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Technical Memorandum

Willits WWTP Influent Flow Meter

23 January 2007

SHN REFERENCE 404027

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Technical Memorandum

Reference: 404027
Date: January 22, 2007
To: City of Willits
Copy to: Brooktrails Township
From:
Subject: Willits WWTP Influent Flow Meter

The purpose of this memorandum is to examine flow metering technologies appropriate for measuring influent flows at the City of Willits new Wastewater Treatment Facility and at the Brooktrails Community Service District's discharge into the City's wastewater collection system. The selected metering system would be installed, in part, to provide an equitable basis for allocating wastewater treatment costs in accordance with the City/Brooktrails agreement.

BACKGROUND

Sewage Flows

The City of Willits Wastewater Treatment Plant collects sewage from two main areas – the City of Willits proper and the adjacent township of Brooktrails. Brooktrails is a community of single-family dwelling units with a current population of about 3,500 persons. The City of Willits has a current year-round population of about 5,500 persons. Both communities own and operate their own sewage collection systems independent of each other. The City of Willits owns and operates the wastewater treatment facility serving both communities.

The collection systems for each community can be characterized as old, having been predominantly constructed some 40 + years ago. Due to their age, the original construction methods, and the materials of construction, both systems can experience significant infiltration and inflow (I/I). Within the past ten years, the City has invested approximately $6 million to rehabilitate portions of their sewer system and reduce the amount of I/I impacting the system. Infiltration and inflow remains a problem for the City and it is believed that the Brooktrails' system also has similar wet weather flow problems.

During peak day wet weather flow (PDF) events, the combined City and Brooktrails flow has been estimated to exceed 9 MGD (estimated from surcharge pond levels). This flow compares to an average dry weather flow (ADWF) rate at the plant of approximately 1.10 MGD. Based on EPA criteria and comparison to flows experienced at similar sized systems in northern California, the I/I flows impacting the combined wastewater system can be considered excessive.

The following Table summarizes the design flows for the project and is taken from the May 2004 SHN Preliminary Engineering Report for the Willits Wastewater Treatment Facilities Upgrade (Table 18). These flows provide the basis for sizing the flow metering equipment at the wastewater treatment facility. The minimum flow experienced at the plant, based on diurnal trends, is estimated at 150 gallons per minute.

Table 1
City of Willits WWTF
Summary of Projected 2025 Design Flows

Parameter	Flow Rate (MGD)[1]
Base Sanitary Flow	0.93
Base I/I Flow	0.25
Average Dry Weather Flow (ADWF)	1.18
Average Wet Weather Flow (AWWF)	2.44
Average Annual Daily Flow (AAF)	1.81
Maximum Month Dry Weather Flow (MMDWF)	2.24
Maximum Month Wet Weather Flow (MMWWF)	4.62
Peak Day Flow (PDAF-5)	9.59
Peak Instantaneous Flow (PIF)	14.25

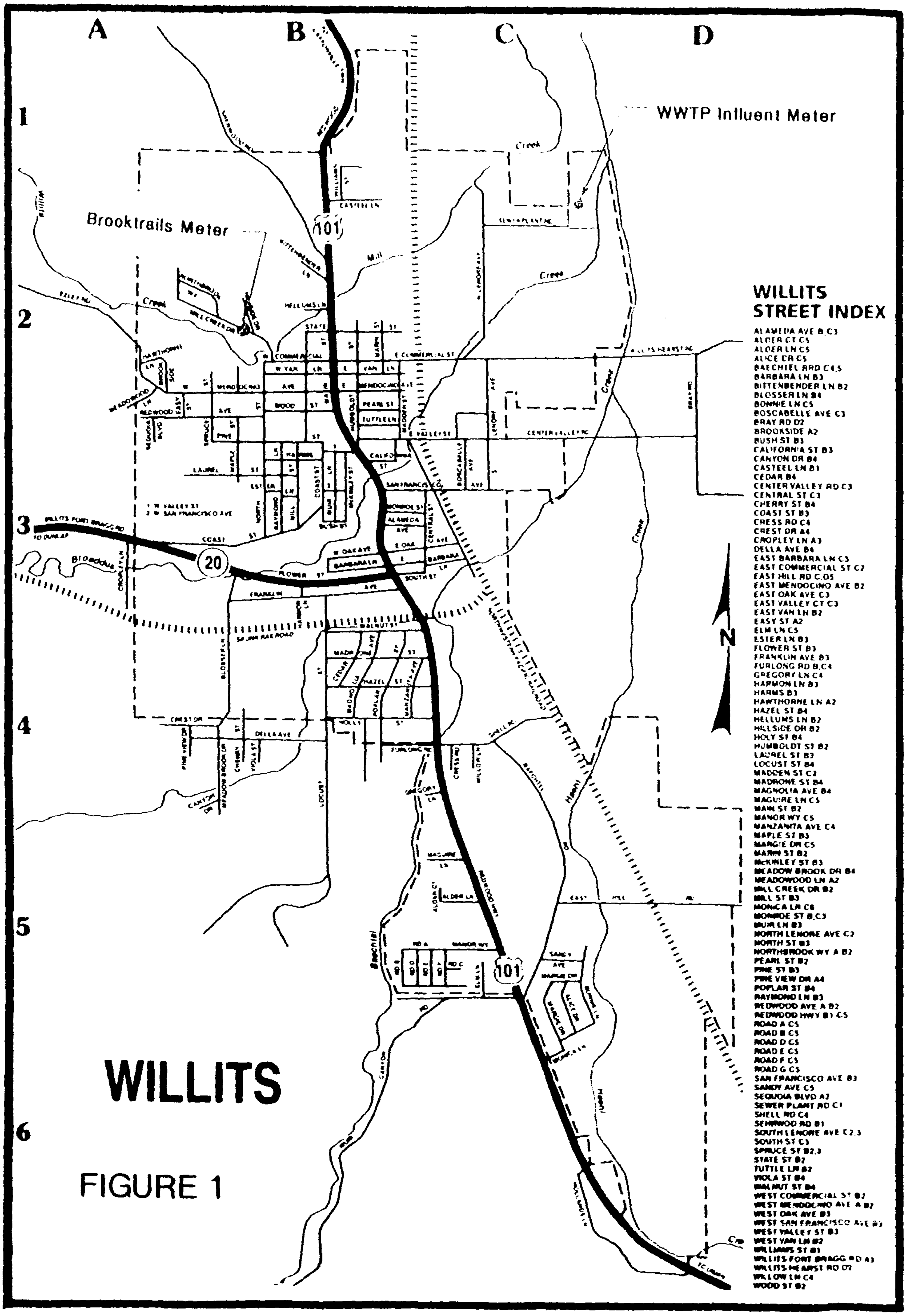
1. MGD: Million Gallons per Day (1.547 CFS) (694.4 GPM)

Existing Flow Metering Equipment

The City of Willits measures the rate of sewer flow at the treatment plant while Brooktrails measures flow at the last manhole in their system. Each system is briefly described below.

The Brooktrails sewer flow is measured by a 12-inch Palmer-Bowlus Flume and a Sigma Ultrasonic Level Sensor. This equipment, located in a manhole and curbside cabinet on Mill Creek Drive (See Figures 1 and 2), measures the flow rate and totalizes the flow collected from the tributary sewer system. The existing Palmer-Bowlus flume is, however, only accurate for flows up to about 500 gpm (1.11 cfs or 0.72 MGD) due to its small size.

The City's influent flow meter consists of an inverted PVC siphon fitted with a clamp-on ultrasonic flow meter and indicator (see Figures 3 - 6 and Appendix A). Due to the type and configuration of the metering device, maintenance of this system is very difficult and consequently, the accuracy of the City's flow meter is questionable.



A
B
C
D
1
2
3
4
5
6
WWTP Influent Meter
Brooktrails Meter
WILLITS
WILLITS
STREET INDEX
ALAMEDA AVE B,C3
ALDER CT C5
ALDER LN C5
ALICE CR C5
BAECHTEL RRD C4,5
BARBARA LN B3
BITTENBENDER LN B2
BLOSSER LN B4
BONNIE LN C5
BOSCABELLE AVE C3
BRAY RD D2
BROOKSIDE A2
BUSH ST B3
CALIFORNIA ST B3
CANYON DR B4
CASTEEL LN B1
CEDAR B4
CENTER VALLEY RD C3
CENTRAL ST C3
CHERRY ST B4
COAST ST B3
CRESS RD C4
CREST DR A4
CROPLEY LN A3
DELLA AVE B4
EAST BARBARA LN C3
EAST COMMERCIAL ST C2
EAST HILL RD C,D5
EAST MENDOCINO AVE B2
EAST OAK AVE C3
EAST VALLEY CT C3
EAST VAN LN B2
EASY ST A2
ELM LN C5
ESTER LN B3
FLOWER ST B3
FRANKLIN AVE B3
FURLONG RD B,C4
GREGORY LN C4
HARMON LN B3
HARMS B3
HAWTHORNE LN A2
HAZEL ST B4
HELLUMS LN B2
HILLSIDE DR B2
HOLY ST B4
HUMBOLDT ST B2
LAUREL ST B3
LOCUST ST B4
MADDEN ST C2
MADRONE ST B4
MAGNOLIA AVE B4
MAGUIRE LN C5
MAIN ST B2
MANOR WY C5
MANZANITA AVE C4
MAPLE ST B3
MARGIE DR C5
MARIN ST B2
McKINLEY ST B3
MEADOW BROOK DR B4
MEADOWOOD LN A2
MILL CREEK DR B2
MILL ST B3
MONICA LN C5
MONROE ST B,C3
MUIR LN B3
NORTH LENORE AVE C2
NORTH ST B3
NORTHBROOK WY A B2
PEARL ST B2
PINE ST B3
PINE VIEW DR A4
POPLAR ST B4
RAYMOND LN B3
REDWOOD AVE A B2
REDWOOD HWY B1 C5
ROAD A C5
ROAD B C5
ROAD D C5
ROAD E C5
ROAD F C5
ROAD G C5
SAN FRANCISCO AVE B3
SANDY AVE C5
SEQUOIA BLVD A2
SEWER PLANT RD C1
SHELL RD C4
SHERWOOD RD B1
SOUTH LENORE AVE C2,3
SOUTH ST C3
SPRUCE ST B2,3
STATE ST B2
TUTTLE LN B2
VIOLA ST B4
WALNUT ST B4
WEST COMMERCIAL ST B2
WEST MENDOCINO AVE A B2
WEST OAK AVE B3
WEST SAN FRANCISCO AVE B3
WEST VALLEY ST B3
WEST VAN LN B2
WILLIAMS ST B1
WILLITS FORT BRAGG RD A3
WILLITS HEARST RD D2
WILLOW LN C4
WOOD ST B2

FIGURE 1

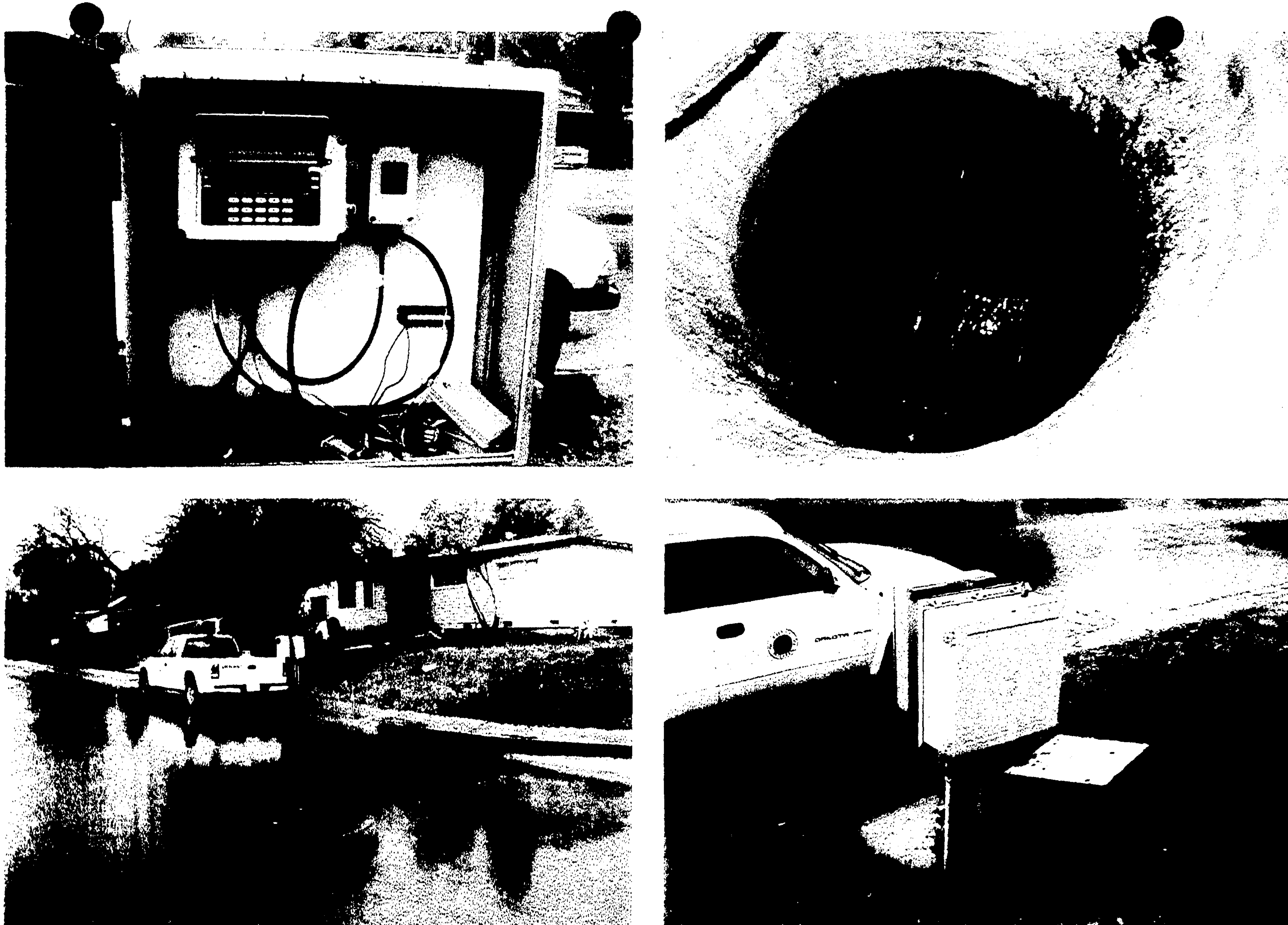


FIGURE 2 – Brooktrails Effluent Flow Meter

FIGURE 3 – WWTP Influent Flow Meter

FIGURE 4 – WWTP Influent Flow Meter

Agency Agreement

The City of Willits and Brooktrails have agreed on a method of measuring flows from each community as follows:

- The flow from Brooktrails will be measured by an effluent meter installed in the collection system at Mill Creek Drive.
- The City will measure the influent flows prior to introduction into the wastewater treatment plant.
- The Brooktrails flow will be subtracted from the total City influent flows at the treatment plant.
- The difference in flows from each metering station will serve as the basis for allocating Brooktrails usage of the treatment facility.

FLOW METERING REQUIREMENT

Regulatory Requirements

In addition to the agency agreement, the City is required by their NPDES Permit to regularly report the total flow to and/or from the facility. This report is based on data collected from the flow meter located in the plant's influent sewer. Flows measurements reported from this location should only include influent flow-that is flows prior to flow splitting to the surge basin and/or the return of any process flows drained back to the influent sewer for subsequent treatment.

Plans for the new wastewater treatment facility will include replacing the existing influent flow-metering device with a new more reliable and accurate system. The location of this device will also be in the influent sewer upstream of the new influent pump station. This metering station should provide an accurate measurement of the diurnal variations in flow experienced at the plant and a greater measurement range that encompasses nighttime low flow rates and peak flow rates experienced during wet weather storm events.

Data from the new metering station should also serve as the basis for comparison with the Brooktrails meter. Consequently, critical design considerations for this metering station are two fold:

1. Provide a more reliable system that allows complete compliance with regulatory criteria and
2. satisfy the City and Brooktrails' agency agreement by providing a flow measurement device that provides data suitable for allocating treatment benefits to each party of the agreement.

Technologies capable of achieving both of these design goals are discussed below.

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INFLUENT FLOW METERING OPTIONS

Full Pipe Flow Devices

As its name implies, full pipe flow devices measure the average velocity of the fluid across a known cross-section of pipe that is completely flooded. The sensed velocity signal is converted to a flow rate for the purposes of recording and totalizing based on the Continuity Equation,

that is: $Q_{flow} = V_{velocity} \times A_{Area}$ [Continuity Equation]

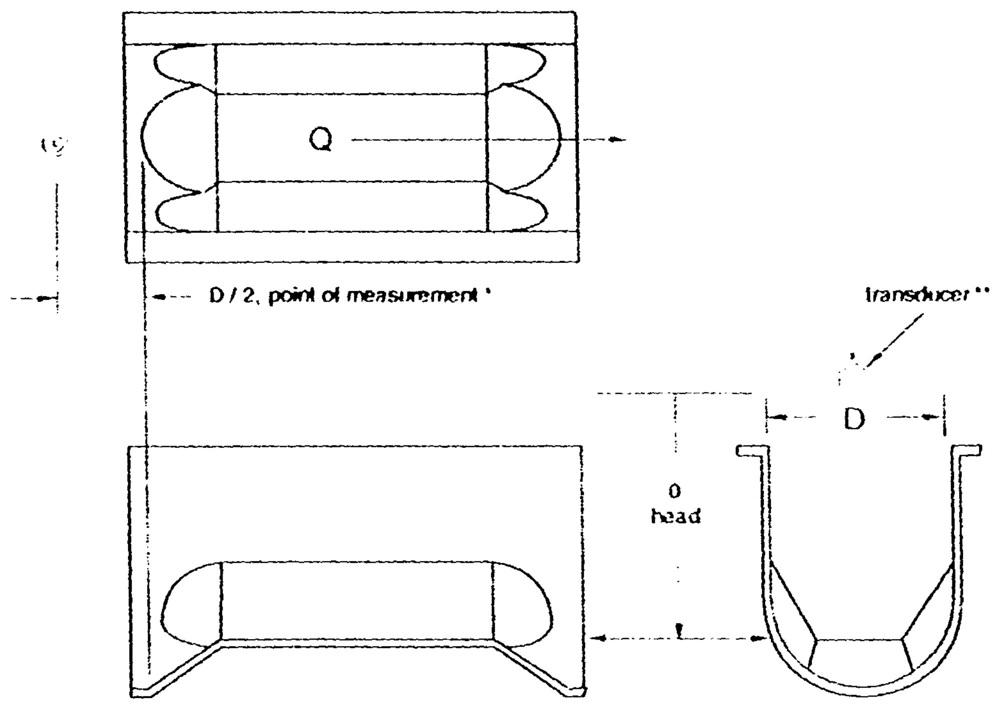
These types of flow metering devices are pre-manufactured as a single unit that bolts into a pipeline. Typical applications for full pipe flow metering devices include pressurized pipelines usually downstream from a pump or other energy adding device. A critical parameter that determines how well these devices work is maintaining line velocities on the order of 2 feet per second (fps) to 15 fps.

When properly installed the accuracy of full pipe flow metering devices is extremely high, typically on the order of ±1 percent of the instantaneous reading. Once installed and in service, however, calibration of the device and therefore, its accuracy cannot be easily verified. (The device must be removed from service and sent to a certified hydraulic testing laboratory for a complete accuracy check. This check is an expensive and time-consuming process that is generally impractical for the operation of a wastewater treatment plant.) Full pipe flow devices can also be subject to errors resulting from fouling or coating of the meter interior from greases or other scaling chemicals. If fouling occurs, the meter accuracy can be disrupted without any outward indication of the disruption. Therefore high pipeline velocities are critical to keeping the pipe clean and the meter within its accuracy tolerances. Based on the constraints imposed by operating a gravity sewer without surcharging, it is difficult to provide full pipe flow while promoting self-cleaning line velocities.

Open-channel flow metering systems

Open channel flow metering devices are systems that are specifically designed to measure flow in an open conduit without flooding or surcharging. Open-channel flow metering systems usually require several components to perform accurately. These components typically include a primary metering element, such as a weir or flume (to produce a specific unique backwater curve which can be electronically or mechanically modeled) and a level-measuring device to determine the depth of water upstream of the primary flow element. The depth of flow is directly proportional to the flow rate of the water passing over or through the primary flow element. Once acquired, the depth measurement is sent to either an electronic or mechanical transducer that converts the depth signal to a rate of flow signal where it can be both recorded and totalized.

The accuracy of an open-channel flow meter system can be verified in service by simply measuring the depth of water at the prescribed location for the primary device and obtaining the related flow rate from a flow-rating chart for the device. A comparison of the chart flow rate with the indicated meter flow rate allows the device's performance to be field verified. Any anomalies in the depth



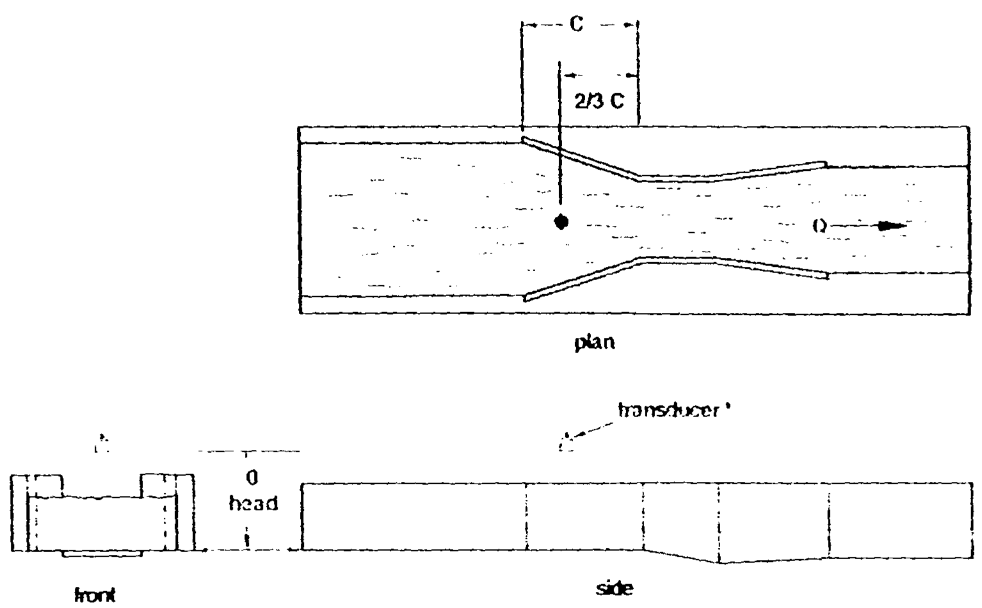
* for rated flows under free flow conditions

** The transducer must be above the maximum head by at least the blanking value, P47.

FIGURE 7

SIMPLE EXPONENTIAL DEVICES, P3 = 0

TYPICAL PARSHALL FLUME



For rated flows under free flow conditions, the head is measured at 2/3 the length of the converging section upstream of the beginning of the throat section.

* The transducer must be above the maximum head by at least the blanking value, P47.

FIGURE 8

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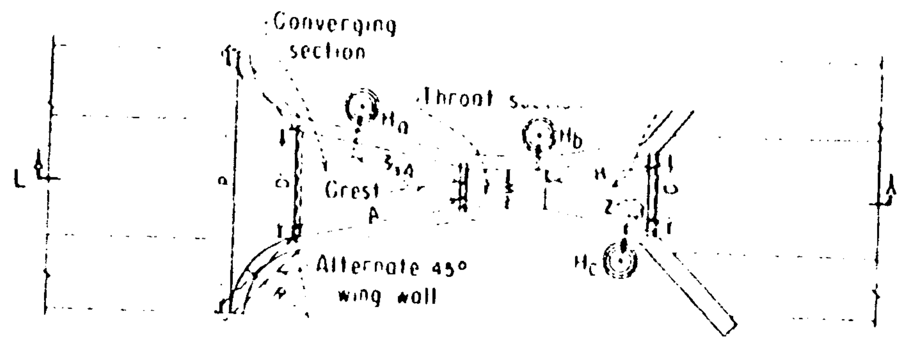
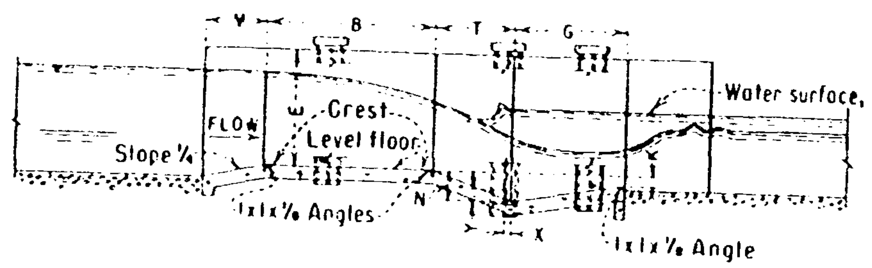


PLAN



SECTION L-L

Figure 19.—Parshall flume dimensions. (Sheet 1 of 2.) 103-D-870.
(Courtesy U.S. Soil Conservation Service.)

	W	A	⅔A	B	C	D	E	F	G	H	K	M	N	P	R	X	Y	Z	FREE-FLOW CAPACITY MINIMUM	FREE-FLOW CAPACITY MAXIMUM
	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	FT. IN.	SEC. FT.	SEC. FT.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Figure 19. Parshall flume dimensions. (Sheet 2 of 2.) 103-D-861

FIGURE 9

measurement can be addressed and corrected without having to replace or adjust the primary flow metering device. Because of the ability to verify the accuracy of an open-channel flow meter in service these are the devices often preferred for allocating treatment benefit or billing purposes.

Open channel flow metering systems, properly set-up and calibrated, are very accurate - usually within ±2 percent of the instantaneous reading. The typical primary devices have all been extensively tested by the Fort Collins, CO, federal hydraulics laboratory over many decades and accurate flow rating curves and formulas exist for these devices. The performance, design, construction, and use of primary flow elements is contained in the *"Flow Measurement Manual"* published by the US Government Printing Office. One limitation of open-channel meters is that they cannot be surcharged or flooded. High flow rates that exceed the primary device capacity will cause backwater effects, which submerge the primary flow element and render the meter system temporarily useless.

FULL PIPE FLOW DEVICES

Two types of pipe flow devices suitable for raw sewage service are available - magnetic flow meters and transit time flow meters. Both types of devices measure the average velocity of the fluid flow across the pipe cross section. A crucial requirement for these devices is that they must be installed in a pipe that remains full at all times and when flow occurs, the line velocity must be very high. Partial flow in the pipe will render the flow signal inaccurate and may damage meter components. Low line velocities will also decrease the meter accuracy and promote fouling conditions that lead to erroneous data or, worse yet, plugging of the line.

Magnetic meters

Magnetic meters operate on the principle of Faraday's Law of magnetic induction which states that an electric current is generated by the flow of conductive material through a magnetic field and is proportional to the strength of the field and the mass flow rate of the material flowing through the field (See Appendix H). A magnetic meter sets up a magnetic field of known strength in the pipe section it occupies. Water flowing through this field generates a voltage directly proportional to its mass flow rate. This voltage is measured and converted electronically to a flow rate by simple multiplication of the known pipe cross-sectional area and the measured average flow velocity.

Magnetic flow meters require full pipe flow and high line velocities. Both of these requirements cannot be satisfied in gravity flow sewers without the use of a flow restricting inverted siphon. Due to these limitations, a magnetic flow meter is not considered an appropriate device for measuring influent flows at the new WWTF or in the Brooktrails collection system.

Transit Time (Sonic) meters

Sonic meters operate on the Doppler principle in the measurement of transit time of a sonic or ultrasonic pulse fired across the pipe section diagonally in each direction (See Appendix I). When no flow exists in the pipe section the transit time of the pulsed signal is of a constant known value. When water is flowing in the pipe the signal transit time is either decreased or increased due to the Doppler effect of the fluid moving past the sensor. The changes in transit times are directly proportional to the velocity of the water. The transit time changes are electronically measured and converted to a flow rate by simple multiplication of the known pipe cross-sectional area and the average flow velocity. Some companies have developed clamp-on ultrasonic flow metering devices, which attach to the outer surface of a suitable section of straight pipe. It has been found over the years that these devices are typically not very accurate due to improper set-up, pipe-transducer interface interference, and vibrations in the piping systems. Sonic meters can also be disrupted by vibrations in the piping system which may become harmonic with the pulsed signals. Clamp-on devices are not recommended for either application under consideration and for these reasons will not be considered further.

OPEN-CHANNEL SYSTEMS

The measurement of gravity flow systems is typically performed using open channel flow metering devices. Two types of devices are considered further below. The first type of device includes a primary flow element employing a flume or a weir to create flow conditions that have been extensively studied in the laboratory. The second type of device includes area velocity metering using modern technologies involving direct measurement of the fluid velocity and depth of flow.

Primary Flow Elements

Several types of flumes and weirs are available as primary flow measuring devices. For raw sewage service only flumes are considered because they pass grit and organic solids whereas weirs create a blockage that causes a build-up of such materials behind the weir plate. Two types of flumes are in wide use - Palmer-Bowlus flumes and Parshall flumes.

Palmer-Bowlus flumes are theoretically ratable (i.e. a flow versus depth curve - a rating curve - can be mathematically determined by performing a trial and error energy balance between the flume section and the pipe section upstream from the flume). Parshall flumes, by reason of their geometry (sloping floor section in the throat) are not theoretically ratable and rely on extensive hydraulic testing to empirically determine their rating curves. Based on these criteria, both flumes are considered acceptable methods for measuring flow in either the City influent sewer or the Brooktrails system.

Both the Parshall and Palmer-Bowlus flumes have rating curves that are equally accurate. The Parshall flume is favored by many engineers because they are self-cleaning whereas Palmer-Bowlus Flumes can cause grit to build up in the upstream approach to the flume, which can slightly alter their flow characteristics. The flumes have the valuable attribute of forcing the flow through what is known as "critical depth", a flow condition which causes a "hydraulic jump" to occur in the flume exit or pipe downstream from the throat. This flow regime is immune from downstream backwater interference up to a certain point where the flow in the flume will become "submerged" and reduced due to downstream effects. There are formulas for accurate flow measurement in this condition up to a point after which, the flow cannot be accurately measured.

Flow Measurement Devices

Several manufacturers of flow measurement systems are available (See Appendices C and E). For raw sewage service only non-contact type systems are considered due to the possibility of fouling of contact-type devices. The non-contact devices include ultrasonic and radar systems and mixtures thereof. These devices operate by bouncing an ultrasonic signal off the surface of the water at a specified point upstream of the primary device. Transit time differences measure the depth of the water and convert the depth into a flow rate according to the rating curve of the primary flow element. This flow signal is then recorded and totalized.

Mixed Radar, Sonic, and Electromagnetic Devices (Marsh-McBirney "Flo-Dar")

Another type of open-channel flow metering device is the area velocity meter. These types of devices record flow by combining a measurement of both the depth of water flow with the velocity of the fluid. In practice, these types of devices require contact with the sewage and therefore are subject to fouling and clogging from debris carried with the sewage. Area velocity meters are good devices for short-term studies but due to the extensive maintenance required to keep the systems free of debris, would not be suitable for long-term duty as the primary flow metering station at a WWTF.

One particular device, however, called the Flo-Dar uses non-contacting sensors to measure both the velocity and the fluid level. The velocity of the sewage is measured using radar technology while the depth of flow is measured using an ultra sonic level sensor similar to a flume (See Appendix D). The surface velocity is converted to average velocity using algorithms developed from research of velocity profiles in partially filled pipe cross-sections. The average velocity combined with depth of flow is used to develop the flow rate by multiplying the average flow velocity by the computed cross-sectional area of flow. These devices are frequently used in the absence of any primary flow element.

Similar to a flume, the functionality of the Flo Dar's radar system is dependent upon undisrupted gravity flow in the open pipe. This approach does not consider, however, that backwater conditions will affect the velocity at the measurement site and therefore, may be periodically susceptible to error during certain flow regimes. Recognizing this short-coming, the manufacturer of the Flo Dar incorporated a secondary flow measurement system into the instrument to allow data collection during surcharge events. This secondary system includes an electromagnetic (EM) sensor for velocity measurement and a pressure sensor for depth measurement. Both the EM and pressure sensor were tested in a hydraulics laboratory to develop algorithms equating surcharge depth and pipe velocity to flow. By incorporating the secondary system into the Flo Dar, the manufacture has attempted to advance open channel flow measurement technologies to include all potential flow regimes encountered in sewage collection systems.

The Flo-Dar device is relatively new on the market and has only been in service about 5 years. The full-time service accuracy and reliability is, as yet, largely unknown due to its short track record. This device, in years to come, may turn out to be unacceptable, very reliable, or useful only under certain conditions. This device will require several more years of performance before its serviceability and usefulness are fully understood.

ANALYSIS

Influent Flow Meter Requirements

A flow meter ahead of the new influent pump station is required to provide information about the diurnal variations of flow, to track storm flows, to report data to the RWQCB, and to allow allocation of wastewater treatment costs based upon usage. Due to the agreement between the City and Brooktrails selection of the influent flow meter device at the plant must be based upon the following considerations.

- The meter must be as accurate as possible since it will serve as the basis billing.
- The meter accuracy must be capable of being verified at any time while in service.
- The flow meter must record the flow rate continuously and permanently for reporting and flow analysis purposes and the flow data must be totalized for billing purposes.
- Charts and flow data must be retained permanently and made available to interested parties as requested.

The flow meter must be sized to accurately record and totalize low flows of about 150 gpm (0.22 MGD) and peak influent flows up to 10,500 gpm (15 MGD).

Full Pipe Flow Metering Devices

Full pipe flow metering devices could be constructed so as to assure a constantly flooded flow section but this would require the use of a meter with a smaller diameter than the influent sewer pipeline. Clogging and blockage would be a constant maintenance problem. A full pipe flow device's accuracy cannot be verified in service. Experience in the existing treatment plant indicates that these devices are susceptible to accuracy disruption. For these reasons these devices will not be considered further for this service.

Open-Channel Flow Meter Systems

Because open-channel flow meter systems utilize standard primary flow elements (flumes) their performance is field verifiable and can withstand downstream backwater effects to a point. Their accuracy is good and performance is reliable. Regular checking and calibration can keep these systems operating at peak verifiable accuracy through the design life of the new facility. An 18-inch

Parshall flume can measure flows from 80 gpm to 11,000 gpm. This size flume can sustain a downstream backwater effect of 70% of the measurement depth before experiencing flow reduction. These devices are capable of being programmed to model a rating curve for a primary element and send a signal to the recording and totalizing devices.

"Flo-Dar"

Because the "Flo-Dar" does not require a primary flow element, the equipment can be installed more easily and at a significantly lower cost than other systems under consideration. Calibration of the units would be more complex than with a flume but could be performed by utilizing a velocity profiler to verify the radar signal and physical measurement to verify the level sensor. The manufacturer would need to provide additional data to correlate these readings to flow. It may be necessary for the City and Brooktrails to have the annual calibration performed by Marsh McBirney representatives. The final limitation of the "Flo-Dar" system is the limited operational experience of the instrumentation.

CONCLUSIONS

The requirements for the influent flow meter indicate that an open-channel system with a primary flow element (flume) and ultrasonic flow measurement device is ideally suited for both technical and agency agreement reasons. This system can also be protected from downstream backwater effects impacting the primary flow element if certain design features are incorporated into the influent pump station. Based upon this technology and a 30-year application life, this "off-the-shelf" flow metering system will be accurate and stable throughout the life of the project and will require minimal maintenance.

The installation of such a system would require an underground vault with interior dimensions of 8'W x 14'L x 12'H, an 18" Parshall flume of fiberglass, an ultrasonic flow measurement device, a 7-Day circular chart recorder, a computer system, a SCADA communications system, and the requisite electric power and signal systems (See Appendix F and G). This system can be constructed for approximately $35,000 to $40,000. Although this system can be flooded out during the peak instantaneous flow events (storm flows) the influent pump station can be designed to avoid surcharge events from impacting the upstream sewer. The added costs to prevent surcharging of the influent sewer are estimated at an additional cost of $20,000 to $30,000.

The Marsh-McBirney "Flo-Dar" device

The Marsh-McBirney "Flo-Dar" device is an acceptable alternative to the Parshall flume. The "Flo-Dar" can be installed in an existing or new manhole as a stand-alone system requiring only power supply, communication link, and flow recorder. The cost of this system installed is approximately $18,000. Influent sewer piping revisions or modifications to the influent pump station wet well would not be necessary.

Over the life of the installation, the "Flo-Dar" equipment may require more frequent calibration by the manufacturer. If the pump station modifications are not incorporated into the design and the influent sewer is allowed to periodically surcharge, then some loss in accuracy should be accepted by the City and Brooktrails. The long term life and replacement costs for components essential to the "Flo-Dar" are currently unknown, therefore it is possible that unanticipated replacement costs could be required.

Brooktrails Flow Meter

The Brooktrails flow meter has insufficient flow range due to its small size. The 8" Palmer-Bowlus Flume can only measure flows up to the daily average dry weather flow and peak wet-weather flows or daily peak flows cannot be measured accurately. It is essential that the peak wet-weather flows and daily peak dry weather flows from Brooktrails be accurately measured for both analysis and billing purposes. If the peak flows from Brooktrails are not measured then it will be impossible to determine what portion of total flow comes from Brooktrails and what portion comes from the City. Therefore a new metering system is required.

Table 2 below summarizes the above conclusions:

TABLE 2 FLOWMETER SYSTEMS COMPARISON		
FLOWMETER LOCATION	FLOWMETER SYSTEM	COMMENTS
1. WWTP Influent Flowmeter	Open-Channel w/ 18" Parshall flume and ultrasonic flowmeter	A. Accuracy is verifiable in-service. Accuracy is ± 2 percent. B. "Off-the -shelf" technology C. Many years of proven performance D. Flooded performance gives useless data E. Cost of \$35,000 - \$40,000 installed
2. WWTP Influent Flowmeter	Open-channel w/ Marsh-McBirney 'Flo-Dar" device	A. Accuracy is questionable during certain flow regimes B. "Off-the-shelf" technology C. Widely used D. Limited performance history E. Cost of about \$18,000 installed
3. Brooktrails Flowmeter	Open-Channel w/ 12" Parshall flume and ultrasonic flowmeter	See Alternative 1 above. Will require revised piping and 2 new manholes for added cost of about \$20,000
4. Brooktrails Flowmeter	Open-channel w/ Marsh-McBirney 'Flo-Dar" device	See Alternative 2 above. This system may not work in this location according to company rep.

RECOMMENDATIONS

WWTP Influent Flow Meter

Construct an open-channel flow metering system utilizing an 18" Parshall flume as the primary flow element and use the Siemens-Milltronics OCM III ultrasonic flow meter coupled with a Foxboro model 740R 7-Day circular chart recorder and SCADA-based computer system to record and totalize flows for billing, analysis, and regulatory reporting purposes. This system will cost between \$55,000 and \$70,000.

Brooktrails Flow Meter

Construct an open-channel flow metering system utilizing a 12" Parshall flume as the primary flow element and use the Siemens-Milltronics OCM III ultrasonic flow meter coupled with a Foxboro model 740R 7-Day circular chart recorder, a telemetric communications system, and a computer system to record and totalize flows for billing and analysis. This system will make it possible to measure peak daily flows and peak wet weather flows. This system will cost between $35,000 and $40,000 for the flowmeter system and an additional $20,000 for piping revisions for a total cost of about $60,000.

Costs Comparison

If the recommended systems are implemented the cost will be about $70,000 for the WWTP Influent Flowmeter and $60,000 for the Brooktrails Flowmeter for a total cost of $130,000. The cost for the Marsh-McBirney "Flo-Dar" device in both locations would be about $18,000 each for a total cost of $36,000.