



Request For Proposal

Grand Traverse County Board of Public Works Master Meter Station Upgrades – Garfield Township Request For Proposal (RFP)

Proposals Due:

10:00 AM, Friday March 28, 2025

Sealed Proposals shall be Delivered and/or Mailed to:

Water System Meter Replacement
Grand Traverse County
2650 LaFranier Road
Traverse City, MI 49686
Attn: Kent Nothstine, Interim Director
knothstine@gtcountymi.gov
Phone: 231-995-6039
Fax: 231-929-7226

Address Questions to:

GFA
Jennifer Graham, P.E. (Engineer)
123 West Front Street
Traverse City, MI 49684
Email: jennifer@gfa.tc
Phone: 231-946-5874
Fax: 231-946-3703

General Scope:

The Charter Township of Garfield owns and operates water infrastructure that provides domestic and fire suppression water service. The water source for the Township is purchased from the City of Traverse City through several mutual metered connection points between the City and Township systems. The Township's municipal water utilities are operated by the County Department of Public Works (DPW).

The DPW is requesting proposals to provide services to perform upgrades to five (5) of these metered connections, known as Master Meter Stations. The scope of work includes removal and replacement of the meters, remote read out displays and installation of cellular communication units along with electrical wiring, conduit, connections and accessories. In addition, the project includes replacement of access frame and hatches, waterproofing, patching and cleaning. Detailed plans and specifications are included with this RFP.

Requirements - General:

- Work must comply with all applicable laws, regulations.
- All labor and materials shall be installed compliant with Township, DPW and manufacturer's recommendations.



- Contractor shall be responsible for obtaining all local regulatory permits, completing inspections and payment of all associated fees which include but are not limited to County Electrical and Mechanical and Township Building Code for Demolition.
- Provide, a one (1) year full labor and material warranty on all workmanship, material and equipment furnished for this project.
- It is strongly recommended that you make a site visit and perform an evaluation of the existing conditions and proposed scope of work. Coordinate with the DPW for site access:
 - Kent Nothstine, DPW Manager: (231) 493-2994

Terms of Agreement:

General:

- To hold bid open for 60 consecutive calendar days from the bid due date
- To enter into and execute a contract with the Grand Traverse County Board of Public Works.

Insurance:

- Contractor will have Worker's Compensation Insurance in limits required by state law and Comprehensive General Liability Insurance coverage in force for all of its operations under this contract.

Bonds:

- The Contractor shall include in the proposal price the cost to provide the following:
 - Maintenance and Guarantee Bond in the amount of 50% of the proposal amount, guarantying for a period of one (1) year from final acceptance of the project work
 - Letter of Surety, licensed to business in the State of Michigan, stating ability to obtain a Performance Bond, and Labor and Material Bond for 100% of the proposal amount.

Schedule:

- To be completed by June 1, 2025
- All work must be completed within thirty (30) calendar days from the beginning of removal to final clean up. Delays by inclement weather shall be approved by the DPW manager.

Services/Materials to be Provided:

Contractor shall provide all equipment and materials necessary to complete the work described herein. The Contractor shall provide a detailed summary of the equipment and services to be provided. The scope of work shall include but shall not be limited to the following:

General:

- Removal of master meter, associated piping, and appurtenances including electrical controls, supports, anchors, bolts etc. to facilitate replacement of the existing meters in accordance with the attached plans and specifications.
- Removal and replacement of existing access hatches and frames in accordance with the attached plans and specifications.
- Crack seal / fill any imperfections in concrete meter vaults and waterproof meter vault and all penetrations as indicated on the plans and specifications.
- Removal all debris and clean sumps (as applicable) to assure positive drainage of infiltration to the sump area as indicated on the plans.
- Contractor shall be responsible to conduct field exploration to verify all conditions prior to beginning work.



- All work including staging, storage and equipment shall remain within confines of ROW and existing easements Disconnect and remove existing wiring and controls as applicable.
- All wiring and conduit to be compatible with meter manufacturer recommendations and NEC.
- Complete Miss Dig prior to any underground excavation.
- Mobilization, demolition, offsite disposal, restoration, and cleanup per the attached drawings be included.
- Disposal of existing equipment to be removed at the direction of the DPW.
- Coordination of delivery and unloading of materials
- Traffic Control and property owner coordination to ensure road and/or driveway access.
- Temporary power supply as needed to complete work. Most sites have power supply as provided by TCLP and contractor responsible to coordinate as applicable. Townline Meter
- Contractor shall comply with schedule and notes identified on the plans to ensure and maintain system operations at all times.

Services / Materials Not To Be Included – Provided by Owner:

- Site accessibility and potable water supply – Available onsite
 - Most sites have a hydrant available for use and contractor shall coordinate with GTC DPW for access and use backflow preventor.
- Meter, Remote Read Display and Cellular Unit have been purchased and available at the GTC DPW Shop. Contractor shall install compliant with manufacturer recommendations. Equipment Specification Sheets are included with this RFP for reference.



Contractors Proposal Form

Bidders are instructed to submit bids for this project on a unit cost basis as stated in the Proposal. All labor, materials and equipment are considered incidental and to be included in total bid price. All work shall be in compliance with bid drawings and specifications, terms identified in the RFP and applicable laws.

No.	Item	Unit	Est. Qty.	Unit Price	Item Cost
General					
1.	Mobilization	LS	1		
2.	Traffic Control	LS	1		
3.	Restoration	LS	1		
Master Meter #1 – South Airport / Lafranier					
1.	Meter Removal and Replacement, 12"	EA	1		
2.	Remote Read Removal and Replacement and Cellular Unit Installation	EA	1		
3.	Electrical Wiring, conduit and connection upgrades	LS	1		
2	Vault cleaning, patching and waterproofing	LS	1		
4	Access Hatch and Frame Removal and Replacement, 24"x24"	EA	1		
Master Meter #3 – Garfield (Bill Marsh)					
1.	Meter Removal and Replacement, 8"	EA	1		
2.	Remote Read Removal and Replacement and Cellular Unit Installation	EA	1		
3.	Electrical Wiring, conduit and connection upgrades	LS	1		
4.	Vault cleaning, patching and waterproofing	LS	1		
5.	Access Hatch and Frame Removal and Replacement, 24"x24"	EA	1		
Master Meter – Townline Road					
1.	Meter Removal and Replacement, 8"	EA	1		
2.	Remote Read Removal and Replacement and Cellular Unit Installation	EA	1		
3.	Electrical Wiring, conduit and connection upgrades	LS	1		
4.	Vault cleaning, patching and waterproofing	LS	1		
5.	Bypass Manhole cleaning, patching and waterproofing	LS	1		



Master Meter – Veterans Drive					
1.	Meter Removal and Replacement, 6"	EA	1		
2.	Remote Read Removal and Replacement and Cellular Unit Installation	EA	1		
3.	Electrical Wiring, conduit and connection upgrades	LS	1		
4.	Vault cleaning, patching and waterproofing	LS	1		
5.	Access Hatch and Frame Removal and Replacement, 36" x 48"	EA	1		
Master Meter #2 – Booster Station #2					
1.	Meter Removal and Replacement, 8"	EA	1		
2.	Remote Read Removal and Replacement and Cellular Unit Installation	EA	1		
3.	Electrical Wiring, conduit and connection upgrades	LS	1		
TOTAL BID					

Bidders Signature

Printed Name:

Business Name:

Address:

MI Contractor License No.:

Telephone:

Email:

The Owner may make such investigations as deemed necessary to determine the ability of the Bidder to perform the Work and the Bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any / all bids if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the work as requested.

Grand Traverse County Board of Public Works reserves the right to accept or reject any or all proposals.

PLANS PREPARED FOR: GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS MASTER METER STATION UPGRADES

CLIENT / AGENCY

GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS
2650 LAFRANIER ROAD
TRAVERSE CITY, MI 49686
231.995.6039



ENGINEER

ENGINEERING
SURVEYING
TESTING & OPERATIONS

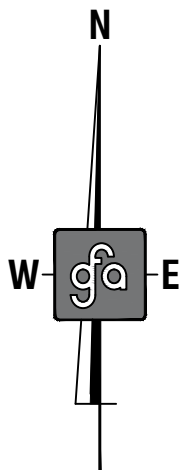
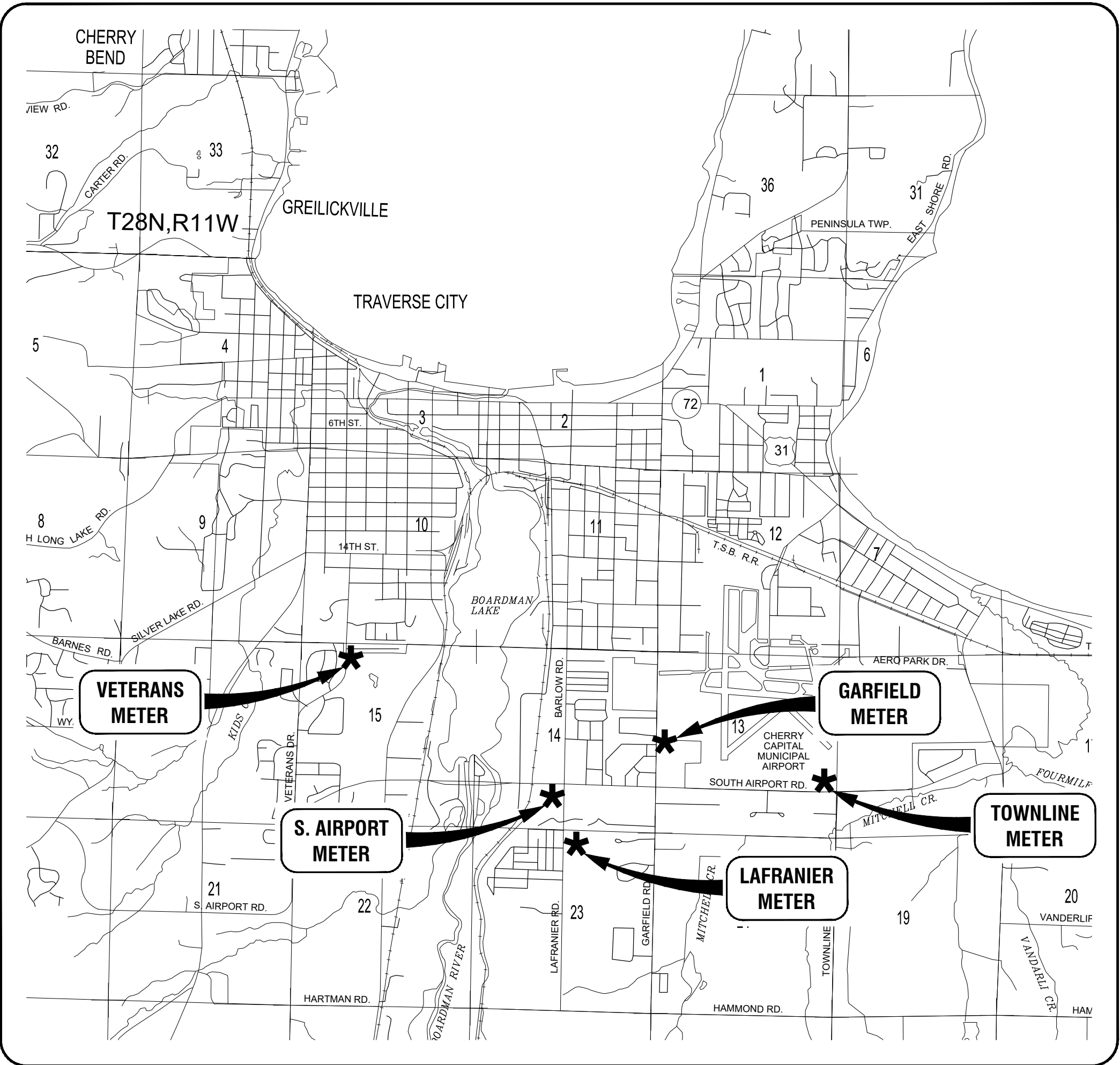
123 West Front Street
Traverse City, MI 49684



 <http://gfa.tc>

 231.946.5874 (p)

 231.946.3703 (f)



SHEET INDEX

- C1.1 COVER SHEET
- C1.2 GENERAL NOTES
- C2.1 S. AIRPORT ROAD MASTER METER (MM#1)
- C2.2 GARFIELD ROAD MASTER METER (MM#3)
- C2.3 TOWNLINE ROAD MASTER METER
- C2.4 VETERANS DRIVE MASTER METER
- C2.5 LAFRANIER ROAD BOOSTER STATION #2 FLOW METER

ISSUED DATE: 02/12/2025

FOR BIDS

LOCATION MAP

GARFIELD TOWNSHIP, GRAND TRAVERSE COUNTY, MICHIGAN
SCALE: 1" = 3,000'

PUBLIC AGENCIES AND UTILITIES

PUBLIC AGENCIES

CITY OF TRAVERSE CITY Telephone: 231.922.4461	GRAND TRAVERSE COUNTY DRAIN COMMISSION Telephone: 231.922.4807
GRAND TRAVERSE COUNTY D.P.W. Telephone: 231.995.6039	MICHIGAN DEPARTMENT OF TRANSPORTATION (M.D.O.T.) Telephone: 231.941.1986
GRAND TRAVERSE COUNTY ROAD COMMISSION Telephone: 231.922.4848	MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, & ENERGY (E.G.L.E.) Telephone: 231.775.3960
GRAND TRAVERSE COUNTY SOIL EROSION SEDIMENTATION CONTROL DEPT. Telephone: 231.995.6042	

UTILITY AGENCIES

CHERRYLAND ELECTRIC COOPERATIVE Telephone: 231.943.8377	CHARTER COMMUNICATIONS Telephone: 231.929.7012
CONSUMERS ENERGY Telephone: 231.929.6242	AT&T MICHIGAN Telephone: 231.941.2707
TRAVERSE CITY LIGHT & POWER Telephone: 231.922.4942	
DTE ENERGY Telephone: 231.592.3244	

EMERGENCY SERVICES

EMERGENCY CALLS 911	FIRE DEPARTMENTS EMERGENCY SERVICE: 911
EMERGENCY AMBULANCE SERVICE 911	City of Traverse City: Telephone: 231.941.2340 Grand Traverse County: Telephone: 231.941.2238
POLICE AGENCIES EMERGENCY SERVICE: 911	MISS DIG Telephone: 1.800.482.7171
City of Traverse City: Telephone: 231.941.2300 Grand Traverse County Sheriff: Telephone: 231.941.2225 Antrim County Sheriff: Telephone: 231.533.8627 Michigan State Police: Telephone: 231.258.4112	



GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS:
MASTER METER STATION UPGRADES

These documents are prepared in accordance with the contractual terms and conditions for this project.

1. EXISTING INFORMATION AND MEASUREMENTS PROVIDED ARE BASED ON SCANNED DRAWINGS OF THE ORIGINAL DESIGN AND FIELD MEASUREMENTS. THIS IS PROVIDED FOR REFERENCE ONLY AND CONTRACTOR IS RESPONSIBLE TO FIELD VERIFY PRIOR TO COMPLETING WORK.

- ## WATERMAIN NOTES

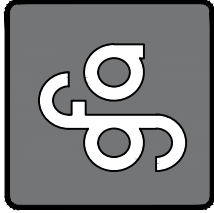
- ## MASTER METER STATION UPGRADE NOTES

- ## CONSTRUCTION/SCHEDULE NOTES

- ## ELECTRICAL NOTES

- ## ELECTRICAL SERVICE WIRE DIAGRAM

 <http://gfa.tc>
 231.946.5874
 231.946.3703



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123 West Front Street
Traverse City, MI 49684

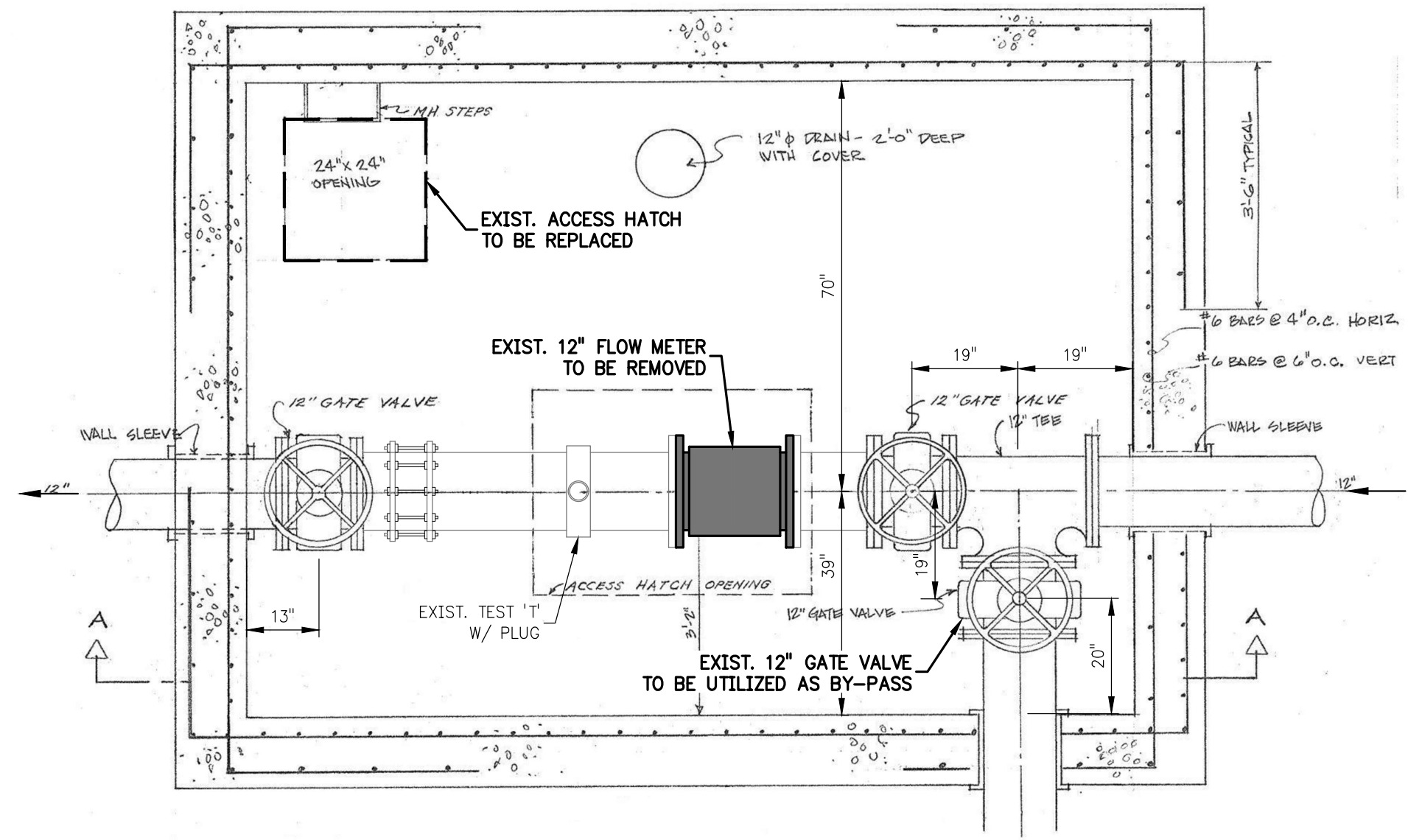
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**GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS
MASTER METER REPLACEMENT
GENERAL NOTES**

GRAND TRAVERSE COUNTY, MICHIGAN

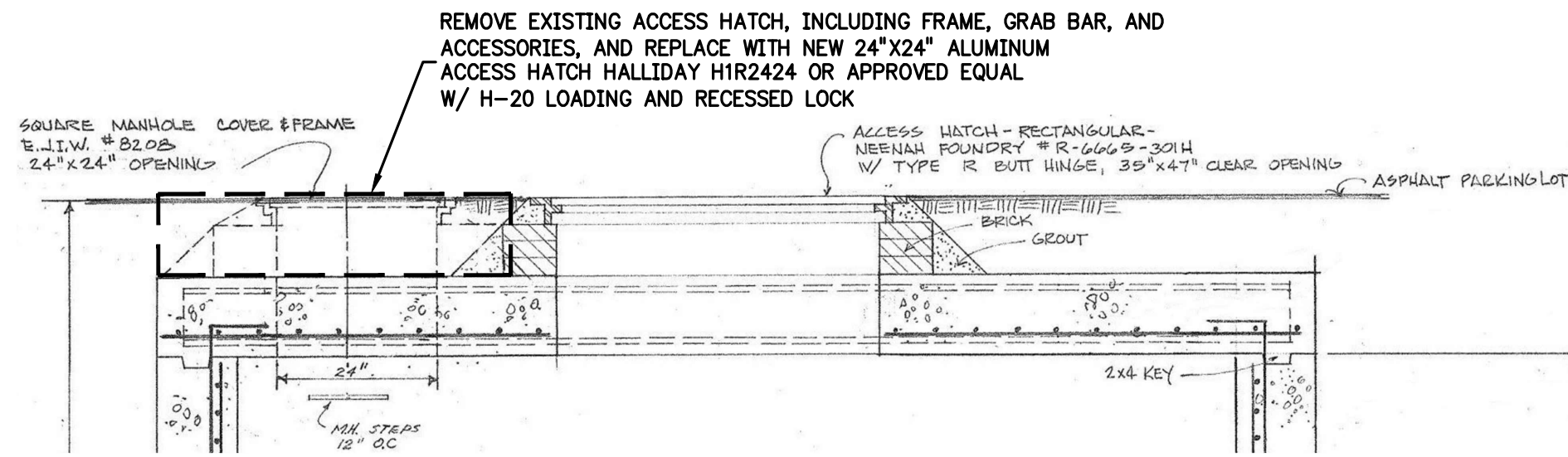
P.M:	
JENNIFER GRAHAM, P.E.	
DR:	CRD:
C. BALLANCE	J. GRAHAM
JOB NO:	
23319	
C1.2	

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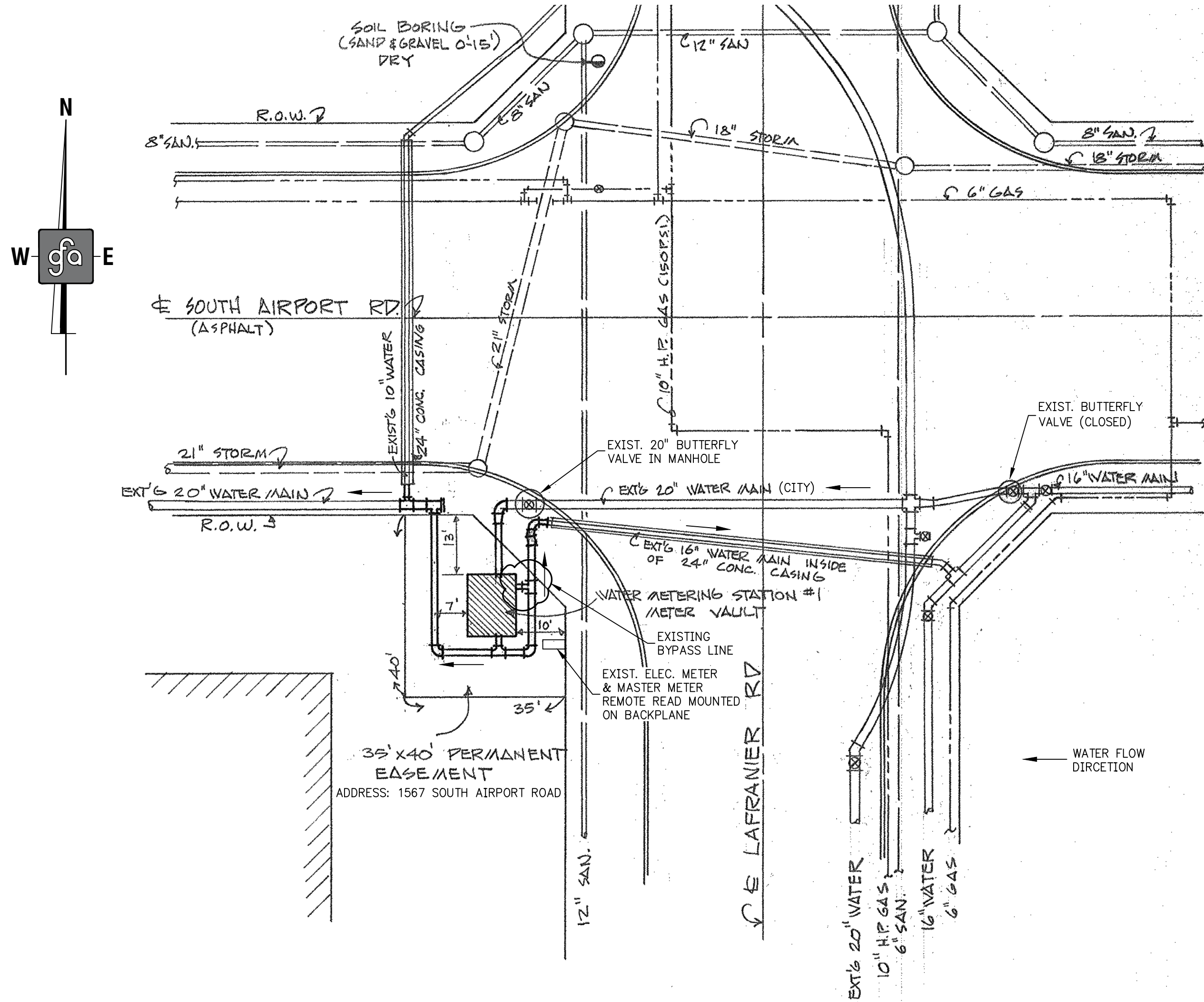
EXISTING/DEMOLITION MASTER METER PLAN

NO SCALE



EXISTING/DEMOLITION MASTER METER SECTION

NO SCALE

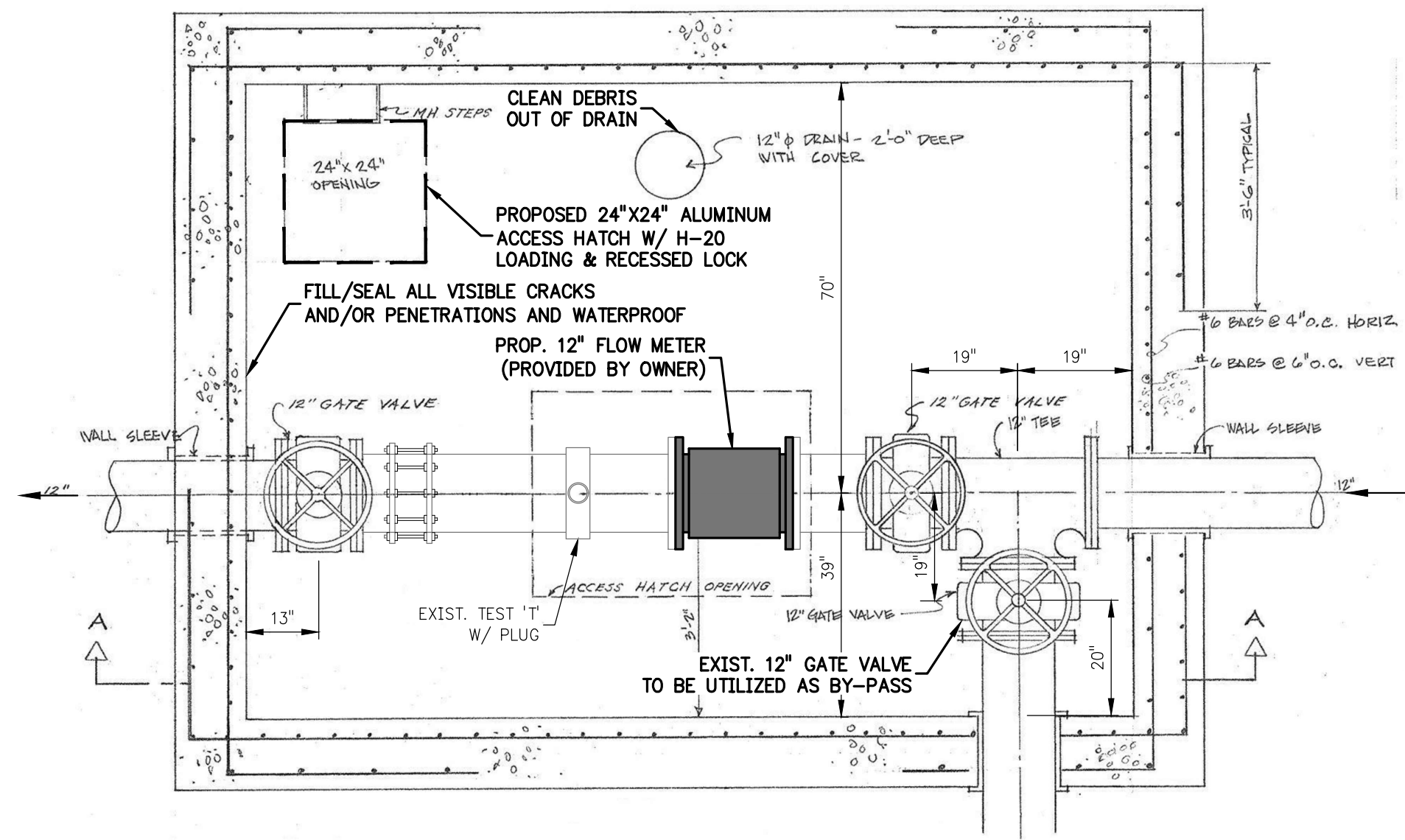


EXISTING MASTER METER SITE PLAN

NO SCALE

NOTES

- ACCESS HATCH REPLACEMENT TO INCLUDE REMOVAL AND REPLACEMENT OF HATCH, FRAME, BRICK AND GROUTING.
- CONTRACTOR TO INSTALL HATCH IN COMPLIANCE WITH MANUFACTURER'S RECOMMENDATIONS AND TO INCLUDE 1/2" GALVANIZED STEEL PIPE (GRAB BAR) W/ CAP EXTENDING 36" ABOVE GRADE.



PROPOSED MASTER METER PLAN

NO SCALE



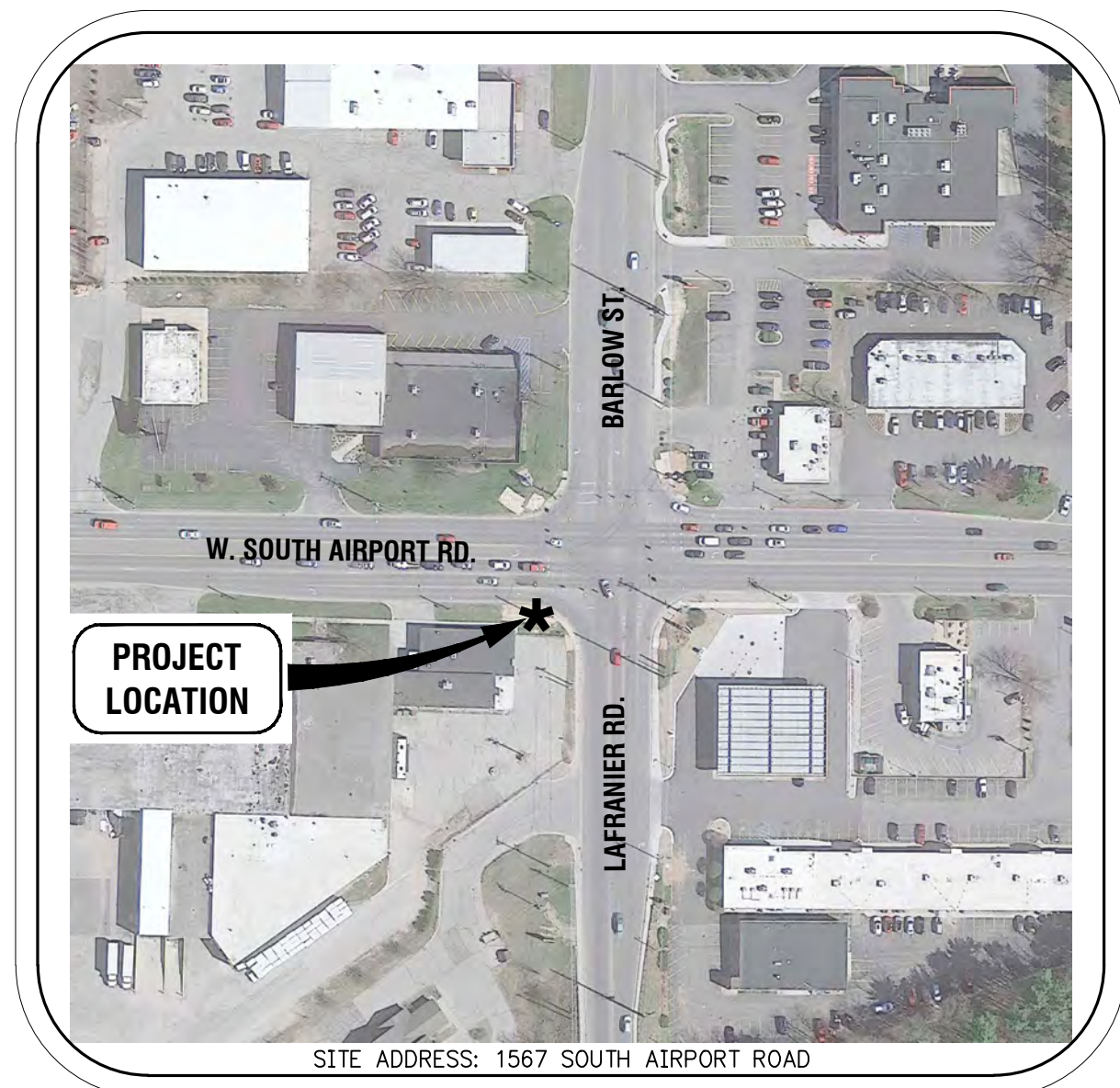
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EXISTING METER VAULT INTERIOR

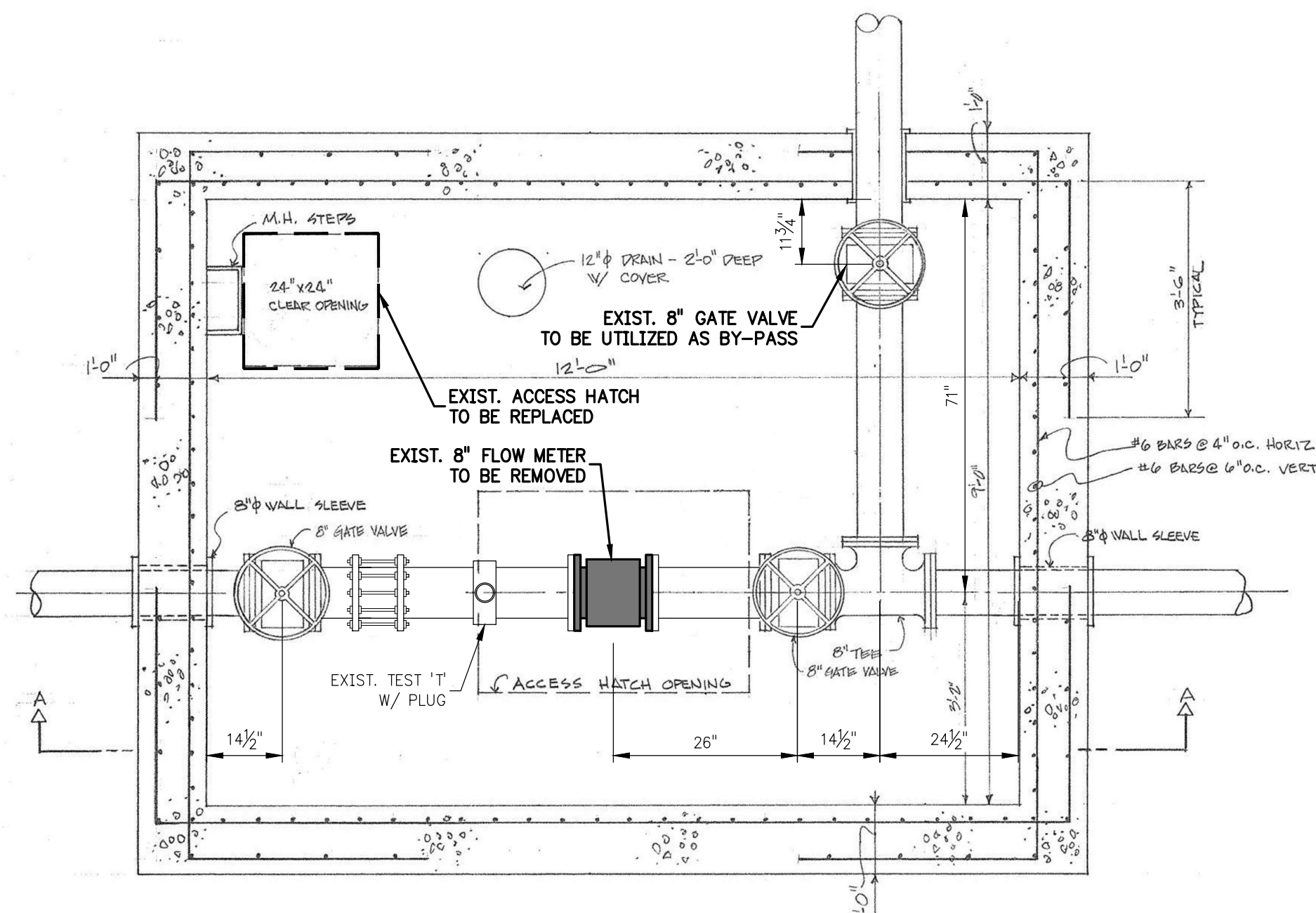


EXISTING METER VAULT HATCH

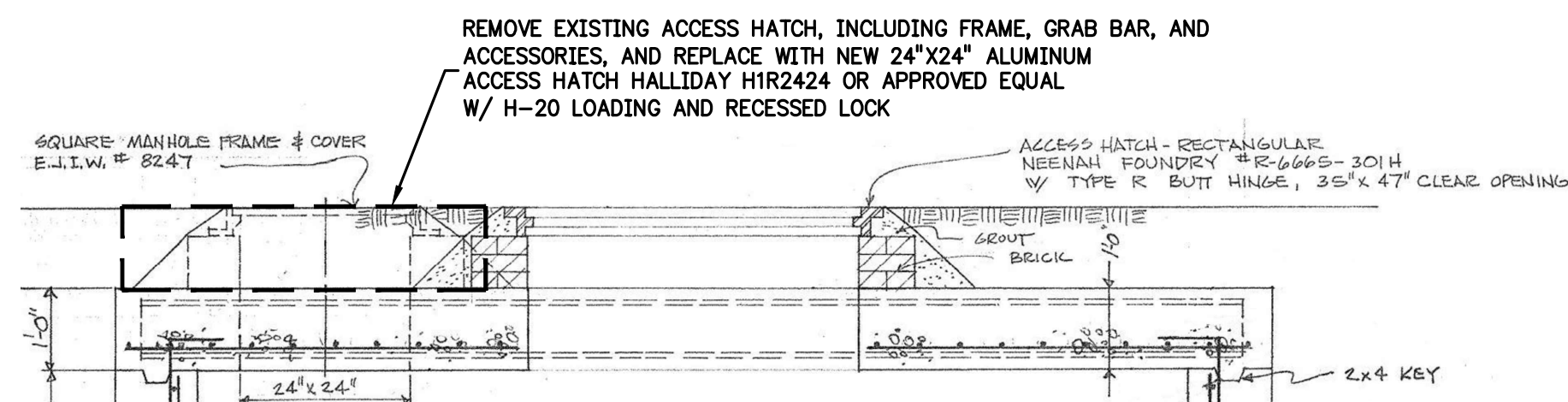


LOCATION MAP

NO SCALE



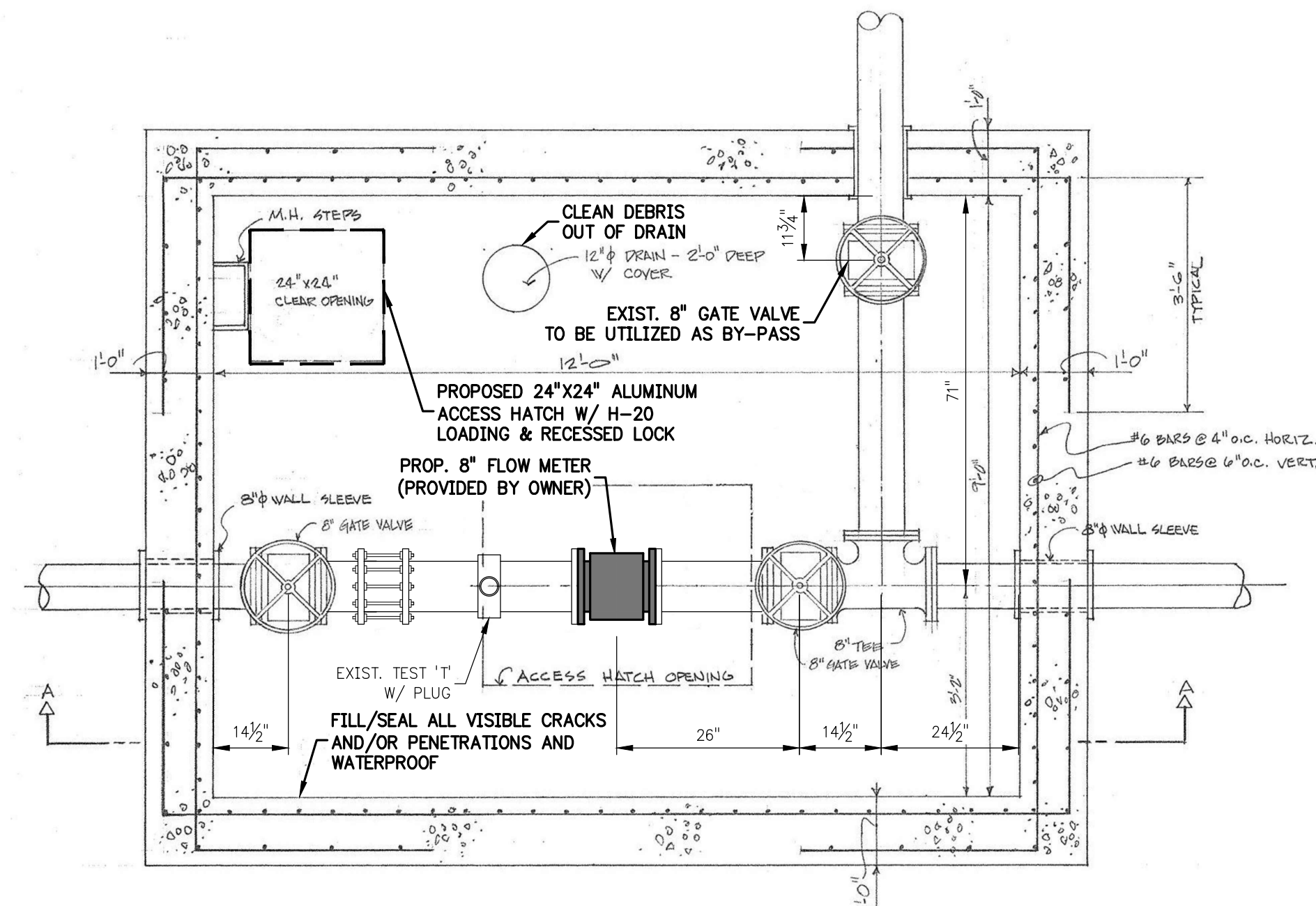
EXISTING/DEMOLITION MASTER METER PLAN
NO SCALE



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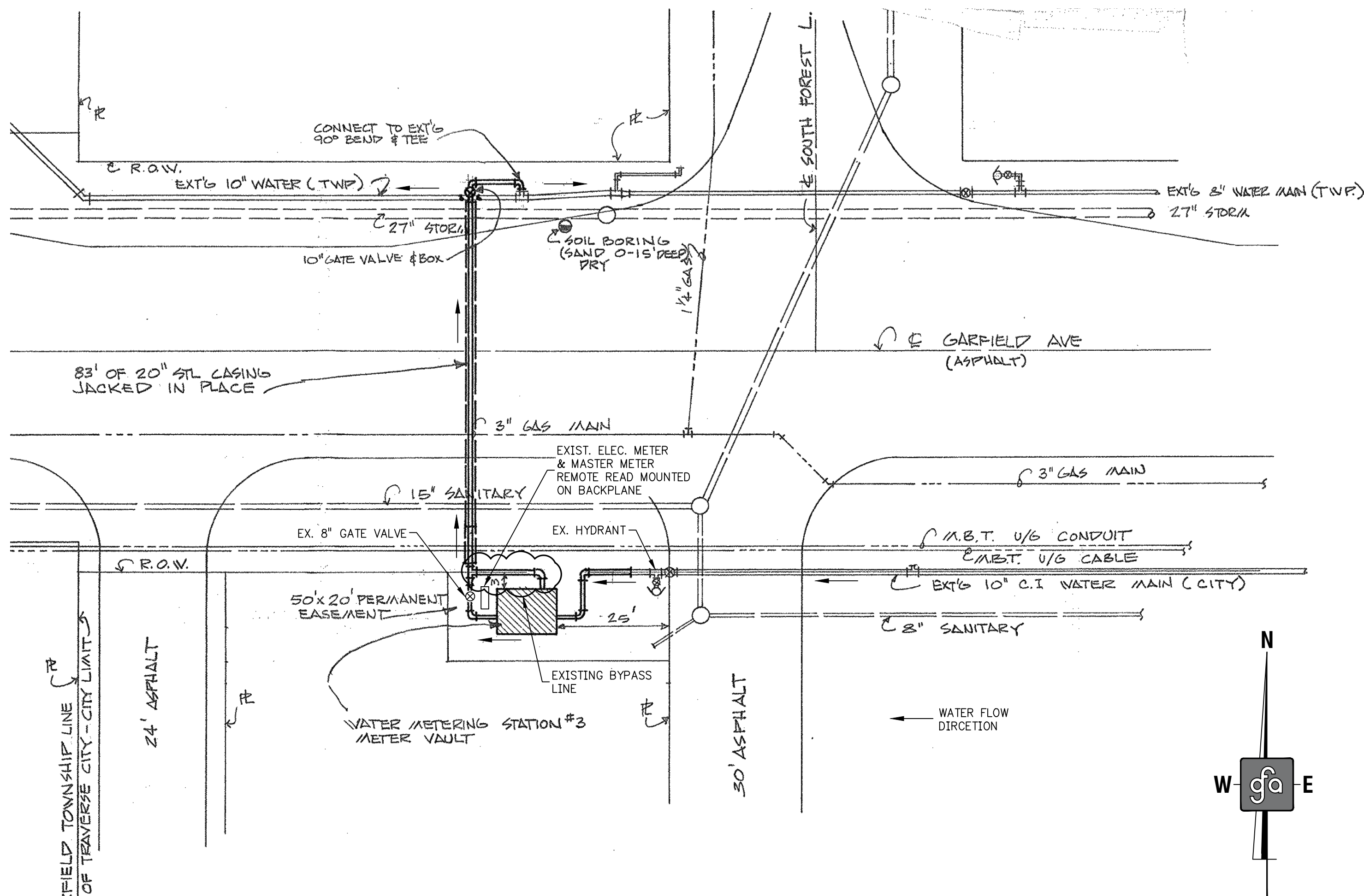
PROPOSED MASTER METER PLAN
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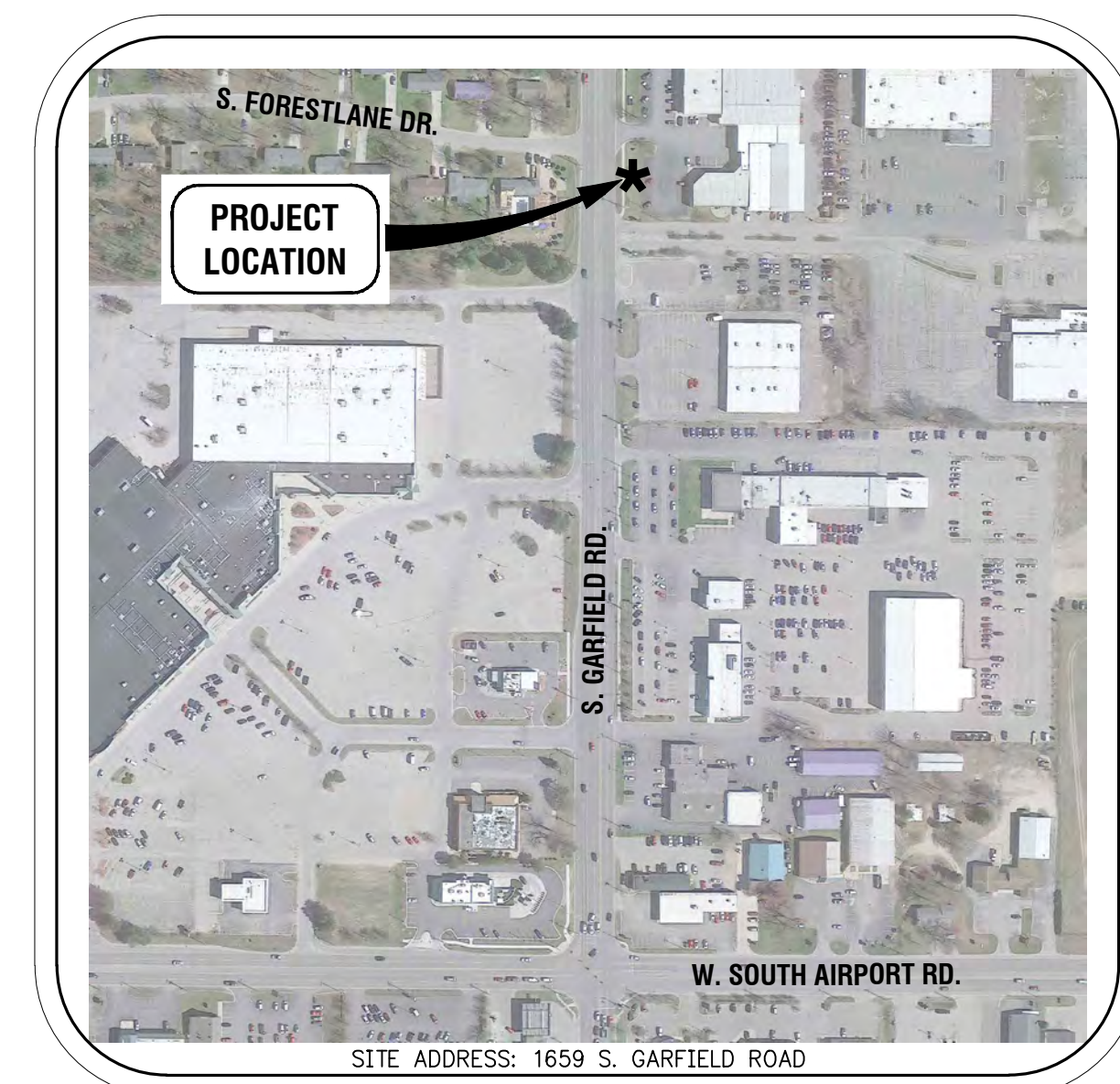
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EXISTING METER VAULT INTERIOR



EXISTING MASTER METER SITE PLAN
NO SCALE



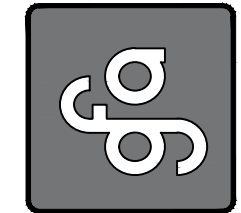
LOCATION MAP
NO SCALE

GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS
MASTER METER REPLACEMENT
GARFIELD ROAD MASTER METER (MM#3)

GRAND TRAVERSE COUNTY, MICHIGAN

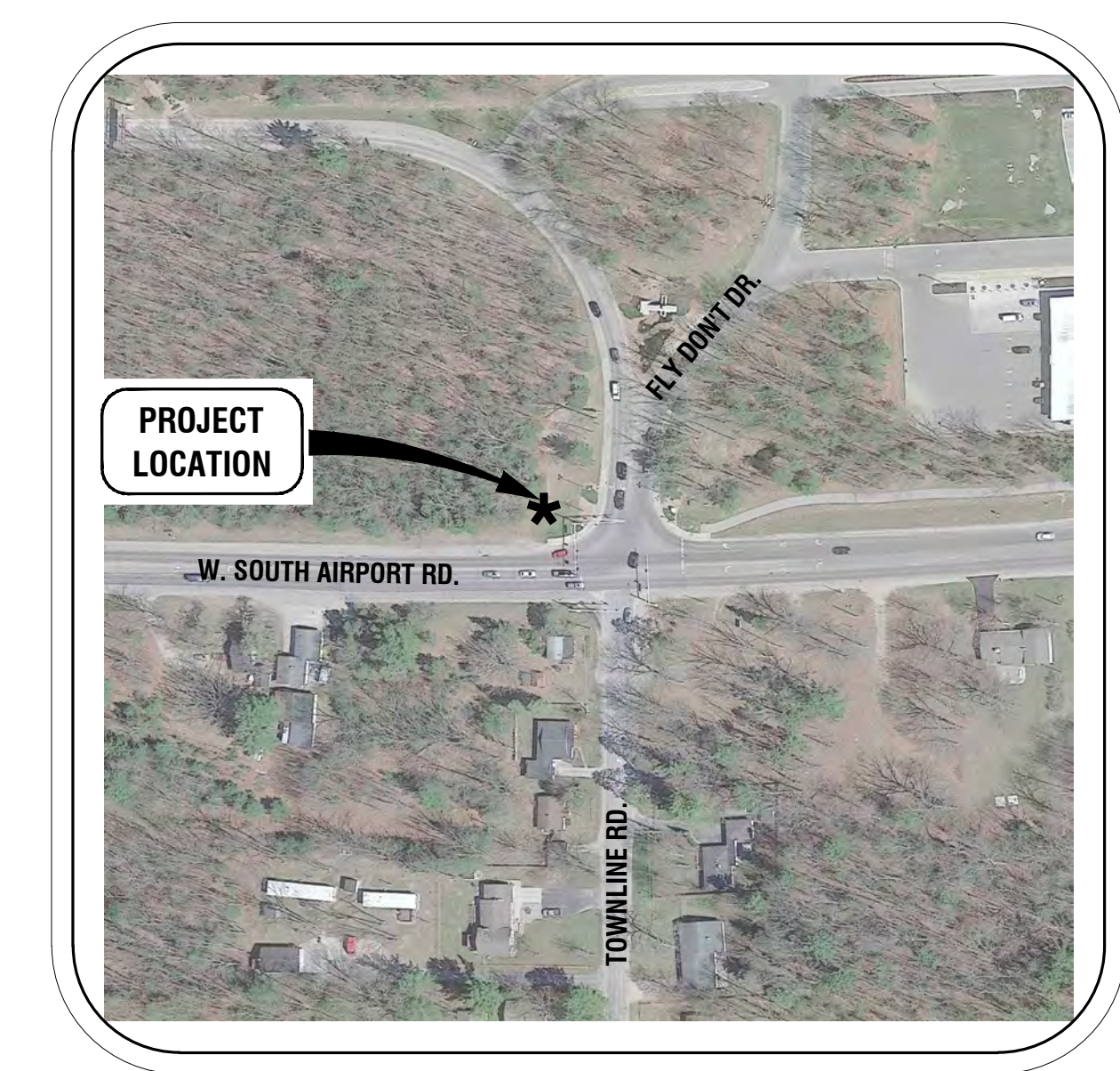
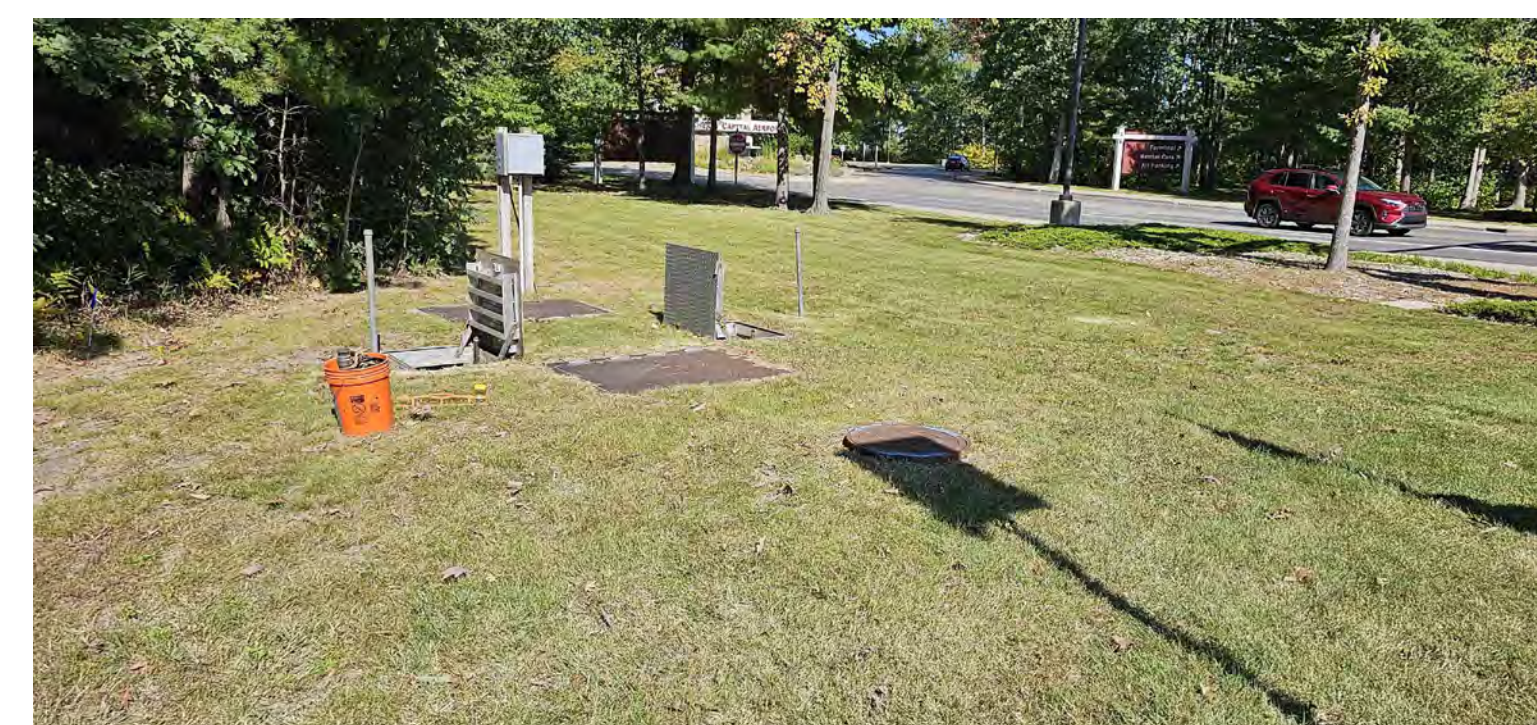
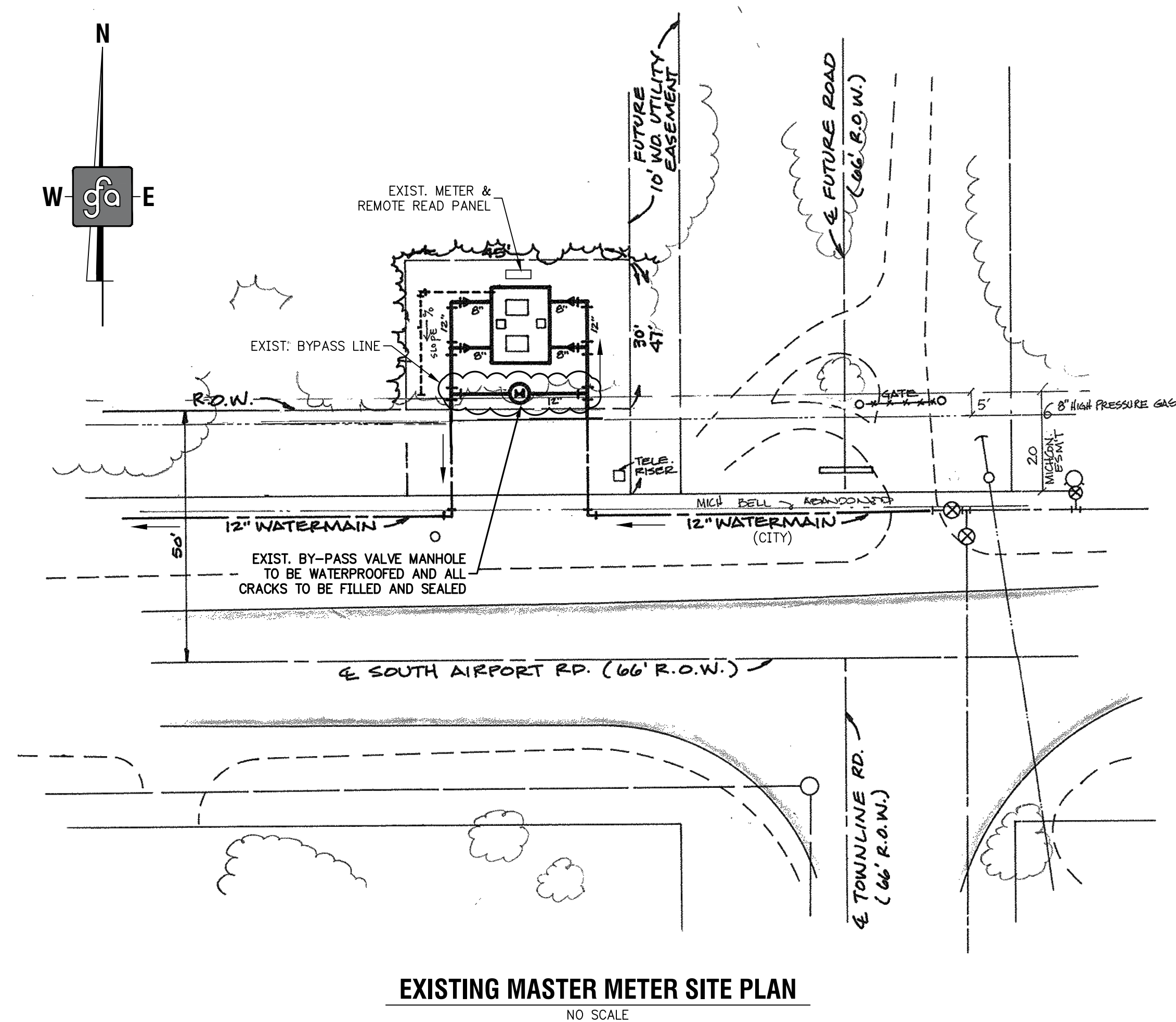
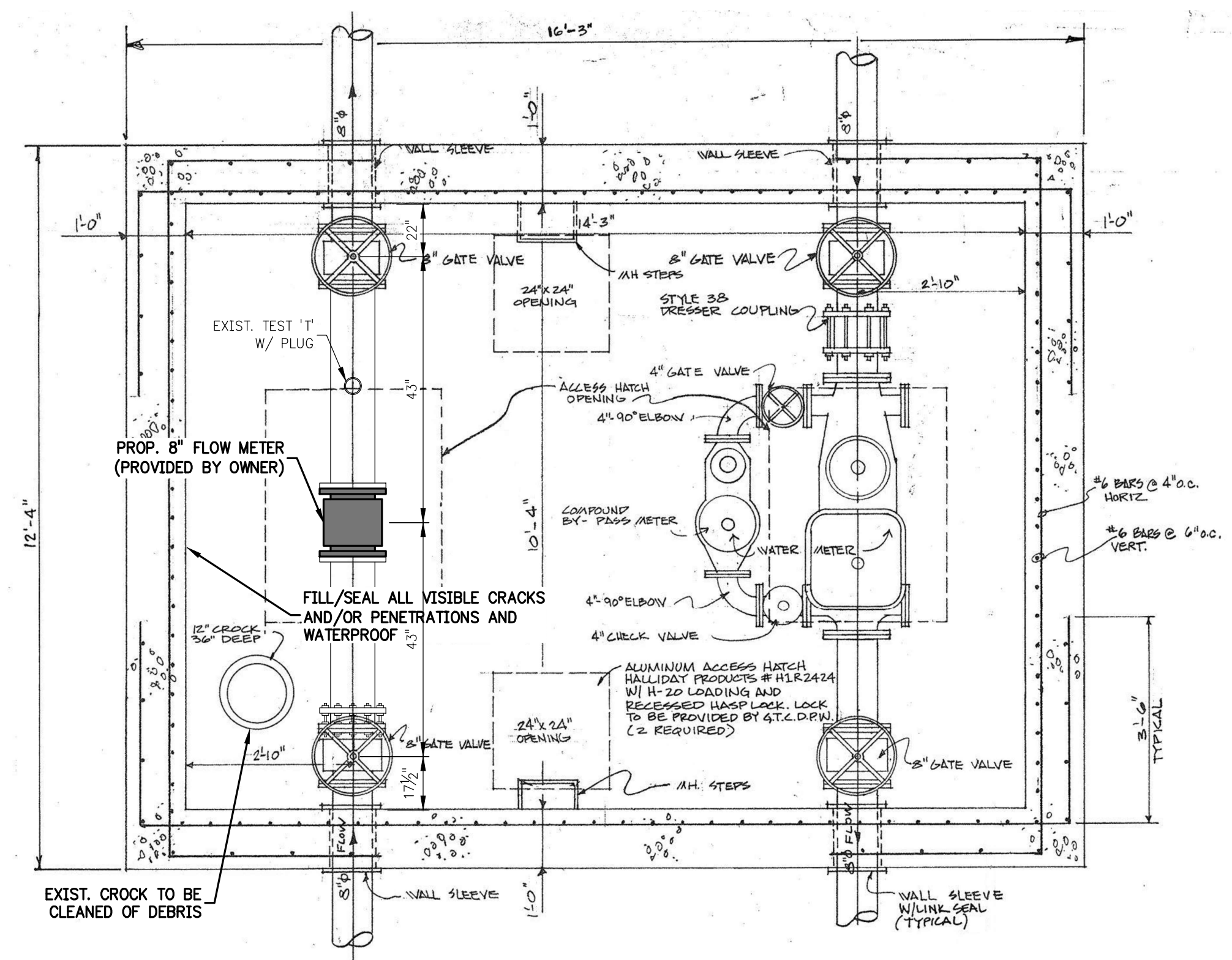
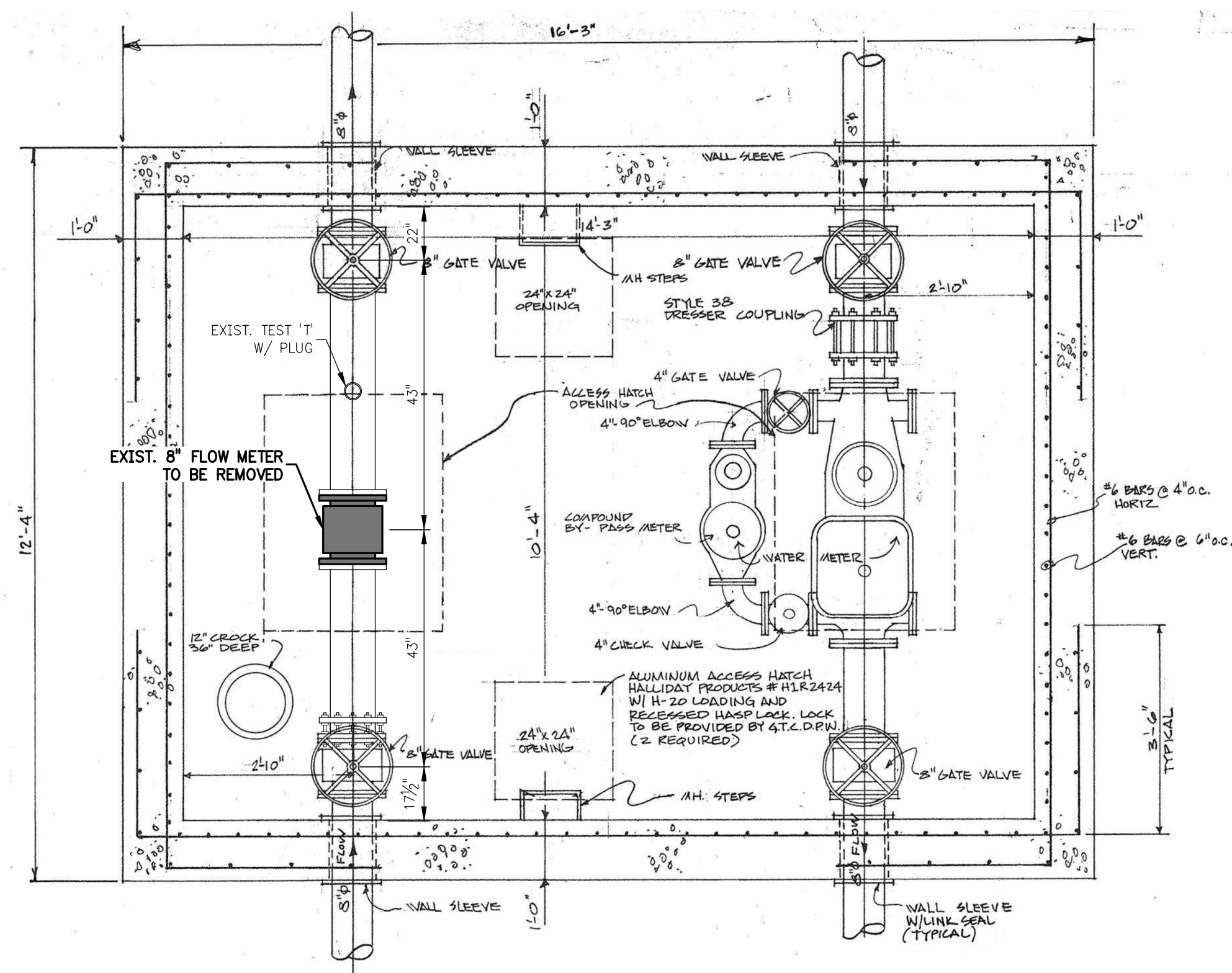
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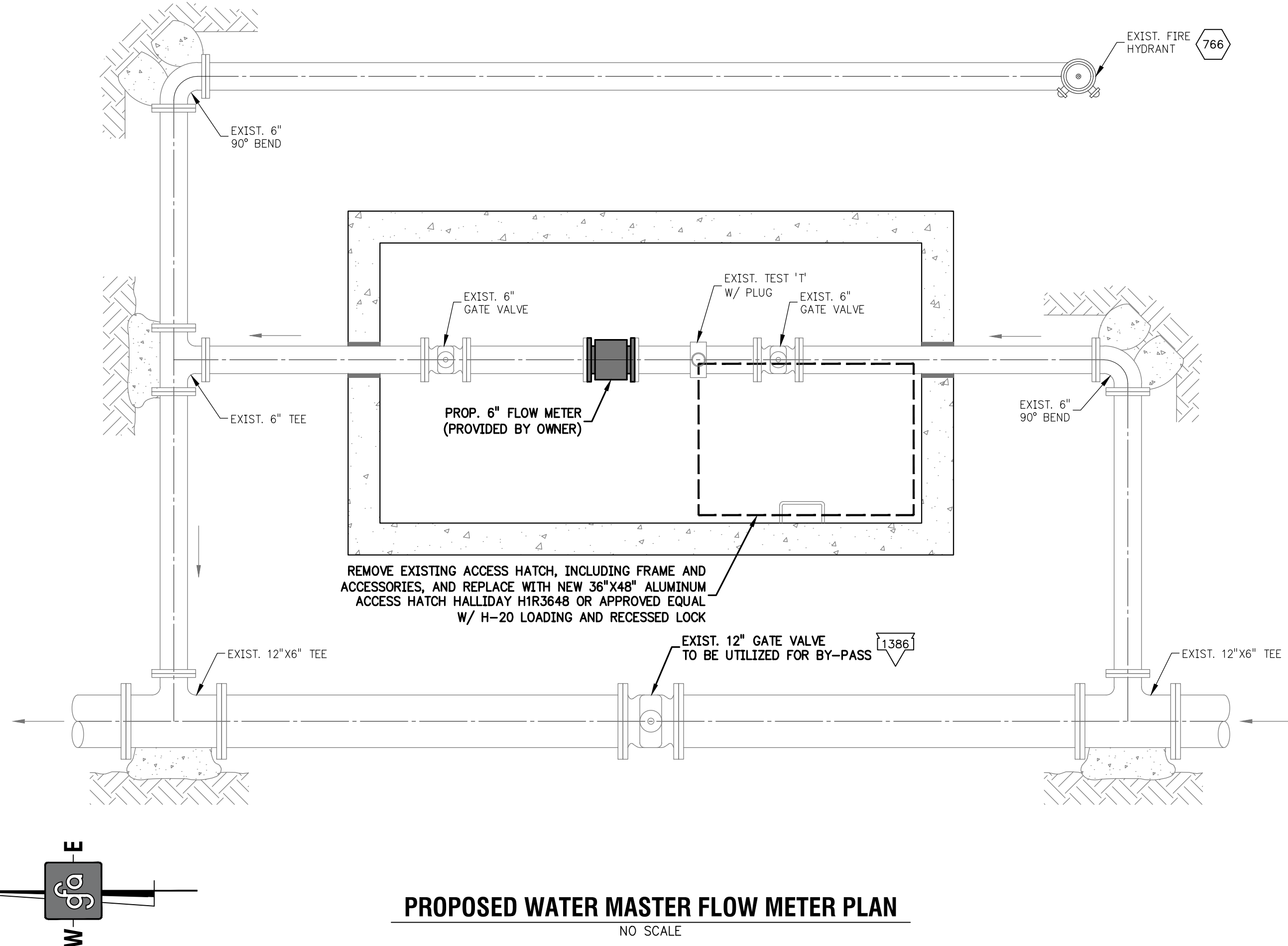
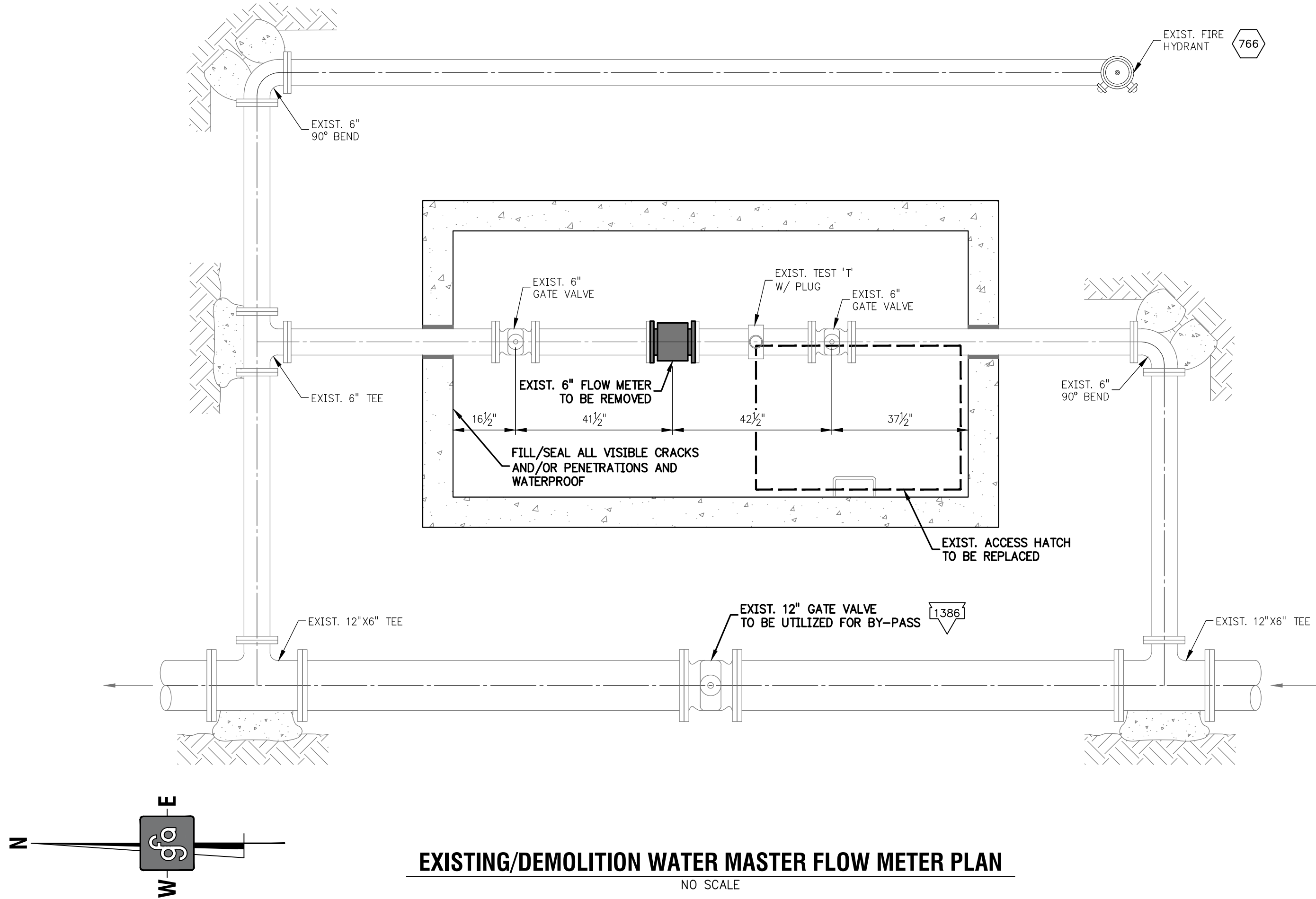
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Traverse City, MI 49684

These documents are prepared in accordance with the contractual terms and conditions for this project.





- NOTES**
1. ACCESS HATCH REPLACEMENT TO INCLUDE REMOVAL AND REPLACEMENT OF HATCH, FRAME, BRICK AND GROUTING.
 2. CONTRACTOR TO INSTALL HATCH IN COMPLIANCE WITH MANUFACTURER'S RECOMMENDATIONS AND TO INCLUDE 1 1/2\"/>



EXISTING METER VAULT INTERIOR



EXISTING METER VAULT HATCH



EXISTING PANEL

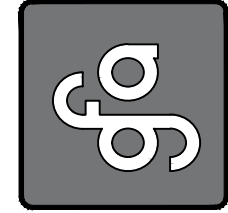


LOCATION MAP
NO SCALE

GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS
MASTER METER REPLACEMENT
VETERANS DRIVE MASTER METER
GRAND TRAVERSE COUNTY, MICHIGAN

PAI: JENNIFER GRAHAM P.E.
DR: C. BALLANCE DO: J. GRAHAM
23319
C2.4

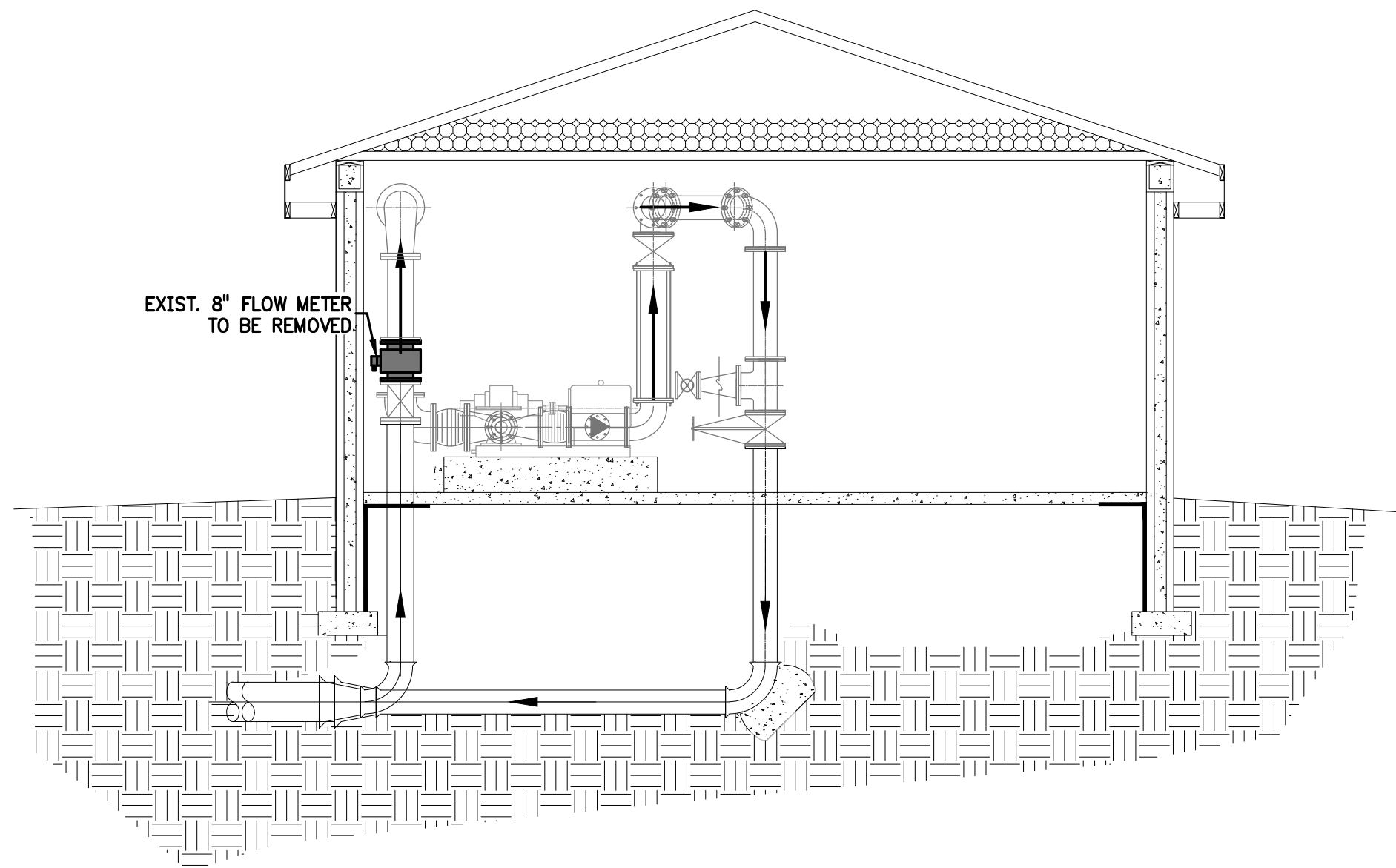
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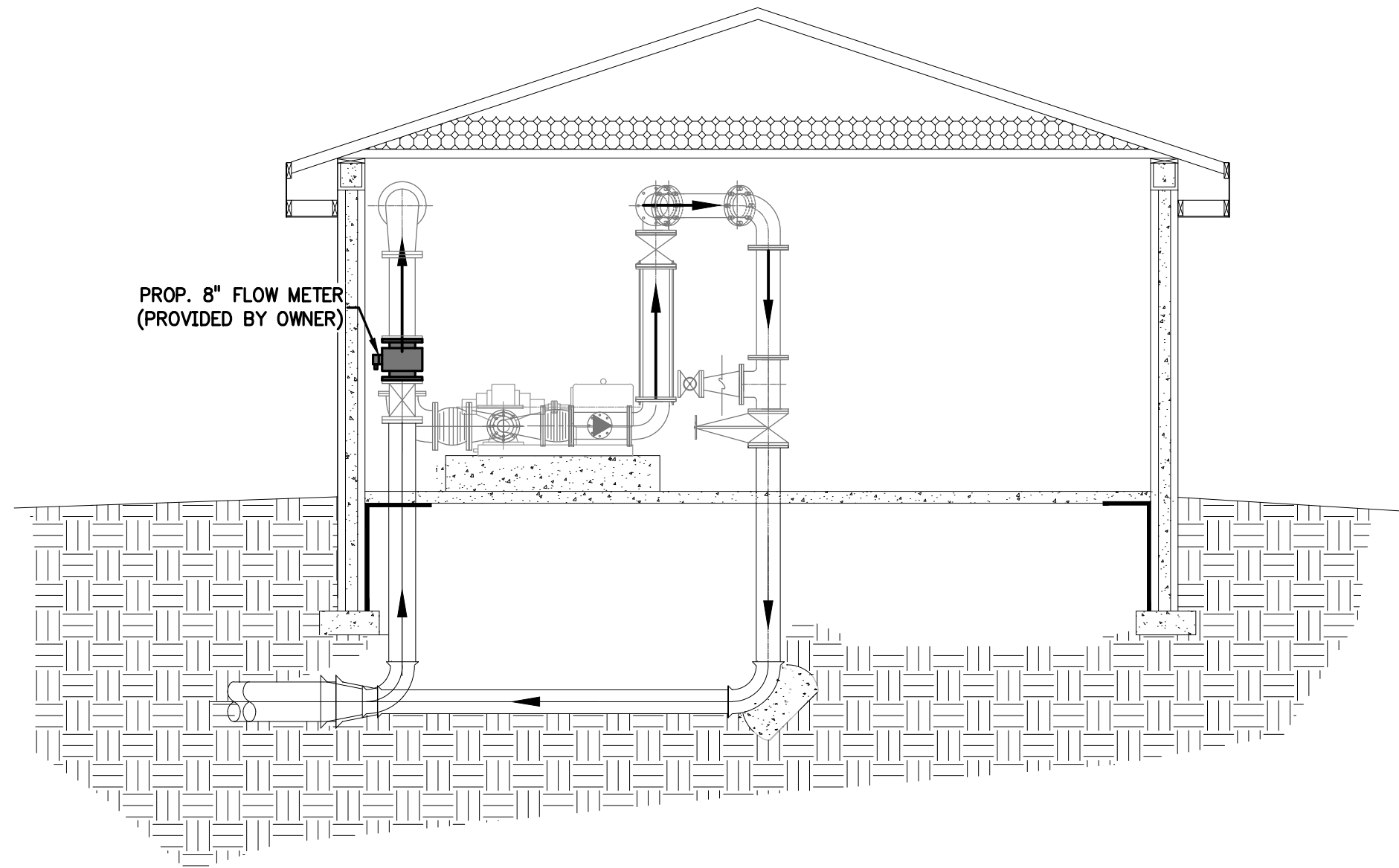
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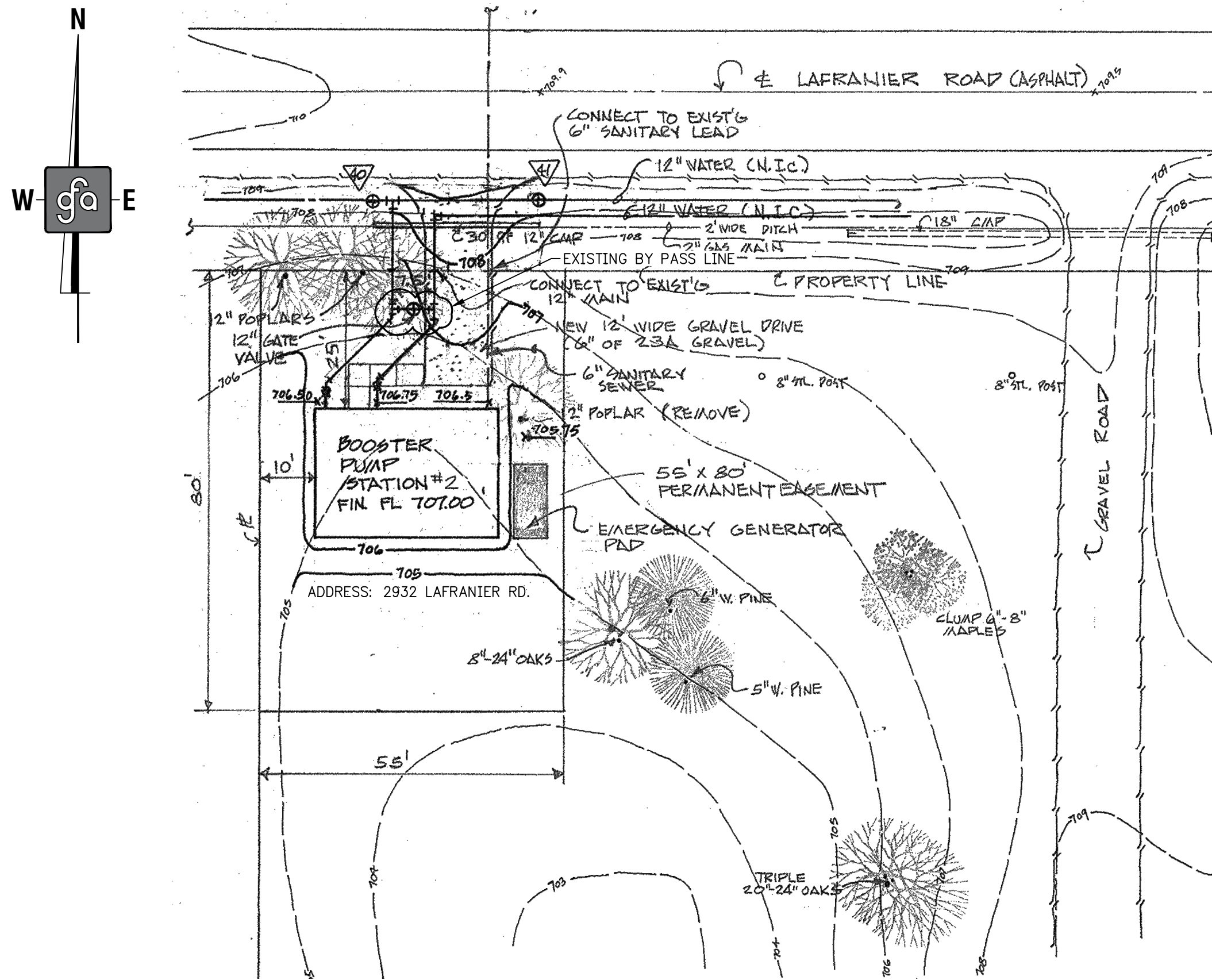
EXISTING/DEMOLITION BOOSTER STATION #2 SECTION

NO SCALE



PROPOSED BOOSTER STATION #2 SECTION

NO SCALE



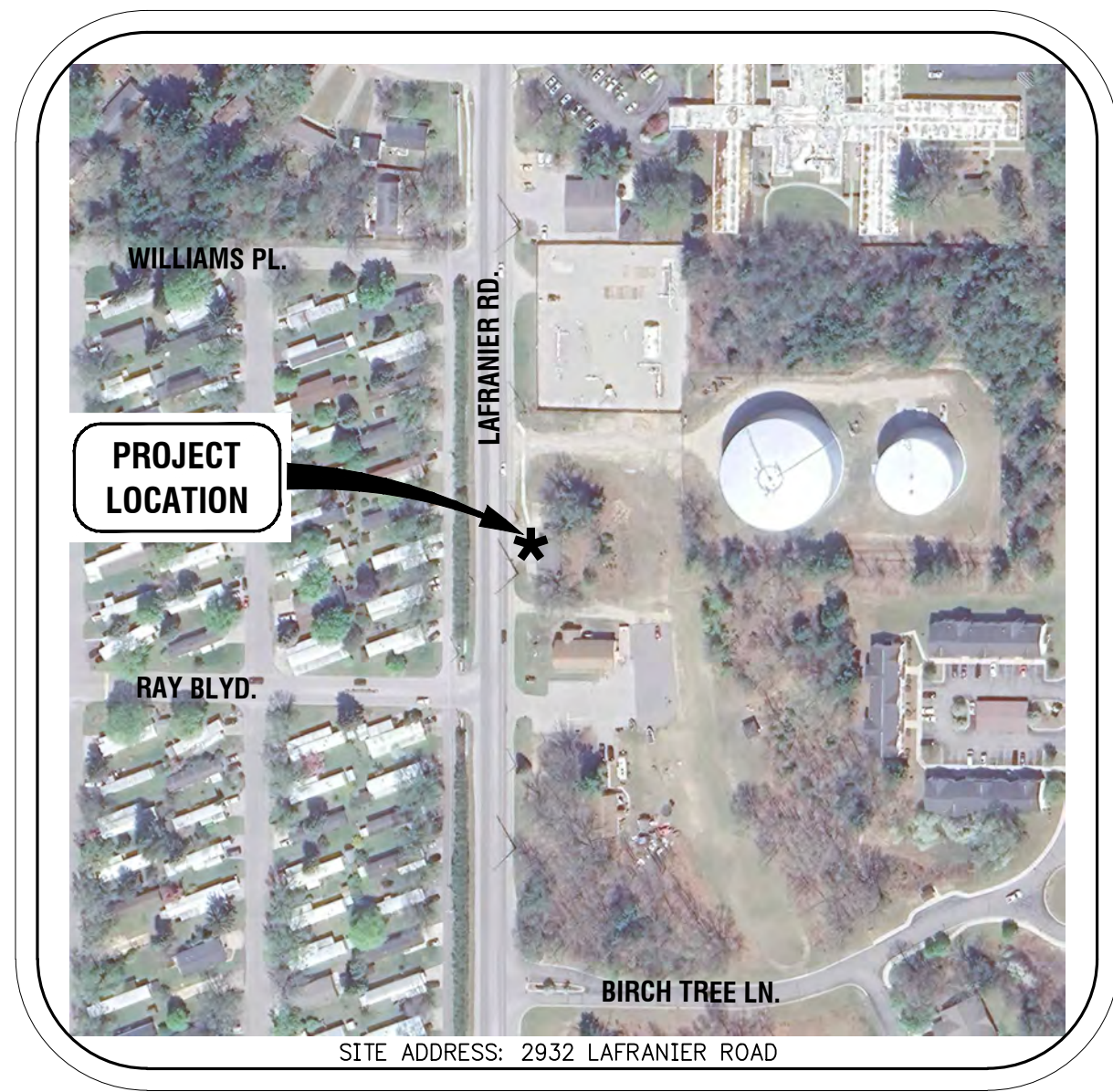
EXISTING BOOSTER STATION #2 SITE PLAN

NO SCALE

EXISTING REMOTE READ TO
BE REMOVED AND REPLACED



EXISTING BOOSTER STATION #2 INTERIOR



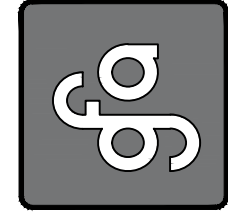
LOCATION MAP
NO SCALE

GRAND TRAVERSE COUNTY DEPT. OF PUBLIC WORKS
MASTER METER REPLACEMENT
LAFRANIER ROAD BOOSTER STATION #2 FLOW METER

GRAND TRAVERSE COUNTY, MICHIGAN

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DR: C. BALLANCE DO: J. GRAHAM
23319
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231.946.3874 (p)
231.946.3703 (f)



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123 West Front Street
Traverse City, MI 49684

REV# DATE DWN ISSUED FOR BIDS DESC

0 02/22/2025 CPM

SECTION 1

GENERAL REQUIREMENTS

1.01 PROJECT DESCRIPTION

Work includes the following major items:

Upgrades to five (5) master meters located within Garfield Township in Grand Traverse County.

- a. Project included removal and installation of meters, remote read out display and installation of cellular units. The DPW is to provide the equipment and contractor install compliant with manufacturer recommendations.
- b. Project includes replacement of access hatches, electrical connections to accommodate replacement of the magnetic flow meters.

1.02 DEFINITIONS

The intent of this section is to identify certain persons involved in the project.

DPW	The agency performing the system operations and maintenance typically identified as a Department of Public Works.
Township Engineer	Engineer whose services are procured by the Township to review sanitary sewage and/or water system plans and installation methods. When the Township is the owner, the engineer will function as the owner's engineer.
Design or Owner's Engineer	Engineer who provided the sanitary sewage and/or water system design, plans and specifications for the owner.
Owner	Project developer or Township who is having sanitary sewage and/or water facilities installed.
Contractor	Contractor is prime Contractor who is so identified by the Owner and is responsible for the sanitary sewage and/or water system facilities installation.
Township	The governing Township (Acme, East Bay, Garfield, Peninsula, Elmwood) that the work is being performed in.

1.03 PRECONSTRUCTION CONFERENCE

Prior to commencement of any construction activities involving the sanitary sewer system and/or water system, a principal member representing the Owner, the Contractor, the Design Engineer, the Township Engineer and the County DPW shall meet at a pre-determined location and time to discuss the project. It shall be the responsibility of the Owner or his/her Design Engineer to organize this meeting. At that time, the Contractor schedule, as well as the Township Engineer's requirements, will be discussed to obtain a mutual understanding of the project and the Township's inspection process.

1.04 LINES AND GRADES FOR CONSTRUCTION

The Owner (his Contractor and/or Engineer) shall provide adequate lines and grades for construction of the sanitary sewer and/or water main prior to installing the utilities.

1.05 PROGRESS SCHEDULE

The Owner shall, as soon as practical, prepare and submit to the Township Engineer three (3) copies of the Progress Schedule regarding sanitary sewer and/or water main construction. This schedule shall show in a clear, graphical manner the proposed date for commencement, progress and completion of the work.

1.06 INTERFERENCE WITH EXISTING SEWAGE TREATMENT WORKS

No bypassing of untreated sewage will be allowed during the construction of this project. The Contractor shall provide a plan of work to the Township Engineer for approval before starting work on any phases of the project which might involve existing sewage facilities.

1.07 RELATIONS TO OTHER CONTRACTORS AND UTILITY FORCES

The Contractor shall so conduct his operations as not to interfere with or injure the work of other contractors or adjacent force account work, and he shall promptly make good any injury or damage which may be done to such work by him or his employees or agents.

The Contractor shall grant to other contractors and forces necessary means of access to their work.

1.08 PERMITTING AGENCIES

The Contractor shall perform all work in accordance with any and all applicable permit requirements. The Owner or his Design Engineer shall present the Township Engineer with a copy of all documentation and calculations for the permit process. The Township, with the assistance of the Township Engineer, will obtain the necessary permit for construction/installation prior to commencement of any work.

1.09 ACCESS TO WORK

The Township Engineer or Township Resident Project Representative shall have access maintained to all sanitary sewer or water main work at all times. Proper notification (48 hours) shall be given to the Township Engineer prior to the start of any construction or testing.

1.10 SHOP DRAWINGS

Shop drawings of all equipment shall be issued to the Design Engineer during the shop drawing review stage for his approval. The Design Engineer shall forward these to the Township Engineer for his review regarding compliance with the Township requirements. The Township Engineer will not perform a technical review. That shall remain the responsibility of the Design Engineer. The Contractor should supply copies* of all equipment shop drawings to the Design Engineer. Final record shop drawings shall be issued to the Township Engineer as part of the close-out procedure in accordance with the close-out section of these specifications. *Digital or hard copies are acceptable, as coordinated with Design/Township Engineer.

1.11 STREAM CROSSINGS

Stream crossings shall be performed in accordance with all permit requirements of the regulatory agencies and Grand Traverse County Technical Specifications.

1.12 DUST AND NOISE REDUCTION

The Contractor shall keep dust and noise from construction operations to a minimum. A dust palliative shall be used on disturbed road sections prior to surfacing if so determined by the Township Engineer.

1.13 MATERIAL CERTIFICATION

Manufacturer's certification slips shall be submitted to the Township Engineer for all pipe, manholes, fittings, etc. used in the installation of sanitary sewer or water mains. This is to verify that the product meets applicable standard specifications required.

1.14 MAINTENANCE BOND REQUIREMENTS

The Contractor shall supply the Owner and Township with a maintenance bond for 50% of the cost of the installation of the sanitary sewer and/or water system that is to be turned over to the Township. The maintenance bond shall be effective from the date of Township acceptance for a period of one (1) year.

1.15 INSURANCE REQUIREMENTS

Where the contract involves construction in a public right-of-way, the Contractor shall provide proof of insurance in the type and amounts required by the Township prior to start of the construction. In addition to the Township, the Grand Traverse County DPW and Township Engineer shall be named as additional insured.

1.16 ESCROW FOR TELEMETRY REQUIREMENTS

When telemetry equipment is required, the owner of the project will be required to provide an account above and beyond the construction contract price in the amount of \$10,500.00 for standard telemetry equipment. This equipment will be integrated into the Grand Traverse County DPW network of monitoring systems. The types of units this may apply to include submersible lift stations, well houses, water booster stations, and pressure reducing valve vaults.

SECTION 2

STANDARDS AND REGULATIONS

2.01 REFERENCE STANDARDS

- A. Throughout these specifications, reference is made to various standard specifications. Such reference gives the serial designation. The latest revised specification shall apply in all cases. These standard specifications, where applicable, shall be binding on all construction activities.
- B. The following specifications and standards form part of this specification to the extent indicated by reference thereto or for quality of workmanship and materials required under the contract.

American Society of Testing Materials	(ASTM)
American Water Works Association	(AWWA)
American National Standards Institute, Inc.	(ANSI)
Michigan Department of Transportation	(MDOT)
American Society of Mechanical Engineers	(ASME)
American Concrete Institute	(ACI)
National Concrete Masonry Association	(NCMA)
Truss Plate Institute	(TPI)
National Electrical Code	(NEC)
MI Dept of Environment, Great Lakes, & Energy	(EGLE)
National Fire Code	(NFC)
Underwriters Laboratories	(UL)
National Sanitation Foundation	(NSF)

2.02 REGULATORY REQUIREMENTS

- A. All construction work, alterations, repairs or mechanical installations and appliances connected herewith shall comply with all the State Rules and Regulations and local ordinances and such other statutory provisions pertaining to this class of work. Such Rules and Regulations and local ordinances are to be considered a part of these specifications by reference.
- B. All electrical work shall be in accordance with the latest edition of the National Electrical Code, the National Electrical Safety Code and applicable state and local codes. This shall not be construed to permit a lower grade of construction where the plans and specifications require workmanship or materials in excess of code requirements. All electrical equipment, wiring, cable, pre-assembled electrical panels, and materials shall be listed by Underwriters Laboratories, Inc.

PROJECT CLOSE OUT

3.01 CLEANUP

Before final acceptance of the sanitary sewer system or water main system work, the Contractor shall remove all false work, excavated or useless materials, and rubbish, and restore to presentable condition per the restoration specifications and satisfactory to the Township Engineer, all property, both public and private, which may have been used or damaged during the installation of the sanitary sewer or water system work.

3.02 OPERATING AND MAINTENANCE DATA

The Contractor shall furnish written instructions for the operation and maintenance of the equipment furnished at the time of submittal of shop drawings. The instructions shall be short, easy to understand, with directions specifically written for this project, describing the various possible methods of operating the equipment. The instructions shall include procedures for tests required, adjustments to be made and safety precautions to be taken with the equipment. Maintenance instructions shall include test and calibration charts, exploded views of assembled components and spare parts lists. At least four (4) and one (1) copy on CD instruction booklets shall be furnished for each separate piece of equipment. These shall be transmitted to the Township Engineer as part of the close out of the project. Record drawings (1 set of paper copy (24" x 36"), one (1) digital copy and one (1) in pdf and AutoCad / ArcView GIS format) shall be submitted to the Township along with hydrant and valve reports, water service lead reports, and sanitary sewer lead reports, as applicable to the project.

A. Pumps

Include the manufacturer's technical specification of the pump along with the application for the pump, the manufacturer's warranty certificate, installation instructions, serial numbers for all pumps, pump performance curve, pump trouble shooting guide and the pump efficiency rating.

B. Control Panel Operation and Maintenance Manual

Include the electrical panel legend, bill of material report, catalog cut sheets indicating make and model of all general accessories, installation instructions for the control panel, recommended spare parts, installation instructions for general accessories and a maintenance frequency chart.

C. Electrical Wiring

A color coded drawing of the as-installed electrical schematic shall be submitted for all electrical work performed as part of the project.

3.03 GUARANTEE

The Contractor shall guarantee all materials and equipment furnished and work performed for a period of one (1) year from the date of Township Acceptance. The Contractor shall warrant and guarantee for a period of one (1) year from the date of Township Acceptance of the system that the completed system is free from all defects due to faulty materials or workmanship. The Contractor shall promptly make such corrections, as may be necessary including the repairs of any damage to other parts of the system resulting from such defects. The Owner or Township, if they have taken over the system, will give notice of observed defects with reasonable promptness. In the event that the Contractor should fail to make such repairs, adjustments or other work that may be made necessary by such defects, the Owner or Township may do so and charge the Contractor the cost thereby incurred. Refer to the form Letter of Guarantee to be included with final close-out documents.

The Contractor shall supply a one (1) year maintenance bond per the "General" section of these specifications.

3.04 FINAL COMPLETION/ACCEPTANCE OF PROJECT BY TOWNSHIP

A. Township Projects

Final payment will not be made to the Contractor until all close out documents have been received and approved by the Township Engineer. These items are listed in Section 3.04.C

B. Private Projects

The Township will not accept the facility or allow connections to or use of the facilities until all close out documents have been received and approved by the Township Engineer. These items are listed in Section 3.04.C

C. Closeout Documents (As applicable)

1. Punch list items satisfactorily completed.
2. Maintenance bond. (Valid for a period of one year from the date of Township acceptance of the system).
3. Letter of guarantee (format provided by Township Engineer).
4. Easement descriptions.
5. Descriptions of the facilities for a bill of sale.
6. Certification by the Engineer reviewing the installation.
7. Sanitary Sewer Lead Reports.

8. Water Service Lead Reports.
9. Water Valve Reports.
10. Hydrant Reports.
11. Operation and Maintenance Manuals
12. Record Drawings
- 12A. Record Drawings (as-constructed) must include a paper copy (24" x 36") and a digital copy (formats listed below) including a .pdf copy of each sheet.

Digital Submittal Format Requirements: The developer shall submit to the Township a digital copy of the Record Drawings (as described in Section 3.04.B Item 12B of the Technical Specifications) in one of the following formats:

- a. AutoCAD (.DWG) release 2004 or higher
- b. ArcView GIS format (.SHP)

All digital record drawings must be submitted utilizing the appropriate Michigan State Plane coordinate system (i.e. NAD 1983 State Plane Michigan Central). No local coordinate systems are allowed.

- 12B. Record Drawings: Record drawings shall consist of plan and profile. Sanitary sewer leads and water service leads shall be re-drawn in the new location along with the mainline structures and piping. Hydrant, valve and manhole numbering sequences shall be obtained from the Township Engineer. Each structure installed, such as manholes, water service leads, hydrants, valves, sewer leads, bends, tees, or other structures placed shall have 3 physical measurements from structures which are to be shown on the plans along with survey and/or gps coordinates and elevations. Lead measurements are to be placed on the individual reports. Survey and/or gps information shall be included in the digital record drawing or provided in shapefile format. Sanitary sewer profiles shall include manhole number, rim and invert elevations, distances between structures, size and type of pipe. Water main profiles shall include hydrant and valve number and rim elevations, all fittings, horizontal/vertical, and the accurate depth of placement. All profiles shall show conflict with existing utilities. Sanitary sewer lead and water service lead information shall be placed in a table format on the record drawings. Each plan sheet shall have a separate table for the type of lead shown on that sheet. See Table 3.1 and Table 3.2 for examples.

Table 3.1

SECTION 3
PROJECT CLOSE OUT

SEWER LEAD NUMBER	DISTANCE FROM DOWNSTREAM MANHOLE	DISTANCE FROM SEWER TO END OF LEAD AT PROPERTY LINE OR EASEMENT LINE	DEPTH BELOW GRADE

Table 3.2

WATER SERVICE LEAD NUMBER	DISTANCE FROM GATE VALVE OR FIRE HYDRANT. INCLUDE VALVE OR HYDRANT NUMBERS.	DISTANCE FROM WATER MAIN TO END OF LEAD AT PROPERTY LINE OR EASEMENT LINE	CURB STOP RIM ELEVATION	CURB STOP COORDINATES

GRAND TRAVERSE COUNTY

WATER/SEWER SYSTEM CLOSEOUT CHECKLIST

Section 3 of the current specifications outline in detail the information to be submitted for close out of the project. The following checklist is being provided as a convenience to the developer completing the project and does not relieve the developer from reviewing the appropriate section (s) in the specifications.

Check If Completed:

Letter of Guarantee (see attached format)	
1-Year Maintenance Bond Valid for 1-Year from Township Acceptance of System	
Material Certifications	
Shop Drawings	
Letter from Developer Outlining Project Costs (Including permitting, engineering and Construction (without service leads)	
Affidavit of Completion/Consent of Surety (See attached format)	
Inspector Daily Reports	
Description of facilities for a Bill of Sale	
Certification of Acceptance by Developer or Developer's Engineering Reviewing Installation	
Water Service Lead Reports	
Water Valve Reports	
Fire Hydrant Reports	
Sanitary Sewer Lead Reports	
Operation and Maintenance Manuals (if applicable)	
Water Main Pressure Test Results	
Water Sample Analytical Results	
Survey Field Notes	
Electronic Copy of Record Drawings in AutoCAD .dwg or Arcview GIS and .pdf Formats (See Section 3 of specification for additional requirements)	
Paper Copy of Record Drawings (See Section 3 of specification for additional requirements)	
Easement Descriptions	
Sanitary Sewer Mandrel Test Results	
Sanitary Sewer Air Test Results	

SECTION 5

CONCRETE WORK

5.01 SCOPE OF WORK

The work under this section shall include all materials, labor and equipment necessary to achieve a finished product, including but not limited to the items in these specifications and those shown on the working drawings. Work includes, but is not limited to building footings, floor slabs, sidewalks, curb and gutter, driveways, etc.

All procedures and materials shall be in accordance with the American Concrete Institute "Building Code Requirements for Structural Concrete" (ACI 318 –) and "Specifications for Structural Concrete" (ACI 301).

5.02 MATERIALS

- A. Cement: Portland cement shall conform to "Specification for Portland Cement" (ASTM C150).
- B. Aggregates: Concrete aggregates shall conform to "Specification for Concrete Aggregates" (ASTM C33). Maximum coarse aggregate size for all members less than eight (8) inches in thickness shall be 3/4 inch. For members with thicknesses greater than or equal to eight (8) inches, the maximum coarse aggregate size shall be 1-1/2 inches.
- C. Mixing Water: All water used in concrete shall be from a potable water supply.
- D. Concrete Mix Proportions

ACI 318 shall be used for selecting concrete proportions. The Contractor shall furnish, for the Engineer's approval, all information necessary to show compliance with ACI 318.

5.03 EXECUTION

A. Concrete Quality

All concrete shall meet the requirements of ACI 318 and shall have a minimum compressive strength of 3000 psi

Air entrainment for exposed concrete shall be per ACI 318 for Severe Exposure.

The concrete shall be of a consistency to work easily into corners, angles of forms and around reinforcement.

B. Mixing and Placing Concrete

1. Preparation of Equipment and Place of Deposit:

- a. Before placement, all equipment for mixing and transporting the concrete shall be cleaned and all debris and ice shall be removed from the places to be occupied by the concrete.
- b. Water shall be removed from place of deposit before concrete is placed. All latents and other unsound material shall be removed from hardened concrete before additional concrete is added.
- c. Expansion joint material shall be placed at all locations where concrete is placed against a structure.

2. Mixing:

- a. Concrete shall be mixed and delivered in accordance with the "Specification for Ready Mixed Concrete" (ASTM C94).
- b. For job mixed concrete, the mixer shall be rotated at a speed recommended by the manufacturer. If mixer performance tests are not made, each batch of 1 cubic yard or less shall be mixed for at least 1 minute after all materials are in the mixer. The mixing time shall be increased 15 seconds for each additional cubic yard or fraction thereof. The entire batch shall be discharged before the mixer is recharged.

3. Conveying:

- a. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent separation or loss of materials.
- b. Conveying equipment shall be of such size and design as to ensure a nearly continuous flow of concrete at the delivery point without separation of materials or loss of plasticity.

4. Depositing:

- a. Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to rehandling or flowing. Concrete shall be placed at such a rate that it is at all times plastic and flows readily. No concrete contaminated by

foreign material shall be used nor shall retempered concrete be used.

- b. When placing is started, it shall be carried on as a continuous operation until placement of a well defined section is completed.
- c. All concrete shall be thoroughly consolidated during placement. It shall be thoroughly worked around embedded fixtures and into the corners of the forms.

5. Hot & Cold Weather Requirements:

- a. Concrete placement during hot weather shall be in accordance with "Hot Weather Concreting" (ACI 305). Concrete placement during cold weather shall be in accordance with "Cold Weather Concreting" (ACI 306).

WATER MAINS AND APPURTENANCES9.01 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labor, materials, and equipment and in performing all operations for the proper installation of the water mains and appurtenances in strict accordance with these specifications and applicable contract drawings.

NOTE:

When selecting pipe materials for water main the Design Engineer should clearly understand that the Township Engineer that reviews the final plans, and the Michigan Department of Environment, Great Lakes, & Energy (EGLE) Office of Drinking Water and Municipal Assistance, will have the final say as to which type is preferred for any given location.

9.02 MATERIALS

A. Pipe Materials: Ductile Iron Pipe (DIP) and fittings are the preferred water main pipe material. DIP should be used as often as possible, with exceptions only granted by the individual Township, in writing, on a case-by-case basis.

1. Ductile Iron Pipe and Fittings shall be designed in accordance with American Water Works Association (AWWA) Standards C150 and C151 also ANSI Standards A21.50 and A21.51. The pipe shall be designed to withstand a minimum working pressure of 200 psi and a minimum hydrostatic test pressure of 300 psi. The pipe shall also be designed for a laying depth of a minimum of six feet (6') of cover. All ductile iron pipe shall meet the requirements of NSF International (NSF) Standard 61.

All ductile iron pipe and fittings shall be coated on the outside with an asphaltic coating of asphalt base one mil thick at the point of manufacture in accordance with the specifications of the AWWA Standard C151 and ANSI Standard A21.51.02. Cement lining requirement shall conform to AWWA Standard C104 and ANSI Standard A21.4. The spigot ends of all pipe lengths which have been cut in the field shall be ground to a smooth surface, tapered back about one-eighth inch ($\frac{1}{8}$ ") at an angle of 30° with the pipe centerline, and painted with two coats of asphaltum metal protective paint.

Ductile iron pipe shall conform to the dimensions set forth in the table below (Design Engineer shall verify expected pressure range with Township Engineer during design phase).

Pipe Size Nominal Inside Diameter in Inches	Outside Diameter in Inches	Pipe Barrel Thickness in Inches	Thickness Class
6"	6.90	.31	52
8"	9.05	.33	52
10"	11.10	.35	52
12"	13.20	.37	52
16"	17.40	.40	52
20"	21.60	.42	52

2. Polyvinyl Chloride Pipe (PVC) and Fittings for Open Cut Construction:

Rigid polyvinyl chloride bell and spigot type pressure pipe and fittings shall be Ductile Iron Pipe Size (DIPS), conform to AWWA C900/C905 Standards, pressure class 235 psi, and DR 18, unless otherwise by the Township Engineer for the application being proposed. PVC water mains shall be designed in accordance with the latest revision of AWWA Standards as follows:

*C900 for 6-inch through 12-inch diameter pipe

*C905 for 14-inch through 36-inch diameter pipe

The pipe shall also be designed for a laying depth of a minimum of six feet (6') and meet the following conditions: Be rated at a Working Pressure of 200 psi and have a Surge Pressure Rating of at least 300 psi. Pipe joints shall be in accordance with ASTM D3139 (latest revision).

Pipe must meet the requirements of NSF Standard 14 and NSF Standard 61 to be used for potable water systems. The pipe shall be blue in color and the exterior wall print line of all pipe proposed for installation and potable use must bear the AWWA and NSF-PW identification. Refer to standard details for the connection of ductile iron pipe to PVC.

Pipe joint gaskets for PVC pipe shall be elastomeric seal type conforming to ASTM F477. Pipe joint lubricants shall be manufacturer's standard nontoxic material conforming to AWWA C900 Standards.

Use of PVC water main shall be treated on a case-by-case situation. The pipe must be approved by the Township Engineer prior to permitting.

3. High Density Polyethylene Pipe (HDPE) for directional drilling applications shall be Ductile Iron Pipe Size (DIPS) and shall meet either of the following two (2) pressure class rating systems:

AWWA C906 or ASTM F714:

Working Pressure of at least 200 psi

Working Pressure and Surge pressure of at least 300 psi

All HDPE pipe shall be joined by heat fusion per manufacturer's requirements. HDPE pipe must meet the requirements of NSF Standard 14 and NSF Standard 61 and AWWA C906. The exterior wall print line of all HDPE pipe proposed for installation and potable use must bear the AWWA C906 and NSF-PW identification.

HDPE sections shall be pressure tested independently of other water main. See Section 9.07 of these specifications for the Acceptance Testing of Water Main. The method and locations must be approved by the Township Engineer. Refer to standard details for the connection of ductile iron pipe to HDPE. Thrust restraint devices must be used and located as recommended by the pipe manufacturer to account for HDPE pipe expansion and contraction due to changes in temperature and internal surges.

Refer to Section 4 – Excavation, Trenching and Backfilling and EGLE Suggested Practice for Water Works Design, Construction and Operation for Type I Public Water Supplies – Fusible thermoplastic pipe requirement for use of HDPE water main.

HDPE pipe shall be inspected prior to installation by a qualified person or by the Township Engineer. If damage is found to be unacceptable according to the manufacturer, then suitable efforts shall be made to repair the damaged pipe or the pipe shall be rejected from use.

The pipe, standard details, and type of bedding shall be approved by the Township Engineer.

Use of HDPE water main shall be treated on a case-by-case situation. The pipe must be approved by the Township Engineer prior to permitting.

4. Fusible Polyvinylchloride (FPVC) Pipe for directional drills shall conform to AWWA C900 or C905, ASTM D1784, and cell classification 12454. Pipe shall be in accordance with ASTM D2241 for Ductile Iron Pipe Size (DIPS) standard dimensions as indicated in these specifications. Compound formulation shall be in accordance with PPI TR-2/2006. Fusible PVC shall meet the same pressure class as specified in 9.02.A.1.

Pipe shall be manufactured with 100% virgin resin. Fusible PVC pipe must meet the requirements of NSF Standards 14 and 61 to be used for potable water systems and must bear the NSF-PW identification.

Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

Fusible polyvinylchloride pipe shall be manufactured in a standard 20', 30' or 40' nominal lengths and shall be blue in color.

Pipe shall be marked per AWWA C900 or AWWA C905, and shall include as a minimum:

1. Nominal size
2. Dimension Ratio (DR18), Standard Dimension Ratio
3. AWWA pressure class or rating
4. AWWA Standard designation number
5. All pipe shall be stamped to indicate compliance with NSF Standard pw.
6. Extrusion production-record code
7. Trademark or trade name
8. Cell Classification 12454 and/or PVC material code 1120 may also be included.

Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other deleterious faults. Refer to Section 4 – Excavation, Trenching and Backfilling and EGLE Suggested Practice for Water Works Design, Construction and Operation for Type I Public Water Supplies – Part 11 (9) Fusible thermoplastic pipe requirements.

Use of Fusible PVC water main shall be treated on a case-by-case situation. The pipe must be approved by the Township Engineer prior to permitting.

- B. Joints for water main pipe shall conform to the following:

DUCTILE IRON:

1. Flanged joints for ductile iron pipe shall be made with flanges, bolts, nuts, washers and gaskets conforming to AWWA Standard C110 and ANSI Standard A21.10.
2. Mechanical joints shall conform to AWWA Standards C110 and C111 along with ANSI Standards A21.10 and A21.11. Rubber gaskets shall conform to manufacturer's standards.
 - a. Retainer glands shall be utilized on all mechanical joint fittings.
 - b. Lead tip gaskets will not be allowed for providing metal to metal contact at joints.
3. Rubber gasket joints for ductile iron pipe shall be of a bell and spigot type which employs a single rubber gasket to affect the joint seal. These joints shall conform to AWWA Standard C111 and ANSI Standard A21.11. These joints shall be similar to "Tyton" as manufactured by U.S. Pipe and Foundry Co., "Bell-Tite" as manufactured by James B. Clow and Sons, Inc. or approved equal.
4. Bell joints shall be cast iron, mechanical, flexible joint tube designed to withstand a working pressure of 200 pounds and a hydrostatic test pressure of 300 pounds. Joints shall be similar to "Molox" as manufactured by the American Cast Iron Pipe Company, "Usiflex" as manufactured by U.S. Pipe and Foundry Co., "River Crossing Pipe" James B. Clow & Sons, Inc. or an approved equal.
5. Field-Loc gaskets/Fast-Grip or equal are accepted for the use of Tyton push on joints for fittings.
6. Ductile sleeves shall have "cookie" piece inserted between two pipes if there is any separation between the two pipes.

PVC PIPE:

1. Compact or short body joints and fittings for ductile iron and PVC pipe shall be made conforming to AWWA Standard C153 and ANSI Standard A21.53.

2. PVC pipe specified in 9.02.A.1 may be used for directional drill pipe, with approval of Township Engineer, using a Diamond Loc-21, or approved equal restraint joint.
3. Rubber gasket joints for PVC pipe shall be of a bell and spigot type compliant with ASTM D-3139 and the joint gasket shall conform to ASTM F-477. These joints shall be as manufactured by National Pipe & Plastics, Inc. or approved equal.

C. Gate Valves

Gate valves shall meet the requirements of AWWA or C515. Valves shall be designed for not less than 250 psi working pressure and shall be tested for leakage and distortion under a hydraulic pressure of not less than 500 psi. Under such pressure, the valves shall show no leakage or distortion.

All gate valves shall be EJIW Flowmaster resilient wedge gate valves. The wedge casting shall be of a solid design and 100% encapsulated with nitrile rubber. Hollow wedges are not allowed and no epoxy coating is allowed in wedge. There shall be 3 stem seal o-rings; two in the seal plate which shall be replaceable with the valve in the full open position at rated working pressure, and one under the stem thrust collar. All gaskets shall be o-ring seals. O-rings set in a cartridge shall not be allowed. Each valve shall have a clear waterway equivalent in area, when open, to that of the connecting pipe. **Valves shall be made to open right (clockwise).** All valves shall be connected to the pipeline by mechanical joints. All valves shall be operated by non-rising stems and shall have square wrench nuts.

All valves shall be furnished with a three piece adjustable valve box as specified herein unless the valve is housed in a manhole.

The operating nut on all valves including hydrant valves will be located with five feet (5') of the finished grade. If the valves operating nuts are greater than five feet (5') below finished grade a fixed stationary rod shall be required in the valve box to allow the valve to be operated with a standard valve wrench.

D. Butterfly Valves

Butterfly valves, as called out on the plans, shall be so designed and fabricated that they will conform to AWWA Standard C504 for Class 150B valves. The rubber valve seat shall cover the entire interior surface of the valve body and the face of the body. The valve disc shall be streamlined, free of external ribs, keyed to the shaft, provided with suitable means for positioning and shall utilize wedge type closing against the rubber liner at a

full close seating angle of 90° to the axis of the pipe. Valves shall be as manufactured by Dresser Manufacturing Division, Keystone International, Inc. or an approved equal.

All Butterfly valves shall be installed in a manhole per the Standard Detail Sheet (for stream crossing only). Caution is advised when cleaning the mains with a poly pig to insure that all gravel and sediment is removed from the main, valves and appurtenances.

E. Valve Boxes

Valve boxes shall be cast iron, three-piece, adjustable type, with a five and one-quarter inches (5¼") shaft. Covers shall be furnished with finger holes and marked "WATER". Valve boxes shall be similar to that as manufactured by the East Jordan Iron Works or an approved equal. Contractors shall be responsible for adjusting valve boxes to meet finish grades once finish grades are established.

F. Fire Hydrants

At the points indicated on the drawings, there shall be installed a hydrant assembly consisting of a hydrant, a six-inch (6") gate valve, a cast iron valve box and all piping and fittings necessary for a complete job. Gate valves shall be as specified above. Valves shall be located three feet (3'), plus or minus, from the hydrant as shown on typical hydrant setting on drawings.

1. Hydrant barrel inside dimension to be seven and one-quarter inches (7¼") I.D. from top to bottom.
2. Nozzles to be on a removable head so that they may be rotated by changing the position of the top flange without removing the barrel.
3. Hydrant to be fully bronze mounted including top of operating stem where it passes through the double "O" ring seal in the bronze packing gland. Operating stem in base and valve seat shall be made of bronze. No "V" type threads are allowed for the operating stem or nut.
4. The drain valve shall be unplugged in all well drained, porous, well drained, soil locations. The plug shall be installed in all groundwater and/or areas of known high water tables, heavy soils, muck soils, or clay soils.
5. Hydrant nozzle shall be located 2'-8" to 3'-2" above breakaway flange.

6. Hydrants furnished for this work shall meet the requirements of AWWA Standard C502 (latest edition). They shall be East Jordan Iron Works Model 5BR Water Master or Water Master 5BR250, or approved equal. Hydrants shall be designed for installation with six feet (6') of cover over the connection. Threads shall conform to national standard threads. Hydrant stems shall be built to open left (counter clockwise).
7. Hydrants shall be of the "break flange" type. Bottom of "break flange" shall be four inches (4") above finished grade. The hydrant shall be so designed that all working parts, including valve and drip mechanism, may be removed from the hydrant through the barrel without the necessity of excavation. The hydrant shall be designed for a working pressure of 150 psi. Operating nuts shall be pentagon one and one-half inch (1½") size, as measured point to opposite flat.
8. **The diameter of the valve port in the hydrant shall be at least five inches (5"). The following Fire Departments require that the hydrants shall be equipped as follows:**

Grand Traverse Metro Fire Department: One (1) four-inch (4") and two (2) two and one-half inch (2½") pumper connections.

Peninsula Township Rural Department: Two (2) four-inch (4") pumper connections with 5" Storz hydrant converters with nut caps.

Elmwood Township Rural Department: Two (2) four-inch (4") pumper connections.

G. Water Service Connections

Water service connections are the water line connections which extend from the water main to the property line or easement line of water system customers. A water service connection shall consist of a corporation stop in the water main, a small diameter water line to the property line, a curb stop at the property line and curb box and cover. The Contractor shall place the water service connections where directed by the Design Engineer. The service line piping and fittings shall be either one-inch or two-inch (1" or 2") size as called out on the plans.

1. Service Line Pipe and Fittings

Pipe material shall be Type K Copper, annealed and soft temper ASTM B.88. Joints shall be flared and/or compression style, as approved by the Engineer. Must conform to AWWA Standard C800.

Service saddles are required on ductile iron pipe for all service taps greater than one-inch (1") and on PVC pipe for all service taps. All service saddles shall be double strap shall be 100% stainless steel. Services larger than two inches (2") shall be constructed in accordance with water main pipe and valve requirements, using a tapping valve and sleeve for the connection to the existing main.

2. Corporation Stops

Ductile Iron Water main Installation: One-inch and two-inch (1" and 2") corporation stops shall be ball style Mueller series B-25000 series, A.Y. McDonald 4100 series, or equal, for copper service pipe. Corporation stops shall be in the "open" position after the service connection is complete. Must conform to AWWA Standard C800.

PVC Water main Installation: One-inch and two-inch (1" and 2") stops shall be Ford B1000 Series, or equal, for copper service pipe. Corporation stops shall be in the "open" position after the service connection is complete. Must conform to AWWA Standard C800.

3. Curb Stops

Curb stops shall be Mueller B-25204, Ford B22 or approved equal. Curb stops shall be of the quarter turn, ball style, positive shut-off type. Must conform to AWWA Standard C800.

4. Curb Boxes

Curb boxes shall be adjustable in height to allow for variable grade elevations. Curb boxes shall be all cast iron construction and coated inside and out with tar base enamel. A cast iron lid shall be furnished with finger holes, or plug in center (with rod) and shall have "WATER" permanently stamped.

Curb boxes for one inch (1") services shall be furnished with a stationary operating rod inside the box and arch pattern base equal to Mueller series H-10314.

Curb boxes for one and one-half inch and two inch (1½" and 2") services shall be the arched pattern base with rod, equal to Mueller series H-10386. Must conform to AWWA Standard C800.

5. Water Service Saddles

Water service saddles shall be compatible with the main and service lead, with straps of a ductile iron material to avoid crushing the main out-of-round. A molded gasket of rubber or neoprene shall completely encircle the tapped opening to ensure a watertight connection. The use of lead gaskets is not allowed. Water service saddles shall be bronze with AWWA tapped threads.

Service saddles used with PVC water main shall be double strap, full circular and provide uniform bearing around the circumference. U-bolt type straps and service taps to HDPE pipe are not allowed.

Saddles shall be manufactured by Mueller BR2S or approved equal.

H. Tapping Sleeve and Valve

Where shown on the plans or where a tee and valve are to be installed on an existing main under pressure, a tapping sleeve and drilling machine shall be used. After installing the sleeve and prior to drilling, the sleeve shall be pressure tested at 150 psi for five minutes. The Township Resident Project Representative and the Grand Traverse County DPW Water Department Operator shall be given 48 hours-notice of all water main live taps. Tapping sleeves for taps smaller than the main line, ex: 8"x10", 10"x12" utilize a stainless steel (vega type) wrap around sleeve. For taps which are size on size ex: 12"x12", 10"x10", use class 250 EJIW cast iron sleeves. Tapping sleeve and valve shall be mechanical joint, class 250, as manufactured by East Jordan Iron Works, or an approved equal. Stainless steel (vega type) wrap around sleeve is also allowed for size on size taps. Tapping sleeves for HDPE shall use spring style washers to accommodate for expansion and contraction of the pipe.

I. Water main Stubs

At the end of a stub, the last three (3) pipe joints shall have Field-Loc gaskets/Fast-Grip gaskets or equal. No galvanized pipe materials shall be allowed. A corporation shall be placed for the use of flushing and sampling.

J. Tracer Wire Box

The tracer wire access box shall be stock number 22408 as distributed by USA Blue Book, or approved equal.

9.03 INSTALLATION OF PIPE AND FITTINGS FOR WATER MAINS

All pipe and fittings shall be installed in strict accordance with the recommendations of the manufacturer and AWWA Standard C600 for Ductile Iron pipe, or AWWA C605 for PVC pipe (latest editions). Piping and fittings for water mains shall be of the types and materials hereinbefore specified. The pipe and accessories shall be new and unused. Before installation, the pipe shall be inspected for defects and any section of pipe or fittings found to be defective, before or after laying, will be rejected and replaced with sound pipe without additional expense to the Owner.

All water main shall be placed with a depth of bury, measured from the top of the pipe to final finished grade, with a minimum of six feet (6') of cover. Depth of cover greater than six feet (6') of cover may require additional easement width be granted to the Township and/or may require developer to assume some future restoration costs.

Water main along private roads shall not be placed in the fore slope of ditches and shall be a minimum of twenty three feet (23') from the centerline of the road.

All water main shall be laid with a continuous one-quarter-inch (1/4") diameter, stainless steel cable tracer wire, per Section 9.12. Tracer wire shall be laid six inches (6") above water main. Tracer wire shall terminate in a tracer wire box. Tracer wire box shall be placed at each hydrant or approximately every four hundred feet (400').

The interior of the pipe and fittings shall be thoroughly cleaned of foreign matter before being lowered into the trench with an approved method and shall be kept clean during laying operations by plugging the ends or other approved methods. The plug shall be fitted with a means for venting. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth, animals or other substance will enter the pipes. When practical, the plug shall remain in place until the trench is pumped completely dry. Care must be taken to prevent pipe floatation, if the trench fills with water. No pipe or fittings shall be laid in water or when the trench or weather conditions are unsuitable for work except by permission of the Township Engineer. Valves shall be installed in the closed position.

Ductile iron pipe and fittings used on ductile iron (except flanged pipe) shall be provided with three brass wedges at each joint, Fastite conductive (American Pipe)

or equal, "Electro-bond" strips of "Cadweld" connectors or other means of providing metal-to-metal contact at the joint to allow an electric current to flow through the joint.

Trench widths shall meet all standards, such as OSHA and AWWA Standard C600 or AWWA C605. The full length of each section of pipe shall rest solidly upon the pipe bed with recesses provided to accommodate the bells and joints. Refer to AWWA Standard C600 or C605 for maximum allowable joint deflection.

When pipe is cut in the field, the outside of the cut end shall be tapered back about one-eighth-inch ($\frac{1}{8}$ ") at an angle of 30° with the centerline of the pipe to remove any sharp, rough edges. Exposed edges shall be coated with two coats of asphaltum metal protective paint.

Fittings at bends in the pipe line shall be firmly wedged against the undisturbed vertical face of the trench to prevent the fittings from being blown off the lines when under pressure. Concrete thrust blocks shall be provided as shown in the standard details or directed by the Township Engineer.

Where pipe ends are left for future connections, they shall be valved, plugged, or capped as called for on the drawings. Where connections are made between new work and existing mains, the connections shall be made by using special pipes and fittings as required to suit the actual conditions.

All temporary and permanent water main stubs shall be restrained with Field-Loc gaskets/Fast-Grip or equal for at least three (3) pipe joints prior to the stub end, including mechanical fittings. This will allow for a connection to the main without removing or reducing the existing water pressure. It is required that a gate valve be installed at the end of the stub.

9.04 SETTING HYDRANTS

Under each hydrant the ground shall be excavated to a depth of at least one foot (1') below the hydrant base and over an area approximately three feet (3') square. This excavation shall be filled up to the elevation of the hydrant base with well compacted, clean, coarse gravel or crushed stone. Refer to the standard details.

The length of a hydrant lead shall not exceed one-half ($\frac{1}{2}$) of the Road right-of-way width or twenty feet (20') if water main is located within a private easement. Each hydrant shall be set truly plumb and held firmly braced in this position. The connection of the hydrant to the branch shall be made by mechanical joint as herein specified under jointing. After the joining has been made, a concrete thrust block shall be poured on the side opposite the branch connection, from the hydrant to the solid undisturbed earth of the excavation wall.

When the concrete has become sufficiently hard, an additional one foot depth of gravel shall be spread and tamped around the hydrant. When this has been done, the remaining backfill shall be placed and compacted, taking care at all times to avoid jarring the hydrant.

Wherever it is necessary to adjust the length of the barrel to meet variations in elevation of the ground surface over the water main and at the hydrant location, suitable extensions shall be provided for the hydrant barrel and operating stem. In all cases, the break flange shall be located at grade.

Contractor shall remove all water from fire hydrants. Water left remaining in each fire hydrant assembly will be removed by pumping prior to acceptance by the Township. Thawing and/or repair of frozen hydrants shall be performed by the Contractor at no additional expenses to the Owner.

In addition to pumping any new hydrant prior to Township acceptance the Contractor shall winterize any new hydrant installed or existing hydrant used during construction, if work done between October 1 and March 31.

9.05 CONNECTING TO EXISTING WATER MAINS

Where connections are made between new work and existing water mains, the connections shall be made by using special pipes and fittings as required to suit the actual conditions. No connections to existing mains shall be made until the new main has been pressure tested; continuity tested chlorinated, and sampled and is ready to be placed into service. When making the connection, swab pipe and fittings with four percent chlorine solution. The Township Engineer shall witness all connections and shall be notified 48 hours prior to the connection of new pipe to existing pipe. Bacteriological samples shall be taken before connection to existing is completed to provide a record for determining the procedures effectiveness per AWWA Standard C651. Conform to AWWA Standards C600 and C651.

9.06 DIRECTIONALLY DRILLED WATER MAIN

A. Description

This work shall consist of constructing underground crossings of a wetland using the directional drilling method of placing pipe to serve as carrier pipe.

B. Depth of Bore

The minimum depth of drill using this method shall be six feet (6') of cover below existing grade, and a minimum depth of three feet (3') under any existing stream.

C. Materials

Plastic Pipe: Section 9.02 A.3 High Density Polyethylene Pipe or Section 9.02 A.4 for Fusible Polyvinyl Chloride Pipe.

D. Construction Method

This method consists of auguring or jacking a steerable rod under the wetland; then pulling back a cone that expands the soil or a wing cutter, which cuts a hole big enough to obtain the desired diameter. The diameter of the reamer or wing cutter is not to exceed the diameter of the pipe being placed plus two inches (2").

A drilling fluid of water and bentonite may be used in all operations of a directional drill. The use of a polymer for lubrication in the drilling fluid is acceptable.

Connection to HDPE Pipe shall not be made immediately after the pipe has been installed. It is recommended to wait overnight so that the pipe can approach an equilibrium temperature with its surrounding environments. Linear dimensions will vary with temperature changes. A tracer wire adequate for future location of the pipe shall be installed with all HDPE projects.

9.07 ACCEPTANCE TESTING WATER MAIN

A. General

Prior to connecting the new water main to an existing water main, the new main shall be flushed, chlorinated, and pressure tested as outlined herein.

The Township Engineer shall be notified 48 hours prior to the start of a pressure test. All acceptance testing shall be witnessed by the Township Engineer or Township Resident Project Representative.

A physical gap of at least three feet (3') must be left between the existing and new water main until all testing results are satisfactory. The testing sequence shall be: 1) flushing, 2) pressure test, and 3) chlorination. Water for testing may be taken from a nearby hydrant or tee connection by using fittings to accommodate a standard fire hose connection. A reduced pressure principle backflow prevention assembly must be used on the two and one-half inch (2½") connection to the main being tested.

B. Flushing of Mains

The water main shall be flushed clean of sand and debris. Flushing shall be done using the "poly-pig" method of flushing. The Contractor shall furnish the brand new, unused, foam "poly-pig" swabs to be used. Prior to pigging and flushing the water main must be charged with water.

Contractor shall insert "poly-pig" swab in the end of the new main nearest the existing water main (or where shown on the plans). The swab shall be passed through the new main using water pressure. The swab shall be recovered at the end of the main through the blow-off assembly.

C. Hydrostatic Testing

The water main or sections thereof shall be tested by the Contractor in the presence of the Township Engineer and all leaks shall be made tight to meet the requirements below. The Contractor shall furnish all piping, bulkheads, pumps, gauges and other equipment required to carry out the test and shall obtain Township Engineer's approval of same prior to testing.

The section of main to be tested shall be slowly filled with water at least 24 hours prior to starting the test. Expel air through corporation stops installed at high points in line. The Contractor shall make arrangements with the operation/maintenance personnel for obtaining water for testing.

All water used shall be metered and quantities reported to the operation/maintenance personnel.

At the start of testing, the main shall be pumped up to a pressure of 150 psi and the test period shall start immediately thereafter. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section. The line shall then be maintained under this test pressure for a continuous period of two hours by pumping water into the line at frequent intervals. The test pressure shall not vary by more than +5 psi for the duration of the test. The volume of water so added shall be measured and considered to represent the leakage from the line under test during the intervals. All water service leads shall be tested with the mainline pipe. Conform to AWWA standard C600 or C605.

Testing allowance. No pipe installation will be accepted if the amount of makeup water is greater than that determined by the following formula:
In inch-pound units,

$$L = \frac{SD\sqrt{P}}{148,000}$$

Where:

L=Testing allowance (makeup water), in gallons per hour

S=Length of pipe tested, in feet

D=Nominal diameter of the pipe, in inches

P=Average test pressure during the hydrostatic test, in pounds per square inch (gauge)

The leakage per 1,000 feet under the conditions of the test shall not exceed the values shown in the following table, in accordance with AWWA Standard C 600 for ductile Iron and C605 for Plastic Pipe.

Hydrostatic testing allowance per 1,000 ft of pipeline-gph
Test Pressure 150 psi

Nominal Pipe diameter	Maximum Leakage Gallons Per Hour Per 1,000 Feet of Pipeline
6"	0.50
8"	0.66
10"	0.83
12"	0.99
14"	1.16
16"	1.32
18"	1.49
20"	1.66
24"	1.99

In the event that the leakage exceeds the specified amount, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or special casting found to be cracked shall be removed and replaced with new pieces by the Contractor. No repair clamps or bell clamps can be utilized for repairs on new construction. After this work has been done, the tests shall be repeated. Final acceptance of the lines will not be made until satisfactory tests have been passed.

Water service leads installed with mainline pipe will be included in the water main pressure test. Installed water service leads shall have a riser (extension of water service) placed at the downstream side of the curb box.

For flushing, testing, and sampling, once all tests are completed, this riser must be removed or buried 6' below grade.

Not more than 1,200 LF of water main shall be tested at one time, plus one set from the end of the line and at least one from each branch greater than one pipe length. If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

Where there is a considerable elevation difference in the section of water main being tested, the test pressure shall average 150 psi over the length of main, but shall be not less than 140 psi at the highest elevation.

All main line valves and hydrant lead valves within the test section shall remain open during the pressure test.

After completion of the two hour pressure test, each valve shall be checked against test pressure.

D. Disinfecting Water mains

After completion of pressure testing and flushing of the water main, the disinfection of the water main shall be carried out in accordance with AWWA Standard C651-14.

The method of chlorination chosen for disinfection of the water main shall be one of the four methods specified under Section 4.4 of AWWA Standard C651-14. Sampling requirements stipulated by the City of Traverse City Water Treatment Department shall also be followed for new construction or extensive repair for all water systems that are operated and maintained by the Grand Traverse County Department of Public Works. This procedure is as follows:

- a) After disinfecting, flush the system until the chlorine residual equals the source water and then allow the water to remain static for 24 hours before drawing the first sample. Submit the first sample which will then be tested using the Colilert procedure.
- b) There are two sampling options: (1) Option A – Samples are taken 16 hours apart and (2) Option B – Samples are taken 15 minutes apart after a 16 hour rest period. The initial sample shall be done using the Colilert procedure and the second shall entail two (2) samples from the same sample point, one of which will be tested using the Colilert procedure and the other using the Membrane Filter procedure. If both of the second samples are negative, authorization

will be given to use the new construction or repair. If the second Colilert sample is negative but the Membrane Filter sample produces background growth, resampling for the Membrane Filter testing shall only be required until no growth occurs on the Membrane Filter sample.

Note: If the system is re-chlorinated or re-pigged the sampling procedure shall be started over as listed above in paragraphs “a)” and “b)”. When no growth occurs on the Membrane Filter, approval will be given to activate the system.

- c) The Contractor shall discuss his proposed disinfection procedure and sample locations with the Township Engineer and have it approved prior to beginning the process.
- d) The Contractor shall supply the chlorine, all necessary equipment and labor necessary for its application. The Contractor shall make suitable arrangements with the Township Engineer for bacteriological analysis and shall be responsible for all cost incurred from bacteriological testing. Bacteriological analysis shall conform to the requirements of the Michigan Safe Drinking Water Act and be performed by the City of Traverse City Water Department. Prior approval from the DPW must be obtained before an alternate State approved drinking water testing laboratory can be used.
- e) One (1) sample shall be taken of the source water prior to connecting the new water main to the existing. The procedure and analysis shall be compliant with the City of Traverse Water Department requirements stated above.
- f) Dechlorination: Contractor shall comply with AWWA C655 on proper dechlorination and disposal of heavily chlorinated water.

9.08 TRANSFER OF WATER SERVICES

Where water services are to be transferred from an existing water main to a new water main, as shown on the plans, Contractor shall provide corporation stop and necessary pipe and fittings. Work shall be scheduled in such manners that transfer of service to any residence or water customer will result in the least possible interruption of water supply service. All services are one inch (1") unless otherwise shown on the plans.

9.09 TRANSFER OF EXISTING HYDRANTS

Where indicated, existing hydrants are to be transferred from an existing main to a new main, as shown on the plans. Contractor shall excavate and reset the hydrant, as shown on Hydrant Assembly Detail, provide new six inch (6") hydrant gate valve, six inch (6") hydrant lead to new main and all fittings required for a complete installation.

9.10 HANDLING PIPE AND STORAGE

All pipes and special castings shall be unloaded and distributed along the line of work in such a manner and with such care as will effectively avoid the cracking of any pipe or casting. Dropping directly from the truck will not be permitted. Care must also be exercised on the inside of the pipe. Wherever the outside coating may be found to have rubbed off, the part shall be thoroughly cleaned by brushing and shall then be recoated with an approved asphaltic paint or as may be required by the nature of the pipe coating. The Contractor shall keep on hand a supply of paint for such purposes.

If stored, materials shall be kept safe from damage. The interior of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times. Valves and hydrants shall be drained and stored in a manner that will protect them from damage by freezing.

9.11 MARKING PIPE

Each cast iron fitting shall have its weight and class designation conspicuously painted or cast on it. All other pipe materials shall have the class designation painted thereon. Where required, other designation marks shall be painted on the pipe or fittings to indicate correct location in the pipe section in conformity to a detailed layout plan.

All PVC pipe shall be marked as required by AWWA C900 and shall be stamped to indicate compliance with NSF Standard pw.

9.12 PIPE LOCATOR

Directional Drilled

A continuous one-quarter inch (1/4") diameter stainless steel cable shall be installed along with the plastic pipe for use as a locator wire on all directionally drilled projects. Contractor shall verify continuity of the locator wire prior to acceptance by the Township Engineer. The one-quarter inch (1/4") stainless steel cable locator wire shall be looped at four hundred foot (400') intervals and installed within a tracer wire access box. This tracer wire box shall be made of cast iron with a

permanently attached 3"x12" ABS tube with a flared end to secure it in the ground. It shall be tamper resistant, with a cast iron locking lid and stainless steel terminal connections on the bottom side to which the tracer wires/cables are attached. Lid will open using a standard AWWA pentagon key. Tracer wire access box as distributed by USA Blue Book shall be utilized or equal. Located at each tracer wire access box a flexible rebounding marking post must be installed. This marking post must be able to snap back to its normal position when hit. It must extend at least three feet (3') above ground for visibility and have a width of four inches (4"). This flexible blue rebounding marking post must have a permanent decal applied indicating "Warning Water Main Pipeline". This marker size and type must be approved by the owner.

Open-Cut

Tracer wire (#10 solid copper insulated trace wire) must be brought up into all valve boxes, fire hydrant valve boxes, metering houses, metering pits, and blow offs. The locator wire shall be looped at 400' intervals and installed within a tracer wire access box. This tracer wire box shall be made of cast iron with a permanently attached 3"x12" ABS tube with a flared end to secure it in the ground. It shall be tamper resistant, with a cast iron locking lid and stainless steel terminal connections on the bottom side to which the tracer wires/cables are attached. Lid will open using a standard AWWA pentagon key. Tracer wire access box as distributed by USA Blue Book shall be utilized or equal. Located at each tracer wire access box a flexible rebounding marking post must be installed. This marking post must be able to snap back to its normal position when hit. It must extend at least three feet (3') above ground for visibility and have a width of four inches (4"). This flexible blue rebounding marking post must have a permanent decal applied indicating "Warning Water Main Pipeline". This marker size and type must be approved by the owner. All underground splices shall be butt spliced, sealed, and waterproofed. This will be done using the heat shrink method and electrical coating, or approved equal. Wire nuts and black tape will not be allowed. Underground caution tape must also be used. Must read "Caution Water Main Buried Below". This must be at a minimum depth of one foot (1') and no more than two feet (2') below finished grade.

9.13 PIPE TAPS

Pipe lines shall be tapped for corporation cocks where shown or required for testing of completed water mains. For ductile iron or steel pipe, cocks shall be threaded directly into the pipe.

9.13 BLOWOFF

Blowoffs shall be placed on all dead-end mains and shall be as shown on the plans. Permanent blow-off assemblies shall be cut off below grade after testing is

complete. Standing water within the blowoff shall be pumped out of the riser, capped, bolted, and buried.

9.14 THRUST BLOCKS

Concrete thrust blocks shall be poured on hand-excavated, undisturbed soil bearing surfaces of a minimum size as shown on the standard details or increased in size according to the actual bearing values of the soil in each location, in accordance with the instructions of the Design Engineer.

Thrust blocks shall be made of 3,000 psi concrete, wet mix. Concrete thrust blocks shall be placed at all 22-½° bends or greater, dead ends, tees, reducers, hydrants and crosses, as required. Pre-cast thrust blocks may be utilized for certain applications, if approved by the Township Engineer. Retainer glands and/or mega lugs shall be utilized on all mechanical joint fittings.

9.15 PAINTING

All pipe, valves, bolts and any other portions of water main exposed inside manholes and other structures shall be painted. If necessary, heat shall be provided to maintain good drying conditions. All items to be painted shall be dry and clean before application of the paint. Any rust or scale shall be removed by wire brushing or scraping.

9.16 FIRE HYDRANT SIGNS

Contractor shall be responsible for the purchase and installation. The sign and its post shall be installed directly behind the hydrant. The sign shall be parallel to the street, and within the road right-of-way or easement. There shall be two feet (2') distance from the center of the top nut of the hydrant to the front face of the sign. The finish elevation of the sign shall not be less than five feet (5') to the top of the sign from grade at the base of the post and no more than six feet (6') to the top of the sign from grade at the base of the post. The post shall extend into the ground a minimum of two feet (2') below grade at the base of the post. Signs shall be constructed according to the Grand Traverse Fire Department Standards for Fire Hydrants. Signs and posts are available to be picked up at the Fire Department for a nominal fee.

9.17 WATER MAIN VALVES

Contractor shall place a four-inch (4") wide fiberglass blue marking post at each main line valve. Marking posts shall be Rhino Fibercurve or approved equal. Valve marking post are available to be picked up at the Township Water Department for a nominal fee.

9.18 SHOP DRAWINGS

The Contractor shall furnish, as prescribed under Section "General Requirements" dimension and erection drawings and details of the water main, valves, and other appurtenances furnished under this section. Complete details of all pipe deflections and ties to adjoining pipe shall be submitted to the Township Engineer for approval.

9.19 CERTIFICATION

The manufacturer of pipe and fittings shall furnish a certified statement that all pipe and fittings furnished by him have been inspected and tested in accordance with the applicable specifications. Pipe will be subject to inspection and approval upon delivery and no cracked, broken, damaged or defective pipe or fittings shall be laid in the work. Any piece that is found to be defective after it has been laid shall be removed by the Contractor and replaced by a sound and perfect piece.

SECTION 11

WELL HOUSE / MASTER METER EQUIPMENT

11.01 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labor, materials and appliances and performing all operations for the installation of piping and equipment as shown on the drawings and hereinafter specified.

11.02 PIPING AND FITTINGS

This work consists of furnishing all plant, labor, equipment and materials in performing all operations necessary to install the piping within the well house building or room as shown on the plans. All work to be performed as shown on the drawings and specified.

A. National Electrical Code (NEC):

All electrical work.

B. American Society for Testing Materials (ASTM):

A-72 Welded Wrought Iron Pipe.

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C. NSF International:

NSF -14 Plastic Potable Water System Components

NSF – 60 / 61 Potable Water System Components and Chemical Additives

NSF-PW Potable Water Application & Meet NSF-14 and NSF-61 Standards

D. Materials

The following items of materials installed within the well house or room shall be furnished by the Contractor and shall conform to the various requirements as hereinafter specified.

1. Ductile Iron Pipe: Conform to the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, Class 150. Inside surfaces of pipe to be cement mortar lined per the requirements of ANSI/AWWA C104/A21.4. No exterior coating.
2. Ductile Iron Fittings: Standard fittings shall conform to the requirements of ANSI/AWWA C110/A21.10, Class 150. Compact or short body fittings shall conform to the requirements of ANSI/AWWA C153/A21.53, Class 150. All fittings to be cement mortar lined per ANSI/AWWA C104/A21.4. No exterior coatings.
3. Stainless Steel Pipe: Conform to ASTM A304.
4. Brass Pipe and Fittings: Conform to current ASTM Standards.
5. Gate Valves: Conform to AWWA C515, Class 150. All valves shall open right, or clockwise. All valves shall be equipped with hand wheel operators.
6. Butterfly Valves: Shall be so designed and fabricated that they will conform to AWWA Standard C504 for Class 150B valves. The rubber valve seat shall cover the entire interior surface of the valve body and the face of the body. The valve disc shall be streamlined, free of external ribs, keyed to the shaft, provided with suitable means for positioning and shall utilize wedge type closing against the rubber liner at a full close seating angle of 90° to the axis of the pipe. Valves shall be manufactured by Dresser Manufacturing Division Keystone International, Inc. or an approved equal.
7. Water Check Valves
 - a) Valves 3" and larger shall have a cast iron body with a minimum non-shock W.O.G. working pressure of 150 psi. Seats shall be Buna-N mounted on the disc and shall provide leak-proof closing. The disc shall consist of one bronze disc which is springloaded to prevent slam, pivoting at a stainless steel hinge pin. The spring shall be 316 S.S.
 - b) Valves shall be wafer type for mounting between ANSI 125 pound standard drill flat faced flanges unless otherwise specified or shown on the drawings.

WELL HOUSE EQUIPMENT

8. Wall Castings and Sleeves shall be installed in all concrete work where pipes, wires, or other equipment pass through. Wall castings for 4-inch diameter or larger pipe shall be of cast iron having an anchor flange located in the center of the concrete wall or floor. Castings and sleeves shall be similar to those as manufactured by the East Jordan Iron Works or approved equal. Joint between pipe and sleeves shall be sealed with "Link-Seal" fittings or approved equal.

9. Pressure Gauges

The gauges shall be 3-inch diameter (minimum) and read pump discharge pressure in "feet of water". Liquid filled gauges shall incorporate a flexible diaphragm seal between the water discharge line and the pressure gauge. The diaphragm seal shall be either the inline-saddle type design with a minimum diaphragm surface of five (5) square inches or the complete flow-thru type design with flange connection. Inline-saddle diaphragms and housing parts exposed to the water shall be 316 ss. The flexible cylinder protecting the sensing liquid on the flow-thru design shall be Buna N and the flanges shall be 316 ss. The inside diameter of the flow-thru assembly shall be the same as the adjacent discharge piping. Use Model R or RP by Ametek, Model Iso-Spool (flanged) or Iso-Ring (wafer) by Ronninger-Peter or equal. Gauge shall be mounted on a tap equipped with a valve to allow complete isolation and removal of the gauge without well house shut down.

- E. Installation of Piping Valves and Fittings

1. Cement Lined Ductile Iron Class 53 or Cast Iron Valves and Fittings shall be used for all piping 4-inch diameter and larger. Flanged piping, valves and fittings shall be used for all interior exposed piping unless otherwise approved by the Township Engineer. Pipe, valves and fittings shall be carefully laid to line and grade. Care shall be taken to keep the pipe clean and free from dirt and other foreign materials. "Victaulic" fittings shall be considered as an acceptable equivalent, subject to the approval of the Township Engineer.

Piping laid in the ground shall have bearing over its entire length. Piping along floors, walls, or ceiling shall be adequately supported by saddles, posts, wall brackets, pipe hangers, or other approved devices. The exact location, number and design thereof shall be subject to the approval of the Design Engineer. "Uni-Flange" type fittings shall be rodded.

2. Stainless Steel Pipe shall be used for all interior piping less than 4 inches in diameter or as approved by the Township Engineer.

F. Disinfection

All piping and equipment shall be disinfected in accordance with AWWA C651, and Section 9, Water Main Specifications.

11.03 VALVE VAULT

A. General

The Contractor shall implement upgrades to the existing vault as noted in Section.

B. Waterproofing

The Contractor shall apply a waterproofing system to the inside of the concrete vault. The material to be used for this operation shall be as specified in these specifications.

The waterproofing system shall be applied and allowed to dry in accordance with the manufacturer's directions. All steps, lids, frames and castings and pipe entering or leaving the vault shall be protected during application to prevent their being coated.

Interior Waterproofing

The interior surfaces shall be thoroughly covered with Tnemec or approved equal. Application shall be compliant with manufacturers recommendation and surface thoroughly cleaned before.

If any leaks in the vault walls are detected twenty-four (24) hours after application of the first coat of the waterproofing system, they shall be sealed by application of a quick-set sealer. This sealer shall be a mixture of Portland Cement - Type One and "Ipanex R", "Waterplug" or equal. The quick-set sealer shall be applied in accordance with the manufacturer's directions. After the patched areas dry, they shall be covered with another coat of the waterproofing and allowed to dry. If any leaks are apparent after that time, the Contractor shall repatch them. The above steps shall be repeated until all leaks are sealed.

WELL HOUSE EQUIPMENT

After all leaks are stopped and there are no leaks apparent after twenty-four (24) hours upon application of the first coat of the waterproofing system or twelve (12) hours after application of a patch, the Contractor shall apply over the dry surface a finish coat.

C. Waterstops

A waterstop shall be installed in the wall of the vault for all conduit connections. This includes patching and grouting to ensure water tight.

D. Electrical

The electrical components of the wet well level control and alarm system shall be 24 volts, corrosion proof, water proof and explosion proof, Class 1 Division 1 rated.

E. Hatch Covers

The vault shall be equipped with a new compartment access covers and frames shall be load rated 300 pounds per sq. foot and shall be of aluminum tread plate construction with a minimum sized opening of 24" X 24" as noted on the plans. The cover shall be a single hinged door with stainless steel hardware and shall include a hold open device when the covers are in the raised position (90 degree locking position). Hatches shall be equipped with aluminum lift handle and 316 grade stainless steel slam lock with keyway (compatible with DPW).

~~A. General~~

~~The Contractor shall furnish and install pressure tanks as shown on the plans and as hereinafter specified.~~

~~B. Pressurized Bladder Vessels~~

~~The Pressurized Bladder Vessels shall have a fiberglass wound and epoxy resin sealed outer tank, one piece high density polyethylene inner cell, heavy mil ethyl vinyl acetate (EVA) air cell, reinforced polypropylene upper and lower flanges, reinforced polypropylene base, stainless steel service steel, brass body, Schrader core assembly air valve, and high density polyethylene weather cap. The air cell shall be capable of being removed and replaced while the tank is installed.~~

~~C. Hydro-Pneumatic Tank~~

~~The hydro-pneumatic tank shall be designed and constructed in accordance with "A.S.M.E. Code for Unfired Pressure Vessels" for 150 psi working~~

WELL HOUSE EQUIPMENT

~~pressure. The tank shall be enclosed within the well house or as approved by the Township Engineer.~~

~~———— The tank shall be equipped with a water level sight gauge mounted on the end of the tank as shown on the plans.~~

~~———— The tank shall also be equipped with a pressure gauge, air pressure relief valve and air volume control mechanism and all tank couplings required to install these items.~~

~~———— The tank shall be coated on the inside with enamel application as appropriate for potable water systems. Outside of tank shall be coated with factory primer prior to delivery.~~

~~D. Air Volume Control~~

~~The air volume control mechanism for the pressure tank shall utilize an air compressor, mounted within the well house, liquid level probe and pressure switches for operation. This unit shall operate automatically and independently from the pumps and shall maintain a constant air charge in the tank. See Section 11.06 for coordination with pump operating sequence.~~

11.04 FLOW METER – SUPPLIED BY OWNER AND INSTALLED BY CONTRACTOR

A. Flow meter shall be a electromagnet flow meter (Mag-Meter) where Primary unit to be a minimum ANSI 150 carbon steel flange sized to match pipe diameter.

1. Liner material shall be manufactured of Tefzel and to be compatible with Sodium Hypo Chlorite.
2. Electrodes shall be manufactured of Titanium and to be compatible with Sodium Hypo Chlorite.
3. Classification shall be non-hazardous NEMA 4X.
4. Primary shall be rated for temporary submergence for a minimum of 30 minutes if installed above grade, and total submergence if installed below grade.
5. Grounding rings shall be used on all applications and connected electrically to the Mag-Meter per manufactures specifications.

B. Flow meter converter shall be a remotely mounted unit with the following specifications. – EQUIPMENT SUPPLIED BY OWNER AND INSTALLED BY CONTRACTOR

WELL HOUSE EQUIPMENT

1. Converter shall be type rated NEMA 4X die-cast Aluminum enclosure.
 2. Converter shall be UL or FM listed
 3. Converter shall operate on 120Volts AC 1Ø power.
 4. Converter shall supply a minimum of 2 dry contact outputs rated at a minimum of 3 VA. One for scalable pulsed flow output, one for reverse flow.
 5. Converter shall supply one 4-20 ma signal output, scalable to current flow rate.
 6. Meter shall have a scalable display where current flow and total flow can be displayed simultaneously.
 7. Total flow display must be scalable so as to read in kgl while current flow can be read in gpm.
 8. Meters under 12 inches in diameter shall have an accuracy of 0.25% of rate from 0.67 feet per second to 30 feet per second.
- C. Meter shall be installed according to the manufactures specifications and in a direction so as to measure forward flow in the normal flow direction when water is moving through the line under normal flow conditions.
1. Converter shall be mounted in a location where meter production data can be easily accessed and seen.
 2. Electrical connections shall be made in accordance with manufactures specifications.
 3. Electrical connections shall be a minimum of NEMA 4 to the meter utilizing manufactures seals and compounds to form necessary water tight connections.
 4. Supplier shall provide proper start up and calibration services.
 5. Supplier shall provide a minimum of one year warranty on all parts and labor.
 6. Supplier shall provide a minimum of 50 feet of manufactures meter cable or as specified on drawings where there shall be no splices between converter and primary unit. All cable shall be protected in conduit unless specified differently by manufacture.

D. Acceptable Manufacturer:

See attached specifications

11.05 PRESSURE RELIEF VALVE/SURGE ANTICIPATOR

~~A. The valve shall be hydraulically operated, single diaphragm-actuated and globe or angle pattern, flanged. The valve shall consist of three major components: the body with seat installed, the cover with bearings installed, and the diaphragm assembly. This equipment must be approved for application by the Grand Traverse County DPW and/or Township Engineer.~~

~~1. Diaphragm Assembly: The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.~~

~~2. Main Valve Body: No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be ductile iron. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer, forming a tight seal against a single removable seat insert. The main valve seat and the stem bearing in the valve cover shall be removable.~~

~~3. Pilot Control System: The pressure relief pilot shall be an adjustable, spring-loaded, normally closed diaphragm control designed to permit flow when upstream pressure exceeds the control setting. The low-pressure pilot shall be an adjustable, spring-loaded, normally open diaphragm control designed to open when the sensed pressure falls below the control setting and close when pressures are normal. The pilot system shall contain an adjustable hydraulic limiter to limit valve travel during low-pressure opening without affecting high-pressure relief valve travel. The contractor shall connect the sensing/pilot supply connection to the main discharge header with minimum 3/4" pipe or tubing.~~

~~4. Products: Subject to compliance with requirements, provide from the following manufacturer:~~

~~a. Cla-Val Model No. 52-03/652-03~~

11.06 PUMP OPERATIONAL CONTROLS

~~A. General~~

WELL HOUSE EQUIPMENT

~~The Contractor shall furnish and install pressure switches, complete, as outlined herein.~~

~~Pressure switches shall be mounted in the well house to operate the well pump based on the water pressure. The pressure switches shall be adjustable from ____ to ____ psi.~~

~~The operation of the _____ well pump(s) shall be controlled based on the pressure within the system and, in the case of a hydro-pneumatic tank, the water level within the tank. The operating sequence shall be as follows:~~

~~_____ USING A PRESSURIZED BLADDER VESSEL~~

~~_____ The lead pump shall operate until the pressure at the well house reaches PSIG. Should the pressure continue to drop with the lead pump operating, and the pressure reaches _____ PSIG, the lag pump shall engage. Both pumps shall operate until the pressure at the well house reaches PSIG.~~

~~USING A HYDRO-PNEUMATIC TANK~~

~~The lead pump shall operate until one of two (2) conditions are met:~~

- ~~1. _____ The pressure at the well house reaches _____ PSIG.~~
- ~~2. _____ The tank water level reaches the high water probe.~~

~~If the tank water reaches the high water probe prior to achieving a pressure of _____ PSIG, the compressor will engage and operate until the pressure increases to _____ PSIG and the pressure switch is reset.~~

~~Should the pressure continue to drop with the lead pump operating, and the pressure fall to _____ PSIG, the lag pump shall engage. Both pumps shall operate until one of the two (2) conditions listed above are met.~~

~~The alternating sequence shall be accomplished by means of an alternator in the electrical circuitry at the well house. A selector switch shall be located at the well house pump panel to allow manual selection of the pumps to be included in the alternating sequence.~~

~~All pumps shall be capable of being operated manually as well as automatically by lever selection of a hand-off-automatic switch at the well house. If one (1) pump is switched off for repairs, the other pump(s) shall be able to operate normally in an automatic mode.~~

WELL HOUSE EQUIPMENT

~~Each pump shall have its own completely independent control system so that the failure of any components in one (1) pump will not affect the automatic or manual operation of the other pump(s).~~

~~Each well pump shall be equipped with an hour run meter mounted in the pump control panel.~~

11.07 ELECTRICAL WORKA. Factory Wiring and Equipment1. General

The well house / meter station control panel shall be completely wired in accordance with National Electrical Code and carry an Underwriters Laboratory certification. It shall be adjusted and ready for operation. All wiring in the panel shall be color coded and numbered as indicated on the wiring diagram portion of the shop drawings. All wiring outside the panel shall be in rigid conduit. It is the Contractor's responsibility to ensure that electrical equipment complies with all federal, state, and local requirements.

(A large, clear, color coded and numbered wiring diagram shall be provided in triplicate with each unit. Wiring diagram shall comply with the latest Township requirements).

2. Control Panel

~~The control panel shall include a circuit breaker and magnetic starter for each pump motor. The magnetic starters shall be Square "D" and have thermal overload protection on all three phases. The control assembly shall provide a convenient means to operate each pump manually or automatically. When operated in the automatic mode, the control assembly shall automatically alternate the position of the "lead" and "lag" pumps after each pumping cycle.~~

~~Control panel shall be equipped with a step-down transformer to supply 120/240 volts for control and auxiliary circuits, as applicable. Primary side of auxiliary power transformers shall be protected by a thermal/magnetic air circuit breaker specifically sized to meet power requirements of the transformer. A 120-volt, 20-amp, duplex receptacle shall be provided with ground fault circuit interruption.~~

~~———— Pump run indicator lights shall be mounted on the control panel.~~

WELL HOUSE EQUIPMENT

~~_____ The control panel shall also incorporate an hour meter to register the elapsed running time for each pump. Meters shall be resettable and utilize a digital readout.~~

~~_____ A time delay relay shall be provided for the pump motor controls to insure that both motors will not start at the same time.~~

~~_____ Controls for the pump motors shall be designed to protect the electric motors from low line voltage, single phase start-up and phase reversal. A phase sequence and under voltage relay shall be installed in the control panel. The unit shall be connected to the well house alarm circuitry to provide a 0.5 second time delay to prevent nuisance tripping of the relay caused by a momentary transient drop in the line voltage. Upon resumption of normal line conditions, the unit shall automatically restore the motors to a running condition.~~

3. Alarm Contacts for Rapid Telemetry (or Alarm Monitoring) and Exterior Alarm Light

~~_____ The well house shall be provided with alarm contacts terminal board control panel by the control panel manufacturer for energizing of the telemetering relays.~~

a. ~~_____ Telemetering (dry) contacts shall be provided for the following conditions:~~

- ~~_____ 1. Well Pump No. 1 on.*~~
- ~~_____ 2. Well Pump No. 2 on.*~~
- ~~_____ 3. Low pressure.~~
- ~~_____ 4. High pressure.~~
- ~~_____ 5. Power Failure~~
- ~~_____ 6. Security.~~
- ~~_____ 7. Flow meter.~~

~~_____ *Additional contacts shall be installed for additional wells.~~

4. Telemetry Equipment – SUPPLIED BY OWNER AND INSTALLED BY CONTRACTOR

~~_____ Telemetry equipment will be supplied and installed by the agency performing operation and maintenance for the facility. Battery back-up must be included.~~

5. Temporary Power Supply

~~_____ The well house shall be provided with a means to accommodate temporary power supply including transfer switch. The type of power~~

WELL HOUSE EQUIPMENT

~~supply (permanent or portable power generation) shall be dependent upon well house size and importance and shall be determined by the Township. It is the Contractor's responsibility to ensure that equipment is properly sized for electrical loads into well house, compatibility with Grand Traverse County DPW equipment, and complies with all federal, state, and local requirements.~~

B. Site Electrical Requirements1. General

The Contractor shall supply and install all site electrical wiring and equipment necessary to operate the well house / meter station in accordance with all federal, state, and local requirements and as described in these specifications and shown on the plans.

2. Contractor Responsibility

It shall be the Contractor's responsibility to have utility installations and hookups for electrical service.

11.08 EQUIPMENT INSTALLATIONS AND START UPA. General

All equipment shall be installed in a neat, workmanlike manner, acceptable to the Design Engineer with concurrence of the Township Engineer and in conformance with all applicable Local, State and Federal codes and requirements.

B. Factory Trained Start-Up Personnel

~~— The Contractor shall furnish the services of an experienced factory trained field representative to start up all equipment. He shall be employed by the Contractor in such capacity to interpret the manufacturer's installation guide and instructions, to supervise the installation and start-up of such equipment and to instruct the operating and maintenance personnel for a reasonable period of time. (A minimum of four (4) hours of instruction.)~~

~~— The representative of the equipment supplier shall be responsible to insure that all equipment, controls, alarms, wiring, flow meter and all associated components are properly installed and functioning properly.~~

C. Systems Start Up

WELL HOUSE EQUIPMENT

- ~~It shall be the Contractor's responsibility to coordinate work between his subcontractors, equipment suppliers and utility companies to insure that all components of the system function properly as described herein. When the system or a major component of the system is entirely installed and ready for testing, the Contractor shall notify the Township Engineer and operation/maintenance personnel, in writing, of the time and date the start-up testing will be done. The Contractor, subcontractor, and equipment supplier's representatives shall be present for final start-up testing. During the start-up test, the Contractor shall operate all equipment in such a manner to demonstrate that all components are functioning properly.~~
- ~~If the equipment fails to perform, it will be the responsibility of the Contractor to arrange for repair or replacement of the defective parts and scheduling of a new start-up session.~~
- ~~Should the equipment pass its initial start-up testing but fails during the one-year guarantee period, the Contractor shall coordinate the necessary repairs or replacements with the subcontractors and suppliers.~~

11.09 SHOP DRAWINGS

- A. The Contractor shall submit, as prescribed under "General Requirements" section, complete shop drawings and details of all equipment to be furnished under this section. These shop drawings shall be submitted and approved by the Design Engineer with concurrence of the Township Engineer prior to installation.
- B. A large, clear, color coded and numbered wiring diagram shall be prepared showing the as-built wiring of the complete well house installation including all control and alarm wiring. Provide four (4) copies.

11.10 OPERATION AND MAINTENANCE INSTRUCTIONS

~~Written instructions for the operation and maintenance of the well house equipment shall be furnished in quadruplicate for each piece of equipment in this section. The instructions shall be easy to understand with directions specifically written for this project describing the various possible methods of operating the equipment.~~

~~The instructions shall include procedures for tests required, pump curves, adjustments to be made, and trouble and safety precautions to be taken with the equipment.~~

~~Maintenance instructions shall include test and calibration charts, exploded views of assembled components, spare parts lists and wiring diagrams.~~

~~These instructions shall be submitted to the Design Engineer and Township Engineer for approval at the same time the shop drawings are submitted.~~

11.11 RECORD DRAWINGS

Any changes that are made in equipment, controls, wiring, etc. from that shown in the plans and specifications shall be made only by approved shop drawings. After such changes are made, the Contractor shall submit to the Design Engineer and Township Engineer, record drawings which show these changes in equipment installation. Contractor shall supply "record" electrical schematic drawing to Design Engineer to be included in final close-out package delivered to the Township.

11.12 GUARANTEE

The Contractor shall furnish a manufacturer's guarantee covering all material and equipment that he furnishes. He shall guarantee his workmanship and material for a period of one year from the date of acceptance. Such guarantee shall provide for the replacement of defective workmanship, together with the restoration of any related materials or workmanship that are disturbed as a result of such imperfections in the work. All such replacements or repairs shall be done without expense to the Owner. All guarantees shall be in written form and submitted to the Owner in triplicate.

11.13 PAINTING

All pipes, valves, flow meters, and any other portions of water main or ferrous metals exposed inside of the well house shall be painted. If installed, the hydro-pneumatic tank shall be painted. If necessary, heat shall be provided to maintain good drying conditions. All items to be painted shall be dry and clean before application of the paint. Any rust or scale shall be removed by wire brushing or scraping. Painting system shall be:

1 coat (350 sf/g) Pug Primer
2 coats (500 sf/g) Rustamor 500

REPLACEMENT AND CLEANUP

13.01 SCOPE OF WORK

Under this item, the Contractor will restore all lawns, trees, gardens, landscape plantings, sidewalks, ramps, trails, fences, commercial signs, water courses and sand, gravel, dirt, asphalt and concrete roads, catch basins, storm sewers, building sewers, water services, water valve boxes, meter vaults, property markers (such as concrete monuments, irons, stakes, pipes, etc.), mailboxes and other items which may be damaged during the course of construction. All replacement and cleanup work will be incidental to the project except those items of work that are delineated in the bid proposal.

All restoration work shall attempt to return the existing facilities to their original condition. Substitutions, such as gravel instead of grass, will not be allowable.

The Contractor shall pay special attention to the requirements of Act 347, "Soil Erosion and Sedimentation Control". In all construction work the Contractor shall take all precautions necessary to prevent erosion and to conform to the requirements of Act 347. Should erosion occur within the guarantee period, the Contractor shall regrade and reseed the disturbed area at no additional cost to the Owner.

Replacement and cleanup operations shall follow immediately behind the construction work. The Contractor shall make every effort to keep the job site clean and free of trash and miscellaneous building materials. The Contractor shall pay special attention in order to restore commercial signs, fences, etc. and to patch and repair pavement, driveways and sidewalks immediately after the construction work. In the event that replacement and cleanup work does not proceed in a satisfactory manner, the Owner may withhold periodic payments or close the construction area until such time as the replacement and cleanup is satisfactory. An exception may be made if there are physical limitations which do not allow for immediate replacement and cleanup.

13.02 PAVEMENT RESTORATION

A. General

All permanent pavement restoration shall be done over compacted backfill and a minimum six (6) inches thick compacted M.D.O.T. 22A gravel base. The gravel base shall be placed and maintained in accordance with the M.D.O.T. Standard Specifications. All patches shall have square, neat, saw cut edges regardless of the final surfacing method planned for that section of the pavement restoration.

No patching work shall be started until the subgrade has been properly prepared. Prior to laying the bituminous patch, the adjacent road surfaces shall be swept clean of all foreign materials and the patch area and pavement primed with Michigan Department of Transportation's approved prime coat.

A bituminous bond coat shall be placed between successive lifts of the bituminous patch and bituminous surfacing. Each lift shall be thoroughly compacted before adding the next lift. This includes running the compaction roller longitudinally along the entire length of the joints between the patch and the existing pavement.

The bituminous mixture to be furnished under these specifications shall be delivered to the paver at a temperature no lower than 250 F. Any mixture that has a temperature below 250 F at the time of "laying" shall be rejected and hauled from the project.

Temporary road patches shall be gravel or bituminous cold patch. The patches shall be maintained in a smooth condition until final repairs are made.

The Design Engineer, Township Engineer and the County Road Commission shall be notified at least two (2) working days prior to the placement of any and all final pavement overlays.

Aggregate for mixes shall conform to Grand Traverse County Road Commission/Leelanau County Road Commission current standards where applicable.

B. Bituminous Patching

Existing asphalt roads and driveways shall be patched using the current Road Commission standards. All patches shall be placed in two lifts of 165 pounds per square yard, each using LVSP.. A bituminous prime coat of 0.25 gallons per square yard and a tack coat of 0.10 gallons per square yard shall be used for all bituminous patches. Shoulders shall be restored to their original width and depth in accordance with M.D.O.T. Standard Specifications using M.D.O.T. 23A gravel.

C. Gravel Roads, Driveways and Shoulders

All gravel roads shall be restored in accordance with M.D.O.T. Standard Specifications using six (6) inches of M.D.O.T. 22A gravel. Shoulders shall be restored to their original width and depth in accordance with the current M.D.O.T. Standard Specification 3.09 using M.D.O.T. 23A gravel. Shoulders shall be raised on the side opposite of sewer construction to match new pavement surfaces.

D. Concrete Pavement, Sidewalk and Driveways

Concrete for restoring pavement, sidewalks, and driveways shall attain a 28-day strength of 3,500 pounds per square inch. Neat edges of patch areas shall be obtained by the use of a concrete saw. Concrete mixing aggregates and curing methods shall conform to Concrete section. Concrete patches shall match the original width and depth and in no case, a depth less than four (4) inches. Sidewalks shall have contraction joints a distance apart equal to the width of the slab.

13.03 GRASS AREA

Grass areas shall be considered as two types: A) Type 1, areas which had lawns before construction, and B) Type 2, open fields or ditches not adjacent to established lawns. The plans may specifically call for Type 1 mixtures in which case the plans will govern. If there is a question as to which mixture to use, the Design Engineer shall make the final decision.

Terraces, lawns, ditches, open fields and other grassy areas shall be topsoiled, fertilized, seeded and mulched in such a manner that a grass approximately equal in type and density of the original is obtained. Slopes between 1:3 and 1:2 shall be sodded and staked or receive seed with mulch blankets.

A. Topsoil

Topsoil furnished shall consist of dark brown or black loam, clay loam, silt loam, or sandy loam surface of fertile, friable humus soil of mineral organics, not including peat or muck. Soil shall be screened topsoil, free of stones, roots, sticks and any other extraneous materials. All topsoil furnished shall be approved by the Design Engineer. Type 1 areas shall be topsoiled to a depth of four (4) inches and Type 2 areas to a depth of two (2) inches.

B. Seeding and Fertilizing

Areas to be seeded and fertilized shall be carefully raked to even surfaces and all stones, sticks and other debris removed.

The area to be seeded shall be fertilized with agricultural fertilizer 12-12-12 analysis, Davco or Agrico or equal, applied on the prepared surface at the rate of 20 pounds per 1,000 square feet. Fertilizer shall be harrowed or raked into the soil to a depth of not less than one (1) inch.

Seeds shall be furnished in durable bags. On each bag of seed, the vendor shall attach a tag giving name, lot number, net weight of contents, purity and germination. All seed shall be thoroughly mixed and sown in a method which will ensure uniform distribution. Seeding during high winds or inclement weather will not be permitted. All seed is to be raked in and

compacted. The seed shall be sown at the rate of five (5) pounds per 1,000 feet. The seeding mixtures shall be composed of certified seed of the purity, germination and proportions by weight as specified in the following table:

Kind	SEEDS		MIXTURES	
	Minimum Purity	Minimum Germination	Type I	Type 2
Perennial Rye Grass	98%	90%	20%	50%
Kentucky Blue Grass	90%	75%	60%	15%
Creeping Red Fescue	98%	80%	20%	35%

C. Mulching

Immediately after seeding all seeded areas, Type 1 and Type 2 shall be mulched with unweathered small grain straw or hay spread uniformly at a rate of 100 pounds per 100 square feet (two tons per acre). Hydroseeding method with similar application rate will be allowed.

D. Mulching Anchoring

All mulch shall be anchored using one of the following methods. The Contractor may use either method unless otherwise shown on the plans.

1. Method "A": The straw mulch shall be anchored by applying one of the following asphalt products at the rate shown. The asphalt may be blown on with the mulch or sprayed on immediately after the mulch is spread.

<u>Asphalt Product</u>	<u>Application Rate</u>
Liquid Asphalt R.C. 1, 2 or 3; M.C. 2 or 3	0.10 gal. per S.Y.
Emulsified Asphalt R.S. 1 or 2; M.S. 2; or S.S. 1	0.04 gal. per S.Y.

2. Method "B": A "Terra-Tak" mulch binder may be used in lieu of asphalt. Mixing and application shall be done in accordance with the manufacturer's recommendations.
3. Method "C": In areas with slopes greater than 10% or where shown on the plans, the Contractor shall place mulch netting or excelsior blanket mulch.

- a. Mulch Netting: Mulch shall be anchored by the use of mulch netting. The light weight fibrous netting shall be properly placed over the mulch and secured to the ground using wire staples, spaced per manufacturer's recommendations.
- b. Excelsior Blanket Mulch: An excelsior blanket shall be used in lieu of other mulch. The excelsior blanket shall be a consistent thickness of evenly distributed wood excelsior fibers, 80% of which are six (6) inches or more in length. The top side of the blanket shall be covered with a coarse net of twisted Kraft paper or biodegradable extruded plastic mesh. Ends and sides shall be securely butted and stapled with U-shaped wire staples of a size and length suited to the soil conditions.

13.04 DITCHES

Ditches which have been grassed and maintained by the abutting property owner shall be restored to the current Grand Traverse County/Leelanau County (where applicable) specifications.

Ditches in which culverts or drain tile have been installed shall have the same tile replaced, if in good condition, or a tile satisfactory to the Design Engineer installed in its place at the original line and grade.

Catch basins shall be reconstructed, if removed or damaged.

13.05 FENCE REPLACEMENT

- A. Chain Link Fence shall be replaced according to M.D.O.T. specifications.
- B. Other Fences shall be replaced equal to and of the same type as existing.
- C. Salvaged material, if approved by the Engineer, may be used for replacement.

13.06 COMMERCIAL SIGNS

Commercial signs, which must be removed by the Contractor in order for work to proceed, shall be replaced and reconstructed to original condition. It is very important that replacement follow immediately behind the construction work.

13.07 BUILDING SEWERS

Building sewers shall include any and all parts of private residential, commercial or industrial sewage disposal system such as sewer pipe, septic tanks, drainfield, etc. Whenever the service of any such facility is interrupted because of the Contractor's operations, he shall provide such interim methods of sewage disposal as are required to maintain a safe, nuisance free, non-polluting construction operation.

13.08 OTHER DEBRIS

The Contractor shall remove, at his own expense from the site, any and all broken pipe, bricks, blocks, lumps of concrete, broken machinery, cans, containers, and other trash and debris.

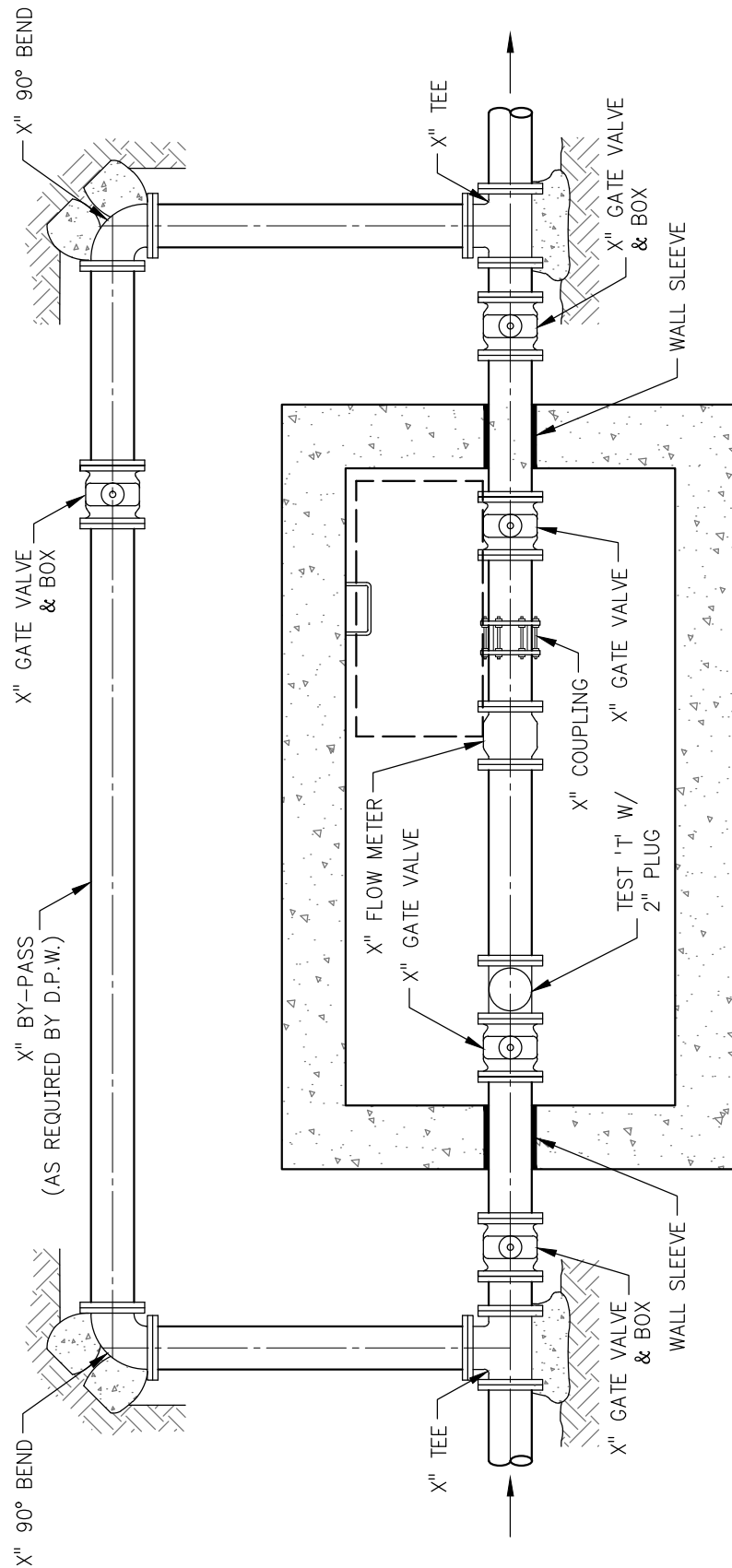
13.09 TREES

The Contractor shall endeavor to save as many trees as possible. Cut trees, including stumps, shall be disposed of by the Contractor. Any elm tree which is removed must be burned. Tree branches which become broken shall be removed by cutting off flush with trunk and the cut on the trunk shall be painted with an approved tree paint. Where removal of a stump would result in damage to existing utilities, the stump may be removed by chipping to a depth of at least one foot below the finished ground surface.

Trees removed by the Contractor and where approved by the Engineer shall be replaced with a reasonably sized tree of the same variety. Trees along the State Highways and County Roads that fall on the property line or in the road right-of-way shall be replaced at a new location off the right-of-way.

Replacement trees of the deciduous or hardwood type shall be furnished from nursery stock, at least 2 to 2½ inches in diameter, and shall have the roots contained in a ball of soil and wrapped in burlap.

Replacement trees of the evergreen type may be furnished from either nursery or native stock, at least 8-10 feet in height, and shall have roots contained in a ball of soil and wrapped in burlap.



WATER METER VAULT PLAN, 3" AND LARGER

NO SCALE

NOTES

1. REFER TO SPECIFICATIONS (SECTION 9) FOR WATER MAIN DETAILS.
2. ALL MATERIALS ARE SUBJECT TO APPROVAL BY THE D.P.W.
3. ALL MATERIALS SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.
4. PIPING AND VALVES IN METER VAULT TO BE THE SAME SIZE AS THE METER AND PAINTED IN COMPLIANCE WITH SPECIFICATIONS.
5. ALL PIPING IS DUCTILE IRON. FITTINGS TO BE FLANGED.
6. REINFORCED CONCRETE METER VAULT TO BE DESIGNED AND REINFORCED FOR DEAD LOAD, SOIL LOAD, AND HS20 WHEEL LOAD.
7. METER TO BE SUPPLIED BY DPW AND INSTALLED BY THE CONTRACTOR.
8. ALL HATCHES & COVERS TO BE LOCKABLE, COORDINATE WITH DPW.
9. CONTRACTOR SHALL BE RESPONSIBLE TO VERIFY WATER TABLE AND COORDINATE WITH ENGINEER FOR BUOYANCY TO ADJUST BALLAST VOLUME AND INSTALL AS NECESSARY AT NO ADDITIONAL COST TO THE PROJECT.
10. STAINLESS STEEL TO BE USED FOR ALL ANGLE IRON, PLATES, BRACKETS, AND FITTINGS INSIDE PUMP CHAMBER.
11. METER VAULT AND WET WELL SHALL BE COATED WITH (2) COATS OF MASTIC ON EXTERIOR AND RAVENCOAT, TNEMEC PERMAGLAZE 435, OR EQUAL ON INTERIOR APPLIED IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
12. METER VAULT ELECTRICAL WIRING METHODS TO COMPLY WITH NATIONAL ELECTRICAL CODE STANDARDS. ALL EQUIPMENT TO COMPLY WITH THE SAME.
13. THE MAGMETER SHALL BE ENDRESS HAUSER PROMAG 10W OR APPROVED EQUAL AND TO BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS. MAGMETER TO BE INSTALLED WITH 5X PIPE DIA. STRAIGHT PIPE LENGTH UPSTREAM AND 2X PIPE DIA. STRAIGHT PIPE DOWNSTREAM. MAGMETER TO BE RATED FOR TOTAL SUBMERGENCE.
14. CONTRACTOR IS RESPONSIBLE FOR PROVIDING, INSTALLING, ENERGIZING, AND CALIBRATING INSTRUMENTATION INCLUDING FLOW METER.
15. METER VAULT SIZE TO BE COORDINATED WITH THE DPW AND ADEQUATELY SIZED TO FIT PIPING AS SHOWN. VAULT CONSTRUCTION SHALL COMPLY WITH ASTM C857 AND C858 AND RING/RISER SHALL COMPLY WITH ASTM C478.

WATER MAIN METER VAULT NOTES

NO SCALE

DESCRIPTION

The Badger Meter ModMAG® M2000 is the result of years of research and field use of electromagnetic flow meter technology. Based on Faraday's law of induction, these meters can measure water, wastewater, water-based fluids and other liquids that meet minimum electrical conductivity.

Designed, developed and manufactured under strict quality standards, this meter features sophisticated, processor-based signal conversion with accuracies of $\pm 0.20\%$ of rate ± 1 mm/s. The wide selection of liner and electrode materials helps provide maximum compatibility and minimum maintenance over a long operating period.

The meter is best suited for bidirectional flow measurement of fluids with a conductivity $> 5 \mu\text{S/cm}$ ($> 20 \mu\text{S/cm}$ for demineralized water). The meter has high accuracy, is easy to use, and can be chosen for a wide variety of applications. The backlit, four-line display shows all actual flow measuring data, daily and complete information, including alarm messages. The standard transmitter has 4 programmable digital outputs, one digital input, power output and different interfaces. Integrated system self checkup makes putting into operation and service easier. For service purpose, the meter configuration can be kept or transferred to another meter without a new parametering via the optional back-up parameter function.

APPLICATION

The M2000 transmitter can be integrally mounted to the sensor or can be remote-mounted, if necessary and has many advantages over other conventional technologies. The meter targets a variety of applications and is well suited for the diverse water and wastewater treatment industry. The M2000 meter can accurately measure fluid flow—whether the fluid is water or a highly corrosive liquid, very viscous, contains a moderate amount of solids, or requires special handling. Today, electromagnetic meters are successfully used in industries including building automation, oil and gas, food and beverage, pharmaceutical, water and wastewater, and chemical.

STRAIGHT PIPE REQUIREMENTS

Run sufficient straight-pipe at the sensor inlet and outlet for optimum meter accuracy and performance. An equivalent of 3...7 diameters of straight pipe is required on the inlet (upstream) side to provide a stable flow profile. Two (2) diameters are required on the outlet (downstream) side.

In applications with limited space, the M2000 can be installed with zero straight pipe requirements and fulfils the accuracy according OIML R49 and MID Annex MI-001.



FEATURES

- Available in sizes 0.25...78 in. (6...2000 mm)
- Accuracy of $\pm 0.2\%$ of reading ± 1 mm/s
- Flow Range 0.03...12 m/s
- Pulsed DC magnetic field for zero point stability
- Integral and remote signal converter availability
- Power Supply of 100...240V AC / 9...36V DC
- Corrosion-resistant liners for long life
- Measurement largely independent of flow profile
- User friendly programming procedure
- Empty pipe detection
- Power loss totalization
- Digital signal processor (32-bit)
- Non-volatile programming memory
- LCD display
- Rotating cover
- IP67 Housing
- Calibrated in state-of-the-art facilities
- Modbus®, HART, Profibus DP, M-Bus, BACnet MS/TP, Modbus MS/TP, EtherNet/IP and BACnet/IP
- Integrated data logger
- Verifications device
- NSF/ANSI/CAN 61 and 372 listed
- CSA / AWWA C715 certified
- BEACON®/AquaCUE® connectivity

ELECTRODES

When looking from the end of the meter into the inside bore, the two measuring electrodes are positioned at three o'clock and nine o'clock. M2000 electromagnetic meters have an "empty pipe detection" feature. This is accomplished with a third electrode positioned in the meter at twelve o'clock.

If this electrode is not covered by fluid for a minimum five-second duration, the meter displays an "empty pipe detection" condition, sends out an error message, if desired, and stops measuring to maintain accuracy. When the electrode again becomes covered with fluid, the error message disappears and the meter resumes measuring.

As an option to using grounding rings, a grounding electrode (fourth electrode) can be built into the meter during manufacturing to assure proper grounding. The position of this electrode is at six o'clock.

OPERATION

The flow meter is a stainless steel tube lined with a non-conductive material. Outside the tube, two DC powered electromagnetic coils are positioned opposing each other. Perpendicular to these coils, two electrodes are inserted into the flow tube. Energized coils create a magnetic field across the whole diameter of the pipe.

As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. The M2000 transmitter receives the sensor's analog signal, amplifies that signal and converts it into digital information. At the processor level, the signal is analyzed through a series of sophisticated software algorithms. After separating the signal from electrical noise, it is converted into both analog and digital signals that are used to display rate of flow and totalization.

With no moving parts in the flow stream, there is no pressure lost. Also, accuracy is not affected by temperature, pressure, viscosity or density and there is practically no maintenance required.

SPECIFICATIONS

NOTE: Permanently connected equipment requires the special considerations to satisfy the CEC and the Canadian deviations in the standard, including overcurrent and fault protection as required.

NOTE: DN represents nominal diameter in mm.

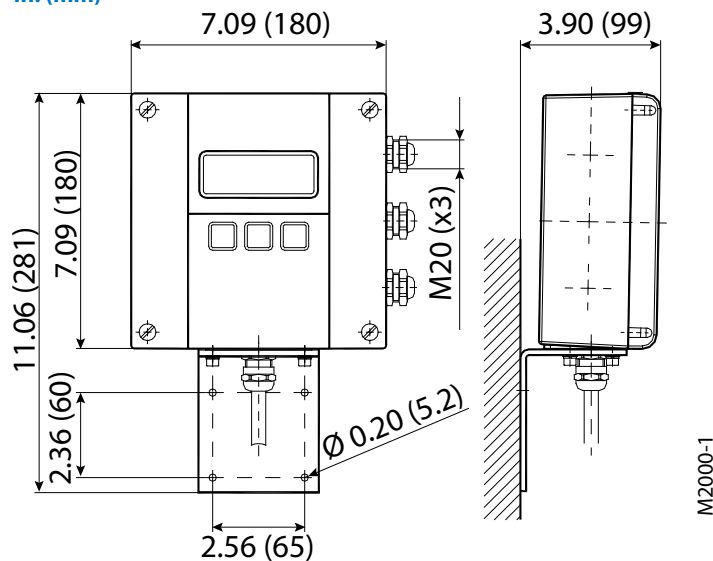
Transmitter Specifications

Flow Range	0.10...39.4 ft/s (0.03...12 m/s)
Accuracy	$\pm 0.20\%$ m.v. ± 1 mm/s OIML/MID: 2...12 in. (DN50...300) with 0d up and 0d downstream $\pm 1\% \geq 0.5$ ft/s (0.15 m/s)
Repeatability	$\pm 0.1\%$
Power Supply	AC Power Supply: 100...240V AC ($\pm 10\%$); Typical Power: 20V A or 15W; Maximum Power: 26V A or 20W Optional DC Power Supply: 9...36V DC; Typical Power: 10W; Maximum Power: 14W
Analog Output	4...20 mA, 0...20 mA, 0...10 mA, 2...10 mA (programmable and scalable) Voltage sourced 24V DC isolated. Maximum loop resistance < 800 Ohms.
Digital Output	Four total, configurable 24V DC sourcing active output (up to 2), 100 mA total, 50 mA each; sinking open collector output (up to four), 30V DC max, 100 mA each; solid-state relay (up to 2), 48V DC, 500 mA max, either polarity Absolute Digital Encoded output for connectivity to AquaCUE or BEACON cellular endpoints
Digital Input	Max 30V DC (programmable – positive zero return, external totalizer reset or preset batch start)
Frequency Output	Scalable up to 10 kHz, open collector up to 1 kHz, solid-state relay
Misc Output	High/low flow alarm (0...100% of flow), error alarm, empty pipe alarm, flow direction, preset batch alarm, 24V DC supply, ADE
Communication	RS232 Modbus RTU; RS485 Modbus RTU, HART, Profibus DP, BACnet MS/TP, Modbus MS/TP, EtherNet/IP and BACnet/IP require separate daughterboards
Pulse Width	Scalable up to 10 kHz, passive open collector up to 10 kHz, active switched 24V DC. Up to two outputs (forward and reverse). Pulse width programmable from 1...1000 ms or 50% duty cycle.
Processing	32-bit DSP
Empty Pipe Detection	Field tunable for optimum performance based on specific application
Excitation Frequency	1 Hz, 3.75 Hz, 7.5 Hz or 15 Hz (factory optimized to pipe diameter)
Noise Dampening	Programmable 0...30 seconds
Low Flow Cut-Off	Programmable 0...10% of maximum flow
Galvanic Separation	250V
Fluid Conductivity	Minimum 5.0 $\mu\text{S}/\text{cm}$ (minimum 20 $\mu\text{S}/\text{cm}$ for demineralized water)
Fluid Temperature	With Remote Transmitter: PFA, PTFE & Halar 302° F (150° C) With Meter-Mounted Transmitter: Rubber 178° F (80° C), PFA, PTFE & Halar 212° F (100° C)
Ambient Temperature	- 4...140° F (-20...60° C)
Relative Humidity	Up to 90 percent non-condensing

Pollution Degree	2		
Installation Category	II		
Altitude	8202 ft (2500 m)		
Flow Direction	Unidirectional or bidirectional two separate totalizers (programmable)		
Totalization	Programmable/resettable		
Units of Measure	Ounce, pound, liter, US gallon, imperial gallon, barrel, hectoliter, mega gallon, cubic meter, cubic feet, acre feet		
Display	4 x 20 character display with backlight		
Programming	Three-button, external manual or remote		
Transmitter Housing	Cast aluminum, powder-coated paint		
Mounting	Meter mount or remote wall mount (bracket supplied)		
Locations	Indoor and outdoor		
Meter Enclosure Classification	Standard: NEMA 4X (IP67); Optional: Submersible NEMA 6P (IP68) depth of 2 m for 72 hr), remote transmitter required		
Junction Box Enclosure Protection	For remote transmitter option: powder-coated die-cast aluminum, NEMA 4 (IP67)		
Cable Entries	M20 cable glands (3)		
Optional Stainless Steel Grounding Rings	Meter Size	Thickness of one ring	Thickness of one ring (DIN Flanges)
	Up through 10 in.	0.135 in. (3.429 mm)	0.12 in. (3 mm)
	12...78 in.	0.187 in. (4.750 mm)	0.12 in. (3 mm)
NSF/ANSI/CAN 61 and 372 Listed	Models with hard rubber liner, 4 in. size and larger; PTFE liner, all sizes		
OIML R49-1 MID MI-001 AWWA C715	Size range: DN50...300 / 2...12 in. Minimum straight inlet flow: 0 DN /outlet flow: 0 DN Forward and reverse (bi-directional) flow on any orientation Ratio (Q3/Q1) up to 250 Accuracy Class 1		
Token Features	Data Logging (Blue token); Store/Restore (Red token); Firmware Upgrade (Black token)		

M2000 Transmitter Dimensions

in. (mm)



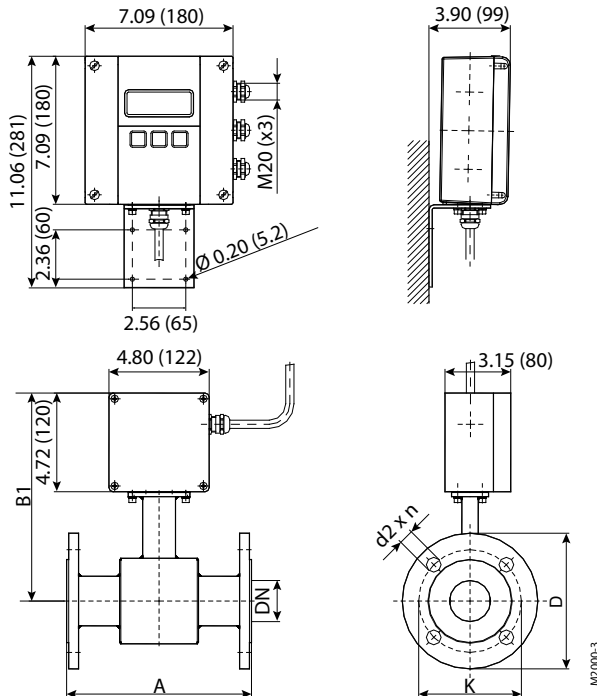
Sensor Type II Specifications

The electromagnetic sensor type II is not only available in a number of different flange process connections (DIN, ANSI, JIS, AWWA) but also in a number of liners like hard rubber, PTFE, PFA, or Halar. The sensor is configurable with up to 4 electrodes for measuring, empty pipe and grounding electrodes. Available in sizes from DN 6 TO DN 2000 and nominal pressures up to PN 100, the sensor type II is best suited for a variety of applications in the industry and the water/waste water industry.

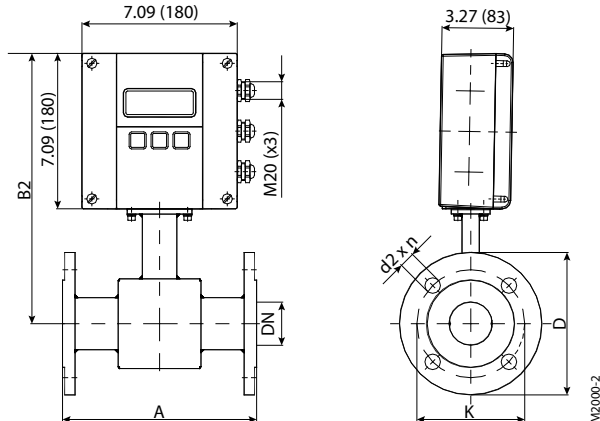
Size	1/4...78 in. (DN 6...2000)		
Flanges	Standard: ANSI B16.5, AWWA, ISO 1092-1, JIS and more in carbon steel; Optional: 304 or 316 stainless steel		
Nominal Pressure	Up to 1450 psi (100 bar)		
Pressure Rating	Line sizes 1/4...24 in: In accordance with ASME B16.5 Class 150 or Flange Rating Class 300 Line sizes 26...72 in: AWWA C-207 Class D or Class E Flange Rating		
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)		
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)		
Liner Material	Hard/soft rubber	1...78 in. (DN 25...2000)	32...176° F (0...80° C)
	PTFE	1/2...24 in. (DN 15...600)	-40...302° F (-40...150° C)
	Halar (ECTFE)	12 in. (DN 300) and larger	-40...302° F (-40...150° C)
	PFA	1/4...3/8 in. (DN 6...10)	—
Electrodes Materials	Hastelloy C (standard), Tantalum Platinum / Gold plated, Platinum / Rhodium		
Housing	Standard: Carbon steel welded; Optional: 316 or 304 stainless steel		
Electrode Materials	Standard: Hastelloy C22; Optional: 316 stainless steel, gold/platinum plated, tantalum, platinum/rhodium		
Lay Length	1/4...3/4 in. (DN 6...20)	6.7 in. (170 mm)	
	1...2 in. (DN 25...50)	8.9 in. (225 mm)	
	2-1/2...4 in. (DN 65...100)	11.0 in. (280 mm)	
	5...8 in. (DN 125...200)	15.8 in. (400 mm)	
	10...14 in. (DN 250...350)	19.7 in. (500 mm)	
	16...28 in. (DN 400...700)	23.6 in. (600 mm)	
	30...40 in. (DN 750...1000)	31.5 in. (800 mm)	
	48...56 in. (DN 1200...1400)	39.4 in. (1000 mm)	
	64 in. (DN 1600)	63.0 in. (1600 mm)	
	72 in. (DN 1800)	70.9 in. (1800 mm)	
	78 in. (DN 2000)	78.7 in. (2000 mm)	

Sensor Type II Dimensions

Remote Version in. (mm)



Mounted Version in. (mm)



IMPORTANT: Flange Sizes ≤ 24 in., Standard: ANSI B16.5 Class 150 RF forged carbon steel; Optional: 300 lb forged carbon steel, 316 or 304 stainless steel

Flange Sizes > 24 in., Standard: AWWA Class D Flanges RF forged carbon steel

Flange ANSI Class 150**Up to 24 in. ASME B16.5 / > 24 in. AWWA Class D (ASME 16.47)**

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/4	6	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
5/16	8	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
3/8	10	6.7	170	—	—	9.0	228	11.3	288	3.5	89	2.4	61	0.6 x 4	16 x 4
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.5	89	2.4	61	0.6 x 4	16 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	3.9	99	2.8	71	0.6 x 4	16 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.3	109	3.1	79	0.6 x 4	16 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	4.6	117	3.5	89	0.6 x 4	16 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.0	127	3.9	99	0.6 x 4	16 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.0	152	4.8	122	0.8 x 4	19 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.0	178	5.5	140	0.8 x 4	19 x 4
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.5	191	6.0	152	0.8 x 4	19 x 4
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.0	229	7.5	191	0.8 x 8	19 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.0	254	8.5	216	0.9 x 8	22 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.0	279	9.5	241	0.9 x 8	22 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.5	343	11.8	300	0.9 x 8	22 x 8
10	250	19.7	500	17.7	450	14.3	362	16.6	422	16.0	406	14.3	363	1.0 x 12	25 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	19.0	483	17.0	432	1.0 x 12	25 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	21.0	533	18.8	478	1.1 x 12	28 x 12
16	400	23.6	600	23.6	600	18.7	475	21.1	535	23.5	597	21.3	541	1.1 x 16	28 x 16
18	450	23.6	600	25.6	—	19.7	500	22.0	560	25.0	635	22.8	579	1.3 x 16	32 x 16
20	500	23.6	600	25.6	—	20.7	525	23.0	585	27.5	699	25.0	635	1.3 x 20	32 x 20
24	600	23.6	600	30.7	—	23.1	588	25.5	648	32.0	813	29.5	749	1.4 x 20	35 x 20
28	700	23.6	600	35.8	—	24.6	625	27.0	685	36.5	927	34.0	864	1.4 x 28	35 x 28
30	750	31.5	800	38.4	—	25.6	650	28.0	710	38.8	986	36.0	914	1.4 x 28	35 x 28
32	800	31.5	800	40.9	—	26.9	683	29.3	743	41.8	1062	38.5	978	1.6 x 28	41 x 28
36	900	31.5	800	46.1	—	28.5	725	30.9	785	46.0	1168	42.8	1087	1.6 x 32	41 x 32
40	1000	31.5	800	51.2	—	31.1	790	33.5	850	50.8	1290	47.3	1201	1.6 x 36	41 x 36
42	1050	39.4	1000	53.7	—	32.5	825	34.8	885	53.0	1346	49.5	1257	1.6 x 36	41 x 36
48	1200	39.4	1000	61.4	—	35.4	900	37.8	960	59.5	1511	56.0	1422	1.6 x 44	41 x 44
54	1350	39.4	1000	69.1	—	38.4	975	40.7	1035	66.3	1684	62.8	1595	1.9 x 44	48 x 44
56	1400	39.4	1000	71.7	—	39.4	1000	41.7	1060	68.8	1748	65.0	1651	1.9 x 48	48 x 48

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456**Flange ANSI Class 300 ASME B16.5**

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.8	95	2.6	67	0.6 x 4	16 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.6	117	3.3	83	0.8 x 4	19 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.9	124	3.5	89	0.8 x 4	19 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.3	133	3.9	99	0.8 x 4	19 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	6.1	155	4.5	114	0.9 x 4	22 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	5.0	127	0.8 x 8	19 x 8
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.5	191	5.9	149	0.9 x 8	22 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	8.3	210	6.6	168	0.9 x 8	22 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	10.0	254	7.9	200	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	11.0	279	9.3	235	0.9 x 8	22 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	12.5	318	10.6	270	0.9 x 12	22 x 12
8	200	15.7	400	13.8	350	13.3	338	15.7	398	15.0	381	13.0	330	1.0 x 12	25 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	17.5	445	15.3	387	1.1 x 16	28 x 16
12	300	19.7	500	19.7	500	16.7	425	19.1	485	20.5	521	17.8	451	1.3 x 16	32 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	23.0	584	20.3	514	1.3 x 20	32 x 20
16	400	23.6	600	23.6	600	18.7	475	21.1	535	25.5	648	22.5	572	1.4 x 20	35 x 20
18	450	23.6	600	25.6	—	19.7	500	22.0	560	28.0	711	24.8	629	1.4 x 24	35 x 24
20	500	23.6	600	25.6	—	20.7	525	23.0	585	30.5	775	27.0	686	1.4 x 24	35 x 24
24	600	23.6	600	30.7	—	23.1	588	25.5	648	36.0	914	32.0	813	1.6 x 24	41 x 24

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 10

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.4	340	11.6	295	0.9 x 8	22 x 8
10	250	19.7	500	17.7	450	14.3	362	16.6	422	15.6	395	13.8	350	0.9 x 12	22 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	17.5	445	15.7	400	0.9 x 12	22 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	19.9	505	18.1	460	0.9 x 16	22 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	22.2	565	20.3	515	1.0 x 16	26 x 16
18	450	23.6	600	25.6	—	19.7	500	22.0	560	24.2	615	22.2	565	1.0 x 20	26 x 20
20	500	23.6	600	25.6	—	20.7	525	23.0	585	26.4	670	24.4	620	1.0 x 20	26 x 20
24	600	23.6	600	30.7	—	23.1	588	25.5	648	30.7	780	28.5	725	1.2 x 20	30 x 20
28	700	23.6	600	35.8	—	24.6	625	27.0	685	35.2	895	33.1	840	1.2 x 24	30 x 24
32	800	31.5	800	40.9	—	26.9	683	29.3	743	40.0	1015	37.4	950	1.3 x 24	33 x 24
36	900	31.5	800	46.1	—	28.5	725	30.9	785	43.9	1115	41.3	1050	1.3 x 28	33 x 28
40	1000	31.5	800	51.2	—	31.1	790	33.5	850	48.4	1230	45.7	1160	1.4 x 28	36 x 28
48	1200	39.4	1000	61.4	—	35.4	900	37.8	960	57.3	1455	54.3	1380	1.5 x 32	39 x 32
56	1400	39.4	1000	71.7	—	39.4	1000	41.7	1060	65.9	1675	62.6	1590	1.7 x 36	42 x 36

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 16

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/4	6	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
5/16	8	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
3/8	10	6.7	170	—	—	9.0	228	11.3	288	3.5	90	2.4	60	0.6 x 4	14 x 4
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 4	18 x 4
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	8.7	220	7.1	180	0.7 x 8	18 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	9.8	250	8.3	210	0.7 x 8	18 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.2	285	9.4	240	0.9 x 8	22 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	13.4	340	11.6	295	0.9 x 8	22 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	15.9	405	14.0	355	1.0 x 12	26 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	18.1	460	16.1	410	1.0 x 12	26 x 12
14	350	19.7	500	21.7	550	17.7	450	20.1	510	20.5	520	18.5	470	1.0 x 16	26 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	22.8	580	20.7	525	1.2 x 16	30 x 16
18	450	23.6	600	25.6	—	19.7	500	22.0	560	25.2	640	23.0	585	1.2 x 20	30 x 20
20	500	23.6	600	25.6	—	20.7	525	23.0	585	28.1	715	25.6	650	1.3 x 20	33 x 20
24	600	23.6	600	30.7	—	23.1	588	25.5	648	33.1	840	30.3	770	1.4 x 20	36 x 20
28	700	23.6	600	35.8	—	24.6	625	27.0	685	35.8	910	33.1	840	1.4 x 24	36 x 24
32	800	31.5	800	40.9	—	26.9	683	29.3	743	40.4	1025	37.4	950	1.5 x 24	39 x 24
36	900	31.5	800	46.1	—	28.5	725	30.9	785	44.3	1125	41.3	1050	1.5 x 28	39 x 28
40	1000	31.5	800	51.2	—	31.1	790	33.5	850	49.4	1255	46.1	1170	1.7 x 28	42 x 28
48	1200	39.4	1000	61.4	—	35.4	900	37.8	960	58.5	1485	54.7	1390	1.9 x 32	48 x 32
56	1400	39.4	1000	71.7	—	39.4	1000	41.7	1060	66.3	1685	62.6	1590	1.9 x 36	48 x 36

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 25

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 4	18 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.3	235	7.5	190	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.6	270	8.7	220	1.0 x 8	26 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.8	300	9.8	250	1.0 x 8	26 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	14.2	360	12.2	310	1.0 x 8	26 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	16.7	425	14.6	370	1.2 x 12	30 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	19.1	485	16.9	430	1.2 x 12	30 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	21.9	555	19.3	490	1.3 x 16	33 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	24.4	620	21.7	550	1.4 x 16	36 x 16
18	450	23.6	600	25.6	—	19.7	500	22.0	560	26.4	670	23.6	600	1.4 x 20	36 x 20
20	500	23.6	600	25.6	—	20.7	525	23.0	585	28.7	730	26.0	660	1.4 x 20	36 x 20
24	600	23.6	600	30.7	—	23.1	588	25.5	648	33.3	845	30.3	770	1.5 x 20	39 x 20
28	700	23.6	600	35.8	—	24.6	625	27.0	685	37.8	960	34.4	875	1.7 x 24	42 x 24
32	800	31.5	800	40.9	—	26.9	683	29.3	743	42.7	1085	39.0	990	1.9 x 24	48 x 24
36	900	31.5	800	46.1	—	28.5	725	30.9	785	46.7	1185	42.9	1090	1.9 x 28	48 x 28
40	1000	31.5	800	51.2	—	31.1	790	33.5	850	52.0	1320	47.6	1210	2.2 x 28	56 x 28

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456

Flange EN 1092-1 / PN 40

Size DN		A Standard		A ISO*		B1		B2		D		K		d2 x n	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
1/2	15	6.7	170	7.9	200	9.4	238	11.7	298	3.7	95	2.6	65	0.6 x 4	14 x 4
3/4	20	6.7	170	7.9	200	9.4	238	11.7	298	4.1	105	3.0	75	0.6 x 4	14 x 4
1	25	8.9	225	7.9	200	9.4	238	11.7	298	4.5	115	3.3	85	0.6 x 4	14 x 4
1-1/4	32	8.9	225	7.9	200	10.0	253	12.3	313	5.5	140	3.9	100	0.7 x 4	18 x 4
1-1/2	40	8.9	225	7.9	200	10.0	253	12.3	313	5.9	150	4.3	110	0.7 x 4	18 x 4
2	50	8.9	225	7.9	200	10.0	253	12.3	313	6.5	165	4.9	125	0.7 x 4	18 x 4
2-1/2	65	11.0	280	7.9	200	10.7	271	13.0	331	7.3	185	5.7	145	0.7 x 4	18 x 8
3	80	11.0	280	7.9	200	10.7	271	13.0	331	7.9	200	6.3	160	0.7 x 8	18 x 8
4	100	11.0	280	9.8	250	10.9	278	13.3	338	9.3	235	7.5	190	0.9 x 8	22 x 8
5	125	15.7	400	9.8	250	11.7	298	14.1	358	10.6	270	8.7	220	1.0 x 8	26 x 8
6	150	15.7	400	11.8	300	12.2	310	14.6	370	11.8	300	9.8	250	1.0 x 8	26 x 8
8	200	15.7	400	13.8	350	13.3	338	15.7	398	14.8	375	12.6	320	1.2 x 8	30 x 12
10	250	19.7	500	17.7	450	14.3	362	16.6	422	17.7	450	15.2	385	1.3 x 12	33 x 12
12	300	19.7	500	19.7	500	16.7	425	19.1	485	20.3	515	17.7	450	1.3 x 12	33 x 16
14	350	19.7	500	21.7	550	17.7	450	20.1	510	22.8	580	20.1	510	1.4 x 16	36 x 16
16	400	23.6	600	23.6	600	18.7	475	21.1	535	26.0	660	23.0	585	1.5 x 16	39 x 16
18	450	23.6	600	25.6	—	19.7	500	22.0	560	27.0	685	24.0	610	1.5 x 20	39 x 20
20	500	23.6	600	25.6	—	20.7	525	23.0	585	29.7	755	26.4	670	1.7 x 20	42 x 20
24	600	23.6	600	30.7	—	23.1	588	25.5	648	35.0	890	31.3	795	1.9 x 20	48 x 20

Other sizes on request

IMPORTANT: ISO* sensor lay length according to ISO 20456

Weight and Flow Range

Size		Estimated Weight with M2000	Flow Range	
in.	DN	lb (kg)	US	Metric
1/4	6	8 (3.5)	0.0134...5.4 GPM	0.051...20.4 l/min
5/16	8	8 (3.5)	0.0239...9.6 GPM	0.09...36.2 l/min
3/8	10	8 (3.5)	0.0373...14.9 GPM	0.141...57 l/min
1/2	15	10 (4.5)	0.084...33.6 GPM	0.318...127 l/min
3/4	20	10 (4.5)	0.149...60 GPM	0.57...226 l/min
1	25	11 (5)	0.233...93 GPM	0.88...353 l/min
1-1/4	32	13 (6)	0.382...153 GPM	1.45...579 l/min
1-1/2	40	15.5 (7)	0.6...239 GPM	2.26...905 l/min
2	50	19 (8.5)	0.93...373 GPM	3.53...1,414 l/min
2-1/2	65	27.5 (12.5)	1.58...631 GPM	0.358...143 m ³ /h
3	80	31 (14)	2.39...956 GPM	0.54...217 m ³ /h
4	100	42 (19)	3.73...1,494 GPM	0.85...339 m ³ /h
5	125	53 (24)	5.8...2,334 GPM	1.33...530 m ³ /h
6	150	60.5 (27.5)	8.4...3,361 GPM	1.91...763 m ³ /h
8	200	87 (39.5)	14.9...5,975 GPM	3.39...1,357 m ³ /h
10	250	129 (58.5)	23.3...9,336 GPM	5.3...2,121 m ³ /h
12	300	204 (92.5)	33.6...13,444 GPM	7.6...3,054 m ³ /h
14	350	262 (119)	45.7...18,299 GPM	10.4...4,156 m ³ /h
16	400	344 (156)	60...23,901 GPM	13.6...5,429 m ³ /h
18	450	397 (180)	76...30,250 GPM	17.2...6,870 m ³ /h
20	500	470 (213)	93...37,345 GPM	21.2...8,482 m ³ /h
22	550	549 (249)	113...45,188 GPM	25.7...10,263 m ³ /h
24	600	617 (280)	134...53,777 GPM	30.5...12,214 m ³ /h
28	700	—	183...73,197 GPM	41.6...16,625 m ³ /h
30	750	930 (422)	210...84,027 GPM	47.7...19,085 m ³ /h
32	800	1171 (531)	239...95,604 GPM	54.3...21,714 m ³ /h
36	900	1378 (625)	302...120,999 GPM	69...27,482 m ³ /h
40	1000	—	373...149,381 GPM	85...33,928 m ³ /h
48	1200	1788 (811)	538...215,109 GPM	122...48,857 m ³ /h
56	1400	—	732...292,787 GPM	166...66,499 m ³ /h
60	1500	2112 (958)	840...336,108 GPM	191...76,338 m ³ /h
64	1600	2339 (1061)	956...382,416 GPM	217...86,856 m ³ /h
72	1800	3219 (1460)	1210...483,996 GPM	275...109,927 m ³ /h
78	2000	4101 (1860)	1494...597,525 GPM	339...135,713 m ³ /h

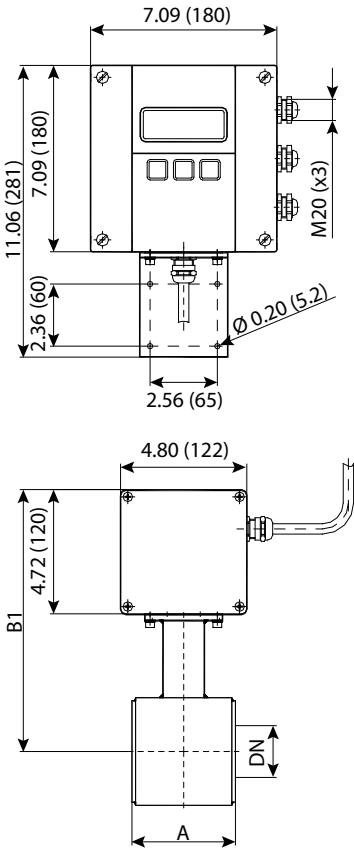
Sensor Type III Specifications

Thanks to its very short lay length, the sensor type III is often the right alternative to a lot of applications. Delivered with a PTFE liner, the sensor type III has a standard nominal pressure of PN 40.

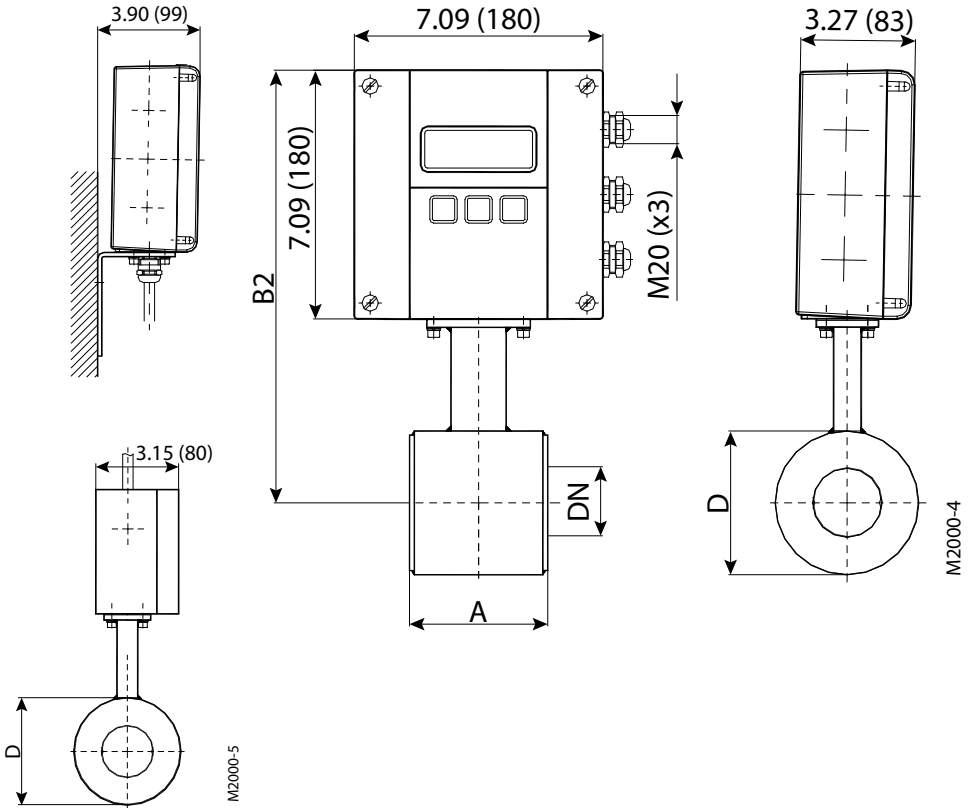
Size	1...4 in. (DN 25...100)	
Process Connection	Wafer connection (in-between flange mounting)	
Nominal Pressure	580 psi (40 bar)	
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)	
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)	
Liner Materials	PTFE	
Electrode Material	Hastelloy C (Standard), Tantal, Platinum / Gold Plated, Platinum / Rhodium	
Housing	Carbon Steel / optional stainless steel	
Lay Length	1...2 in. (DN 25...50)	4 in. (100 mm)
	2-1/2...4 in. (DN 65...100)	6 in. (150 mm)

Sensor Type III Dimensions

Remote Version
in. (mm)



Mounted Version
in. (mm)



in.	DN	A	B1	B2	D
1	25	3.94 (100)	9.37 (238)	7.24 (184)	2.91 (74)
1-1/4	32	3.94 (100)	9.57 (243)	7.44 (189)	3.31 (84)
1-1/2	40	3.94 (100)	9.76 (248)	7.64 (194)	3.70 (94)
2	50	3.94 (100)	9.96 (253)	7.83 (199)	4.09 (104)
2-1/2	65	5.91 (150)	10.47 (266)	8.35 (212)	5.08 (129)
3	80	5.91 (150)	10.67 (271)	8.54 (217)	5.51 (140)
4	100	5.91 (150)	10.98 (279)	8.86 (225)	6.14 (156)
580 psi (40 bar)					

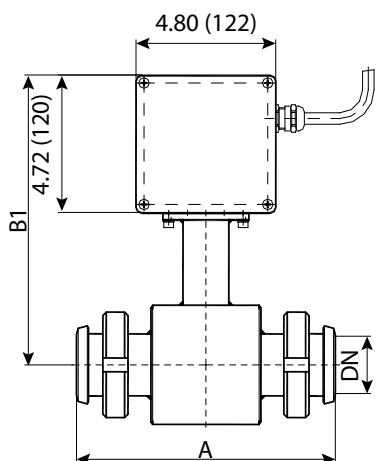
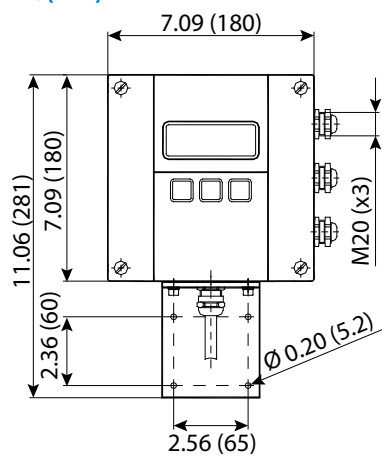
Sensor with Sanitary Process Connections Specifications

The sensor model is available with Tri-Clamp® BS4825/ISO2852, DIN11851, and more process connections. The sanitary sensor is delivered in a stainless steel housing and with PTFE/PFA lining.

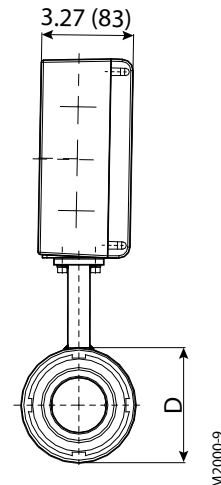
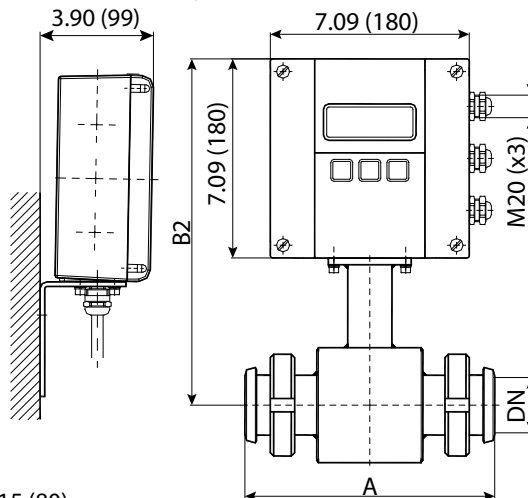
Size	3/8...4 in. (DN 10...100)		
Process Connection	Tri-Clamp BS4825/ISO2852, DIN 11851, customer specified, and more		
Nominal Pressure	145/230 psi (10/16 bar)		
Protection Class	NEMA 4X (IP67), optional NEMA 6P (IP68)		
Minimum Conductivity	5 µS/cm (20 µS/cm for demineralized water)		
Liner Materials	PTFE/PFA	−40...302° F (−40...150° C)	
Electrode Material	Standard: Hastelloy C; Optional: Tantal, Platinum / Gold plated, Platinum / Rhodium		
Housing	Standard: Carbon Steel; Optional: Stainless Steel		
Lay Length	Tri-Clamp Connection	3/8...2 in. (DN 10...50)	6 in. (145 mm)
		2-1/2...4 in. (DN 65...100)	8 in. (200 mm)
	DIN 11851 Connection	3/8...3/4 in. (DN 10...20)	7 in. (175 mm)
		1...2 in. (DN 25...50)	9 in. (225 mm)
		2-1/2...4 in. (DN 65...100)	11 in. (280 mm)

DIN 11851 Connection Dimensions

Remote Version in. (mm)



Mounted Version in. mm

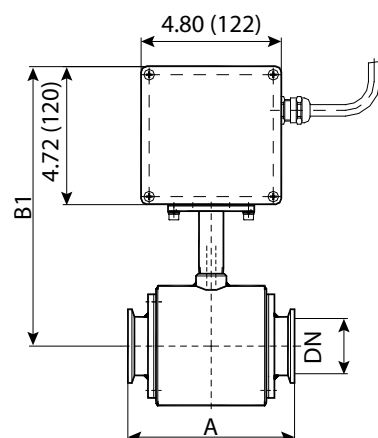
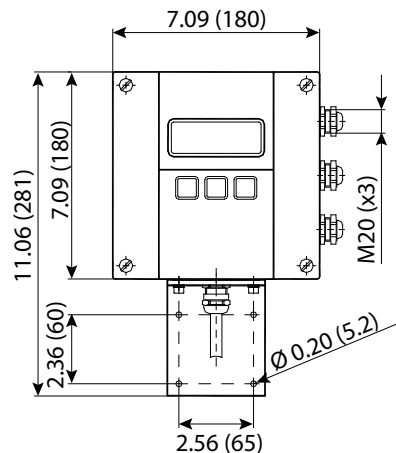


in.	DN	A	B1	B2	D
3/8	10	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
1/2	15	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
3/4	20	6.69 (170)	9.37 (238)	7.24 (184)	2.91 (74)
1	25	8.86 (225)	9.37 (238)	7.24 (184)	2.91 (74)
1-1/4	32	8.86 (225)	9.57 (243)	7.44 (189)	3.31 (84)
1-1/2	40	8.86 (225)	9.76 (248)	7.64 (194)	3.70 (94)
2	50	8.86 (225)	9.96 (253)	7.83 (199)	4.09 (104)
2-1/2	65	11.02 (280)	10.47 (266)	8.35 (212)	5.08 (129)
3	80	11.02 (280)	10.67 (271)	8.54 (217)	5.51 (140)
4	100	11.02 (280)	10.98 (279)	8.86 (225)	6.14 (156)

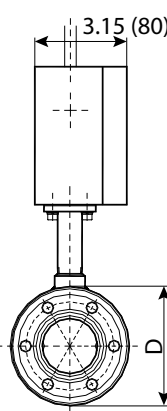
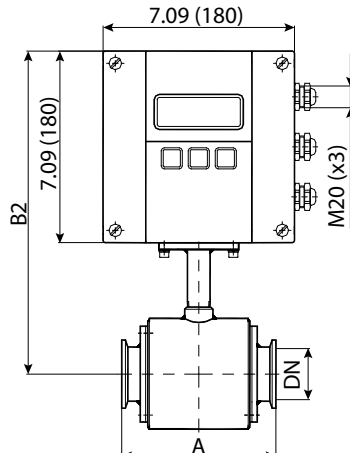
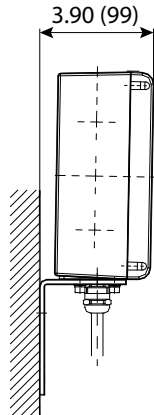
230 psi (16 bar)

Tri-Clamp Connection Dimensions

Remote Version in. (mm)



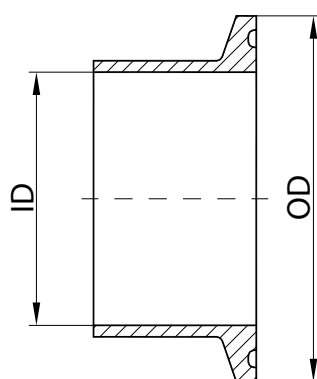
Mounted Version in. (mm)



in.	DN	A	B1	B2	D
3/8	10	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1/2	15	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
3/4	20	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1	25	5.71 (145)	8.98 (228)	7.52 (191)	2.91 (74)
1-1/2	40	5.71 (145)	9.37 (238)	7.91 (201)	3.70 (94)
2	50	5.71 (145)	9.57 (243)	8.11 (206)	4.09 (104)
2-1/2	65	7.87 (200)	10.08 (256)	8.62 (219)	5.08 (129)
3	80	7.87 (200)	10.28 (261)	8.82 (224)	5.51 (140)
4	100	7.87 (200)	10.59 (269)	9.13 (232)	6.14 (156)

150 psi (10 bar)

Tri-Clamp Connection

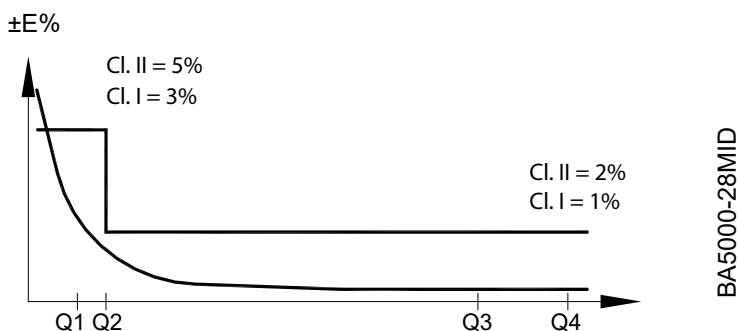


BS4825					ISO2852				
Size	OD		ID		Size	OD		ID	
in.	in.	mm	in.	mm	DN	in.	mm	in.	mm
—	—	—	—	—	10	0.98	25.0	0.55	14.0
1/2	0.98	25.0	0.37	9.4	15	1.99	50.5	0.71	18.1
3/4	0.98	25.0	0.62	15.75	20	1.99	50.5	0.90	22.9
1	1.99	50.5	0.87	22.1	25	1.99	50.5	1.13	28.7
—	—	—	—	—	32	2.52	64.0	1.51	38.4
1-1/2	1.99	50.5	1.37	34.8	40	2.52	64.0	1.74	44.3
2	2.52	64.0	1.87	47.5	50	3.05	77.5	2.22	56.3
2-1/2	3.05	77.5	2.37	60.2	65	3.58	91.0	2.84	72.1
3	3.58	91.0	2.87	72.9	80	4.17	106.0	3.32	84.3
4	4.69	119.0	3.83	97.4	100	5.12	130.0	4.32	109.7

Nominal Pressure 145 psi (10 bar)

OIML APPROVED METER

The M2000 is type approved according to the international water meter standards OIML R49. The meter is approved as Class I and Class II for the detector sizes 2...12 inches (DN 50...300).



$Q2/Q1 = 1.6$ and $Q4/Q3 = 1.25$

OIML R 49 specification for Class I

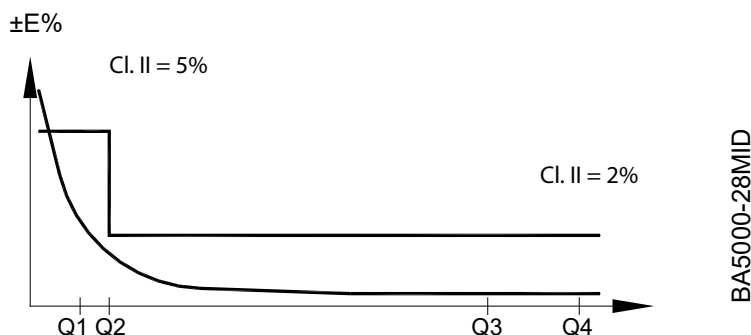
Size in. (DN)	2 (50)	2 1/2 (65)	3 (80)	4 (100)	5 (125)	6 (150)	8 (200)	10 (250)	12 (300)
R (Q3/Q1)	200	200	200	250	250	160	160	160	100
Q1 [m ³ /h]	0.315	0.5	0.8	1	1.6	3.94	6.25	10	15.63
Q2 [m ³ /h]	0.504	0.8	1.28	1.6	2.56	6.3	10	16	25
Q3 [m³/h]	63	100	160	250	400	630	1000	1600	1600
Q4 [m ³ /h]	78.75	125	200	312.5	500	787.5	1250	2000	2000
OIML R49 Class	1								

OIML R 49 specification for Class II

Size in. (DN)	6 (150)	8 (200)
R (Q3/Q1)	250	250
Q1 [m ³ /h]	2.52	4
Q2 [m ³ /h]	4.03	6.4
Q3 [m³/h]	630	1000
Q4 [m ³ /h]	787.5	1250
OIML R49 Class	2	

MID APPROVED METER (MI-001)

The M2000 is type approved according to Directive 2004/22/EC of the European Parliament and Council of March 31, 2004 Measuring Instruments (MID) Annex MI-001. The meter is approved for the detector sizes 2...12 inches (DN 50...300).



$Q2/Q1 = 1.6$ and $Q4/Q3 = 1.25$

Size in. (DN)	2 (50)	2-1/2 (65)	3 (80)	4 (100)	5 (125)	6 (150)	8 (200)	10 (250)	12 (300)
R (Q3/Q1)	200	200	200	250	250	250	250	160	100
Q1 [m ³ /h]	0.315	0.5	0.8	1	1.6	2.52	4	10	15.63
Q2 [m ³ /h]	0.504	0.8	1.28	1.6	2.56	4.03	6.4	16	25
Q3 [m³/h]	63	100	160	250	400	630	1000	1600	1600
Q4 [m ³ /h]	78.75	125	200	312.5	500	787.5	1250	2000	2000

The conformity declaration of above certificate is according to module B (type approval) and D (quality insurance of production).

If you are interested in a product configuration that is not designated for your region, please contact Badger Meter.

Hard Rubber Liner

DESCRIPTION

ORION® Cellular water endpoints are innovative, two-way endpoints for smart water applications. The endpoints utilize existing IoT (Internet of Things) cellular infrastructure to efficiently and securely deliver meter reading data to the utility in a Network as a Service (NaaS) approach. Leveraging existing cellular infrastructure, the NaaS solution offers all the performance benefits of AMI, while eliminating network-related maintenance and technology concerns and enhancing deployment flexibility.

Cellular endpoints are members of the time-tested ORION family of products from Badger Meter, designed for maximum flexibility. Since 2002, the ORION product family has provided comprehensive Advanced Metering Analytics (AMA) for interval meter reading and data capture using both one-way and two-way communications.

FUNCTIONALITY

Operation: ORION Cellular water endpoints communicate with the encoder and capture 15-minute interval read data and meter status information. The endpoints then automatically broadcast the information, including endpoint status information, via the cellular network to BEACON® Software as a Service (SaaS). ORION NaaS is powered by the proven ORION system for interval data capture and two-way communication. The solution employs cellular endpoints which, as they leverage the public cellular network and require no proprietary gateways to operate, dramatically reduce infrastructure requirements compared to a traditional fixed network. This speeds installations and simplifies expansion as a system evolves.

The endpoints are designed to call in four times each workday and feature a configurable schedule that enables utility customers to select call-in times that best support their processes.

Activation: ORION Cellular water endpoints are shipped in an inactive, non-transmitting state. The Badger Meter IR Communication Device can be used to activate the endpoints and verify the encoder connection. Successful endpoint function can be confirmed through a web app demonstrating that communication has been verified to both the encoder and the network.

Alternatively, the endpoints offer a Smart Activation feature. After installation, the endpoints begin broadcasting data when the encoder senses the first usage of water. No field programming or special tools are required.

Broadcast Mode: ORION Cellular water endpoints broadcast fixed network reading data through the secure cellular network within the service area.

Specific configurations also transmit a radio frequency (RF) message to facilitate troubleshooting in the field. See ["Configurations" on page 2](#).

Data Storage: The endpoints store 42 days of 15-minute data.



ORION Cellular C endpoint (pictured)

Output Message: ORION Cellular water endpoints broadcast a unique serial number, meter reading data, and applicable status indicators. As an advanced data security measure, each message is securely transported to BEACON SaaS only via private network and never over the public internet.

APPLICATION

Configurations: ORION Cellular water endpoints are multi-purpose endpoints that can be deployed in indoor, outdoor and pit (non-metal pit lid) applications. The electronics and battery assembly are fully encapsulated in epoxy for environmental integrity. The endpoint is available with a connector assembly for ease of installation.

Meter Compatibility: When attached to a Badger Meter High Resolution Encoder, the ORION Cellular water endpoint is compatible with all current Badger Meter Recordall® Disc, Turbo Series, Compound Series, Combo Series and Fire Service meters and assemblies, and with E-Series G2® Ultrasonic, E-Series® Ultrasonic, E-Series® Ultrasonic Plus, and ModMAG® electromagnetic flow meters.

Encoder Compatibility: The ORION Cellular water endpoint is suitable for use with a Badger Meter High Resolution Encoder as well as the following Badger Meter approved three-wire encoder registers that have a manufacture date within 10 years of the current date as long as the encoder has three wires connected to it and is programmed into the three-wire output mode for AMR/AMI: Honeywell® (Elster/ABB) ScanCoder, evoQ4 meter with Sensus® protocol module; Master Meter® Octave® Ultrasonic meter encoder output; Metron-Farnier Hawkeye; Mueller Systems 420 Solid State Register (SSR) LCD; Neptune® ProRead, E-Coder®, ARB-V®, and ProCoder; and Sensus iPerl®.

SPECIFICATIONS

Dimensions	5.125 in. (130 mm) (H)
	1.75 in. (44 mm) Diameter at top
	2.625 in. (W) x 2.875 in. (D) at base
	(67 mm (W) x 73 mm (D) at base)
Broadcast Network	LTE-M cellular network (primary communication technology)
	NB-IoT (secondary communication technology for certain variants)
RF Message for Troubleshooting	Where available (see table below) frequency is FCC-regulated 902...928 MHz frequency hopping modulation
Operating Temperature Range	
	• Storage, Meter Reading and RF Message (for troubleshooting)
	• Cellular Communications
Humidity	0%...100% condensing
Battery	One (1) lithium thionyl chloride D cell (nonreplaceable)

Construction: All ORION Cellular water endpoints are housed in an engineered polymer enclosure with an ORION RF board, battery and antenna. For long-term performance, the enclosure is fully potted to withstand harsh environments and to protect the electronics in flooded or submerged pit applications.

Wire Connections: ORION Cellular water endpoints are available with inline connectors (Twist Tight® or Nicor®) for easy installation and connection to compatible encoders/meters. The endpoints are also available with flying leads for field splice connections. Other wire connection configurations may be available upon request.

FEATURES

Smart City Ready	Future-proof technology
Communication Type	Two-way
Application Type	Control/Monitor
Endpoint Communication	Configurable call-in schedule, up to four times each workday
Reading Interval Type	15-minute
Encoder Compatibility	Absolute
Fixed Network Reading	✓
Cut-Wire Indication	✓
Encoder Error	✓
Low Battery Indication	✓
Remote Clock Synchronization	✓
Firmware Upgrades	✓

CONFIGURATIONS

Endpoint	Notes
ORION Cellular C	Includes RF and IR messages for troubleshooting
ORION Cellular HLD	Includes RF and IR messages for troubleshooting
ORION Cellular LTE-M	Includes RF and IR messages for troubleshooting

NOTE: For the ORION Cellular LTE-MP endpoint, see the *ORION Cellular LTE-MP Endpoint product data sheet*, available at www.badgermeter.com.

ORION Cellular endpoints are IoT Network Certified by CTIA, an association representing the U.S. wireless communications industry and companies throughout the mobile ecosystem. The certification signifies that the endpoints meet global 4G and 5G standards and are ready for use on wireless IoT networks.



- License Requirements:

ORION Cellular water endpoints comply with Part 15, Part 22, Part 24, and Part 27 of the FCC Rules. No license is required by the utility to operate an ORION meter reading system. This device complies with Industry Canada license-exempt RSS standard(s).
- Transportation:

WARNING: The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.
- Warning:

To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.
- Caution:

Endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries. Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

This Quick Start Guide* details the four main steps for installing ORION® Cellular C, HLD, CS, LTE-M, LTE-MS, HLA, HLC and LTE water endpoints.

1. **Connect the endpoint to the encoder**
(This step can be done before, or as part of installation.)
2. **Install the endpoint**
3. **Activate the endpoint**
4. **Confirm activation**

To reduce the possibility of electrical fire and shock hazards, never connect the cable from the endpoint to any electrical supply source. The endpoint cable provides SELV low voltage limited energy power to the load and should only be connected to passive elements of a water meter register.



The endpoint batteries are *not* replaceable. Users should make no attempt to replace the batteries. Changes or modifications to the equipment that are not expressly approved by Badger Meter could void the user's authority to operate the equipment.

ORION endpoints installation must comply with all applicable federal, state and local rules, regulations and codes. Proper performance and reliability of ORION endpoints depend upon installation in accordance with these instructions. Endpoints not properly installed may not be covered under warranty.

Failure to read and follow these instructions can lead to misapplication or misuse of this product, resulting in personal injury and damage to equipment.

*Complete installation information for all ORION endpoints can be found in the [ORION Water Endpoints Installation Manual](#), available at www.badgermeter.com.

ENDPOINTS AND ENCODERS

ORION Cellular water endpoints are three-wire metering devices for indoor/outdoor use. The ORION Cellular C endpoint is shown in [Figure 1](#).



Figure 1: ORION Cellular C Endpoint

Each endpoint has an FCC label on the back and the serial number engraved on the front. The serial numbers start with the numbers shown below:

- ORION Cellular HLD 16xxxxxxx
- ORION Cellular C and CS 13xxxxxxx
- ORION Cellular LTE-M and LTE-MS 12xxxxxxx
- ORION Cellular HLA 14xxxxxxx
NOTE: Some early release HLA endpoints may have the 13xxxxxxx series.
- ORION Cellular HLC 149xxxxxx
- ORION Cellular LTE 11xxxxxxx

The endpoints have the same dimensions ([Figure 2](#)).

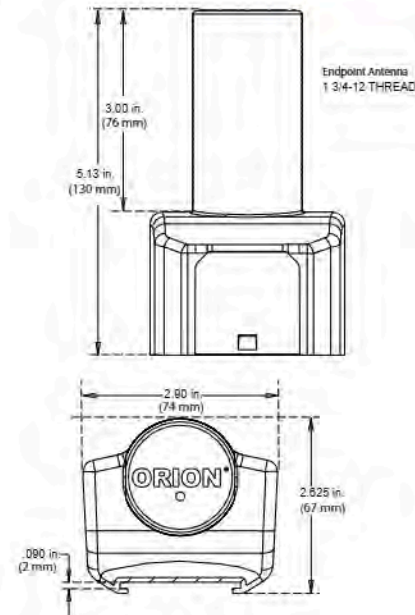


Figure 2: Endpoint dimensions

ORION Cellular water endpoints are compatible with Badger Meter high resolution encoders and E-Series Ultrasonic meters as well as a number of competitive encoders. See the [ORION Water Endpoints Installation Manual](#) for the complete list.

CONNECT ENDPOINTS AND ENCODERS

ORION Cellular water endpoints require connection to an encoder to complete the assembly.

Endpoints with inline connectors can be easily connected to an encoder in the field. No tools are necessary.

Endpoints with flying leads can be connected to existing wires from the encoder or directly to the encoder terminal screws, depending on the application and manufacturer.

ORION endpoint wires: **Red** = Power/Clock; **Black** = Ground; **Green** = Data

See the wiring chart in the [ORION Water Endpoints Installation Manual](#) if you need help.

INSTALLATION

Choose an appropriate location within the limits of the endpoint/encoder connector harness.

Indoor/Outdoor Installation:

- Indoor installation is **recommended**. Mount endpoints indoors, in the floor joist near an outside wall and away from large metal objects.
- Outdoor installation is **acceptable** and may be required where signal strength does not support an indoor installation.

Pit Installation

Mount endpoints through a NON-METAL pit lid—**REQUIRED**. See [Figure 3](#).

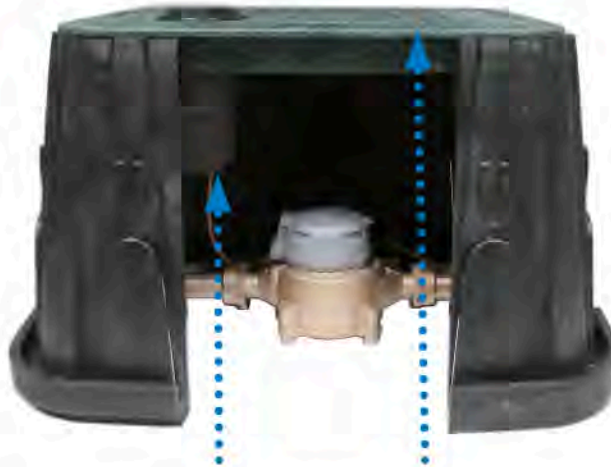


Figure 3: ORION Cellular C endpoint installed per instructions through non-metal pit lid

Installation Kits

Endpoint installation kits are available. Kit information can be found in the ORION Water Endpoint Installation Manual.

ENDPOINT ACTIVATION

Activation is dependent on whether the endpoint radio is in Pause ("soft sleep") or Stop ("hard sleep") mode. ORION endpoint radios in Pause mode offer a Smart Activation feature which utilizes consumption to automatically start the endpoint. ORION endpoint radios in Stop mode must be manually activated. The Product Configuration Utility (PCU) software can be used to identify the endpoint radio mode. See the [Product Configuration Utility for ORION Endpoints User Manual](#) available at www.badgermeter.com.

Activating Endpoints in Pause Mode via Smart Activation

With Smart Activation, the endpoint radio in Pause mode automatically "wakes up" on its own and begins broadcasting data after the encoder to which it is connected detects enough water usage from the register after installation. The amount of water consumption depends on the encoder output and meter size. This section explains how Smart Activation affects endpoints connected to encoders at the factory (Endpoint/Encoder Assemblies) and endpoints connected to an encoder in the field (Endpoint Only).

Endpoint/Encoder Assemblies

An initial encoder read is stored by the endpoint at the time the encoder and endpoint are factory connected and the endpoint is placed in Pause mode. While in Pause mode, the endpoint monitors the encoder for consumption, checking once every fifteen minutes. When the endpoint/encoder assembly is installed and water is running through the meter, the endpoint automatically "wakes up" and transitions to its active operational mode once the required amount of consumption is registered (see table below).

Encoder Output	Dial Change Required to Activate Endpoint
7-dial	Any 1 unit change in the least significant digit
8-dial	Any 5 unit change in the least significant digit
9-dial	Any 5 unit change in the least significant digit

Endpoint Only

Like endpoint/encoder assemblies, ORION “endpoint only” configurations can be shipped in Pause mode. The initial encoder read is established the first time the endpoint is field connected to an encoder.

TIP: It may take up to fifteen (15) minutes for an endpoint to recognize the initial encoder read. To expedite this process, Badger Meter recommends connecting the endpoint to the encoder in advance of field installation so a baseline encoder read can be captured before installation.

After the initial encoder read is stored, the endpoint monitors the encoder for consumption, checking for a change in the encoder read once every fifteen minutes. The endpoint automatically “wakes up” and transitions to its operational mode when the required amount of consumption is registered. See the table on the previous page.

Tools

For Smart Activation, no special tools or field programming are required. For more immediate activation or for endpoints in Stop mode, infrared (IR) activation tools are available.

Activating Endpoints Using IR

NOTE: Endpoint radios in Stop mode **must** be manually activated using IR communication.

1. The Badger Meter **IR Communication Device** (Figure 4) can be used to activate an endpoint in Stop or Pause mode and verify the encoder connection. Instructions are included with the device. For a short video about how to use the device, go to BEACON Help videos at <https://helpbeaconama.net/training-2/#videos>
2. Endpoints can also be activated using the PCU software with an ORION or customer-supplied Windows® device. The software can also identify the endpoint radio mode. Instructions are available in the *Product Configuration Utility for ORION Endpoints User Manual* available at www.badgermeter.com.

NOTE: Using the IR Alignment Tool (Figure 5) is recommended for IR activation of ORION Cellular endpoints. The IR Alignment Tool is a hands-free tool for positioning the IR Communication Device or an IR programming cable head.



Figure 4: IR Communication Device (PN: 68891-001)



Figure 5: IR Alignment Tool (PN: 68779-001)

CONFIRMING INSTALLATION

Before leaving the installation site, you can confirm endpoint activation using one of the following tools.

1. BEACON® Software as a Service (SaaS) users can check endpoint activation status with the **ORION Endpoint Status** tool (<https://orionstatus.beaconama.net>). Endpoints do not need to be provisioned in BEACON to display using the tool. See the *ORION Water Endpoints Installation Manual* for more information.
2. The **IR Communication Device** (Figure 4) can be used to activate the endpoint and verify the encoder connection.

IMPORTANT

Badger Meter IR Communication Devices (Figure 4) that shipped **prior to March 8, 2021** require a firmware update to support use with ORION Cellular C endpoints. Contact Badger Meter Technical Support (800-616-3837).

Endpoint Network Registration

When the endpoint transitions to Active mode during activation, it automatically begins the network registration process. BEACON assigns a daily call-in time to the endpoint as part of this process. An active operating endpoint obtains a current encoder read every 15 minutes.

Changing Registration for an Existing Endpoint Assembly

If you change the encoder connected to an ORION Cellular endpoint, the endpoint will recognize the new encoder, once connected, and report previous and current interval data.

LICENSE REQUIREMENTS

ORION Cellular C, HLD, CS, LTE-M, LTE-MS, HLA, HLC and LTE endpoints comply with Part 15, Part 22, Part 24, and Part 27 of FCC Rules. Operation is subject to the following conditions: (1) These devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation of the device.

In accordance with FCC Regulations, "Code of Federal Regulations" Title 47, Part 2, Subpart J, Section 1091, transmitters pass the requirements pertaining to radiation exposure. However, to avoid public exposure in excess of limits for general population (uncontrolled exposure), a 20 centimeter distance between the transmitter and the body of the user must be maintained during operation.

No FCC license is required by a utility to operate an ORION meter reading system.

ENDPOINT TRANSPORTATION



The operation of transmitters and receivers on airlines is strictly prohibited by the Federal Aviation Administration. As such, the shipping of radios and endpoints via air is prohibited. Please follow all Badger Meter return and/or shipping procedures to prevent exposure to liability.

ADDITIONAL RESOURCES

For information not included in this guide, refer to these documents, available at www.badgermeter.com.

- [ORION Water Endpoints Installation Manual](#)
- [ORION Cellular Endpoint Installation Dos and Don'ts Quick Reference Guide](#)
- [ORION Water Endpoint Installation Kits Ordering Guide](#)
- [ORION Water Endpoint Parts List](#)
- [Product Configuration Utility for ORION Endpoints User Manual](#)

ORION Cellular LTE-MP

Another ORION Cellular endpoint, the ORION Cellular LTE-MP pulse endpoint, is available for a limited market and for connectivity with Badger Meter M-Series Electromagnetic flow meters. For more information, contact your local Badger Meter Sales Representative.

SMART WATER IS BADGER METER

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