility to the extent practical. Both assume the overall project requires detention. Runoff directed to a detention basin is required to meet the post-construction water quality requirements of the overall project.

Figure SW11.5 Right-of-way Improvements Requiring Stormwater Detention

Improvement Type	Detention Requirements
Newly Defined Right-of-way (Plats and Development Plans)	Detention Required
Lane Improvements to Existing Roadway and/or Drive Entrances Greater than 28-feet in width	Detention Required
Sidewalks and Trails	Detention Required
Drives 28-feet or less in width	Perpetuate the drainage patternNo Detention Required

SW11.04 Acceptable Stormwater Quality Calculation Methods

There are three acceptable methods for calculating the stormwater quality features. They are the:

- Reduced Runoff Method
- Volume Based Method
- Soil Conservation Service (SCS) Runoff Method

The type of stormwater quality feature will dictate which calculation method is required.

SW11.05 Reduced Runoff Method for Stormwater Quality Calculations

The Reduced Runoff Method (a.k.a. Quality Volumetric Control) is applicable when retaining the water quality storm event on-site. The objective is to prevent any of the runoff from the initial 1-inch rainfall from leaving the site. This method is the preferred option for providing water quality. The stormwater quality volume is discharged only by infiltration, evapotranspiration, and / or reuse of run-off. These calculations are required for low impact design (LID) water quality features that are “before the pipe” such as water quality swales, rain gardens and porous pavement.

Designers should utilize the LID storage volume within the site’s stormwater quantity management calculations. This requires utilizing the retention within the LID features into the overall site hydrograph model with the appropriate rainfall for the 10-year and 100-year events. Refer to **Exhibit SW11-3** which illustrates how some runoff volumes exit the system before leaving the site.

A “micro-model” of the overall development is used to document the stormwater retention for compliance with the stormwater quality imperative. All the sub-basins of the site are modeled as interconnected basins. A site that has a zero discharge from the site per the micro-model for the 1-inch rainfall event is compliant with the stormwater quality imperative. The volume required in the detention basin(s) for larger rainfall events will be decreased by using this methodology.

The Reduced Runoff Method is described below.

1. Delineate the sub- or micro-watersheds. A micro-watershed is the area that contributes to an LID feature. The micro-watershed will have the impervious and the pervious areas delineated separately.
2. Determine the time of concentration for each LID feature using the TR-55 methodology per **Exhibit SW5-1** “Time of Concentration Worksheet”. The minimum time of concentration for any micro- watershed is 5 minutes.
3. Calculate the curve numbers (CN) for the impervious area and the pervious area of each basin per **Exhibit SW5-3** “Runoff Curve Numbers for Urban Areas”.
4. Determine the available storage volume and release paths for each LID feature. The LID features will be modeled as ponds with overflow weirs at an elevation above the water quality storage volume. The infiltration rate of LID features shall be included in the calculations as a constant outflow rate based on the soil permeability established by geotechnical report and the bottom surface area of the water quality feature. See **Exhibit SW11-4** “Methodology for Modeling LID Features” for the method required to calculate the LID features.
5. Construct a micro-model using the above input parameters. See **Exhibit SW11-5** for an example of a modeling diagram for the reduced run-off method.
6. Run a hydrograph calculation for each LID feature utilizing the TR-20 method of modeling the 1-inch storm with the appropriate Huff rainfall distribution at the 0.5-, 1-, 2-, 3-, 6-, 12-and 24-hour durations.
7. A zero discharge from the site during a 1-inch rainfall is considered a successful PC-SWPPP for stormwater quality.

The stormwater quality micro-models shall be incorporated into the site’s overall stormwater quantity management calculations.

SW11.06 Volume Based Method Stormwater Quality Calculations

Volume based stormwater quality calculations can be utilized for sites to treat and release the water quality volume (WQv), sometimes referred to as the conventional stormwater quality volume. It is defined as the volume needed to capture 80% of the rainfall events at a site. It is utilized for sizing “end of pipe” performance-based LID features such as bioretention basins and wet detention basins. The storage in forebays and other pre-treatment trains are included in the WQv.

The volume-based stormwater quality calculation is:

$$WQ_v = \frac{(P)(R_v)(A)}{12}$$

Where:

WQ_v = Water quality volume in acre-feet

P = Water quality storm, 1-inch rainfall

R_v = Volumetric runoff coefficient, 0.05+0.009(I)

where I is the percent impervious cover

A = Drainage area in acres

The draw-down time for the WQv must be 12 to 48 hours to meet the required stormwater quality imperative.

SW11.07 SCS Method for Proprietary Stormwater Quality Units

The stormwater quality rate shall be determined using the Soil Conservation Service (SCS) runoff methodology for proprietary stormwater quality units (proprietary units). Proprietary units shall be used when LID stormwater quality techniques are not a reasonable option.

The capacity of a proprietary unit is sized based on the stormwater quality treatment rate. These treatment rates are the peak flow through the proprietary unit that will remove 80% or more of the total suspended solids during the 0.3-inch rainfall event. The stormwater quality rate is determined using the SCS runoff methodology as outlined below.

1. Delineate the watershed basin(s) to be served by the proposed proprietary stormwater quality unit(s). Tabulate the total impervious and pervious areas. The sizing calculations assume the impervious area is connected directly to the stormwater quality unit and the time of concentration calculation must be adjusted for this assumption (i.e. no flow over grass) for the impervious basin. This is accomplished by creating two basins, one with an area equivalent to the total new impervious area and the other with an area equivalent to the total pervious area of the delineated watershed to be served by the proprietary unit.
2. Determine the time-of-concentration for each basin using the TR-55 methodology, **Exhibit SW5-1** “Time of Concentration Worksheet”. The minimum time of concentration shall be 5 minutes.
3. Calculate the curve numbers (CN) for each basin, use a CN=98 for the impervious basin(s).
4. Use the hydrograph method to determine the peak discharge from the 0.3-inch storm using the appropriate Huff, 50% rainfall distribution. See Figure SW5.4 “Huff Rainfall Distribution”
5. A single hydrograph for each basin should be determined and all basin hydrographs combined to determine the peak flow for the water quality rate. Storm durations of 15, 30 and 45 minutes as well as 1, 2, 3, 6, 12 and

24 hours should be checked to determine the peak water quality rate of flow.

See **Exhibit SW11-6** for an example of the rated based stormwater calculations.

The various proprietary units have maximum treatment rates established by independent labs. The preapproved treatment rates are found in **Exhibit MA5-3**.

All proprietary stormwater quality units shall be off-line and upstream of any stormwater detention facilities. Use of proprietary units downstream of stormwater detention facilities is prohibited.

SW11.08 Stormwater Detention Calculations

There are two acceptable methods for calculating stormwater detention facilities: the Rational Method and the Hydrograph Method.

1. Rational Method

   The Rational Method or the Hydrograph Method can be used for projects of 20 acres or less.

   - The Rainfall Intensities shall be per Figure SW5.2 “Intensity-Duration-Frequency” or the current “Precipitation-Frequency Atlas of the United States” by NOAA. The NOAA publication will govern if there is a significant difference in the values.
   - The run-off coefficients shall be based on values per **Exhibit SW5-2** “Coefficients for Use in Rational Formula”.
   - The outfall rate shall be per Figure SW11.1 or per Figure SW11.2 as appropriate.

2. Hydrograph Method

   The Hydrograph Method can be used for projects smaller than 5 acres and shall be used for projects greater than 20 acres in area.

   - The Rainfall values shall be per Figure SW5.3 “Depth-Duration-Frequency” or the current “Precipitation-Frequency Atlas of the United States” by NOAA.
   - The runoff curve numbers shall be composites based on **Exhibit SW5-3** and **Exhibit SW5-4**.
   - The appropriate Huff Distribution shall be utilized in the hydrograph method per Figure SW5.4 “Huff Rainfall Distribution”.
   - The detention provided by LID features, if applicable, should be utilized in the overall detention calculations. See **Exhibit SW11-5** “Reduced Runoff Method (Micro Model)” for additional information.

   Use of the NRCS Type II 24-Hour Rainfall Distribution will not be accepted.

   See **Exhibit SW11-12** for a sample detention facility design Summary.

SW11.09 Acceptable Types of Stormwater Storage Facilities

The majority of SMPs will require stormwater storage to meet the peak discharge requirements. The following types of facilities are acceptable in Fort Wayne.

1. Detention Basins (Wet or Dry)
2. Retention Basins
3. Underground Detention
4. Parking Lot Detention
5. Porous Pavement Systems

Other types of stormwater storage facilities will require conceptual approval by City Utilities prior to the calculation submittals.

Channel or stream inline stormwater storage is prohibited.

SW11.10 Design Standards for Detention and Retention Basins

Detention basins with a permanent pool are considered wet detention basins. Dry detention basins have no permanent pool. Special considerations can be incorporated into some designs to meet stormwater quality requirements.

Retention basins have no obvious outfall. They drain by percolation into the soil and evapotranspiration processes. They share the same design standards and physical characteristics as the detention basins except for the lack of an outfall structure. Retention basins satisfy the stormwater quality requirements.

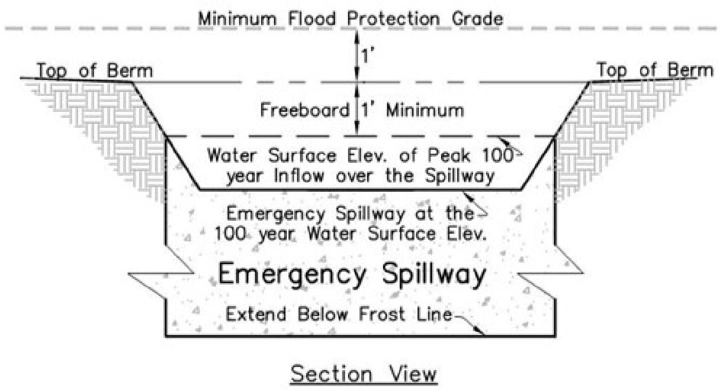
This manual will use the generic term “stormwater basin” to include detention and retention basins. Stormwater basins must comply with the following criteria:

1. Grading Requirements
   - The maximum side slope is 3:1.
   - The minimum top of berm width is 8-feet.
   - Berms constructed of fill material are to be keyed into virgin soil and compacted to a Standard Proctor Value of at least 95% dry density.
2. Use of Retaining Walls
   - The use of retaining walls in stormwater basins is generally discouraged. However, if walls are unavoidable, they shall receive railing or fencing to prevent falls when the vertical change is 30” or greater from the top of the wall to the ground (basin floor) below.
   - A professional engineer shall stamp the retaining wall plans. The structural design details and requirements for the retaining wall(s) shall be included in the construction drawings.

3. Emergency Spillway

   - Stormwater basins shall have an emergency spillway. The spillway shall be set at the basin's peak 100-year water elevation. It shall be sized to pass the peak 100-year inflow.
   - The spillway must direct the emergency overflows away from buildings and other structures.
   - The emergency spillway must be resistant to vertical movement; concrete grade beams must extend below the frost line.

Figure SW11.6 Emergency Spillway, Freeboard and Minimum Flood Protection Grade



4. Freeboard

   Stormwater basins shall have a minimum of 1-foot of freeboard. Freeboard is the vertical difference between the basin's top of berm and the water surface of the peak 100-year inflow passing over the emergency spillway.

5. Minimum Flood Protection Grade

   - All buildings adjacent to a stormwater basin shall have a Minimum Flood Protection Grade established. The elevation shall be 2-feet above the water surface elevation of the peak 100-year inflow passing over the emergency spillway (1-foot above the freeboard elevation). "Adjacent" to a stormwater basin shall be any building that is within 100-feet of the basin's peak water limits or on a parcel that is contiguous with the basin.
   - The Minimum Flood Protection Grade applies to the lowest opening of a building that surface water could enter: a basement window, a walkout basement doorway or the structure's finished floor, whichever is lower.

6. Pipe Outfalls into the Basin

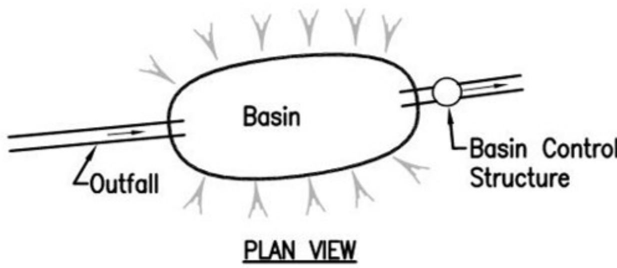
   Pipes that outfall into stormwater basins shall have:

   - Screen or bars to prevent entry by people or animals. Pipes that are smaller than 12-inches in diameter are exempt from having screens or bars.
   - Energy dissipaters (e.g., riprap aprons or forebay).

- Anchoring to prevent vertical movement of pipe materials that are susceptible to floating. The anchor can be a concrete end section, ties to a concrete footer or other similar means.

The storm sewer outfall must be upstream of the stormwater basin's storage volume. Figure SW11.7 is the acceptable flow configuration. Basin outfall shall be above the normal water surface elevation.

Figure SW11.7 Acceptable Flow Configuration between Outfall & Basin



7. Stormwater Basin Control Structures

   Stormwater basin control structures limit the peak flows as established by Figures SW11.1 or SW11.2, as appropriate. The control structure can control the flows by utilizing orifices, weirs and/or culvert pipes. The minimum size of a pipe connected to the control structure is 12-inches regardless of the basin's release rate. The connected pipe must have capacity to handle the peak release rate of the basin by gravity flow.

   Stormwater basin control structures must be designed to minimize the chances of clogging. **Exhibit SW11-7** includes examples of control structures that are designed to minimize clogging.

   Stormwater basin control structures must be vertically stable. Pipes and structures that are susceptible to floating must be anchored to prevent vertical movement. The anchor can be a concrete end section, ties to a concrete footer or other reasonable means.

8. Public Protection Guidelines

   Stormwater basins can be a public hazard. The basins shall have 6-inch (or taller) non-mountable curb or an earth berm that is at least 3-feet higher in elevation than the edge of the parking lot pavement in the following conditions. Refer to **Exhibit SW11-8**.

   a. Parking spaces that are perpendicular to and adjacent to stormwater basins
   b. Drives and streets that are parallel to stormwater basins
   c. Drives and streets that terminate perpendicular to stormwater basins shall have a visible barrier such as a dual arrow sign or substantial shrub hedge

9. Landscaping Guidelines

   Landscaping around stormwater basins shall not be detrimental to the basin’s structural integrity, overall performance or safety. In addition:

   - No mulch shall be placed in or around basin.
   - Landscaping shall allow for adequate vehicle access and general maintenance around the top of detention basin embankments. There shall be at least one access path to the bottom of dry detention basins that will accommodate lawn mowing equipment or small earth moving equipment.
   - Surface vegetation shall provide erosion control and sediment entrapment.
   - Side slopes, berms and basin surface shall be planted with species compatible with the expected hydrologic conditions.

10. Multi-use Configuration

    Lands dedicated to detention/retention facilities should be laid out to promote multiple uses such as green spaces for recreational activities, wildlife habitat and/or buffer space between mixed uses.

    The construction of some basins may require state approval. Any dam constructed for the purpose of storing water, with a surface area, volume, or dam height as specified in Indiana Code 14-27-7.5 and Title 312 IAC 10.5 Regulation of Dams as amended, shall require the approval of the plans by the Indiana Department of Natural Resources (IDNR). Those facilities subject to state statutes shall be designed and constructed in accordance with the criteria of the state, in addition to these criteria.

SW11.11 Stormwater Pretreatment

Stormwater entering basins and most LID stormwater quality features requires pretreatment, especially from point discharges. The purpose of the pretreatment is to reduce the energy gradient and capture the larger loads of the pollutants in the stormwater. Pretreatment measures associated with stormwater basins include forebays and biofilters. Proprietary water quality units can be used in lieu of a forebay or biofilter.

1. Forebays

   The most common pretreatment practice for stormwater basins is a forebay. **Forebays are not stand-alone post-construction stormwater quality practices.** Forebays are recommended for any discharge into green infrastructure. Figure SW11.8 depicts a typical section view of a forebay.

   a. Design Considerations

      - The forebay must be sized to contain the volume equal to 0.1-inches of rain per impervious acre of contributing drainage shed area. For example:

There is 0.8 acres of impervious area in a 1.5 acres shed area. The forebay size would be 290 cu. ft.

$$0.8 \text{ acres x } \frac{43560 \text{ sq. ft.}}{1 \text{ acre}} \text{ x } \frac{0.1''}{12''} = 290 \text{ cu. ft.}$$

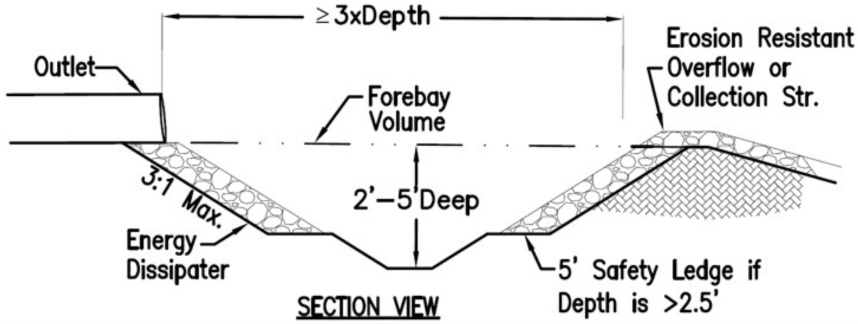
- The volume of the forebay is to be included in the total stormwater quantity management volume.
- The forebay must have direct maintenance access. The maintenance access shall have a maximum grade of 3:1.
- The side slopes of the forebay shall not exceed 3:1.
- The minimum depth of the wet forebay shall be 2.5-feet.
- The maximum depth of the wet forebay shall be 5-feet. A safety ledge is required when the forebay depth will be greater than 2.5-feet. Safety ledge requirements are included in **Section SW11.12 – Design Standards Unique to Wet Basins**.
- The minimum flow length from the inlet pipe to the forebay overflow structure shall be 3 times the depth.
- The forebay overflow can be an earthen berm with scour protection, a concrete grade beam or a concrete structure such as a manhole with a grate.
- The wet perimeter of the forebay shall have native wetland grasses and other native wetland plants. The designer must specify the appropriate plants for the intended conditions. A list of acceptable native plants is available at **utilities.cityoffortwayne.org/wp-content/uploads/2024/01/City-Utilities-Plant-List-2024.pdf.**
- If the forebay is used as a sediment control measure during construction, the forebay must be restored to the design capacity after the site has substantial vegetation established.

b. Operation and Maintenance Considerations

- It must include a schedule for inspection and maintenance of the forebays. Forebays shall be inspected weekly until there is a substantial vegetative cover. The inspections can be scheduled monthly after the vegetation is well established.
- It must identify a process for measuring the sediment deposits within the forebay. This can be by requiring a fixed vertical sediment depth marker, specifying a depth from the pipe outfall or another logical method.
- It must state when the sediment deposits from the forebay needs to be removed. This should be given as a depth of sediment accumulation that is equal to the loss of 50% of the forebay’s capacity or at least once every 5 years, whichever occurs first.
- It must address inspection and maintenance requirements for excessive weed and algae growths within the forebay(s).

- It must address mosquito control.

Figure SW11.8 Forebay Example



2. Biofilters

   Biofilters, like forebays, are pretreatment practices. They are not stand-alone post-construction stormwater quality practices. The biofilters use dense vegetation to slow the velocity of the run-off so that large, suspended solids can settle out of the flow. The vegetation also acts as a mechanical filter. Figure SW11.10 depicts a typical section view of a biofilter.

   a. Design Considerations

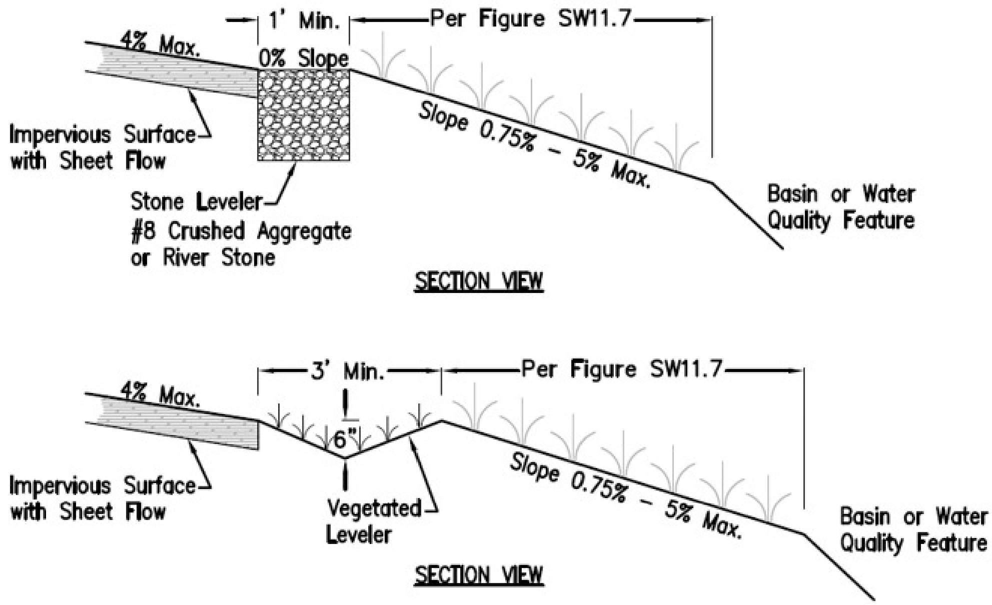
      - The drainage area entering a biofilter shall be 5 acres or less.
      - The biofilter shall be densely vegetated with grasses. It can include trees and other wood-stemmed vegetation, but mulch is prohibited.
      - The water entering and traveling through the biofilter shall be by sheet flow. (No concentrated flow outfalls.)
      - A leveler is required between the impervious surface and the biofilter to ensure the surface flows are entering the biofilter as a fully distributed sheet flow. The leveler can be:
      - a 12-inch width, or greater, band of crushed aggregate or river stone with no slope
      - a concrete grade beam or
      - a 3-foot-wide vegetated buffer that has retentive grading of 6-inches, or more.
      - The minimum slope for a biofilter is 0.75%.
      - The maximum slope for a biofilter is 5%.
      - The width of the biofilter shall be at least 20-feet. The width is measured perpendicular to the flow.
      - The length of flow across the biofilter shall be per Figure SW11.9. The length is measured parallel to the flow.

Figure SW11.9 Maximum Flow Parameters for Biofilters

Parameters	Impervious Areas				Pervious Areas			
Inflow Approach Length*	≤35’		35’-75’		≤75’		75’-100’	
Biofilter Strip Slope	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%	≤ 2%	> 2%
Biofilter Strip Length	10’	15’	20’	25’	10’	12’	15’	18’

* Greater inflow approaches will produce run-off quantities that exceed the benefit capacity of the biofilter.

Figure SW11.10 Section View of Biofilters



b. Operation and Maintenance Considerations

- Biofilters shall be inspected weekly until there is substantial vegetive cover. The inspections can move to monthly after the vegetation is well established.
- The biofilter shall be inspected for “rill and gulley erosion” at least twice a year. These areas shall be repaired and reseeded as necessary.
- The drainage flows into the biofilter should be inspected for concentrated flow characteristics. These characteristics are to be addressed.
- The leveler shall be inspected for erosion or other grading changes that negates its function.

SW11.12 Design Standards Unique to Wet Basins

In addition to the requirements of Section SW11.10 — Design Standard for Detention and Retention Basins, wet basins shall also conform to the following requirements:

- Wet Basins shall be at least 1 mile from an airport unless the Fort Wayne – Allen County Airport Authority has provided prior permission in writing.
- A maintenance ledge of at least 6-feet in width is required around the wet basin. The maintenance ledge shall be 12-inches, measured vertically, above the normal pool elevation.
- A safety ledge of at least 6-feet in width is required. It shall be between 12-inches and 18-inches below the normal water surface.
- The average permanent pool depth of a wet basin shall be at least 4-feet.
- Bank armor to prevent wave action erosion is required 12-inches above and 12-inches below, measured vertically, the normal pool elevation. The armor can be stone, crushed aggregate, or a proprietary product.
- Refer to **Exhibit SW11-9** for an example of a typical plan view and cross section.

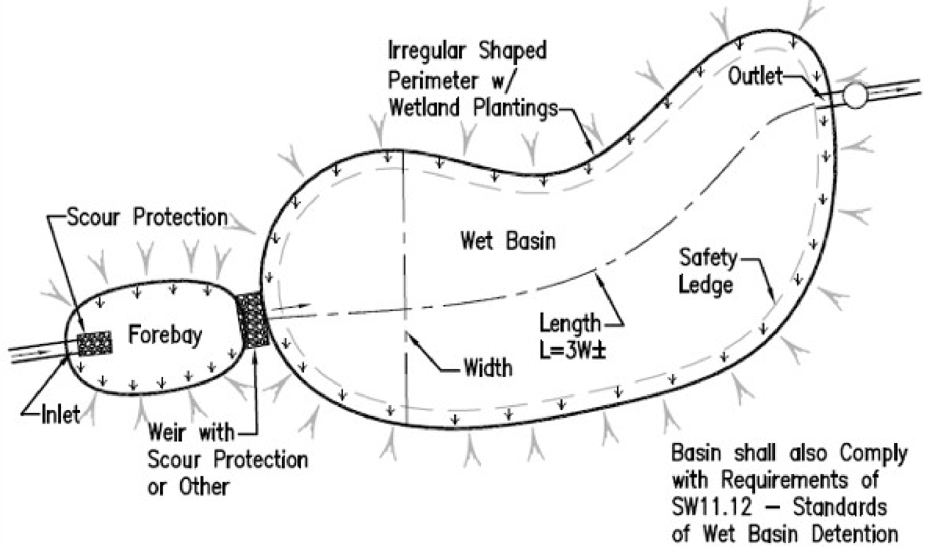
Wet detention basins can also be used for meeting the stormwater quality requirements. For a wet detention basin to meet the 80% TSS removal it shall comply with the following criteria. Figure SW11.11 depicts a typical wet detention basin.

1. Design Considerations

   - The basin shall have a length to width ratio of 3:1 or greater. The length is the travel distance between the inlet and outlet structures. The width of the basin is the empirical average.
   - The length shall be maximized. Baffles or other controls shall be used when the placement of the inlet and outlet structures cannot be maximized.
   - Irregular basin shapes are encouraged.
   - The wet perimeter of the basin can have native wetland grasses and other native wetland plants in place of the bank armor required in **Exhibit SW11-10**. Refer to **utilities.cityoffortwayne.org/wp-content/uploads/2024/01/City-Utilities-Plant-List-2024.pdf** for a list of acceptable native wetland plants. The designer that specifies these plants shall have the appropriate knowledge and experience.
   - All basins being used for water quality must include a forebay or proprietary stormwater quality unit where the concentrated flow discharges into the basin(s).
   - All pipes that discharge into the basin require energy dissipation treatments.
   - Forebays are required at the concentrated flow discharges into the basin(s).
   - The minimum drainage area for a wet detention basin to be utilized for water quality and stormwater management is 25 acres or if it has a drawdown time of at least 12 hours for the water quality storm event.

- If the basin and/or forebay are used as a sediment control measure during construction, the basin and/or forebay must be restored to the design capacity after the site has substantial vegetation established.

Figure SW11.11 Typical Wet Detention Basin for Water Quality



2. Operation and Maintenance Manual Considerations

   - It must include a schedule for inspection and maintenance of the basin and the basin's accessories such as forebays.
   - It must address inspection and maintenance requirements for excessive weed and algae growths within the basins.
   - It must be inspected for sediment accumulation at and above the safety ledge. A decrease in volume of 25% or more in comparison to the approved design drawings will require sediment removal.

SW11.13 Design Standards Unique to Dry Basins

In addition to the requirements of **Section SW11.10 – Design Standard for Detention and Retention Basins**, dry basins shall also conform to the following requirements:

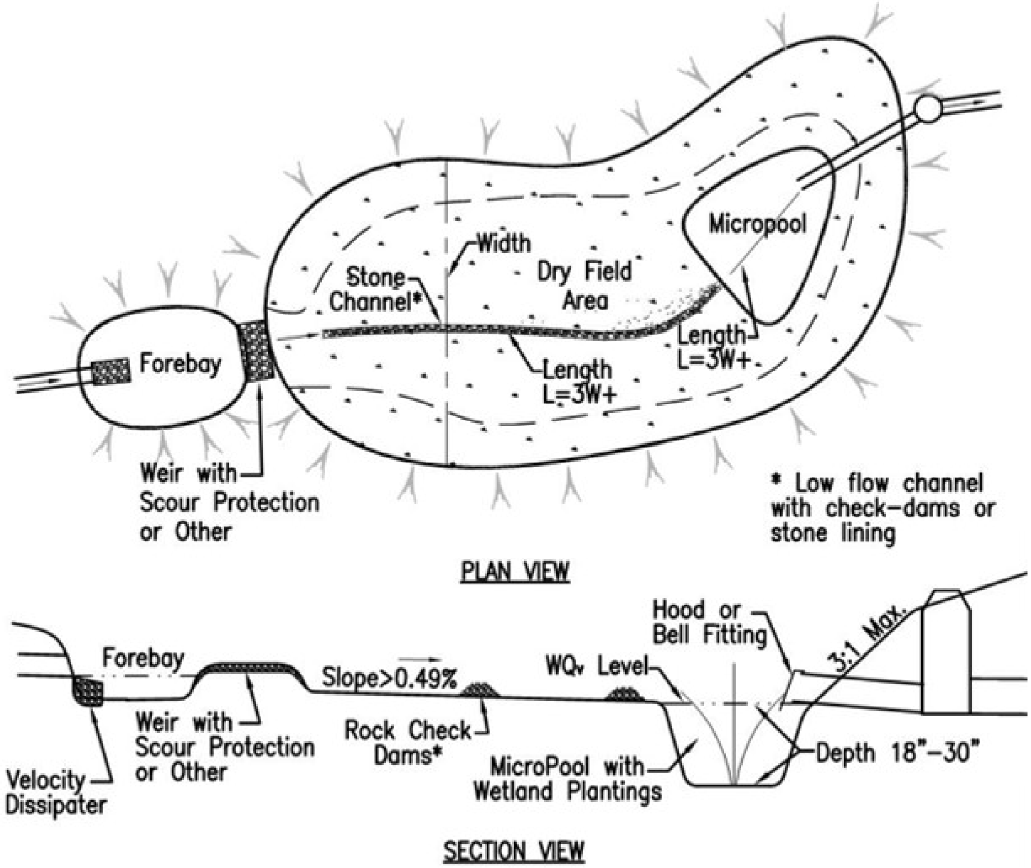
- Dry basins shall completely drain within 48 hours of the rainfall event.
- Dry basins shall have a minimum longitudinal grade of 0.5% to the outlet structures.
- The dry basin shall have a minimum cross-slope of 1%.
- Refer to **Exhibit SW11-10** for an example of a typical plan view and cross section.

Dry detention basins by themselves do not meet the stormwater quality requirements. A micropool component can be added to reach the stormwater quality requirements. This configuration is a micropool extended detention basin. For a micropool extended detention basin to meet the 80% TSS removal it shall comply with the following criteria. Figure SW11.12 depicts a typical micropool extended detention basin.

1. Design Considerations
    - The basin shall have a length to width ratio of 3:1 or greater. The length is the travel distance between the inlet and outlet structures. The width of the basin is the empirical average.
    - The length shall be maximized. Baffles or other controls shall be used when the placement of the inlet and outlet structures cannot be maximized.
    - Irregular basin shapes are encouraged.
    - Forebays are required at the concentrated flow discharges into the basin(s).
    - All pipes that discharge into the basin require energy dissipater treatments.
    - The minimum drainage area for a micropool extended detention basin is 10 acres or if it has a drawdown time of at least 12 hours for the water quality storm event.
    - If the basin and/or forebay are used as a sediment control measure during construction, the basin and/or forebay must be restored to the design capacity after the site has substantial vegetation established.
    - The micropool shall be 18-inches to 30-inches deep.
    - The micropool shall have a length to width ratio of 3:1 or greater.
    - The micropool shall be planted with wetland vegetation. Refer to utilities.cityoffortwayne.org/wp-content/uploads/2024/01/City-Utilities-Plant-List-2024.pdf for a list of acceptable native wetland plants.
    - The outfall control structure shall be protected with a hood or turned-down elbow to prevent debris from entering the structure.
    - A low-flow channel between the forebay and the micropool should be defined. The channel shall be lined with INDOT #2 stone or include permanent rock check dams to reduce flow velocities.
2. Operation and Maintenance Manual Considerations
    - It must include a schedule for inspection and maintenance of the basin and the basin's accessories such as forebays.
    - It must address inspection and maintenance requirements for the vegetation within the basin and the micropool.
    - It must be inspected for sediment and organic accumulation in the micropool. A decrease in volume of 25% or more in comparison to the design drawings will require removal of the accumulations.
    - The manual shall address the inspection of the wetland vegetation in the micropool and require removal of invasive species.
    - It must specify the inspection of the basin's banks for signs of erosion.

- It must address inspection for and control of mosquito larva.

Figure SW11.12 Typical Micropool Extended Detention Basin



SW11.14 Design Standards for Retention Basins

Retention basins have no obvious outfall. They drain by percolation into the soil and other evapotranspiration processes.

A site investigation is required to determine if the site is appropriate for a retention basin. A geotechnical engineer or a registered soil scientist shall conduct the investigation. The investigation must include at a minimum:

- Location of the groundwater table
- Location of bedrock
- Seasonal fluctuation of water table
- Soil permeability and porosity
- Soil profile
- Environmental conditions (e.g. contaminated soils)
- Proximity to structures (e.g. basements).

1. The following conditions preclude the use of a retention basin:

    - A seasonal high groundwater table that is less than 4-feet below the bottom of the basin.
    - Bedrock within 4-feet of the bottom of the basin.
    - Surface and underlying soil classified as NRCS Hydrologic Soil Group D.
    - Saturated infiltration rate not sufficient to drain the basin dry for the 100-year storm event within 72 hours.
    - Fill material is utilized to bring the bottom of the basin to design grade.
    - A negative recommendation by the registered soil scientist or geotechnical engineer.

The general requirements of a retention basin shall be the same as those required for a dry detention basin set forth in **Section SW11.13 – Design Standards Unique to Dry Basins**.

Retention basins meet the stormwater quality requirements because they have a zero discharge, excluding infiltration. There are several stormwater quality features that utilize retention of the stormwater quality event on-site such as constructed wetlands, bioretention basins, and bioswales.

SW11.15 Design Standards for Constructed Wetlands

Constructed wetlands when properly designed will remove 83% of the total suspended solids. The use of naturally existing wetlands as the water quality practice is prohibited.

The soils, vegetation selections and various pool depths are critical to designing a successful constructed wetland. The design must be by a professional wetland scientist, a licensed landscape architect, or a professional engineer with at least 3 years of experience with wetland design experience.

The constructed wetlands must meet or exceed the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure SW11.12 depicts a typical wetland configuration.

1. Design Considerations

    - A geotechnical report shall be prepared for the site. The report must be based on site-specific field data. The general information gathered from the soil surveys is insufficient for designing wetlands and bioretention basins.
    - Soil types conducive to wetland vegetation need to be present. These soil types can be imported to create an appropriate soil liner for the proposed wetlands. These soil types are identified in **Exhibit SW11-11** Hydric Soils Suitable for Wetland Construction.
    - A water balance must be performed to demonstrate that a stormwater wetland could withstand a thirty-day drought at summer evaporation rates without completely drawing down the pool elevation. The inflow of water must be greater than that leaving the wetland by infiltration or

exfiltration. The following water balance equation should be included in the wetland calculations:

$$S = Q_i + R + Inf - Q_o - ET$$

Where:

S = net change in storage

Q_i = stormwater runoff inflow

R = contribution from rainfall

Inf = net infiltration (infiltration – exfiltration)

Q_o = surface outflow

ET = evapotranspiration

- The wetlands must be designed for a detention time of approximately 48-hours for the water quality volume. Refer to **Exhibit SW11-5** for an example of the "Reduced Runoff Method".
- The surface area of the wetland must be greater than 12% of the water shed surface area draining into it.
- The wetlands shall have a length to width ratio of 2:1. The length is the travel distance between the inlet and outlet structures.
- All concentrated discharges into the wetlands must be into a forebay.
- The design must maximize the use of pondscape grading to create vertical diversity. The proportion for the wetlands surface area for the different depths must comply with Figure SW11.13 "Required Vertical Depths for Constructed Wetlands".

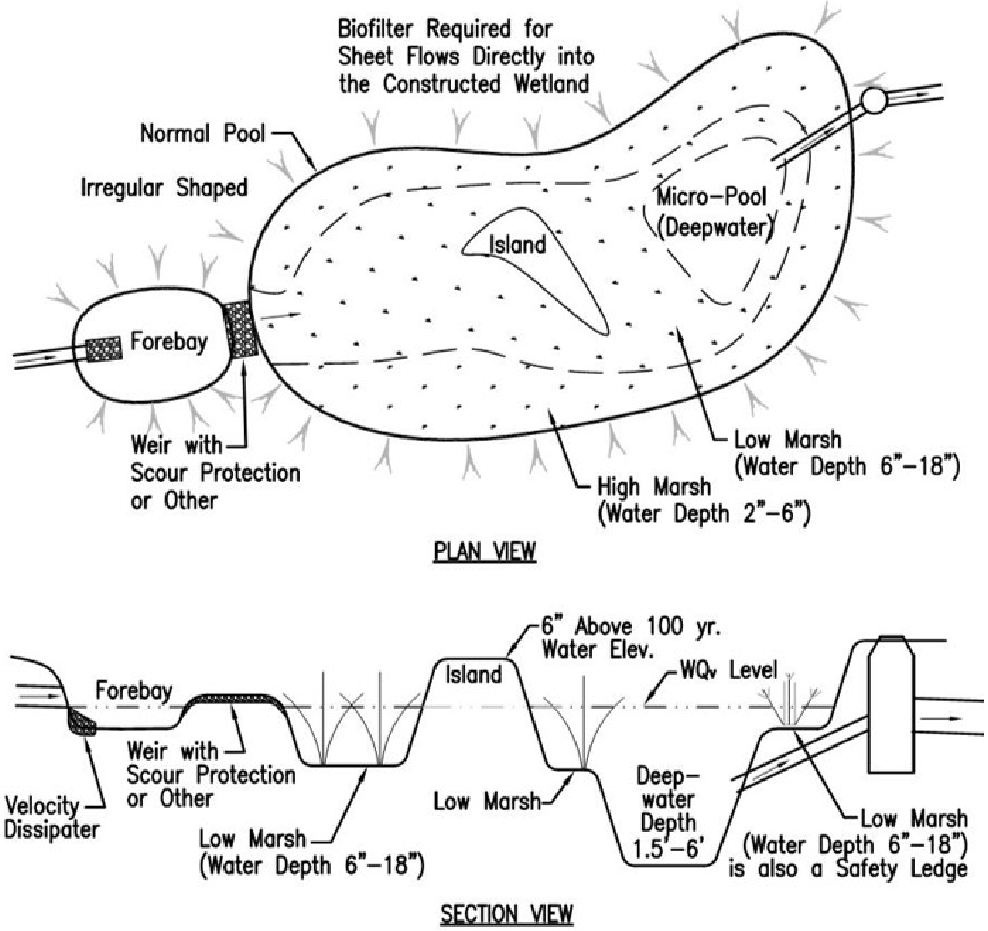
Figure SW11.13 Required Vertical Depths for Constructed Wetlands

Strata	Depth from Pool Elevation	Surface Area
Deepwater	1.5' to 6' below	20%
Low Marsh	6" to 8" below	35%
High Marsh	0" to 6" below	40%
Semi-wet Zone	Areas of periodic flooding	5%

- A minimum of two types of aggressive emergent wetland species (primary species) that are native to Indiana shall be established in a quantity of 30%-50% coverage of the appropriate wetland surface area. The plantings shall be at the optimal pool depth required for the selected wetland species of emergent wetland plants. These plantings shall be near the pool's edge.
- An additional three wetland species of native vegetation (secondary species) shall also be planted within the wetland. The secondary species must be planted at a rate of 50 individual plants per acre of total wetland surface area. They are to be planted in clumps of approximately 5 individual plants. The plantings shall be at the optimal pool depth required for the selected wetland species.

- A minimum 50-foot buffer must be planted around the wetland with native riparian and upland vegetation.
- A micro-pool is required at the outfall of constructed wetlands. It can be a part of the deep-water strata.
- The outfall shall be a reversed pipe or protected by a hood.

Figure SW11.14 Typical Constructed Wetland Configuration



2. Operation and Maintenance Considerations

- A schedule shall be included for the inspection and maintenance of the wetlands and its accessories. The initial inspections shall occur on a weekly basis. These initial inspections shall include removing evasive species. The proposed vegetation shall be evaluated. Growing supplements and replanting shall occur as necessary to stimulate vegetative cover.
- The wetland vegetation coverage shall be at least 50% of the surface area after the second growing season.
- Monitor wetland vegetation and address “bare” spots as necessary on a semi-annual schedule after the third year.
- Inspect for invasive vegetation and remove, as necessary, on an annual schedule.

- Inspect inlet, outlet and embankments for damage on an annual schedule.
- It must address inspection and maintenance requirements for excessive algae growths within the wetlands.
- The wetland must be maintained to prevent the loss of volume of ponded water available for emergent vegetation due to sedimentation and/or biomass.

SW11.16 Design Standards for Constructed Bioretention Basins

Constructed bioretention basins will remove approximately 90% of the total suspended solids. The volume of stormwater stored in a bioretention basin shall be included in the stormwater management detention calculations.

The bioretention must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure SW11.15 depicts a typical bioretention basin configuration.

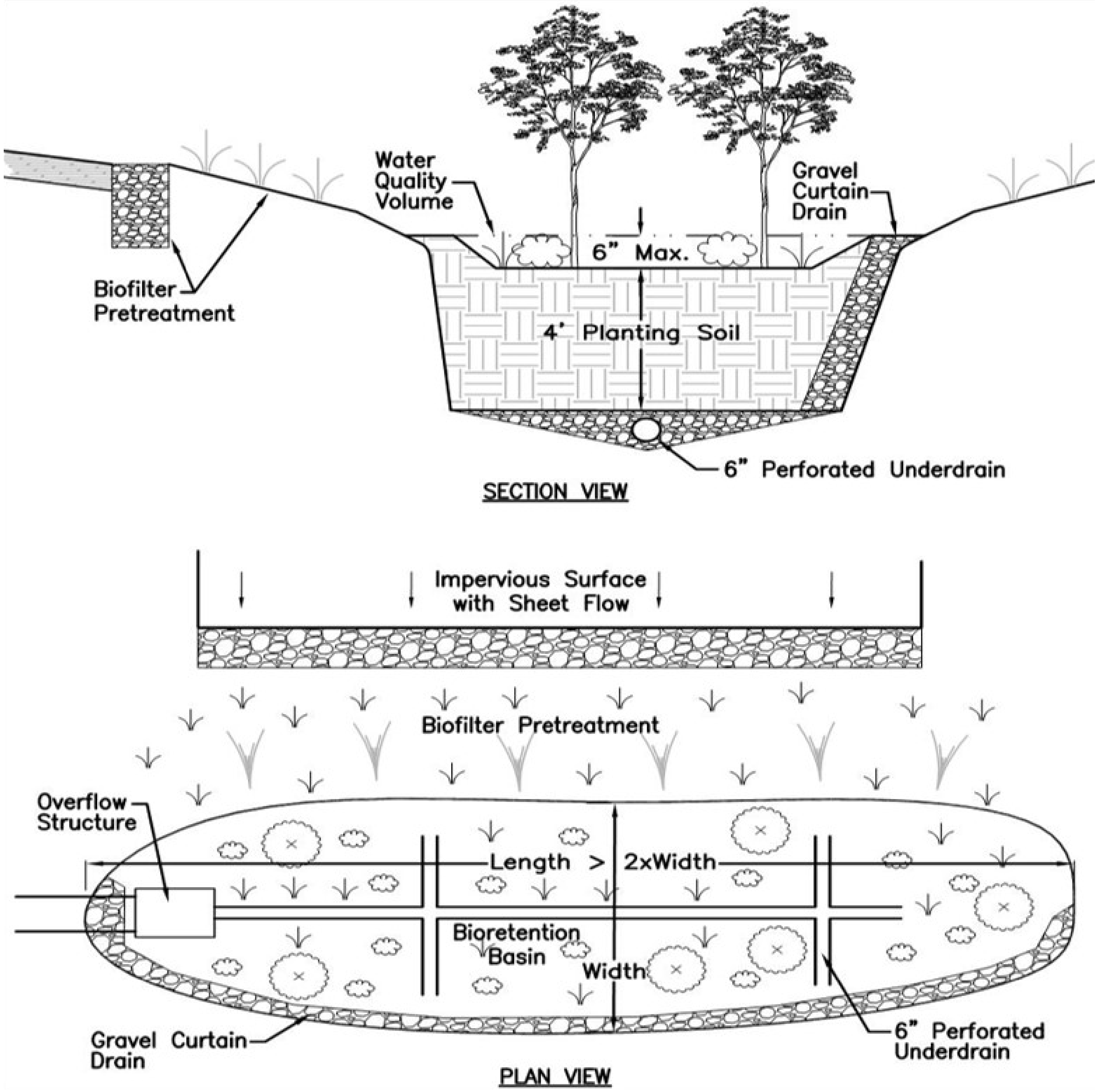
1. Design Considerations
    - The watershed area contributing to a bioretention basin must be less than 5 acres. The optimal watershed areas for bioretention basins are between 0.5 to 2.0 acres.
    - The bioretention storage volume must equal or exceed the water quality volume. (See **Section SW11.06 – Volume Based Stormwater Quality Calculations**)
    - The run-off must enter the bioretention basin as sheet flow.
    - A biofilter strip is required between the contributing drainage area and the bioretention basin. See Figure SW11.09 – Maximum Flow Parameters for Biofilters for the biofilter strip requirements.
    - The minimum size for a bioretention basin is 200 sq. ft.
    - The length to width ratio shall be at least 2:1. The length is the travel distance between the average inlet point and the outlet structure.
    - The bioretention basin must have a slope that is less than 5%.
    - The bioretention basin must have a planting soil bed with a depth of at least 4-feet.
    - The soil shall be sandy-loam, loamy sand or a loam textured with a clay content less than 25%.
    - The infiltration rate for the planting soil shall be at least 0.5-inches per hour.
    - The planting soil shall have a pH value between 5.5 and 6.5.
    - The planting soil shall have an organic content between 1.5% and 3.0%.
    - The maximum water quality pool depth in a bioretention basin is 6-inches.
    - The use of trees and shrubs are encouraged in the bioretention limits. The species shall be conducive to the fluctuating water levels.

- The ground cover vegetation shall be conducive to the fluctuating water levels.
- An underdrain system is required under the planting soil. The underdrain system shall include at least 8-inches of gravel and a 6-inch diameter perforated pipe. The pipe shall be a rigid wall PVC or HDPE.
- A non-woven geotextile (filter fabric) is required between the planting soil and the underdrain gravel.
- The seasonally high-water table must be a minimum of 2-feet below the underdrain envelope.
- Continuous flows into the bioretention basin are prohibited.
- Geothermal discharges into bioretention basins are prohibited.
- An overflow structure and a non-erosive overflow channel are required for storm events that exceed the bioretention's volume capacity.
- If the bioretention basin is used as a sediment control measure during construction, it must be restored to the design capacity after the site has substantial vegetation established.

2. Operation and Maintenance Considerations

- A schedule shall be included for the inspection and maintenance of the bioretention and its accessories.
- The vegetation within the bioretention and biofilter pretreatment shall be inspected on a semiannual schedule. Address "bare" spots as necessary.
- Inspect for invasive vegetation and remove on a semiannual schedule.
- Inspect the overflow structure for debris and blockage on a semiannual schedule.
- Inspect for erosion and address as necessary.
- The bioretention basin and the pretreatment filter strip shall be policed for litter on a regular basis.
- Mulches used in and adjacent to a bioretention basin must consist of non-floating materials.
- The vegetation aggregate shall be inspected and maintained according to the approved plan.

Figure SW11.15 Typical Bioretention Basin Configuration for Water Quality



SW11.17 Design Standards for Water Quality Swales

Water Quality Swales are channels that convey stormwater but also utilize low velocities and vegetation to treat stormwater during low flow events. The channels utilize retentive grading, terracing, check dams or other means to capture the stormwater. These are also referred to as bioswales or retentive grading practices. Water quality swales will remove approximately 81% of the total suspended solids.

Water quality swales can include an underdrain system. The water quality volume will pass through the topsoil and out the underdrain. Most of the time the channels are dry.

The water quality swale must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative. Figure SW11.16 depicts a typical water quality swale configuration.

1. Design Considerations

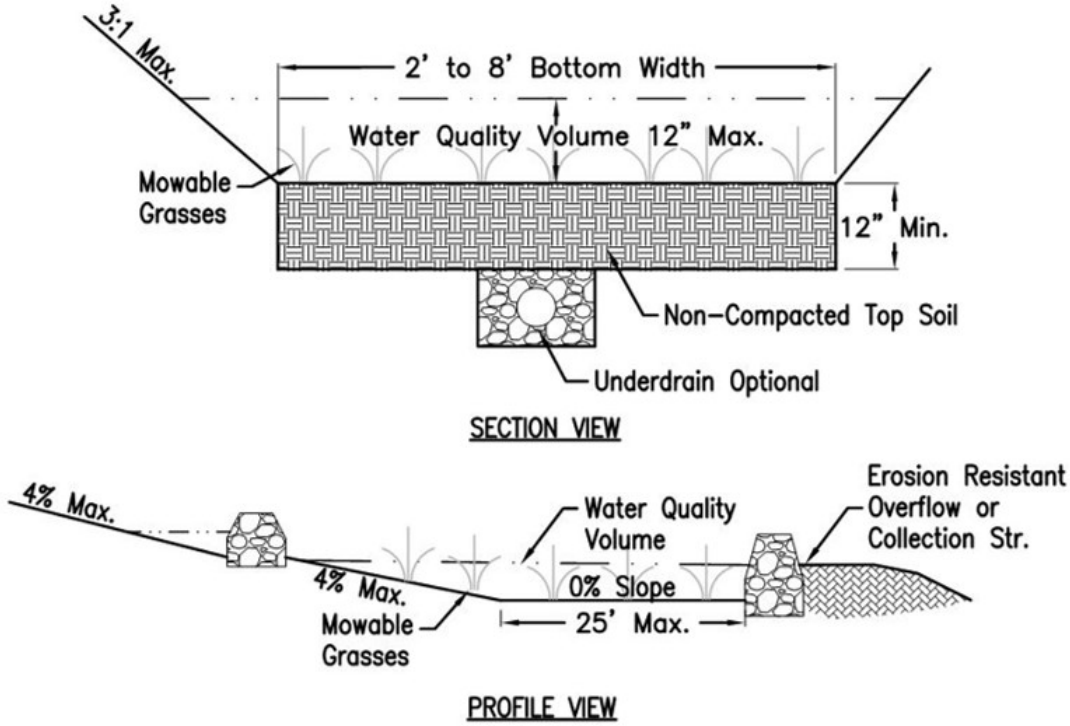
    - The captured storage volume must equal or exceed the water quality volume. Refer to **Exhibit SW11-5** for an example of the “Reduced Runoff Method”.
    - A maximum void ratio of 25% can be used for calculating the stormwater storage volume within the non-compacted topsoil.
    - The maximum watershed draining to a water quality swale shall be less than 5 acres.
    - The drawdown time for the water quality volume shall be at least 30 minutes and shall not exceed 24 hours.
    - A perforated underdrain is required for soils with an infiltration rate less than 1-inch per hour.
    - The ponding depth of the water quality volume cannot exceed 12-inches. The peak 10-year flow depth cannot exceed 18-inches.
    - The swale is to have a flat bottom (not V-bottom). The bottom width shall be at least 2-feet wide and not exceed 8-feet.
    - The maximum longitudinal slope for the swale is 4%.
    - The swale can be terraced with a flat (zero) slope for a lineal distance of 25-feet or less.
    - The seasonally high-water table must be at least 3-feet below the bottom of the swale.
    - Concentrated flows entering the water quality swale shall be through a forebay.
    - The water quality swale shall have an overflow for storm events that exceed the water quality volume.

2. Operation and Maintenance Considerations

    - A schedule shall be included for the inspection and maintenance of the water quality swale and the pretreatment practices, if applicable.
    - The vegetation within the bioretention and biofilter pretreatment shall be inspected on a semiannual schedule. Address “bare” spots as necessary.
    - The water quality swale and any pretreatment practices shall be monitored for litter on a regular basis.
    - The vegetation of the swale’s bottom and side slopes shall be inspected and maintained as appropriate.
    - Debris and biomass build-up shall be raked, or otherwise removed, when the drawdown time is noticeably increased.
    - Fertilizers and other lawn maintenance chemicals to be used only if necessary to establish the initial vegetation.

- The storage volume shall be re-established when 50% of the volume is lost.

Figure SW11.16 Typical Water Quality Swale Configuration



SW11.18 Design Standards Stormwater Basins Adjoining Open Channels

City Utilities may allow stormwater basins immediately adjoining the top of bank of a river, stream or regulated open drain to provide detention storage without constructing a restricted outfall. The non-restricted stormwater basin will be open to, and utilized by, the waters of the open channel during high water events. This option must be discussed and approved in concept by City Utilities Development Services before the construction plans are submitted. Figure SW11.17 depicts an example of a non-restricted stormwater basin section. The applicant will also need to get consent from other governing entities with jurisdiction.

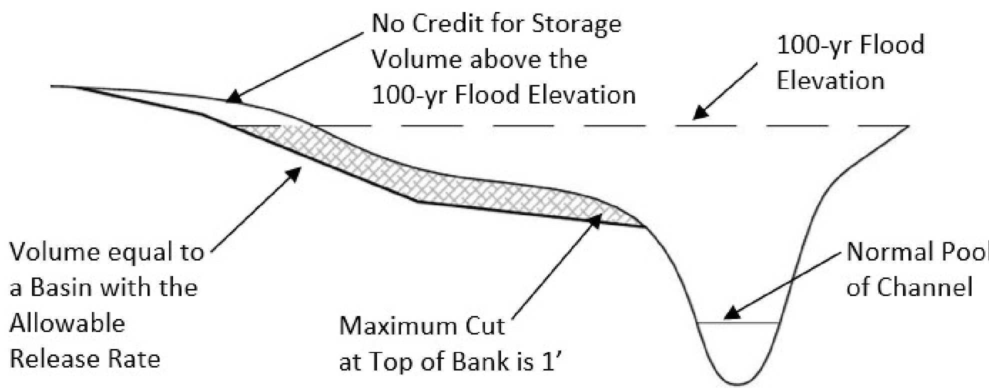
A non-restricted stormwater basin's storage volume shall be calculated based on the project's allowable release rate set in Figure SW11.1. The resulting storage volume must be provided. The project's stormwater run-off shall be treated for water quality prior to being released into the non-restricted stormwater basin.

Non-restricted stormwater basins shall:

- Be immediately adjacent to the open channel on the project site. It cannot cross an adjoining property to get to the open channel.
- Be adjacent to an open channel with a known 100-year water elevation. This can be per the current FEMA Map Studies, Indiana Department of Natural Resources Division of Water Best Available Map Data, or calculated by the consultant.

- Provide the required storage volume vertically between the adjoining channel’s normal pool elevation and the 100-year water surface elevation.
- Be designed to the same grading requirements set forth in Section SW11.08 – Stormwater Detention Calculations.
- Use an overland flow path or an equalization culvert to allow the open channel’s backwaters to enter and exit the basin. The equalization culvert needs to be designed to pass the 50-year event and be at least 18-inches in diameter. The construction of the overland flow path shall not lower the existing top of bank of the open channel by more than 1-foot. (See Figure SW11.17)
- Not compromise a protection levee.
- Not endanger adjacent parcels by increasing the chances of flooding.
- Not be a part of a water quality plan.

Figure SW11.17 Non-Restricted Stormwater Basin Section



SW11.19 Design Standards for Parking Lot Detention

Parking lot detention allows stormwater to remain on a parking lot surface for an extended amount of time.

1. Depth Limitations
   - Parking lot detention shall not exceed a depth of 8-inches at an inlet or 6-inches at a distance of 10-feet from the inlet.
2. Parking Lot Detention is prohibited from:
   - Overflowing into a public right-of-way.
   - Preventing access between a building and a public right-of-way by submerging all driving lanes.
3. Outlet Configuration
   - Restrict the stormwater release rate per Section SW11.02 – Stormwater Management Plans for New Developments or Section SW11.03 – Stormwater Managements Plan for Redevelopments, as appropriate. This can be by utilizing orifices, weirs, or culvert pipes.

- Utilize a storm pipe, if applicable, that is a minimum of 12-inches in diameter.
- Be designed to minimize the chances of clogging.

4. Surcharging

   Parking Lot Detention can be created by surcharging an inlet within the parking lot.

5. Parking Lot Maintenance

   Any repaving or other modification of the parking lot shall be evaluated for impact on stormwater storage volume and release rates. City Utilities must review and approve any such modifications.

SW11.20 Design Standards for Underground Detention

Underground detention provides detention storage underground in vaults or pipes. The installation and design shall comply with the manufacturer's installation and design standards, as applicable. Non-vendor underground detention shall comply with the standards provided in this section.

For underground storage systems that utilize the bedding and backfill for storage, the storage of stormwater within the voids of the bedding and backfill shall be calculated as 40% of the stone volume. These systems will require an underdrain or an outfall configuration that will drain the bedding and backfill voids.

1. Materials
   - Underground detention shall be constructed using reinforced concrete pipe, high-density polyethylene (HDPE) pipe, concrete vaults or approved equivalents. See **Chapter MA5 – Stormwater Materials and Testing Requirements**.
   - Bedding and backfill requirements shall meet or exceed those provided by the manufacturer or the City's requirement for the material being utilized, whichever is more stringent.
   - The pipe and vault material shall be designed to withstand HS-20 loading at a minimum.
2. Configuration
   - Underground detention chambers shall not be within public rights-of-way or easements dedicated for use by public or private utilities.
   - Detention chambers cannot be under buildings or foundations.
   - Underground detention shall be downstream of the stormwater quality facilities.
   - Pipes and structures installed for the primary purpose of being a stormwater conveyance are not to be included in the detention volume calculations.

3. Basin Control Structure Configuration
   - The basin control structure shall be designed to release the design storm events according to the sections SW11.02 or SW11.03, as appropriate.
   - The minimum outlet pipe size shall be 12-inches in diameter.
4. Maintenance Access
   - Maintenance access to inlet and outlet structures shall be by manholes.
   - An inspection/maintenance port shall be provided at each end of every manifold.
   - At least one inspection/maintenance port is required for each lateral.
   - Inspection/maintenance ports shall be at least 4-inches in diameter.

SW11.21 Porous Pavement System Requirements

Approved porous pavement systems include pavers and interlocking systems. Porous concrete and asphalt systems shall be evaluated on a case-by-case basis with City Utilities Development Services. This option must be discussed and approved in concept by City Utilities Development Services before the construction plans are submitted. The detention volume for porous pavement is provided within the voids of the stone aggregate below the pavement system. Gravel parking areas and gravel drives are not considered to be porous pavement.

1. Components

   The components of a porous pavement system must consist of:

   - Permeable surface
   - Open-graded aggregate sub-base
   - Uncompacted, level sub-grade
   - Underdrain
   - Overflow System
2. Site Requirements

   The following are minimum site requirements for porous pavement systems:

   - The surface area of the porous pavement shall provide an infiltration rate equal to or greater than the 10-year storm event.
   - The depth from the “high” ground water table to the bottom of sub-grade must be greater than 4-feet.
   - Porous pavement shall be at least 100-feet from any ground water well.
   - Porous pavement shall be at least 10-feet from building foundations or as required by building code.

3. Storage Volume

   The storage of stormwater within the voids of the bedding and backfill is 40% of the stone volume.

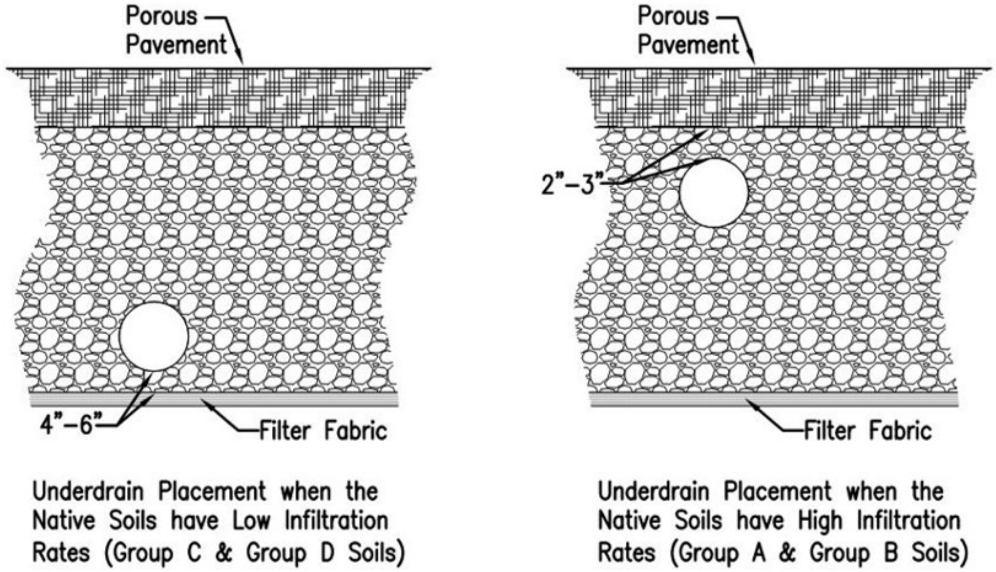
4. Outlet

   Porous pavement systems shall have at least one underdrain that will drain the sub-base within 48 hours. Additional underdrains may be necessary based on layout and unique site conditions.

5. Properly designed porous pavement systems, including the use of pavers, meet the stormwater quality requirements. The porous pavement must meet the following requirements to be considered successful in accomplishing the stormwater quality imperative.

   - The surface area of the porous pavement shall be at least 50% of the total watershed area collecting on the porous pavement.
   - The captured storage volume in the voids of the sub-base materials must equal or exceed the water quality volume. See **Section SW11.06 – Volume Based Stormwater Quality Calculations**. The storage volume can be adjusted for infiltration rates.
   - Run-off entering the porous pavement shall be by sheet flow.
   - The surface slope of the porous pavement cannot exceed 5%.
   - The cross-section of the porous pavement shall be designed upon the anticipated load requirements.
   - A non-woven geotextile fabric (filter fabric) is required between the sub-grade and the gravel aggregate sub-base.
   - The subgrade shall be flat (zero slope).
   - A perforated underdrain pipe(s) is required. The pipe shall be a 4-inch or 6-inch diameter perforated schedule 40 PVC or an equivalent HDPE.
   - The underdrain pipe(s) shall have at least one clean-out.
   - The underdrain pipe(s) shall be near the top of the aggregate sub-base when the native soils have high infiltration rates (Hydrological Soil Types “A” or “B”). The underdrain pipe(s) shall be near the bottom of the aggregate sub-base when the native soils have low infiltration rates (Hydrological Soil Types “C” or “D”). See Figure SW11.18 Underdrain Placement for Porous Pavement.
   - The porous pavement system shall be modeled as a detention system to ensure the underdrain system is adequate for a 10-year storm event or provide an overflow structure.
   - A concrete header, or similar device, is required to prevent water from migrating into the gravel aggregate sub-base of adjoining impervious surfaces.

Figure SW11.18 Underdrain Placement for Porous Pavement



6. Maintenance

   Appropriate inspections and maintenance, including regular vacuum sweeping, shall be included in O&M agreement.

7. Operation and Maintenance Considerations

   Operations and Maintenance for porous pavements must include the following considerations:

   - Schedule for inspection and maintenance.
   - Monthly inspection for debris and sediment accumulations.
   - Clearing of leaves and lawn clippings.
   - Vacuumed at least once per year.
   - Sand and chemical deicers shall not be used on porous pavement or immediately adjoining surfaces.
   - Metal snowplows are prohibited.
   - Snow stockpiles are prohibited on porous pavement.
   - There shall be no surface treatments to the porous pavement (e.g. surface sealants, resurfacing…)

SW11.22 Design Standards for Rainwater Harvesting Methods

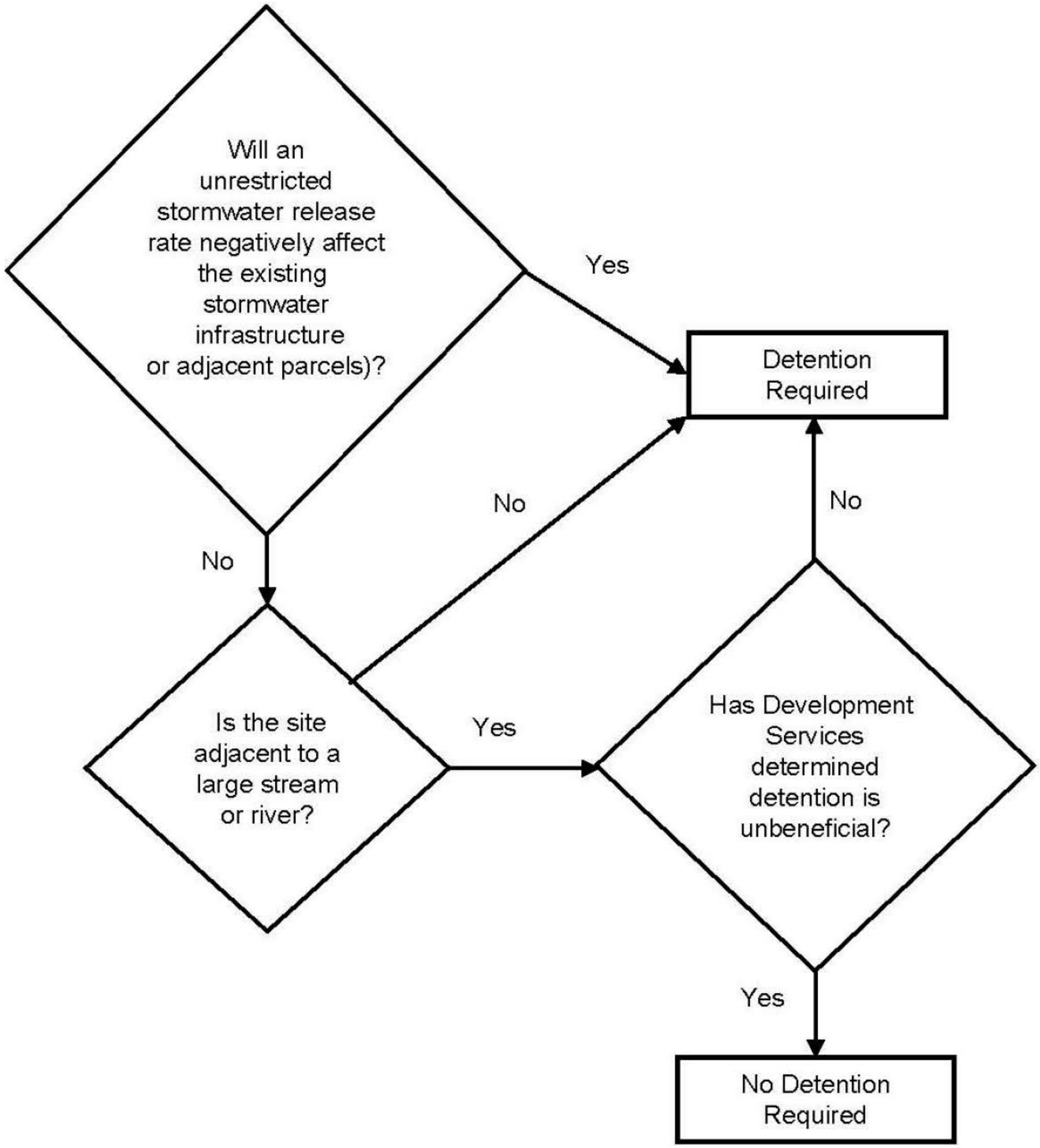
Rainwater harvesting is the collecting and retaining of rainwater that will be utilized for irrigation or other practical on-site uses. On a small scale, the rainwater is collected in rain barrels from roof downspouts. Large scale projects can utilize large tanks that collect rainwater from any impervious surface.

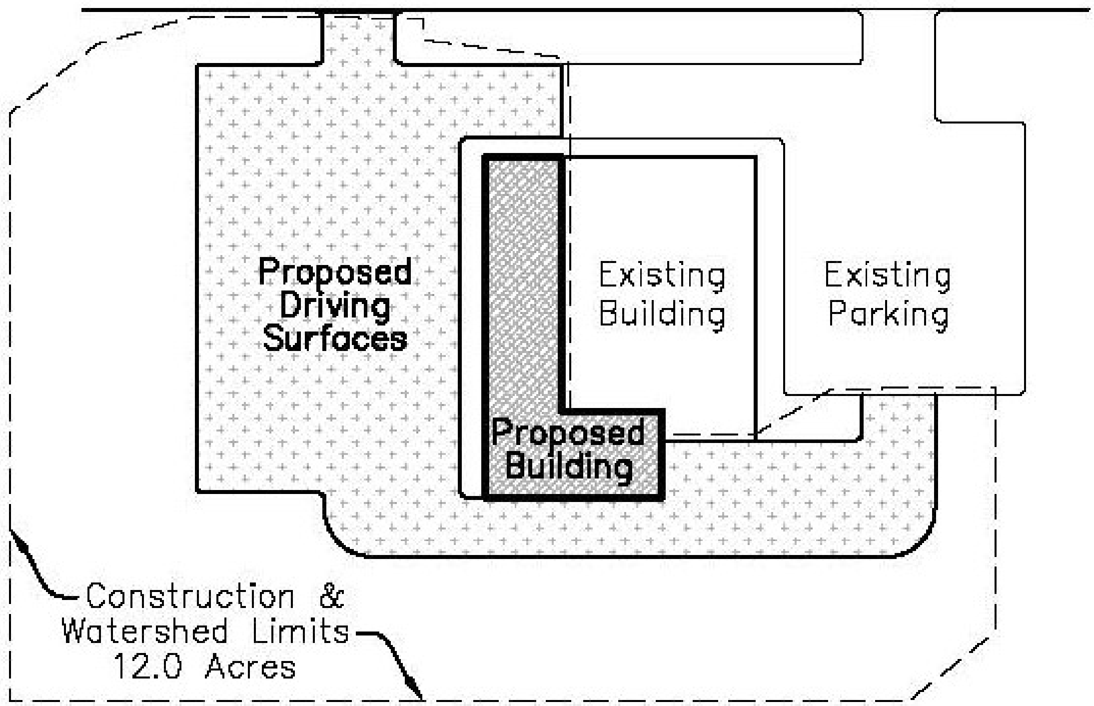
The retention of the run-off from the impervious surfaces during the water quality storm event will meet the stormwater quality imperative. The volume of the rainwater captured should be modeled in the site's overall hydrologic model.

The rainwater harvesting plan must comply with the following considerations.

1. Design Considerations
   - The rainwater harvesting vessel shall be, at a minimum, sized to retain the runoff volume from the 1-inch rainfall event. An overflow system shall be included for greater events.
   - A utilization plan shall be included that illustrates that the harvested rainwater can be used on site.
   - A structural engineer shall stamp any plans that elevate the retention vessel.
2. Operation and Maintenance Considerations
   - The O&M manual shall address the winterization of the harvesting system. The system shall be fully functional from March through November.
   - A schedule shall be provided for the inspection of the collection, retention and water utilization components.
   - The growth of algae and mosquito larva shall be addressed.

Rainwater harvesting is a developing concept in northeast Indiana. LEED projects might implement rainwater harvesting for grey water use and other uses not currently contemplated. City Utilities will review these rainwater harvesting plans based on commonly accepted design principles.

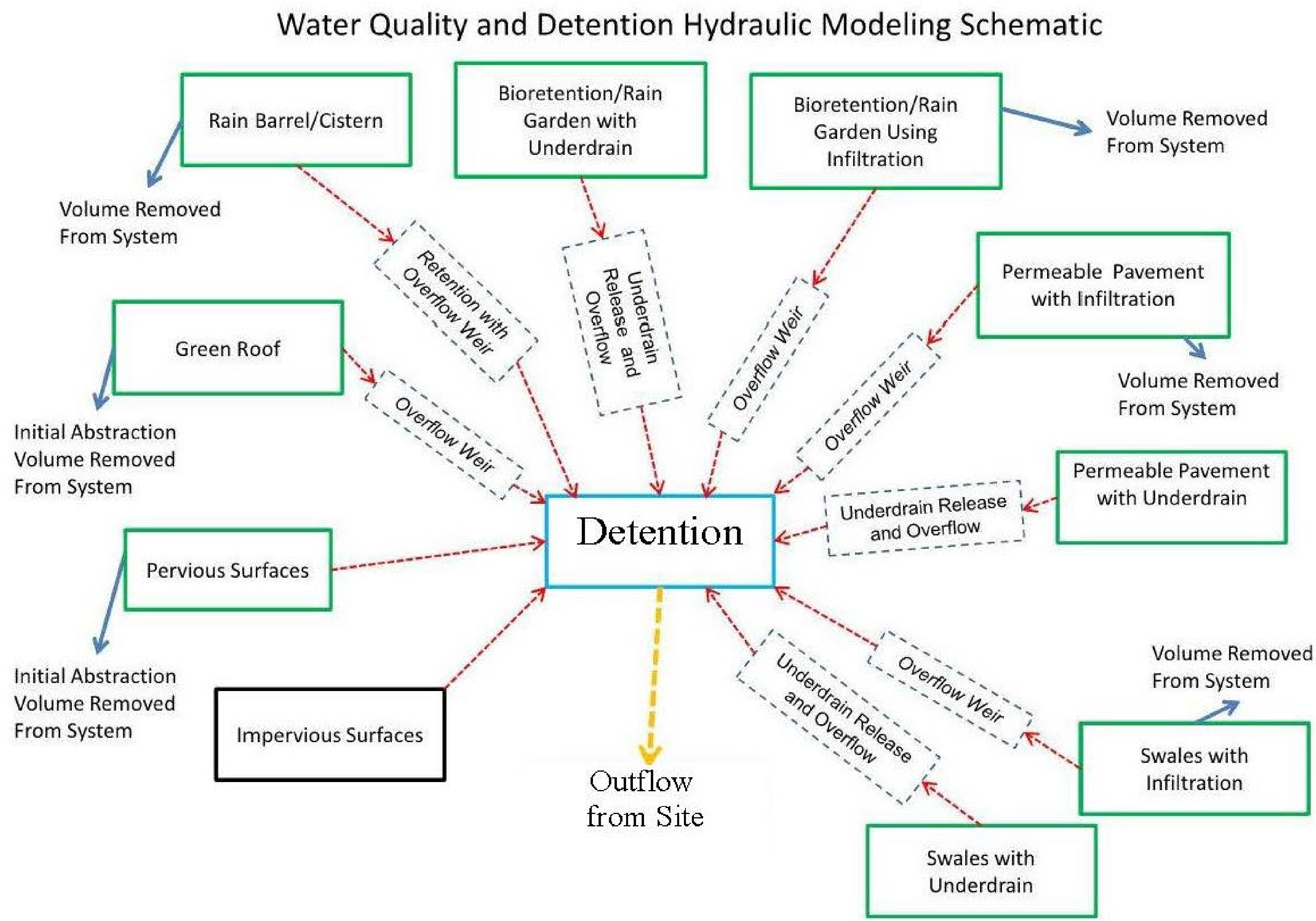

Will an unrestricted stormwater release rate negatively affect the existing stormwater infrastructure or adjacent parcels)?
Yes
Detention Required
No
No
No
Is the site adjacent to a large stream or river?
Yes
Has Development Services determined detention is unbeneficial?
Yes
No Detention Required



Existing Conditions	
Building	2.5 acres
Existing Parking	3.0 acres
Total Impervious Surface	5.5 Acres

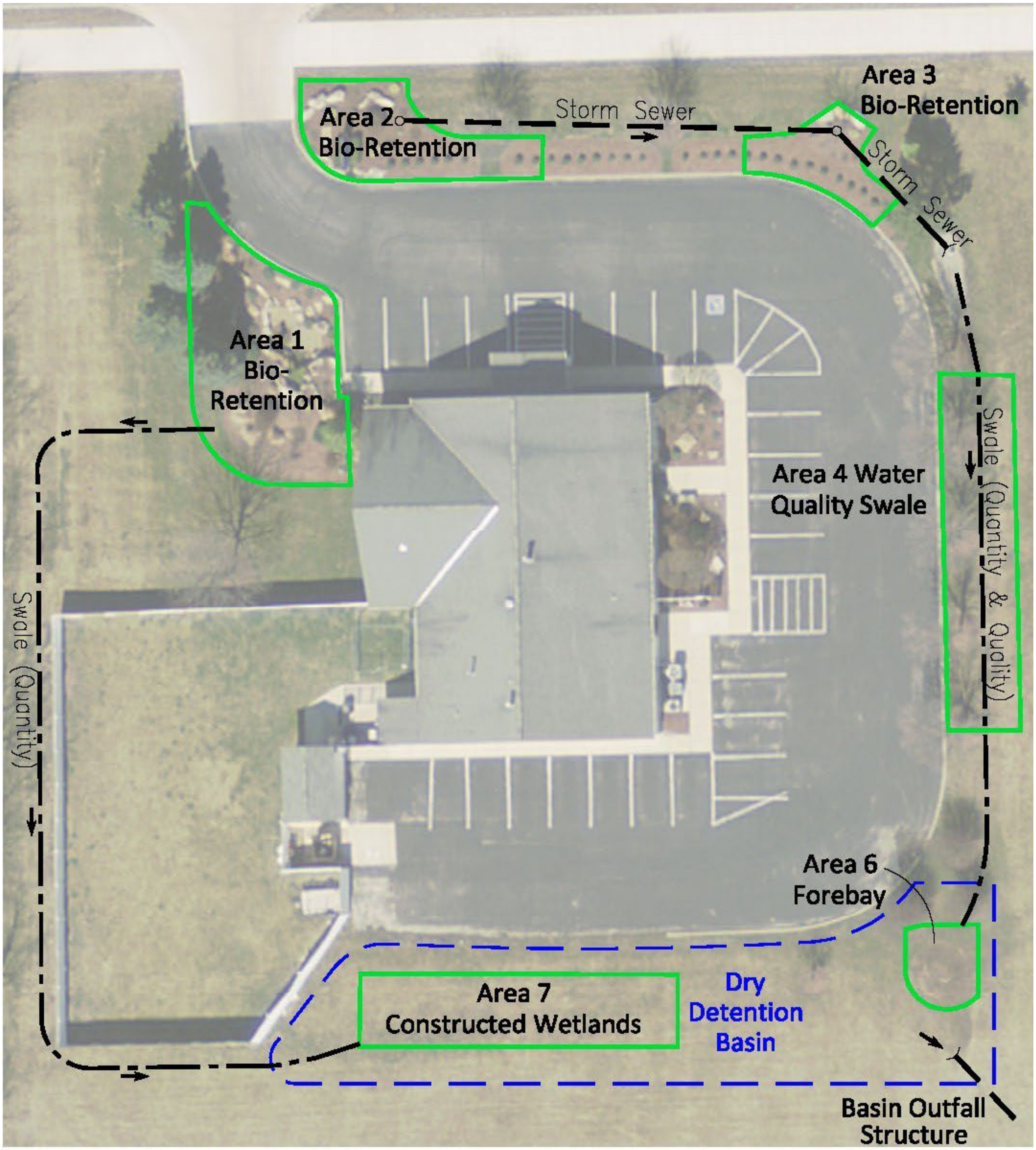
Proposed Net Changes	
Building	1.0 acres
Driving Surfaces	6.5 acres
Net Impervious Change	7.5 Acres

Post-Construciton Requirements
The Post-construction water quality plan shall address the net change in impervious surfaces 7.5 acres
The peak 100-year release rate is 0.18 cfs/acre (Figure SW11.01) x 12.0 acres of construction limits 2.16 cfs
The run-off from the existing impervious area can remain in the existing conditions

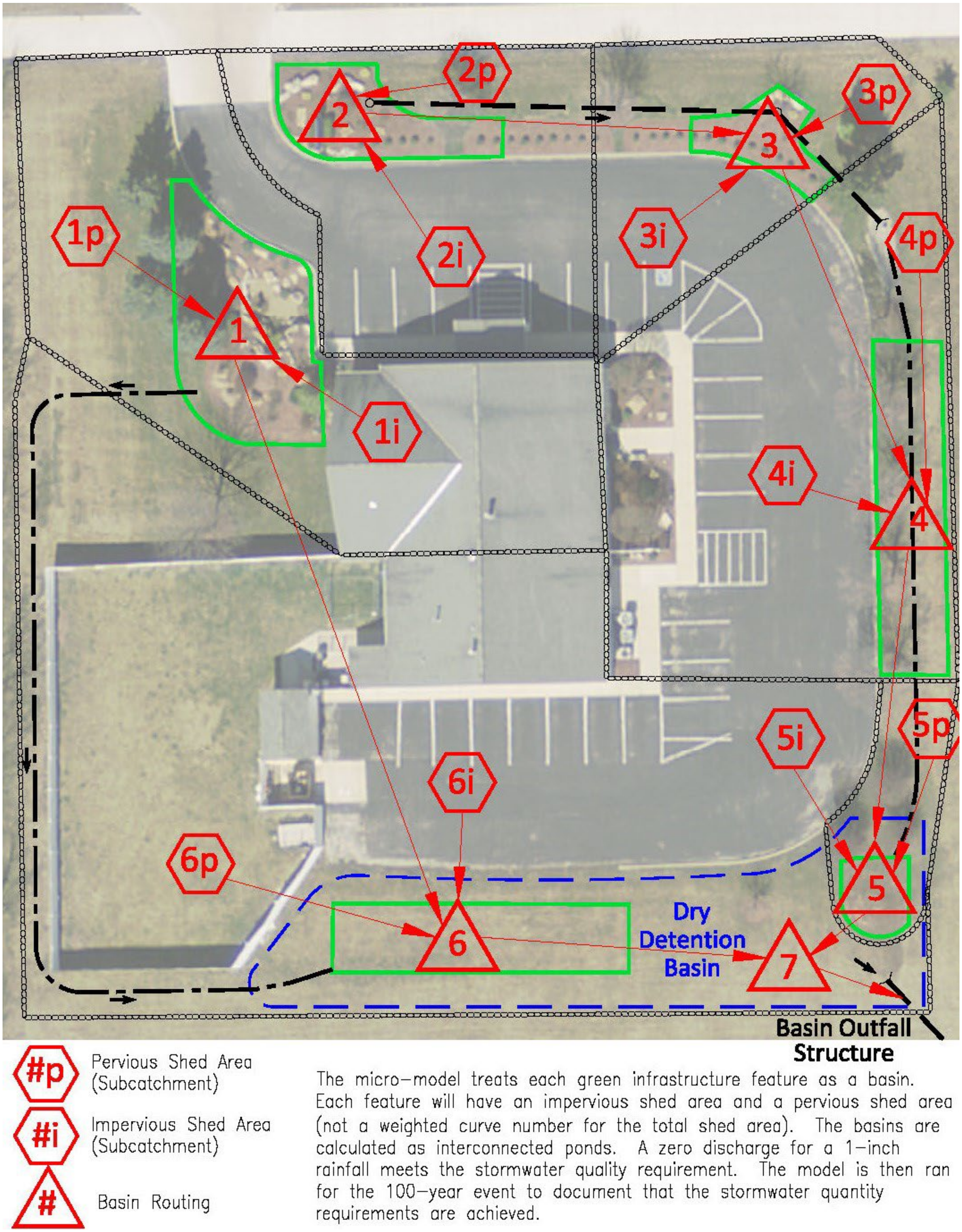

Water Quality and Detention Hydraulic Modeling Schematic
Rain Barrel/Cistern
Bioretention/Rain Garden with Underdrain
Bioretention/Rain Garden Using Infiltration
Volume Removed From System
Volume Removed From System
Retention with Overflow Weir
Underdrain Release and Overflow
Overflow Weir
Permeable Pavement with Infiltration
Green Roof
Overflow Weir
Volume Removed From System
Overflow Weir
Initial Abstraction Volume Removed From System
Permeable Pavement with Underdrain
Detention
Underdrain Release and Overflow
Pervious Surfaces
Overflow Weir
Volume Removed From System
Underdrain Release and Overflow
Initial Abstraction Volume Removed From System
Swales with Infiltration
Impervious Surfaces
Outflow from Site
Swales with Underdrain

Green Infrastructure	TSS Removal	Calculation Method	Modeling Method
Green Roofs	NA	Curve Number (CN) Adjustment	CN Reduced based on average depth of planting media [98-(2*Avg Depth in inches)]
Permeable Pavers	95%	Reduced Runoff Method	Modeled as a pond with an overflow structure – Volume based on depth of gravel and porosity of stone (#8 washed stone = 40% porosity)
Rainwater Harvesting	NA	Reduced Runoff Method	Modeled as a pond with an overflow structure – Volume based on volume of Cistern/Rain Barrel
Filter Strips	NA	N/A (Pre-Treatment)	(Volume Based on Constructed Depressional Volumes)
Bioretention	90%	Volume Based	Modeled as a pond with an overflow structure – Volume based on Storage Volume below lowest outlet
Constructed Wetlands	83%	Volume Based	Modeled as a pond with an overflow structure -– Volume based on Storage Volume below lowest outlet
Water Quality Swales with Retentive Grading	81%	Reduced Runoff Method	Modeled as multiple ponds with overflow structures – Volume based on Constructed Depressional Volume
Subsurface Infiltration	90%	Reduced Runoff Method	Modeled as a pond with an overflow structure and Documented Infiltration rate. Infiltration should be addressed as a constant outflow (Outflow rate = soil infiltration rate * bottom surface area).
Wet Detention Basins	85%	Volume Based	Modeled as a pond with an overflow structure – Volume Based on Volume Below Lowest Outlet
Forebays	NA	Volume Based (Pre-Treatment)	Modeled as a pond with an overflow structure – Volume Based on Volume Below Lowest Outlet

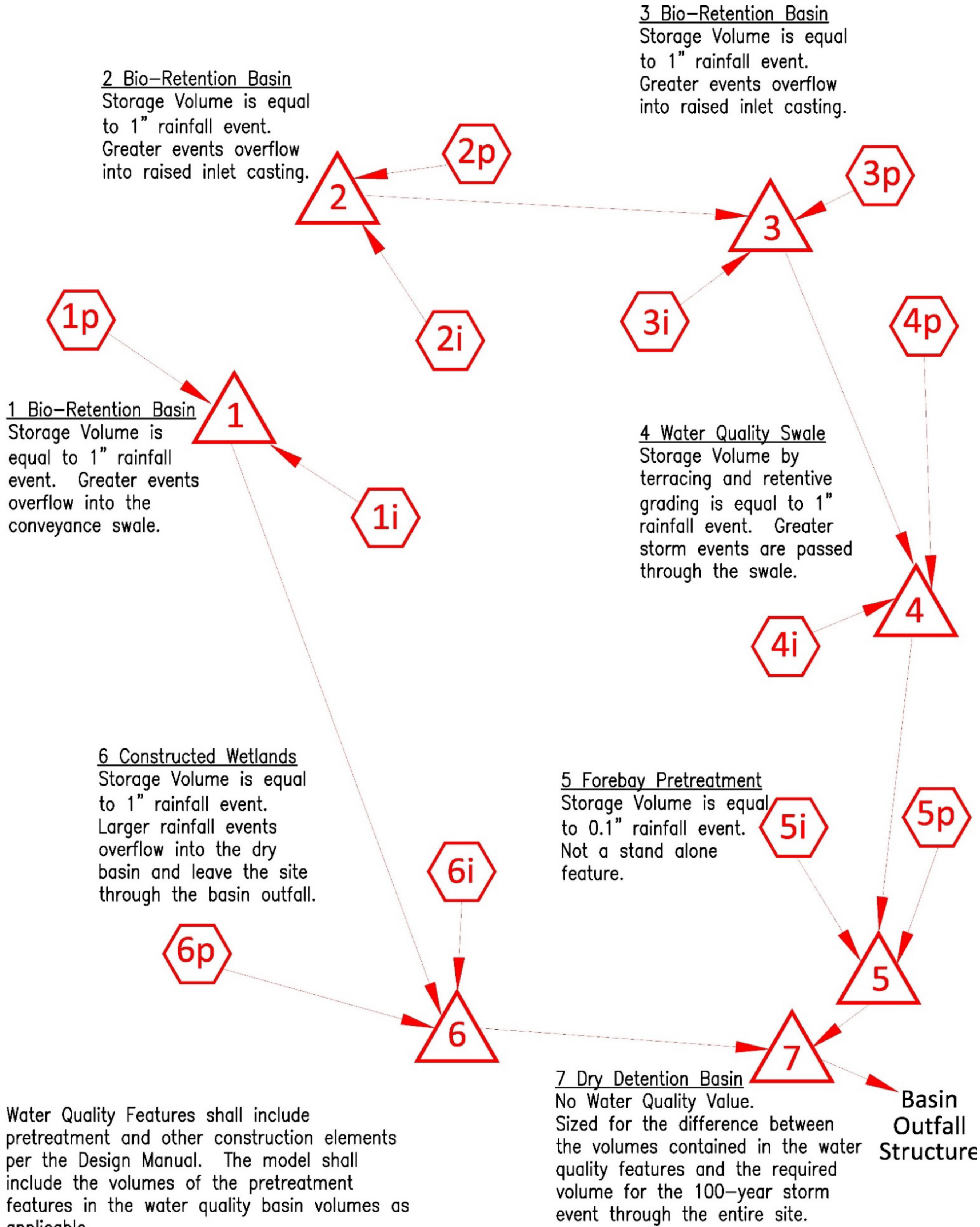
NA – The green infrastructure is a pretreatment feature and cannot stand alone or it functions by retaining the quantity of the stormwater quality event.

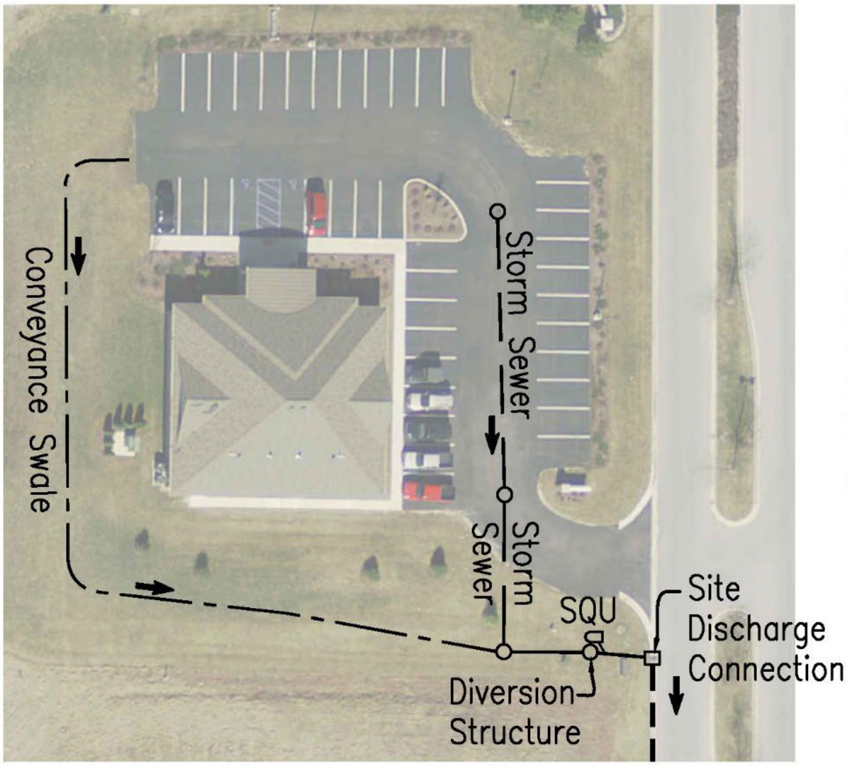


Per SW11.05 – Reduced Runoff Method for Stormwater Quality Calculations, a zero discharge from the site during a 1–inch rainfall will meet the stormwater quality requirement. This site layout utilizes several different green infrastructure techniques to this end.

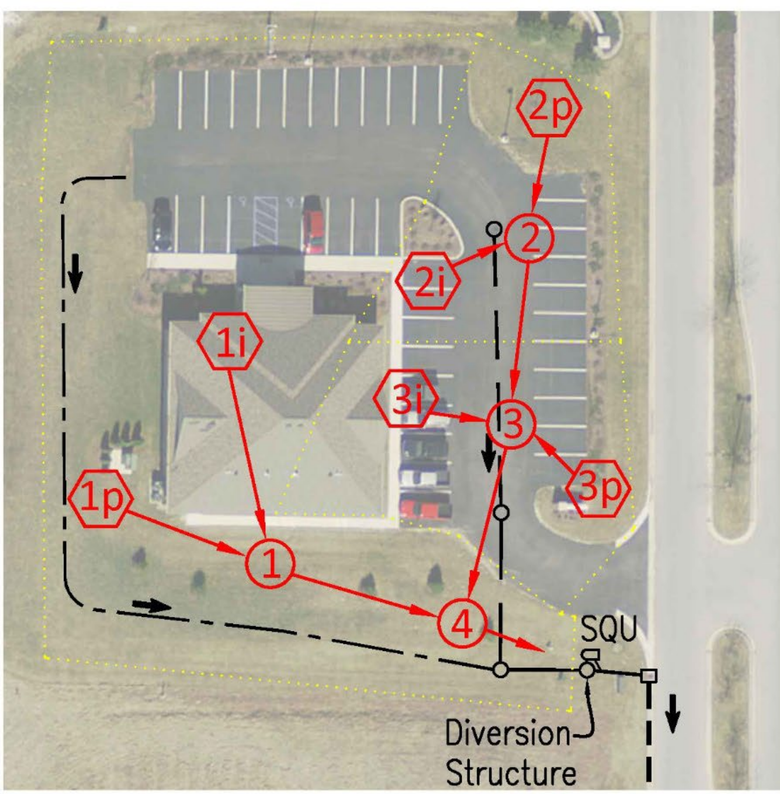


The micro-model treats each green infrastructure feature as a basin. Each feature will have an impervious shed area and a pervious shed area (not a weighted curve number for the total shed area). The basins are calculated as interconnected ponds. A zero discharge for a 1-inch rainfall meets the stormwater quality requirement. The model is then ran for the 100-year event to document that the stormwater quantity requirements are achieved.


3 Bio-Retention Basin
Storage Volume is equal to 1" rainfall event. Greater events overflow into raised inlet casting.
2 Bio-Retention Basin
Storage Volume is equal to 1" rainfall event. Greater events overflow into raised inlet casting.
2p
2
3p
3
1p
2i
3i
4p
1 Bio-Retention Basin
Storage Volume is equal to 1" rainfall event. Greater events overflow into the conveyance swale.
1
1i
4 Water Quality Swale
Storage Volume by terracing and retentive grading is equal to 1" rainfall event. Greater storm events are passed through the swale.
4
4i
6 Constructed Wetlands
Storage Volume is equal to 1" rainfall event. Larger rainfall events overflow into the dry basin and leave the site through the basin outfall.
5 Forebay Pretreatment
Storage Volume is equal to 0.1" rainfall event. Not a stand alone feature.
5i
5p
6i
6p
5
6
7
7 Dry Detention Basin
No Water Quality Value. Sized for the difference between the volumes contained in the water quality features and the required volume for the 100-year storm event through the entire site.
Basin Outfall Structure
Water Quality Features shall include pretreatment and other construction elements per the Design Manual. The model shall include the volumes of the pretreatment features in the water quality basin volumes as applicable.



SW11.07 – SCS Method for Proprietary SQUs – This site layout illustrates a common use of the SQU. The bulk of the runoff from the impervious areas is directed into an inlet casting with minimal time of concentration. A small portion of the impervious area is transported overland before entering the stormsewer system. The site is required to address the stormwater quality before it drains to a regional basin through a stormsewer collection system.

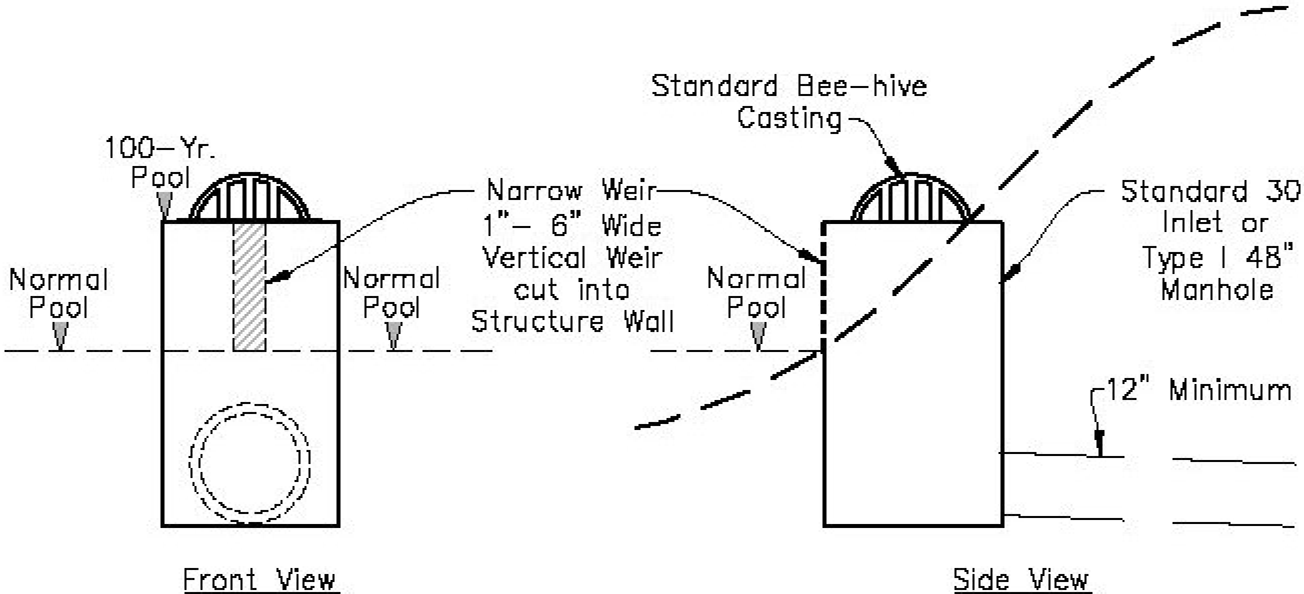


#p Pervious Shed Area (Subcatchment)

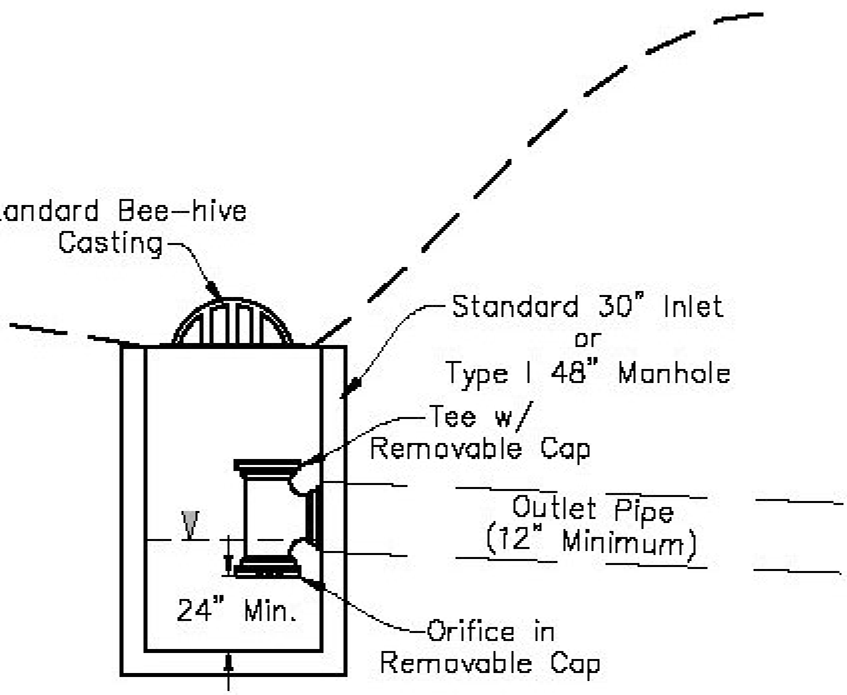
#i Impervious Shed Area (Subcatchment)

Junction

The Huff distribution stormwater model is run for a 0.3" rainfall for the storm durations identified in SW11.07. The shed areas are broken into pervious and impervious areas. A composite curve number should not be used. The pervious areas typically contribute 0 cfs. Therefore, the impervious areas and the time of concentration become the critical factors in sizing the SQU. The diversion structure shall direct the calculated peak flow to the SQU while allowing greater flows to by-pass the SQU. Runoff should not be entering the casting of the diversion structure.

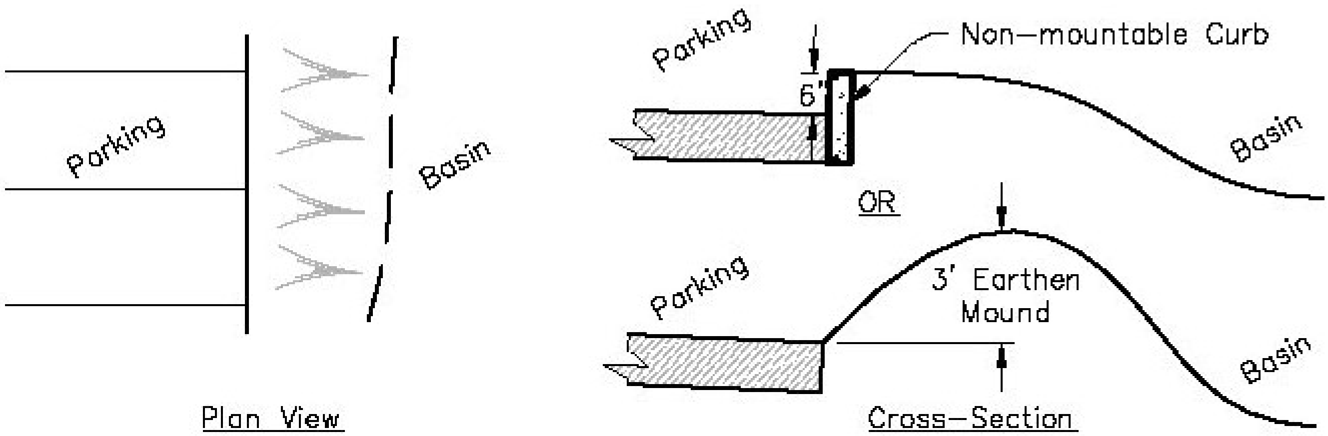


Narrow Vertical Weir

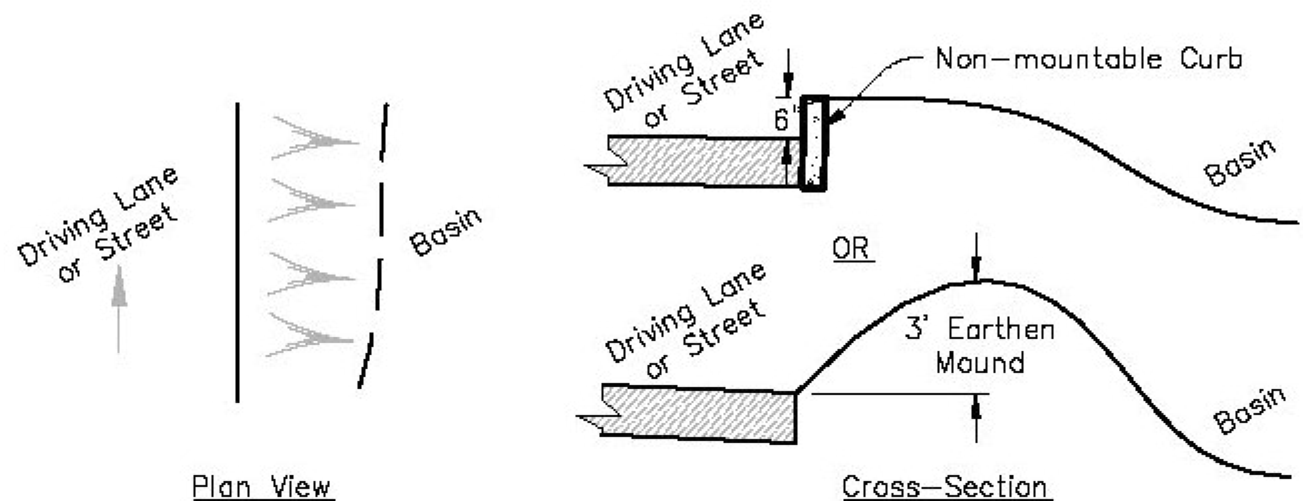


Inverted Tee w/ Orifice

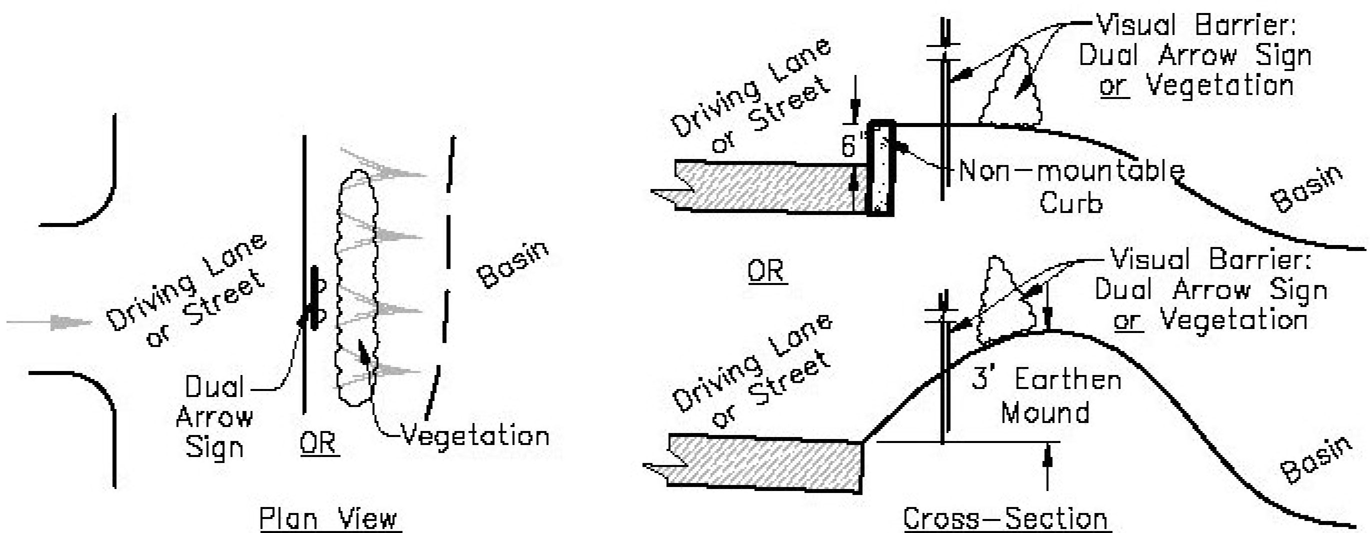
City Utilities Design Standards Manual	Exhibit SW11- 8 Public Protection Details
	Version: February 5, 2013



Parking Perpendicular to Basin

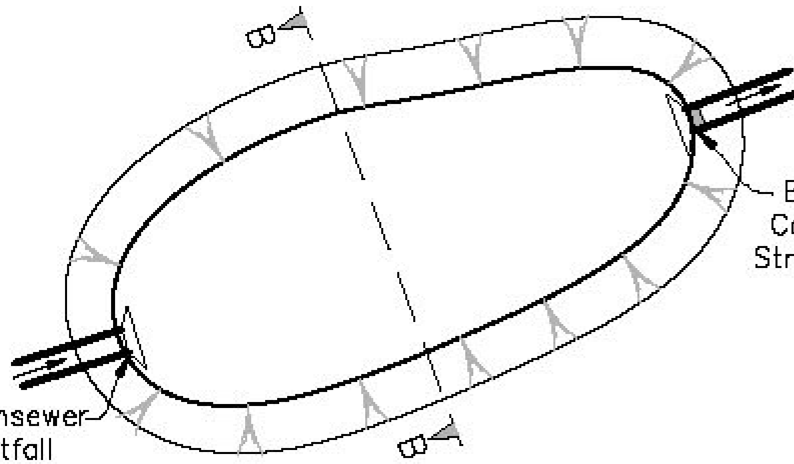


Driving Lanes/Street Parallel with Basin

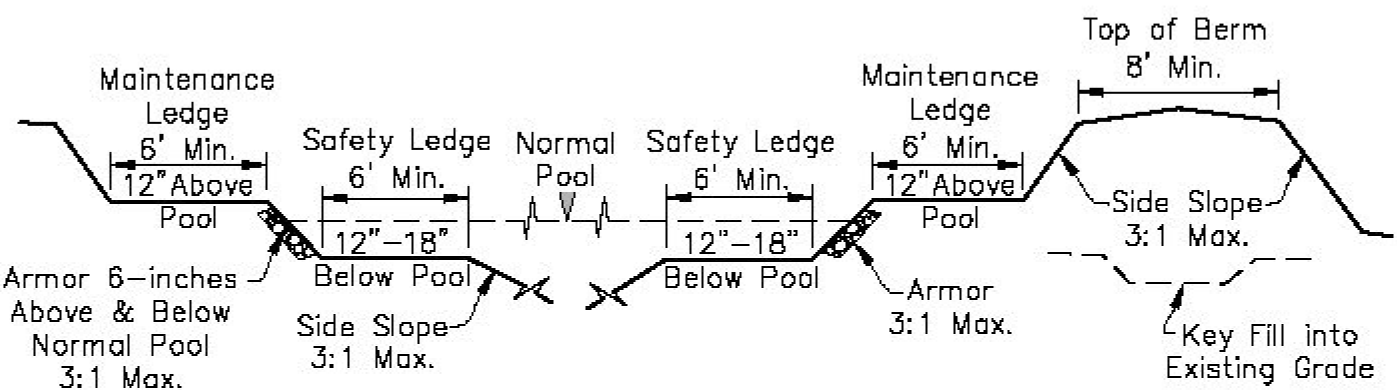


Drives/Streets Terminating Perpendicular to Basin

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SW11- 9 Wet Detention Basin Detail Version: February 5, 2013

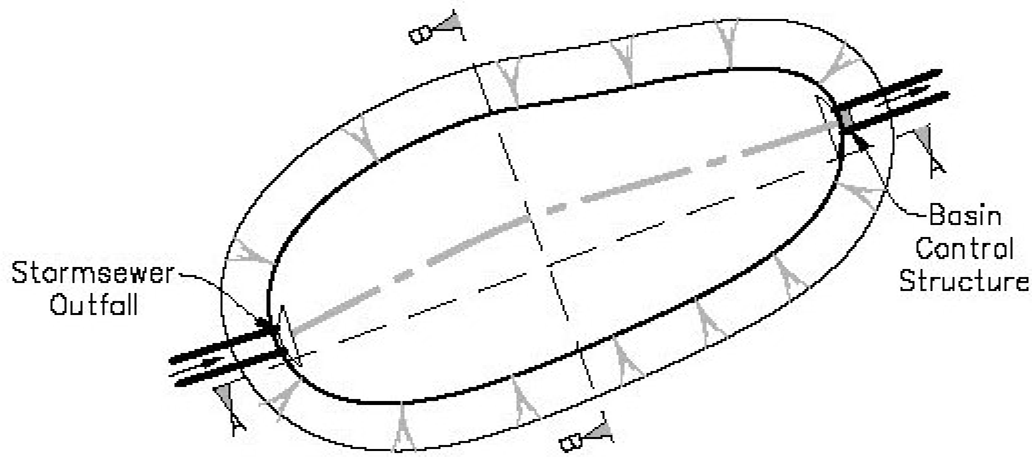


Typical Wet Detention Basin – Plan View

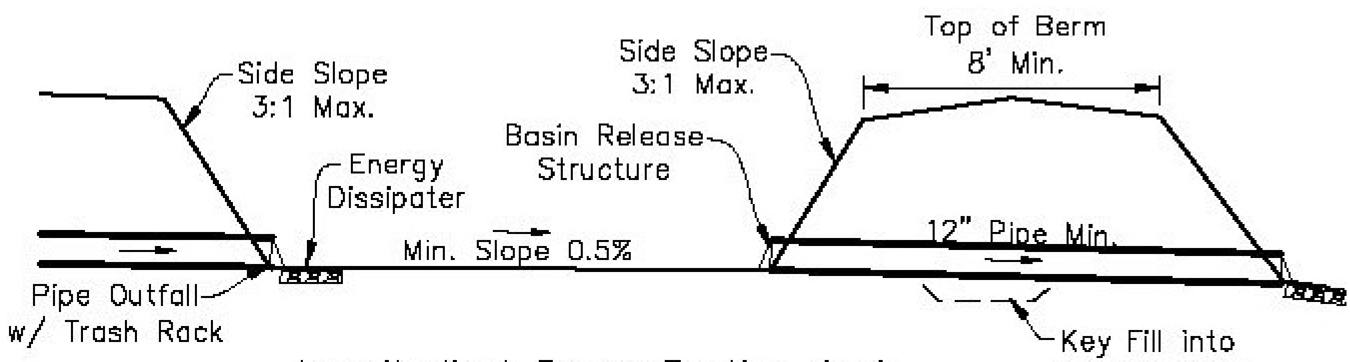


Cross–Section B–B

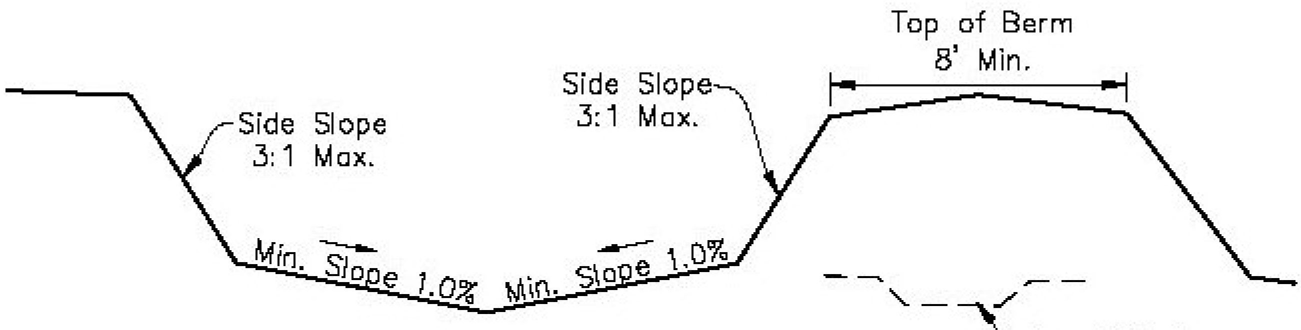
CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SW11-10 Typical Dry Basin Configuration
		Version: February 5, 2013



Typical Dry Detention Basin — Plan View



Longitudinal Cross-Section A-A



Transversal Cross-Section B-B

Soil Name	Hydric Soil Component	NRCS Soil Symbol
Brookston Silty Clay Loam	Brookston	Br
Rensselaer Clay Loam	Rensselaer	Re
Sloan Silt Loam	Sloan	Sn
Urban land – Brookston Complex	Brookston	Ub
Urban land – Westland Complex	Westland	Uw
Westland Clay Loam	Westland	We
Crosby Silt Loam, 0 to 2 percent slopes	Brookston	CrA
Crosby-Miami Silt Loams, 2 to 4 percent slopes	Brookston	CsB2
Fox Loam, 0 to 2 percent slopes	Westland	FoA
Miami Silt Loam, 2 to 6 percent slopes, eroded	Brookston	MmB2
Miami Silt Loam, 6 to 12 percent slopes, eroded	Brookston	MmC2
Shoals Silt Loam	Sloan	Sh
Sleeth Loam	Westland	Sk
Urban land - Crosby	Brookston	Uc

Project Name: ____Date: ___________________

Total Project Area: ___________ acres Project's Impervious Area: ___________ acres

Basin Name or Identification: ____________________________

Total Drainage Area to Facility: ___________ acres

On-site Shed to Facility: ___________ acres

Off-site Shed to Facility: ___________ acres

Basin's Composite Run-off Coefficient or Curve Number: c= _______ or CN= ________

Detention Sizing Method: ____

	Release Rates (cfs/acre)	
Design Return Period	**Maximum Allowable Release Rate**	**Designed Peak Release Rate**
10 year		
100 year		

	Detention Facility Characteristics	
Design Return Period	**Storage Volume (acre-ft)**	**Water Surface Elevation (ft)**
WQ_v		
10 year		
100 year		

Detention Method:

Dry Detention Basin ☐

Wet Detention Basin ☐

Retention Basin ☐

Parking Lot Detention ☐

Underground Detention ☐

Permeable Pavement System ☐

Other: ___________________ ☐

Note: Attach Stage-Storage, Stage-Discharge, and Routing Calculations as appropriate.

Provide Design Summary Sheet for each basin and performance water quality feature.

Book 2

Stormwater

SW12 Stormwater Pollution Prevention Plan (SWP3)

SW12.01 Purpose

The purpose of this Chapter is to coordinate this manual with the governing rules and regulations. It will focus on the implementation of the requirements defined by IDEM's Construction Stormwater General Permit (IDEM CSGP). See full document for more detailed requirements at **IDEM's website**. This chapter is not all inclusive of the requirements defined by IDEM CSGP SWP3. It remains the designer's responsibility to know and abide by the requirements.

SW12.02 Applicability of IDEM CSGP

A SWP3 is required for construction sites that disturb more than one acre (The submittal of the construction site's proposed land disturbance shall only be reported out to 2 decimal places of accuracy). "Land-disturbing activity" is defined by Appendix A of the IDEM CSGP. Land-disturbing activity also encompasses activities that are often questioned including, but not limited to, removing asphalt, asphalting over a gravel parking lot, and demolition of a building into pervious area.

For general reference, a site less than one acre will require a SWP3 if:

1. There is offsite land disturbance causing the net area of disturbance (onsite and offsite) to be greater than one (1.0) acre or more associated with the project. This offsite disturbance can be things such as utility extensions, street improvements and/or drive constructions.
2. The site is less than one acre but part of a larger development. Per IDEM CSGP a SWP3 is required if the site is:
    a. a designated outlot of a large development.
    b. a sell off of a larger common plan of development or sale.
    c. dependent upon an off-site borrow pit or soil disposal site. Such offsite activities shall be included in the SWP3.
    d. A utility extension project that disturbs more than an acre over several parcels, including any laydown yards and/or staging areas.

Phasing of the project or multiple contractors working on the site does not alleviate land disturbing requirements.

Appendix A of the IDEM CSGP also states the following types of projects require a SWP3.

1. A single-family residential site that disturbs more than an acre when all of the on and offsite disturbed areas are totaled.

2. A pond, lake or similar surface water impoundment is constructed.

Appendix A of the IDEM CSGP includes additional guidance regarding inclusions and exceptions to the SWP3 requirements. As the MS4 administering the rule, City Utilities Development Services shall determine if a particular project requires a SWP3.

SW12.03 SWP3 Construction Plan Submittal

For a project site where the proposed land disturbance is one (1) acre or more, the following requirements apply:

1. Prior to the initiation of any land-disturbing activities a construction plan, including the stormwater pollution prevention plan (SWP3), must be submitted to City Utilities Development Services. See **Exhibit SW12-1** and **Exhibit SW12-2**.

SW12.04 SWP3 Construction Plan Review

City Utilities Development Services may determine the following after review:

1. The plan requires modifications, terms, and conditions as necessary to meet requirements of the permit or local ordinance or the Design Standards Manual.
2. The plan is deemed deficient based on the following:
    a. The content requirements of the IDEM CSGP or City's Ordinances or Design Standards Manual are not met.
    b. The plan does not include Federal or State permits as required associated with wetlands, state/federal jurisdictional water, or other natural feature and work activities.

If the plan is determined deficient, the submitting consultant will receive a review document. The review document will identify what elements were found to be deficient or ambiguous. The Consultant shall provide revised or additional documents as necessary to alleviate the found deficiencies. The plan must be resubmitted with modifications to meet the requirements of the CSGP permit prior to land disturbance.

3. The plan is found to be acceptable and NOI can be submitted for the project.

If a notification of plan review verification is not received within:

1. The review period as established by the MS4, a NOI may be submitted to IDEM with documentation of the delivery date of the plan and NOI submittal.
2. Twenty-eight (28) days after the plan is received by the department, a NOI may be submitted to IDEM with documentation of the delivery date of the plan and NOI submittal. If a notice of deficiency is received an approved modification is required prior to submitting the NOI.

SW12.05 Construction Plan

This information is critical to how a Construction Plan and SWP3 is developed and implemented.

The construction plan elements can be presented in many formats. It includes the elements in a narrative fashion with exhibits and map attachments. The other common format is placing the information on a sheet within the construction plans. There is no preference on the format.

The necessary elements are:

1. Index

   The index will identify where the required elements can be found. An index is most useful for the report elements. However, it should also provide information regarding the location of the construction elements.

2. Vicinity Map

   The vicinity map shall include at least one street intersection or well-known landmark.

3. Project Narrative, see **Section SW12.07 – Construction Plan Project Narrative**.

4. Existing and Final Project Site Layout, see **Section SW12.08 – Construction Plan Existing and Final Project Site Layout**.

5. Stormwater Pollution Prevention Plan SWP3, see **Section SW12.9 – Construction Plan Stormwater Pollution Prevention Plan (SWP3)**.

6. Post-Construction SWP3, see **Section SW12.10 – Construction Plan Post-Construction SWP3**.

   a. The Post-construction Plan is required, and is not to be mistakenly developed after construction.

See the Technical Review and Comments Form (**Exhibit SW12-3**) which provides a checklist of what should be included in the submittal.

SW12.06 SWP3 Construction Plan Modification

Modifications to the construction plan or SWP3 are required when:

1. There are changes to the construction plan/SWP3, land disturbance activities, stormwater management measures, pollution prevention measures, off-site borrow and disposal areas, or other activities at the project site no longer accurately reflect the plan(s).

2. Evaluations per implementation of the self-monitoring program (SMP) or investigations by project management staff deem that it is necessary for management of the project and IDEM CSGP permit compliance.

3. A reasonable cause is determined by IDEM or City Utilities Development Services.

If modifications or revisions are requested, plans must be submitted to the appropriate entity within twenty-one (21) calendar days, or a later date determined by the inspecting authority, see **Exhibit SW12-6**. Contact City Utilities Development Services for all inquiry if there is any uncertainty or questions whether a Construction Plan Modification will be necessary.

SW12.07 Construction Plan Project Narrative

The elements and detailed information required for the SWP3 construction plan's project narrative section is listed below.

a. Project Narrative and supporting plan documents

b. Description of the nature and purpose of the project.

c. Legal description of the existing project site with legal section(s), or alternative land division(s), township and range.

d. Latitude and longitude in decimal representation at the location specified for the following cases:

    1. Non-linear projects: at the approximate entrance to the project site that is obtaining permit coverage.

    2. Linear projects: the beginning of the project site.

e. Size of the project area expressed in acres.

f. Total expected land disturbance expressed in acres.

g. Construction support activities that expected to be part of the project.

    ii. Surface flows coming from adjacent sites

    iii. Surface water discharges from onsite to adjacent sites

h. Soils

    i. This shall identify the expected soils from the Web Soil Survey

    ii. Provide general characteristics and properties of the expected soil including, but not limited to, the Hydrological Soil Group and its susceptibility to erosion

    iii. Other limitations and hazards susceptible by the expected soil

    iv. Measures that will be integrated to overcome or minimize adverse soil conditions.

i. General construction sequence of the phasing. This "phasing" shall define the approximate area of the site to be developed and operational prior to the start of the next. This "phasing" is not construction activity specific. It is related to Land Planning and Site Development Schedules.

j. Plat or project site map for all phases or sections of the project site, including:

i. The boundaries of the project site represented in the full construction plans that the notice of intent (NOI) will be submitted in regard to.
ii. The boundaries of each phase, section, or other divisions of the project site in association with construction activity.
iii. Lot numbers, lot boundaries, road layout, and road names
iv. Legend

k. Identification and location of any wetlands, lakes and water courses on or adjacent to the project site.
l. Identification, location, and discuss any in-stream activities
m. Identification and status of any other required state or federal water quality permits
n. Identification of US EPA approved or established TMDL and the associated pollutant.
o. Identification of discharges to a water on the current 303(d) list of impaired water and pollutants

SW12.08 Construction Plan Existing and Final Project Site Layout

The minimum required elements and outline for SWP3 construction plans is listed below.

1. Existing Site Plan
   a. Identification of all surface water and wetland features. This shall include those features that are adjacent to the site.
   b. The location of all existing structures on the project site.
   c. Boundaries of the 100-year flood zones. These shall be labeled and the source identified. (FEMA’s FIRM maps or Indiana Floodplain Information Portal – Best Available Floodplain)
   d. A soil map of the predominant soil types, as determined by the United States Department of Agriculture, Natural Resources Conservation Service (USDA, NRCS) Soil Survey, an equivalent publication, or as determined by a soil scientist. A soil legend must be included with the soil map.
   e. Identification and delineation of natural buffers and existing vegetative cover.
   f. Identification of adjacent land uses.
   g. Existing topography with contours appropriate to indicate drainage patterns.
   h. The location(s) of where run-offs enters the project site.
   i. The location(s) of where run-off discharges from the project site.

2. Final Site Plan
    a. All of the proposed structures and impervious surface improvements, including, but not limited to:
        i. Buildings, Structures
        ii. Parking Areas, Roads, Drives
        iii. Lots (delineation and identification)
        iv. Utilities
    b. Boundaries of the 100-year flood zones
    c. Proposed final topography with contours appropriate to indicate drainage patterns.
    d. Delineation and labeling of boundaries for natural features that will not be disturbed, including, but not limited to, wetlands, steep slopes, riparian corridors, and natural buffers.
3. Grading Plan
    a. Delineate the limits of the disturbed area (construction limits), including known off-site activities that will provide services to the project site.
    b. Proposed on-site and off-site soil stockpile, borrow, and disposal locations.
    c. Existing and proposed contours.
4. Drainage Plan
    a. The storm water drainage systems, including location, sizes, and dimensions of:
        i. Storm structures
        ii. Storm sewers, culverts, and conveyance channels
        iii. Swales
    b. Identification of stormwater and non-stormwater discharge points and peak discharge rates.
    c. Identification of potential locations for stormwater discharging into ground water, such as abandoned wells, sinkholes, and karst features.
    d. Identification of the receiving waters. This shall include the first named system (MS4 storm sewer or named regulated drain) and the name of the receiving river or lake. The names of regulated drains between the two are not necessary.
    e. Identification, location, size, and dimensions of features such as existing permanent retention and detention facilities, including manmade wetlands and other stormwater basins.

SW12.09 Construction Plan Stormwater Pollution Prevention Plan (SWP3)

The minimum requirements of a SWP3 construction plan shall be:

1. A description of the potential pollutants and their sources that are associated with construction activities.
2. The plan identifying the location, construction details and specification for the stormwater quality measures (See Section SW13 Erosion and Sediment Control for design guidance):
    a. Erosion control measures
    b. Sediment control measures
    c. Perimeter control measures
    d. Run-off control measures
    e. Dewatering applications and management methods
    f. Measures utilized to cross water resources for the accessibility needed to perform construction.
    g. Measures utilized to isolate or separate construction activities from work within waterbodies.
    h. Concrete and cementitious washout areas and management measures.
    i. Stormwater outlet protection locations
    j. Grade stabilization structure locations
    k. Stable construction entrance locations
3. Temporary and permanent surface stabilization plans
    a. Include sequence requirements for implementation planned to minimize the footprint of disturbed, unstable soil
    b. Specifications and application rates for seed mixes and soil amendments, if necessary
    c. Include the type and application rate for anchored mulch, erosion control blanket, or other appropriate stabilization options.
4. Maintenance standards for each temporary measure utilized. This shall include guidelines that specify when corrective measures are required and/or replaced with alternative measures.
5. Planned construction sequence as it relates to the implementation of measures appropriate to the construction activity, including temporary and permanent stabilization and stages of construction activities. This includes measures that will be implemented prior to land disturbance and measures to be implemented along as construction progresses throughout the project.
6. The provisions for erosion and sediment control on individual building lots regulated under the permit.

7. Material handling and spill prevention and spill response plan. This shall include:
    a. Meeting the requirements in 327 IAC 2-6-1
    b. The contact information for IDEM Emergency Spill Line (888) 233-7745 or (317) 233-7745
    c. The contact information for local emergency personnel
    d. Requiring a passive protection system, such as a small clay berm, to contain minor spill around the construction fueling and maintenance areas of liquid contaminates.
8. Material handling and storage procedures associated with construction activity describing the management and disposal of construction products and waste.
9. A completed Storm Water Permit Certificate (**Exhibit SW12-5**).
10. See **Chapter SW11 – Stormwater Management** for Post-construction stormwater quality plan requirements.

SW12.10 Construction Plan Post-Construction SWP3

The minimum requirements of a post-construction SWP3 shall be:

1. A description of the potential pollutants generating sources and list of pollutants from the proposed land use that may reasonably be expected to contribute pollutants to stormwater discharges.
2. A description of stormwater quality and stormwater management measures that will be installed to address post-construction sources that are expected to generate pollutants in stormwater discharges after construction activities have been completed.
3. The location, dimensions, detailed specifications, and construction details of all post-construction stormwater quality and stormwater management measures.
4. A sequence describing when each post-construction stormwater measure will be installed in relation to project construction.
5. An operation and maintenance manual that includes a description of the maintenance guidelines for all post-construction stormwater measures to facilitate their proper long-term function.
6. When known at the time of plan submittal, the entity that will be responsible for operation and maintenance of the post-construction system.

SW12.11 Notice of Intent (NOI)

NOI:

The Notice of Intent (NOI) is a formal notice to IDEM that discharges of stormwater associated with construction activity and land disturbance will occur in compliance with the conditions of the Construction

Stormwater General Permit (CSGP) marking the start of preparation and implementation for a Stormwater Pollution Prevention Plan (SWP3). Refer to IDEM's Construction Stormwater General Permit (IDEM CSGP) for all content required to be included in this notice to the authorities.

Deadlines for NOI submittal:

1. For a new project, the NOI must be submitted at least 48 hours prior to any land disturbance, or a discharge occurs.
2. A copy of the completed NOI, once submitted to IDEM must also be submitted to the appropriate plan review agency and/or MS4(s), where the land-disturbing activities are to occur.

Submitting the NOI and Processing Fee:

1. The NOI and all supporting documents must be submitted online through the Regulatory ePortal.

SW12.12 Notice of Termination (NOT)

NOT Content:

1. The Notice of Termination (NOT) is a formal notice to IDEM that discharges of stormwater associated with construction activity and land disturbance in compliance with the conditions of the Construction Stormwater General Permit (CSGP) have ceased. Refer to IDEM's Construction Stormwater General Permit (IDEM CSGP) for all content required to be included in this notice to the authorities.

Deadlines for NOT submittal:

1. Where a project site has coverage under this general permit and the MS4 has regulatory authority for that project, the permittee must obtain verification of eligibility to terminate from the MS4 prior to submittal of the NOT.
2. The permittee must submit a NOT to the department and a copy to the appropriate MS4.

Submitting the NOI and Processing Fee:

1. The NOT and all supporting documentation must be submitted online through the Regulatory ePortal.

SW12.13 Self Inspections

The Construction SWP3 is the minimal requirements expected to control the erosion and sediment for a project. The implementation of the SWP3 over the life of the construction project will require adjustments to be successful. To this end, the construction SWP3 shall include requirements for the contractor to implement self-inspections.

The SWP3 shall include a self-inspection form for the contractor's use. It shall be applicable to the measures and management processes anticipated for the project. The contractor is expected to add items to the form as necessary.

Self-inspection records shall be kept on site for review by representatives of City Utilities, IDEM, Allen County NRCS, and other regulatory agencies. A construction site inspection form is available as **Exhibit SW12-4**.

The SWP3 shall be completed by a "trained individual", as defined in SW1.03 Definitions.

The SWP3 shall include a schedule for the contractor to implement self-inspections. These inspections shall occur:

1. At least once per week.
2. Within one workday after a rainfall event of 0.5-inches or more in a 24-hour period.
3. Within one workday prior to a forecasted rainfall event with a likelihood of 0.5-inches of rain or more.
4. Within one workday after a sudden thaw when there is snow cover.

The SWP3 shall clearly specify the contractor is responsible to control the sediment from leaving the site. They are responsible for taking actions to meet this objective. The construction SWP3 shall be updated to document any such necessary actions to this end.

For detailed requirements, see 3.6 Monitoring and Project Management Requirements of the IDEM's Construction Stormwater General Permit (IDEM CSGP).

Guidance Document for
Storm Water Pollution Prevention Plan (SWP3) Submittal

<u>Construction Plan - General Plan Components (Section A)</u>

A1 - Index of the location of required plan elements in the construction plan:

The plan index should include a list of the required items in the CSGP and where they occur in the plan. Plan preparers often have their plan index mirror items in the IDEM standard plan review checklist. An MS4 may have different requirements and plan expectations based on their local ordinance.

A2 - A vicinity map depicting the project site location in relationship to recognizable local landmarks, towns, and major roads:

The plan should include a map that depicts the site in relation to other areas in the city or county and should be sufficient for someone not familiar with the area to find the project site location. Acceptable map types include USGS topographic maps, county road maps, city street maps, or other options if the map adequately depicts the site location.

A3 - Narrative describing project nature and purpose:

The plan should include information in narrative form regarding the nature and purpose of the project. This is a narrative describing the overall objective of the project. For example, is the project a borrow/disposal site, utility/infrastructure project, a subdivision, commercial park, or limited to a specific activity or purpose such as land grading. The narrative and the content of the plan will establish the overall scope of the project and what the application (Notice of Intent) for permit coverage will include.

A4 - Latitude and longitude to the nearest fifteen (15) seconds:

The approximate latitude and longitude in decimal representation at the approximate entrance to the project site if the project is not linear. If the project is linear, use the latitude and longitude for a beginning point of the project. This is the same information that will be included in the Notice of Intent when submitting for permit coverage.

A5 - Legal Description of the Project Site:

The legal description of the project site should be identified to the nearest quarter section and include township and range coordinates, and civil township name.

A6 – 11 X 17-inch plat showing building lot numbers/boundaries and road layout/names:

The reduced size plat of the project is intended to be a basic representation of the project layout. At a minimum, and where applicable or available, it should include building lot boundaries, lot numbers, road layout, and road names. It is not intended to be a complete representation of the construction plan or the SWP3. The purpose of the reduced plat is primarily to provide the plan reviewer a simplified layout of the project.

The plat should be legible, there based on the size of the project it is acceptable to have multiple sheets of 11 X 17.

This plat map must also be included with the Notice of Intent when submitting for permit coverage

A7 - Boundaries of the one hundred (100) year floodplains, floodway fringes, and floodways:

This information is relevant to the project if a stream is located on or near the property. If applicable, the plan should at a minimum include a notation of the presence of the floodplains, floodway fringes, and floodways and to a further extent delineation on the plan. If this element is not applicable to the project, the plan preparer should note this in the plan.

A8 - Land use of all adjacent properties:

This information provides information for the overall project including potential downstream impacts, but also other contributing factors that are discharging onto the project site. It is important to understand the impact the project may have on surrounding properties and sensitive areas, but also have an understanding of the runoff and other potential pollutants that may be discharged from areas in the watershed above the project.

The intent of this element is to identify the types of land use, such as single-family residential, multi- family residential, commercial, agricultural, forested, etc. that are above and downstream of the project site.

A9 - Identification of U.S. EPA approved or established TMDL:

Total Maximum Daily Load (TMDL) reports are assessments of water quality in rivers, lakes, and streams in each watershed where impairments exist. TMDL Reports can be found at **https://www.in.gov/idem/nps/resources/total-maximum-daily-load-reports/**. If the project area falls within the watershed for which there is a TMDL, the plan should identify the name of the TMDL and pollutant(s) included in the TMDL. TMDLs can also be found at EPA: **https://mywaterway.epa.gov/**. This is also a required element when submitting the Notice of Intent.

A10 - Name(s) of the receiving water(s):

The plan should identify all named streams, or other water bodies that will potentially receive run-off from the project site. If the discharge is to a municipal storm sewer, the plan should identify the owner or operator of the storm drainage system as well as the ultimate receiving water for the storm drain system.

A11 - Identification of discharges to a water on the current 303(d) list of impaired waters and the pollutant(s) for which it is impaired:

The 303(d) list identifies where many of Indiana's water quality problems exist and the nature of those impairments. Using https://mywaterway.epa.gov/ the plan preparer can search by address, zip-code, or watershed to identify if the waterbody to which the project discharges is on the 303(d) list. When you open the Waterbody Report, you will be able to see if there is a TMDL established as well.

For compliance with the CSGP, the plan must identify any direct discharges to a receiving water on the 303(d) list, the category, and the pollutant(s) for which it is impaired.

This is also a required element when submitting the Notice of Intent.

A12 - Soils map of the predominate soil types:

Each plan should provide a soil map for the project site. The map should be accompanied by descriptions of each soil type that occurs on the site. A legible copy of the appropriate soil map from the USDA Soil Survey for the county is sufficient. Boring logs and a geotechnical report or site mapping by a soil scientist is also considered acceptable for satisfying this requirement.

In addition to a soil map and a description of the soil types, the plan should include a discussion of the soil characteristics and limitations associated with the project site and the measures that will be integrated into the project to overcome any limitations. For example, if sanitary sewer does not service the site and on-site septic systems will be Stormwater Program Page 5 of 17 CSGP – Construction/Stormwater Pollution Prevention Plan Guidance March 8, 2022 used for waste disposal, the plan preparer should provide information concerning the suitability of the soil and the type of systems that will be required to overcome soil limitations.

A13 - Identification and location of all known wetlands, lakes, and water courses on or adjacent to the project site (construction plan, existing site layout):

This information is important in planning the project and identifies the areas that must be considered to ensure stormwater measures are adequate and appropriate to reduce the impact to natural areas associated with the project site. Identification of nearby watercourses and lakes may place an additional importance on sediment control and project management in a particular area of the project.

A14 - Identification of any other state or federal water quality permits or authorizations that are required for construction activities:

The plan should identify any permits related to the project site, such as Construction in a Floodway from DNR, 401 Water Quality Certification from IDEM, 404 permits from the U.S. Army Corps of Engineers, etc.

It is not necessary for the project site owner to possess these permits at the time of the plan submittal. However, the plan preparer should be knowledgeable of other permits that may be required and actively working to obtain these permits.

If the permits or authorizations have not been obtained, provide the expected timeline for obtaining the permits or authorizations.

A15 - Identification and delineation of existing cover, including natural buffers:

The plan should delineate the boundaries of major vegetative cover types, such as crop or crop residue, grass, brush, trees, etc. It is not necessary for the plan to identify individual vegetative species. As a component of the delineation, the plan preparer should evaluate the areas to determine if natural buffers will require preservation in accordance with the CSGP.

The CSGP defines "Natural Buffer" as an existing (prior to land disturbance) undisturbed area adjacent to or surrounding surface waters within which construction/land-disturbing activity is restricted. For the purposes of implementation of the CSGP buffer requirement the areas that must be preserved include ephemeral, intermittent and perennial streams with a defined bed and bank, natural lakes, and reservoirs. Guidance for determining if an area must be preserved in accordance with the CSGP can be found in the Buffer Guidance Document at https://www.in.gov/idem/stormwater/resources/stormwater-programtransition-to-master-general-permits/.

A16 - Existing site topography at an interval appropriate to indicate drainage patterns:

This information is critical to properly identify, design and/or layout the proposed stormwater measures. Site topography may be depicted in multiple ways such as continuous contour lines and spot elevations (if there are a sufficient number of locations to be able to demonstrate the site topography). A graphical profile of the project may also be acceptable for highway, road, utility, and other linear projects.

A17- Location(s) where run-off enters the project site:

Identify areas where stormwater flows onto the project site. This includes both concentrated flow and areas where sheet flow enters the project site. These areas, including drainage acreage must be considered to properly design the stormwater management system for the project site.

A18 - Location(s) where run-off discharges from the project site prior to land disturbance:

The plan should clearly identify where stormwater exits the site. It is not necessary that the location be identified with a notation on the plan unless it is not clear from the topographic or storm drainage system information.

A19 – Location of all existing structures on the project site:

Identify all existing structures on the project site, including buildings, ponds, and any other existing infrastructure. Infrastructure may include storm sewers, sanitary sewer, or other utility lines. These items must be clearly labeled on the plan with a legend.

A20 - Existing permanent retention or detention facilities, including manmade wetlands, designed for the purpose of stormwater management:

Features may include existing post-construction stormwater measures that may be used or potentially impacted by the proposed project. These measures primarily include but are not limited to permanent regional retention or detention facilities and green infrastructure. Clearly locate these existing features on the plan and that the existing features include capacity for the run-off from the proposed project.

A21 - Locations where stormwater may be directly discharged into ground water, such as abandoned wells, sinkholes, or karst features:

The plan should include the location of all areas where stormwater may be potentially discharged to groundwater. These areas include sinkholes or uncapped abandoned wells, which may be located on the project site or downstream of the project site and could potentially be impacted by stormwater discharges. It may also include existing stormwater infiltration systems such as drywells. These existing areas must be located on Stormwater Program Page 7 of 17 CSGP – Construction/Stormwater Pollution Prevention Plan Guidance March 8, 2022 the plan, with adequate protection measures to prevent sediment-laden and/or contaminated run-off from entering the groundwater. Abandoned wells should be properly capped.

A22 - Size of the project area expressed in acres:

Total size of the project area including areas that will and will not be disturbed. This information is also required for the Notice of Intent (NOI).

A23 - Total expected land disturbance expressed in acres:

The total area of land that is expected to be disturbed by the proposed project. The extent of disturbance has a profound impact on what measures may be necessary to adequately manage stormwater run-off and the selection of stormwater quality measures.

This information is also required for the Notice of Intent (NOI).

A24 - Proposed final topography:

The final topography is critical to properly plan project stormwater management measures. This item is typically related to how grading will occur onsite as construction progresses until final grades are achieved. Site topography may be depicted in multiple ways such as continuous contour lines and spot elevations if there are a sufficient number of locations to be able to demonstrate the site topography. A graphical profile view of the project may also be acceptable for highway, road, utility, and other linear projects.

A25 - Locations and approximate boundaries of all disturbed areas:

The plan should identify the construction limits of the project. If disturbance boundaries are not identified inside of the project boundary, it will be assumed that the entire site as being disturbed for the purposes of evaluating the proposed stormwater quality measures.

Construction limits are critical in determining the appropriate measures to manage runoff and control sediment. Areas such as unused right-of-way outside construction limits must be clearly delineated as off-limits to disturbance.

A26 - Locations, size, and dimensions of all stormwater drainage system such as culverts, stormwater sewer, and conveyance channels:

All proposed stormwater systems, including swales, channels, piping, culverts, etc. should be clearly shown on the plans. In addition to location, the plan should include the size and dimensions of the specific stormwater systems.

A27 - Locations of specific points where stormwater and non-stormwater discharges will leave the project site:

The plan should clearly identify where stormwater and non-stormwater discharges are likely to leave the project site. Topographic or drainage system information can be used to identify the location of the discharges. If the location is not easily discernable then a notation must be provided for clarification.

A28 - Location of all proposed site improvements, including roads, utilities, lot delineation and identification, proposed structures, and common areas:

Lot boundaries and numbers are required to be shown on the plan. In addition, the plan should show all proposed site improvements, including but not limited to utilities, roads (names, if available), structures, and common areas. Single lot projects should show the location of any proposed structures.

Any services such as sanitary sewers, waterlines, other utilities, roads, etc. which are located within the proposed project site or located off-site and under the control of the project site owner must be included in the plan.

It is important that the project site owner understand that all land disturbance associated with their project is subject to compliance with the CSGP. The same burden of compliance is necessary for these off-site areas as they are for the project site itself. If there are no off-site activities, or others are conducting the off-site activities, a simple notation should be sufficient to satisfy this requirement.

A29 - Location of all on-site and off-site soil stockpiles and borrow areas:

Plans should show the location of on-site stockpiles and borrow areas within disturbance limits. Often borrow and disposal areas occur off the project site. If these off-site areas are known at the time of plan submittal they need to be included as part of the plan submittal. If there are no stockpile, borrow or disposal areas planned, a simple notation should be sufficient to satisfy this requirement.

A30 - Construction support activities that are expected to be part of the project:

This item should include the approximate location of all other support activities that may be necessary during construction. Location of support activities, where possible, should avoid sensitive areas, such as proximity to water resources or sensitive resource features (i.e., karst). These activities include but are not limited to concrete or asphalt batch plants, staging areas, and material storage areas. Support activities must be directly related to the construction site and not a commercial/industrial operation or serve multiple unrelated construction projects. Support Activities must not continue to operate beyond the completion of the construction activity for the project it supports.

A31 - Location of any in-stream activities that are planned for the project including, but not limited to, stream crossings and pump arounds:

Locate areas where activities are anticipated that will require contractors to cross or work within waterbodies (creeks and streams) and/or wetlands to perform work on the project site. These activities are often left unaddressed during the initial planning of a project. These activities often require other permits from DNR, IDEM, and the U.S. Army Corps of Engineers. If these activities are not considered early in the project planning, delays may occur while the appropriate permits are obtained.

Stormwater Pollution Prevention– Construction Component (Section B)

B1 - Description of the potential pollutant generating sources and pollutants, including all potential non-stormwater discharges:

This item is included in the permit to place an emphasis on identification of pollutants that are associated with construction and land-disturbing activities. Potential pollutant sources include material and fuel storage areas, fueling locations, leaking vehicles and equipment, etc. Sediment is one of the major pollutants that is associated with active construction sites.

To satisfy this item, the plan needs to contain a written description of the expected pollutants that have the potential to be generated and comingle with stormwater during active land-disturbing and construction operations. In addition, the plan preparer should include the measures and/or operational activities that will be initiated to minimize the discharge of pollutants.

B2 - Stable construction entrance locations and specifications:

All projects except for some linear projects and residential strip developments should include designated areas for ingress and egress to the project site. These areas will require a stable construction entrance. The plan should clearly show the location of all proposed entrance locations, as well as specifications as to how the entrance is to be constructed and maintained.

B3 - Specifications for temporary and permanent stabilization:

The plan should provide detailed specifications, including sequencing information, regarding which stabilization methods that are to be employed. There should be multiple methods provided, as the various seasons need to be considered. Even if the project is expected to be short lived, these seasonal options must be provided. Delays are common in the construction industry and projects may take longer than expected. The plan needs to cover these contingencies. The stabilization methods should be clearly specified, including sequencing information, in the plan.

For applications that include seeding, the plan should include application rates for soil amendments and seed mixtures. The type and application rate for mulch and the method of anchoring must also be provided. Where erosion control blanket is used, the type of blanket and the installation specifications for the product.

Specifications for item B3 must be included on the plans and not by reference.

B4 - Sediment control measures for concentrated flow areas:

This item is intended to address areas of the site where run-off will occur in a concentrated flow condition. The plan preparer should evaluate these areas and design the stormwater control measures to ensure that the proposed measures are adequate for the site characteristics and drainage area. Each proposed measure must include the location accompanied by construction details and specifications.

B5 - Sediment control measures for sheet flow areas:

This item is intended to identify the areas of the site where run-off will primarily be discharged under a sheet flow condition. The plan preparer should evaluate these areas and select adequate sediment control measures that are properly sized for site characteristics and the expected drainage area. It may also be necessary to evaluate if concentrated flow measures might be more applicable rather than just relying on sheet flow measures. Each proposed measure must include the location and accompanied by construction details and specifications.

B6 - Run-off control measures:

This item refers to measures that are utilized to manage and direct run-off. Run-off control measures include but are not limited to diversions, rock check dams, and slope drains. These types of measures may not be necessary on every project but are often utilized in conjunction with sediment control measures. Each proposed measure must include the location and be accompanied by construction details and specifications.

B7 - Stormwater outlet protection location and specifications:

All stormwater discharge locations need to be adequately protected to prevent scour erosion. The plan should specify protection measures appropriate for site characteristics. Each proposed measure must include the location and be accompanied by construction details and specifications.

B8 - Grade stabilization structure locations and specifications:

This item includes but is not limited to measures such as rock chutes, toe wall, and drop structures. These types of measures may not be necessary on every project but should be considered during the plan development stage. Each proposed measure must include the location and be accompanied by construction details and specifications.

B9 - Dewatering applications and management methods:

If dewatering activities are anticipated appropriate measures should be identified and included on the plans. This plan element is primarily associated with activities that include pumping of accumulated water associated with excavated areas.

If dewatering is planned or becomes necessary on site, identify the method or methods that will be used. As part of the plan, it may be useful to specify measures as a contingency in the event dewatering is required. Discharged water must be treated with an appropriate sediment control measure or measures, prior to discharge.

Other measures such as sediment basins and sediment traps or the use of flocculants should be considered components of items (B4) and (B5) above.

B10 - Measures utilized for work within waterbodies:

The plan should identify the type of measure(s) that are proposed for any in-stream activities. Measures include, but are not limited to crossings, cofferdams, isolation of work areas, or other measures. Identify if the measures are temporary or permanent. Each proposed measure must include the location and be accompanied by construction details and specifications.

B11 - Maintenance guidelines for each proposed stormwater quality measure:

Each proposed temporary measure must be accompanied by criteria/standards and instructions for evaluating the measure for maintenance once installed. While permanent measures are considered long-term it will also be necessary to have criteria/standards in the plan while the permanent measures are being constructed or until final stabilization of the measure is achieved.

While the CSGP identifies a schedule for self-monitoring inspections, it is not uncommon for specific measures to include a more aggressive maintenance/evaluation schedule to ensure the integrity of measures are maintained and remain functional. This is particularly true of inlet protection measures which many stormwater manuals and guidance documents specify daily monitoring to ensure functionality. This item in the plan should include specific criteria and/or standards for each measure.

It is not necessary to outline the self-monitoring schedule as described in the CSGP. The self-monitoring program is a requirement of the CSGP, and project site owner and their designated representatives must comply with this requirement. When establishing the self-monitoring program refer to the CSGP to ensure the schedules and requirements of the self-monitoring program are met.

B12 - Planned construction sequence that describes the implementation of stormwater quality measures in relation to land disturbance:

A complete construction sequence is required and should reflect what measures will be implemented on the project site and when these measures will be installed in relation to land disturbance and construction activities. All measures, including but not limited to run-off control, sediment control, and stabilization should be part of the sequencing that is specified for the project.

There are three (3) critical phases of construction sequencing that should be identified which include initial perimeter control, interim erosion and sediment control, and project completion. Specific dates of installation are not necessary or is the intent of this requirement. Details on construction sequencing can be found in the Indiana Stormwater Quality Manual at https://www.in.gov/idem/stormwater/resources/indiana-stormwater-quality-manual/.

B13 - Provisions for erosion and sediment control on individual residential building lots regulated under the proposed project:

The CSGP places specific requirements on activities conducted on individual building lots within a project site. The plan should meet the minimum lot standards established in Section 3.8 of the CSGP. Plan preparers should take into consideration the size of the lots and topography (steepness) of the lots when identifying applicable stormwater quality measures.

If the overall project site owner will be responsible for activities on each lot or will only have responsibility for a few of the lots an individual lot SWP3 should be developed for those lots and included in the overall SWP3 for the project site.

Note: If residential lots within the larger project site will be developed by lot operators (builders) other than the overall project site owner it is required for the builder on those lots to obtain their own permit coverage or submit a "Construction Stormwater Residential Registration Form" as specified in Appendix A (a)(1). An individual lot SWP3 must be developed but is not required to be submitted with the overall project site construction/SWP3.

B14 - Material handling and spill prevention and spill response plan meeting the requirements in 327 IAC 2-6.1:

The plan should identify expected materials that may be present on the site during construction. A written description of how these materials will be managed to minimize the potential for the materials to be released and become comingled with stormwater run-off must be addressed in the plan. There should also be procedures directing the contractor and others operating on the project site on the required response to any spills that may occur during construction operations. Contact information for state and local emergency spill response should always be included on the plan.

B15 - Material handling and storage procedures associated with construction activity:

Appropriate measures must be implemented to manage wastes or unused building materials including, but not limited to garbage, debris, cleaning wastes, wastewater, concrete or cementitious washout water, mortar/masonry products, soil stabilizers, lime stabilization materials, and other substances. Wastes and unused building materials must be managed and disposed of in accordance with all applicable statutes and regulations. Proper storage and handling of materials, such as fuels or hazardous wastes, and spill prevention and clean-up measures must be implemented to minimize the potential for pollutants to contaminate surface or ground water or degrade soil quality. Concrete or cementitious washout areas, where washout is permissible, must be identified for the site and locations clearly posted. Wash water must be directed into leak-proof containers or leak-proof containment areas which are located and designed to divert stormwater run-off away from the measure and sized to prevent the discharge and/or overflow of the wash water.

Stormwater Pollution Prevention - Post-construction Component (Section C)

The post-construction stormwater pollution prevention plan must include the implementation of stormwater quality measures to address pollutants that will be associated with the final land use of the project. Post-construction stormwater quality measures should be functional upon completion of the project. Long-term functionality of the measures is critical to their performance and should be monitored and maintained.

Post-construction is not required for:

- Land-disturbing activities where there will be no additional impervious surfaces added.
- Single-family residential developments of four lots or less.
- Single-family residential strip developments.
- Individual building lots within a permitted project site.
- Single family residences and private ponds that are not part of a larger common plan of development or sale.

Off road courses or other sites that will remain disturbed in perpetuity, must utilize postconstruction measures to control sediment and other pollutants that may be associated with the post-construction land use.

C1 - Description of pollutants and their sources associated with the proposed land use:

The plan should include a narrative description of the final land use and the expected pollutants that will typically be generated by this type of land use. The description should also discuss the sources of these pollutants within the completed project site. Common pollutants include, oil, grease, antifreeze, brake fluid, brake dust, rubber fragments, gasoline, diesel fuel and other hydrocarbons, metals from vehicular and other sources, grit (sediment) from wearing of the road surface and falling or washing off of vehicles, trash (including bacteria and other biological agents contained in the trash) from littering and other types of improper disposal or storage, and elevated receiving water temperatures from stormwater run-off contact with impervious surfaces.

C2 - Description of proposed post-construction stormwater measures:

The plan should include a description of how the project was designed to minimize the generation of post-construction pollutants, and how the proposed post-construction stormwater measures will manage the quality and quantity of stormwater discharges from the completed project. It may be feasible for a project to comply with the postconstruction requirements without installing elaborate and expensive treatment systems. Reducing impervious surfaces and increasing vegetative surfaces to trap pollutants may be sufficient. Post-construction measures may include but are not limited to stormwater retention and detention, bio-retention, vegetated swales, and infiltration systems. Low impact development and green infrastructure strategies are encouraged to enhance water quality and to reduce stormwater run-off. Generally, these strategies are designed to mimic natural processes, minimize land disturbance, reduce surface imperviousness, and maximize green space.

The run-off rate of stormwater run-off and/or volume from the project site must meet local requirements to address stormwater quantity as established by ordinance or other regulatory mechanism. When a local requirement does not exist, the post-development run-off discharge from the project site must not exceed the pre-development run-off discharge based on the two-year, ten-year, and one-hundred-year peak storm events. As a component of plan development, the plan preparer should research and apply any local post-construction quantity requirements to the selection and design of post-construction stormwater measures. If there is a local requirement to manage the quantity of stormwater it would be helpful to include a reference to the local ordinance.

When impervious surfaces are added to a project site, post-construction stormwater quality measures must be sized to treat the Water Quality Volume (WQv) or water quality flow rates. Indiana utilizes a one (1) inch precipitation depth to calculate WQv, which is a sufficient depth to minimize pollutants and reduce channel and stream bank erosion.

The preferred equation to calculate water quality volume (WQv) is:

WQv = Rv x A x P

Rv = Run-off Coefficient, Rv = 0.05 + 0.9i

Variable	Definition
WQv	"Water Quality Volume" is the volume of stormwater run-off which must be captured and treated prior to discharge from the developed site after construction is complete. WQv is based on the expected run-off generated by the mean storm precipitation volume from post-construction site conditions at which rapidly diminishing returns in the number of run-off events captured begins to occur.
A	"Drainage Area" is the total surface area that will drain to a certain point, such as a detention basin inlet.
P	"Precipitation Depth" is the depth of design storm that is used to treat most storm events. The standard in Indiana is one (1) inch of rainfall over 24 hours. This corresponds to the 90th percentile of events, and therefore, provides treatment for most events.
Rv	"Run-off Volumetric Coefficient" is the fraction of total rainfall that will appear at the outlet as run-off.
i	"Percentage of Impervious Area" is the fraction of the drainage area that is impervious.

C3 – Plan details for each stormwater measures:

All proposed post-construction stormwater measures should be clearly located on the plan, and include dimensions, specifications, and construction details.

C4 - Sequence describing stormwater measure implementation.

The plan should provide a sequence of when the proposed post-construction stormwater quality measures will be installed. Consider post-construction measures, like basins or ponds that can be utilized during construction for sediment control. If a measure serves a dual purpose this should be identified in the sequencing for construction and how and when it will be modified for use as a post-construction measure.

If a post-construction measure that does not tolerate sediment impacts is installed early in the construction phase, sediment control measures and management practices should be implemented to ensure that it is not inundated with construction phase sedimentation.

C5 - Maintenance guidelines for proposed post-construction stormwater measures:

Provide an operation manual and where applicable a narrative description of the maintenance guidelines for all post-construction stormwater measures to facilitate their proper long-term function. This documentation must be made available to future parties who will assume responsibility for the operation and maintenance of the postconstruction stormwater measures. All proposed measures must be accompanied by guidelines for monitoring and maintenance. If manufactured products are utilized, the manufacturers operation and maintenance manual/guidance may be referenced and is acceptable.

C6 - Entity that will be responsible for operation and maintenance of the postconstruction stormwater measures:

If known, the plans should also identify the parties or individuals that will be responsible for the future long-term maintenance of the post-construction measures. Identification does not need to be a name of an individual but should include the entity that will assume responsibility. This may include, but is not limited to the project site owner, governmental entity, or a homeowner's association.

Application for SWP3 Permit

Type of Plan:
- ☐ **Demolition**
- ☐ **Grading**
- ☐ **Site Const. Plan**
- ☐ **Foundation**
- ☐ **Utilities**
- ☐ **Primary Devel. Plan**
- ☐ **Secondary Devel. Plan**
- ☐ **Parking/Driveway**

Project Name: ____

Project Location/Address, Zip Code: ____

____

Latitude: N ____________________ Hydrologic Unit Code: ____________________

Longitude: W ____________________

Civil Township: Quarter: Section: Township: Range:

Project Site Owner (Person)*: ____

Relationship to Property/Project Owner: ____

Address: ____

City: ____________________ State: __________ Zip: __________

Phone: ______________ Fax: ______________ Email: ______________________

Plan Preparer Name: ____

Relationship to Owner: ____

Address: ____

City: ____________________ State: __________ Zip: __________

Phone: ______________ Fax: ______________ Email: ______________________

On Site Erosion Control Supervisor: ____

(A trained individual responsible for self-inspection and record-keeping as defined by 327 IAC 15-5-4)

Phone: ______________ Fax: ______________ Email: ______________________

Name of receiving water/point of discharge: ____

(If stormwater is retained on site, name the nearest possible receiving water.)

Total Project Acreage: **Acres** **Acreage to be Disturbed:** **Acres**

Total Impervious Surface for Complete Project: __________ **Square Feet**

(as defined by 327 IAC 15-5-4(16) including structures, roads, parking lots, and other similar improvements)

Signature of Project Site Owner*:____

*As defined by 327 IAC 15-5-4, "Project Site Owner" means the person who is responsible for submitting the construction plans, the notice of intent (NOI) letter and the notice of termination (NOT) letter; and who is either (1) any person financially responsible for construction activity, or (2) an owner of the property who sells or leases, or offers for sale or lease, any lots in a subdivision, or (3) a person who has financial and operational control of construction activities and project plans and specifications, including the ability to make modifications to those plans and specifications.

For Office Use

SWP3 No. ____________________ **Permit No.** ____________________

Date Received ______________ **Date Approved** ______________ **By** ____________________

Submit SWPPP to City Utilities Development Services 200 E. Berry St Ste. 250 Fort Wayne, IN 46802

Construction/Stormwater Pollution Prevention Plan Technical Review and Comment

Project Name: Scope of Project: County(ies): Latitude: Longitude:	Plan Submittal Date: Plan Review Date:
Plan Preparer: Affiliation: Address: City: State: Zip: Phone: Cell Phone: Email:	
Project Site Owner: Company Name (if applicable): Address: City: State: Zip: Phone: Cell Phone: Email:	
Plan Reviewer: Affiliation: On behalf of: Address: City: State: Zip: Phone: Cell Phone: Email:	

Plan Review Status:

☐	**Plan is Adequate**	A comprehensive plan review has been completed and it has been determined that the plan satisfies the minimum requirements of the Relevant Local Ordinance(s) and the Construction Stormwater General Permit INRA00000 (Effective 12-18-2021).
☐	**Preliminary Review**	A comprehensive review will not be completed at this time. The plan review authority reserves the right to perform a comprehensive review at a later date, and revisions may be required at that time.
☐	**Conditional Acceptance**	Acceptance of the plan is conditional. The conditional acceptance is contingent upon addressing the issues identified in the comment sections.
☐	**Plan is Deficient**	Significant deficiencies were identified and must be addressed. Refer to the comment sections.

Action:

☐	**Submit a Notice of Intent:** • Submit the Notice of Intent (NOI) online through the IDEM Regulatory ePortal. It is required to upload a copy of this review form when submitting the NOI through the IDEM Regulatory ePortal: (https://stormwater.idem.in.gov/ncore/external/home)
☐	**Do not file a Notice of Intent or commence land-disturbing activities:** Deficiencies must be adequately addressed and acceptable plan review completed.
☐	**Comments:** Refer to Plan Review Comments Sections of this document.
☐	**Revisions:** Update and submit the revised Construction/Stormwater Pollution Prevention Plan as indicated below.
	☐ Update and submit a complete plan set that addresses plan deficiencies.
	☐ Update and submit a document (narrative and/or plan sheets) that address plan deficiencies.
	☐ Update and submit a complete plan set that address plan deficiencies. A comprehensive plan review will not be completed.

Plan Review Information

- *The technical review and comment is intended to evaluate the completeness of the Construction/Stormwater Pollution Prevention Plan for the project. The Plan submitted was not reviewed for the adequacy of engineering design. All measures included in the plan, as well as those recommended in the comments should be evaluated as to their feasibility by a qualified individual with structural measures designed by a qualified engineer. The Plan has not been reviewed for other local, state, or federal permits that may be required to proceed with this project.*
- *Additional information, including design calculations may be requested to further evaluate the plan.*
- *All proposed stormwater pollution prevention measures and those referenced in this review must meet the design criteria and standards set forth in the "Indiana Stormwater Quality Manual" from the Indiana Department of Environmental Management or similar Guidance Documents.*
- *Construction activities and unforeseen weather conditions may affect the performance of the erosion and sediment control system, individual measures, or the effectiveness of the plan. The plan must be a flexible document, with provisions to modify or substitute measures as necessary to ensure compliance.*

Section A: Construction Plan Elements

Adequate	Deficient	NA	A	*The construction plan elements include general information associated with the project site that are critical for the evaluation of the stormwater pollution prevention plan component. This information includes, but is not limited to an index, resource information, reference maps, grading information, project layout and design, and drainage plan.*
☐	☐	☐	**1**	Index of the location of required plan elements in the construction plan (SW12.05.1)
☐	☐	☐	**2**	A vicinity map depicting the project site location in relationship to recognizable local landmarks, towns, and major roads (SW12.05.2)
☐	☐	☐	**3**	Narrative of the nature and purpose of the project (SW12.07.b)
☐	☐	☐	**4**	Latitude and longitude to the nearest fifteen (15) seconds (SW12.07.d)
☐	☐	☐	**5**	Legal description of the project site (SW12.07.c)
☐	☐	☐	**6**	11 X 17-inch plat showing building lot numbers/boundaries and road layout/names (SW12.07.j)
☐	☐	☐	**7**	Boundaries of the one hundred (100) year floodplains, floodway fringes, and floodways (SW12.08.1.c)
☐	☐	☐	**8**	Land use of all adjacent properties (SW12.08.1.f)
☐	☐	☐	**9**	Identification of a U.S. EPA approved or established TMDL (SW12.07.n)
☐	☐	☐	**10**	Name(s) of the receiving water(s) (SW12.08.4.d)
☐	☐	☐	**11**	Identification of discharges to a water on the current 303d list of impaired waters and the pollutant(s) for which it is impaired (SW12.07.o)
☐	☐	☐	**12**	Soil map of the predominant soil types (SW12.08.1.d)
☐	☐	☐	**13**	Identification and location of all known wetlands, lakes and water courses on or adjacent to the project site (construction plan, existing site layout) (SW12.07.k)
☐	☐	☐	**14**	Identification of any other state or federal water quality permits or authorizations that are required for construction activities (SW12.07.m)
☐	☐	☐	**15**	Identification and delineation of existing cover, including natural buffers (SW12.08.1.e)
☐	☐	☐	**16**	Existing topography at a contour interval appropriate to indicate drainage patterns (SW12.08.1.g)
☐	☐	☐	**17**	Location(s) of where run-off enters the project site (SW12.08.1.h)
☐	☐	☐	**18**	Location(s) of where run-off discharges from the project site prior to land disturbance (SW12.08.1.i)
☐	☐	☐	**19**	Location of all existing structures on the project site (SW12.08.1.b)
☐	☐	☐	**20**	Existing permanent retention or detention facilities, including manmade wetlands, designed for the purpose of stormwater management (SW12.08.1.a)

Adequate	Deficient	NA	A	*The construction plan elements include general information associated with the project site that are critical for the evaluation of the stormwater pollution prevention plan component. This information includes, but is not limited to an index, resource information, reference maps, grading information, project layout and design, and drainage plan.*
☐	☐	☐	**21**	Locations where stormwater may be directly discharged into ground water, such as abandoned wells, sinkholes, or karst features (SW12.08.4.c)
☐	☐	☐	**22**	Size of the project area expressed in acres (SW12.07.e)
☐	☐	☐	**23**	Total expected land disturbance expressed in acres (SW12.07.f)
☐	☐	☐	**24**	Proposed final topography (SW12.08.2.c)
☐	☐	☐	**25**	Locations and approximate boundaries of all disturbed areas (SW12.08.3.a)
☐	☐	☐	**26**	Location, size, and dimensions of all stormwater drainage systems, such as culverts, storm sewers, and conveyance channels (SW12.08.4.a)
☐	☐	☐	**27**	Locations of specific points where stormwater and non-stormwater discharges will leave the project site (SW12.08.4.b)
☐	☐	☐	**28**	Location of all proposed site improvements, including roads, utilities, lot delineation and identification, proposed structures, and common areas (SW12.08.2.a)
☐	☐	☐	**29**	Location of all on-site soil stockpiles and borrow areas (SW12.08.3.b)
☐	☐	☐	**30**	Construction support activities that are expected to be part of the project (SW12.07.g)
☐	☐	☐	**31**	Location of any in-stream activities that are planned for the project including, but not limited to stream crossings and pump arounds (SW12.07.l)

Section A – Comments:

- Evaluate areas with potential waters of the state and, where required, verify if permits/authorizations are required prior to any impacts to waters of the state. These potential resources include areas with hydric soil, hydrophytic vegetation, pooling water, or evidence of flowing water such as swales, ditches, drains, or natural conveyances. Evaluation of hydric soil, hydrophytic vegetation, or pooling water should conform to the US Army Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, and the applicable regional supplement https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/reg_supp/. Avoidance and minimization of impacts to waters of the state should be prioritized.
-

Section B: Stormwater Pollution Prevention Plan – Erosion and Sediment Control/Project Site Management

Adequate	Deficient	NA	B	*The construction component of the Stormwater Pollution Prevention Plan includes stormwater quality measures to address erosion, sedimentation, and other pollutants associated with land disturbance and construction activities. Proper implementation of the plan, maintenance of measures, and administering a self-monitoring program is required to manage the project site to minimize the discharge of sediment and other pollutants. Construction activities and unforeseen weather conditions may affect the performance of the erosion and sediment control system, individual measures, or the effectiveness of the plan. The plan must be a flexible document, with provisions to modify or substitute measures as necessary to ensure compliance.*
☐	☐	☐	**1**	Description of the potential pollutant generating sources and pollutants, including all potential non-stormwater discharges (SW12.09.1)
				Where applicable, Items in 2 through 10 below will be evaluated for Location, dimensions, detailed specification, and construction details
☐	☐	☐	**2**	Stable construction entrance locations and specifications (SW12.09.2.k)
☐	☐	☐	**3**	Specifications for temporary and permanent stabilization (SW12.09.3)
☐	☐	☐	**4**	Sediment control measures for concentrated flow areas (SW12.09.2.b)
☐	☐	☐	**5**	Sediment control measures for sheet flow areas (SW12.09.2.b)
☐	☐	☐	**6**	Run-off control measures (SW12.09.2.d)
☐	☐	☐	**7**	Stormwater outlet protection locations and specifications (SW12.09.2.i)
☐	☐	☐	**8**	Grade stabilization structure locations and specifications (SW12.09.2.j)
☐	☐	☐	**9**	Dewatering applications and management methods (SW12.09.2.e)
☐	☐	☐	**10**	Measures utilized for work within waterbodies (SW12.09.2.g)
☐	☐	☐	**11**	Maintenance guidelines for each proposed temporary stormwater quality measure (SW12.09.4)
☐	☐	☐	**12**	Planned construction sequence describing the relationship between implementation of stormwater quality measures in relation to land disturbance (SW12.09.5)
☐	☐	☐	**13**	Provisions for erosion and sediment control on individual building lots regulated under the proposed project (SW12.09.6)
☐	☐	☐	**14**	Material handling and spill prevention and spill response plan meeting the requirements in 327 IAC 2-6.1 (SW12.09.7)
☐	☐	☐	**15**	Material handling and storage procedures associated with construction activity (SW12.09.8)

Section B – Comments:

- Stormwater quality measures for the reduction of sediment have not been evaluated for adequacy of design. The proposed measures included in this SWP3 are being accepted based on the design engineer’s submittal.
-

Section C: Stormwater Pollution Prevention Plan – Post-Construction

Adequate	**Deficient**	**NA**	**C**	*The post-construction component of the Stormwater Pollution Prevention Plan includes the implementation of stormwater quality measures to address pollutants that will be associated with the final project land use. Post-construction stormwater measures should be functional upon completion of the project. Long term functionality of the measures is critical to their performance and should be monitored and maintained.*
☐	☐	☐	**1**	Description of pollutants and their sources associated with the proposed land use (SW12.10.1)
☐	☐	☐	**2**	Description of proposed post-construction stormwater measures (SW12.10.2)
☐	☐	☐	**3**	Plan details for each stormwater measure (SW12.10.3)
☐	☐	☐	**4**	Sequence describing stormwater measure implementation (SW12.10.4)
☐	☐	☐	**5**	Maintenance guidelines for proposed post-construction stormwater measures (SW12.10.5)
☐	☐	☐	**6**	Entity that will be responsible for operation and maintenance of the post-construction stormwater measures (SW12.10.6)

Section C – Comments:

- Post-construction stormwater quality and quantity measures have not been evaluated for adequacy of design. The proposed measures included in this SWP3 are being accepted based on the design engineer's submittal.
- The rate of stormwater run-off and/or volume from the project site must meet local requirements to address stormwater quantity as established by ordinance or other regulatory mechanism. When a local requirement does not exist, the post-development run-off discharge from the project site must not exceed the pre-development discharge based on the two-year, ten-year, and one-hundred-year peak storm events.
-

Instructions

Using the Inspection Report

This inspection report is designed to be customized according to the BMPs and conditions at your site. For ease of use, you should take a copy of your site plan and number all of the stormwater BMPs and areas of your site that will be inspected. A brief description of the BMP or area should then be listed in the site-specific section of the inspection report. For example, specific structural BMPs such as construction site entrances, sediment ponds, or specific areas with silt fence (e.g., silt fence along Main Street; silt fence along slope in NW corner, etc.) should be numbered and listed. You should also number specific non-structural BMPs or areas that will be inspected (such as trash areas, material storage areas, temporary sanitary waste areas, etc).

You can complete the items in the "General Information" section that will remain constant, such as the project name, City Permit number, and inspector (if you only use one inspector). Print out multiple copies of this customized inspection report to use during your inspections.

When conducting the inspection, walk the site by following your site map and numbered BMPs/areas for inspection. Also note whether the overall site issues have been addressed (customize this list according to the conditions at your site). Note any required corrective actions and the date and responsible person for the correction in the Corrective Action Log.

Stormwater Construction Site Inspection Report

General Information			
Project Name			
City Permit No.		Location	
Date of Inspection			
Inspector’s Name(s)			
Inspector’s Title(s)			
Inspector’s Contact Information			
Inspector’s Qualifications			
Describe present phase of construction			

Type of Inspection

☐ Regular ☐ Pre-storm event ☐ During storm event ☐ Post-storm event

Weather Information

Has there been a storm event since the last inspection? ☐ Yes ☐ No

If yes, provide:

Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):

Weather at time of this inspection?

☐ Clear ☐ Cloudy ☐ Rain ☐ Sleet ☐ Fog ☐ Snowing ☐ High Winds

☐ Other: Temperature:

Has any other sediment left the site since the last inspection? ☐ Yes ☐ No

If yes, describe:

Are there any discharges of sediment at the time of inspection? ☐ Yes ☐ No

If yes, describe:

Site-specific Best Management Practices, BMPs

- *Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1	Ex: Silt Fence	☐ Yes ☐ No	☐ Yes ☐ No	
2	Ex: Inlet Protection	☐ Yes ☐ No	☐ Yes ☐ No	
3		☐ Yes ☐ No	☐ Yes ☐ No	
4		☐ Yes ☐ No	☐ Yes ☐ No	
5		☐ Yes ☐ No	☐ Yes ☐ No	
6		☐ Yes ☐ No	☐ Yes ☐ No	
7		☐ Yes ☐ No	☐ Yes ☐ No	
8		☐ Yes ☐ No	☐ Yes ☐ No	
9		☐ Yes ☐ No	☐ Yes ☐ No	
10		☐ Yes ☐ No	☐ Yes ☐ No	

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
11		☐ Yes ☐ No	☐ Yes ☐ No	
12		☐ Yes ☐ No	☐ Yes ☐ No	
13		☐ Yes ☐ No	☐ Yes ☐ No	
14		☐ Yes ☐ No	☐ Yes ☐ No	
15		☐ Yes ☐ No	☐ Yes ☐ No	
16		☐ Yes ☐ No	☐ Yes ☐ No	
17		☐ Yes ☐ No	☐ Yes ☐ No	
18		☐ Yes ☐ No	☐ Yes ☐ No	
19		☐ Yes ☐ No	☐ Yes ☐ No	
20		☐ Yes ☐ No	☐ Yes ☐ No	

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

	BMP/Activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	Are all slopes and disturbed areas not actively being worked on properly stabilized?	☐ Yes ☐ No	☐ Yes ☐ No	
2	Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) projected with barriers or similar BMPs?	☐ Yes ☐ No	☐ Yes ☐ No	
3	Are perimeter controls and sediment barriers adequately installed (keyed into substrate) and maintained?	☐ Yes ☐ No	☐ Yes ☐ No	
4	Are discharge points and receiving waters free of any sediment deposits?	☐ Yes ☐ No	☐ Yes ☐ No	
5	Are storm drain inlets properly protected?	☐ Yes ☐ No	☐ Yes ☐ No	
6	Is the construction exit preventing sediment from being tracked into the street?	☐ Yes ☐ No	☐ Yes ☐ No	
7	Is trash/litter from work areas collected and placed in covered dumpsters?	☐ Yes ☐ No	☐ Yes ☐ No	
8	Are washout facilities (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	☐ Yes ☐ No	☐ Yes ☐ No	

	BMP/Activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
9	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	☐ Yes ☐ No	☐ Yes ☐ No	
10	Are materials that are potential stormwater contaminants stored inside or under cover?	☐ Yes ☐ No	☐ Yes ☐ No	
11	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	☐ Yes ☐ No	☐ Yes ☐ No	
12	(Other)	☐ Yes ☐ No	☐ Yes ☐ No	

Non-Compliance Notes by City/Inspector

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT BY DEVELOPER/OWNER

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: ____

Signature: ____ Date: ________________

City Utilities Design Standards Manual	Exhibit SW12-5 Storm Water Permit Certification Form
CITY UTILITIES WATER THAT WORKS	Version: June 2024 — Fillable Version

Contract or SWP3 Number: ____________ Project: ______________________________

Owner: ______________________________

Each Contractor and Subcontractor identified in the Storm Water Pollution Prevention Plan (SWP3) must certify that they understand the permit conditions and their responsibilities. Every Contractor and Subcontractor performing an activity that involves soil disturbance shall sign this certification and submit it to the Engineer prior to performing the Work. This certification shall be signed by an owner, principal, president, secretary, or treasurer of the firm.

> I certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWP3 for the construction Site identified in such SWP3 as a condition of authorization to discharge storm water. I also understand that my firm and its employees and Subcontractors shall comply with the terms and conditions of Owner's general permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards, Laws, or Regulations.

Engineering Firm: ______________________________

Address: ______________________________

City: ______________ State: ____________ Zip: ____________

____________________	____________________	__________
Contractor's or Sub's Name (Print)	Contractor's or Sub's Signature	Date
Contractor's or Sub's Title		

____________________	____________________	__________
Engineer's Name (Print)	Engineer's Signature	Date
Engineer's Title		

____________________	____________________	__________
Owner's Name (Print)	Owner's Signature	Date
Owner's Title		

Owner:
Site:
Project:
Contractor:

Date of Inspection:

Sheet No. ________ of ________ Sheets

This form shall be used when revisions to the current Storm Water Pollution Prevention Plan (SWP3) are required by the Storm Water General Permit for Construction Activity or the Contract Documents.

Reason for the Revision(s): Revisions were requested by State: ☐ Yes ☐ No

Describe the Revision(s) to the SWP3:

I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: ______________________ Prepared: ______________ (Date) Submitted: ______________ (Date)

Copy to: ☐ Engineer ☐ Contractor

Book 2

Stormwater

SW13 Erosion and Sediment Control

SW13.01 Purpose

This chapter intends to address appropriate products, procedures, and measures that should be used for erosion and sedimentation control on all projects.

The Construction SWP3 outlines the minimal requirements expected to control the erosion and sediment for a project. The implementation of the SWP3 over the life of the construction project will require adjustments and use of effective erosion and sediment control measures to be successful.

As new proprietary products associated with erosion and sediment control are continuously entering the market, the manufacturer’s details for these products will need to be evaluated for use within the City’s jurisdiction as they are submitted.

Projects located within the City’s MS4 jurisdiction that do not require a SWP3 shall submit an erosion control plan for review and approval by Development Services.

SW13.02 Planning and Scheduling Practices

The best way to control sediment from migrating is preventing it from being dislodged. For construction activities, this means minimizing the disturbed areas and stabilizing as quickly as possible. This can be accomplished by implementing a construction schedule that incorporates these goals.

1. Minimizing the Construction Footprint

   The design for the end use shall minimize the construction footprint to the extent practical. Areas that have well established vegetation, such as woods or unmaintained grasslands, should be incorporated into the design. They shall be conspicuously labeled on the plans and in the field as Do Not disturb. These areas shall be protected from sediment dislodged by the surrounding construction activities.

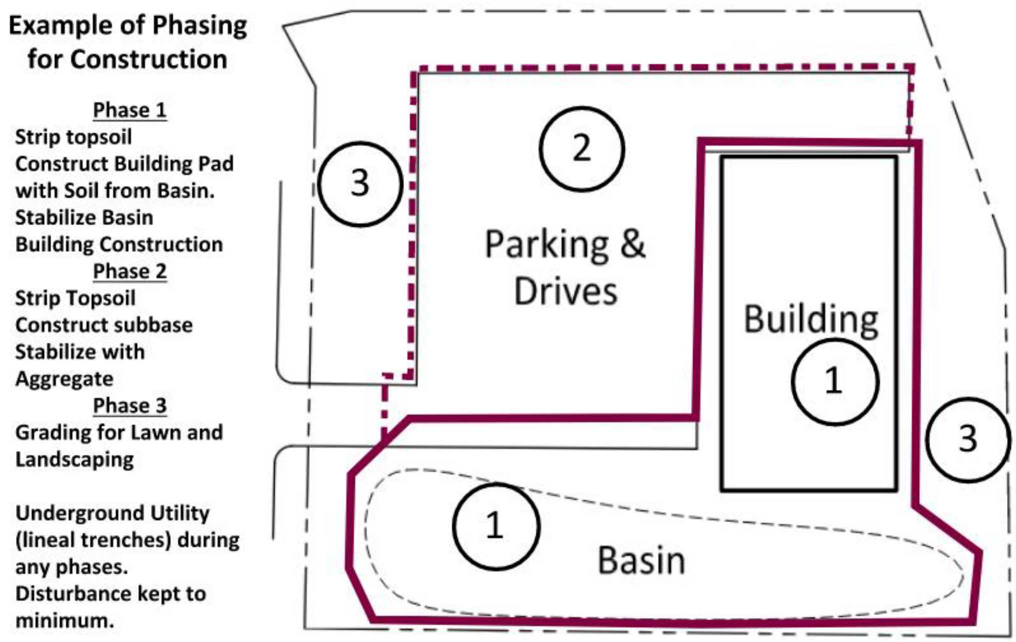
2. Phasing and Construction Sequencing

   Site Phasing, in this context, refers to the area of land disturbance and stabilized within the construction sequence at a given time. The area void of stabilization shall always be as minimal as practical.

   Stripping the entire site on day one and stabilizing the entire site on the last day is prohibited.

   The SWP3 plan needs to clearly delineate and plan the phases of the site. Each phase shall be stabilized as soon as possible. No phase shall remain unworked without stabilization for more than 7 consecutive days. Stabilization needs to be completed in 14 days. Permanent stabilization of pervious areas shall occur as soon as possible. If temporary stabilization is required, it shall include seeding and blankets or mulch as appropriate. Temporary stabilization for future impervious surfaces shall be stone aggregate or a similar treatment.

Figure SW13.1 Example SWP3 Construction Phasing



3. Soil Stockpiling

   All site development and utility projects will require soil stockpiling. The most common is that of topsoil that was stripped for earthwork. Many projects may also have stockpiles associated with the placement of good or relocation of bad soils. A statement of “there will be no stockpiles” is not an acceptable response for construction plans.

   Stockpiling is not intended for long term storage. Plans associated with site development projects shall show a location for soil stockpiles. The locations shall be away from stormwater infrastructure, flood plains, swales, wetlands, and water bodies. Sediment controls shall be downstream of the stockpiles to prevent pollutants from migrating.

SW13.03 Erosion Control Measures

Erosion is the removal or displacement of soil, rock, or other materials by water or wind forces. In the context of construction plans, erosion protection measures are those that reduce the risk of materials, dominantly soil particles, from being displaced. A disturbed area that is protected by an appropriate erosion control measure is considered stabilized. There are numerous erosion control measures for different types of applications.

Sheet Flow Applications

Vegetation is the most common form of erosion control for pervious areas. The seeding to establish vegetation can be temporary in nature. This is commonly used when surface will be unworked for an extended period; but the area will be disturbed in the future. Permanent seeding is appropriate when no future grading is expected. Plan submittals shall have the requirements for temporary and permanent seeding.

1. Erosion Control Blankets are used in tandem with seeding. The blankets protect the soil from the impact of rain and wind. It also protects the slopes from sheet flow forces.

   Erosion control blankets are required on all slopes of 6:1 or steeper. There are numerous material options for erosion control blankets. The blankets are generally classified on the intended life expectancy.

   A. Short-term Erosion Control Blankets

      Erosion control blankets with a functional longevity of 6 months or less are considered short-term. Short-term Erosion Control Blankets are to have the minimum requirements listed in **Chapter MA5 – Stormwater Materials and Testing Requirements**.

   B. Long-term Erosion Control Blankets

      Erosion control blankets with a functional life of 12 months or more are considered long-term. Long-term blankets are to meet the minimum requirements listed in **Chapter MA5 – Stormwater Materials and Testing Requirements**.

   The Designer is to designate at a minimum the life expectancy of the erosion control blanket required for each installation and/or area of the site.

2. Stone Aggregate is an appropriate erosion control measure for future impervious areas. It is best when the subgrade is established but final paving is not feasible in the near term.

3. Straw Cover and Mulch can be applied to flat areas (slopes less than 6:1) that are seeded, however, are highly discouraged. This practice will reduce risk of erosion during minor rain events. However, the mulch and straw can become a pollutant if dislodged by wind or intense rain events. Their use is acceptable when anchored to the soil. The preferred method is to use blankets or hydroseeding for erosion control.

Concentrated Flow Applications

Concentrated flow paths require additional erosion control consideration. In this section, concentrated flow is assumed to mean an ephemeral surface conveyance path for stormwater such as a swale. The following measures are for addressing the erosion. These same locations may also need sediment control measures.

1. Erosion Control Blankets and established Vegetation are sufficient in most swale and minor channel applications. The erosion control blankets in a concentrated flow application shall have a life expectancy of 24 months or more. The choice in product shall also consider the maximum slope and allowable flow velocities provided in the manufacturers' documentation.
2. Turf Reinforcement products are necessary when anticipated flow velocities exceed 8 feet per second in the channel. These products have non-degradable elements for extended life expectancies. The seeding requirements with turf reinforcement mats shall follow the manufacturer's recommendations.
3. Cellular or grid like soil confinement and stabilization products such as GeoGrid, Geocell, and StrataGrid are useful for steep slope and bank stabilization. These products are generally composed of a 3D blanket of interconnected cells that allows for soil and natural vegetation to grow around its interlocked web of openings. Refer to manufacturer's recommendations to for its proper installation.
4. Rigid Armor for a channel should be a last option. Rigid or hard armor is the use of concrete or stone products to protect the channel from erosive flow velocities. The installation shall follow the manufacturer's recommendations. If rigid armor is required, evaluate using only to the ordinary high water mark with another alternative above the ordinary high water mark.

   Rigid armor brings challenges to the post-construction water quality plan. It reduces the opportunity for infiltration of stormwater into the soil. It typically increases the potential flow velocities. It introduces heat retention where natural vegetation does not.

SW13.04 Sediment Control Measures

Sediment control measures collect or reduce the amount of soil particles (pollutants) that are migrating in the runoff. This is accomplished by filtering flows, slowing flow velocities, and/or retaining the flows on-site to allow settling.

<u>Filtering Applications</u>

1. Silt Fence should only be used for sheet flow situations.
2. Filter Tube and Filter Socks are tube like products with various fill materials, including Coir Logs . They are available in various diameters. The plan shall specify the size and material (or manufacturer's product name). They must be anchored and trenched as recommended by the manufacturer.

   Straw wattles are prohibited in the City of Fort Wayne. Strawbales are prohibited as a sediment control measure except as an emergency stop-gap.

Coir logs can be specified as vegetated or non-vegetated installations. The plan shall designate accordingly. If vegetated installation is required, planting requirements shall also be specified.

3. Inlet Protection

   a. Proprietary Inlet Protection products are evolving. Many are currently permitted within the City's jurisdiction. Contact the City regarding the use of products that are new to the market. The maintenance and inspection specification shall follow the manufacturer's recommendations.

   b. Fabricated Inlet Protection Measures utilize silt fence, aggregate or other products to craft a sediment control measure on-site. These measures are defined by the Indiana Stormwater Handbook and the City's standard details. These fabricated inlet protections include:

      i. Excavated Drop Inlet Protection

      ii. Gravel Donut Drop Inlet Protection

      iii. Geotextile Fabric Drop Inlet Protection

      iv. Filter Sock Inlet Protection

   The appropriate inlet protection measure is dependent upon the location. The particular inlet protection measure for a structure may change as the project develops. For instance, an excavated drop inlet protection might be appropriate until the base for the parking lot is installed. The structure may need a proprietary measure after the asphalt is placed.

   Geotextile fabric placed directly under the inlet grate is prohibited. Coconut fiber mats placed directly over or under the inlet grate is prohibited.

   The inherent safety of the measure shall be considered. **Stone Bag Rings and similar inlet protections are a traffic hazard. They shall not be utilized in a public right-of-way.**

<u>Slowing Velocity Applications</u>

1. Check Dams are used in swales and minor ephemeral channels to slow velocities. They shall not be used in perennial streams. Check dams lower velocities to allow pollutants to settle out of the run off and are typically used in tandem with an erosion control measure. Check dams can be:

   a. Rock check dams

   b. Coir log dams

   c. Proprietary product

<u>Retaining Flow Applications</u>

1. Temporary Sediment Traps are small pools without grade. The pollutants will settle out.

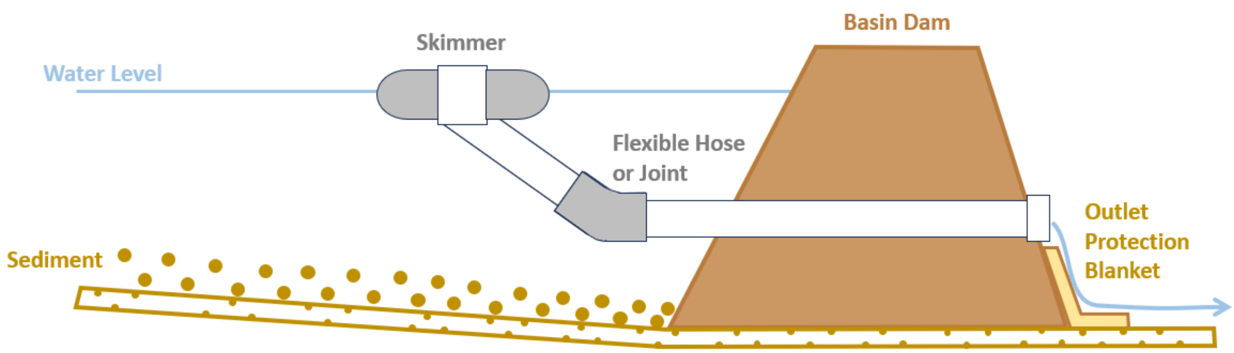
Sediment traps shall be designed. The volume of a sediment trap shall be based on a routed two-year frequency, 24-hour duration storm event. (Discharge rate of 0.) The elevation of the spillway shall equal the water surface from the stated two-year routing.

Sediment traps shall drain from the surface of the water column. Floating pond skimmers shall be incorporated to the sediment trap design for high discharge water quality. Floating skimmers draw clarified water with greatly reduced sediment concentrations from the surface of the settled stormwater as shown in Figure SW13.2.

a. For Skimmer Sizing refer to following design guidance document from Faircloth Skimmer Surface Drain:
   Determining the Skimmer Size

b. For Pond Skimmer installation guidance refer to the following from Faircloth Skimmer Surface Drain:
   Instructions for Assembly, Use and Maintenance

Figure SW13.2 Pond Skimmer and Sediment Basin Diagram



Alternative measures can be explored to equally reduce sediment instead of withdrawal from the top of the water column. Examples of such measures include increasing basin length to width ratio to 4:1 or greater, implementation of porous baffles, use of flocculants/polymers, and/or phasing of project land disturbance that incorporates a rapid stabilization program. During freezing conditions, the implementation of alternative withdrawal methods may be utilized.

A detention basin is not considered a temporary sediment trap unless specifically designed and indicated on the construction plan.

SW13.05 Perimeter Control Measures

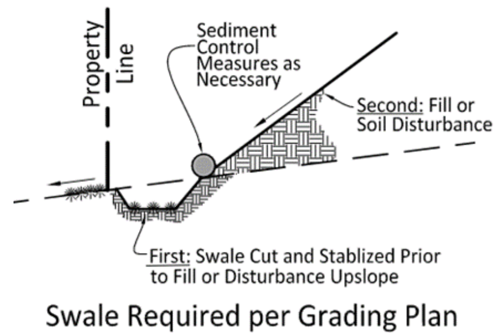
Perimeter control measures act like sediment control measures. They are ultimately responsible for preventing sediment from leaving a site. Many of the control measures are also the same as sediment control measures, such as the use of silt fences and coir logs. However, there are a few measures that are unique to the perimeter of a site.

1. Grading near Property Lines and Right-of-ways

   Land disturbing activities near the limits of a site are problematic. Visually, they are the focus points for the adjoining owners and general public. They are also a compacted area for numerous improvements and activities. These are most problematic when there is a substantial change in grade.

   The grading near the project's limits is often a swale. If a swale is required, its flowline shall be established and stabilized as a construction priority. This will reduce the potential of sediment migrating onto the adjoiner or right-of-way. See Figure SW13.3.

   Figure SW13.3 Site Stabilization with Swale

   Stabilization for this purpose means seeded and protected with an erosion control blanket or similar anchoring measure. No fill placement or major soil disturbance shall occur upstream of the swale until it is stabilized.

   Contrarily, some proposed grading along the project limits will direct runoff onto the adjoining parcel or right-of-way. This shed area is generally limited to the recovery slopes necessary for meeting the existing grades (i.e., landscaping mounds, slopes from a shed break). This will require an undisturbed buffer of vegetation.

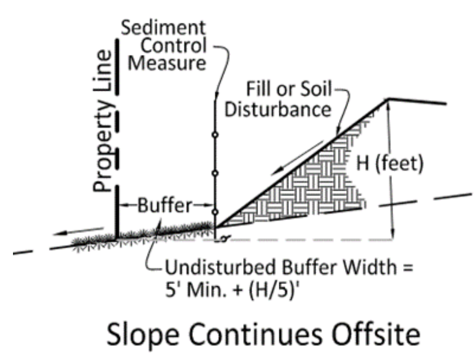
   This buffer shall be five (horizontal) feet plus 20% of the height of the fill (or soil disturbance) to the shed break. See Figure SW13.4.

   Buffer equations: 5 + 0.2(H) = Required Buffer

   For example, a slope with a height (vertical change) of 12 feet will require an undisturbed buffer of 7.4 feet. Example: 5 feet + (12 feet/5) = 5 feet + 2.4 feet = 7.4 feet.

   "Buffer" in this context means an undisturbed, well-established vegetation. In the absence of such vegetation, seeding and stabilization shall occur.

   Figure SW13.4 Site Stabilization with Buffer

2. Natural Buffers along Water Bodies

   Natural buffers shall be protected from erosion and sediment. To this end, erosion and sediment control measures shall be implemented at the upstream side of the buffer. Appropriate run-off control measures shall also be utilized to prevent erosion within the buffer area.

See **Chapter SW9 – Open Channels** for additional information on Natural Buffers.

3. Construction Entrances

   Vehicle control onto the site shall be maintained to minimize sediment from being tracked off-site. The plan shall identify a suggested location for the construction entrance. The plan shall include a detail for a construction entrance. The use of an existing impervious drive is not sufficient by itself. The construction entrance shall have measures to reduce the sediment collected on tires.

   The adjacent streets and impervious surfaces shall be kept clear of sediment accumulations. This shall be done by sweeping or other methods that collect the sediment.

   Site operators shall inspect streets daily for sediment. When sediment is tracked or discharged onto streets, sweeping shall be conducted by the close of that business day (and during the day as needed). Street sweepers using water while sweeping are preferred in order to minimize dust. Flushing off impervious surface with water to remove sediment is prohibited.

SW13.06 Runoff Control Measures

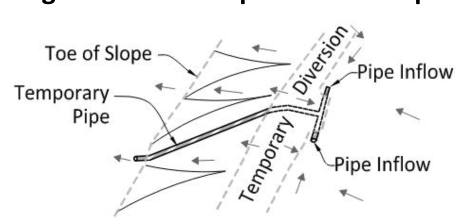
Runoff control measures are intended to reduce the risk of erosion and sediment migration. They are measures and practices associated with routing the runoff through a disturbed site with the least amount of impact.

1. Temporary grading to divert runoff is a valuable technique for controlling runoff. This may include diverting the flows from a disturbed area to a temporary sediment basin. This can be done by constructing a temporary mound or cutting a temporary ditch. The appropriate erosion control and/or sediment control shall be utilized with temporary grading.

   Diversion grading is typically utilized and defined with the phasing of construction.

2. Slope Drains collect the runoff at the top of a steep slope. It is directed to a temporary pipe or channel. The temporary pipe discharges the flow at the bottom of the slope. This allows the bulk of the slope to stabilize with minimal flows. The slope drain and the temporary diversion are then removed.

Figure SW13.5 Slope Drain Example



SW13.07 Dewatering Measures

Pump discharges associated with grading and utility construction shall be through a dewatering sediment bag or into a sediment trap. Dewatering bags shall be proprietary devices. They shall provide a minimum Total Suspended Solids removal efficiency of 80% or more. The discharge from the sediment bag shall be such that additional pollutants are not dislodged or transported. Uncontaminated storm water can be surface discharged over a stabilized surface after the dewatering bag or sediment trap.

The engineer or contractor shall notify City Utilities if ground water is encountered. If dewatering is required, the City Utilities Development Services will dictate where the ground water can be discharged.

The engineer shall establish a plan for dewatering if contamination, beyond sediment, is expected. City Utilities shall dictate where and how the contaminated ground water can be discharged. The design engineer shall include the services of someone competent in the remediation of contaminated water and soil.

SW13.08 Channel Crossings

Construction activities within a channel shall take the necessary measures to reduce disturbance to the channel bed and slopes. The designer shall provide a plan to minimize the disturbance, control sediment migration and restore the site. The designer is responsible for obtaining all state and federal permits necessary.

SW13.09 Wash Water from Concrete and Cementitious Materials

Construction activities include the use of potentially hazardous waste. The contractors are expected to follow the manufacturer’s recommendations for these products. There are also materials that are routinely used without recognition of the dangers. A construction plan shall address these dangers as they apply to the environment and requires that they are identified and located at all construction sites.

The liquid from washing concrete chutes and similar maintenance activities shall be captured and properly disposed.

Concrete and cementitious washouts can be a proprietary product or an on-site fabricated system. They shall be watertight. They shall be located such that runoff is not directed into them.

SW13.10 Storage and Handling of Fertilizers and Herbicides

Storage and handling of hazardous material such as fertilizer, herbicides can be a danger to the adjoining water bodies.

The use of fertilizers and herbicides shall be minimized. The specifications for the seeding should address the application rates of the products. The specifications or construction notes shall also address waste disposal associated with the use of the products.

In the case where fertilizers and herbicides must be used, application of fertilizer shall be carried out with appropriate planning and timing. Factors to consider with its application include project location, proximity to waterbody, time of year, and timed to coincide with period of maximum vegetative uptake and growth. Fertilizers shall not be applied immediately prior to anticipated precipitation events that will ultimately result in stormwater run-off from the applied area.

Ensure that the SWP3 contains a material handling and spill prevention and spill response plan meeting the requirements as outlined in SW12.10 Construction Plan Stormwater Pollution Prevention Plan (SWP3).

SW13.11 Storage and Handling of Fuels

Storage and handling of hazardous materials, such as fuel, can be a danger to adjoining water bodies and soil. Spill prevention (primary containment and secondary containment) must be implemented to minimize the potential for pollutants to contaminate surface or ground water or degrade soil quality. To minimize contamination from diesel fuel, oil, hydraulic fluids, other petroleum products, and other chemicals, manage the following activities:

1. Fueling and maintenance of equipment
2. Washing of equipment, tools, applicators, containers, and vehicles
3. Other handling and disposal of fuels
4. Dispensing and utilization of fuels

Contractors shall have Spill Cleanup Kits onsite for minor spills. Minor clay berms or similar barriers are appropriate measures to be utilized to reduce the risk of contaminants from migrating.

CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 3 Sanitary

CITY UTILITIES

WATER THAT WORKS

Book 3

Sanitary (SA)

SA1 Acronyms and Definitions

SA1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the Sanitary Sewer Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

SA1.02 Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACF	Area Connection Fee
ADF	Average Daily Flow
ANSI	American National Standards Institute
ASTM	ASTM International (formerly American Society of Testing and Materials)
AWG	American Wire Gauge
AWWA	American Water Works Association
CIPP	Cured-In-Place Pipe
CUE	City Utilities Engineering
DIP	Ductile Iron Pipe
DVS	Development Services
ERU	Equivalent Residential Unit
GPD	Gallons Per Day
HDPE	High Density Polyethylene
HP	Horsepower
I/I	Infiltration and Inflow
IAC	Indiana Administrative Code
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IESNA	Illuminating Engineering Society of North America
IMUTCD	Indiana Manual on Uniform Traffic Control Devices

INDOT	Indiana Department of Transportation
IPC	Indiana Plumbing Code
NEC	National Electric Code (NFPA 70)
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPSH	Net Positive Suction Head
NTS	Not To Scale
PE	Professional Engineer
PVC	Polyvinyl Chloride
PSI	Pounds Per Square Inch
RCP	Reinforced Concrete Pipe
ROW	Right-Of-Way
RPR	Resident Project Representative
SDR	Standard Dimension Ratio
SWMM	EPA Storm Water Management Model
TDH	Total Dynamic Head
UL	Underwriters Laboratories, Inc.
VCP	Vitrified Clay Pipe
VFD	Variable Frequency Drive
WPCP	Water Pollution Control Plant

SA1.03 Definitions

Adjusting	Ring A cylindrical ring, usually comprised of concrete, secured on top of a manhole upon which the frame will rest.
Area Connection Fee	A one-time fee (ACF) charged per ERU at the time of, or prior to, the connection to the sewer utility.
Average Daily Flow	Average 24-hour dry weather flow, including a nominal amount of infiltration, within a sewer.
Backfill	Earth and/or other material used to replace material removed from trenches or other excavations during construction activities. The backfill lies above the pipe bedding.
Bedding	The fractured face stone which encases the sewer pipe to a minimum depth above and below the barrel of the pipe. The bedding serves as the pipe support.

Book	Organizational grouping of utility design standards by topic. These Books consist of General Requirements, Stormwater, Sanitary Sewer, Potable Water Distribution Systems and Materials.
Building Sewer	Private sewers which connect building plumbing to public sewers. Building sewers normally begin outside the building foundation.
Buoyancy	The act of supporting a floating body, including the tendency to float an empty pipe or structure by exterior hydraulic pressure.
Capital Improvement Surcharge	The additional monthly charge per ERU for sewer service collected from retail sanitary sewer users.
City	The City of Fort Wayne, Indiana.
City Utilities	The department of the City of Fort Wayne that manages the stormwater, wastewater and water utilities.
City Utilities Engineering	The division within City Utilities that develops City Utility Engineering Standards, manages City Utilities Projects, and performs planning and system analysis for the stormwater, wastewater and water utilities.
City Utilities Projects	Publicly funded projects that improve the stormwater, wastewater, and water utilities and are under direction of City Utilities Engineering.
City Utilities Design Standards Manual	A document that provides guidance and requirements for the planning, design, and construction of stormwater, wastewater, and water utility infrastructure.
Cleanout	A pipe or some other opening through which a device may be run to unplug a sewer.
Collar	A monolithic concrete encasement of sanitary cleanout casting in pavement.
Collector Sewer	Sewer that is primarily installed to receive wastewater directly from building sewer connections and convey the wastewater to an interceptor line.
Combination Air Valve	A valve on sewage force mains that automatically releases air and gas from a filling system, admits air into a draining system, and releases air and gas in a pressurized flowing system.
Combined or Combination Sewer	A sewer which carries storm, surface and groundwater runoff as well as wastewater.
Concrete Pipe	Includes reinforced concrete pipe, horizontal and vertical elliptical concrete pipe, concrete arch pipe and concrete box sections.
Crown	The top or highest point of the internal surface of a conduit or sewer pipe.

Development — Any man-made change to improved or unimproved real estate, including but not limited to, buildings, or other structures, filling, grading, paving, excavation, substantial improvements, placement of mobile homes, subdivision of land.

Development Services — The division within the department of the City Utilities that oversees Non-capital projects.

Easement — A right to occupy, access or otherwise utilize the real property of another for a specifically defined use.

Encasement — The enclosing or surrounding of a conduit with concrete or other suitable material.

Equivalent Residential Unit — A unit of measurement representing the average daily sewage flow of a single-family dwelling. One ERU is equivalent to 310 gallons per day typically with a peak factor of 4.

Flexible Pipe — Comprises all pipe materials other than concrete pipe, including but not limited to ductile iron pipe, polyvinylchloride pipe, high density polyethylene pipe, fiberglass reinforced pipe, and polypropylene pipe.

Force Main — A pressurized pipe that conveys flow from the discharge side of a pump.

Grease Interceptor — Device which collects organic substances including fats, vegetable and mineral oils, waxes, fatty acids from soaps, and other long-chain hydrocarbons before they enter the sewer system, thus reducing the risk of blockages in sewers.

Hydraulic Grade Line — Measure of pressure head available at specific points within a sewer system. The hydraulic grade line is a line connecting the points to which the liquid would rise at various places along any pipe if piezometer tubes were inserted in the liquid.

Infiltration — Groundwater that enters the sewer system via such means as pipe cracks, joints, connections, or defects in manhole structures.

Inflow — Surface water which enters the sanitary sewer system via an improper drain connection (foundation drain, roof drain, yard drain, inlet structure, storm sewer cross connection, or sump pump) or from sources such as leaks through manhole cover.

Interceptor Sewer — Principal sewer to which collector sewers are tributary. Interceptor sewers convey the wastewater to treatment or other disposal facilities.

Invert — The bottom or lowest elevation of the internal cross-section of a conduit or sewer pipe.

Inverted Siphon — A gravity sewer which is designed to drop below the hydraulic grade line.

Lift Station	Any arrangement of pumps, piping, valves, and controls that conveys wastewater to or over a higher elevation.
Low Pressure Sewer System	A system of small diameter (2”-4”) pressurized sewer mains that collect and convey sewage from small pump stations built to serve individual buildings that grind up sewage and deliver it to the main via a 1 ¼” pressurized service.
Manhole	Sanitary sewer confined space through which a person may enter to gain access to an underground sanitary sewer.
Monolithic	Concrete structure cast as a single piece and formed without joints or seams.
Peak Hourly Flow	The largest volume of flow to be received during a one hour period expressed as a volume per unit time.
Permit	Written permission from agency with authority to control operation.
Population, Equivalent	A hypothetical number of persons for which flow contributions are calculated.
Population Build-Out	The actual (equivalent) population that exists or would exist when an area is fully developed.
Precast	A concrete item which is formed or molded.
Private Sewer	Pipe owned and maintained by a private person or company which conveys wastewater.
Public Sewer	Pipe used to convey wastewater which all owners of abutting property have equal rights to and is controlled and maintained by the City of Fort Wayne.
Right-of-Way	A general term denoting land, property or interest therein, usually in a strip of land acquired for or devoted to the construction of a highway, road or street that will include the travelled way, shoulders, roadsides, auxiliary lanes, medians, border areas, park strips, sidewalks, curbs, gutters, and fronting roads.
Sand/Oil Separators	Device designed to remove sand and oil from wastewater prior to discharge to main line sewer.
Sanitary Sewer	A sewer which carries domestic and unpolluted industrial sanitary wastewater and to which storm, surface, groundwaters and unpolluted industrial waste waters are not intentionally admitted.
Service Area	A geographical area served by a public utility or sewage collection system.
Sewer	Pipe used to convey wastewater to a treatment facility.
Springline	The horizontal centerline of a conduit or sewer pipe.

Standards	Fort Wayne City Utilities Design Standards Manual. The requirements for the design and construction of utilities within Fort Wayne's jurisdiction.
Submersible Pump	A pump capable of being fully placed beneath a water surface.
Wastewater	The water-carried wastes from residences, business buildings, institutions and industrial establishments, singularly or in any combination, together with such ground, surface and storm waters as may be present.
Wet Well	A short-term storage tank containing a pump or pump suction into which wastewater is conveyed.

Book 3

Sanitary (SA)

SA2 Introduction

SA2.01 Purpose

The purpose of this Chapter is to provide an introduction to how the Sanitary Book is presented. The purpose of the Sanitary Book is to provide guidance so that public sanitary sewers:

- Protect the health and welfare of residents
- Comply with local, state and federal laws
- Protect public and private property
- Protect the environment from pollutants transported by wastewater
- Provide adequate sanitary sewer service
- Ensure operability and maintainability of public sanitary systems

The Standards establish the minimum requirements for the design and construction of sanitary sewer systems that will be owned, operated and/or maintained by City Utilities.

SA2.02 Applicability

The Standards applies to all projects that result in sanitary sewer systems that are owned, operated and/or maintained by City Utilities, and also building sewers that are owned by property owners and maintained by property owners. Sanitary sewer systems include, but are not limited to:

- Sanitary sewers including buildings sewers
- Lift stations
- Low pressure sewer systems

For private sanitary systems, which are wholly owned, operated and maintained by a private entity, this manual constitutes best management practices. Incorporation of these standards is required.

SA2.03 Variance from Standards

Variance from the Standards may be granted under specific conditions. Refer to Chapter GR3 – Variances for the variance procedures and requirements.

SA2.04 Organization of Sanitary Standards

The Sanitary Book contains the process, procedures and technical requirements needed to comply with City of Fort Wayne sanitary sewer regulations. Chapter

SA4 – Drawings and Submittals outlines the minimum requirements for the submittal, approval, and acceptance of sanitary sewer system work.

The remaining Chapters are dedicated to key sanitary sewer topics. Each Chapter contains technical requirements including, but not limited to:

- Allowable design approaches (methods, equations)
- Minimum allowable sizing
- Implementation limitations
- Criteria for submittal
- Minimum geometry requirements

SA2.05 Sanitary Materials

Allowable materials and minimum requirements for use are provided in the Materials Book of the Standards. Relevant chapters include:

- Chapter MA2 – Introduction
- Chapter MA3 – Certification of Materials
- Chapter MA4 – Common Materials and Testing Requirements
- Chapter MA6 – Sanitary Sewer Materials and Testing Requirements

Materials used must comply with the Materials Standards. Deviations from the Standards may be considered in accordance with Chapter GR3 – Variances.

SA2.06 Sanitary Specifications

City Utilities maintains a library of Master Specifications for use on City Utilities projects and may be used on other projects. Specifications are available via the City's website at:

utilities.cityoffortwayne.org/contractors-engineers-developers/master-specifications

The Master Specifications have been developed to support the requirements established in this manual. The Master Specifications are provided as a service to design engineers and do not waive the design engineer's responsibility or liability for the site specific design of the sanitary sewer system.

SA2.07 Compliance with Other Standards

Compliance with these standards does not eliminate the need to comply with other applicable City, County, State and Federal ordinances and regulations. These standards are intended to supplement other guides and manuals produced by the City of Fort Wayne as well as other agencies. Other regulations and resources include, but are not limited to:

- Chapters 51, 52 and 53 of the Fort Wayne Code of Ordinances

- Fort Wayne Water Pollution Control Utility (Wastewater Utility) General Rules and Regulations
- Storm Water Design and Specification Manual, Green Infrastructure Supplemental Storm Water Document
- Indiana Department of Environmental Management (IDEM) Regulations including Title 327 of the Indiana Administrative Code (327 IAC)
- Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Wastewater Facilities, latest edition. (Also referred to as “Ten State Standards for Wastewater Facilities”)
- Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Water Works, latest edition. (Also referred to as “Ten State Standards for Water Works”)
- Indiana Plumbing Code of Indiana Administrative Code (675 IAC 16)
- Indiana Department of Natural Resources (IDNR) Storm Water Quality Manual
- Indiana Department of Transportation (INDOT) Standard Specifications, latest edition
- Indiana Manual on Uniform Traffic Control Devices (IMUTCD), latest edition
- American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highway and Streets, latest edition
- American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide, latest edition

Other submission and approval requirements may include preliminary and final subdivision plats, permits (IDEM or City issued) for sanitary facilities construction, and building and zoning permits; construction inspections; appeals; and similar matters.

The provisions of this document shall be deemed as additional requirements to minimum standards required by other applicable ordinances and standards. In the case of conflicting requirements, the most restrictive shall apply.

Book 3

Sanitary (SA)

SA3 Special Discharges

SA3.01 Purpose

This Chapter outlines the policies for the design and construction of sanitary sewer facilities and building sewers within the jurisdiction of City Utilities.

Policies included in these Standards have been adopted by City Utilities and are required for sanitary sewer facilities that are owned, operated and/or maintained by City Utilities and building sewers that are owned and maintained by property owners.

SA3.02 Connections

Whenever a public sanitary sewer is available for use and within a specified distance, property owners may be required to connect to it.

Building sewer connections to sanitary or combined sewers shall not include clear water. In combined sewer areas, clear water shall be discharged to storm sewer, when available. Prohibited sources of clear water are described further in **Chapter SW4 – Special Discharges** and in **Chapter SA6 – Building Sewer and Appurtenance Design**.

For additional information, refer to the Wastewater Utility General Rules and Regulations, located at **utilities.cityoffortwayne.org/about/utility-rules-regulations**;

and the Allen County Code Title 10 Department of Health located at

http://www.allencountyhealth.com/wp-content/uploads/2014/10/Septic-Ord-Commiss-Version-FINAL-amended-Comm-8-15-14.pdf

SA3.03 Ownership and Maintenance

City Utilities owns, operates and maintains the public sewer collection system that includes; sanitary and combined sewers, manholes, lift stations, force mains, and various other sanitary sewer facilities.

Property owners own and maintain their entire building sewer from the building to the connection to the public sewer, including infrastructure such as building cleanouts, grease interceptors, sand/oil separators and grinder pump stations and appurtenances.

SA3.04 Septic Tank Elimination

For polices related to septic tank elimination projects refer to **Chapter SA9 – Low Pressure Sewer Systems**.

Book 3

Sanitary (SA)

SA4 Drawings and Submittals

SA4.01 Purpose

The purpose of this Chapter is to outline the minimum drawing and submittal requirements for sanitary sewer improvements. Requirements for sewers, building sewers, and lift stations are included. These requirements are intended to supplement Chapter 51 of the Fort Wayne Code of Ordinances and the Fort Wayne Water Pollution Control Utility Rules and Regulations.

Drawing and submittal requirements shall be discussed with City Utilities during the preliminary planning phase for all projects.

SA4.02 Sewers

This section expands on process and information listed in **Chapter GR5 – Project Coordination** Section GR5.02 and outlines information needed for approval of sanitary sewer projects. If a lift station is proposed, refer to Section SA4.04 for specific lift station submittal requirements.

1. Conceptual Review

   When required, submit the following:

   - Area map showing project location
   - Proposed land usage
   - Estimated wastewater flow
   - Point of connection to existing sewer facilities
   - Project schedule

   A. An example Area Map is included as **Exhibit SA4-1**.

   B. Flow Computations

      To calculate the estimated wastewater flow, a sanitary sewer service map is used. An example Sanitary Sewer Service Area Map is included in **Exhibit SA4-2**. Typical information shown on the map includes, but is not limited to:

      - A general location map showing all areas which could contribute flow to the proposed sanitary system.
      - Major streets shall be referenced.
      - A general layout of the proposed system with the tributary sewershed areas to each major element of the system clearly defined.

- The basis for determining both the number of existing and future users together with the equivalent population for each area. The number of single-family and multi-family residential units or the type and size of all industrial, commercial, and institutional facilities shall be clearly stated. Refer to **Chapter SA5 – Sewer Design** for calculating design flows from various developments.
- A use designation such as residential, commercial, or industrial, for each drainage area.
- A designation for each sewer segment.
- A designation for manholes. This designation shall be carried through to computation sheets.
- All proposed sewer sizes.
- All proposed sewer slopes.
- Adjacent future contributing areas
- The location of estimated or actual flow entering the system for outside areas. These areas shall include the same information required for the proposed project area.
- An adequate number of spot elevations and/or contours in project area to depict the natural drainage of the area.
- The connection point of the proposed sewer system to an existing public system.

Although an Area Map may be acceptable for Conceptual Approval, a more comprehensive Sanitary Sewer Service Area Map may be required for the actual project design.

2. Capacity Availability Notification

   Upon review of the submittal, DVS will issue a statement addressing the existing system's ability to receive the proposed flow. The notification will express City Utilities' acceptance or denial of service to the proposed project and, if relevant, an explanation for the basis of denial.

3. Construction Documents

   Upon granting a Conceptual Approval the design engineer shall complete construction drawings and specifications for the sanitary sewer project in accordance with all guidelines outlined in these Standards. The checklist found in **Exhibit SA4-3** shall serve as the guideline for the submittal of construction drawings. Items called for in the Exhibit shall be submitted in order for DVS to review the plans.

4. Construction Documents Approval

   DVS will review the construction documents and issue written comments on the submittal. All review comments shall be addressed and construction documents updated appropriately. Upon completion of all City Utilities requirements, an approval letter shall be issued.

SA4.03 Building Sewers

1. Residential

   Formal construction documents are not required for typical single family residential building sewers. Requirements for building sewers are listed in **Chapter SA6 – Building Sewer and Appurtenance Design**.

2. Non-Residential

   In general, the requirements for non-residential taps shall be as described in the following sections. Adherence to all Federal, State, and local regulations, codes, and statutes is also required.

   In addition, all requirements of Chapter 51 of the Fort Wayne Code of Ordinances, Sections 51.030 through 51.041, are hereby incorporated herewith for commercial and industrial wastes. All submittals shall be transmitted to DVS.

   A. Conceptual Review

      When required submit the following:

      - Area map showing project location
      - Proposed land usage
      - Estimated wastewater flow
      - Point of connection to existing sewer facilities
      - Project schedule
      - Pollutants
      - Federal Categorical Industrial User Classification, if applicable

   B. Building Sewer Connection Notification

      Upon review of the submittal, DVS will issue a statement addressing the existing system's ability to receive the proposed flow. The notification will express City Utilities'' acceptance or denial of service to the proposed building sewer and, if relevant, an explanation for the basis of denial.

   C. Construction Documents

      Upon notification of approval for building sewer connection, construction drawings and specifications shall be completed for the non-residential building sewer in accordance with all guidelines outlined within these Standards and all relevant plumbing codes. The checklist found in **Exhibit SA4-3** shall serve as the guideline for the submittal of construction drawings. All items called for in the Exhibit as well as the completed checklist shall be submitted in order for City Utilities to review the drawings.

   D. Construction Documents Approval

      DVS will review the construction documents and issue written comments. All review comments shall be addressed and construction documents updated appropriately. Upon completion of all City Utilities requirements, an approval letter shall be issued.

SA4.04 Lift Stations

Lift Stations are intended to serve areas where it is unfeasible or cost prohibitive to install only gravity sanitary sewers. If a lift station is proposed a Conceptual Review must be completed to provide justification for a lift station. After approval of the Conceptual Review, the final design process may begin.

1. Conceptual Review

   The purpose of a Concept Design Plan is to provide City Utilities with preliminary design data for proposed lift stations and related appurtenances such as force mains. The preliminary data will allow City Utilities to determine compatibility with existing systems and will provide the foundation for justification of a lift station alternative.

   A. Concept Design Plan

      When required submit the following:

      - Ultimate tributary area with corresponding land use categories as defined by City Utilities
      - Municipal boundaries
      - Phase boundaries
      - Preliminary lift station location
      - Preliminary force main location
      - Preliminary air release valve locations
      - Pertinent flood elevations

   B. Engineering Report

      When required submit the following:

      1. Data Collection and Review
         - Discuss proposed development phasing (flows, timing, etc.)
         - Obtain and review existing mapping, utility information, and other available data
         - Results of a site visit and tour of the area
         - If needed, results of a preliminary design field survey for verification of critical elevations
      2. Analysis and Solutions - Compute design flow calculations which include:
         - Flow projections
         - A chart or table showing development phase and phase completion dates
         - Projected cumulative average and peak flows for each phase of development

- Estimate total dynamic head (TDH)
- A system head loss versus flow rate chart, typically graphical, with proposed manufacturer's pump curves for the selected pumps superimposed over the chart
- A chart showing the minimum and maximum cycle times for each phase of development with the maximum time between cycles based on average daily flows
- A chart showing the minimum and maximum number of cycles/pump/hour for each phase. The maximum number of starts per hour shall be based on peak flows.
- A chart showing the maximum residence time that sewage will remain in the force main
- The ultimate peak flow's impact on the existing collection system. City Utilities shall be consulted for this information.
- Preliminary development and location of the lift station and force main system. The development shall be broken down by phase and shall be completed for build-out development.

3. Recommendations and Report

   - Briefly describe all alternatives explored. The possibility of gravity service must be addressed.
   - Recommend a specific solution.
   - Complete a life cycle cost effective analysis, refer to **Chapter GR11 – Life Cycle Cost Analysis**.
   - Prepare a brief Engineering Report documenting the analysis and recommendations.
   - Discuss how the lift station could be modified as future phases develop.

Submit the Engineering Report to City Utilities for review and approval.

2. Final Design

Upon granting Conceptual Approval, construction drawings and specifications shall be prepared and submitted. The following paragraphs outline requirements of the Final Design phase:

A. Field Survey and Subsurface Investigations

Complete final design field survey as required to define topography and surface features, tie station to the alignment of the pipe, locate above and below ground utilities, and tie the proposed project alignment into existing monumentation of record.

- Process field survey information and provide existing condition drawings and electronic files, if available.
- Complete subsurface investigation as needed to identify the geotechnical properties and subsurface conditions.

B. Design

Complete the design and submit the following:

- Hydraulic, structural and other computations to define the final lift station improvements
- Wet well calculations
- Force main calculations
- Pump curve/system curve in feet of total dynamic head versus flow in gallons per minute with the following labels: Pump Curve; Single Pump Operation Curve; Two-Pump Operating Curve; Three-Pump Operating Curve (if applicable); Design Point(s); Operation Points; and Operating Envelope
- Total dynamic efficiency at the operating point(s)
- Pump cycle time
- Valve configuration
- Float setting calculations
- Buoyancy calculations
- Force main pressure and, for larger stations, water hammer calculations
- Need for air-release and/or combination air/vacuum release valves
- Odor control calculations or assumptions
- Electrical calculations and/or power requirements
- Materials and product selections in accordance with **Chapter MA6 – Sanitary Sewer Materials and Testing Requirements**
- Location of the proposed improvements and temporary or permanent right-of-way needs.

C. Construction Documents

Submit the following:

- Plan and profile drawings for the project. The drawings should be developed in accordance with all provisions of the Standards
- Project specifications
- A field review of the proposed layout to identify any constraints not readily identified during surveying

SA4.05 Permits, Fees, and Contracts

The following additional information for sewer permits, tap fees and service contracts shall be used in addition to the requirements and information provided in **Chapter GR4 – Contracts, Fees, and Permits**. The **Fort Wayne Code of Ordinances** and the **Fort Wayne Sewer Utility General Rules and Regulations** shall also be referenced for additional information.

1. Local Permits

   The local tap permits shall be obtained from DVS for all connections to the City's sewer system. A drawing or sketch of the tap location shall be included with the Sewer Tap Permit Information Form.

2. State Permits

   A. An IDEM construction permit shall be obtained from IDEM prior to commencement of any sewer main extension construction. The permit is in accordance with 327 IAC 3-2.1. Permit applications may be obtained from the following address:

      Indiana Department of Environmental Management
      Office of Water Quality – Mail Code 65-42
      Facilities Construction Section
      100 North Senate Avenue, room N1255
      Indianapolis, IN 46204-2251
      website: www.in.gov/idem/water/permits

      The IDEM permit may be issued by City Utilities using "Local Permitting Authority" in accordance with 327 IAC 8-2.1. Standard forms utilized by City Utilities for the local review process are found in **Exhibit GR4-3**. City Utilities may be consulted for more information regarding the appropriateness, requirements and procedures of using "Local Permitting Authority" with a particular project.

3. Fees

   A. Local Tap and Permit Fees

      Fees shall be assessed at the time of application for a sewer tap permit. The cost of all permits and tap fees shall be per the most recent City Sewer Use Ordinance.

   B. Permit Application Fees for State Permits

      Permit application fees for state permits shall be determined by the respective state agency at the time of permit application.

   C. Additional Fees

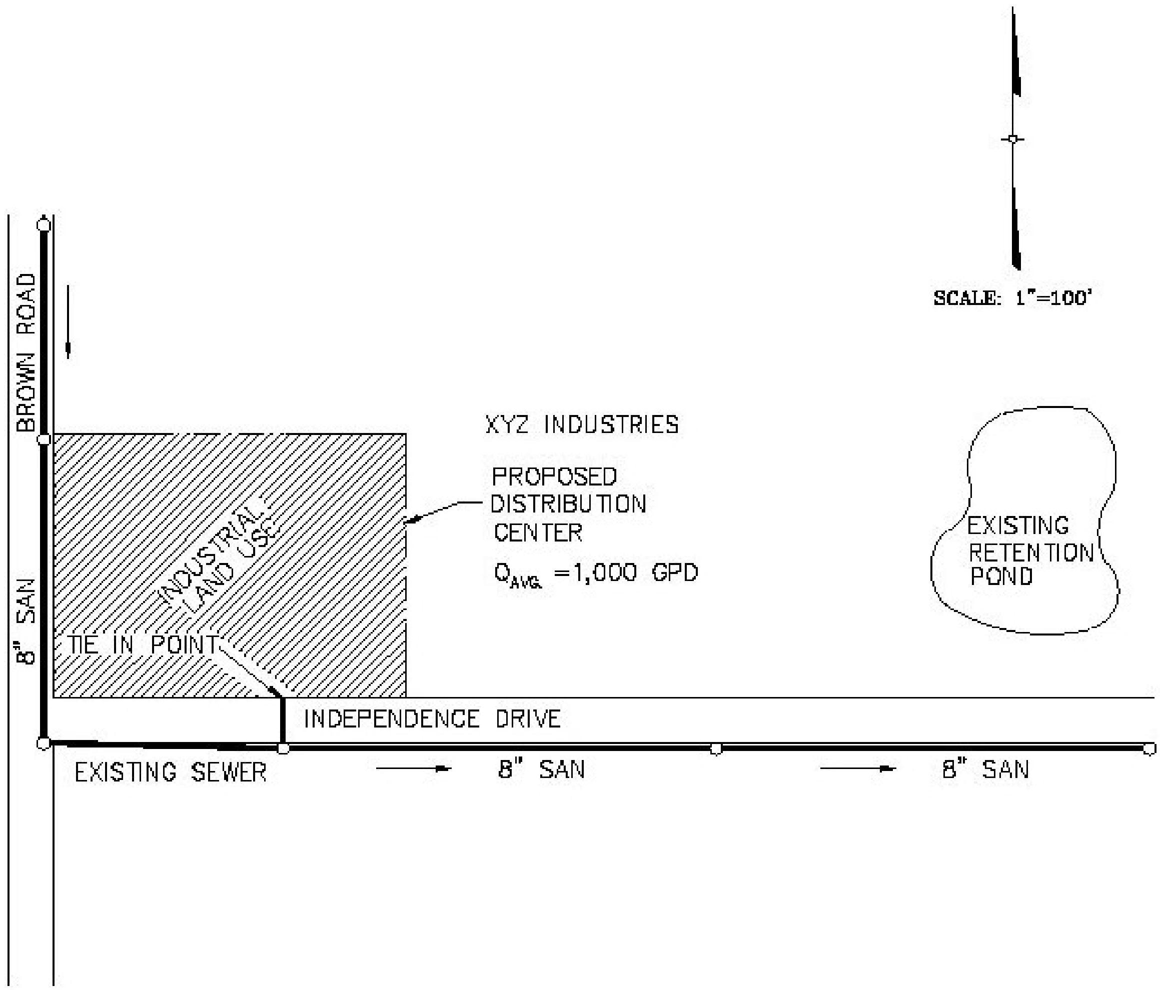
      Area connection fees and inspection fees may be assessed by the Board of Public Works. These fees will be determined per the current Sewer Use Ordinance or as noted in the executed sewer contract for the specific project. Area connection fees will be based on the ERU calculation described in **Section SA5.07 – Design Flow**.

      In addition, local connection reimbursements as detailed in the executed project sewer contract may apply on a case-by-case basis.

4. Contracts

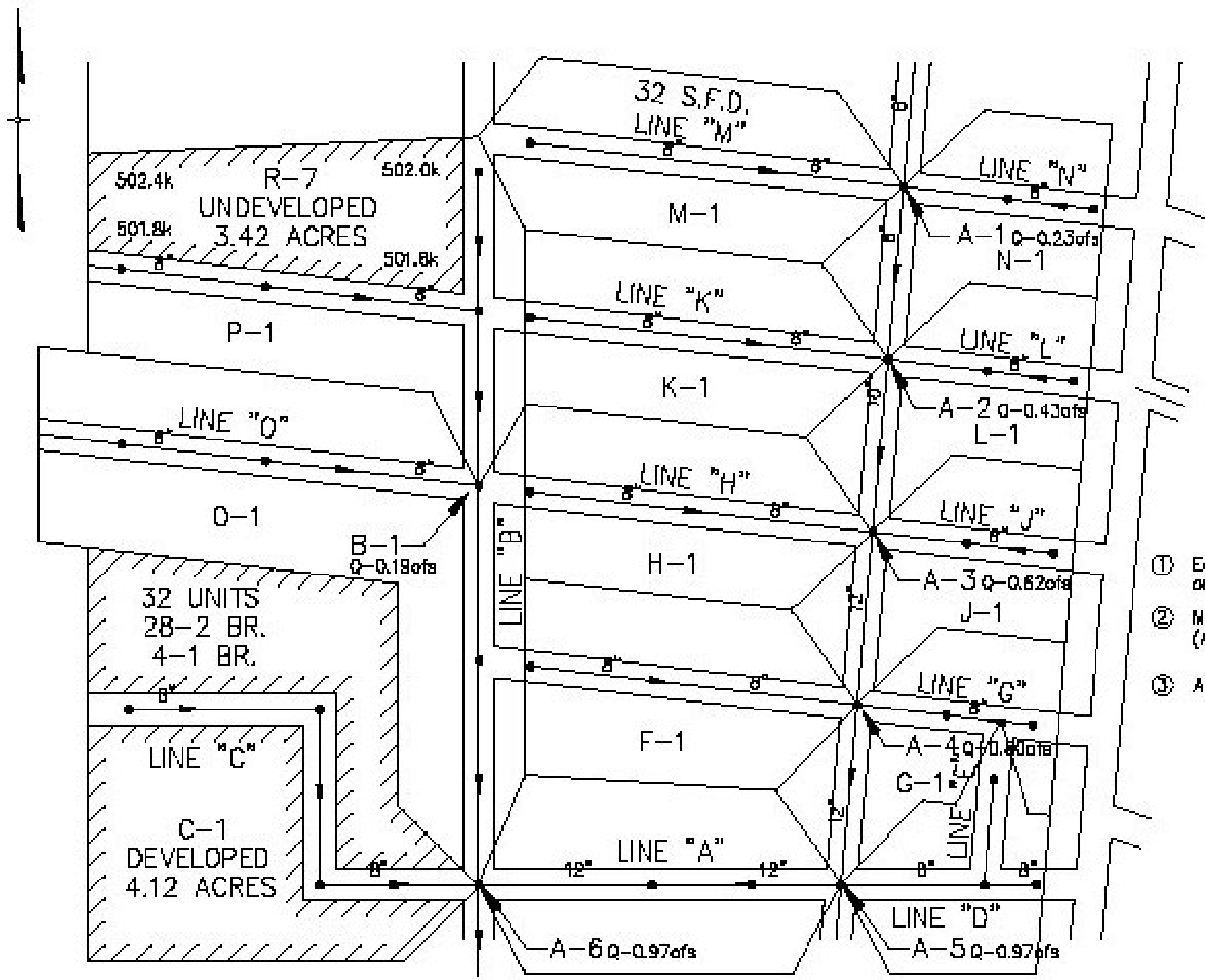
   Whenever a developer extends the City sewer system, the developer shall be required to enter into a sewer contract with City Utilities. A copy of a standard contract is available from DVS upon request.

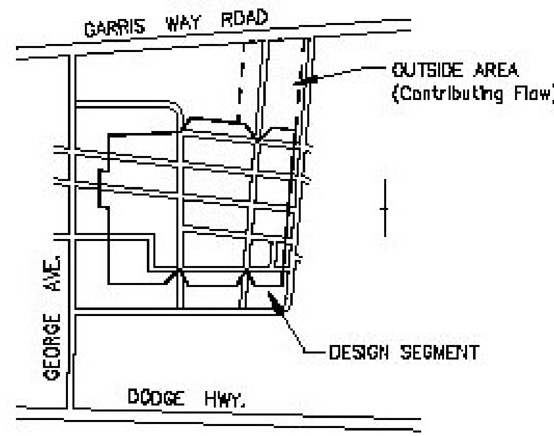
City Utilities — Water That Works	City Utilities Design Standards Manual	Exhibit SA4-1 Area Map
		Version: October 2013



CENTENNIAL INDUSTRIAL PARK SECTION VIII

(NOTE: If road is not nearby, give distance to nearest landmark.)





KEY MAP

1. Each drainage area (M-1, N-1, etc.) must indicate number of single or multiple family dwellings and/or bowls for flow.
2. Manholes must be numbered to correspond with computations. (A-1, A-2, etc.)
3. All lines sizes shall be shown.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SA4-3 Sample Sanitary Sewer Facilities Review Checklist
		Version: October 2013 **Fillable Version**

Project Name: ____ Date: ____________________

Project Number: ________________________ Submitted by: _________________________

The Applicant shall check each item submitted. If any item is not applicable, indicate with a N/A in the space provided.

		Submitted	Date
Permit Information			
1.	Local Unit Construction Permit (see Exhibit GR4-3)		
2.	8 $^{1}/_{2}$" x 11" Site Plan		
3.	Possibly Affected People (Project Dependent)		
IAC Design Summary			
4.	Number of proposed Building Sewers (Residential, Apartment, Industrial, Commercial) (See Exhibit GR4-4)		
5.	Design Peaking Factor		
6.	Peak Daily Flow		
7.	Length, Diameter, Type & Material of Sewer listed/match plans		
8.	Type pipe jointing (ASTM F679)		
9.	Location of Proposed Connection		
10.	Who shall provide Wastewater Treatment		
11.	Who shall provide the inspection during construction		
12.	Who shall be legally responsible for Sewer Maintenance post construction		
13.	Certification by Professional Engineer (See Exhibit R4-5)		
Plan and Profile Sheets			
14.	100 yr Floodplain elevation or Zone X FIRM Map No.		
15.	Plan-profile on sewer (or roadway centerline)		
16.	Conform to 327 IAC: slopes, drop manholes, cover, alignment, distance from water main, etc.		
17.	Easements required		
18.	Request for alternative to technical standards		
19.	Documentation showing that potential conflicts with existing utilities have been addressed to the satisfaction of the utility company.		
20.	Compliance with CU Design Standards Manual		

Book 3

Sanitary (SA)

SA5 Sewer Design

SA5.01 Purpose

This Chapter focuses on the design elements and basic hydraulic criteria necessary for the proper design of sanitary sewers. This Chapter establishes the minimum standards and technical design criteria for all City of Fort Wayne sanitary sewers. All variances from these design standards must be approved prior to commencement of design in compliance with **Chapter GR3 – Variances**.

1. Basic Elements of Design
   - Horizontal alignment to efficiently provide service to existing and potential sanitary sewer users.
   - Vertical alignment with consideration of service depth, minimum cover, depth of additional sewers within the system, underground utility conflicts, constructability and system hydraulics.
   - Total design flow with consideration of existing and future population served by the sanitary sewer.
   - Sewer size, material, bedding, and construction method.
   - Necessary appurtenances and additional structures required for a complete and maintainable system.
2. Covered in this Chapter
   - General Improvement Location Criteria
   - Horizontal Alignment Criteria
   - Vertical Alignment Criteria
   - Pipe Bedding
   - Pipe Materials
   - Design Flow
   - Hydraulic Design Criteria
   - Downstream Capacity Evaluation
   - Sewer Pipe Criteria
   - Inverted Siphons
   - Connections of New Sewers to Existing Sewers
3. Covered in Other Chapters
   - **Chapter SA6 – Building Sewer and Appurtenance Design**
   - **Chapter SA7 – Manhole Design**
   - **Chapter SA8 – Lift Station and Force Main Design**

SA5.02 General Improvement Location Criteria

General location criteria of proposed sewer alignment to be considered should include, but not be limited to the following:

- Use existing rights-of-way and/or City Utility easements whenever possible.
- Thoroughly evaluate service needs of both present service area and future service area.
- Serve entire tributary area in best way possible.
- Elevation requirements to provide service to first floor of buildings, with consideration that service to basements may not be an option due to depth, constructability and cost.
- Existing underground and overhead utilities, roadways and railroads.
- Proposed utilities such as sewer, stormwater and water facilities.
- Environmentally sensitive areas including creeks, rivers, wetlands, trees, protected habitats, etc.
- Easement requirements, property values, and potential damages to all affected properties.
- Potential development and utility or street extensions into adjacent areas.
- 100-year flood elevations and regulatory floodways.
- Continuity with adjacent design segments.
- Maintenance of traffic during construction.
- Availability of materials.
- Subsurface conditions: soils and ground water.
- Access for maintenance.

SA5.03 Horizontal Alignment Criteria

In general, sanitary sewers should be located on the opposite side of the street from the water main. Sanitary sewers are generally located on the south and east sides of the public right-of-way.

Every effort should be made to locate the sewer outside of the pavement, but within existing or proposed right-of-way.

1. Placement in Existing Right-of-Way
    - For sanitary sewers located within existing or proposed street right-of-way, the preferred placement should be as generally defined in Standard Drawing **BS-1**.
    - Allowances for future curb and gutter should be made.

- The existence of curbs or proposed curbs and gutter should be taken into account when evaluating the benefit of reducing the number of manhole in curve streets.
- In areas with concrete pavement, consider placing the sewer such that one edge of the pavement to be removed coincides with existing construction joints.
- Manhole structures shall be either completely outside the pavement or completely within the pavement.

2. Placement Outside of Existing Right-of-Way

   Where sewers cannot be placed within right-of-way, easements shall be procured. Easement widths shall be required per **Section GR7.04 – Easement Widths** and Figure GR7.1.

3. Minimum Horizontal Separation from Water Mains

   - Refer to Standard Drawing **BS-7** Sewer and Water Main Separation
   - A 10- foot horizontal distance edge to edge shall be maintained between sanitary sewer and existing or proposed water main per Title 327 IAC 8-3.2-9.
   - The crossing must maintain a minimum angle of 45 degrees measured from the centerlines of the sanitary sewer and water main.
   - If it is not possible to maintain the 10-foot separation, the following design criteria shall apply:

     A. Installation of the sanitary sewer closer to the water main may be approved, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation such that the bottom of the water main is at least 18 inches above the top of the sanitary sewer.

     B. The sewer shall be constructed of water main grade pipe material from manhole to manhole, with pressure rated joints complying with Title 327 IAC 8-3.2-8. All water main grade pipe material requirements are defined in **Chapter MA7 – Water Materials and Testing Requirements**.

     C. Either the sewer or water main shall be encased in a watertight casing pipe which extends for a minimum distance of 10 feet from either side of the water main or sewer as measured from the outside edge of the water main to the outside edge of the sewer.

     D. If the deviation described above is not possible, both the water main and sanitary sewer must be constructed of pipe material and joints complying with Title 327 IAC 8-3.2-8 Water Main Material per Title 327 IAC 3-6-9 Separation of Collection Systems from Water Mains and Drinking Water Wells.

4. Rear Lot Alignment
   - In certain limited situations, rear lot sanitary sewer alignment may be considered and approved by variance.
   - Where rear lot alignment is used, a utility or sanitary easement shall be required and the sewer shall not be located within drainage swales.
5. Minimum Distance from Utilities Other than Water Mains
   - All drawings shall show the location of both underground and overhead utilities.
   - Utility locations shall be derived from the most reliable and up-to-date information.
   - Each utility shall receive a set of drawings prior to final submittal. On these drawings, they may note changes or addition to utility information.
   - Separation distance of sanitary sewer from other utilities shall be determined by the representative of other utilities and the applicant.
   - Any necessary relocation shall be closely coordinated with the respective utility representative.
6. Minimum Distance from Structures
   - Where sewer depth is 10-feet or less, sewer mains and manholes shall be located a minimum of 10-feet horizontally from any part of a building structure or its foundation. For sewer depths greater than 10- feet, this minimum distance shall be 15-feet.
7. Location in Relation to Streams and Waterways
   - Sanitary sewers shall be separated from existing or proposed water bodies by 10- feet horizontally measured from the outside edge of the sanitary sewer to the edge of the water line at normal pool elevation per Title 327 IAC 3-6-10 Collection Systems near Surface Water Bodies.

SA5.04 Vertical Alignment Criteria

1. Sewer Depths
   - Except as specified herein, sanitary sewers shall have a minimum cover of 4- feet as measured from the top of pipe.
   - Basement elevations shall be considered. In instances where a limited number of houses on the sanitary sewer have existing basement facilities, the overall impact on the entire system shall be considered prior to proposing gravity basement service.
   - Where the building level to be served by gravity sanitary sewer is less than one 1- foot above the top of the manhole casting elevation of the first upstream manhole on the public sewer to which the connection is made, backflow prevention on the building sewer shall be included in the design to prevent sanitary sewer backups.

- The sanitary sewer elevation necessary to serve the entire tributary area shall be considered when designing a sanitary sewer. This design shall include areas beyond the boundary of a design section.
- In areas where excessive depths are encountered in the sanitary interceptor sewer, a separate parallel sanitary sewer collector line constructed at a higher elevation shall be considered. The parallel line would end in a drop manhole structure as opposed to individual property service connection to the interceptor. A parallel collector sewer will be addressed and approved on a case-by-case basis by variance.

2. Minimum Vertical Separation from Water Mains

- Refer to Standard Drawing **BS-7** Sewer and Water Main Separation
- A minimum vertical separation of 18-inches measured vertically from the outside edge of the sanitary sewer to the outside edge of the water shall be maintained per Title 327 IAC 3-6-9 Separation of Collection Systems form Water Mains and Drinking Water Wells.
- The crossing point shall be aligned such that the sewer joint is as far as possible from the water main joint.
- If it is not possible to maintain an 18-inch vertical separation, The following design criteria shall apply:

  A. Installation of the sanitary sewer closer to the water main may be approved, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation such that the bottom of the water main is at least 18-inches above the top of the sanitary sewer.

  B. The sewer shall be constructed of water main grade pipe material from manhole to manhole, with pressure rated joints complying with Title 327 IAC 8-3.2-8. All water main grade pipe material requirements are defined in **Chapter MA7 – Water Materials and Testing Requirements**.

  C. Either the sewer or water main shall be encased in a watertight casing pipe which extends for a minimum distance of 10-feet from either side of the water main or sewer as measured from the outside edge of the water main to the outside edge of the sewer.

  D. If it is not possible to maintain proper vertical separation as described above, both the water main and sanitary sewer must be constructed of pipe material and joints complying with Title 327 IAC 8-3.2-8 Water Main Material per Title 327 IAC 3-6-9 Separation of Collection Systems from Water Mains and Drinking Water Wells.

  E. Every effort shall be made to construct the sanitary sewer below the water main.

  F. If a water main must cross beneath a sanitary sewer, this requires an alternative technical standard per IDEM on a case-by-case basis. Structural support, exfiltration testing of the water main to ensure its integrity, and/or relocation of the water main to maintain a vertical separation distance of 36-inches may be required.

3. Stream and Waterway Crossings

   Sanitary sewers located under surface water bodies shall meet the following and comply with Title 327 IAC 3-6-10 Collection Systems near Surface Water Bodies:

   - Sanitary sewers located under surface water bodies shall be constructed of ductile iron pipe or PVC having a DR of 21 and in conformance with ASTM D2241-96b, with mechanical joints rated to two hundred (200) psi and backfilled with crushed limestone or coarse aggregate.
   - A minimum of 3-feet of cover shall be provided.
   - In paved stream channels, the top of the sewer shall be placed below the bottom of the channel pavement.
   - Cross perpendicular to the stream flow.
   - Have no change in grade.

SA5.05 Pipe Bedding and Backfill

See Standard Drawing BS-4 General Rigid Pipe Bedding Detail.

See Standard Drawing BS-5 General Flexible Pipe Bedding Detail.

See Standard Drawing BS-6 Ductile Iron Pipe Trench Section.

Refer to Chapter MA4 – Common Materials and Testing Requirements for typical materials used in sanitary sewer projects.

SA5.06 Pipe Materials

Refer to Chapter MA6 – Sanitary Sewer Materials and Testing Requirements for typical materials used in sanitary sewer projects.

SA5.07 Design Flow

In general, sanitary sewers shall be designed to accommodate the peak hourly flow within the sewer system.

1. Average Daily Flow (ADF)

   - The minimum unit of design for average daily flow shall be 1 ERU (310 gallons per day).
   - The design of all sanitary sewer facilities shall take into account flow from both existing and projected future developments.
   - Development Flows: Average Daily flows shall be calculated based on the design flow rate requirements shown in Figure SA5.1. These requirements are the minimum that can be utilized for the design of all collection system infrastructure and water pollution treatment/control facilities. If the appropriate design unit for a development is not listed in Figure SA5.1, please contact Development Services for review and determination.

Figure SA5.1 Wastewater Design Flows

DEVELOPMENT	AVERAGE GALLONS PER DAY PER UNIT
Airport	3 per passenger plus 20 per employee
Apartment or Condominium, multi-family dwelling: one bedroom	200 per unit
Apartment or Condominium, multi-family dwelling: two bedrooms	300 per unit
Apartment or Condominium, multi-family dwelling: three bedrooms	350 per unit
Apartment or Condominium, one and two family dwelling	150 per bedroom
Apartment or Condominium Clubhouse	10 per person
Assembly hall	3 per seat
Athletic field (baseball, soccer, football, etc.)	1 per participant and spectator with additions for concessions
Auction and flea market: with full kitchen	5 per customer
Auction and flea market: with warming kitchen	4 per customer
Auction and flea market: without kitchen	3 per customer
Automatic self-cleaning bathroom	20 per cycle (3 per day)
Banquet caterer	10 per person
Bar / Tavern (without food)	10 per seat
Bar / Tavern (with food)	35 per seat
Beauty salon (cut without wash)	5 per person
Beauty salon (cut with wash)	10 per person
Beauty salon (perm or color changes)	35 per customer
Bed and breakfast	150 per bedroom
Bowling alley (with bar and/or food)	125 per lane
Bowling alley (without food)	75 per lane
Bus station	3 per passenger
Campground (organizational) with flush toilets, showers, central kitchen	40 per camper
Campground (organizational) without flush toilets, privy use, central dining hall, no showers, handwashing	20 per camper
Campground (recreational) with individual sewer connection	100 per campsite
Campground (recreational) without individual sewer connection	50 per campsite
Church with full kitchen	5 per sanctuary seat
Church with warming kitchen	4 per sanctuary seat
Church without kitchen	3 per sanctuary seat
Conference center	10 per attendee
Correctional facilities	120 per inmate
Day care center	20 per person
Dentist	200 per chair plus 75 per employee
Doctor's office	75 per doctor, plus 75 per nurse, plus 20 per support staff

DEVELOPMENT	AVERAGE GALLONS PER DAY PER UNIT
Factory/Industrial/Manufacturing with showers	35 per employee with additions for process flows*
Factory/Industrial/Manufacturing without showers	20 per employee with additions for process flows*
Fire station: staff live on-site	75 per firefighter
Fire station: staff live off-site	35 per firefighter
Food service operations: cocktail lounge or tavern	35 per seat
Food service operations: restaurant (not open 24 hours)	35 per seat
Food service operations: restaurant (open 24 hours)	50 per seat
Food service operations: restaurant (not open 24 hours but located along interstate)	50 per seat
Food service operations: restaurant (open 24 hours and located along interstate)	70 per seat
Food service operations: curb service (drive-in)	50 per car space
Funeral Home	20 per employee + .1 per sq ft
Golf comfort station	3 per 50% of maximum number of golfers
Golf main clubhouse	5 per golfer with additions for food service and showers
Hospital, medical facility	200 per bed
Hotel / Motel	100 per room
Kennels and vet clinics (sum of all of the following at facility)	
a. cages;	5 per cage
b. inside runs;	10 per run
c. outside runs;	20 per run
d. grooming;	10 per animal
e. surgery; plus	50 per surgery room
f. staff	75 per veterinary doctor, plus 75 per veterinary assistant, plus 20 per support staff
Mental health facility	100 per patient
Mobile home park	200 per lot
Nail salon	5 per station
Nursing home	100 per bed
Office building without showers	20 per employee
Office building with showers	35 per employee
Outpatient surgical center	50 per patient
Picnic area	5 per visitor
Race tracks	5 per attendee, 20 per staff
School: elementary	15 per pupil
School: secondary	25 per pupil
School with dormitory	100 per bed

DEVELOPMENT	AVERAGE GALLONS PER DAY PER UNIT
Service station: convenience store/service center	1,000 with additions for food preparation and seating
Service station with only two (2) restrooms	400 per restroom
Service station with only unisex restroom	600 per restroom
Service station with automatic self-cleaning restroom	60 per day
Shopping center	0.1 per square foot of floor space, plus 20 per employee
Swimming pool bathhouse	10 per swimmer
Theater: drive-in	5 per car space
Theater: inside building	5 per seat
YMCA	10 per max # swimmers + 20 per avg # patrons
<u>Future Land Use - development areas not specific at time of design</u>	
Residential	900 per acre
Commercial / Industrial / Factory / Manufacturing	850 per acre with addition of estimated process flow*

* Process Flows = sewer flows from mechanical systems, processes or the production of goods by the development that are above the standard flows generated by employee related activities and will be discharging to sewer system to be provided by the Development Engineer and approved by Development Services on case-by-case basis

2. Peak Design Flow – by calculation using multiplier
   - The minimum peaking factor used to multiply by the total calculated design average daily flow shall be 4.
3. Peak Design Flow – using Sewer or Water Meter Flow Metering data
   - When actual sewage flow metering data is available that includes daily flow values in 15 minute increments or less, the monitored peak flows may be considered in the peak flow design on a case by case basis as determined by Development Services.
   - When actual metered peak water consumption data is available that includes daily flow values in 15 minute increments or less, the monitored peak flows may be considered in peak flow design on a case by case basis as determined by Development Services.

Calculation of ERU for basis of use in Area Connection Fee (ACF) development

- The ERU total utilized in developing the ACF amount shall include any approved special discharge stormwater flow rates plus the highest resulting ERU calculated by the following method or combination of methods:
  - The Average Day flow divided by 310 gallons per day
  - The Peak Design Flow – division of peak hour design flow rate by 1,240 gallons per day

- The Max Day Design Flow – division of max day process design flow rate by 310 gallons per day.
  - This flow rate applies to nonresidential or non-domestic portions of sewer discharge flow.
  - The minimum conversion factor for Average Day to Max Day utilized shall be 2.5
- Conversion of Equivalent Capacity of the peak flow rate capacity of the water meter or flow meter being utilized. Sewer capacity for water meter equivalency shall be per Figure SA5.2.

Figure SA5.2 Sewer Capacity Equivalency Factor

Water Meter Size	Sewer Capacity Equivalency Factor
5/8” – ¾”	1.0
¾”	1.5
1”	2.1
1 ½”	4.4
2”	7.4
3”	16.6
4”	28.6
6”	64.8
8”	115.2
10”	179.7
12”	258.6

- The ERU calculation performed at the design and new construction stage of a project is based upon the best available information provided to City Utilities. If the development increases its water use, sewer discharge or its capacity in any way in the future, and those capacities exceed the initial ERU calculation, then the customer will be required to pay the difference for the capacity at the current ACF rates.

SA5.08 Hydraulic Design Criteria

Manning’s Equation shall be used to determine the required pipe size and slope. Manning’s equation is as follows:

$$Q = (1.49/n) * A * R_h^{2/3} * S^{1/2}$$

Where

Q = Flow Rate, (cfs)

A = Cross-sectional Area of Pipe, (ft^2)

n = Manning’s Roughness Coefficient, (no units)

R_h = Hydraulic Radius, (ft)

= A/P

A = cross-sectional area of flow (ft^2)

P = wetted perimeter (ft)

S = Slope (ft/ft)

Design shall be for full flow with the following characteristics:

- Roughness coefficient, n = 0.013
- Minimum pipe diameter of 8- inches
- Minimum allowable slopes per pipe diameter

Exhibit SA5-1 presents a chart showing relative velocity and flow in circular pipe based on Manning's equation. The chart can be utilized to determine full flow capacity of sewer pipes.

1. Velocity
   - The minimum velocity allowed in sanitary sewer pipes under design flow conditions shall be 2.0 ft/sec for sewers between 8-inches and 42-inches diameter and 3.0 ft/sec for sewers 48-inches in diameter and larger. The maximum allowable velocity shall be 15 ft/sec per Ten States Standards.
   - Design flow will be considered as pipe at full flow which is defined as 80% depth of flow in the pipe.
2. Slopes
   - Figure SA5.3 defines the minimum allowable slopes for various pipe sizes. These minimum slopes shall be required for design. Existing sewers with slopes less than allowable per design which result in flow velocity less than 2.0 ft/sec for pipe sizes under 48-inch diameter and flow velocity less than 3.0 ft/sec for pipe sizes 48-inch diameter and larger may not be accepted by City Utilities Engineering.
   - Maximum pipe slope shall be 3%.
   - Sewers shall have uniform slope between manholes or other junction structures.

Figure SA5.3 Minimum Allowable Slopes

Manning's "n" = 0.013			
Pipe Diameter (inches)	**Slope***		**Velocity Full (ft/sec)**
	(ft/ft)	**Percent**	
8	0.004	0.4	2.2
10	0.0028	0.28	2.1
12	0.0022	0.22	2.1
15	0.0015	0.15	2
18	0.0012	0.12	2
21	0.001	0.1	2.1
24*	0.0008	0.08	2
27*	0.00067	0.067	2
30*	0.00058	0.058	2
33*	0.00052	0.052	2
36*	0.00046	0.046	2
42*	0.00037	0.037	2
48*	0.00069	0.069	3
54*	0.00059	0.059	3
60*	0.00051	0.051	3
66*	0.00045	0.045	3
72*	0.0004	0.04	3
78*	0.00036	0.036	3
84*	0.00033	0.033	3
96*	0.00026	0.026	3
108*	0.00026	0.026	3.2
120*	0.00026	0.026	3.4
132*	0.00026	0.026	3.6
144*	0.00026	0.026	3.8

Note -*To ensure contractibility, a pipe slope of .001 ft/ft (.1%) must be evaluated and utilized unless specifically approved by CUE.

3. Changes in Sewer Size

- Sewer size changes are only allowed at manholes and junction chamber structures. The energy gradient must be maintained at these changes. An approximate method to achieve this is to match the pipe crown elevations.
- Pipes less than or equal to 24-inch diameter:
  - When increasing pipe diameter by 6-inches or less, crown elevations at the centerline of the manhole shall match.
  - When increasing pipe diameter by more than 6- inches, the springlines of the pipes at the centerline of the manhole shall match.
- Pipes 27-inches in diameter and greater:
  - The junction shall first be designed by matching crowns at the centerline of the manhole or junction chamber.

- The energy grade line shall then be evaluated in both the upstream and downstream segments.
- The grade line shall not increase in the downstream segment.
- If the energy grade line of the downstream segment lies below the energy grade line of the upstream segment, the downstream sewer may be raised by two-thirds of the difference between the upstream and downstream grade lines.

4. Minimization of Solids Deposition

   The pipe diameter and slope shall be selected to obtain the greatest practical flow velocities to minimize solids deposition. Sewer shall not be oversized to allow for construction on a flatter slope. If the proposed slope is less than the minimum slope of the smallest pipe which could properly accommodate the peak hourly design flow, a variance shall be obtained prior to approval.

SA5.09 Downstream Capacity Evaluation

To evaluate the downstream capacity of a receiving sanitary sewer, City Utilities Engineering will rely on the following:

1. Available Data/Information
   - Existing number of customers connected to existing sewer
   - Existing flow monitoring data
   - Sanitary sewer studies
   - Maintenance records
   - Complaint records
   - Past and/or proposed Capital Improvement Projects
   - Any other information deemed relevant by City Utilities Engineering
2. Additional Data/Information

   If adequate data/information is not available, the applicant may be required to conduct, at no cost to the City, all the necessary tasks to allow City Utilities Engineering to make an informed decision on the adequacy of the downstream sanitary sewer facilities. Tasks may include:

   A. Temporary Flow Monitoring

   - Number of Monitors – The complexity of the downstream system will determine the number of temporary monitors required. Maximum number shall be five (5).
   - Monitoring Duration – The monitoring duration shall be a minimum of sixty (60) days or until one and 1 ½-inches of rainfall in a 24-hour period is recorded, whichever is the greater period of time.
   - Monitoring Period – If possible, part of the monitoring period shall be done during the months of March, April, May, and June. An alternate time period may be considered. Monitoring shall not be done during January.

- Temporary Rain Gages – Temporary rain gages shall be installed at or near the temporary flow monitoring site(s) during the flow monitoring period, unless monitors are located within one-half mile of an existing operating City Utilities Engineering rain gage.
- Flow Monitoring Data and Format
- Depth/Velocity Hydrographs
- Flow Hydrographs
- Scatterplots/Scattergraphs
- Any other data deemed necessary by City Utilities Engineering

B. Hydraulic Modeling

Extension of existing sanitary sewer collection system model to the point of connection of the proposed development may be required. If a model extension is necessary, the SWMM Model shall be used. To assure consistency, the Model shall be coordinated with City Utilities Engineering.

C. Lift Station System Modeling

An evaluation of one or more lift station systems may be required. The evaluation may include the following systems:

- Hydraulic
- Electrical
- Mechanical
- Instrumentation & Control
- Any other systems deemed necessary by City Utilities Engineering

3. Inadequate Downstream Capacity

If downstream capacity is not available for the proposed flow from the sewered area, the following options may be considered:

Make additional capacity available in the downstream system by:

- Increasing capacity in the system
- Removing sufficient volume of inflow/infiltration
- Connecting to an alternate point within the sanitary or combined sewer system. A downstream analysis at the alternate point of the system may be required.

SA5.10 Sewer Pipe Criteria

1. Sewer Pipe Design

- The minimum allowable inside diameter for sewer pipe shall be 8-inches.
- All building sewer connections shall have a minimum inside diameter of 6- inches. Commercial and industrial connections shall be reviewed on a case-by-case basis.

- All sanitary sewers shall be constructed with a straight alignment between manholes.
- Pipe materials shall be in accordance with **Chapter MA6 – Sanitary Sewer Materials and Testing Requirements**.
- Pipe testing and bedding requirements shall be in accordance with **Chapter MA4 – Common Materials and Testing Requirements**.
- All sanitary sewers shall be designed to prevent damage from applied loads both during and after construction. Load allowance shall be based upon trench width and depth. In instances in which standard strength pipe is not sufficient, extra strength pipe or special construction methods shall be specified. In these special circumstances, calculations addressing both live and dead loads shall be submitted to City Utilities Engineering for review. All loading requirements must be taken into account when considering material selection and installation methods.
- Concrete sewers 60- inches in diameter and larger shall be designed using the "D" method as specified in the latest edition of the "Concrete Design Manual" published by the American Concrete Pipe Association. The "D" load design shall be limited to increments of 200 feet or more and shall not vary between manholes unless approved by City Utilities Engineering. The "D" load design shall be based on a trench width approved by City Utilities Engineering prior to design.

2. Flotation

- All sewers and sewer structures to be constructed shall be protected against flotation and excessive pipe deformation in areas where high groundwater conditions exist or flooding of the trench is anticipated.

3. Anchors

- Sewers constructed on ground slopes of 20% or greater shall be anchored securely with concrete or other acceptable material.
- All design methods for anchors shall be approved by City Utilities Engineering prior to construction.

4. Concrete Encasement

Concrete encasements may be utilized in the following instances:

- When it is necessary to prevent flotation.
- When crossing streams, ditches, existing storm drains, or in railroad or highway rights-of-way.
- Where soil conditions indicate the possibility of heavy erosion.
- In areas where less than the desired cover is provided.

The concrete encasement shall extend a minimum length of 2-feet beyond the point where a 4-foot depth of cover is reached or to a point 5-feet beyond the tops of banks when crossing a ditch or stream.

The encasement of flexible pipes shall not be allowed except when the encasement is completed from structure to structure, unless otherwise recommended by the pipe manufacturer.

5. Railroad Crossings

   When any railroad is crossed, the specifications and precautionary measures required by the respective railroad officials shall be followed. A copy of the railroad crossing application and proof of approval from the respective railroad entity shall be submitted to City Utilities. In the absence of specific railroad requirements, the following general criteria shall apply:

   - Criteria

     The following criteria shall apply to instances in which sanitary sewer construction affects railroad rights-of-way and facilities. In certain instances, the requirements of the specific railroad company may be more stringent than these standards. In those instances, the more stringent standard shall apply.

     - Sanitary sewers shall cross tracks at an angle as close as possible to 90 degrees (90°). The crossing angle shall never be less than 45 degrees (45°).
     - Sanitary sewer mains crossing beneath railroad tracks shall be constructed in bored and jacked casings.
     - Casing pipe under railroad tracks and across railroad rights-of-way shall extend to a point a minimum distance of 25-feet from the centerline of the outside track or the right-of-way line, whichever occurs first and a minimum of 5-feet beyond the top of ditch bank within the railroad right-of-way.
     - Sanitary sewer mains laid longitudinally along railroad rights-of-way shall be located as far as practical from the tracks. If the sewer is located within 25-feet of the centerline of any track, the sewer shall be encased or shall be of a special design as approved by City Utilities Engineering.
     - Casings under tracks and across railroad rights-of-way shall be a minimum of four 4-feet deep as measured from the bottom of the track rail to the top of the casing pipe.

   - Railroad Crossing Drawings

     A railroad crossing drawing shall be prepared and address the following:

     - Both a plan and profile view shall be provided. **Exhibit SA5-2** and **Exhibit SA5-3** show examples of plan and profile views, respectively.
     - The following items shall be included on the drawing: relationship between the proposed sewer and the railroad, angle of crossing, location of utilities, original survey station of the railroad (when available), right-of-way lines, limits of boring or casing liner, topography, and general layout. The profile shall clearly show the sewer in relation to both the tracks and existing ground elevations.

Boring limits by station, sewer line soundings and borings, and other pertinent information shall be included on the drawings.

- The crossing drawing and project drawings shall be submitted to both City Utilities Engineering and the appropriate railroad company for review and approval.

6. Highway Crossings

   When any highway is crossed, the specifications and precautionary measures required by the respective highway officials shall be followed. A copy of the highway crossing application and proof of approval from the respective highway entity shall be submitted. In the absence of specific highway requirements, the following general criteria shall apply:

   - Criteria

     The following criteria shall apply to instances in which sanitary sewer construction affects highway rights-of-way and facilities. In certain instances, the requirements of the highway department may be more stringent than these standards. In those instances, the more stringent standard shall apply.

     - Sanitary sewers shall cross the roadway at an angle as close as possible to 90 degrees (90°). The crossing angle shall never be less than 45 degrees (45°).
     - Sanitary sewer mains crossing beneath the highway shall be constructed in bored and jacked casings.
     - Sewers shall not be placed under roadway bridges where the possibility of restricting the required waterway area or where a possibility of compromising the structural integrity of bridge foundations exists.
     - Pipes crossing beneath highways shall be installed by jack and bore method with a casing pipe, tunneling method or micro-tunneling method.
     - Borings under highways shall have a minimum depth of cover of 3-feet as measured from the surface elevation to the top of the casing. The top of the casing shall not be above the invert of existing or proposed ditches.
     - Borings under highways shall extend a minimum of 10-feet (measured perpendicularly) outside the outer edge of existing pavement or to the toe of slope when the roadway is on fill and the toe of slope exceeds the outside of pavement requirement of 10-feet.
     - Sanitary sewer mains laid longitudinally along highway rights-of-way shall be located a sufficient distance outside of the existing edge of pavement to ensure worker and motorist safety during construction.
     - Sanitary sewer mains laid outside of pavement but inside of roadway right-of-way shall have a minimum depth of cover of 4-feet.

7. Jacking and Boring

- Casing Pipe

  Casing pipe shall be bare wall steel pipe with a minimum yield strength of 35,000 psi. The inside diameter of the casing pipe shall be a minimum of 4-inches greater than the outside diameter of the carrier pipe joints or couplings for carrier pipe less than 6-inches in diameter and at least 6-inches greater than the outside diameter of the carrier pipe joints or couplings for carrier pipe 6-inches in diameter and greater. The casing pipe shall have a minimum wall thickness as required by Figure SA5.4 below:

Figure SA5.4 Casing Pipe Minimum Wall Thickness

Casing Outside Diameter (inches)	Casing Wall Thickness Highway Crossings (inches)	Casing Wall Thickness Railroad Crossings (inches)
8.625	0.250	0.250
10.750	0.250	0.250
12.750	0.250	0.250
14	0.250	0.281
16	0.250	0.281
18	0.250	0.312
20	0.250	0.344
24	0.250	0.406
30	0.375	0.469
36	0.375	0.532
42	0.375	0.563
48	0.500	0.625
54	0.625	0.688
60	0.625	0.750
66	0.625	0.813
72	0.750	0.875

Minimum depth of the casing pipe shall be 54-inches or as required by the affected highway, railroad, etc.

- City Utilities Engineering reserves the right to require larger diameter carrier pipes to accommodate additional proposed or future utility lines.

- Casing pipe shall have end seals to prevent the entrance of foreign material.

- The casing pipe and carrier pipe shall be separated by insulators/spacers. The insulator spacing shall be installed to support the weight of the pipe and its contents. At a minimum, spacers shall be placed a maximum of 10-feet from each side of a joint and at maximum 10-foot intervals.

SA5.11 Inverted Siphons

Design and construction of inverted siphon structures requires written approval from City Utilities Engineering prior to commencement of the design process.

Inverted siphon structures shall have a minimum of two barrels. Minimum allowable barrel diameter shall be 8-inches. Design of the structure shall provide sufficient head and appropriate pipe sizes to secure a minimum velocity of 3.0 ft/sec for average design flows. The structure inlet and outlet shall be designed such that the average design flow is diverted to one siphon barrel, therefore allowing for either barrel to be taken out of service for cleaning and/or repair.

Permanent access provisions must be designed and constructed with all siphons to allow for efficient maintenance activities. Items shall include the following at each end of the siphon:

- Access hatches on the structure
- Permanent easement to the nearest public right-of-way
- Stone maintenance road

SA5.12 Connection of New Sewers to Existing Sewers

Sanitary sewers and force mains shall only be connected to the existing sewer system at manholes.

Existing systems may require rehabilitation before being extended or connected to. The decision to rehabilitate existing sewer systems will be at the discretion of City Utilities Engineering. Rehabilitation methods will be determined on a case-by-case basis.

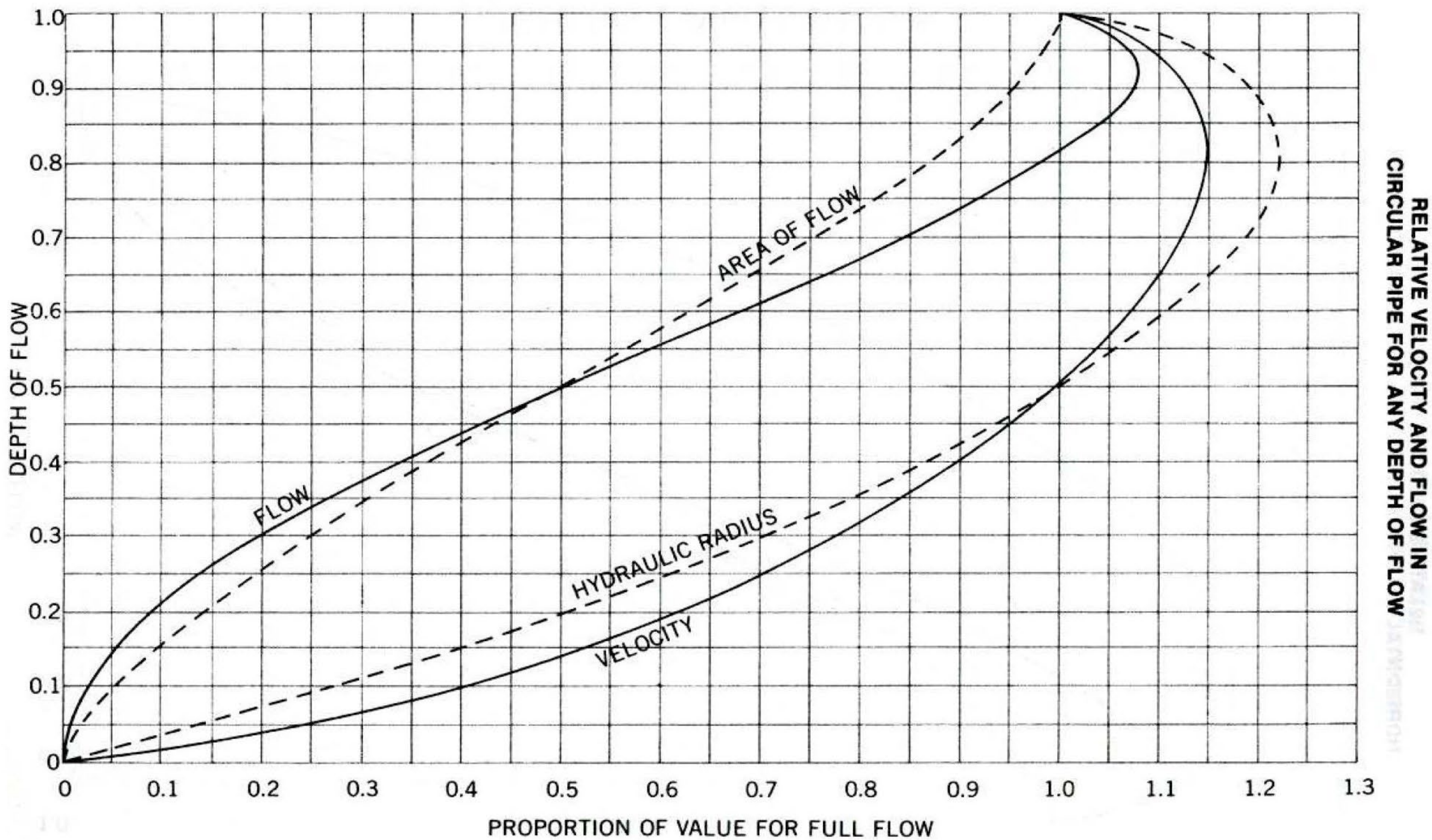
Blind tee connections to existing sewers are prohibited.

If an existing manhole is not available as determined by City Utilities Engineering, a new manhole shall be installed.

The construction of new combined sewers or extensions to existing combined sewers is prohibited.

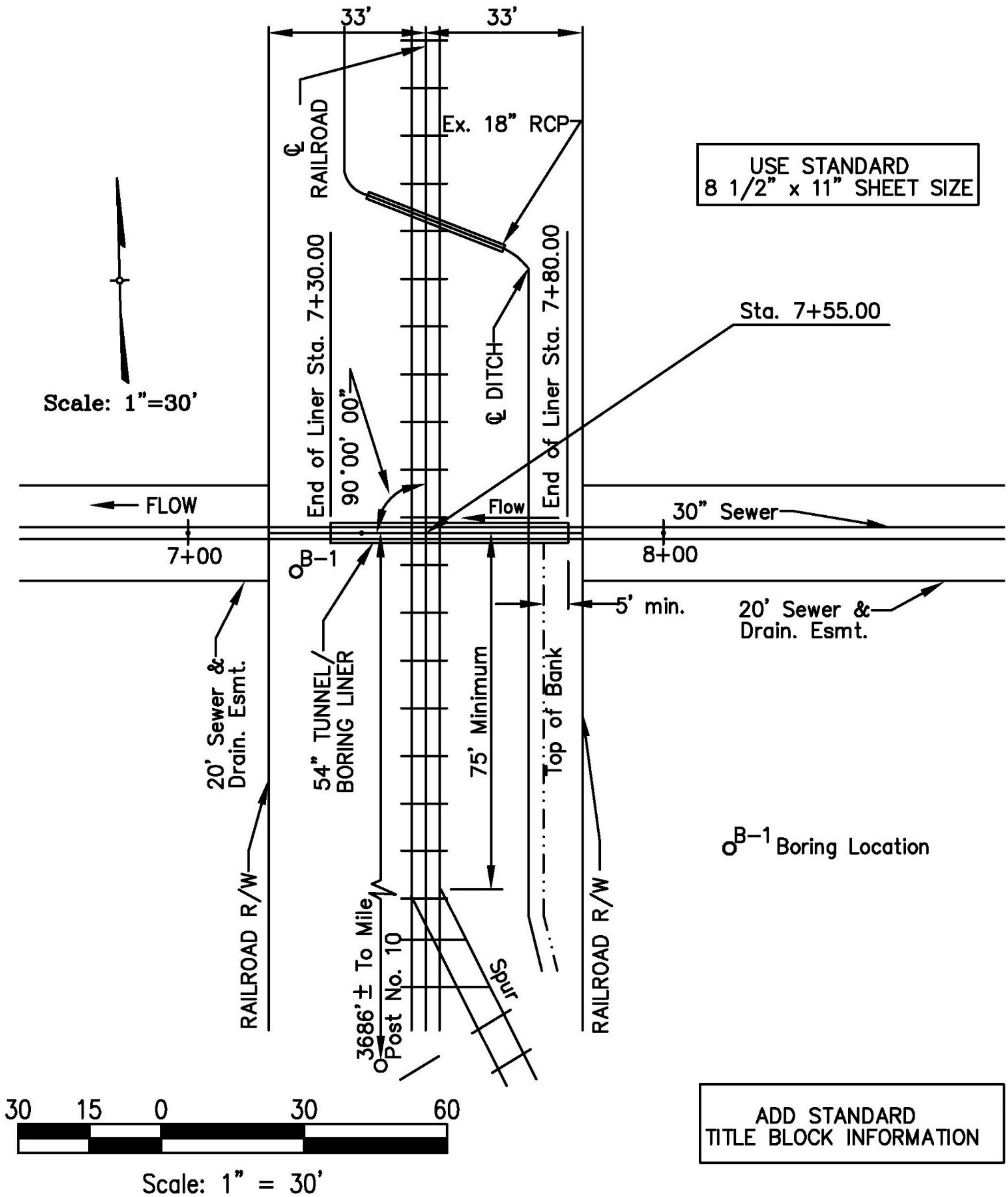
For new construction within the combined sewer system, all new or proposed sanitary and storm sewers shall be separated prior to connecting to the combined sewer system. Each system shall be connected individually to the combined sewer if a separate storm sewer, structure, ditch or swale is not available.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SA5-1 Hydraulic Elements of Circular Sewers*
		Version: January 2002

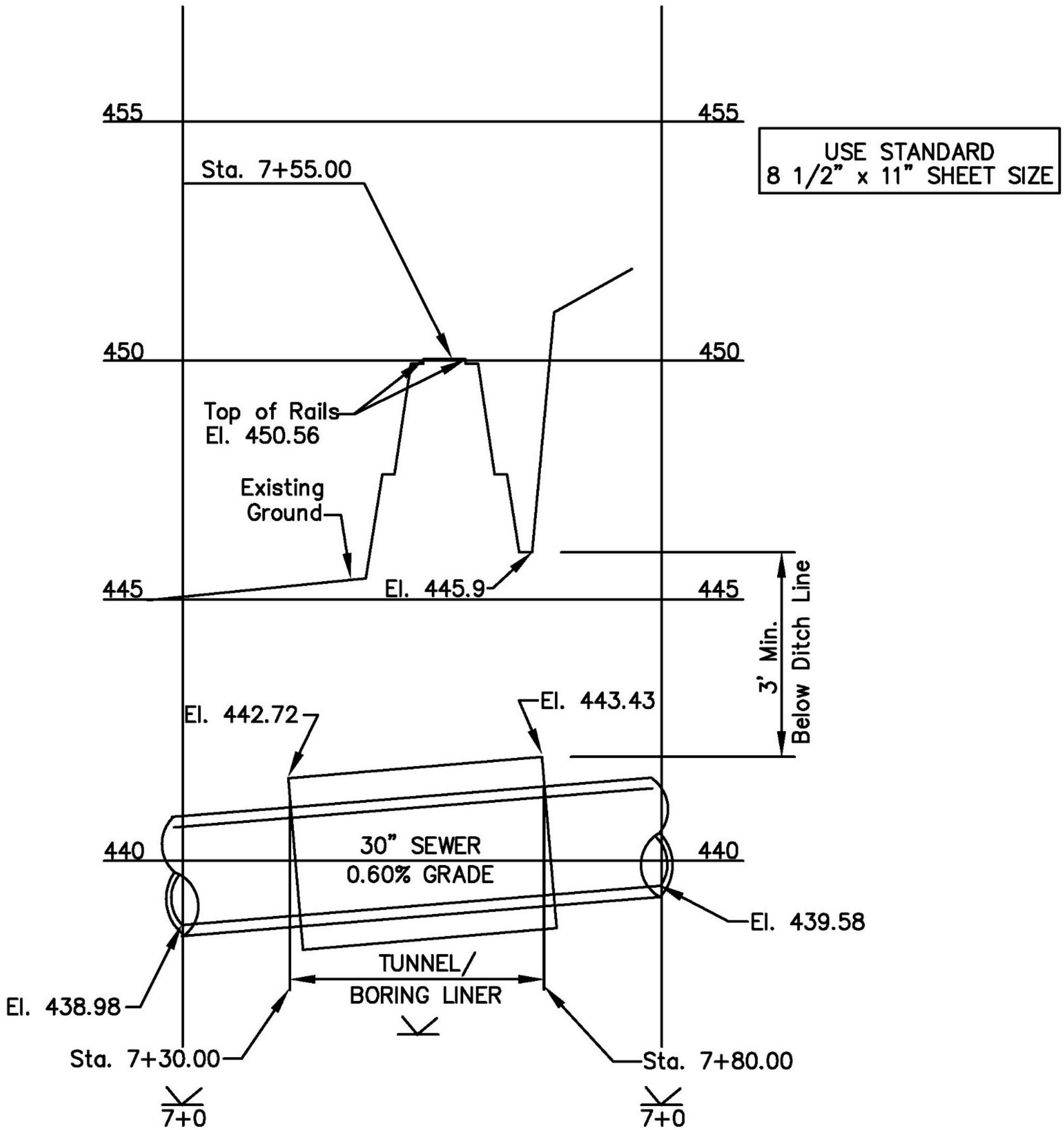


*Excerpted from the Concrete Pipe Design Manual

City Utilities Design Standards Manual	Exhibit SA5-2 Sample Railroad Crossing Drawing, Plan View
	Version: January 2002



CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SA5-3 Sample Railroad Crossing Drawing, Profile View
		Version: January 1, 2002



ADD STANDARD
TITLE BLOCK INFORMATION

Book 3

Sanitary (SA)

SA6 Building Sewer and Appurtenance Design

SA6.01 Purpose

This Chapter establishes the technical design and construction criteria for gravity building sewers connected to City Utilities sewers. Any variances from these design standards must be approved through City Utilities Development Services (DVS).

1. Plumbing Codes

   Building sewers shall conform to the latest adopted version of the **Indiana Plumbing Code (IPC) 675 IAC 16** and to these standards, whichever is more restrictive.

2. Covered in this Chapter

   - Buildings Serviced
   - Building Sewer Location, Length and Spacing
   - Building Sewers Crossing Drainage Ways
   - Hydraulic Design
   - Building Sewer Pipe
   - Building Sewer Appurtenances
   - Building Sewer Connections to Main Line Sewers
   - Connections Using an Existing Building Sewer
   - Future Connections

3. Covered in Other Chapters

   - Materials of Construction (**Chapter MA4 – Common Materials and Testing Requirements** and **Chapter MA6 – Sanitary Sewer Materials and Testing Requirements**)
   - Gravity Sanitary Sewers (**Chapter SA5 – Sewer Design**)
   - Manholes (**Chapter SA7 – Manhole Design**)
   - Lift Stations (**Chapter SA8 – Lift Station and Force Main Design**)
   - Private Pressure Sewer Connections (**Chapter SA9 – Low Pressure Sewer Systems**)

4. Prohibited Connections

   No building sewer with any of the following sources of clear water shall be connected to the City's sanitary sewer system:

   - Foundation or footing drains, by gravity or sump pump
   - Yard drains

- Storm drain connections
- Roof drains/downspouts
- Any other sources of surface runoff or groundwater

5. Allowed Connections if Capacity Available and Flow/Capacity Paid for by Customer

   The following connections may be approved for connection if City Utilities has available capacity. Connection(s) must be approved in advance by City Utilities Engineering, have the flow metered or equivalent capacity determined and the rates outlined the City of Fort Wayne Sewer Ordinance 51.074 will apply.

   - Sump pump discharges
   - Heat pump discharges
   - Cooling water discharges

SA6.02 Buildings Serviced

1. Separate Building Sewer

   A separate and independent building sewer shall be provided for every building, except where one building stands at the rear of another. The building sewer from the front building may be extended to the rear building and the whole considered as one building sewer. Calculations supporting sizing must be provided. Prior approval for such configuration and sizing must be obtained from DVS.

   Shared building sewers (laterals) by different property owners are not allowed to be constructed. If existing shared laterals are discovered, the City may issue notice to the property owners that they must separate or sign an agreement with City to continue having sewer service.

2. Gravity Sewer Service

   Gravity building sewer connections shall be constructed for homes or buildings where the lowest elevation to have sanitary services is one (1) foot or more above the top of the manhole casting elevation of the first upstream manhole on the public sewer to which the connection is proposed to be made. Exhibit SA6-1 illustrates acceptable and unacceptable connection situations.

   In instances where this one foot distance is not achievable and in areas susceptible to back-ups, proper backflow prevention shall be required. If the first upstream manhole is at a higher elevation due to the natural topography of the area, an alternate method may be selected by City Utilities for the purpose of determining the feasibility of gravity connection.

3. Non-Gravity Sewer Service

   For instances in which gravity flow is not feasible, wastewater carried by building sewers shall be pumped by an approved means and subsequently discharged to the building sewer or mainline sewer.

SA6.03 Building Sewer Location, Length and Spacing

The location, maximum length, and spacing of laterals shall be as follows:

1. Location

   The location of the building sewer shall be as follows:

   - All properties shall be served from the street, alley or easement side of the property.
   - A building sewer shall not cross the property of another private owner unless such private owner has granted a permanent easement for such building sewer which is duly recorded in the Office of the Allen County Recorder.
   - Building sewers shall not be located within ten (10) feet of any existing or proposed water well.
   - Where a building sewer location unavoidably lies within fifty (50) feet of a drinking water well, pressure grade pipe material shall be used and comply with 327 IAC 8-3.2-8 Water Main Material per 327 IAC 3-6-9 Separation of collection systems from water mains and drinking water wells.

2. Distance of Building Sewer from Property Line

   - The minimum horizontal distances between the building sewer and the property line is eight (8) feet.
   - Refer to Standard Drawing **SAN 1-1** Building Sewer Standard for Crossing Street.

3. Spacing Between Adjacent Building Sewers

   - The minimum horizontal distance between adjacent building sewers and their connections is sixteen (16) feet.
   - Refer to Standard Drawing **SAN 1-1** Building Sewer Standard for Crossing Street.

SA6.04 Building Sewers Crossing Drainage Ways

Building sewers shall be separated from existing or proposed water bodies by a minimum twenty (20) feet, horizontally as measured from the outside edge of the building sewer to the top of the bank.

Building sewers crossing proposed or existing lakes, ponds, and/or retention or detention areas (either wet or dry) are prohibited.

SA6.05 Hydraulic Design Criteria

1. Minimum Slopes

   Building sewers shall be laid on a minimum slope of 2.08% (1/4” per foot).

   For building sewers eight (8) inches and larger, follow Figure SA5.03 Minimum Allowable Slopes located in **Chapter SA5 – Sewer Design**.

SA6.06 Building Sewer Pipe

1. Size

   - The minimum allowable diameter for gravity building sewers shall be six (6) inches.
   - Larger pipe sizes for commercial and industrial connections shall be approved on a case-by-case basis.

2. Depth

   The minimum pipe depth from the finished grade to the crown of a building sewer shall be three (3) feet.

3. Material

   Pipe materials shall be in accordance with **Chapter MA6 – Sanitary Sewer Materials and Testing Requirements**.

4. Bedding

   Pipe bedding requirements shall be in accordance with **Chapter MA4 – Common Materials and Testing Requirements**.

5. Backfill

   Backfill classifications, materials, and methods of compaction shall be in accordance with **Chapter MA4 – Common Materials and Testing Requirements**.

6. Applied Loads

   All sewers shall be designed to prevent damage from applied loads both during and after construction. Load allowance shall be based upon trench width and depth. In instances in which standard strength pipe is not sufficient, extra strength pipe or special construction methods shall be specified. All loading requirements must be taken into account when considering material selection and installation methods.

SA6.07 Building Sewer Appurtenances

1. Cleanouts

   A cleanout shall be provided adjacent to all building structures. The cleanout shall be located between five (5) and ten (10) feet of the exterior building wall. The adapter shall be located at least five (5) feet from the exterior building wall.

Cleanout shall be extended to match grade in paved areas. Cleanouts shall be extended to above grade in non-paved areas.

Cleanouts shall be spaced a maximum of every one hundred (100) feet.

Cleanouts shall match the size of the building sewer pipe up to a maximum of eight (8) inches.

The cleanout cover shall be threaded-type, water tight, and capped at all times. Covers within paved areas shall be metallic and able to withstand traffic loads.

Cleanouts installed under concrete or asphalt pavement shall be extended flush with the pavement and have a concrete collar.

Refer to the following hotlinks for cleanout details:

- Standard Drawing **SAN-1** Building Sewer Connection Layout
- Standard Drawing **SAN-2** Standard Sanitary Cleanout
- Standard Drawing **SAN-3** Standard Sanitary Cleanout in Pavement

2. Grease Interceptors and Sand/Oil Separators

Any building sewer which will have or has the potential of discharging waste containing grease, oil, sand, or similar substances, having quantity and characteristics above that of a normal single family residence waste, shall have a grease interceptor and/or a sand/oil separator installed. The structure shall provide, at all times, the effective removal of grease, oil, sand, and/or similar substances before discharge to the main line sewer.

Installation of a grease interceptor and/or sand/oil separator will be required when any of the following conditions exist:

- Abnormal maintenance of the sewer has been required to prevent the occurrence of blockages, back-ups, etc., and evidence indicates that the cause of this abnormal maintenance is the result of the discharge of prohibited wastes and/or wastes in excess of limitations set out in **utilities.cityoffortwayne.org/about/utility-rules-regulations**.
- There exists a concentration of persons discharging prohibited wastes into a public sewer without the benefit of any grease interceptor and/or sand/oil separator.
- The results of laboratory analysis have demonstrated that the strength of wastes being discharged into the public sewer is in excess of the limitations set out by the **Fort Wayne Code of Ordinances Chapter 51 - Sewers**.

For grease interceptors and sand/oil separators, refer to the following standards for more detailed information:

- International Plumbing Code Section 1003 Interceptors and Separators, latest edition
- Uniform Plumbing Code Chapter 10, latest edition

- IAPMO/ANSI American National Standard for Prefabricated Gravity Grease Interceptors

Requirements for grease interceptors:

- Must be located outside the building
- If facility has one of the following, a grease interceptor is required:
    - 3- or 4-basin sink
    - Pre-rinse sink
    - Pots & pans sink
    - Wok station
    - Soup kettle
    - Dipper well
    - Warewasher sink
- If facility has one of the following, a grease interceptor is *recommended*:
    - Floor drains in food prep area
    - Trench drain
    - Mop sink
- The following CANNOT go through a grease interceptor unless a permanent solids separator is installed per current Uniform Plumbing Code:
    - Garbage disposal
    - Dishwasher
    - Domestic waste
- The minimum capacity of a grease interceptor is 1,000 gallons.
- Grease Interceptors must be accessible for periodic maintenance and cleaning and shall have the following features at minimum:
    - Two lids, one over the influent pipe and one over the effluent tee
    - Baffel wall
    - Effluent tee and down-leg
- Refer to Standard Drawing **STR-24** and Standard Drawing **STR-24-1** for a detail of a 1,000 gallon precast grease interceptor structure and a 1,500 gallon precast grease interceptor structure, respectively.

Requirements for sand/oil separators:

- If facility has one of the following, then a sand/oil separator is required:
    - Repair garage with trench or floor drain
    - Car washing facility
    - Trench drains
    - Factories where oily & flammable liquid wastes are produced

    - Hydraulic elevator pits
  - Refer to Standard Drawing **STR-24-2** for a detail of a 1,000 gallon sand/oil separator.

3. Control Manholes

   When required by City Utilities, a control manhole shall be included in the building sewer design.

   If a grease interceptor or sand/oil separator exists or is required, then a control manhole is required.

   If flow from the building sewer is expected to be 50,000 gpd or greater, then a metered control manhole may be required by DVS. This requirement will be determined on a case by case basis.

   All speculative (spec) buildings are required to install a control manhole.

   Control manholes require the approval of the Industrial Pretreatment Coordinator.

   For control manholes greater than four (4) feet in depth, manhole steps may be required.

   Refer to Standard Drawing **STR-11-2** for the Non-Metered Control Manhole detail.

   Refer to Standard Drawing **STR-11-1** for the Metered Control Manhole detail.

SA6.08 Building Sewer Gravity Connection to Main Line Sewer

A gravity building sewer shall connect to the main line sewer using a manufactured mainline fitting. The preferred method of connection to RCP is a Kor-N-Tee connection.

Saddle connections are allowed only if a manufactured fitting does not exist and the mainline pipe is 15-inch diameter or larger.

Saddle connections to vitrified clay pipe (VCP) are not permitted.

The building sewer shall not protrude into the mainline.

Refer to the following Standard Drawings for service connection details:

- Standard Drawing **SAN-4** Shallow Building Sewer Connection
- Standard Drawing **SAN-5** Deep Building Sewer Connection
- Standard Drawing **SAN-6** Cut-In Wye Method
- Standard Drawing **SAN-7** Saddle Connection

When tapping a cured-in-place (CIP) sewer pipe, the following method applies:

- The host pipe (original pipe) regardless of material must be removed where the tap is to go. Once the CIP liner is exposed, the liner must be core drilled.

The host pipe should be removed to an extent beyond the new tap to allow the Kor-N-Tee to be placed directly in the CIP liner.

Where connections to manhole structures are necessary, rubber water stop joints or rubber gaskets (boots) shall be specified for water tightness between the pipe and the manhole. When new holes into manholes are required, core drilling of the new hole shall be specified.

Direct connection of a building sewer to a sewer larger than 18-inches in diameter is prohibited.

SA6.09 Building Sewer Low Pressure Sewer Connection to Main Line Sewer

Low pressure building sewers may be discharged into main line gravity sewers or low pressure force mains.

Low pressure building sewer shall connect to a main line gravity sewer by using a mainline fitting.

Low pressure building sewer shall connect to force mains shall be by using a prefabricated HDPE fitting, mechanical saddle, or fused saddles as per the following.

- Connections to PVC force mains shall use a mechanical tapping saddles applicable for pressurized pipe application.
- Connections to existing HDPE force mains shall use an electrofusion HDPE tapping saddle for pressurized pipe application.
- Connections to new HDPE force mains may be done using prefabricated HDPE tees that match or exceed the HDPE pipe pressure rating, or an electrofusion HDPE tapping saddle for pressurized pipe application.

Refer to the following Standard Drawings for Low Pressure Sewer service connection details:.

- Standard Drawing **SAN-4-1** Low Pressure Building Sewer Service Connection Detail
- Standard Drawing **SAN-4-2** Low Pressure Building Sewer Tracing Wire Detail
- Standard Drawing **SAN-6** Cut-In Wye Method
- Standard Drawing **SAN-9-3** Grinder Pump Station and Low Pressure Building Sewer Layout Detail

SA6.10 Connections Using an Existing Building Sewer

Existing building sewers may be used in connection with new buildings only when they are found, upon examination and testing, to meet the current code requirements for building sewers.

SA6.11 Future Connections

Building sewer installed for future connections shall be terminated at the street right-of-way or easement and shall be properly plugged with a manufactured plug to ensure a watertight seal.

A tracer wire shall be installed terminating at a metal locator rod at the end of the plugged line to within one 1-foot of the finished grade. The tracer wire is to be attached to the locator rod with a brass or stainless steel clamp. Tracer wire shall be installed above and along the non-metallic building sewer to the building and grounded.

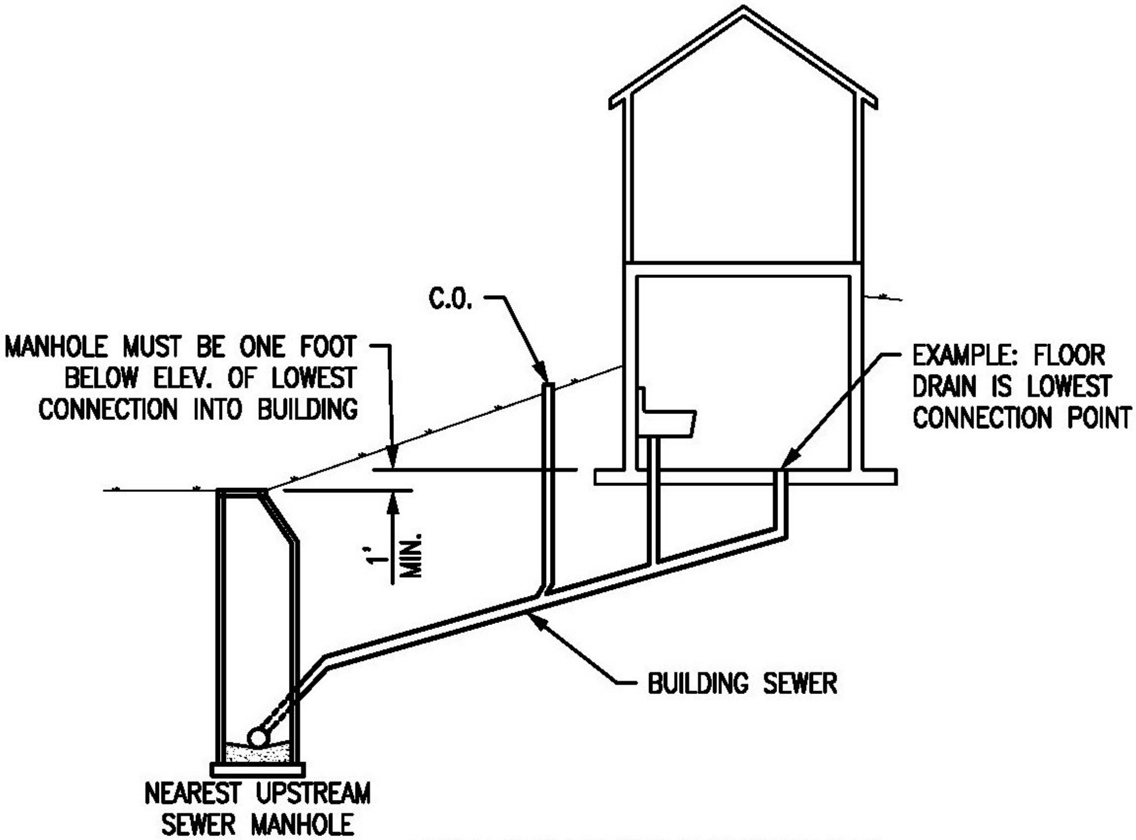
SA6.12 Proper Abandonment of Building Sewer

Every abandoned building sewer, or part thereof, shall be plugged or capped in an approved manner within 10 to 15 feet of the building foundation.

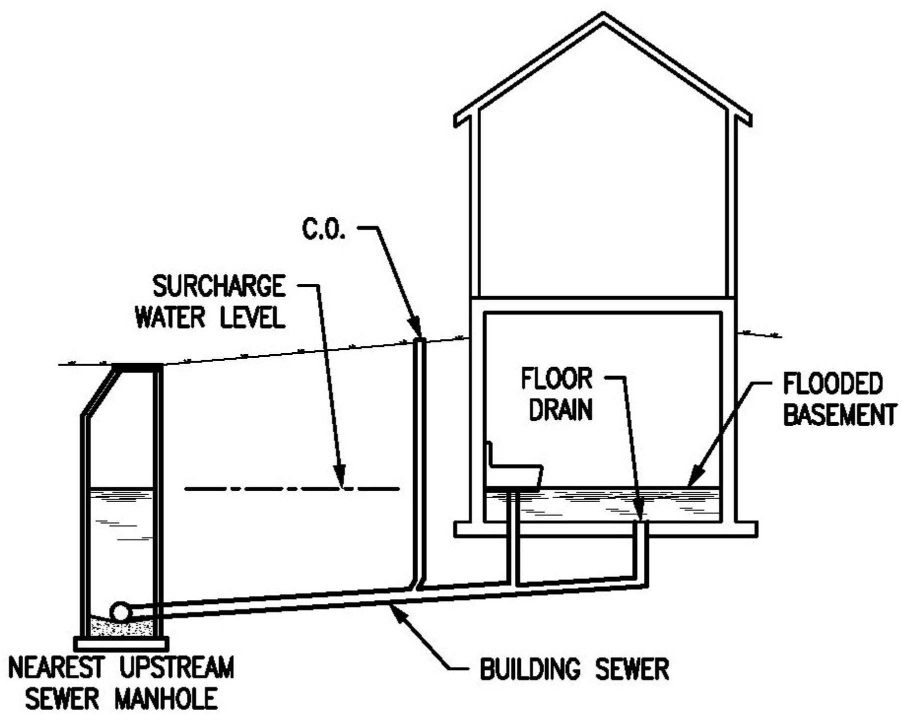
SA6.13 Correcting Inflow and Infiltration

If private building sewers or associated private infrastructure are found to allow inflow or infiltration into the sanitary sewer system, the owner of the private building sewer system shall be responsible for correcting and eliminating all inflow or infiltration.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit SA6-1 Acceptable and Unacceptable Gravity Building Sewer Connections
		Version: August 2013 Scale: N.T.S.



ACCEPTABLE GRAVITY CONNECTION



UNACCEPTABLE GRAVITY CONNECTION

Book 3

Sanitary (SA)

SA7 Manhole Design

SA7.01 Purpose

This Chapter establishes the minimum standards and technical design criteria for City of Fort Wayne sanitary sewer system manholes. Variances from these design standards must be approved in compliance with **Chapter GR3-Variances**.

1. This Chapter covers the following topics:
   - Location of Manholes and Manhole Spacing
   - Manhole Dimensions
   - Manhole and Cleanout Castings
   - Standard Manholes
   - Flow Channel and U-Shaped Bench
   - Protection Against Ponding and Potential I/I
   - Watertight Bolt Down Construction
   - Buoyancy
   - Connections
   - Casting Adjustments
2. The following topics are covered in other Chapters:
   - Gravity Sanitary Sewers (**Chapter SA5 – Sewer Design**)
   - Metering Structures and Separators (**Chapter SA6 – Building Sewer and Appurtenance Design**)
   - Wet Wells and Valve Vaults (**Chapter SA8 – Lift Station and Force Main Design**)

SA7.02 Manholes

1. General
   - Building sewers shall not be connected at manholes if avoidable. See **Chapter SA6 – Building Sewer and Appurtenance Design** for further information.
   - Cleanouts shall not be used in lieu of manholes on publicly owned, operated and maintained systems, and
   - Manholes shall be cast-in-place or pre-cast concrete.
2. Location

   Manholes shall be placed at the following locations:
   - End of each sewer segment

- Changes in sewer slopes, size, alignments or pipe material
- Sewer junctions
- Where spacing requirements justify placement

3. Manhole Spacing

Figure SA7.1 provides requirements for maximum spacing between manhole structures.

Figure SA7.1 Manhole Spacing

Pipe Diameter	Maximum Distance Between Manholes
8” to 15”	400’
18” to 30”	500’
33” and greater	600’

4. Manhole Dimensions

Change in flow direction (internal angles between pipes) at manhole junctions of less than 90 degrees (90°) are not allowed due to hydraulic losses.

A minimum access diameter of 24-inches shall be provided. All manholes must have sufficient wall space between pipe openings to meet the following criteria:

For circular structures, the minimum distance allowed between pre-cast holes shall be six-inches.

The following Figures present general criteria for the maximum pipe size that can connect to a specific diameter manhole structure. These Figures are for guidance as existing conditions may dictate variance.

Figure SA7.2 Manhole Angles

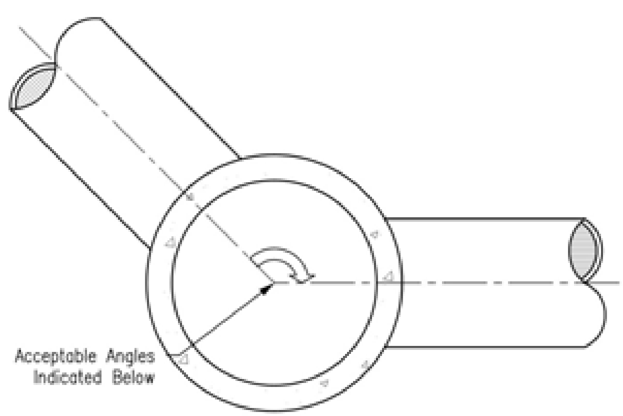


Figure SA7.3 Pipe Connections Less Than 30-Inch Diameter

Applicable Pipe Materials and Sizes				Opening Required (in)	Acceptable Angles (deg) for the Following Manhole sizes:		
RCP	HDPE	DI	PVC				
ASTM C 76	ASTM F714	AWWA C151	ASTM F679		48 in	60 in	72 in
12" Wall B	16"	14"	15" ASTM	18	180-90		
12" Wall C	18"	16"		20	180-90		
15" Wall B	20"	18"	18"	22	180-90		
15" Wall C	22"	20"	21"	24	180-90		
18" Wall B&C	24"			26	180-90		
21" Wall B		24"	24"	28	180-100	99-90	
21" Wall C			27"	30		180-90	
24" Wall B				32		180-90	
24" Wall C				34		180-90	
27" Wall B				36			180-90
27" Wall C				38			180-90

NOTES: 1. Pipe angles less than 90° not allowed.
2. This table is a guide. Existing conditions may dictate variance.
3. Square or rectangular structures should be considered in place of 96" and 108" diameter manhole structures.
4. Contact manhole supplier for size verification for diameters smaller than indicated in table.
5. Wall B and Wall C are ASTM designations for pipe wall thickness where Wall C is thicker by approximately ¾ of an inch.

Figure SA7.4 Pipe Connections 30-Inch Diameter and Greater

Applicable Pipe Materials and Sizes		Opening Required (in)	Acceptable Angles (deg) for the following Manhole sizes:				
RCP ASTM C 76	PVC ASTM F679		72 in	84 in	96 in	108 in	Larger
	30"	38	180-90				
	36"	44	180-90				
30" Wall B		45	180-90				
30" Wall C		46.5	180-100	99-90			
33" Wall B		48.5	180-104	103-90			
33" Wall C		50	180-107	106-90			
36" Wall B		52	180-112	111-90			
36" Wall C		53.5	180-115	114-96	95-90		
42" Wall B		59	180-130	129-106	105-90		
42" Wall C		60.5	180-134	133-109	108-90		
48" Wall B		66	180-152	151-120	119-100	99-90	
48" Wall C		67.5	180-158	157-124	123-104	103-90	
54" Wall B		73		180-137	136-114	113-98	CONTACT MFR
54" Wall C		74.5		180-142	141-116	115-100	
60" Wall B		80		180-161	160-129	127-108	
60" Wall C		81.5		180-169	168-130	129-110	
66" Wall B		87			180-145	144-120	
66" Wall C		88.5			180-140	139-123	

NOTES: 1. Pipe angles less than 90° not allowed.
2. This table is a guide. Existing conditions may dictate variance.
3. Square or rectangular structures should be considered in place of 96" and 108" diameter manhole structures.
4. Contact manhole supplier for size verification for diameters smaller than indicated in table.
5. Wall B and Wall C are ASTM designations for pipe wall thickness where Wall C is thicker by approximately ¾ of an inch.

5. Manhole Castings

   Refer to Standard Drawing C-1-1 for 24-inch sanitary manhole casting details.

   Refer Standard Drawings C-2-1 and C-2-2 for watertight sanitary manhole casting details.

6. Cleanout Castings

   Refer to Standard Drawings C-3-1 and C-3-2 for standard cleanout casting details.

7. Standard Manholes

   Refer to the following Standard Drawings:

   - STR-20-1 Standard 48-inch Manhole
   - STR-20-2 Standard 60-inch Manhole
   - STR-20-3 Standard 72-inch Manhole
   - STR-20-4 Standard 84-inch to 96-inch Manhole
   - STR-12-1 Cast in Place Base 48-inch and Less
   - STR-12-2 Cast in Place Base 54-inch to 96-inch

   A doghouse manhole may be used when placing a new manhole over an existing sewer main line.

8. Flow Channel

   For all manholes with equal diameter influent and effluent pipes, a minimum 0.10 foot drop between the inverts of the influent and effluent pipes shall be maintained to offset losses experienced at manhole structures. For change in direction 45 degrees to 90 degrees, a minimum 0.20 foot drop shall be maintained.

   The flow channel through a manhole shall be made to conform in shape, and slope to that of connecting sewers. The channel walls shall be shaped or formed to the full height of the crown of the outlet sewer so that maintenance, inspection, and flow in the manhole are not obstructed.

   Refer to Standard Drawings STR-13-1 and STR-13-2 for details of manhole flow channel shapes.

9. U-Shaped Bench

   A bench shall be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter. The bench shall be sloped no less than ½ -inch per foot (4.17 percent slope).

10. Protection Against Ponding and Inflow/Infiltration

    To provide protection against ponding, manholes shall be designed and constructed to provide positive drainage away from the top of casting as follows:

    - Paved or stone areas – Top of casting shall be flush with finished grade.

- Unpaved areas – Top of casting shall be a minimum of 3-inches above finished grade.

To minimize the potential for extraneous clear water known as inflow/infiltration (I/I) entering the sewer system, manholes shall not be designed or installed in any drainage path such as, but not limited to, the following locations:

- Swales or ditches
- Roadside gutters
- Inverted crowns of streets
- Low points of paved or unpaved areas
- Adjacent to stormwater inlets

11. Watertight Bolt-Down Construction

    Watertight manholes and covers shall be used in all areas where flooding by street runoff or anticipated high water levels are expected, in a floodway or floodplain. (Title 327 IAC 3-6-16)

12. Buoyancy

    Buoyancy shall be analyzed on the manhole structure to determine whether additional methods of restraint are necessary. Mechanical equipment, water weight, and other temporary loads shall not be included in the analysis.

    Buoyancy force, opposing force and factor of safety shall be computed as follows:

    Buoyancy Force = (Displaced Volume) X (Unit Weight of Water)

    Opposing Force = Weight of Barrels + Weight of Bottom Slab + Weight of Top Slab + Net Weight of Saturated Soil Over Bottom Slab Extension + Any Additional Constraints (excluding electrical and mechanical components). The unit weight of water is 62.4 lbs/cu.ft.

$$Factor\ of\ Safety = \frac{Opposing\ Force}{Buoyant\ Force} > 1.25$$

    If the factor of safety is not greater than 1.25, restraint measures shall be employed. City Utilities Engineering shall be consulted in these instances.

13. Connections

    For pipe connections to manhole refer to Standard Drawing **STR-14-1** for pipes 36-inches in diameter and smaller, and to Standard Drawing **STR-14-2** for pipes larger than 36-inches in diameter.

    A. External Drop

    - An external vertical drop shall be provided for any pipe invert entering a manhole at an elevation greater than 2- feet above the pipe invert through the manhole.
    - The drop shall be concrete encased.

- Refer to Standard Drawing **STR-15-1**.

B. Internal Drop

- An internal vertical drop may be used for connection to an existing manhole that would require a deep excavation to enter the manhole to within 2-feet above the pipe invert through the manhole.
- See Standard Drawing **STR-15-2** Inside Drop Connection for detail of gravity sewer internal drop into existing manhole and Standard Drawing **STR-22-1** Typical Drop Connection for Low Pressure Pumping System for detail of force main internal drop into existing manhole.

14. Casting Adjustment

- In general, acceptable riser ring sizes are 3, 4, and 6-inches. Refer to Standard Drawing **STR-23-1** for the sanitary casting adjustment detail.
- Minimum wall thickness of riser ring is 5- inches.
- Total number of riser rings shall not exceed two.
- An external chimney seal shall be provided on new manholes.
- Where a water tight casting is specified, as an alternative to adjusting rings, a cast-in-place section is required. See Standard Drawing **STR-16-1** for detail.

Book 3

Sanitary (SA)

SA8 Lift Station and Force Main Design

SA8.01 Purpose

This Chapter establishes the minimum standards and technical design criteria for all City of Fort Wayne sanitary lift stations and force mains. All variances from the Standards must be approved prior to commencement of design in compliance with **Chapter GR3 - Variances**.

Design criteria in this Chapter govern the planning and design of small lift stations with maximum peak not exceeding 700 gallons per minute and/or total dynamic head not exceeding 80-feet. For proposed construction expansion of lift stations exceeding the above ranges, City Utilities Engineering shall be consulted for additional design requirements. This Chapter covers the following items:

1. Discussion of Lift Station Justification and Life Cycle Cost Analysis
2. Basic Elements of Design
    - Lift Station Location Criteria
    - Lift Station Type
    - Lift Station Hydraulic Design
    - Pump Design Criteria
    - Wet Well Design
    - Electrical Design
    - Telemetry
    - Operating Set Points
    - Valve Vaults, Combination Air Valve Structures, and Meter Vaults
    - Valves, Meter and By-Pass Connection
    - Ventilation of Structures
    - Emergency Operation
    - Force Main Design Criteria
3. Covered in Other Chapters
    - Plan Requirements and Submittals (**Chapter SA4 – Drawings and Submittals**)
    - Design Flow (**Chapter SA5 – Sewer Design**)
    - Low Pressure Sewer Systems (**Chapter SA9 – Low Pressure Sewer Systems**)

SA8.02 Lift Station Justification and Life Cycle Cost Analysis

The need for a sanitary lift station is required to be justified according to one or more of the following criteria:

- The lift station is recommended by City Utilities Engineering.
- The elevation of a proposed service area is too low to be served by an existing, on- or off-site, gravity sewer.
- The proposed sanitary lift station has been determined to be a cost effective alternative to an on- or off-site gravity sewer through a life cycle cost analysis.

1. Life Cycle Cost Analysis

   The life cycle cost analysis between a lift station and a gravity sewer shall include both economic and non-economic factors. Refer to **Chapter GR11 – Life Cycle Cost Analysis**.

SA8.03 Lift Station Location Criteria

Lift station locations will be evaluated by City Utilities Engineering on a case-by-case basis. At a minimum, the lift station shall be located to assure the following:

1. Adequate Access

   The lift station shall be located to assure that adequate access is available for operation and maintenance activities. Consideration should be given to the following structure and appurtenance locations:

   A. Wet Well, Valve Vault, By-Pass Structure, Concrete Pad for Control Panel and Generator

      - Distance from adjacent property lines
      - Distance from public right-of-way
      - Distance from private paved streets or paved areas
      - Distance from adjacent structures or buildings

   B. Access Drive

      - Distance from adjacent property lines

      Lift stations shall not be located in inaccessible areas such as rear yards. See **Exhibit SA8-1** Lift Station Details for lift station site plan options.

2. Protection Against Flooding

   Wastewater lift stations should remain fully operational and accessible during a 25-year flood event. In addition, lift station structures and electrical and mechanical equipment shall be protected from physical damage during a 100-year flood event (Title 327 IAC 3-6-10).

3. Parking Requirements

   Adequate space for the off-street parking of two vehicles shall be provided. The entrance to the parking area shall be a minimum of ten (10) feet wide. The parking area must be constructed of stone or other approved materials.

4. Lighting Requirements

   Site shall include light and pole by control panel. Light shall be (2) 21LED bar, shoebox, bronze finish, integral photocell, mounted on a 15-foot tall square steel pole. Pole shall be mounted to concrete pole base.

5. Required Lift Station Items

   - Wet Well
   - Valve Vault
   - By-Pass Structure (Portable Pump Connection)
   - Telemetry
   - Power/Control Panel with Concrete Pad
   - Light Pole by Control Panel
   - Access Drive
   - Force Main
   - Drain Line from Valve Vault and By-Pass Structures

6. Optional Lift Station Items (to be considered based on site selection)

   - Fencing
   - Gates
   - Metering Pit/Metering Piping
   - On-Site Generator and Concrete Pad
   - Chemical Tank

SA8.04 Lift Station Type

- Lift stations shall be (at a minimum) duplex with submersible type pumps in a wet well.
- Lift stations shall operate automatically under normal conditions but shall be capable of manual control.
- All pumps shall be submersible type for handling raw, unscreened wastewater.
- The pump type, number, and configuration shall be consistent with flows and accessibility. Pumps and their respective control systems shall be compatible. In instances in which only two pumps are provided, the pumps shall be of equal capacity. Units shall have capacity such that, with any unit out of service, the remaining unit(s) will have capacity to handle the design peak hourly flow.
- Pumps shall automatically alternate between pumping cycles.

- Both pumps shall be allowed to operate simultaneously at high level set point.
- Valves shall not be located in the wet well. A separate valve vault is required.

SA8.05 Lift Station Hydraulic Design

1. Pumping Capacity

   The pumping capacity shall be calculated as follows:

   $$Q = \frac{DesignFlow}{1{,}440}$$

   Where:

   Q = pumping rate, gallons per minute (gpm)

   Design Flow in gallons per day (gpd) = ADF*4

   Use Average Daily Flow as determined in **Chapter SA5 – Sewer Design**.

   Each pump in a duplex station shall have a pumping capacity of Q.

   City Utilities Engineering may require the pumping capacity to be increased or decreased, if deemed necessary.

2. Initial Pumping Capacity

   Because proposed improvements may only be a portion of the lift station build-out service area, City Utilities Engineering may allow or require the pumping capacity to be reduced for the proposed improvements if the following conditions are met:

   - The area of the proposed improvements is less than 50% of the lift station build-out service area.
   - The required Pumping Capacity for the proposed improvements is less than 50% of the required Pumping Capacity for the lift station build-out service area.

   At a minimum, each pump shall be sized to accommodate the Design Flow of the proposed improvements plus 20%.

   Meeting the above criteria does not guarantee a reduction will be allowed.

   The specific equipment requirements and allowable reductions will be at the discretion of City Utilities Engineering. Only the pumps, motors, and relevant control panel equipment will be considered for allowable reductions. The wet well, valve and meter vaults (if required), piping, valves, and force main shall be sized for the lift station build-out service area.

3. Total Dynamic Head Calculations

   The Total Dynamic Head (TDH) shall be calculated for the pumping capacity of the lift station.

The TDH is the sum of the static head, friction losses and minor losses for a given pumping rate in a defined pumping system. TDH shall be calculated as follows:

$$TDH = h_s + h_f + h_m$$

Where:

TDH = Total Dynamic Head, feet

h_s = Static Head, feet

h_f = Piping friction losses, feet

h_m = Minor losses, feet

The above variables shall be calculated as follows:

- h_s = Static Head, feet

  Static Head = Force Main Discharge Elevation – Pump Off Elevation

  When the high point in a force main is not at the discharge elevation, the elevation of the high point shall be evaluated to determine if the pump performance characteristics are adversely affected.

- h_f = Piping friction losses, feet

  Piping friction losses shall be calculated using the following Hazen Williams formula for friction loss:

$$h_f = 10.44L \frac{Q^{1.85}}{C^{1.85} * D^{4.8655}}$$

  Where:

  D = inside pipe diameter, inches

  Q = pumping rate, gpm

  C = pipe roughness coefficient (100, 120, & 140)*

  L = force main length, feet

  * A roughness coefficient of C = 120 shall be used to determine the friction losses at the Operating Point. However, due to changing force main conditions over time, the h_f and the TDH shall also be calculated using C = 100 at the Pump Off elevation and C = 150 at the Pump On elevation.

Minor losses are due to pipe fittings and shall be calculated as follows:

$$h_m = \frac{KV^2}{2g}$$

Where:

h_m = Minor losses, feet

K = proportionality constant (see Figure SA8.1)

V = velocity, ft/sec

g = acceleration due to gravity = 32.2 ft/sec^2

Figure SA8.1 Typical *K* Values

Fitting	*K*
Check Valve	2.5
Plug Valve	1.5
Tee	0.9
90° Elbow	0.3
45° Elbow	0.2

From Crane Co. as published in Chicago Pump Hydraulics Booklet

Minor losses may also be calculated using the equivalent lengths of pipe method. See **Exhibit W5-4** Minor Losses/Equivalent Length Nomograph for equivalent lengths of common fittings.

4. Pump Selection

- The pump capacity and system TDH, as calculated previously, shall be used to create the system curve when selecting the pump model. The operating point is defined as the point where the designed system curve (*C* = 120 at Design Flow) intersects the pump manufacturer's performance curve.
- The pump, motor, and impeller shall be non-overloading throughout the entire operating range for all roughness coefficients.
- The system head curves for each roughness coefficient shall be plotted on the pump performance curve to determine the operating characteristics.
- Plot the pump curve in parallel in the case where both pumps, or multiple pumps are allowed to operate simultaneously.
- The operating point shall fall within the envelope between 70% and 120% of the pump manufacturer's Best Efficiency Point (BEP), based on flow rate. For example, it the selected pump has a BEP of 300 gpm at 50' TDH, the designed system curve should intersect the manufacturer's pump performance curve somewhere between 210 gpm and 360 gpm regardless of TDH. If the system curve intersects the pump performance curve outside of that range, a different pump should be evaluated.

- Engineering judgment may be used when evaluating pump alternatives. If justified, City Utilities Engineering may require a different operating point or an alternate pump to be used.

5. Net Positive Suction Head Available ($NPSH_A$)

   The ($NPSH_A$) is the total absolute suction head in feet of the liquid being pumped, less absolute vapor pressure of the liquid being pumped, measured at the impeller eye of a submerged pump. (Cameron Hydraulic Data)

   The formula for calculating is:

$$NPSH_A = H_a - H_{vp} + H_{st} + H_f$$

   Where:

   H_a = The absolute pressure on the surface of the liquid in the wet well

   H_{vp} =Absolute vapor pressure of the liquid at the pumping temperature

   H_{st} = The vertical distance between the surface of the liquid in the wet well and the centerline of the pump

   H_f = Friction losses in the suction piping

   Net Positive Suction Head Required ($NPSH_A$) is the minimum pressure required at the suction port of the pump to keep the pump from cavitating.

   $NPSH_A$ is a function of the system and must be calculated, whereas $NPSH_R$ is a function of the pump and must be provided by the pump manufacturer. The ratio of $NPSH_A$ to $NPSH_R$ shall be greater than or equal to 1.5.

SA8.06 Pump Design Criteria

1. Pump Openings

   Pumps handling raw wastewater shall, at a minimum, be capable of passing spheres 3-inches in diameter. Pump suction and discharge openings shall be at least 4- inches in diameter.

2. Intake

   Each pump shall have an individual intake. Wet well and intake design shall be such as to avoid turbulence near the intake and to prevent vortex formation.

3. Pump Guide Rail System

   A guide rail system shall be provided for the easy removal of the pump and motor assembly for inspection and service. The system shall not require a person to enter the wet well to remove the pump and motor assembly. Two rails of corrosion resistant stainless steel, or other approved material, shall be provided for each pump. The guide rails shall be positioned and supported by the pump mounting base. The guide rails shall be aligned vertically and supported at the top by attachment to the access hatch frame.

One intermediate stainless steel guide rail support is required for each 20-feet of guide rail length.

All pumps shall be equipped with sliding brackets or rail guides. A stainless steel lifting chain of adequate length for the wet well depth shall be provided for each pump. The rails and rail guides shall allow the complete weight of the pump unit to be lifted on dead center without binding and stressing the pump housing. The system shall allow the pump to automatically align the pumping unit to the discharge connection by a simple downward movement of the pump.

SA8.07 Wet Well Design

1. Wet Well Sizing

   A circular concrete wet well shall be provided. The wet well shall be designed for peak hourly flow for the lift station build-out service area. The number of pump starts per hour shall generally not exceed five (5) starts per hour. The maximum detention time in the wet well shall average no more than thirty (30) minutes.

   The wet well volume for optimal operation shall be computed as follows:

$$V = \frac{(\emptyset Q)}{4}$$

   Where:

   V = required capacity (gallons)

   Ø = minimum time of one pumping cycle (minutes) from start to start. (Ideally Ø = 15 minutes, but 12 minutes ≤ Ø ≤ 30 minutes is acceptable in certain instances).

   Q = pump capacity (gpm); use peak flow for lift station build-out service area

   Detention times shall be computed for both initial average flow and lift station build-out service area average flow.

   The wet well volume shall be based on a maximum drawdown range of 4-feet.

2. Buoyancy

   Buoyancy shall be analyzed on the wet well to determine whether additional methods of restraint are necessary. Mechanical equipment, water weight, and other temporary loads shall not be included in the analysis. A minimum safety factor of 1.25 shall be used.

   Buoyancy force, opposing force and factor of safety shall be computed as follows:

   - Buoyancy Force = (Displaced Volume) X (Unit Weight of Water)
   - Opposing Force = Weight of Barrels + Weight of Bottom Slab + Weight of Top Slab + Net Weight of Saturated Soil Over Bottom Slab Extension +

Any Additional Constraints (excluding electrical and mechanical components).

- Factor of Safety = (Opposing Force) / (Buoyant Force) > 1.25.
- If the factor of safety is not > 1.25, restraint measures shall be employed. City Utilities shall be consulted in these instances.

3. Floor Slope

   The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the pump intake.

4. Connection to Wet Well

   For proposed lift stations, only one incoming connection to the wet well shall be allowed. The connection shall be of sufficient depth to provide service to the lift station build-out service area. The inlet pipe shall be located between the pumps and on the wall opposite the discharge pipe(s).

5. Hydrogen Sulfide Protection

   Coat interior surface of the wet well with an approved material to mitigate concrete deterioration caused by hydrogen sulfide gas.

SA8.08 Electrical Design Criteria

1. Codes and Standards

   All lift station designs shall meet or exceed the following applicable codes and standards:

   - International Building Code (IBC)
   - National Electrical Code (NFPA 70)
   - Underwriters Laboratories, Inc. (UL)
   - National Fire Protection Association (NFPA)
   - National Electrical Manufacturers Association (NEMA)
   - National Electrical Contractors Association (NECA)
   - Occupational Safety and Health Administration (OSHA)

2. Phase, Starters and Voltage Selection

   Figure SA8.2 shall be used in selecting the appropriate phase, starter, and voltage for the lift station pumps. Selections shall be coordinated with the pump supplier to meet the pump requirements.

Figure SA8.2 Electrical Design Matrix

	Phase		Starters[3]			Voltage[2]		
HP	**Single Phase**	**3-Phase**	**Across the Line**	**Soft Start**	**VFD**	**208V**	**240V**	**480V**
<4	X		X				X	
5-15	X[1]	X	X			X	X	X
16-25		X[2]		X				X
>25		X[2]			X			X

1 – VFD for Phase conversion shall be used
2 – Coordinate available power with local utility
3 – Starter selection shall be coordinated with pump supplier

3. Control and Power Panels

   Low voltage controls equipment must be installed in a separate enclosure from power equipment.

   City Utilities Engineering shall provide designers with standard drawings for construction of Low Voltage Control Panels and Power Panels. Drawings are complete with dimensions, wiring diagrams, and Bill of Materials. CUE designed panels must be used on all lift stations which are to be owned and maintained by the City after construction.

SA8.09 Telemetry

1. General Telemetry

   City Utilities uses radio, fiber, and cellular service to transfer signals from lift stations back to the WPCP. Radio telemetry covers a majority of CU stations. CU has standardized on MDS SD-9 radios. If there is a need or desire to deviate from radio communication as outlined below, CUE must be contacted prior to proceeding. In addition to CU specifications, all local codes relating to antenna height requirements, aircraft flight paths, and other pertinent issues must be adhered to.

2. Propagation Study

   a. A propagation study is required to determine the required antenna height and which mounting method shall be used. The propagation study should be performed during a season when trees have full leaf development. The following information is required to initiate a propagation study:

      - Site plan outlining where equipment is to be placed
      - Latitude/Longitude
      - Physical address

   b. A propagation study shall accomplish and identify the following which should be included in a comprehensive report:

- Existing transmitter and antenna at the master/repeater location by transmitting a calibrated 900MHz signal (licensed) for one end of every path
- Site information including color photographs, coordinates, site drawings, and recommended installation method
- Signal strength tested in the recommended antenna location at a minimum of four heights
- Antenna height and gain; acceptable Received Signal Strength Indication (RSSI) shall be in the range of -60 dBm to -85 dBm. Readings outside of this range require approval from CUE prior to installation
- Detailed drawings of typical antenna system recommended for installation

3. Typical Antenna Mounting Methods (in order of preference)

   a. Low profile antenna - For areas where good line of site and signal can be obtained from the top of the enclosure.
   b. Mast pipe on enclosure - Areas requiring height under 25-feet can utilize a 2-inch aluminum mast pipe attached to the back of the stand-alone enclosure or riser.
   c. Fiberglass pole – Areas requiring height in excess of 25-feet especially where aesthetics are of great concern. Color selection should involve CUE.
   d. Tripod tower structure - Areas requiring height in excess of 25-feet. This requires a concrete base pad that needs to be designed based on loads and soil conditions.

SA8.10 Operating Set Points

1. Control Settings

   All pumps shall stop at the wet well level equal to the minimum level recommended by the manufacturer of the proposed pumps. A minimum drawdown range of at least 3- feet but not greater than 4- feet is desirable between the high level alarm and the pump “stop elevation”. The increment in levels between the multi-pump start points shall be a minimum of 1-foot . All pumps shall shut off a minimum of 1- foot below the last pump start elevation. The high water alarm level shall be at or below the invert of the lowest influent pipe invert and at least 1-foot above the last pump start elevation.

2. High Water Alarm

   The high water alarm shall be set at or below the invert of the inlet pipe. Pipes shall not be used for storage during normal lift station operation.

3. Alarm Beacon Light

   Provide an alarm beacon light which shall be energized on high water alarm condition only. The beacon light shall be watertight, suitable for outdoor installation and provided with a red lens mounted externally on the side of the pump control panel. The light source shall be high intensity strobe type, with light intensity of 1,000,000 peak candle power.

SA8.11 Valve Vaults, Combination Air Valve Structures, and Meter Vaults

1. Valve Vault

   A circular concrete valve vault with an access hatch shall be provided and located next to the wet well to house the pump discharge valves. The arrangement shall provide for easy access to the equipment for maintenance purposes.

   Provisions shall be made to drain or remove accumulated water from the valve vault to the wet well using a sloped floor, floor drain, drain pipe with P-Trap and a check valve or duckbill in the wet well. Refer to **Exhibit SA8-1** Lift Station Details.

   Pressure Gauge: Provide a pressure gauge on the tee fitting of the valve vault piping.

2. Combination Air Valve Structure

   A circular concrete structure with an access hatch or manhole lid shall be provided for combination air release/vacuum valves. A combination air release/vacuum valve shall be placed at high points in the force main to prevent air locking. Long, horizontal runs and changes in slope may require combination air release/vacuum valves.

   A combination air release/vacuum valve may be required at low points in the force main.

   The location of the combination air release/vacuum valves shall be discussed with City Utilities Engineering prior to design.

   Each air release valve and air vacuum valve that exhausts above ground must be equipped with an exhaust pipe extended to a downward facing elbow covered with a corrosion-resistant, 24-mesh screened opening at an elevation of eighteen 18- inches above ground level.

   Automatic air release/vacuum valves shall not be located in areas within the 100-year flood plain or where flooding may occur, unless the automatic air release/vacuum valve is equipped with an exhaust pipe as described in the paragraph above with extension above the 100-year flood elevation.

   Refer to Standard Drawing **STR-21-1** for air release structure detail.

3. Meter Vault and Sample Point Structure

   All customers that will be billed through a monthly billing according to a contract are required to install meters and sampling points. These installations will be addressed on a case-by-case basis as required by City Utilities Engineering.

   The structure to house the meter and provide for sampling shall be configured for easy access to the metering equipment and easy access for sampling. The structure shall be a circular concrete structure with an access hatch.

Provisions shall be made to drain or remove accumulated water from the meter vault to the wet well using a sloped floor, floor drain, drain pipe with P-Trap and a check valve or duckbill in the wet well. Refer to Standard Drawing PS-1 Lift Station Meter Pit.

SA8.12 Valves, Meters, and By-Pass Connection

1. Valve orientation

   All plug and check valves shall be installed horizontally in a valve vault separate from the wet well. The arrangement shall provide for easy access to the equipment for maintenance purposes. The check valve shall be located between the shutoff valve and the pump.

   All valves shall be capable of withstanding normal pressure and surge.

2. Check Valves

   Check valves shall be suitable for the material being handled, shall be equipped with an external lever and weight and have an anti-slam design.

3. Plug Valves

   Plug valves shall eccentric design with resilient plug facings.

4. Combination Air Release/Vacuum Valves

   Air release valves are generally to exhaust pockets of air accumulated during operation and air vacuum valves are to exhaust or admit air during filling or draining of the force main. Consequently, an air release valve shall be placed at high points in the force main to prevent air locking. Long, horizontal runs and changes in slope may require combination air release/vacuum valves. Low points may require air vacuum valves. The location of any type of air valve shall be discussed with City Utilities Engineering prior to design. Combination air valves shall be used as a basis of design for all points along a force main.

5. Metering Equipment

   In cases where metering is required, consult with City Utilities Engineering for orientation of meter, type of meter and readout requirements.

6. By-Pass Connection

   For emergency by-pass of the lift station using a portable pump, a tee off of the force main with a connection for by-passing shall be provided.

   Provisions shall be made to drain or remove accumulated water from the by-pass riser pipe using a ¾-inch diameter drain line sloped to drain to the wet well.

   The by-pass configuration shall consist of the following:

   - A shut off plug valve located between tee by-pass riser pipe

- Riser pipe to two feet above grade with female Bauer socket connection for portable pump

Refer to Standard Drawing PS-2 Lift Station By-Pass (portable pump connection).

SA8.13 Ventilation of Structures

Ventilation shall be provided for wet wells and air release/vacuum valve structures.

- No interconnection of ventilation systems shall exist between wet wells and valve vaults.
- Goose neck or mushroom style static vents shall be placed through the top slab of the structure. A minimum 6-inch diameter vent pipe shall be used.

SA8.14 Emergency Operation

1. General

   A lift station shall be provided with the equipment necessary for emergency operation by two of the following:

   - Dual utility feeds from separate substations with automatic transfer switch
   - Standby generator and automatic transfer switch. Natural gas is preferred over diesel driven engines.
   - Receptacle for portable generator and manual transfer switch
   - On-site standby pump
   - Connection for portable standby pumping. See Standard Drawing PS-2 Lift Station By-Pass (Portable Pump Connection).

2. Automatic Transfer Switches

   Automatic Transfer switches shall meet the following requirements:

   - Service Entrance Rated, listed to UL 891 for Dead-Front Switchboards.
   - Circuit breaker sized for 100A, 200A or 400A with solid neutral.
   - NEMA 3R enclosure with strip heater
   - Microprocessor controller capable of the following:
     - In-phase monitor to transfer motor loads
     - Engine exerciser to automatically test backup generator each week, with or without load
     - Selective load disconnect
     - Serial communication port

3. Manual Transfer Switches

   Manual transfer switch shall meet the following requirements:

   - Service Entrance Rated double-throw switch with dual element fuses.

- Fuse size shall be 100A, 200A or 400A.
- NEMA 3R enclosure.
- Generator receptacle shall be attached to bottom of transfer switch

4. Portable Generator Receptacles

   Receptacles at stations shall be male type connection with reversed contacts. Plugs on Utility portable generators are all female type connection with reversed contacts.

SA8.15 Force Main Design Criteria

1. General

   The following criteria shall apply to force mains:

   - Velocities in force mains shall be kept between two (2) and eight (8) ft/s. For design, the goal is at least 3 ft/s.
   - Minimum acceptable diameter shall be 4- inches.
   - Force mains shall not drain between pumping cycles.
   - Force mains shall be designed to resist hydraulic forces.
   - Force mains shall be designed to resist surge.
   - Force mains shall be designed to enter the gravity sewer system at a point not more than 2- feet above the flow line of the receiving manhole.
   - The receiving manhole shall be coated with an approved polymer coating.
   - Tracing wire shall be specified for all force mains.

2. Force Main Pressure and Surge Analysis (Water Hammer)

   Surge or water hammer is an increase in pressure in a pipe caused by a sudden change in velocity (i.e. stopping or starting a pump or closing of a valve). The maximum surge pressure encountered is a function of wave velocity, a, as follows:

$$a = \frac{4660}{\left(1 + \left(\frac{kd}{Et}\right)\right) 1/2}$$

Where

a = wave velocity

k = fluid bulk modulus (300,000 psi for water)

d = pipe inner diameter (inches)

E = modulus of elasticity of pipe (400,000 psi for PVC, 24,000,000 psi for ductile iron, 111,000 psi for polyethylene)

t = pipe wall thickness (inches)

The maximum surge pressure, P, is computed as follows:

$$P = \frac{(aV)}{2.31g}$$

Where P = surge pressure (psi)

V = maximum change in velocity

g = acceleration due to gravity (32.2 ft/s)

a = wave velocity

Total pressure is computed by the following formula:

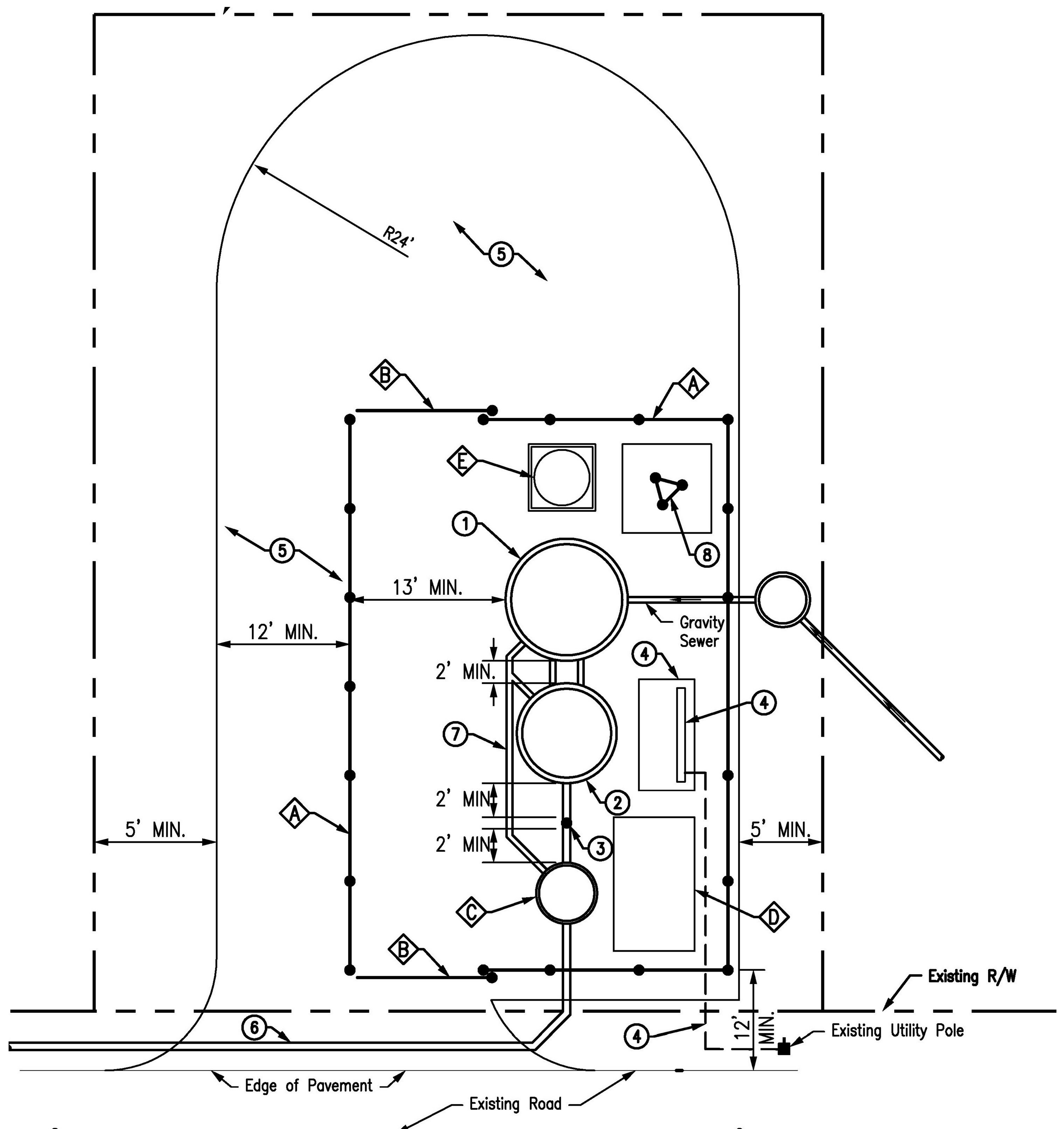
Total Pressure = Maximum Surge Pressure + Static Pressure = $P + h_s$

The total pressure must be less than the rated pressure, including surge allowance, of the pipe.

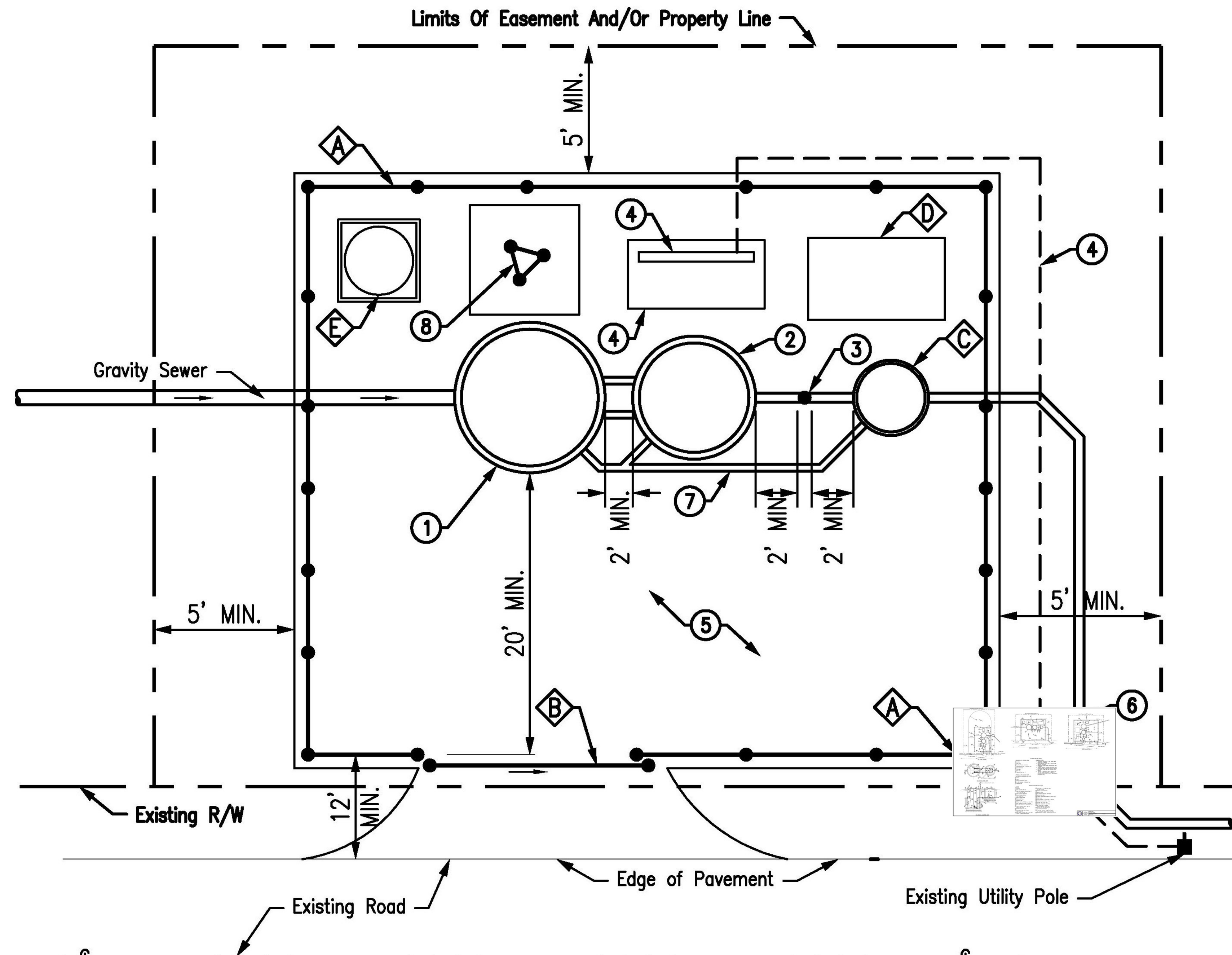
3. Hydrogen Sulfide Prevention/Odor Control

   The need for hydrogen sulfide prevention and/or odor control shall be considered when the detention time in the force main is greater than 6 hours. When hydrogen sulfide prevention and/or odor control is warranted, City Utilities Engineering shall be consulted prior to design of control measures.

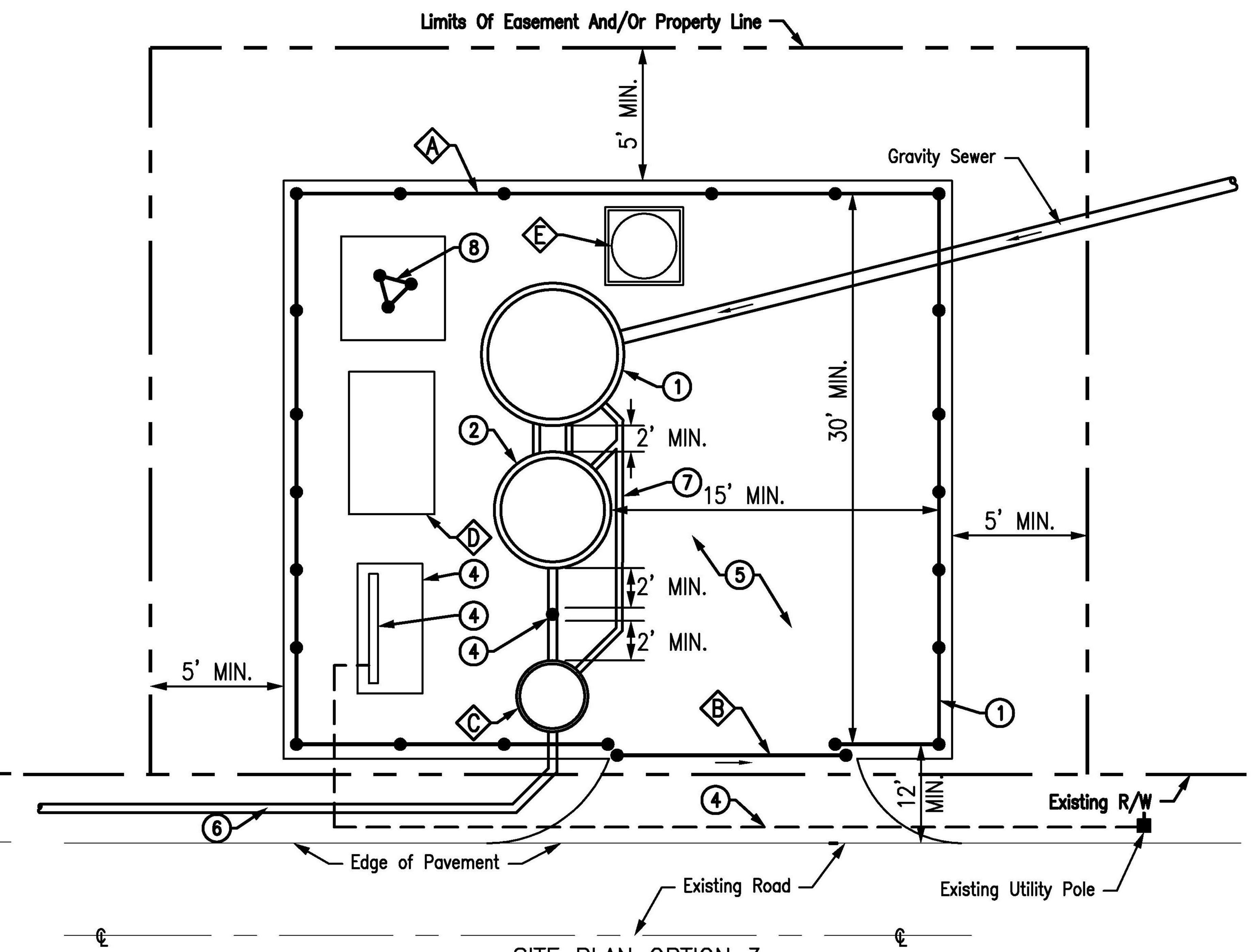
   A chemical container located at the lift station site with chemical feed to the wet well may be required.



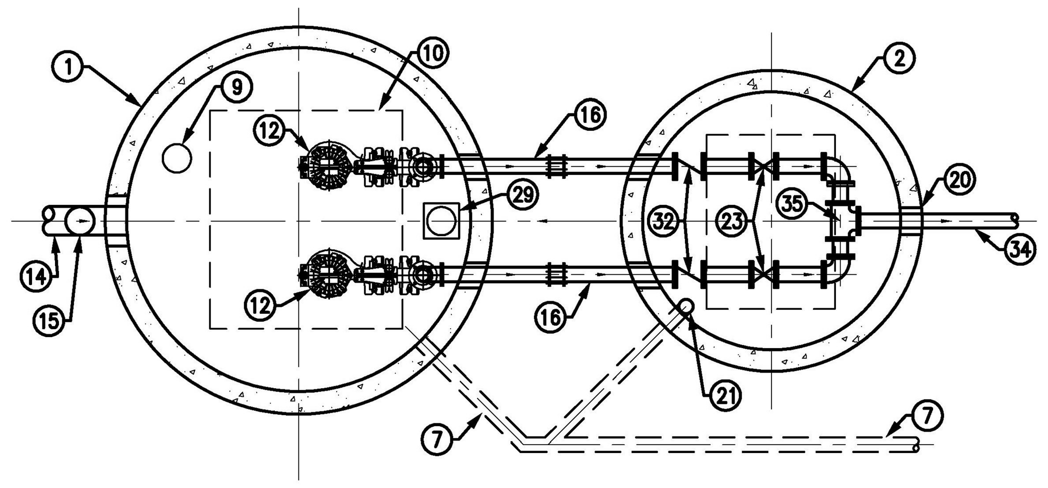
SITE PLAN OPTION 1



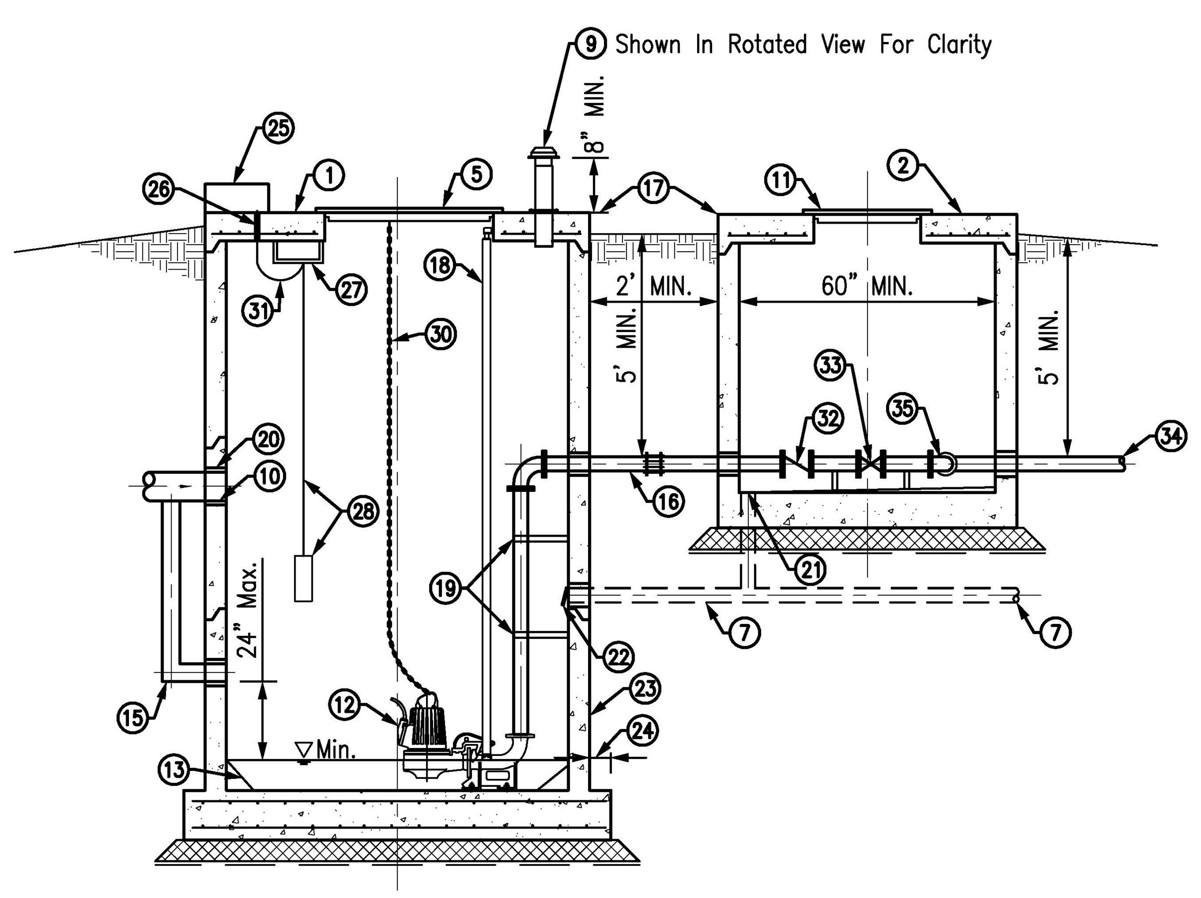
SITE PLAN OPTION 2



SITE PLAN OPTION 3



LIFT STATION PLAN VIEW



LIFT STATION ELEVATION VIEW

Lift Station Site Plan Legend

REQUIRED LIFT STATION ITEMS

1. Wet Well
2. Valve Vault
3. By-Pass Pumping Connection
4. Power/Control Panel w/ Concrete Pad
5. Stone Drive Area
6. Force Main
7. Drain Line
8. Telemetry (See Note 6)

OPTIONAL LIFT STATION ITEMS THAT MAY BE REQUIRED BY C.U.E.

- A Fencing
- B Gates
- C Metering Pit/Metering Piping
- D On-Site Generator & Concrete Pad
- E Chemical Tank

GENERAL NOTES:

1. All Electrical Lines To Be In PVC Conduit When Under Stone Or Asphalt
2. Maintain Drainage Around Site & Minimum 2.0% Slope On Stone Drive
3. Maintain 24-Inches Between All Structures, Slabs & Fencing
4. All Piping, Structure Excavation & Trenches Shall Be Backfilled With An Approved Structural Backfill.
5. Coat Interior Of Wet Well With Approved Coating Material.
6. Telemetry Is Required For All Lift Stations. Size, Type And Location Of Antenna Or Need For Concrete Pad And Tower Are To Be Determined By Propagation Study.

Lift Station Plan & Elevation Legend

LEGEND

1. Wet Well
2. Valve Vault, Min. 60" Dia,
7. Drain Pipe, Maintain Minimum Slope Of 1/4"/FT Into Wet Well
9. Green or Goose Neck Vent
10. Hatch, Stainless Steel w/ Dual Safety Grate
11. Hatch, Stainless Steel
12. Submersible Pump
13. Concrete Fillets
14. Influent Line Invert (High Level Alarm On)
15. Drop Connection, Encased In Concrete
16. Force Main, Ductile Iron Restrained Joints
17. Top Of Structure, Min. 6", Max. 12" Above Finish Grade
18. Stainless Steel Guide Rail
19. Intermediate Guide Bars Bracket (Req'd Over 20')
20. Seal Opening w/ Press Seal or Link Seal (Typical Of All Pipe Penetrations)
21. Floor Drain w/ P-Trap; Grout Floor w/ Slope To Drain
22. Backflow Preventer/Duckbill
23. Monolithic Base
24. Anti-Flotation Extensions (As Req'd)
25. Junction Box, NEMA 7
26. Explosion Proof Sealed Conduit To Control Panel
27. Cable Hanger
28. Level Transducer w/ Float Stick as Back-up
29. Hoist Socket, Locate Above Pumps
30. Stainless Steel Lifting Cable
31. Separate Conduits For Each Pump
32. Ball Check Valve w/ External Lever & Weight w/ Bronze Face
33. Shut-off Plug Valve, Dezurik Type w/ Square Nut & Handle
34. Force Main Transition Fitting From Ductile Iron To Alternate Material (PVC, HDPE, etc.)
35. Restrained Tee & Elbow; Pressure Gauge on Tee

CITY UTILITIES WATER THAT WORKS	City Utilities Design Standards Manual	Exhibit SA8-1 Lift Station Details Created: April 25, 2013 Scale: N.T.S.

Book 3

Sanitary (SA)

SA9 Low Pressure Sewer Systems

SA9.01 Purpose

This Chapter establishes the minimum standards and technical design criteria for all City of Fort Wayne low pressure sanitary sewer systems including grinder pump stations and appurtenances. The main reason for acceptance of low-pressure sewer systems is for septic elimination in areas of failed or failing septic systems. Low pressure sewer systems must be specifically approved by CUE for new development. All variances from these design standards must be approved prior to commencement of design in compliance with **Chapter GR3 -Variances**.

1. This Chapter covers the following topics:
    - Low Pressure Sewer System Service Area
    - Responsibility
    - System Design and Layout
    - Maximum Connections to Grinder Pump Stations
    - Grinder Pump Type
    - Grinder Pump Equipment
2. The following topics are covered in other Chapters:
    - Drawings and Submittals (**Chapter SA4 – Drawings and Submittals**)
    - Sewer Design (**Chapter SA5 – Sewer Design**)
    - Lift Station and Force Main Design (**Chapter SA8 – Lift Station and Force Main Design**)
    - Electrical and Instrument & Control Design (**Chapter SA8 – Lift Station and Force Main Design**)

SA9.02 Low Pressure Sewer System Service Area

The applicant shall prepare a Low Pressure Sewer System Service Area Study where low pressure sewer system locations will be evaluated by City Utilities on a case-by-case basis.

SA9.03 Responsibility

The City will only be responsible for the operation and maintenance of the common force main, i.e. the main line low pressure force main, and the portion of the building sewer from the common force main to the edge of the right-of-way or easement.

The property owner shall be responsible for all piping, pumping equipment, and appurtenances between the building and the right-of-way or easement.

Refer to Standard Drawing SAN-9-3 Low Pressure Sewer System Installation for a plan and profile view of the components and configuration.

SA9.04 System Design and Layout

Due to the variability of each site, the design of low-pressure sewer systems shall rely on sound engineering judgment and manufacturer's recommendations. City Utilities may, if reasonably justified, make any requirement deemed necessary to ensure the system performs as intended.

The minimum requirements for the design and layout of low-pressure sewer systems shall be per the most recent version of the Standard Detail Sheets, the manufacturer's recommendations, and as follows:

1. Pipe Size

   Minimum pipe size for a public common force main shall be 2-inches. Minimum size of the grinder pump station discharge force main shall be one and one-quarter (1 ¼) inches.

   Gravity building sewer pipe between building and grinder shall be 4-inches or 6-inches in diameter for residential services. Commercial and industrial service line sizing shall be reviewed on a case by case basis.

2. Overall System Design/Layout

   System designs shall take into consideration the following parameters:

   - Design Flow Rate shall be calculated using the EPA simplified formula:

     $Q = 0.5N + 20$

     Where:
     Q = design flow (gpm)
     N = Number of properties to be served
   - System shall have sufficient flows to achieve a minimum cleansing velocity of two (2) feet per second in the common force main, at least once per day.
   - System shall be designed without any "loops" or parallel pumping segments.
   - Grinder station lid elevation shall be 1-foot lower than the elevation of lowest floor served or a backflow prevention device shall be installed on the building sewer between the building served and the grinder station.

3. Cleanouts

   Cleanouts shall be located per pump manufacturer's recommendations but at a minimum at the following locations:

   - At the terminal end of each common force main; and
   - Where two or more force mains are connected.
   - Refer to Standard Drawing SAN-9-1 Terminal Cleanout for Low Pressure Sewer Systems

4. Air Release Valves

   Air release valves shall be installed at the following locations:

   - All intermediate high points in the system;
   - Are recommended to be installed at intervals of 2,000 feet on all horizontal runs lacking a clearly defined high point.
   - Refer to Standard Drawing STR-21-1 Sanitary Sewer Air Release Structure.

5. Building Sewer Connection

   Refer to Standard Drawing SAN-9-3 and also Section SA6.09 – Building Sewer Low Pressure Sewer Connection to Main Line Sewer.

   - Builder and/or property owner to provide to City Utilities information on proposed pump system and force main alignment. Fort Wayne City Utilities will approve all grinder pump stations before commencing construction.
   - All building sewer connections shall have a curb stop and an emergency check valve on the discharge force main line from the grinder pump station. Curb stop and emergency check valve can be separate mechanisms or a single assembly and shall be placed within the public Right-of Way or Easement on the property being served. Emergency check valves shall be stainless steel.
   - Builder and/or property owner shall contact City Utilities at time of grinder pump station and force main connection for waste discharge.
   - Installation will be inspected by City Utilities.

6. Low Pressure Common Force Main Connection to Manhole

   Refer to Standard Drawing STR-22-1 Low Pressure Collection System Discharge.

   Receiving manhole shall be coated with a City approved polymer coating.

7. Low Pressure Connections to Existing Force Mains

   a. Public low-pressure collector mains serving multiple properties may be allowed to connect into existing public force mains if all of the following conditions are met:

      - The receiving public force main is 8-inches in diameter or smaller.
      - Expected Total Dynamic Head from furthest grinder station to discharge point of public force main does not exceed 100 feet.
      - Velocities in collector force mains shall be withing the range of 2 to 8 fps.

   b. Individual properties may be allowed to connect to public force mains on a case by case basis as determined by Development Services and if all the following conditions are met:

- Complete review of potential for public main extension to property for future service to other properties. Typically, Development Services will prefer public main extension to minimize individual property connections.
- The receiving public force main is 8-inches diameter or smaller.
- Expected Total Dynamic Head from grinder station to discharge point of public force main does not exceed 100 feet.
- A low-pressure collector main is not feasible due to sparseness of population density or undue economic impact.
- Property Owner must enter a hold-harmless agreement with the City for any damages which may occur on private property as a result of their connection to the public pressurized system.

c. Engineering analyses shall be performed using criteria provided in **Chapter SA8 – Lift Station and Force Main Design**. Upon request, City Utilities Engineering shall provide information relative to existing lift stations and force mains to assist designers in determining the existing system Energy Grad Line (EGL) at point of connection. Designers shall be required to provide an analysis from furthest proposed grinder station (most remote analysis) as well as system analysis for total number of properties being served.

SA9.05 Maximum Connections to Grinder Pump Stations

No more than one building will be permitted to connect to a grinder pump station.

Common grinder pump stations for one building with multiple residential units are also prohibited, except for the following:

- Condominiums where different floors have different owners (only one building per grinder pump station).

The intent is to have individual residential units be served by individual grinder pump stations.

Industrial facilities will be handled on a case-by-case basis.

SA9.06 Grinder Pump Type

To assure all the grinder pump stations are compatible, all units serving the same low pressure sewer system shall be the same make and model number, and have the same pump performance characteristics, unless justified.

Replacement units shall be the same make and model as was originally approved by City Utilities.

The type of grinder pumps and allowable applications are as follows:

1. Positive Displacement Pumps

   May be used on a case by case basis.

2. Semi-Positive Displacement Pumps

   May be used on a case by case basis.

3. Centrifugal Pumps

   May be used in all low pressure sewer system applications. Consult with pump manufacturer for single-stage vs. two-stage applications. Two-stage centrifugal pumps may be required for higher total dynamic head applications.

SA9.07 Grinder Pump Station Equipment

Simplex or duplex grinder pumps may be used for single dwelling units. For uses other than single dwelling units, the Engineer shall determine which is appropriate.

General equipment requirements are as follows:

1. Grinder Pump Station

   The grinder pump stations shall be a complete package consisting of all equipment and appurtenances required for a fully operable pumping system. Pump, wet well, level controls, starter, alarm, piping, fittings, valves, and all accessories shall be part of a factory fabricated package so that after burying the wet well, the field connection of the gravity lateral, discharge line and electrical service line to the control box will complete the installation.

2. Manufacturer

   Each grinder pump station shall be manufactured and assembled by a single manufacturer.

3. Pumps

   The pumps shall be capable of macerating all materials in normal domestic and commercial wastewater, including reasonable amounts of foreign objects such as wood, plastic, glass, rubber, and the like to a fine slurry that will pass freely through the pump and 1 ¼-inch discharge pipe.

4. A guide rail system shall be provided for the easy removal of the pump and motor assembly for inspection and service. The system shall not require a person to enter the wet well to remove or install the pump and motor assembly. Electrical Motor and Level Controls

   Electrical and level controls shall be provided by the pump manufacturer. All controls shall be mounted so they can be cleaned or replaced without disturbing the pump or piping.

5. Control Panels

   The control panels and all associated components on each standard unit shall be U.L. Approved and installed per manufacturer's recommendations. All equipment associated with each unit shall meet the current requirements of all applicable Federal, State, and Local electrical codes.

CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 4 Water

Book 4

Water (W)

W1 Acronyms and Definitions

W1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the Water Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

W1.02 Acronyms

ANSI	American National Standards Institute
AG	Air Gap (Backflow Prevention)
ASTM	ASTM International (formerly American Society of Testing and Materials)
AVB	Atmospheric Vacuum Breaker (Backflow Preventer)
AWWA	American Water Works Association
CITY	The City of Fort Wayne, Indiana
CUE	City Utilities Engineering
DC	Double Check Valve (Backflow Preventer)
DPS	Department of Planning Services
DVS	Development Services
HDPE	High Density Polyethylene
IAC	Indiana Administrative Code
IBC	International Building Code
IFC	Indiana Fire Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation
IPC	International Plumbing Code
IURC	Indiana Utility Regulatory Commission
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PVB	Pressure Vacuum Breaker (Backflow Preventer)
PVC	Polyvinyl Chloride

ROW	Right-Of-Way
RP	Reduced Pressure Principle (Backflow Preventer)
SDC	System Development Charge
USC	University of Southern California

W1.03 Definitions

Air-Gap	The unobstructed vertical distance, through the free atmosphere, between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle. An air-gap is an approved method for backflow prevention.
Atmospheric Vacuum Breaker	A backflow prevention device consisting of an air inlet valve, a check seat and an air port.
Backfill	Earth and/or other material used to replace material removed from trenches or other excavations during construction activities. The backfill lies above the pipe bedding.
Backflow	Flow of water or contaminants into the public water supply distribution system from a source other than the public water supply.
Backflow Prevention Device	A device to prevent the flow of water or contaminants into the public water supply distribution system that has been approved for use by IDEM and City Utilities.
Bedding	The fractured face stone which encases the pipe to a minimum depth above and below the barrel of the pipe. The bedding serves as the pipe support.
Book	Organizational grouping of utility design standards by topic. These Books consist of General Requirements, CADD, Stormwater, Sanitary Sewer, Water and Materials.
Booster Pump	Pump installed on a pipeline to increase water pressure.
City	The City of Fort Wayne, Indiana.
City-Owned Service Line	The pipeline from the water main to the curb stop or service valve including the tap on the water main and curb stop or service valve.
City Utilities	The department of the City of Fort Wayne that manages the stormwater, wastewater and water utilities.
City Utilities Engineering	The division within City Utilities that develops City Utility Engineering Standards, manages City Utilities Projects, and performs planning and system analysis for the stormwater, wastewater and water utilities.

City Utilities Projects Publicly funded projects that improve the stormwater, wastewater and water utilities and are under direction of City Utilities Engineering.

City Utilities Design Standards Manual A document that provides guidance and requirements for the planning, design, and construction of stormwater, wastewater, and water utility infrastructure.

Contamination An impairment of the quality of the public water supply by the presence of any foreign substance (organic, inorganic, radiological, or biological) to a degree which creates a hazard to the public health through poisoning or through the spread of disease or creates a nuisance condition such as discoloration, staining, tastes, or odors.

Cross Connection Any physical arrangement, including cross connection control devices not in working order, whereby a public water supply distribution system is directly connected, either continuously or intermittently, with any secondary source of supply, sewer, drain, conduit, pool, piping, storage reservoir, plumbing fixture, or other device which contains, or may contain, and is capable of imparting to the public water supply, contaminants, contaminated water, sewage, or other waste or liquid of unknown or unsafe quality.

Cross Connection Control Device Any device or assembly, approved by the commissioner of IDEM for construction on or installation in water supply piping, which is capable of preventing contaminants from entering the public water supply distribution system.

Cross Connection Control Device Inspector Person who has successfully completed training in testing and inspection of cross connection control devices from a training provider approved by the commissioner of IDEM, has received a registration number from the commissioner, and who has not been notified by the commissioner that the registration number has been revoked in accordance with section 11 (b) of IDEM Rule 327 IAC 8-11.

Cross Connection Hazard Any facility which, because of the nature and extent of activities on the premises or the materials used in connection with the activities or stored on the premises, would present an immediate or potential danger of health hazard to customers of the public water supply should backflow occur.

Curb Stop (Service Valve) A fitting inserted in the service pipe for turning on and shutting off water to the premises supplied or to be supplied.

Customer-Owned Service Line The pipeline from the curb stop or service valve, not including the curb stop or service valve, to the meter. If the meter is located outside in a meter pit the customer-owned service line extends from the meter to the first branch, internal shutoff valve or secondary source of supply.

Developer	Any person, association, corporation, or entity desiring new water service for premises under their control.
Development	Any man-made change to improved or unimproved real estate, including but not limited to, buildings, or other structures, filling, grading, paving, excavation, substantial improvements, placement of mobile homes, subdivision of land.
Development Services (DVS)	The division within the department of the City Utilities that oversees non-capital projects.
Distribution System (Public)	Network of water mains and appurtenances that deliver potable water from the filtration plant to the user.
Double Check Valves	A device or assembly composed of two (2) tightly closing shut-off valves surrounding two (2) independently acting check valves, with four (4) test cocks, one (1) upstream of the four (4) valves and one (1) between each of the four (4) check and shut-off valves.
Easement	A right to occupy, access or otherwise utilize the real property of another for a specifically defined use.
Grade	The inclination or slope of a conduit or natural ground surface usually expressed in terms of the percentage the vertical rise (or fall) bears to the corresponding horizontal distance.
Permanent Easement	A permanent right-of-way to use a described parcel of land for the purposes to construct, operate, control, maintain, reconstruct, or remove a water main and appurtenances along, under, and across said easement.
Permit	Written permission from an agency with authority to control operation.
Population, Equivalent	A hypothetical number of person for which flow contributions are calculated.
Population Build-Out	The actual (equivalent) population that exists or would exist when an area is fully developed.
Pressure Vacuum Breaker	A device or assembly containing an independently operating internally loaded check valve and an independently operating loaded air inlet valve located on the downstream side of the check valve for relieving a vacuum or partial vacuum in a pipeline.
Protection Device	Any of the following devices: air gap separation; approved double check valve assembly; approved reduced pressure principle backflow prevention assembly; or atmospheric or pressure vacuum breaker.
Private Fire Service	A privately owned arrangement of pipes, fixtures and devices designed for stand-by service and from which water is taken only for the extinguishment of fires.

Private Water Main Water main owned and operated by a private person(s), company or other non-public entity.

Public Water Main Pipe used to convey water to which all owners of abutting property have equal rights to and is controlled and maintained by the City of Fort Wayne or other public authority and regulated by the Indiana Utility Regulatory Commission.

Reduced Pressure Principle Backflow Preventer A device composed of two (2) tightly closing shut-off valves surrounding two (2) independently acting pressure reducing check valves that, in turn, surround an automatic pressure differential relief valve, and four (4) test cocks, one (1) upstream of the five (5) valves and one (1) between each of the four (4) check and shut-off valves. The check valves effectively divide the structure into three (3) chambers; pressure is reduced in each downstream chamber allowing the pressure differential relief valve to vent the center chamber to atmosphere should either or both check valves malfunction.

Right-Of-Way A general term denoting land, property or interest therein, usually a strip of land acquired for or devoted to the construction of a highway, road or street that will include the travelled way, shoulders, roadsides, auxiliary lanes, medians, border areas, park strips, sidewalks, curbs, gutters and fronting roads.

Secondary Source of Supply Any well, spring, cistern, lake, stream, or other water source, intake structure, pumps, piping, treatment units, tanks, and appurtenances used, either continuously or intermittently, to supply water other than from the public water supply to the customer. This includes tanks used to store water to be used only for fire fighting, process water, etc., even though the water contained therein is supplied from the public water supply.

Service Area A geographical area served by a public utility or water distribution system.

Service Pipe The pipeline from the water main to the meter. If the meter is located outside in a meter pit the line extends from the meter to the first branch, internal shutoff valve or secondary source of supply. The water service pipe is made up of the City-Owned Service Line and Customer-Owned Service Line.

Standards Fort Wayne City Utilities Design Standards Manual. The requirements for the design and construction of utilities within Fort Wayne’s jurisdiction.

System Development Charge (SDC) A one time fee charged primarily charged at the time of, or prior to, the connection to the water utility. May also be charged in instances where an existing facility is requesting an increase in its water meter size.

<u>Water Distribution System (Public)</u> Network of water mains and appurtenances that deliver potable water from the filtration plant to the user.

<u>Water Main</u> Water conduits three inches (3”) in diameter and larger, together with all appurtenances, any necessary valves, fire hydrants, and associated materials receiving potable water and distributing it to more than one customer.

<u>Water Main Extension</u> Extension of the distribution system which may serve new customers.

<u>Water Service</u> Water provided by the City of Fort Wayne or other public authority and regulated by the Indiana Utility Regulatory Commission for customer use.

Book 4

Water (W)

W2 Introduction

W2.01 Purpose

The purpose of this Chapter is to provide an introduction on how the Water Book is presented. The purpose of the Water Book is to provide guidance so that the design, construction and maintenance of the City's water main system will provide the level of service necessary to:

- Protect the health and welfare of residents
- Comply with local, state and federal laws
- Protect public and private property from unnecessary damage
- Protect the public from potential contaminants in the water
- Provide quality water in adequate quantity suitable for consumption
- Ensure proper operation and maintenance of public water systems

W2.02 Applicability

The Standards establish the minimum requirements for the design and construction of water main systems. The Standards apply to all projects that result in water main systems that are owned or maintained by the City of Fort Wayne and also private water mains that are owned and maintained by property owners. Water main systems include, but are not limited to:

- Water mains including service pipes
- Appurtenances (valves, fire hydrants, etc.)
- Backflow Prevention
- Fire Services

For private water mains, which are wholly owned, operated and maintained by a private entity, this manual constitutes best management practices. Customers proposing private water main infrastructure larger than 12" diameter water mains or that have the risk of significantly impacting the public water system if the private system were to fail will be required to meet requirements of this manual. Incorporation of these standards is required.

W2.03 Variance from Standards

Variance from the Standards may be granted under specific conditions. Refer to Chapter GR3 – Variances of the General Requirements book for the variance procedures and requirements.

W2.04 Organization of Water Standards

The Standards contain the process, procedures and technical requirements needed to comply with City of Fort Wayne water regulations. Chapter W4 – Drawings and Submittals outlines the minimum requirements for the submittal and acceptance of water mains.

The remaining chapters are dedicated to key water topics. Each chapter contains technical requirements including, but not limited to:

- Allowable design approaches (methods, equations)
- Minimum allowable sizing
- Implementation limitations
- Criteria for submittal
- Minimum geometry requirements

W2.05 Water Materials

Allowable materials and minimum requirements for use are provided in the Materials Book of the City Utilities Design Standards Manual. Relevant Chapters include:

- Chapter MA2 – Introduction
- Chapter MA3 – Certification of Materials
- Chapter MA4 – Common Materials Requirements and Testing Requirements
- Chapter MA7 – Water Materials and Testing Requirements

Materials used must comply with the Materials Standards. Deviations from the Standards may be considered in accordance with Chapter GR3 – Variances.

W2.06 Water Specifications

City Utilities maintains a library of Master Specifications for use on City Utilities projects and may be used on other projects. Specifications are available via the City's website at:

utilities.cityoffortwayne.org/contractors-engineers-developers/master-specifications

The Master Specifications have been developed to support the requirements established in this manual. The Master Specifications are provided as a service to design engineers and do not waive the design engineer's responsibility or liability for the site specific design of the water main system.

W2.07 Compliance with Other Standards

Compliance with these standards does not eliminate the need to comply with other applicable City, County, State and Federal ordinances, regulations and policies. These standards are intended to supplement other guides and manuals produced by the City of Fort Wayne and other agencies. Other regulations, resources and documents that shall be incorporated into these Standards include, but are not limited to the following:

- American Water Works Association (AWWA) Standards
- Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers, Recommended Standards for Water Works, latest edition. (Also referred to as Ten State Standards for Water Works)
- Indiana Department of Environmental Management (IDEM) Regulations
- Indiana Administrative Code Title 327 Water Pollution Control Board
- Indiana Administrative Code Title 675 Article 16 Plumbing Code
- Indiana Building Code
- City of Fort Wayne Code of Ordinances
- Indiana Fire Code
- Indiana Department of Transportation (INDOT) Standard Specifications, latest edition
- Indiana Manual on Uniform Traffic Control Devices (IMUTCD), latest edition
- **Fort Wayne Water Utility General Rules and Regulations**
- Water Main Extension Policy
- **Developer Installed Water Taps Policy**
- **Policy and Procedures for Water Service Disconnections – Building Demolitions**
- **Cross-Connection Regulation – Fort Wayne Water Utility**

The provisions of this document shall be deemed as additional requirements to minimum standards required by other applicable ordinances and standards. In the case of conflicting requirements between these Standards and other referenced documents the most restrictive shall apply.

Book 4

Water (W)

W3 Special Requirements

W3.01 Purpose

The purpose of this Chapter is to provide general information on the requirements and guidelines for water service accounts and water utility.

This information included in these Standards shall be followed for all water facilities that are owned or maintained by City Utilities and for private water mains and customer-owned services lines that are owned and maintained by property owners that are connected to the City's water supply.

W3.02 Water Service Accounts

Water service provided by City Utilities shall require a service application or contract with the Utility. The property owner or customer shall apply for service and pay the required deposit for a service contract.

Each customer shall be responsible to pay the required monthly service charge and usage charges. The customer shall notify the Utility at least seven (7) working days in advance of the discontinuance of service.

Refer to the **Fort Wayne Water Utility General Rules and Regulations** for further detailed rules and regulations regarding water services, service connections, metering and billing.

W3.03 Ownership and Maintenance

City Utilities owns, operates and maintains the public water distribution system that includes; water treatment plants, water mains, booster stations, water storage tanks, water towers, and various other water facilities.

City Utilities owns and maintains all city-owned water service lines from the water main tap to the curb stop or service valve. The property owner shall own and maintain the customer-owned service line and fixtures, except the meter, from the curb stop or service valve into the property. Large services shall have a service valve immediately after the water main tap, resulting in the property owner owning and maintaining all water service line piping.

Book 4

Water (W)

W4 Drawings and Submittals

W4.01 Purpose

The purpose of this Chapter is to outline the minimum drawing and submittal requirements for water improvements. Requirements for the installation of public water mains, building service water mains, and fire services are also included. These requirements are intended to supplement **Chapter 52 of the Fort Wayne Code of Ordinances** and the **Fort Wayne Water Utility General Rules and Regulations**.

Drawing and submittal requirements may include preliminary and final subdivision plans, permits (IDEM and or City) for water main construction, building and zoning permits, construction inspections and other requirements. Drawing and submittal requirements shall be discussed with City Utilities during the preliminary planning phase for all projects.

W4.02 Water Mains

This section expands on process and information listed in **Chapter GR5 – Project Coordination** sections GR5.02 and GR5.07 outlining information needed for approval of all water main projects. The following submittal process shall be a guide for the design and approval of all water mains.

1. Conceptual Site Plans

   The Conceptual Site Plan review process shall include preliminary discussions and submittals with the Development Services Department (DVS). Based on the project description and the details for the water main improvement project the following submittals may be required:

   - Preliminary layout/development plans
   - Plans for new commercial buildings
   - Plans for new residential communities

   DVS will review and provide direction as to whether the project is sufficient to proceed with a formal submittal.

2. Development Plans

   The requirements for submittals and approval of all Development Plans shall be coordinated with the Department of Planning Services (DPS). All plan review will be completed by DPS and DVS. Additional City Departments may be consulted for review as required.

3. Construction Documents Approval

   DVS will review the construction drawings and issue comments. All review comments shall be addressed, and construction documents shall be updated appropriately. Upon the completion and final submittal an approval letter shall be issued.

W4.03 Water Services

All water services will require a water main tap permit. Permit requirements and fees shall be in accordance with section W4.04 of this Chapter. All services shall adhere to Federal, State and local regulations, codes and statutes as required.

1. Residential Water Service

   Refer to **Chapter W6 – Building Services** for residential water service design requirements. Formal construction drawings are not required for a typical residential building water service connection.

2. Non-Residential Water Service

   Non-residential water services, including industrial and commercial taps, shall meet all the requirements of **Chapter W6 – Building Services**. Non-residential water service approval may require additional submittal requirements. It is recommended that DVS be contacted to discuss each specific building water service on a case-by-case basis to determine if a submittal and approval are required.

   The submittal process for non- residential water service shall follow section W4.02 of this Chapter.

3. Fire Service

   Fire Service designs shall meet all the requirements of **Chapter W9 – Fire Services**. A submittal and approval is required for the installation of any fire service. All submittals, including the interior and exterior fire suppression drawings, shall be submitted to DVS and follow the submittal procedures as noted in section W4.02 of this Chapter. The following are minimum requirements that shall be included in the fire service design submittal:

   - Fire Service Site Plans
   - Interior Fire Suppression Plans
   - Final Construction Site Plans
   - As-Built Site Plans

W4.04 Permits, Fees, and Contracts

The following additional information for water permits, tap fees and service contracts shall be used in addition to the requirements and information provided in **Chapter GR4 – Contracts, Fees, and Permits**. The Fort Wayne Code of Ordinances and the **Fort Wayne Water Utility General Rules and Regulations** shall also be referenced for additional information.

1. Local Permits

   The local tap permits shall be obtained from DVS for all connections to the City's water system. A drawing or sketch of the tap location shall be included with the permit application.

2. State Permits

   A. An IDEM construction permit shall be obtained from IDEM prior to commencement of any water main extension construction. The permit is in accordance with 327 IAC 8-3-3(a). Permit applications may be obtained from the following address:

   Drinking Water Branch
   Indiana Department of Environmental Management
   100 North Senate Avenue
   P.O. Box 6015
   Indianapolis, IN 46206-6015
   website: www.in.gov/idem/water/permits

   The IDEM permit may be issued by City Utilities using "Local Permitting Authority" in accordance with 327 IAC 8-3-3.1. Standard forms utilized by City Utilities for the local review process are found in **Exhibit GR4-2**. City Utilities may be consulted for more information regarding the appropriateness, requirements and procedures of using "Local Permitting Authority" with a particular project.

3. Fees

   A. Local Tap and Permit Fees

   Fees shall be assessed at the time of application for a water tap permit. The cost of all permits and tap fees shall be per the most recent City ordinance.

   B. Permit Application Fees for State Permits

   Permit application fees for state permits shall be determined by the respective state agency at the time of permit application.

   C. Additional Fees

   System Development Charges (SDC), Water availability fees, construction water fees, testing & maintenance fees, tap fees and inspection fees may be assessed by the Board of Public Works. These fees will be determined and noted in the water contract issued for the specific project. In addition, local connection reimbursements as detailed in the project water contract may apply on a case-by-case basis. SDC will be based on the water meter size and capacity as described in **Section W5.08 – Hydraulic Design Criteria**.

4. Contracts

   Whenever a developer extends the City water system, the developer shall be required to enter into a water contract with City Utilities. A copy of a standard contract is available from DVS upon request.

Book 4

Water (W)

W5 Water Main Design

W5.01 Purpose

The purpose of this Chapter is to provide requirements on the design elements and basic hydraulic criteria necessary for the proper design of potable water distribution systems. This Chapter establishes the minimum standards and technical design criteria for all City of Fort Wayne water distribution systems. All projects that result in infrastructure that is to be owned or maintained by City Utilities shall follow these requirements. All variances from these design standards shall be approved prior to commencement of design in compliance with **Chapter GR3 – Variances**.

1. Basic Elements of Design
    - Horizontal alignment with consideration of separation from sanitary and storm sewers, potential sources of contamination and efficiently provide service to existing and potential water service users.
    - Vertical alignment with consideration of service depth, minimum cover, underground utility conflicts and constructability.
    - Total design flow with consideration of existing and future population served by the water main.
    - Water main size, material, bedding and construction method.
    - Necessary appurtenances and additional items required for a complete and functional water system.
2. Covered in this Chapter
    - General Improvement Location Criteria
    - Horizontal Alignment Criteria
    - Vertical Alignment Criteria
    - Pipe Bedding and Backfill
    - Pipe Materials
    - Design Flow
    - Hydraulic Design Criteria
    - Water Main Pipe Requirements
    - Joint Restraint
    - Casing Pipe
    - Infrastructure Crossings
3. Covered in Other Chapters
    - **Chapter W6 – Building Services**

- Chapter W7 – Appurtenances
- Chapter W8 – Backflow Prevention
- Chapter W9 – Fire Services

W5.02 General Improvement Location Criteria

General improvement location criteria of proposed water main alignment to be considered shall include, but not be limited to the following:

- Use existing rights-of-way and/or easements whenever possible.
- Permanent easements shall be required for all water main installations along proposed major corridors and non-residential streets. Consult City Utilities regarding easement acquisition for water main installation.
- Easement requirements, property values, and potential damages to all affected properties.
- Evaluate service needs of both present service area and future service area.
- Potential development and utility or street extensions and widening into adjacent areas.
- Serve entire area in best way possible.
- Existing underground and overhead utilities, roadways, and railroads.
- Proposed utilities such as sewer, stormwater, and other water facilities.
- Environmentally sensitive areas including creeks, rivers, wetlands, trees, protected habitats, etc.
- 100-year flood elevations and regulatory floodways.
- Continuity with adjacent design segments.
- Maintenance of traffic during construction.
- Availability of materials.
- Foundation conditions.
- Construction costs.
- Subsurface conditions: soils and ground water.
- Access for maintenance and repair.

W5.03 Horizontal Alignment Criteria

In general, water mains shall be located on the opposite side of the street from the sanitary sewer and away from gas mains. Water mains are generally located on the north and west sides of the public right of way. Every effort shall be made to locate the water main outside of the pavement, but within existing or proposed right-of-way or easements. Refer to Chapter GR7 – Easements for further guidelines regarding water main easements.

1. Placement in Existing Right-of-Way

   A. For water mains located within existing or proposed street right-of-way, the preferred placement shall be as generally defined in Standard Drawing **BS-1** Recommended Utility Placement in Public Right-of-Way.

   B. Allowances for future sidewalk shall be made.

   C. The location of the roadway, curb and gutter, sidewalk and other utilities shall be taken into account.

2. Placement Outside of Existing Right-of-Way

   A. Where water mains cannot be placed within right-of-way, easements shall be procured.

   B. Easements adjacent to the right-of-way shall be required for all water main installations along major arterial corridors and non-residential streets.

   C. Refer to Figure GR7.1 Minimum Easement Widths in **Chapter GR7 – Easements** for minimum easement widths required for water main installation.

3. Minimum Horizontal Separation from Sewers

   A. A ten (10) foot horizontal distance edge to edge shall be maintained between water main and any existing or proposed gravity or pressurized sewer line or structure per Title 327 IAC 8-3.2-9.

   B. The crossing must maintain a minimum angle of intersection of 45 degrees (45o) measured from the centerlines of the water main and sewer line. This angle of intersection shall be maintained for a minimum distance of 10 feet (10’) from either side of the water main.

   C. If it is not possible to maintain the ten (10) foot horizontal separation, the following design criteria shall apply:

      - Installation of the water main closer to the sewer may be approved, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation such that the bottom of the water main is at least 18 inches (18”) above the top of the sewer.

      - The sewer shall be constructed of water main grade pipe material from manhole to manhole with pressure rated joints complying with Title 327 IAC 8-3.2-8. All water main grade pipe material requirements are defined in **Chapter MA7 – Water Materials and Testing Requirements**.

      - Either the water main or sewer shall be encased in a watertight casing pipe which extends for a minimum distance of 10 feet (10’) from either side of the water main or sewer as measured from the outside edge of the water main to the outside edge of the sewer.

4. Minimum Distance from Buildings

   A. Water mains (not service pipes) shall be located a minimum of 10 feet (10') horizontally from any part of a building structure or its foundation.

5. Minimum Distance from Storage Tanks

   A. The following shall apply when storage tanks are in the vicinity of the proposed water main:

      - Storage Tanks Containing Hazardous Materials: Water mains shall be separated from existing and proposed above ground or underground storage tanks and their local distribution devices (pumps) containing or potentially containing hazardous materials, petroleum products, or waste materials by a distance of 25 feet (25') horizontally measured from the outside edge of the water main to the outside edge of the tank or distribution device and shall not cross such tanks or local distribution devices.

      - Other Storage Tanks: Water mains shall be separated from all other below ground storage tanks not defined above (excluding potable water storage tanks) by 10 feet (10') measured horizontally from the outside edge of the water main to the outside edge of the storage tank.

6. Minimum Distance from Liquid Petroleum and High Pressure Piping

   A. Liquid Petroleum and any high pressure piping shall be separated from water mains in the same manner as sanitary and storm sewer lines and related structures or the respective owner's specifications. In the event of conflicting specifications, the more stringent shall apply.

7. Minimum Distances from Utilities Other than Sewers

   A. When practical, all utility lines not addressed in other sections (electric, cable, telephone) shall be separated a minimum of 3 feet (3') or per the respective owner's specifications. In the event of conflicting specifications, the more stringent shall apply.

   B. Large electrical transmission line foundations shall be a minimum 10 feet (10') away from water mains.

   C. All drawings shall show the location of both underground and overhead utilities.

   D. Utility locations shall be derived from the most reliable and up-to-date information.

   E. Each utility shall receive a set of drawings prior to final submittal. On these drawings, they shall note changes or addition to utility information.

   F. Separation distance of water main from other utilities shall be determined by the representative of other utilities and the applicant.

G. Any necessary relocation shall be closely coordinated with the respective utility representative.

8. Minimum Distance from Potential Contamination Sources

A. The following shall apply when potential contamination sources are in the vicinity of the proposed water main:

- Sewage or Septic Areas: Water mains shall be separated from sewage or septic treatment equipment and septic tank absorption field trenches and lift stations by 10 feet (10’) measured horizontally from the outside edge of the water main to the outside edge of the defined structure.
- Grave Sites: Water mains shall be separated from grave sites by 10 feet (10’) measured horizontally from the outside edge of the water main to the outside edge of the grave site.
- Landfills: Water mains shall be separated from existing or proposed landfills by 50 feet (50’) measured horizontally from the water main to the outside edge of the waste boundary of an existing or proposed landfill. In addition, water mains within 300 feet (300’) of the outside edge of the waste boundary of an existing or proposed landfill shall be constructed of non-permeable materials. Water mains shall not cross or pass through the waste boundary of an existing or proposed landfill.
- Organic Compounds: Where distribution systems are installed in areas of groundwater contaminated by organic compounds, pipes and joint materials which are not subject to permeation of the organic compounds shall be used. The non-permeable materials shall be used for all portions of the system including the water main, service connections, and hydrant leads

9. Location in Relation to Streams and Waterways

A. Water mains located along existing or proposed streams or waterways shall be located outside of the stream bed or edge of the water line and sufficiently separated to allow for future improvements to the stream or waterway channel.

B. Water mains shall be separated from existing or proposed water bodies by a minimum of 10 feet (10’) horizontally measured from the outside edge of the water main to the outside edge of the typical water line or ditch outside edge if the stream is intermittent.

C. If bridge structure wingwalls are present at the stream or waterway crossing, a minimum distance of three (3) feet horizontal must be maintained between the outer edge of the wingwall and the outer edge of the water main pipe.

10. Allowable Horizontal Pipe Deflection

    A. When it is necessary to deflect pipe horizontally from a straight line, the amount of joint deflection for PVC pipe shall not exceed 50-percent of the manufacturer recommended deflection. Consult the manufacturer's literature for allowable joint deflections for allowable pipe deflections.

    B. The allowable joint deflection for ductile iron pipe shall be as shown in **Exhibit W5-1**, Maximum PVC Joint Deflections. For design purposes, deflection shall be limited to 80 percent (80%) of the values shown.

    C. If the manufacturer's specified deflection allowance is greater than that described above and in **Exhibit W5-1**, City Utilities can be consulted to allow such deflections.

11. Angle of Intersection

    A. Water mains are preferred to cross other utility conduits, highways, and railroads at 90 degree (90°) angles.

W5.04 Vertical Alignment Criteria

1. Minimum Depth of Cover

    - Minimum depth of cover for water main pipes located within the right of way of arterial streets shall be 6 feet as measured from the proposed surface elevation to the top of the water main pipe.
    - Minimum depth of cover for all water main pipes outside of an arterial street right of way shall be 5 feet as measured from the proposed surface elevation to the top of the water main pipe.
    - Minimum depth of cover for service pipes shall be 5 feet.
    - Minimum depth of cover for all water main pipes located in areas where swales and ditches are part of the stormwater conveyance system and along an unimproved road (without curb and gutter) shall be 6 ft as measured from the existing surface elevation to the top of the water main. In all instances where this coverage cannot be met, City Utilities shall be consulted for guidance and approval.

2. Minimum Vertical Separation from Sewers

    - A minimum vertical separation of 18 inches (18") measured vertically from the outside edge of the water main to the outside edge of any existing or proposed gravity or pressurized sewer line or structure shall be maintained per 327 IAC 8-3.2-9.
    - When crossing a sewer the 18 inches (18") vertical separation shall be maintained for a minimum distance of 10 feet (10') from either side of the water main as measured from the outside edge of the water main to the outside edge of the sewer line.
    - If it is not possible to maintain the 18 inch (18") vertical separation, the following criteria shall apply:

A. The sewer shall be constructed of water main grade pipe material from manhole to manhole with pressure rated joints complying with 327 IAC 8-3.2-8. All water main grade pipe material requirements are defined in **Chapter MA7 – Water Materials and Testing Requirements**.

B. Either the water main or sewer shall be encased in a watertight casing pipe which extends for a minimum distance of 10 feet (10') from either side of the water main or sewer as measured from the outside edge of the water main to the outside edge of the sewer.

3. Air Release Structures

   - Air Release Valves or similar shall be installed in locations where the vertical alignment of the water main results in a high point in the elevation.
   - Refer to **Chapter W7 – Appurtenances** for air release structure requirements.

4. Stream and Waterway Crossings

   - Water mains located above streams, waterways or any water bodies are not allowed.
   - Water mains located under existing or proposed streams, waterways or water bodies less than 15 feet (15') in width at the crossing point shall be covered with a minimum of 60 inches (60") of cover and constructed with butt fused HDPE.
   - Water mains crossing under existing or proposed streams, waterways or water bodies greater than 15 feet (15') in width at the crossing point shall be covered with a minimum of 60 inches (60") of cover, constructed with butt fused HDPE, have valves placed at both ends of the surface water body. The valves shall be easily accessible, not subject to flooding, and have the valve closest to the supply source located in a manhole structure. It is desirable to have permanent taps made on each side of the valve within the manhole to allow insertion of a small meter to determine leakage and for sampling purposes.

5. Allowable Vertical Pipe Deflection

   - When it is necessary to deflect pipe horizontally from a straight line, the amount of joint deflection for PVC pipe shall not exceed 50-percent of the manufacturer recommendation for deflection. Consult the manufacturer's literature for allowable joint deflections and for allowable pipe deflections.

W5.05 Pipe Bedding and Backfill

1. See Standard Drawing **BS-4** General Rigid Pipe Bedding Detail.
2. See Standard Drawing **BS-5** General Flexible Pipe Bedding Detail.

3. Refer to Chapter MA4 – Common Materials and Testing Requirements for bedding and backfill specifications.
4. Refer to Chapter MA7 – Water Materials and Testing Requirements for backfill requirements for valves, fire hydrants and curb stops.

W5.06 Pipe Materials

Refer to Chapter MA7 - Water Materials and Testing Requirements for approved water main pipe materials.

W5.07 Design Flow

In general, water mains shall be designed to provide for the Design Demand in accordance with the criteria established below.

1. Design Demand

   The Design Demand is the combination of maximum daily demand plus fire flow demand as follows:

   DD = (Max day) + FF

   where:

   DD = Design Demand (gpm)

   Max day = Maximum daily demand (gpm)

   FF = Fire flow demand (gpm)

   Each of the above demands is described in the following sections. Please note that this section presents the minimum values and rates. Higher or more conservative values and rates can be utilized. Exhibit W5-2 Design Demand Determination Worksheet provides a guideline to aid in determining Design Demand.

2. Maximum Daily Demand

   Maximum Daily Demand is the summation of all domestic, processing, indirect and unknown demands with applied peaking factors (PF) as follows:

   Max day = (Dom + Proc + Indirect + Unk) x PF

   where:

   Max day = Maximum daily demand (gpm)

   Dom = domestic demands (gpm)

   Proc = process demands (gpm)

   Indirect = indirect demands (gpm)

   Unk = unknown water demands (gpm)

   PF = peaking factor (note that peaking factors can be applicable only to a specific water demand)

   - Domestic Demand

     Domestic demand (Dom) is the amount of water needed for household and sanitary purposes. This includes water needed at home or at work for drinking, washing, bathing, cooking, flushing, and other purposes. Domestic demand shall be determined as follows:

Dom = residential domestic demand + commercial domestic demand + industrial domestic demand

A. Residential Domestic Demand

The residential domestic demand shall be determined using one of the two following methods:

- Method A – General Average

  The residential domestic demand shall be determined by using the proposed number of residential units and the following general average:

  0.35 gallons/residential unit/minute

  This rate shall be multiplied by the proposed number of residential units to determine the residential domestic demand of the development. A residential unit represents a single family home, apartment unit, mobile home lot, or a single portion of a multiple family dwelling unit.

- Method B – Determined Average

  The residential domestic demand may be determined using the proposed number of residential units and the determined average (using data provided by City Utilities). The determined average shall be as follows:

  (ADCD10) / (SC10)

  where:

  ADCD10 = the average daily customer demand as reported by City Utilities over the previous ten (10) years

  SC10 = number of service connections at the time of ADCD10

  This rate shall be multiplied by the proposed number of residential units to determine the residential domestic demand of the development. A residential unit represents a single family home, apartment unit, mobile home lot, or a single portion of a multiple family dwelling unit.

- Commercial and Industrial Domestic Demand

  The commercial and industrial domestic demand shall be determined using the proposed number of people at building capacity, the proposed number of operating shifts (1, 2, or 3), and the following general average:

  0.07 gallons / capita / shift / minute

- Process Demand

  Process demand (Proc) is the amount of water needed for commercial and industrial processing such as cooling water or that used for processes such as canning or bottling. Process water demand shall be evaluated on a case-by-case basis. Justification and documentation shall be submitted for each processing water demand in accordance with Chapter W4 – Drawings and Submittals.

- Indirect Demand

  Indirect demand (indirect) is the amount of water set aside for future off-site extensions of the water main such as additional sections of subdivisions. Indirect demand is usually comprised of the types of demand (dom, proc) that are estimated (or set aside) for future anticipated demand. This demand must be stated as zero (0) if no considerations are being made for indirect demands.

- Unknown Demand

  Unknown demand (unk) is the amount of water set aside for the on-site development of the proposed project if the project occupants are unknown (i.e. spec buildings or industrial development park). Unknown demand can either be assumed or intentionally determined to maximize the water demand capacity of the proposed development. Note that assumed unknown demands that are too low may limit the eventual build out of the proposed development while assumed unknown demands that are too high may increase construction costs. This demand must be stated as zero (0) if no considerations are being made for unknown demands.

- Peaking Factors

  Peaking factors are used to recognize that water demand is not always constant. Demand throughout the day, week, season, or by weather can cause fluctuations from average values.

  A. The following minimum peaking factors shall apply:

     - Domestic demand 2.5*
     - Process demand 1.6
     - Indirect demand (unless domestic)1.6
     - Unknown demand 1.6

       **Domestic demand peaking factors shall apply to indirect demands that are domestic in nature.*

  B. An alternative method of determining the domestic demand may be determined using data provided by City Utilities as follows:

PF* = MDD10 / 10YADD

where:

PF* = alternative domestic demand peaking factor

MDD10 = the maximum single day demand as reported by City Utilities over the previous 10 years

10YADD = the 10-year average daily demand as reported by City Utilities

3. Fire Flow

   Fire flow (FF) is the fire protection demand based upon the type of construction, size, number of floors, type of occupancy and exposure of the structures.

   - Residential

     In the case of residential areas, water mains shall be designed to provide a minimum fire flow demand of 1,000 gpm at the most remote fire hydrant in the project area.

   - Commercial and Industrial

     Commercial and industrial demand rates will be dependent on the type of facility constructed. These flows will need to be evaluated on a case-by-case basis taking specific facility activity into account. Information from the I.S.O. “Guide for Determination of Required Fire Flow” can provide guidance. Generally, commercial areas range from 1,500-2,500 gpm and industrial areas range from 2,000-3,500 gpm. In the absence of other information, the high end of the above ranges shall be utilized.

     Above typical fire flow rates desired by individual facilities may not be possible without private, on-site fire hydrants, water storage tanks, and fire pumping facilities. City Utilities shall be consulted in accordance with **Chapter W9 – Fire Services**.

W5.08 Hydraulic Design Criteria

Sound engineering judgment shall be employed when designing water distribution systems. The following sections outline specific design requirements and considerations.

1. Pressure and Flow Rate

   All potable water distribution system projects shall be designed to maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under maximum daily demand plus fire flow demand. In addition, all distribution systems shall be designed to maintain a minimum static (no flow) pressure of 35 psi.

2. Velocity

Velocity in a water main shall be determined as follows:

$$V = 0.409\ Q/D^2$$

where:

V = velocity, ft/sec

Q = flow rate (referred to as design demand, see above), gpm

D = nominal diameter of pipe, inches

The maximum velocity of water within a proposed water main under maximum daily demand plus fire flow demand (Design Demand) shall be per Figure W5.1 as follows:

Figure W5.1 Maximum Velocity

Pipe Diameter (inches)	Maximum Velocity (ft/sec)	Corresponding Design Demand (gpm)
6	12.22	1075
8	7.36	1150
12	4.68	1650
16	4.23	2650
>16	Consult City Utilities	

3. Data Requirements

- Topographic

  Topographic data including proposed ground contours and surface features will be required for water main design. The general improvement location criteria shall be referenced for determining required topographic information.

- Flow Testing

  Flow testing results, provided by City Utilities, representative to each of the points of connection to the proposed project are required for design basis of the proposed project and determine the adequacy of the system to handle anticipated demands.

4. Hydraulic Calculations

Hydraulic calculations that demonstrate the adequacy of design must be submitted with each proposed project. The calculations must be consistent with the requirements for calculations and shall address the existing conditions and translation of the flow test results as well as the determination of the changes in these conditions along existing water mains. The calculations must demonstrate that the proposed design meets the required design flow criteria in Section W5.07 at all most remote points in the proposed potable water distribution system.

- Hydraulic calculations completed for distribution system design must be reproducible using the Hazen-Williams equation.

- h_f = Piping friction losses, psi

  Piping friction losses shall be calculated using the following Hazen Williams formula for friction loss:

$$h_f = [10.44L\frac{Q^{1.85}}{C^{1.85} * D^{4.8655}}]/2.31$$

  Where:

  D = inside pipe diameter, inches

  Q = flow rate, gpm

  C = pipe roughness coefficient (100, 110, 120)

  L = main length, feet

- Commercial programs may be utilized to compute distribution system hydraulic calculations but if requested by City Utilities must be reproduced utilizing Hazen-Williams related equations.
- General Hydraulic Calculation Requirements

  A. Roughness Coefficients

  Proposed projects must address design life expectancy of water mains. The roughness coefficients to be used for existing pipe and proposed pipe are shown in Figure W5.2.

Figure W5.2 Roughness Coefficients

C Factor	Age of Pipe
120	New and Existing HDPE Pipe
120	New and Existing PVC Pipe
120	New Ductile Iron Pipe (24” or larger)
120	All Existing Pipe (Less than 20 years)
110	All Existing Pipe (20 to 40 years)
100	All Existing Pipe (Greater than 40 years)

  Theoretical methods using constants other than C factors to demonstrate pipe roughness must provide a demonstration of equivalent assumptions. Site specific C factors shall be used for existing pipe in lieu of the C factors presented in this subsection.

  B. Minor Losses

  Minor losses shall be determined when the length of the proposed project is less than 1,500 times the diameter of the included pipe. This determination to include minor losses must be included with the calculations. Refer to **Exhibit W5-3** and **Exhibit W5-4** for the Minor Losses Worksheets 1 and 2 as an aid in this determination.

  C. Friction Losses

  Friction losses along a water main due to pipe roughness shall be determined when evaluating the adequacy of design. These friction losses can be determined using Hazen-Williams theories. Refer to **Exhibit W5-5** Friction Losses, Unidirectional Dead End Segment Worksheet for guidance in determining unidirectional, dead end friction losses. Hardy-Cross theories can be utilized to determine friction losses in loops of water mains. **Exhibit W5-6** Friction Losses, Unidirectional Single Loop Worksheet presents a worksheet for determining friction losses over a loop of water mains.

D. Changes Due to Elevation

Hydraulic calculations shall be completed to evaluate static head. The flow test data is applicable to the elevation of the pressure hydrant and its relationship to and translation to the proposed design is necessary.

5. Translation of Flow Test Results

The flow test results prepared by City Utilities present current performance capacity in the proposed project area. Using the static pressure, residual pressure, and measured flow rate data from the flow test and the design demand for the proposed project, the following translation of the residual pressure shall be completed:

$$RP_{DD} = ST_{FT} - [(ST_{FT} - RP_{FT})^{1/1.85} * Q_{DD}/Q_{FT}]^{1.85}$$

where:

RP_{DD} = residual pressure at pressure hydrant location at design demand

ST_{FT} = static pressure at pressure hydrant location

RP_{FT} = residual pressure at pressure hydrant location at flow test measured flow rate

Q_{DD} = flow rate, design demand

Q_{FT} = flow rate, flow test measured

For larger development projects or main extensions that have significant impact on the distribution system, City Utilities shall be consulted to determine the need to review the proposed project utilizing the City's water model.

Exhibit W5-7 Translation of Flow Test Results presents a worksheet to aid in the calculation of flow test results.

6. Existing Water Main Conditions

The flow test pressure hydrant will likely not be the point of connection for the proposed water main. As such, the effect of the existing water mains between the pressure hydrant and the proposed point of connection must be determined. These effects are calculated by minor losses (if required), friction losses, and changes in elevation. Requirement of the calculation of minor losses is determined with the aid of **Exhibit W5-3** and **Exhibit W5-4**. Friction losses can be determined with the aid of **Exhibit W5-5** and **Exhibit W5-6**. Changes in elevation must address both the elevation of the pressure hydrant and the point(s) of connection.

7. Most Remote Tests

   Once the point of connection conditions are established, the adequacy of the proposed water main design must be demonstrated by determining if the performance criteria is fulfilled throughout. This shall be accomplished by the use of "most remote tests".

   Most remote tests include the calculation of all performance criteria at all "plausible" most remote locations in the proposed design. This would include but not be limited to all end points to the proposed distribution system, all areas of higher relative elevation, all points of significant point demand, and all points furthest from a point of connection (regardless if end point). Other plausible most remote points may exist and must be investigated.

   Each most remote test will include the effects of minor losses (if required), friction losses, and changes due to elevation. Requirements for the calculation of minor losses can be determined with the aid of **Exhibit W5-3** and **Exhibit W5-4**. Friction losses can be determined with the aid of **Exhibit W5-5** and **Exhibit W5-6**. Changes in elevation must be relative to the pressure hydrant of the respective flow test.

   All remote points must be investigated or stated why a location was not investigated (i.e. redundant). **Exhibit W5-8**, Most Remote Test Results provides worksheets for use in providing the results of the most remote testing.

8. Water Main Over-sizing

   City Utilities shall be consulted to determine the need for water main over-sizing to accommodate anticipated future demands.

9. System Development Charge (SDC) basis

   The basis of the SDC is the size of the water meter installed. The water meter size corresponds to an equivalent peak capacity potential that the meter can convey water through to the facility it serves. An SDC will be charged for each water meter installed for a facility. The only exception to a SDC fee charge is for irrigation only meters on residential homes, where the irrigation meter is an additional water meter being fed by the same 1" or less service pipe as the primary water meter.

W5.09 Water Main Pipe Requirements

Water main pipe requirements are as follows:

1. All pipe materials shall per **Chapter MA7 – Water Materials and Testing Requirements**.

2. All water mains shall be constructed and tested per **Chapter MA7 – Water Materials and Testing Requirements**.

W5.10 Joint Restraint

Adequate precautions must be taken to prevent the separation of joints at tees, elbows, hydrants, valves, reducers and plugged ends. This shall be done by the use of restrained joints. Concrete blocking only is not acceptable. HDPE, if not connecting to existing materials, is a fully restrained system.

1. Restrained Joint Location Requirements

   Joint restraint devices are required at the following locations and as directed by the Engineer or Inspector:

   - Bends
   - Tees
   - Fire hydrants
   - Reducers (both sides)
   - In-line valves
   - Plugs or caps
   - Pipe inside casings

2. Restrained Joint Calculations

   Joint restraint lengths vary depending on multiple factors such as; the type of fitting, surrounding soil conditions, pipe material, pipe diameter, test pressure, depth of bury, restrained length encroachment etc. The Ductile Iron Pipe Research Association (DIPRA) manual contains detailed information on determining the required joint restraint lengths. Standard Drawing W-54-1 Thrust Restraint Calculations (Polywrapped DIP), Standard Drawing W-54-2 Thrust Restraint Calculations (Non-Polywrapped DIP), and Standard Drawing W-54-3 PVC Non-Encroaching Thrust Restraint Calculations, lists minimum restrained joint lengths calculated based on the DIPRA manual and typical site conditions experienced in Fort Wayne. Each standard drawing lists the assumptions used to calculate the restraint length. If actual project conditions differ recalculate the required restraint joint lengths. These standard drawings are not applicable when fittings are in close proximity and the calculated restraint lengths overlap (encroach), refer to the DIPRA Manual for encroachment calculations.

3. Restrained Joint Materials

   - Refer to Chapter MA7 – Water Materials and Testing Requirements for acceptable types of Joint Restraint.
   - The extent of the restraint shall be in accordance with the following Standard Drawings: W-44, W-45, W-46, and W-47.

W5.11 Casing Pipe

In cases where the water main shall be installed inside a casing the following criteria shall apply.

1. Casing Pipe Requirements

   Casing pipe shall be bare wall steel pipe with a minimum yield strength of 35,000 psi or HDPE DR 11 with appropriate clearances. The inside diameter of the casing pipe shall be a minimum of six inches (6”) greater than the outside diameter of the carrier pipe joints or couplings. The casing pipe shall have a minimum wall thickness as required by Figure W5.3 below:

Figure W5.3 Casing Pipe Thickness

Casing Outside Diameter (inches)	Casing Wall Thickness Highway Crossings (inches)	Casing Wall Thickness Railroad Crossings (inches)
16	0.25	0.281
18	0.25	0.312
20	0.25	0.344
24	0.25	0.406
30	0.375	0.469
36	0.375	0.532

   Minimum depth of cover of the casing pipe shall be 54 inches (54”) or as required by the affected highway, railroad, etc.

   City Utilities reserves the right to require larger diameter carrier pipes to accommodate additional proposed or future utility lines.

   Refer to Standard Drawing W-48 Typical Jacked and Bored Casing Pipe.

2. Casing End Seals

   The casing pipe shall have end seals between the casing pipe and the carrier pipe to prevent the entrance of foreign material.

   Refer to Standard Drawing W-50 Casing End Seals.

3. Casing Spacers

   The steel casing pipe and carrier pipe shall be separated by insulators, spacers or skids. The insulators, spacers or skids shall be installed to support the weight of the pipe and its contents. At a minimum, they shall be placed a maximum of one foot (1’) from each side of a joint and at maximum five foot (5’) intervals. HDPE casing pipe does not require casing spacers.

   Refer to Standard Drawing W-49 Casing Spacers.

W5.12 Infrastructure Crossings

1. Railroad Crossings

   When any railroad is crossed, the specifications and precautionary measures required by the respective railroad officials shall be followed. A copy of the railroad crossing application and proof of approval from the respective railroad entity shall be submitted to City Utilities. In the absence of specific railroad requirements, the following general criteria shall apply:

A. Criteria

The following criteria shall apply to instances in which water main construction affects railroad rights-of-way and facilities. In certain instances, the requirements of the specific railroad company may be more stringent than these standards. In those instances, the more stringent standard shall apply.

- Water main shall cross tracks at an angle as close as possible to 90 degrees (90°).
- Water mains crossing beneath railroad tracks shall be constructed in bored and jacked casings.
- Casing pipe under railroad tracks and across railroad rights-of-way shall extend to a point a minimum distance of 25 feet (25’) from the centerline of the outside track or the right-of-way line, whichever occurs first and a minimum of 5 feet (5’) beyond the top of ditch bank within the railroad right-of-way.
- Water mains laid longitudinally along railroad rights-of-way shall be located as far as practical from the tracks. If the water main is located within 25 feet (25’) of the centerline of any track, the water main shall be encased or shall be of a special design as approved by City Utilities Engineering.
- Casings under tracks and across railroad rights-of-way shall be a minimum of 54 inches (54”) deep as measured from the bottom of the track rail to the top of the casing pipe.

B. Railroad Crossing Drawings

A railroad crossing drawing shall be prepared and address the following:

- Both a plan and profile view shall be provided.
- The following items shall be included on the drawing: relationship between the proposed water and the railroad, angle of crossing, location of utilities, original survey station of the railroad (when available), right-of-way lines, limits of boring or casing liner, topography, and general layout. The profile shall clearly show the water main in relation to both the tracks and existing ground elevations.

The crossing drawing and project drawings shall be submitted to both City Utilities Engineering and the appropriate railroad company for review and approval.

2. Highway Crossings

When any highway is crossed, the specifications and precautionary measures required by the respective highway officials shall be followed. A copy of the highway crossing application or Right-of-Way permit and proof of approval from the respective highway entity shall be submitted. In the absence of specific highway requirements, the following general criteria shall apply:

A. Criteria

The following criteria shall apply to instances in which water main construction affects highway rights-of-way and facilities. In certain instances, the requirements of the highway department may be more stringent than these standards. In those instances, the more stringent standard shall apply.

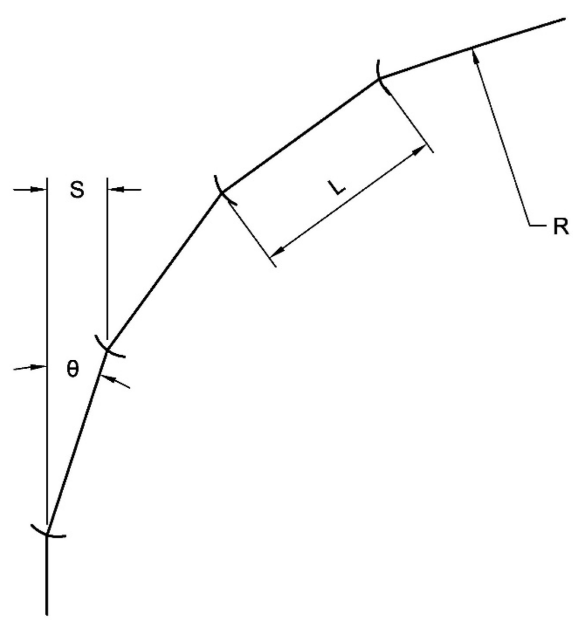
- Water mains shall cross the roadway at an angle as close as possible to 90 degrees (90°).
- Water Mains shall not be placed under roadway bridges where the possibility of restricting the required waterway area or where a possibility of compromising the structural integrity of bridge foundations exists.
- Pipes crossing beneath highways shall be installed by jack and bore method with a casing pipe, tunneling method or micro-tunneling method.
- Borings under highways shall have a minimum depth of cover of 54 inches (54”) as measured from the surface elevation to the top of the casing. The top of the casing shall have a minimum of 48 inches (48”) of cover below the invert of existing or proposed ditches.
- Borings under highways shall extend a minimum of 10 feet (10’) (measured perpendicularly) outside the outer edge of existing pavement or to the toe of slope when the roadway is on fill and the toe of slope exceeds the 10 feet (10’) outside of pavement requirement.
- Water mains laid longitudinally along highway rights-of-way shall be located a sufficient distance outside of the existing edge of pavement to ensure worker and motorist safety during construction.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit W5-1 Maximum PVC Joint Deflections Version: May 2023 Scale: N.T.S.

PUSH ON JOINT (PVC) MAXIMUM DEFLECTION		
NOMINAL PIPE SIZE	DEFLECTION ANGLE - θ	MAXIMUM OFFSET - S* IN. L* =
IN.	DEG.	20 FT.
4	1	24
6	1	16
8	1	12
10	1	9
12	1	8
14	1.5[1]	6
16	1.5[1]	6
18	1.5[1]	6
20	1.5[1]	6
24	1.5[1]	6
30	1.5[1]	6
36	1.5[1]	6
42	1.5[1]	6
48	1.5[1]	6

MECHANICAL JOINT (PVC) MAXIMUM DEFLECTION		
NOMINAL PIPE SIZE	DEFLECTION ANGLE - θ	MAXIMUM OFFSET - S* IN. L* =
IN.	DEG.	20 FT.
4	5.7	23
6	4.0	16
8	3.0	12
10	2.5	10
12	2.1	8
14	1.8	7
16	1.6	6
18	1.4	5
20	1.3	5
24	1.1	4

* SEE FIGURE BELOW
[1] SEE NOTE 1. BELOW



θ = DEFLECTION ANGLE
S = JOINT DEFLECTION OFFSET
L = LAYING LENGTH
R = RADIUS OF CURVE

$$R = \frac{L}{2 \tan \frac{\theta}{2}}$$

NOTES:

1. FOR 14" AND LARGER PUSH-ON JOINTS, MAXIMUM DEFLECTION ANGLE MAY BE LARGER THAN SHOWN ABOVE; CONSULT THE MANUFACTURER.

Complete the following table to determine the Design Demand:

DEMAND TYPE		Average (gpm)	Peak Factor	Maximum (gpm)
Domestic Demand				
Residential, # of homes	☐ x 0.35 =		x 2.5	
Commercial, # of capita	☐ x 0.07 =		x 2.5	
Industrial, # of capita	☐ x 0.07 =		x 2.5	
Other:			x ☐	
*** Process Water Demand**				
Description:			x 1.6	
Description:			x ☐	
*** Indirect Demand**				
Description:				
Description:				
*** Unknown Demand**				
Description:				
Description:				

Fire Flow (check all that apply but use only highest flowrate in Design Demand determination)

- ☐ Residential (minimum 1,000 gpm) ______
- ☐ Commercial (typically 1,500 - 2,500 gpm) ______
- ☐ Industrial (typically 1,500 - 3,500 gpm) ______
- ☐ Other ______

DESIGN DEMAND TOTAL ______

* Documentation verifying or justifying this type of demand must be provided. This can include text references, studies, comparisons, or other sources of information.

Complete the following table to determine if minor losses must be included in overall hydraulic calculations.

Length of Proposed Project (sorted by diameter)	Diameter (inches)	Diameter Length (DL)
Example: 700 LF of 6” diameter pipe		
700	x 6 /12 =	350
	x /12 =	
	x /12 =	
	x /12 =	
	x /12 =	
	x /12 =	
	x /12 =	

TOTAL = feet*

* If DL total is equal to or less than 1,500 feet, then minor losses must be considered in overall hydraulic calculations. See Exhibit W5-4, Minor Losses Worksheet 2. If DL total is greater than 1,500, then minor losses may be omitted in overall hydraulic calculations.

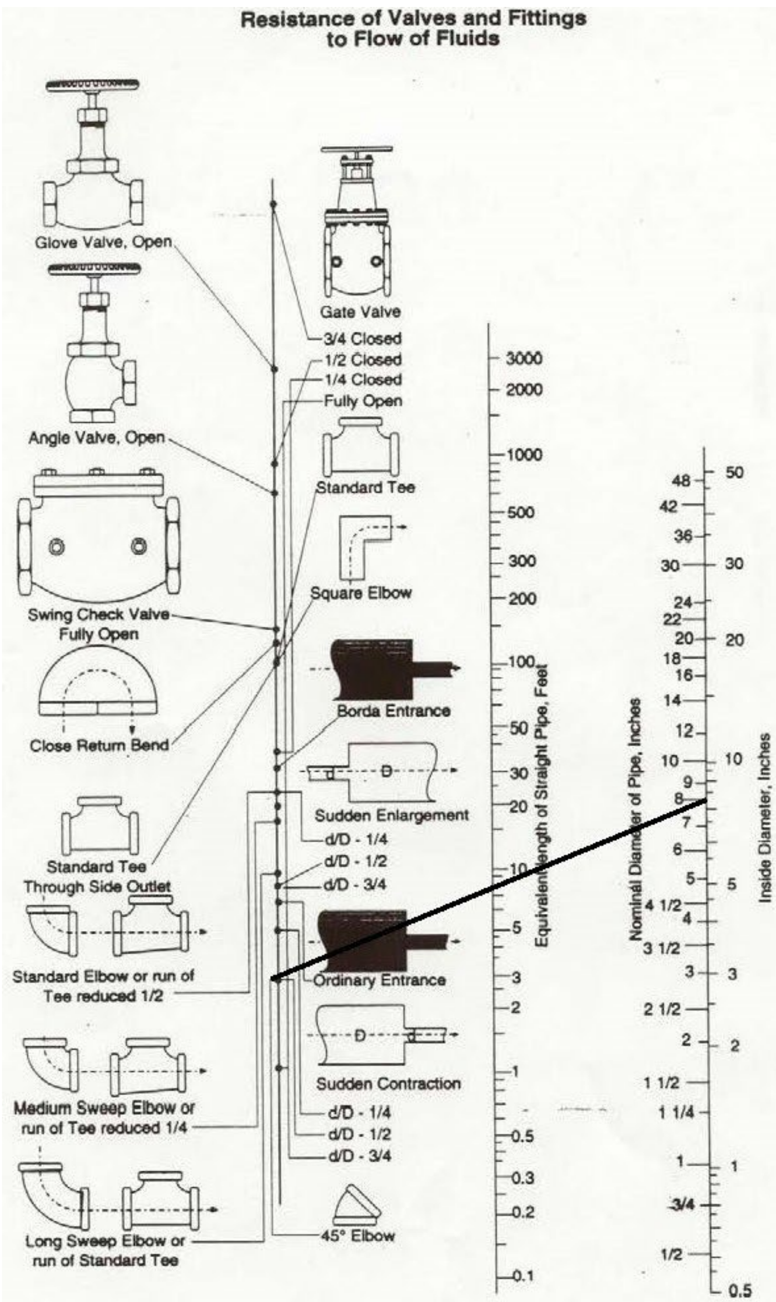
City Utilities	City Utilities Design Standards Manual	Exhibit W5-4 Minor Losses Worksheet 2
		Version: June 10, 2014

METHOD #1

Minor losses can be generalized into the pipe segment calculations by assuming a C factor of 10% less than original values.

Example:	New PVC pipe without minor losses:	C=120
	New PVC pipe assuming minor losses:	C=108 (120 x 0.9 = 108)

METHOD #2



Determine Minor Losses by using equivalent lengths of pipe by drawing a straight line between the diameter of the pipe and the appropriate source of loss (fitting, valve, entrance, etc.), read the equivalent length of straight pipe.

Example:
Given: 45 degree elbow on 8" diameter line (see drawn line)

Solution: Equivalent length of straight pipe = 8 feet; Thus use 8 feet of 8" pipe for the friction loss calculations of the fitting.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit W5-5 Friction Losses, Unidirectional Dead End Segment Worksheet Version: June 10, 2014 **Fillable Version**

Step 1: Sketch the Pipe Segment

Segment ID# ______________

Step 2: List Variables

Flow ⟷ (circle one) diameter _____________ (in) C ___________

L _____________ (ft) Q _________________ (gpm) Age: ☐ New or _________ years

Step 3: Determine head loss (in feet)

$$h_f = (10.44)\,(L)\left(\frac{Q^{1.85}}{C^{1.85} * \text{diameter}^{4.87}}\right)$$

$$h_f = (10.44)\,(\boxed{})\left(\frac{\boxed{}^{1.85}}{\boxed{}^{1.85} * \boxed{}^{4.87}}\right)$$

$$h_f = (\boxed{})\left(\frac{\boxed{}}{\boxed{} * \boxed{}}\right)$$

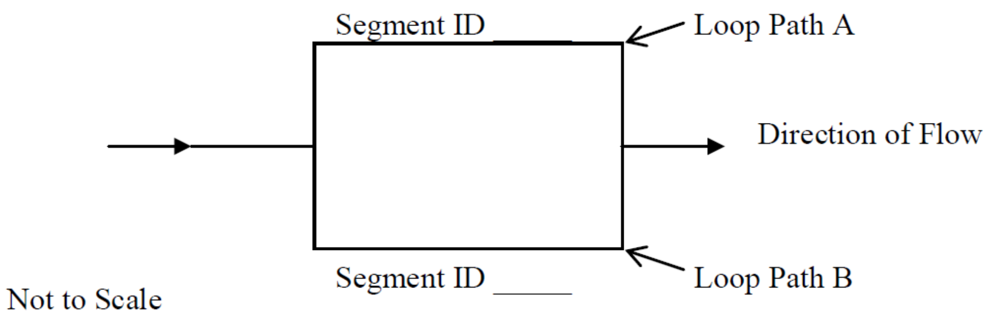
$$h_f = (\boxed{}) * (\boxed{}) = \qquad \text{ft of loss}$$

Step 4: Convert head to psi

$$h_f(\text{ft}) = \boxed{} * \frac{1 \text{ psi loss}}{2.31 \text{ ft loss}} = \qquad \text{psi of loss}$$

City Utilities Design Standards Manual	Exhibit W5-6 Friction Losses, Unidirectional Single Loop Worksheet
	Version: June 10, 2014 — Fillable Version

Step 1: Label the Loop



Step 2: List Variables

	Loop Path A	Loop Path B
Diameter	________________	______________________
Age:	☐ New or ________ years	☐ New or ________ years
C	______________	C ______________
L	______________	L ______________

Step 3: Converge Loop Path Qs

		Loop Path A	Loop Path B
Trial #1	Q	_______________	_______________
	h_f	_______________	_______________
Trial #2	Q	_______________	_______________
	h_f	_______________	_______________
Trial #3	Q	_______________	_______________
	h_f	_______________	_______________

After each trial, compare hf values. If not within 1.0 psi or less, reduce the corresponding Q of the higher h_f. Repeat trials until loop path h_f values are within 1.0 psi or less. Then use the higher value.

Repeat trials until loop path h_f values are within 1.0 psi or less. Then use the higher value.

Step 1: List Variables

FLOW TEST ID# ____________ *

ST_{FT} = Static Pressure @ Pressure Hydrant location _____________ psi *

RP_{FT} = Residual Pressure @ Pressure Hydrant location _____________ psi *

Q_{FT} = Flow rate @ Residual Pressure of flow test ____________ gpm *

Q_{DD} = Flow rate of Design Demand _____________ gpm

RP_{DD} = Residual Pressure @ Pressure Hydrant @ Design Demand see below

* = Directly read from FLOW TEST

Step 2: Determine RP_{DD}

$$RP_{DD} = ST_{FT} - \left((ST_{FT} - RP_{FT})^{1/1.85} * \frac{Q_{DD}}{Q_{FT}} \right)^{1.85}$$

$$RP_{DD} = \boxed{} - \left((\boxed{} - \boxed{})^{1/1.85} * \frac{\boxed{}}{\boxed{}} \right)^{1.85}$$

$$RP_{DD} = \boxed{} - \left((\boxed{})^{1/1.85} * \boxed{} \right)^{1.85}$$

$$\boxed{} - (\boxed{} * \boxed{})^{1.85}$$

$$\boxed{} - \boxed{}^{1.85}$$

$$\boxed{} - \boxed{}$$

RP_{DD} = $\boxed{}$ psi

Step 1: Sketch Schematic of Overall Project

PROJECT NAME ___________________________

Highest elevation in project area _________ feet

NOT TO SCALE

Sketch must include Pressure Hydrants for all flow tests, existing pipe, point(s) of connection, segment ID#'s, diameter, length, and C factor. The elevation for all Pressure Hydrants must be shown. Label all "plausible" Most Remote Point(s) in project area. Test each Most Remote Point with Steps 2, 3, and 4. More Most Remote Points may be added during testing.

Step 2: Sketch Most Remote Test Point (separate sheet for each test)

Most Remote Test Point # ______________________________

Sketch must include Pressure Hydrant, existing pipe, point of connection, Most Remote Point #, segment ID#'s, diameter, length, and C factor, and elevation at Pressure Hydrant and Most Remote Point.

Step 3: Sum the losses to the Most Remote Point

Segment ID#		***Velocity***	***Losses along Segment***	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	
Segment #			Friction Losses Minor Losses	

Elevation @ Most Remote Point					
Elevation @ Pressure Hydrant					
Difference	±		x 1ft/2.31 psi	±	
Sum of Losses to Most Remote Point				±	

Residual Pressure @ Pressure Hydrant @ Design Demand (RP_{DD}) Result of Exhibit W5-7		
Sum of Losses to Most Remote Point (from above)		
Difference (Note: Result must be a minimum of 20 psi)	±	

Book 4

Water (W)

W6 Building Services

W6.01 Purpose

This Chapter establishes the technical design and construction criteria for all water service pipe within the City of Fort Wayne water distribution system. Any variances from these requirements shall be approved by City Utilities Development Services (DVS) and in compliance with **Chapter GR3 – Variances**.

See **Section W1.03 – Definitions** for the definition of customer service line, public service line, and water service line.

1. Plumbing Codes

   Water Service pipe shall conform to the latest adopted version of the **Indiana Plumbing Code (IPC) 675 IAC 16** and to these standards, whichever is more restrictive.

2. Covered in this Chapter

   - Service Pipes
   - Services 2” and Less
   - Services Greater than 2”
   - Service Meters
   - Connections Using an Existing Building Service
   - Future Connections

3. Covered in Other Chapters

   - **Chapter MA4 – Common Materials and Testing Requirements**
   - **Chapter MA7 – Water Materials and Testing Requirements**
   - **Chapter W1 – Acronyms and Definitions**
   - **Chapter W5 – Water Main Design**
   - **Chapter W8 – Backflow Prevention**
   - **Chapter W9 – Fire Services**

W6.02 Water Service Lines

1. Sizing Water Service Pipes

   The AWWA M22 design manual, Sizing Water Service Lines and Meters, is a reference guide for water service pipe design. The latest version of the AWWA M22 design manual shall be used determine the maximum flows that can be expected, and provide criteria for designing and sizing the proposed service lines and meters from the main.

The AWWA M22 design manual requirements shall be used for all service conditions. If other water service pipe design methods are used they shall require consultation with and approval from City Utilities.

2. Water Service Pipe Requirements

- The minimum diameter of service pipe shall be one inch (1”) for HDPE DR9.
- Customer owned service lines with private fire hydrants shall be a minimum of six inches (6”) in diameter.
- Individual customer owned service lines will be required for each house or facility served by the public water supply system. Customer owned service lines shall be individually metered.
- A water service pipe shall not cross the property of another private owner unless such private owner has granted a permanent easement for such water service pipe which is duly recorded in the Office of the Allen County Recorder.
- All water service pipe connections to water mains 16 inches (16”) in diameter shall require prior approval from City Utilities.
- Water service pipe connections shall not be installed on water mains larger than 16 inches (16”) in diameter.
- The minimum depth of cover above the pipe shall be five (5) feet.
- Pipe materials shall be in accordance with **Chapter MA7 – Water Materials and Testing Requirements**.
- Tracing wire shall be installed on all water service pipes. Refer to Standard Drawings **W-52** and **W-53** for tracing wire installation for water service lines.

W6.03 Water Service Pipes 2” and Less

Refer to Standard Drawing **W-40** Service Installations for requirements for small service installations. Service installations for services two inches (2”) in diameter and less shall meet the following requirements:

1. Water Service Taps

   Corporation stops or HDPE tapping trees shall be required at each service line tap to the distribution system. If HDPE tapping tees are used and the desire is to use two public service lines from the single HDPE tapping tee consult with City Utilities for approval.

2. Curb Stops

   Curb stops shall be installed for each service. Curb stops shall be placed a minimum of eight feet (8’) from the side property line. Curb stops shall be located within the right-of-way a minimum of two feet (2’) from the front property line. The curb stop shall be located between the curb and the sidewalk. All efforts shall be made to keep the curb stop outside of proposed driveway locations. The curb box and lid shall accompany each curb stop and shall be placed flush with the final grade. Refer to Standard Drawing STR-44 Curb Box for requirements.

3. Metering

Water meters shall be installed on each customer owned service line and shall meet the requirements per section W6.05 of this Chapter. Refer to Standard Drawing W6-1 for Small Water Meter Spacing (sizes 5/8" - 1"). For Standard Water Meter Spacing for Large Meters (sizes 1 1/2" - 10") refer to Standard Drawing W6-3 for Standard Meter Spacing for interior installations and Standard Drawing W6-5 for pit installations.

New developments that are proposed to have multiple buildings served by a private water main system, especially if the buildings are all on one property or owned by one property owner, may be required to be master metered at the private water main connection to the City Utilities water system.

W6.04 Water Service Pipe Greater Than 2"

Refer to Standard Drawing W-40 Service Installations for requirements for large service installations. Service installations for services greater than two inches (2") in diameter shall meet the following requirements:

1. Connection

Services greater than two inches (2") in diameter shall be connected to the water main with a tee and independent valve. All service pipe shall be properly restrained.

All critical customers shall have two mainline values installed in addition to the tap connection unless approved by City Utilities.

Critical Customers' are defined as consumers or service connections that are critical to community resiliency (public safety or health), or demand a large volume of water to sustain economic resiliency, or service a susceptible population such as but not limited to and specific to Fort Wayne:

- State or Federal Prisons and Jails
- Hospitals / Medical Centers (including dialysis centers)
- Nursing Homes / Assisted Living / Homeless Shelters
- Universities / High Schools / Elementary / Middle Schools / Preschool and Day Care Centers

2. Metering

Water meters shall be installed on each individual service line and shall meet the requirements per section W6.05 of this Chapter. For Standard Water Meter Spacing for Large Meters (sizes 1 1/2" - 10") refer to Standard Drawing W6-3 for Standard Meter Spacing for interior installations and Standard Drawing W6-5 for pit installations. Refer to Standard Drawing W6-4 for Fire Line Water Meter Spacing.

New developments that are proposed to have multiple buildings served by a private water main system, especially if the buildings are all on one property or owned by one property owner, or if there is a large amount of private water main proposed in the development, will typically be required to be master metered at the private water main connection to the City Utilities water system.

W6.05 Service Meters

Water meters shall be located within the building. Any meter proposed to be located outside of the building shall be approved by City Utilities and shall be located within an approved meter pit.

1. Meter Requirements

   A. Meter sizing must recognize average and peak demand needs of the facility served and the route of delivery. Water meters shall have their size recommended by the project engineer and reviewed and approved by CU Engineering before work requests are sent to Water Maintenance & Service for installation.

      a. Water meters larger than 4 inches shall be sized based on a maximum peak flow allowed of 50% of the Safe Maximum Operating Capacity listed in AWWA standards, unless there are multiple water meters feeding the customer

   B. Meters shall meet the requirements as noted in Chapter MA7 – Water Materials and Testing Requirements.

   C. Refer to Standard Drawing W6-1, Standard Drawing W6-3, Standard Drawing W6-4, and Standard Drawing W6-5 for spacing requirements during installation.

   D. Meter pits shall be per the requirements as shown in Standard Drawing W-61.

   E. Remote capabilities as defined by City Utilities shall be required on water meters. Water meters shall be set to include installation of wiring from the meter to a radio endpoint on the side or front of the building or residence as shown in Standard Drawing W6-2 Water Meter Radio Equipment.

   F. City Utilities shall be consulted for remote capability requirements and coordination for the installation location.

   G. For water meters six inch and larger on master metered customers, designs of the vault shall include a dual output meter capability located inside a sealed steel capsule including sump pump, high water alarm, dehumidifier, anode corrosion protection system, exhaust fan, lighting and lighting panel, ladder, ladder up, heater, and a sealed hatch. Electrical power, PLC, and controls wiring to meet city utilities standards. Consult with City Utilities Engineering for approved vault manufacturers.

2. Bypass Requirements

   A. A bypass around all new meter installations shall be required under any of the following circumstances, where:

      - The service line on the outlet side of the meter is one and one-half inches (1 ½”) or larger.
      - The water service must not, for any other reason, be interrupted while the meter is being repaired or replaced.

   B. The bypass around the meter shall be furnished and installed by the utility customer according to the Utility’s specifications.

   C. Where existing piping not containing a by-pass is altered to meet any of the above conditions, the alteration shall also include the installation of a by-pass.

   D. A bypass around irrigation lines shall not be permitted.

   E. For Customers with meters six inch and larger and water use needs that require water service to maintained at potentially high rates of flow for an extended period of time while the water meter is being worked on, the bypass line must be metered or the customer must have more than one metered connection.

W6.06 Connections Using an Existing Building Service

Existing building water service lines may be used in connection with new buildings only when they are found, upon examination and testing, to meet the current code requirements for building water service lines.

W6.07 Future Connections

Water service pipe installed for future connections shall be terminated at the street right-of-way or easement and shall be properly capped.

A tracer wire shall be installed terminating at a metal locator rod at the end of the capped water service pipe to within one (1) foot of the finished grade. Refer to **Chapter MA7 – Water Materials and Testing Requirements** for tracing wire material requirements.

W6.08 Private Booster Pumps

Booster pumps on domestic water systems are not allowed unless specifically approved by DVS and CUE. See **Fort Wayne Water Utility General Rules and Regulations**.

Book 4

Water (W)

W7 Appurtenances

W7.01 Purpose

This Chapter focuses on the appurtenances necessary for the proper design of potable water distribution systems. This Chapter establishes the minimum standards and technical design criteria for water main appurtenances for all City of Fort Wayne water distribution systems. All variances from these design standards shall be approved prior to commencement of design in compliance with **Chapter GR3 – Variances**. Refer to **Chapter MA7 – Water Materials and Testing Requirements** for material requirements.

This Chapter covers the following items:

- Valves
- Fire Hydrants
- Fittings
- Air Release Valves
- Blow-off Assemblies
- Temporary Test Risers
- Tracing Wire

W7.02 Valves

Valves are to be provided on water mains for isolation of the water distribution system as necessary for inspection and repair.

1. Valve Location
    - Valves shall be located at three (3) branches of a cross intersection. Crossing fittings are not allowed and two tees should be used.
    - Valves shall be located at two (2) branches of a tee intersection. Where three 12” or larger water mains are connected valves shall be installed on all sides of the tee, unless approved by City Utilities.
    - Valves shall be located as required to maintain the Maximum Allowable Valve Spacing per Figure W7.1 below.
    - Refer to the Typical Valve Placement Standard Drawings, **W-1** and **W-2**, for schematic layouts for valve location requirements.
    - Line valves along long runs shall be bolted to the hydrant tee.
2. Valve Requirements
    - Valves shall meet the requirements as defined in **Chapter MA7 – Water Materials and Testing Requirements**.

- A valve box and lid shall accompany each valve.
- Refer to the Standard Drawing **STR-43** Valve Box for requirements for installation.
- Valves 24-inches or greater shall be butterfly valves. Valves less than 24-inches shall be resilient seat wedge valves.

Figure W7.1 Water Main Line Valve Spacing

Maximum Allowable Valve Spacing Intervals	
6” and 8”	900’
12”	1,600’
16”	2,200’
24” and greater	Consult City Utilities

W7.03 Fire Hydrants

Fire Hydrants shall be installed along all water mains that are at least six-inches in diameter and that have been designed to carry fire flow. Hydrants shall be designed per the following guidelines:

1. Hydrant Requirements

   A. All fire hydrants shall meet the requirements as defined in **Chapter MA7 – Water Materials and Testing Requirements**.

   B. All fire hydrants shall be equipped with an auxiliary valve.

   C. All fire hydrants shall be restrained for the entire length from the hydrant to the tee fitting.

2. Assembly Configurations

There are six (6) fire hydrant assembly configurations that are acceptable for use in the distribution system. These configurations are depicted in Standard Drawings **W-10**, **W-10-1**, **W-12**, **W-12-1**, **W-13**, **W-14**, **W-15**, **W-16**, and **W-16-1**.

3. Drainage

   A. Hydrants shall be placed within a drainage pit. The drainage pit area shall consist of aggregate material consisting of INDOT No. 5, INDOT No. 8, or INDOT No. 9. Refer to the Standard Drawing **W-17** Standard Hydrant Setting for installation requirements.

   B. No hydrant drainage pit shall be connected to a sewer.

4. Location

   A. Fire hydrants shall be located in a manner to provide complete accessibility, and in such manner that the possibility of damage from vehicles or injury to pedestrians is minimized.

   B. Fire hydrants should be located at every major intersection and shall not exceed average spacing intervals of 500-feet in residential areas, 400-feet in commercial areas, and 350-feet in industrial or other higher risk areas.

C. When hydrants are required at intermediate points between intersections they shall be placed near property lines, in locations that avoid driveways and in locations where they will not be damaged.

D. When set in the lawn space between the curb and the sidewalk, or between the sidewalk and the right-of-way, no portion of the hydrant or nozzle caps shall be within 6-inches of the sidewalk.

E. When placed behind curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle caps will be less than 12-inches from the back of the curb. Refer to the General Location of Fire Hydrant Standard Drawings **W-18** and **W-19**.

F. When hydrants are placed in sidewalks, block-outs should be utilized per the Block-Outs in Sidewalks for Fire Hydrants Standard Drawing **W-20**.

G. Fire hydrants shall be separated from potential sources of contamination by at least ten feet (10’) horizontally measured from the outside edge of the hydrant to the outside edge of the potential contamination source. Refer to **Chapter W5 – Water Main Design** for distance requirements from potential contamination sources.

H. When feasible, align hydrant barrels with property corner lines.

I. Hydrants shall have a minimum clear zone of 3-feet from utility poles and have a minimum of 5-feet of separation between a utility pole and any hose nozzle.

5. Protection

A. When structural protection of the hydrant is directed from the developer, engineer, or City Utilities, protective guard bollards should be placed. Posts shall be per the Standard Drawing W-21 Fire Hydrant Bollards.

6. End Points of Water Mains

A. Flushing devices consisting of fire hydrants or blow-off assemblies shall be placed at permanent or temporary end points of water mains.

B. Type III fire hydrant followed by a reducing valve and a blow-off assembly shall be placed at water main end points greater than 8-inches in diameter.

C. Blow-off Assemblies shall be placed at water main end points for water mains 8-inches in diameter and less. Refer to **Section W7.06 – Blow-Off Assemblies**.

D. Type III fire hydrant followed by a reducing valve and 2 inch main is the preferred method of ending a main in a cul-de-sac or short dead-end road. The maximum dead-end length of 2-inch pipe into a cul-de-sac or dead-end road is 400 feet. The maximum dead-end length of 6-inch pipe is 600 feet and shall end with a fire hydrant assembly.

W7.04 Fittings

All water main fittings shall meet the requirements as defined in **Chapter MA7 – Water Materials and Testing Requirements**.

1. Water Main Crossing Connection

   Water main replacement or proposed water main installation with a proposed connection into the crossing water main shall be completed with a tee fitting and elbow and shall not connect with a cross fitting. Refer to the Standard Drawing W-41 Round Way Connection for an example.

2. Water Main Deflection

   When space allows the preferred method for vertical and horizontal deflections shall be to use 45 degree, 22 ½ degree and 11 ¼ degree bends in lieu of a 90 degree bend.

W7.05 Air Release Valves

Air release valves or other air release devices shall be installed at any intermediate apex points in the water main where air may accumulate in the water main. In typical circumstances, either water service pipe or fire hydrants act as air release structures. A specific project design may require the installation of an air release valve. The installation of an air release valve shall be considered primarily for water mains with limited water service pipe connections. City Utilities shall be consulted and a request for a variance shall be submitted for approval to install an air release valve.

W7.06 Blow-Off Assemblies

Flushing devices consisting of fire hydrants or blow-off assemblies shall be placed at all permanent or temporary end points of all water mains. Fire hydrants are the preferred method of ending a main. Blow-off assemblies may be used to end water mains 8-inches in diameter or less only where a fire hydrant has not already been required due to an intersection or spacing requirements. Blow-off assemblies should be limited to 2-inches without prior approval from the Engineer.

The Standard Drawing **STR-42** Blow-Off Assembly provides temporary and permanent blow-off assembly configurations.

W7.07 Temporary Test Risers

Temporary test risers will be required during construction of the distribution system extension for use in pressure testing and disinfection. DVS or CUE shall be consulted to determine the riser locations. In general, the temporary risers shall be installed as required for pressure and disinfection and as specified in the materials and construction sections and shall be removed at the end of construction. Risers shall be located at least once for every 1,200-feet of main and at dead end locations. The preference is to utilize test risers for water service pipes where possible.

Refer to the Standard Drawings **W-24**, and **W-25** for configuration details and requirements for test risers.

W7.08 Tracing Wire

Tracing wire shall be used for identifying buried water infrastructure. Tracing wire shall be installed on all water main lines, services and hydrants. The tracing wire shall be brought to ground level at each valve and hydrant.

1. Tracing wire shall meet the requirements as defined in **Chapter MA7 – Water Materials and Testing Requirements**.

Book 4

Water (W)

W8 Backflow Prevention

W8.01 Purpose

The purpose of this Chapter is to provide general backflow (cross connection) prevention requirements for service pipes connecting to the City of Fort Wayne water distribution system. All variances from these design standards shall be approved prior to commencement of design in compliance with **Chapter GR3 – Variances**.

Definitions are located in **Chapter W1 – Acronyms and Definitions**.

1. Codes

   Backflow prevention shall meet the requirements of these standards and the latest adopted versions of the following codes, whichever is more restrictive:

   - Indiana Administrative Code, 327 IAC 8-10
   - Indiana Building Code

2. Covered in this Chapter

   - Submittals and Approvals
   - Backflow Prevention Requirements
   - Backflow Prevention Exemption
   - Types of Backflow Prevention
   - Appropriate Use of Backflow Prevention Devices
   - Installation Requirements
   - Inspection Requirements
   - Inspection Reports
   - Disconnection/Removal/Bypass

3. Covered in Other Chapters

   - **Chapter MA4 – Common Materials and Testing Requirements**
   - **Chapter MA7 – Water Materials and Testing Requirements**
   - **Chapter W5 – Water Main Design**
   - **Chapter W6 – Building Services**
   - **Chapter W9 – Fire Services**

W8.02 Submittals and Approvals

All project submittals, approvals and permits for backflow prevention shall be per the requirements of the Development Services Department (DVS).

W8.03 Backflow Prevention Requirements

Backflow prevention is required for the protection of the City's water distribution system from contamination through uncontrolled cross connections. The City of Fort Wayne has regulatory authority regarding the control and requirements for all cross connections within the City's water distribution system.

Backflow prevention is required when one or more of the following situations apply:

1. By Order of IDEM

   Backflow prevention is required for proposed or existing facilities if the commissioner of IDEM so orders. This order shall be a written notification from the commissioner of IDEM in accordance with Title 327 IAC 8-10-4(d). The notice shall specify the nature of the customer activity that necessitates designation of the facility as a cross connection hazard and the date by which the facility must comply with the order.

2. By Order of City Utilities

   Backflow prevention is required for proposed or existing facilities if City Utilities so orders. A notice shall be given specifying the nature of the customer activity that necessitates designation of the facility as a cross connection hazard and the date by which the facility must comply with the order.

3. New Construction

   Backflow prevention shall be required for the following proposed facilities:

   - Cross Connection Hazard Facilities - Backflow prevention shall be required for all proposed facilities designated as a cross connection hazard by Title 327 IAC 8-10-4(c).
   - Spec Buildings - Backflow prevention shall be required for all proposed facilities with currently unknown tenants. These facilities are commonly called "spec buildings".
   - Facilities with Carbonated Fountain Soft Drink Machines - Backflow prevention shall be required for all proposed facilities that plan to use carbonated soft drink machines.
   - Facilities with Secondary Source of Supply - Backflow prevention shall be required for all proposed facilities that include a secondary source of supply for any use including, but not limited to, emergency use, fire prevention, irrigation or economics.
   - Facilities with Fire Protection Service - Backflow prevention shall be required for all proposed facilities that plan to use fire protection service lines into the facility. This does not include those proposed facilities that plan only the use of private, on-site or outside fire hydrants.

Exhibit W8-1 Summary Checklist for Backflow Preparation Requirements is a checklist summarizing when backflow prevention is required for new construction.

4. Existing Facilities

   Backflow prevention shall be required for the following existing facilities that are proposing modifications:

   - Installation of Customer-Owned Service Line - Backflow prevention shall be required for all existing facilities if that facility proposes installation of a service pipe (new customer) and the existing (or proposed modified) facility meets the description of any of the proposed facilities listed in Exhibit W8-1.

   - Modifications to Customer-Owned Service Line – Backflow prevention shall be required for all existing facilities if that facility proposes modifications to their customer-owned service line and the existing (or modified) facility meets the description of any of the proposed facilities listed in Exhibit W8-1.
   - Modification to Customer Service Meter – Backflow prevention shall be required for all existing facilities if that facility proposes installing additional or a larger capacity meter(s) and the existing (or modified) facility meets the description of any of the proposed facilities listed in Exhibit W8-1.

5. Existing Facilities with a Cross Connection

   Backflow prevention shall be required for all existing facilities where a cross connection has occurred.

W8.04 Backflow Prevention Exemption

Backflow prevention that has been required by any of section W8.03 Backflow Prevention Requirements of this Chapter may only be granted an exemption of backflow prevention requirements or a lessening of backflow prevention requirements with approval from IDEM and the City. IDEM approval shall be per Title 327 IAC 8-10-4€. City approval shall be per a variance submitted in compliance with Chapter GR3 – Variances.

W8.05 Types of Backflow Prevention

Backflow prevention devices that are approved for use shall meet the requirements per section MA7.10 of Chapter MA7 – Water Materials and Testing Requirements. Isolation valves are not acceptable for backflow prevention and are not approved devices for use in backflow prevention. The following are types of approved devices for use in backflow prevention:

1. Air Gap (AG)

   Air gaps (AG) are acceptable devices for backflow prevention. A representative sketch of these devices is presented in Standard Drawing W-30 Air Gap – Backflow Prevention.

An AG is the unobstructed vertical distance through a free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank, plumbing fixture, or other device and the flood level rim of the receptacle.

The discharge pipe of an AG shall terminate per one of the following:

- A minimum of two (2) pipe diameters of the discharge pipe or 6-inches, whichever is the lesser, above the maximum recorded flood level or above the flood level rim of the receiving vessel, whichever is higher.
- A minimum of three (3) pipe diameters of the discharge pipe or 6-inches, whichever is the lesser, above the maximum recorded flood level or above the flood level rim of the receiving vessel, whichever is higher where:
- a side wall, rib, or similar obstruction is spaced closer than three (3) pipe diameters from the piping affecting the AG or
- two (2) intersecting walls are located closer than four (4) pipe diameters from the piping affecting the AG
- The minimum AG separation shall be 1-inch.

2. Atmospheric Vacuum Breaker (AVB)

Atmospheric Vacuum Breakers (AVB) are acceptable devices for backflow prevention for only specified types of cross connection hazards as discussed in section W8.06 Appropriate Use of Backflow Prevention Devices of this Chapter. A representative sketch of this device is shown in Standard Drawing **W-31** Atmospheric Vacuum Breaker Backflow Preventer.

All AVBs shall meet the following requirements:

- Contain an air inlet valve, a check seat, and an air port.
- Installed as near as possible to the cross connection hazard.
- Positioned not less than 6-inches from the base of the AVB down to the flood level rim of the receptacle.
- Installed at a location that allows access to the device for maintenance or replacement from floor or ground level without the use of a ladder or similar temporary apparatus.
- Located in an area not subject to flooding, excessive heat, or freezing.

3. Pressure Vacuum Breaker (PVB)

Pressure Vacuum Breakers (PVB) are acceptable devices for backflow prevention for only specified types of cross connection hazards as discussed in section W8.06 Appropriate Use of Backflow Prevention Devices of this Chapter. A representative sketch of this device is shown in Standard Drawing **W-32** Pressure Vacuum Breaker Backflow Preventer.

All PVBs shall meet the following requirements:

- Contain an internally loaded check valve and an internally loaded air inlet valve.

- Installed with shut-off valves and test cocks located at each end of the assembly.
- Installed as near as possible to the cross connection hazard.
- Positioned not less than 6-inches from the base of the PVB down to the flood level rim of the receptacle and not less than 12-inches from the centerline of the PVB outlet to the highest outlet, whichever is greater.
- Installed at a location that allows access to the device for maintenance and testing from floor or ground level without the use of a ladder or similar temporary apparatus.
- Located in an area not subject to flooding, excessive heat, or freezing.
- Installed between two (2) tightly closing shut-off valves with its center or datum point a minimum of 12-inches above the following:
- Floor level
- The highest downstream piping or shut-off valve
- The highest downstream overflow rim or discharge point

4. Double Check Valves (DC)

   Double Check Valves (DC) are acceptable devices for backflow prevention for only specified types of cross connection hazards as discussed in section W8.06 Appropriate Use of Backflow Prevention Devices of this Chapter. A representative sketch of this device is shown in Standard Drawing **W-33** Double Check Valve Backflow Preventer.

   All DCs shall meet the following requirements:

   - Consist of two (2) tightly closing shut-off valves surrounding two (2) independent acting check valves.
   - Contain four (4) test cocks; one (1) upstream of the four (4) valves and one (1) in between each of the four (4) check and shut-off valves.
   - Installed at a location that allows access to the device for maintenance and testing from floor level or ground level without the use of a ladder or similar temporary apparatus.
   - Located in an area not subject to flooding, excessive heat, or freezing.

   Double Check Valves may be installed within a pit upon prior approval from the City.

5. Reduced Pressure Principle Backflow Preventer (RP)

   Reduced Pressure Principle Backflow Preventers (RP) are acceptable devices for backflow prevention. A representative sketch of this device is shown in Standard Drawing **W-34** Reduced Pressure Principle Backflow Preventer.

   All RPs shall meet the following requirements:

   - Consist of two (2) tightly closing shut-off valves surrounding two (2) independently acting pressure reducing check valves.
   - Consist of two (2) independently acting pressure reducing check valves shall surround an automatic pressure differential relief valve and four (4)

test cocks; one (1) upstream of the five (5) valves and one (1) between each of the four (4) check and shut-off valves.

- Located to effectively divide the structure into three (3) chambers.
- Reduced pressure in each downstream chamber allowing the pressure differential relief valve to vent the center chamber to atmosphere should either or both check valves malfunction.
- Installed with no additional piping affixed to the pressure differential relief valve port, and with the pressure differential relief valve port a minimum of 12-inches and maximum of 60-inches above floor level.
- Installed at a location where any leakage from the pressure differential relief valve port may be observed or noted.
- Installed at a location that allows access to the device for maintenance and testing from floor level or ground level without the use of a ladder or similar temporary apparatus.
- Located in an area not subject to flooding, excessive heat, or freezing.

W8.06 Appropriate Use of Backflow Prevention Devices

The effective prevention of cross connecting is highly dependent on the use of the appropriate backflow prevention device for the hazard. Air Gap (AG) backflow prevention devices and Reduced Pressure Principle Backflow Preventers (RP) are appropriate for all cross connection hazards.

Exhibit W8-2 provides a guideline for the appropriate backflow prevention device to use with facilities that have a cross connection hazard. Exhibit W8-3 provides a guideline for the appropriate backflow prevention device to be used for fixtures with a cross connection control hazard.

Facilities shall construct an AG or install a RP or a DC assembly on the customer owned service line to each of the following:

- Tanks used only to store water from the public water supply for fire suppression that are constructed to maintain the bacteriological quality of the water.
- Secondary sources of supply that:
- use well water as the only private source of supply;
- are constructed to maintain the bacteriological quality of the water,
- produce, without treatment, water meeting the drinking water quality standards.

Facilities shall construct an AG or install a RP on the facility service pipe to or into a facility having a secondary source of supply of a type other than those identified that is used for only fire suppression. No secondary source of supply of a type other than those identified above shall be physically connected on the facility service pipe to or into the facility.

Facilities shall construct an AG, or install a RP or PVB on the water service pipe connecting the public water supply to any subsurface land irrigation system.

Any other situation not already discussed or presented in **Exhibit W8-1**, **Exhibit W8-2**, or **Exhibit W8-3** but requiring backflow prevention shall require an AG or RP.

W8.07 Installation Requirements

Backflow prevention devices shall be installed per the requirements discussed below.

1. Location
   - Backflow prevention devices shall be installed after the meter (on 5/8-inch through 1-inch services) or after the meter bypass line (on 1 ½-inch or larger services).
   - Pit, chamber, manhole or other below grade installation of backflow prevention devices is prohibited with the exception of DC.
   - Backflow prevention devices shall be installed at a height between 12-inches and 60-inches above the finished floor elevation with the exception of DC in a pit, chamber, manhole or other below grade installation.
2. Multiple Services

When two (2) or more piping systems are used for water in a building or industrial plant, extreme care should be taken not to interconnect the systems. There may be a potable water system and systems carrying lesser quality water such as fire protection. To help prevent the possibility of the two systems being interconnected, pipes should be identified adequately by legends and color coding.

W8.08 Inspection Requirements

All backflow prevention devices shall be inspected at the time of installation and results shall be presented to City Utilities. To ensure that the backflow prevention devices are maintained in working order, the backflow prevention devices shall be inspected as follows:

- AG – Intervals not exceeding one (1) year
- RP – Intervals not exceeding one (1) year
- DC – Intervals not exceeding one (1) year
- PVB – Intervals not exceeding one (1) year
- AVB – No inspection requirement
- All cross connection control device inspectors shall be registered with IDEM.

W8.09 Inspection Reporting

Inspection results reporting shall be the responsibility of the facility owner. This includes insuring that the following cross connection control device inspector responsibility is completed:

All required inspection results shall be submitted by the cross connection control device inspector to the customer possessing the backflow prevention device (tenant), facility owner, City Utilities, and, if requested, IDEM within 30 days of the inspection or test.

W8.10 Disconnection/Removal/Bypass

Disconnection/removal/bypass of backflow protection shall not be allowed without prior approval per section W8.04 Backflow Prevention Exemption of this Chapter.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit W8-1 Summary Checklist for Backflow Preparation Requirements
		Version: June 10, 2014 **Fillable Version**

Project Name: ____ Date: ____________________

Project Number: _________________________ Submitted by: _________________________________

Telephone Number: ______________________

Backflow prevention is required for proposed facilities fitting the following description in accordance with 327 Indiana Administrative Code 8-10-4 (c) and the requirements of the City of Fort Wayne.

Read through each item and check the 'yes' box if the corresponding description fits your proposed facility. Check the 'no' box if your proposed facility does not fit the description.

☐ yes ☐ no Aircraft and missile manufacturing plants.

☐ yes ☐ no Automotive plants, including those plants that manufacture motorcycles, automobiles, trucks, recreational vehicles, and construction and agricultural equipment.

☐ yes ☐ no Beverage bottling plants, including dairies and breweries.

☐ yes ☐ no Canneries, packing houses, and reduction plants.

☐ yes ☐ no Car washes.

☐ yes ☐ no Chemical, biological, and radiological laboratories, including those in high schools, trade schools, colleges, universities, and research institutions.

☐ yes ☐ no Hospitals, clinics, medical buildings, autopsy facilities, morgues, other medical facilities, and mortuaries.

☐ yes ☐ no Metal and plastic manufacturing, fabricating, cleaning, plating, and processing facilities.

☐ yes ☐ no Plants manufacturing paper and paper products.

☐ yes ☐ no Plants manufacturing, refining, compounding, or processing fertilizer, film, herbicides, natural or synthetic rubber, pesticides, petroleum or petroleum products, pharmaceuticals, radiological materials, or any chemical that could be a contaminant to the public water supply.

☐ yes ☐ no Commercial facilities that use herbicides, pesticides, fertilizers, or any chemical that could be a contaminant to the public water supply.

☐ yes ☐ no Plants processing, blending, or refining animal, vegetable, or mineral oils.

☐ yes ☐ no Commercial laundries and dye works, excluding coin-operated laundromats.

☐ yes ☐ no Sewage, stormwater, and industrial waste treatment plants and pumping stations.

☐ yes ☐ no Waterfront facilities, including piers, docks, marinas, and shipyards.

☐ yes ☐ no Industrial [or commercial] facilities that recycle water.

☐ yes ☐ no Restricted or classified facilities (federal government defense or military installations), or other facilities closed to the supplier of water or to the commissioner.

☐ yes ☐ no Facilities with soft drink machines.

☐ yes ☐ no Spec. Facilities.

☐ yes ☐ no Facilities with a secondary source of supply.

☐ yes ☐ no Facilities with fire suppression service line (does not including facilities limited only to private hydrants).

If the 'yes' box is checked on any of the above items, backflow prevention is required. See the City of Fort Wayne Design Standards Manual – Water Standards, Chapter W8 Backflow Prevention for guidance.

Facility	Recommended Backflow Prevention Device
Aircraft and missile plants	RP
Automotive plants	RP
Beverage bottling plants	RP
Breweries	RP
Car Washes	RP
Canneries, packing houses, and reduction plants	DC
Chemical plants	RP
Commercial laundries and dye works	RP
Dairies and cold storage plants	DC
Fertilizer manufacturing plants	RP
Fountains	AG/RP
Medical buildings, hospitals, mortuaries, sanitariums, and nursing homes	RP
Laboratories	RP
Metal manufacturing, cleaning, plating, processing and fabricating plants	RP
Motion picture studios	RP
Oil and gas production plants	RP
Paper and paper products plants	RP
Photo labs	RP
Power plants	RP
Rubber plants	RP
Schools and colleges with laboratories	RP
Swimming Pools	AG/RP
Wastewater treatment plants, wastewater/stormwater pumping stations	RP
Waterfront facilities and industries	RP
Water treatment plants	RP

<u>Device</u>

AG - Air Gap

AVB - Atmospheric Vacuum Breaker

DC - Double Check Valve

PVB - Pressure Vacuum Breaker

RP - Reduced Pressure Principle Backflow Preventer

Backflow Prevention Devices

AG – Air Gap
AVB – Atmospheric Vacuum Breaker
DC - Double Check Valve
PVB – Pressure Vacuum Breaker
RP – Reduced Pressure Principle Backflow Preventer

Fixture Type	Recommended Backflow Prevention
Air conditioning equipment with dual safe and unsafe water supplies or with or with direct sewer connection for wastewater Sewer connection for wastewater	RP
Aquariums with a below-the-rim water inlet	AG/RP
Aspirator on surgical, dental, or industrial equipment operated by water ejector	AVB
Automatic devices for filling tanks, boilers, and vats which have overflow connections to a sewer	AVB
Any direct connection between water pipes and sewers, even though gate valves are used	AG/AVB
Any individual vat, tank, etc., which has in inverted water supply confectioner a water supply connection below the top of the spill rim	RP
Baptistery with below-the-rim water connection	AG/AVB
Bath with below-the-rim water connection	Not Allowed
Bedpan washer and sterilizer with below-the-rim water connection, or with inverted water supply subject to direct contamination	AVB
Bidet with submerged inlet	AVB
Boilers	AG/RP
Bird bath with submerged inlet	AG/RP
Cellar drains of the water ejector type	AG
Cistern supply in private home, cross connected with the city supply	RP
Coffee urn with direct water supply and sewer connections	AVB
Combination faucet with one safe and one unsafe supply	AVB
Condenser on medical and industrial equipment	AG/RP
Cuspidor with water supply connection	RP
Commercial dishwashing machines	AVB
Dual water supplies, such as hot water supply from an unsafe source	AG/RP
Dental cuspidor and saliva ejector with unprotected water supply connection	RP
Drinking fountain with submerged water inlet or with the water supply line passing through the drain	Not Allowed
Dishwasher with water inlet below the rim	AVB
Dual water supplies cross connected in factories, etc.	RP
Egg boiler having direct water supply and sewer connections	AVB
Ejector actuated by direct water connection	RP

Fixture Type	**Recommended Backflow Prevention**
Filter with waste connected direct to sewer	AG
Fish pond with submerged water inlet	AG/RP
Floor drain with flushing connection, often used in operating rooms	AVB
Flushometer valve not protected with siphon breaker	AVB
Foot tub with submerged water inlet	Not Allowed
Floor drain having automatic device for sealing	AG
Frost-proof water closet, whether or not the valve drains to the sewer or to the ground surrounding the sewer	AVB
Fire Hydrant with drain connection to sewer or weephole	RP
Garbage can washers	RP
Gas-type chlorinator with dual feed to mixing basin and clear well	AG/RP
Grease trap with water supply connection for flushing	AG
Hose for sink, laundry tray, soap kettles, etc.	AVB
Hose outlets for washing down industrial, commercial, or other equipment	AVB
Hydraulic elevator with waste connection direct to sewer	AG
Hospital equipment such as autoclave, instrument sterilizer, utensil sterilizer, etc., with submerged inlets and with direct connections to the sewer	RP
Industrial processes requiring direct water connections	RP
Industrial water supplies process appliances with direct water supply connections not having adequate air gaps	RP
Kitchen fixtures with common waste and supply lines	Not Allowed
Laundry machinery with common waste and supply lines	RP
Laundry tub with submerged inlet	RP
Lavatory with submerged inlet or with hose connection extended into the fixture, such as used by barbers or beauticians with hair-washing apparatus	AVB
Lawn sprinkling systems	PVB/DC
Lawn sprinkling systems with automatic chemical dispenser	RP
Leaky water main or service near sewer	RP
Make-up water tank at swimming pool with below-water inlet	AG
Ordinary home and store-type evaporative air cooling units, with a float valve to maintain water at a constant level	RP

Fixture Type	Recommended Backflow Prevention
Pump used for dual purposes, with one safe and cone unsafe supply	AG/RP
Pump used for unsafe material having a direct water connection for priming	AG/RP
Pump pit with drain connection to sump or sewer line	AG
Rubber hose with hand control or self-closing faucets attached, as used in connection with baths, industrial vats, containers etc.	AVB
Refrigeration equipment with water cooling	AG/RP
Rubber hose connection extending water line to below the overflow rim of sinks, lavatories, tanks, tubs, laboratory apparatus, etc.	AVB
Sealing ring on sewage pump with direct water connection	AG/RP
Sewage lift with direct water connection	AG/RP
Sinks with below-the-rim water inlets	Not Allowed
Sludge line with direct water connection for flushing	AG/RP
Sterilizers of all kinds, both medical and dental, with submerged inlets	RP
Still with direct water connection	RP
Steam table with water supply connection entering the bottom of the table	AVB
Seat-action toilet with pressure tank with a flush valve in or attached to the bowl	AVB
Swimming pool with direct water connection	AG/RP
Siphon flush tank with water connection below the overflow rim	AG
Therapeutic bath with submerged inlet	AG
Toilet equipped with flushometer valve attached to the bowl	AVB
Tumbler washing in beverage sink having submerged inlet	AG/AVB
Tank with inverted supply or below-the-rim supply	AG
Urinal having direct flushing device	AG
Vat with inverted supply or below-the-rim supply	AG/RP
Water softener overflow pipe	AG
Water cooler improperly designed and using toxic refrigerant which may pollute the water supply	RP
Watering troughs (dairies, hog farms, and horse stables)	AG/AVB
Water-operated aspirator on a suction flask in laboratories, etc	AVB
Water closet of the hopper type with pressure tank having a flush valve in or attached to the bowl	AVB
X-ray developing tank with submerged water supply inlet	RP
Yard hydrant constructed such that ground water may drain into the water supply	RP

Book 4

Water (W)

W9 Fire Services

W9.01 Purpose

The purpose of this Chapter is to provide general requirements and guidelines for fire protection and fire suppression service connections to the City of Fort Wayne water distribution system. Any variances from these requirements shall be approved in compliance with **Chapter GR3 – Variances**.

This Chapter does not detail specific building requirements for fire protection or fire suppression systems. Building fire systems are privately owned arrangement of pipes, fixtures and devices designed for stand-by service from which water supply is taken from the water distribution system for the extinguishment of fires.

1. Codes

   Fire systems shall be installed as required and in accordance with the Indiana Building Code (IBC), the Indiana Fire Code (IFC) and the National Fire Protection Association (NFPA). These codes shall be referenced directly for specific requirements. All fire services shall conform to the latest adopted version of these codes and to these standards, whichever is more restrictive.

2. Covered in this Chapter

   - Submittals and Approvals
   - General Requirements
   - Service Line Separation
   - Meters
   - Appurtenances
   - Installation and Inspection

3. Covered in Other Chapters

   - **Chapter MA4 – Common Materials and Testing Requirements**
   - **Chapter MA7 – Water Materials and Testing Requirements**
   - **Chapter W5 – Water Main Design**
   - **Chapter W6 – Building Services**
   - **Chapter W8 – Backflow Prevention**

W9.02 Submittals and Approvals

All project submittals and approvals from the City Utilities for fire protection system service connections shall be per the requirements in **Chapter W4 – Drawings and Submittals**.

W9.03 General Requirements

Fire protection systems shall be adequately designed to provide fire suppression during fires. The type of fire suppression system (i.e. water, chemical) is subject to approval by state agencies, City Utilities and other local officials.

W9.04 Service Line Separation

The fire service and water service lines shall be separate water service lines with independent valves located outside of the facility served.

When two (2) or more piping systems are used for water in a building or industrial plant, extreme care should be taken not to interconnect the systems. There may be a potable water system and systems carrying lesser quality water such as fire protection. To help prevent the possibility of the separate systems being interconnected, pipes should be adequately identified by legends and color coding.

W9.05 Meters

All fire systems that are to be metered shall allow space for the meter to be located within the building. Any meter proposed to be located outside of the building shall be approved by City Utilities and shall be located within a meter pit or structure.

1. Meter Requirements
    A. Meter sizing shall be based on the flow requirements of the building's fire protection system.
    B. Meters shall meet the requirements as noted in **Chapter MA7 – Water Materials and Testing Requirements** and **Chapter W6 – Building Services**.
    C. Refer to Standard Drawing **W6-4** Fire Line Water Meter Spacing for spacing requirements during installation.
    D. Meter pits shall be per the requirements as shown in Standard Drawing **W6-5**.
    E. Remote capabilities as defined by City Utilities shall be required on water meters. City Utilities shall be consulted for remote capability requirements.
2. Bypass Requirements
    A. A bypass around all fire line meters shall be required. The meter bypass may be one (1) pipe size smaller than the main fire service line. If the meter is located within a meter pit the bypass valves shall be located outside of the meter pit.
    B. The bypass around the meter shall be furnished and installed by the utility customer according to the Utility's specifications.

W9.06 Appurtenances

1. General

   Appurtenances used in conjunction with fire protection services must meet state and local requirements. Materials utilized on the public water supply side of the fire service line shall be consistent with the requirements of **Chapter W7 – Appurtenances** and **Chapter MA7 – Water Materials and Testing Requirements**.

2. Backflow Prevention Device

   A backflow prevention device must be present on all fire protection service lines. Backflow prevention shall be in accordance with **Chapter W8 – Backflow Prevention**.

3. Post Indicator Valve

   Post indicator valves are acceptable. Wall mounted indicator valves require prior approval from City Utilities prior to construction.

4. Fire Booster Pump

   Wherever a fire suppression system has a booster pump installed only for fire suppression, it shall have a control valve installed on the booster pump discharge to automatically throttle the flow as necessary to maintain a minimum of twenty (20) psi gauge, pump suction pressure.

5. On-Site Water Storage

   In some cases, on-site storage of water for firefighting purposes may be required. City Utilities shall coordinate with the facility requiring fire protection services to evaluate these storage requirements on a case-by-case basis.

W9.07 Installation and Inspection

1. Installation

   A. Refer to Standard Drawing **W-40** Service Installations for fire service connection requirements to the water main.

   B. Refer to **Exhibit W9-1** Fire Services Riser for schematic requirements for fire protection service installations.

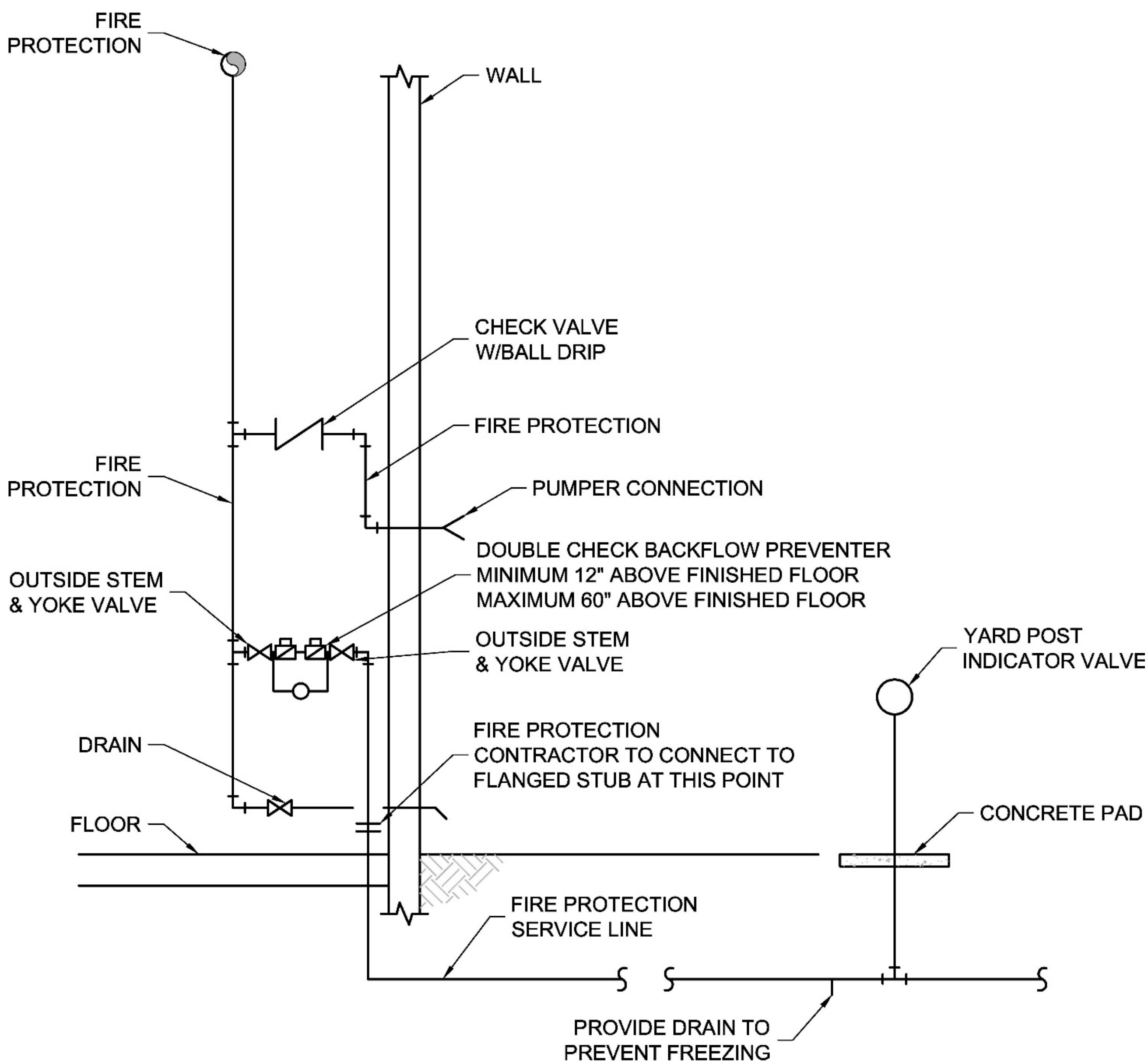
   C. Fire services greater than two inches (2”) in diameter shall be connected to the water main with an independent valve. All service pipes shall be properly restrained.

2. Inspection

   A. The fire service connection shall be inspected upon installation.

   B. The connection of the fire protection system to the service including meters, backflow preventers, valves and any other required appurtenances shall be inspected upon installation to meet the requirements in Standard Drawing **W-64**.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit W9-1 Fire Service Riser Detail
		Version: June 12, 2014 Scale: N.T.S.



NOTES:

1. FIRE PROTECTION CONTRACTOR TO INSTALL REQUIRED SIZE PIPE DIAMETER BASED ON THE DETERMINED FLOW NEEDS.

CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 5 Materials

Book 5

Materials (MA)

MA1 Acronyms and Definitions

MA1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the Materials Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

MA1.02 Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACI	The American Concrete Institute
AC	Alternating Current
ANSI	American National Standards Institute
ASTM	ASTM International (formerly American Society of Testing and Materials)
AWWA	American Water Works Association
CIPP	Cured-In-Place Pipe
CUE	City Utilities Engineering
CMP	Corrugated Metal Pipe
DIP	Ductile Iron Pipe
DVD	Digital Video Disk
NASSCO	National Association of Sewer Service Companies
PACP	Pipeline Assessment and Certification Program
DR	Dimension Ratio
GFI	Ground Fault Interrupter
FRP	Fiberglass Reinforced Plastic
HDPE	High Density Polyethylene
HEP	Horizontal Elliptical Pipe
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation
PP	Polypropylene
PVC	Polyvinyl Chloride

RCP	Reinforced Concrete Pipe
SCADA	Supervisory Control and Data Acquisition
VCP	Vitrified Clay Pipe
VEP	Vertical Elliptical Pipe

MA1.03 Definitions

Admixtures	A chemical added to concrete mixtures to accelerate the speed of concrete hardening.
Aggregate	A component, material, or particle used in a construction mixture such as concrete, soil mixtures, or grout.
Appurtenances	An item attached to or belonging to a water main to control flow, identify, or ease assembly.
Backfill	Earth and/or other material used to replace material removed from trenches or other excavations during construction activities. The backfill lies above the pipe bedding.
Bedding	The fractured face stone which encases the pipe to a minimum depth above and below the barrel of the pipe. The bedding serves as the pipe support.
Book	Organizational grouping of utility design standards by topic. These Books consist of General Requirements, CADD Standards, Stormwater, Sanitary, Water, and Materials.
Cast in Place	Method of building concrete structures on site by using forms and placing concrete.
Castings	The base and cover of a manhole designed to bear the weight of traffic and open for routine inspection; often made of cast iron.
Check Dams	Structures built with graded rock, which slows water velocity, but is permeable enough for water to flow through.
Chimney Seal	Sealant material used to bridge gaps between manhole components during construction to prevent infiltration.
City Utilities	The department of the City of Fort Wayne that manages the stormwater, wastewater and water utilities.
City Utilities Engineering	The division within City Utilities that develops City Utility Engineering Standards, manages City Utilities Projects, and performs planning and system analysis for the stormwater, wastewater and water utilities.
City Utilities Design Standards Manual	A document that provides guidance and requirements for the planning, design, and construction of stormwater, wastewater, and water utility infrastructure.

Concrete Pipe	Includes reinforced concrete pipe, horizontal and vertical elliptical concrete pipe, concrete arch pipe, and concrete box sections.
Corrugated	Refers to a pipe profile that contains interior molding or ribbing for additional support and reduction of diametrical deformation.
Culvert	An open ended stormwater pipe or structure that is dependent upon hydraulic head for performance. Typically, a culvert conveys runoff under a road, berm or railway.
Corrugated Dual Wall	Pipe with a smooth interior wall and a corrugated exterior to provide protection against deformations.
Dowel	A reinforcing adhesive material or bar used to strengthen the connection between set concrete and masonry wall.
Easement	A right to occupy, access or otherwise utilize the real property of another for a specifically defined use.
Filter Sock for Underdrain	A woven or mesh material wrapped around the circumference of a perforated pipe or drain to prevent the intrusion of fine sediment.
Fittings	A connection or joint to connect pieces of pipe of the same or different shape/size.
Flexible Pipe	Comprises all pipe materials other than concrete pipe, including but not limited to ductile iron pipe, polyvinylchloride pipe, high density polyethylene pipe, fiberglass reinforced pipe, and polypropylene pipe.
Flowable Fill	A controlled low strength, high slump material typically used as an alternative to compacted granular fill.
Gaskets	An annular seal that fills the void space between two connecting pipes to prevent leakage.
Geotextiles/Geosynthetics	Permeable fabrics in woven, nonwoven, gridded, or meshed composition which have the ability to separate, filter, reinforce, protect, or drain; often used to stabilize soils and embankments.
Grout	A construction material often comprised of water, sand, and cement used to fill gaps in concrete structures.
Inlet	A structure designed to allow runoff to enter the stormwater system.
Manhole	Confined space that provides access to an underground sewer.
Non-Pressure	Describes a pipe which is designed to convey flow by the force of gravity.
Precast	Concrete structures that are placed and set into a form or mold at the manufacture’s facility.

Pressure	Describes a pipe that conveys flow by the force of pressure head, not gravity.
Private Stormwater Facilities	Various stormwater and drainage works not under the control or ownership of the city, county, state, and/or federal government, which may include inlets, conduits, pipes, pumping stations, manholes, structures, channels, outlets, retention or detention basins, other structural components and equipment designed to transport, move or regulate stormwater.
Public Stormwater Facilities	Various stormwater and drainage works under the control and/or ownership of the city, county, state, or federal government which may include inlets, conduits, pipes, culverts, pumping stations, manholes, structures, channels, outlets, retention or detention basins, other structural components and equipment designed to transport, move or regulate stormwater.
Revetment	A facing added to a structure or slope that provides additional support, typically used to describe a type of stone or riprap.
Right-of-Way	A general term denoting land, property or interest therein, usually in a strip of land acquired for or devoted to the construction of a highway, road or street that will include the travelled way, shoulders, roadsides, auxiliary lanes, medians, border areas, park strips, sidewalks, curbs, gutters, and fronting roads.
Riprap	Large stones typically used for permanent or semi-permanent soil erosion protection of embankment slope, channels, and shorelines.
Riser Ring	A cylindrical ring, usually comprised of concrete, secured on top of a manhole and used to adjust the casting frame to finished grade.
Sanitary Sewer	A sewer which carries domestic and unpolluted industrial sanitary wastewater and to which stormwater, surface runoff, groundwater and unpolluted industrial waste waters are not intentionally admitted.
Seating Ring	A rubber ring located in the body of a butterfly valve to provide protection and a water tight seal.
Standards	Fort Wayne City Utilities Design Standards Manual. The requirements for the design and construction of utilities within Fort Wayne's jurisdiction.
Storm Sewer	A sewer designed or intended to convey only stormwater, surface runoff, street wash waters, and drainage, and not intended for sanitary sewage and industrial wastes other than unpolluted cooling water. The portion of a sewer intended to carry stormwater only, which begins at the grating or opening where water enters said sewer, through the sewer and any

	other conduits to the outlet structure where water enters a channel, natural watercourse or combined sewer.
Tackifier	A mulch additive used as a bonding agent to prevent wind and water erosion in hydroseeded areas.
Tapping Saddles	A device used to puncture water main for corporation stops where water will be delivered to the customer.
Telemetry	Automated controls and meters placed within the pipe network used to assess system performance remotely.
Tracing Wire	A metallic wire placed in the trench with pressure non- metallic and large diameter pipes for future identification of the buried pipe.
Underdrains	Small diameter perforated plastic pipe installed in bioretention areas, footings, detention walls etc., to drain excess water and reduce the hydrostatic pressure.
Valve Vaults	Valve housing, usually made of concrete, to protect and surround the valve outlet point of wet well flow.
Water Main	Pipe that is owned by City Utilities, located in a street, easement, road, right-of-way and/or alley and used to distribute finished water.
Wet Well	A short-term storage tank containing a pump or pump suction into which wastewater is conveyed.

Book 5

Materials (MA)

MA2 Introduction

MA2.01 Purpose

The purpose of this Chapter is to provide an introduction to how the Materials Book is presented. The purpose of the Materials Book of the City Utilities Design Standards Manual is to provide guidance for materials accepted for use in construction of utilities within the jurisdiction of the Fort Wayne City Utilities. The Chapters of this Book are organized into certification of materials, common material requirements, storm sewer materials, sanitary sewer materials, and potable water distribution materials.

MA2.02 Description and Use

1. Compliance with other Standards

   Compliance with the Standards does not eliminate the need to comply with other applicable City, County, State, and Federal ordinances, regulations, and construction requirements. This includes, but is not limited to, the submission and approval of preliminary and final subdivision plats; IDEM permits for potable water and sanitary facilities construction; building and zoning permits; railroad; city; county and INDOT right-of-way crossing permits; construction inspection; appeals; and similar matters.

2. Conflicting Standards

   The provisions of this document shall be deemed as additional requirements to minimum standards required by other applicable ordinances and standards. In the case of conflicting requirements, the most restrictive shall apply.

3. Minimum Material Standards

   The materials listed within this Book are the City of Fort Wayne's minimum requirements. Materials that do not meet these requirements require a Variance, see Chapter GR3 – Variances.

   Materials used for infrastructure that will ultimately be owned, operated, and maintained by the City must be provided as new.

4. Non-Standard Materials

   Alternative materials on occasion may be warranted, and a variance from these standards may be permitted. See Chapter GR3 – Variances for more information on the procedures and process for submitting for a variance.

MA2.03 Material Installation Testing Requirements

Installation includes provisions for on-site work and incorporating products into the project. Minimum testing requirements are listed with the respective materials within this Book. Where the project needs more stringent requirements, an engineer is responsible for providing additional installation and testing requirements.

MA2.04 Master Specifications

City Utilities Engineering has developed standardized Master Specifications for use on construction projects. Master Specifications standardize minimum material and performance requirements. The information listed within this Book is in accordance with the materials in the Master Specifications.

City Utilities Master Specifications are provided as a convenience and a tool for engineers doing work with or for the City Utilities. Master Specifications are provided to the Engineer with Notes to Specifier (NTS), throughout the documents. Each NTS identifies sections within the specification that must be reviewed and edited by the Engineer.

MA2.05 Additional References

Additional references for use with, and to supplement these material standards, include:

- American Association of State Highway and Transportation Officials Standards (AASHTO)
- American Society for Testing and Materials (ASTM) International Standards
- American Water Works Association Standards (AWWA)
- Construction Specifications Institute Standards and Formats (CSI)
- Indiana Department of Environmental Management (IDEM) – Indiana Storm Water Quality Manual
- Indiana Department of Transportation (INDOT) Standards and Specs
- Fort Wayne Department of Public Works Standards

MA2.06 City Utilities Standard Drawings

City Utilities has developed multiple standard drawings for use on typical utility projects. Many drawings are referenced throughout this Book. The most current electronic versions can be found in **Chapter CADD8 – Standard Drawings**.

Book 5

Materials (MA)

MA3 Certification of Materials

MA3.01 Purpose

The purpose of this Chapter is to outline requirements for the certification of construction materials for storm, sanitary, and potable water systems.

MA3.02 Referenced Standards

Standards establish uniform guidelines, criteria, methods, processes, and practices for products and materials. Standards are usually developed and maintained by a consensus of members of an association, society, council or institute directly involved with the service, product, or installation.

Associations that produce the standards that are referenced throughout this Book are listed below. Copies of each standard may be obtained by purchasing copies from the association.

1. American Concrete Institute (ACI)
   38800 Country Club Dr.
   Farmington Hills, MI 48331-3439 USA
   1-248-848-3700
   http://www.concrete.org
2. ASTM International
   100 Barr Harbor Drive, PO BOX C700,
   West Conshohocken, PA, 19428-2959
   1-877-909-ASTM
   http://www.astm.org/
3. American Water Works Association (AWWA)
   6666 W. Quincy Ave.,
   Denver, CO, 80235
   1-800-926-7337
   http://www.awwa.org/
4. American Association of State Highway and Transportation Officials (AASHTO)
   444 N Capitol St. NW – Suite 249,
   Washington, DC, 20001
   1-202-624-5800
   http://transportation.org/

5. Indiana Department of Transportation (INDOT)
   Fort Wayne District
   5333 Hatfield Road,
   Fort Wayne, IN, 46808
   1-866-227-3555 (24hour dispatch)
   http://www.in.gov/indot/
6. Indiana Department of Environmental Management (IDEM)
   Indianapolis Central Office
   Indiana Government Center North 100 N. Senate Ave.
   Indianapolis, IN 46204
   1-317-232-8603
   http://www.in.gov/idem/

MA3.03 Quality

Material requirements listed throughout this Book establish quality. The quality of all materials, the process of manufacturing, and the finished products are subject to inspection by City Utilities. Quality inspections may be made at the place of manufacture, or at the project site, or at both places and the materials shall be subject to rejection at any time on account of failure to meet any of these material requirements. Minimum quality assurance and quality control (QA/QC) requirements are listed throughout this Book. For more stringent requirements the engineer is responsible for adding additional products and QA/QC requirements.

1. Quality Assurance

   Quality assurances are procedures for guarding against defects and deficiencies before and during the execution of the Work.

   A. Qualifications

      Qualifications specify requirements for, and qualifications of manufacturers, suppliers, fabricators, installers, applicators, erectors, testing agencies, and licensed professionals.

   B. Certifications

      Certifications include statements describing certification of compliance with specified requirements.

   C. Preconstruction Testing

      Test to be performed to qualify products prior to procurement and before submitting product data submittals. These tests are usually on products or assemblies for which a contractor has been given some responsibility for design selection.

   D. Field or Site Samples

      Field or site samples are usually used to state requirements for sample field applications of finishes, or other finish materials or coatings.

2. Quality Control

   Quality controls are procedures for evaluating completed activities and elements the work.

   A. Source Quality Control

      Source quality controls are tests or inspections conducted off-site at the manufacturers or fabricators' location. This type of quality control is used for verifying the characteristics of products from manufacturers. Different forms of source quality control include tests, inspections, and manufacturers services.

   B. Field or Site Quality Control

      Field Quality Controls are tests and inspections for on-site activities and installed materials, manufactured units, equipment, components, and accessories. These are different and separate tests and inspections required for materials and products than those conducted prior to installation or application.

MA3.04 Material Markings

Each length of pipe, all associated appurtenances, and manufactured or precast structures (i.e., manholes, inlets, catch basins, etc.) shall be marked per the requirements of the appropriate standards referenced throughout this Book.

MA3.05 Material Submittals

1. Design Submittals

   The extent of design submittals will be evaluated on a case-by-case basis. In general, City Utilities will not require design submittals for standard materials. When non-standard materials and products are proposed, a variance request shall be submitted. Refer to **Chapter GR3 – Variances** for the process.

2. Construction Submittals

   During construction the Contractor is usually required by the Contract Documents to submit product data, shop drawings, samples, informational submittals, closeout submittals, and maintenance material submittals for the Engineer to review.

   At a minimum, construction submittals shall include, comprehensive listing of all materials proposed to be furnished and installed and operations and maintenance manuals.

   Based on the project, additional construction submittals may be required. The following are examples of as requested submittals:

   - Layout, detail, and shop drawings to ensure proper construction, assembly, and installation of the work specified.
   - Satisfactory written certification of compliance with the ASTM, AWWA, AASHTO, etc. Standards.

- Material supplier information and information describing the method of manufacturing and the composition of the materials.
- Catalog information and manufacturer brochures showing material specifics, and construction and installation detail.
- Itemized listing of installation procedures.
- Results from required quality control test results.
- Required calculations (i.e., structural).
- Detail descriptions for future repair, maintenance, connection, etc.

MA3.06 Pilot Projects

City Utilities may choose to utilize alternative products in pilot projects to determine product performance and application. Potential pilot projects will be derived from materials submitted for approval under the requirements of **Chapter GR3 – Variances**.

Book 5

Materials (MA)

MA4 Common Materials and Testing Requirements

MA4.01 Purpose

This Chapter covers typical materials used for storm, sanitary, and water utility projects.

MA4.02 Erosion Control

This section provides general procedures and requirements for site control during construction, including controls for stormwater runoff, sedimentation, and erosion. The listed materials and techniques outline typical erosion control requirements for the majority of utility projects. When projects require additional erosion control methods refer to the Indiana Storm Water Quality Manual. The latest version can be obtained from IDEM's website (**https://www.in.gov/idem/stormwater/2363.htm**).

All materials provided under this section shall meet the requirements of the applicable sections of the Indiana Department of Transportation Standards Specifications (INDOTSS), latest edition or Indiana Storm Water Quality Manual.

1. Quality Assurance

   Erosion Control methods and procedures shall comply with Title 327 IAC 15-5. Any inconsistencies with Title 327 IAC 15-5 will not apply except if inconsistency has been approved by IDEM or the IDNR Division of Soil Conservation.

2. Site Preparation

   A. Perimeter Protection - Filter Sock

      Sediment barriers are used in situations which only sheet or overland flows are expected. Figure MA4.1 lists available material types. The required diameter is project specific.

      For the general layout of filter socks refer to Standard Drawing **EROS-2-2**.

      Filter socks are filled with a compost or mulch and shall meet the following requirements.

      - Compost shall be well decomposed, stable and weed free.
      - Variable particle size with maximum dimensions of (2' L x ½" W x ½" D)
      - Refuse free (less than 1% by weight)
      - Free of any contaminates and materials toxic to plant growth

- pH of 5.5 to 8.0
- Carbon-Nitrogen ratio not to exceed 100

The following are acceptable filter sock products:

- Filtrexx Sediment Control Soxx
- Or engineer approved equal

Figure MA4.1 Filter Sock Material

Material Type	3mil HDPE	5mil HDPE	5mil HDPE	Multi-Filament Polypropylene (MFPP)	Multi-Filament Polypropylene Safety Soxx
Material Characteristics	Photodegradable	Photodegradable	Biodegradable	Photodegradable	Photodegradable
Design Diameters (inch)	5 8 12 18	5 8 12 18 24 32	8 12 18 24 32	8 12 18 24 32	8 12 18 24 32
Mesh Opening (inch)	⅜	⅜	⅜	⅜	⅛
Tensile Strength (psi)	ND	26	26	44	202
% Original Strength from Ultraviolet Exposure (ASTM G-155)	23% at 1,000 hr	23% at 1,000 hr	ND	100% at 1,000 hr	100% at 1,000 hr
Functional Longevity/Project Duration	6 mo–2 yr	9 mo–3 yr	6 –12 months	1 –4 year	2 –5 year

B. Temporary Perimeter Protection- Silt Fence

Sediment barriers are used in situations which only sheet or overland flows are expected.

Use a slit film woven geotextile for silt fences. Silt fences are a temporary barrier used to trap sediment by reducing the velocities of sheet flow. Acceptable silt fence woven geotextile requirements are listed in Figure MA4.7. These woven geotextile requirements are also applicable for temporary inlet protection.

For the general layout of temporary silt fences refer to Standard Drawing EROS-2-1.

Figure MA4.2 Woven Geotextile Fabric Requirements for Silt Fence

Physical Properties	Test Method	Unit	Minimum Value
Grab Tensile Strength	ASTM D 4632	lbs.	95-125
Grab Tensile Elongation	ASTM D 4632	%	15
Puncture Strength	ASTM D 4833	lbs.	60
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	#30
Permittivity	ASTM D 4491	sec^{-1}	0.1
Flow Rate	ASTM D 4491	$gal/min/ft^2$	10

C. Temporary Construction Entrance

For the general layout of temporary construction entrances refer to Standard Drawing EROS-1.

Geotextiles for temporary construction entrances are woven to prevent elongation and provide aggregate separation. Acceptable temporary construction entrance geotextile requirements are listed in Figure MA4.3. The following product is acceptable:

- Mirafi HP270
- Or engineer approved equal

Figure MA4.3 Woven Geotextile Fabric Requirements for Temporary Construction Entrances

Physical Properties	Test Method	Unit	Minimum Value	
			MD	CD
Tensile Strength (at ultimate)	ASTM D4595	lbs/ft	2640	2460
Tensile Strength (at 2% strain)			480	588
Tensile Strength (at 5% strain)			1212	1356
Tensile Strength (at 10% strain)			2340	2412
Factory Sewn Seam	ASTM D4884	lbs/ft	1250	
Flow Rate	ASTM D4491	$gal/min/ft^2$	50	
Permeability		cm/sec	0.04	
Permittivity		sec^{-1}	0.7	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve	30	
UV Resistance (at 500hrs)	ASTM D4355	% strength retained	80	

Base aggregate material shall consist of INDOT #2 aggregate and capped with INDOT #5 aggregate. For aggregate requirements refer to Figure MA4.9.

The temporary construction entrance shall not impede or block current stormwater flow. If the site has current site drainage that must be maintained, install a drainage culvert in the temporary construction entrance. Acceptable culvert pipe materials are listed in Chapter MA5 – Stormwater Materials and Testing Requirements.

The minimum allowable size for a temporary construction culvert is 15-inches.

3. Concrete Washout Area

A concrete washout location shall be designated and a system shall be implemented to reduce the discharge of pollutants associated with concrete washout waste.

Standard Drawings EROS-3-1 and EROS-3-2 illustrate concrete wash out requirements for below and above grade applications.

A. Common Concrete Washout Area

Place signage in area to designate location of concrete washout system.

Use a pit or bermed area designed and maintained at a capacity to contain all liquid and concrete waste generated by washout operations, between scheduled cleanout periods.

Line pit with 10-mm thick polyethylene lining to control seepage.

B. Prefabricated Concrete Washout Area

Prefabricated concrete washout areas may be acceptable; refer to manufacturer’s requirements.

4. Erosion Control Blankets

The following erosion control blankets are acceptable for use on areas with a 2:1 slope or less. For slopes steeper than 2:1 and installation longer than 12 months, coordinate with City Utilities.

Standard Drawings EROS-4-1, EROS-4-2, and EROS-4-3 illustrate erosion control blanket installations for channel, slope and shoreline applications.

A. Short Term Erosion Control Blankets

Short term blankets are intended for installations of less than 6 months.

Blankets are composed of 100% straw fiber matrix, stitched with a photodegradable thread. The blanket is made of double-net construction.

Blankets are anchored using 6 to 12-inch staples or pins and comply with the manufacturer’s recommendations for the specific application.

Properties of short term erosion control blankets are listed Figure MA4.4.

Figure MA4.4 Short Term Erosion Control Blanket Requirements

Physical Property	Unit	Min. Value
Top Net Weight	lbs/1,000 ft^2	1.5
Straw Fiber Density	lbs/yd^2	0.5
Bottom Net Weight	lbs/1,000 ft^2	1.5
Anchoring	Anchors/yd^2	1.5

B. Long Term Erosion Control Blankets

Long term blankets are intended for installations between 6 to 12 months.

Blankets are composed of straw fiber and coconut fiber combination, with a minimum coconut fiber content of 30%, stitched with a photodegradable thread. The blanket is made of double-net construction.

Blankets are anchored using 8 to 12-inch staples or pins and comply with the manufacturer recommendations for the specific application.

Properties of long term erosion control blankets are listed Figure in MA4.5.

Figure MA4.5 Long Term Erosion Control Blanket Requirements

Physical Property	Unit	Min. Value
Top Net Weight	lbs/1,000 ft^2	3
Straw Fiber Density	lbs/yd^2	0.35
Coconut Fiber Density	lbs/yd^2	0.15
Bottom Net Weight	lbs/1,000 ft^2	1.5
Anchoring	Anchors/yd^2	2

5. Rock Check Dams

Rock check dams are structures constructed of graded rock, which slows water velocity, but is permeable enough for water to flow through.

For the general layout of rock check dams refer to Standard Drawing **EROS-5**.

Use a non-woven geotextile fabric to separate the sub-base and base aggregate materials. Properties of geotextile fabrics for aggregate separation are listed in Figure MA4.6.

Figure MA4.6 Non-Woven Geotextile Requirements for Aggregate Separation

Physical Properties	Test Method	Unit	Min Value
Grab Tensile Strength	ASTM D 4632	lbs.	200
Grab Tensile Elongation	ASTM D 4632	%	50
Puncture Strength	ASTM D4833	lbs.	500
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	#80
Flow Rate	ASTM D 4491	gal/min/ft^2	95

Use revetment riprap for temporary check dams, Figure MA4.12 lists the gradation requirements for riprap.

Riprap must have a minimum depth of 18-inches.

Filter medium used for temporary rock check dams is well graded INDOT #5 aggregate. When INDOT #5 is not available INDOT #8 aggregate is acceptable. For aggregate gradation requirements refer to Figure MA4.9.

6. HDPE Check Dams

HDPE check dams are lightweight structures constructed of a matrix of HDPE, which slows water velocity, but is permeable enough for water to flow through. When required for project provide a GeoRidge HDPE check dam, or similar.

For the general layout of HDPE check dams refer to Standard Drawing **EROS-5-2**.

Use an erosion control blanket to separate the sub-base and the HDPE check dam. For information on acceptable erosion control blankets refer to Section MA4.02.4 - Erosion Control Blankets. Secure the erosion control blanket with landscape staples and the edges with a 4-inch deep earthen anchor trench.

7. Temporary Inlet Protection

A. Geotextile Fabric Under Inlet Grate

Geotextile fabric under an inlet grate is strictly prohibited.

B. Temporary Inlet Protection - Geotextile Fabric

Geotextile fabric inlet protection is installed at existing and new storm sewer inlets, where area surrounding inlet is not paved.

Geotextile fabric inlet protection is not permitted for use where area immediately surrounding inlet is paved.

For the general layout of inlet protection using geotextile fabric refer to Standard Drawing **EROS-6-1**.

Structures are constructed to a height 12 to 18-inches above the top of the storm drain inlet, with a maximum post spacing of 36-inches.

Properties of woven geotextiles fabrics are listed in Figure MA4.2.

Structures shall be constructed and braced as required to withstand 1½-inches head of sediment without collapsing or undercutting.

Use of pre-manufactured and site constructed structures, that meet these requirements are acceptable.

C. Temporary Inlet Protection - Sediment Control Sack

Temporary sediment control sack inlet protection is installed at existing and new storm sewer inlets, where area surrounding inlet is paved.

Temporary sediment control sack inlet protection is not permitted for use where area immediately surrounding inlet is not paved.

For the general layout of inlet protection using sediment control sacks refer to Standard Drawing **EROS-6-2**.

Proprietary inlet protection devices shall provide a filtering efficiency that removes at least 80% of the Total Suspended Solids (TSS).

- Temporary sediment control devices include framework or basket that filters the stormwater runoff.
- Each device must include a bypass to allow stormwater to flow into the storm system during excessive storm events, and dumping straps to allow for ease of maintenance.
- The frame or basket must fit into the inlet and be supported by the inlet grate, or storm sewer.
- Each temporary sediment control sack shall be used for the specific type of inlet they were designed and recommended by the manufacturer.

D. Temporary Inlet Protection - Stone Bags

Temporary stone bags are intended for use with a drainage area of ≤1 acre per inlet. Stone bag inlet protection is installed on existing and new storm sewer inlets and curb inlets, in both paved and un-paved areas.

Standard Drawings **EROS-6-3**, **EROS-6-4**, and **EROS-6-5** illustrate various stone bag installations.

- Stone bag inlet structures are constructed to a height of 1 to 3 layers of bags, to a minimum height of 12-inches.
- Stone bags made of non-woven geotextile fabric.
- Bags are filled with INDOT #5 washed aggregate. The aggregate must be larger than the storm sewer inlet grate openings. For aggregate gradation requirements refer to Figure MA4.9.

E. Temporary Inlet Protection - Filter Sock

Temporary filter socks are intended for use with a drainage area of ≤1 acre per inlet. Filter sock inlet protection is installed on existing and new storm sewer inlets and curb inlets, in both paved and un-paved areas.

For the general layout of inlet protection using filter socks refer to Standard Drawing **EROS-6-6**.

For the material requirements of filter socks refer to section Figure MA4.1.

F. Temporary Inlet Protection - Straw Bales

Straw bales are prohibited as a primary measure of inlet protection. When used in conjunction with another inlet protection measure, straw bales must be wire-bound or string-tied.

G. Temporary Inlet Protection – Latex Bound Coir Mat

Temporary latex bound coir mats are prohibited as a primary inlet protection measure, nor may they be used in conjunction with straw bales or wattles. Additionally, even as a secondary protection measure, they are intended for use with a drainage area of ≤1 acre per inlet. Mat inlet protection is installed on existing and new storm sewer inlets, in paved areas.

Provide mats that are comprised of 100-percent coir fiber bonded to a fiberglass mesh backing. Secure to the inlet using plastic zip ties.

8. Sediment Trap

Temporary sediment traps are intended for use with a drainage area of ≤5 acres. Traps are installed at the outlets of pipes, culverts, conduits, and channels.

For the general layout of sediment traps refer to Standard Drawing **EROS-7**.

Use a non-woven geotextile fabric to separate the aggregate materials from the embankment. Figure MA4.6 lists the non-woven geotextile fabric requirements.

Use revetment riprap for temporary sediment traps, Figure MA4.12 lists the gradation requirements for riprap.

Riprap must have a minimum depth of 18-inches.

Filter medium used for temporary sediment traps is well graded INDOT #5 aggregate. When INDOT #5 is not available INDOT #8 aggregate is acceptable. For coarse aggregate gradation requirements refer to Figure MA4.9.

9. Temporary Sediment Control Dewatering Bag

Temporary sediment control dewatering bags are installed at the discharge point of all dewatering pipes and hoses.

Temporary sediment control dewatering bags are proprietary devices, coordinate with City Utilities for acceptable products.

Proprietary dewatering bags shall provide a filtering efficiency that removes at least 80% of the Total Suspended Solids (TSS).

For the general layout of dewatering bags refer to Standard Drawing **EROS-8**.

Dewatering bags require an aggregate underlayment for stabilization. Use a non-woven geotextile fabric for separation of the subbase and aggregate underlayment. Figure MA4.6 lists the geotextile material requirements.

Dewatering bags shall be made of non-woven geotextile fabric and manufactured specifically for the purpose of sediment control from dewatering pipes and hoses. Refer to Figure MA4.7 for typical dewatering bag geotextile requirements.

Figure MA4.7 Geotextile Requirements for Dewatering Bags

Physical Properties	Test Method	Unit	Min Value
Grab Tensile Strength	ASTM D 4632	lbs.	205
Grab Tensile Elongation	ASTM D 4632	%	50
Puncture Strength	ASTM D4833	lbs.	130
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	#80
Flow Rate	ASTM D 4491	gal/min/ft^2	95
UV Resistance (at 500hrs)	ASTM D4355	% strength retained	70

10. Coir Logs for River/Lake Shore Protection

    Use coir logs to protect river or lake shores from erosion.

    Based on the project, coir logs can be installed with or without erosion control blankets. For information on acceptable erosion control blankets refer to Section MA4.02.4 - Erosion Control Blankets.

    Based on the project, coir logs can be installed as vegetated or non-vegetated. If vegetation is required, coordinate with City Utilities.

    For the general layout of coir logs refer to Standard Drawing **EROS-9-1**.

    Coir logs shall have a minimum diameter of 6-inches.

    Coir logs for river/lake shore protection are made of 100% decorticated coconut fibers with a minimum density of 3½ lb/ft^3.

    Biodegradable netting with a life expectancy of ≥ 6 months shall be used.

11. Trackout Plates

    Use metal track out plates, or rattle gates, as required to create temporary construction entrances the require the removal of dirt and debris from construction vehicles.

    Size the grate to handle the anticipated construction loads and debris accumulation.

    Conduct periodic maintenance of plates to remove debris build up.

12. Turf Reinforcement Mats

    Use plastic turf reinforcement mats for temporary or permanent applications.

Provide a polymer type turf reinforcement mat called GeoRunner, or similar, as manufactured by Presto GeoSystems.

Unit Properties:

- Material shall be constructed of polymer.
- Color shall be green.
- Color shall be uniform throughout all units in a pallet.
- Mats shall provide corrosion and chemical resistance.

Unit Dimensions:

- Nominal Width shall be 24 inches.
- Nominal Length shall be 48.75 inches.
- Nominal Depth shall be 0.5 inches.
- Nominal Area shall be 8 ft2.
- Nominal mesh openings shall be 0.84 inches square.
- Mesh open area shall be 55% of total area.
- Nominal weight shall be 8 pounds.

Accessories:

- Nylon, X-mas tree rivets shall be used to secure the panels together on the short end (2 feet). Three rivets are required for each panel. The rivets shall be 0.312 inches thick by 1.163 inches long.
- Heat treated metal side clips are used to secure the panels together on the long end (4 feet). Two side clips are required for each panel to panel connection. The side clips shall be 22 gauge heat treated steel with zinc clear chromate plate.
- The earth anchor consists of Duckbill® anchor, 3/32 galvanized cable, ferrule, Gripple® and anchor brace. Duckbill anchor break strength shall be 300 lb.
- Four anchors shall be provided for each surface protection mat. Six anchors are required on the row of panels on the upstream/upslope end of the project.
- The anchors shall be located per the Manufacturer’s instructions.

13. Open Structural Mat

Use plastic open structural for temporary or permanent applications.

Provide a HDPE type turf reinforcement mat called GeoTerra, or similar, as manufactured by Presto GeoSystems.

Unit Properties:

- Material shall be constructed of high-performance polyethylene.
- Color shall be black.
- Mats shall provide corrosion and chemical resistance.

Unit Dimensions:

- Nominal Width shall be 3.15 feet.
- Nominal Length shall be 1.57 feet.
- Nominal Depth shall be 2 inches.
- Cell size shall be 3.1 inches x 3.2 inches.
- Nominal weight shall be 9.05 pounds.

Accessories:

- Provide PadLoc® Connection Device to join the mats together.
- Provide GEOTERRA Earth Anchor 800-33 with 800 lbf resistance against pullout and (33 in) cable length.
- Earth anchor shall have a steel cable with a formed (stamped) steel anchor head at one end and a tensioning loop at the other end. A washer and cable stop move freely along the cable.

MA4.03 Temporary Fencing

1. Temporary 48-inch Construction Fence
   - For layout and post spacing of temporary fencing refer to standard detail EROS-10.
   - Use high-density polyethylene safety orange fencing with mesh openings that are 1¾” by 1¾”.
   - Fence post shall be made of steel with either a U, Y, or T channel section, with corrugations, knobs, notches or studs.

MA4.04 Concrete

This section covers projects with minor, uncomplicated concrete work. Intended for small general-use construction that does not include water retaining structures.

1. Quality Assurance

   Listed below are typical quality assurance methods. Different requirement may be needed based on the project.

   A. Concrete Testing Laboratory Qualifications:

      All standard tests shall be conducted by an approved independent laboratory and will be made at the expense of the contractor, unless specifically noted otherwise.

      - Testing agency shall be in accordance with ASTM E329 and ASTM C1077.
      - Testing laboratory shall have been inspected and passed within previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for: testing concrete aggregates, and for preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation

indicating how deficiencies, if any, in most recent CCRL inspection report were corrected.

- Selection of testing laboratory is subject to City's acceptance.

B. Concrete Material Testing:

The cement, fine aggregate, coarse aggregate and reinforcing steel used shall be tested in accordance with the ASTM and specification for the type and class of material indicated. The manufacturer's certificate of tests will generally be accepted.

C. Laboratory Trial Batch Testing

Where more than 100 cubic yards of concrete are required for the entire Project, advance tests of each concrete mix design used shall be made by an independent laboratory in accordance with ASTM C39 and ASTM C33. Perform the following testing on each trial batch:

- Aggregate gradation for fine and coarse aggregates
- Slump
- Air content
- Compressive strength based on 8 cylinders of each mix design; 4 tested at 7 days and 4 tested at 28 days
- Water content for mix designs shall be varied to produce values for water to content-strength curves

Submit for each trial batch the following information:

- Project identification name and number (if applicable)
- Date of test report
- Complete identification of aggregate source of supply
- Tests of aggregates for compliance with the Contract Documents
- Scale weight of each aggregate
- Absorbed water in each aggregate
- Brand, type, and composition of cementitious materials
- Brand, type, and amount of each admixture
- Amounts of water used in trial mixes
- Proportions of each material per cubic yard
- Gross weight and yield per cubic yard of trial mixtures
- Measured slump
- Measured air content
- Compressive strength developed at 7 days and 28 days, from not less than 4 test cylinders cast for each 7 day and 28-day test, and for each design mix

D. Certification of Concrete Mix

The requirement for trial batch will be waived upon compliance with requirements of this Paragraph. Verify compressive strength of each specified mix by data from series of at least 30 consecutive tests that have been made within previous 12 months. Test is the average strength of all specimens of the same age fabricated from sample taken from a single batch of concrete. Tests shall have been made on concrete with identical mix design to mix design proposed for the project, including sources of aggregate and manufacturers of cementitious materials and admixtures. Tests shall average above specified strength with no individual test falling more than 500 psi below specified strength and no three consecutive tests averaging below specified strength. Standard deviation for series of tests shall not exceed 640 psi in accordance with ACI 214.

2. Field Quality Control

Listed below is typical quality control methods different requirement may be needed based on the project.

A. Site Testing Services

Contractor shall employ independent testing laboratory to perform field quality control testing for concrete. Engineer will direct where Samples are obtained.

Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.

Contractor shall provide curing and necessary cylinder storage. Actual curing in the structure shall be closely paralleled.

B. Quality Control Testing During Construction

Perform sampling and testing for field quality control during concrete placing, as follows:

- Sampling Fresh Concrete: ASTM C172
- Slump: ASTM C143/C143M; one test for each concrete load at point of discharge
- Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
- Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
- Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
- Compression Test Specimens: In accordance with ASTM C31, make one set of compression cylinders for each 50 yd3 of concrete, or fraction thereof, of each mix design placed each

day. Each set shall be four standard cylinders, unless otherwise directed by Engineer.

C. Cold Weather Placing:

1. Protect concrete Work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures, in compliance with ACI 306R and the Contract Documents.

2. When air temperature has fallen to or may be expected to fall below 40 degrees F, provide adequate means to maintain temperature in area where concrete is being placed between 50 degrees F and 70 degrees F for a period of seventy-two hours after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain temporary heating and protection as necessary so that ambient temperature does not fall more than 30 degrees F in the 24 hours following the seventy-two hour period. Avoid rapid dry out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.

3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing for concrete as required to obtain concrete mixture temperature not less than 70 degrees F and not more than 90 degrees F at point of placement.

4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Before placing concrete, verify that forms, reinforcing, and adjacent concrete surfaces are entirely free of frost, snow, and ice.

5. Do not use salt or other materials containing antifreeze agents. Do not use chemical accelerators or set control admixtures unless approved by Engineer and tested in mix design proposed for use.

6. During pouring and curing periods, a permanent temperature record shall be kept showing the date, hour outside temperature at several points within the enclosure to show the most favorable and unfavorable conditions to which the concrete is subjected. Thermometer readings shall be taken at the start of Work in the morning and again in the late afternoon, and the data so obtained shall be recorded in such a manner that it will show the location of each reading and any conditions which might have an effect on the temperature. A copy of the temperature record shall be made available to the Engineer.

7. Before concreting any section of a structure, the section shall be completely housed or enclosed in a manner that will provide the maintenance of the specified temperatures. The housing shall be left in place for the curing period specified. except that sections may be temporarily removed as required to accommodate the placing of

column forms or concrete, provided that they are replaced immediately after the form or concrete is in its final position.

8. In placing floor slabs, tarpaulins supported on horses or other framework shall follow closely the placing of the concrete so that only a few feet of the finished slab is exposed to the outside atmosphere at any one time. Such tarpaulins shall be arranged so that the heated air from the space below can circulate freely in the space between the tarpaulin and the freshly placed concrete. If necessary, in order to maintain the proper temperature between the slab and the tarpaulins, temporary openings may be left in the floor and forms to facilitate the circulation of warm air in this space. Such openings shall not exceed 18 inches in their greatest dimension.
9. Top covers may be removed between the hours of 8:00 a.m. and 5:00 p.m. on days when the temperature is above 35 degrees F to permit erection of forms, but they shall be replaced not later than 5:00 p.m.
10. Within the enclosure, such means of artificial heat shall be provided as will maintain the temperatures specified continuously and with reasonable degree of uniformity in all parts of the enclosure. All exposed concrete surfaces within the heated area shall be wet with a hose stream at least once every 24 hours during the hardening period, except where a stream curing is provided.
11. The Contractor shall provide adequate fire protection accessible at all times where heating is in progress and shall maintain watchmen or other attendants to keep the heating units in continuous operation.
12. Heating appliances shall not be placed in such a manner as to endanger form work or centering or expose any area of concrete to drying out or other injury due to excessive temperatures.

D. Hot Weather Placing:

1. When hot weather conditions exist that would impair the quality and strength of concrete, place concrete in compliance with ACI 305R and the Contract Documents.
2. When ambient air temperature is at or above 90 degrees F and rising, cool ingredients before mixing concrete to maintain concrete temperature at time of placement below 80 degrees F. When ambient air temperature is at or above 90 degrees F and falling, cool the ingredients before mixing concrete to maintain concrete temperature at time of placement below 85 degrees F. In no case shall the concrete temperature at time of placement exceed 90 degrees F.
3. Mixing water may be chilled, or chopped ice may be used to control concrete temperature provided the water equivalent of ice is

calculated in total amount of mixing water. If required, reduce the time from addition of mix water to placement, or use set-retarding admixture.

4. Cover reinforcing materials with water soaked burlap if ambient air temperature becomes too hot, so that reinforcing material temperature does not exceed ambient air temperature immediately before embedment of reinforcing in concrete.
5. Wet forms thoroughly before placing concrete.
6. Do not place concrete at temperature that causes difficulty from loss of slump, flash set, or cold joints.
7. Do not use set control admixtures unless approved by Engineer in mix design.
8. Obtain Engineer's approval of substitute methods and materials proposed for use.

3. Cementations Material

Portland cement Type I or Type I/II produced per ASTM C150 is typically used. Type II cement is also acceptable and used when the concrete is subject to corrosive environments. Type II cement adds corrosion resistance to the concrete.

4. Aggregates

Aggregates for concrete shall conform to ASTM C33, Class Designation 4S. The designation is based on a Northern weather region.

Aggregates containing soluble salts or other substances, such as iron, sulfides, pyrite, marcasite, ochre or other materials that can cause stains on exposed concrete are not acceptable.

A. Fine Aggregate

- Fine aggregate is clean, sharp natural sand that is free of loam, clay, lumps and other deleterious substances.
- Dune sand, bank run sand and manufactured sand is unacceptable.

5. Water

Water used in producing and curing concrete shall be clean and free of injurious quantities of oils, acids, alkalis, organic materials and other substances that may be deleterious to concrete and steel

6. Concrete Admixtures

The American Concrete Institute (ACI) 116R-00 defines concrete admixture as “a material other than, water, aggregates, hydraulic cement, and fiber reinforcement, used as an ingredient of a cementations mixture to modify its freshly mixed, setting, or hardened properties and that is added to the batch before or during its mixing.” Admixtures are chemicals that are used to improve concrete performance. Listed below are acceptable concrete admixtures.

Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise approved by engineer.

A. Air Entraining Admixtures: ASTM C260.

Air entraining admixture shall be vinsol resin or vinsol rosin-based.

B. Water Reducing Admixture: ASTM C494, Type A.

Proportion Class “A”, and Class “B” concrete with non-air-entraining, normal setting, water reducing, aqueous solution of modified organic polymer. Admixture shall not contain lignin, nitrates, or chlorides added during manufacturing.

C. High Range Water Reducing Admixture (HRWR): ASTM C494, Type F/G.

Use high range water reducing admixture in the concrete classifications so specified or indicated. When used, HRWR admixture shall be added to concrete in accordance with admixture manufacturer’s published instructions.

D. Set Control Admixtures: In accordance with ASTM C494. Use the following as required:

- Type B, Retarding
- Type C, Accelerating
- Type D, Water-reducing and Retarding
- Type E, Water-reducing and Accelerating
- Type F, Water-reducing, high-range admixtures
- Type G, Water-reducing, high-range, and retarding admixtures

E. Calcium Chloride: Do not use calcium chloride.

7. Proportioning and Design of Mixes

Acceptable concrete mix designs are listed in Table MA4.8

Figure MA4.8 Concrete Mix Design

Concrete Class	Coarse Aggregate[1]		Minimum Cementitious (lbs/cu yd)	Max. W/CM[2]	Slump[3]	Air (%)	Min. 28 day Comp Strength[4] (psi)
	Size A	Size B					
Class “A”	No. 57	No. 8	564	0.45	4" max.	6 +/- 1	4,000
Class “B”	No. 57 or No. 67		517	0.5	4" max.	6 +/- 1	3,000

Notes:

(1) Coarse aggregate size numbers refer to ASTM C33. Where Size A and B are designated in Figure MA4.6, it is intended that the smaller Size B aggregate is to be added, replacing a portion of the coarse or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with sand content not exceeding 41 percent of total aggregate.

(2) Quantity of water to be used in the determination of water-cementitious materials (W/CM) ratio shall include free water on aggregates in excess of SSD and water portion of admixtures.

(3) Slumps indicated are prior to addition of high range water reducer (super plasticizer).

(4) Mix designs shall be made so that the compressive strength achieved for laboratory trial batches will not ≤ 125 % of specified design strength.

A. Admixtures

- Use air-entraining admixture in concrete.
- Use water-reducing or HRWR admixtures in all Class “A” concrete.
- If adding water at the Site is desired, withhold water at the batch plant so that specified water-cement (or cementitious material) ratio is not exceeded. Addition of water shall be accordance with ASTM C94. After high-range water-reducing admixture is incorporated into the batch, addition of water is not allowed.

8. Forms

Forming I is used to shape the concrete and they must safely support vertical and lateral loads that might be applied during construction, until such loads can be supported by the concrete structure. Design, erect, support, brace and maintain forming in accordance with ACI 347.

A. Forms for Smooth Finish Concrete

- Forms for smooth finish concrete are constructed with plywood, metal, metal-framed plywood-faced, or other panel type materials.
- Acceptable form surfaces are continuous, straight, smooth as-cast with no wood grain or other surface texture imparted by forming.
- Use forming, in largest practical sizes, which minimize the number of joints; and material with sufficient thickness to withstand pressure of newly placed concrete without bowing or deflection.

B. Forms for Standard Finish Concrete

- Forms for smooth finish concrete are constructed with plywood, lumber, or metal.

- Lumber used for forming must be dressed on at least 2 edges and 1 side.

C. Form Ties

Form ties used for small concrete projects are typically snap ties, removable ties are available but not commonly used.

- Use factory-fabricated metal from ties, designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal.
- Holes left behind on the concrete surface from form ties shall be no larger than 1-inch in diameter
- Use ties with waterstops on all exterior, below-grade walls, and walls subject to hydrostatic pressure
- Do not use wire ties.

D. Forms Coatings

- Forms shall be coated in commercial formulated form-coating compounds that will not bond with, satin, nor adversely affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compounds.
- Use mineral oil based coatings when concrete surfaces will be in contact with potable water or water that will be treated to become potable.

9. Reinforcing Materials

A. Reinforcing Bars

Use reinforcing bars that are manufactured in accordance with ASTM A615, Grade 60 deformed bars.

B. Welded Wire Fabric

Use welded wire fabric that is manufactured in accordance with ASTM A185, Grade 60 deformed bars.

C. Reinforcing Supports

Use reinforcing supports including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in pace.

- Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
- For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.

- For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
- Provide precast concrete supports over waterproof membranes.

D. Adhesive Dowels

Adhesive dowels are reinforcement used after the concrete has set. Typically, they are used for the connection of masonry walls to an existing concrete wall. A hole is drilled into the existing concrete and a project specific adhesive is used to bind the dowel to the concrete. The adhesive dowels reinforce the connection between the existing concrete and masonry wall. Adhesive is not specified because it is based on project specific requirements.

- Use dowel reinforcing bars manufactured in accordance with ASTM A615, Grade 60.

10. Related Materials

A. PVC Waterstops

PVC waterstops that comply with CRD-C572 are acceptable. Do not use reclaimed or scrap material.

- The following manufacturers of PVC waterstops are acceptable:
    1. W.R. Meadows, Inc.
    2. Greenstreak Plastic Products Company.
    3. Or approved equal.
- The minimum thickness of waterstops is ⅜-inch.
- Each waterstops shall have a minimum of 7 ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum ⅛-inch in height.
- Waterstops used for construction joints shall be 6-inch wide flat-strip type.
- Waterstops used for expansion joints shall be 9-inches wide centerbulb type.

B. Hydrophilic Waterstops

Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 % of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

- The following manufacturers of Hydrophilic Water Stops are acceptable:
    1. Duroseal Gasket, by BBZ USA, Inc.
    2. Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
    3. Hydrotite, by Greenstreak Plastic Products Company.

4. Or approved equal.

- Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
- Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
- Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
- Minimum cross-sectional dimensions: 3/16-inch by ¾-inch.
- Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured. The following manufacturers are acceptable:

    1. Duroseal Paste, by BBZ USA, Inc.
    2. Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
    3. Hydrotite, by Greenstreak Plastic Products Company.
    4. Or approved equal.

C. Vapor Retarder

Vapor retarder must be compatible with other applied finishes. Refer to each manufacturer's literature. Use caution with coordinating use of vapor retarder's with the requirements of chemical resistant coatings and concrete hardeners.

- The following manufacturers of vapor retarders are acceptable:

    1. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
    2. Griffolyn 10-mil, by Reef Industries.
    3. Moistop Ultra, by Fortifiber Industries.
    4. Or approved equal.

- Vapor retarder membrane shall comply with the following:

    1. Water Vapor Transmission Rate: ASTM E96: 0.04 perms or lower.
    2. Water Vapor Retarder: ASTM E1745: Meets or exceeds Class C.
    3. Thickness of Retarder (plastic): ACI 302 1R: Not less than 10 mils.
    4. Provide accessories by same manufacturer as vapor retarder.

D. Concrete Curing Materials

Concrete curing methods must be compatible with any applied flooring finishes or treatments. Liquid membrane-forming curing compound must be compatible with other applied finishes. Refer to the curing compound manufacturer's literature. Use caution when coordinating the use of curing compounds with the requirements of chemical-resistant coatings and concrete hardeners.

- Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 oz/yd2 and complying with AASHTO M 182, Class 3.
- Curing Mats: Shall be heavy carpets or cotton mats, quilted at 4" on centers, and weighing minimum of 12 oz/yd2 when dry.
- Moisture-Retaining Cover: Provide one of the following, complying with ASTM C171:
    1. Waterproof paper.
    2. Polyethylene film.
    3. White burlap polyethylene sheet.
- Liquid Curing Compound: ASTM C309 Type 1-D (water retention requirements):
    1. Provide fugitive dye.
    2. Curing compound shall be applied by roller or power sprayer.
    3. If concrete is to be in contact with potable water product shall be listed in NSF 61.

E. Epoxy Bonding Agent

- Two-component epoxy resin bonding agent from the following manufactures are acceptable:
    1. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
    2. Eucopoxy LPL, by the Euclid Chemical Company.
    3. Or approved equal.

F. Epoxy-Cement Bonding Agent

- Three-component blended epoxy resin-cement bonding agent from the following manufactures are acceptable:
    1. Sika Armatec 110 EpoCem, by Sika Corporation.
    2. Duralprep A.C., by Euclid Chemical Company.
    3. Or approved equal.

G. Preformed Expansion Joint Filler

- Preformed expansion joint filler complying with ASTM D1752 Type I (sponge rubber) or Type II (cork) are acceptable:

H. Joint Sealant and Accessories used on Isolation Joints, Control Joints, and Expansion Joints

If joint sealants are to be used on water retaining structures or may be submerged in potable water, provide a separate joint sealant than listed below which has additional requirements.

- For exterior and interior horizontal and vertical joints; submerged and intermittently submerged in wastewater use one of the following two-component Polyurethane Sealants:
    1. Sikaflex- 2c NS by Sika Corporation.
    2. Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
    3. Or approved equal.
- For exterior and interior vertical joints; non-submerged use one of the following two-component Polyurethane sealants:
    1. Sikaflex- 2c NS by Sika Corporation.
    2. Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
    3. Or approved equal.
- For exterior and interior horizontal joints; non-submerged, use one of the following two-component Polyurethane sealants:
    1. Sikaflex- 2c SL by Sika Corporation.
    2. THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
    3. Or approved equal.

11. Grout

A. Non-shrink Grout:

- Use pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site, with a minimum 28-day compressive strength of 7,000 psi.
- The following products and manufactures are acceptable
    1. NS Grout by Euclid Chemical Company.
    2. Set Grout by Master Builders, Inc.
    3. NBEC Grout by Five Star Products, Inc.
    4. Or approved equal.

B. Epoxy Grout:

- Used pre-packaged, non-shrink, non-metallic, 100% solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.

- Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
- Products and Manufacturers: Provide one of the following:
    1. Euco High Strength Grout, by Euclid Chemical Company.
    2. Sikadur 42, Grout Pak, by Sika Corporation.
    3. Five Star Epoxy Grout, by Five Star Products, Inc.
    4. Or approved equal.

C. Grout Fill:

- Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
- Proportion and mix grout fill as follows:
    1. Minimum Cement Content: 564 lb/yd3.
    2. Maximum Water-Cement Ratio: 0.45.
    3. Maximum Coarse Aggregate size: ½-inch, unless otherwise indicated.
    4. Minimum 28-day Compressive Strength: 4,000 psi.

MA4.05 Bedding and Backfill

This section covers requirements for trench bedding and backfill used for linear utility projects.

1. Quality Assurance

A. Testing Services:

Testing of materials, testing for moisture content during placement and compaction of fill materials, and testing of compaction for compliance with technical requirements of these standards shall be performed by a testing laboratory. Testing shall conform to ASTM D422, ASTM D427, ASTM D1557, ASTM D 2166, ASTM D 698, and ASTM D4318.

- Test proposed materials in the laboratory and/or field for compliance with these standards.
- Perform field moisture content and density tests to verify that the specified compaction of backfill materials has been obtained.
- Inspect and approve subgrades and fill layers are in compliance
- Report test results to City Utilities.

B. Testing Frequency –Pre-Installation

1. Complete gradation tests in accordance with ASTM D422. Perform one test for every 1,000 yd^3 of each of the following types of materials:
    - Pipe Bedding Material

- Special Backfill
- General Fill

2. Demonstrate the adequacy of compaction equipment and procedures before exceeding any of the following amounts of earthwork quantities:

   - 200 linear feet of special backfill per lift.
   - 10 yd^3 of structural backfill.
   - 100 yd^3 of embankment work.
   - 50 yd^3 of base material.

   If compaction fails to conform to the specified requirements, remove and replace the backfill at proper density or bring the density up to specified level by other means acceptable.

C. Testing Frequency – During Installation

The frequency confirmation tests shall be not less than as follows: Each test location for trenches shall include tests for each layer, type, or class of backfill from bedding to finish grade.

Use the following testing frequencies and intervals,

Trenches for Underground Facilities:

- In Open Fields: Two locations every 1,000 linear feet.
- Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
- Crossing Paved Roads: 2 locations along each crossing.
- Under pavement cuts or within 2-feet of pavement edges: One location every 400 linear feet.

For Structural Backfill:

- On 30’ intervals on all sides of the structure for every compacted lift, but no less than one per lift on each side of the structure for structures less than 60’ long on a side.

In Embankment or Fill:

- One per 1,000 ft^2 on every compacted lift.

Base Material:

- One per 1,000 ft^2 on every compacted lift.

2. Quality Control

A. Compaction Density Requirements:

The degree of compaction required for all types of fills shall be 95% density as determined by the Modified Proctor Test. Compaction may be obtained by mechanically tamping the material in 6”lifts. Water “flooding” or “jetting” methods of compaction are prohibited unless a variance is obtained from CUE. Note that the lifts may change based on material and compaction techniques used. Material shall be moistened or aerated as necessary to provide the moisture content that will facilitate obtaining the specified compaction.

- All fill must be wetted and thoroughly mixed to achieve, +2% or -1% of the optimum moisture content, with the following exceptions: On-site clayey soils optimum to plus 3%.
- Natural undisturbed soils or compacted soil subsequently disturbed or removed by construction operations shall be replaced with materials compacted as specified above.

Complete field density tests, during each day of compaction work. If the tests indicate unsatisfactory compaction, provide the additional compaction necessary to obtain the specified degree of compaction.

When required complete compaction testing requirements for water service pipe excavations within roadway. Compaction testing for water service pipe excavations outside of roadway will be on an as need basis.

B. Replacement of Unacceptable Excavated Materials

In cases where over-excavation for the replacement of unacceptable soil materials is required, the excavation shall be backfilled to the required subgrade with Special Backfill material and thoroughly compacted as specified above. Sides of the excavation shall be sloped in accordance to the maximum inclinations specified for each structure location.

3. Native Fill

Use soil materials for backfill and fill, free of rock or gravel larger than 3-inches in any dimension, debris, waste, frozen materials, vegetation and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for backfill. Testing may be required for general backfill and fill materials.

The following paragraphs outline material requirements for native backfill and fill used for open cut excavations.

A. Native Fill

- Materials acceptable for use as backfill against walls, foundations, underground ductbanks, and other structures shall be stockpiled native sandy clay or granular soils obtained from on-site excavations and which are uniformly mixed, contain no organic matter, nor contain rocks or fragments greater than 3-inches in size, nor have greater than 40% passing the 200 sieve.
- The maximum expansion of on-site materials shall be 1.5% as performed on a sample remolded to approximately 95% of the maximum dry density as determined in accordance with ASTM D698 at 2% below optimum moisture content under a 100 psf surcharge pressure.

4. Special Backfill

   Use special backfill for beneath structures, concrete slabs, and pavements to provide structural support.

   - Special backfill for utility projects is in accordance with the Indiana Department of Transportation (INDOT) Standard Specifications latest edition, Sections 211 and 904.
   - The material shall be acceptable quality, free from large or frozen lumps, wood, or other extraneous matter.
   - Use # 53/73 aggregate for special backfill, refer to Figure MA4.5 for the gradation distribution.
   - The aggregate shall be crushed stone or air-cooled blast furnace slag (ACBF), Class D or higher.

5. "B" Borrow

   The use of "B" Borrow as defined in Indiana Department of Transportation (INDOT) Standard Specifications latest edition, Sections 211 and 904, is prohibited and requires a variance for use on Fort Wayne projects. Refer to **Chapter GR3 – Variances** for submittal procedures.

6. Bedding

   Bedding for pipes and structures varies based on the material type used. The following lists acceptable bedding requirements. The material numbers are from INDOT's gradation classifications for course graded aggregate. For more information refer to INDOT Standard Specification Section 904.03. For the gradation distribution requirements see Figure MA4.5.

   A. Bedding for RCP

      Refer to Standard Drawing **BS-4** for depths and thickness of the pipe bedding.

      Compacted Granular Bedding Material:

      - The compacted granular bedding shall consist of angular ¼ to 1 ½-inch, graded stone.
      - INDOT Classification No. 5, No. 8 and No. 9 are acceptable.

      Shaped Subgrade Bedding:

      - The shaped subgrade material shall be No. 8 crushed stone.
      - The compacted granular bedding shall consist of angular, ¼ to 1 ½-inch graded stone. INDOT Classification No. 5, No.8 or No. 9 are acceptable.

   B. Bedding for Flexible Pipes

      Flexible pipes include PVC, HDPE, CMP, FRP, DIP and PP refer to Standard Drawing **BS-5** for depths and thickness of the pipe bedding.

- The compacted granular bedding material shall consist of angular, graded stone. INDOT Classification No. 5, No. 8, and No. 9 are acceptable.

C. Bedding for Precast Structures

- Precast base sections for structures shall be placed on a well graded, compacted granular bedding material.
- The compacted granular bedding material shall consist of angular, graded stone.
- INDOT Classification No. 5, No. 8, No. 9, are acceptable.

7. Flowable Fill

Flowable fill may be utilized at utility crossings and other such instances, and be a self-compacting flowable cementitious concrete material.

Use flowable fill with 50 psi - 200 psi 28 day compressive strength when tested according to ASTM C495. In addition, the diameter of spread shall be greater than or equal to 8-inches.

Self-compacting flowable cementitious concrete material shall be produced from the following:

- Cementitious material (Portland cement and fly ash): 100 to 350 lbs
- #23 washed sand: 2000 to 3000 lbs
- Water: 30 to 40 lbs (water to cement ratio= 1.0 to 1.5)
- Air: 10 to 30% (Use Flowable Fill Performance Admixture – Eucon Easy Fill or equal)
- Maximum 200 psi compressive strength recommended

8. INDOT Sieve Analysis Requirements

Figure MA4.9 lists coarse aggregate sieve analysis requirements in accordance with INDOT Section 904.03.

Figure MA4.9 Coarse Aggregate Sizes (Percent Passing)

Sieve Sizes	Coarse Graded								Dense Graded	
	2	5	8	9	11	12	43[(1)]	91	53[(1)]	73[(1)]
4 in.										
3½ in.										
2½ in.	100									
2 in.	80-100									
1½ in.		100					100		100	
1 in.	0-25	85-98	100				70-90	100	80-100	100
¾ in.	0-10	60-85	75-95	100			50-70		70-90	90-100
½ in.	0-7	30-60	40-70	60-85	100	100	35-50		55-80	60-90
⅜ in.		15-45	20-50	30-60	75-95	95-100				
No. 4.		0-15	0-15	0-15	10-30	50-80	20-40		35-60	35-60
No. 8.		0-10	0-10	0-10	0-10	0-35	15-35		25-50	
No. 30						0-4	5-20		12-30	12-30
No. 200[(2)]							0-6.0		5.0-10.0[(4)]	5.0-12.0
Decant (PCC)[(3)]		0-1.5	0-1.5	0-1.5	0-1.5	0-1.5		0-1.5		
Decant (Non-PCC)	0-2.5	0-2.5	0.3.0	0-2.5	0-2.5	0-2.0		0-2.5		

Notes:
1. The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5.The liquid limit shall be determined in accordance with AASHTO T89 and the plasticity index in accordance with AASHTO T90.
2. Includes the total amount passing the No. 200 sieve as determined by AASHTO T11 and T27
3. Decant may be 0-2.5 for stone and slag.
4. When slag is used for PCCP separation layers (as defined in INDOT) 302.01, the total amount passing the No.200 sieve shall be 10.0 to 12.0.

Note: Table excerpt from latest edition of INDOT Standard Specification section 904.03(e).

MA4.06 Geosynthetics for Earthwork

This section covers requirements for geosynthetics for earthwork, including requirements for woven and non-woven geotextiles and cellular confinement systems. Included is the material properties of various geosynthetics, and there intended application.

1. Geotextiles for Underdrains

   Use a non-woven geotextile for protecting the underdrain from fine sediment clogging. Acceptable non-woven geotextile requirements are listed in Figure MA4.10.

Figure MA4.10 Non-Woven Geotextile Requirements for Underdrains

Physical Properties	Test Method	Unit	Min Value
Grab Tensile Strength	ASTM D 4632	lbs.	80
Grab Tensile Elongation	ASTM D 4632	%	50
Trapezoid Tear Strength	ASTM D 4533	lbs.	30
Permittivity	ASTM D 4491	sec^{-1}	2.1
Flow Rate	ASTM D 4491	$gal/min/ft^2$	155

2. Cellular Confinement Systems

   Cellular confinement systems are used to provide soil stabilization and turf protection. Figure MA4.11 list acceptable cellular confinement system properties. Acceptable cellular confinement systems include:

   - Geoweb Cellular Confinement System as manufactured by Presto Geosystems
   - Or engineer approved equal

A. Cell Properties

   - Cell GW20V
   - Length = 8.8-inches
   - Width = 10.2-inches
   - Nominal Area= 44.8 in^2
   - Nominal Depth= 6-inches

B. Stake Anchorage

   - ATRA Anchors- Standard ½ -inch steel reinforcing rod with an ATRA clip attached as an end cap.

C. Cell Infill Materials

   - INDOT #53 Stone over #8 stone.

Figure MA4.11 Cellular Confinement System Requirements

Physical Properties	Test Method	Unit	Min Value
Density	ASTM D 1505	lbs/ft^3	58.4-60.2
ESCR	ASTM D 1693	Hours	5000
Strip Sheet Thickness	ASTM D 5199	Mil	50(-5%, +10%)
Textured Sheet Thickness	ASTM D 5199	mill	60±6

MA4.07 Riprap

This section covers riprap for use on utility projects. Riprap consists of large aggregate that is typically used for permanent or semi-permanent erosion protection of embankment slopes, channels, and shorelines.

Riprap shall be employed when normal vegetative cover or alternate erosion control measures are not appropriate to prevent soil erosion under design flow conditions. Riprap aggregate shall consist of quarried limestone or other approved materials. Stone containing shale, unsound sandstone, or other material that will disintegrate readily, shall not be used. Grouted riprap is not permitted.

1. Revetment Riprap

   Revetment Riprap shall be coarse aggregate, INDOT Class F or higher, in accordance with INDOT 904.03. The maximum dimension of individual pieces shall not be greater than three times the minimum dimension. Refer to Figure MA4.12 for revetment gradation requirements.

2. Hand-Laid Riprap

   Hand-laid aggregate shall consist of pieces, except spalls, not less than 1/3 ft^3 in volume and no less than 3-inches in the least dimension. The width of each piece shall be no less than 6-inches for 6-inch hand-laid riprap, or less than 12-inches for 12-inch hand-laid riprap.

Figure MA4.12 INDOT Riprap Gradation Requirements

Percent Smaller	
Size, in.	**Revetment**
30	
24	
18	100
12	90-100
8	
6	20-40
3	0-10
1	
Minimum Depth of Riprap	18 in.

Note: Table excerpted from INDOT standard specifications section 904.04(f)

MA4.08 Paving

This section covers general pavement requirements for repairing and replacing the pavement that has been removed during utility projects. Also covered is general information on the various porous pavement types.

1. Flexible Paving

   Flexible paving must be in compliance with the appropriate authority having jurisdiction of the roadway.

2. Rigid Paving

   Rigid paving must be in compliance with the appropriate authority having jurisdiction of the roadway.

3. Trench Pavement Repair

   Trench pavement repair is specific to linear utility pipe repair or replacement projects. Replacement pavement thickness and layouts vary based on the exiting pavement type and traffic loads. Refer to Standard Drawings **BS-8**, **BS-9**, **BS10**, and **BS-11** for the dimensions and layouts.

4. Permeable Paving

   Permeable pavement provides the structural support of conventional pavements, but allows stormwater to drain directly through the surface into an underlying stone base and soils. Listed below are the various types of acceptable permeable pavements for multiple applications.

   - Unit (block) Pavers
   - Reinforced Turf Paving

   Design guidance for permeable pavements can be found in Section 4.0 of the Green Infrastructure Design Manual located here: **utilities.cityoffortwayne.org/contractors-engineers-developers/green-design-standards**

   Unit pavers and reinforced turf paving are typically proprietary products. Coordinate with manufactures for acceptable applications and design.

5. Curb, Gutters, Sidewalks, Ramps, and Driveways

   Acceptable curb, gutter, sidewalk, ramp and driveway requirements must be in compliance with applicable requirements of governing authorities having jurisdiction.

MA4.09 Lawns and Grasses

This section contains requirements for seeding, soil supplements, planting accessories, sodding, and topsoil.

1. Topsoil

   Use fertile, friable, natural topsoil, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than ½-inch in diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D5268.

   Reuse of surface soil stockpiled on-site is acceptable. Verify suitability of stockpiled surface soil to produce topsoil, as specified. If not suitable, amend topsoil to meet requirements. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

   Topsoil layer shall be placed at a minimum thickness of 2-inches.

2. Grass Seed

   Lawn Grass Seed Mixture: Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by the supplier.

Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed as listed below.

A. Lawn Grass Seed

- 50% Premium Grade Kentucky Bluegrass (2 types)
- 50% perennial ryegrass (2 types)

B. No Mow Grass Seed

- 50% Fawn Tall Fescue (containing no Endophytes).
- 25% Annual Ryegrass.
- 25 % Perennial Ryegrass.

3. Turf Grass Sod

Sod shall be a variety or blend of Kentucky Bluegrass or fescue cut to a height of 2 to 3-inches, and shall be free from all primary and noxious weeds.

Use strongly rooted machine-cut sod, not less than 2 years old of uniform density, color and texture from a similar climate region. Sod shall be capable of vigorous growth and development when planted (viable, not dormant) and in strips of no less than 16-inches wide and shall be no less than 2-feet in length. Edges of sod shall be cut to a uniform thickness of no less than ¾-inch (excluding top growth and thatch).

4. Fertilizers

Provide commercial grade complete fertilizer of neutral character, consisting of fast and slow release nitrogen with an analysis of 12-12-12.

5. Mulches

Where seeded lawns are subject to wind or water erosion use an appropriate mulch to protect the grass seed. Provide air-dry, clean, mildew- and certified seed- free, straw mulch.

If applicable, to prevent hydroseeded areas from wind and water erosion during establishment use one of the following:

- Fiber Mulch - Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- Nonasphaltic tackifier - Colloidal tackifier shall be recommended by fiber-mulch manufactures for slurry applications; nontoxic and free of plant growth or germination inhibitors.

6. Water

Provide water acceptable for lawn and grass application, containing no material harmful to plant growth and establishment. Water shall be free from oil, acids, alkalis, and salts.

7. Hydraulic Growth Medium

   When the project site contains locations that have locations that are difficult to establish growth, require a hydraulic growth medium. Typical locations are where channelized flow is expected or steep slopes. As required, provide Biotic Earth Black, or similar as produced by Verdyol.

   Apply using a hydroseeder and at an application rate of 3,500 lbs per acre. Add seed or other amendments to the slurry prior to application.

MA4.10 Utility Pipe Jacking

1. Quality Assurance

   Perform Work in accordance with applicable permitting entities that apply, the National Utility Contractors Associations (NUCA) Trenchless Excavation Construction Equipment & Methods Manual, NUCA Pipe Jacking & Microtunneling Design Guide, American Railway Engineering and Maintenance-of-Way Association. (AREMA), and associated guidelines.

   When boring, jacking, or tunneling under the applicable permitting entity's property, make application for and obtain occupancy permit as required in the applicable permitting entity's Specifications and requirements.

2. Casing and Jacking Pipe Materials

   Casing and jacking pipe materials are in accordance with the specifications and requirements of the applicable permitting entity.

3. Carrier Pipe Materials

   Carrier pipe materials vary based on the application. Acceptable carrier pipe materials are listed in **Chapter MA5 – Stormwater Materials and Testing Requirements**, **Chapter MA6 – Sanitary Sewer Materials and Testing Requirements** and **Chapter MA7 – Water Materials and Testing Requirements**.

4. Cover Materials

   Soil Backfill for Trench Approaches and Pits to Finish Grade: Subsoil with no rocks over 6-inches in diameter, frozen earth or foreign matter.

5. Casing End Seals

   Brick and Mortar Grout Mix: One part Portland cement, and 6 parts mortar sand mixed with water to consistency applicable for brick and mortar grouting.

   - Mortar Sand: ASTM C33
   - Portland Cement: ASTM C150
   - Carrier Pipe Padding: 15 pound Building Felt

6. Casing Spacers

   Acceptable casing spacers include:

   - CCS Series by Cascade Waterworks Manufacturing

- Or approved equal

7. Steel Strapping

   Use steel strapping in accordance with ASTM A36/A36M.

Book 5

Materials (MA)

MA5 Stormwater Materials and Testing Requirements

MA5.01 Purpose

This Chapter covers typical materials used for stormwater projects.

MA5.02 Allowable Pipe Materials and Testing Requirements

Figure MA5.1 summarizes pipe materials used for gravity storm sewer installations and is to be used as a reference for acceptable storm sewer pipe materials. The following sections in this chapter provide detailed requirements for each pipe material.

Figure MA5.1 Allowable Pipe Materials Summary

<table>
<tr><th rowspan="2">Pipe Material</th><th rowspan="2">ASTM Standard</th><th rowspan="2">[1]Min Cover (ft)</th><th colspan="2">Sizes (Diameter, in.)</th><th rowspan="2">Bedding Requirements</th><th rowspan="2">Master Spec Number</th></tr>
<tr><th>Min</th><th>Max</th></tr>
<tr><td colspan="7">Preferred Pipe Materials</td></tr>
<tr><td>Reinforced Concrete (RCP)</td><td>ASTM C76
ASTM C507
ASTM C506
ASTM C1577
ASTM C1504</td><td><3</td><td>12</td><td>144</td><td>Rigid
Drawing - BS-4</td><td>33 05 34.13</td></tr>
<tr><td>High Density Polyethylene (HDPE)</td><td>ASTM F2306
ASTM F2648</td><td>3</td><td>12</td><td>36</td><td rowspan="3">Flexible
Drawing - BS-5</td><td>33 05 38.13</td></tr>
<tr><td rowspan="2">Dual Wall Corrugated Polypropylene (PP)</td><td>ASTM F2736</td><td>2</td><td>12</td><td>30</td><td>33 05 51</td></tr>
<tr><td>ASTM F2881</td><td></td><td>36</td><td>48</td><td>33 05 51</td></tr>
<tr><td>Pipe Underdrains</td><td>ASTM F2648 (HDPE)
ASTM F949 (PVC)</td><td>-</td><td>6</td><td>-</td><td>-</td><td>33 46 16.19</td></tr>
<tr><td colspan="7">Pipe Materials When the Usage of Aforementioned Pipes are Constrained and Documented</td></tr>
<tr><td>Polyvinyl Chloride (PVC)</td><td>ASTM D3034
ASTM F679</td><td rowspan="3">3</td><td>12</td><td>48</td><td rowspan="3">Flexible
Drawing - BS-5</td><td rowspan="2">33 05 37.13</td></tr>
<tr><td>Profile Wall Polyvinyl Chloride</td><td>ASTM F949</td><td>12</td><td>36</td></tr>
<tr><td>Corrugated Metal* (CMP)
*(Approved for Private Driveway Culverts only)</td><td>ASTM A760
ASTM A762
ASTM B745
ASTM A761
ASTM B746</td><td>12[2]</td><td>48</td><td>33 05 41</td></tr>
</table>

All stormwater projects shall use materials from the preferred pipe material list. If, for reasons provided as part of permit submittal and aside from material costs, the engineer finds the need for a different pipe material, engineer should use the approved list. Use of these materials will require written statement of explanation. Any project proposing ductile iron, corrugated metal, or other material not included on this list, or a material on this list in a size not approved, will be required to follow the variance process.

Notes:

1 - Minimum cover from finished grade to top of pipe (O.D), at completion of all project restoration.
2 – Minimum driveway culvert size is 12”. Minimum public culvert size is 15”.

1. Pipe Testing Requirements

   The following subsections include quality assurance and quality control requirements for the pipe material listed in this chapter.

2. Quality Assurance

   A. Manufacturers Qualifications

      - Pipe manufacturers shall have a minimum of 5 years of successful experience producing specified pipe and fittings and must document their success by showing evidence of at least 5 installations in satisfactory operation within the United States.
      - Concrete pipe and fittings shall be from a source listed in the most recent INDOT list of Certified Precast Concrete Producers, in accordance with ITM 813.

   B. Supply and Compatibility

      - Pipe, fittings and appurtenances shall be suitable for the specified service and integrated into the overall piping system by the pipe supplier.

3. Field Quality Control

   This section covers pipe-testing requirements after installation of the pipe. The following testing is required for stormwater projects:

   - Vertical Deflection Test (Mandrel Test) for Flexible Pipe
   - Televised Inspections (for public projects)

   The following testing for stormwater pipe is used based on project specific requirements:

   - Low Pressure Air Test
   - Hydrostatic Test
   - Large Diameter Pipe Joint Test

   A. Vertical Deflection Test (Mandrel Test) for Flexible Pipe

      1. Conduct vertical deflection tests not less than 30 days after the installation of the pipe, bedding and backfill.
      2. Testing is conducted on all pipe runs (defined as length of continuous pipe from structure to structure) containing 3 or more pipe-to-pipe joints.
      3. A rigid ball or mandrel that has a diameter of at least 95% percent of the base inside diameter or average inside diameter of piping is used to test the deflection of the piping. The ball diameter depends on which is specified in applicable ASTM standard, including the appendix, to which the pipe is manufactured.
      4. The test is performed without mechanical pulling devices.
      5. Pipe segments that exceed a deflection of 5% are not acceptable and must be replaced/repaired, in compliance with City Utilities Engineering standards.

B. Televised Inspection for All Pipe Materials

1. Televise completed sewer and appurtenant structures, including manholes and chambers, and provide to City Utilities Engineering a copy of the video on digital video disc (DVD) or portable storage device. Software shall be compatible with Pipelogics version 6.0 software.
2. Inspection shall be performed by a subcontractor certified in Pipeline Assessment Certification Program (PACP) by National Association of Sewer Service Companies (NASSCO). Provide copy of PACP certification prior to starting inspection.
3. Televising shall conform to coding and reporting standards and guidelines specified in PACP. Identify report annotations, pipe conditions, and pipe defects in accordance with PACP. Severity ratings shall be calculated in accordance with PACP.
4. Camera for main line shall be pan-and-tilt, radial viewing, pipe inspection camera that pans plus-or-minus 275° and rotates 360°. Use camera with an accurate footage counter that displays on television monitor exact distance of camera from centerline of starting manhole. Use camera with height adjustment so that lens is always centered at one-half inside diameter or higher, in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Camera shall operate in 100% humidity. Camera, television monitor, and other components of video system must produce a minimum 450-line resolution colored video picture. Picture quality and definition shall be satisfactory to City Utilities Engineering.
5. Repair apparent leaks in a manner satisfactory to City Utilities Engineering without additional cost to City Utilities and re-televise the pipe.

C. Low Pressure Air Test for Gravity Storm Sewers:

- DIP (for diameters ≤ 36-inches)
- PVC
- HDPE

1. Plug and bulkhead ends of pipe segment to be tested.
2. One plug shall have an orifice to pass air and a second orifice shall be continuously connected to a pressure gauge having a range from 0 to 10 psi, minimum divisions of 0.10 psi, and accuracy of 0.04+/- psi.
3. The air supply line shall have a positive on-off valve and suitable means for readily disconnecting from the control panel.
4. The section of pipe shall be pressurized to approximately 4 psi.

5. The air shall be shut off and allowed to stabilize for a minimum of 2 minutes. If during this time the pressure drops below 3.5 psi, more air shall be added to raise pressure to a minimum of 3.5 psi.
6. After the air has stabilized, the air line shall be disconnected and timing will begin.
7. The time of test in minutes will be equivalent to one-half of the nominal diameter of the pipe being tested.
8. The maximum allowable pressure drop during the specified time period will be 1.0 psi.

D. Hydrostatic Testing for:

- DI Pressure (AWWA Manual M41)
- PVC Pressure Pipe (AWWA Standard C605)
- HDPE Pressure Pipe (ASTM F2164)
- Concrete Pressure Pipe (AWWA M9)

1. Preparation for Testing:
    - Follow appropriate preparation for testing as specified in the manuals above for specified pipe material.
    - Prior to testing the contractor shall ensure that the line is clean and free of dirt and debris.
    - Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
    - Prior to testing, install test riser and ensure equipment is properly calibrated.
2. Test Procedure for DIP and PVC Pressure Pipe:
    - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
    - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
    - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
    - Add fluid as required to pressurize line to 150psi or otherwise specified test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
    - Timed test period shall not begin until after pipe has been filled, air has been expelled, and pressure stabilized.
    - Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure.

- Pump from test container to maintain test pressure. Measure volume of water pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.
- Results of the test shall be logged using the inspection form provided in **Exhibit MA6-1**.

3. Test Procedure for HDPE Pressure Pipe:

- Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
- Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
- Examine exposed joints and valves, and make repairs to eliminate visible leakage.
- The test section and the test liquid shall be allowed to equalize to a common temperature.
- After filling pipeline and purging air, gradually pressurize pipe to 150 psi or otherwise specified test pressure and maintain required test pressure for 4 hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
- Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
- Timed Test Period: After 4-hour expansion phase, reduce test pressure by 10 psig and do not add liquid. Test pressure shall then remain steady for 1 hour, indicating no leakage.
- If no visible leakage is observed and pressure remains within 5% of the original test pressure for 1 hour, a passing test is indicated.
- Results of the test shall be logged using the inspection form provided in **Exhibit MA6-2**.

4. Test Procedure for Concrete Pressure Pipe

- Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
- Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
- After filling the pipe allow for a 48-hour momentum wetting period to saturate the concrete lining.

- Bring the pipeline to 120% of the working pressure, and maintain, within 5 psig, the pressure for the test duration of a minimum of 2 hours.

5. Makeup Water Allowances:

- The allowable makeup water allowance is the maximum amount of water that is added into a pipeline undergoing hydrostatic pressure testing. The allowable leakage rates for the various pipe materials and joints are listed below.
- Pipes with flanged, welded, or fused joints
    - No addition of makeup water
- Allowance rates for DIP and PVC pipes joined with rubber gaskets as sealing members include the following joint types; bell and spigot, push on, mechanical, bolted sleeve type couplings, grooved and shouldered couplings
    - Calculate makeup water rates using the following equation.

$$Q = \frac{LD\sqrt{P}}{148{,}000}$$

Where:

Q = quantity of makeup water (gph)

L = length of pipe section being tested (ft)

D = nominal diameter of the pipe (in)

P = average test pressure during the hydrostatic test (psi_{gauge})

    - Figure MA5.2 represents the calculated values of rates per 1,000 feet of pipe at the 150 psi test pressure.

Figure MA5.2 Allowable Testing Allowance for DIP and PVC Pipe (per 1,000' of pipeline at 150 psi)

Nominal Pipe Diameter (in)	Testing Allowance (gph)
4	0.33
6	0.5
8	0.66
10	0.83
12	0.99
16	1.32
20	1.66
24	1.99
30	2.48
36	2.98
42	3.48
48	3.97
54	4.47
60	4.97

Note: Table is an excerpt from AWWA M41 and AWWA C605.

- Allowance rates for Concrete Pressure Pipe conform to Figure MA5.3.

Figure MA5.3 Allowable Testing Allowance Concrete Pressure Pipe

Type of Pipe	Makeup Allowance (gal/in dia/mi pipe/24h)
AWWA C300, 301 and C303	10

Note: Table is an excerpt from AWWA M9.

MA5.03 Culverts

1. Culverts are pipes that are exposed, or open, at the upstream and downstream ends of the pipe and typically provide conveyance of surface water underneath a road, driveway, berm, and railway. Refer to the appropriate pipe material section, within this chapter, for specific pipe requirements. End treatments for use on culverts are listed in Section MA5.14. For information on design of culverts and other related technical details refer to Standard Drawing **SW-8** Roadway Culverts.

   Concrete pipe is acceptable for roadway crossings.

2. Driveway Culverts

   Concrete pipe and CMP, with appropriate cover, are acceptable for private driveway crossings. The minimum allowable diameter is 12-inches.

MA5.04 Concrete Pipe

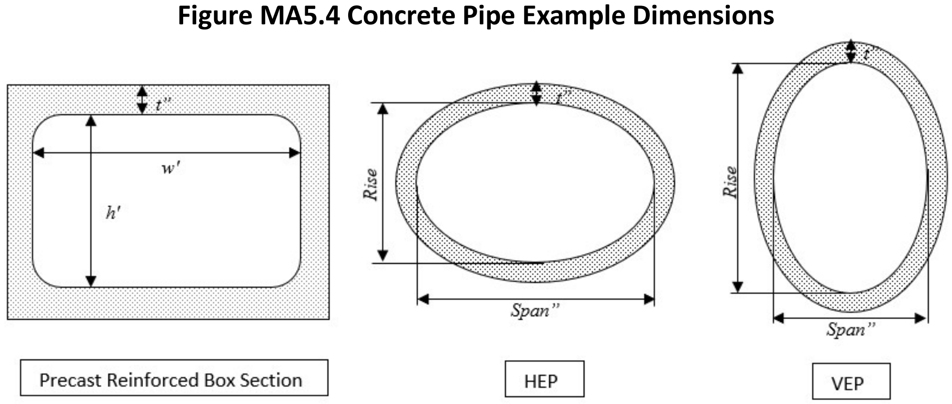
This section covers concrete pipe, including reinforced concrete pipe, elliptical pipe, arch pipe and concrete box sections, for use in non-pressure stormwater applications. Figure MA5.5 lists acceptable concrete pipe for public storm water facilities.

1. Reinforced Concrete Pipe (RCP)
   - Select pipe class based on the project specific external live and dead loads.
   - Class III pipe is the minimum class accepted for public storm water facilities.
2. Horizontal and Vertical Elliptical Pipe (HEP / VEP)
   - Select pipe class based on the external live and dead loads.
   - Horizontal elliptical pipe - Class HE-II is the minimum accepted for public storm water facilities.
   - Vertical elliptical pipe - VE-III is the minimum accepted for public storm water facilities.
   - Elliptical pipe size is specified by (rise" x span"). See Figure MA5.4 for example dimensions.
   - Elliptical pipe is typically tongue and groove joints. Bell and spigot joints are available from various manufacturers but, are not typical.
3. Concrete Arch Pipe

   Select pipe class based on the external live and dead loads.
   - Class A-III is the minimum acceptable for public storm water facilities.
   - Arch pipe size is specified by (minimum rise" x minimum span").
4. Precast Reinforced Box Sections

   Precast reinforced concrete box sections are manufactured according to ASTM C1577.
   - Table 1 in ASTM C1577 lists the design requirements for precast concrete box sections under earth dead and HL-93 live load conditions.
   - Box sections sizes specified by (w' x h' x t"). See Figure MA5.4 for example dimensions.

Figure MA5.4 Concrete Pipe Example Dimensions



5. Precast Reinforced Three Sided Structures

   Precast reinforced concrete three-sided structures are manufactured according to ASTM C1504. These structures do require a footing to support the structure from settlement.

   - Dimension and reinforcements details are designed in accordance with Section 3, 5, and 12.14 of the AASHTO - LFRD Bridge Design Specifications.
   - The minimum concrete compressive strength is 5,000 psi, and the minimum steel yield is 65,000 psi for welded wire reinforcement and 60,000 psi for deformed billet-steel bars.

Figure MA5.5 Concrete Pipe

Material	Class	Designation	Joints	[1]Gaskets	Sizes (in)	
					Min	Max
Reinforced Concrete Pipe	III IV V	ASTM C76	Bell and Spigot	Rubber Gasket (ASTM C443)	12	144
[2]Horizontal Elliptical Pipe	HE-II HE-III HE-IV	ASTM C507	Tongue and Groove	Rubber Gasket (ASTM C443)	18	144
[2]Vertical Elliptical Pipe	VE-III VE-IV VE-V VE-VI			Flexible Sealant (ASTM C990)	36	144
[2]Arch Pipe	A-III A-IV	ASTM C506		Rubber Gasket (ASTM C443)	15	132
Concrete Box Sections	ASTM C1577 Table 1	ASTM C1577	Tongue and Groove	Flexible sealant with External joint sealer system or membrane system	3' W x 2' H x 4" Wall Thickness	12'W x 12'H x 12" Wall Thickness
Concrete Three Sided Structures	-	ASTM C1504			-	-

Note- 1- For RCP, Horizontal Elliptical pipe and Arch Pipe with diameters larger than 24", flexible sealants may be used in lieu of rubber gaskets.
Note-2-The sizes listed are the pipe designated equivalent round size; refer to the related ASTM for exact pipe dimensions.

MA5.05 High Density Polyethylene (HDPE) Pipe – Non-Pressure

This section covers non-pressurized High Density Polyethylene (HDPE) pipe, Figure MA5.6 lists HDPE pipe acceptable for public storm water facilities. Based on project specific requirements, HDPE pipe may be specified with or without perforations and with soil or water tight joints.

1. Dual Wall Corrugated HDPE Pipe has a smooth interior liner in the waterway and includes an exterior corrugation that helps brace the pipe against deformations. The following list ASTM standards for dual wall HDPE pipe:

   - Pipe manufactured per ASTM 2306 is made of virgin Polyethylene (PE) plastic compound.
   - If project calls for HDPE pipe with recycled content, then require compliance with ASTM F2648.

   Corrugated dual walled pipe is also available with water tight joints; performance is based on ASTM D3212.

Figure MA5.6 High Density Polyethylene (HDPE) Pipe

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Dual-Wall Corrugated HDPE Pipe	ASTM F2306 (AASHTO M294, Type S)	AASHTO M252 AASHTO M294	ASTM F477	ASTM F2306 AASHTO M252 AASHTO M294	12	36

MA5.06 Dual Wall Corrugated Polypropylene (PP) Pipe

This section covers information on polypropylene utility piping. Figure MA5.7 lists acceptable PP pipe for public stormwater facilities. Based on project specific requirements, PP pipe may be specified with or without perforations and with soil or watertight joints.

1. Dual Wall Corrugated Polypropylene Pipe (PP)

   PP pipe has a smooth interior liner in the waterway and includes exterior corrugation that helps brace the pipe against deformations.

Figure MA5.7 Dual-Wall Polypropylene (PP) Pipe

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Dual-Wall Corrugated PP Pipe	ASTM F2736	Bell and Spigot (ASTMF2736)	ASTM F477	ASTM F2736	12	30
	ASTM F2881	Bell and Spigot (ASTMF2881)	ASTM F477	ASTM F2881	36	48

MA5.07 Underdrains

This section covers information related to stormwater underdrains. Underdrains are small diameter pipes that provide subsurface drainage. These pipes are available in multiple materials, with or without perforations and must be protected from fine sediment with geotextiles.

1. Underdrain Pipe Materials

   Figure MA5.8 lists acceptable underdrain pipes for stormwater facilities.

Figure MA5.8 Underdrain Pipe Materials

Material	Designation	Perforations	Joints	Gaskets	Fittings	Sizes (in) Min
Dual Wall Corrugated PVC Pipe	ASTM F949	ASTM F949	Bell and Spigot (ASTM F949)	ASTM F477	ASTM F949 ASTM F794	6
Dual Wall Corrugated HDPE Pipe	AASHTO M252 or ASTM F2648	AASHTO M252 AASHTO M294 ASTM F2648	AASHTO M252 AASHTO M294 ASTM D3212	ASTM F477	AASHTO M252 AASHTO M294	6

2. Perforations

   Dimensions and configurations of perforations are based on the application and manufacturer’s recommendations.

   - Pipe connected by bell and spigot joints shall not be perforated in the area of the bells and spigots.

3. Fine Sediment Protection

   Perforations on underdrains must be protected from fine sediment to prevent the underdrain from clogging. The following are two acceptable methods for providing protection:

   - A geosynthetic filter sock wrap that fits around the circumference of the pipe per manufacturer’s recommendations. Coordinate the material requirements with the pipe manufacturer.
   - Wrap the underdrain pipe trench with a nonwoven geotextile fabric. Refer to Chapter MA4 – Common Materials and Testing Requirements for nonwoven geotextile fabric requirements.

4. Cleanouts

   Cleanouts must be spaced as follows to allow maintenance access to all sections of the pipe.

   - Cleanouts are spaced at a minimum of 300 feet apart along the total length of the underdrain.

- The material, joints, and fittings of cleanouts must be compatible with the underdrain pipe material per pipe manufacturer's recommendations.

MA5.08 Polyvinylchloride (PVC) Pipe – Non-Pressure

This section covers non-pressurized PVC pipe, Figure MA5.9 lists acceptable PVC pipe for public storm water facilities.

1. PVC Pipe has an integral bell elastomeric seal joint and smooth inner wall.
    - If project requires PVC pipe with recycled content, then request pipe that is in compliance with ASTM F1760.
2. Profile Wall PVC Pipe has a corrugated outer wall with a smooth inner wall.

Figure MA5.9 Polyvinylchloride (PVC) Pipe

<table>
<tr><th rowspan="2">Material</th><th rowspan="2">Designation</th><th rowspan="2">Min Wall Thickness</th><th rowspan="2">Joints</th><th rowspan="2">Gaskets</th><th rowspan="2">Fittings</th><th colspan="2">Sizes (in)</th></tr>
<tr><th>Min</th><th>Max</th></tr>
<tr><td rowspan="2">PVC Pipe</td><td>ASTM D3034</td><td>SDR35</td><td rowspan="2">Bell and Spigot</td><td rowspan="2">ASTM F477 and ASTM D3212</td><td>ASTM D3034</td><td>12</td><td>15</td></tr>
<tr><td>ASTM F679</td><td>PS46</td><td>ASTM F679</td><td>18</td><td>48</td></tr>
<tr><td>Profile Wall PVC Pipe</td><td>ASTM F949</td><td>PS46</td><td>Bell and Spigot (ASTM F949)</td><td>ASTM F477</td><td>ASTM F949
ASTMF794</td><td>12</td><td>36</td></tr>
</table>

MA5.09 Corrugated Metal Pipe (CMP)

This section covers information on corrugated metal utility piping. Figure MA5.10 lists acceptable metal pipe for stormwater facilities.

CMP is manufactured with various coatings, linings and metal types. They vary based on the required service life and durability. The project site corrosivity must be considered. Highly corrosive environments reduce the lifespan of metal pipe. Consider the following site environmental factors including, but not limited to:

- Soil Resistivity – Soils with a low soil resistivity value tends to allow electrical currents to travel more freely, potentially leading to increased corrosion. Typically, clay soils have a low resistivity, while rock has high resistivity.
- Soil and Water pH – A normal pH is around 5.8, pH values above or below 5.8 tends to increase corrosion.
- Abrasion – High solids within the stormwater increase the abrasion to the pipe and damage the pipes protective coating.

1. Corrugation Patterns
    - CMP may be specified with various corrugation patterns, based on project requirements.
    - The varying patterns provide different flow characteristics.

- Each pipe material ASTM standard lists acceptable corrugation types.

2. Joint Systems
   - CMP has various jointing systems classified as soil tight, silt tight, leak resistant or special design; see the American Iron and Steel Institute Modern Sewer Design Manual.
   - Leak resistant (gasketed) joints are the minimum acceptable for stormwater facilities.

3. CMP Types

   Listed below are typical CMP types these provide varying levels of corrosion and abrasion resistance.

   A. Aluminized Steel
      - The steel sheet used in fabrication of pipe manufactured per ASTM A760 has a protective metallic coating of aluminum (aluminized).

   B. Polymer Coated
      - The steel sheet used in fabrication of pipe manufactured per ASTM A762 has a polymer protective coating over a metallic coating of zinc (galvanizing) or an aluminum alloy.
      - Some severe environments may cause problems to accessory items such as rivets or coupling band hardware that does not have a polymer coating.
      - Additional protection for polymer pre-coated steel pipe can be provided by use of coatings applied after fabrication as described in ASTM A849.

   C. Aluminum Alloy
      - Pipe manufactured per ASTM B745 specifies aluminum-alloy sheet metal.

   D. Corrugated Structural Plate Pipe

      Structural plate pipe is typically used in the construction of pipe, pipe-arches, arches, underpasses, box culverts, and special shapes for field assembly. The following list the acceptable standards for corrugated structural plate pipe:

      - ASTM A761 – Galvanized corrugated steel flat plate for field bolted pipe
      - ASTM B746 – Aluminum alloy steel flat plate for field bolted pipe.

Figure MA5.10 Corrugated Metal (CMP) Pipe

Type	Pipe Designation	Material	Material Designation	Min Gauge	Joints	Gaskets	Fittings	Sizes (in)	
								Min	Max
Corrugated Metal Pipe	ASTM A760	Aluminized Steel	ASTM A929	14	External Semi-Corrugated (Hugger) Coupling Band	Rubber O-Ring	Match Pipe Mat.	12	144
	ASTM A762	Polymer-Coated Steel	ASTM A742					12	144
	ASTM B745	Aluminum Alloy	ASTM B744	14	External Semi-Corrugated (Hugger) Coupling Band	Rubber O-Ring		12	120
Corrugated Steel Structural Plate	ASTM A761	Galvanized	ASTM A761	-	Field Bolted		-	-	-
Corrugated Aluminum Alloy Structural Plate	ASTM B746	Aluminum Alloy	ASTM B209	-	Field Bolted		-	-	-

MA5.10 Manholes

This section covers information on precast concrete storm drainage manholes and pipe to manhole connection requirements. Precast storm drainage manholes are manufactured by wet cast methods using forms. Table MA5.11 lists typical storm drainage manholes.

Figure MA5.11 Storm Drainage Manholes

Material	Designation	Drawing Numbers	Joints	Gaskets	Pipe Connections	Sizes (in) Min
Precast Concrete	ASTM C478	STR-30-1 STR-30-2 STR-30-3 STR-30-4	Tongue and Groove	Preformed Flexible Sealant (ASTM C990)	Grout Collar or Rubber Gasket Boot	48

1. Pipe Connections to Manhole
   A. Pipe opening in manholes are either pre-formed by the manufacturer or field drilled

- When using RCP, the pipe manhole opening diameter shall not exceed the pipe outer diameter plus six inches (O.D.+6”)
- When using non-concrete pipe, the manhole pipe opening diameter shall not exceed the pipe outer diameter plus four inches (O.D.+4”)

B. Connections between the manhole and pipe must be soil tight. The following methods are appropriate:

- Grout collar- placed in the annular space between the manhole and pipe. Use Class A or Class B grout in accordance with **Chapter MA4 – Common Materials and Testing Requirements**.
- Rubber Gasket Boot – Use one of the following manufactured in accordance with ASTMC3923.

  a) For pipes ≤36” diameter:

  - Press-Seal PSX: Positive Seal
  - NPC Kor-N-Seal II 306 Series

  b) For pipes ≥36” diameter:

  - A-Lok Premium
  - Press-Seal WS 30 Waterstop Grouting Ring

Note - Projects that are located in the downtown district, or near building foundations and structures, or are located in areas of soil or groundwater contamination must utilize rubber gasket boots.

MA5.11 Inlet Structures

This section covers information on stormwater drainage inlets. Inlets are area drains, catch basins and yard drains and typically used to convey stormwater runoff into the collection system. Figure MA5.12 lists typical inlet structures for use in stormwater applications. For each inlet’s application information refer to **Exhibit MA5-1**.

1. Precast Inlet Structures

   Precast structures are available in a variety of sizes and are typically used within the right-of-way and parking areas.

2. Plastic Inlet Structures

   Nyloplast plastic structures are available in a variety of sizes ranging from an 8” drain basin to a 30” drain basin and typically used for applications outside of the right-of-way. Each drain basin size has a matching grate assembly that is available from the manufacturer and is based on the specific application. Nyloplast structures shall only be used in landscaping applications on private systems. Use in public systems shall be by variance.

3. Pipe to Structure Connection

   Connections between the inlet and pipe must be soil tight. Projects that are located in the downtown district, or near sensitive building foundations and structures must require that rubber gasket boots are utilized for the pipe to manhole and inlet connections. The following methods are appropriate:

   - Rubber Gasket Boot- Use one of the following manufactured in accordance with ASTMC923.

     a) For pipes ≤36" diameter:

        - Press-Seal PSX: Positive Seal
        - NPC Kor-N-Seal II 306 Series

Figure MA5.12 Inlet Structures

Material	Designation	Drawing Numbers	Joints	Size Min
Precast Concrete	ASTM C478	STR-32-1 STR-32-2 STR-32-3 STR-34-1 STR-34-2 STR-34-3 STR-34-4	Tongue and Groove	30" Diameter 30" x 30" Square
Plastic	ADS Nyloplast Drain Basin (or approved equal)			12" Diameter

MA5.12 Utility Trench Drains

This section covers linear utility trench drains that capture overland sheet flow and convey runoff to the stormwater collection system. Figure MA5.13 lists the common trench drain types.

- Utility trench drain pipes that are PVC, HDPE, or CMP must have the pipe encased in concrete.
- Proprietary trench drains are acceptable and for use outside of the right-or-way. Coordinate with manufacturer's requirements and recommendations.

Figure MA5.13 Utility Trench Drains

Type	Grate I	Pipe/Trench Material	Drawing Numbers
Trench Drain Type I	Cast Iron Grate	Reinforced Concrete	SW-5-1
Trench Drain Type II	Slotted Vane Drain	HDPE PVC CMP	SW-5-2
Proprietary Trench Drains	Conform to manufacturer's requirements		

MA5.13 End Treatments

This section covers end treatments for storm sewer pipe including end sections, erosion control, backflow prevention and pipe anchoring. End treatments are required to ensure free flowing inflow and outflow, prevent floatation, and protect against soil erosion. Based on project requirements various end treatment shapes may be utilized including:

- flared
- safety metal grated
- headwalls
- headwall with wingwalls
- slope matching mitered structures
- grated box
- engineered baffles and structures

Typical end section structures are listed in Figure MA5.14.

Figure MA5.14 End Treatments

<table>
<tr><th>End Treatment Material</th><th>Material Designation</th><th>Joint to Pipe</th><th>Drawing Number</th></tr>
<tr><td>Precast Concrete – Flared End Section</td><td>ASTM C76</td><td>Tongue and Groove</td><td>STR-36-4</td></tr>
<tr><td rowspan="3">Metal</td><td rowspan="3">AASHTO M 218 or ASTM A929</td><td>Flat Strap Connector</td><td rowspan="3">STR-36-1
STR 36-2
STR 36-3</td></tr>
<tr><td>Threaded Rod</td></tr>
<tr><td>Dimple Band Collar (Bolted to End Section)</td></tr>
</table>

1. Anchoring

   Provide pipe anchoring for all non-concrete pipes, to protect against floatation.

   An 18” toe plate extension is required for all steel end sections. See Standard Drawing STR-37 for toe plate extension.

   For pipes ≥ 60-inches, the applicable INDOT standard details and specifications shall be used for pipe end anchors.

2. Energy Dissipation

   Energy dissipation is used to reduce the outlet velocity and to help prevent erosion. The following are acceptable energy dissipation materials:

   - Riprap – Refer to Chapter MA4 – Common Materials and Testing Requirements
   - Engineered baffled spillway

- Geotex
- Scourstop
- Proprietary erosion control products

3. High Water Protection-Gates and Check Valves

   For locations where backflow from waterways or water bodies into the piping network is a concern, utilize the appropriate valves or gates.

   A. Rubber Duckbill Check Valves

      Rubber duckbill check valves shall be flow operated check type with a slip-on connection. Inlet port area shall be 100 percent of the connecting pipe port size. The port area shall contour down to a duckbill that shall allow flow in one direction while preventing reverse flow. The flexible duckbill shall be one piece construction with fabric reinforcement. The valve shall also have a Neoprene exterior wrapping, or approved equal, for protection against sunlight attack. The following products are acceptable:

      - Tideflex by Red Valve Company
      - Or approved equal

   B. Metal Top-Hinged Flapgates

      Metal top-hinged flapgates shall be flow operated check type. The port opening shall be equal in size to the connecting pipe. The flap shall allow flow in one direction while preventing reverse flow. The upper hinge shall be stainless steel and designed such that minimal maintenance is required. The following products are acceptable:

      - Waterman Industries F-25 and F-55 cast iron, automatic drainage gates
      - Or approved equal

   C. Sluice Gates

      Use sluice gates in locations where isolation of the system is necessary. Sluice gate design and materials are based on project specific requirements and must be approved by CUE.

4. Trash Racks

   For locations where large objects and debris are a concern utilize trash racks to protect pipes from clogging and downstream facilities. Trash racks should be used at the inlet of an outfall structure. Trash rack bar spacing are designed based upon specific hydraulic and site requirements. Trash rack structures are available in a variety of sizes and manufactured for all pipe material.

5. Stormwater Basin Outfall

   To minimize overloading downstream stormwater facilities, use a t-shape orifice outfall structure. Use a minimum outfall pipe diameter of 12-inch; see **Exhibit SW11.7** for the layout and configuration.

MA5.14 Castings, Frames, and Covers

This section covers the various types of stormwater manhole and inlet structures castings, frames, covers, and grates.

All castings must include environmental lettering to notify the public that the stormwater system drains to the river.

In pedestrian traveled areas, castings frames and covers must comply with current ADA requirements with a max opening of ½-inch. Utilize pick hole plugs as appropriate.

1. Metal Castings
   - Gray iron castings are recommended for metal castings.
   - Ductile iron may be required when design loading is greater than AASHTO H-20 loading. Consult the manufacturers when loads greater than AASHTO H-20 are required.
2. Adjusting Rings
   - Precast concrete grade rings, manufactured in accordance with ASTM C478, are used to adjust the finish elevation of the metal casting. See Standard Drawing **STR-33-1** for appropriate thickness and height of the grade rings.
   - Grade rings are sealed with a preformed flexible rope joint sealant manufactured in accordance with ASTM C990 and AASHTO-M198. The following products are acceptable:
     a) EZ Stik by Press-Seal Gasket Corporation, or
     b) Kent Seal No. 2 by Hamilton Kent, or
     c) Approved equal
   - The exterior of the grade rings are sealed with a non-woven geotextile fabric. Fabric requirements are listed in **Chapter MA4 – Common Materials and Testing Requirements**.
3. Plastic Castings

   Plastic castings are used with plastic drainage structures. Ensure that the casting is compatible with the structure as per the manufacturer. Plastic castings are for yard drain applications and not for vehicle loading situations or within the public right-of-way.

MA5.15 Green Infrastructure

Green infrastructure is used to manage stormwater on site-constructed rather than factory constructed measures. For additional information regarding green infrastructure, see **Chapter SW11 – Stormwater Management**.

1. Bioretention

   Common to all bioretention systems is the use of amended soils and plants that provide a catalyst for infiltration, evapotranspiration and stormwater treatment. Material requirements for these systems are listed below.

   A. Underdrain Piping

      Underdrain piping material acceptable for bioretention construction is listed in **Section MA5.07 – Underdrains**.

   B. Filter Aggregate

      Pipe filter aggregate is a 6-inch layer of washed INDOT #5 stone and a 4-inch layer of washed INDOT #11 stone. Stone gradation requirements are listed in **Chapter MA4 – Common Materials and Testing Requirements**. The stone cannot contain more than 1% silt, clay, or organic material, and cannot contain any Pre-Cenozoic limestone, dolomite, or stone containing phosphate.

   C. Revetment Stone

      Revetment stone is installed in sediment forebays, weirs and spillways. It consists of washed INDOT revetment stone and contains no more than 1% silt, clay or organic material.

   D. Geotextile Fabric

      Geotextile fabric acceptable for bioretention construction is listed in **Chapter MA4 – Common Materials and Testing Requirements**.

   E. Amended Soil

      Amended soil is a mixture of 50% coarse sand and 50% compost.

      - Sand for amended soil is clean construction sand, free of deleterious materials, and shall conform to the grading requirements of the ASTM C33, as shown in Figure MA5.16.
      - Compost for amended soil is aged leaf compost free of deleterious materials, including but not limited to clay, silt, manure solids, woody debris, plastics, construction debris, or other material that may negatively affect infiltration.
      - The compost pH shall range from 5.5 to 8.5, and all particles must pass through a one 1” screen or smaller.
      - Compost that smells putrid, has an ammonia odor, or shows visible signs of mold is unacceptable.

Figure MA5.15 Amended Soil Sand Gradation Requirements

Sieve Size (in)	Percent Passing
3/8 in	100
No. 4	95 to 100
No. 8	85 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

Note: Table based on ASTM C33

F. Double Shredded Hardwood Mulch

- Mulch is composed of shredded hardwood bark and does not contain colored dyes or other chemical treatments.
- Mulch shall not contain any foreign material, debris, or compounds that may be detrimental to plant growth.
- The depth of mulch for bioretention shall be less than or equal to 3-inches.

G. Plants

Plants acceptable for bioretention are listed in Section MA5.18 – Plant List.

H. Bioretention Quality Assurance

Installers shall be qualified laborers who have at least 3 years of experience with native planting and shall have successfully performed at least 5 native planting projects similar in size and scope to the current project. An on-site supervisor, experienced in native planting with a minimum 4-year degree in natural resources, biology, or related field, shall be required.

2. Green Roofs

A green roof or vegetated roof is a system consisting of waterproofing materials, growing medium and vegetation. Green roofs can be used in lieu of a traditional roof to reduce the roofs impervious area and help manage the runoff. Materials vary based on the roof structure and application.

3. Cisterns and Rain Barrels

Cisterns and rain barrels are structures used to intercept and store stormwater runoff from rooftops. The stored water is then reused for irrigation or plumbed into buildings per building codes. These systems are manufactured in many shapes and sizes and can either be above or below ground and drained by either gravity or pump.

4. Inlet and Outlet Controls

   Inlet and outlet controls are structures or landscape features that manage flow into and out of a storm water management facility. Flow splitters, level spreaders, curb openings, energy dissipaters, infiltration inlets, and curbless design are all examples of inlet controls. Outlet controls include risers and orifices, underdrains, permeable weirs, positive overflows, sub-thermocline basin release, and impervious covers. Inlet and outlet controls are typically design elements or proprietary structures.

5. Filters

   Filters are structures or excavated areas containing layers of sand, compost, organic material, or other filter media, and are used to reduce pollutant levels in storm water runoff. Filters can be site-specific design or proprietary structures.

6. Pervious Pavement

   Acceptable pervious pavement is listed in **Chapter MA4 – Common Materials and Testing Requirements**.

MA5.16 Underground Stormwater Storage

There are multiple different styles and types of underground storage structures that fit specific site footprints and applications. These underground storage systems can be used to store, infiltrate, facilitate infiltration and retain stormwater flows. **Exhibit MA5-2** shows the acceptable types of underground storage. Refer to manufacturer's recommendations for installations and material requirements.

MA5.17 Manufactured Stormwater Quality Units (SQU)

The City and other MS4's are required by their NPDES stormwater permit to implement Best Management Practices (BMPs) in order to improve the stormwater runoff water quality. The City's preference is the use of Green Infrastructure. However, there are instances when Green Infrastructure is not a viable option. In those instances, manufactured stormwater quality units (SQUs) can be utilized.

SQUs vary in capacity and configuration between manufacturers. The City has evaluation processes for determining the recognized capacity of the units. The capacity stated by the vendor may be in conflict with the City's evaluation. The City's stated capacity of a model unit in **Exhibit MA5-3** "Accepted Capacity Rates for Proprietary SQUs" shall govern. SQUs that are not on the exhibit are not an acceptable option within the City's jurisdiction.

Manufacturers can submit their SQU's data to the City to get the accepted capacity of a model on the said exhibit. Manufacturers can contact City Utilities for the steps and details of the submittal process. Official acceptance of SQUs shall be at the discretion of the City Utilities and is not guaranteed by the submittal of the minimum informational requirements. When capacity results have been established by multiple independent laboratory testing and certification protocols, the City shall have the option to select the flow rate to be approved.

Approvals of SQUs may be revoked at any time by City Utilities based changes in materials, design parameters, observations from the field, changes in regulatory requirements or similar changes since the initial acceptance.

1. Types of SQUs

   Manufactured SQUs are classified into two general groups – gravity settling devices that function based on a linear flow path and particle settling rate and hydrodynamic devices that incorporate a non-linear motion in the flow path. Specific information for each SQU model / unit shall be provided and each model / unit shall be approved individually.

   Specific information for gravity settling devices shall include, but is not limited to:

   - Calculations addressing particle size and settling rates;
   - Design drawings for each model proposed for approval.

   Specific information for hydrodynamic devices shall include, but is not limited to:

   - Independent third-party laboratory testing;
   - Design drawings for each model proposed for approval.

2. Testing and Certification of SQUs

   All technical information provided shall be certified by a professional engineer and laboratory testing data shall be certified by an independent professional engineer. All SQUs submitted shall be evaluated based on the following minimum required parameters:

   a. Verification / Testing / Certification

      Gravity settling units shall be verified at a minimum by calculations certified by a professional engineer shall be accepted for evaluation. Only hydrodynamic units that have been verified by laboratory testing shall be accepted for evaluation.

      Manufacturers must submit each their units for approval. Units certified by other regulatory authorities will not automatically be accepted for use in the City.

      In addition, units will only be approved for installation in the configurations tested. Installation in configurations other than those tested (e.g. multiple inlets pipes or surface inlets) will not be approved.

   b. Access / Ease of Maintenance

      Complete detailed drawings (plan and profile) of the proposed SQU shall be provided with a detailed narrative describing the recommended cleaning procedure. The narrative should address:

- Entering the SQU as appropriate and if necessary for cleaning and inspection.
- Captured material (including material with a density less than water) removal and the ease of access by an individual shall be addressed.
- Observation ports.
- Detailed cleaning procedures and frequency (e.g. vac truck, jetting, special tools, etc.). The narrative should also address specific steps followed for jet cleaning.
- Confined space requirements.

c. Oil / Organic Capture

The submission shall include a discussion of the SQU's ability to capture or skim pollutants including but not limited to: floating oils / immiscible materials, retention under high flow scenarios and cleaning procedure. All testing data shall be included in the submittal.

d. Trash/ Floatable Material

The submission shall include a discussion of the SQU's ability to capture both floating and suspended solid material (trash, organic material, etc.) and other pollutants. Opening Size(s) for all screens (if applicable) shall be specified. The maximum size of captured material (including material with a density less than water) that may be removed shall also be specified. The discussion should also include retention during flows greater than the design treatment flow. The submission is to also address the trash loading and characterization applied to the SQU, complete with range of size distribution representative of trash.

e. On-line / Off-line Application (i.e., Performance under Pressure Flow)

In addition, the verification report must include documentation for head loss through the entire SQU, for the range of corresponding test flows and pollutant loadings, including the on-line applications. The calculations must address the losses for the test conditions and potential design conditions. The submission must also include applicable guidance for use by design engineers to calculate head loss for their specific application.

f. Materials of Construction

The submission shall include detailed sheets with all materials of construction identified and labeled. The submission shall also address minimum design life for structural components and internal operational components devices subject to wear in the SQU.

g. Installation Requirements / Limitations

The submission shall include a discussion of all installation requirements, procedures and / or limitations including but not limited to:

- Keeping existing systems in operation while tie-in connections are made for retrofitted applications;
- Backfilling requirements;
- Joint connections;
- Pipe connections: (Note- multiple inlet pipe connections must be supported by testing data for approval);
- Special anchoring requirements;
- Impacts on performance;
- Surface and system loading limitations (maximum applied loads).

h. Existing Installations and Owner References

The submission shall include a list of locations where units have been installed and current owner contact information. Current owners may be contacted by the City or its representative to discuss their experiences with the units including with maintenance.

i. Certification

The submission shall include the following certification stamped and signed by an independent or third-party professional engineer:

I certify the information provided to the City of Fort Wayne or their designated representative(s) pertaining to the _ stormwater quality treatment system is accurate and correct and was obtained as required by the evaluation protocol specified by the of the City of Fort Wayne. I certify I have no financial relationship, including an ownership interest or investment interest, with the manufacturer involved in this test or any affiliate of the manufacturer. I further certify I have been compensated only for my time and effort related to this testing certification and I will receive no other compensation for the actions related to this certification.

3. Revocation of Approvals

Approvals of SQUs may be revoked at any time by City Utilities based changes in materials, design parameters, observations from the field, changes in regulatory requirements or similar changes since the initial acceptance.

Revocation of an SQU may take any of the following forms:

1. A revision in the allowed capacity of a unit.
2. Removal of a unit from the preapproved list.
3. Prohibiting a unit from particular configurations. (i.e., prohibiting online use, prohibiting under traffic…)

MA5.18 Plant List

City Utilities has developed a list that identifies plant types best suited for the climate and conditions in Fort Wayne. Refer to **utilities.cityoffortwayne.org/wp-**

content/uploads/2024/01/City-Utilities-Plant-List-2024.pdf for a list of Fort Wayne native plant species that includes information such as salt tolerance, sun exposure, and plant height. This information is important to consider when choosing plants for green infrastructure applications.

MA5.19 Gabions and Mattress Linings

Gabions and mattress linings can be utilized for bank stabilization and erosion control. In general, gabions and mattresses shall be designed and installed per manufacturer's recommendations. Refer to Standard Drawings EROS-9-2, EROS-9-3, and EROS-9-4 for the various layouts of gabion boxes mattresses.

1. Gabion and Mattress Linings General Guidelines
   - Standard gabions and mattress linings shall be fabricated so as to be of a single unit construction - the base, lids, and sides shall be woven into a single unit.
   - The mesh sizes shall be clearly indicated. Standard sizes include 6 x 8 and 8 x 10. The mesh shall be hexagonal woven mesh with all joints formed by twisting each pair of wires through 3 ½ turns.
   - Lacing (connection) of the gabions and mattress linings shall be clearly specified. In general, lacing wire shall be secured at the corner of the gabion or mattress and the lacing wire shall be laced alternating with single and double loops every other opening at intervals of not more than 6-inches. Rings may be used in lieu of lacing wire.
   - Gabion and mattress linings shall be coated with zinc or, in aggressive environments, PVC. Zinc coated (galvanized) wire shall conform to ASTM A641. Coating specifications shall be detailed in the project specifications.
   - Geotextile filter fabric shall be specified at required gabion and/or mattress soil interfaces to prevent soil intrusion into the gabion. Refer to Chapter MA4 – Common Materials and Testing Requirements for geosynthetic fabric requirements.
2. Gabion Fill Material
   - Gabion box shall be filled with clean, hard, dense, durable stone, rounded and angular shape that shall not disintegrate on exposure to water of weathering during the life of the structure.
   - No stone shall pass through the mesh.
   - Provide INDOT Uniform A rip rap in accordance with INDOT Section 904.04(d), stone with the following gradation requirements:

Figure MA5.16 INDOT Rip Rap Uniform A- Gradation Requirements

Gradation Requirements (Percent Smaller)	
Size, in	**Uniform A**
8	100
6	35-80
3	
1	0-20

Table Based on INDOT Standard Specification Section 904.40(f).

3. Reno Mattress Fill Material

   - Mattress shall be filled with clean, hard, dense, durable stone, rounded and angular shape that shall not disintegrate on exposure to water of weathering during the life of the structure.
   - No stone shall pass through the mesh.
   - Provide INDOT Uniform B rip rap in accordance with INDOT Section 904.04(d), stone with the following gradation requirements:

Figure MA5.17 INDOT Rip Rap Uniform B- Gradation Requirements

Gradation Requirements (Percent Smaller)	
Size, in	**Uniform B**
8	-
6	95-100
3	35-80
1	0-20

Table Based on INDOT Standard Specification Section 904.40(f).

MA5.20 Channel Protection Systems

Channel protections systems covers a wide range of materials that are used to reinforce and stabilize channel banks, stormwater outfalls and other locations that require erosion control. In general, the channel protection systems shall be designed and installed per manufacturer’s recommendations.

1. Cellular Confinement System

   Cellular confinement system shall be polyethylene stabilized black and a perforated textured cell, and shall control shearing lateral and vertical movement of the surface. Carbon Black content shall be 1.5 to 2 percent by weight, through addition of a carrier with certified carbon black content. The cellular confinement system, GeoWeb, or similar, is manufactured by Presto Geosystems.

   Utilize cellular confinement systems as channel erosion control, to create channel wet weather storage area.

Select the cell size and appropriate anchorage system based on project conditions, coordinate with the manufacturer. Fill the cells with an appropriate aggregate topsoil, concrete or vegetation.

2. Concrete Cloth

   Concrete cloth is a flexible, cement impregnated fabric that hardens with hydrated to form a thin, durable, water and fire resistant concrete layer. The concrete cloth, or similar, is manufactured by Miliken.

   Utilize concrete cloth as channel bank stabilization, outfall protection, or various locations where hard armoring is required.

   Select the thickness and appropriate anchoring system based on project specific requirements, soil conditions and intended use. Coordinate with manufacturer as needed.

   Prepare a smooth subbase to avoid any rips or tares in the fabric during installation. Use appropriate tools to unroll and place the cloth, do not overstretch or drive on the material. Once installation is complete and appropriate anchorage installed.

3. Concrete Filled Fabric

   Concrete filled fabric forms are filled in place with fine aggregate concrete to form hard armoring and provide erosion control. The concrete filled fabric, Hydrotex, or similar, is manufactured by Geostar Corporation.

   Utilize concrete filled fabric as channel bank stabilization, outfall protection, or various locations where hard armoring is required.

   Select the appropriate fabric pattern based and anchoring system based on project specific requirements, soil conditions and intended use. Coordinate with manufacturer as needed. The fine aggregate concrete fill shall be pumpable with a water cement ration between 0.65 to 0.75 and be supplied from a concrete batch plant.

   Prepare a smooth subbase to avoid any rips or tares in the fabric during installation. Install a permeable filter fabric underlayment, select the required fabric type based on subgrade soil layer. Once installation is complete and appropriate anchorage installed, fill the fabric with the fine aggregate concrete.

4. Interlocking Concrete Units

   Interlocking concrete units are pre-determined concrete blocks that conform to ASTM D 6684 to form hard armoring and provide erosion control. The interlocking concrete units, A-Jacks, or similar, are manufactured by Armortec.

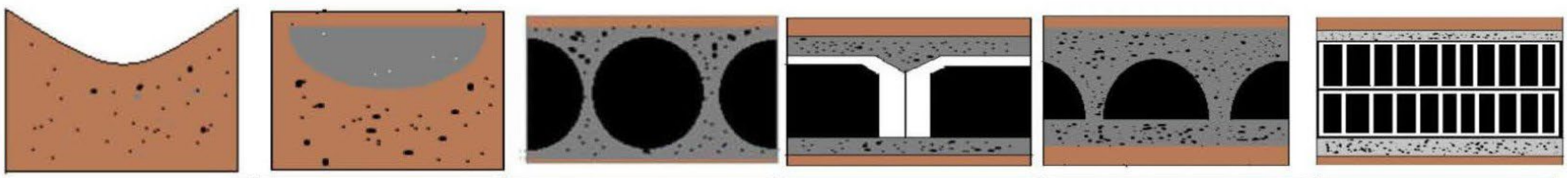
   Utilize concrete filled fabric as channel bank stabilization, outfall protection, bridge pier scour protection or various locations where hard armoring is required.

For streambank protection utilize the AJ-240inch concrete block unit. Based on project specific requirements include a subbase geosynthetic separation layer. Coordinate with manufacturer as needed.

Prepare a smooth subbase to ensure proper contact between the concrete units and the slope face. Install a permeable filter fabric underlayment, select the required fabric type based on subgrade soil layer. Install a minimum of 2-inches of clean aggregate bedding (INDOT No. 8, or similar). Place units in a consistent and repeatable pattern, while orienting the exposed projecting unit arm in the downstream direction. installation is complete and appropriate anchorage installed, fill the fabric with the fine aggregate concrete.

APPLICABLE SETTING	INLET TYPE	DRAWING NO.	CASTING	DRAWING NO.
			30" x 30" Beehive Grate	
			Neenah R-4215 with grate C	C8-1
			East Jordan 6610 with grate O	C8-2
			2'x2' Curb and Gutter Casting	
			Neenah R-3010 with grate A, R, or S	C10-1, C10-3, C10-5
Swale or Channel	**30" Round Inlet**		East Jordan 7010ZM1T1 with grate M1, M5, or M3	C10-2, C10-4, C10-6
Green space	Precast 30" Round Inlet	STR 26	**2'x2' Alley Casting**	
Pavement	Field Created 30" Round Inlet	STR 27	Neenah R-3036-B with grate S	C9-1
			East Jordan 5100ZM1 with grate M1 5105	C9-2
			Neenah R-3036-B or East Jordan 5105	C-11
			33" Round Curb & Gutter Casting	
			East Jordan 7020Z with grate M1 or M2	C12-1, C12-2
			Neenah R-3159 with grate S	C12-3
	33" Round Inlet		**33" Round Curb & Gutter Casting**	
Swale or Channel	Precast 33" Round Inlet	STR 28	East Jordan 7020Z with grate M1 or M2	C12-1, C12-2
	Field Created 33" Round Inlet	STR 29	Neenah R-3159 with grate S	C12-3
			2'x3' Curb and Gutter Casting	
Curb	**2' x 3' Inlet**	STR 32	Neenah R-3067 with grate C or R	C11-1, C11-3
			East Jordan 7030Z1 with grate M2, M3, or M5	C11-2, C11-4, C11-5
			Neenah R-3067 or East Jordan 7030 M5	C13
			30" x 30" Beehive Grate	
			Neenah R-4215-C	C14
Swale or Channel	**30" x 30" Inlet**	STR 33	East Jordan 6610	C14
			Neenah R-4215 with grate C	C8-1
			East Jordan 6610 with grate O	C8-2
			24" Beehive Casting	
			Neenah R-1772 with grate R-4351-D	C7-1
			East Jordan 1022Z1 with grate 6509-0	C10
			24" Storm Manhole Casting	
			Neenah R-2502 with grate D	C6-1
			East Jordan 1022Z1 with grate M1	C6-1
			30" x 30" Beehive Grate	
			Neenah R-4215 with grate C	C8-1
Swale or Channel			East Jordan 6610 with grate O	C8-2
Green space	**Standard 48" Manhole**	STR1,	**2'x2' Curb and Gutter Casting**	
Pavement		STR1a	Neenah R-3010 with grate A, R, or S	C10-1, C10-3, C10-5
			East Jordan 7010ZM1T1 with grate M1, M5, or M3	C10-2, C10-4, C10-6
			2'x2' Alley Casting	
			Neenah R-3036-B with grate S	C9-1
			East Jordan 5100ZM1 with grate M1 5105	C9-2
			Neenah R-3036-B or East Jordan 5105	C-11
			33" Round Curb & Gutter Casting	
			East Jordan 7020Z with grate M1 or M2	C12-1, C12-2
			Neenah R-3159 with grate S	C12-3
Swale or Channel	**Trash Rack**		Refer to manufacturer's requirements	

APPLICABLE SETTING	INLET TYPE	DRAWING NO	CASTING	DRAWING NO
Pavement	**Trench Drain**			
	Type I Type II	STR35 STR36	Grate type varies based on trench drain type and project application.	
Pedestrian Areas	**Standard 48" Manhole**	STR 30-1 - STR 30-4	**24" ADA Casting** Neenah R-1772 Frame R-2015 Type Q Grate East Jordan 1022Z1 Frame with M3 ADA Grate	
			30" Round ADA Casting Neenah R-2750 with Grate Q East Jordan 1320Z Frame with 1480M1 ADA Grate	C-22-1, C22-2
	2' x 2' Inlet	STR 32-1	**22" x22" ADA Casting** Neenah R-3210Q with Grate Q East Jordan V5324-1 Frame with 5424M ADA Grate	C-15-1, C15-2
			24" x 24" ADA Casting Neenah R-1878-A6 with Grate Q East Jordan V5624-80 Frame with ADA Grate	C-19-1, C19-2
			26" x 26" Low Profile ADA Casting Neenah R-4859-Q Angle Frame with Grate Q East Jordan 5110Z Frame with 5110M5HD ADA Grate	
	2' x 3' Inlet	STR 32-2	**2' x 3' ADA Casting** Neenah R-3067-C with R-3067 DR/DL Grate East Jordan 7030Z2 Frame with 7030M10 ADA Grate	C-20-1, C20-2
	30" x 30" Inlet	STR 32-3	**30" x 30" ADA Casting** Neenah R-1878-A9G with Grate Q East Jordan V5630 Frame with 5630-80 ADA Grate	C-21-1, C21-2
	30" x 46" Inlet	STR 32	**24" x 46" ADA Casting** Neenah R-3572-2Q with Grate Q Neenah R-3573-2Q with Grate Q East Jordan 5357ZPT Frame with 5355M6 ADA Grate East Jordan 5356Z Frame with 5355M6 ADA Grate	C-16-1, C16-2 C-17-1, C17-2
			24" x 46" Low Profile ADA Casting Neenah R-3574-2Q with Grate Q East Jordan 5355Z Frame with 5355M6 ADA Grate	C-18-1, C18-2
	Trench Drain	STR 35	**12" x 24" ADA Trench Grate** Neenah R-4990-CX Frame Type Q Grate East Jordan V-7383 Trench Grate with 6950Z1 Trench Rail	
			14" x 24" ADA Trench Grate Neenah R-4990-DX Frame Type Q Grate East Jordan V-7384 Trench Grate with 6900Z1 Trench Rail	



	Open Pond	French Drain	Pipe	Concrete Vault	Arched Chamber	Plastic Modules
Approximant Void Space	100%	25-40%	62%	85%	57%	97%
Surface Area Required	No usable space	Large footprint	Medium footprint	Small footprint	Large footprint	Small footprint
Strength	Not applicable	Not applicable	H-20	H-25	H-20	Hs-25
Cleanability	Some difficulty	Re-install	Some difficulty	Easy	Difficult	Easy
Installed Cost	Low	Low	Medium	High	Medium	Medium

All units shall be configured as offline.

Manufacturer	SQU Model	Max Treatment Flow (cfs)
Stormceptor®[2]	STC 450	0.37
	STC 900	0.83
	STC 1200	0.83
	STC 1800	0.83
	STC 2400	1.38
	STC 3600	1.38
	STC 4800	2.3
	STC 6000	2.3
	STC 7200	3.22
	STC 11000	4.59
	STC 13000	4.59
	STC 16000	6.43
Hydro International Downstream Defender®	4 Foot Diameter	1.12
	6 Foot Diameter	2.52
	8 Foot Diameter	4.49
	10 Foot Diameter	7.00
	12 Foot Diameter	10.08
VortSentry®	VS30	0.28
	VS40	0.58
	VS50	1.01
	VS60	1.6
	VS70	2.35
	VS80	3.28
Aqua Shield Aqua-Swirl®	AS-2	0.36
	AS-3	0.71
	AS-4	1.18
	AS-5	1.46
	AS-6	2.11
	AS-7	2.87
	AS-8	3.74
	AS-9	4.73
	AS-10	5.84
	AS-11	7.07
	AS-12	8.42
	AS-13	9.87
ADS Barracuda	S3	0.70
	S4	1.25
	S5	1.95
	S6	2.80
	S8	5.00
	S10	7.80

Manufacturer	SQU Model	Max Treatment Flow (cfs)
Aqua Shield Aqua-Swirl Xcelerator[1]	XC-2	0.57
	XC-3	1.13
	XC-4	1.86
	XC-5	2.78
	XC-6	3.88
	XC-7	5.17
	XC-8	6.64
	XC-9	8.29
	XC-10	10.13
	XC-11	12.15
	XC-12	14.35
	XC-13	15.53
Contech Cascade Separator	CS-3	1.02
	CS-4	1.80
	CS-5	2.81
	CS-6	4.05
	CS-8	7.20
	CS-10	11.30
	CS-12	16.20
CDS Technologies (Offline)	CDS-3	0.52
	CDS-4	0.93
	CDS-5	1.50
	CDS-6	2.10
	CDS-7	2.80
	CDS-8	3.70
	CDS-10	5.80
	CDS-12	8.40
Oldcastle Infrastructure Dual Vortext Separator (DVS) Circular Units	DVS-36	0.56
	DVS-48	1.00
	DVS-60	1.56
	DVS-72	2.25
	DVS -84	3.06
	DVS-96	4.00
	DVS-120	6.25
	DVS-144	9.00
Prinsco	WQU3620	0.70
	WQU3640	1.50
	WQU4220	0.80
	WQU4240	1.80
	WQU4820	1.10
	WQU4840	2.40
	WQU6020	1.50
	WQU6040	3.10

Manufactured SQU	SQU System Model	Max Treatment Flow (cfs)
Hydro International First Defense High Capacity	3-ft	0.85
	4-ft	1.50
	5-ft	2.35
	6-ft	3.38
	7-ft	4.60
	8-ft	6.00
BioClean Debris Separating Baffle Box	2-4	0.70
	2.5-5	1.10
	3-6	1.59
	4-6	2.11
	4-8	2.82
	5-10	4.40
	6-12	6.34
	7-14	8.63
	8-14	9.86
	8-16	11.27
	9-18	14.27
	10-18	15.85
	10-20	17.61
	10-22	19.37
	11-22	21.31
	11-24	23.25
	12-24	25.36
ADS / Hancor Stormwater Quality Units	3620WQB	0.70
	3640WQB	1.50
	4220WQB	0.80
	4240WQB	1.80
	4820WQB	1.10
	4840WQB	2.40
	6020WQB	1.50
	6040WQB	3.10
Haviland	SWQU 36X20-B	0.70
	SWQU 36X40-B	1.50
	SWQU 42X20-B	0.80
	SWQU 42X40-B	1.80
	SWQU 48X20-B	1.10
	SWQU 48X40-B	2.40
	SWQU 60X20-B	1.50
	SWQU 60X40-B	3.10

Manufactured SQU	SQU System Model	Max Treatment Flow (cfs)
SciClone[1]	SC-3	0.39
	SC-4	0.70
	SC-5	1.09
	SC-6	1.57
	SC-7	2.14
	SC-8	2.80
	SC-9	3.54
	SC-10	4.37
	SC-11	5.29
	SC-12	6.30
Oldcastle Infrastructure Nutrient Separating Baffle Box (NSBB)	2-4	0.62
	3-6	1.40
	3-8	1.87
	4-8	2.49
	5-10	3.89
	6-12	5.60
	6-13.75	6.42
	7-14	7.62
	7-15	8.17
	8-14	8.71
	8-16	9.96
	9-18	12.60
	10-17	13.22
	10-20	15.56
	12-21	19.60
	12-24	22.40
HydroStorm by Hydroworks, LLC	HS-3	0.50
	HS-4	0.88
	HS-5	1.37
	HS-6	1.98
	HS-7	2.69
	HS-8	3.52
	HS-9	4.45
	HS-10	5.49
	HS-11	6.65
	HS-12	7.91

Notes:

1. Poly Coated Steel (PCS) Not Approved for use in Public ROW
2. Not Approved for use with an open grate top (i.e., an inlet)

ADS/Hancor/Prinsco Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. The maximum sediment depth in inches, not referenced to the size of the unit.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons.
    4. A maximum inspection frequency of 6 months.
    5. That the unit shall be cleaned at least once a year.
    6. That the unit is to be refilled after cleaning.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 6” of #57 or #8 crushed aggregate for the bedding.
    2. The installation details, including the 6 step detail that is available on the manufacturers’ websites.
    3. Concrete collars for risers when used in traffic loading conditions.
    4. A minimum of two 24” access openings (maintenance risers).

AquaShield *Aqua-Swirl* Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly specified maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons that includes absorbent pads.
    4. A maximum inspection frequency of six months.
    5. That the unit shall be cleaned at least once a year.
    6. An inspection of each chamber of the unit is to be addressed.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 12” of Class I bedding, compacted to 90% proctor density, extending at least 3.5’ beyond the unit.
    2. A construction detail that shows Class I backfill, compacted to 90% proctor density, extending for the full height of the unit.
    3. A construction detail that shows the connection is made with a flexible connector and a sheer guard.
    4. A reinforced concrete pad over the unit when used in traffic loading conditions. The pad shall extend beyond the outside of the unit by 12”.
    5. Bollards are required around the unit when in a non-traffic condition.

Contech *VortSentry* Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly shown maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons.
    4. A maximum inspection frequency of six months.
    5. That the unit shall be cleaned at least once a year.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 6” of crushed aggregate for the bedding.

Contech *Stormvault* Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly shown maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons that includes absorbent pads.
    4. A maximum inspection frequency of six months.
    5. That the unit shall be cleaned at least once a year.
    6. Inspection of each chamber of the unit is to be addressed.
2. SWPPP sheet shall include:
    1. A construction detail of the unit that includes the bedding and backfill requirements as specified by the manufacturer.

Contech *Vortechs* Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly specified maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons.
    4. A maximum inspection frequency of 6 months.
    5. That the unit shall be cleaned at least once a year.
    6. That inspection of each chamber of the unit is to be addressed.
2. SWPPP sheet shall include:
    1. A construction detail of the unit that includes 6” of stone bedding.
    2. A note for the contractor to level the unit.
    3. The Inlet 90° to the side of the unit.
    4. The unit must be off-line if peak design flow greater than 100 gpm/ft^2 (0.22275 cfs/ft^2) of treatment (grit) chamber.

Continuous Deflective Separation (CDS) Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly specified maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons.
    4. The maximum inspection frequency of 6 months.
    5. That the unit shall be cleaned at least once a year.
    6. That the inspection of the inner and outer areas of the screen for sediment.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 6” of crushed aggregate for the bedding.
    2. A detail of the unit with a 2400_m screen specified. The 4800_m screen is prohibited.
    3. A minimum of a 24” access openings (maintenance risers).

Hydro International *Downstream Defen*der Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly specified maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment.
    3. A procedure for removing oils and hydrocarbons.
    4. The maximum inspection frequency of 6 months.
    5. That the unit shall be cleaned at least once a year.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 6” of crushed aggregate for the bedding.
    2. A construction detail of the unit that includes the backfill requirements as specified by the manufacturer.

Imbrium *Stormceptor* Stormwater Quality Units

1. Operations and Maintenance Manual shall include:
    1. A clearly specified maximum sediment depth.
    2. A graphical and written procedure for measuring the sediment. This should include the use of a dipstick tube equipped with a ball valve (e.g. Sludge Judge)
    3. A procedure for removing oils and hydrocarbons.
    4. A maximum inspection frequency of 6 months.
    5. That the unit shall be cleaned at least once a year.
2. SWPPP sheet shall include:
    1. A construction detail that shows a minimum of 6” of crushed aggregate for the bedding.
    2. A construction detail that shows the elevation of the outlet pipe should be a minimum of one-inch below the elevation of the inlet pipe.
    3. A minimum requirement of 2’ of cover above the crown of the pipe to grade for the unit.
    4. The velocity of the water entering the unit must be less than 4.27 feet per second.

Book 5

Materials (MA)

MA6 Sanitary Sewer Materials and Testing Requirements

MA6.01 Purpose

This Chapter covers typical materials used non-pressure and pressurized sanitary sewer utility projects. Variances form these materials must be approved in compliance with Chapter – GR3 Variances.

MA6.02 Allowable Pipe Materials and Testing Requirements

Figure MA6.1 summarizes pipe materials used for sanitary sewer installations and is to be used as a reference for acceptable sanitary sewer pipe materials. The following Sections within this Chapter list more detailed requirements for each pipe material.

Figure MA6.1 Allowable Pipe Materials

Pipe Material	Designation	Sizes (Diameter, in.)		Master Spec Number
		Min	Max*	
Polyvinyl Chloride (PVC)	ASTM D3034	8	15	33 05 37.13
	ASTM F679	18	36	
Polyvinyl Chloride (PVC) Pressure	AWWA C900	4	36	33 05 37.16
High Density Polyethylene (HDPE) Pressure	AWWA C906	2	24	33 05 38.16
Dual Wall Corrugated Polypropylene (PP)	ASTM F2736	8	48	33 05 51
Triple Wall Corrugated Polypropylene (PP)	ASTM F2764	8	48	33 05 51
Fiberglass Reinforced Plastic (FRP)	ASTM D3262	18	84	33 05 39

Note: Minimum cover shall be 4 ft. from finished grade to top of pipe (O.D), at completion of all project restoration. Bedding requirements for all pipe materials and sizes shall be flexible (BS-5).

** Proposed pipe sizes larger than 36-inch diameter for PVC, 48-inch diameter for PP, and 84-inch diameter for FRP and sizes larger than 24-inch for HDPE shall have the approval of City Utilities.*

1. Pipe Testing Requirements

   The following subsections include quality assurance and quality control requirements for the pipe material listed in this chapter.

2. Quality Assurance

   A. Manufacturers Qualifications

      - Pipe manufacturers shall have a minimum of 5 years of successful experience producing specified pipe and fittings, and document their success by showing evidence of at least 5 installations in satisfactory operation within the United States.

- Concrete pipe and fittings shall be from a source listed in the most recent INDOT list of Certified Precast Concrete Producers, in accordance with ITM 813.

B. Supply and Compatibility

- Pipe, fittings and appurtenances shall be suitable for the specified service and integrated into the overall piping system by the pipe supplier.

Allowable infiltration/exfiltration for any portion of the sewer shall not exceed 100 gallons per inch of pipe diameter per day per mile of pipe.

3. Field Quality Control

This section covers pipe-testing requirements after installation of the pipe. The following testing is required for sanitary sewer projects:

- Vertical Deflection Test (Mandrel Test) for Flexible Pipe
- Televised Inspections (for public projects)
- Low Pressure Air Test

The following testing for sanitary sewer pipe is used based on project specific requirements:

- Hydrostatic Test
- Infiltration/Exfiltration Test
- Large Diameter Pipe Joint Test

A. Vertical Deflection Test (Mandrel Test) for Flexible Pipe

1. Vertical deflection tests are conducted not less than 30 days after the bedding and backfill have been placed.
2. Testing is conducted on all pipe runs (defined as length of continuous pipe from structure to structure) containing 3 or more pipe-to-pipe joints.
3. A rigid ball or mandrel that has a diameter of at least 95% of base inside diameter or average inside diameter of piping is used. The ball diameter depends on which is specified in applicable ASTM standard, including the appendix, to which the pipe is manufactured.
4. The test is performed without mechanical pulling devices.
5. Pipe segments that exceed a deflection of 5% are not acceptable and must be replaced/repaired in compliance with City Utilities Engineering standards.

B. Televised Inspection

1. Televise completed sewer and appurtenant structures, including manholes and chambers, and provide to City Utilities Engineering

copy of video on digital video disc (DVD) or portable storage device. Software shall be compatible with Pipelogics version 6.0 software.

2. Inspection shall be performed by a company certified in Pipeline Assessment Certification Program (PACP) by National Association of Sewer Service Companies (NASSCO). Provide copy of PACP certification prior to starting inspection.
3. Televising shall conform to coding and reporting standards and guidelines specified in PACP. Identify report annotations, pipe conditions, and pipe defects in accordance with PACP. Severity ratings shall be calculated in accordance with PACP.
4. Camera for main line shall be pan-and-tilt, radial viewing, pipe inspection camera that pans plus-or-minus 275 degrees and rotates 360 degrees. Use camera with an accurate footage counter that displays on television monitor exact distance of camera from centerline of starting manhole. Use camera with height adjustment so that lens is always centered at one-half inside diameter or higher in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Camera shall operate in 100 percent humidity. Camera, television monitor, and other components of video system must produce a minimum 450-line resolution colored video picture. Picture quality and definition shall be satisfactory to City Utilities Engineering.
5. Repair apparent leaks in pipe in manner satisfactory to City Utilities Engineering without additional cost to City Utilities and re-televise the pipe.

C. Low Pressure Air Test for Gravity Sewers:

- DIP (for diameters ≤ 36-inches)
- PVC
- HDPE
- RCP

1. Plug and bulkhead ends of pipe segment to be tested.
2. One plug shall have an orifice to pass air and a second orifice shall be continuously connected to a pressure gauge having a range of 0 to 10 psi, minimum divisions of 0.10 psi, and accuracy of 0.04 +/- psi.
3. The air supply line shall have a positive on-off valve and suitable means for readily disconnecting from the control panel.
4. The section of pipe shall be pressurized to approximately 4 psi.
5. The air shall be shut off and allowed to stabilize for a minimum of 2 min. If during this time the pressure drops below 3.5 psi, more air shall be added to raise pressure to a minimum of 3.5 psi.
6. After the air has stabilized, the air line shall be disconnected and timing will begin.

7. The time of test in minutes will be equivalent to one-half of the nominal diameter of the pipe being tested.
8. The maximum allowable pressure drop during the specified time period will be 1.0 psi.

D. Hydrostatic Testing for:

- DI Pressure Pipe (AWWA Manual M41)
- PVC Pressure Pipe (AWWA Standard C605)
- HDPE Pressure Pipe (ASTM F2164)

1. Preparation for Testing:
   - Follow appropriate preparation for testing as specified in the manuals above for specified pipe material.
   - Prior to testing, the contractor shall ensure that the line is clean and free of dirt and debris.
   - Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
   - Prior to testing, install test riser and ensure equipment is properly calibrated.
2. Test Procedure for DIP and PVC Pressure Pipe:
   - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
   - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
   - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
   - Add fluid as required to pressurize line to 150 psi or otherwise specified test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   - Timed test period shall not begin until after pipe has been filled, air has been expelled, and pressure stabilized.
   - Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure.
   - Pump from test container to maintain test pressure. Measure volume of water pumped from test container and record on test report. Record pressure at test pump at 15-minute intervals for duration of test.
   - Results of the test shall be logged using the inspection form provided in **Exhibit MA6-1**.

3. Test Procedure for HDPE Pressure Pipe:
    - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
    - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
    - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
    - The test section and the test liquid shall be allowed to equalize to a common temperature.
    - After filling pipeline and purging air, gradually pressurize pipe to 150 psi or otherwise specified test pressure and maintain required test pressure for 4 hours for pipe to expand. During expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.
    - Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
    - Timed Test Period: After 4-hour expansion phase, reduce test pressure by 10 psig and do not add liquid. Test pressure shall then remain steady for 1 hour, indicating no leakage.
    - If no visible leakage is observed and pressure remains within 5% of the original test pressure for 1 hour, a passing test is indicated.
    - Results of the test shall be logged using the inspection form provided in **Exhibit MA6-2**.
4. Makeup Water Allowances:
    - The allowable makeup water allowance is the maximum amount of water that is added into a pipeline undergoing hydrostatic pressure testing. The allowable leakage rates for the various pipe materials and joints are listed below.
    - Pipes with flanged, welded, or fused joints
        - No addition of makeup water
    - Allowance rates for DIP and PVC pipes joined with rubber gaskets as sealing members include the following joint types; bell and spigot, push on, mechanical, bolted sleeve type couplings, grooved and shouldered couplings
        - Calculate makeup water rates using the following equation.

$$Q = \frac{LD\sqrt{P}}{148{,}000}$$

Where:

Q = quantity of makeup water (gph)

L = length of pipe section being tested (ft)

D = nominal diameter of the pipe (in)

P = average test pressure during the hydrostatic test (psi_{gauge})

- Figure MA6.2 represents the calculated values of rates per 1,000 feet of pipe at the 125 psi test pressure.

Figure MA6.2 Allowable Testing Allowance for DIP and PVC Pipe (per 1,000' of pipeline at 125 psi)

Nominal Pipe Diameter (in)	Testing Allowance (gph)
4	0.3
6	0.45
8	0.6
10	0.76
12	0.91
16	1.21
20	1.51
24	1.81
30	2.27
36	2.72
42	3.17
48	3.63
54	4.08
60	4.53

Note: Table is an excerpt from AWWA M41 and AWWA C605.

E. Continuity Testing

Continuity testing of the tracing wire shall be performed by the contractor in the presence of the engineer. Continuity testing shall be performed using a direct-connect signal generating device and Schonstedt or equivalent underground pipe locating equipment along mains. Breaks in conductivity shall be repaired and the wire re-tested until tracing wire passes test.

F. Joint Acceptance Testing: For pipes larger than or equal to 36-inches

Conduct joint testing on the following:

- RCP (ASTM C1103)
- FRP
- PVC
- PP

1. Joint Test Procedure:
    - Conduct individual joint tests on each joint for 36-inch and larger precast concrete pipe, in accordance with ASTM C1103.
    - Prior to testing, clean the joint and interior surface to eliminate debris, and as necessary wet the pipe walls.
    - Conduct joint test as Work progresses, do not complete backfilling until joint has successfully passed testing.
    - The line for pressurizing the void volume shall include a 6 psi pressure relief device.
    - Position the testing apparatus over the joint and make sure the end element sealing tubes straddle both sides of the joint. For the water test the bleed-off petcock must be located at the top dead center.
    - Joint Air or Water Test
        - Pressurize the void with air or water to 3.5 psi greater than the pressure exerted by ground water above the pipe. Allow the air pressure to stabilize before shutting of the air or water supply and start of test timing.
        - If pressure holds, or drops less than 1 psi in 5 sec, the joint is acceptable.
        - If the joint fails, it shall be retested, or repaired if necessary and retested.
        - If the pressure required for the test is greater than 6 psi to meet the testing requirement listed above, the joint test shall not be used.

G. Infiltration/Exfiltration Testing

Conduct infiltration/exfiltration testing on the following:

- All gravity pipe materials

The allowable infiltration/exfiltration for any portion of the sewer shall not exceed 100 gallons per inch of pipe diameter per day per mile of pipe.

If the infiltration/exfiltration in any section of the sewer is greater than the above infiltration rate, the contractor shall make required repairs and retest the sewer segment until listed infiltration rate is met.

Below are the infiltration/exfiltration test requirements:

1. Infiltration Test Procedure:
    - Conduct testing from manhole to manhole or between more than 2 manholes. The length of main tested shall not exceed 700 feet.
    - Stop all dewatering operations and allow the groundwater to return to its normal level.

- Groundwater level shall be 2 feet above the crown of the pipe for the entire test section.
- Plug all pipe outlets discharging into the upstream manhole.
- Measure the groundwater elevation and determine the average head over the test section.
- Measure infiltration leakage at the outlet of the test section, using one of the following methods:
    - Fill a small container of known volume and record the time it takes to fill the container.
    - Install small weirs and record the flow over the weir.
    - Install an electronic flow monitoring device.
- If the test section fails, repair and retest until section passes infiltration test.

2. Exfiltration Test Procedure:
    - Plug and bulkhead ends and lateral connections of pipe segment to be tested and admit fluid until the pipe is full. Admit fluid slowly to minimize air entrapment. Groundwater level shall be below the pipe during exfiltration test.
    - Before measuring leakage, allow fluid to wet pipe interior for the following period:
        - Concrete Pipe: 48 hours.
        - Cement Mortar-lined Pipe: 24 hours.
        - Other Pipe: Wetting period not required.
    - Maintain hydrostatic head during test to equal an elevation two feet above present and future maximum groundwater elevation at pipe segment tested. Determine test water surface elevation for each pipe segment.
    - Provide minimum hydrostatic head during test of two feet above crown of upstream end of pipe segment tested.
    - Add fluid from test container or from metered supply as required to maintain test water level within three inches of test head throughout the test.
    - Test duration shall be at least two hours.

MA6.03 Ductile Iron Pipe (DIP)

This section covers ductile iron pipe (DIP) for buried applications. Figure MA6.3 lists acceptable ductile iron pipe for sanitary sewer applications.

- Standard ductile iron pipe is cement mortar lined with a bituminous seal-coat.

- Consider alternative linings for services involving abrasives, pH levels below 4 and above 12 (6 and 12 without seal coat), acids, industrial wastes, chemicals and scum and grease lines.

Figure MA6.3 Ductile Iron Pipe

Material	Designation	Pressure Class		Joints	Gaskets	Lining	Coating	Sizes (in)	
		Class	Designation					Min	Max
Ductile Iron (DIP)	AWWA C151	350	AWWA C150	Push-on AWWA C111	Vulcanized SBR	Cement Mortar- AWWA C104	Asphaltic- AWWA C151	8	12
		250-350						14	60

1. Exterior Coating

   Minimum thickness of the asphaltic coating is 1-mil.

2. Exterior Wrap

   Encase DIP and appurtenances in a polyethylene wrap in accordance with AWWA C105. Polyethylene wrap supplied in sheets or tubes is acceptable. Minimum thickness of linear low-density polyethylene film is 8-mils. Circumferential wraps of adhesive tape should be placed at 2-foot intervals along the barrel of the pipe.

MA6.04 Reinforced Concrete Pipe (RCP)

This section covers RCP for use in non-pressure sanitary sewer applications. Figure MA6.4 list various non-pressure concrete utility piping.

Figure MA6.4 Reinforced Concrete Pipe

Material	Class	Designation	Joints	Gaskets	Sizes (in)	
					Min	Max
Reinforced Concrete Pipe (RCP)	III IV V	ASTM C76	Bell and Spigot	Rubber Gasket ASTM C443	24	144
[1]Horizontal Elliptical Pipe (HEP)	HE-II HE-III HE-IV	ASTM C507	Tongue and Groove	Flexible Sealant ASTM C990	24	144
[1]Vertical Elliptical Pipe (VEP	VE-III VE-IV VE-V VE-VI				36	144

Note-1-The sizes listed are the pipe designated equivalent round size; refer to the related ASTM for exact pipe dimensions.

1. Reinforced Concrete Pipe (RCP)
   - Select pipe class based on the project specific external live and dead loads.
   - Class III pipe is the minimum class accepted for sanitary sewers.

A. Reinforced concrete pipe with bell and spigot joints uses either of the following gaskets.
    - Rubber gaskets conforming to ASTM C443 intended to be watertight.
    - Flexible Joint Sealants conforming to ASTM C990 intended to prevent the flow of solids through the joint.

2. Horizontal and Vertical Elliptical Pipe (HEP / VEP)
    - Select pipe class based on the external live and dead loads.
        - Horizontal elliptical pipe - Class HE-II is the minimum accepted for public storm water facilities.
        - Vertical elliptical pipe - VE-III is the minimum accepted for public storm water facilities.
        - Elliptical pipe size is specified by (rise” x span”).

MA6.05 Polyvinylchloride (PVC) Pipe - Non-Pressure

This section covers non-pressurized PVC pipe, Figure MA6.5 lists typical PVC pipe.

Figure MA6.5 Polyvinylchloride (PVC) Pipe-Non-Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
PVC Pipe	ASTM D3034	Bell and Spigot	ASTM F477 and ASTM D3212	ASTM D3034	8	15
	ASTM F679			ASTM F679	18	27

1. PVC Pipe

    Pipe manufactured per ASTM D3034 is available in four standard dimension ratios (SDR). For sanitary sewers, a minimum wall thickness of SDR 35 is required.

    Pipe manufactured per ASTM F679 is available in three pipe stiffness’s. For sanitary sewers, a minimum pipe stiffness of forty-six (46) psi is required.

MA6.06 Polyvinylchloride (PVC) Pipe - Pressure

This section covers pressurized PVC pipe and the various joint types. Figure MA7.4 list typical pressure PVC pipe used for buried applications. Tracing wire must be used when this pipe is specified.

1. Pressure PVC Pipe

    Minimum wall thickness for sanitary sewer applications is DR 18, sizes are based on DIP size.

2. Gaskets

    When pipe is installed in oil contaminated soils use Nitrile Gaskets.

3. Pipe Material Designation

   Pipe and couplings are made from PVC compounds having a minimum cell classification of 12454, as defined in ASTM D 1784.

Figure MA6.6 Polyvinylchloride (PVC) Pipe- Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Polyvinyl Chloride Pipe (PVC)	AWWA C900	Bell and Spigot	ASTM F477 ASTM D3139	AWWA C110 AWWA C111	4	12
	AWWA C905				14	36
Certa-Lok PVC	AWWA C900/RJ™	PVC Coupling	ASTM F477	Ductile Iron	4	16

MA6.07 High Density Polyethylene Pipe (HDPE)-Pressure

This section covers pressurized HDPE pipe. Figure MA7.5 list typical HDPE pipe used for buried applications. Tracing wire must be used when this pipe is specified.

1. Pressure HDPE Pipe

   Minimum wall thickness for sanitary sewer applications is is DR11, sizes are based on DIP size.

2. Pipe Material Designation

   Pipe material used for the manufacture of HDPE shall be extra high molecular weight, high density ethylene/hexane copolymer PE 4710 polyethylene resin meeting the requirements of ASTM D3350 with a cell classification of PE 445574C.

3. Pipe Joints

   All joints must be butt-fused or jointed with electrofusion couplings. Mechanical joints and couplings are prohibited.

4. Adaptors

   Fused mechanical joint adaptors shall be used to connect to fittings and valves. Pipe stiffeners are not permitted.

Figure MA6.7 High Density Polyethylene (HDPE) - Pressure

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
High Density Polyethylene (HDPE) Pressure Pipe	AWWA C906	Butt Heat Fusion ASTM D3262	-	Ductile Iron	2*	24

*Note: * 2-inch diameter is minimum size for low pressure systems. 4-inch shall be the minimum diameter for all other applications.*

MA6.08 Corrugated Polypropylene Pipe (PP)

Figure MA6.8 lists typical PP. PP for sanitary sewers is available in corrugated dual wall pipe with water tight joints.

Figure MA6.8 Polypropylene (PP) Pipe

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Dual-Wall Corrugated PP Pipe	ASTM F2736	Bell and Spigot (ASTMF2736)	ASTM F477	ASTM F2736	8	27

1. Dual Wall Corrugated Polypropylene Pipe (PP)

   Corrugated dual walled PP pipe has a smooth interior liner in the waterway and includes exterior corrugation that helps brace the pipe against deformations.

   - Sanitary sewer joints and fittings shall be watertight and conform to the requirements of ASTM D3212.

MA6.09 Fiberglass Reinforced Plastic (FRP) Pipe

This section covers FRP pipe for sanitary sewers. Figure MA6.9 lists typical FRP pipe.

Figure MA6.9 Fiberglass Reinforced Plastic (FRP) Pipe

Material	Designation	Joints	Gaskets	Fittings	Sizes (in)	
					Min	Max
Fiberglass Reinforced Plastic (FRP) Pipe	ASTM D3262	Field Connection-Fiberglass Sleeve Coupling – ASTM D4161	ASTM F477	ASTM D3262	18	27

MA6.10 Building Sewers and Appurtenances

This section covers building sewer and appurtenances for all connections to the public sanitary sewer.

1. Pipe Materials

   Figure MA6.10 lists appropriate building sewer pipe materials.

Figure MA6.10 Building Sewer Pipe Materials

<table>
<tr><th>Type</th><th>Pipe Designation</th><th>Classification</th><th>Joints</th><th>Gaskets</th><th>Fittings</th><th>Acceptable Minimum Size (in)</th></tr>
<tr><td rowspan="2">Polyvinyl Chloride Pipe (PVC)</td><td rowspan="2">ASTM D3034</td><td rowspan="2">SDR35</td><td rowspan="2">Bell and Spigot</td><td rowspan="2">ASTM F477
ASTM D3139</td><td rowspan="2">ASTM D3034</td><td>6</td></tr>
<tr><td>6</td></tr>
<tr><td>High Density Polyethylene (HDPE) Pipe</td><td>AWWA C906</td><td>DR 11</td><td>Butt Heat Fusion ASTM D3261</td><td>-</td><td>-</td><td>1 ¼ *</td></tr>
</table>

**For low pressure building sewer, minimum acceptable size is 1 ¼-inch. For all other applications, use minimum diameter of 6-inches.*

2. Building Connection and Cleanouts

   For acceptable building sewer connections, refer to Standard Drawing SAN-1. Schedule 40 PVC clean out caps are acceptable for building sewer cleanouts.

3. Grease Interceptor and Sand/Oil Separators

   For acceptable grease interceptors, refer to Standard Drawings STR-24 and STR-24-1.

4. Inspection Manholes/Non- Metered Control Manhole

   For acceptable metered control manholes and non-metered control manholes, refer to Standard Drawings STR-11-1 and STR-11-2, respectively.

MA6.11 Manholes

1. Quality Assurance

   A. Manufacturer Qualifications

      Precast sanitary sewer manholes shall be from a source listed in the most recent INDOT list of Certified Precast Concrete Producers.

   B. Supply and Compatibility

      Imperfections in precast manhole sections may be repaired, subject to the approval of City Utilities Engineering, after demonstration by the manufacturer that a strong and permanent repair will result. Repairs shall be carefully inspected before final approval.

   C. Field Quality Control

      Conduct vacuum testing on all sanitary sewer manholes in accordance with ASTM C1244.

      - Temporarily plug pipe connections entering manhole to be tested.
      - All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

- Following set-up of test apparatus, draw vacuum of 10- inches of mercury on manhole being tested. The time shall be measured for the vacuum to drop to 9-inches mercury.
- Start test upon reaching specified test vacuum. Test duration shall be in accordance with ASTM C1244.
    - Minimum test times for various manhole diameters shall conform to the Figure MA6.11 per ASTM C1244, or be 1 minute, whichever is longer:

Figure MA6.11 Vacuum Test Times (Modified table per ASTM C1244)

Depth (ft)	Diameter, in.												
	48	54	60	66	72	78	84	90	96	102	108	114	120
	Time, in seconds												
<4													
6													
8													
10				60							63	67	71
12								62	67	71	76	81	85
14						62	67	72	78	83	89	94	100
16					69	70	76	83	89	95	101	108	114
18				65	73	79	86	93	100	107	114	121	128
20			65	72	81	88	95	103	111	119	126	135	142
22		64	72	79	89	97	105	114	122	131	139	148	156
24		64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	85	94	105	114	124	134	144	155	164	175	185
28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	72	87	98	108	121	132	143	155	166	178	189	202	213

2. Sanitary Sewer Manholes

   Precast sanitary sewer manholes are manufactured by wet or dry cast methods using forms. Figure MA6.12 lists typical sanitary sewer manholes. Sanitary manholes shall be constructed with Type II Portland Cement and have a maximum water/cement ratio of 0.45.

Figure MA6.12 Sanitary Sewer Manholes

Material	Designation	Standard Drawing	Joints	Gaskets*	Sizes (in) Min	Sizes (in) Max
Precast Concrete	ASTM C478	STR-20-1 STR-20-2 STR-20-3 STR-20-4	Tongue and Groove	Preformed Flexible Sealant (ASTM C990)	48	96**

*Note *: Rubber gaskets manufactured in accordance with ASTM C44, may be used in lieu of preformed flexible sealant.*
*Note **: For structures larger than 96” in diameter, consult CUE.*

3. Joint Exterior

   A. To seal the exterior of the manhole joint use a trowable butyl rubber backplaster around the circumference of the joint. The following materials and manufacturers are acceptable:

      - Trowable EZ Stik # 3 by Press Seal Gasket Corporation, or
      - Approved Equal

   B. To protect the trowable butyl rubber backplaster install polyethylene plastic sheeting covering the butyl rubber. The following materials and manufacturers are acceptable:

      - 6-mil polyethylene plastic sheeting film by Visqueen, or
      - Approved Equal

4. Metal Castings and Rings

   Refer to Section MA6.12, Castings, Frames, and Covers.

5. Manhole Steps

   Manhole steps are not acceptable in sanitary sewer manholes.

6. Poured In Place Manhole Bases

   For manhole diameters of 48-inches, refer to Standard Drawing STR 12-1. For manhole diameters ranging from 54 to 96-inches refer to Standard Drawing STR 12-2.

7. Resilient Connectors between Manhole Structures and Pipes.

   To protect against infiltration and create a watertight joint, provide a resilient connector between each pipe entering and exiting the manhole. Refer to Figure MA6.13 for acceptable resilient connectors.

Figure MA6.13 Resilient Connectors

Pipe Size Range	Designation	Manufacturers and Products	Standard Drawing
≤36-inch Diameter	ASTM C923	Press Seal PSX: Positive Seal	STR 14-1
		NPC Kor N-Seal II 306 Series	
> 36-inch Diameter		A-Lok Premium	STR 14-2
		Press Seal WS 30: Waterstop Grouting Ring	

MA6.12 Castings, Frames, and Covers

In pedestrian traveled areas, castings frames and covers must comply with current ADA requirements with a max opening of ½-inch. Utilize pick hole plugs as appropriate.

1. Sanitary Metal Castings

   This section covers iron castings for various types of manhole frames and covers. Figure MA6.14 lists sanitary sewer manhole metal castings.

Figure MA6.14 Metal Castings

Casting Type	Designation	Class	Standard Drawing	Neenah Foundry Company		East Jordan Iron Works Inc.	
				Frame	Lid/Grate	Frame	Lid/Grate
24" Sanitary Manhole Casting	ASTM A48	35B	C-1-1	R-1772	Solid	1022Z1	Solid
Watertight Sanitary Manhole Casting			C-2-1 C-2-2	R-1772	Solid Bolted	1022Z1PT	Solid Bolted
Standard Cleanout Casting			C-3-1 C-3-2	R-1976	Solid	1578	Solid

2. Manhole Adjusting Rings and Chimney Seals

   A. Concrete riser rings are used to adjust the finish elevation of the metal casting. Adhere grade rings using a preformed flexible joint sealant manufactured in accordance with ASTM C990 and AASHTO-M198. Maximum number of rings that may be used on a structure is 2. Adjusting rings may range in height from 2-inches to 6-inches. See Standard Drawing STR-23-1.

   B. To protect against infiltration and help seal the joints between the manhole structure, adjustment rings, and metal castings, provide one of the following external chimney seals:

      - External Chimney Seal by Cretex Specialty Products, or
      - Wrapidseal by CANUSA-CPS, or
      - Approved Equal.

MA6.13 Sanitary Lift Station Components

1. Duplex Submersible Pump Stations

   The following material requirements are specific to duplex submersible lift stations.

   A. Pumps

      Base lift station pump design on current manufactures recommendations of Xylem Flygt Pumps.

   B. Pump Design

      The pumps shall be automatically and firmly connected to the discharge connection, guided by 304 stainless steel guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. No portion of the pump shall bear directly on the sump floor.

C. Pump Construction

Major pump components shall be grey cast iron, ASTM A-48, Class 35B, with smooth surface devoid of blow holes or other irregularities. All exposed nuts and bolts shall be AISI Type 316 stainless steel. All metal surfaces coming in contact with the pump, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

D. Cable Entry Seal

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by terminal board, which shall isolate the interior from foreign material gaining access through the pump top.

E. Pump Motor

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of no less than 15 [30 for Premium Efficiency Motors] evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out. The motor shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

F. Bearings

The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

G. Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydro dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. No system requiring a pressure differential to offset pressure and to affect sealing shall be used.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The motor shall be able to operate dry without damage while pumping under load. Seal lubricant shall be FDA approved, non-toxic.

H. Protection

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 260 degrees F, the thermal switches shall open, stop the motor and activate an alarm. A leakage sensor shall be provided to detect water in the stator chamber. The float leakage sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote. Use of voltage sensitive solid state sensors and trip temperature above 125 degrees C (260 degrees F) shall not be allowed. The thermal switches and FLS shall be connected to a mini CAS (Control and Status) monitoring unit. The mini CAS shall be designed to be mounted in the control panel.

2. Pipe and Valves

A. Pipe

The discharge pipe and fittings shall be ductile iron Class 350. Inside pipe and fittings shall be flanged. Bell end pipes or fittings with mechanical joints shall be provided at or near the outside face of the station well. Piping shall be supported independent of the sewage flanges. Piping joints shall be EBAA Iron Works Megalug Series 1100 mechanical joint restraints for ductile iron pipe.

All metal piping other than cast or ductile iron and copper tubing shall be galvanized steel pipe. Guide rails and all interior miscellaneous metals, including bolts, shall be stainless steel.

B. Valves

All plug valves shall be lever operated. One lever shall be provided for each plug valve. All plug valves shall be Dezurik Style PEF eccentric plug valve with square nut actuator.

All check valves shall be iron body, bronze mounted with outside weight and lever swing type with bolted covers and flanged ends. Provide swing type check valves as manufactured by Clow or M & H, The style of swing check valve varies with size, specific the lever and weight based on specific project requirements.

3. Wet Well, Valve Vaults

A. Wet Well and valve vaults shall be circular pre-cast concrete, conforming to the requirements of ASTM C478, with a minimum compressive strength of 4,000 psi.

B. Gaskets: Use rubber O-ring gaskets manufactured in accordance with ASTM C443.

- Use a sand-cement mixture mortar to seal the interior joints. Mortar mix shall be one part cement to two parts sand.
- Wrap the exterior joints with a 6-inch wide EZ-wrap.

4. Station Access Hatches

The following manufacturers are acceptable for lift station access hatches:

- Bilco
- Halliday

A. Frames shall be ¼-inch extruded aluminum with an anchor flange around the perimeter. Mill finish with bituminous coating to be applied to exterior frame by manufacturer.
B. Door leaf shall be ¼-inch aluminum diamond plate reinforced with aluminum stiffeners. The door shall open to 90-degrees and lock automatically in that position. Door shall be built to withstand a live load of 300 lbs per square foot.
C. Use all stainless steel hardware. Handle shall be snap lock and removable.
D. A 1 ½-inch drainage coupling shall be provided in the right front corner of the channel frame.
E. Factory finish shall be aluminum lacquer. All surfaces in contact with concrete shall have a bituminous coating.
F. The access hatches shall be of the minimum size required for unobstructed access or equipment removal.
G. Each access hatch shall be equipped with aluminum safety grating. The safety grate shall be made of 6061 – T6 aluminum safety grating per the most current edition of the Specification for Aluminum Structures by the Aluminum Association, Inc. The grating shall withstand a minimum live load of 300 psf, using 17,300 psi as the design stress for the aluminum. Both the access hatch and safety grating shall be from the same manufacturer.
    - Grate openings shall be 5-inches by 5-inches.
    - Provide grates with a permanent hinging system, which will lock the grate in the 90-degree position once opened.
    - Coat the grate with an OSHA type safety orange color powder coating system applied by electrostatic spray process.

5. Electrical, Controls, and Control Panels

The following requirements may change depending on the type of power that is available at the site.

A. Level sensors

Provide a multi-point float stick and a submersible continuous level sensor to measure water depth in the wet well. The multi-point float stick shall serve as the primary level sensor. Cable and probe lengths are based on wet well depth and control panel location. The following are acceptable level sensors:

- Pump Control and Monitoring Equipment: MultiTrode®, Inc. MultiSmart model MSM3MP.

- Continuous Level Sensors: MultiTrode® model MTPT with mounting bracket, intrinsic safety barrier, and other items as required.
- Multi-point float stick: MultiTrode® probe, mounting brackets, and other items as required.

B. Enclosures

- The enclosure shall contain a properly sized cooling unit. Enclosures only require installation of a cooling unit if controls and VFD will be placed in same enclosure. Cooling units manufactured by ICE QUBE INC. are acceptable.
- The interior of the enclosure shall be provided with properly sized industrial grade corrosion inhibitors.
- The enclosure shall be provided with thermostatically controlled, properly sized condensate heater. The heater shall be mounted on the lower portion of the enclosure internal panel.
- Furnish a door limit switch actuated panel fluorescent light, similar to Hoffman Catalog No. A LFDA2.
- Include a door intrusion alarm.
- Integrate alarm beacon light.
- Panduit shall be installed as a wire way. This wire way should be 40% larger than required for future wiring.
- All conduit entry into the enclosure, originating from the wet well, shall be sealed with explosion-proof conduit seals to prevent moisture and gas vapors from entering the enclosure.
- All wiring within the enclosure must use plastic wiring ducts. Do not mix low level signal wiring with high voltage (110 Volts AC or greater) wiring in the same duct.
- Include reference sheet in an archival quality acid-free sheet protector. It shall list initial pump set points, float stick set points, and wet well elevations. Include level controller ‘zero’ elevation.
- Enclosure shall be NEMA 4X stainless steel.

C. Power

The incoming pump power wiring shall be terminated at distribution lugs and shall be provided with voltage surge arresters to protect all equipment mounted within the enclosure from switching surges and lightning induced surges.

- Locate surge arresters in such a manner as to facilitate inspection and future replacement of damaged units. Comply with UL 1449 and ANSI C62.41 Standards.

Power within the panel shall be distributed further through thermal magnetic circuit breakers and motor circuit protectors, which shall be accessible from the front of the swing-out panel without opening the swing-out panel. Provide the following:

- A motor circuit protector for each pump
- If the incoming power is 480 Volts AC or higher then use a circuit breaker for a 480/120 Volt AC transformer, and require a minimum 6-foot clearance.
- Circuit breakers shall have minimum interrupting rating of 25,000 Amperes.
- Separate incoming terminals for control circuit panel control power, pressure transducer power supply and telemetry transceiver.

If the incoming power is 480 Volts AC or higher then use a transformer to obtain 120 Volts AC power.

- Transformer shall be high efficiency type, with 105 º C temperature class, extra regulation and low losses.
- Size transformer to feed all 120 Volts AC within the enclosure +20%. Minimum size of the transformer shall be 1.0 KVA.

Provide conduit seal offs, a NEMA 7 junction box, and terminal strips for all control wiring and power wiring entering and exiting rated spaces.

Distribute 120 Volt AC power through single pole circuit breakers, which shall have minimum interrupting rating of 10,000 Amperes. Provide a circuit breaker for each of the following items:

- Motor control circuit.
- Panel light and thermostatically controlled enclosure heater described above.
- Convenience GFI receptacle.
- Additional as specified on single line diagram.

Include a duplex convenience receptacle. Receptacles shall be 15 Ampere, Ground Fault Interrupting (GFI) non-feed through types.

Protect each motor power with magnetic only motor circuit protector. Motor circuit protectors shall be as follows:

- Size, voltage and configuration shall be as required.
- Provided with adjustable instantaneous trips.
- Minimum rating: 25,000 Amperes Interrupting Capacity (AIC).

Provide each pump starter with the following:

- A minimum of two sets of normally open starter auxiliary contacts.
- A minimum of two sets of normally closed starter auxiliary contacts.
- One set of normally open auxiliary overload alarm contacts.

Provide terminal blocks, which shall be grouped together, for remote control and monitoring wiring.

Provide all electro mechanical relays as necessary to achieve the intended operation as described. Relays shall be plug-in ice-cube style, 3PDT or 4PDT, with manual operator and indicator light. Contacts shall be rated a minimum of 10 amps at 240 VAC.

Manufacturers shall be as listed below. Products of other manufacturers assembled to provide all specified functions, including reliability equal to or exceeding that of the manufacturers listed below may be submitted for approval.

- Circuit breakers and motor circuit protectors shall be Square D or Eaton.
- Pilot and control devices shall Allen-Bradley, or Square D.

Pump station shall have either a permanent generator or a generator receptacle with a service-rated manual transfer switch.

Generator receptacles shall be as follows:

- 100A – Arktite #AREA10426S22
- 200A – Arktite #AREA20427S22
- 400A – Arktite #AREX40428S22

All generator receptacles shall be male.

Manual transfer switch shall be double throw fused safety switch, service rated, NEMA 3R enclosure. Approved manufacturers shall be Square D, Siemens and Eaton Cutler-Hammer.

D. Pump Controller

The listed pump controller is only intended for a maximum of 3 pumps.

Use a microprocessor based, intelligent pump controller with pre-configured pump control logic and fault handling.

- Provide pump control module and user interface model #IO-3PC (MultiTrode).
- Provide motor protection module, model #IO-3MP (MultiTrode).

Standard functions: The pump controller shall be provided with pre-configured (default) parameters which are selectable via the user interface keypad, including:

- Set point adjustment for pump activation/deactivation and level alarms.
- Level device inputs: 4-20mA signal or (conductive) level probe.
- Redundant level device inputs.
- Selectable between charge (fill) & discharge (empty).
- Pump control of up to 3 pumps.
- Pump grouping and alternation.
- Station optimization including:

   a. Maximum off time for any pump.
   b. Maximum pumps to run simultaneously.
   c. Maximum pump starts per hour.
   d. Inter-pump start and stop delays.
   e. Maximum run time for any pump.
   f. Blocked pump detection.
- Well washer control functions.
- Well clean out (periodic pump down to off point).
- Alternate profiles of level set points (Conditional pump management).
- Data logger functions.
- 3-phase supply monitoring and supply protection including:
   a. Under-voltage.
   b. Over-voltage .
   c. Phase fail.
   d. Phase rotation.
   e. Monitoring of dc supply, battery voltage, and internal temperature.
- Additional Functions (Firmware Enabled):
   a. Over current and under current detection.
   b. Ground / earth fault.
   c. Insulation resistance testing for motor windings.
   d. KVA, kW and power factor measurement.
- Calculated flow function.
- Input/Output Description.

Available I/O types shall include:

- Digital inputs (voltage free, discrete input).
- Digital outputs (240V, 5A resistive).
- Analog inputs (10bit) (4-20ma).
- Analog outputs (10bit) (4-20ma).
- Standard (Configurable) Digital Inputs:
   a. Seal/Leakage sensor.
   b. PTC Thermistor or other over temp device.
   c. PT100.
   d. ITT Xylem FLS Sensor.
   e. Conductive probe (for liquid level sensing).
- Motor Protection & Monitoring Inputs:
   a. Insulation resistance test (IRT) to 1000v, 1 phase per pump.
   b. 3-phase current monitoring.
   c. 3-phase supply monitoring.
   d. Three (3) current transformers (CTs) shall be supplied and installed per pump. Each pump’s full load amps (FLA) are to be taken into consideration to obtain correct CT ratio.

User Interface:

- The field hardware shall include a user interface for operations and configuration. The display shall provide status of the pump station, control of pumps, resetting of faults and configuration of parameters.
- The following parameters shall be displayed on the main status screen:
  a. Level.
  b. Set points for alarms and pump start/stop.
  c. Pump Running/Stopped.
  d. Pump Available.
  e. 3-phase current for each motor Pump faults.
  f. 3-phase supply.

Provide access to Faults, History, Information and Settings.

The following information screens and parameters shall be available via the keypad:

a. Elapsed Time accumulators for each pump & the pump station.
b. Number of Starts accumulator for each pump & the pump station.
c. Flow values, either derived from calculations or via a flow meter, including inflow, pump flow rate, total volume.
d. Overflow information, including start time, duration, estimated volume.
e. Insulation resistance value for each motor.
f. Status of Inputs & Outputs.

The following control functions/devices shall be industrial grade oil tight and watertight types. Each pump shall be provided with the following controls (through the user-interface), which shall be visible from the front of the swing-out panel, with the enclosure door opened:

a. Pump mode for each pump, (Hand/Off/Auto) – 22.5-mm operator.
b. Pump fault reset.
c. Level alarm reset.
d. An amber “FAIL” pilot light.
e. An amber “SEAL FAILURE” pilot light.
f. A red motor ”RUN” pilot light.
g. A green motor “OFF” pilot light.
h. A “RESET” push button.
i. A non-resettable elapsed time meter.
j. A non-resettable elapsed time meter for when both pumps operate simultaneously.

In addition to previously listed points to be indicated by the system the following conditions shall also be indicated:

a. Communication Fail
b. Inflow Rate
c. Outflow Rate
d. Pump Run Status (all pumps)
e. Pump Failure (all pumps)
f. Power Failure
g. Volume Today
h. Volume Yesterday
i. Wet Well Level
j. Wet Well High Level
k. Personnel at Station

E. Communications

Complete telemetry systems include antenna mountings, panels, and interfaces. All local codes relating to antenna height requirements, aircraft flight paths, FAA code and other pertinent issues must be adhered to. The system shall communicate with City Utilities SCADA system via an MDS licensed frequency radio, configured to coordinate with City Utilities' system for remote communications.

The pump controller shall include the following types of connection ports:

- Ethernet port up to 10Mbit/s.
- (3) RS232 ports up to 115kBit/s.

The communication protocols supported shall be as follows: MODBUS RTU, DNP3, MULTI (Multitrode Protocol)

F. Wiring

- All wiring shall be stranded copper, minimum 12-gauge for power wiring, 14-gauge for control wiring, THHN-THWN type.
- All conduit above grade and entering/exiting rated spaces shall be pvc-coated rigid steel conduit.
- Conduit below grade, not entering/exiting rated spaces shall be Schedule 40 PVC non-metallic.

Seal-offs shall be provided for all conduits entering/exiting rated spaces.

MA6.14 Force Main Appurtenances

This section covers water appurtenances, for potable water distribution systems. Including:

- Buried Piping Identification
- Restraint Devices
- Fittings

1. Buried Piping Identification

The following materials are used for identifying buried force mains. Tracing wire is used on all force mains regardless of diameter.

A. Tracing Wire

Use # 10 or stronger High Strength, Copper Clad Steel Reinforced, HDPE insulated tracing wire with 21% conductivity for locating purposes and a minimum break load of 600lbs. Tracing wire insulation shall be green.

B. Waterproof Connection Device

Use a DRYCONN direct bury lug to connect mainline tracing wire to service line tracing wire and splice tracing wire.

2. Restraint Devices for PVC

For restraining force main joints use wedge action retainer glands that are manufactured in accordance with AWWA C110 or AWWA C153. The following types or approved equal are acceptable:

- EBBA Iron– MegaLug
- Romac – RomaGrip
- Sigma – One-Lok
- Stargrip – Series 3000

When force main diameter exceeds 16-inches, consult with City Utilities for appropriate restraint devices.

3. Restraint Devices for HDPE

Fused mechanical joint adaptors shall be used.

Thrust anchors or approved equal shall be used where the Poisson effect is anticipated.

4. Fittings

Fittings for force mains shall be ductile iron and conform to the requirements listed in Figure MA6.15. Appropriate pressure rating, gaskets, bolts, and nuts shall be used for joints. All valve bolts are to be stainless steel.

Figure MA6.15 Force Main Fittings

Fittings	Designation	Gaskets	Coating	Lining
Standard	AWWA C110	AWWA C111	Asphaltic	Cement Mortar AWWA C104
Compact	AWWA C153	AWWA C111	Asphaltic	Cement Mortar AWWA C104

	Project Work order number
	Location
	Date
	Pipe Diameter

	Start Time

	Start Pressure (150 psi)
	Pressure at 15 minutes
	Pressure at 30 minutes
	Pressure at 45 minutes
	Pressure at 60 minutes
	Pressure at 75 minutes
	Pressure at 90 minutes
	Pressure at 105 minutes
	Pressure at 120 minutes

	Water added during testing
	Water allowed to be added during testing (see lookup table below)

	Was test successful? Yes if no visible leaking and water added is less than water allowed

	Contractor signature
	City Utilities authorized representative signature

Pipe Diameter (inches)	Leakage Allowance per 1000 feet of main (gallons)
6	1.00
8	1.32
12	1.98
16	2.64

This complete form shall be submitted by the contractor into PMIS prior to final completion.

	Project Work order number
	Location
	Date
	Pipe Diameter

	Start Time

Expansion Phase

	Start Pressure (150 psi) - expansion phase
	End Pressure (150 psi) after 4 hours of expansion - note add water as required to expand pipe.

Test Phase

	Start Pressure (140 psi)
	End pressure after 1 hour

	Was test successful? Yes if no visible leaking and end pressure was within 5% of test pressure (133 psi)

	Contractor signature
	City Utilities authorized representative signature

This completed form shall be submitted by the contractor into PMIS prior to final completion.

Book 5

Materials (MA)

MA7 Water Materials and Testing Requirements

MA7.01 Purpose

This Chapter covers materials used for potable water distribution utility projects.

MA7.02 Allowable Pipe Materials and Testing Requirements

Figure MA7.1 summarizes water main pipe materials used for potable water distribution system installations and is to be used as a reference for acceptable water pipe materials. The following Sections within this Chapter list more detailed requirements specific to each pipe material.

Figure MA7.1 Allowable Public Water Main Pipe Materials

<table>
<tr><th>Pipe Material</th><th>Designation</th><th>[1]Min Cover (ft)</th><th>Sizes (Diameter, in.)</th><th>Bedding Req.</th><th>Master Spec Number</th></tr>
<tr><td>Polyvinylchloride (PVC) Pressure</td><td>AWWA C900</td><td rowspan="2">5</td><td>DIPS DR18 – 6”, 8”, 12”, 16”</td><td rowspan="2">Flexible Drawing - BS-5</td><td>33 05 37.16</td></tr>
<tr><td>High Density Polyethylene (HDPE)</td><td>AWWA C906</td><td>IPS DR9 – 2”
DIPS DR11 – 6”, 8”, 12”, 16”, 24”, 30”, 36”, 42”
36</td><td>33 05 38.16</td></tr>
</table>

Note: 1 - Minimum cover from finished grade to top of pipe (O.D), at completion of all project restoration.

1. Pipe Testing Requirements

   The contractor shall be responsible for pipe testing. City Utilities will monitor testing. The following subsections include quality assurance and quality control requirements for the material listed in this Chapter.

2. Quality Assurance

   A. Manufacturers Qualifications

      - Pipe manufacturers shall have a minimum of 5 years of successful experience producing specified pipe and fittings, and document their success by showing evidence of at least 5 installations in satisfactory operation within the United States.
      - HDPE pipe and fittings manufacturers and distributors shall be listed as current members of the Plastics Pipe Institute (PPI).

B. Supply and Compatibility

- Pipe, fittings and appurtenances shall be suitable for the specified service and integrated into the overall piping system by the pipe supplier.

3. Water Main Start-Up Sequencing – Gap Concept

When connecting new or replacement water main to City Utilities' water distribution system, use the following method:

- Only one point of connection between the new/replacement water main and the in-service water main system prior to pressure testing and disinfection.
- Contractor shall operate valves the connect to the existing service, under the observation of Water Maintenance and Service.
- The separation between the new/replacement water main is commonly called an air gap, and used to maintain the integrity of the in-service water main system.
- Successfully complete the pressure testing and disinfection of the new water main.
- Services shall be approved for potable use after successful pressure testing and disinfection of public water main.
- After successful pressure testing and disinfection on redevelopment mains, install all service connections. For new mains, services may be installed, but not activated, prior to successful pressure testing and disinfection.
- Continue this process until all water mains within the project are connected to City Utilities' water distribution system.
- The Contractor is responsible for turning all valves not accepted as part of the distribution system.
- After water main has successfully passed pressure testing and disinfection, contractor may make additional connections as necessary to finish installation.

4. Field Quality Control

This section covers pipe testing requirement after installation of the pipe. The following testing is required for water distribution projects:

- Hydrostatic Test
- Electrofusion Saddle Joint Test
- Disinfection Test
- Continuity Test

Prior to pressure testing and disinfection water mains complete the items listed in the data collection checklist.

A. Hydrostatic Testing for:

- PVC Pressure Pipe (AWWA Standard C605)
- HDPE Pressure Pipe (ASTM F2164)

1. Preparation for Testing:
    - Follow appropriate preparation for testing as specified in the manuals above for specified pipe material.
    - Prior to testing the contractor shall ensure that the line is clean and free of dirt and debris.
    - Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
    - Prior to testing, install test riser and ensure equipment is properly calibrated.
2. Test Procedure for PVC Pressure Pipe:
    - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
    - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
    - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
    - Add fluid as required to pressurize line to 150 psi or otherwise specified test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
    - Timed test period shall not begin until after pipe has been filled, air has been expelled, and pressure stabilized.
    - Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure.
    - Pump from test container to maintain test pressure. Measure volume of water pumped from test container and record on test report. Record pressure at test pump at 15-minute intervals for duration of test.
    - Results of the test shall be logged using the inspection form provided in Fort Wayne's Project Management Information System (PMIS).
3. Test Procedure for HDPE Pressure Pipe:
    - Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
    - Expel air from pipe as required. Obtain approval of City Utilities Engineering prior to tapping pipe for expelling air.
    - Examine exposed joints and valves, and make repairs to eliminate visible leakage.
    - The test section and the test liquid shall be allowed to equalize to a common temperature.
    - After filling pipeline and purging air, gradually pressurize pipe to 150 psig or otherwise specified test pressure and maintain required test pressure for four hours for pipe to expand. During

expansion, add fluid to maintain required test pressure. Begin timed test period after expansion period and other requirements are met.

- Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
- Timed Test Period: After four hour expansion phase, reduce test pressure by 10 psig and do not add liquid. Test pressure shall then remain steady for 1 hour, indicating no leakage.
- If no visible leakage is observed and pressure remains within 5% of the original test pressure for 1 hour, a passing test is indicated.

5. Makeup Water Allowances:
    - The allowable makeup water allowance is the maximum amount of water that is added into a pipeline undergoing hydrostatic pressure testing. The allowable leakage rates for the various pipe materials and joints are listed below.
    - Pipes with flanged, welded, or fused joints
        - No addition of makeup water
    - Allowance rates for PVC pipes joined with rubber gaskets as sealing members include the following joint types; bell and spigot, push on, mechanical, bolted sleeve type couplings, grooved and shouldered couplings
        - Calculate makeup water rates using the following equation.

$$Q = \frac{LD\sqrt{P}}{148{,}000}$$

Where:

Q = quantity of makeup water (gph)
L = length of pipe section being tested (ft)
D = nominal diameter of the pipe (in)
P = average test pressure during the hydrostatic test (psi_{gauge})

- Figure MA7.2 represents the calculated values of rates 1,000 feet of pipe at the 150 psi test pressure.

Figure MA7.2 Allowable Testing Allowance for PVC Pipe (per 1,000’ of pipeline at 150 psi)

Nominal Pipe Diameter (in)	Testing Allowance (gph)
4	0.33
6	0.5
8	0.66
10	0.83
12	0.99
16	1.32

Note: Table is a short listed excerpt from AWWA C605.

B. Electrofusion Saddle Joint Test for:

- HDPE Pipe with electrofusion saddle connection for water service lines.

It is recommended for the contractor to test the electrofusion saddle joint for leakage prior to tapping into the water main. Testing procedures are as follows:

1. Install electrofusion saddle based on the manufacturers recommended procedures and allow the joint to cool.
2. Visually inspect for defects, and repair, prior to conducting joint pressure test.
3. Install an appropriate joint testing device into the corporation stop. Device shall have a plain end HDPE pipe that directly connects to the service corporation stop and include a pressure gauge, and appropriate testing fitting appurtenance.
4. Gradually fill the saddle with air to 10 psig. The joint is acceptable if the 10 psig is maintained for at least 5 min. If testing for greater than 10 psig consult with Owner.
5. After successful testing of the saddle joint, complete tapping procedures.
6. If electrofusion saddle joint fails, completely remove the saddle and reinstall according to the listed installation requirements.

C. Cleaning and Disinfection

The contractor shall be responsible for cleaning and disinfecting the pipe. City Utilities is only responsible for monitoring, collecting, and testing samples during the cleaning and disinfection process.

1. Cleaning

   - Thoroughly clean all piping, including flushing with water, in manner approved by City Utilities, prior to placing in service. Chlorine solution and sodium hypochlorite solution shall be flushed with water.

2. Disinfection:

   - City Utilities requires disinfection of all potable and finished water piping.
   - All equipment, tools, and mixing machines used in the disinfection process, shall be clean and free from debris, and substances not acceptable for contact with potable water.
   - Prior to disinfection, clean piping as specified and flush thoroughly.
   - Conform to procedures described in AWWA C651. Use the continuous feed or slug method of disinfecting.
   - No chlorine tabs are to be glued to the inside of the pipe or fittings.

- Do not place any other material or substance inside the pipe, including dye, without prior approval from Owner.
- Water for initial flushing, testing, disinfection, will be provided by the owner. Work and all necessary equipment, tools, and machines will be furnished by Contractor. Contractor shall be responsible for damage caused by water from hydrants.
- Use a clean and free from debris rotary mixer for chlorine preparation. Any other equipment shall be approved by Owner.
- Utilize calcium hypochlorite in granular form or hydrated calcium hypochlorite labeled for drinking water containing 65 percent available chlorine by weight for disinfection.
- Dechlor chemical, injector pump and hoses shall be provided by the Contractor, if necessary.
- Test Risers shall be installed every 1,200 feet of new water main plus one at the end of branches. Contractor shall be responsible for maintaining all test risers in operable condition, erosion protection, and that test risers are ready for sampling when the Owner arrives. Test riser maintenance includes but is not limited to freezing, and protection from dust and dirt, Obtain owner approval prior to allowing more than a pencil diameter flow through a test risers shall not flow more than a pencil diameter water flow without Contractor presence. Contractor shall coordinate test risers to be ready for sampling at the time when the Owner arrives.
- Bacteriologic samples and tests will be performed by a Water Maintenance and Service Technician. This includes procuring the sample, transporting sample to the Filtration Plant, and receiving and communicating the results of the test. Certified test laboratory report will be provided as needed. Notify Water Maintenance and Service a minimum 24 hours prior to testing.
- Chlorine concentration in water flowing through the new water main shall not have less than 100 mg/L free chlorine. The chlorine shall be applied continuously and for a sufficient period to expose all piping interior to a concentration of approximately 100 mg/L for at least 3 hours but not more than 24 hours. Disinfect piping and all related components. Repeat as necessary to provide complete disinfection.
- After required retention period,
  - Flush dechlorinated water to the Sanitary Sewer, unless otherwise acceptable to City Utilities.
  - If water has been properly dechlorinated, flushing to the Storm Sewer is acceptable. Properly dispose of chlorinated water in accordance with Laws and Regulations.
  - Do not discharge chlorinated water to storm sewers, ditches, or overland.
  - No flushing during a rain event.
- If first sample fails, one more is allowed. If the second sample fails, another flush must take place. If the sample failures

continue, the disinfection process must be repeated. Contractor must remain on site for the entire disinfection process until the pipe passes.

D. Tracing Wire Testing

Testing of the tracing wire shall be performed by the contractor in the presence of the engineer. Tracing wire testing shall be performed using a direct-connect signal generating device and Schonstedt or equivalent underground pipe locating equipment along mains and services. Breaks in conductivity shall be repaired and the wire re-tested until tracing wire passes test.

MA7.03 Polyvinylchloride (PVC) Pipe - Pressure

This section covers pressurized PVC pipe and the various joint types. Figure MA7.3 list typical pressure PVC pipe used for buried applications.

1. Pressure PVC Pipe

   Minimum wall thickness for potable water distribution is DR 18, sizes are based on DIP size.

2. Gaskets

   When pipe is installed in oil contaminated soils use Nitrile Gaskets.

3. Pipe Material Designation

   Pipe and couplings are made from PVC compounds having a minimum cell classification of 12454, as defined in ASTM D 1784.

Figure MA7.3 Polyvinylchloride (PVC) Pipe- Pressure

Material	Designation	DR Minimum	Joints	Gaskets	Fittings	Sizes (in)	
						Min	Max
Polyvinyl Chloride Pipe (PVC)	AWWA C900	18	Bell and Spigot	ASTM F477 ASTM D3139	Refer to Section MA7.11 – Water Appurtenances	6	16

MA7.04 High Density Polyethylene (HDPE) Pipe - Pressure

This section covers pressurized HDPE pipe, Figure MA7.4 list typical HDPE pipe used for buried applications.

1. Pressure HDPE Pipe

   Minimum wall thickness for Potable Water Distribution is DR11, sizes are based on DIP size.

2. Pipe Material Designation

   Pipe material used for the manufacture of HDPE shall be extra high molecular weight, high density ethylene/hexane copolymer PE 4710 polyethylene resin meeting the requirements of ASTM D3350 with a cell classification of PE 445574C-CC3.

3. Adaptors

   Fused mechanical joint adaptors shall be used to connect to fittings and valves. Pipe stiffeners and wedge-style restraint are not permitted.

4. Joints

   All joints must utilize butt-fusion or electrofusion couplings.

Figure MA7.4 High Density Polyethylene (HDPE) Pipe - Pressure

Material	Designation	Joints	Gaskets	Fittings
High Density Polyethylene (HDPE) Pipe	AWWA C906	Butt Heat Fusion ASTM D3262	-	Refer to Section MA7.11 – Water Appurtenances

MA7.05 Concrete Pressure Pipe

This section covers concrete pressure pipe, Figure MA7.5 list typical concrete pressure pipe.

1. Concrete Pressure Pipe

   - Pressure class is to be selected based on the project specific external and internal live and dead loads.

   A. Reinforced Concrete Cylinder Pipe is comprised of the following:

      - welded steel cylinder with steel joint rings welded to its ends
      - reinforcing cage or cages of steel bars
      - wire, or welded wire fabric surrounding the steel cylinder
      - wall of dense concrete covering the steel cylinder and reinforcing cage or cages inside and out
      - joints with a preformed watertight gasket.
      - fittings are fabricated from welded steel sheet or plate, and lined and coated with cement mortar

   B. Prestressed Concrete Cylinder Pipe is comprised of the following:

      - welded steel cylinder with steel joint rings welded to its ends
      - steel cylinder encased in concrete
      - reinforcement consisting of high-tensile wire wound around outside of the core in one or more layers at a predetermined stress and securely fastened at its ends
      - coating of dense mortar or concrete covering the core and wire, except surfaces of joint rings; self-centering joint with watertight preformed rubber gasket

- For embedded cylinder pipe at least one-third of total core thickness shall be outside of cylinder.
- Fittings are fabricated from welded steel sheet or plate, and lined and coated with cement mortar.

C. Concrete Bar-Wrapped Cylinder Pipe is comprised of the following:

- welded steel cylinder with sized steel joint rings welded to its ends
- lining of concrete or cement mortar centrifugally applied within steel cylinder and spigot ring
- reinforcement consisting of continuous steel rod wound helically around outside of cylinder at predetermined stress and securely fastened by welding to steel joint ring at each end of cylinder
- a coating of dense mortar covering cylinder and rods, except for necessary exposed surfaces of spigot joint rings and a self-centering watertight preformed rubber gasket.
- Fittings are fabricated from welded steel sheet or plate, and lined and coated with cement mortar.

2. Restrained Joints

Refer to manufactures restrained joint recommendations for concrete pressure pipe.

Figure MA7.5 Concrete Pressure Pipe

<table>
<tr><th rowspan="2">Material</th><th rowspan="2">Designation</th><th rowspan="2">Pressure Class</th><th rowspan="2">Joints</th><th rowspan="2">Gaskets</th><th rowspan="2">Fittings</th><th colspan="2">Sizes (in)</th></tr>
<tr><th>Min</th><th>Max</th></tr>
<tr><td>Reinforced Concrete Cylinder Pipe</td><td>AWWA C300</td><td>150-260 PSI</td><td rowspan="4">Bell and Spigot – Mortar Encased</td><td rowspan="4">Rubber O-Ring</td><td>AWWA C300</td><td>30</td><td>54</td></tr>
<tr><td>Prestressed Concrete Cylinder Pipe - Lined</td><td rowspan="2">AWWA C301</td><td rowspan="2">250-350 PSI</td><td rowspan="2">AWWA C301</td><td>24</td><td>48</td></tr>
<tr><td>Prestressed Concrete Cylinder Pipe - Embedded</td><td colspan="2">54</td></tr>
<tr><td>Concrete Bar-Wrapped Cylinder Pipe</td><td>AWWA C303</td><td>400+ PSI</td><td>AWWA 303</td><td>24</td><td>54</td></tr>
</table>

MA7.06 Service Connections

This section covers small and large service connections used for potable water distribution systems, refer to Figure MA7.6 for acceptable pipe material. For typical layouts of service connections refer to Standard Drawing W-40.

1. Buried Service Identification

   - Refer to Section MA7.11 – Water Appurtenances for tracing wire material requirements.

- Refer to Standard Drawings W-52 and W-53 for installation of tracing wire.

Figure MA7.6 Service Connections

Service Size	Material	Designation	Sizes (in)
Small Services	High Density Polyethylene (HDPE) Tubing (DR9)	AWWA C901	CTS – 1", 1.5", 2"
Large Services	PVC DR18 and HDPE DR11		DIPS – 4", 6", 8", 12"[1]

Notes: 1-10" requires approval. DI permitted at building in conjunction with backflow prevention or fire suppression.

2. Corporation Stops

Figure MA7.7 lists corporation stop requirements for various service diameters.

- The corporation stops shall be ball type valves of extra heavy, all brass construction.
- The corporation stops shall have a flat, thick, operating head with a 360 degree rotation.
- The corporation stop inlet threads shall be machined with standard AWWA tapered threads.

Figure MA7.7 – Corporation Stops

Manufacturer	Material	Product Number	Pressure Rating	Valve	Inlet	Outlet
Mueller	No Lead Brass	B-25008N	300 PSI	Ball	AWWA Thread	Quick Connection
Ford Meter Box Company	No Lead Brass	FB1000-NL	300 PSI	Ball	AWWA Thread	Quick Connection
A.Y. McDonald	No Lead Brass	74701B Q	300 PSI	Ball	AWWA Thread	Quick Connection

3. Curb Stops

Figure MA7.8 lists curb stop requirements for various service diameters. To maintain consistency install curb stops, in the open position, perpendicular to the street.

- The curb stops shall be minimum ball type valves of extra heavy, all brass construction
- The curb stops shall have a heavy or thick tee-head operator and a 90 degree rotation of the ball.
- Each stop shall be equipped with a curb box.
- Ball valves shall have manufacturer recommended coated balls and hard or synthetic rubber seat-rings.

4. Curb Boxes

   - Curb boxes shall be cast iron, Buffalo screw type boxes, and have a shaft size of 3” with a base sized appropriately to fit over the service pipe.
   - The word “water” shall be cast on the valve and curb box lid.
   - Refer to Standard Drawing STR-44, for curb box layout.
   - Use Vadle or equivalent centering piece on ¾-inch and 1-inch curb stops.

Figure MA7.8 – Curb Stops

Manufacturer	Material	Product Number	Pressure Rating	Valve	Inlets/Outlets
Mueller	No Lead Brass	B-25209N	300 PSI	Ball	Quick Connection
Ford Meter Box Company	No Lead Brass	FB44Q	300 PSI	Ball	Quick Connection
A.Y. McDonald	No Lead Brass	76100BQ	300 PSI	Ball	Quick Connection

5. Service Tapping Saddles

   - Tapping saddles for PVC:

     The tapping saddles and hardware shall be ductile iron with epoxy coating, stainless steel or bronze material with AWWA tapered threads, and shall be hinged or bolted, both with a minimum strap width of 2”. A 3 piece tapping saddle design is not allowed.

   - Tapping Saddles and Tapping Tees for HDPE:

     Electrofusion saddles or tapping tees shall be used for service connections, and are manufactured in accordance with ASTM F-1055. Conform with the following material requirements:

     a) Pre-Blended resin PE2406/2708 which complies with ASTM D3350.
     b) Resin must be acceptable for use with potable water and comply with NSF Standard 61.

6. Pipe Stiffener for Services

   - Use full length stainless steel pipe inserts intended for use with compression style fittings.
   - Segmented and none-segmented styles are acceptable.
   - Stiffener must match the service pipe inner diameter and extend fully into the fitting.

MA7.07 Fire Hydrants and Mainline Valves

This section covers fire hydrants, mainline valves and valves boxes for potable water mains.

1. Fire Hydrants

   Refer to Figure MA7.9for acceptable fire hydrant types and manufactures or approved equal. Fire hydrants are manufactured in accordance with AWWA C502.

   A. Fire Hydrants shall comply with the following requirements:

   1. Conform to AWWA C502.
   2. Complete with all necessary fittings and accessories.
   3. Rated for 250 psi working pressure.
   4. One 4 ½ inch pump connection and two 2 ½ inch hose connections with NSFH threads of four threads and 7 ½ threads per inch, respectively.
   5. 5 ¼ inch main valve opening.
   6. Valve will remain closed if the upper portion of the fire hydrant is removed or broken off.
   7. Open left (counterclockwise) with pentagonal operating nut.
   8. Sufficient stem length for 5 foot burial.
   9. Painted federal yellow before shipment and after installation.
   10. Has an auxiliary valve as detailed on fire hydrant assembly standards.

   The following fire hydrants, or approved equal, are acceptable for potable water mains, listed by manufacturer and model number:

Figure MA7.9 – Fire Hydrants

Manufacturer	Model	Designation	Working Pressure (psig)	Hydrant Color	Standard Drawing
American	American Flow Control B62B	AWWA C502	200	Federal Yellow	W-17
Clow	Medallion		250		
Muller	A-423		250		

2. Mainline Valves

   Refer to Figure MA7.10 for acceptable resilient wedge gate and butterfly valves, or approved equals. Use butterfly valves for valves 24-inches in diameter or greater; use resilient wedge gate valves for valves smaller than 24-inches in diameter.

A. Resilient Wedge Gate Valves

Resilient seated gate valves are to be manufactured in accordance with AWWA C515, and be equipped with the following:

- Valves shall be ductile iron bronze mounted
- Resilient seats applied in accordance with AWWA C515
- Potable water mains use resilient seat gate valves unless the valves are not available in a required size.
- Valves shall have mechanical joints, unless HDPE fusible end valve is used.
- Valves shall open right (clockwise) and shall be equipped with O-ring packing and a 2” operating nut and non-rising stem.
- Valves shall have stainless steel bolting.
- Valve body bonnet bolts shall be stainless steel

B. Butterfly Valves

Butterfly valves are to be manufactured in accordance with AWWA C504 and be equipped with the following:

- Short bodied butterfly valves shall not be used on HDPE pipe.
- Stainless steel shafts, bolts, screws, and nuts.
- The shaft seats, bearings, operators, body and discs shall be designed based on Class 150B.
- The seating ring shall be made of rubber and located in the body or on the disc and shall be adjustable and field replaceable. The shaft shall be of the through type or stub type and shall be marked on the end to indicate the position of the valve disc with respect to the shaft.
- Discs shall be of corrosion-resistant alloy cast iron. The valves shall be equipped with a stainless steel stop in the body to prevent the disc from rotating through the closed position. The shaft seals shall be of the “split-V” or Chevron type. The operator shall be permanently lubricated and sealed for buried service and shall be equipped with a 2” square opening nut.
- The operator shall be constructed such that the valve will open right (clockwise).

3. Valve Boxes

- Valve boxes shall be cast iron, two piece, screw type, and have a shaft size of 5¼”, with a round base.
- The word “water” shall be cast on the valve box lid.
- Refer to Standard Drawing STR-43, for layout of valve boxes.
- Use Posicap valve box aligner or equivalent.

4. Mechanical Joint Bolts

   - All bolts shall be Cor Blue, Blue Fluoro, or approved equal.

Figure MA7.10 – Mainline Valves

Mainline Valve Type	Manufacturer	Model	Designation	Working Pressure (psig)	Sizes (in)	
					Min	Max
Ball Valve	See Figure MA7.8				2	2
Resilient Wedge Gate Valves	American Flow Control	2500 Series	AWWA C515	250	4	24
	Clow	2638			4	16
	Kennedy	KS-RW			4	16
	Mueller	2360 / 2361			4	48
	AVK (for HDPE)	Series 66			6	12
Butterfly Valves	Clow/Kennedy	4500 Series	AWWA C504	250	24	24
		1450 Series			30	48
	Mueller	Lineseal XPII		250	24	48
	DeZurik	BAW		250	24	48

MA7.08 Air Release Structures

This section covers air release structures for water mains. In typical urban applications, water service pipe and fire hydrants act as air release structures. Based on project specific requirements air release structures may be necessary and include the following:

- Doghouse style manhole
- Saddle or tee connection to the mainline
- Valmatic Model #25 VC Air Release Valve, or equal

Refer to Standard Drawings STR 40-1, STR 40-2, and STR 40-3 for layout of acceptable air release structures.

MA7.09 Backflow Prevention

This section covers backflow prevention devices for use with potable water distribution systems. All backflow prevention devices must be approved and listed by the Foundation for Cross Connection Control and Hydraulic Research as published by the University of Southern California. Current listings are available from the following locations:

- University of Southern California

  https://fcchr.usc.edu/

- IDEM – Title 327 IAC 8- 10

  http://www.in.gov/legislative/iac/T03270/A00080.PDF

Refer to Standard Drawings W-30, W-31, W-32, W-33, and W-34 for the layouts of acceptable backflow prevention devices.

MA7.10 Water Meters

This section covers water meters and water meter boxes for potable water distribution systems.

1. Water Meters

   Meters are supplied, installed, and maintained by Water Maintenance and Service.

2. Water Meter Boxes

   - Water Meter Boxes shall be manufactured by Ford Meter Box Company Wabash, or Engineer approved equal, and equipped with a double lid cover and a yoke bar.
   - Use a plastic pit setter; refer to W-61 for the size and spacing requirements and W-56 & W-57 for the meter pipe cover requirements.

MA7.11 Water Appurtenances

This section covers water appurtenances, for potable water distribution systems, including:

- Buried Piping Identification
- Restraint Devices
- Fittings

1. Buried Piping Identification

   The following materials are used for identifying buried water infrastructure. Tracing wire is used on all water mains, regardless of material, including service pipes.

   A. Tracing Wire

      - Open Cut Installation: Use # 12 or stronger High Strength, Copper Clad Steel Reinforced, HDPE insulated tracing wire with 21% conductivity for locating purposes and a minimum break load of 300lbs.
      - Trenchless Installation: Use # 12 or stronger Extra High Strength, Copper Clad Steel Reinforced, HDPE insulated tracing wire with 21% conductivity for locating purposes and a minimum break load of 1,100lbs.

   B. Waterproof Connection Device

      Use a DRYCONN direct bury lug to connect mainline tracing wire to service pipe tracing wire and splice tracing wire.

2. Restraint Devices for PVC

   For restraining water main joints use wedge action retainer glands that are manufactured in accordance with AWWA C110 or AWWA C153. The following types or approved equal are acceptable:

   - EBBA Iron– MegaLug
   - Romac – RomaGrip
   - Sigma – One-Lok

   When water main diameter exceeds 12-inches, consult with City Utilities for appropriate restraint devices.

3. Restraint Devices for HDPE

   Fused mechanical joint adaptors shall be used.

   Thrust anchors or approved equal shall be used where the Poisson effect is anticipated.

4. Fittings for PVC Pipe

   Fittings for PVC water mains shall be ductile iron and conform to the requirements listed in Figure MA7.11. Appropriate pressure rating, gaskets, bolts, and nuts shall be used for joints. All restraint bolts are to be Co Blue Fluoro or approved equal.

Figure MA7.11 – Ductile Iron Water Main Fittings for PVC

Fittings	Designation	Gaskets	Coating	Lining
Compact	AWWA C153	AWWA C111	Asphaltic	Cement Mortar AWWA C104

5. Fittings for HDPE Pipe

   Fittings for HDPE water mains shall be HDPE and conform to the requirements listed in Figure MA7.12. Fittings shall have a pressure rating equal to or greater than the pipe mainline material and conform to NSF Standard 61 and AWWA C906. Join fittings with butt fusion welds or electrofusion couplings.

Figure MA7.12 – HDPE Water Main Fittings for HDPE Pipe

Fittings	Designation	Pressure Rating	Sizes	
Molded	ASTM D3261	≥ pressure rating of mainline pipe	6	12
Fabricated	ASTM F2206	Min. DR9 (Pressure Class 200)	16	24

CITY UTILITIES
DESIGN STANDARDS MANUAL

Book 6 CADD

Book 6

CADD Standards (CADD)

CADD1 Acronyms and Definitions

CADD1.01 Purpose

The purpose of this Chapter is to define acronyms and terms used throughout the CADD Standards Book of the Design Standards Manual. This Chapter covers the intent and meaning of the referenced acronyms and terms.

CADD1.02 Acronyms

Acronyms should be kept to a minimum. However, when used, they shall follow and not conflict those established in the NCS v.5, Module 5.0.

In a situation where an acronym is not listed and is intended to be used more than once, the complete term to be abbreviated shall be completely spelled out with the acronym enclosed in parentheses immediately after the term (ex. Computer Aided Design and Drafting (CADD)).

ACAD	Autodesk AutoCAD
A/E/C	Architecture, Engineering, and Construction
CAD	Computer-Aided Design (or Drawing)
CADD	Computer Aided Design and Drafting
CTB	Color-Dependent Plot Style
CTC	Conformed to Contract
CUE	City Utilities Engineering
DD	Discipline Designator
DND	Do Not Disturb
DOC	Microsoft Word
DST	Sheet Set File
DWF	Design Web Format
DWG	AutoCAD Drawing
DWS	AutoCAD Drawing Standards File
DWT	AutoCAD/Civil 3D AutoCAD Drawing Template
GIS	Geographic Information System
GR	General Requirements
IN83-EF	Indiana State Plane, East Zone, US (Survey) Foot on NAD83 datum

JPG	Joint Photographic Experts Group Format
NAD83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NCS	National CAD Standard v.5.0
PDF	Adobe Acrobat Portable Document File Format
PNG	Portable Network Graphic Format
P&P	Plan and Profile
PSA	Professional Services Agreement
OSN	Order Sequence Number
RGB	Red, Green, and Blue
SSN	Subset Sheet Number
STB	Named Plot Style
TD	Sheet Type Designator
TXT	Text
UDS	Uniform Drawing System
XLS	Microsoft Excel
XML	Extensible Markup Language

CADD1.03 Definitions

ACAD Model Space — In Autodesk AutoCAD Model space, everything is drawn at a scale of one to one and may also be positioned on a specific coordinate system, such as a national mapping grid, in order to integrate accurately with other drawings.

ACAD Paper Space — The sheet file layout. A typical Paper Space layout will consist of a standardized title block containing information about the drawing; drawing number, date completed etc. This title block will be drawn to accurately fit on a standardized sheet of paper.

Bylayer — An object that will get its property from the value assigned for that property to the layer.

CADD Deliverables — The quantifiable CADD goods or services that will be provided during and upon the completion of a project.

CADD Electronic Data — Any original and any non-identical copies (whether non-identical because of notes made on copies or attached comments, annotations, marks, transmission notations, or highlighting of any kind), of mechanical, facsimile, electronic, magnetic, digital or other programs (whether private, commercial, or work-in-progress), programming notes or instructions, activity listings of electronic mail receipts or transmittals, output resulting from

	the use of any software program, including word processing documents, spreadsheets, database files, charts, graphs and outlines, electronic mail or "e-mail,", instant messenger messages, operating systems, source code of all types, programming languages, linkers and compilers, peripheral drives, PDF files, PRF files, batch files, ASCII files, crosswalks, code keys, pull down tables, logs, file layouts and any and all miscellaneous files or file fragments, regardless of the media on which they reside and regardless of whether said electronic data consists of an active file, deleted file or file fragment as it pertains to Computer Aided Design and Drafting.
CADD Electronic Drawings	CADD Drawings created with use of computer systems to assist in the creation, modification, analysis, or optimization of a design. The digital equivalent of a drawing, figure or schematic created using a CAD system.
CADD File	An electronic computer file, containing CADD data entities, which can be changed and manipulated by a CADD software program.
Conformed to Contract	Construction Drawings and Documents modified to incorporate changes made via Addendum during the bidding process. CTC documents are created after bids are accepted, but prior to issuing the Contractor's Notice to Proceed.
Construction Drawings	Referred to as working drawings. Drawings with keyed notes detailing the work required and types of materials to be used in constructing the improvements.
Discipline Designator	An alphanumeric character identifying the sheet as part of a discipline subset.
Drawing	Graphic and pictorial portions of the documents showing the design, location, and dimensions of the project, generally including plans, elevations, sections, details, schedules, and diagrams.
Drawing Area	The paper space drawing area of a sheet layout contains all graphics, notes, text, schedules etc. It is divided into modules with alphanumeric and numeric coordinates to aid in placing details and objects within sheets. The model space drawing area is the infinite area where items are drawn at a one to one scale.
Drawing File Organization	A standardized method which establishes guidelines for consistency in the creation and compilation of electronic files.
Drawing Set Organization	A standardized method for organizing information that is presented graphically.
Drawing Sheet Organization	A standardized method which establishes guidelines for consistency in the systematic presentation of drawings organized on sheets.

Dynamic Model A data model where parts of the model have a "live" link to other parts. When a change is made in one part, it propagates to other linked part(s). For example, if a manhole from a dynamic pipe network model is moved horizontally in plan view, the attached pipes will change angles, location and direction to remain attached to the manhole. The location will also be updated horizontally in any profile view which shows that same manhole.

Exploding/Editing Dimensions/Texts To create components that can be edited individually from a compound dimension or multi-line text.

File Naming The naming of a file with these five components: project work order number designator, discipline designator, model type designator, data object designator, sequence number and the file extension preceded by a period.

Fonts The typographic style property of text. Fonts may be drafting style (one line thickness) or typographic such as that being used in this document. Fonts are commonly managed by the operating system, not the CAD program and can be difficult to translate from one computer to another or one CAD program to another. Fonts can be set to text styles in CAD software.

Full Scale The 1:1 ratio of the linetype scale of the plot style corresponding to the linetype scale of the drawing (or model). Generally used when plotting a CADD drawing on the same paper size corresponding to the CADD layout size to which the drawing was created.

Guidelines Required. Part of the United States National CAD Standard.

Half Scale The 1:2 ratio of the linetype scale of the plot style corresponding to the linetype scale of the drawing (or model). Generally used when plotting a CADD drawing on a smaller paper size corresponding to the CADD layout size to which the drawing was created to allow for the linetypes and lineweights of the drawing to be presented correctly.

Hatching Area pattern fills. They can be made up of a solid pattern, a gradient (in later versions of AutoCAD) or more usually a specific pattern.

Identity Symbols Indicate individual objects and are generally used in mechanical and electrical drawings.

Layer A property of any drawing object. Usually objects are organized onto different layers for organizational purposes and ease of drawing, viewing and editing. Layers often can be named and can have default colors or other properties associated with them.

Level 1 Discipline Designator	One (1) alphanumeric character identifying the sheet as part of a discipline subset.
Library File	Files used as sources of information for more than one project. Examples are catalogs of detail, schedule, text, symbol, border and title block files.
Line Symbols	Indicate continuous objects and are either single or double lines. These symbols are scale independent.
Material Symbols	Graphically indicate certain materials and are used to help the reader differentiate one material from another. These symbols may be in elevation, vertical, or horizontal section and should be used as necessary but not overdone and used where a material begins and ends or changes direction.
Model File	Electronic DWG file that contains a whole or partial full-scale digital model and graphics of a building, site or work area. The paper space sheet layout is normally not used in a model file.
Nested	Electronic data (such as survey drawing, surface model, or pipe network) that are referenced into another file before being referenced into the construction drawing.
North arrow	A graphical symbol used to indicate the direction to the north.
Object Symbols	Resemble the actual objects being symbolized. These symbols are scale dependent.
Optional	Left to individual choice.
Order Number	A number to define the Sheet Type
Plot File	An electronic CTB computer file containing information necessary to print one drawing sheet formatted for output to a printing or plotting device no longer stored in its native CADD file format.
Plotting	Final touch on a drawing in preparation for on-screen display or hard copy printing from scale, layout and dimension, weight and color.
Production Data Area	The location where the sheet file saved path and name, including the file (DWG) extension. Print, date, title, and time shall be located on the lower left and upper left margin reading vertically.
Project Folder Structure Template	A pre-formatted folder that serves as the standard for the arrangement of files within the project folder.
Publishing	Prepares a sequential set of multiple drawings for hard copy or electronic plotting of the set.
Real-world	Referring to the scale to which the model is to be drawn. The dimensions of the model shall be the same as the actual dimensions as it was measured in the “Real-Time”.

Recommended	Not required, suggested method only.
Reference Symbols	Refer the reader to information in another area of the set of drawings or give basic information regarding the drawing or data on the drawing. These symbols are scale independent.
Required	Imposed as a condition or necessary for a specific purpose.
Route	A course, way, or road for passage or travel that needs improvement.
Shape Files	A shape file is a digital vector storage format for storing geometric location and associated attribute information. Shape files store the primitive geometric data types of points, lines, and polygons. File extension is .shp
Sheet File	A "ready-to-plot, DWG electronic file comprised of multiple referenced model files viewed in whole or part within a border and title block sheet. It may generally also include sheet-specific text, graphics and symbols within model or paper space.
Sheet Identification	The naming of a CAD drawing file that represents a certain sheet in the drawing set, although there are certain variations.
Sheet Order	The order of sheets shall follow NCS Guidelines. The first sheet shall be the Cover or Title Sheet and other sheets shall follow within their respective (discipline) subset.
Sheet Type Designator	One alphanumeric character identifying the type of information on the sheet.
Styles	Combination of properties that bring your drawing to give visual appeal.
Subset Sheet Number	Two numerical characters, starting with 01, designating the sheet number within the discipline subset. Sheets of the same discipline/design content shall be numbered sequentially with the characters 01, 02, etc. including as many drawings as required.
Supporting Data Files	Any computer file that holds data containing information relating to the project.
Templates	A pre-formatted file that serves as the standard for the arrangement of information within the file. A template may contain text styles, notes, dimension styles and other pre-formatted annotative objects specific to a standard outlined by the project owner.
Text Symbols	Graphically indicate a word or words that may be used in notations on drawings.
True North	Is the direction along the earth's surface towards the geographic north pole. True north is marked with a line terminating in a five-pointed star. The east and west edges of the USGS topographic quadrangle maps of the United States are

meridians of longitude, thus indicating true north (so they're not exactly parallel).

Uniform Drawing Systems (UDS) Interrelated modules consisting of standards, guidelines, and other tools for the organization and presentation of drawing information used for the planning, design, construction, and operation of facilities.

Unverified Data Structures or other features depicted that have not been surveyed, confirmed, substantiated, or proven to be true.

Book 6

CADD Standards (CADD)

CADD2 Introduction

CADD2.01 Purpose

This Chapter establishes the minimum standards for all Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE). These standards establish procedures and requirements for proper development, delivery and reuse of CADD electronic data and drawings. They ensure that end products are clear and applicable for their intended use for project design, approval, and construction.

These CADD Standards are not required, but are recommended for non-capital projects.

CADD2.02 Administration

1. CADD Standards Scope

   The CADD Standards shall be followed for the production and dissemination of electronic information and construction drawings. The United States National CAD Standard (NCS) will be utilized to supplement this document.

   CUE has adopted NCS Version 5 published in April 2011 except for Uniform Drawing System (UDS) Module 8.0: Code Conventions

   CADD deliverables prepared for CUE, including design and construction, shall comply with all adopted aspects of NCS Version 5. Information about the National CAD Standard Version 5 can be found at the following website: **http://www.nationalcadstandard.org/ncs5/**.

   These CADD Standards establish additional requirements for the organization and format of CADD drawings, specifications, and data.

   It is anticipated that some projects will not utilize all parts of the CADD Standards due to the size, scope and type of the project. However, the CADD Standards shall be applied on each CADD drawing, plan sheet, specification, etc… created; including all supporting data files used to produce a CUE project. Also, portions of the CADD Standards are labeled as “optional” or “recommended” and substantial conformance with the CADD Standards would not necessarily require use of these items.

2. Implementation

   CUE will provide, via electronic or web distribution, documents and tools to aid in the CADD Standards implementation.

   Concerns regarding the impact of the CADD standards on a particular project must be discussed with the project CUE Project Manager.

3. Software Information

   This standard does not target any specific CAD System or software. CUE is currently using Autodesk's AutoCAD Civil 3D software. Engineer shall verify the current software release with the project CUE Project Manager. Other software packages may be utilized for creating CADD drawings, CADD specifications, and data.

CADD2.03 Resources Available from CUE

Below is a list of CADD Standards-related files available for download (or as an integral part of another file).

No warranties are extended or granted, either expressed or implied, with respect to the accuracy and/or performance of any materials or resources provided.

1. Project Folder Structure Template

   Standard project folder template created to help develop and implement a standard electronic filing structure for efficient use and retrieval. See "Project (CADD) Folder Structure" **Exhibit CADD2-1**.

2. AutoCAD/Civil 3D Templates

   DWT templates which contain items and settings required within the CADD drawing (*.dwg) model files such as object styles, layers layouts, etc... It is recommended that all project drawings be created utilizing these templates.

3. CUE Civil 3D Pipes Catalog

   Pre-configured files, folders and drawing files for AutoCAD Civil 3D Part Catalog containing definitions for storm sewer, sanitary sewer, and other modelled pipe networks that can be inserted into a drawing.

4. CUE Civil 3D Corridor Assemblies

   Standard resource files with CUE customized subassembly parts to depict typical sections.

5. Standard Symbols

   Standard resource files containing commonly used symbols and blocks.

6. Plot Styles (Pen Settings)

   Settings within a CAD file which control how an object or layer is plotted by determining plotted properties such as lineweights, color, and fill style.

7. CADD Layers

   Components of CAD drawings used to organize, segregate and control the visibility of objects and to assign properties to objects in drawings.

8. DWS Standards Files

   Standard files with the .dws file extension used to check CADD standards such as layers, dimension styles, text styles, colors, etc… within certain versions or Autodesk AutoCAD-based software such as AutoCAD and Civil 3D.

9. Border and Title Block Sheets

   Standard DWG format templates developed for use when preparing sheet file drawings, including borders, title blocks, drawing settings, layouts, layers, etc...

10. Font and Shape Files

    Standard fonts and shapes utilized within drawings.

11. Line Type Files

    Standard files containing custom line types.

12. Minimum Electronic CADD Deliverables Checklist

    Refer to **Exhibit CADD3-1**.

Additional resources that may be available include existing CADD data from past projects. The data shall be used as a base reference only. Engineer is responsible for field verification of existing conditions and ensuring that all electronic deliverables are accurate and conform to the CADD Standards. In addition, it is recommended to research City documents including existing sanitary, stormwater, water, and transportation facilities data for existing mapping, record drawings, City and County (GIS), and other pertinent data for the project area.

CITY UTILITIES WATER THAT WORKS	**City Utilities Design Standards Manual**	Exhibit CADD2-1 Project (CADD) Folder Structure
		Version: November 14, 2016 Scale: N.T.S.

- XXXXX - Root Project CADD Folder
  - _Shortcuts
    - Alignments
    - PipeNetworks
    - Profiles
    - Surfaces
    - ViewframeGroups
  - Correspondences & Transmittals
    - AutoCAD files for Construction Stakeout
    - CAD from designer
    - Redlines - Markups
  - External References
    - DWF
    - DWG
      - Data Shortcuts Drawings
      - OLD VERSIONS
      - Title Border Drawings
    - Excel
    - Images
    - PDF
  - Misc Resource Files
    - GIS Working Data
    - Misc Images
  - Original Received Files
    - Existing Utility Maps
    - GIS Data
    - Survey
    - Survey Database
  - Pipe Network Catalog (External Firms)
  - Published Files
    - 30% Plots
    - 60% Plots
    - 95% Plots
    - 100% Plots
    - CTC Plots
    - Draft Record Drawings Plots
    - Final Record Drawings Plots
    - GIS Maps
  - Reports
  - Sheet Drawings
    - Old Versions
    - Plan Production
  - Sheet Sets
  - XML

Book 6

CADD Standards (CADD)

CADD3 Submittals

CADD3.01 Purpose

This Chapter provides minimum standards for the submittal and review of Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE) at any design stage.

Proper submittal and review standards ensure that electronic CADD files prepared for and submitted to CUE consist of all components, properties and formats necessary to create construction drawings as specified and intended. They also ensure that the CADD files reflect what is designed and/or what is constructed in the field.

CADD3.02 CADD File Submittal Requirements

Electronic files shall be submitted once the CADD requirements, as specified by the project Contract and Project Manager, are complete. Submitted files shall conform to all chapters and sections of the CADD Standards, including the project (CADD) folder structure described in **Exhibit CADD2-1** and **Exhibit CADD3-1** “Minimum Electronic CADD Deliverables”.

Optional: All project electronic files may be submitted to CUE at the 30% submittal phase for review of proper project setup and conformity to the CADD Standards.

1. Submittal methods

   Submittal of electronic project files is preferred via the City Utilities FTP site (**ftp://acfw-ftp1**). Instructions and credentials to access the FTP site will be provided per request. Other submittal methods may be used as approved.

2. File Format

   CADD drawing files shall be submitted in Autodesk Drawing (DWG) format. The required current CUE DWG version shall be verified with the CUE Project Manager prior to initiating CADD work.

   Unless authorized, electronic plot files shall be submitted in Adobe Acrobat Portable Document File format (PDF) and Autodesk Drawing Web File format (DWF).

3. Model File Drawing Scale and Units

   Drawings shall be created at full (1:1 in model space) scale. Distance units shall be set to decimal feet and angle type to decimal degrees. Insertion scale units shall be set to feet.

4. Autodesk/Civil 3D Software

   If using Autodesk Civil 3D, the drawings and data objects shall be submitted within the native Civil 3D (DWG) drawing format. Civil 3D data shortcuts shall be submitted within the "_Shortcuts" folder of the project folder structure.

   If using Autodesk software, a Sheet Set (DST) file shall be submitted.

5. Drawing File Components and Properties

   CADD drawing files shall include all project data and final versions of pertinent objects such as, but not limited to, points, linework, survey databases, data shortcuts, surfaces, 3D faces, alignments, profiles, utilities, benchmarks, images, and sheet layouts required to rebuild and modify the project.

   Drawing files shall be submitted as full files, uncompressed, unzipped, and free of any errors. They shall be purged of all unused items (e.g. blocks, layers, line types, nested items, etc.).

   A legend shall be included within the drawings submittal which shows and explains all symbols, patterns, blocks, line types, and other pertinent information.

6. Support Files

   Support files necessary for initializing, editing, and plotting drawing files shall be submitted for review. The support files shall be a standard component of Autodesk AutoCAD, Microsoft Windows, or an integral and standard component within the drawing file. Support files shall not require additional licensed software to be used. Support files include, but are not limited to, linetypes, hatch patterns, blocks, font styles, plot styles format (*.ctb), layer filters, display configurations, and object styles.

7. External References

   Externally referenced files necessary for the project shall be included within the submittal, use relative paths and be attached as overlays. Unnecessary or unused files shall be detached.

8. Photographs and Images

   Photographs and images taken or used on the project areas or part of the drawings shall be submitted during the CADD review process. Portable Network Graphic format (PNG) and Joint Photographic Experts Group format (JPG) are the only acceptable formats when using digital photographs and images as part of CUE projects.

9. Datum

   Drawings shall be submitted in Indiana State Plane coordinates with a minimum of two points of geodetic control for spatial reference, unless otherwise authorized by CUE. All controls and control witnesses used shall be referenced and shown in the CADD drawings.

The North American Datum of 1983 (NAD83) Indiana State Plane, East Zone, US (Survey) Foot (IN83-EF) grid coordinate system shall be used for horizontal control.

The North American Vertical Datum of 1988 (NAVD 88) shall be used for vertical control.

Any items or features which are spatially-referenced or referenced on other coordinate systems shall be translated to this same (NAD83/IN83-EF) grid coordinate system.

10. Model Drawings

    The following is a list of possible model files that may be required for review:

    - Base Drawings
    - Survey TOPO Drawings
    - Surfaces Drawings
    - Alignments Drawings
    - Pipe Networks Drawings
    - Profiles Drawings
    - Cross Sections
    - Corridor Drawings
    - Border and Title Block Drawings

11. Sheet Drawings

    The following is a list of possible sheet files that may be required for review:

    - Title Sheet
    - General Notes and Legend Sheets
    - Plan Sheet Index Sheets
    - Survey Control Sheets
    - Traffic Control Sheets
    - Pavement Marking and Signage
    - Demolition Sheets
    - Restoration Sheets
    - Plan Sheets
    - Plan and Profile Sheets
    - Cross Section Sheets
    - Erosion Control Sheets
    - Structure Data Sheets
    - Detail Sheets

12. Design Surveys

    Refer to design criteria included in **Chapter GR6 – Surveying**.

CADD3.03 Final Record Drawing Requirements

Final Record Drawings shall follow and conform to **Chapter GR10 – Final Record Drawings**, as well as, all requirements of the CADD Standards. Final Record Drawing CADD Files shall be created and submitted using all of the project CADD files and folder structure for the (final/conform to contract (CTC)) construction drawings with the following requirements.

1. Drawings without dynamic models
   A. All constructed Work shall be shown. Original Contract Drawings information shall under no circumstances be erased. Supplemental information collected during construction shall be added to the Final Record Drawings.
   B. Where constructed Work differs from the Contract Drawings, red lines shall be used to neatly cross out the Contract Drawings information, so that it is still legible, the recorded Work shall appear, in red color, adjacent to the crossed-out Contract Drawings information and a red cloud shall be placed around the recorded Work information.
   C. Where constructed Work matches Contract Drawings information, a red cloud shall be placed around the Contract Drawings information that has been verified to be correct as constructed.
2. Drawings with Dynamic Models (ex. 3D Pipe Networks)
   A. All constructed Work shall be shown. Supplemental information collected during construction shall be added to the Final Record Drawings.
   B. Where constructed work differs from the Contract Drawings and the constructed Work is, or will be, part of a dynamic model within the CADD drawings, the model shall be modified and updated per the marked-up set of Contract Drawings and/or Supplemental Drawings to reflect actual constructed Work. All graphics, labels, and information pertaining to the model shall be shown and updated. A red cloud shall be placed around the recorded Work information to show that it differs from the Contract Drawings information.
   C. Where constructed Work matches Contract Drawings information, a red cloud should be placed around the Contract Drawings information that has been verified to be correct as constructed.
3. Record Drawing Disclaimer
   A. Record Drawings shall have a disclaimer note on the Title Sheet with language similar to the following:

      FINAL RECORD DRAWINGS NOTE:

      THIS RECORD DRAWING HAS BEEN PREPARED FROM FIELD DATA COLLECTED DURING AND AFTER CONSTRUCTION AND/OR, IN PART, BASED UPON INFORMATION FURNISHED BY OTHERS. WHILE THIS

INFORMATION IS BELIEVED TO BE RELIABLE, CITY UTILITIES ENGINEERING AND CITY UTILITIES ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OF THIS RECORD DRAWING OR FOR ANY ERRORS OR OMISSIONS THAT MAY HAVE BEEN INCORPORATED INTO IT AS A RESULT OF INCORRECT INFORMATION PROVIDED. THOSE RELYING ON THIS RECORD DOCUMENT ARE ADVISED TO OBTAIN INDEPENDENT VERIFICATION OF ITS ACCURACY.

B. The disclaimer note shall have the Date and Prepared By fields completed and shall have the Project Engineer’s stamp and signature.

C. The Final Record Drawings shall have the “Final Record Drawings” phase stamp on every sheet within the Title Block Area of the sheet.

4. Submission of Final Record Drawing files

A. All electronic folders and files associated with Final Record Drawings, including updated CAD (DWG) files, shall be submitted to CUE conformant to CADD3.02 CADD File Submittal Requirements as well as, all requirements of the CADD Standards.

CADD3.04 CADD Files Submittal Review

CUE will review all CADD deliverables and other materials submitted. **Exhibit CADD 3-2** provides a checklist that can be used to ensure compliance. In addition to the manual review, Autodesk batch standards checker and other tools will be utilized by CUE to audit a drawing file for conformance to the CADD standards. Content not conforming to all pertinent aspects of the CADD standards shall be updated and resubmitted.

Project Name:	
Work Order Number:	

To be submitted to City Utilities Engineering by: ___________________________

☒ All electronic Project files on USB flash drive, cloud storage, FTP or as directed. Upload to the City's FTP site (**ftp://acfw-ftp1**) is preferred. The necessary credentials for FTP access are provided by CUE/City personnel.

☐ Two (2) sets of 24" x 36" (Full scale) hard-copy (printed) plans of the drawing(s).

☐ Two (2) sets of 12" x 18" (Half scale) hard-copy (printed) plans of the drawing(s).

☐ One (1) set of 24" x 36" (Full scale) drawings/plans in Autodesk .dwf format.

☒ One (1) set of 24" x 36" (Full scale) drawings/plans in Adobe Acrobat Portable Document File (PDF) format.

☒ Drawing(s) in Autodesk Drawing (*.dwg) format created in Model Space at Full (1:1) scale.

☐ Final, existing ground conditions 3D surface of surveyed area (ex. Triangulated Irregular Network (TIN)).

☐ Plan and Profile Sheets along the supplied survey or alignment route(s) at 1" = ___ ft. scale (Full scale). Survey or alignment routes shall be defined on a CUE-provided map. (Survey limits highlighted, outlined and/or labeled.)

☐ Cross Section Sheets along the supplied survey or alignment route(s) at 1" = ___ ft. scale (Full scale). Survey or alignment routes shall be defined on a CUE-provided map. (Survey limits highlighted, outlined and/or labeled.)

☒ A dated **LandXML** (.xml format) file including all final versions of pertinent Civil 3D data objects (points, surfaces, alignments, profiles, pipe networks, corridors, etc.…). A separate xml file for each type of data object or a single xml file containing all data objects may be submitted.

☐ Civil 3D Pipe Networks within a Civil 3D drawing file

☐ Latest CUE Civil 3D Pipe Network Catalog Used if Deliverables include Civil 3D Pipe Networks

☐ Latest CUE Pipe Networks Part List used

☐ Appropriate Pipe Networks Structure and Pipe Properties filled in

☐ Appropriate Pipe Networks Structure and Pipe label Styles used

☒ Latest CUE DWT Template used

☐ Additional Requirements

CUE requires the use of all design standards within the City Utilities Design Manual, including CADD Standards, as found at the following website: **utilities.cityoffortwayne.org/contractors-engineers-developers/design-standards-manual**

The following are excerpts and references to or from the CADD Standards. Shall any discrepancy occur, the requirements listed in the CADD Standards shall prevail.

City Utilities Engineering has several files which aid in the setup of CAD drawings/projects. A list and explanation of these files is included in CADD Standards, Chapter 2, CADD2.03 Resources Available from CUE. Please contact the CUE Project Manager to request the latest versions or visit the following website: **utilities.cityoffortwayne.org/contractors-engineers-developers/design-standards-manual**. For example, CUE-provided drawing (.dwt) templates are recommended which may contain some of the required title blocks, drawing settings, layouts, layers, styles, etc.…

Drawing settings shall be set to 1” = 20’ scale. All CAD drawings shall be submitted in the current CUE-used Autodesk Drawing (*.dwg) format. Drawings shall be created at full (1:1 in model space) scale. Distance units shall be set to decimal feet and angle type to decimal degrees. Insertion scale units shall be set to feet.

All submitted files and plans shall conform to General Requirements, Chapter 6 Surveying of the City Utilities Design Manual. Refer to the City’s project contact person and Surveying Scope Checklist for Design Surveys.

If using Autodesk Civil 3D, the drawings and data objects shall be submitted within the native Civil 3D (DWG) drawing format. Drawings which include data shortcuts of Civil 3D objects shall be submitted within the “…External References\DWG\Data Shortcut Drawings” folder of the project folder structure.

If using Autodesk software, a Sheet Set (DST) file shall be submitted. CADD drawing files shall include all project data and final versions of pertinent objects such as, but not limited to, points, linework, survey databases, data shortcuts, surfaces, 3D faces, alignments, profiles, utilities, benchmarks, images, and sheet layouts required to rebuild and modify the project.

Drawing files shall be submitted as full files, uncompressed, unzipped, and free of any errors. They shall be purged of all unused items (e.g. blocks, layers, line types, nested items, etc.). Include descriptions for all layers within dwg layers or Provide documentation in text (.txt), Microsoft Excel (.xls) or Microsoft Word (.doc) format which includes a list of all layers and layer descriptions. An electronic version of a legend shall be included within the drawings submittal which shows and explains all symbols, patterns, blocks, line types, and other pertinent information.

Support files necessary for initializing, editing, and plotting drawing files shall be submitted for review. The support files shall be a standard component of Autodesk AutoCAD, Microsoft Windows, or an integral and standard component within the drawing file. Support files shall not require additional licensed software to be used. Support files include, but are not limited to, linetypes, hatch patterns, blocks, font styles, plot styles format (*.ctb), layer filters, display configurations, and object styles.

All externally referenced files necessary for the project shall be included. Otherwise, they shall be detached. A report explaining the externally referenced files and their association to other files/drawings shall be submitted. All referenced files shall use relative paths.

Drawings shall be submitted in Indiana State Plane coordinates with a minimum of two points of geodetic control for spatial reference, unless otherwise authorized by CUE. All controls and control witnesses used shall be referenced and shown in the CADD drawings.

The North American Datum of 1983 (NAD83) Indiana State Plane, East Zone, US (Survey) Foot (IN83-EF) grid coordinate system shall be used for horizontal control.

The North American Vertical Datum of 1988 (NAVD88) shall be used for vertical control.

Any items or features which are spatially-referenced or referenced on other coordinate systems shall be translated to this same (NAD83/IN83-EF) grid coordinate system.

Drawings and/or plot files shall be set up so that when the drawings are plotted, existing surveyed items are plotted with lighter and/or thinner lines and proposed items are plotted with darker/bolder and thicker lines. This will ensure that there is a definite distinction between existing and proposed items. The preferred plot style convention is color dependent (.ctb).

All project files shall be placed and submitted within the CUE CADD Project Folder structure in their native format. A CUE CADD Project Folder structure template will be provided by CUE upon request.

The root folder of the CUE CADD Project Folder structure shall be named in the following format:

City of Fort Wayne Work Order Number – City of Fort Wayne Project Name

For example, "**83131 – Dwight Ave Drainage Improvements**"

The Source and External Reference/Model Files (DWG) shall be named per Chapter CADD4.04, Item 3A:

*For example, "**83131C – 3DPN01.dwg**"* (For a pipe network model file, where 3D = Isometric View, PN01= Pipe Networks Drawing 01)

*For example, "**83131C – GPAL01.dwg**"* (For an alignment model file, where GP = General Plan, AL = Alignment Drawing 01)

*For example, "**83131C – XPBS01.dwg**"* (For a baseplan model file, where XP = Existing Plan, BS = Base Drawing 01)

The Sheet files (DWG) shall be named per chapter CADD4.04, Item 3B:

*For example, **83131C–107–03.dwg*** (For the third (plan) sheet of the Civil subset).

The Published plot files (PDF and DWF) shall be named in the following format:

*For example, **83131 – 107-03.pdf*** (For an Adobe Acrobat design file for the third (plan) sheet of the Civil subset).

*For example, **83131C – Dwight Ave Storm Drainage Improvements (30%).pdf*** (For an Adobe Acrobat design file including the complete drawing set at the 30% phase).

*For example, **83131C – Dwight Ave Storm Drainage Improvements (60%).dwf*** (For an Autodesk Design Review design file including the complete drawing set at the 60% phase).

The work order number and official project name will be furnished by the City of Fort Wayne/City Utilities Engineering project contact person.

All submitted plan and plan and profile sheets shall use the standard CUE title block(s). Refer to CADD Standards Chapter CADD 4 Drawing Organization for requirements for the following items:

1. File Organization
2. Sheet Order
3. Sheet Assembly
4. Sheet File Identification
5. File Naming
6. Drawing Sheet Organization
7. Schedules

Electronic plot files (PDF and DWF) shall follow the same file naming convention of Sheet Files as mentioned in CADD Standards, Chapter CADD 4, Section 4.04, Sub-section 3, File Naming.

Refer to CADD Standards Chapter 5, Drafting Conventions for requirements for the following items:

1. Drawing File Scale
2. Presentation Graphics
3. Text
4. Dimensions Labels and Leaders
5. Precision
6. Notations
7. Sheet Requirements
8. Sheet Types
9. Civil Plans – Plan View Criteria/Requirements
10. Civil Plans – Profile View Criteria/Requirements
11. Miscellaneous – Civil Plans Criteria/Requirements
12. Electrical Plans Criteria/Requirements

City Utilities Engineering (CUE) compiled a list of common layer names and assignments within model and sheet files to follow for the creation of drawings. The CUE standard layer lists are provided in Exhibit CADD6-1 which will be supplied upon request. Refer to CADD Standards Chapter 6 *Layers* for requirements.

CUE has created and maintains a library of CADD resource files including commonly used symbols that are used for defining various features often found in a set of drawings. AutoCAD .dwg format files and a list of many of the required symbols may be obtained upon request. Refer to CADD Standards Chapter 7 *Symbols* for requirements.

All submitted files and plans shall use Standard CUE Drawings and Details. The Standard Drawings and Details are available in the following location in Adobe Acrobat Portable Document File (PDF) and Autodesk review design file (DWF) format. **utilities.cityoffortwayne.org/contractors-engineers-developers/design-standards-manual** Refer to Exhibit CADD8-1 or the Table of Contents on the website for a list of Standard Drawings and Standard Details available. The appropriate Standards Drawings and Details are to be used as part of the Project Documents related to the CUE project. Refer to CADD Standards Chapter 8, *Standard Drawings and Details* for requirements.

For questions, comments, requests for deviations from CADD Standards requirements and to coordinate submittals please contact:

City Project Manager
City of Fort Wayne, Indiana
Phone: 260-427-5066

Deliverables submitted to City Utilities Engineering on: ____________________

Project Name:	
Work Order #:	

Required	**Submitted**	
☐	☐	Two (2) sets of 24" x 36" (Full scale) hard-copy (printed) plans of the drawing(s).
☐	☐	Two (2) sets of 12" x 18" (Half scale) hard-copy (printed) plans of the drawing(s).
☐	☐	One (1) set of 24" x 36" (Full scale) drawings/plans in Autodesk DWF (Design Review) format.
☒	☐	One (1) set of 24" x 36" (Full scale) drawings/plans in Adobe Acrobat Portable Document File (PDF) format.
☐	☐	Final, existing ground conditions 3D surface of surveyed area (Ex. Triangulated Irregular Network (TIN)).
☐	☐	Plan and Profile Sheets along the supplied survey or alignment route(s) at 1" =__ft. scale (Full scale).
☐	☐	Cross Section Sheets along the supplied survey or alignment route(s) at 1" =__ft. scale (Full scale).
☒	☐	**LandXML** (.xml format) file(s) including all final versions of pertinent Civil 3D data objects (points, surfaces, alignments, profiles, pipe networks, corridors, etc.…).
☒	☐	Plans use Standard CADD1 Acronyms and Abbreviations
☒	☐	Plans use Standard CADD2 Introduction
☒	☐	Plans use Standard CADD3 Submittals
☐	☐	Insertion scale units set to feet.

Required	**Submitted**	
☒	☐	Project files are placed within the City Utilities Engineering (CUE) Project CADD) Folder Structure per Exhibit CADD2-1 of the CADD Standards.
☒	☐	All electronic files submitted as directed.
☒	☐	Drawing(s) in current Autodesk Drawing (*.DWG) format.
☐	☐	Drawings created In Model Space at Full (1:1) scale.
☒	☐	All CAD drawings submitted include all project files, data and final versions of pertinent objects (points, linework, databases, survey databases, data shortcuts, surfaces, 3D faces, alignments, profiles, utilities, images, sheet layouts, gradings, etc…) associated with drawing/project required to rebuild and/or modify the drawing(s)/project.
☐	☐	Autodesk Civil 3D drawings' data and/or objects are in the native internal Civil 3D format and structure.
☐	☐	Distance units are set to decimal Feet and Angle type decimal degrees.
☐	☐	Symbol & linetype legend included
☐	☐	North Arrow & Scale included
☐	☐	Pipe Networks submitted
☐	☐	Latest CUE Pipe Network Catalog used submitted
☐	☐	Latest CUE Pipe Networks Parts List used
☐	☐	CUE Pipe Networks Structure and Pipe Properties filled in
☐	☐	CUE Pipe Networks Structure and Pipe Label Styles used
☒	☐	Latest CUE DWT Template used
☐	☐	Pertinent notes included
☒	☐	Benchmark included

Required	Submitted	
☐	☐	Match-lines included
☐	☐	Sheet Set (DST) file submitted.
☒	☐	Drawings submitted in Indiana State Plane coordinates with a minimum of two points of geodetic control for spatial reference. All controls and control witnesses used referenced and shown in the CADD drawings.
☒	☐	The North American Datum of 1983 (NAD83) Indiana State Plane, East Zone, US (Survey) Foot (IN83-EF) grid coordinate system used for horizontal control.
☒	☐	The North American Vertical Datum of 1988 (NAVD 88) used for vertical control. Any spatially-referenced or referenced on other coordinate systems were translated to this same grid coordinate system.
☒	☐	Drawings and/or plot files are set up so that when the drawings are plotted, existing surveyed items are plotted with lighter and/or thinner lines and proposed items are plotted with darker/bolder and thicker lines. Definite distinction between existing and proposed items created. Color dependent (.CTB) plot style convention used.
☒	☐	All support files necessary for initializing, editing and plotting drawing files provided. They are a standard component of Autodesk® or Microsoft Windows ®; or they are an integral and standard component within the drawing file that requires no third party custom utility or program to utilize. Support files include, but are not limited to, linetypes, hatch patterns, blocks, font styles, plot styles (*.CTB or *.STB), layer filters, display configurations and object styles.
☒	☐	Drawing files are full files, uncompressed, and unzipped. All unused items (e.g. blocks, layers, line types, nested items, etc.) purged. Layer descriptions included within .dwg file or Documentation in text (.TXT), Microsoft Excel (.XLS) or Microsoft Word (.DOC) format which includes a list of all layers and layer descriptions provided.
☒	☐	Plans use Standard CADD4 Organization
☒	☐	Plans use Standard CADD5 Drafting Conventions

Required	Submitted	
☒	☐	All externally referenced files included in part of project; otherwise detached.
☒	☐	All referenced files use relative paths and Overlay insertion method.
☒	☐	Plans use Standard CADD6 Layers
☒	☐	Plans use Standard CADD7 Symbols
☒	☐	Plans use Standard CADD8 Standard Drawings and Details
☒	☐	Project Folder Structure root folder or the top-most folder named in the following format: *City of Fort Wayne Work Order Number – Official City of Fort Wayne Project Name* *For example, "**83131 – Dwight Ave Storm Drainage Improvements**"*
☒	☐	Source and External Reference/Model Files (DWG) per Chapter CADD4.04, Item 3A: *For example, "**83131C – 3DPN01.dwg**"* (For a pipe network model file, where 3D = Isometric View, PN01= Pipe Networks Drawing 01) *For example, **"83131C – GPAL01.dwg"*** (For an alignment model file, where GP = General Plan, AL = Alignment Drawing 01) *For example, **"83131C – XPBS01.dwg"*** (For a baseplan model file, where XP = Existing Plan, BS = Base Drawing 01)
☒	☐	Sheet files (DWG) per chapter CADD4.04, Item 3B: *For example, **83131C–107–03.dwg*** (For the third (plan) sheet of the Civil subset).
☐	☐	Report explaining the external reference files and their association to other files/drawings submitted.

☐ ☐ Published plot files (PDF and DWF) in the following format:

For example, ***83131C – 107-03.pdf*** (For an Adobe Acrobat design file for the third (plan) sheet of the Civil subset).

For example, ***83131C – Dwight Ave Storm Drainage Improvements (30%).pdf*** (For an Adobe Acrobat design file including the complete drawing set at the 30% phase).

For example, ***83131C – Dwight Ave Storm Drainage Improvements (60%).dwf*** (For an Autodesk Design Review design file including the complete drawing set at the 60% phase).

☐ Additional Requirements:

Deliverables Submittal Review Date: ______________________

☐ Deliverables Submittal Approved

☐ Deliverables Submittal Declined, please resubmit

☐ Additional Deliverables items necessary, please submit (see comments below)

Reviewed by: ______________________

Deliverables Submittal Comments:

Note: This CADD Deliverables review is only for adherence to CUE CADD Standards and not necessarily for topographical survey content or accuracy. Additional questions and/or comments may arise in the near future.

For questions and comments please contact Reviewer or:

City Project Manager
City of Fort Wayne, Indiana
Phone: 260-427-5066

Book 6

CADD Standards (CADD)

CADD4 Organization

CADD4.01 Purpose

This Chapter establishes the minimum standards for file, sheet, and drawing set organization as related to Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE).

Sheet and Drawing Set Organization requirements set by this Chapter build on and conform to the organization standards, tools and guidelines of the United States National CAD Standard (NCS) Version 5 (UDS modules 0.0, 1.0 and 2.0).

CADD4.02 File Organization

1. Default Origin

   The Autodesk AutoCAD (ACAD) origin of a 2D drawing file shall be 0,0 (corresponding to X,Y Cartesian coordinates). For 3D drawing files, it shall be 0,0,0 (corresponding to X,Y,Z Cartesian coordinates). However, the z-origin may be set to allow for elevations below zero.

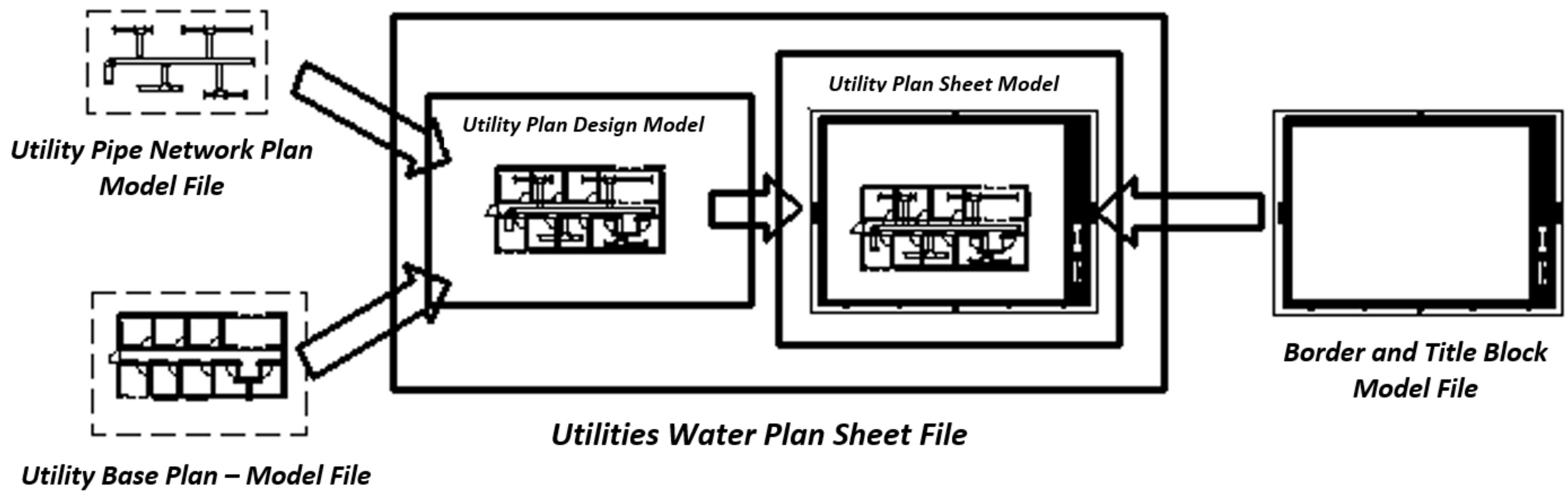
2. Model Files

   - Shall have graphics created at their “real-world” size in their “real-world” units and coordinates, unless otherwise authorized.
   - Shall not contain layouts (paper space) except for the ACAD default and may only contain drawing objects, symbols and text within the ACAD model space and not within ACAD paper space.
   - Shall always be referenced by other sheet or model files.

3. Sheet Files

   - Shall use the default origin for all reference model files.
   - Shall only contain one layout (paper space) per file and result in one sheet per drawing file.
   - Shall consist of different model files and data objects referenced into ACAD model space (i.e., via the ACAD external referencing method) to create a new “ready-to-plot” DWG file.
   - Shall contain the project border and title block model file in ACAD paper space.
   - May also contain sheet-specific drawing objects, symbols, and text within ACAD paper space.
   - Shall never be referenced by other sheet or model files.

Figure CADD4.1 How different model files are referenced in to create a sheet file



CADD4.03 Sheet Assembly

Sheet assembly consists of using a model file (ACAD model space) to reference in all other necessary model files, data object references necessary for the desired graphic display, and a sheet file (ACAD paper space) to reference the project border and title block model file. The sheet file also generally contains at least one viewport which references the objects and graphics within the model space and displays the desired portion at a standard scale. The result should be a "ready-to-plot" sheet file. Figure CADD4.1 illustrates the sheet assembly process.

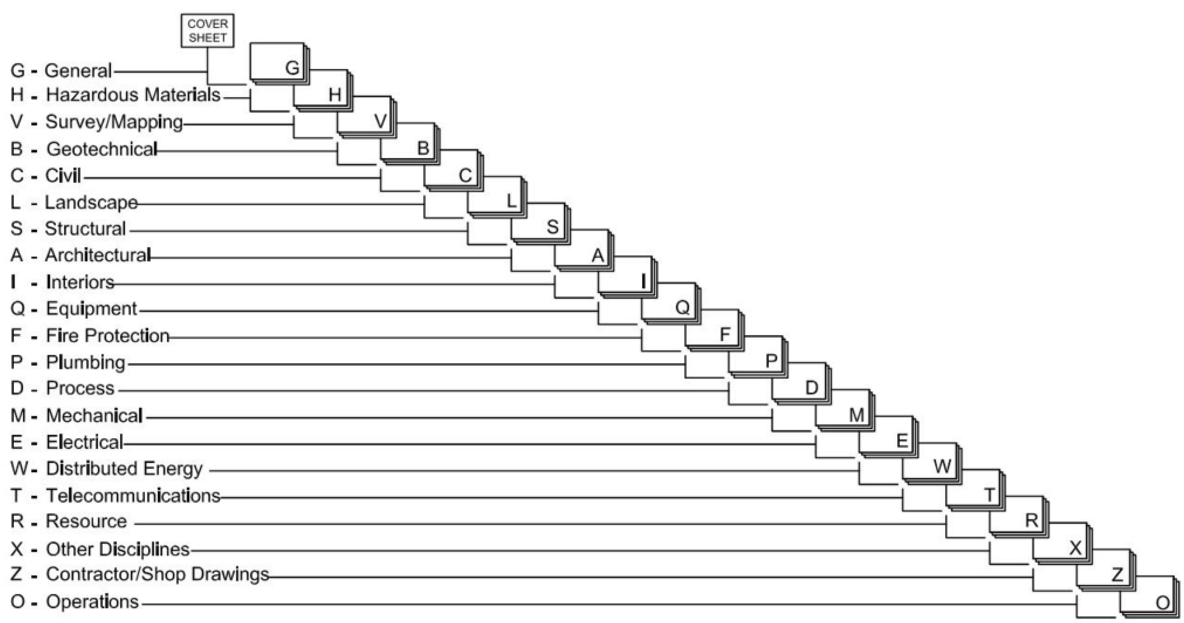
Nested referenced border and title block sheet model files are not allowed.

CADD4.04 Drawing Set Organization

1. Sheet Order

   The order of sheets shall follow NCS guidelines. Figure CADD4.2 shows the sheet order to follow to create a CUE project drawing set. The first sheet file shall be the Cover or Title Sheet and other sheets shall follow within their respective (discipline) subset as shown in the following figure. Some (discipline) subsets may not be used in certain projects due to scope and or the size of the project. In other cases, additional subsets not shown may have to be created.

Figure CADD4.2 Sheet Order



2. File Naming

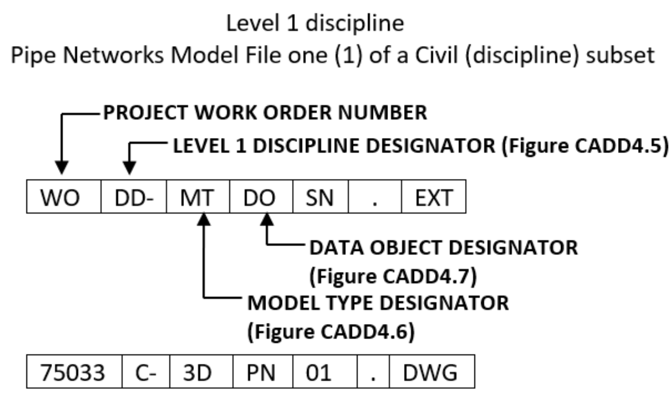
   A. Model file naming shall follow NCS guidelines except for detail files and consist of the following five required components:

      - Project Work Order Number Designator (WO): Five numeric characters designating the project work order number.

- Discipline Designator (DD): One (Level 1 discipline) alphabetical character identifying the (discipline) subset. Refer to Figure CADD4.5 for a list of DD.
- Model Type Designator (MT): Two alphabetical characters designating the type of model. A list of approved MT is shown as Figure CADD4.6.
- Data Object Designator (DO): Two alphanumeric characters designating the Data Object Type represented within the model file. See Figure CADD4.7 for a list of DO designators.
- Sequence Number (SN): Two numeric characters representing the model file sequence number. It shall numbered sequentially between 01 and 99.
- File extension preceded by a period

Figure CADD4.3 shows the application of WO, DD, MT, and DO for a Civil project model file naming syntax.

Figure CADD4.3 Model File Naming Syntax and Example



Example of a 3D Pipe Network Model File Naming

Figure CADD4.4 Model File Naming Examples

Model File	(WO) Varies	(DD) Varies	(MT) Constant	(DO) Constant	(SN) Varies	(EXT) Constant	Result
Base	#####	V-	XP	BS	01	.DWG	#####V-XPBS01.DWG
Topography	#####	V-	XP	TP	01	.DWG	#####V-XPTP01.DWG
Topography	#####	V-	XP	TP	02	.DWG	#####V-XPTP02.DWG
Surface	#####	C-	3D	SF	01	.DWG	#####C-3DSF01.DWG
Alignment	#####	C-	GP	AL	01	.DWG	#####C-GPAL01.DWG
Profiles	#####	C-	3D	PR	01	.DWG	#####C-3DPR01.DWG
Cross Section	#####	C-	3D	XS	01	.DWG	#####C-3DXS01.DWG
Pipe Network	#####	C-	3D	PN	01	.DWG	#####C-3DPN01.DWG
Corridor	#####	C-	3D	CR	01	.DWG	#####C-3DCR01.DWG
General Plan	#####	C-	GP	MS	01	.DWG	#####C-GPMS01.DWG
Schematic	#####	E-	DG	MS	01	.DWG	#####E-DGMS01.DWG
Power Plan	#####	E-	GP	PW	01	.DWG	#####E-GPPW01.DWG
One-Line	#####	E-	DG	PW	01	.DWG	#####E-DGPW01.DWG
Lighting Plan	#####	E-	GP	LT	01	.DWG	#####E-GPLT01.DWG
Equipment Plan	#####	E-	GP	QP	01	.DWG	#####E-GPQP01.DWG
Grounding Plan	#####	E-	GP	GR	01	.DWG	#####E-GPGR01.DWG

Figure CADD4.5 Common Level 1 Discipline Designators

Designator Level	Description of Suggested Names	Content
G	General	• Phasing, schedules, contractor staging areas, fencing, haul routes, temporary and special requirements • List of sheets and symbols, code summary, symbol & linetype legend, orientation maps • Photographs, soil borings
V	Survey/Mapping	• Aerial surveyed points and features • Computated points and features • Field surveyed points and features • Digitized points and features • Node points and features • Staked Points and features
C	Civil	• Structure removal and site clearing • Excavating, grading, drainage, erosion control • Pavers, flagstone, exterior tile, furnishings, retaining walls, and water features • Roads, driveways, parking lots • Plats, dimension control • Waterways, wharves, docks, trams, railways, people movers • Water, sanitary sewer, storm sewer, power, communications, fiber optic, telephone, cable television, natural gas, and steam systems • Symbol and Linetype Legend
E	Electrical	• Protection, termination, and removal • Controls, relays, instrumentation, and measurement devices • Utility tunnels, site lighting • Telephone, network, voice, and data cables • Alarms, nurse call, security, CCTV, PA, music, clock, and program
R	Resource	• Existing facility architectural drawings • Surveyor's information and existing civil drawings • Existing facility electrical drawings • Existing facility mechanical drawings • Real Estate Drawings • Existing facility structural drawings

Figure CADD4.6 Model File Type Designators

Model File Types (MT)	
FP	Floor Plan
DP	Demolition Plan
XP	Existing Plan
GP	General Plan
EL	Elevation
SC	Section
SH	Schedules
3D	Isometric/3D
DG	Diagrams

Figure CADD4.7 Data Object Designators

First Two Characters of Data Object Designators	
BS	Base Drawing
TP	Topography Drawing
SF	Surfaces Drawing
AL	Alignments Drawing
PN	Pipe Networks Drawing
PR	Profiles Drawing
XS	Cross Sections Drawing
CR	Corridors Drawing
PW	Power Drawing
LT	Lighting Drawing
QP	Equipment Drawing
MS	Miscellaneous Drawing

B. Sheet file naming shall be consistent with the format for the sheet identification as explained in Section CADD4.04, Item 3. The sheet identification should be preceded by the work order number and followed with a period and file type extension. Also refer to Figure CADD4.8 for an example of sheet file naming syntax.

Figure CADD4.8 Sheet File Naming Syntax Example

Syntax

WO	DD-	TD	ON	—	SSN	.	EXT

Detail sheet number one (1) of a Civil (discipline) subset.

12345	C-	5	01	—	01	.	DWG

Result: *12345C-501-01.DWG*

C. Published plot file naming shall be consistent with the format for the Sheet File naming as explained in Section CADD4.04, Item 2.B. For example: ***83131C-107-03.DWF*** (For an Autodesk Design Review file). Also refer to Figure CADD4.8 for an example of sheet file naming syntax.

In the case where all sheets for the entire project are published, the published plot files shall use the same name as the CADD 2.1 "Project Root Folder Structure" (Work Order Number – Official Project Name) with the percentage of submittal completion appended. For Example: ***83131 – Dwight Ave Drainage Improvements (95%).PDF*** (For an Adobe Portable Document File).

3. Sheet Identification

   Sheet identification shall follow the guidelines as shown in Figure CADD4.9.

Figure CADD4.9 Sheet Identification Syntax Examples

Level 1 Discipline
Detail sheet one (1) of a Civil discipline subset

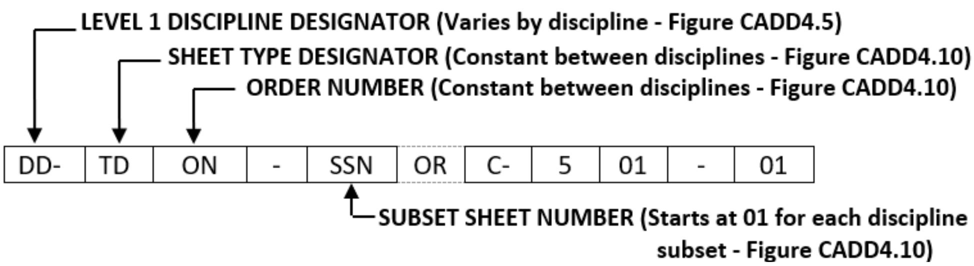


Figure CADD4.10 Sheet Identification Examples

Sheet	(DD)	(TD)	(ON)	(SSN)	Result
Title or Cover	G-	0	01	-01	G-001-01
General Notes	G-	0	02	-02	G-002-02
Layout Index	C-	1	01	-01	C-101-01
Survey Control	C-	1	02	-02	C-102-02
Erosion Control	C-	1	03	-03	C-103-03
Traffic Control	C-	1	04	-04	C-104-04
Demolition	C-	1	05	-05	C-105-05
Restoration	C-	1	06	-06	C-106-06
Plan	C-	1	07	-07	C-107-07
Plan and Profile	C-	1	08	-08	C-108-08
Pavement Markings and	C-	1	09	-09	C-109-09
Easements	C-	1	10	-10	C-110-10
Sections	C-	3	01	-11	C-301-11
Large Scale View	C-	4	01	-12	C-401-12
Details	C-	5	01	-13	C-501-13
Schedules and Diagrams	C-	6	01	-14	C-601-14
3D Representations	C-	9	01	-15	C-901-15
Power Plan	E-	1	07	-01	E-107-01
Lighting Plan	E-	1	07	-02	E-107-02
One-Line Diagram	E-	6	01	-03	E-601-03

Sheet identification shall follow NCS guidelines for Level 1 discipline designator and sheet type designator. Sheet identification shall consist of the following four required components:

- Discipline Designator (DD): One (Level 1 discipline) alphanumeric character identifying the sheet as part of a (discipline) subset. For a list of Level 1 Discipline Designators refer to Figure CADD4.5.
- Sheet Type Designator (TD): One alphanumeric character identifying the type of information on the sheet. Figure CADD4.10 shows a summary of TD.
- Order Number (ON): CUE projects drawings shall follow the plan sheet identification sequence presented on Figure CADD4.10.
- Subset Sheet Number (SSN): Two numerical characters, starting with 01, designating the sheet number within the (discipline) subset. Sheets of the same discipline/design content shall be numbered sequentially with the characters 01, 02, etc. including as many drawings as required.
- Figure CADD4.9 shows the application of DD, TD, ON and SSN for a Civil project sheet identification. Refer to Figure CADD4.11 for an example of a sheet index demonstrating the approved sheet identification plan sheet order sequence.

Figure CADD4.11 Sheet Index Example

SHEET INDEX			
NO.	**SHEET ID NO.**	**DESCRIPTION**	**REMARKS**
1	G-001-01	Title Sheet	
2	G-002-02	General Notes	
3	C-101-01	Layout Index	
4	C-102-02	Survey Control	
5	C-103-03	Erosion Control	
6	C-104-04	Traffic Control	
7	C-105-05	Demolition	
8	C-106-06	Restoration	
9	C-107-07	Plan - Water	Alignment A
10	C-108-08	Plan and Profile - Sanitary	Alignment A
11	C-108-09	Plan and Profile - Sanitary	Alignment B
12	C-108-10	Plan and Profile - Storm	Alignment A
13	C-108-11	Plan and Profile - Storm	Alignment B
14	C-109-12	Pavement Markings and Signage	
15	C-301-13	Cross Sections	
16	C-401-14	Large Scale Views	Valve Vault
17	C-501-15	Details	
18	C-501-16	Details	
19	C-601-17	Structure Data Schedules	
20	C-901-18	3D Representations	Lift Station Telemetry/Photos

Figure CADD4.12 Sheet Type Designators

Sheet Type Designators		
0	General	(Title Sheet, Symbols & legend, notes, etc.)
1	Plans	(horizontal views, plan and profile, closely associated schedules)
2	Elevations	(vertical views)
3	Sections	(sectional views, wall sections, civil cross sections)
4	Large-Scale Views	(plans, elevations, stair sections, or sections that are not details)
5	Details	(details)
6	Schedules and Diagrams	(schedules and diagrams)
7	User Defined	(for types that do not fall in other categories, including typical detail sheets)
8	User Defined	(for types that do not fall in other categories)
9	3D Representations	3D Representations, 3D Models

4. Layout Tab Naming

   Layouts within DWG drawings shall be named to show the intended sheet size followed by the type of sheet. All text shall be capitalized. For example: 24X36 TITLE, 24X36 PLAN, 24X36 P&P, 24X36 X-SECT, 8.5X11 EASE, 8.5X11 DET, ect...

5. Sheet Set Naming

   Sheetsets shall use the same naming convention as the CADD 2.1 “Project Root Folder Structure” (Work Order Number – Official Project Name). The sheetset file (AutoCAD sheetset file extension .dst) shall be located in the Sheet Set folder as outlined in CADD2.1 (See Exhibit CADD2-1).

   For Example: ***83131 – Dwight Ave Drainage Improvements.dst***

   Sheets within the sheetset as it is displayed in the Sheetset Manager shall be named in the following format: Sheet Number – Sheet Identification – Sheet Layout Name. For Example: ***1 – C-107 – 01 – 24 X 36 PLAN***.

CADD4.05 Drawing Sheet Organization

1. Sheet Sizes

   Typical architecture, engineering, and construction (A/E/C) projects shall be prepared on standard Architectural D size sheets unless otherwise authorized. Figure CADD4.13 shows a summary of standards sheet sizes and typical applications.

Figure CADD4.13 Standard Sheet Sizes and their Typical Uses

Sheet Sizes				
Architectural		ANSI		
Standard	Size (inches)	Standard	Size (inches)	Typical Uses
A	9 x 12	A	8.5 x 11	Project specification book, Details, Supplemental drawings.
B	12 x 18	B	11 x 17	Reduced drawings from "D" size and "A1" size originals. Supplemental drawings.
C	18 x 24	C	17 x 22	Small projects accommodating preferred plan scale.
D	24 x 36	D	22 x 34	Projects accommodating preferred plan scale. Government projects.
E	36 x 48	E	34 x 44	Large projects accommodating preferred plan scale. Mapping and GIS.
F	30 x 42	N/A	N/A	Alternate size for projects accommodating preferred plan scale.

2. Sheet Layout

   The main components of sheet layout that shall be used on all construction drawing sheets are drawing area, production data area, title block area, and border.

   Plan, detail, general, and cross section sheets shall include all the layout components including module lines.

   On plan and profile (P&P) sheets and cross section sheets module lines shall be turned off. P&P sheets shall be split between a plan view area on the top half and a profile view area on the bottom half of the drawing area. Cross section sheets shall only have section view area(s).

   All plan view areas shall include a plan viewport to show a plan view of the model file (model space) at the accommodating preferred scale.

   All profile view areas shall include a profile viewport to show a profile view of the model file (model space) at the accommodating preferred scale.

   The components and sheet layout requirements, including layers, text styles and sizes, border, modules, and other components are pre-built into CUE AutoCAD/Civil 3D AutoCAD drawing templates (DWT) and AutoCAD Drawing (DWG) templates. Refer to Figure CADD4.14 for a summary of construction drawing sheet layout components.

3. Drawing Area

   The drawing area shall contain all graphics, notes, text, schedules, etc... It shall be divided into modules with alphanumeric and numeric coordinates to aid in placing details and objects within sheets. Module lines and coordinates shall not be plotted.

The module column closest to the title block shall be used for notes (keynotes, general notes, etc.) beginning at the top of the column. When a key plan is used, it shall be located in the lowest module of the notes block.

4. Production Data Area

   The Production Data Area shall consist of the sheet file saved path and name, including the file (DWG) extension. Print, date, title, and time shall be located on the lower-left and upper-left margin reading vertically as included in CUE AutoCAD/Civil 3D DWT and DWG Templates.

5. Title Block Area

   The Title Block Area shall contain all items shown and shall be filled in completely with project and sheet specific information. Figure CADD4.15 shows the title block area components.

6. Standard Details and Drawings

   The components and sheet layout requirements for standard details and drawings (details), including layers, text styles and sizes, border, modules, and other components are pre-built into CUE AutoCAD/Civil 3D AutoCAD drawing templates (DWT) and AutoCAD Drawing (DWG) templates. In general, standard details and drawings (details) are not drawn to scale and should be denoted as N.T.S. within the CUE-provided Detail Title Block. All objects shall be placed in model space. All notes shall be located at the bottom of the page/detail drawing and be bottom-left justified. All text shall be capitalized. Fractions shall be diagonal; not horizontal. All fields of the sheet title block shall be populated appropriately.

CADD4.06 Schedules

Schedules summarize pertinent information for different civil project design elements. Schedules shall consist of at least a heading and a minimum of three columns of related information. The columns shall at a minimum be for the Mark, Item Description, and Distinguishable Feature. A Notes column may also be used. Typical schedules for civil project include structure data, approach tables, and erosion control summary tables. Additional requirements for schedules will be discussed in **Chapter CADD5 – Drafting Conventions**.

Schedules shall use consistent terms, abbreviations, and format throughout the project.

Schedules shall be placed on the same sheet as the subject matter, items or information that makes up the schedule. If the schedule is too big and there is not enough space on the sheet drawing area, it shall be placed on a separate sheet at the end of the corresponding (discipline) subset.

Data within schedules shall be linked between the drawing file and the data source. The data source file shall be saved within the project folder structure for archiving purposes. An example would be a schedule created from a Microsoft Excel spreadsheet.

Example Schedule templates will either be pre-built into CUE AutoCAD/Civil 3D DWT and DWG templates or supplied in electronic format by CUE.

Figure CADD4.14 Sheet Layout Components

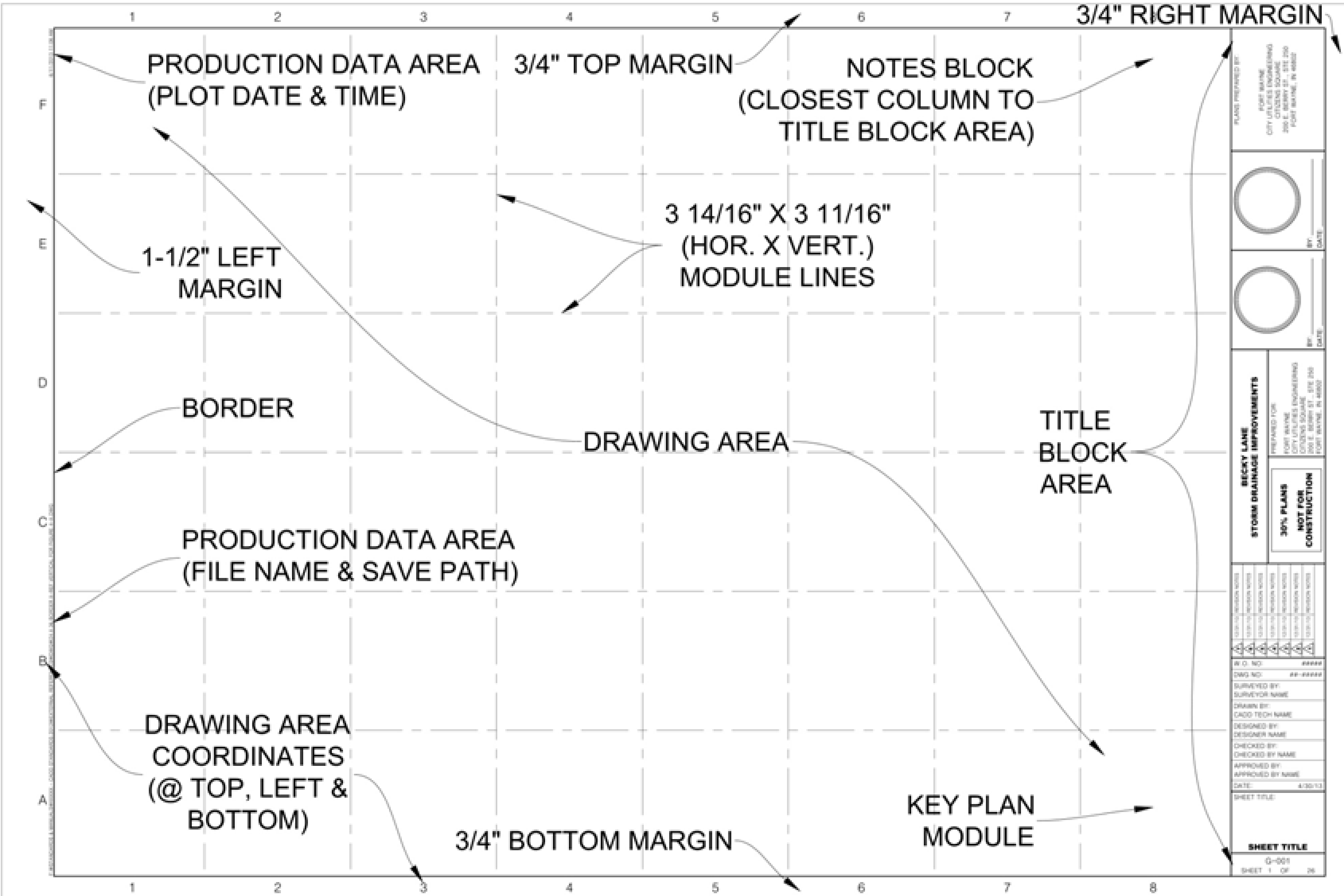
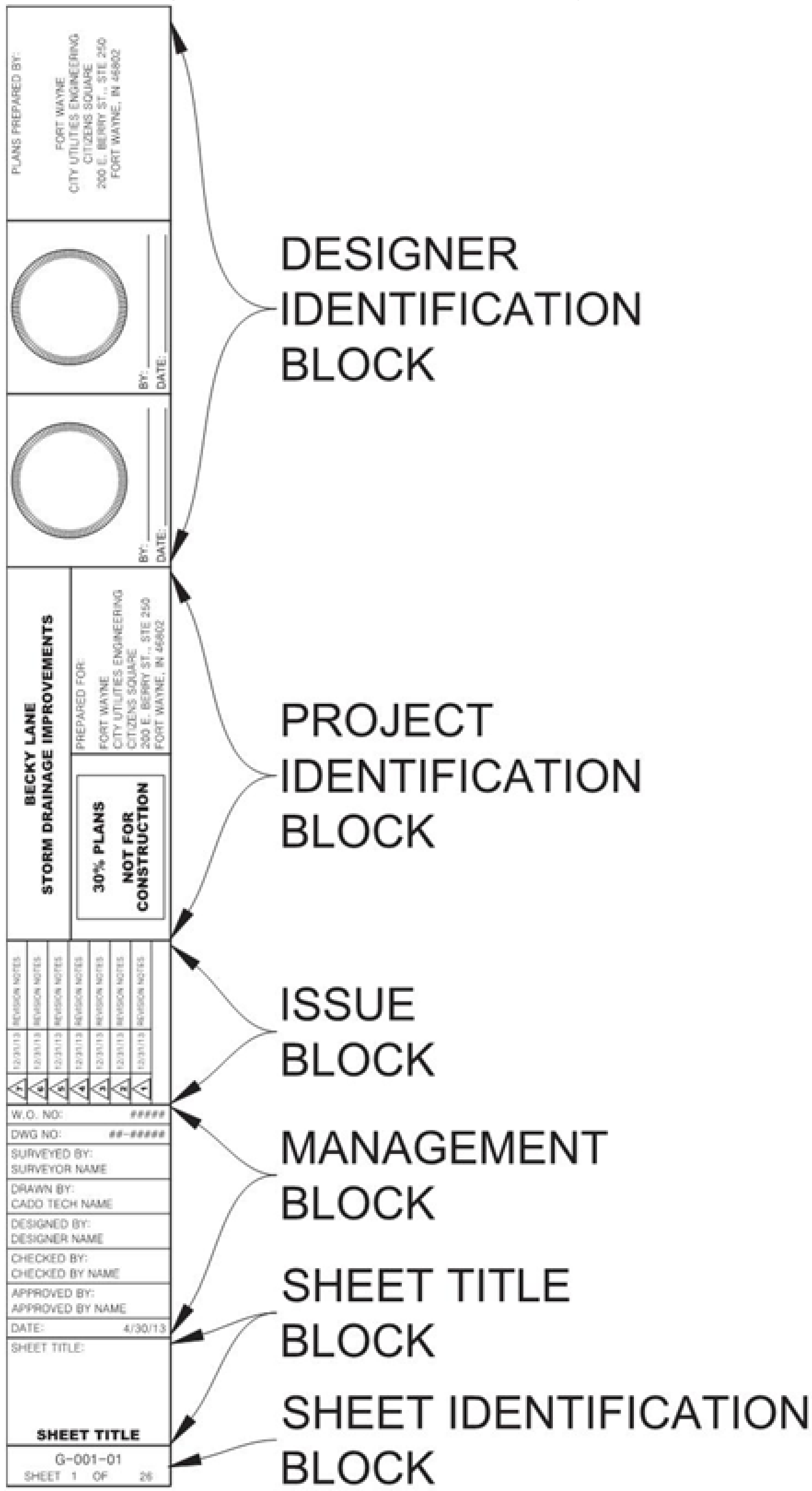


Figure CADD4.15 Title Block Area Components



Book 6

CADD Standards (CADD)

CADD5 Drafting Conventions

CADD5.01 Purpose

This Chapter establishes the minimum standards for drafting conventions as related to Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE).

Drafting conventions provide standard formats for graphics and text information, ensure visual consistency and provide ease of data reusability within CADD drawings. They build on and shall conform to the standards, tools, and guidelines of the NCS Version 5, UDS modules 4.0 and 7.0.

CADD5.02 General

CADD files shall be prepared in a neat, uniform manner. All lettering and lines shall be of an adequate weight and well-spaced in order to provide clarity and composition to the drawings. Information shall follow the CADD Standards and be presented in such a manner that it will be legible when the plans are viewed, scanned, reproduced, or reduced.

Consistent styles and standard lettering shall be used throughout any given sheet.

All general notations pertaining to proposed items shall be lettered in upper case; however, any lengthy sentence or phrase pertaining to proposed items may be lettered in upper and lower case. General notations pertaining to existing items shall be lettered in upper and lower (sentence) case where only the first letter is capitalized.

Generally, a noticeable and distinguishable difference between existing and proposed items shall be evident. For example, existing items shall be shown with “lighter”, thinner lines and proposed items shall be shown with “darker”, bolder lines.

Drawings shall be clear, concise and correct. Items on drawings shall be complementary to project specifications and information shall be shown on either the project specifications or drawings; not both. Specifications should address qualitative project requirements and drawings shall address quantitative project requirements. Duplications shall be avoided to eliminate redundancies and conflicts between drawings and specifications.

CADD5.03 Drawing File Scale

A consistent scale shall be used throughout projects. Figure CADD5.1 shows standard drawing scales and their typical uses.

All plan views within sheets shall include a graphic bar scale at the upper right corner of the view directly below the “north arrow”. Standard graphic bars are located in Chapter CADD7 – Symbols.

All profile views within sheets shall include a horizontal and vertical numeric (textual) scale at an appropriate location of the view noted as “Horizontal Scale:” and “Vertical Scale”, both followed by the view numeric scale. The preferred location is at the upper right corner of the profile drawing view. See Exhibit CADD5-7 for an example.

All cross section views within sheets shall include a horizontal and vertical numeric (textual) scale at an appropriate location of the view noted as “Horizontal Scale:” and “Vertical Scale:” both followed by the view numeric scale. The preferred location is at the center of the cross section view. See Exhibit CADD5-3 for an example.

All drawing views within sheets which are not to scale, shall include a numeric (textual) scale at an appropriate location of the view noted as “Scale: N.T.S.”. The preferred location is at the upper right corner of the view.

1. Model Files

   Graphics within Model Space in Model files shall be created at full 1:1 scale.

2. Sheet Files

   Views on Sheet files shall use the typical scales shown in Figure CADD5.1 unless otherwise specified. Generally, horizontal scale should be the same for plan view and profile view within plan and profile (P&P) sheets.

Figure CADD5.1 Typical Drawing Plot Scales

Drawing View Type	Typical Plot Scales	Scale Type
Plan Views	1” = 20’	Horizontal
Profile Views	1” = 20’	Horizontal
	1” = 5’	Vertical
Cross Sections Views	1” = 20’	Horizontal
	1” = 5’	Vertical
Site Plans and Maps	1”=20’ up to 1” =5000’	Horizontal
Interior Elevations	1/4” = 1’-0”	N/A
	1/8” = 1’-0”	N/A
Exterior Elevations	1/8” = 1’-0”	N/A
	3/32” = 1’-0”	N/A
Detail Views	Not to Scale	Horizontal
	Not to Scale	Vertical

CADD5.04 Presentation Graphics

1. Alignments and Stationing

   Alignment Stationing shall be located on the centerline of the pipe or project improvement route. It shall begin at 0+00 and increase in value as it approaches the end of the project improvement route. Negative stationing will not be accepted to define the alignment centerline. Alignments and Stationing shall begin at least ten (10) feet prior to the beginning of the project improvement route. One hundred foot stations and fifty foot tick marks shall be shown as part of the project drawings.

   A. Force Main and Gravity Sewer Drawings

      Project alignment and stationing shall begin at the downstream end and increase in value as it approaches the upstream end.

   B. Other Drawings

      Project alignment and stationing shall begin at the West or South end of the project improvement (route) and increase in value as it approaches the East or North end.

2. Orientation

   A. Model File Drawings

      Model File Drawings shall be oriented so that the entire project area and model is created in (Autodesk) model space and all other requirements of the CADD Standards are met.

   B. Sheet File Drawings

      Sheet File Drawings shall be oriented so that the entire project area is shown on one drawing view if possible. If not possible, standard match lines shall be used to designate which sheet or view the project continues on.

      Drawing views shall be oriented so that north is toward the top or the right of the sheet if practical. The most appropriate method which allows more of the project improvement (route) to be viewed shall be used.

      Drawing views shall be oriented so that the project improvement route is as parallel as possible with the edges of the sheet title block and centered within the view.

      The plan view generally should be shown on the same sheet as the profile view with the plan view located at the top of the sheet and the profile view at the bottom. The alignment stationing on the plan view shall line up horizontally with the profile view within the sheet when possible. Profile views shall be oriented so that alignment stationing begins at the left side of the sheet and stationing increases as it approaches the right of the sheet.

      A sample plan and profile sheet is available in **Exhibit CADD5-7**.

Cross-section views shall be shown with sections looking up station and placed on the sheet progressing from the bottom of the sheet for lower stations to the top of the sheet for higher stations and left to right if more than one column of cross-sections is presented.

A sample cross-section sheet is available in **Exhibit CADD5-3**.

C. Maps

Vicinity and location maps shall be oriented with north toward the top of the sheet.

3. North Arrow

The North Arrow (True North) shall be rotated to correspond to the drawing orientation within sheet file drawing views. It shall be located on the upper right corner of the drawing view it corresponds to.

4. Line Widths (Lineweights)

To visually improve readability and clarity, drawing objects shall be set to use line widths as specified in **Chapter CADD6 – Layers**. Figure CADD5.2 shows Line Width guidelines when creating new layers. Typically, Extra Fine or Fine line widths shall be used for existing items and proposed items shall be set to use thicker line widths. Object Line widths within CADD files shall be set to use “By Layer”.

Figure CADD5.2 Line Width Guidelines & Comparison

Line Width Name	Line Width (in.)	Line Width (mm.)	Typical Line Width Use
Extra Fine	0.005	0.13	Existing object lines, Minor Grid lines, Existing item labels and notes, Fine detail not achievable with Fine lines
Fine	0.007	0.18	Existing object lines, Hatching, patterning and material indicators
Thin	0.010	0.25	Existing object lines, Dimension lines, leaders, extension lines, break lines, grid lines, schedule minor grid lines, hidden objects, center lines, phantom lines and setback lines
Medium	0.014	0.35	Proposed object lines, text, property lines, terminator marks, schedule grid accent lines
Wide	0.020	0.50	Major object lines, cut lines, section cutting plane lines, property lines, drawing block borders, and titles
Extra Wide	0.028	0.70	Minor title underlining, footprints, match lines, schedule outlines, sheet borders, large titles, and object lines requiring special emphasis
XX Wide	0.040	1.00	Major title underlining and separating portions of drawings
XXX Wide	0.055	1.40	Border sheet outlines and cover sheet line work
XXXX Wide	0.079	2.0	Border sheet outlines and cover sheet line work

5. Line Types

   To improve readability and clarity, drawing objects shall be set to use line types specified in Chapter CADD6 – Layers. Proposed items shall be set to use the continuous linetype.

   Standard linetypes shall be found in CUE-provided (.LIN) linetype files and presented graphically in Chapter CADD7 – Symbols. All object linetypes within CADD drawing files shall be set to use “By Layer” linetype.

6. Object Colors

   Object colors shall be in accordance with those specified within CUE CADD Layers and NCS v.5.0 and shall be used to aid working with graphics and items on a computer screen. Yellow color shall not be used due to the fact it is difficult to see on a white sheet and items could be missed.

   When assigning colors, default AutoCAD screen colors and their corresponding Red, Green and Blue (RGB) values shall be used. It is recommended to use colors within Chapter CADD 6 – Layers for similar or related items.

   All object colors within CADD files shall be set to use “By Layer” color.

7. Plotting and Publishing

   Drawing files shall use CUE-provided plot styles, standard (sheet) paper sizes, margins, and plot settings. Plot area shall consist of the sheet file layout (Autodesk paper space) and be plotted at 1” = 1’ scale.

   Plotting and publishing shall be independent of color for plotted line widths and follow line widths designated within each object’s CADD layer.

   CUE AutoCAD/Civil 3D DWG and DWT templates have pre-defined page setups, paper sizes, plot offsets and listed plot styles. Engineer shall verify all settings to ensure proper plotting, publishing and file output.

   Color and/or black and white, DWF and PDF plot files shall be created for each design and review phase as instructed.

   - Color plotting and Publishing shall use the CUE-provided plot style files for color plots. The colors used shall be default AutoCAD screen colors.
   - Black and White plotting and Publishing shall use a revised version of NCS v.5.0 Black/White/Gray Plotting Guidelines and the CUE-provided plot style file. The colors used shall be those shown on Figure CADD5.3 Black, White, Gray Plotting and Publishing Guidelines with the exception of Screened colors. Due to the difficulty in scanning, screened colors which result in Gray plotted color shall not be used unless absolutely necessary and authorized.

Figure CADD5.3 Black, White, Gray Plotting and Publishing Guidelines

Color Number			Plotted Color	Plotted RGB Values			Screening	
NCS	AutoCAD	MicroStation		Red	Green	Blue	Percent	Output
1-249	1-249	1-249	Black	0	0	0	100	
250	250	250	Gray	102	102	102	60	
251	251	251	Gray	128	128	128	50	
252	252	252	Gray	153	153	153	40	
253	253	253	Gray	179	179	179	30	
254	254	254	Gray	204	204	204	20	
255	255	255	Background (White)	N/A	N/A	N/A	0	

8. Hatching (Patterning)

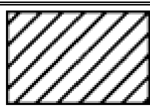
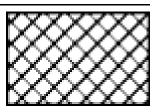
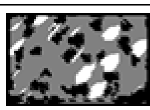
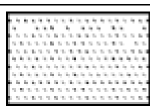
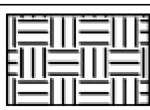
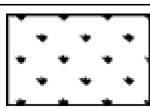
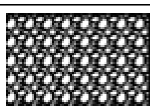
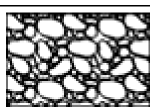
   Hatching may be used to draw attention to or designate a material to design areas in plan, section or detail within a CADD drawing, but, because hatching greatly increases file size and the potential for file corruption, hatching shall be used to a minimum. Existing materials in plan view shall be labeled and not hatched.

The hatching used for materials shall be those designated within Chapter CADD7 – Symbols. Figure CADD5.4 shows examples of typical hatch patterns and their typical uses.

The colors, line weights and line types for hatching shall be those designated within Chapter CADD6 – Layers and Chapter CADD7 – Symbols.

Hatching used shall be shown and described in the project legend.

Figure CADD5.4 Typical Material Hatch Patterns

Hatch Pattern	Autodesk	Typical Scale	Typical Use or Designation
	ANSI31	20	Removal
	ANSI37	20	Resurfacing, Others
	AR-CONC	0.75	Concrete Material
	DOTS	20	Pavement Material
	EARTH	20	Earth Compacted Material
	GRASS	5	Grass/Seeding Material
	GRAVEL	3	Gravel/Stone Material
	RIPRAP	10	Riprap Material

CADD5.05 Text

1. Styles, Fonts and Shape Files

   All text fonts and shape files shall be a standard component of Autodesk AutoCAD or Microsoft Windows. Use of non-standard fonts is prohibited. With the exception of the Romans.shx font, only TrueType fonts shall be used.

   Figure CADD5.5 shows standard text styles and fonts for use on Construction Drawings. Figure CADD5.6 shows standard text styles and fonts for use on Standard Detail Drawings.

Figure CADD5.5 Construction Drawings Standard Text Styles, Fonts and Typical Uses

CUE Text Style	Font Name	Font Type	Typical Example Uses	Remarks
Arial	Arial	TrueType	Proposed item labels and notes	7/64” plotted text height typical
Arial Black	Arial Black	**TrueType**	Bold text such as sheet and project titles	---
Dotum	Dotum	TrueType	Existing item labels, sheet title block area and property annotation, dimensions	3/32” plotted text height typical
Romans	Romans.shx	Shape	Text within linetypes for existing utilities	Not searchable in PDF and DWF plots such as TrueType fonts
Slanted	Dotum	*TrueType*	Text for property information (ex. Addresses & Owners)	21.8 deg. Oblique Angle Slant

Figure CADD5.6 Detail Drawings Standard Text Styles, Fonts and Typical Uses

CUE Text Style	Font Name	Font Type Example	Typical Example Uses	Remarks
Arial – Paper Space	Arial	TrueType	Standard Drawings and Details’ Paper Space text	3/32” plotted text height
Arial – Model Space	Arial	TrueType	Standard Drawings and Details’ Model Space text	3/32” (annotative) plotted text height
TNR – Small Titles	Times New Roman	TrueType	Standard Drawings and Details’ Paper Space Title text	5/32” plotted text height
TNR – Large Titles	Times New Roman	TrueType	Standard Drawings and Details’ Paper Space Title text	3/16” plotted text height

2. Text height

   The minimum plotted height for any text on full-size, Arch D sheets shall be 3/32 inches (2.4 millimeters).

   Text height and width shall be assigned equal values. Line spacing shall be equal to one half of the text height. Figure CADD5.7 shows the required or associated plotted text height for typical sheets, views and objects.

   Text style and height requirements for the Title Block Area, Title Sheet, dimensions, are pre-defined within the CUE AutoCAD/Civil 3D DWG and DWT Templates.

Figure CADD5.7 Required/Associated Plotted Text Heights

Sheet, View or Object Type	Text Type	Required Plotted Text Heights (Full-Size Arch D Sheet Plots)	
		(in.)	(mm.)
General Notes or Plan Sheet	Notations (ex. General and Key notes)	7/64	2.8
Varies	Existing Item Notes, Labels and Dimensions	3/32	2.4
	Titles (ex. Map views, Details)	3/16	4.8
	Proposed Item Notes, Labels and Dimensions	7/64	2.8
Plan View	Street and Alley Names	3/16	4.8
	Addresses, Property Owners and Property Identification	7/64	2.8
Title Block	Issue Block	3/32	2.4
	Designer Identification Block, Project Identification Block, Management Block, Sheet Title Block, Sheet numbers, Drawing Area Coordinate	1/8	3.2
	Project Title, Sheet Title, Sheet Identification, Production Data Area	5/32	4
Schedules	Schedule Titles	1/4	6.4
	Schedule Headers	3/16	4.8
	Schedule Data	7/64	2.8
Title Sheet Drawing Area	Project Name	3/4	19.1
	FW CUE Identification, Resolution Number	1/2	12.7
	Mayor Text, Department Names,	1/4	6.4
	Staff Titles & Names	3/16	4.8
	Project Location Leader, Location Map Titles, Scale Text, City Map Numbers	1/8	3.2
Large-Scale Maps	Street Names	3/32	2.4

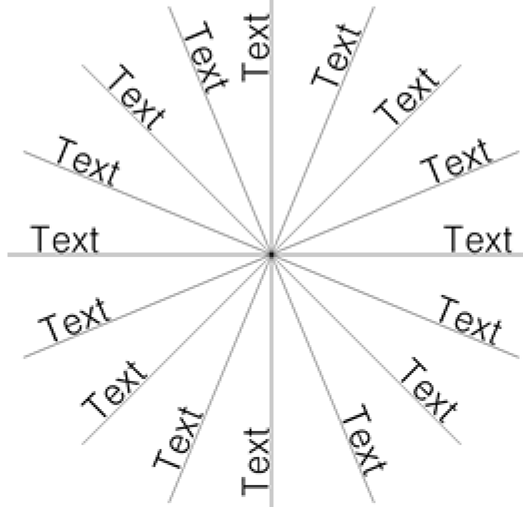
3. Text Placement

Every attempt shall be taken to avoid placing text on top of other text, lines or hatching. When placed within a patterned or hatched area, the hatching shall go around the text.

Appropriate text justification for text shall be used. For example, if text is placed to the right of an item it labels or refers to, the text shall have center left justification. If text is placed to the left of an item it labels or refers to, the text shall have center right justification.

Text shall be placed so that it is always read from the bottom or right of the sheet. When text is placed at an angle due to the angle of a feature, the Typical Text Placement Guide shown in Figure CADD5.8 should be used.

Figure CADD5.8 Typical Text Placement Guide



CADD5.06 Dimensions

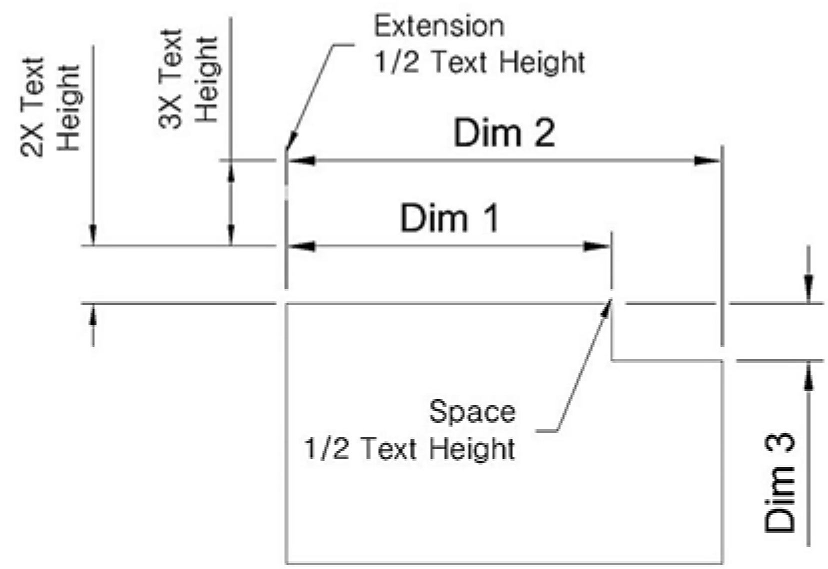
Exploding dimensions or manually editing/overriding the dimension text is strongly discouraged except for the following: where software limitations prevent users from providing the appropriate dimensioning, where the dimension is intended to be an approximation and is notated as such, or where a dimension is displayed as a mathematical formula. Refer to Figure CADD5.9 for an example utilizing the correct dimension placement procedures.

1. Dimension Lines
    - Shall be placed to minimize clutter, overlapping or crossing with other dimension lines, text or graphics. When a dimension line must cross another dimension line, one of the lines shall be broken or gapped.
    - Shall be created on the appropriate CUE CADD Layer.
    - Shall have closed, filled arrows as terminators that consists of a 3:1 length to width ratio. The length for the arrows shall be equal to the dimension text height.
    - Shall have extension lines offset from the origin (object being dimensioned) 1/16”
    - Shall be offset from object lines a minimum of 9/16”
    - Shall be offset from other dimension lines 3/8”

- Shall be dimensioned to the outside edge of objects such as structures and buildings.
- Shall be dimensioned to the centerline of objects such as posts and columns
- Shall be placed where dimensions of smaller components of the object are closer and the overall dimension of the object is the farthest away.
- Are available as pre-defined styles within CUE AutoCAD/Civil 3D DWG and DWT Templates.

2. Dimension Text
   - Shall use a diagonal bar for textual fractions.
   - Shall have a zero in front of the decimal point for decimal fractions.
   - Shall be in feet and inches for architectural dimensions.
   - Shall be located at the midpoint and on top of the dimension line whenever possible. If not possible, it shall be located to the side.
   - Shall never be placed within and break the dimension line.
   - Shall be created on the appropriate CUE CADD Layer.
   - Is available as pre-defined styles within CUE AutoCAD/Civil 3D DWG and DWT Templates.

Figure CADD5.9 Dimension Example

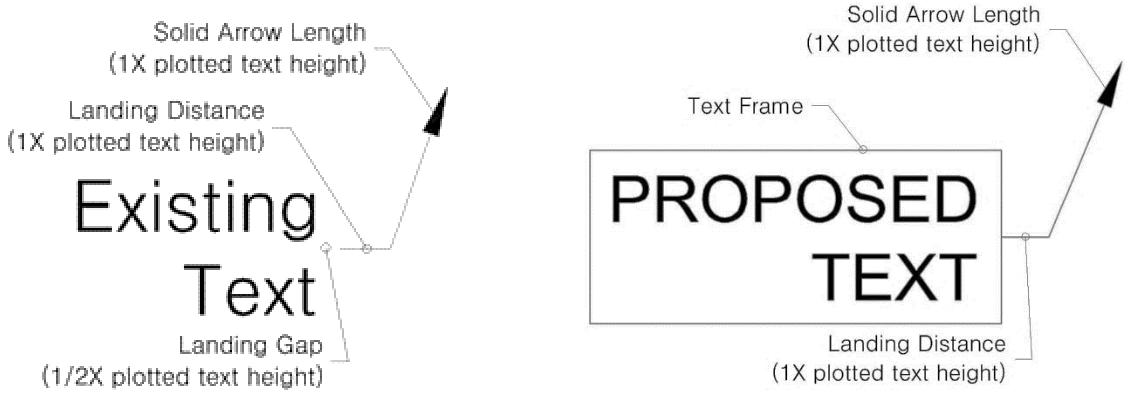


CADD5.07 Labels and Leaders

All labels and leaders shall follow the text height and style requirements set in Section CADD5.05. Labels may have straight leaders as needed for clarity purposes. Figure CADD5.10 shows examples of labels with leaders for existing and proposed items.

1. All Leaders shall have:
   - Landing Gap equal to one half of the plotted text height
   - Landing distance equal to the plotted text height
   - Solid filled arrows with length equal to the plotted text height
2. Labels with leaders for proposed items shall have:
   - A text frame with spacing between the frame and text equal to one half of the plotted text height
   - Background masking

Figure CADD5.10 Existing and Proposed Item Labels with Leaders



CADD5.08 Drafting Precision

Fractions should not be less than 1/16” unless accuracy in the field requires more precision. Decimal fractions shall always have a zero before the decimal point (ex. 0.125) and include a symbol or text to denote units. Generally, architectural construction distances are shown in feet and inches (ex. 184’-6”); civil construction distances, such as those set by surveying equipment, shall be shown in decimals to the nearest hundredths (ex. 184.50’).

Elevations shall be recorded to the nearest hundredths (ex. ELEV. 800.34’).

Coordinates shall be rounded to the nearest ten-thousandth (ex. N= 2119866.6370, E= 477039.5160).

CADD5.09 Notations

Notations in drawings identify features, work, design discipline and indicate information required to properly construct the project to meet design specifications. Drawing notes shall match the terminology in the Master Specifications.

Notations (Notes) shall:

- Be as brief as possible; especially in tables or schedules.
- Be clear, correct, and concise.
- Use generic terms for products, materials, and components.
- Minimize the use of abbreviations.

- Use consistent terms between specifications and drawings.
- Avoid repetition on a sheet.
- Eliminate broad references to the specifications (ex. “per specs”).
- Use a plotted text height minimum of 3/32”
- Use paragraph spacing distance minimum of 3/32” or equal to note text height

Notes are categorized in five different types of notes:

- General Notes,
- General Discipline notes,
- General Sheet Notes, and
- Sheet Keynotes or Legend.

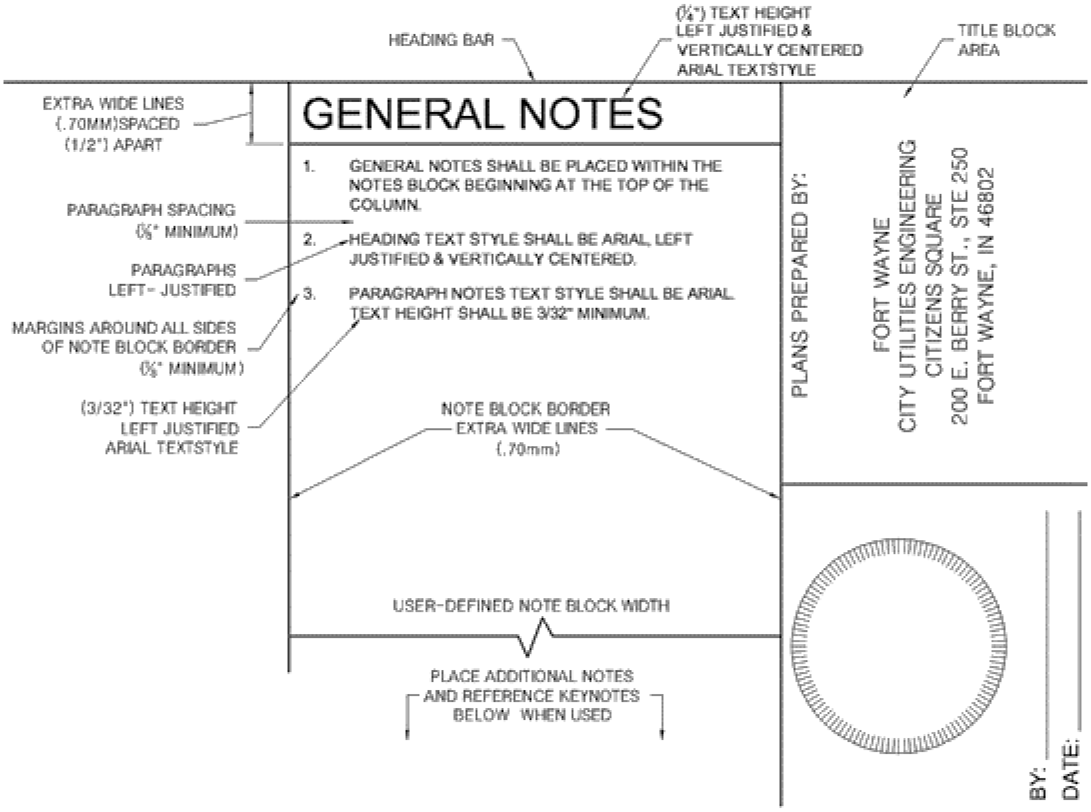
General notes, general discipline notes, and general sheet notes do not directly correspond to a graphic representation and are not directly "linked" by symbol (or other identifier) to other drawings or specifications.

Notes shall be placed within the Notes Block beginning at the top of the column. Additional notes shall be placed below the previous notes. When a notes column reaches the bottom of the sheet drawing area, additional notes shall be placed beginning at the top and left of the previous notes column as described in **Chapter CADD4 – Organization** and follow the notes hierarchy in the order listed below and as shown in Figure CADD5.11 and Figure CADD5.12. If a certain type of notes is not used, shift up the notes types that would normally follow underneath.

1. General Notes

   General notes shall be located within the G-series, General Drawings sheet types and shall be shown on the first plan sheet (not Title Sheet), if space permits, or General Notes sheet, if necessary. General Notes shall apply to the entire construction drawings and shall not be repeated anywhere else. Whenever general notes are used, they shall be shown with a 1/4” heading of “GENERAL NOTES”. All notes under the heading shall be numbered sequentially beginning at one (1) and follow the typical layout shown in Figure CADD5.11.

Figure CADD5.11 General Notes Typical Layout



2. General Discipline Notes

   General discipline notes shall be located on the 0-Series sheets of a particular discipline, only apply to the sheets of that discipline and shall not be repeated anywhere else on the construction drawings. Whenever general discipline notes are used, they shall follow the same typical layout as General Notes and shall be shown with a 1/4” heading of “GENERAL (Insert Discipline) NOTES”.

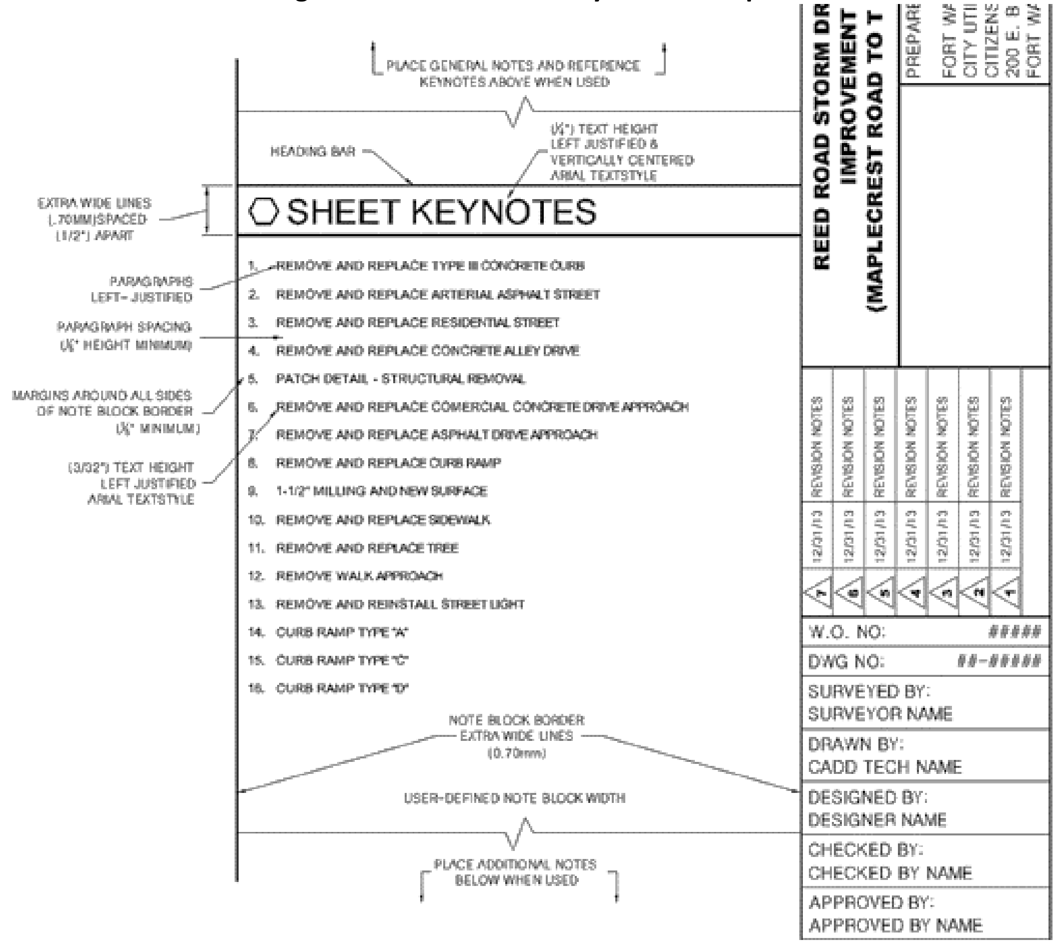
3. General Sheet Notes

   General sheet notes shall be located only on the specific sheets they apply to. Whenever general sheet notes are used, they shall follow the same typical layout as General Notes and shall be shown with a 1/4” heading of “GENERAL SHEET NOTES”.

4. Sheet Keynotes

   Sheet keynotes are drawn with a hexagonal symbol containing a number or letter with leader(s) from the hexagon to the identified item and are listed in sequential order within the notes block. Whenever Sheet keynotes are used, they shall be shown with a 1/4” heading of a hexagonal symbol and “SHEET KEYNOTES” Sheet keynotes shall follow the typical layout shown in Figure CADD5.12.

Figure CADD5.12 Sheet Keynotes Example



CADD5.10 Symbols

Symbols shall be used as graphic representations of items or materials by association, resemblance, or convention in accordance with Chapter CADD7 – Symbols.

CADD5.11 Title Sheet Requirements

1. Title Sheet

   A title sheet shall accompany all plan sets, unless otherwise approved. The Title Sheet shall include all components and requirements of the plan sheet layout, as specified in Chapter CADD4 – Organization except for the module lines and drawing area coordinates. In addition, the Title Sheet shall include other components and information within the drawing area unique to the project.

   A project location map and standard north arrow shall be placed within the pre-built viewport at the accommodating preferred scale so that at least two major arterial or collector streets are shown (referenced from model space) near the project location area; preferably intersecting each other. Generally, in addition to annotation, hatching and symbols, only right-of-way lines are shown to represent streets.

A vicinity map showing the approximate project location shall be placed to the right of the project location map at the accommodating preferred scale or be labeled N.T.S (not to scale). The vicinity map shall show major arterial or collector street centerlines with street labels and be oriented with north toward the top of the sheet.

On projects with a small amount of sheets (less than 10), a sheet index schedule may be placed, centered to the right of the project location map viewport and below the vicinity map. On larger projects, the sheet index schedule should go on a separate sheet such as the sheet (layout) index sheet or general notes sheet.

The additional components and title sheet layout requirements, including layers, text styles and sizes, utility oversight board, CUE project staff names, etc., are pre-built into CUE AutoCAD/Civil 3D DWT and DWG templates. Refer to **Exhibit CADD5-1** for an example of a Title sheet.

CADD5.12 Sheet Types

Sheet types shall consist of scaled views and non-scaled views. Scaled views shall be plans, elevations, sections, large-scale plans, and details. Non-scaled views shall be diagrams, 3D representations, details and schedules.

Each sheet type shall include the subject matter and minimum information designated below within each sheet type requirement section. However, on small projects, different subject matter or information may be combined on the same sheet. For example, a sheet layout index and general notes may be shown on the same sheet.

In instances where subject matter or information is combined, each separate subject matter or information shall be clearly labeled.

Figure CADD5.13 (also refer to **Chapter CADD4 – Organization**, Figure CADD4.7 Sheet Type Designator) shows the different types of sheets and typical uses for each.

Figure CADD5.13 Sheet Types, Designators and Typical Uses

Sheet Type Designator	Sheet Type	Sheet Type Typical Use
0	**General**	(Title Sheet, symbols & legend, notes, etc.)
1	**Plans**	(horizontal (plan) views, plan and profile, closely associated
2	**Elevations**	(Vertical views)
3	**Sections**	(sectional views, wall sections, civil cross sections)
4	**Large-Scale Views**	(plans, elevations, stair sections, or sections that are not details)
5	**Details**	(Vertical, Horizontal, Isometric, 3D details)
6	**Schedules and Diagrams**	(Schedules and Diagrams)
7	**User Defined**	(for types that do not fall in other categories, including typical detail sheets)
8	**User Defined**	(for types that do not fall in other categories)
9	**3D Representations**	(3D Representations)

The following shall be used for minimum information necessary for each sheet type.

1. Sheet Type 0 - General

   General sheets shall provide general information that applies to the entire project as well as to each discipline. These sheets shall be placed following the title sheet and at the beginning of each discipline subset. Title, General notes, general (discipline) notes, sheet list index and plan sheet layout sheets shall be considered Type 0 - General sheets. Refer to **Exhibit CADD5-1** and **Exhibit CADD5-2** for examples of general sheet types.

2. Sheet Type 1 - Plans

   Plans shall consist of, but not be limited to, Civil, Landscape, Structural, Architectural, Interior, Fire Protection and Plumbing, Mechanical and Electrical plans.

   A. Civil Plans

      Civil Plans shall include, but not be limited to, demolition, site improvement, dimension (survey) control, grading, paving, traffic, restoration, plan and profile, erosion control, and site utilities plans. Smaller design projects may require a combination of sheet types described as part of the civil plans criteria Section CADD5.15. See Section CADD5.13 thru Section CADD5.15.

3. Sheet Type 2 - Elevations

   Elevations sheets shall provide a vertical view from a side of a structure. Each elevation is labeled in relation to the direction it faces, so the 'north elevation' of a structure is the side that most closely faces north. Elevation sheets are part of architectural building drawings.

4. Sheet Type 3 – Sections

   A sample cross-section sheet is provided as **Exhibit CADD5-3**. When cross sections are required, the information to be shown shall include, but not be limited to, the following:

   - Existing and proposed water mains, storm and sanitary structures, within the influence of the proposed construction.
   - Property lines, easement lines, and/or right-of-way lines.
   - Half-sections shown to provide driveway profiles affected by change in final topography.
   - Existing gas lines, telephone conduit, fences, poles, etc. within the influence of the proposed construction.
   - Cross-sections shall be submitted for all proposed ditch projects as well as projects including roadway or alley construction.
   - Cross-sections shall be provided every 50 foot station along the proposed construction centerline or baseline or as specified by CUE.

5. Sheet Type 4 – Large-Scale Views

   Large-scale views are drawings reproduced at a larger scale to provide more detailed information that cannot be accommodated at the smaller-scaled drawing. Sometimes, a large-scale view can be accommodated and shown within the same sheet that the enlarged area is located on. If this cannot be accomplished, then a type 4 sheet may be created.

   Examples of large-scale views are pump or lift stations, floor plans or areas of civil plans where the amount of detail needed, requires a larger view.

   Areas to be shown at a larger scale shall have a dashed line placed around the area to be enlarged. The information shall only be shown in one of the views, the large-scaled view or standard scale view. Figure CADD5-14 shows an example of a large-scale view.

Figure CADD5.14 Large-Scale View Example

6. Sheet Type 5 – Details

   Details sheets shall utilize CUE standard drawings and details as listed in [Chapter CADD8 – Standard Drawings].

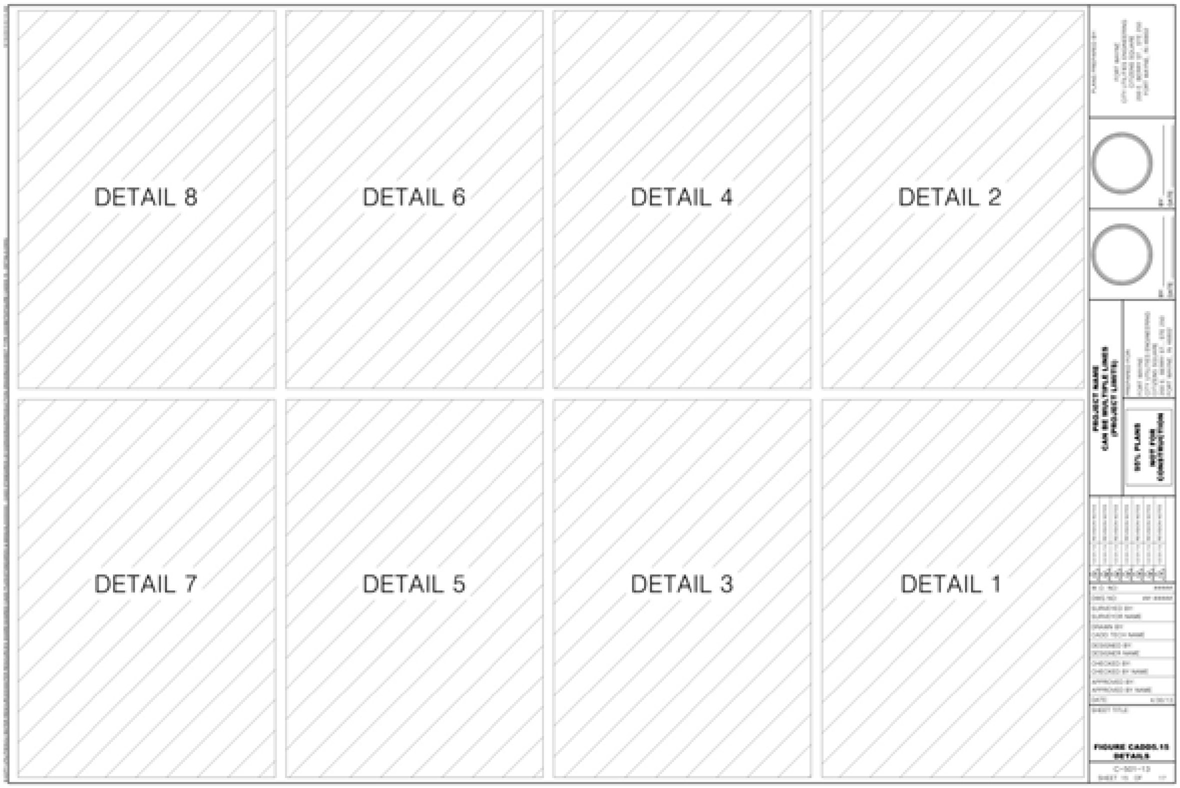
   Standard Drawings shall be placed within the drawing area utilizing the drawing area modules specified in [Chapter CADD4 – Organization], Section CADD4.05 Drawing Sheet Organization. The first standard drawing and detail shall be placed on the lowest, right-most available module; usually being next to the title block area. The placement of standard drawings shall follow the procedure and order shown in Figure CADD5.15.

   All standard drawings placed in the sheet drawing area shall have identifying elements such as a drawing (block) title, drawing area coordinate identifying number and a scale.

   Standard drawings utilized which are not drawn to scale, shall be inserted at an appropriate scale to maintain readability and attempt to maintain the minimum text height requirements. Standard drawings which are not drawn to a standard scale shall be noted with the words “Scale: N.T.S.”. If drawn to a standard scale, they shall be inserted to plot at the corresponding scale. Refer to **Exhibit CADD5-4** for an example of a Detail Sheet.

Refer to **Section CADD8.02 – General** for additional requirements.

Figure CADD5.15 Standard Drawings Identification Example



7. Sheet Type 6 – Schedules and Diagrams

   Schedules shall follow the organization requirements specified in **Section CADD4.06 – Organization Schedules**. Schedules on Sheet Type 6 shall use linetypes, layers, text styles and text height requirements set in the respective sections of the CADD Standards. Margins around text shall equal half of the text height used within schedules.

   When a particular schedule or a group of schedules encompass the majority of a sheet or is the only type of graphic information on the sheet, the sheet shall be designated as Type 6.

   Examples of project schedules are Structure Data Schedules, Alignment Line and Curve Data Schedules, Earthwork Summary Volume Schedules and Approach Quantity Schedules. Refer to **Exhibit CADD5-5** for a sample Structure Data Schedule.

8. Sheet Type 7 & 8 – User Defined

   These sheets allow the user to accommodate sheet types that do not fall under any of the listed sheet types.

9. Sheet Type 9 – 3D Representations

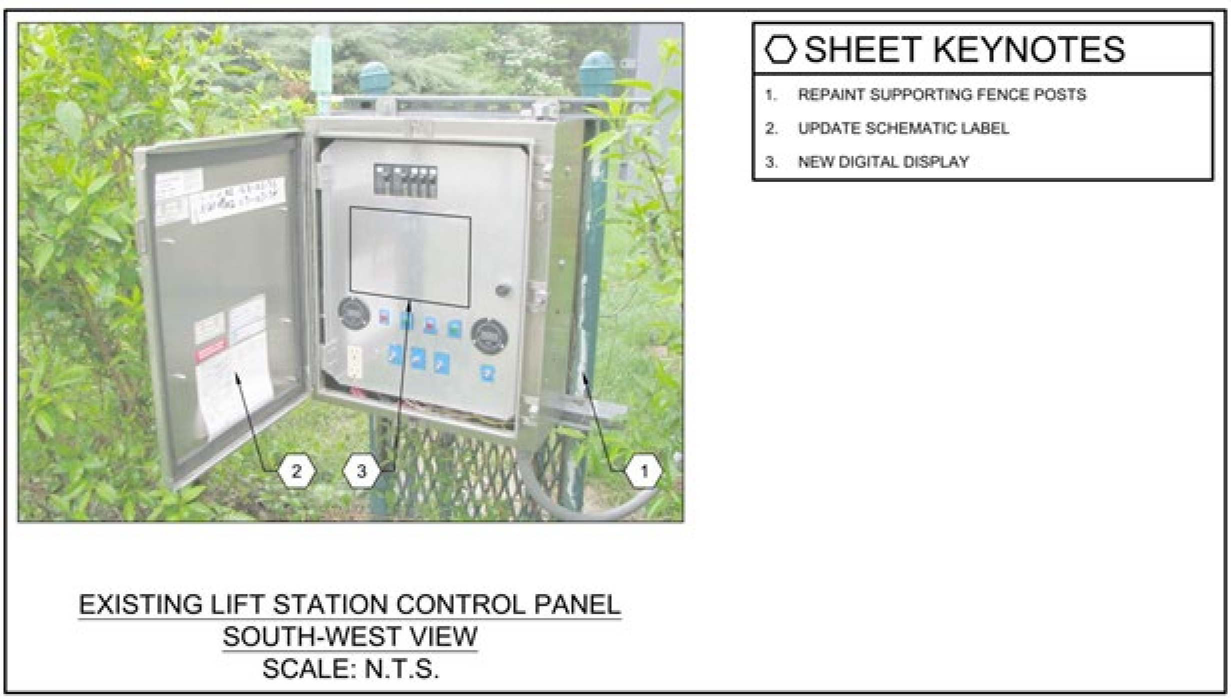
   Sheet Type 9 consists of isometric, diametric, trimetric, oblique views of drawings, perspectives, and photographs. These types of drawings and documents can be used to aid in showing different sides, angles and aspects of the desired design.

   When 3D representations are used, a title, scale and direction of view must be noted. If the 3D representation is not to scale, it shall be noted with the words “Scale: N.T.S.”.

   Digital pictures created from photographs may be inserted into computer programs and used as a background overlaid with the new Work. Figure CADD5.16 shows an example of a photograph used to depict proposed work.

   A cross-reference symbol shall be shown on the plans, sections or elevations when utilizing photographs to denote where and at what angle the photograph was taken.

Figure CADD5.16 Photograph Example



CADD5.13 Civil Plans – Plan View Criteria/Requirements

A sample plan view is provided in **Exhibit CADD5-6**. The information which appears on the plan view shall include, but is not limited to, the following:

1. The size, location, and direction of flow for all existing pipes, culverts and appurtenances shall be labeled.
2. The size, location, direction of flow and description for all proposed infrastructure with appropriate stations shall be labeled.
3. Field references to control points in the plan view.
    A. Permanent horizontal and vertical control shall be accurately plotted and labeled on the plans.
    B. A description and location of each control points including its station and offset relative to the proposed lines shall be also given.
    C. References to project control point descriptions shall be shown on its own separate survey control plan. Refer to Section CADD5.15, item 1 for survey control plan requirements.
4. Delta or deflection angles for proposed alignments with the bearing direction and northing and easting coordinates, if applicable. All angles shall be shown to the nearest second. This information may also be shown in separate Alignment Line and Curve Data schedules.
5. The location of the centerline for the proposed improvements shall be referenced by dimensions to the nearest easement lines, right-of-way lines or property lines and to the nearest control points.
6. Mailboxes, houses, fences and drives for a minimum of 50 feet beyond the right-of-way or to the fronts of the houses for proposed lines located within the right-of-way. Topographic features to the extent that they may be pertinent to the improvement location or construction.
7. Trees with a designation of type, diameter at Breast-height and drip line limits.
8. Property lines, lot lines, easement lines and other boundary lines to a minimum of 50 feet beyond any right-of-way. In instances where additional information might be required, the limit shall be extended.
9. Generally, only the outside lines of a pipe on the plans. However, a thin centerline shall be shown within these outside lines where any of the following conditions exist:
    A. A distance is shown from a point or line to the centerline of the pipe.
    B. The delta or deflection angle is shown.
10. The toe of slope, center and top of bank lines for ditches and channels. The width of the paved ditch area, where a paved ditch exists.
11. Structure Inventory Program Identification Number (as supplied by CUE).
12. The Deed Book, Page Number and dimensions shall be shown for existing Sewer or Drainage Easements which are impacted by construction.
13. Easements and right-of-way, property line dimensions when adjacent to the proposed improvements.

14. Street right-of-way widths adjacent to and after the street name. For example: “COLDWATER ROAD 50' R/W” (if uniform width) or “COLDWATER ROAD (R/W VARIES)” (when dimension of the width is not uniform).
15. When existing topography within the proposed improvements route of construction are to remain in place, a note depicting the appropriate action, such as “Protect”, “Do Not Remove” or “Do Not Disturb”, shall be used and included as part of the sheet legend.
16. Street number and property owner name(s) for all private and commercial parcels within the building footprint and drawn parallel to the street(s).
17. The soil boring locations shall be shown in plan view. Northing and Easting coordinates for soil borings shall be shown in schedules as applicable.
18. The following note shall be placed on the General Notes sheet and the first plan sheet to notify the Contractor of the procedure required for the location of utilities prior to construction:

    “NOTE - CAUTION EXISTING UTILITIES:

    THE INFORMATION SHOWN ON THESE DRAWINGS CONCERNING TYPE AND LOCATION OF UNDERGROUND UTILITIES IS NOT GUARANTEED TO BE ACCURATE OR ALL-INCLUSIVE. LOCATION, SIZE AND MATERIAL SHOWN ON UTILITIES ARE FROM AVAILABLE RECORDS AND AVAILABLE FIELD MARKINGS, SUPPLIED BY THE RESPECTIVE UTILITY COMPANY. THE INDIANA UNDERGROUND PLANT PROTECTION SERVICE (IUPPS) INDIANA811 MUST BE NOTIFIED IN ACCORDANCE TO THEIR REQUIRED PROCESS (MINIMUM OF 48 HOURS NOTICE) PRIOR TO ANY EXCAVATION FOR VERIFICATION OF LOCATION, SIZE AND MATERIAL FOR EXISTING UNDERGROUND UTILITIES (1-800-382-5544 OR 811). THE CONTRACTOR SHALL PROMPTLY NOTIFY THE ENGINEER IN WRITING IF ANY UNDERGROUND STRUCTURE OR UTILITY DIFFERS MATERIALLY FROM THE CONDITIONS SHOWN ON THE PLANS AS TO IMPACT THE WORK.”
19. Grading Plans

    The grading plans shall include the following information:

    A. Site grading with controlling grades to assure proper drainage. Critical spot elevations must be positioned relative to a survey control point, structure, or road baseline.
    B. Limits of grading work.
    C. Sizes of new drainage facilities with controlling grades.
    D. Modified contours for the new design.
    E. Ensure positive drainage to structures and other discharge points.
    F. Spot elevations at corners and points adjacent to building entrances.

CADD5.14 Civil Plans – Profile View Criteria/Requirements

A sample profile view to be included on all plan and profile sheets is depicted in Exhibit CADD5-7. The information to appear in the profile view shall include, but not be limited to, the following:

1. The grid shall be set up on a 1” = X’ basis for the Horizontal scale as well as the Vertical Scale. Unless approved otherwise, the Horizontal scale shall match the Horizontal scale of the corresponding plan view.
2. The limits, by station, for all concrete caps, cradles and encasements, tunnels and bored segments.
3. When the proposed line improvement crosses a right-of-way, delineate the limits of the right-of-way and label the width.
4. The type of backfill material under the roadway pavement and its limits.
5. The pipe length, size, material, grade, and ASTM or AASHTO designation and pipe classification shall be indicated between all structures. This information shall be parallel to and labeled above or below smaller pipes. However, on pipes of sufficient diameter, this information shall be placed inside and at the center of the pipe segment. Grades shall be shown as a percent. Information for existing pipes shall be shown in sentence case text. Information for Proposed pipes shall be shown in capital letters. (i.e. “128 L.F. OF 12” SDR35 PVC @ 0.50 %.”)
6. Invert elevations shall be placed at the following locations:
   A. All breaks in the grade.
   B. Breaks necessary for profile continuation onto another sheet.
   C. All pipes entering and exiting proposed structures.
   D. Other conduits critical to the pipe gradient.
   E. Pipe intersections.
   F. All locations necessary to substantiate the profile grade.
   G. Both pipe invert edges when there is a drop or slant inlet.
   H. Other conditions shown on the typical drawings.
   I. Each catch basin or surface inlet connection.
7. Proposed manhole and surface inlet grates rim elevations shall be shown to the nearest hundredth. The water surface elevations of ponding and/other 100-year floodway and flood plain elevation with zone description.
8. Borings, if required or completed, indicating depths and type of soils encountered shall be shown if not shown on a separate soils sheet.
9. The flow line of all existing and proposed ditches shall be plotted and labeled as flow line ditch, left or right. Also a label identifying the ditch slope shall be provided. On large channels, it may be necessary to show the left and right tops of bank.

10. Existing ground profile shall be labeled, including any proposed street grades or improvements.
11. Basement floor elevations, when applicable, otherwise the first floor elevations. Assumed basement floor elevation shall be noted on the profile using the word “Assumed” adjacent to the elevation.
12. Any existing underground utility, when crossing a proposed improvement.

CADD5.15 Miscellaneous Civil Plans Criteria/Requirements

1. Plan layout Index Sheet Plans

   A plan layout index sheet shall be prepared to identify the location of the proposed improvements shown on each plan sheet. The location shall be shown on a map covering the entire project area at an appropriate scale. The map shall show, at a minimum, the public right-of-way, roadway labels, north arrow, graphical and textual scale and labeled polygons/figures designating the proposed improvement area covered by each plan drawing view.

   If the profile is on a separate sheet, the layout index sheet shall include a reference to the location of the profile for the utility lines on each plan sheet. For some projects, the plan layout index may be shown on the project location map which is located on the title sheet. See **Exhibit CADD5-8** for an example of a layout index sheet.

2. Dimension (Survey) Control or Layout Plans

   The dimension (survey control) plans shall include the following information:

   A. Base plans showing information from field survey including benchmark and survey control point locations.
   B. Interrelationships of buildings, streets, parking areas, fences, and utilities.
   C. Locations for access and egress to facilities.
   D. Location and limits of site improvements.
   E. Standards for Dimension Control or Layout Plans (i.e. witnesses, control points, benchmarks and temporary bench marks).
   F. Structures should be located by horizontal coordinates where possible.

   Exhibit CADD5-9 shows an example of a survey control plan sheet.

3. Erosion Control Plans

   Erosion and sediment control plans shall minimize the areas of disturbed soils and the duration of exposure. The erosion control plan design shall provide measures to control water at upslope site perimeters, control water on-site, control sediment on-site, and control sediment at the downslope site perimeters. Refer to **Exhibit CADD5-10** for a sample erosion control plan sheet.

4. Traffic Control Plans

   Traffic control plans shall be prepared and obtain City's approval of that plan when construction, repair, or maintenance work is to be conducted within the City's right-of-way. The plan shall be consistent with the provisions found in the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways. Refer to **Exhibit CADD5-11** for a sample traffic control plan sheet.

5. Demolition Plans

   The demolition plans shall include and indicate, but not be limited to, the following information:

   A. Limits of items to be removed from the site.
   B. Curbs to be cut.
   C. Items to be demolished and removed from site.
   D. Items to be salvaged and turned over to owner.
   E. Items to remain undisturbed and be protected.

   See **Exhibit CADD5-12** and **Exhibit CADD5-13** for examples of demolition plans for different design elements.

6. Restoration and Paving Plans

   The restoration plans shall include and indicate, but not be limited to the following information:

   A. Show the proposed design information, including new structures, new curb limits, location for ADA ramps, limits of new pavement restoration with dimensions, etc.
   B. Limits of what areas are to be restored, and the boundaries of the site. Discuss the timing and sequence of the restoration effort.
   C. Label the existing right-of-way, property lines, and easements.

   See **Exhibit CADD5-14** for an example of restoration plans for different design elements.

   The paving plans shall include but not be limited to the following information:

   A. Large paved areas. Locate by establishing a baseline.
   B. Roads. Locate based on a centerline horizontal alignment.
   C. Paving. Indicate types.
   D. Core lines and expansion, contraction, and control joints. Dimension each item to the nearest fixed point.

7. Pavement Marking and Signage Plans

   The pavement markings and signage plan sheet shall provide a location and a legend describing if the sign being installed is new, reset, replaced, removed or used as is. All pavement markings in the plans shall describe the type of marking and all lane widths, including turn lanes. Wherever there is a change in the pavement marking pattern, note the beginning and end stations for the transition area. The pavement marking types and sign detail shall be approved by the City of Fort Wayne and comply with MUTCD requirements. See **Exhibit CADD5-15** for an example of pavement markings and signage plan sheet.

CADD5.16 Electrical Plans Criteria/Requirements

Electrical plans shall consist of the design requirements for sanitary wastewater lift stations. **Exhibit CADD5-16** shows a sample electrical plan sheet.

At a minimum, electrical plans shall locate the lift station control panel, receptacles, portable generator connection, outlets, electrical panels, junction boxes, motors, switch gear, transformers, emergency generators, communication equipment and other components of the electrical power system.

Electrical plans shall include these items superimposed on Architectural backgrounds.

FORT WAYNE
CITY UTILITIES ENGINEERING

PROJECT NAME
(CAN BE MULTIPLE LINES)

RESOLUTION NO.

MAYOR

HONORABLE THOMAS C. HENRY

BOARD OF PUBLIC WORKS

ROBERT P. KENNEDY, CHAIRMAN

KUMAR MENON, MEMBER

MIKE AVILA, MEMBER

CITY UTILITES ENGINEERING

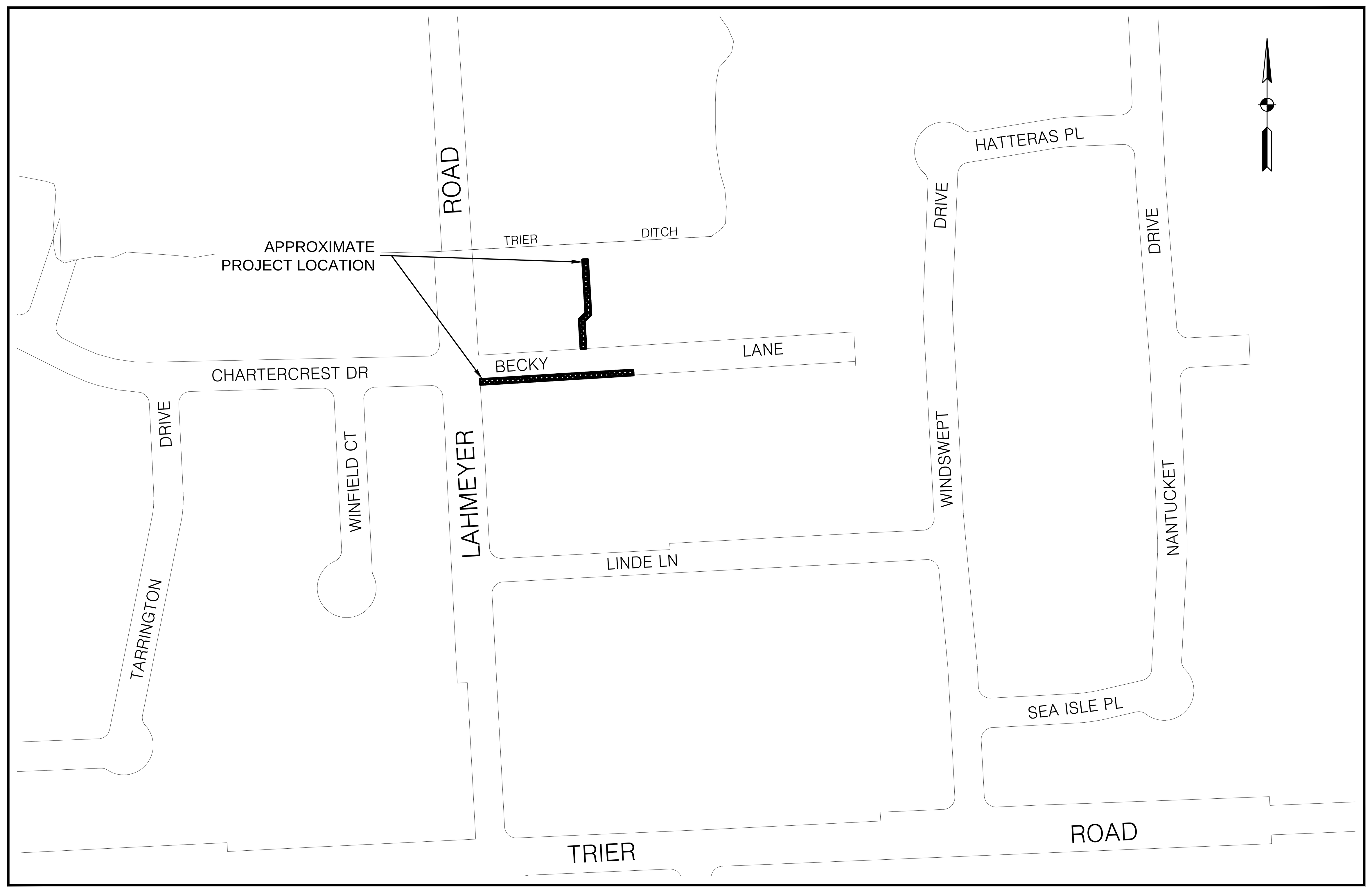
MATTHEW A. WIRTZ, P.E.,
DEPUTY DIRECTOR/CHIEF ENGINEER

PROGRAM MANAGER NAME
PROGRAM MANAGER

DESIGNER NAME
DESIGNER TITLE

CADD TECH NAME
CADD TECHNICIAN

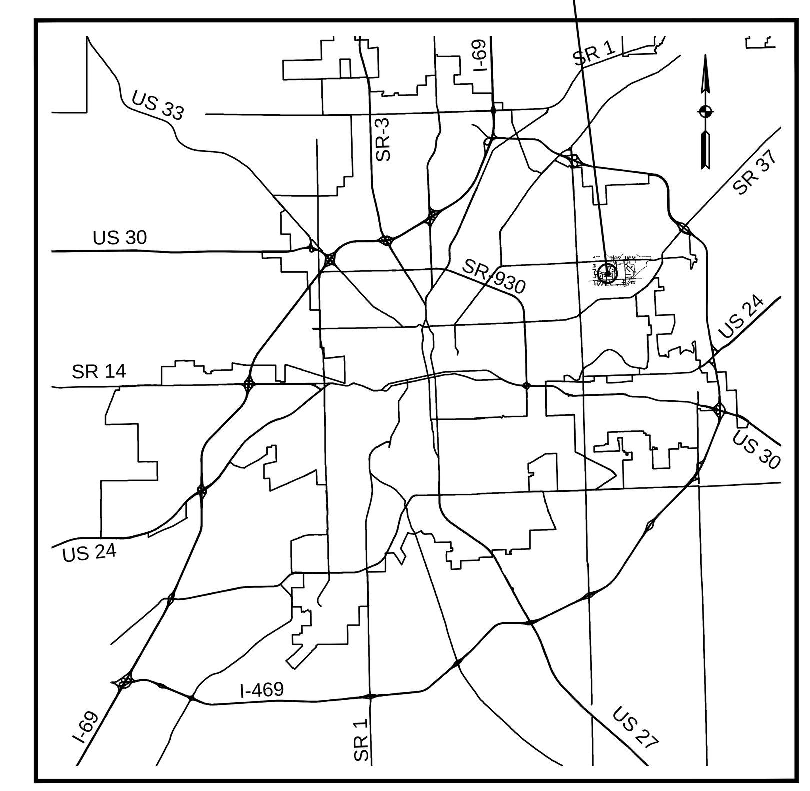
CADD TECH NAME
CADD TECHNICIAN



LOCATION MAP

0 150 300 600

CITY MAP(S): X-##



CITY VICINITY MAP
Scale: N.T.S.

SHEET INDEX

NO.	ID NO.	DESCRIPTION	REMARKS
1	G-001-01	TITLE SHEET	
2	G-002-02	GENERAL NOTES	
3	C-101-01	LAYOUT INDEX	
4	C-102-02	SURVEY CONTROL	
5	C-103-03	EROSION CONTROL	
6	C-104-04	TRAFFIC CONTROL	
7	C-107-05	PLAN	
8	C-108-06	PLAN AND PROFILE	LINE A
9	C-301-07	CROSS SECTIONS	
10	C-501-08	DETAILS	

Know what's below. Call before you dig.

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
6	12/31/13	REVISION NOTES
5	12/31/13	REVISION NOTES
4	12/31/13	REVISION NOTES
3	12/31/13	REVISION NOTES
2	12/31/13	REVISION NOTES
1	12/31/13	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
SURVEYED BY:
SURVEYOR NAME
DRAWN BY:
CADD TECH NAME
DESIGNED BY:
DESIGNER NAME
CHECKED BY:
CHECKED BY NAME
APPROVED BY:
APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-1
TITLE

G-001-01
SHEET 1 OF 17

3/18/2015 12:44 PM
G:\CU WATER RESOURCES\WATER RESOURCES SHARE\SHARED CADD FILES\STANDARDS & MANUALS\CADD STANDARDS - WORKING DOCS\CADD 5 - DRAFTING CONVENTIONS\XXXXX - CADD STANDARDS 2013\DRAWINGS\SHEET DRAWINGS\SHEET TYPE EXHIBITS\EXHIBIT CADD5-1 - TITLE.DWG

SUPPORT CONTACTS

SANITARY SEWERS
CITY OF FORT WAYNE, DIVISION OF UTILITIES
PROGRAM MANAGER SEWER CAPACITY AND CSO
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 250
FORT WAYNE, IN. 46802
260–427–5066

STORMWATER/DRAINAGE – CITY
CITY OF FORT WAYNE, DIVISION OF UTILITIES
PROGRAM MANAGER STORMWATER PLANNING AND DESIGN
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 250
FORT WAYNE, IN. 46802
260–427–5066

POTABLE WATER
CITY OF FORT WAYNE, DIVISION OF UTILITIES
PROGRAM MANAGER WATER CAPACITY
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 250
FORT WAYNE, IN. 46802
260–427–5066

WATER MAINTENANCE & SERVICE (WMS)
CITY OF FORT WAYNE – WMS
415 E. WALLACE STREET
FORT WAYNE, IN. 46803
260–427–2475

DEVELOPMENT SERVICES
CITY OF FORT WAYNE, DIVISION OF UTILITIES
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 130
FORT WAYNE, IN. 46802
1–260–427–5064

CONSTRUCTION IN CITY STREET OR R.O.W.
RIGHT OF WAY PERMIT DEPARTMENT
OFFICE OF THE CITY ENGINEER
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 210
FORT WAYNE, IN. 46802
260–427–1172

STREET LIGHTS
CITY OF FORT WAYNE – STREET LIGHTS ENGINEER
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 210
FORT WAYNE, IN. 46802
260–427–2787

STORMWATER/DRAINAGE – COUNTY
BENCHMARKS, CORNERSTONES AND
SURVEYING MONUMENTS
ALLEN COUNTY SURVEYOR
CITIZENS SQUARE
200 EAST BERRY STREET, SUITE 350
FORT WAYNE, IN. 46802
260–449–7922

CABLE TELEVISION
COMCAST CABLEVISION
720 TAYLOR STREET
FORT WAYNE, IN. 46802
260–458–5107

ELECTRIC
AMERICAN ELECTRIC POWER CO.
SR ENGINEERING TECHNOLOGIST – FW DISTRICT
3514 LANDIN ROAD
NEW HAVEN, IN. 46774–9460
260–408–1895
260–421–1766

NORTHEASTERN REMC
BRAD DEUTSCH
FIELD ENGINEERING SUPERVISOR
4901 EAST PARK 30 DRIVE
COLUMBIA CITY, IN 46725
260–244–6111 ET. 427

GAS
NORTHERN INDIANA PUBLIC SERVICE CO.
1501 HALE AVE.
FORT WAYNE, IN. 46802
260–439–1315

TELEPHONE
FRONTIER
8001 W. JEFFERSON BLVD.
FORT WAYNE, IN. 46804
260–461–2896

TRAFFIC ENGINEERING
SIGN DIVISION
FORT WAYNE, IN.
260–427–1224

Indiana 811
Know what's below.
Call before you dig.

GENERAL LEGEND

- ANCHOR GUY WIRE (SINGLE)
- ANCHOR GUY WIRE (MULTIPLE)
- ESMT — EASEMENT LINE
- Z — ABANDONED (ORIG) PLAT LINE
- PL — CURRENT PARCEL LINE
- R/W — RIGHT–OF–WAY LINE
- x — FENCE LINE(CHAINLINK)
- FENCE LINE(WOOD)
- SF — SILT FENCE
- UGFO — UNDERGROUND FIBER OPTIC LINE
- OHEL — OVERHEAD ELECTRIC LINE
- UGEL — UNDERGROUND ELECTRIC LINE
- OHSL — OVERHEAD STREET LIGHT LINE
- UGSL — UNDERGROUND STREET LIGHT LINE
- OHPH — OVERHEAD TELEPHONE LINE
- UGPH — UNDERGROUND TELEPHONE LINE
- UGUL — UNDERGROUND UTILITY LINE
- OHUL — OVERHEAD UTILITY LINE
- UGTRAF — UNDERGROUND TRAFFIC LINE
- OHTRAF — OVERHEAD TRAFFIC LINE
- OHCATV — OVERHEAD CABLE TV LINE
- X" FM — FORCE MAIN LINE
- X" G — GAS LINE
- X" SS — SANITARY SEWER LINE
- X" ST — STORM SEWER LINE
- X" W — WATER LINE
- X" PWM — PRIVATE WATER LINE
- CONSTRUCTION LIMITS
- FLOW DIRECTION
- TRAFFIC SIGNAL –1 LIGHTS
- TRAFFIC SIGNAL –2 LIGHTS
- TRAFFIC SIGNAL –3 LIGHTS
- TF — TRAFFIC MANHOLE
- TRAFFIC PEDESTAL
- POWER POLE WITH ONE LIGHT ARM
- LIGHT POST 1 ARM 1 HEAD
- LIGHT POST 2 ARMS 2 HEADS
- LIGHT POST W/O ARM
- POWER POLE
- YARD LIGHT
- E — ELECTRIC MANHOLE ROUND
- E — ELECTRIC HAND HOLE
- M — ELECTRICAL METER
- J — ELECTRICAL JUNCTION BOX
- PB — PULL BOX
- TRANSFORMER
- T PED — TELEPHONE PEDESTAL
- TV — CABLE TV PEDESTAL
- T — TELEPHONE MANHOLE
- SATELLITE DISH
- EARTH
- GRASS
- GRAVEL
- UNDISTURBED EARTH
- RIPRAP
- CONCRETE
- REMOVAL
- RESURFACING, OTHER
- M — UTILITY SERVICES MANHOLE
- W — UTILITY WATER MANHOLE
- W — UTILITY WATER TANK
- UTILITY POLE
- 11° BEND
- 22° BEND
- 45° BEND
- 90° BEND
- WATER TEE
- WATER CROSS
- TAPPING SLEEVE & VALVE
- WATER VALVE
- PIPE THRUST BLOCK
- WATER REDUCER
- CURB BOX SERVICE REPLACEMENT
- TYPE III HYDRANT ASSEMBLY
- TYPE I HYDRANT ASSEMBLY
- TYPE V HYDRANT ASSEMBLY
- WATER BLOW OFF
- CUT & PLUG
- W — WATER METER
- UNKNOWN WATER SRVC CURB BOX
- FIRE HYDRANT
- W — WELL
- CB — CATCH BASIN
- CB — CATCH BASIN ROUND
- D — STORM DRAINAGE MANHOLE
- I — STORM SEWER INLET ROUND
- I — STORM SEWER INLET
- CO — SANITARY CLEANOUT
- S — SANITARY SEWER MANHOLE
- S — SANITARY METER
- L — SANITARY LIFT STATION
- CHECK VALVE
- SANITARY VALVE
- GAS VALVE
- G — NATURAL GAS MANHOLE
- G — NATURAL GAS METER
- C — COMMUNICATIONS MANHOLE
- BENCHMARK/CONTROL POINT
- R — IRON ROD
- P — IRON PIPE
- R/W MONUMENT
- BUSH
- TREE STUMP
- EVERGREEN TREE
- DECIDUOUS TREE
- AC — AIR CONDITIONING UNIT
- MB — MAILBOX
- SIGN
- FLAG POLE — FLAG POLE
- PAY PHONE — PAY PHONE

SHEET KEYNOTES

A. REMOVAL OF CURB
B. CONCRETE SIDEWALK (4")
C. CONCRETE CURBFACE SIDEWALK (6")
D. CONCRETE WING WALKS & RAMPS
E. REMOVAL OF CURB
F. CONCRETE SIDEWALK (4")
G. CONCRETE CURBFACE SIDEWALK (6")
H. CONCRETE WING WALKS & RAMPS
I. 2" CONCRETE CURBFACE WALK REQUIRED
J. CONCRETE FOR RESIDENTIAL DRIVES (6")
K. CONCRETE FOR COMMERCIAL & ALLEY DRIVES (8")
L. CONCRETE CURB TYPE III
M. CONCRETE CURB TYPE II-A
N. CONCRETE CURB TYPE II-B
O. CONCRETE CURB TYPE I-A
P. CONCRETE CURB TYPE I-B
Q. CEMENT CONCRETE PAVEMENT, PLAIN 7"
R. CLASS A, INCLUDES TYPE I-A CURB
S. 2" CONDUIT REQUIRED (LOCATION TO BE DETERMINED BY PROJECT ENGINEER)
T. ADJUST CASTING TO GRADE
U. PRUNE & FERTILIZE TREE
V. CURB RAMP TYPE "A"
W. CURB RAMP TYPE "B"
X. CURB RAMP TYPE "C"
Y. CURB RAMP TYPE "D"
Z. CURB RAMP TYPE "E
AA. CURB RAMP TYPE "F"
AB. CURB RAMP TYPE "G"
AC. CURB RAMP TYPE "H"
AD. CURB RAMP TYPE "K"
AE. CURB RAMP TYPE "L"
AF. CURB RAMP TYPE "M"
AG. CURB RAMP TYPE "N"
AH. CURB RAMP TYPE "O"
AI. TREE REMOVAL
AJ. TREE FERTILIZATION

1. GROUT PIPE
2. REMOVE TREE
3. REMOVE AND REPLACE TREE
4. REMOVE EXISTING PIPE
5. EARTHEN CLAY LEVEE
6. BULKHEAD (PLUG PIPE W/BRICKS & CONCRETE MORTAR)
7. REMOVE EXISTING FLAP GATE
8. REMOVE EXISTING CONCRETE HEADWALL
9. SPECIAL BACKFILL #53/73 STONE
10. CONCRETE LEVEE WALL
11. REMOVABLE BOLLARD POST (SEE DETAILS)
12. ASPHALT TRAILWAY
13. REMOVE AND REPLACE ASPHALT TRAILWAY
14. CONCRETE PAD
15. REMOVE AND REPLACE TYPE I-A CONCRETE CURB
16. REMOVE AND REPLACE TYPE I-B CONCRETE CURB
17. REMOVE AND REPLACE TYPE II-A CONCRETE CURB
18. REMOVE AND REPLACE TYPE II-B CONCRETE CURB
19. REMOVE AND REPLACE TYPE III CONCRETE CURB
20. REMOVE AND REPLACE LOCAL/RESIDENTIAL/COLLECTOR ASPHALT STREET
21. REMOVE AND REPLACE MAJOR ARTERIAL ASPHALT STREET
22. REMOVE AND REPLACE LOCAL/RESIDENTIAL/COLLECTOR/ARTERIAL CONCRETE STREET
23. REMOVE AND REPLACE MAJOR ARTERIAL CONCRETE STREET
24. REMOVE AND REPLACE CONCRETE ALLEY DRIVE
25. PATCH DETAIL - STRUCTURE REMOVAL
26. REMOVE AND REPLACE COMMERCIAL CONCRETE DRIVE APPROACH
27. REMOVE AND REPLACE ASPHALT DRIVE APPROACH
28. REMOVE AND REPLACE CURB RAMP
29. 1-1/2" MILLING AND NEW SURFACE
30. REMOVE AND REPLACE TYPICAL CONCRETE SIDEWALK
31. REMOVE AND REPLACE TYPICAL CURBFACE SIDEWALK
32. REMOVE WALK APPROACH
33. REMOVE AND REINSTALL STREET LIGHT

GENERAL NOTES

1. IF ANY ERRORS BECOME APPARENT, THESE SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IN WRITING PRIOR TO CONSTRUCTION SO THAT CLARIFICATION OR REDESIGN MAY OCCUR.
2. EXISTING SIGNS TO BE REMOVED AND RESET AFTER CONSTRUCTION SHALL BE COORDINATED WITH THE CITY OF FORT WAYNE SIGN SHOP, 427-1224. UNLESS OTHERWISE SPECIFIED OR APPROVED, THE SIGN SHOP WILL REMOVE AND RESET ALL EXISTING TRAFFIC SIGNS.
3. THE CONTRACTOR SHALL CONFINE ALL WORK WITHIN THE LIMITS SHOWN.
4. THE CONTRACTOR SHALL COMPLY WITH THE REQUIREMENTS OF ALL PERMITS OBTAINED FOR THE PROJECT.
5. THE CONTRACTOR SHALL RESTORE GROUND SURFACE, DRAINAGE DITCHES AND EMBANKMENTS TO ORIGINAL GRADE AND VEGETATION ACCORDING TO PROJECT SPECIFICATIONS UNLESS OTHERWISE NOTED ON PLANS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL LINES, GRADES AND ELEVATIONS. ALL PIPES SHALL SLOPE UNIFORMLY BETWEEN INVERT ELEVATIONS SHOWN.
7. THE CONTRACTOR SHALL ENSURE THAT EACH BUSINESS AND HOMEOWNER HAS ONE SAFE POINT OF ACCESS FOR CUSTOMERS AND DELIVERIES AT ALL TIMES. THE CONTRACTOR SHALL MAINTAIN ACCESS, KEEP IT SAFE, CLEAN AND FREE OF DEBRIS AND PROVIDE THE NECESSARY SAFETY DEVICES WHERE NEEDED.
8. THE CONTRACTOR SHALL GIVE AFFECTED BUSINESS OWNERS AND HOMEOWNERS AT LEAST A TWO (2) WORKING DAY ADVANCED NOTICE OF REMOVAL, DEMOLITION AND /OR CONSTRUCTION ACTIVITY IN FRONT OF OR AFFECTING ACCESS TO THAT BUSINESS OR HOME.
9. SAW CUTS ON EXISTING PAVEMENT FOR PATCHING SHALL HAVE A TYPICAL MINIMUM WIDTH OF 24 INCHES UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
10. THE CONTRACTOR SHALL NOTIFY THE TRAFFIC ENGINEERING DIVISION OR THE RESPECTIVE HIGHWAY DEPARTMENT PRIOR TO THE REMOVAL OR ADJUSTMENT OF ANY TRAFFIC WARNING SIGNS.
11. THE CONTRACTOR SHALL PRESERVE AND PROTECT PROPERTY MARKERS, SECTION CORNERS, SURVEY MARKS AND BENCH MARKS, SUCH AS STONES, PIPES, OR OTHER MONUMENTS ENCOUNTERED. IF THE CONTRACTOR MUST DISTURB THE PROPERTY MARKERS OR MONUMENTS, THEIR HORIZONTAL AND VERTICAL LOCATION SHALL BE DETERMINED AND RECORDED BY A REGISTERED LAND SURVEYOR AND THE OWNER NOTIFIED BEFORE DISTURBING. ALL PROPERTY MARKERS AND MONUMENTS DISTURBED DURING CONSTRUCTION SHALL BE RE-ESTABLISHED BY A REGISTERED LAND SURVEYOR.
12. AREAS OUTSIDE OF THE IMMEDIATE CONSTRUCTION VICINITY, THE CONTRACTOR MAY NEATLY TRIM BRANCHES OR LIMBS WITHIN THE RIGHT-OF-WAY THAT ARE IMPACTED BY EQUIPMENT OR IN THE WAY OF THE WORK. IT IS THE INTENT OF THIS PROJECT NOT TO DAMAGE OR REMOVE EXISTING TREES UNLESS OTHERWISE NOTED.
13. ALL MATERIALS REQUIRED MUST BE PROVIDED AS NEW.

EXISTING UTILITIES

1. CAUTION: THE INFORMATION SHOWN ON THESE DRAWINGS CONCERNING TYPE AND LOCATION OF UNDERGROUND UTILITIES IS NOT GUARANTEED TO BE ACCURATE OR ALL-INCLUSIVE. LOCATION, SIZE, MATERIAL AND DEPTH SHOWN ON UTILITIES ARE FROM AVAILABLE RECORDS AND AVAILABLE FIELD MARKINGS, SUPPLIED BY THE RESPECTIVE UTILITY COMPANY OR FROM ABOVE-GROUND INSPECTION OR MEASUREMENT. THE CONTRACTOR SHALL VERIFY ALL EXISTING UTILITIES INFORMATION CONTAINED IN THE CONTRACT DOCUMENTS PRIOR TO ANY CONSTRUCTION WHICH WOULD BE IMPACTED BY UTILITIES NOT LOCATED AS SHOWN IN THE CONTRACT DOCUMENTS.
2. THE INDIANA UNDERGROUND PLANT PROTECTION SERVICE (IUPPS) MUST BE NOTIFIED 48 HOURS PRIOR TO ANY EXCAVATION FOR VERIFICATION OF LOCATION, SIZE AND MATERIAL FOR EXISTING UNDERGROUND UTILITIES (1-800-382-5544 OR 811). THE CONTRACTOR SHALL PROMPTLY NOTIFY THE ENGINEER IN WRITING IF ANY UNDERGROUND UTILITY OR STRUCTURE DIFFERS FROM THE CONDITIONS SHOWN ON THE PLANS AS TO IMPACT THE WORK.
3. IN GENERAL, UTILITY SERVICE LINES TO INDIVIDUAL CUSTOMERS ARE NOT SHOWN ON THE PLANS. CONTRACTOR SHALL ASSUME THAT UNDERGROUND SERVICE LINES EXIST TO EACH PROPERTY ALONG THE NEW SEWER ROUTE FOR WATER, SANITARY SEWER, GAS, ELECTRIC, TELEPHONE, AND CABLE TV. THE CONTRACTOR SHALL LOCATE, PROTECT, AND IF DAMAGED BY CONTRACTOR, REPAIR ALL UTILITY SERVICE LINES ENCOUNTERED. RESPONSIBLE FOR ANY DAMAGE TO THEM FROM THE ASSOCIATED CONSTRUCTION ACTIVITIES. ALL UTILITY POLES ARE TO BE SUPPORTED ADEQUATELY FOR THE WORK.
4. THE CONTRACTOR SHALL MAKE PROVISIONS TO MAINTAIN FLOWS IN ALL SANITARY, COMBINED SEWERS, AND OVERFLOWS AT ALL TIMES. BYPASS PUMPING OR ALTERNATE PROVISIONS MAY BE REQUIRED AND SHALL BE SUFFICIENT TO CONVEY FLOWS UNDER ALL CONDITIONS.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR/REPLACEMENT TO ALL DAMAGED WATER SERVICES. CONTRACTOR MUST NOTIFY WATER MAINTENANCE AND SERVICE DISPATCHER OF ANY DAMAGES TO THE WATER FACILITIES. DAMAGED WATER FACILITIES MUST BE REPAIRED BY THE CONTRACTOR WITHIN TWO (2) HOURS AT NO ADDITIONAL COST TO THE OWNER. IF WATER MAINTENANCE AND SERVICE ARE REQUIRED TO MAKE REPAIRS, THE CONTRACTOR WILL BE BILLED.
6. DRIVEWAY CULVERTS, MAIL BOXES, AND SMALL SHRUBS AND TREES MAY NOT BE SHOWN ON THE DRAWINGS FOR CLARITY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING THESE ITEMS OR REPLACING IF DISTURBED.
7. ANY EXISTING PIPE OR TILE(S), WHICH ARE CUT DURING CONSTRUCTION, SHALL BE REPLACED WITH EQUAL OR BETTER MATERIALS AND CONSTRUCTION METHODS.
8. BEFORE LEAVING WORK FOR THE NIGHT, DURING A STORM, OR FOR ANY OTHER REASON, CARE MUST BE TAKEN THAT THE UNFINISHED END OF ANY PIPE IS SECURELY CLOSED WITH A TIGHTLY FITTING COVER OR PLUG. ANY EARTH OR OTHER MATERIAL THAT MAY FIND ENTRANCE INTO THE PIPE, THOUGH ANY SUCH OPEN END OF AN UNPLUGGED PIPE SHALL BE REMOVED AT THE CONTRACTOR'S EXPENSE.
9. WATER CONNECTIONS. THE CITY OF FORT WAYNE WATER MAINTENANCE AND SERVICE (WM&S) DEPARTMENT SHOULD BE NOTIFIED A MINIMUM OF 48 HOURS IN ADVANCE OF ANY CONNECTION TO THE CITY OF FORT WAYNE WATER SYSTEM. ONLY WM&S EMPLOYEES ARE TO OPERATE WATER VALVES FOR ISOLATION OF THE CONNECTION.
10. INTERRUPTION OF WATER SERVICE. THE CONTRACTOR SHALL GIVE WRITTEN NOTICE TO ALL AFFECTED PROPERTY OWNERS AT LEAST 24 HOURS, BUT NOT MORE THAN 72 HOURS PRIOR TO ANY TEMPORARY INTERRUPTION OF WATER SERVICE. SERVICE INTERRUPTIONS SHALL BE LIMITED TO 4 HOURS UNLESS OTHERWISE APPROVED BY CITY UTILITIES.

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
6	12/31/13	REVISION NOTES
5	12/31/13	REVISION NOTES
4	12/31/13	REVISION NOTES
3	12/31/13	REVISION NOTES
2	12/31/13	REVISION NOTES
1	12/31/13	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
SURVEYED BY: SURVEYOR NAME
DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-2
GENERAL NOTES

G-002-02
SHEET 2 OF 17

3/18/2015 12:45 PM

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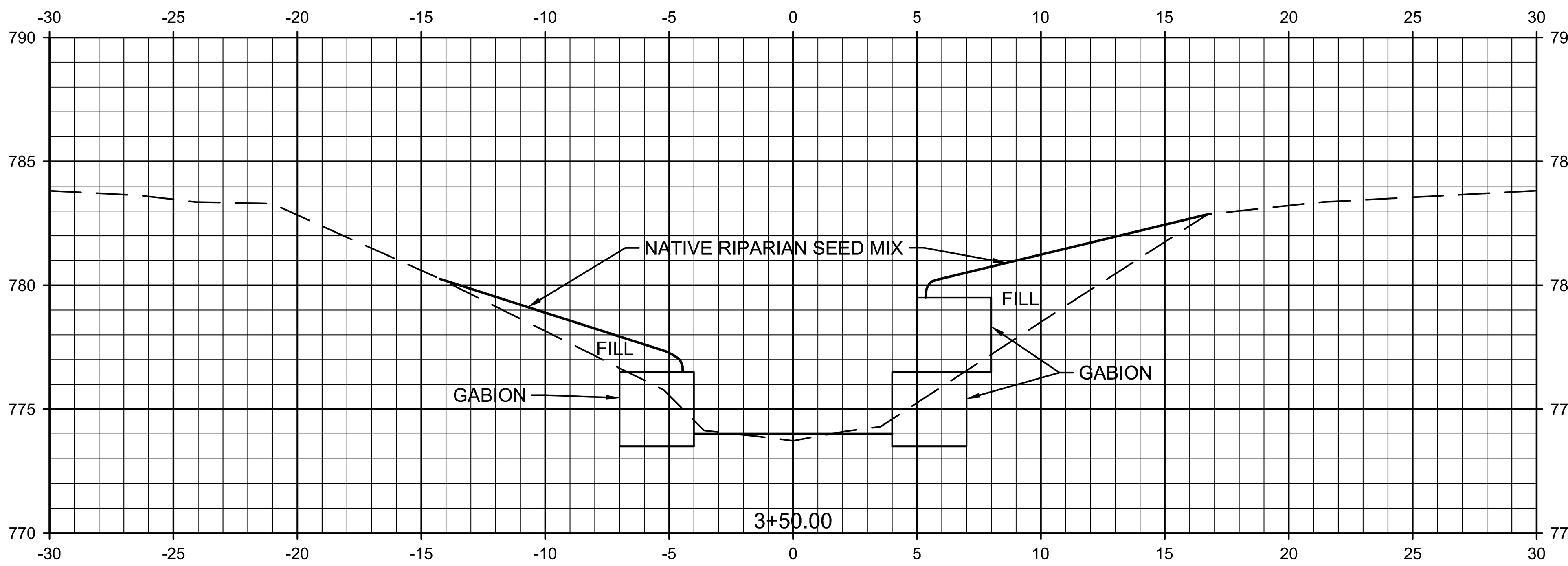
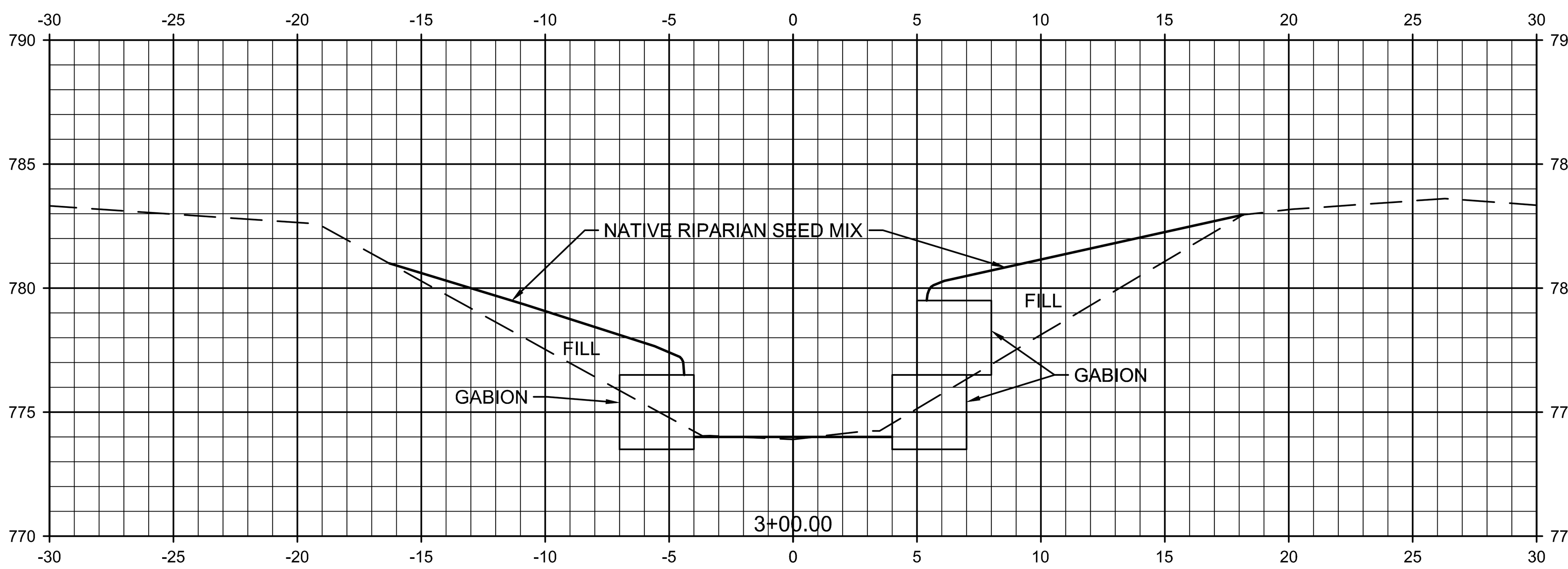
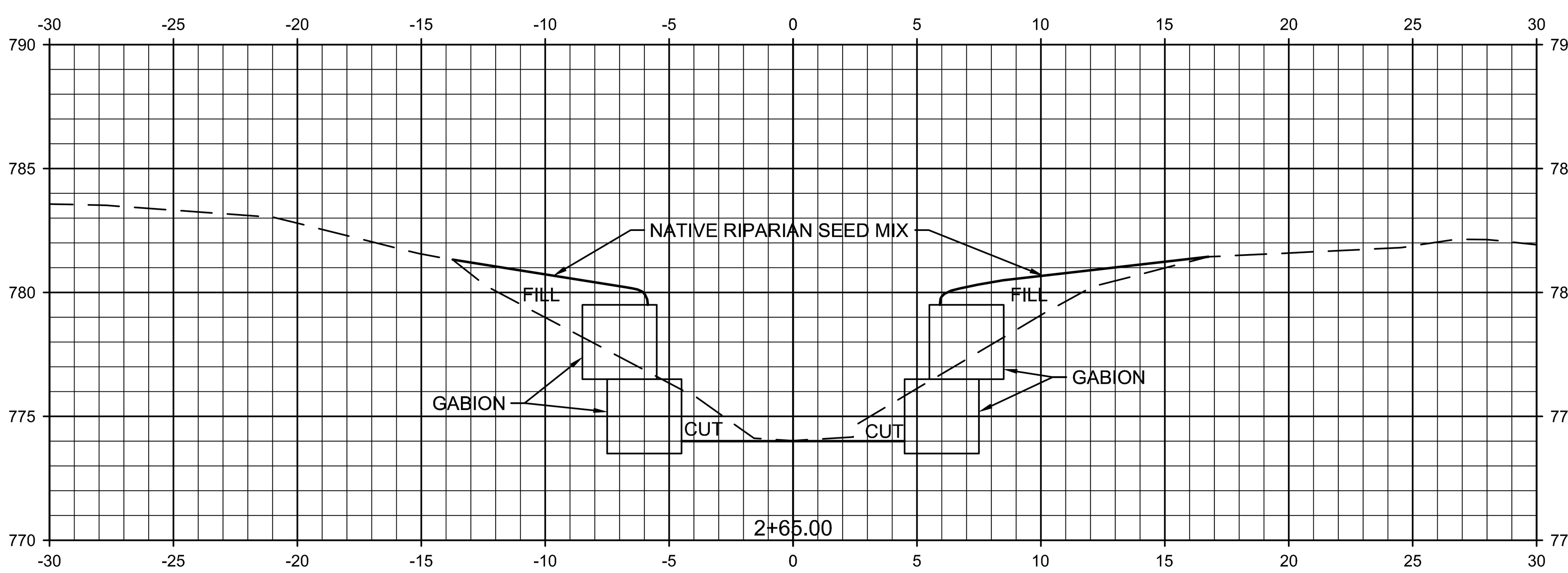
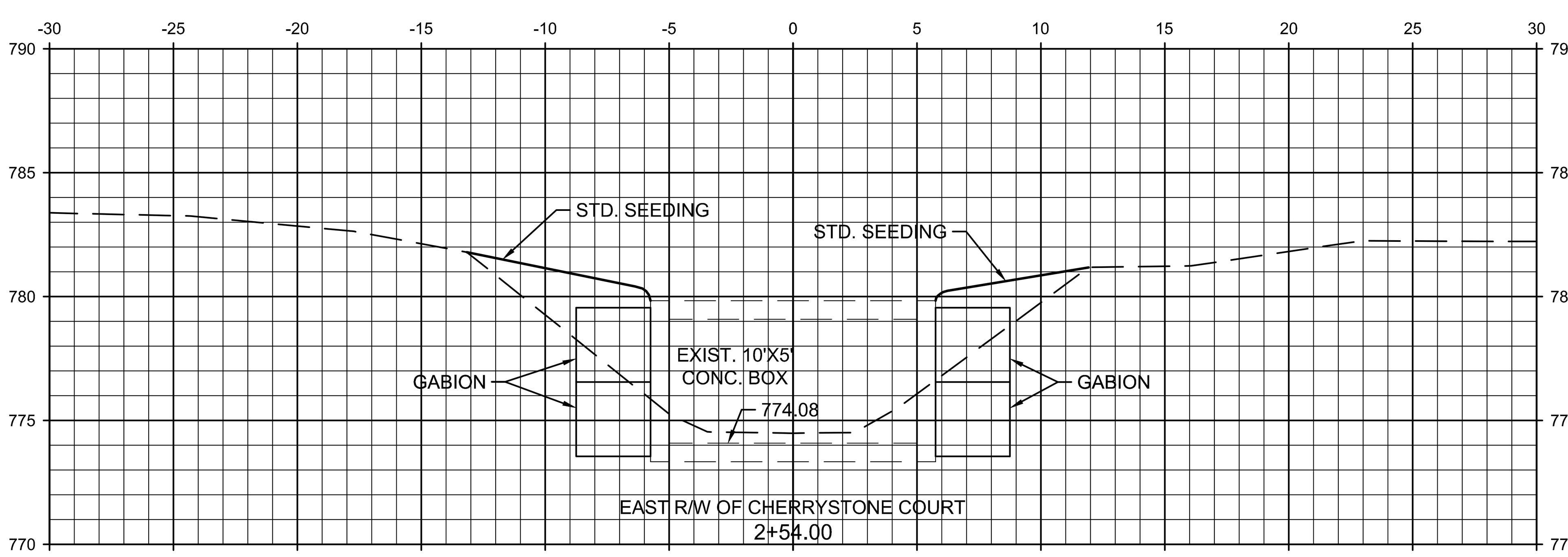






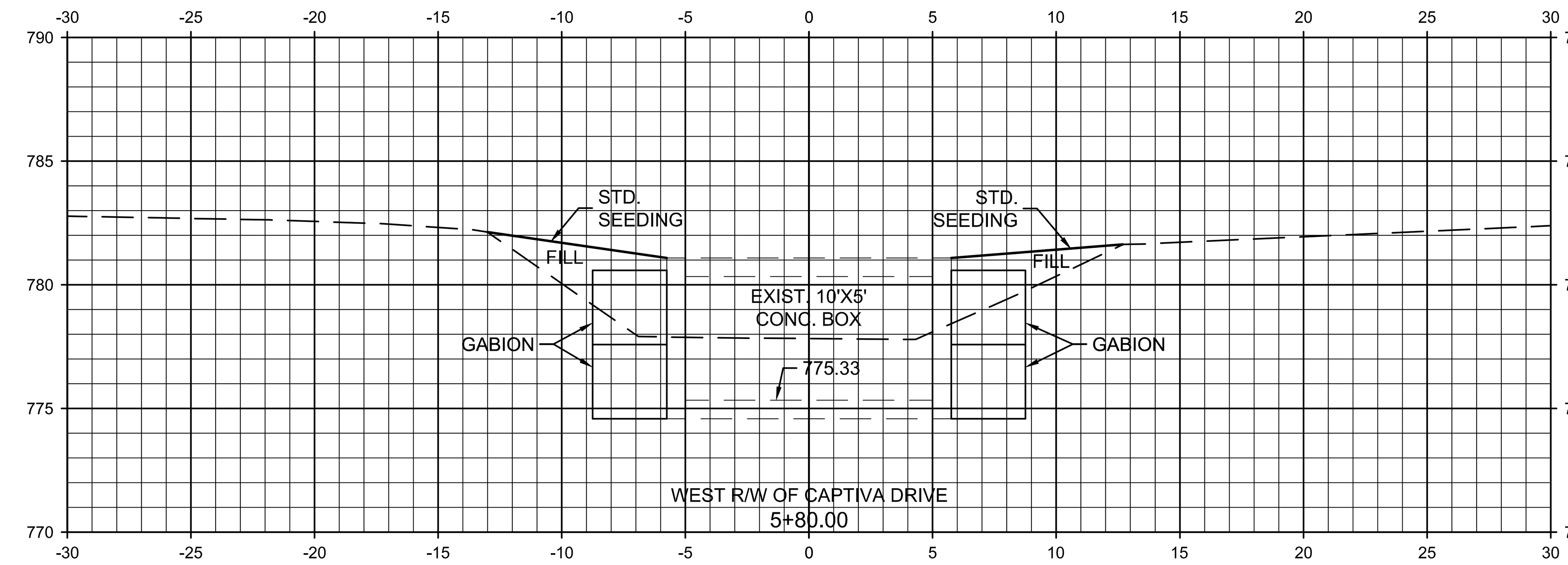


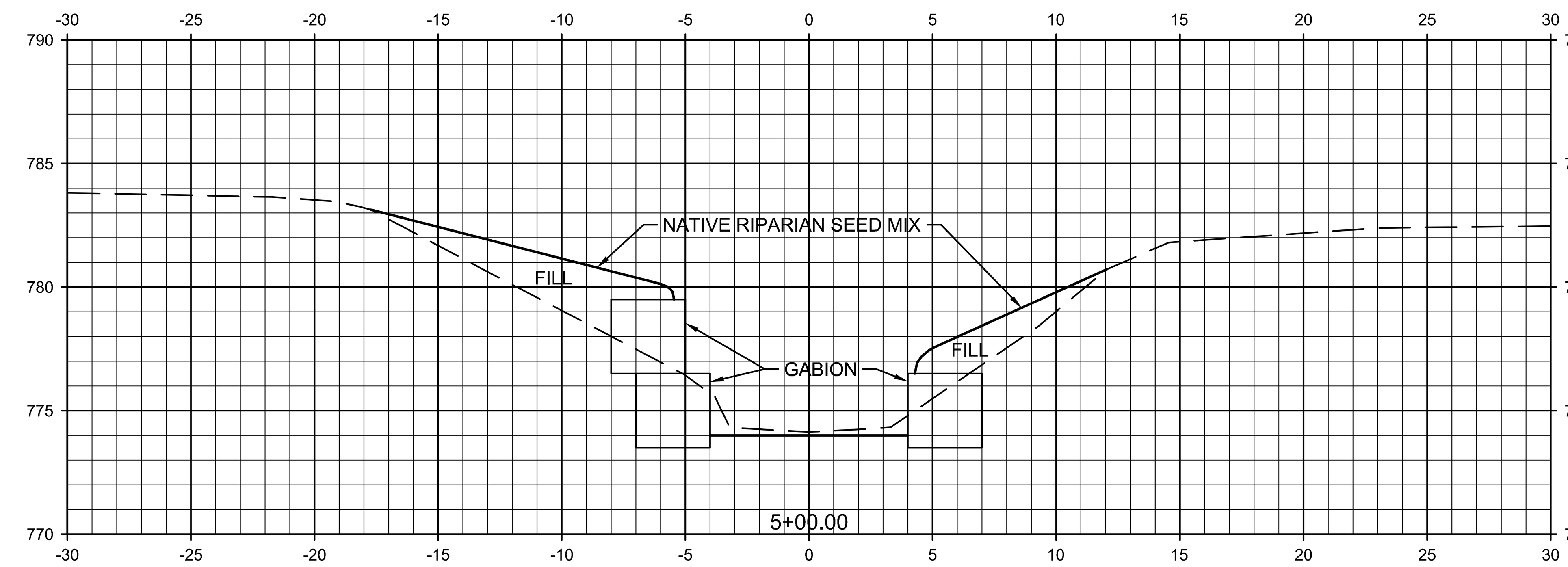
SANIBEL ACRES ADD.
CUT/FILL QUANTITIES
(STA. 2+54 TO STA. 5+80)

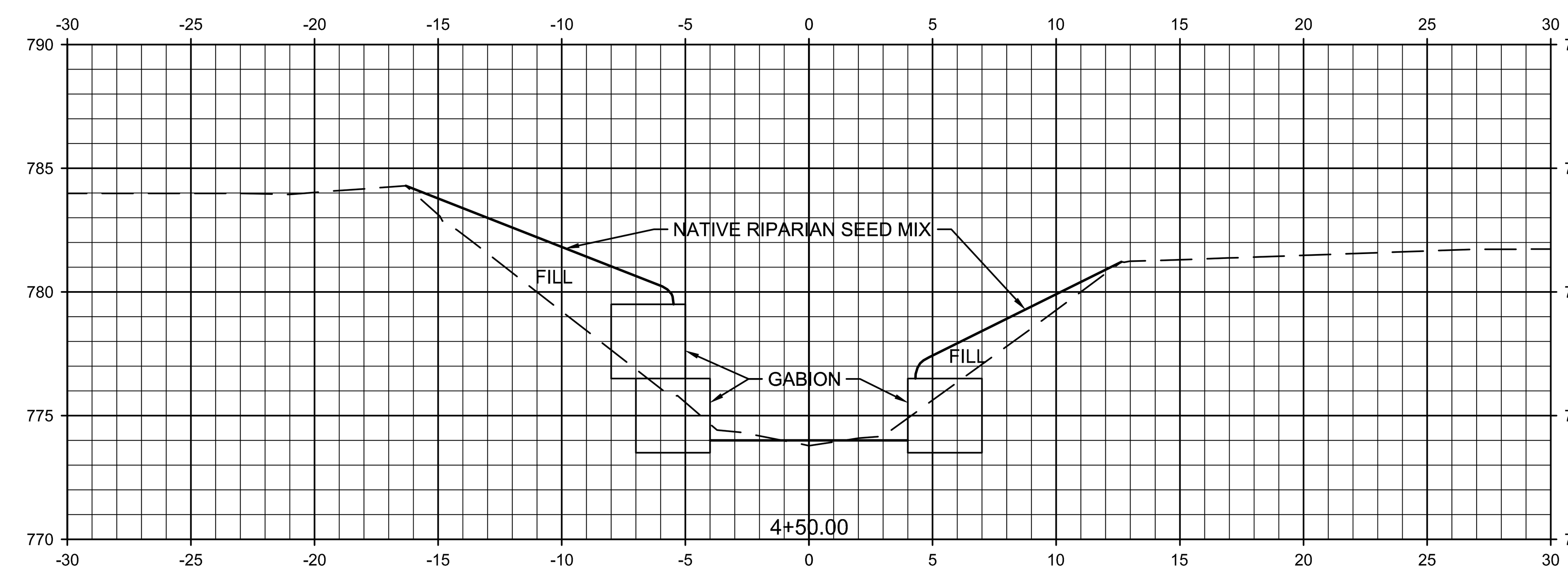
CUT:
EXIST. RIP-RAP: - 11 CY
EXIST. SOIL: - 225 CY
TOTAL CUT: 236 CY

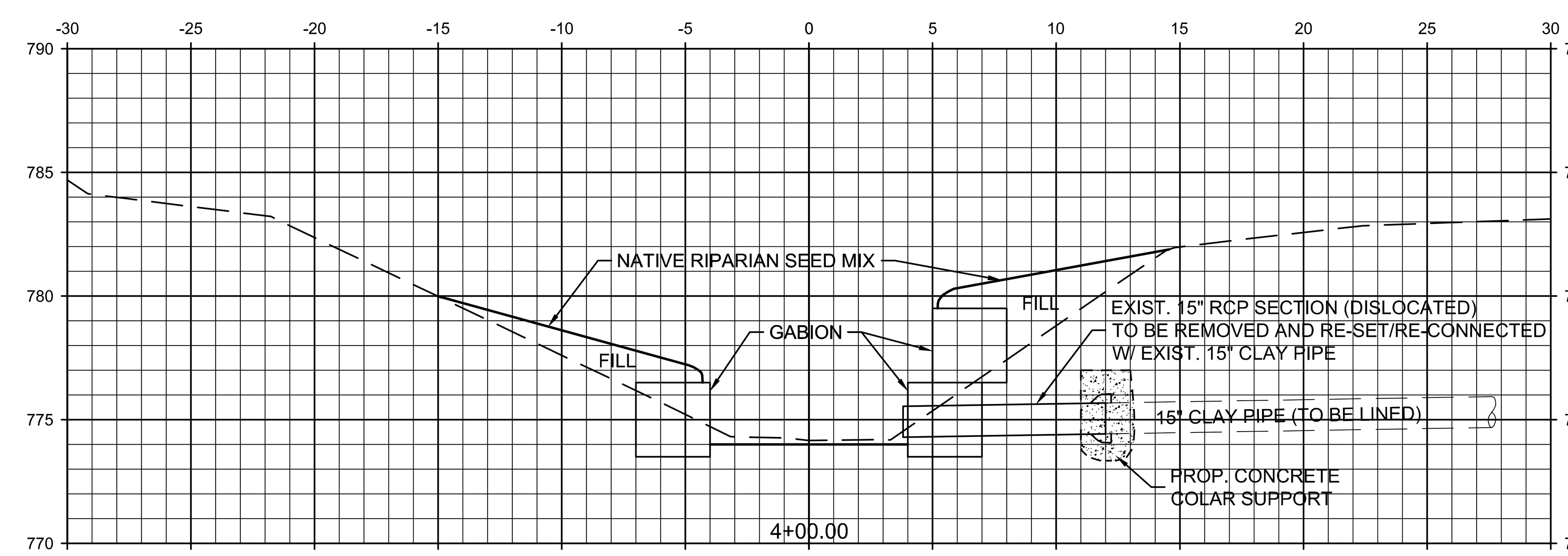
FILL:
PROP. GABION: - 292 CY
PROP. RIP-RAP: - 8 CY
PROP. SOIL: - 55 CY
TOTAL FILL: 355 CY

CROSS SECTIONS SCALES:
1"=5' HOR.
1"=5' VERT.









PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
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2	12/31/13	REVISION NOTES
1	12/31/13	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
SURVEYED BY: SURVEYOR NAME
DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-3
CROSS SECTIONS

C-301-12
SHEET 14 OF 17

3/18/2015 12:46 PM

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DETAIL 8

DETAIL 6

DETAIL 4

DETAIL 2

DETAIL 7

DETAIL 5

DETAIL 3

DETAIL 1

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

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APPROVED BY:
APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-4
DETAILS

C-501-13
SHEET 15 OF 17

SHEET INDEX

NO.	ID NO.	DESCRIPTION	REMARKS
1	G-001-01	TITLE SHEET	
2	G-002-02	GENERAL NOTES	
3	C-101-01	LAYOUT INDEX	
4	C-102-02	SURVEY CONTROL	
5	C-103-03	EROSION CONTROL	
6	C-104-04	TRAFFIC CONTROL	
7	C-107-05	PLAN	
8	C-108-06	PLAN AND PROFILE	LINE A
9	C-301-07	CROSS SECTIONS	
10	C-501-08	DETAILS	

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10	C-501-08	DETAILS	

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
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3	12/31/13	REVISION NOTES
2	12/31/13	REVISION NOTES
1	12/31/13	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
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DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-4
SCHEDULES

C-601-14
SHEET 16 OF 17

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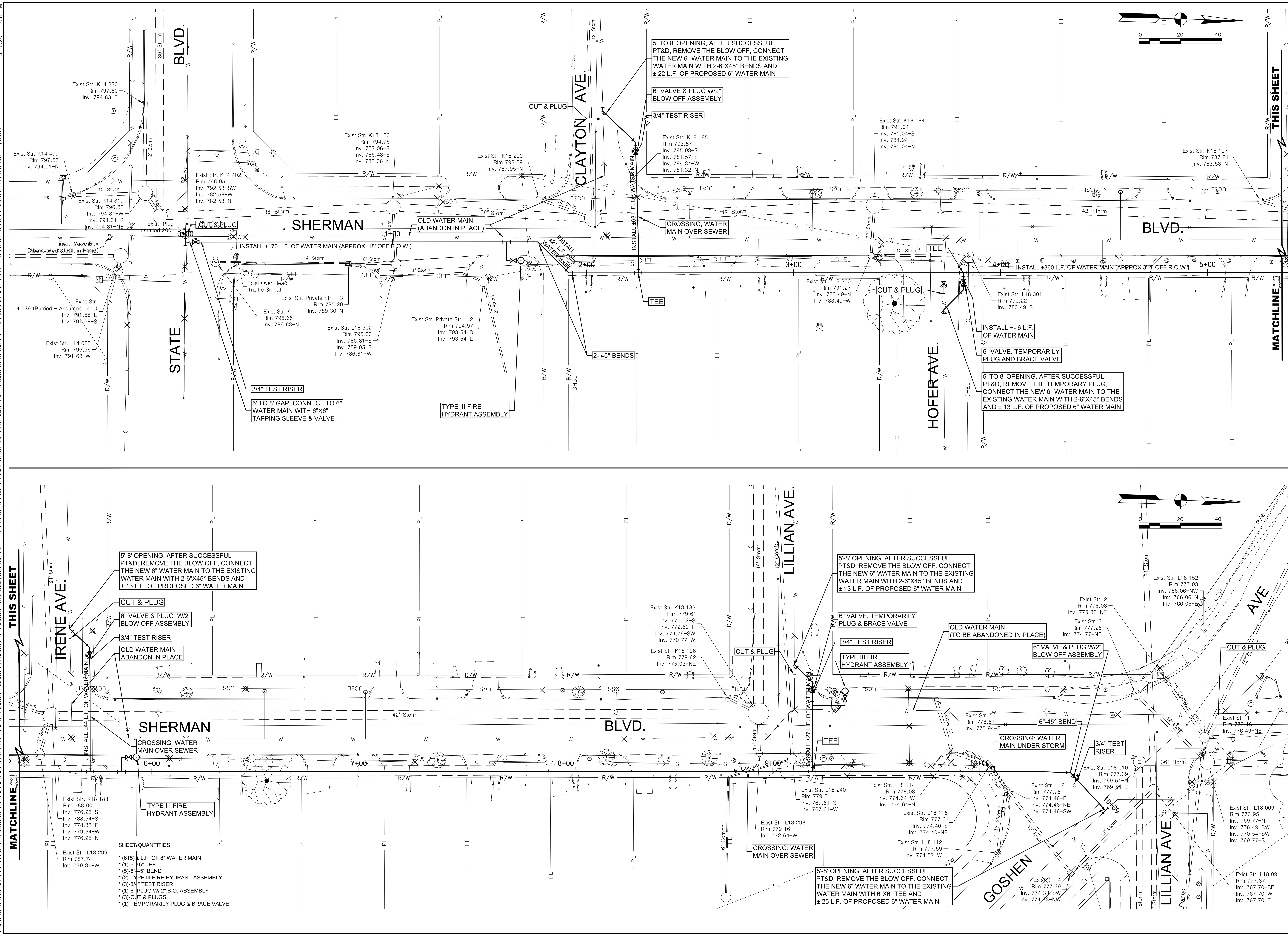

SHEET QUANTITIES

* (615) ± L.F. OF 8" WATER MAIN
* (1)-6"X6" TEE
* (5)-6"-45° BEND
* (2)-TYPE III FIRE HYDRANT ASSEMBLY
* (3)-3/4" TEST RISER
* (1)-6" PLUG W/ 2" B.O. ASSEMBLY
* (3)-CUT & PLUGS
* (1)-TEMPORARILY PLUG & BRACE VALVE

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY: ____ DATE: ____

BY: ____ DATE: ____

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
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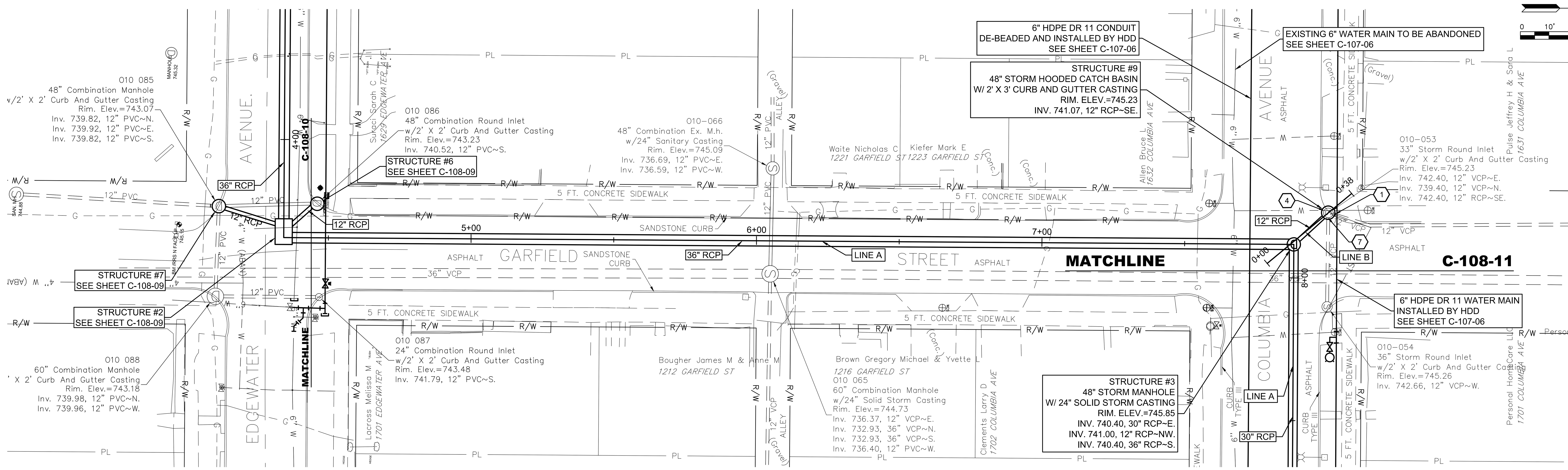
DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

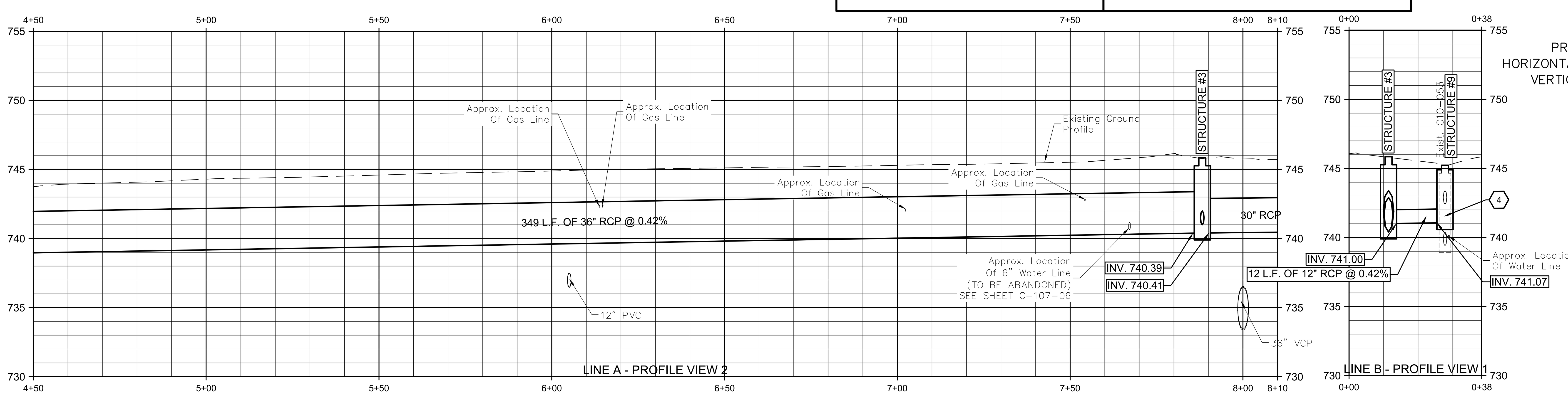
EXHIBIT CADD5-6
PLAN

C-107-09

7/18/2023 10:53 AM



⬡ SHEET KEYNOTES	NOTES
1. BULK HEAD PIPE OR PLUG HOLE AT MH/INLET STRUCTURE 2. REMOVE MANHOLE 3. REMOVE PIPE 4. REMOVE INLET 5. (NOT USED) 6. SPECIAL BACKFILL #53 OR #73 7. CONNECT EXISTING PIPE TO NEW STRUCTURE 8. EXISTING STREET LIGHT POLES AND CABLES WITHIN THE CONSTRUCTION ZONE TO BE REMOVED, RESET, AND REWIRED	A. ALL RIM ELEVATIONS FOR PROPOSED STRUCTURES IN PAVEMENT INTENDED TO MATCH EXISTING GRADE. B. BIKE PATH TO REMAIN OPEN DURING CONSTRUCTION. REROUTE SIGNS TO BE POSTED C. ONE WEEK ADVANCE NOTICE REQUIRED BEFORE CLOSING OF BIKE PATH. D. COORDINATE WET WELL LIFT STATION WORK WITH OWNER ONE WEEK IN ADVANCE E. ALL WORK ON NORTH ANTHONY TO BE COORDINATED AND COMPLETED WITHIN 3 WEEK TIME PERIOD . NO WORK ON NORTH ANTHONY BETWEEN NOVEMBER 22, 2021 AND JANUARY 7, 2022



PROFILE SCALE:
HORIZONTAL: 1" = 20'
VERTICAL: 1" = 5'

K:\DRAFTING PROJECTS\2020 PROJECTS\MATTHEW GRIEGER\83695 - NORTH ANTHONY STORMWATER IMPROVEMENTS\DRAWINGS\SHEET DRAWINGS\83695C-108-10.DWG

SHEET PREPARED BY:
CITY UTILITIES
WATER THAT WORKS
CITY OF FORT WAYNE
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY: DATE:

MATTHEW RICHARD GRIEGER
REGISTERED
No. 11800844
STATE OF INDIANA
PROFESSIONAL ENGINEER

BY: DATE: 05/25/2021

NORTH ANTHONY STORMWATER IMPROVEMENTS

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

CONFORMED TO CONTRACT
REVISED TO CONFORM TO CONTRACT DOCUMENTS AS REVISED BY ADDENDA
BY: ERIC KLEINRICHERT
DATE: 8-12-2021

1	12/1/21	NORTH ANTHONY DESIGN CHANGES

W.O. NO: 83695
DWG NO: SY-75476
SURVEYED BY: A & Z ENGINEERING LLC
DRAWN BY: S. MILLER E. KLEINRICHERT, E. BURNS
DESIGNED BY: MATTHEW GRIEGER
CHECKED BY: BRYAN N. BAGGETT, P.E.
APPROVED BY: MATTHEW GRIEGER, P.E.
DATE: 12/1/2021
SHEET TITLE:

EXHIBIT CADD 5-7 PLAN & PROFILE (LINES A AND B)

C-108-10
SHEET 12 OF 21

3/18/2015 12:49 PM

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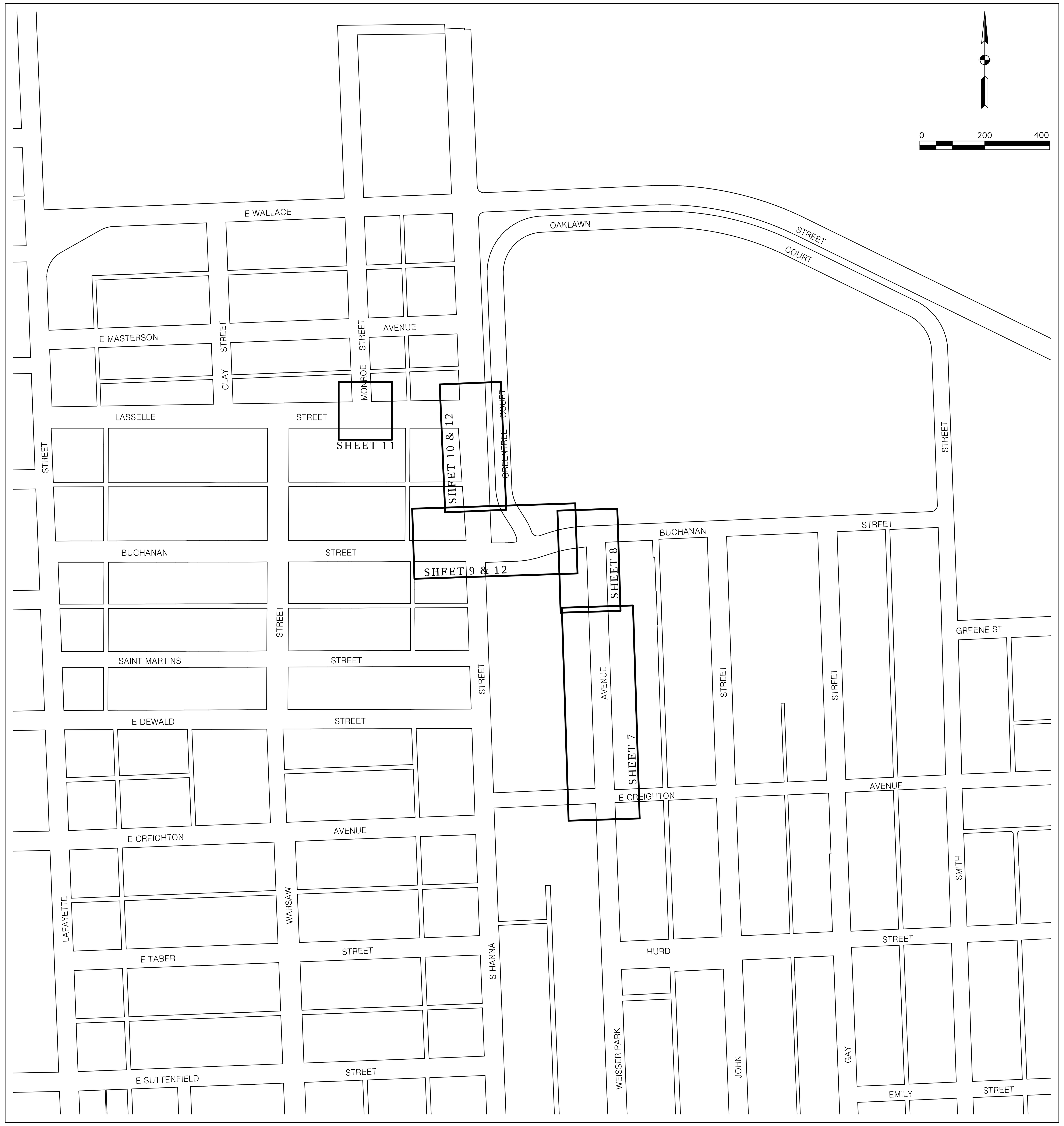


SHEET LAYOUT INDEX

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY: ____
DATE: ____

BY: ____
DATE: ____

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

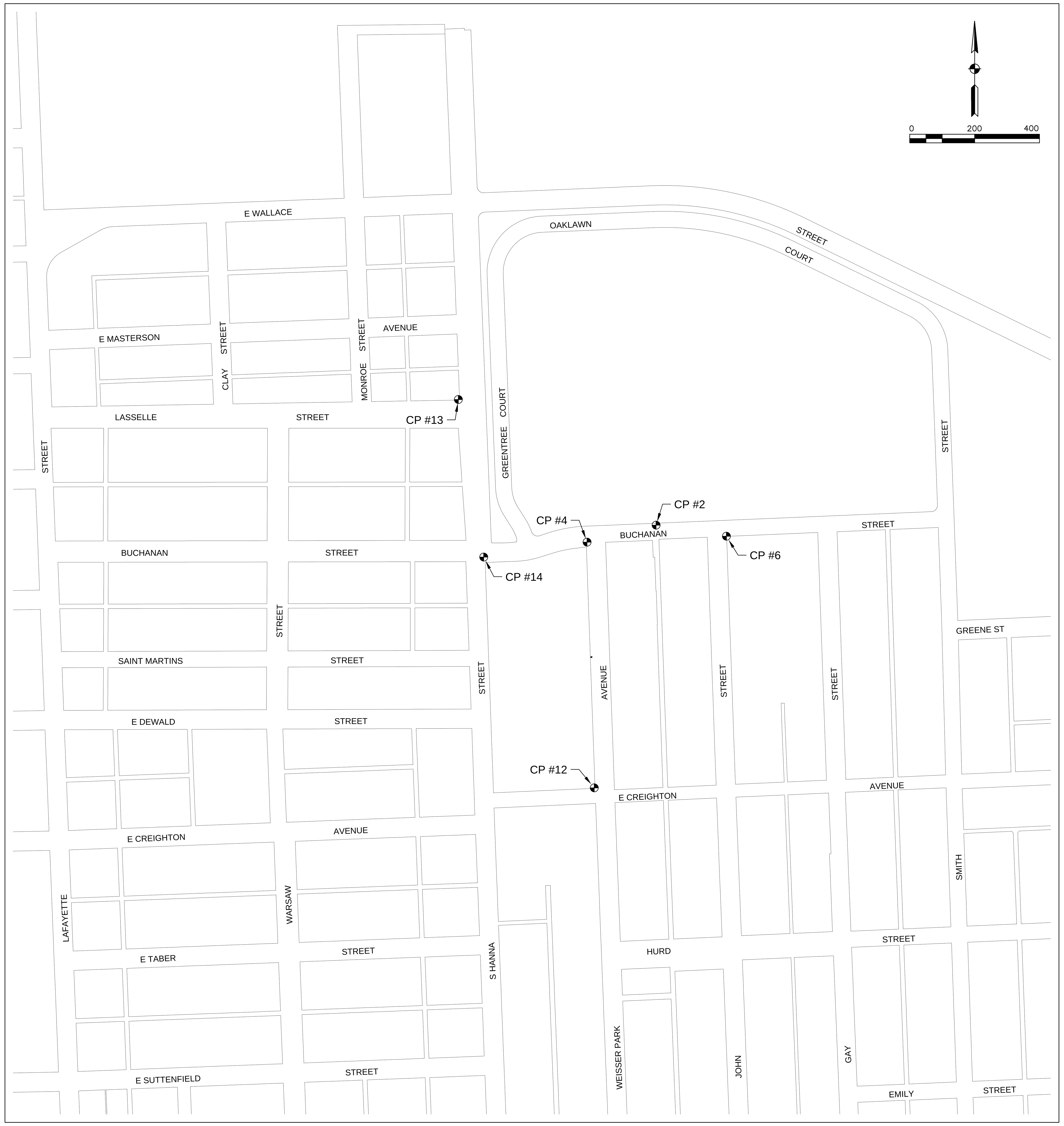
30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
6	12/31/13	REVISION NOTES
5	12/31/13	REVISION NOTES
4	12/31/13	REVISION NOTES
3	12/31/13	REVISION NOTES
2	12/31/13	REVISION NOTES
1	12/31/13	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
SURVEYED BY: SURVEYOR NAME
DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-8
LAYOUT INDEX

C-101-01
SHEET 3 OF 17

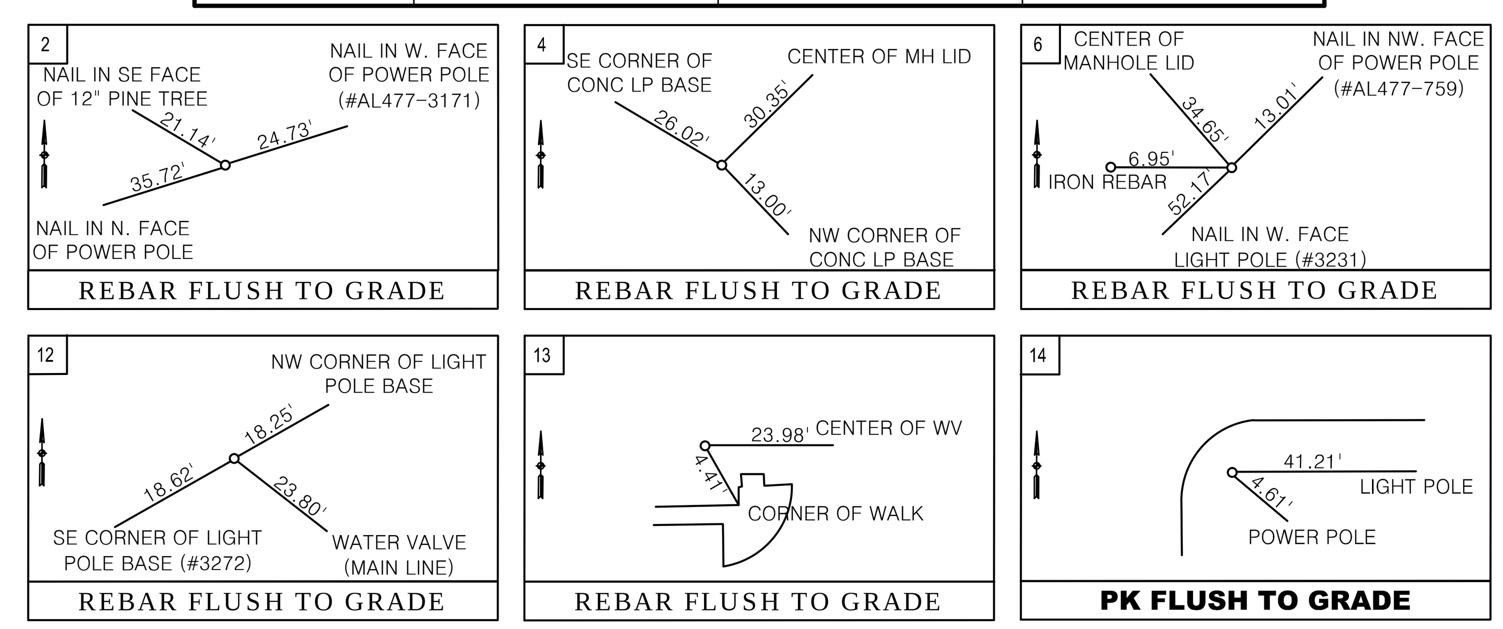


CONTROL POINTS

BENCHMARKS:
TBM ~ NORTH RIM OF MANHOLE AT SE CORNER OF BUCHANAN AND HANNA
ELEV. = 791.67

CONTROL POINT INDEX

CP	NORTHING	EASTING	ELEVATION
2	2119866.6370	477039.5160	795.16
4	2119813.9550	476825.4580	793.54
6	2119832.4800	477257.2010	798.00
12	2119052.1900	476847.7170	812.89
13	2120256.3770	476426.5780	788.71
14	2119767.6510	476505.1280	791.39



FIELD REFERENCES

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
DATE:

BY:
DATE:

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
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200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

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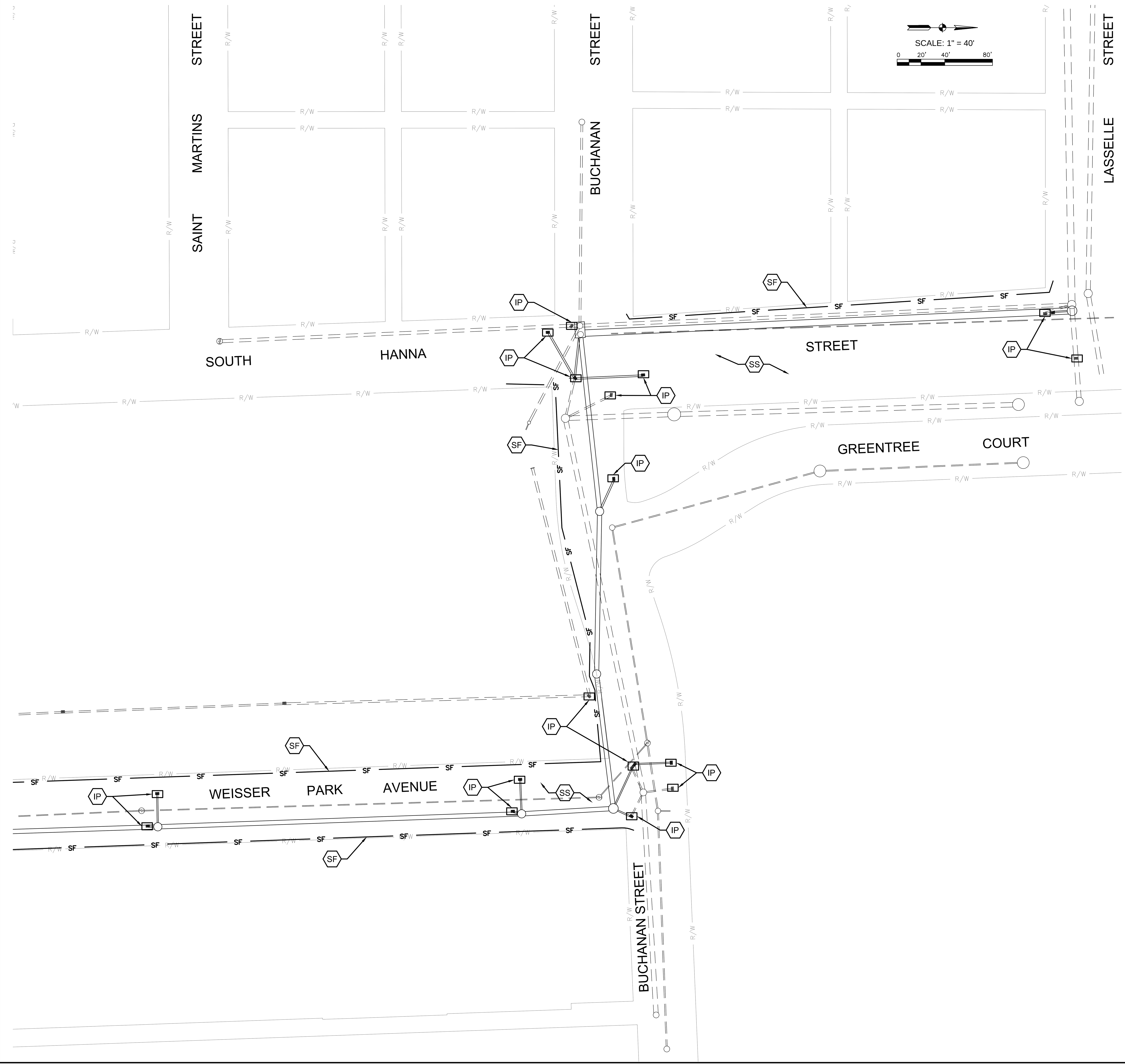
EXHIBIT CADD5-9
SURVEY CONTROL

C-102-02
SHEET 4 OF 17



EROSION CONTROL NOTES

1. UNLESS OTHERWISE INDICATED, ALL VEGETATIVE, EROSION AND SEDIMENT CONTROL PRACTICES WILL BE CONSTRUCTED AND MAINTAINED ACCORDING TO THE APPROVED EROSION CONTROL PLANT, STATE AND LOCAL ORDINANCES THAT APPLY AND REQUIREMENTS OF THE CONTRACT DOCUMENTS.
2. ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSTALLED IF DEEMED NECESSARY BY ONSITE INSPECTION AND/OR LOCAL AUTHORITY
3. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF PRODUCING RAINFALL EVENT.ANY NECESSARY REPAIRS TO MAINTAIN THE EFFECTIVENESS OF THE EROSION CONTROL DEVICES AND CLEANUP OF SEDIMENTATION ARE THE RESPONSIBILITY OF THE CONTRACTOR.
4. SEDIMENT DEPOSITS SHALL BE DISPOSED OF IN A LOCATION WHICH DOES NOT CAUSE SEDIMENTATION ELSEWHERE.
5. THE CONTRACTOR SHALL LIMIT SITE ACCESS BY CONSTRUCTION VEHICLES TO ENTRANCES PROTECTED BY A STONE CONSTRUCTION ENTRANCE OR AN APPROVED COMPARABLE CONTROL MEASURE.
6. STOCK PILES OF SOIL AND OTHER ERODIBLE MATERIALS SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING DEVICES.
7. EFFLUENT FROM DE-WATERING OPERATIONS SHALL BE FILTERED OR PASSED THROUGH AN APPROVED SEDIMENT TRAPPING DEVICE, OR BOTH AND DISCHARGED IN A MANNER THAT DOES NOT ADVERSELY AFFECT ADJACENT PROPERTIES, WETLANDS, WATERWAYS, OR STORM DRAINAGE SYSTEMS.
8. TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES ARE NOT TO BE REMOVED UNTIL ALL DISTRIBUTED AREAS ARE STABILIZED.
9. CONTRACTOR SHALL ENSURE THAT ALL APPLICABLE EROSION AND SEDIMENT CONTROL MEASURES ARE IN PLACE DURING ALL THE APPROPRIATE PHRASES OF CONSTRUCTION.
10. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE ALL MUD, DIRT, GRAVEL, AND ANY OTHER MATERIALS TRACKED ONTO ANY PUBLIC OR PRIVATE STREETS, PARKING LOTS, OR WALKS. THIS MATERIAL REMOVAL OR SWEEPING OF THE STREETS SHALL BE DONE AS FREQUENTLY AS NECESSARY TO MAINTAIN REASONABLY CLEAN AREAS. THE CONTRACTOR SHALL ALSO CONTROL DUST THROUGH THE USE OF WATERING, APPLICATION OF DUST PALLIATIVE, OR OTHER APPROVED METHODS. NO DIRECT PAYMENT WILL BE MADE FOR ANY SUCH CLEANING WORK OR DUST CONTROL.
11. RE-GRADE AREAS AS NECESSARY WITHIN THE CONSTRUCTION LIMITS TO ALLOW PROPER DRAINAGE TO EXISTING AND PROPOSED STORM SEWER STRUCTURES AND DRAINAGE DITCHES. ANY EXCESS SOIL AND SPOIL MATERIAL SHALL BE DISPOSED OF BY THE CONTRACTOR OFF-SITE.

⬡ SHEET KEYNOTES

CD. TEMPORARY ROCK CHECK DAM
CL. COIR LOG
CW. CONCRETE WASHOUT
DB. DEWATERING BAG FOR SEDIMENT CONTROL
EB. EROSION CONTROL BLANKET
EL. EARTHEN CLAY LEVEE
FS. FILTER SOCK FOR PERIMETER PROTECTION
IP. INLET PROTECTION
NT. REMOVE AND REPLACE TREE
PS. PERMANENT SEEDING/MULCHING
PT. PROTECT TREE
RR. RIPRAP SLOPE PROTECTION
RT. REMOVE TREE
SF. SILT FENCE FOR PERIMETER PROTECTION
SS. STREET SWEEPING
ST. SEDIMENT TRAP
TE. TEMPORARY CONSTRUCTION ENTRANCE
TM. TURF-REINFORCEMENT MAT
TS. TEMPORARY SEEDING/MULCHING

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY:
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DATE:

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(PROJECT LIMITS)

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FORT WAYNE
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30% PLANS
NOT FOR CONSTRUCTION

7	12/31/13	REVISION NOTES
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DESIGNER NAME
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CHECKED BY NAME
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APPROVED BY NAME
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SHEET TITLE:

EXHIBIT CADD5-10
EROSION CONTROL

C-103-03
SHEET 5 OF 17

GENERAL SHEET NOTES

1. CONTRACTOR TO COMPLETE EACH PHASE BEFORE MOVING ON TO THE NEXT PHASE.

SHEET KEYNOTES

A. ROAD CONSTRUCTION AHEAD
B. ROAD CLOSED AHEAD
C. DETOUR AHEAD
D. TYPE III BARRICADE WITH ROAD CLOSED LOCAL TRAFFIC ONLY & DETOUR (RIGHT/LEFT)
E. DETOUR RIGHT
F. DETOUR THRU
G. DETOUR LEFT
H. TYPE III BARRICADE WITH ROAD CLOSED
I. TYPE III BARRICADE
J. TYPE III BARRICADE WITH ROAD CLOSED LOCAL TRAFFIC ONLY

LEGEND

SIGN
BARRICADE

3/18/2015 12:51 PM
G:\CU WATER RESOURCES SHARE\WATER RESOURCES SHARE\SHARED CADD FILES\STANDARDS & MANUALS\CADD STANDARDS - WORKING DOCS\CADD 5 - DRAFTING CONVENTIONS\XXXXX - CADD STANDARDS 2013\DRAWINGS\SHEET DRAWINGS\SHEET TYPE EXHIBITS\EXHIBIT CADD5-11 - TRAFFIC CONTROL.DWG

PLANS PREPARED BY:
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CITY UTILITIES ENGINEERING
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200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY: ____ DATE: ____

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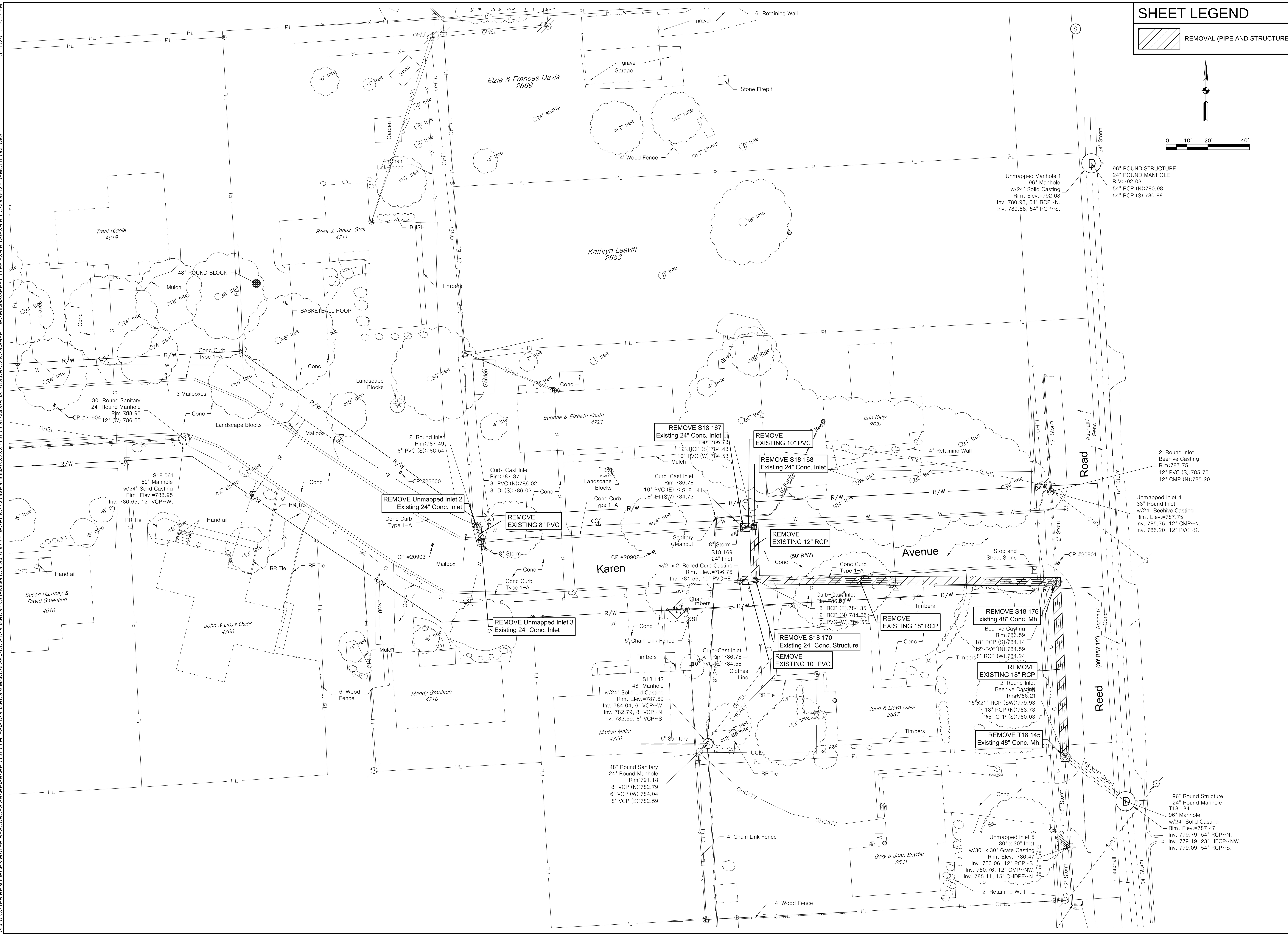
EXHIBIT CADD5-11
TRAFFIC CONTROL

C-104-04
SHEET 6 OF 17



PLANS PREPARED BY:
FORT WAYNE
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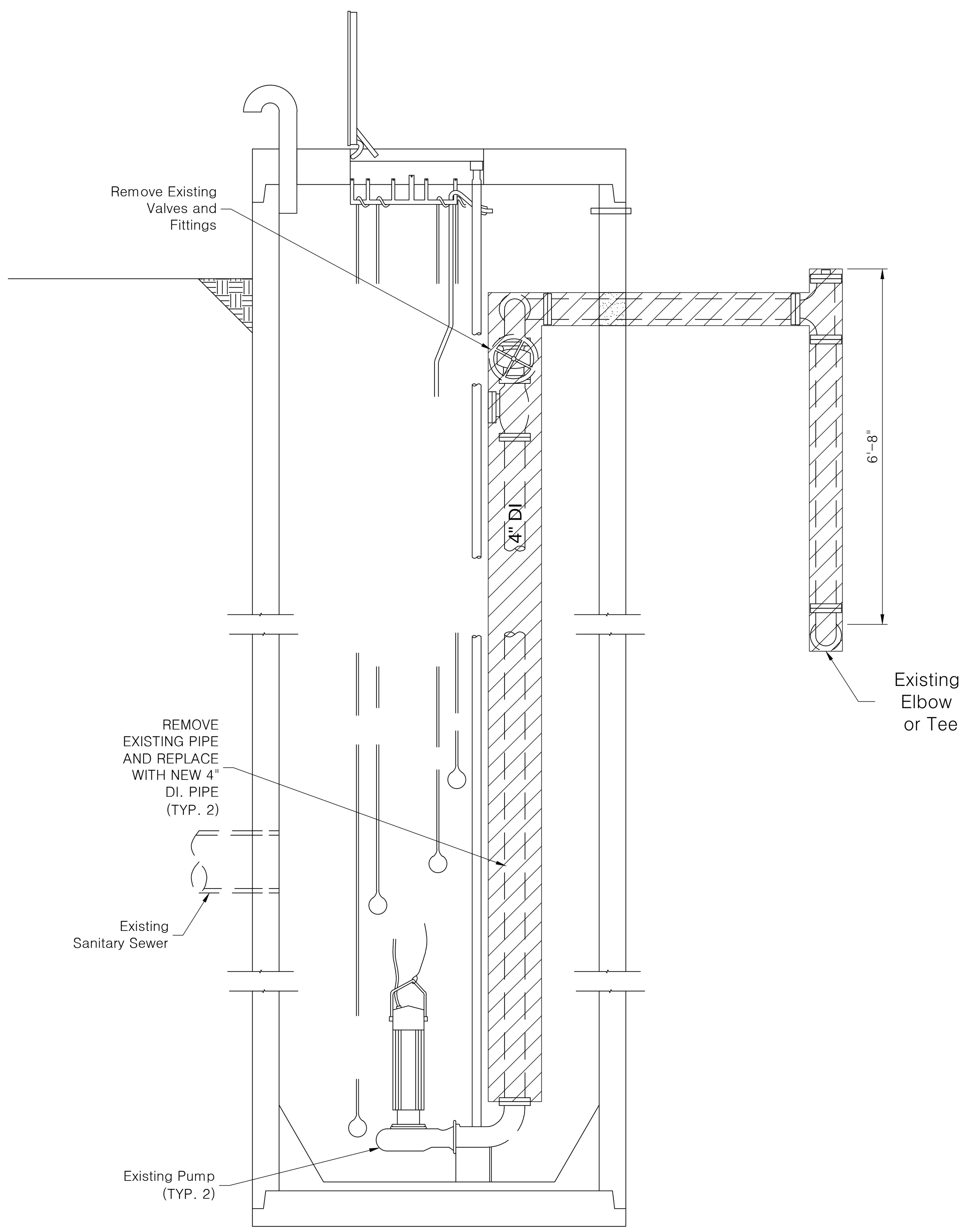
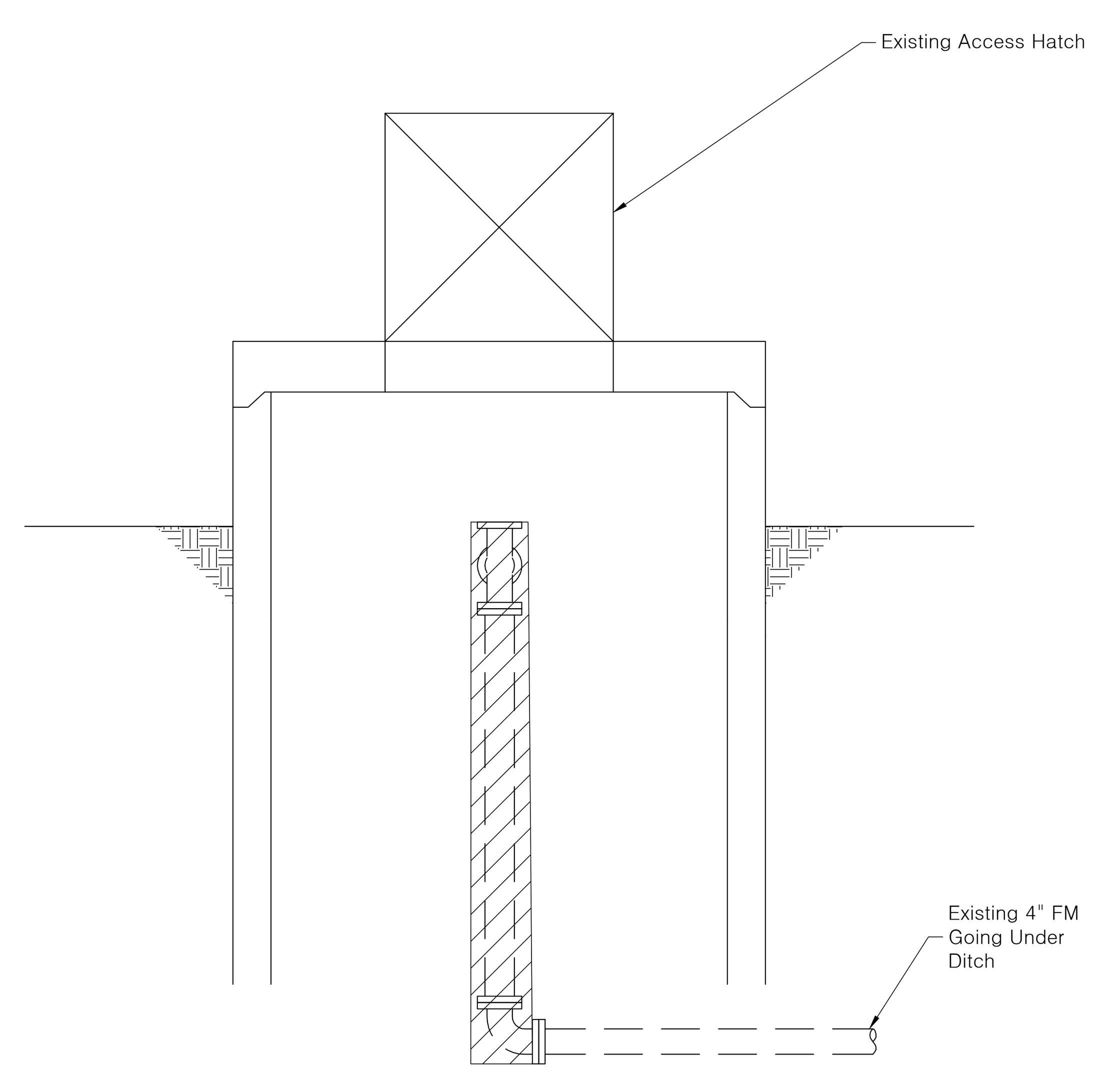
SHEET TITLE:

EXHIBIT CADD5-12
DEMOLITION

C-105-05
SHEET 7 OF 17



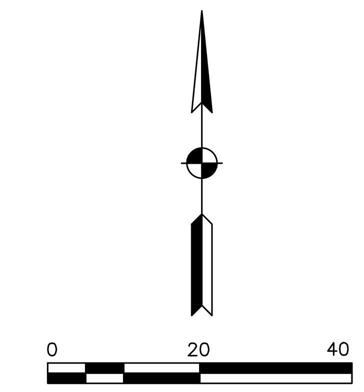
EXISTING WET WELL
SCETION A-A
SCALE: N.T.S.

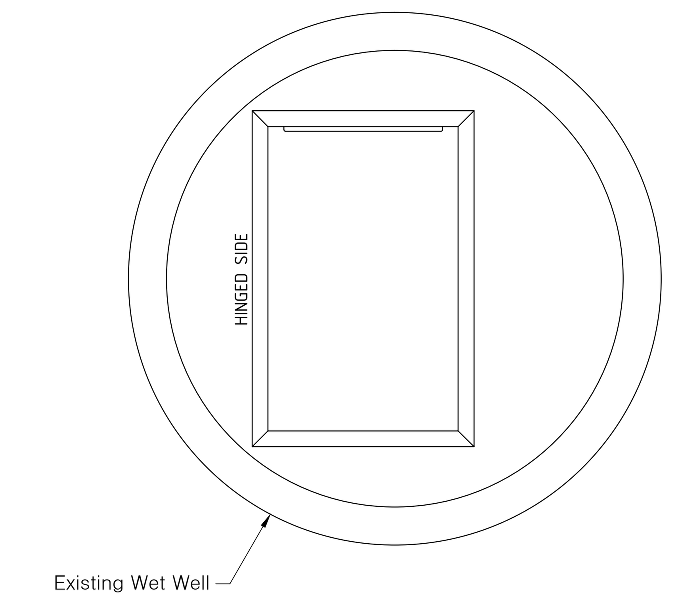


EXISTING 4" FM
SECTION B-B
SCALE: N.T.S.

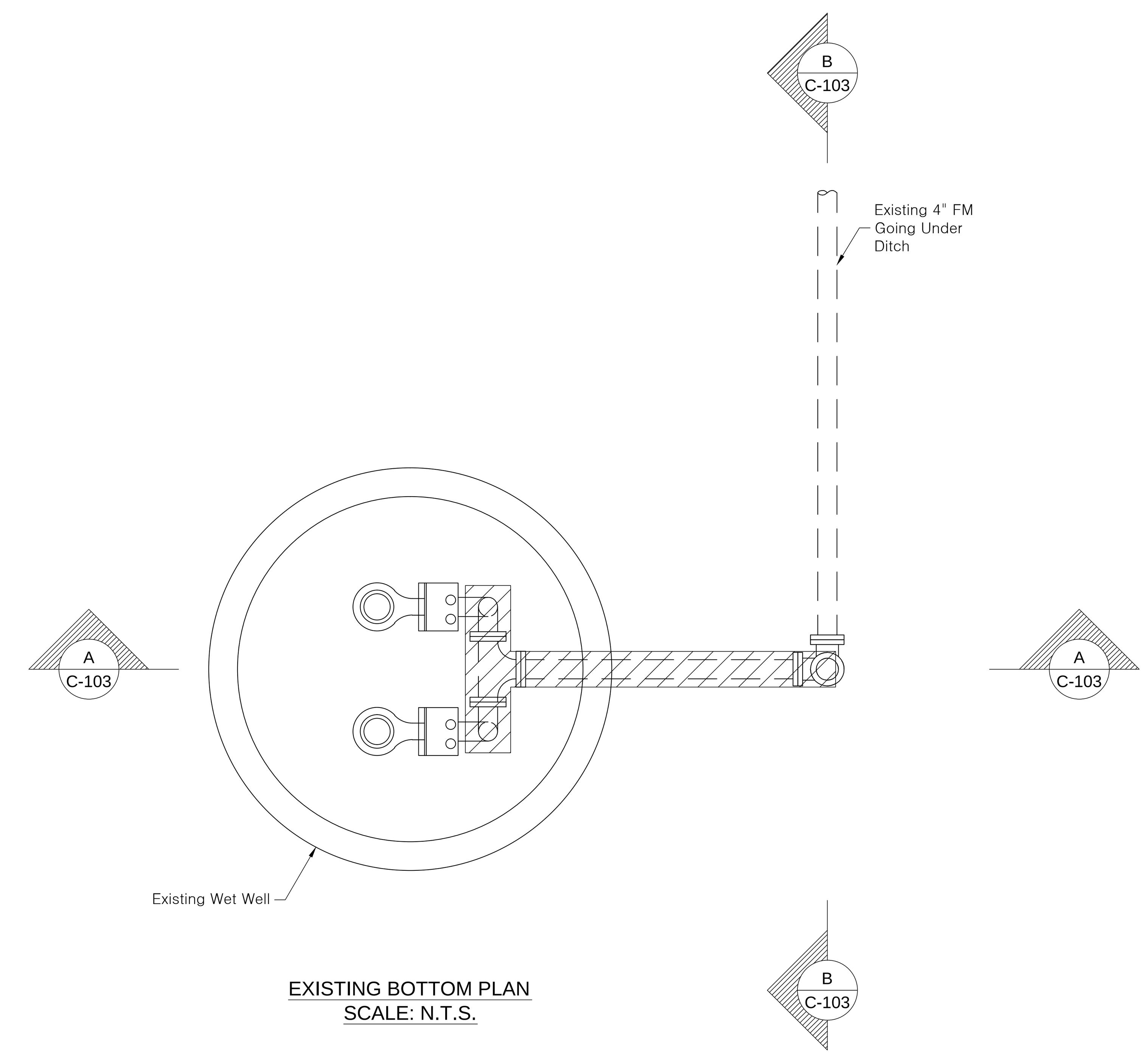
SHEET LEGEND

REMOVAL





EXISTING TOP PLAN
SCALE: N.T.S.



EXISTING BOTTOM PLAN
SCALE: N.T.S.

PLANS PREPARED BY:
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CITIZENS SQUARE
200 E. BERRY ST., STE 250
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BY:
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DATE:

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PREPARED FOR:
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DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-13
DEMOLITION

C-105-06
SHEET 8 OF 17

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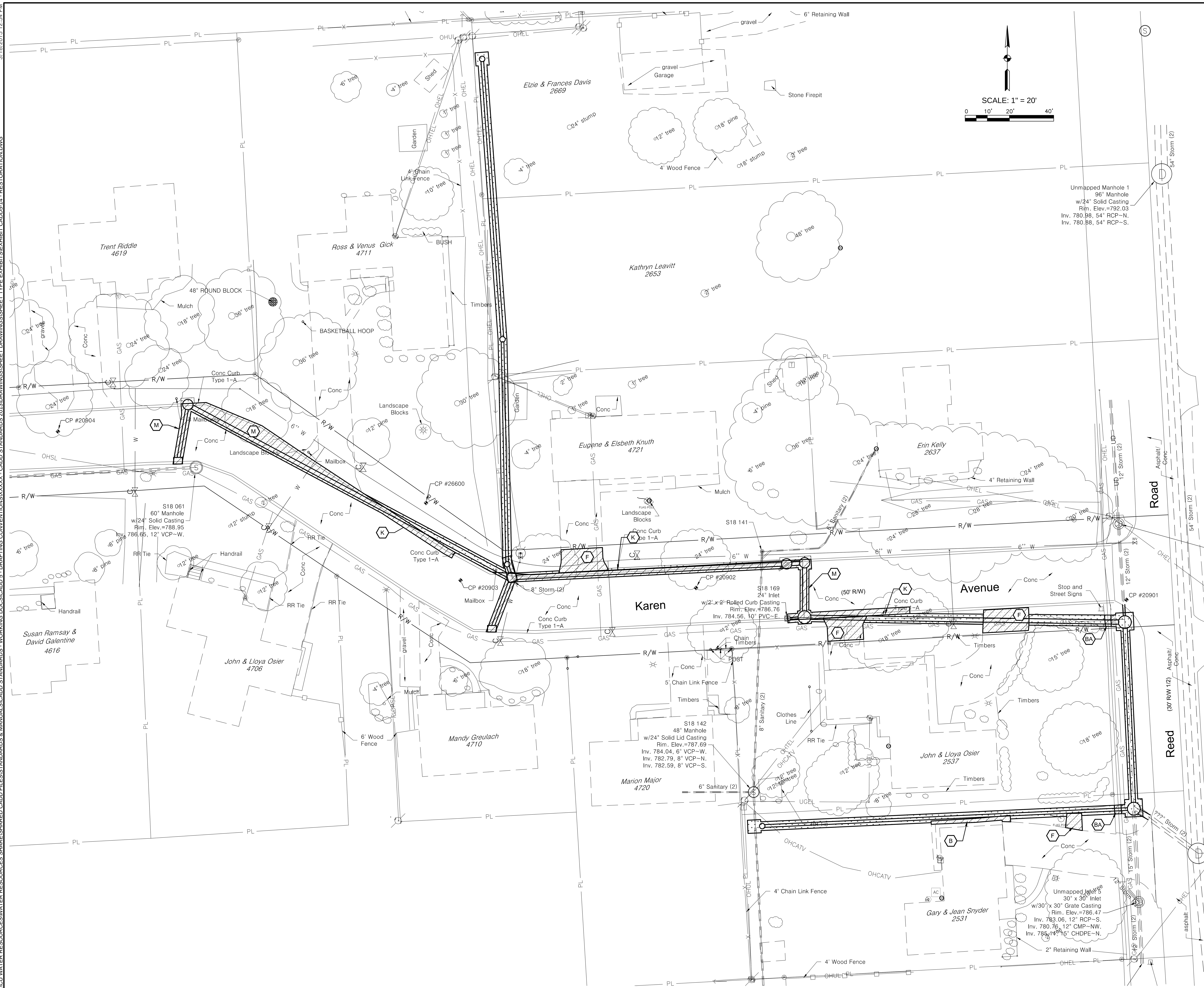

SHEET KEYNOTES

B	CONCRETE SIDEWALK
BA	ASPHALT SIDEWALK
F	CONCRETE FOR RESIDENTIAL DRIVES (6")
K	CONCRETE CURB TYPE I-A
M	7" CONCRETE REQUIRED, INCLUDES TYPE I-A CURB
PF	PRUNE & FERTILIZE TREE
TR	TREE REMOVAL
TF	TREE FERTILIZATION

SHEET LEGEND

- REMOVAL
- PAVEMENT MATERIAL
- SEED

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200 E. BERRY ST., STE 250
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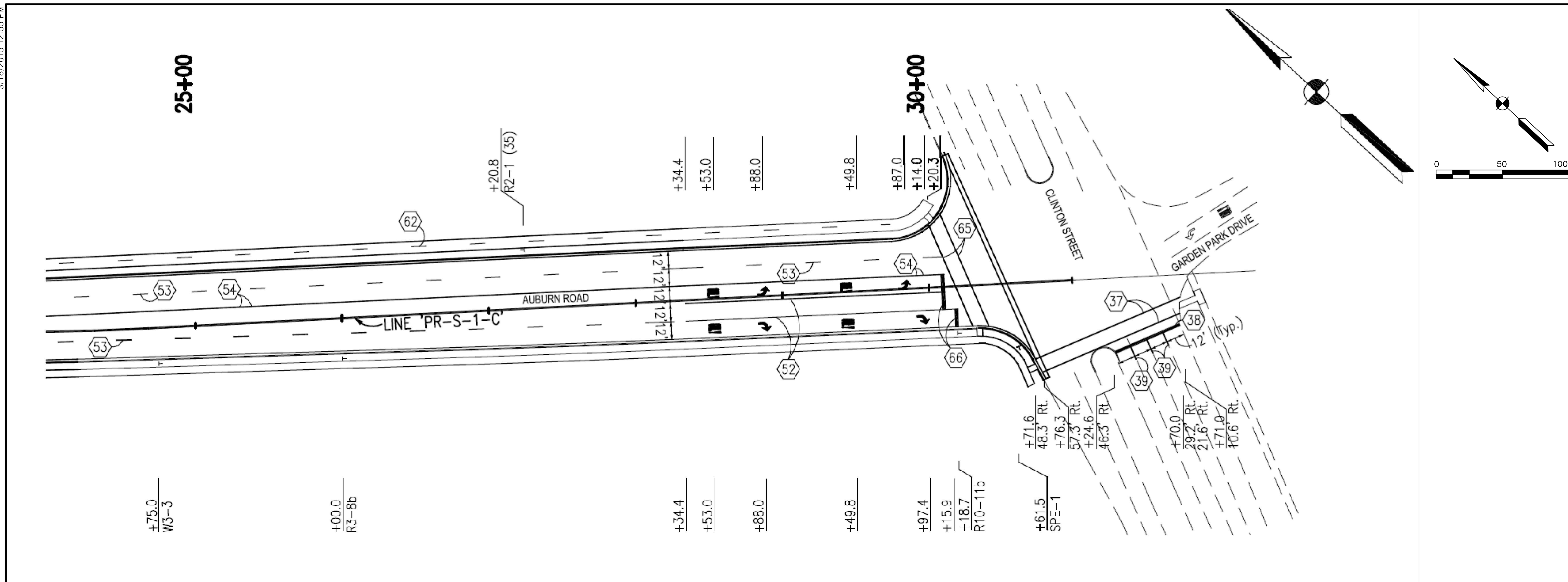
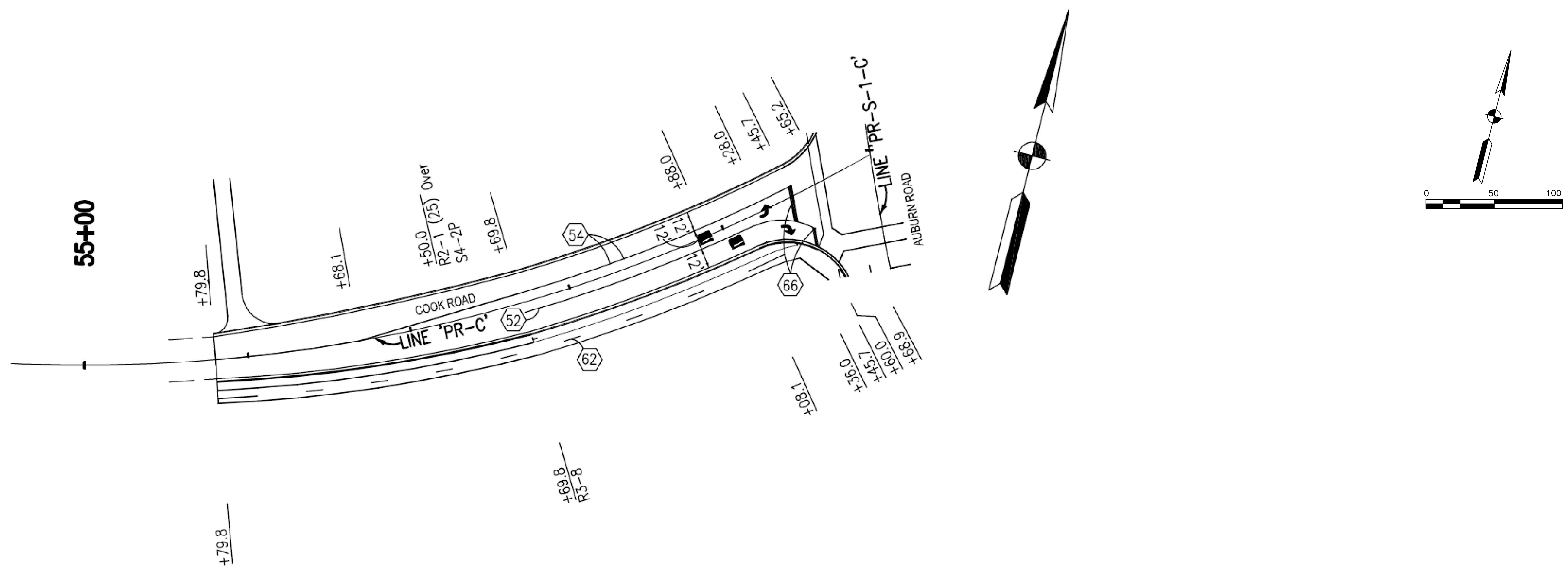
EXHIBITCADD5-14
RESTORATION

C-106-07
SHEET 9 OF 17

3/18/2015 12:55 PM



PAVEMENT MARKINGS AND SIGNAGE - INTERSECTION OF AUBURN ROAD AND CLINTON STREET



PAVEMENT MARKINGS AND SIGNAGE - INTERSECTION OF AUBURN ROAD AND COOK ROAD

SHEET KEYNOTES

1. REMOVE AND REPLACE TYPE III CONCRETE CURB
2. REMOVE AND REPLACE ARTERIAL ASPHALT STREET
3. REMOVE AND REPLACE RESIDENTIAL STREET
4. REMOVE AND REPLACE CONCRETE ALLEY DRIVE
5. PATCH DETAIL - STRUCTURAL REMOVAL
6. REMOVE AND REPLACE COMERCIAL CONCRETE DRIVE APPROACH
7. REMOVE AND REPLACE ASPHALT DRIVE APPROACH
8. REMOVE AND REPLACE CURB RAMP
9. 1-1/2" MILLING AND NEW SURFACE
10. REMOVE AND REPLACE SIDEWALK
11. REMOVE AND REPLACE TREE
12. REMOVE WALK APPROACH
13. REMOVE AND REINSTALL STREET LIGHT
14. CURB RAMP TYPE "A"
15. CURB RAMP TYPE "C"
16. CURB RAMP TYPE "D"

LEGEND

GROUND MOUNTED SHEET SIGN

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, LANE INDICATION ARROW

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, "ONLY"

SIGN LEGEND

GROUND MOUNTED SHEET SIGN

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, LANE INDICATION ARROW

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, "ONLY"

GROUND MOUNTED SHEET SIGN

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, LANE INDICATION ARROW

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, "ONLY"

GROUND MOUNTED SHEET SIGN

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, LANE INDICATION ARROW

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, "ONLY"

GROUND MOUNTED SHEET SIGN

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, LANE INDICATION ARROW

PAVEMENT MESSAGE MARKING, THERMOPLASTIC, "ONLY"

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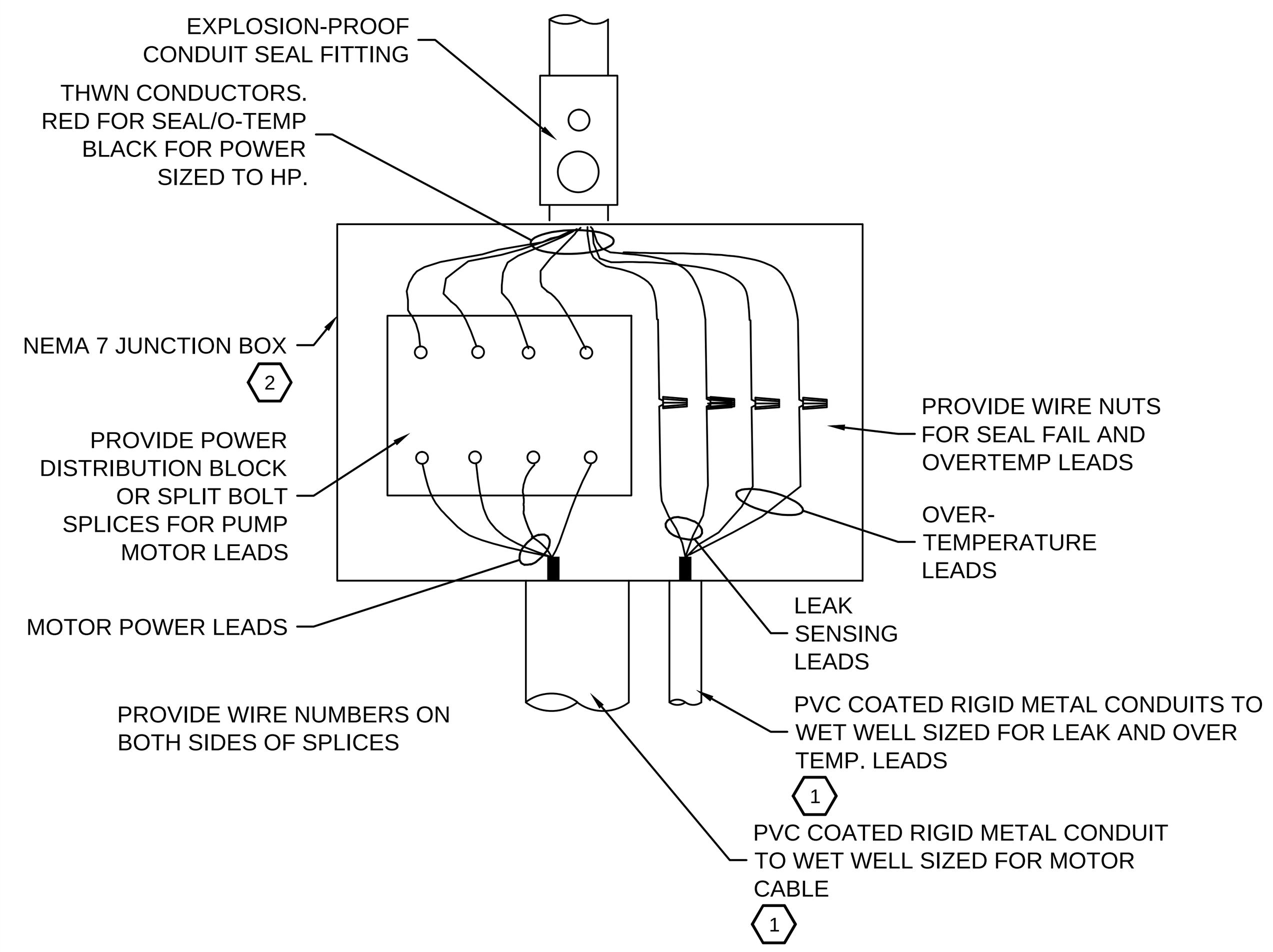
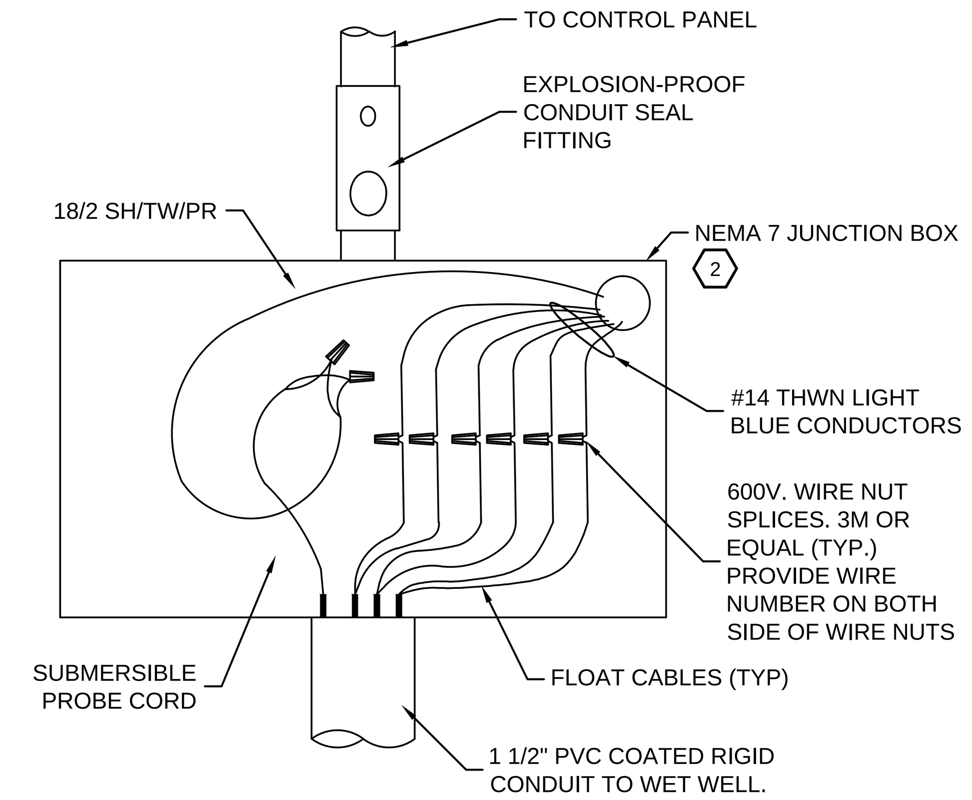
EXHIBIT CADD5-**15**
PAVEMENT MARKINGS AND SIGNAGE

C-109-11
SHEET 13 OF 17

G:\CUWATE~1\WATERR~1\SHARED~2\STANDA~1\CA8F47~1\CADD5~1\XXXXX~1\DRAWINGS\SHEETD~1\SHEETT~1\EXHIBIT CADD5-16 - PAVEMENT MARKINGS AND SIGNAGE W MARKUPS.DWG

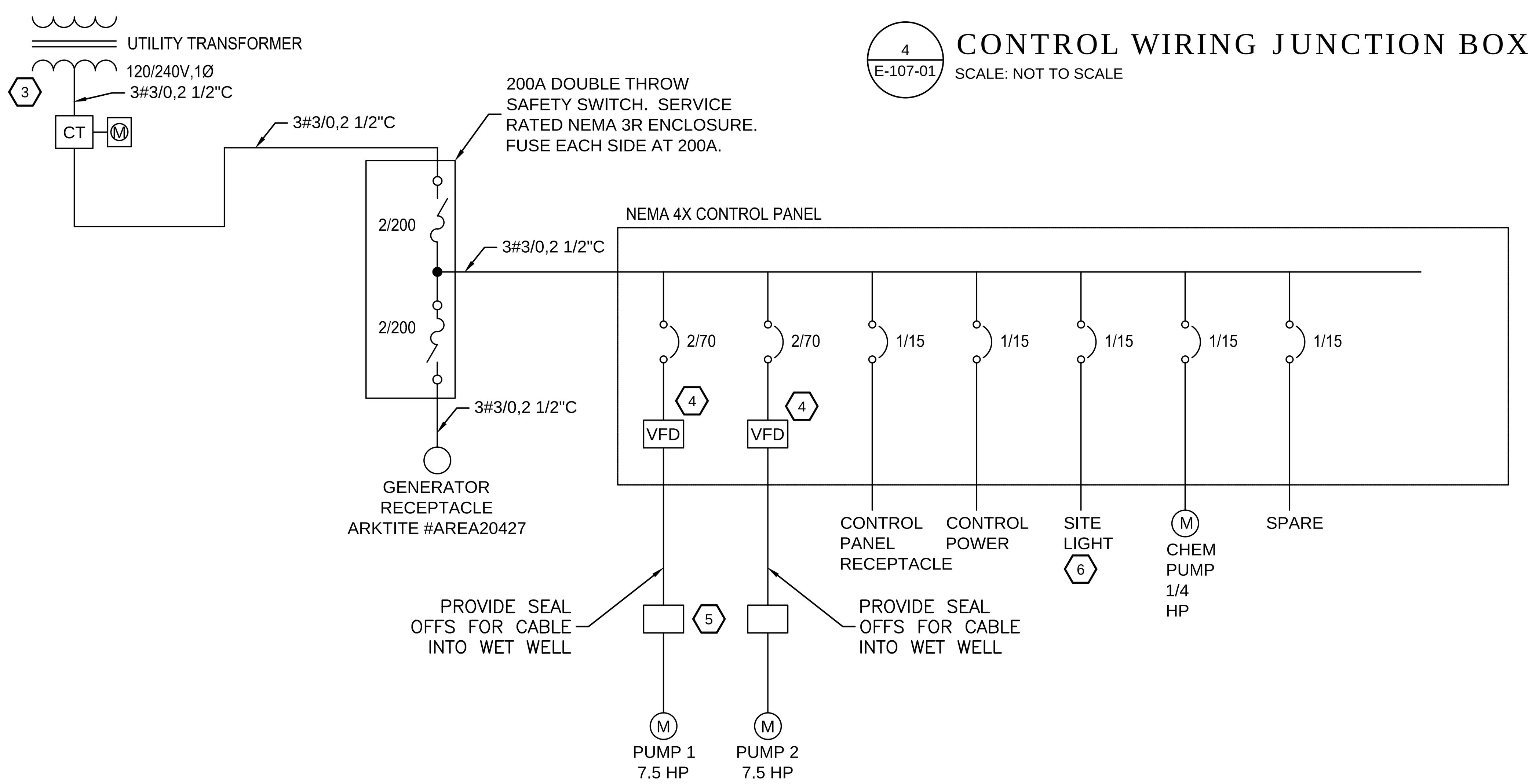


5
E-107-01
MOTOR LEAD JUNCTION BOX
SCALE: NOT TO SCALE

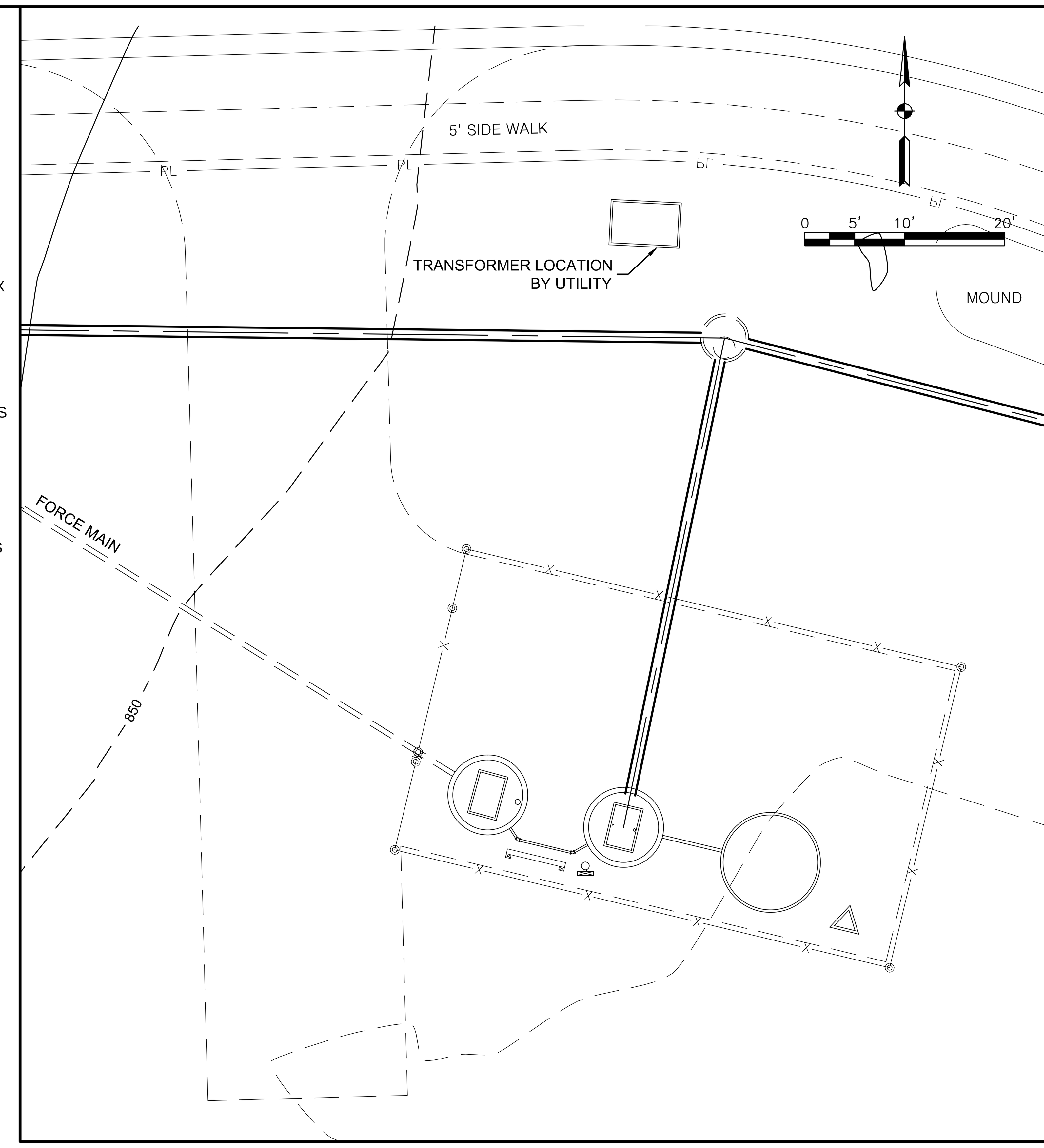


4
E-107-01
CONTROL WIRING JUNCTION BOX
SCALE: NOT TO SCALE

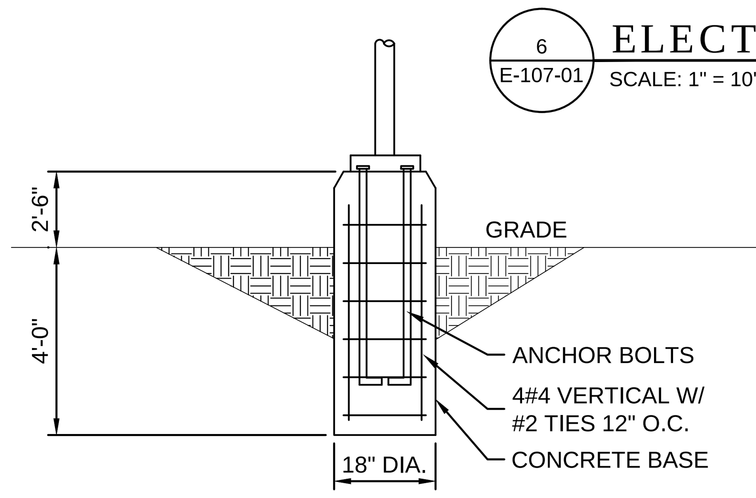
4
E-107-01
CONTROL WIRING JUNCTION BOX
SCALE: NOT TO SCALE



3
E-107-01
SINGLE LINE DIAGRAM
SCALE: NOT TO SCALE



6
E-107-01
ELECTRICAL SITE PLAN
SCALE: 1" = 10'



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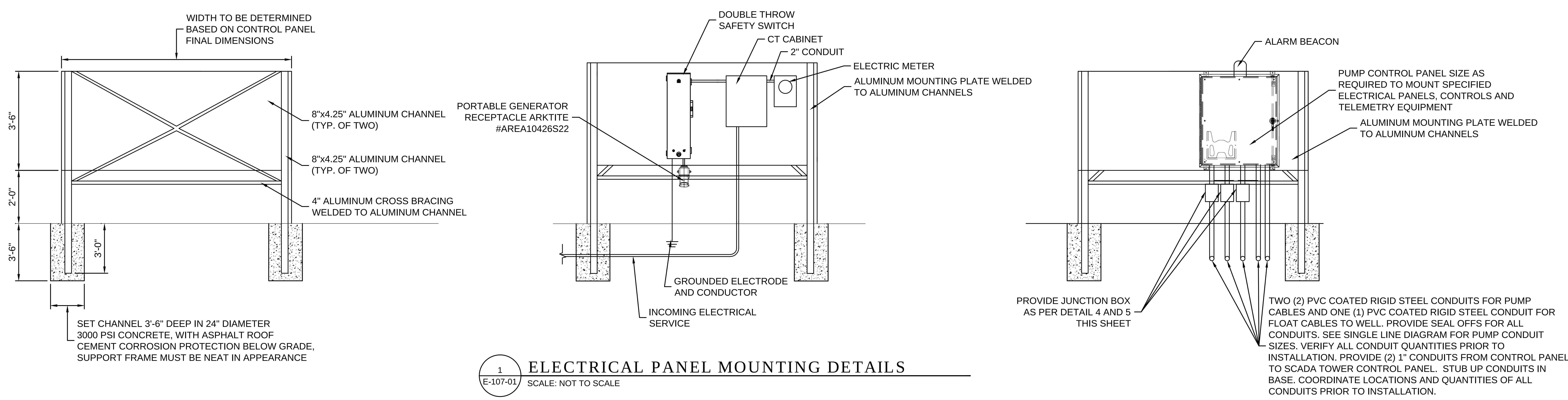
E-107-01
POLE BASE
SCALE: NOT TO SCALE



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E-107-01
ELECTRICAL PANEL MOUNTING DETAILS
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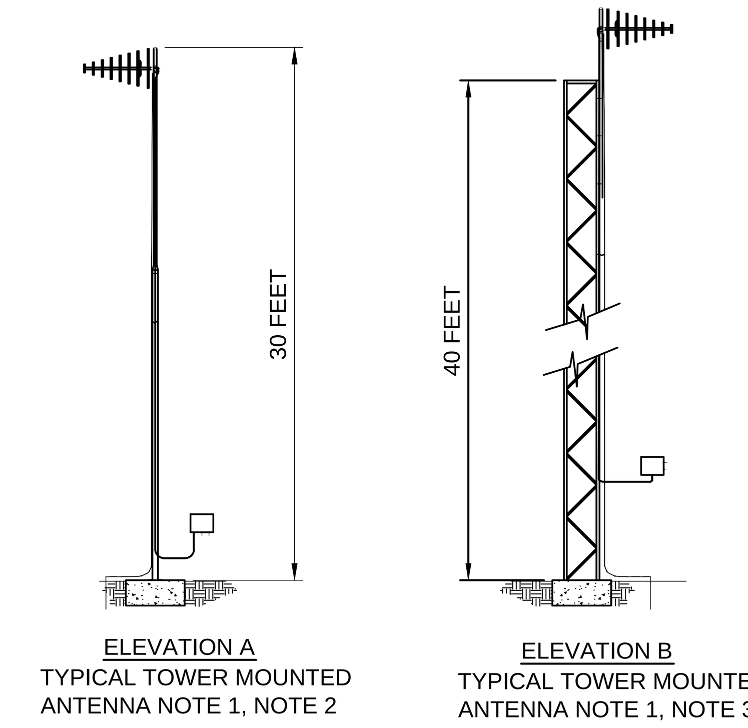


7
E-107-01
TELEMETRY TOWER
SCALE: NOT TO SCALE

GENERAL SHEET NOTES

1. REFER TO ELECTRICAL SPECIFICATIONS FOR EQUIPMENT INSTALLATION REQUIREMENTS.
2. CONTRACTORS TO COORDINATE THEIR WORK WITH ALL OTHER TRADES ON SITE. EXTRAS WILL NOT BE GIVEN FOR FORESEEABLE WORK COORDINATION.
3. PROTECT ALL EXISTING EQUIPMENT AND FINISHES FROM DUST, DEBRIS AND DAMAGE.
4. ALL WORK TO BE IN ACCORDANCE TO INDIANA AND NATIONAL ELECTRIC CODES.
5. ALL EQUIPMENT IS SHOWN IN APPROXIMATE LOCATIONS. VERIFY EXACT LOCATION ON SITE.
6. EXCEPT WHERE NOTED OTHERWISE, SIZE BRANCH CIRCUIT CONDUCTORS WITHIN THE FOLLOWING MAXIMUM LENGTH LIMITS: (MEASURE CENTER OF THE LOAD FOR LIGHTING AND MOST REMOTE OUTLET FOR RECEPTACLE CIRCUITS).

CIRCUIT BREAKER	CIRCUIT LENGTH	CONDUCTOR SIZE
120V,20A	65 FEET	#12
	110 FEET	#10
	165 FEET	#8
	270 FEET	#6

PROVIDE #12 AWG MINIMUM FOR ALL 120 VOLT CIRCUITS. PROVIDE ADDITIONAL DERATING PER NEC SECTION 310 FOR ALL HOME RUNS WITH MORE THAN THREE CURRENT CARRYING CONDUCTORS IN A SINGLE RACEWAY.

7. ALL 120 VOLT BRANCH CIRCUITS SHALL BE WIRED WITH 2#12, 1#12G, 3/4"C UNLESS OTHERWISE NOTED ON DRAWINGS.
8. ALL HARDWARE REQUIRED TO ANCHOR ELECTRICAL PANELING EQUIPMENT TO MOUNTING PLATE SHALL BE STAINLESS STEEL.
9. CONTRACTOR TO USE J & K COMMUNICATION TO PERFORM PROPAGATION STUDY WHICH WILL DETERMINE HEIGHT/TYPE OF ANTENNA.

SHEET KEYNOTES

1. CONTRACTOR MAY SUBSTITUTE PVC SCH 80 CONDUIT FOR RIGID METAL CONDUIT IF APPROVED BY ELECTRICAL INSPECTOR. ALL EXPOSED CONDUIT STILL MUST BE RIGID METAL.
2. ONLY INTRINSICALLY SAFE CONDUCTORS SHALL BE PERMITTED WITHIN THIS JUNCTION BOX AND CONDUITS.
3. PROVIDE NEW ELECTRICAL SERVICE, 120/240V, 1Ø. COORDINATE ALL WORK WITH UTILITY PRIOR TO INSTALLATION.
4. PROVIDE VFD IN CONTROL PANEL FOR LIFT STATION PUMPS. SINGLE PHASE INPUT, 3-PHASE OUTPUT. ALLEN BRADLEY #20AB054, POWERFLEX 70
5. PROVIDE NEMA 7 JUNCTION BOX FOR WIRE TERMINATION AS SHOWN IN DETAILS 4 AND 5.
6. PROVIDE NEW LIGHT AND POLE. INVUE #VXS-B02-LED-E1-T3-BZ-PC, OR EQUAL BY LITHONIA (2) 21 LED BAR, SHOEBOX, BRONZE FINISH, INTEGRAL PHOTOCELL, 15' SQUARE STEEL POLE ON CONCRETE BASE PER DETAIL 2. CIRCUIT TO BREAKER IN CONTROL PANEL.
7. SCADA TOWER FOUNDATION. PROVIDE (2) 1" CONDUITS FROM TOWER PANEL TO CONTROL PANEL. CONDUITS SHALL RUN THROUGH FOUNDATION, NOT ON TOP. COORDINATE LOCATION WITH TOWER SUPPLIER. PROVIDE (3) 1" CONDUITS IN SLAB FOR TOWER GROUNDING CONDUCTORS. COORDINATE EXACT LOCATION WITH TOWER SUPPLIER. CONDUITS SHALL 90° OUT OF SIDE OF FOUNDATION TO NEAREST SIDE OF SLAB AND SHALL STUB OUT 1". ALL CONDUITS SHALL HAVE PULLWIRES.

PLANS PREPARED BY:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

BY: ____ DATE: ____

BY: ____ DATE: ____

PROJECT NAME
CAN BE MULTIPLE LINES
(PROJECT LIMITS)

PREPARED FOR:
FORT WAYNE
CITY UTILITIES ENGINEERING
CITIZENS SQUARE
200 E. BERRY ST., STE 250
FORT WAYNE, IN 46802

30% PLANS
NOT FOR CONSTRUCTION

1	2	3	4	5	6	7
12/31/13	12/31/13	12/31/13	12/31/13	12/31/13	12/31/13	12/31/13
REVISION NOTES	REVISION NOTES	REVISION NOTES	REVISION NOTES	REVISION NOTES	REVISION NOTES	REVISION NOTES

W.O. NO: #####
DWG NO: ##-#####
SURVEYED BY: SURVEYOR NAME
DRAWN BY: CADD TECH NAME
DESIGNED BY: DESIGNER NAME
CHECKED BY: CHECKED BY NAME
APPROVED BY: APPROVED BY NAME
DATE: 8/18/14
SHEET TITLE:

EXHIBIT CADD5-**16**
ELECTRICAL

E-107-01
SHEET 17 OF 17

Book 6

CADD Standards (CADD)

CADD6 Layers

CADD6.01 Purpose

This Chapter establishes the minimum standards for CAD layers as related to Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE).

Layers allow organization, efficiency, and coordination of information within CADD drawings. They help with visualization on a computer screen and aid with converting information as needed for the printed version of construction drawings.

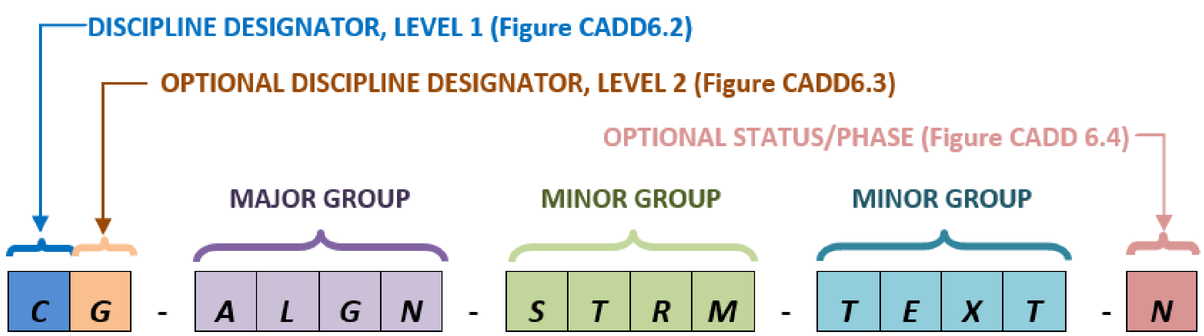
Layer requirements set by this chapter build on and conform to the National CAD Standard (NCS) Version 5 (AIA CAD Layer Guidelines).

CADD6.02 Layer Format

The CADD Standard layer names are organized as a hierarchy. This arrangement allows expansion and addition to the layer list. This arrangement allows selecting from a number of pre-defined options for naming layers according to the level of detail desired.

Layers may consist of up to five (5) data field groups, separated from one another by dashes, which combined may add up to fifteen characters. Figure CADD6.1 shows all possible data field groups of the layer name format. The first two characters denote the discipline designator. The next four characters denote the major group. The following two data field groups (four characters each) denote minor groups. The minor groups are followed by one optional character identifying the project status/phase.

Figure CADD6.1 Layer Name Format



Figures CADD6.2 and CADD6.3 show the letters that shall be used for the Level 1 and Level 2 discipline designator character of the discipline code. Level 2 is an optional modifier which should only be used when a greater level of detail is desired.

Figure CADD6.2 Discipline Designator, Level 1

Level 1 Discipline Designators	
A	Architectural
B	Geotechnical
C	Civil
D	Process
E	Electrical
F	Fire Protection
G	General
H	Hazardous Materials
I	Interiors
L	Landscape
M	Mechanical
O	Operations
P	Plumbing
Q	Equipment
R	Resource
S	Structural
T	Telecommunications
V	Survey/Mapping
W	Distributed Energy
X	Other Disciplines
Z	Contractor/Shop Drawings

Figure CADD6.3 Examples for Discipline Designator, Level 1 and Level 2

Level 1 Designator	Level 2 Designator	Discipline
A		Architectural
A	D	Architectural Demolition
A	E	Architectural Elements
A	F	Architectural Finishes
A	G	Architectural Graphics
A	I	Architectural Interiors
A	S	Architectural Site
A	J	User Defined
A	K	User Defined
C		Civil
C	D	Civil Demolition
C	G	Civil Grading
C	I	Civil Improvements
C	J	User Defined
C	K	User Defined
C	N	Civil Nodes
C	P	Civil Paving
C	S	Civil Site
C	T	Civil Transportation
C	U	Civil Utilities
E		Electrical
E	D	Electrical Demolition
E	I	Electrical Instrumentation
E	J	User Defined
E	K	Electrical Lighting
E	P	Electrical Power
E	S	Electrical Site
E	T	Electrical Telecommunications
E	Y	Electrical Auxiliary Systems
G		General
G	C	General Contractual
G	I	General Information
G	J	User Defined
G	K	User Defined
G	R	General Resource
V		Survey / Mapping
V	A	Survey / Mapping Aerial
V	C	Survey / Mapping Computated Points
V	F	Survey / Mapping Field
V	I	Survey / Mapping Digital
V	J	User Defined
V	K	User Defined
V	N	Survey / Mapping Node Points
V	S	Survey / Mapping Stake Points
V	U	Survey / Mapping Combined Utilities

Figure CADD6.4 Status/Phase Field Codes

Status/Phase Field Codes	
A	Abandoned
D	Existing to Demolish
E	Existing to Remain
F	Future Work
M	Items to be moved
N	New Work
T	Temporary Work
X	Not in contract
1-9	Phase numbers

All layer names shall have the Level 1 discipline designator, a major group data field, and one minor group field.

The colors for each layer shall be consistent and all objects shall be drawn in color BYLAYER. Using BYLAYER will ensure all objects assigned to a specific layer should be the same color. Each layer shall use the appropriate Plot Style provided.

Layers shall fall into the following two categories:

- Model file layers
- Sheet file layers

Model file layers are designated for objects and information found within model files which are typically shared or referenced between other model files. Sheet file layers are designated for sheet-specific objects and information found within sheet files which are usually not shared or referenced between other files.

The following layering conventions shall be used:

- General Sheet File Layers – Used for sheet specific items on General Drawings, Detail Drawings and sheet title blocks.
- Surveying/Mapping Model File Layers – Used for existing items derived from maps or surveying placed in model space.
- Civil Model File Layers – Used for proposed Civil items in model space.
- Electrical Model File Layers – Used for electrical drawings and power drawings

City Utilities Engineering (CUE) compiled a list of common layer names and assignments within model and sheet files to follow for the creation of drawings. Refer to the CUE **CADD 6 – Standard Layer Lists**. City Utilities CADD Standards layers can also be obtained within CUE-provided Autodesk AutoCAD and Civil 3D templates upon request or from the City Utilities website.

CADD6.03 New Layers

The need to create a new layer can arise in cases when CUE defined layers are not available. Layers within CADD drawings shall follow the layer format, requirements and pre-defined data field groups described in this section and NCS Version 5 to allow for ease of customization. All created layers shall be listed and be subject to CUE review for conformance.

Book 6

CADD Standards (CADD)

CADD7 Symbols

CADD7.01 Purpose

This Chapter establishes the minimum standards for symbols and notations as related to Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE).

Symbols and Notations requirements set by this chapter build on and conform to the United States National CAD Standard (NCS) Version 5 (Uniform Drawing System (UDS) modules 6.0, Symbols).

CADD7.02 Symbols

CUE has created and maintains a library of CADD resource files including commonly used symbols that are used for defining various features often found in a set of drawings. Consistent use of these files is required and essential to organize and standardize drawings to communicate the design efficiently.

The CUE Standard Symbols commonly used in preparing drawings projects are organized as a hierarchy by discipline. These symbols shall be used in CADD drawings and Project plans.

There are unique situations that may require symbols that do not exist already. For such instances, first refer to the available list of standard symbols compiled by CUE and the NCS. If a standard symbol does not apply to the specific project feature, a symbol may be created and submitted to the City Project Manager for approval. Upon approval, a graphical representation of the symbol with a clear description shall be included as part of the symbol project legend. Symbols shall be created with a specified base point and inserted into the drawing at an appropriate scale and appropriate layer.

All plan sheets shall include a legend, which defines all symbols used in the drawing, including non-standard symbols. At a minimum, the legend shall be included as part of the General Notes/Index sheet. A sample key legend sheet is available from CUE.

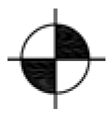
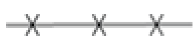
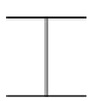
CADD7.03 Symbols Classification

Symbols used in drawings are classified in terms of type. Figure CADD7.1 shows examples for the different symbol types.

- Identity: Identity symbols indicate individual objects and are generally used in mechanical and electrical drawings.
- Line: Line symbols indicate continuous objects and are either single or double lines. These symbols are scale independent.

- Material: Material symbols graphically indicate certain materials and are used to help the reader differentiate one material from another. These symbols may be in elevation, vertical, or horizontal section. These symbols should be used as necessary but not overdone and used where a material begins and ends or changes direction.
- Object: Object symbols resemble the actual objects being symbolized. These symbols are scale dependent.
- Reference: Reference symbols refer the reader to information in another area of the set of drawings or give basic information regarding the drawing or data on the drawing. Included with these symbols are drawing block titles, graphic scales, north indicator, fixture and equipment identifiers, key note identifiers, leaders, dimension lines with terminators, match lines, and revision clouds with identifiers. These symbols are scale independent.
- Text: Text symbols graphically indicate a word or words that may be used in notations on drawings.

Figure CADD7.1 Symbols Type Examples

Symbol: 	***Description:*** Elevation indicator ***<u>Example A – Identity Type</u>***
Symbol: 	***Description:*** Chain link fence ***<u>Example B – Line Type</u>***
Symbol: 	***Description:*** Riprap ***<u>Example C – Material Type</u>***
Symbol: 	***Description:*** Column, I-beam symbol ***<u>Example D – Object Type</u>***
Symbol: 	***Description:*** North indicator ***<u>Example E– Reference Type</u>***
Symbol: 	***Description:*** Property line ***<u>Example F – Text Type</u>***

Book 6

CADD Standards (CADD)

CADD8 Standard Drawings

CADD8.01 Purpose

This Chapter establishes the minimum standards for Standard Drawings as related to Computer Aided Design and Drafting (CADD) work performed by or for City Utilities Engineering (CUE).

The Standard Drawings shall be used in conjunction with all other chapters of the City Utilities Design Standards Manual, as applicable.

CADD8.02 General

The Standard Drawings are available in Adobe Acrobat Portable Document File (PDF) and Autodesk review design file (DWF) format. Refer to **utilities.cityoffortwayne.org/contractors-engineers-developers/CADD-resources** for a list of Standard Drawings available.

The appropriate Standards Drawings are to be used as part of the Project Documents related to the City project.

The drawings are expected to be used as presented. When a special drawing is created, it must not conflict with other requirements in the Standards, other CUE Standard Drawings, or NCS guidelines.

Drawings which are not City standard, shall not be used on project plans without prior approval from the City Project Manager. When a non-standard drawing or detail is approved and used on project plans, workflows, processes, and requirements shall conform to Chapter CADD8 – Standard Drawings as well as all other sections of the CADD Standards and the CAD (DWG) format files for the detail drawing shall be submitted to City Project Manager per requirements of **Chapter CADD3 – Submittals**.

Standard drawings shall not be modified without approval from the City Project Manager. When standard drawings are modified with approval, the newly created drawing should either have a completely new title and page number or the title and page number should be revised to include the word “MODIFIED”.

Standard drawings which are not City standard, shall not include standard detail items such as the City Utilities Standard Detail title block, logo and “Design Standards Manual” text designation.

Refer to **Section CADD5.12 – Sheet Types**, Sheet Type 5 - Details for additional requirements and conventions for Standard Drawings.