Item No. 9e (1)

Meeting Date: November 12, 2014

AGENDA SUMMARY REPORT

To: Honorable Mayor and Council Members

From: Rod Wilburn, Public Works Director

Agenda Title: DISCUSSION REGARDING WASTEWATER TREATMENT PLANT INFLUENT METERING SYSTEM EVALUATION

Type: ☐ Presentation ☐ Consent ☒ Regular Agenda ☐ Public Hearing ☐ Urgent Time: 30 min.

Summary of Request: This presentation to the City Council is meant to provide an overview of the issues related to the influent metering system at the Willits Wastewater Treatment Plant (WWTP), seeking City Council direction as to how to proceed in rectifying the construction-related issues. The accuracy of the influent meter was called into question by a report prepared by Brelje & Race for the Brooktrails Township Community Services District (BTCSD) on October 18, 2013. This report was subsequently provided to the City of Willits and no further action was taken until July 2014 when the records for the calibration of the influent meter were requested through a Public Records Act Request.

It was at this time that the City contacted MCC Control Systems (MCC) to schedule a Parshall flume inspection and meter calibration to verify accuracy or confirm any issues raised by the Brelje & Race report. As a result of this communication with MCC, City staff learned that MCC had inspected the influent meter and flume on October 3, 2013. MCC supplied the City with that report on July 30, 2014 and that report identified several issues that could potentially affect the accuracy of the influent meter. After reviewing these two reports, it was apparent that two separate elements of the influent metering system needed to be evaluated. The first being the construction of the Parshall flume and the second being how the meter itself and its associated transducer were installed.

The primary issue with the construction of the Parshall flume as presented in the Brelje & Race report was that the flume was constructed at a 1% longitudinal slope and that was affecting the level of flows within the flume and, thus, skewing the resulting flow calculations. Another issue raised in the report is the fact that there are triangular voids in the concrete walls immediately upstream of the Parshall flume that cause eddies or interrupted flow that also affects the accuracy of the meter. The existence of the triangular voids is not disputed and should be corrected if the Parshall flume remains as part of the influent metering system. In order to confirm or deny the construction issue, I asked the City Engineer and staff to perform a field survey of the flume. We found a longitudinal slope of 0.88% and determined through discussions with MCC that this slope would not affect the accuracy of the influent meter.

City staff scheduled MCC for another field evaluation of the influent meter, the Brooktrails Sewer Meter on Mill Creek Drive, and other mag-meters at the Wastewater Treatment Plant on August 14, 2014. City staff, BTCSD staff and Engineering Representative, and a GHD Engineering Representative on behalf of the City of Willits were in attendance to observe the MCC field evaluation. MCC found the same issues with this evaluation as were found on October 3, 2013 and provided a report dated August 20, 2014 summarizing the issues. Subsequent to this report, MCC was scheduled to return to the site on September 26, 2014, at which time they moved the meter transducer to the proper, specified location. MCC also checked the accuracy of the transducer with respect to measuring the distance to the surface of the influent since that is how the volume of wastewater is calculated. As is stated in their report, it was determined that the distance from the bottom of the transducer to the bottom of the flume was 42-7/8 inches and the maximum distance measured by the transducer was set to 38 inches. This created the circumstance mentioned in the Brelje & Race report in which the meter would not measure flows below what was estimated to be 4 inches. When the meter was installed, this parameter was “mis-set” creating a meter that would only read down to approximately 350-400 gallons per minute. These issues were resolved by MCC and the meter and flume can be considered accurate.

However, during the field survey by the City Engineer and staff, a construction issue was identified immediately downstream of the Parshall flume that also affects the accuracy of the influent metering system. The survey revealed that the 30” between the two manholes immediately downstream of the Parshall flume was installed at an adverse slope of 1.36% and the bottom of the pipe is below the bottom of the most downstream manhole. The pipe is also offset horizontally, creating a 3 inch lip both at the bottom of the pipe and a lip of approximately the same dimension on the south side of the pipe at the manhole. A plan and profile drawing that illustrates the situation in detail is included herewith and entitled, *Gravity Inlet Sewer Plan and Profile*.

When considering the accuracy of the influent meter as a result of all of the above mentioned construction and installation issues, staff chose to compare the influent meter values to the values calculated at the new mag-meter installed on August 18, 2012, which measures the discharge from the mechanical treatment plant to the enhancement wetlands and is referred to as EFF-002. The difference between the influent meter and EFF-002 for the following 10 months of fiscal year 2012-2013 and fiscal year 2013-2014 is shown in the following tables:

Influent -Effluent (EFF-002) Comparison (09/12 – 06/14)

	Influent Meter Value	Influent Flow (gallons)	EFF-002 Meter Value	Effluent Flow (gallons)	Difference (gallons)
July 1, 2012	4,703,461	25,431,000			
August 1, 2012	4,728,892	26,103,000	New effluent meter installed 8-18-12.		
September 1, 2012	4,754,995	24,679,000	18,239	16,260,000	8,419,000
October 1, 2012	4,779,674	20,887,000	34,499	18,067,000	2,820,000
November 1, 2012	4,800,561	35,173,000	52,566	31,737,000	3,436,000
December 1, 2012	4,835,734	101,639,000	84,303	97,673,000	3,966,000
January 1, 2013	4,937,373	43,214,000	181,976	40,707,000	2,507,000
February 1, 2013	4,980,587	38,382,000	222,683	26,469,000	11,913,000
March 1, 2013	5,018,969	46,970,000	249,152	35,820,000	11,150,000
April 1, 2013	5,065,939	34,660,000	284,972	32,032,000	2,628,000
May 1, 2013	5,100,599	22,584,000	317,004	22,347,000	237,000
June 1, 2013	5,123,183	21,316,000	339,351	20,460,000	856,000
July 1, 2013	5,144,499		359,811		
	07/12 – 06/13	441,038,000			
	09/12-06/13	**389,504,000**	**09/12 - 06/13**	**341,572,000**	**47,932,000**
				Percent Difference*	**12.3%**

**Percentage based on 09/12-06/13, new EFF-002 meter was installed and fully operational by 09/01/12*

	Influent Meter Value	Influent Flow (gallons)	EFF-002 Meter Value	Effluent Flow (gallons)	Difference (gallons)
July 1, 2013	5,144,499	17,621,000	359,811	19,278,000	(1,657,000)
August 1, 2013	5,162,120	17,396,000	379,089	18,584,000	(1,188,000)
September 1, 2013	5,179,516	18,385,000	397,673	18,206,000	179,000
October 1, 2013	5,197,901	18,879,000	415,879	18,860,000	19,000
November 1, 2013	5,216,780	18,927,000	434,739	18,282,000	645,000
December 1, 2013	5,235,707	20,257,000	453,021	20,157,000	100,000
January 1, 2014	5,255,964	17,007,000	473,178	17,545,000	(538,000)
February 1, 2014	5,272,971	41,761,000	490,723	40,209,000	1,552,000
March 1, 2014	5,314,732	67,831,000	530,932	62,371,000	5,460,000

April 1, 2014	5,382,563	38,772,000	593,303	36,818,000	1,954,000
May 1, 2014	5,421,335	19,358,000	630,121	20,569,000	(1,211,000)
June 1, 2014	5,440,693	15,186,000	650,690	15,943,000	(757,000)
July 1, 2014	5,455,879		666,633		
		311,380,000		**306,822,000**	**4,558,000**
				Percent Difference	**1.5%**

Following the discovery of this construction issue, SHN was asked to evaluate the situation and provide a recommendation; MCC was advised so it could be considered in their calibration reporting; and GHD was asked to review the issue and documentation and provide recommendations, as well. These reports and some email correspondence regarding recommendations have been included herewith.

It has been recommended by both MCC and GHD that the effluent flow meter EFF-002 be used for totalizing flow, given the issue identified by staff, immediately downstream of the influent meter. This would have a direct effect on the annual cost allocation for BTCSD, especially given the large disparity for the 10 months in fiscal year 2012-2013 of 47,932,000 gallons.

At this time, we do not have a chosen alternative for the repair and/or alterations to the influent metering system because BTCSD will likely have their Engineering Representative perform their own evaluation. Once we have their opinion, we will move towards a plan for resolving the issue.

Recommended Action: No action necessary at this time; informational only.

Reviewed by: ☒ City Manager ☒ City Attorney ☐ Finance Director ☐ Human Resources ☐ Risk

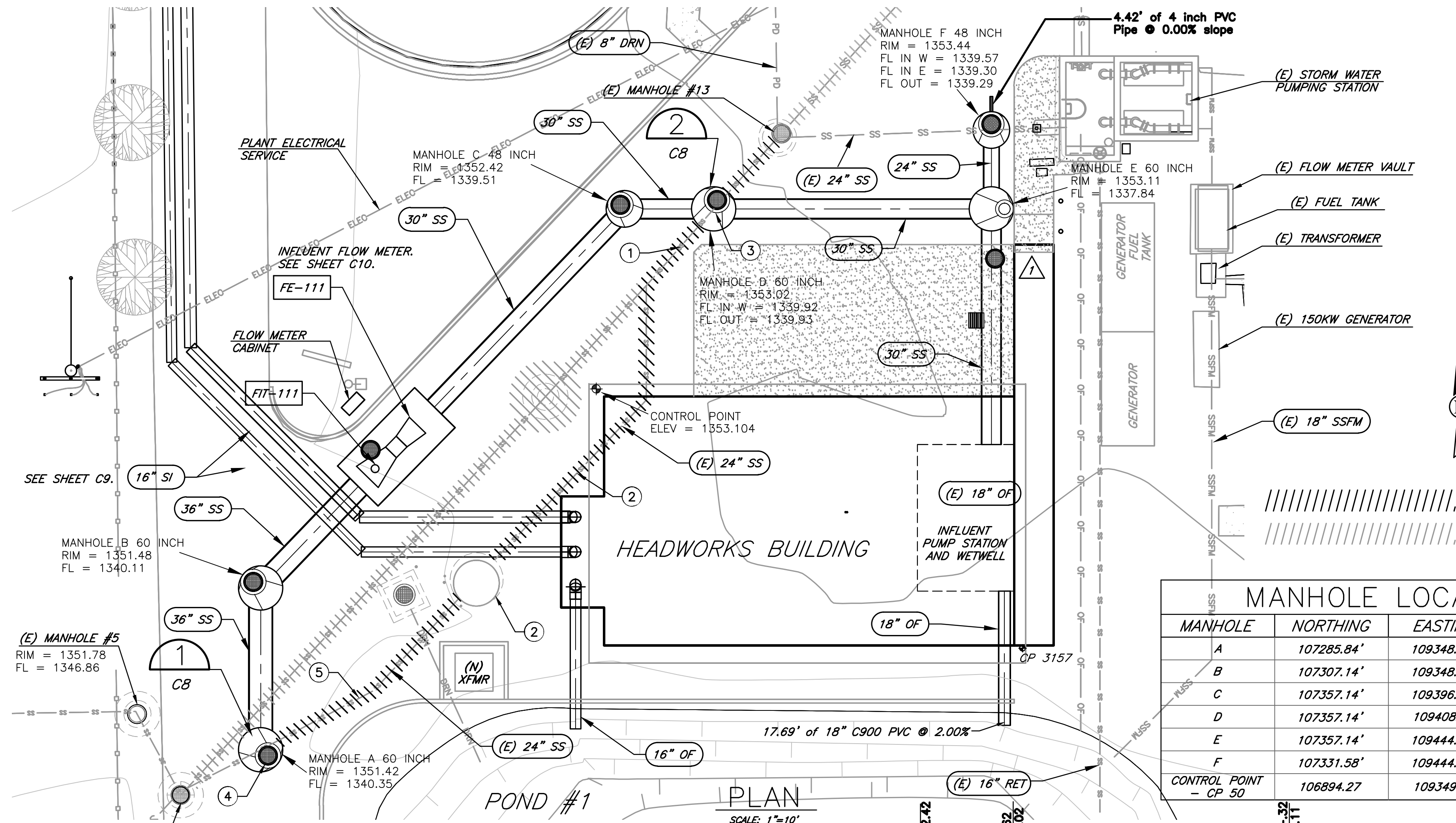
Council Action: ☐ Approved ☐ Denied ☐ Other: ____

Records: ☐ Agreement ☐ Resolution #_________ ☐ Ordinance #_________ ☐ Other _________

CONSTRUCTION NOTES PER RECORD DRAWINGS

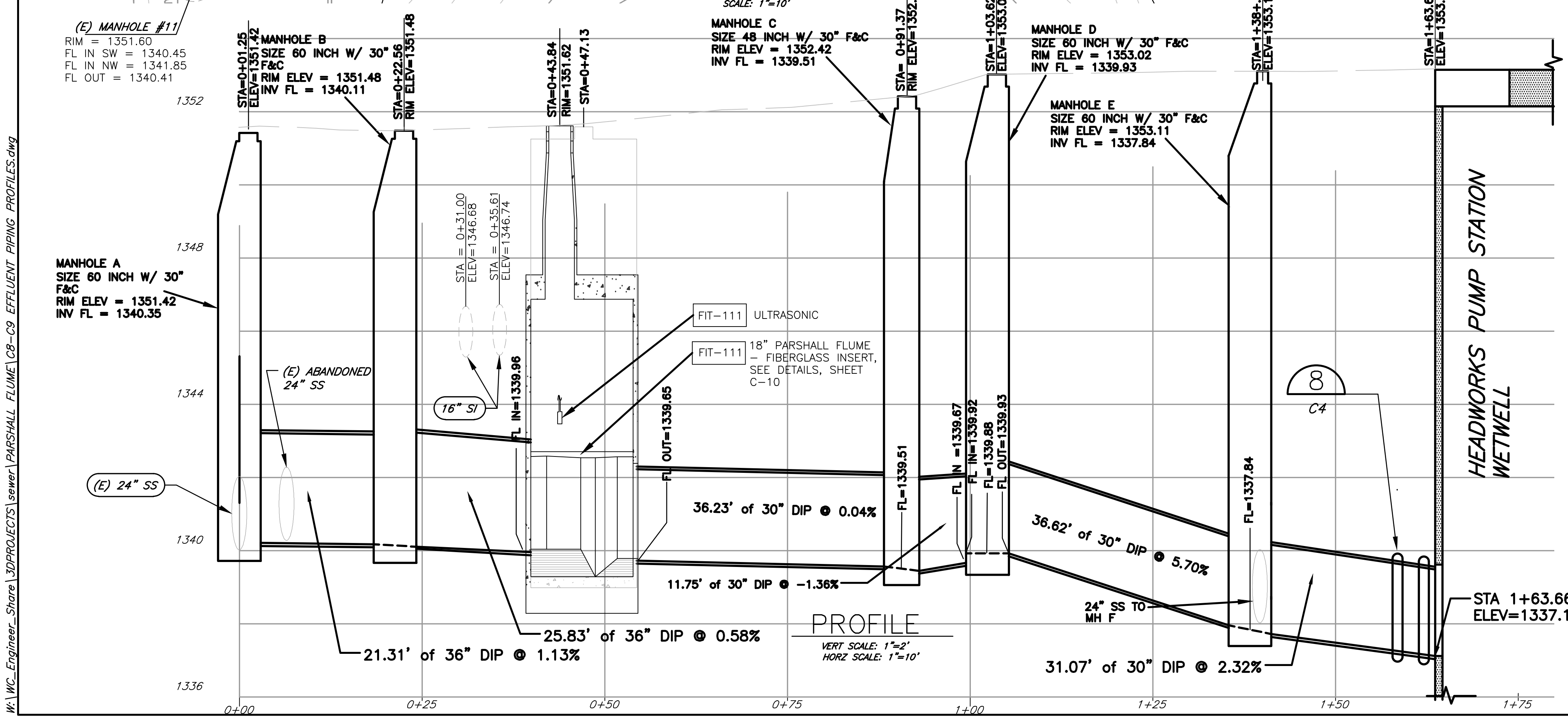
1. ABANDON (E) 24" SANITARY SEWER IN PLACE BY FILLING WITH CLSM AFTER BREAKING OUT (E) PIPE IN MANHOLE 'D'.
2. DEMOLISH UPPER PORTION OF (E) METER MANHOLE TO MAKE WAY FOR NEW 16" PE LINES. BACK FILL REMAINING MANHOLE BOTTOM WITH CLSM. BACK FILL ABOVE REMAINING MANHOLE BASE WITH 1" CAB. SALVAGE SUMP PUMP AND METER CABINET AND (E) BOLLARDS.
3. MANHOLE 'D': SEE DETAIL 2, THIS SHEET.
   A. CONSTRUCT NEW MANHOLE 'F' AND NEW 8" DRAIN LINE AS SHOWN.
   B. CONSTRUCT INTER TIE WITH (E) 24" SANITARY SEWER LINE.
   C. DO NOT BREAK OUT (E) PIPE IN MANHOLE 'D' UNTIL THE NEW HEADWORKS BUILDING AND EQUIPMENT ARE READY FOR USE AND OBTAINING WRITTEN PERMISSION FROM CITY'S REPRESENTATIVE.
4. MANHOLE 'A': SEE DETAIL 1, THIS SHEET.
   A. DO NOT BREAK OUT EXISTING PIPE IN THIS MANHOLE UNTIL THE NEW HEADWORKS FACILITY IS FUNCTIONING SATISFACTORY TO THE CITY AND HAS BEEN ACCEPTED IN WRITING AND PERMISSION IS GIVEN IN WRITING BY THE PROJECT REPRESENTATIVE.
5. ABANDON (E) 24" SANITARY SEWER IN PLACE BY FILLING WITH CLSM ONLY AFTER BREAKING OUT (E) PIPE IN MANHOLE 'A'.

NOTES:
1. SEE SHEET M-1 FOR MECHANICAL EQUIPMENT SCHEDULE.

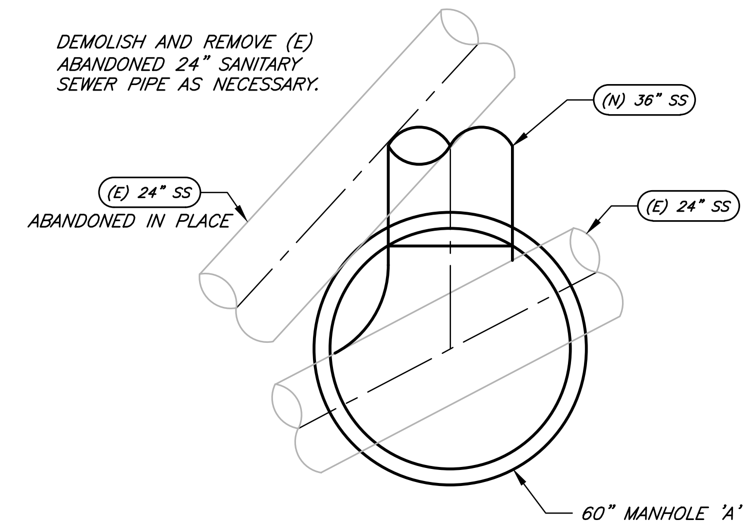


MANHOLE LOCATION

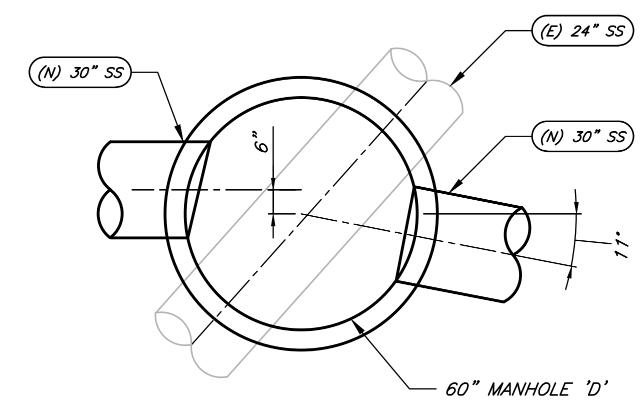
MANHOLE	NORTHING	EASTING	IE OUT
A	107285.84'	109348.32'	1340.35
B	107307.14'	109348.32'	1340.11
C	107357.14'	109396.32'	1339.51
D	107357.14'	109408.07	1339.93
E	107357.14'	109444.69'	1337.84
F	107331.58'	109444.69'	1339.29
CONTROL POINT – CP 50	106894.27	109349.22	1350.603



DEMOLISH AND REMOVE (E) ABANDONED 24" SANITARY SEWER PIPE AS NECESSARY.



MANHOLE 'A' (1)
Scale: NONE



MANHOLE 'D' (2)
Scale: NONE

AS-BUILT DRAWING

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

City of Willits
Engineering Department
380 East Commercial St.
Willits, California 95490-3188

NO	DATE	REVISION	BY

DSGN DSGN | DR DRFTR | CHK CHKR | APVD DMS

PROJECT LOCATION

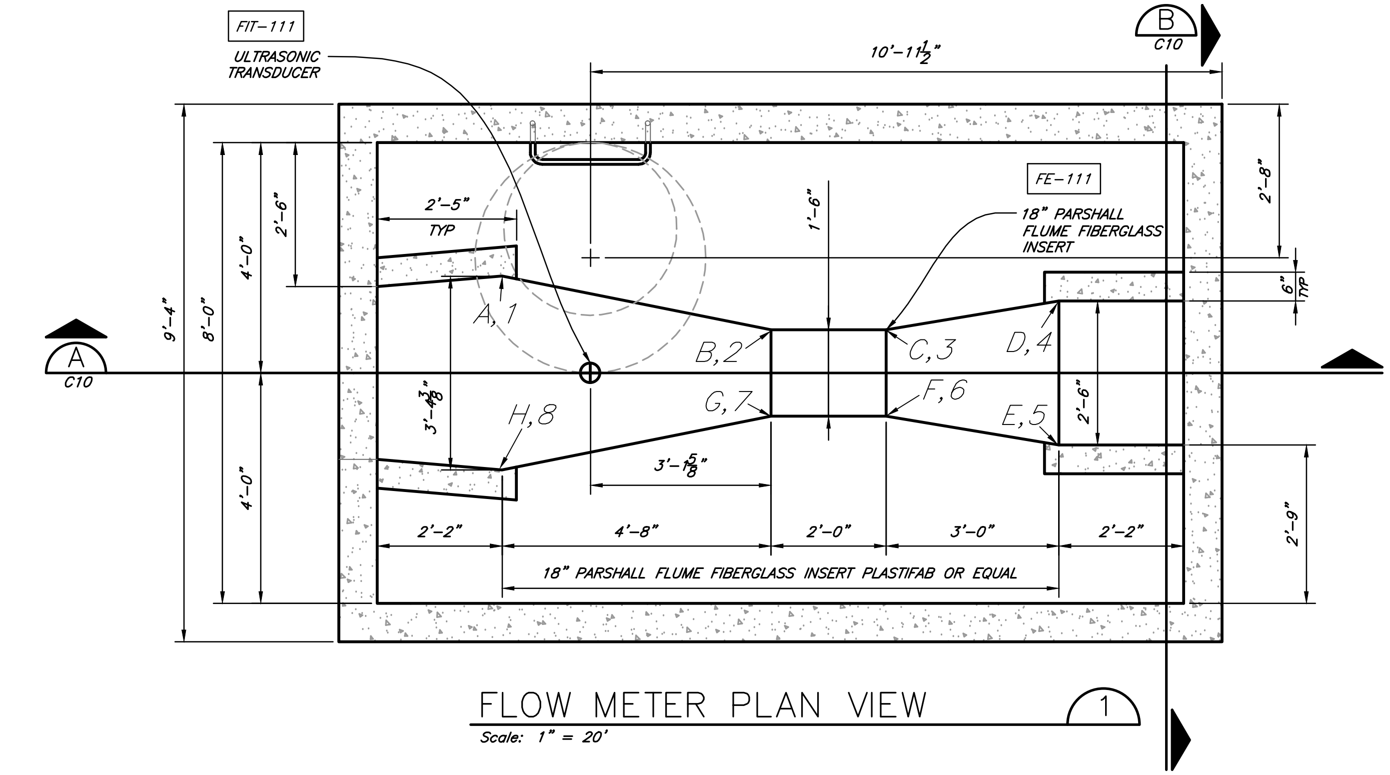
GRAVITY INLET SEWER PLAN AND PROFILE

SHEET

DATE

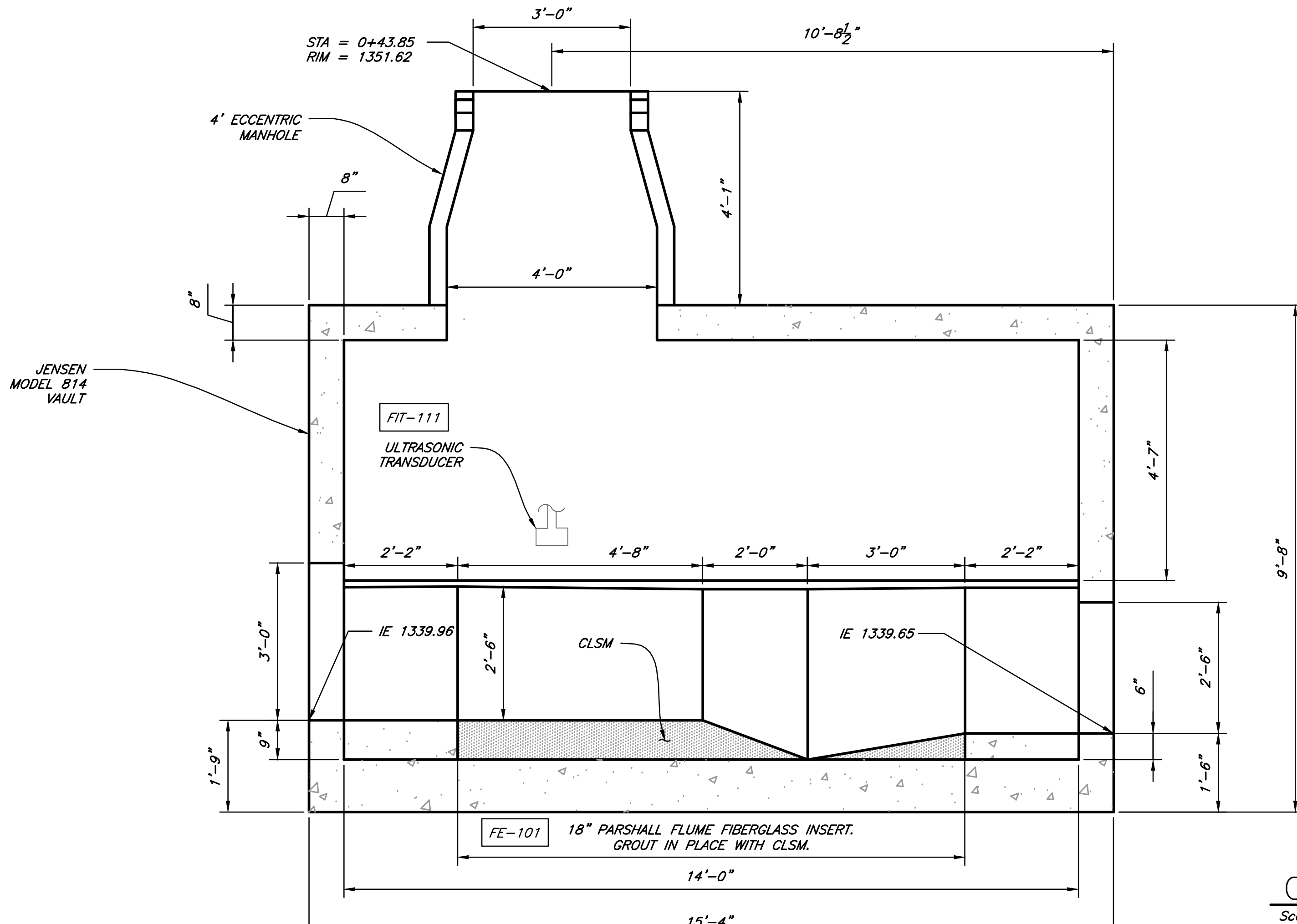
PROJ. NO.

W:\WC_Engineer_Share\3DPROJECTS\sewer\PARSHALL FLUME\C8-C9 EFFLUENT PIPING PROFILES.dwg
11/7/2014 3:32:46 PM
Jeremy Ronco



FLOW METER PLAN VIEW (1)

Scale: 1" = 20'

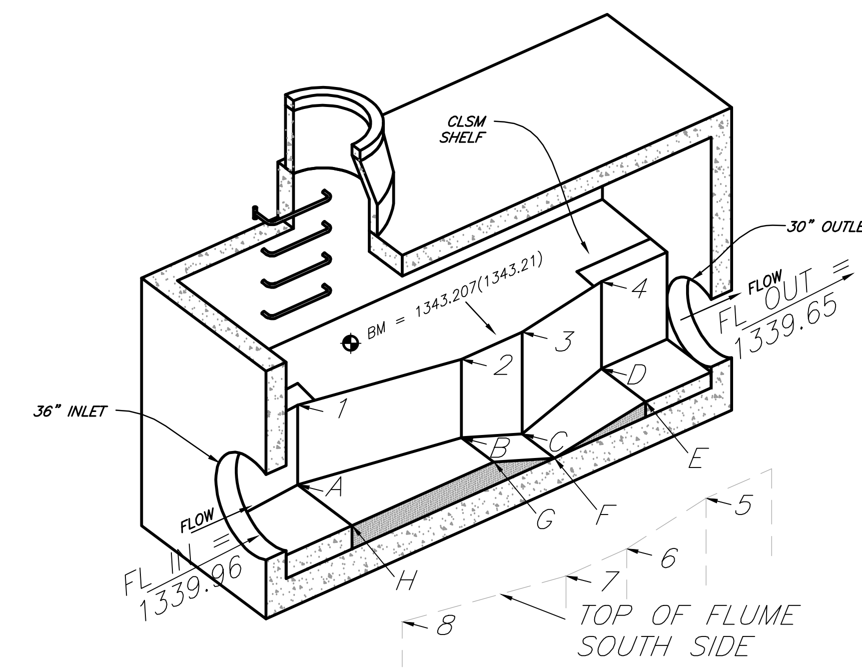


FLOW METER SECTION (A)

Scale: 1" = 20'

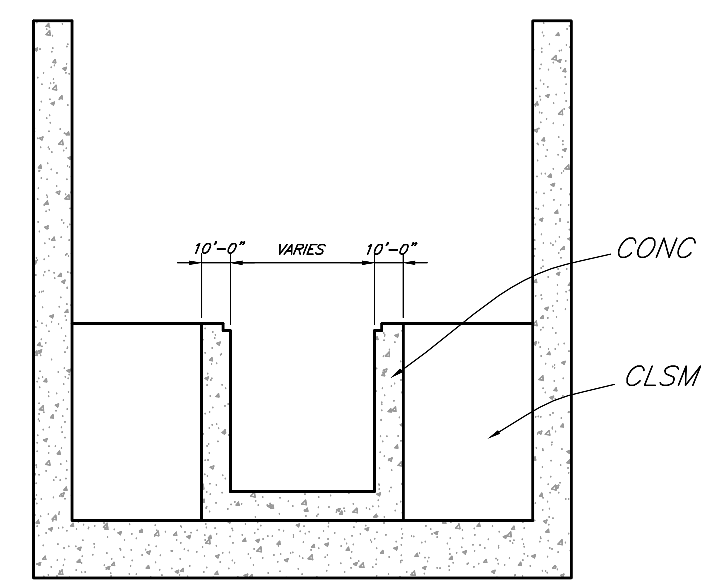
FLUME ELEVATIONS	
A	1340.04
B	1340.02
C	1339.24
D	1339.69
E	1339.71
F	1339.26
G	1340.02
H	1340.04
1	1343.05
2	1343.03
3	1343.00
4	1342.97
5	1342.98
6	1343.02
7	1343.03
8	1343.06

NOTE:
LETTERS DENOTE BOTTOM OF CHANNEL AND NUMBERS DENOTE TOP OF FIBERGLASS FLUME. ELEVATIONS.



FLOW METER ISO SECTION (2)

Scale: NONE



CONCRETE TRANSITION SECTION (B)

Scale: 1" = 20'

AS-BUILT DRAWING

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

City of Willits
Engineering Department
380 East Commercial St.
Willits, California 95490-3188

NO	DATE	REVISION	BY
1	8-26-14	DETAIL, CONC. WALL	

DSGN | DR | CHK | APVD

CLIENT
PROJECT
LOCATION
INFLUENT FLOWMETER

SHEET C-10

DATE 8/26/14

PROJ. NO.

Jeremy Ronco
11/7/2014 3:37:40 PM
W:\WC_Engineer_Share\3DPROJECTS\sewer\PARSHALL FLUME\C10 INFLUENT FLOWMETER.dwg

Rod Wilburn

From: Alex Culick <Alex.Culick@ghd.com>
Sent: Thursday, October 30, 2014 11:22 AM
To: Rod Wilburn
Cc: lancelaw@pacific.net; Adrienne Moore; Andrea Trincado; Steven Mitchell; David Carter
Subject: RE: Willits WWTP Influent Metering Issues

Rod –

Based on our conversation on Tuesday below is a summary of GHD's input and recommendations:

1. Our opinion is that the option to use multiple ultrasonic level meters and make a calculation to estimate the flow is not acceptable. The City should have a more reliable way to physically measure the flow as originally designed for the project.
2. It is our opinion that either the flume should be repaired so that it operates properly as designed or a magnetic flow meter be installed to measure the flow.
3. A magnetic flow meter could be installed upstream of the influent pump station. This would require a modification to the influent piping, installation of a vault or manhole and a new magnetic flow meter. The influent piping at this location is approximately 9 feet deep and new piping/flow meter would have to be installed at this depth.
4. We understand there are magnetic flow meters on the discharge of both influent pumps. Some flow is returned from the treatment process to the head of the plant. Another option and in order to accurately measure the influent flow the returned flow(s) should also be metered and deducted from the overall flow measured at the flow meters on the influent pumps. The SCADA system could be programmed to make the required deductions and report and overall influent flow. This may be the most economical and acceptable way to measure the influent flow.
5. In the meantime we would recommend that the City use the effluent flow meter for reporting purposes of influent flow. We reviewed the water balance and plant evaporation appears to be well less than 1% so the effluent flow meter is a relatively accurate measurement of influent flow on a monthly basis. Obviously depending on what is occurring within the plant the instantaneous and potentially daily flow may be approximated differently. In addition when flows are low in the summer and as they have been throughout the drought the influent Flume will still provide accurate flow measurement when the backwater affects are not occurring so the Flume flow can also be used and compared to the effluent flow meter for reporting purposes.

If you have any questions please don't hesitate to give me a call.

Alex Culick, PE
Water Conveyance and Infrastructure
Service Group Manager

GHD
T: 707 523 1010 | F: 707 527 8679 | C: 707 599 6936 | E: alexculick@ghd.com
2235 Mercury Way, Suite 150 Santa Rosa, CA 95407-5472 USA | www.ghd.com

From: Rod Wilburn [mailto:rwilburn@willitscity.com]
Sent: Wednesday, October 22, 2014 4:42 PM
To: Alex Culick
Cc: lancelaw@pacific.net; Adrienne Moore; Andrea Trincado; Steven Mitchell; David Carter
Subject: Willits WWTP Influent Metering Issues

Alex,

After discussions with Jim and Adrienne, I am forwarding you the memorandum prepared by SHN related to the issues we've encountered immediately downstream of the parshall flume at the wastewater treatment plant.

I believe we are in agreement that the adverse slope and offset pipe can affect the accuracy of the total flow measurements. In addition to considering this memorandum for the water balance calculations, we are interested in having GHD review and comment on the approach and conclusions presented by SHN.

Please give me a call when you have the opportunity to discuss this matter. Thank you.

Respectfully,

Rod Wilburn, P.E.
Public Works Director
City of Willits
380 E. Commercial St.
Willits, CA 95490
707-459-7143 *office*
707-304-2996 *cell*

CONSULTING ENGINEERS & GEOLOGISTS, INC.
335 S. Main St., Willits, CA 95490-3977• 707-459-4518 • FAX: 707-459-1884 • willitsinfo@shn-engr.com

Reference: 412072.001

October 22, 2014

Mr. Rod Wilburn, Director of Public Works
City of Willits
111 E. Commercial Street
Willits, CA 95490

Subject: Parshall Flume Design Memorandum

Dear Mr. Wilburn:

On February 24, 2009, SHN presented to the City of Willits a memorandum that detailed the design parameters used to size the Parshall flume at the City of Willits wastewater treatment plant. These design parameters are as follows:

- Maximum Expected 2025 Peak Day Flow: 9.59 MGD
- Hydraulic Peak Day Flow: 10 MGD
- Maximum Peak Instantaneous Flow: 14.25 MGD

The memorandum indicated that the expected operating level of the new wet well is at an elevation of ±1,335.0 feet. The memorandum stated that this level will not have a backwater impact on the Parshall flume and that the Parshall flume will be able to handle the flows shown above that are expected by the City.

It was recently discovered that one of the pipes downstream of the flume (between manholes C and D) was installed with an adverse grade. SHN created a model of the as-built condition to evaluate the extent of backwater effects and whether there could be an effect on the flow measurements at the flume. SHN used AutoCAD Storm and Sanitary Analysis 2012 modeling software. This software uses Manning's Equation to calculate the flow rate in conduits and open channels, and solves the complete St. Venant equations to model backwater effects through a drainage network.

To determine if there are backwater impacts on the Parshall flume at peak day flows, the piping system segment from MH B, located just upstream of the flume down to the wet well, was entered into the modeling program. The rim and invert elevations used were measured by SHN surveyors on September 9, 2014. The surveyed inverts indicated that the pipe section between MH-C and MH-D has an adverse grade, with the outlet end of the pipe being 0.27 feet higher than the inlet end. This adverse grade was included in the model. In addition, the pipe entering MH D does not align properly with the "as-constructed" manhole opening. This misalignment was determined to be 3 inches, which constricts flow as it enters the manhole. To account for this constriction in the model, a pipe that is 3 inches smaller in diameter was used for the pipe section upstream of MH D. The remaining pipe sizes and lengths were taken off of as-built drawings, and pipe slopes were then automatically calculated by the program.

The Parshall flume was modeled as a 2-foot-long rectangular channel with dimensions matching those provided by the manufacturer and a 0% slope. A short section of pipe was also added to the model directly upstream of the 2-foot flume section. This added section is where the depth of flow is being measured to compare the theoretical flow depth and the modeled flow depth. The junction structures between the flume and the upstream pipe are required by the modeling software; however, to reduce modeling error, the entrance and exit losses at this structure were set to zero. To complete the model, additional assumptions were made based on the above referenced memorandum and are as follows:

- Water surface elevation at the wet well is 1,335.0 feet (wet well elevation at the invert of the 30-inch influent pipe)
- The model was calibrated at each flow run to match the theoretical flow depth of the flume in the pipe section upstream of the modeled flume section.

The model for each run was calibrated by running the model with a free outfall condition directly past the flume. The entrance loss and the roughness coefficient of the flume section were adjusted until the pipe section directly upstream of the flume was at the theoretical flow depth, as published by the Bureau of Reclamation. Once the model of the Parshall flume was calibrated, the downstream pipe network was added in to match as-built conditions and the model was run again. The model was then changed to match the as-designed conditions and was run again to verify whether the as-designed condition had any effect on the Parshall flume. For each of these conditions, three different flows were modeled, and the following table shows the theoretical flow depth, the free outfall modeled flow depth, the as-built flow depth, and the as-designed flow depth.

	1.18 MGD*	**5 MGD**	**10MGD**
Theoretical Head	0.46 ft	1.18 ft	1.85 ft
Free outfall modeled Head	0.46 ft	1.18 ft	1.84 ft
As-Designed modeled Head	0.46 ft	1.21 ft	1.97 ft
As-Built modeled Head	0.47 ft	1.35 ft	2.11 ft
*2025 projected average dry weather flow			

The overall model results (see attached hydraulic profiles) show that there are effects at the flume due to backwater under all three flow conditions for the as-built condition. Based on the published data, the backwater effect would result in a reading of 1.21 MGD vs. 1.18 MGD (2.5% increase), then 6.15 MGD vs. 5 MGD (23% increase), and finally 12.23 MGD vs. 10 MGD (22% increase). The model also indicates that at the as-designed condition, there would be some backwater effect at the 5-MGD and 10-MGD flow depths.

Based on discussions with a flume manufacturer, there are two ways to mitigate for the backwater effects on the flow measurement. The first is to raise the floor of the flume so that the bottom of the flume is above any backwater effects from downstream. The second is to install ultrasonic level readers at two locations along the flume. The level readings would then be fed to a programmable logic controller (PLC), which would use the correct theoretical equation, based on the presence or absence of backwater conditions, to calculate the correct flows to within the normal tolerance of a

Parshall flume (±3-5%). We would be happy to discuss these options further with you.
It should be noted that the model is a simulation of real conditions and the numeric results should be taken as a general indication only.

Please call me if you have further questions.

Sincerely,

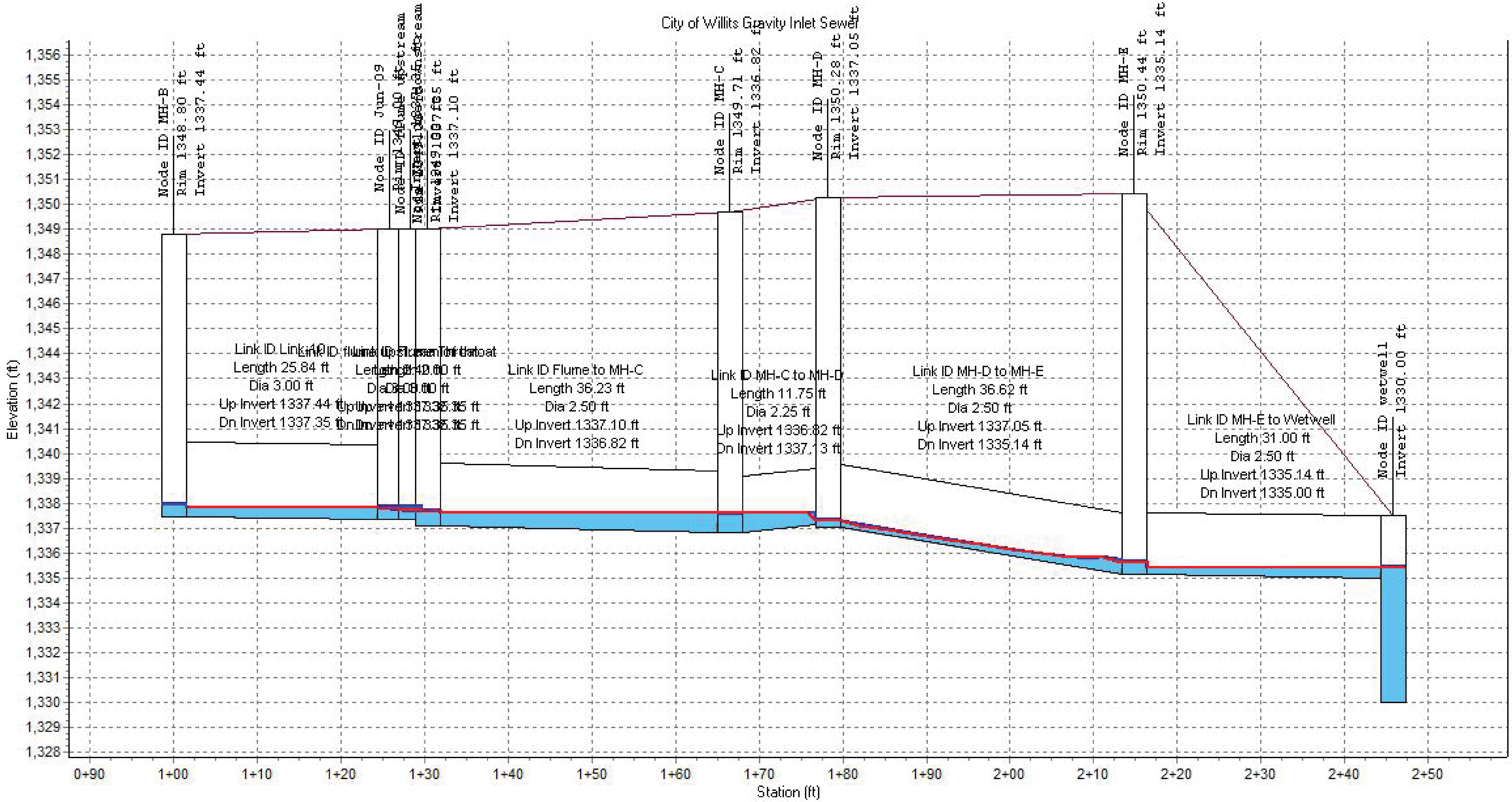
SHN Consulting Engineers & Geologists, Inc.

PROFESSIONAL ENGINEER GREGORY N. HUFFORD 75778 CIVIL STATE OF CALIFORNIA

Gregory N. Hufford, PE
Project Engineer
Tel: 707-441-8855
Cell: 707-498-3779

GNH:lms

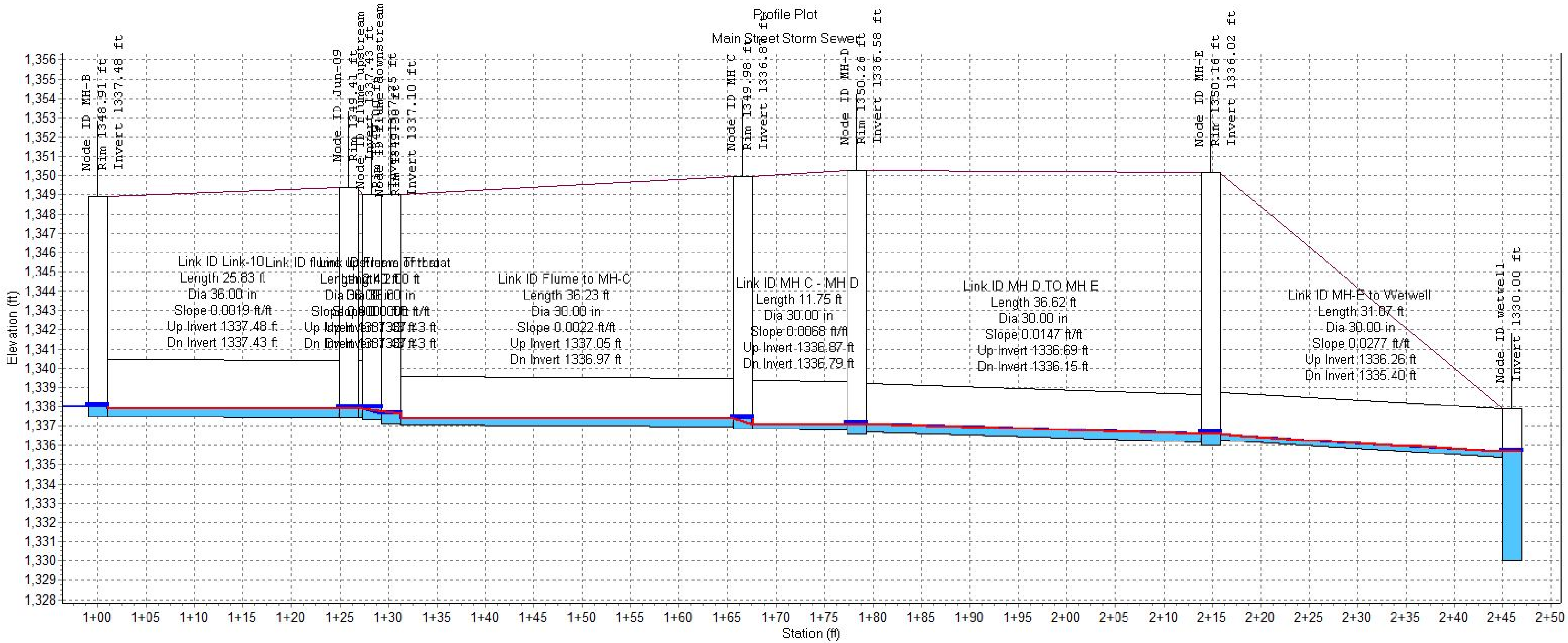
Attachments: AutoCAD Storm and Sanitary Analysis Hydraulic Profiles



1.18 MGD As Built Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH-C	MH-D	MH-E	wetwell
Rim (ft):	1348.80	1349.00	1349.00	1349.00	1349.71	1350.28	1350.44	
Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	1330.00
Min Pipe Cover (ft):	8.36	8.65	8.65	8.65	10.39	10.73	12.80	
Max HGL (ft):	1338.51	1338.51	1349.00	1340.35	1338.04	1337.49	1335.89	1335.76
Link ID:	Link-10	flume upstream of...	Flume Throat	Flume to MH-C	MH-C to MH-D	MH-D to MH-E	MH-E to Wetwell	
Length (ft):	25.84	2.40	2.00	36.23	11.75	36.62	31.00	
Dia (ft):	3.00	3.00	3.00	2.50	2.25	2.50	2.50	
Slope (ft/ft):	0.0035	0.0000	0.0000	0.0077	-0.0264	0.0522	0.0045	
Up Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	
Dn Invert (ft):	1337.35	1337.35	1337.35	1336.82	1337.13	1335.14	1335.00	
Max Q (mgd):	2.95	10.00	675.45	10.00	2.82	5.07	3.61	
Max Vel (ft/s):	3.47	3.87	50.00	4.27	3.76	7.10	6.64	
Max Depth (ft):	0.50	0.47	0.40	0.68	0.53	0.37	0.47	

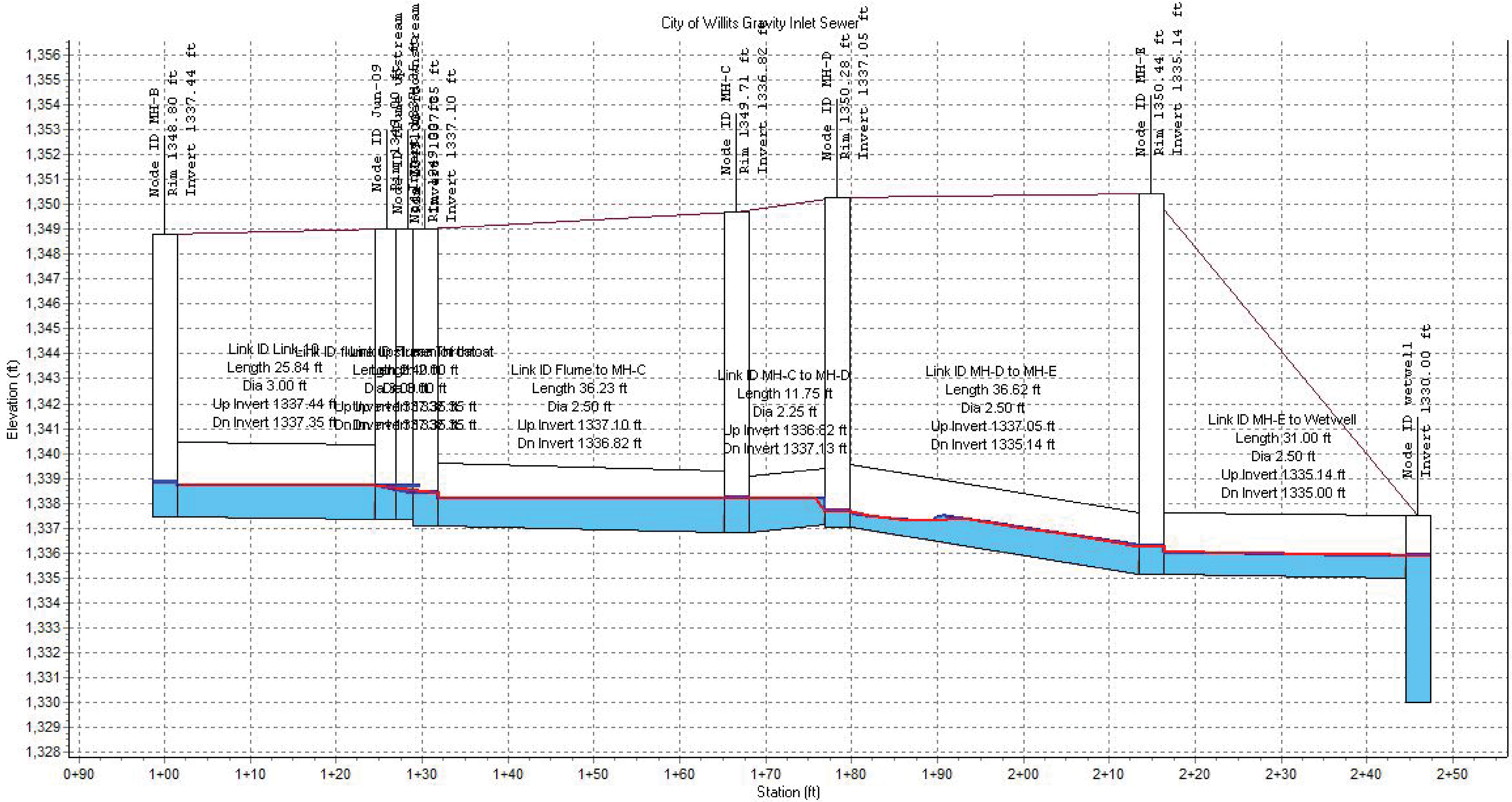
1.18 MGD As Built Condition



1.18 MGD As Designed Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH C	MH-D	MH-E	wetwell
Rim (ft):	1348.91	1349.41	1349.00	1349.00	1349.98	1350.26	1350.16	
Invert (ft):	1337.48	1337.43	1337.35	1337.10	1336.87	1336.58	1336.02	1330.00
Min Pipe Cover (ft):	8.43	8.98	8.57	8.57	10.51	10.97	11.40	
Max HGL (ft):	1340.03	1339.73	1349.00	1339.59	1339.93	1342.19	1343.19	1336.21
Link ID:	Link-10	flume upstream of throat	Flume Throat	Flume to MH-C	MH C - MH D	MH D TO MH E	MH-E to Wetwell	
Length (ft):	25.83	2.40	2.00	36.23	11.75	36.62	31.07	
Dia (in):	36.00	36.00	36.00	30.00	30.00	30.00	30.00	
Slope (ft/ft):	0.0019	0.0000	0.0000	0.0022	0.0068	0.0147	0.0277	
Up Invert (ft):	1337.48	1337.43	1337.43	1337.05	1336.87	1336.69	1336.26	
Dn Invert (ft):	1337.43	1337.43	1337.43	1336.97	1336.79	1336.15	1335.40	
Max Q (mgd):	10.00	10.00	225.56	10.00	10.00	10.82	10.00	
Max Vel (ft/s):	3.38	4.05	50.00	6.30	4.59	5.52	9.05	
Max Depth (ft):	0.50	0.46	0.38	0.48	0.45	0.41	0.30	

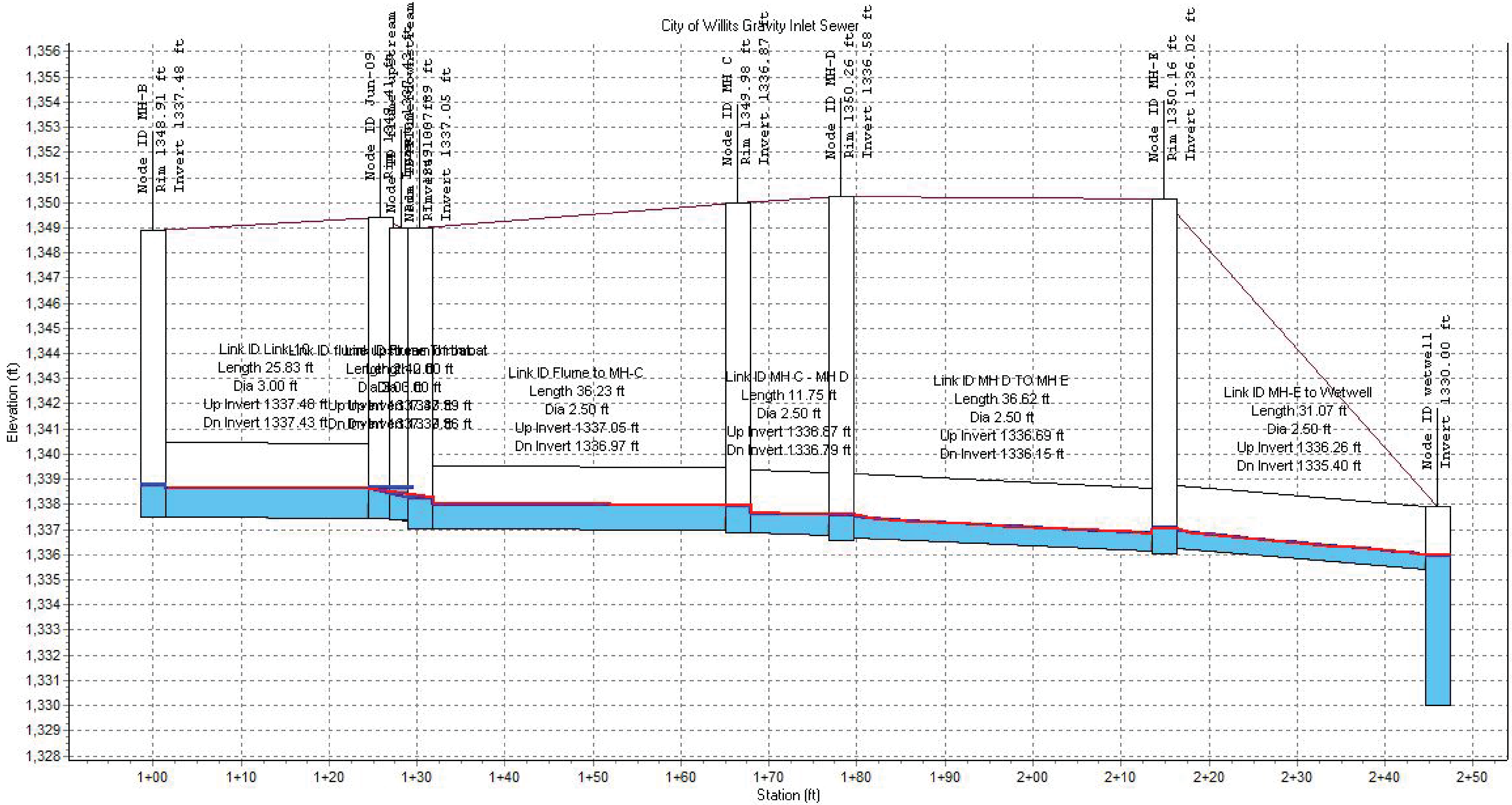
1.18 MGD As Designed Condition



5 MGD As Built Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH-C	MH-D	MH-E	wetwell
Rim (ft):	1348.80	1349.00	1349.00	1349.00	1349.71	1350.28	1350.44	
Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	1330.00
Min Pipe Cover (ft):	8.36	8.65	8.65	8.65	10.39	10.73	12.80	
Max HGL (ft):	1338.81	1338.70	1338.70	1338.39	1338.21	1337.69	1336.24	1335.91
Link ID:	Link-10	flume upstream of...	Flume Throat	Flume to MH-C	MH-C to MH-D	MH-D to MH-E	MH-E to Wetwell	
Length (ft):	25.84	2.40	2.00	36.23	11.75	36.62	31.00	
Dia (ft):	3.00	3.00	3.00	2.50	2.25	2.50	2.50	
Slope (ft/ft):	0.0035	0.0000	0.0000	0.0077	-0.0264	0.0522	0.0045	
Up Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	
Dn Invert (ft):	1337.35	1337.35	1337.35	1336.82	1337.13	1335.14	1335.00	
Max Q (mgd):	5.47	5.00	5.00	5.00	5.00	5.00	5.00	
Max Vel (ft/s):	5.15	3.38	5.26	5.23	4.59	7.47	4.20	
Max Depth (ft):	1.36	1.35	1.19	1.34	0.99	0.85	1.00	

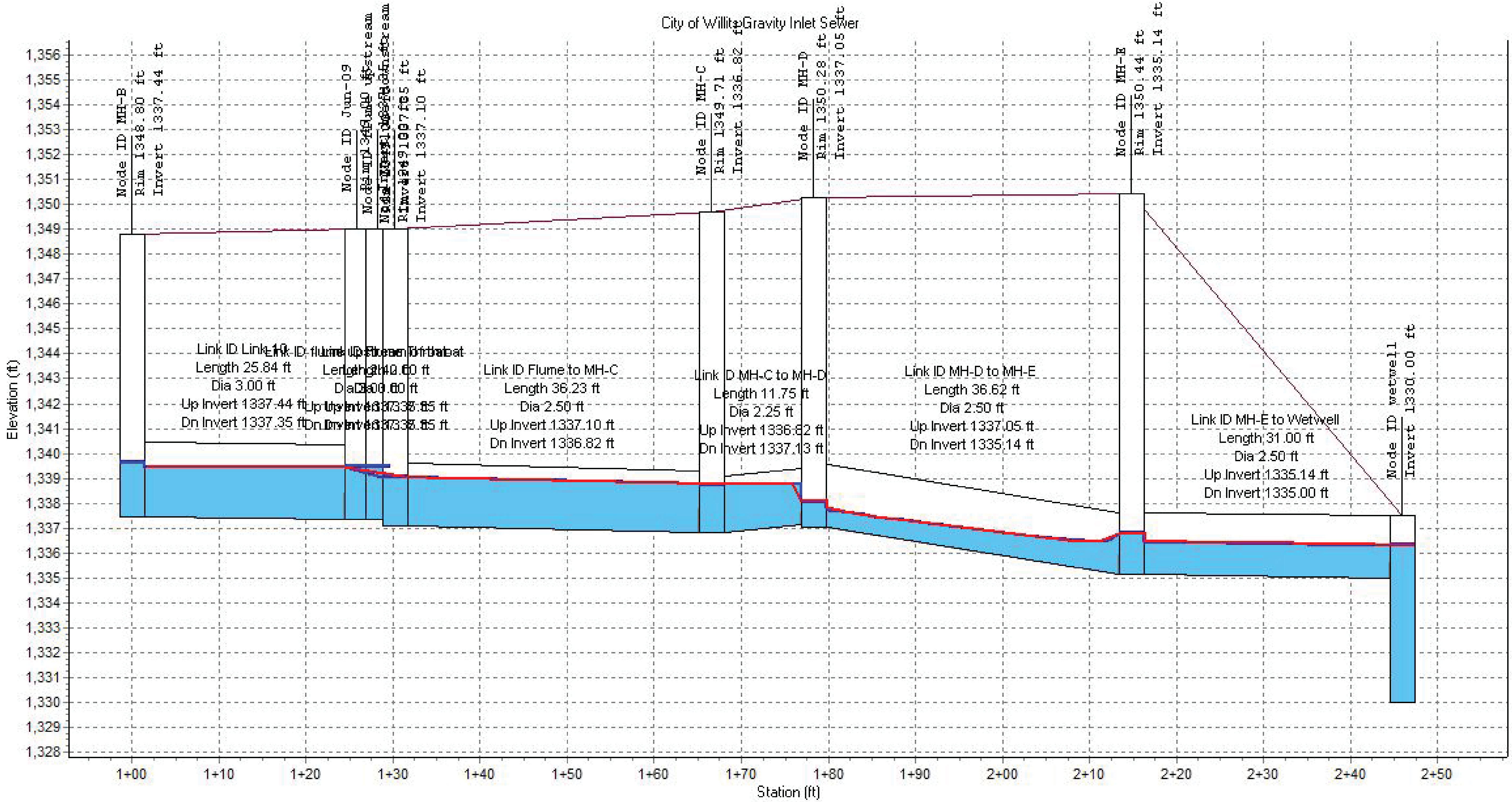
5 MGD As Built Condition



5 MGD As Designed Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH C	MH-D	MH-E	wetwell
Rim (ft):	1348.91	1349.41	1349.00	1349.00	1349.98	1350.26	1350.16	
Invert (ft):	1337.48	1337.43	1337.39	1337.05	1336.87	1336.58	1336.02	1330.00
Min Pipe Cover (ft):	8.43	8.98	8.57	8.64	10.51	10.97	11.40	
Max HGL (ft):	1338.78	1338.64	1338.63	1338.26	1337.95	1337.60	1337.08	1335.99
Link ID:	Link-10	flume upstream of...	Flume Throat	Flume to MH-C	MH C - MH D	MH D TO MH E	MH-E to Wetwell	
Length (ft):	25.83	2.40	2.00	36.23	11.75	36.62	31.07	
Dia (ft):	3.00	3.00	3.00	2.50	2.50	2.50	2.50	
Slope (ft/ft):	0.0019	0.0150	0.0150	0.0022	0.0068	0.0147	0.0277	
Up Invert (ft):	1337.48	1337.43	1337.39	1337.05	1336.87	1336.69	1336.26	
Dn Invert (ft):	1337.43	1337.39	1337.36	1336.97	1336.79	1336.15	1335.40	
Max Q (mgd):	5.46	5.00	5.00	5.00	5.00	5.00	5.35	
Max Vel (ft/s):	5.08	3.61	4.87	3.80	4.54	5.04	7.59	
Max Depth (ft):	1.25	1.21	1.07	1.09	0.95	0.88	0.67	

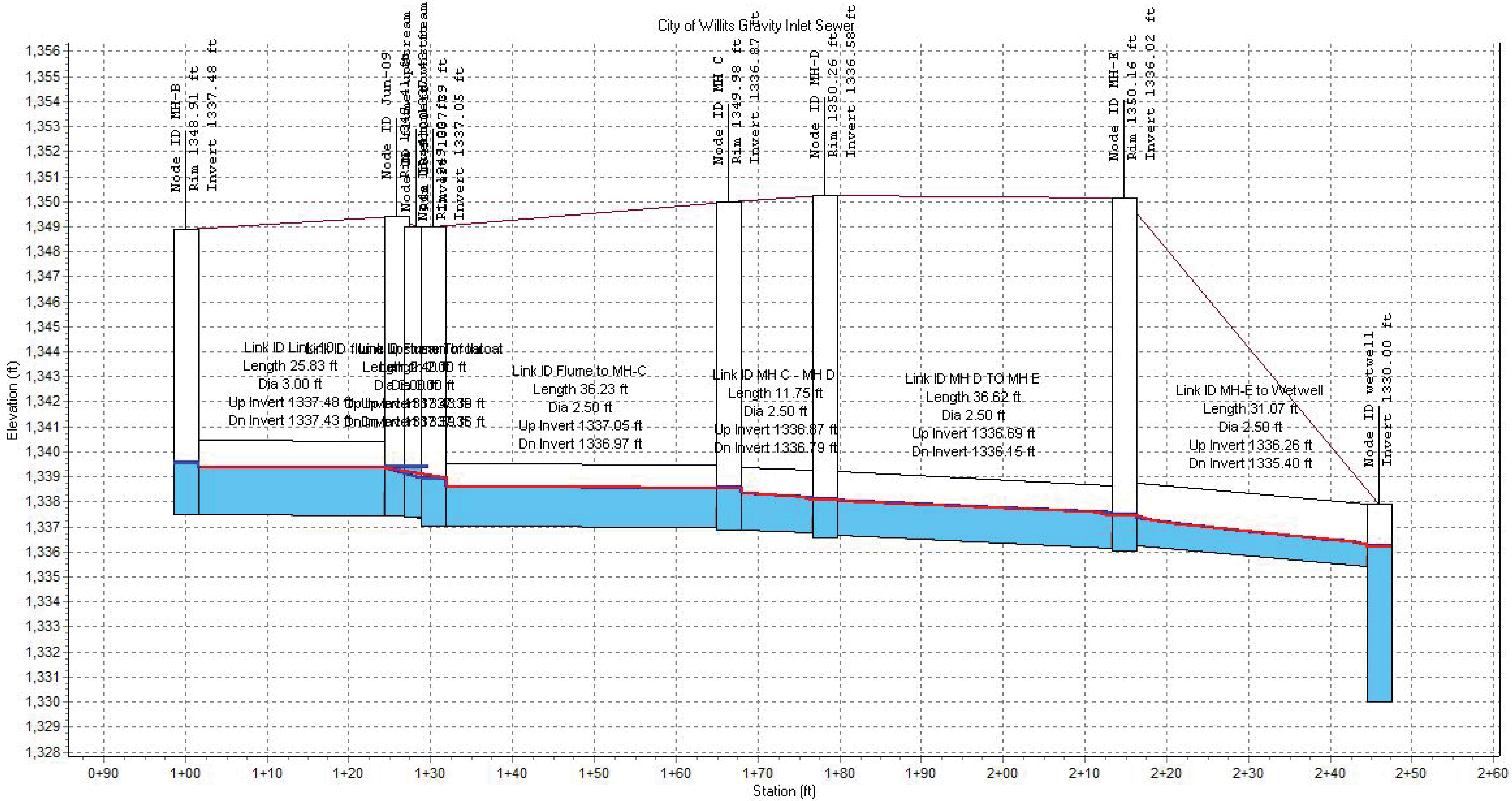
5 MGD As Designed Condition



10 MGD As Built Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH-C	MH-D	MH-E	wetwell
Rim (ft):	1348.80	1349.00	1349.00	1349.00	1349.71	1350.28	1350.44	
Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	1330.00
Min Pipe Cover (ft):	8.36	8.65	8.65	8.65	10.39	10.73	12.80	
Max HGL (ft):	1339.61	1339.46	1339.46	1339.06	1338.75	1338.14	1336.82	1336.33
Link ID:	Link-10	flume upstream of...	Flume Throat	Flume to MH-C	MH-C to MH-D	MH-D to MH-E	MH-E to Wetwell	
Length (ft):	25.84	2.40	2.00	36.23	11.75	36.62	31.00	
Dia (ft):	3.00	3.00	3.00	2.50	2.25	2.50	2.50	
Slope (ft/ft):	0.0035	0.0000	0.0000	0.0077	-0.0264	0.0522	0.0045	
Up Invert (ft):	1337.44	1337.35	1337.35	1337.10	1336.82	1337.05	1335.14	
Dn Invert (ft):	1337.35	1337.35	1337.35	1336.82	1337.13	1335.14	1335.00	
Max Q (mgd):	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
Max Vel (ft/s):	6.03	4.73	6.38	6.11	5.78	8.10	5.07	
Max Depth (ft):	2.14	2.11	1.91	1.95	1.44	1.34	1.49	

10 MGD As Built Condition



10 MGD As Designed Condition

Node ID:	MH-B	Jun-09	flume upstream	flume downstream	MH C	MH-D	MH-E	wetwell
Rim (ft):	1348.91	1349.41	1349.00	1349.00	1349.98	1350.26	1350.16	
Invert (ft):	1337.48	1337.43	1337.39	1337.05	1336.87	1336.58	1336.02	1330.00
Min Pipe Cover (ft):	8.43	8.98	8.57	8.64	10.51	10.97	11.40	
Max HGL (ft):	1339.56	1339.40	1339.39	1338.93	1338.54	1338.10	1337.51	1336.21
Link ID:	Link-10	flume upstream of...	Flume Throat	Flume to MH-C	MH C - MH D	MH D TO MH E	MH-E to Wetwell	
Length (ft):	25.83	2.40	2.00	36.23	11.75	36.62	31.07	
Dia (ft):	3.00	3.00	3.00	2.50	2.50	2.50	2.50	
Slope (ft/ft):	0.0019	0.0150	0.0150	0.0022	0.0068	0.0147	0.0277	
Up Invert (ft):	1337.48	1337.43	1337.39	1337.05	1336.87	1336.69	1336.26	
Dn Invert (ft):	1337.43	1337.39	1337.36	1336.97	1336.79	1336.15	1335.40	
Max Q (mgd):	10.00	10.00	10.00	10.00	10.00	10.00	10.00	
Max Vel (ft/s):	5.88	4.36	6.22	4.52	5.15	5.78	8.55	
Max Depth (ft):	2.02	1.97	1.79	1.73	1.48	1.34	0.99	

10 MGD As Designed Condition

Rod Wilburn

From: Raul Baca <rsbaca@mccwater.com>
Sent: Monday, October 06, 2014 8:37 AM
To: Rod Wilburn
Cc: Andrea Trincado
Subject: Effluent Flowmeter and Billing

Dear Mr. Wilburn (and whomever else it may concern with the City of Willits),

This is a follow-up to an earlier discussion. I would be inclined to use the Effluent Flowmeter for flow totalization which is intended for billing purposes. The reasons for this are:
- It is new and factory calibrated. As such it is as accurate as a flowmeter can be in your application.
- It is an industry standard instrument.
- There are no known, or even suspected, issues with its installation or with its associated piping (to my knowledge).
- It thus offers flow totals that are more easily defended than the Influent Meter.

While the Influent Flowmeter seems to be working very well, and is as accurate as it can calibrated to be, there are some facets of its associated piping and physical installation which allow questions to be raised about its accuracy. Using the Effluent Flowmeter removes these from any possible future discussion. (It would be interesting to keep track of the flow total differential though.)

Cordially,

Raul Baca
Field ServicesManager & RME

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September 29, 2014

Willits WWTP Parshall Flume Flowmeter Calibration

On September 26, 2014 MCC CS performed calibration services on the Willits WWTP Influent Flowmeter. As all parties are aware, this is an 18" Parshall Flume flowmeter with a Siemens OCM III ultrasonic measurement instrument.

Previous site investigations had brought to light two facts that were cause for concern regarding this instrument's accuracy. First, the transducer head was located too far forward by approximately 3.75". Second, the flowmeter was not registering flow at flume depths under approximately 4 inches. The first issue may possibly have been within an acceptable range of tolerance; there were differing professional opinions on this topic among engineers onsite during a recent visit. However, all of the industry reference literature MCC CS was able to find, as well as all of the Siemen's literature, was insistent that the ultrasonic transducer be located exactly two-thirds of the way along the flume funnel (please refer to the first attached drawing as it explains this better than this paragraph). Some reference material showed this "two-thirds" distance measured along the flume centerline. Other material showed the "two-thirds" distance measured along the hypotenuse of the flume funnel (with the centerline being the base of the triangle, so to speak). As the difference between these layouts worked out to less than an inch, MCC CS split the difference between the two to arrive at a correct location.

While on-site, MCC CS removed the transducer. We cleaned the sensor and also wished to affix it to a test jig where distance measurements could be taken accurately under a controlled enviroment. It should be noted that the OCM III was configured to hold any last 4-20mA output under echo loss conditions, which meant readings to SCADA remained constant while we performed our removal, cleaning, and reinstallation work. During measurement tests SCADA did receive some brief but erroneous flow signals. Flow in the flume itself remained very constant during our time onsite.

The transducer was found to be in good shape and was successfully cleaned. The OCM III's temperature transducer was found to be in good condition and functional as well. While removing the transducer, we found the existing EYS (explosion proof conduit body) had not been packed and sealed. This was concerning as it conceivably allowed sewer gases to migrate up the conduit to the OCM III. This is primarily a concern as a possible source of combustion if methane were to find a spark or heat source. MCC CS sealed the fitting when we were done.

While we had come equipped to remove and replace the existing conduit and transducer mounting, it was found that the transducer mount was loose enough to allow it to be moved. So the transducer was simply relocated to the proper location and the existing hardware was retained. It should be made clear that "loose" meant the assembly could be moved with an 18" Rigid pipe wrench. It was by no means loose enough to move by hand. The end result was that the transducer location was satisfactorily corrected.

MCC CS also measured the actual distance from the bottom of the flume (directly below the transducer face) to the transducer face with a straightedge scale. This was found to be 42 7/8". This measurement was verified upon reinstallation.

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Once the transducer itself was affixed to our test jig, out of the vault and at street level, we found that the transducer/OCM III was indeed not measuring past approximately 38”. This was found to be caused by parameters D9 and P45 being mis-set. D9 is Nominal Target Range. This was set to low, resulting in the loss of readings at 38”. P45 is Low Flow Cut-Off, in other words, where to begin ignoring readings. This was set at 1.88”, which also differed from the recorded setting of 1.5” in the O&M provided to City of Willits and then supplied to MCC CS. The difference in these parameter settings explained why the flowmeter was not “seeing” flow until there was 4’ of water in the flume. We adjusted both settings (to 43 and 0 respectively) and found the OCM was then able to see targets out to 43” and measure flume depths down to .25”. We ran multiple tests in our jig to confirm the readings before any changes were made to the parameters, during the parameter changes and afterwards. All of this was done in order to be 100% certain the instrument was behaving exactly as desired. All tests reflected a level of performance that inspired confidence and that was greatly improved.

While conducting these distance measurement tests, the flow results at various test “depths” were monitored and compared to known flow values for 18” Parshall Flume flowmeters. The measurements showed some discrepancies at low levels, but were increasingly accurate as “flows” rose. At higher flows the results were spot on. (It should be noted that the measurements cannot be expected to be 100% accurate in our test jig. The temperature transducer was located in the vault where ambient temperature was much warmer than at our test jig. Thus, the sound speed compensation was off somewhat. Our test target is also wood, as opposed to the flume’s water, resulting in different resonant characteristics. So some difference at low flow was not unexpected or alarming in our tests. The jig provides an easy way to test target settings and instrument set-up and is more accurate than trying to provide a movable target in the flume itself. All of our test results were within expected tolerances.)

After adjusting the two parameters mentioned above, we were able to measure flow down to 11 gpm with consistency. Due to the flow measurement cutting-off at 4”, previous minimum flow measurements would have been around 400-350gpm. Any flow below that would have been ignored and un-measured.

Mill Creek Flow Meter Calibration

Also on September 26, 2014, MCC CS tested the flowmeter located at the Mill Creek intersection. This flowmeter is also an exponential flume type with an ultrasonic transducer. It however uses a Sigma 970 flow measurement instrument.

Calibration and maintenance are very simple for this instrument. Other than regular cleaning, the manufacturer does not recommend any other servicing. “Calibration” merely consists of measuring the actual head and flow media depth and then comparing that information to the 970’s actively displayed data. This activity is what was performed and the measurements were found to be spot on. MCC CS is confidant this instrument is performing properly.

It should be pointed out that this device is long discontinued and no longer supported by the manufacturer. It may be worth beginning to consider a replacement for the Mill Creek Sigma 970. While the device itself is currently fine, as it is no longer supported and is a “vintage” piece of equipment one must expect it to expire in the not too distant future. It would be prudent to plan accordingly.

Flowmeter Accuracy, Installation and Related Issues

Some time ago, the topic of flow differential between the WWTP's recorded influent and effluent totals was discussed. Quoted below is the email reply to this topic.

As you are well aware there are numerous variables involved in evaluating why recorded flow between two such instruments can differ. They include:

- *Whether influent liquid is being re-routed (temporarily) through the process to assist with aeration, digestion, etc.*
- *Whether liquid is being re-directed for use in sludge thickening (depending on the sludge processing this can account for an almost 1% difference in flow totals alone, according to my research).*
- *Whether water is being used for on-site irrigation.*
- *Losses to evaporation can be significant as well, depending on time of year and the processes involved.*
- *Influent solids are likely less of a concern than we expected. From what I've learned a heavy solids concentration is around 1250 ppm (roughly .1%).*
- *And most importantly, no two instruments ever are in perfect agreement. We can honestly expect a .5% difference between the two flowmeters to be normal.*

With all of that reiterated, after speaking to others here at MCC with far more experience than myself, we all agreed 2% was not an unreasonable difference over a roughly two year period between the influent and effluent meters. As your most recent calculations show a difference of only 1.45% I feel comfortable that your differences in flow are well within an acceptable margin.

While onsite on the 26th of September, more information was provided which relates directly to this topic. As detailed in the attached drawings, there is a significant installation issue with the installation of the WWTP's influent flowmeter. An elevation discrepancy exists between the flow meter flume's outlet and the piping behind it. This conceivably could cause flow to back-up into the Parshall Flume. This would greatly, and adversely, affect the accuracy of the device. The elevation difference appears to be .27 tenths of a foot. This equates to roughly 360 gpm if my calculations are correct. Combined with the mis-set parameters found in the flowmeter, it seems likely there has been a great deal of flow through this device which has gone unrecorded over the years. Unlike the parameter issue, the issue with the actual installation will be much more difficult to address. While there are tests which can be performed to determine if the flume is suffering from a submergence condition, they would require an amount of labor equal to installing a new flow measurement device. As such, it would be the opinion of MCC CS that the effort would be better directed at procuring and installing a replacement flow measurement instrument that would not be affected by the flume's actual physical installation. MCC CS concurs with the City opinion that a Hach FloDar would work well as the WWTP influent measuring device. Eventually, the best course of action would be to replace entire Parshall Flume with a Magnetic Flowmeter (such as a Siemens Sitrans). These are the world wide industry standard and almost above reproach for accuracy and dependability. Given their factory calibration and the need for zero maintenance after installation, installation of such an instrument would provide a great deal of peace of mind for the City in this application.

While this paragraph may seem to conflict with some of what is written above, it is worth pointing out that despite all of the issues mentioned in this portion of this report, a differential of 1.45% as discussed above is still within an acceptable margin. Whether the data gathered to arrive at this 1.45% flow differential was accurate may be questionable given the physical installation issues that have come to light as well as the OCM III's previous configuration. It also brings into question the 1.45% itself. Until an influent flowmeter is in place that is known to be reliable and accurate, flow totals, flow differentials, and the like are somewhat conjectural.

The current influent flow meter is configured as accurately as possible. The OCM III is functional and providing accurate flow totals in relation to the flume depths it is detecting. Any issues that may exist with the flume installation are outside of what can be corrected by the OCM III set-up.

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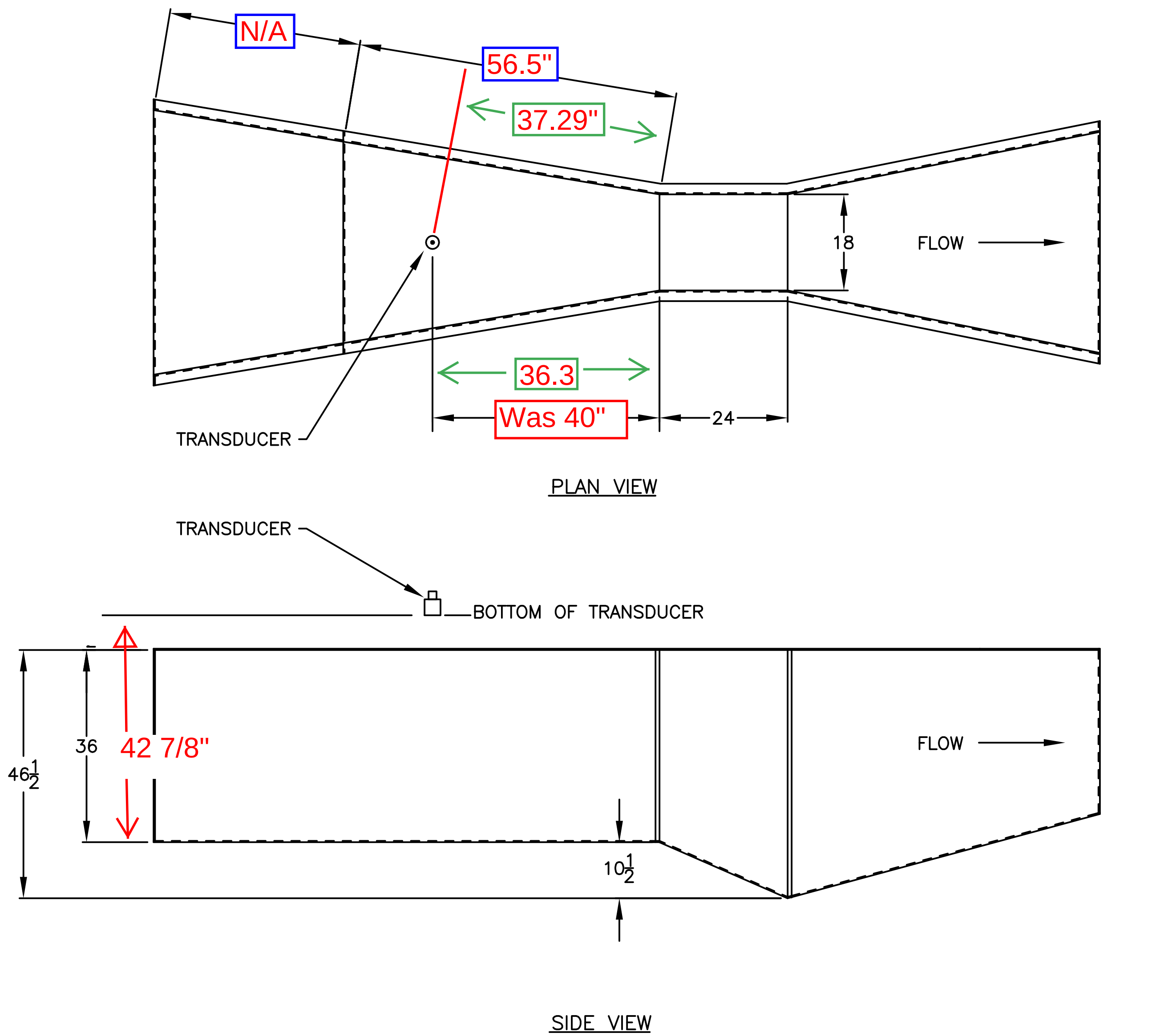

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DIMENSIONS

UNLESS OTHERWISE SPECIFIED
INCHES
AND TOLERANCES FOR
1 PLACE DIMS ± 0.1
2 PLACE DIMS ± 0.01
3 PLACE DIMS ± 0.002
ANGULAR DIMS ± 30'
FRACTION DIMS ± 1/32"
0" —— 1"
THIS LINE EQUALS ONE INCH, IF NOT ON THIS SHEET, ADJUST SCALES ACCORDINGLY

REVISIONS

NO.	DATE	REVISION	BY	APP

TESTING

TEST	DATE	BY

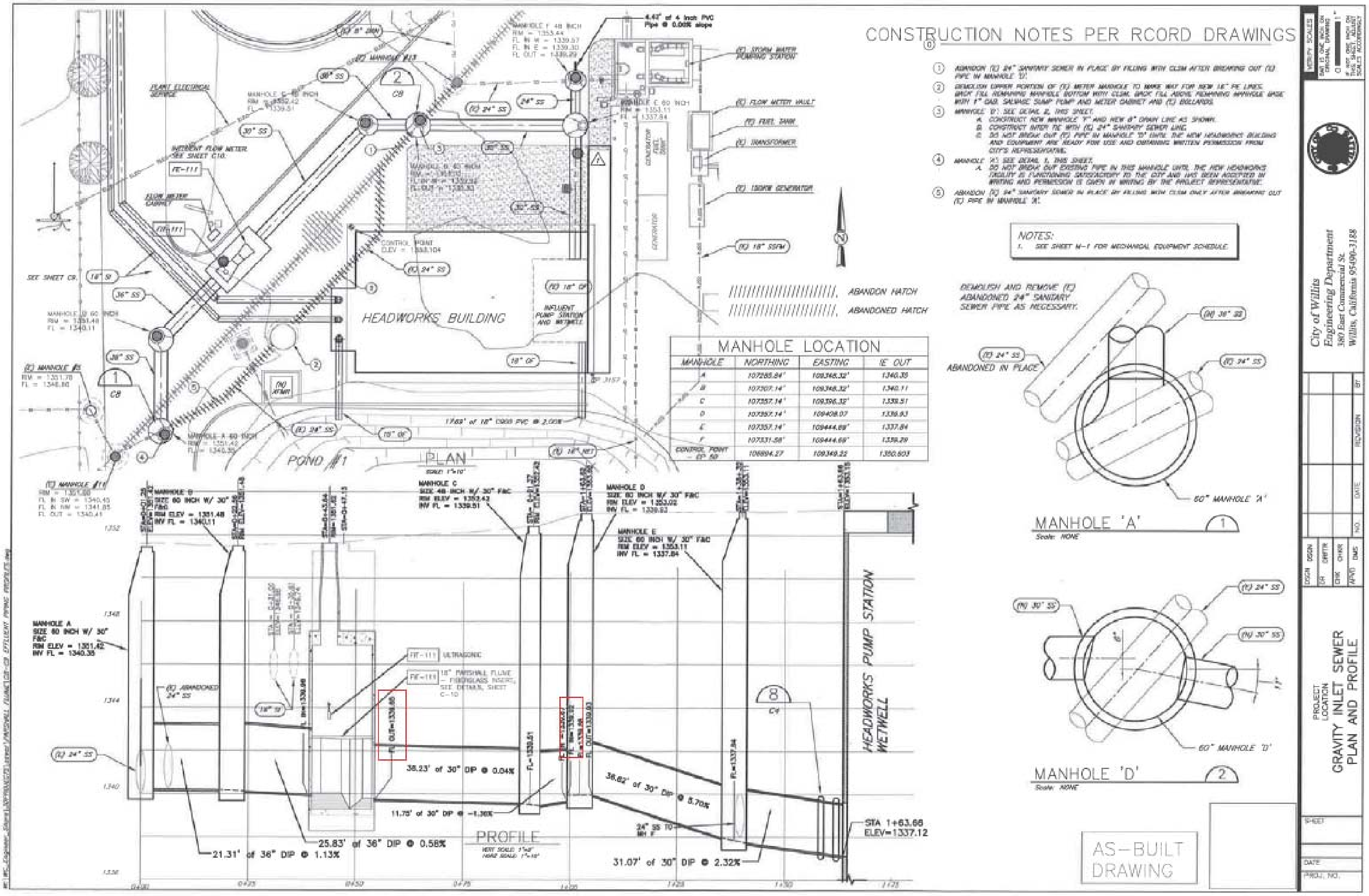
PROJECT: WILLITS WWTP

TITLE: 18" FLUME

CUSTOMER:

DESIGNED BY	RB	DATE:	10/13
DRAWN BY	PC	SCALE:	NTS
CHECKED BY	RB	REF:	
APPROVED BY	RB	SHEET	1 OF 1

SIZE: A DRAWING: 07640.01-A01



CONSTRUCTION NOTES PER RCORD DRAWINGS

1. ABANDON (E) 24" SANITARY SEWER IN PLACE BY FILLING WITH CLSM AFTER BREAKING OUT (E) PIPE IN MANHOLE 'D'.
2. DEMOLISH UPPER PORTION OF (E) METER MANHOLE TO MAKE WAY FOR NEW 18" PE LINES. BACK FILL REMAINING MANHOLE BOTTOM WITH CLSM. BACK FILL ABOVE REMAINING MANHOLE BASE WITH 1" CAB. SALVAGE SUMP PUMP AND METER CABINET AND (E) BOLLARDS.
3. MANHOLE 'D': SEE DETAIL 2, THIS SHEET.
   - A. CONSTRUCT NEW MANHOLE 'F' AND NEW 8" DRAIN LINE AS SHOWN.
   - B. CONSTRUCT INTER TIE WITH (E) 24" SANITARY SEWER LINE.
   - C. DO NOT BREAK OUT (E) PIPE IN MANHOLE 'D' UNTIL THE NEW HEADWORKS BUILDING AND EQUIPMENT ARE READY FOR USE AND OBTAINING WRITTEN PERMISSION FROM CITY'S REPRESENTATIVE.
4. MANHOLE 'A': SEE DETAIL 1, THIS SHEET.
   - A. DO NOT BREAK OUT EXISTING PIPE IN THIS MANHOLE UNTIL THE NEW HEADWORKS FACILITY IS FUNCTIONING SATISFACTORY TO THE CITY AND HAS BEEN ACCEPTED IN WRITING AND PERMISSION IS GIVEN IN WRITING BY THE PROJECT REPRESENTATIVE.
5. ABANDON (E) 24" SANITARY SEWER IN PLACE BY FILLING WITH CLSM ONLY AFTER BREAKING OUT (E) PIPE IN MANHOLE 'A'.

MANHOLE LOCATION

MANHOLE	NORTHING	EASTING	IE OUT
A	107285.84'	109348.32'	1340.35
B	107307.14'	109348.32'	1340.11
C	107357.14'	109396.32'	1339.51
D	107357.14'	109408.07	1339.93
E	107357.14'	109444.69'	1337.84
F	107331.58'	109444.69'	1339.29
CONTROL POINT - CP 59	106894.27	109349.22	1350.603

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August 20, 2014
City of Willits
Andrae Trincado
Influent Flowmeter Evaluation

This report is intended to document the findings of our site investigation conducted on August 14, 2014. It will be brief as the investigation was well observed and was also discussed at length with all parties onsite.

With regards to the Influent Parshall Flume Flowmeter there are a few things of significance which are worth noting. First, it is greatly reassuring that the flowmeter has been inspected by a qualified engineer and found to be acceptably level (I believe I recall it was found to be within one half of a degree side-to-side and fore-to-aft). Second, we were able to confirm the sensor head is mounted 3.6" too far forward compared to the manufacturer's recommendations. The sensor was also slightly out of plume, which while not a major issue is, however, not ideal. Flow through the flume appeared to be proper.

Prior to calibration we would recommend relocating the sensor to the proper location, installing it plume and level, and raising it slightly so that it has greater buffer distance between the top of the flume and the sensors "blanking distance" (i.e. where measured medium is so close to the sensor that it can no longer be "seen" by the instrument). This will involve dismantling the current EYS condulet and conduit and remounting the sensor. I am strongly considering a new EYS at the current location, a stainless steel strut assembly to mount the sensor and sealt-tite conduit between the two. The only reason I recommend replacing the EYS is that due to corrosion I suspect it will not survive disassembly. If this is acceptable to the City of Willits I will order the material to perform this work at once.

The MagTube Flowmeters at the WWTP all appear to be properly installed and functioning fine. While two are installed in vertical piping runs, and this is usually not recommended by the manufacturers, they are installed in such a manner that the flow tubes should remain full which will ensure they operate accurately. It should be kept in mind that Magmeters need to have the flow tubes full for proper measurement to occur.

The Mill Creek flowmeter is an older device that I am still researching. I am hoping to hear back from the manufacturer very soon regarding it after which I can offer accurate advice.

Cordially,
Raul Baca

MCC CONTROL SYSTEMS
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October 3, 2013

MCC CS inspected the Influent Siemens Open Channel Flow Meter at the Willits WWTP on October 1, 2013. We had been asked to examine the flow meter to determine if it was operating properly. Brelje & Race Consulting Engineers was onsite concurrent with our presence.

Several things must be explained as a preface to our report.

- Flowmeters cannot be field **calibrated** except under extraordinary circumstances. Depending on the type of meter, doing so without the manufacturer's engineering representative present usually voids the warranty as well as any guarantee of accuracy.
- Open flume flowmeters can have their calibration adjusted more easily than Ultra-sonic or Magmeter type meters.
- This calibration is dependent upon accurately measuring the **actual flow**. This can only be done by routing the flow into a sealed vessel where in the actual volume of liquid can be then measured and correlated against the time it took to fill the vessel.
- This must be done with the utmost accuracy. The calibration is only as accurate as the least significant digit in any of the measurements.
- Calibration must be done at as many different flow medium levels in the flume as is possible and each measurement must be repeated as many times as possible to achieve an accurate mean number at each level. In our case, I would feel it necessary to measure flow at 1 inch intervals from 0 to 36.
- This obviously borders the impossible due to time constraints and the reality of flowmeter piping installations.
- All flowmeters are more accurate the higher the flow volume. Almost all are inherently inaccurate at low flows. Some more so than others depending on the volume of media to be measured, where it is to be measured, and the type of meter in question. Meter selection is a balancing act of media, physical installation requirements, maintenance concerns and environmental concerns.
- As might be expected from the above information, MCC CS can only vouch for the configuration (that is the set-up) of the current Influent flowmeter. We can offer a "ball park" assessment of accuracy.
- Contrary to what some parties involved in this issue seems to believe, when Robert Pitts of MCC CS was involved with this meter some months ago, he did not calibrate it. Nor did he configure it. He checked it for fault codes and any obvious errors in parameter set-up. As he found nothing of significance, he left it configured as he found it.
- The presence of Brelje & Race was unexpected by MCC CS. Many of the tests they ran were ones we had intended to.

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With all of the above stated, we can discuss our findings.

The Siemens flowmeter is a Milltronics OCM III. At first inspection it seemed to be installed and functioning correctly. We made several measurements of the actual physical installation of the hardware as accurately as was possible under the conditions present. Doing so was important in that the physical dimensions are crucial to proper set-up and function of the flowmeter. It is also desirable to have such information recorded for future use.

During the testing and evaluation several areas of concern became apparent.

- The most concerning of these was that any depth of water through the flume less than 4" did not register any flow. This is greatly concerning as the volume, while not great on a momentary basis, would be large cumulatively. It would be necessary to examine historical trending data from SCADA to see how often flow is "zero". One would expect this should be almost never. Prolonged periods of "zero flow" may indicate unrecorded influent flow.
- The ultra-sonic transducer appears to be mounted too low. The manufacturer's manual specifies the face be greater than the "blanking distance" from the top of the flume (max head height). This is not the case as our drawing of measured dimensions shows. Blanking distance is set at 12 inches, which is likely near the minimum blanking distance for such a transducer and cannot be reduced. And while maximum head is set in the parameters at 30 inches, the top of the flume is 36 inches. Under normal conditions, this allows a margin of .5 inches. As the influent could get to 36 inches, the current installation is possibly inadequate under some conditions of high flow. It would be advisable to raise the transducer six inches or so if possible. (Blanking distance is the area close to the transducer in which it cannot accurately measure distances and the flowmeter is thus configured to ignore such false readings in that area.)
- We also noted a good deal of solids deposits on the downstream slope of the flume. This can act as an unintended weir and throw off the accuracy of the Flowmeter. MCC CS recommends these be cleaned out on a regular basis to ensure proper accuracy of readings.

Brelje & Race attempted to record level measurements and flow readings and we applaud their efforts. However, having attempted the same exercise on numerous occasions in the past we were able to recognize areas of concern regarding the accuracy of their gathered data.

- While attempting to determine the accuracy of the transducers' level measurements, they were relying on a hand held scale and clipboard as a reflective target. As these flowmeters measure distance from the transducer to the media surface to determine depth and then use an algorithm to extrapolate flow from depth in a known volume over time (which is a greatly simplified explanation of the process) the distance measurement must be **very accurate**. From experience we know hand held measuring devices are not accurate to .1 inch, much less to the .001 required.

- Also, while later simulating flow readings, influent level measurements were taken from the installed scale in the flume. This did not provide nearly the fine measurement of level readings needed. Comparing this to the indicated flow shown on the flowmeter Human Machine Interface is made difficult by the damping and sample time intervals built into the flow meter itself.
- In these instances MCC CS has found it best to pull the transducer from service, install it in a test stand with a mechanically adjustable target that can be torqued into position to assure it does not move, flex, or vibrate, and then measure the transducer to target distance with an engineering scale certified to .001 inch at various distances. Any other measurement is simply not accurate enough to calibrate the transducers readings.

We have attached a list of current configuration parameters. We have also attached a drawing of the flume and its dimensions. The flume layout and shape was copied directly from the Siemens manual for the flowmeter in question.

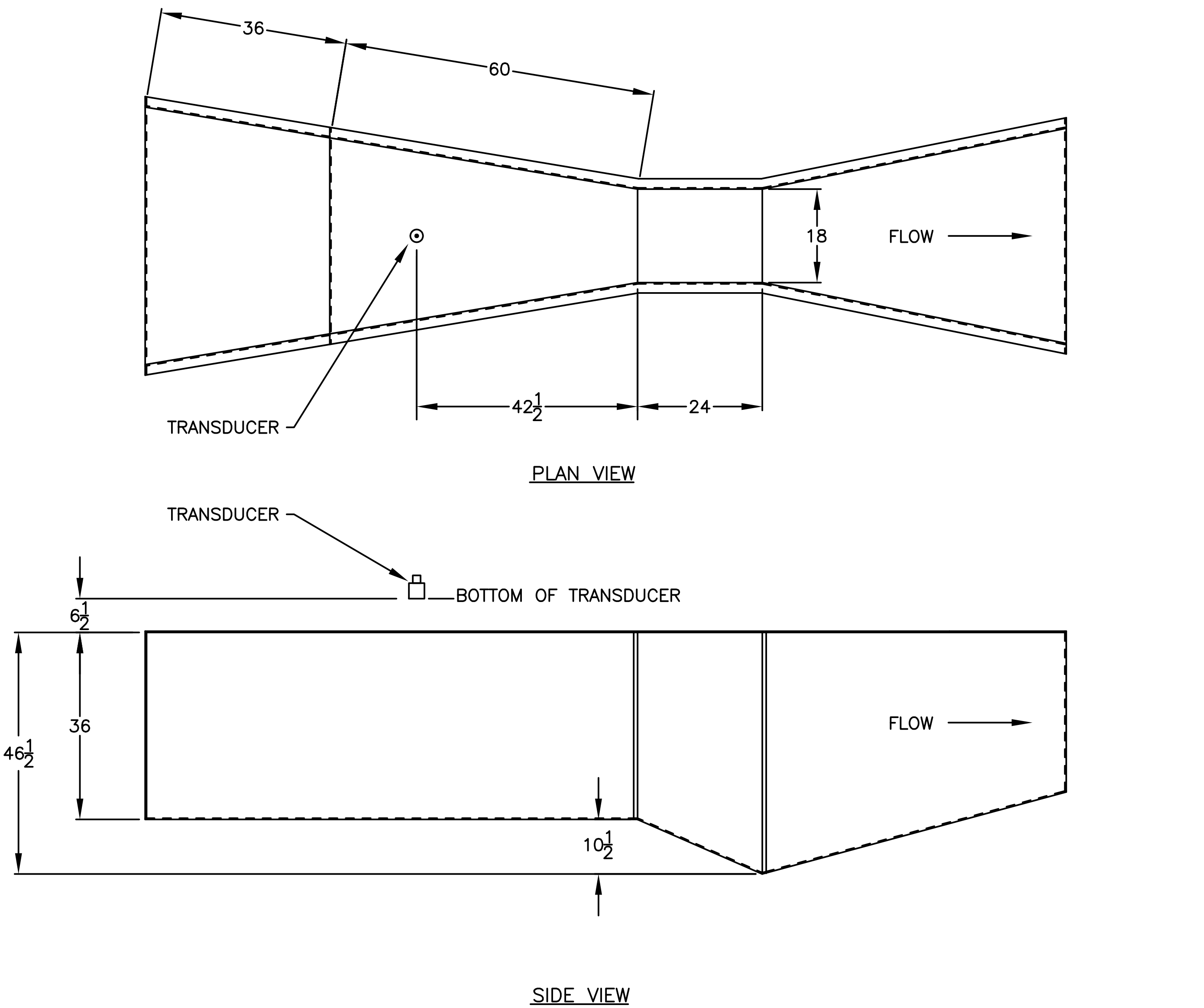
In conclusion MCC CS offers the following observations and recommendations.

- It is clear the current Flowmeter is accurate at mid-range flow levels.
- It is clear it is inaccurate at very low flow levels.
- There exists the possibility for inaccuracy at very high flow levels.
- The current installation requires adjustment of transducer elevation.
- The downstream portion of the flume requires regular cleaning.
- If low flow measurement is a concern, a flowmeter of lesser range is required to accurately record it. The current unit is most likely over-sized for this application.
- Customers having concerns about their flow into the Willits WWTP should install a reputable and accurate flowmeter to measure their discharge. This is the only way to accurately gauge the level of their flow. Doing so is an industry standard between municipalities in similar situations.
- McCrometer and Siemens offer Flowmeters that are considered industry standards.

Siemens Milltronics OCM III

Parameters
(recorded 10/1/2013)

P0	Language	**0** (English)
P1	Dimensional Units	**1** (Inches)
P2	Temperature Units	**1** (Fahrenheit
P3	Primary Element	**0** (Exponential Device)
P4	Method of calculation	**1** (Ratiometric)
P5	Flow Rate Units	**3** (US Gallons/Minute)
P6	Flow at Max Head	11023
P7	Height of Maximum Head	30"
P8		
P13	Display Dampening	**0** (Off)
P14	Display Lighting	**0** (On)
P15		**35** (Flow Pulse Totalization)
P16		1000 Gallons/Pulse
P24	mA Assignment	**0** (Flow Rate)
P26	mA Span	**0** (4-20)
P27	mA Damping	10 Seconds
P28	mA Options	**0** (Don't Track Emulator)
P29	Fail Safe Time	60 Seconds
P30	Fail safe analog Value	**0** (Hold Last Value)
P32	Totalizer Multiplier	**3** (x1)
P33	Flow Rate Display	**0** (No Decimal Places)
P36	Measurement Interval	**0** (1 Seconds)
P42	Head Determination	**0** (OCM-3 Sensor)
P45	Low Flow Cut-Off	1.5"
P47	Blanking Distance	12"



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DIMENSIONS

UNLESS OTHERWISE SPECIFIED
INCHES
AND TOLERANCES FOR
1 PLACE DIMS ± 0.1
2 PLACE DIMS ± 0.01
3 PLACE DIMS ± 0.002
ANGULAR DIMS ± 30'
FRACTION DIMS ± 1/32"
0" — 1"
THIS LINE EQUALS ONE INCH, IF NOT ON THIS SHEET, ADJUST SCALES ACCORDINGLY

REVISIONS

NO.	DATE	REVISION	BY	APP

TESTING

TEST	DATE	BY

PROJECT	WILLITS WWTP
TITLE	18" FLUME
CUSTOMER	
DESIGNED BY: RB	DATE: 10/13
DRAWN BY: PC	SCALE: NTS
CHECKED BY: RB	REF:
APPROVED BY: RB	SHEET 1 OF 1
SIZE: A	DRAWING: 07640.01–A01

Brelje & Race
CONSULTING CIVIL ENGINEERS

MEMORANDUM

TO: Board of Directors, Brooktrails Community Services District

FROM: Richard Ingram, Sarah Yardley

SUBJECT: Review of City of Willits Wastewater Treatment Plant Influent Flow Meter
B&R File No. 3478.00

DATE: October 18, 2013

At the request of Brooktrails Community Services District (BTCSD), Brelje & Race (B&R) conducted a review of the installation and flow readings of the influent flow meter at the City of Willits (City) wastewater treatment plant (WWTP) on October 1, 2013. BTCSD staff and City operations staff provided essential assistance to the review. This memorandum summarizes our observations. Sections of the memorandum include Background, Observations, Discussion and Conclusions. A list of references, and supporting exhibits, are at the end of the memorandum.

BTCSD contracts with the City for treatment and disposal of its wastewater. The annual fee is based upon the year's average dry weather flow (ADWF) measurement for BTCSD as a fraction of the measured ADWF at the City WWTP. The ADWF is calculated as the average daily flow for the months of May through September, for each entity. BTCSD staff are concerned that the reported 2013 early dry season flows at the City WWTP have been 20 to 30 percent lower than typical of recent years. Review of the meter was intended to indicate whether the low recorded flows measurements may be due to inaccuracy of the meter.

Background

The influent meter at the City WWTP is an 18-inch Parshall Flume, installed in a vault approximately 12 feet below ground surface in the plant entrance road. The flume was installed in 2009 as part of Phase 1 of the City's recent WWTP improvement project. A copy of the City's as-built record drawing for the vault is attached as Exhibit A. Access to the vault is through a 36-inch manhole.

The Parshall Flume was developed in the 1920's by Dr. Ralph Parshall of the U.S. Soil Conservation Service, primarily to measure flows in irrigation channels. The constricted throat and drop in the floor of the downstream section produce a predictable relationship between flow and water depth upstream of the throat. The rate of flow can be calculated from a properly measured depth of flow. The flume design is not patented and discharge tables are widely available (The discharge table for an 18-inch Parshall Flume is attached as Exhibit B.). If the flume is configured precisely as specified, flow measurement is typically accurate within ±3% [1].

The literature advises against relying on an 18-inch Parshall Flume for measuring flows less than 80 gallons per minute (gpm) (0.10 foot water depth) or greater than 11,000 gpm (2.5 foot water depth)[2]. We were told by City operations staff that electronic controller of the City's meter was configured to interpret any depth less than 1.5 inches (0.125 feet) as zero flow. At times that the influent flow rate was less than approximately 110 gpm, the flow totalizer would therefore be expected to register no flow.

The City WWTP installation includes a staff gauge for visual monitoring of flow depth and an ultrasonic level instrument for measuring the height of the water surface. Measurement on the staff gauge is in decimal feet, at 0.02 foot increments. The level instrument transmits its reading to a PLC (programmable logic controller), which translates the height of the water surface into flowrate (gallons per minute, also total gallons), which can be observed at an operator interface next to the road adjoining the vault. Values are transmitted to the plant SCADA (Supervisory Control and Data Acquisition) for recording and display.

Observations

Observations are presented in the following paragraphs. The potential effects of the observed irregularities on measurement and recording of dry weather flows are discussed in the following section.

A. Flume Configuration

The dimensions of the flume were measured in the field, to the extent possible, and compared with the dimensions specified by the flume design. A figure with the comparative dimensions is attached as Exhibit C. Photographs of the flume installation are included in Exhibit D. The flume was constructed using a preformed fiberglass form, which ensured that the basic dimensions are correct. As can be seen in the photographs, the throat and downstream sections of the flume and channel are covered by grating. Dried wastes on the top of the grating and adjoining floor give evidence that sewage has backed up into the vault in the past. The frequency of such events is not known. B&R was not able to lift the grates to measure and observe the downstream portions of the flume and channel.

A few discrepancies between the specified Parshall Flume configuration and the installed flume were noted, as follows:

1. The upstream configuration does not include the specified radiused entrance walls or ramp in the floor. The ramp is often eliminated in flume installations for sewage flow measurement, because of concerns that solids deposition will occur in the channel upstream of the ramp [1]. The radiused walls are intended to enable water from a wide channel to enter the flume with a consistent velocity distribution. The absence of radiused walls is

believed to be of little or no importance at the City's WWTP because the flow is coming from a 36-inch sewer pipe with a straight 20-foot long approach.

2. It was, however, observed that the walls of the influent channel from the sewer pipe outlet to the molded flume are not as shown in the as-built record drawing (Exhibit A). The drawing shows the walls going directly from the sides of the sewer pipe to the opening of the flume structure. In fact, the walls go from the corners of the vault to the flume opening, as can be seen in the attached Exhibit D, Photograph 1. This configuration creates triangular "coves" on each side of the channel. The coves may cause flow irregularities such as stagnant zones or eddies.

   It is not known what, if any, effect the channel wall configuration may have on water depth at the measuring device, when compared to the specified configuration. The literature discusses the importance of creating inlet conditions that produce a flattening of the incoming velocity distribution and states that "a sudden change in direction of the sidewall from the straight channel to the converging wall of the flume causes lateral curvature in the entrance flow" [1]. In Photograph 1, the water appears to be exhibiting this behavior, with mounding on each side of the channel as it funnels into the flume.

3. The ultrasonic level measuring device appears to be located approximately three inches upstream of the specified position. The water level may be slightly greater at the installed location, which could cause the flume to read a higher flow rate than actually occurs. The difference is not likely to be more than a few percentage points.

4. The angle of the floor of the throat was measured using an electronic level. The flume is level laterally. The instrument indicated that the floor of accessible portions of the flume is not level longitudinally, but slopes 1.2% downstream (slope of 0.012). A downstream slope would result in reduced water depth and a computed flow rate lower than the actual rate. Error due to sloping floors has been observed to increase with decreasing water depth. The literature states laboratory experiments on a 3-inch flume at a slope of 0.01 have shown an error of 3% at a depth of 0.5 feet, increasing to an error of approximately 10% at a depth of 0.15 feet. These depths would be comparable to depths of approximately 3.0 feet and 0.9 feet in an 18-inch flume. The literature further states that case-specific calculations have been developed to correct for a sloping floor for installations where the slope is less than 0.005 [1].

   We are not aware of any documentation of the effect of a sloping floor on the accuracy of an 18-inch flume, nor of corrective methods for a slope greater than 0.005, as in this case. We would expect that flowrates may be under-represented by 3 to 10 percent, with potential for greater error at flow rates below approximately 2,000 gpm (depth 0.9 feet and less).

B. Depth Measurements and Flow Readings

The depth in the flume and the flow reading at the PLC operator interface adjoining the vault were recorded simultaneously. Flow rates associated with the measured depths were then compared with flowrates in the flume discharge tables. The comparisons were made in two ways, which are described below.

First, WWTP staff used an inflatable pig to block the upstream sewer and stop flow into the flume. The manhole where the pig was placed is approximately 20 feet upstream of the flume. B&R then held a flat surface (a clipboard) level in the flume, beneath the ultrasonic level instrument, at a series of measured distances from the channel floor, to simulate a water surface. Distance from the floor to the board was measured using the staff gauge, which had been previously been verified to measure from the floor of the flume, on one side, and a graduated steel measuring ruler on another side. The clipboard was held at each level for approximately 30 seconds or longer. The board was held by hand. Accuracy of the board height and reading is estimated to be ±0.02 feet.

At the same time, the flow measurements displayed at the PLC were recorded. It was observed that the display would hold a steady value for ten or fifteen seconds, and then show an up-dated measurement. Typically three readings were made for each height of the board in the flume to allow the controller to equilibrate, as can be seen on the observation sheets in Exhibit E.

These measurements were intended to allow measurement of the water depth/flow reading relationship in a controlled manner, particularly for higher water depths that would not be available using the plant flows at the time. The measurements began with a high level reading and continued through a low reading. Readings are shown in Table 1, below. Copies of the observation sheets are attached as Exhibit E.

Table 1: Comparison of WWTP Flow Display and Tabulated Flow Rates (First Trial)

Board Height[1]	Flow Rate: WWTP Display[2]	Flow Rate: Discharge Table[3]	Difference in flow (display compared to table)		Difference Within Acceptable Error[4]?
ft.	gpm	gpm	gpm	percent	
2.50	10,682	11,020	-338	-3.1%	YES
2.33	9,774	9,890	-117	-1.2%	YES
1.33	4,131	4,175	-44	-1.1%	YES
1.17	3,129	3,428	-299	-8.7%	NO
1.00	2,406	2,693	-288	-10.7%	NO
0.83	1,908	2,022	-114	-5.6%	YES
0.67	1,302	1,454	-150	-10.3%	NO
0.50	922	927	-5	-0.5%	YES
0.33	462	489	-27	-5.5%	YES
0.17	459	176	283	160.8%	NO
0.13	120	110	3	2.6%	YES

Measurements are shown in the order they were taken, at descending board heights.

[1] Values in the Board Height column are the measurements of the height of the board held by B&R engineer, read from the steel ruler. Accuracy is ±0.02 feet.

[2] Values under WWTP Display are the average values displayed at the operator interface adjoining the meter vault. Several flow readings were made for each board height, until the meter appeared to have stabilized. Early readings are not included in the average in cases where they are greatly different from the last reading(s). Calculations are in Exhibit F.

[3] Values under Discharge Table are the flow values given in the standard table for an 18-inch Parshall Flume, for the measured board height.

[4] "Acceptable Error" consists of the industry-recognized 3% allowable error plus the visual measurement error of ±0.02 feet.

In assessing the accuracy of the displayed flow readings, the industry-recognized meter error of ±3% and the error of the field measurement of the water depth were considered. Column six of Table 1 indicates whether each displayed flow rate was within the combined acceptable error (Calculations may be found in Exhibit F). Seven of the eleven measured board heights yielded flow readings that were within the acceptable range of error. The remaining flow rates displayed on the operator interface were greater or smaller than the tabulated flow rates by 8% or more.

After the tests using a board to simulate water level had been completed, the WWTP operations staff allowed the sewer flow to resume gradually, by incrementally releasing air from the inflatable pig that had been blocking the sewer. At each increment, the depth was allowed to stabilize and then measured at the staff gauge. The flow reading at the PLC interface was recorded at the same time. Readings are shown in Table 2, below. Copies of the field observation sheets are attached as Exhibit E. It should be noted that, because the water was pushing through narrow spaces between the pig and the pipe walls, the flow patterns were disturbed, as evidenced by wave patterns on the water surface (Exhibit D, Photograph 5). The surface waves, which caused the water depth to range within a band of approximately ±0.01 feet, could have caused flow measurement to be less accurate than under usual flow conditions.

Table 2: Comparison of WWTP Flow Display and Tabulated Flow Rates (Second Trial)

Water Depth[1]	Flow Rate WWTP Display[2]	Flow Rate Discharge Table[3]	Difference in flow (display as compared to table)		Difference Within Acceptable Error[4]?
ft.	gpm	gpm	gpm	percent	
0.20	0	227	-227	-100.0%	NO
0.30	0	423	-423	-100.0%	NO
0.35	0	536	-536	-100.0%	NO
0.40	554	658	-104	-15.8%	NO
0.50	695	927	-232	-25.0%	NO
0.55	812	1,074	-262	-24.4%	NO
0.60	959	1,227	-268	-21.8%	NO
0.65	884	1,388	-504	-36.3%	NO
0.70	1,262	1,556	-294	-18.9%	NO
0.74	1,457	1,695	-238	-14.0%	NO
0.78	1,478	1,838	-360	-19.6%	NO
0.80	1,612	1,911	-299	-15.6%	NO
0.85	1,841	2,097	-256	-12.2%	NO
0.90	2,040	2,290	-250	-10.9%	NO
0.95	2,129	2,489	-360	-14.5%	NO
1.00	2,301	2,693	-392	-14.6%	NO
1.08	2,494	3,031	-537	-17.7%	NO

Measurements are shown in the order they were taken, at increasing water depths.

[1] Values in the Water Depth column are the measurements of the depth at the staff gauge at the flume, as read by B&R engineer. Accuracy is ±0.02 feet.

[2] Values under WWTP Display are the average values displayed at the operator interface adjoining the meter vault. Several flow readings were made for each water depth, until the meter appeared to have stabilized. Early readings are not included in the average in cases where they are greatly different from the last reading(s). Calculations are in Exhibit F.

[3] Values under Discharge Table are the flow values given in the standard table for an 18-inch Parshall Flume, for the measured water depth.

[4] "Allowable Error" consists of the industry-recognized 3% allowable error plus the visual measurement error of ±0.02 feet.

The industry-recognized meter error of ±3% and the error of the field measurement of the water depth were considered in assessing the accuracy of the displayed flow readings. As in the first trial, an error of ±0.02 feet was used to account for visual measurement of the water depth. As can be seen in Table 2, all of the flow readings at the operator interface were lower than associated with the observed water depth and were outside the acceptable range of error (Calculations may be found in Exhibit F).

In this second series of measurements, the readings at the PLC were zero gallons per minute at water depths up to 0.35 feet (4.2 inches). It appears that the controller may have a built-in delay, in the order of several minutes, that causes it not to register the transition between flows too low to record and flows great enough to record, until the transition has been established for some period of time. This sort of delay mechanism is commonly used in controllers, as it avoids data "chatter." If there is a delay mechanism, it would not make a measureable impact on total flow measurement.

At depths of 0.4 feet and above, the displayed flow rates were consistently lower than the values in the Parshall Flume discharge table, by an average of 18 percent. It was observed that the displayed flow rate would sometimes stay the same through several cycles and other times would continue to change (Exhibit E, field observation sheets).

The system's reporting of lower flow rates than would be expected based upon measured water depth at the staff gauge may reflect a delay mechanism in the controller. Also the flows in the sewer were not representative of typical operations, due to the sewage flowing around the pig under pressure. The water surface was observed to fluctuate, which is known to impair flow reading [2].

A graph of the WWTP SCADA trending for influent flow rate was printed for the period of the observations. A copy of the graph is attached as Exhibit G. Notation has been added to indicate the activities at the flume.

C. Graphs of Flow Trends

Graphs of the WWTP influent flow rate were printed from the WWTP SCADA for the night hours of the preceding night and of the night one week earlier (September 23 and 24, 2013). The graphs are included as Exhibit H, attached. The nighttime graphs were reviewed for an indication of the potential effect of the low water depth cut-off of flume meter readings on the total flow readings for the nights. The lowest flow rate that registers on the graphs is approximately 110 gpm, which is consistent with the information provided by plant operations (Note that the two graphs are at different vertical scales.). In the early hours of September 24, the meter recorded zero flow for just over four hours. If the actual flow had been 100 gpm during the period, approximately 24,000 gallons of sewage flow would not have been recorded. By contrast, the meter recorded zero flow three times, each only a few minutes, in the early hours of October 1, making a negligible effect on measured total daily flow.

Discussion

This review focused on the physical configuration of the flume and on a comparison of instantaneous depth/flow rate readings. The findings are discussed below.

A. Flume Configuration

The above-noted discrepancies in the flume configuration may cause inaccuracies in the flow measurement. The cumulative extent and consistency of such potential inaccuracies are not known. Two aspects of the installed configuration are not consistent with recommended Parshall Flume installation:

1. The side walls of the channel flare out between the incoming sewer and the beginning of the flume structure. Observations indicate that eddying occurs in the side coves produced by this configuration, and water entering the flume was observed to mound. The City's as-built record plan shows the walls making a direct, smooth transition from the edge of the sewer to the flume. There may be reasons, which we are unaware of, for installation to have been built as it is, but our conclusion is that the transition walls shown on the plans would have produced less irregularities in the water surface.

2. Measurements indicate that the floor of the flume slopes downstream at a slope of 0.012. This slope could have a real impact on flow measurement. Flow rates may be under-represented by 3 to 10 percent, and there is potential for greater error at flow rates below approximately 2,000 gpm (depth 0.9 feet and less). It should be noted that any effect on flow records would have been occurring since the flume was installed and would not lead to the reduction in recorded flow observed in the 2013 dry season.

B. Depth Measurements and Flow Readings

The flow rate displayed at the operator interface showed a general correspondence with flow values in the discharge table for the measured water depths. In the first trial, which used a board to simulate water depth, the difference between the displayed and tabulated flowrates was greater than the acceptable error in less than one half the measurements. In the second trial, which measured depth of water while the sewer which was partially blocked by the inflatable pig, all displayed flow rates were lower than tabulated values. The greater difference that occurred during the second trial may have been due to undulations of the water surface or delays in the controller logic. Because the available methods used to measure the depth are responsible for introducing some error, it is not possible to conclude whether the meter is displaying the correct flow rate for water depth.

C. Graphs of Flow Trends

The graphs of influent flows during early morning hours indicate that on at least one occasion the meter did not record approximately 24,000 gallons of influent flow. If the daily

> flow was 770,000 gallons (the City's dry season average daily flow, based on available records from 2010 through 2013), the recorded flow for that day may have been low by approximately three percent. Without a full review of flow records for the entire dry season, the effect of this flow recording method might have on calculation of the Average Dry Weather Flow cannot be determined.

The professional services scope did not include comparison of instantaneous display of flow rates with flow recorded into the SCADA history. The translation of data streams into a manageable set of discrete values for recording typically entails averaging of groups of data points over specific time increments. Average values that appear in data records therefore are typically slightly different from specific values read in real time at an operator interface. We have no reason to believe that the data recording is not accurate and do not recommend pursuit of that question.

Conclusions

The observations of the influent Parshall Flume at the City of Willits WWTP on October 1, 2013, indicate that the sloped floor of the flume installation may cause depths to be lower than standard for flows through a Parshall Flume. If the water depths are lower than normal, the reported flow would be lower than flows actually passing through the flume. Additionally, the configuration of the sidewalls between the upstream sewer and the flume opening may cause a non-uniform flow distribution and non-standard water depths through the flume. Note that errors due to the flume configuration would have been occurring since the flume was installed and would not be associated with the observed decrease in measured flows in the 2013 dry season.

There were significant differences between the flow rates displayed at the operator interface and the flowrates in the standard Parshall Flume tables for the measured water depths. The differences may be due to measurement errors and/or to the condition of the influent flow at the time. It is also possible that the meter is recording flows inaccurately. Observations of the controller-measured flow rates as compared to the tabulated rates for particular flow depths support the possibility that the meter may record lower flows than are associated with the water depths in the flume. If there are errors in the meter, they may be recent, or may be long-standing.

An accurate way to verify the influent flow readings would be to conduct a test using the downstream wet well to measure total flow, for comparison with metered flow. The test would be done by pumping the wet well down to its lowest level and turning off the pumps while the wet well filled. It appears, based on the as-built record plans for the wet well, that there would in the range of 4,000 to 5,000 gallons of wet well capacity for the test. The increase in the volume of water in the wet well could then be compared to the influent meter's totalized flow for the time span. The test would require careful coordination of start and finish times and measurement of the water depths as well as an understanding of the relationship between instantaneous flow measurements and display of totalized flow by the meter controller. It should be noted that the floor of the wet well has a complex configuration, probably designed to minimize solids settling, which would make volume determinations challenging. Such a test would best be performed by the WWTP staff. We do not know whether tests were conducted for flume calibration during start-up of the facilities in 2009.

References

[1] U.S. National Bureau of Standards, "Recommended Practice for the Use of Parshall Flumes and Palmer-Bowlus Flumes in Wastewater Treatment Plants," November 1984 (EPA600/2-84-186)

[2] Grant, Douglas M., Open Channel Flow Measurement Handbook, Third Edition, 1989, ISCO, Inc.

Attachments

Exhibit A. Record Drawing, City of Willits Influent Metering Vault

Exhibit B. 18-inch Parshall Flume Discharge Table

Exhibit C. Figure with Parshall Flume Dimensions (specified and field measured)

Exhibit D. Photographs

Exhibit E. Field Observation Sheets

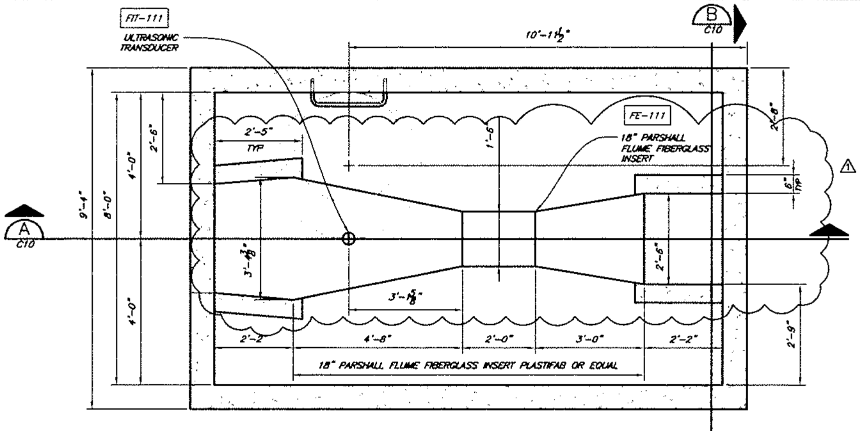
Exhibit F. Comparison of displayed flows with values in Parshall Flume discharge table

Exhibit G. City WWTP SCADA trending graph for influent flow, morning of October 1, 2013

Exhibit H. City WWTP SCADA trending graphs for influent flow, night hours of September 24 and October 1, 2013

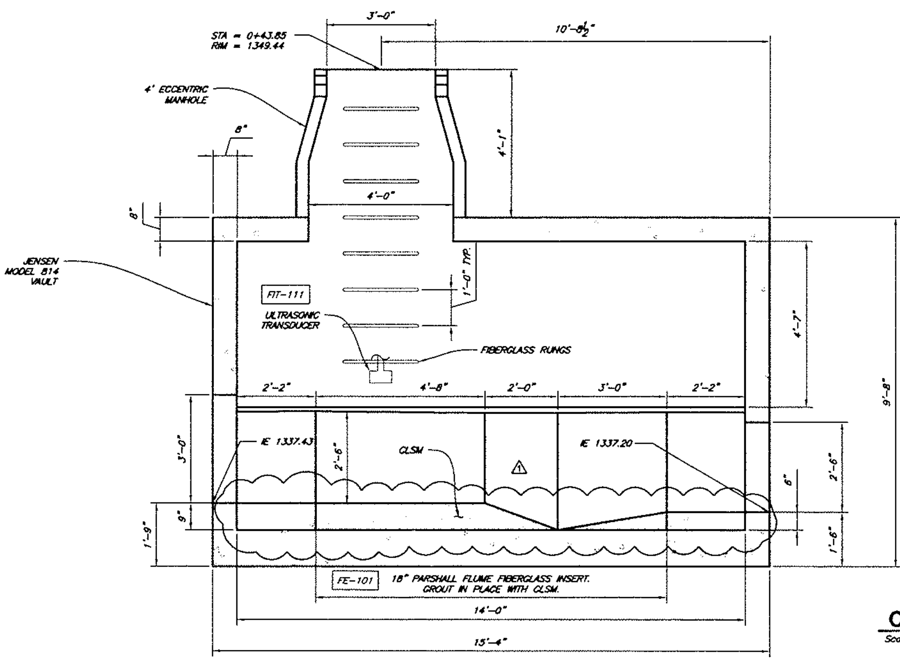
Exhibit A

Record Drawing, City of Willits Influent Metering Vault



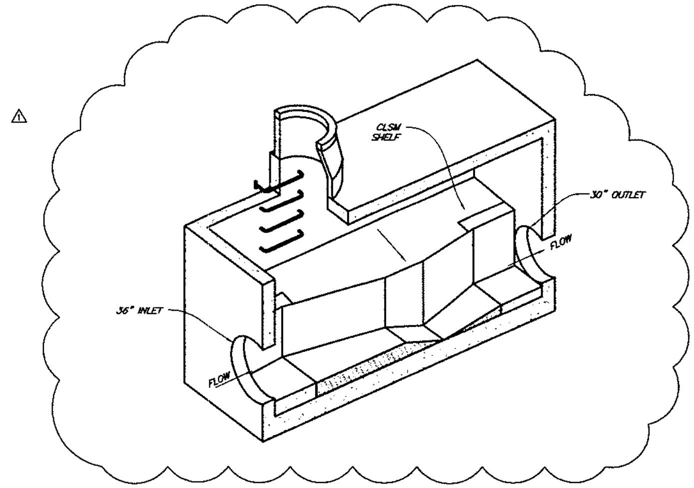
FLOW METER PLAN VIEW (1)

Scale: 1" = 20'



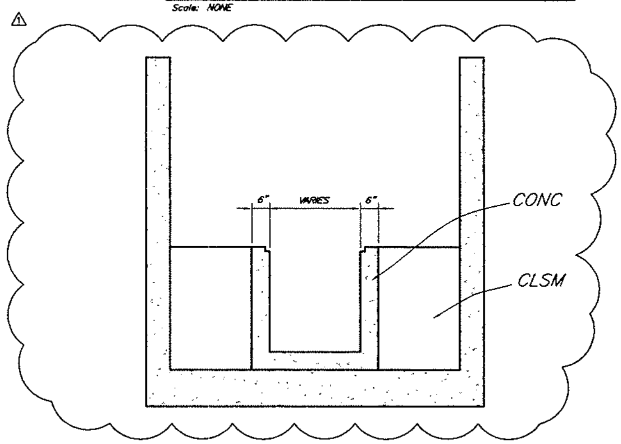
FLOW METER SECTION (A)

Scale: 1" = 20'



FLOW METER ISO SECTION (2)

Scale: NONE



CONCRETE TRANSITION SECTION (B)

Scale: 1" = 20'

REDUCED DRAWING VERIFY SCALES

RECORD DRAWINGS

John C Franklin

REGISTERED PROFESSIONAL ENGINEER JOHN C. FRANKLIN JR. No. C30413 EXP. 3-31-10 CIVIL STATE OF CALIFORNIA

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
493 S. MAIN STREET (707)459-4518
WILLITS, CA 95490 FAX (707)459-1884

NO.	DATE	REVISION	BY
1	8-26-08	DETAIL, CONC. WALL	RH

DSGN	TRL
DR	MDS
CHK	MCV
APVD	DMS

CITY OF WILLITS
WASTE WATER TREATMENT FACILITY STAGE 1
300 N. LENORE ST. WILLITS, CA 95490
INFLUENT FLOWMETER

SHEET C10
1
DATE 9/2007
PROJ. NO. 404027.200

O:\2004\404027_WILLITS_WWTP\404027-200_STAGE_1\PHS 1 RECORD DWGS\Dwg\C10 INFLUENT FLOWMETER.dwg
8/7/2009 2:59:54 PM Ryan Houghton

Exhibit B

18-inch Parshall Flume Discharge Table

12-7: $1^{1}/_{2}$ ft. Parshall Flume Discharge Table

Formulas: CFS = $6.000H^{1.538}$ GPS = CFS x 7.481
GPM = CFS x 448.8 MGD = CFS x 0.6463
MGD = 3.8775 $H^{1.538}$

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
0.01	0.0050	0.0377	2.260	0.0033	0.51	2.130	15.94	956.0	1.377
0.02	0.0146	0.1094	6.564	0.0095	0.52	2.195	16.42	985.0	1.418
0.03	0.0273	0.2041	12.25	0.0176	0.53	2.260	16.91	1014	1.461
0.04	0.0425	0.3177	19.06	0.0275	0.54	2.326	17.40	1044	1.503
0.05	0.0599	0.4478	26.87	0.0387	0.55	2.392	17.90	1074	1.546
0.06	0.0792	0.5928	35.56	0.0512	0.56	2.460	18.40	1104	1.590
0.07	0.1004	0.7514	45.08	0.0649	0.57	2.527	18.91	1134	1.634
0.08	0.1233	0.9227	55.35	0.0797	0.58	2.596	19.42	1165	1.678
0.09	0.1478	1.106	66.35	0.0955	0.59	2.665	19.94	1196	1.722
0.10	0.1738	1.301	78.02	0.1124	0.60	2.735	20.46	1227	1.768
0.11	0.2013	1.506	90.34	0.1301	0.61	2.805	20.99	1259	1.813
0.12	0.2301	1.721	103.3	0.1487	0.62	2.876	21.52	1291	1.859
0.13	0.2603	1.947	116.8	0.1682	0.63	2.948	22.05	1323	1.905
0.14	0.2917	2.182	130.9	0.1885	0.64	3.020	22.60	1356	1.952
0.15	0.3243	2.426	145.6	0.2096	0.65	3.093	23.14	1388	1.999
0.16	0.3582	2.679	160.7	0.2315	0.66	3.167	23.69	1421	2.047
0.17	0.3932	2.941	176.5	0.2541	0.67	3.241	24.24	1454	2.095
0.18	0.4293	3.212	192.7	0.2775	0.68	3.316	24.80	1488	2.143
0.19	0.4665	3.490	209.4	0.3015	0.69	3.391	25.37	1522	2.191
0.20	0.5048	3.777	226.6	0.3263	0.70	3.467	25.93	1556	2.241
0.21	0.5442	4.071	244.2	0.3517	0.71	3.543	26.51	1590	2.290
0.22	0.5845	4.373	262.3	0.3778	0.72	3.620	27.08	1625	2.340
0.23	0.6259	4.682	280.9	0.4045	0.73	3.698	27.66	1660	2.390
0.24	0.6682	4.999	299.9	0.4319	0.74	3.776	28.25	1695	2.440
0.25	0.7115	5.323	319.3	0.4599	0.75	3.855	28.84	1730	2.491
0.26	0.7558	5.654	339.2	0.4884	0.76	3.934	29.43	1766	2.543
0.27	0.8009	5.992	359.5	0.5176	0.77	4.014	30.03	1801	2.594
0.28	0.8470	6.336	380.1	0.5474	0.78	4.094	30.63	1838	2.646
0.29	0.8940	6.688	401.2	0.5778	0.79	4.175	31.24	1874	2.699
0.30	0.9418	7.046	422.7	0.6087	0.80	4.257	31.85	1911	2.751
0.31	0.9905	7.410	444.5	0.6402	0.81	4.339	32.46	1947	2.804
0.32	1.040	7.781	466.8	0.6722	0.82	4.422	33.08	1984	2.858
0.33	1.091	8.158	489.4	0.7048	0.83	4.505	33.70	2022	2.912
0.34	1.142	8.541	512.4	0.7379	0.84	4.589	34.33	2059	2.966
0.35	1.194	8.931	535.8	0.7715	0.85	4.673	34.96	2097	3.020
0.36	1.247	9.326	559.5	0.8057	0.86	4.758	35.59	2135	3.075
0.37	1.300	9.728	583.6	0.8404	0.87	4.843	36.23	2174	3.130
0.38	1.355	10.13	608.0	0.8756	0.88	4.929	36.87	2212	3.186
0.39	1.410	10.55	632.8	0.9113	0.89	5.015	37.52	2251	3.242
0.40	1.466	10.97	657.9	0.9474	0.90	5.102	38.17	2290	3.298
0.41	1.523	11.39	683.4	0.9841	0.91	5.190	38.83	2329	3.354
0.42	1.580	11.82	709.2	1.021	0.92	5.278	39.48	2369	3.411
0.43	1.638	12.26	735.3	1.059	0.93	5.366	40.15	2408	3.468
0.44	1.697	12.70	761.8	1.097	0.94	5.455	40.81	2448	3.526
0.45	1.757	13.14	788.6	1.136	0.95	5.545	41.48	2489	3.584
0.46	1.817	13.60	815.7	1.175	0.96	5.635	42.15	2529	3.642
0.47	1.879	14.05	843.1	1.214	0.97	5.725	42.83	2570	3.700
0.48	1.940	14.52	870.9	1.254	0.98	5.816	43.51	2610	3.759
0.49	2.003	14.98	898.9	1.295	0.99	5.908	44.20	2651	3.818
0.50	2.066	15.46	927.3	1.335	1.00	6.000	44.89	2693	3.878

12-7: $1^{1}/_{2}$ ft. Parshall Flume Discharge Table *(Continued)*

Formulas: CFS = $6.000H^{1.538}$ GPS = CFS x 7.481
GPM = CFS x 448.8 MGD = CFS x 0.6463
GPM = 2693 $H^{1.538}$

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
1.01	6.093	45.58	2734	3.938	1.51	11.31	84.60	5075	7.309
1.02	6.186	46.27	2776	3.998	1.52	11.42	85.46	5127	7.383
1.03	6.279	46.97	2818	4.058	1.53	11.54	86.33	5179	7.458
1.04	6.373	47.68	2860	4.119	1.54	11.66	87.20	5231	7.533
1.05	6.468	48.38	2903	4.180	1.55	11.77	88.07	5284	7.609
1.06	6.563	49.09	2945	4.241	1.56	11.89	88.95	5336	7.684
1.07	6.658	49.81	2988	4.303	1.57	12.01	89.83	5389	7.760
1.08	6.754	50.53	3031	4.365	1.58	12.13	90.71	5442	7.836
1.09	6.850	51.25	3074	4.427	1.59	12.24	91.59	5495	7.913
1.10	6.947	51.97	3118	4.490	1.60	12.36	92.48	5548	7.990
1.11	7.045	52.70	3162	4.553	1.61	12.48	93.37	5601	8.066
1.12	7.142	53.43	3206	4.616	1.62	12.60	94.26	5655	8.144
1.13	7.241	54.17	3250	4.680	1.63	12.72	95.16	5709	8.221
1.14	7.340	54.91	3294	4.744	1.64	12.84	96.06	5763	8.299
1.15	7.439	55.65	3339	4.808	1.65	12.96	96.96	5817	8.377
1.16	7.539	56.40	3383	4.872	1.66	13.08	97.87	5871	8.455
1.17	7.639	57.15	3428	4.937	1.67	13.20	98.78	5926	8.533
1.18	7.739	57.90	3473	5.002	1.68	13.33	99.69	5980	8.612
1.19	7.840	58.65	3519	5.067	1.69	13.45	100.6	6035	8.691
1.20	7.942	59.41	3564	5.133	1.70	13.57	101.5	6090	8.770
1.21	8.044	60.18	3610	5.199	1.71	13.69	102.4	6145	8.850
1.22	8.147	60.94	3656	5.265	1.72	13.82	103.4	6201	8.930
1.23	8.249	61.71	3702	5.332	1.73	13.94	104.3	6256	9.009
1.24	8.353	62.49	3749	5.398	1.74	14.06	105.2	6312	9.090
1.25	8.457	63.26	3795	5.466	1.75	14.19	106.1	6368	9.170
1.26	8.561	64.04	3842	5.533	1.76	14.31	107.1	6424	9.251
1.27	8.666	64.83	3889	5.601	1.77	14.44	108.0	6480	9.332
1.28	8.771	65.61	3936	5.669	1.78	14.56	109.0	6537	9.413
1.29	8.876	66.40	3984	5.737	1.79	14.69	109.9	6593	9.495
1.30	8.982	67.20	4031	5.805	1.80	14.82	110.8	6650	9.576
1.31	9.089	67.99	4079	5.874	1.81	14.94	111.8	6707	9.658
1.32	9.196	68.79	4127	5.943	1.82	15.07	112.7	6764	9.740
1.33	9.303	69.60	4175	6.013	1.83	15.20	113.7	6821	9.823
1.34	9.411	70.40	4224	6.082	1.84	15.33	114.7	6879	9.905
1.35	9.519	71.21	4272	6.152	1.85	15.45	115.6	6936	9.988
1.36	9.628	72.03	4321	6.223	1.86	15.58	116.6	6994	10.07
1.37	9.737	72.84	4370	6.293	1.87	15.71	117.5	7052	10.15
1.38	9.847	73.66	4419	6.364	1.88	15.84	118.5	7110	10.24
1.39	9.957	74.48	4468	6.435	1.89	15.97	119.5	7168	10.32
1.40	10.07	75.31	4518	6.506	1.90	16.10	120.5	7226	10.41
1.41	10.18	76.14	4568	6.578	1.91	16.23	121.4	7285	10.49
1.42	10.29	76.97	4618	6.650	1.92	16.36	122.4	7344	10.58
1.43	10.40	77.81	4668	6.722	1.93	16.49	123.4	7403	10.66
1.44	10.51	78.65	4718	6.794	1.94	16.63	124.4	7462	10.75
1.45	10.63	79.49	4769	6.867	1.95	16.76	125.4	7521	10.83
1.46	10.74	80.33	4819	6.940	1.96	16.89	126.4	7580	10.92
1.47	10.85	81.18	4870	7.013	1.97	17.02	127.4	7640	11.00
1.48	10.97	82.03	4921	7.087	1.98	17.16	128.3	7700	11.09
1.49	11.08	82.88	4972	7.161	1.99	17.29	129.3	7760	11.17
1.50	11.19	83.74	5024	7.235	2.00	17.42	130.3	7820	11.26

12-7: $1^1/_2$ ft. Parshall Flume Discharge Table *(Continued)*

Formulas: CFS = $6.000H^{1.538}$ GPS = CFS x 7.481
GPM = CFS x 448.8 MGD = CFS x 0.6463

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
2.01	17.56	131.3	7880	11.35	2.51	24.71	184.8	11090	15.97
2.02	17.69	132.4	7940	11.43	2.52	24.86	186.0	11160	16.07
2.03	17.83	133.4	8001	11.52	2.53	25.01	187.1	11230	16.17
2.04	17.96	134.4	8061	11.61	2.54	25.16	188.3	11290	16.26
2.05	18.10	135.4	8122	11.70	2.55	25.32	189.4	11360	16.36
2.06	18.23	136.4	8183	11.78	2.56	25.47	190.5	11430	16.46
2.07	18.37	137.4	8245	11.87	2.57	25.62	191.7	11500	16.56
2.08	18.51	138.4	8306	11.96	2.58	25.78	192.8	11570	16.66
2.09	18.64	139.5	8367	12.05	2.59	25.93	194.0	11640	16.76
2.10	18.78	140.5	8429	12.14	2.60	26.08	195.1	11710	16.86
2.11	18.92	141.5	8491	12.23	2.61	26.24	196.3	11780	16.96
2.12	19.06	142.6	8553	12.32	2.62	26.39	197.5	11850	17.06
2.13	19.20	143.6	8615	12.41	2.63	26.55	198.6	11920	17.16
2.14	19.33	144.6	8677	12.50	2.64	26.70	199.8	11980	17.26
2.15	19.47	145.7	8740	12.59	2.65	26.86	200.9	12050	17.36
2.16	19.61	146.7	8802	12.68	2.66	27.02	202.1	12120	17.46
2.17	19.75	147.8	8865	12.77	2.67	27.17	203.3	12190	17.56
2.18	19.89	148.8	8928	12.86	2.68	27.33	204.4	12270	17.66
2.19	20.03	149.9	8991	12.95	2.69	27.49	205.6	12340	17.76
2.20	20.17	150.9	9054	13.04	2.70	27.64	206.8	12410	17.87
2.21	20.32	152.0	9118	13.13	2.71	27.80	208.0	12480	17.97
2.22	20.46	153.0	9181	13.22	2.72	27.96	209.2	12550	18.07
2.23	20.60	154.1	9245	13.31	2.73	28.12	210.3	12620	18.17
2.24	20.74	155.2	9309	13.41	2.74	28.28	211.5	12690	18.27
2.25	20.88	156.2	9373	13.50	2.75	28.43	212.7	12760	18.38
2.26	21.03	157.3	9437	13.59	2.76	28.59	213.9	12830	18.48
2.27	21.17	158.4	9501	13.68	2.77	28.75	215.1	12900	18.58
2.28	21.31	159.4	9566	13.77	2.78	28.91	216.3	12980	18.69
2.29	21.46	160.5	9630	13.87	2.79	29.07	217.5	13050	18.79
2.30	21.60	161.6	9695	13.96	2.80	29.23	218.7	13120	18.89
2.31	21.75	162.7	9760	14.05	2.81	29.39	219.9	13190	19.00
2.32	21.89	163.8	9825	14.15	2.82	29.56	221.1	13260	19.10
2.33	22.04	164.9	9890	14.24	2.83	29.72	222.3	13340	19.21
2.34	22.18	165.9	9955	14.34	2.84	29.88	223.5	13410	19.31
2.35	22.33	167.0	10020	14.43	2.85	30.04	224.7	13480	19.41
2.36	22.47	168.1	10090	14.53	2.86	30.20	225.9	13550	19.52
2.37	22.62	169.2	10150	14.62	2.87	30.37	227.2	13630	19.62
2.38	22.77	170.3	10220	14.72	2.88	30.53	228.4	13700	19.73
2.39	22.92	171.4	10280	14.81	2.89	30.69	229.6	13770	19.84
2.40	23.06	172.5	10350	14.91	2.90	30.85	230.8	13850	19.94
2.41	23.21	173.6	10420	15.00	2.91	31.02	232.0	13920	20.05
2.42	23.36	174.8	10480	15.10	2.92	31.18	233.3	13990	20.15
2.43	23.51	175.9	10550	15.19	2.93	31.35	234.5	14070	20.26
2.44	23.66	177.0	10620	15.29	2.94	31.51	235.7	14140	20.37
2.45	23.81	178.1	10680	15.39	2.95	31.68	237.0	14220	20.47
2.46	23.96	179.2	10750	15.48	2.96	31.84	238.2	14290	20.58
2.47	24.11	180.3	10820	15.58	2.97	32.01	239.4	14360	20.69
2.48	24.26	181.5	10890	15.68	2.98	32.17	240.7	14440	20.79
2.49	24.41	182.6	10950	15.77	2.99	32.34	241.9	14510	20.90
2.50	24.56	183.7	11020	15.87	3.00	32.51	243.2	14590	21.01

12-8: 2 ft. Parshall Flume Discharge Table

Formulas: CFS = $8.000H^{1.550}$ GPS = CFS x 7.481
GPM = CFS x 448.8 MGD = CFS x 0.6463

Head Feet	CFS	GPS	GPM	MGD	Head Feet	CFS	GPS	GPM	MGD
0.01	0.0064	0.0475	2.852	0.0041	0.51	2.817	21.08	1264	1.821
0.02	0.0186	0.1392	8.351	0.0120	0.52	2.903	21.72	1303	1.876
0.03	0.0349	0.2610	15.66	0.0225	0.53	2.990	22.37	1342	1.933
0.04	0.0545	0.4076	24.45	0.0352	0.54	3.078	23.03	1382	1.989
0.05	0.0770	0.5760	34.56	0.0498	0.55	3.167	23.69	1421	2.047
0.06	0.1021	0.7642	45.84	0.0660	0.56	3.257	24.36	1462	2.105
0.07	0.1297	0.9704	58.22	0.0838	0.57	3.347	25.04	1502	2.163
0.08	0.1595	1.194	71.60	0.1031	0.58	3.439	25.73	1543	2.222
0.09	0.1915	1.433	85.94	0.1238	0.59	3.531	26.42	1585	2.282
0.10	0.2255	1.687	101.2	0.1457	0.60	3.624	27.11	1627	2.342
0.11	0.2614	1.955	117.3	0.1689	0.61	3.718	27.82	1669	2.403
0.12	0.2991	2.238	134.2	0.1933	0.62	3.813	28.53	1711	2.465
0.13	0.3386	2.533	152.0	0.2188	0.63	3.909	29.24	1754	2.526
0.14	0.3798	2.842	170.5	0.2455	0.64	4.006	29.97	1798	2.589
0.15	0.4227	3.162	189.7	0.2732	0.65	4.103	30.69	1841	2.652
0.16	0.4672	3.495	209.7	0.3019	0.66	4.201	31.43	1886	2.715
0.17	0.5132	3.839	230.3	0.3317	0.67	4.300	32.17	1930	2.779
0.18	0.5607	4.195	251.7	0.3624	0.68	4.400	32.92	1975	2.844
0.19	0.6098	4.562	273.7	0.3941	0.69	4.501	33.67	2020	2.909
0.20	0.6602	4.939	296.3	0.4267	0.70	4.602	34.43	2066	2.975
0.21	0.7121	5.327	319.6	0.4602	0.71	4.705	35.20	2112	3.041
0.22	0.7653	5.725	343.5	0.4946	0.72	4.808	35.97	2158	3.107
0.23	0.8199	6.134	368.0	0.5299	0.73	4.912	36.75	2204	3.174
0.24	0.8758	6.552	393.1	0.5660	0.74	5.016	37.53	2251	3.242
0.25	0.9330	6.980	418.7	0.6030	0.75	5.122	38.32	2299	3.310
0.26	0.9915	7.418	445.0	0.6408	0.76	5.228	39.11	2346	3.379
0.27	1.051	7.864	471.8	0.6794	0.77	5.335	39.91	2394	3.448
0.28	1.112	8.320	499.2	0.7188	0.78	5.443	40.72	2443	3.518
0.29	1.174	8.786	527.1	0.7590	0.79	5.552	41.53	2492	3.588
0.30	1.238	9.260	555.5	0.7999	0.80	5.661	42.35	2541	3.659
0.31	1.302	9.742	584.5	0.8417	0.81	5.771	43.17	2590	3.730
0.32	1.368	10.23	613.9	0.8841	0.82	5.882	44.00	2640	3.801
0.33	1.435	10.73	643.9	0.9273	0.83	5.993	44.84	2690	3.873
0.34	1.503	11.24	674.4	0.9712	0.84	6.106	45.68	2740	3.946
0.35	1.572	11.76	705.4	1.016	0.85	6.219	46.52	2791	4.019
0.36	1.642	12.28	736.9	1.061	0.86	6.332	47.37	2842	4.093
0.37	1.713	12.82	768.9	1.107	0.87	6.447	48.23	2893	4.167
0.38	1.785	13.36	801.3	1.154	0.88	6.562	49.09	2945	4.241
0.39	1.859	13.91	834.2	1.201	0.89	6.678	49.96	2997	4.316
0.40	1.933	14.46	867.6	1.249	0.90	6.795	50.83	3049	4.391
0.41	2.009	15.03	901.5	1.298	0.91	6.912	51.71	3102	4.467
0.42	2.085	15.60	935.8	1.348	0.92	7.030	52.59	3155	4.544
0.43	2.163	16.18	970.6	1.398	0.93	7.149	53.48	3208	4.620
0.44	2.241	16.76	1006	1.448	0.94	7.268	54.37	3262	4.698
0.45	2.320	17.36	1041	1.500	0.95	7.389	55.27	3316	4.775
0.46	2.401	17.96	1078	1.552	0.96	7.509	56.18	3370	4.853
0.47	2.482	18.57	1114	1.604	0.97	7.631	57.09	3425	4.932
0.48	2.565	19.19	1151	1.657	0.98	7.753	58.00	3480	5.011
0.49	2.648	19.81	1188	1.711	0.99	7.876	58.92	3535	5.090
0.50	2.732	20.44	1226	1.766	1.00	8.000	59.85	3590	5.170

Exhibit C

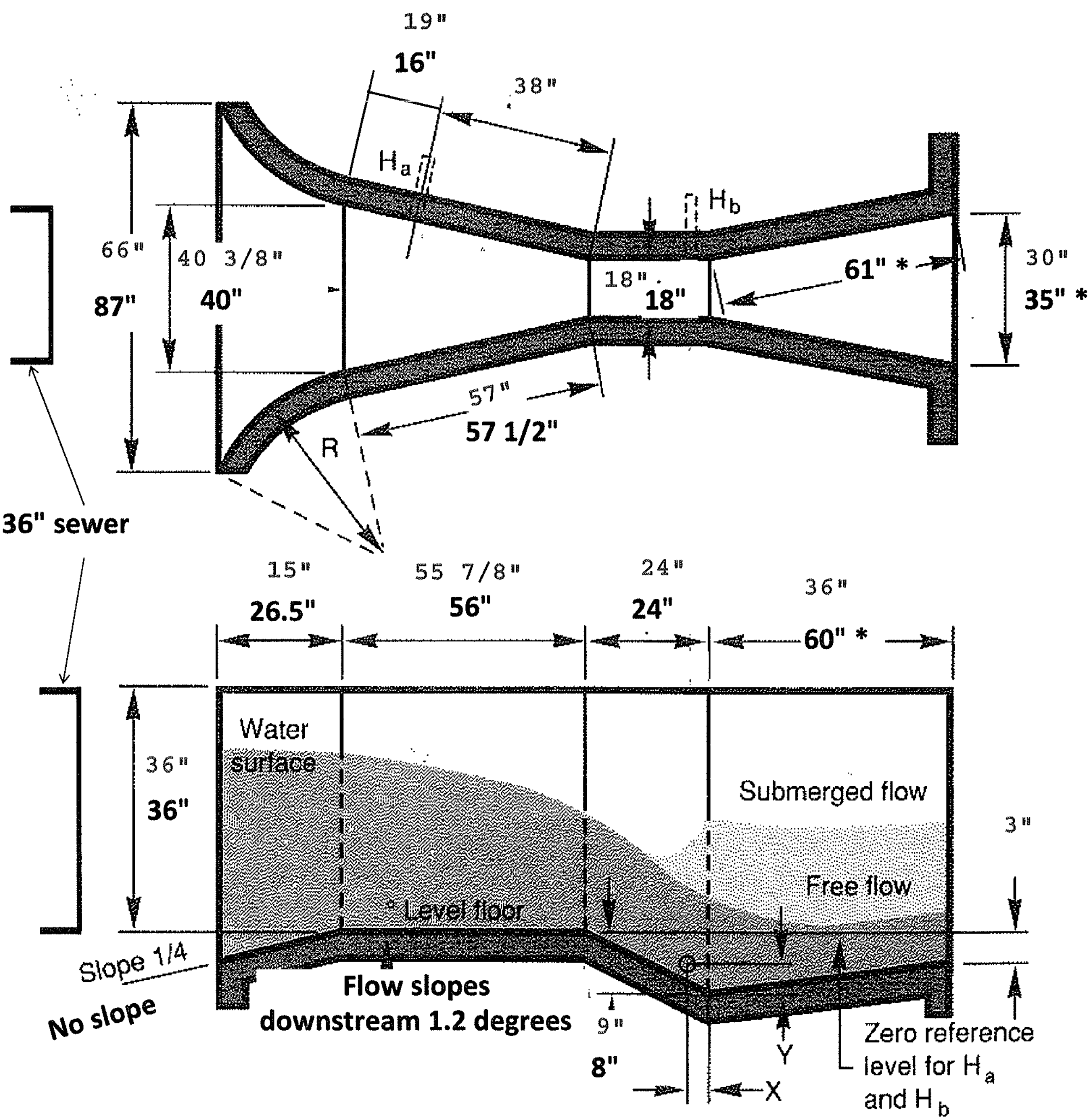
Figure with Parshall Flume Dimensions (specified and field measured)

BROOKTRAILS CSD REVIEW OF CITY OF WILLITS WWTP INFLUENT FLOW METER

COMPARISON OF THE INSTALLED FLUME DIMENSIONS WITH THE SPECIFIED PARSHALL FLUME CONFIGURATION

`Dimensions specified for an 18" Parshall Flume are in this font.`

Dimensions measured at the site are in this font.



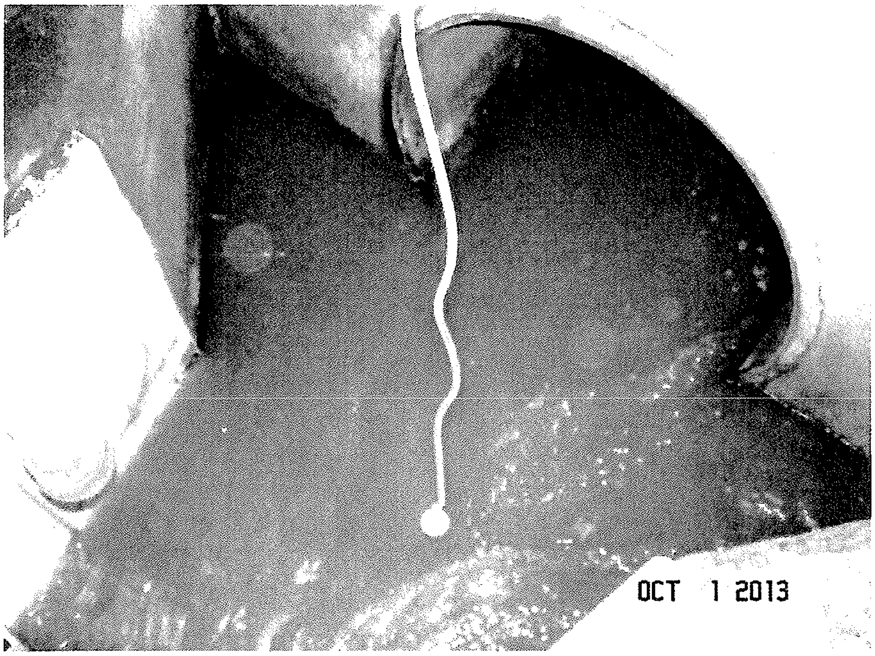
*** Measurement to wall of vault, not end of flume structure**

`Drawing is not to scale.`

Exhibit D

Photographs

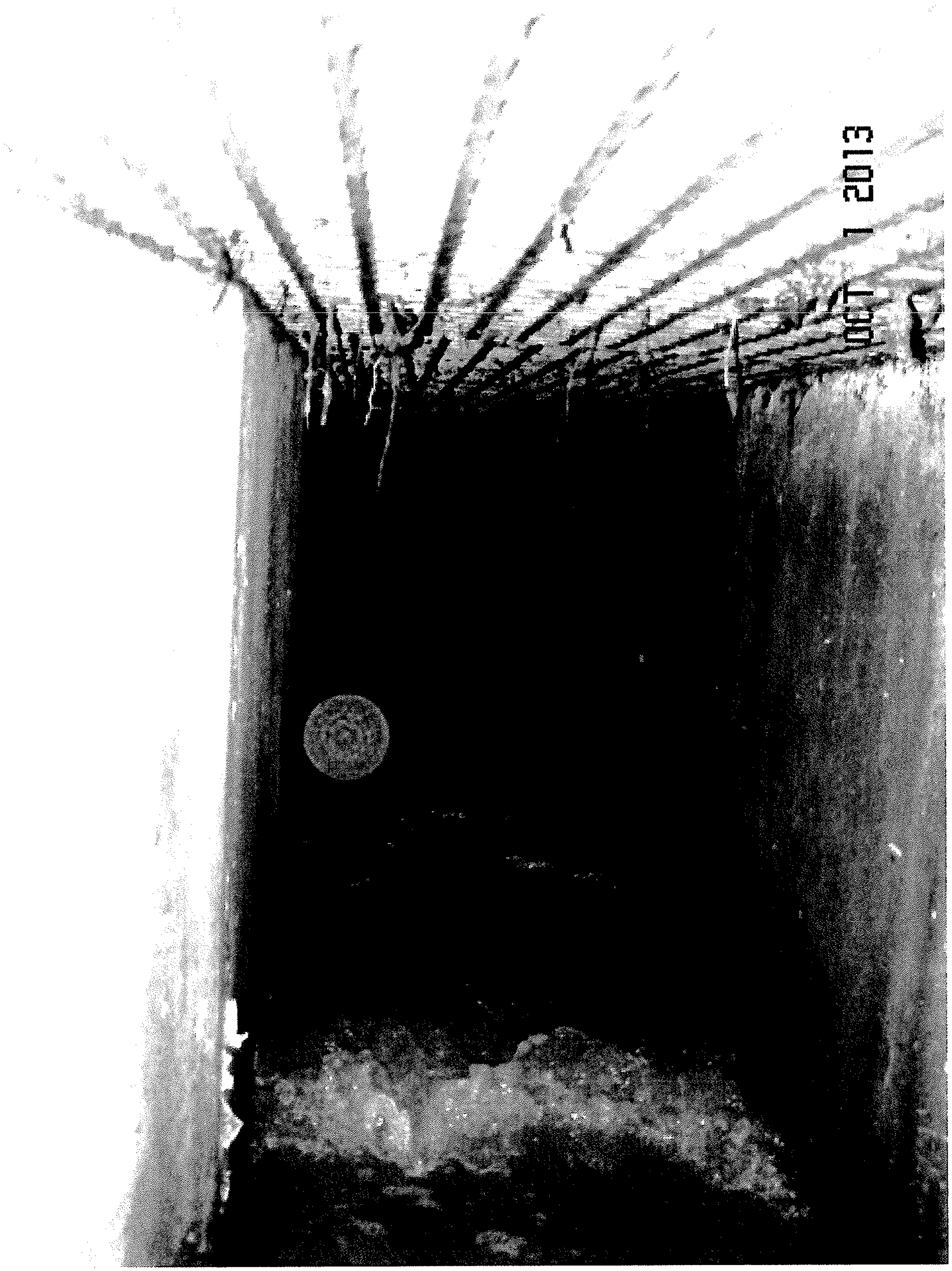
Exhibit D
Photographs of the Flume



1. Inlet to flume. 36" sewer at upper right. Staff gauge and ultrasonic level device at lower left. Device at center is gas detection device for confined space entry.

2. Flume inlet with staff gauge and ultrasonic level instrument. The upstream sewer had been blocked and flow is just starting again.

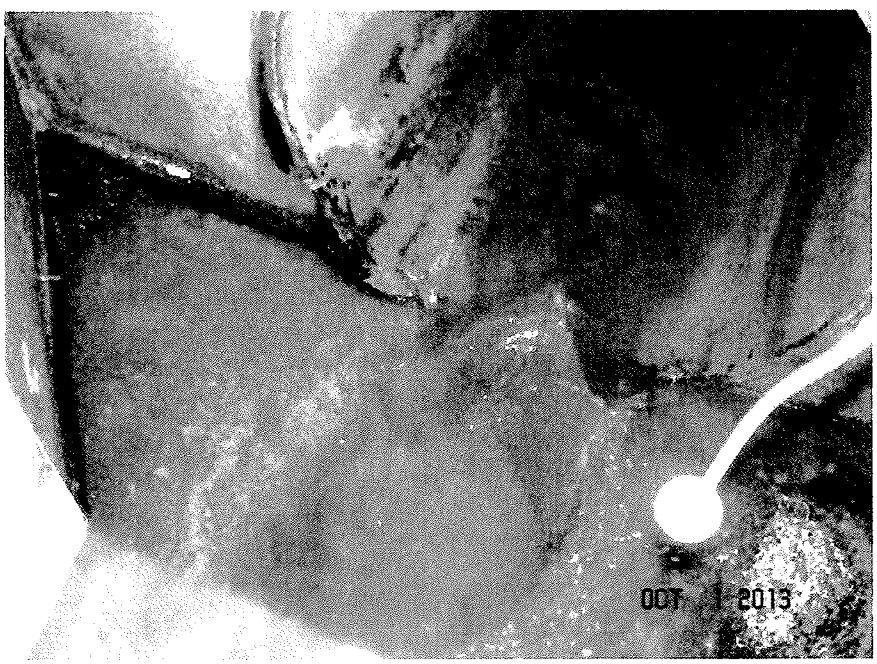
Exhibit D
Photographs of the Flume



3. Looking through the flume downstream. A hydraulic jump is visible in the foreground.

Exhibit D
Photographs of the Flume

4. Debris on floor and obstructing grating above the flume outlet.



5. Inlet flow during period that pig was being deflated,with waves visible

Exhibit E

Field Observation Sheets

Brelje & Race
CONSULTING CIVIL ENGINEERS

Parshall Flume Observation Report

Date: October 1, 2013 @ ________

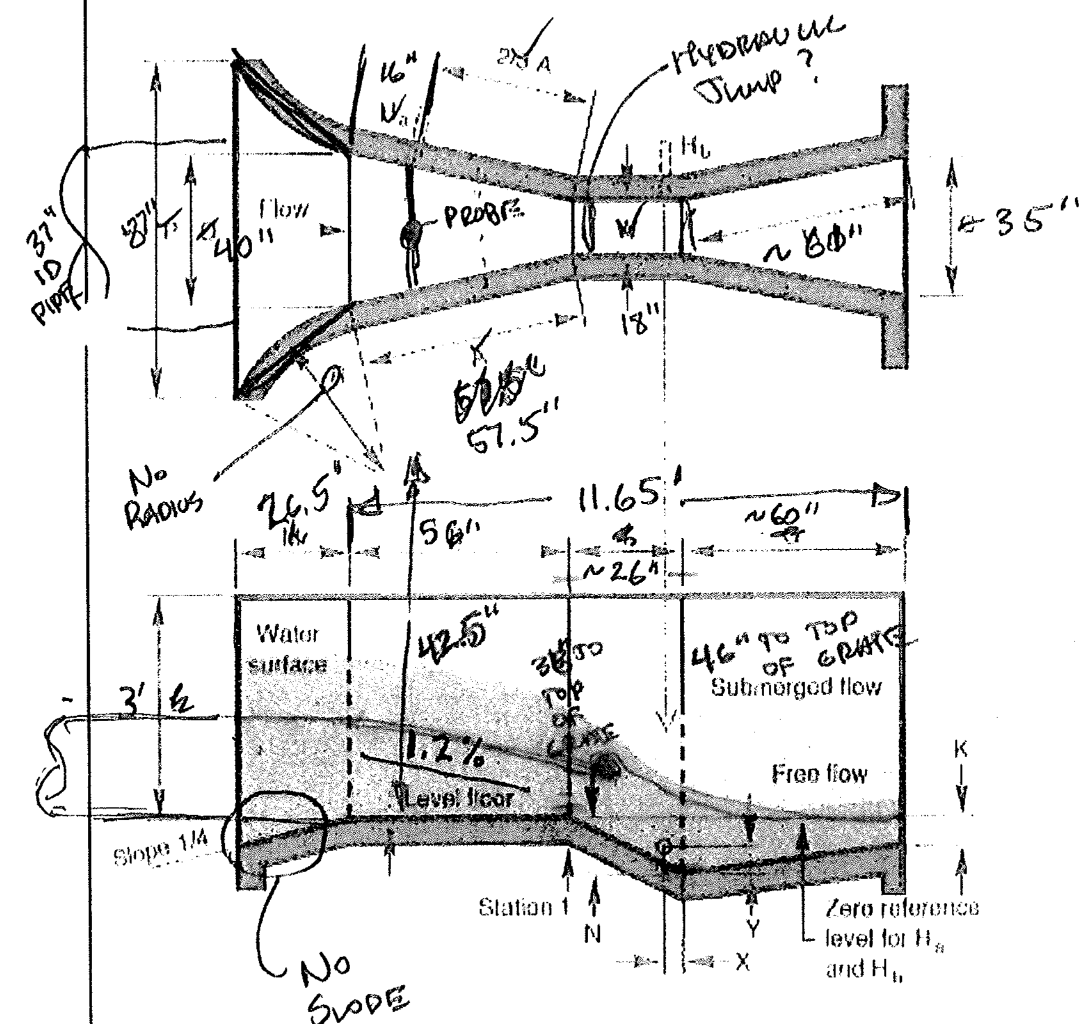
Project Information

Project: City of Willits WWTP Influent Meter	**Owner / Agency:** Brooktrails TCSD

Personnel and Information

Site:	City of Willits Wastewater Treatment Plant
Personnel at Site:	Sarah Yardley (B&R), Benjamin Bryant (B&R),
Activities:	Measure dimensions and alignments of Parshall Flume. Compare measured water depth in flume with readings at plant SCADA.

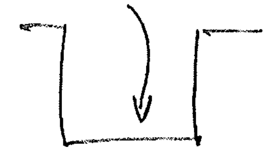
Flume Measurements



W = 18"

RED = NICK'S MEASUREMENTS

FLOOR IS LEVEL



Longitudinally Level?

;ansversely Level?

Brelje & Race CONSULTING CIVIL ENGINEERS

Parshall Flume Observation Report

Field Observations

Upstream Channel:
- Length ______________________
- Obstructions? ______________________
- Description______________________

Downstream Channel:
- Length ______________________
- Obstructions? ______________________
- Description______________________

Flow Characteristics
- Upstream Water Surface ______________________
- Approaching Flow Distribution ______________________
- Downstream Hydraulic Jump? ______________________
- Downstream Submergence? ______________________

Flow/Depth Measurements - using clipboard for bits

Time	Water depth, ~~feet~~ inches	Flow - WWTP reading*	Flow - Table gpm	Comments
11:30	30" 2.5	777 10682 809	11020	
	28 2.33	9723 9747 9800	9890	
	16 1.33	4122 4139	4175	
	14 1.17	3021 3220	3428	
	12 1.00	2403 2406 2405	2693	
	10 0.83	1889 1910 1906	2020	
	8 0.67	1310 1304 1299	1454	
	6 0.5	~~921~~ 809 1079	927	
	4 .33	462 460 464	489	
	2" 0.17	459 459	176	

1.5 0.125 ~~459~~ 120 110

.WWTP ______________________

Brelje & Race
CONSULTING CIVIL ENGINEERS

Parshall Flume Observation Report

Field Observations

Upstream Channel:
Length ____________
Obstructions? ____________
Description ____________

Downstream Channel:
Length ____________
Obstructions? ____________
Description ____________

Flow Characteristics
Upstream Water Surface ____________
Approaching Flow Distribution ____________
Downstream Hydraulic Jump? ____________
Downstream Submergence? ____________

Flow/Depth Measurements   Sewage

Time	Water depth, feet	Flow - WWTP reading*	Flow - Table	Comments
12:19	0.2	ø		
	0.3	ø		
	0.35 0.4	ø ø 554		
	0.5	693 696		
	0.55	812		
	0.6	1003 877 998		
	0.65	884		
	0.7 0.7	1155 1369		
	0.74 .78	~~[illegible]~~ 1457 1478		
	.8 .8	1493 1612	[illegible]	pulling pig

WWTP ____________

Exhibit F

Comparison of displayed flows with values in Parshall Flume discharge table

BROOKTRAILS CSD REVIEW OF CITY OF WILLITS WWTP INFLUENT PARSHALL FLUME **October 1, 2013**

COMPARISON OF SCADA FLOW READINGS WITH TABULATED FLUME FLOW VALUES, FOR MEASURED WATER DEPTHS

allowable error -3%

TRIAL NO.1 - USE OF BOARD TO SIMULATE WATER DEPTH

Board Height*, feet	Flow Readings Recorded from Treatment Plant Operator Interface, gpm						Flow Values from Parshall Flume Discharge Table, gpm			Potential Percent Error due to Visual Measurement Method	Difference in flow***		Acceptable error (allowable + meas'mt errors)	Was read within acceptable error?
	Read No.1	Read No.2	Read No.3	Read No.4	Read No.5	Average**	for Ht -0.02'	for Ht	for Ht + 0.02'		gpm	percent		
2.50	~~797~~	10,682	~~807~~			10,682	10,890	11,020	11,160	-1.2% to 1.3%	-338	-3.1%	-4.2%	YES
2.33	9,773	9,747	9,800			9,773	9,760	9,890	10,020	-1.3% to 1.3%	-117	-1.2%	-4.3%	YES
1.33		4,122	4,139			4,131	4,079	4,175	4,272	-2.2% to 2.3%	-44	-1.1%	-5.2%	YES
1.17		3,037	3,220			3,129	3,339	3,428	3,519	-2.5% to 2.7%	-299	-8.7%	-5.5%	NO
1.00	2,403	2,406	2,405			2,405	2,610	2,693	2,776	-3.0% to 3.1%	-288	-10.7%	-6.0%	NO
0.83	~~1,889~~	1,910	1,906			1,908	1,947	2,022	2,097	-3.6% to 3.7%	-114	-5.6%	-6.6%	YES
0.67	1,310	1,304	1,299			1,304	1,388	1,454	1,522	-4.3% to 4.7%	-150	-10.3%	-7.3%	NO
0.50	927	809	1,029			922	871	927	985	-5.7% to 6.3%	-5	-0.5%	-8.7%	YES
0.33	462	460	464			462	444	489	536	-8.4% to 9.6%	-27	-5.5%	-11.4%	YES
0.17		459	459			459	146	176	209	-14.4% to 18.8%	283	160.8%	21.8%	NO
0.13		~~459~~	120			120	90	117	146	-18.5% to 24.8%	3	2.6%	27.8%	YES

7 of 11 were within allowable error + measurement error

TRIAL NO.2 - MEASUREMENT OF WATER DEPTH AS INFLATED PIG WAS REMOVED FROM THE SEWER

Water Depth*, feet	Flow Readings Recorded from Treatment Plant Operator Interface, gpm						Flow Values from Parshall Flume Discharge Table, gpm			Potential Percent Error due to Visual Measurement Method	Difference in flow***		Acceptable error (allowable + meas'mt errors)	Was read within acceptable error?
	Read No.1	Read No.2	Read No.3	Read No.4	Read No.5	Average**	for Ht -0.02'	for Ht	for Ht + 0.02'		gpm	percent		
0.20	0	0	0			0	193	227	262	-13.0% to 15.4%	-227	-100.0%	-16.0%	NO
0.30	0	0	0			0	380	423	467	-9.2% to 10.4%	-423	-100.0%	-12.2%	NO
0.35	0	0	0			0	489	536	584	-8.0% to 9.0%	-536	-100.0%	-11.0%	NO
0.40	0	554				554	608	658	709	-7.1% to 7.8%	-104	-15.8%	-10.1%	NO
0.50		693	696			695	871	927	985	-5.7% to 6.3%	-232	-25.0%	-8.7%	NO
0.55	812					812	1,014	1,074	1,134	-5.3% to 5.6%	-262	-24.4%	-8.3%	NO
0.60	1,003	877	998			959	1,165	1,227	1,291	-4.8% to 5.2%	-268	-21.8%	-7.8%	NO
0.65	884					884	1,323	1,388	1,454	-4.5% to 4.8%	-504	-36.3%	-7.5%	NO
0.70	1,155	1,369				1,262	1,488	1,556	1,625	-4.2% to 4.4%	-294	-18.9%	-7.2%	NO
0.74	1,457					1,457	1,625	1,695	1,766	-4.0% to 4.2%	-238	-14.0%	-7.0%	NO
0.78	1,478					1,478	1,766	1,838	1,911	-3.8% to 4.0%	-360	-19.6%	-6.8%	NO
0.80	~~1,493~~	1612				1,612	1,838	1,911	1,984	-3.7% to 3.8%	-299	-15.6%	-6.7%	NO
0.85	1,846	1836				1,841	2,022	2,097	2,174	-3.4% to 3.7%	-256	-12.2%	-6.4%	NO
0.90	~~1,891~~	~~1,838~~	2178	1967	1974	2,040	2,212	2,290	2,369	-3.3% to 3.4%	-250	-10.9%	-6.3%	NO
0.95	2,129	2128				2,129	2,408	2,489	2,570	-3.2% to 3.3%	-360	-14.5%	-6.2%	NO
1.00	~~2,128~~	2281	2297	2305		2,294	2,610	2,693	2,776	-3.0% to 3.1%	-399	-14.8%	-6.0%	NO
1.08	~~2,305~~	2488	2498	2497		2,494	3,031	3,031	3,118	0.0% to 2.9%	-537	-17.7%	-3.0%	NO

Average percent difference between displayed and discharge table flow values -18.7%

All displayed flow values were greater than table readings + allowable error + measurement error

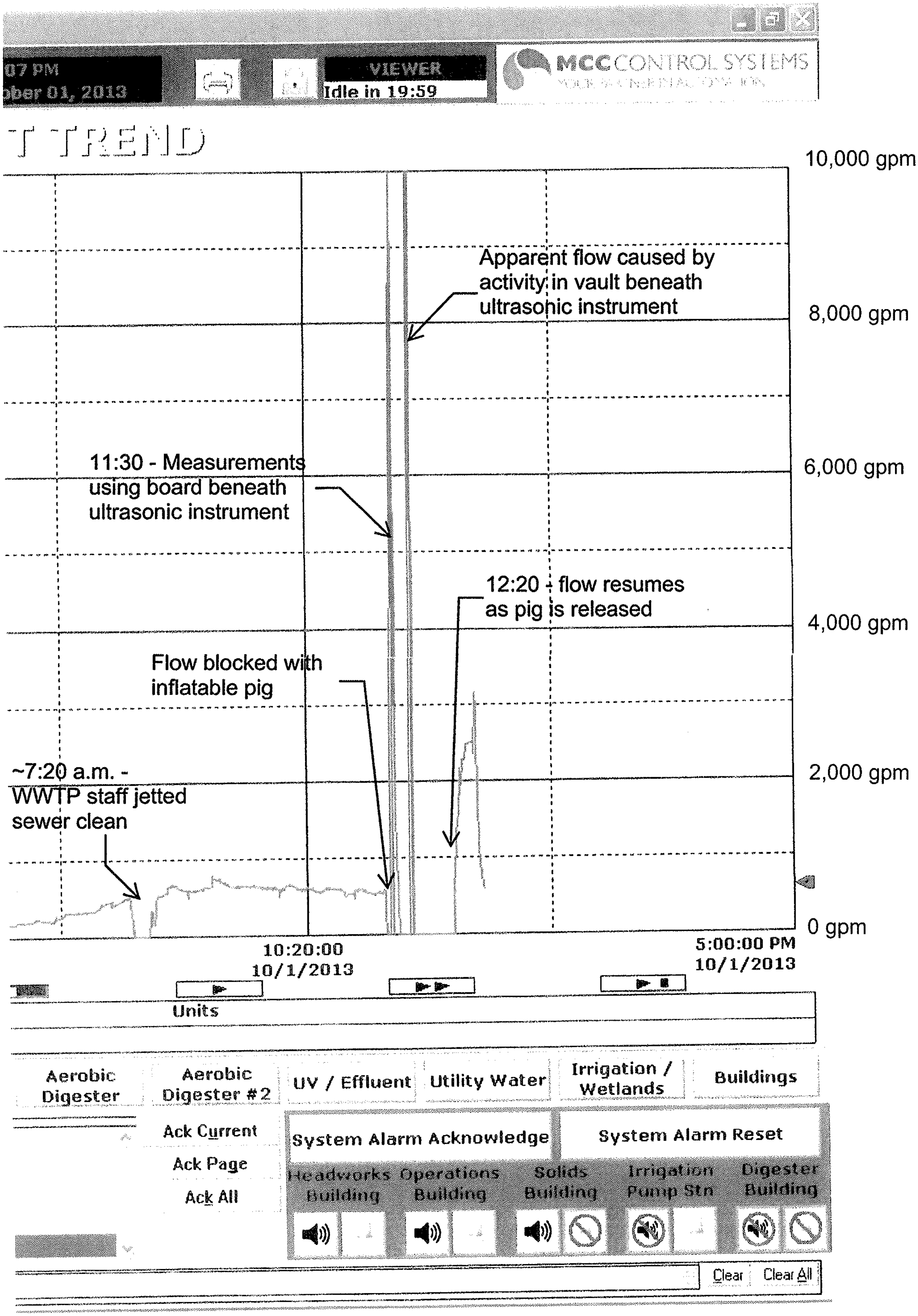
*Field measurement

**Values not used in average are shown as crossed-out.

*** Difference between value from discharge table and value read at operator interface

Exhibit G

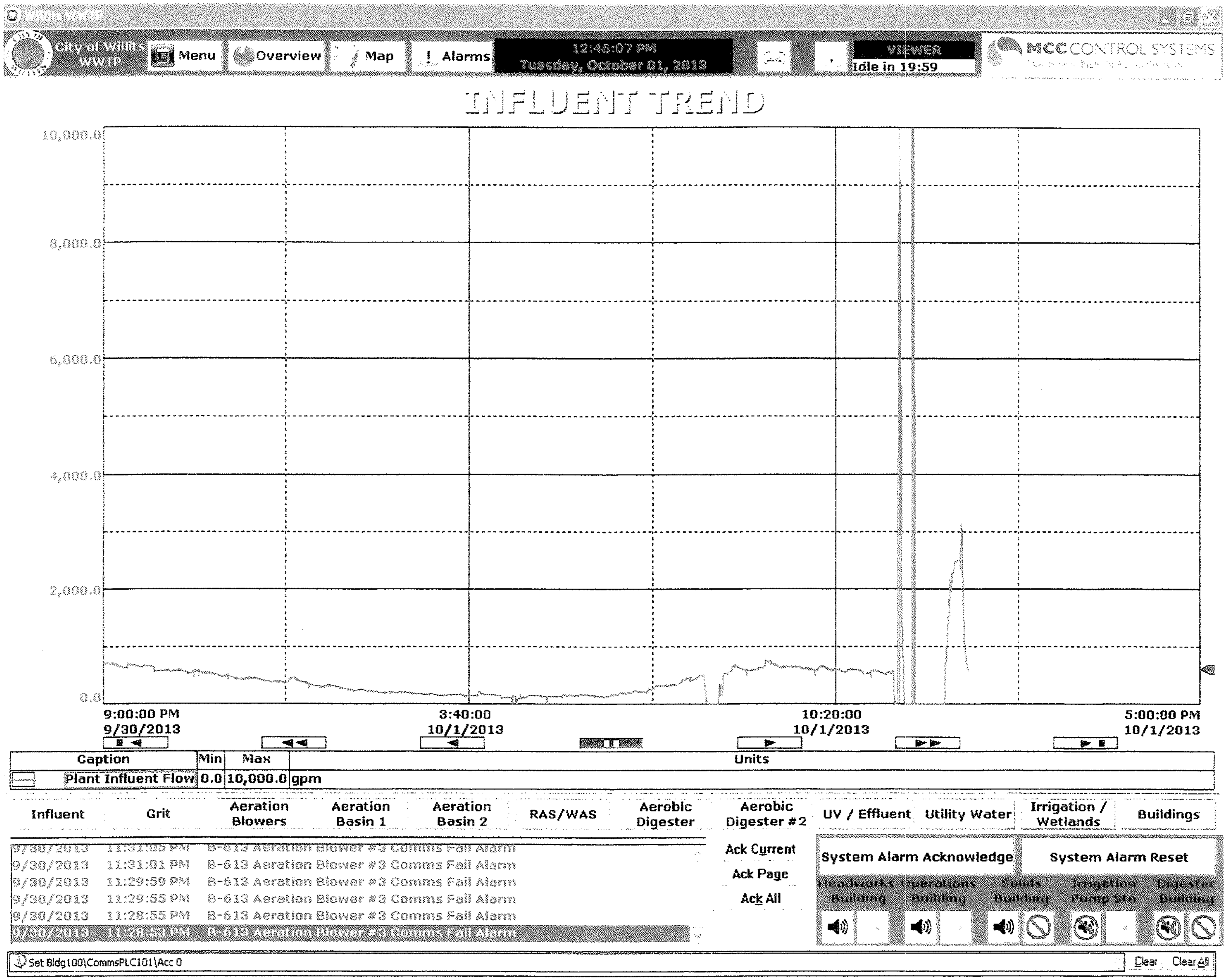
City WWTP SCADA trending graph for influent flow, morning of October 1, 2013



07 PM
ober 01, 2013
VIEWER
Idle in 19:59
MCC CONTROL SYSTEMS
T TREND
10,000 gpm
8,000 gpm
6,000 gpm
4,000 gpm
2,000 gpm
0 gpm
Apparent flow caused by activity in vault beneath ultrasonic instrument
11:30 - Measurements using board beneath ultrasonic instrument
12:20 - flow resumes as pig is released
Flow blocked with inflatable pig
~7:20 a.m. - WWTP staff jetted sewer clean
10:20:00 10/1/2013
5:00:00 PM 10/1/2013
Units
Aerobic Digester
Aerobic Digester #2
UV / Effluent
Utility Water
Irrigation / Wetlands
Buildings
Ack Current
Ack Page
Ack All
System Alarm Acknowledge
System Alarm Reset
Headworks Building
Operations Building
Solids Building
Irrigation Pump Stn
Digester Building
Clear
Clear All

Exhibit H

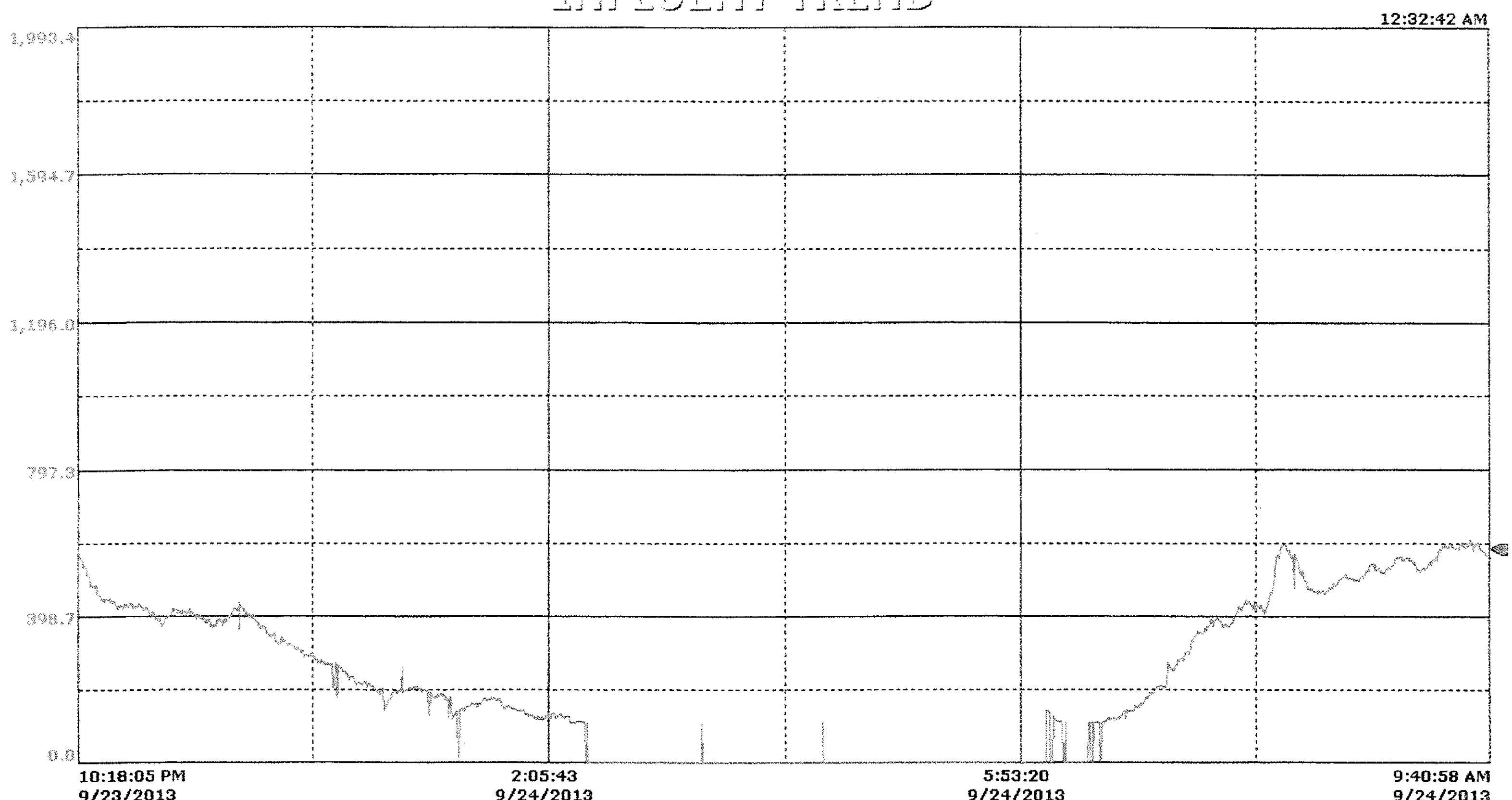
City WWTP SCADA trending graphs for influent flow, night hours of September 24 and October 1, 2013


Willits WWTP
City of Willits WWTP
Menu
Overview
Map
Alarms
12:46:07 PM
Tuesday, October 01, 2013
VIEWER
Idle in 19:59
MCC CONTROL SYSTEMS
INFLUENT TREND
10,000.0
8,000.0
6,000.0
4,000.0
2,000.0
0.0
9:00:00 PM 9/30/2013
3:40:00 10/1/2013
10:20:00 10/1/2013
5:00:00 PM 10/1/2013
Caption
Min
Max
Units
Plant Influent Flow
0.0
10,000.0
gpm
Influent
Grit
Aeration Blowers
Aeration Basin 1
Aeration Basin 2
RAS/WAS
Aerobic Digester
Aerobic Digester #2
UV / Effluent
Utility Water
Irrigation / Wetlands
Buildings
9/30/2013 11:31:01 PM B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013 11:29:59 PM B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013 11:29:55 PM B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013 11:28:55 PM B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013 11:28:53 PM B-613 Aeration Blower #3 Comms Fail Alarm
Ack Current
Ack Page
Ack All
System Alarm Acknowledge
System Alarm Reset
Headworks Building
Operations Building
Solids Building
Irrigation Pump Sta
Digester Building
Set Bldg100\CommsPLC101\Acc 0
Clear
Clear All

Willits WWTP

City of Willits WWTP | Menu | Overview | Map | Alarms | 12:53:40 PM Tuesday, October 01, 2013 | VIEWER Idle in 20:00 | MCC CONTROL SYSTEMS

INFLUENT TREND



Caption	Min	Max	Units
Plant Influent Flow	0.0	1,993.4	gpm

Influent | Grit | Aeration Blowers | Aeration Basin 1 | Aeration Basin 2 | RAS/WAS | Aerobic Digester | Aerobic Digester #2 | UV / Effluent | Utility Water | Irrigation / Wetlands | Buildings

9/30/2013	11:42:51 PM	B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013	11:42:47 PM	B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013	11:41:47 PM	B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013	11:41:43 PM	B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013	11:40:43 PM	B-613 Aeration Blower #3 Comms Fail Alarm
9/30/2013	11:40:39 PM	B-613 Aeration Blower #3 Comms Fail Alarm

Ack Current
Ack Page
Ack All

System Alarm Acknowledge | System Alarm Reset

Headworks Building | Operations Building | Solids Building | Irrigation Pump Stn | Digester Building

Set Bldg100\CommsPLC101\Acc 0 | Clear | Clear All

Subject: RE: Sewage system meter readings
From: "Joanne Cavallari" <Joanne@WillitsCity.com>
Date: 10/1/2012 9:05 AM
To: "'Mike Phelan'", "'Lori Mayo'"
CC: "'Paul Cayler'"

Good Morning Mike & Lori:

The readings for August 1, September 1, and October 1 are:

	Influent	Brooktrails (External)
August 1	4,728,892	645,153
September 1	4,754,995	650,754
October 1	4,779,590	656,258

Let me know if you need any other information.

Joanne