

Scattergraphs Used to Reduce Scattered Results

Matthew Brown
Kevin Enfinger, P.E.
Pat Stevens, P.E.

NEWEA Collection Systems Specialty Conference & Exhibit
September 10, 2018

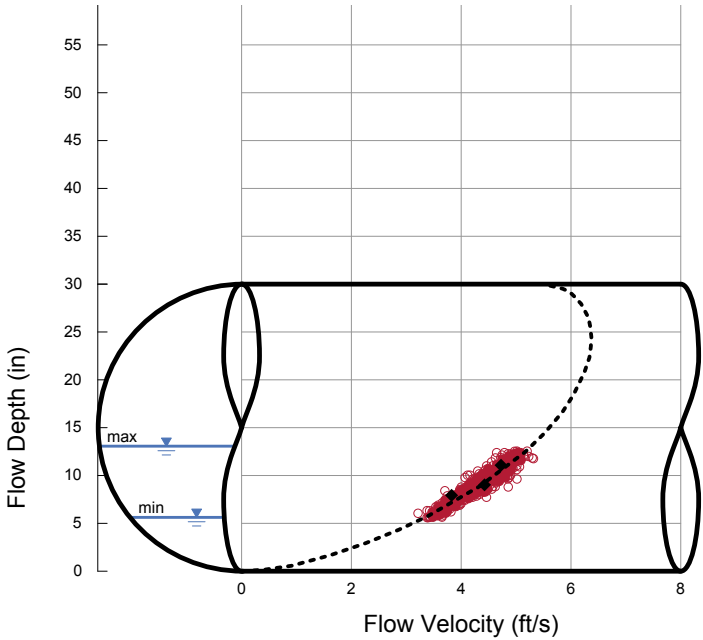
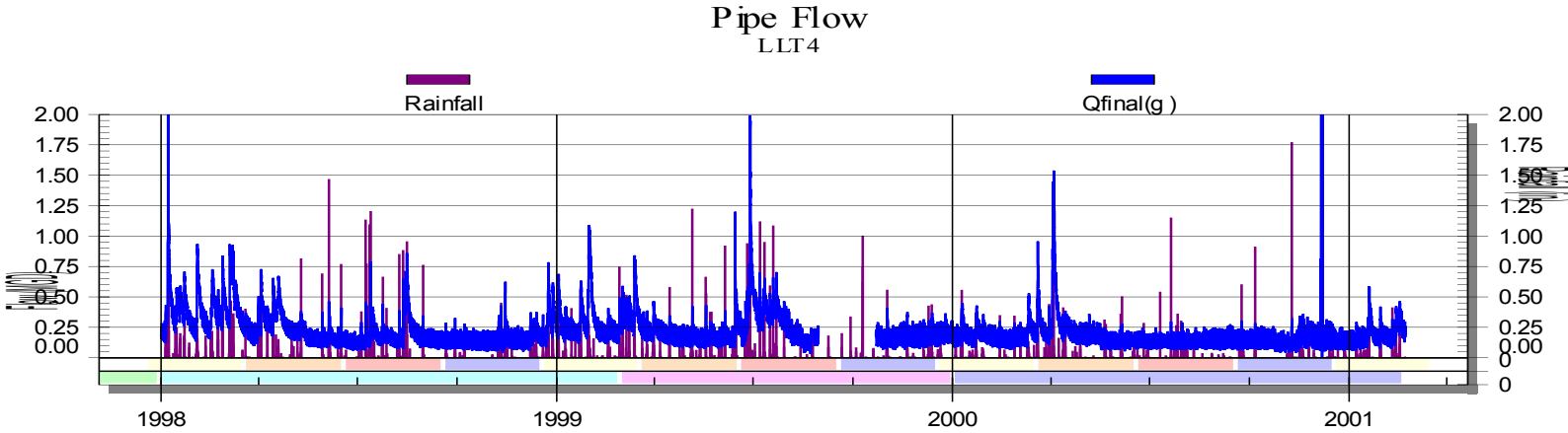
Overview

- What is a Scattergraph in Relation to Flow Monitoring Data
- How to Use a Scattergraph in QA/QC
- Extra Benefits of Using Scattergraphs in Wet Weather Analysis

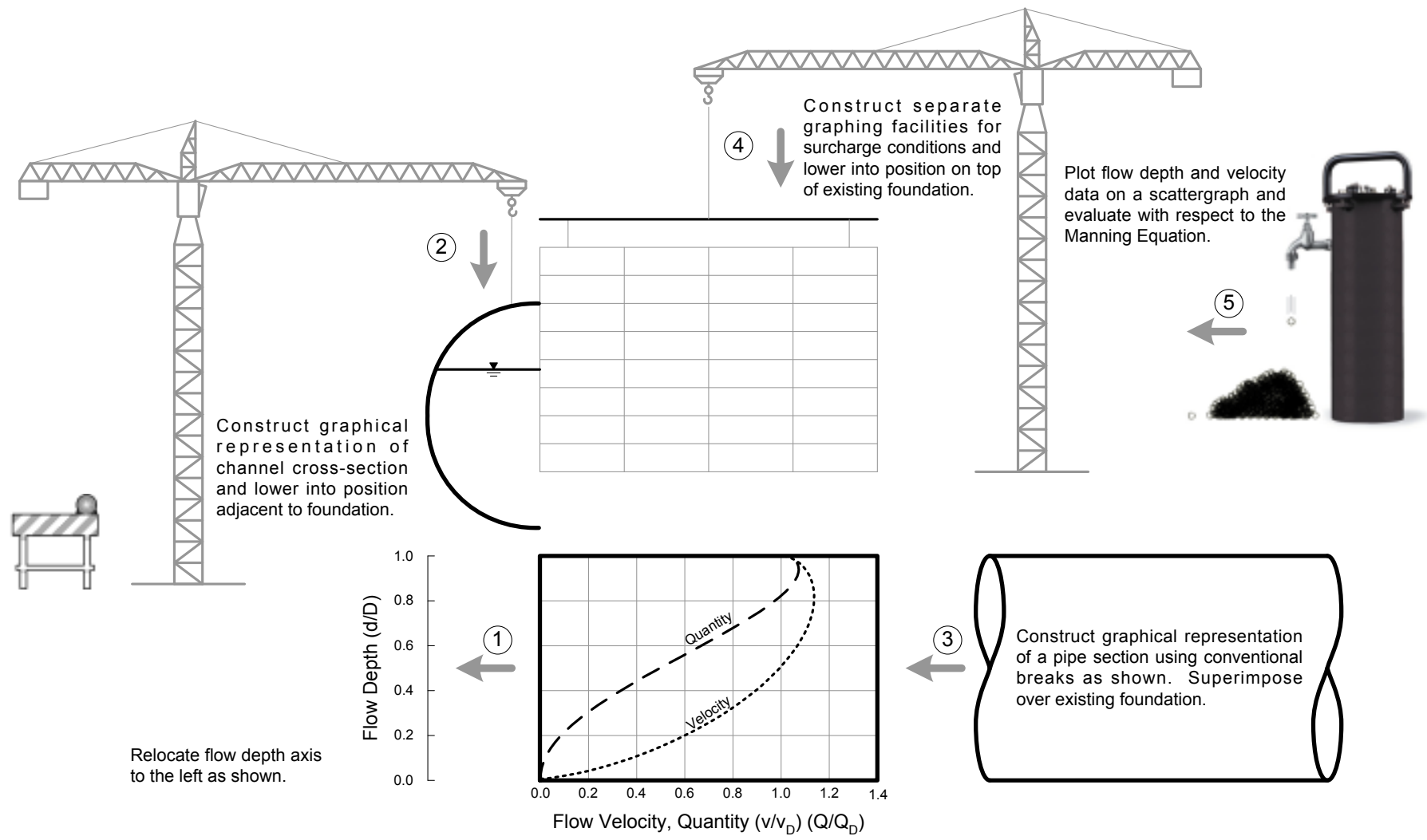
Why Do We Flow Monitor



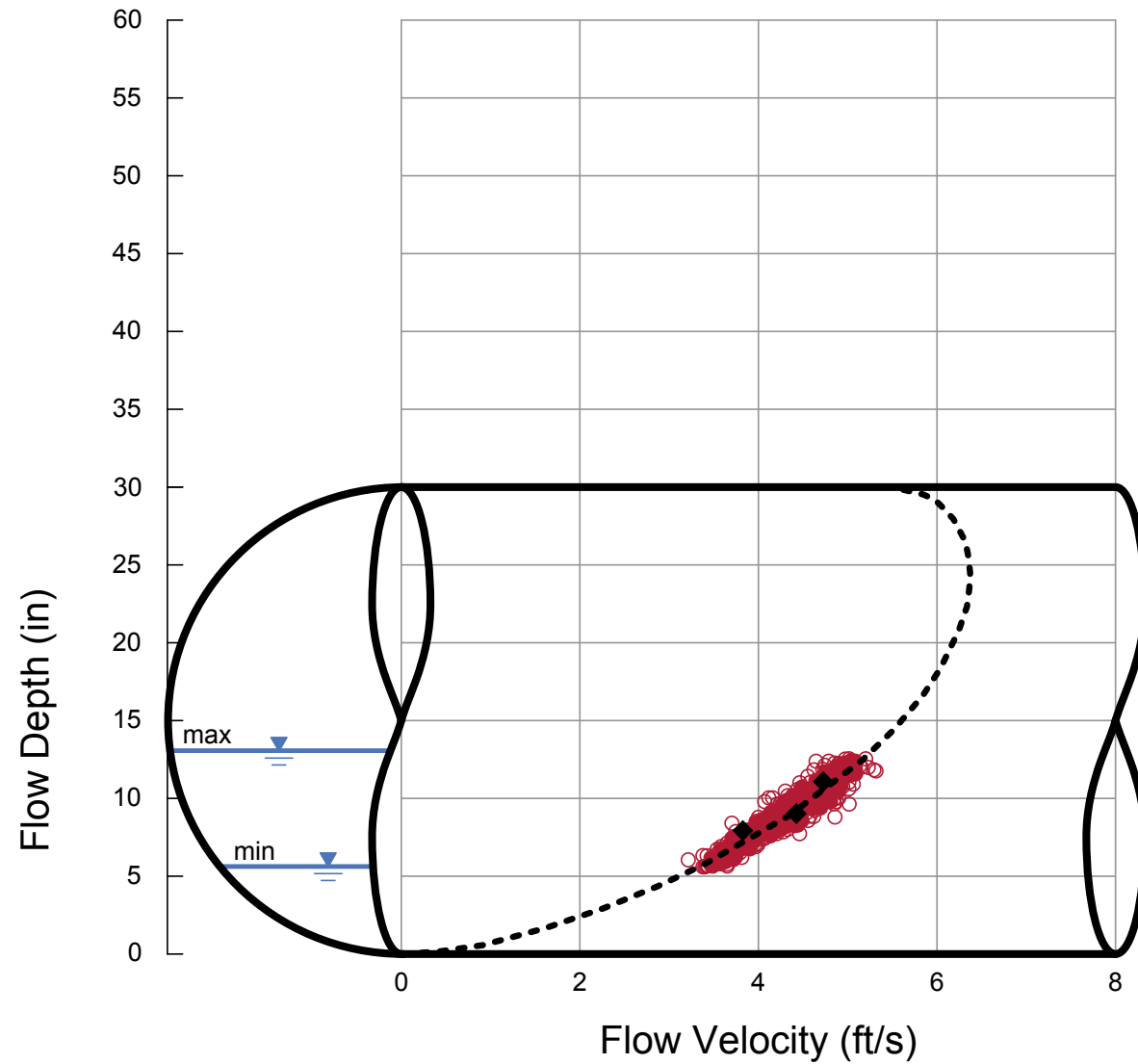
What to Do with Flow Monitoring Data



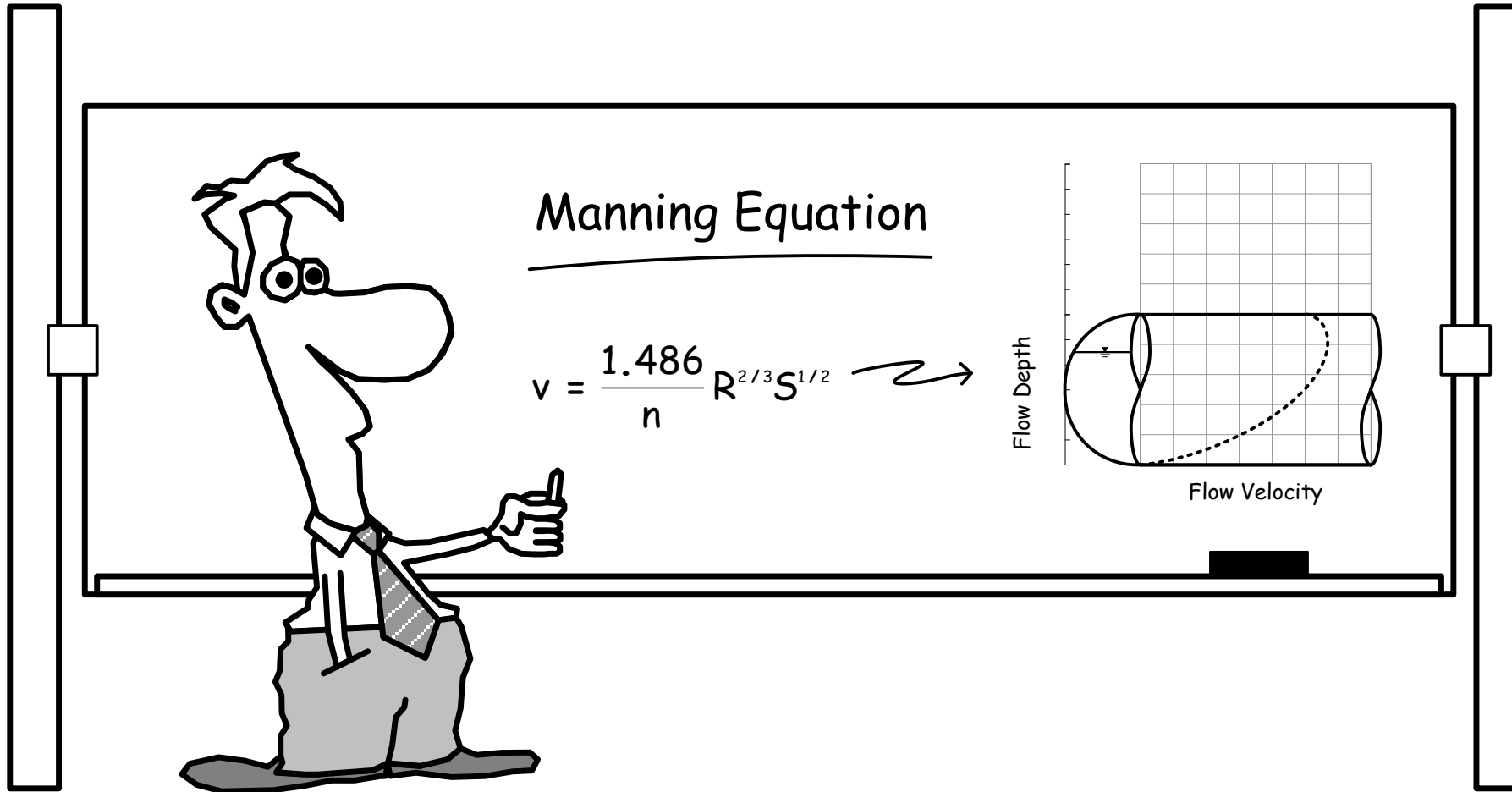
Formula for Constructing a Scattergraph



The Scattergraph in all of Its Glory!



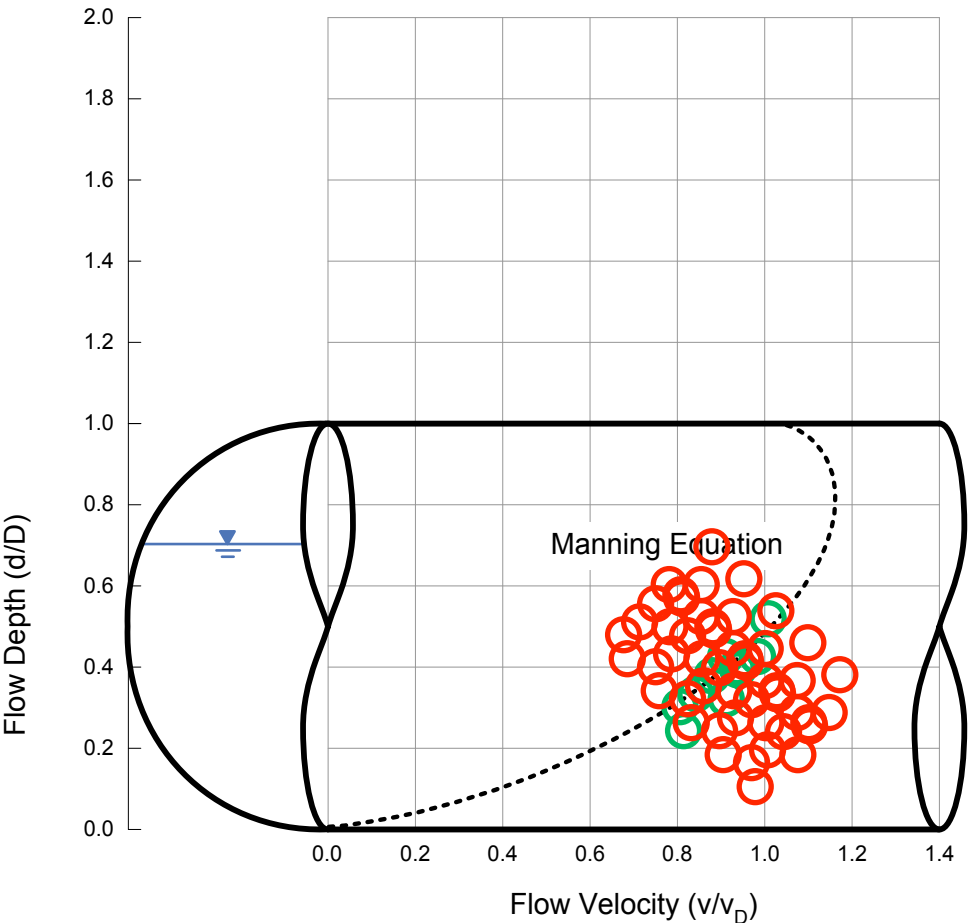
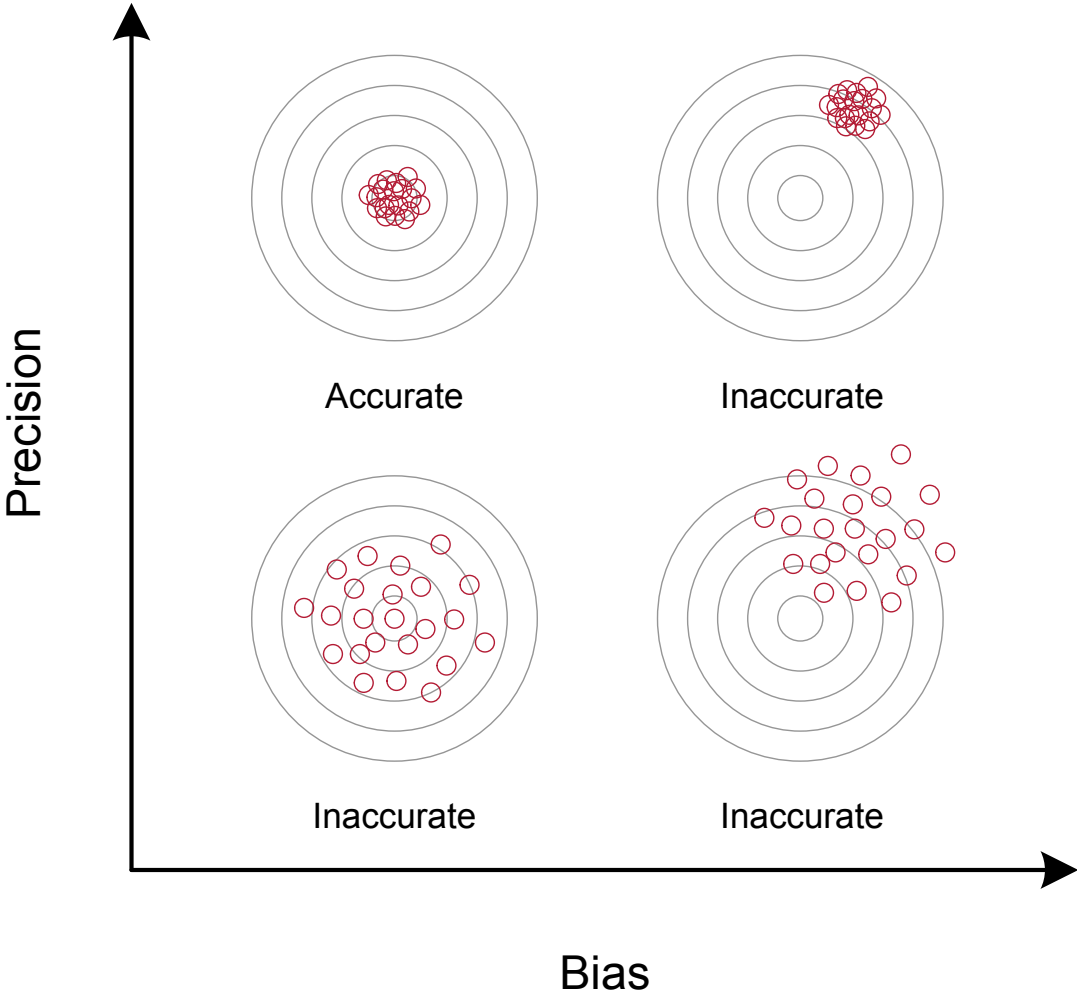
Design Curves Provide Scientific Approach to Evaluate Flow Behavior



The **Manning Equation** is an empirical formula that describes a relationship between depth and velocity under ideal conditions and is commonly used to design sewer systems.

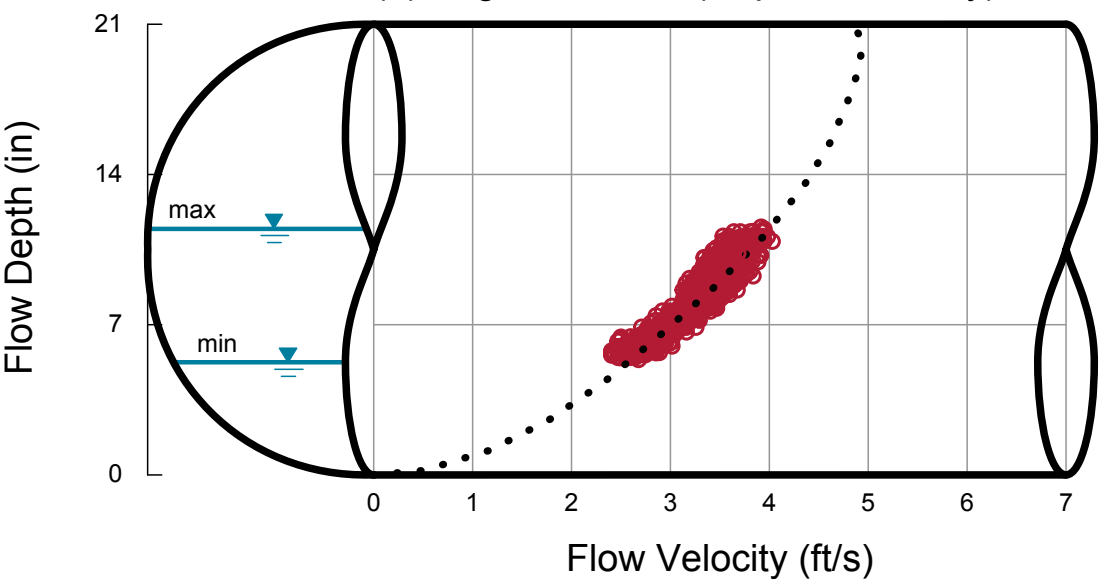
In order for the **Manning Equation** to apply, the sewer must be in free flow/ gravity flow conditions.

Precision and Accuracy Applied to Flow Data

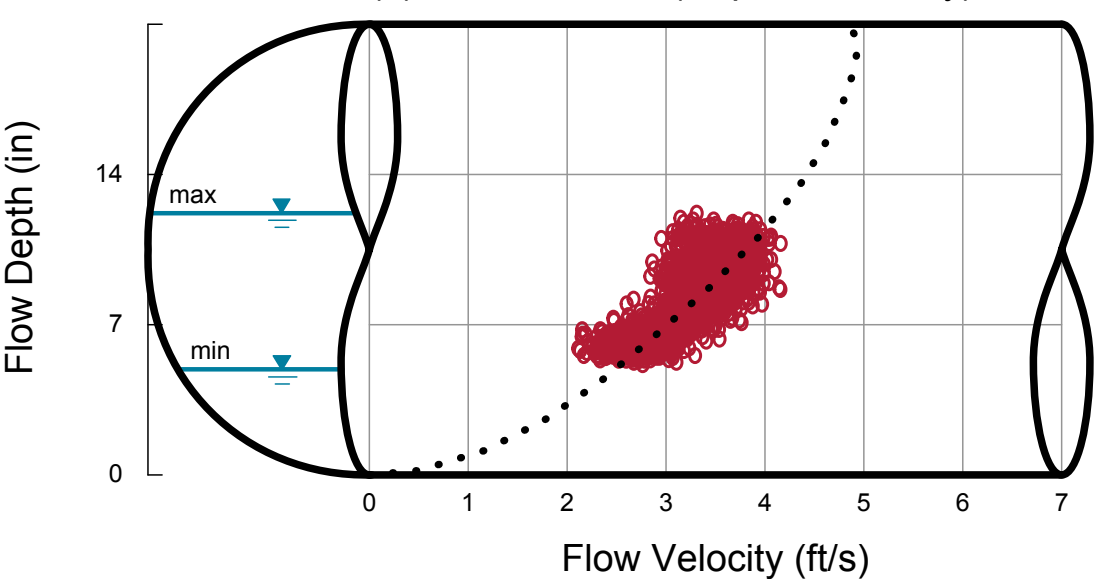


Precision and Accuracy Applied to Flow Data

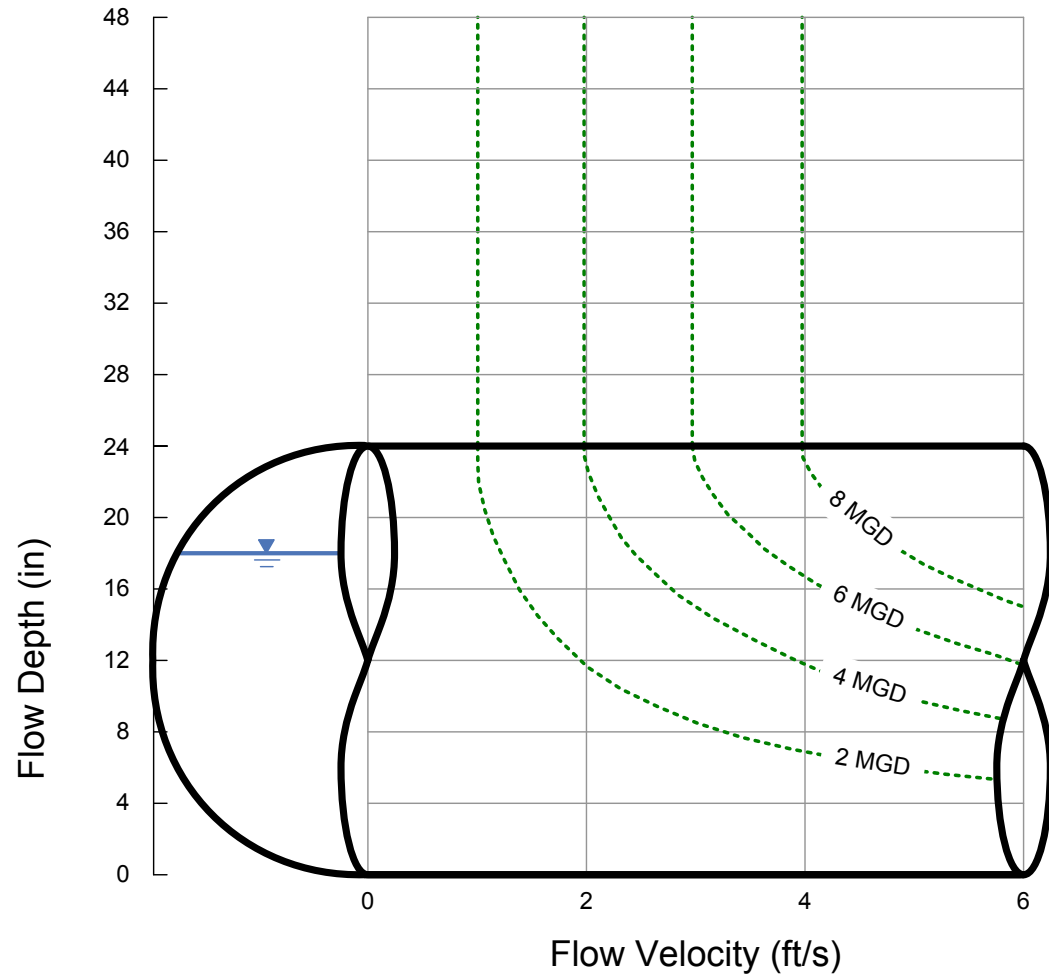
(a) High Precision (Depth & Velocity)



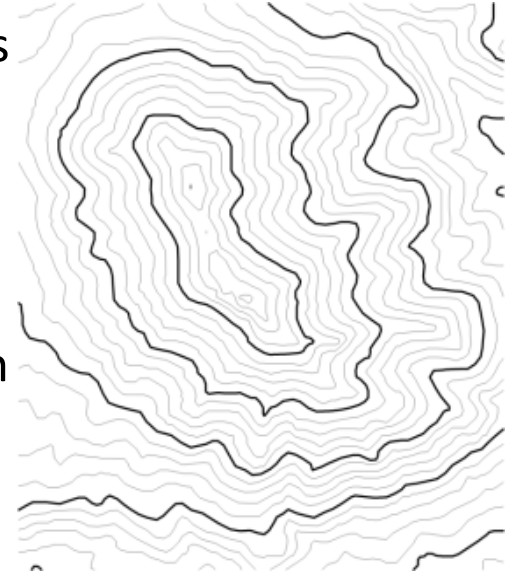
(b) Low Precision (Depth & Velocity)



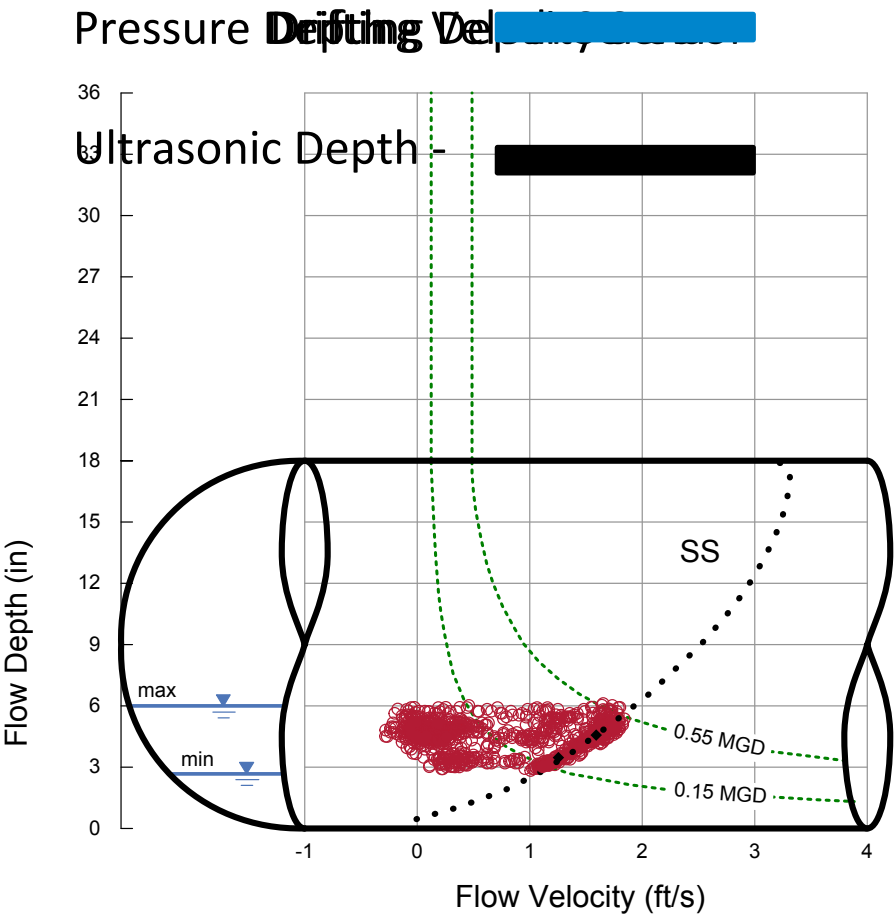
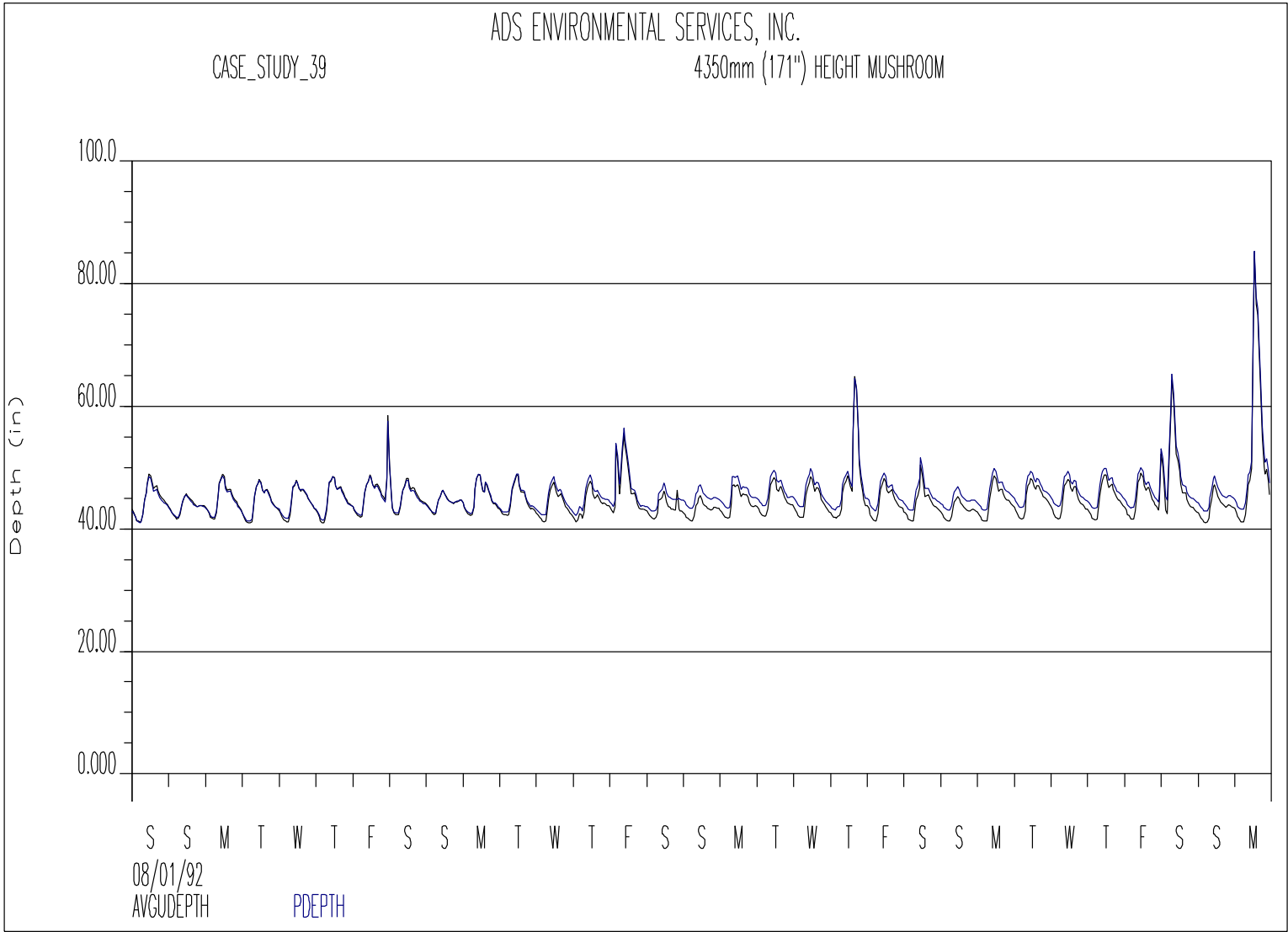
Adding Even More Value to Your Scattergraph – ISO Q Lines



- Iso-Q lines are analogous to contour lines on a topographic map.
- When you cross contour Lines, you go up or down in elevation.
- When you cross Iso-Q lines, you go up or down in flow rate.

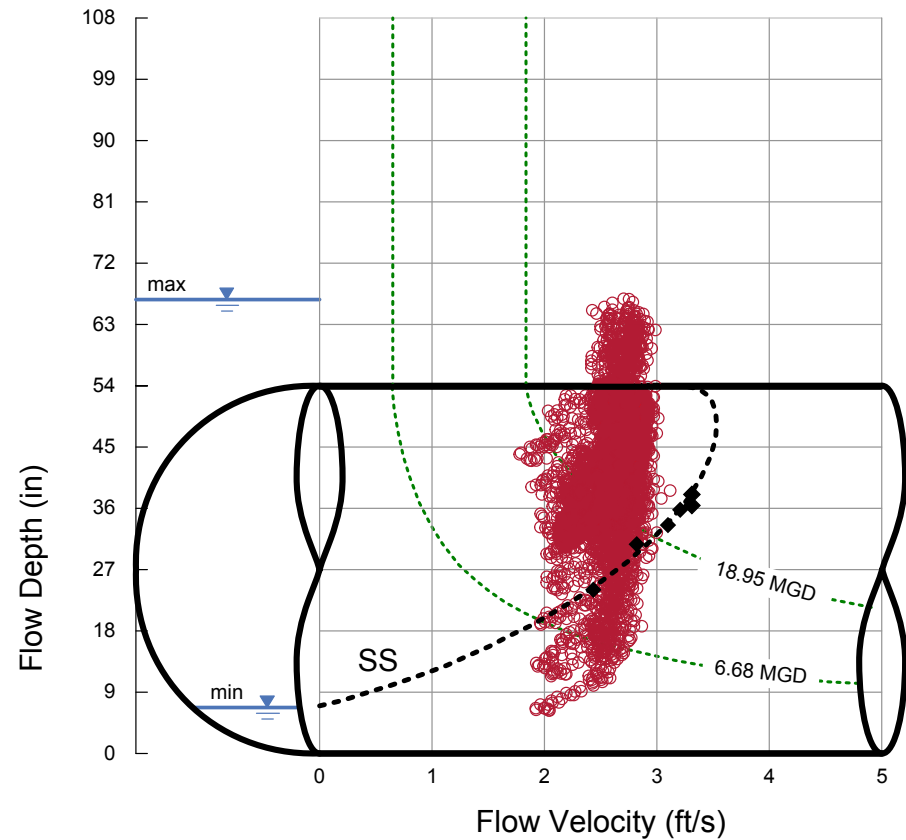


Scattergraphs in QA/QC Procedures



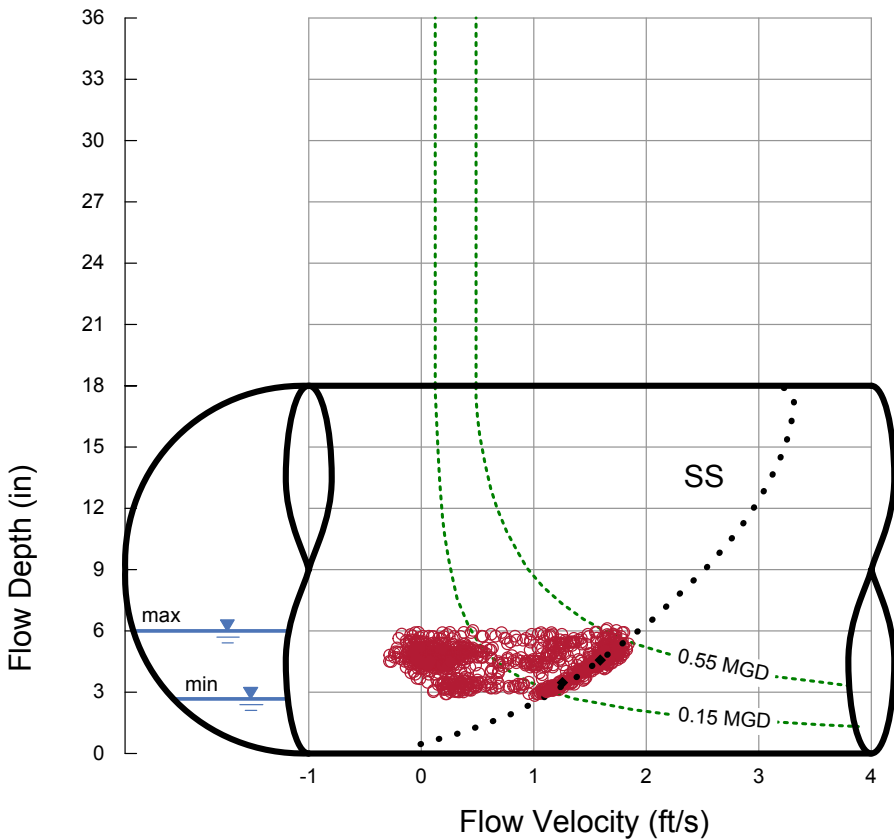
Scattergraphs in QA/QC Procedures

Drifting Depth Sensor



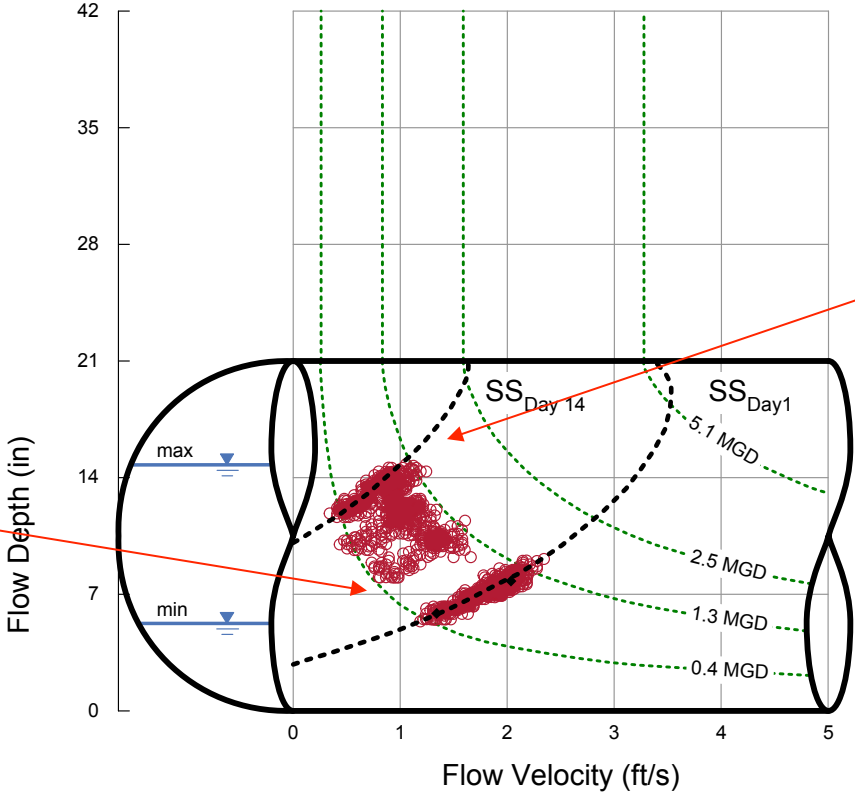
Remember
According to a design curve all changes in one either depth or velocity should warrant a change in its counterpart.

Drifting Velocity Sensor

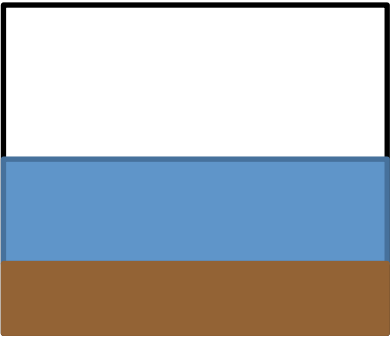


Debris Accumulation

Pipe Day 1
No Sediment or Debris

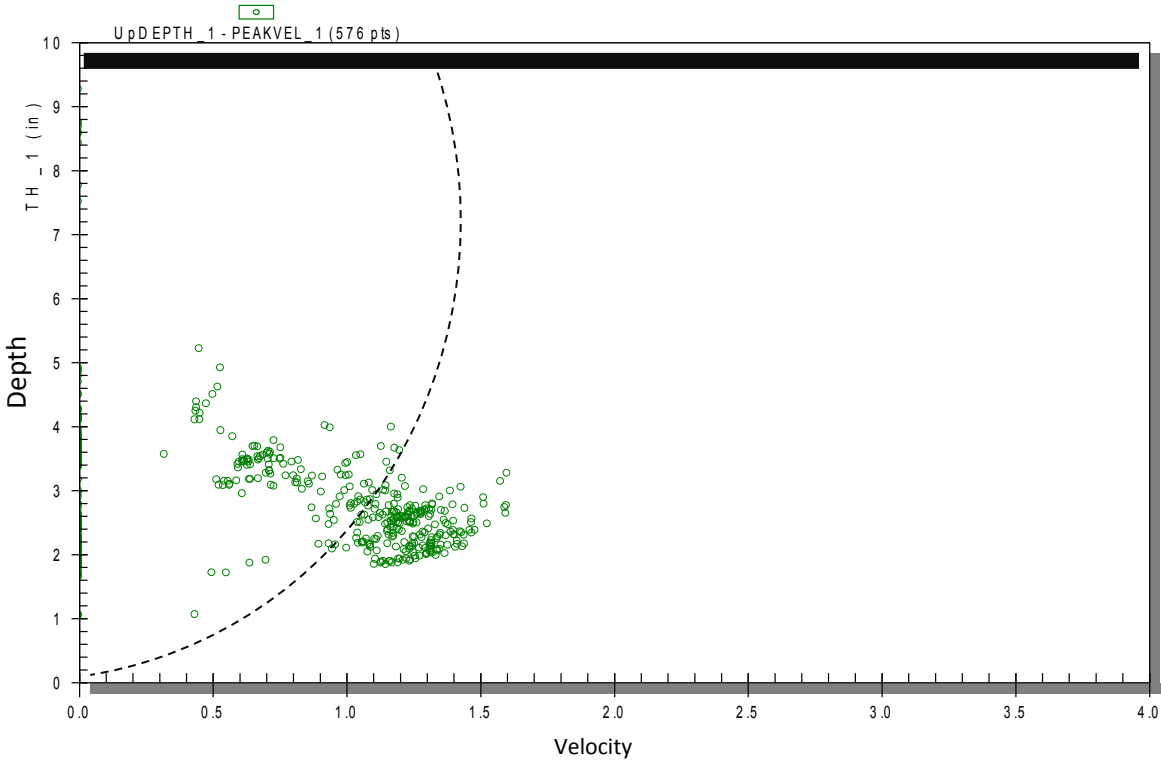


Pipe Day 14
Sediment or Debris
Present

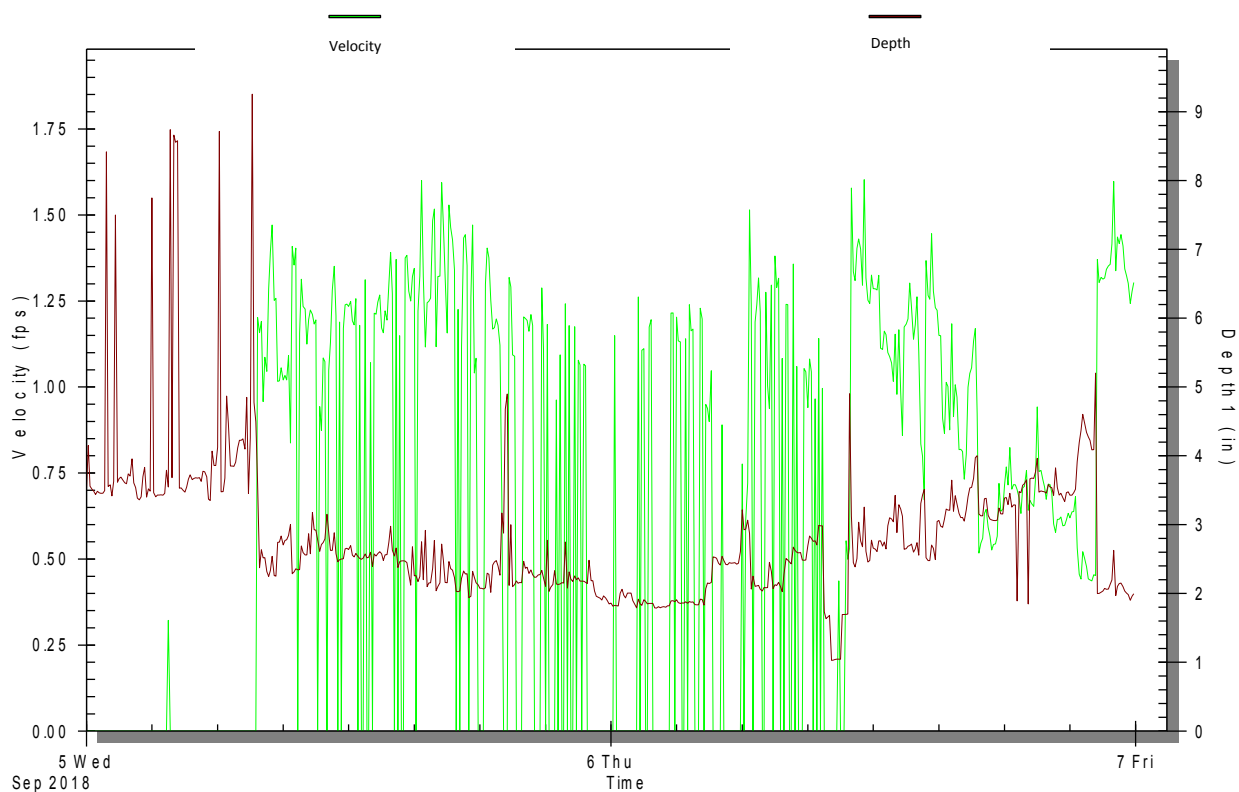


Debris on Sensor

ADS Environmental Services
9/5/2018 12:00:00 AM - 9/6/2018 11:59:00 PM



ADS Environmental Services
Hydrograph



Wet Weather Applications

Questions When Dealing with Wet Weather

How much flow is being conveyed in my system?

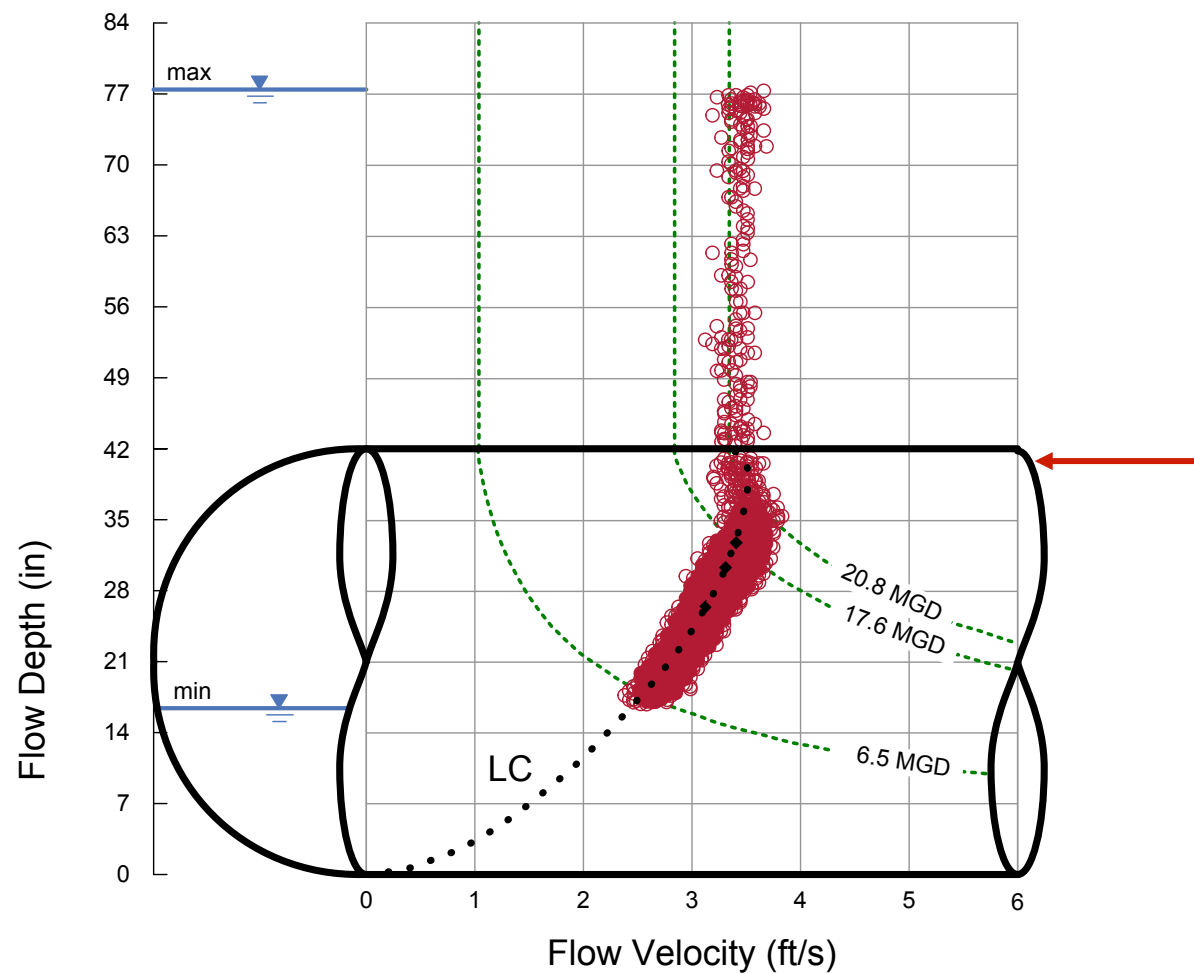
Do I have I/I?

How severe are my surcharge events?

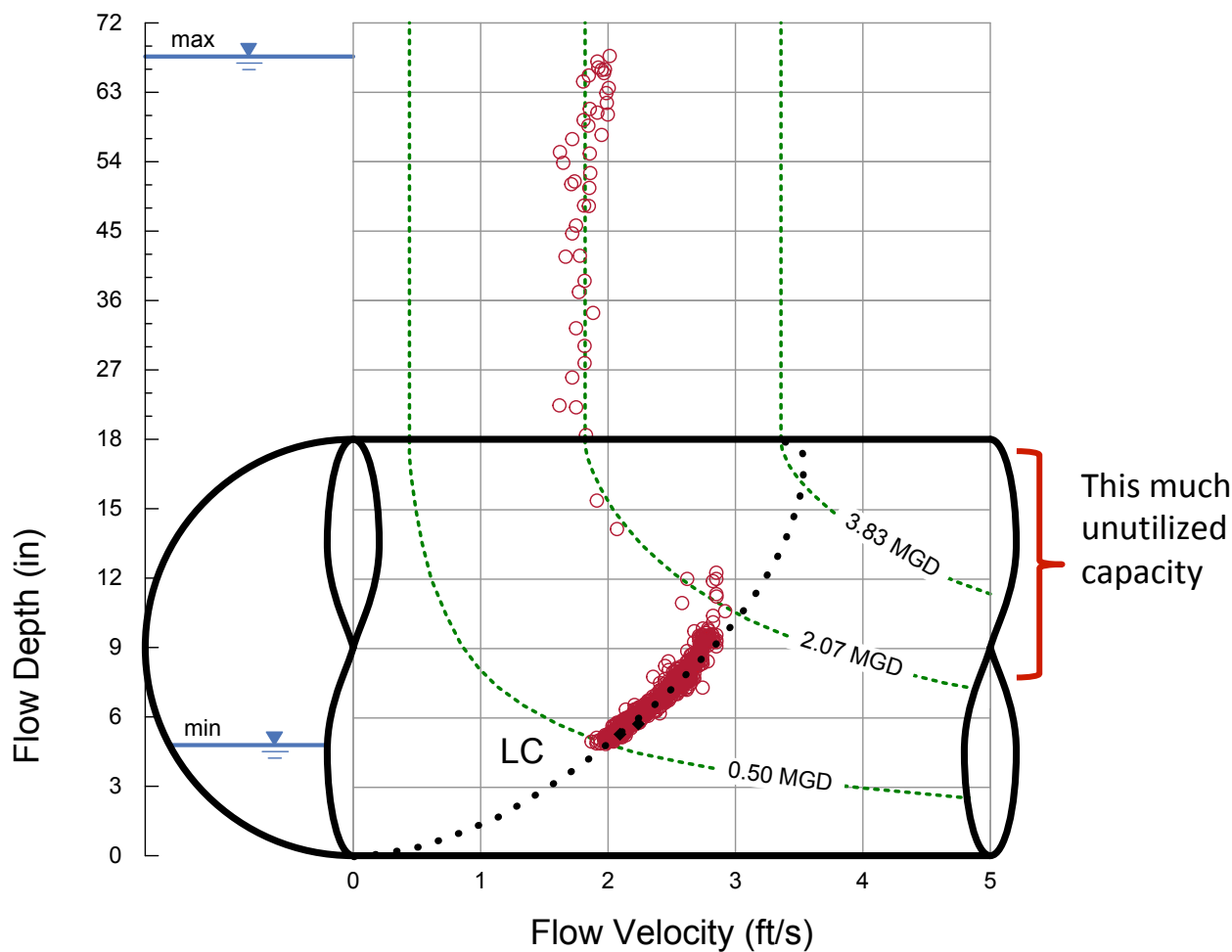
Am I experiencing overflows (CSO/SSO)?



Surcharge and Capacity Concerns

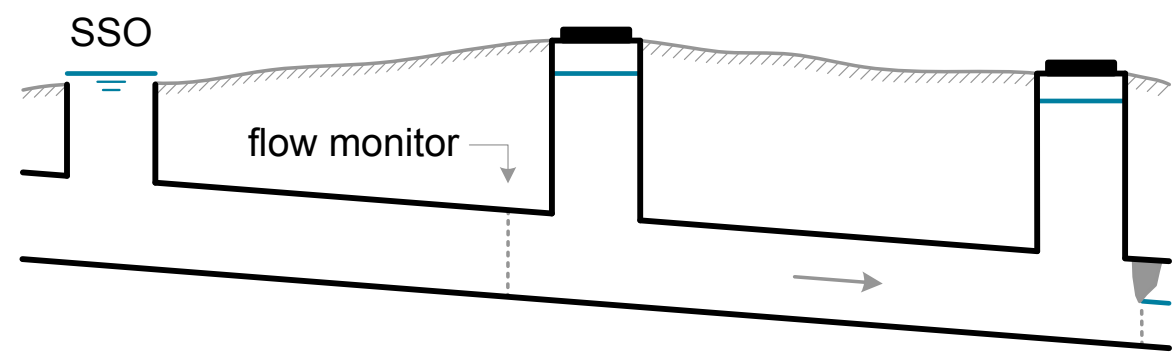
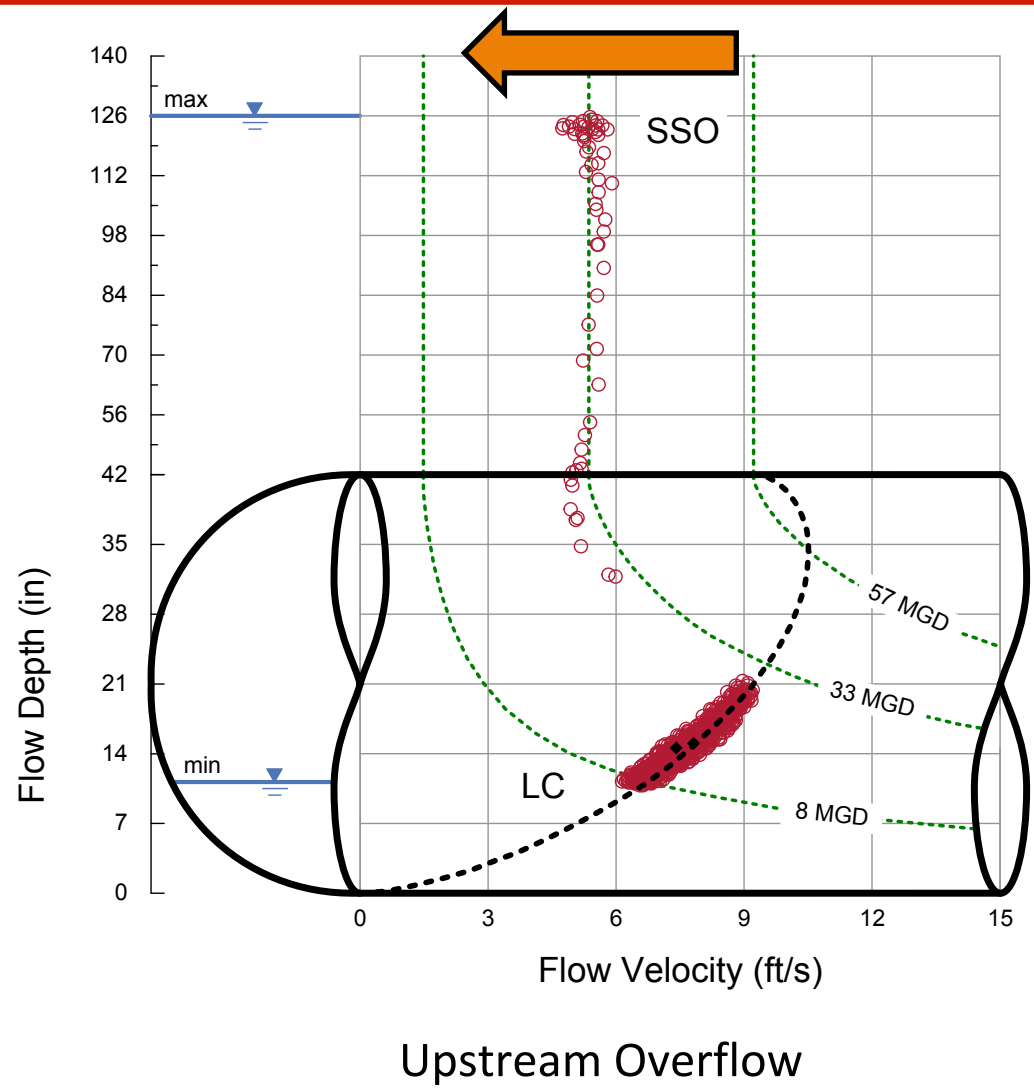


Pipe Operating at Full Capacity



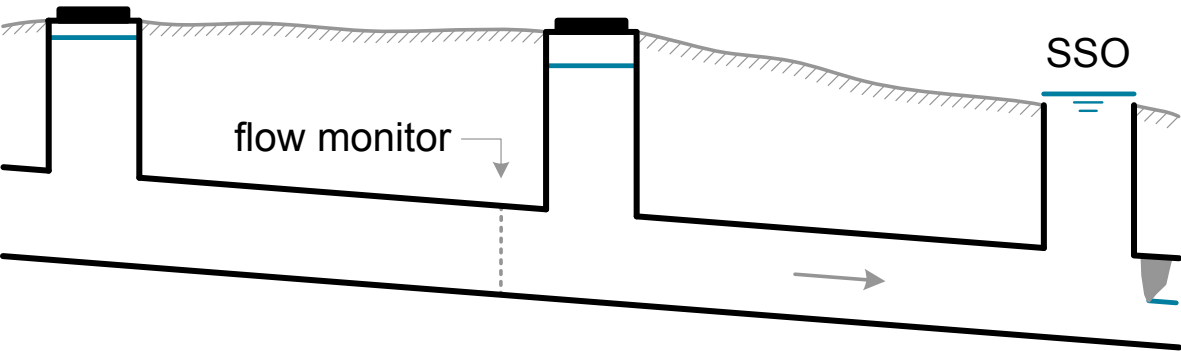
Pipe Operating at Limited Capacity

A Closer Look at Surge Events

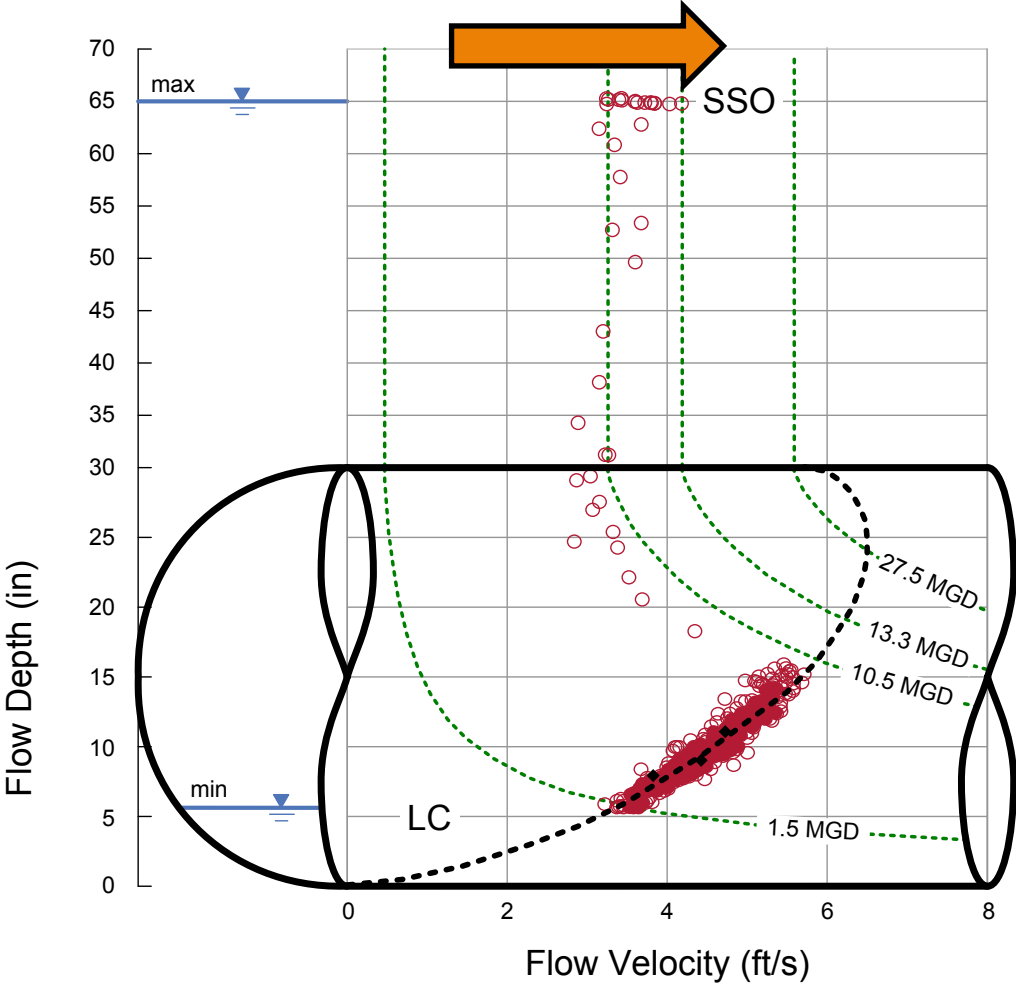


Relief Upstream causes less flow to be observed at the monitoring location

A Closer Look at Surge Events

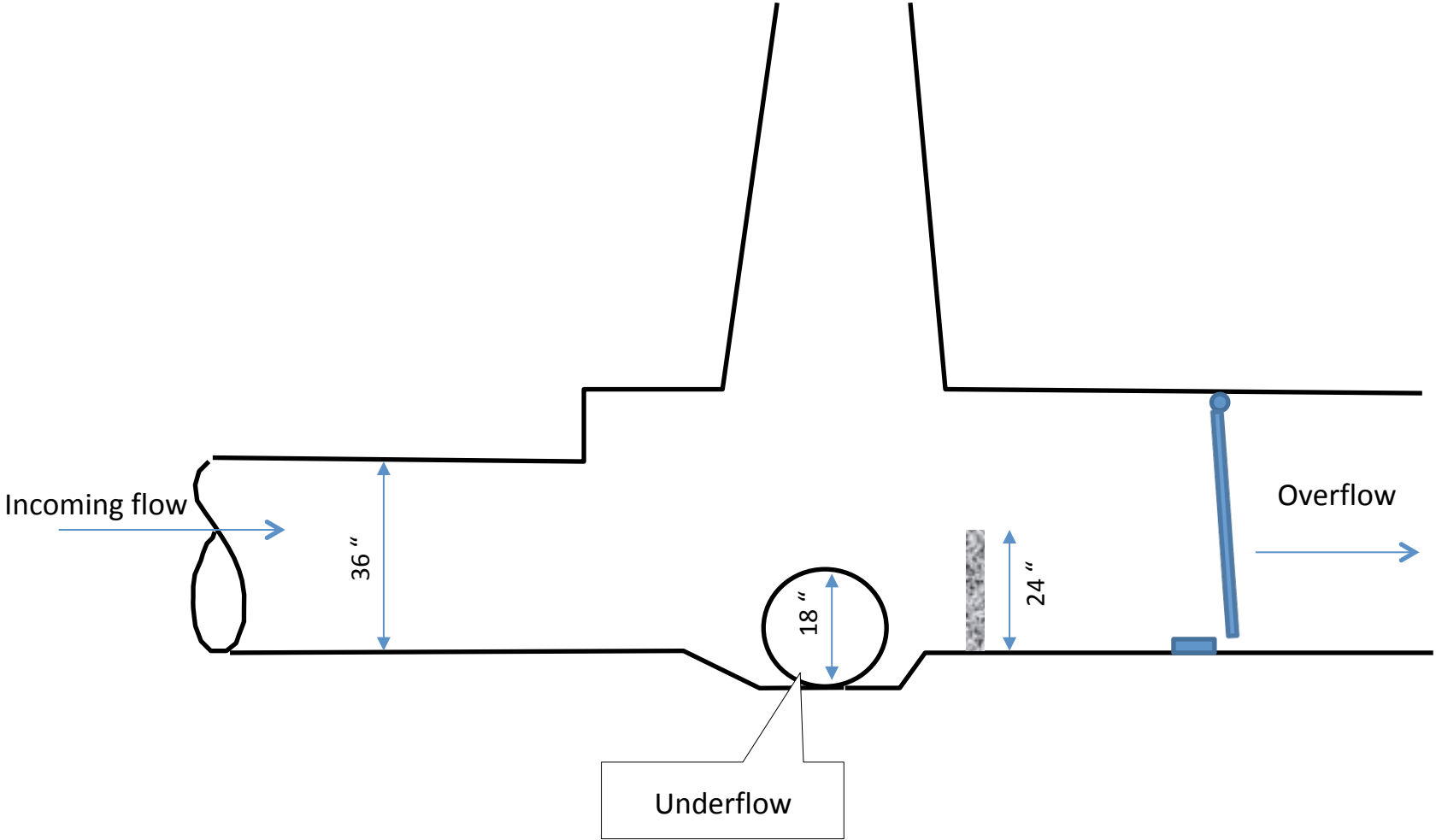


Relief Downstream causes more flow to be observed at the monitoring location



Downstream Overflow

Quantifying CSO Events



Quantifying CSO Events

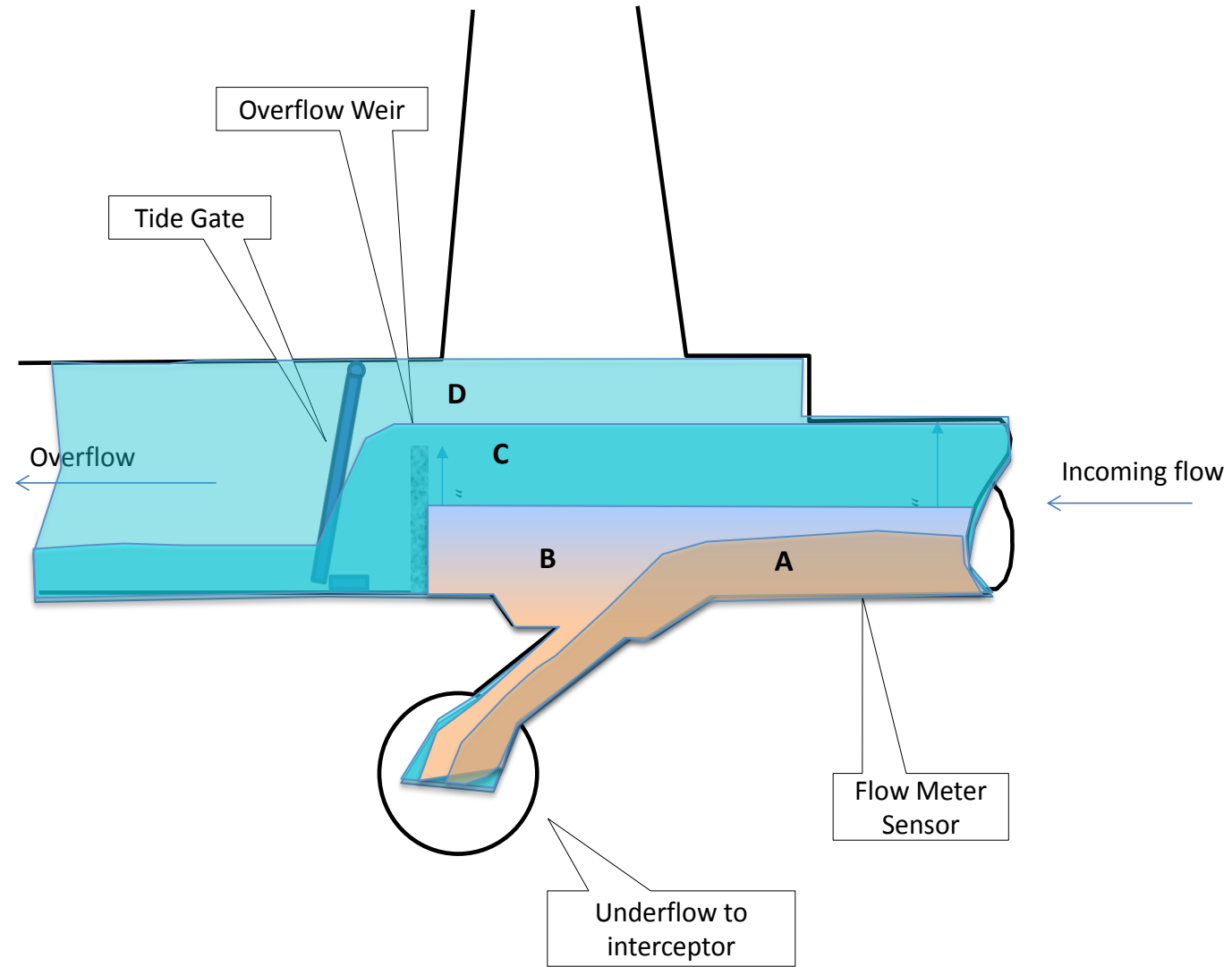


Outgoing Line

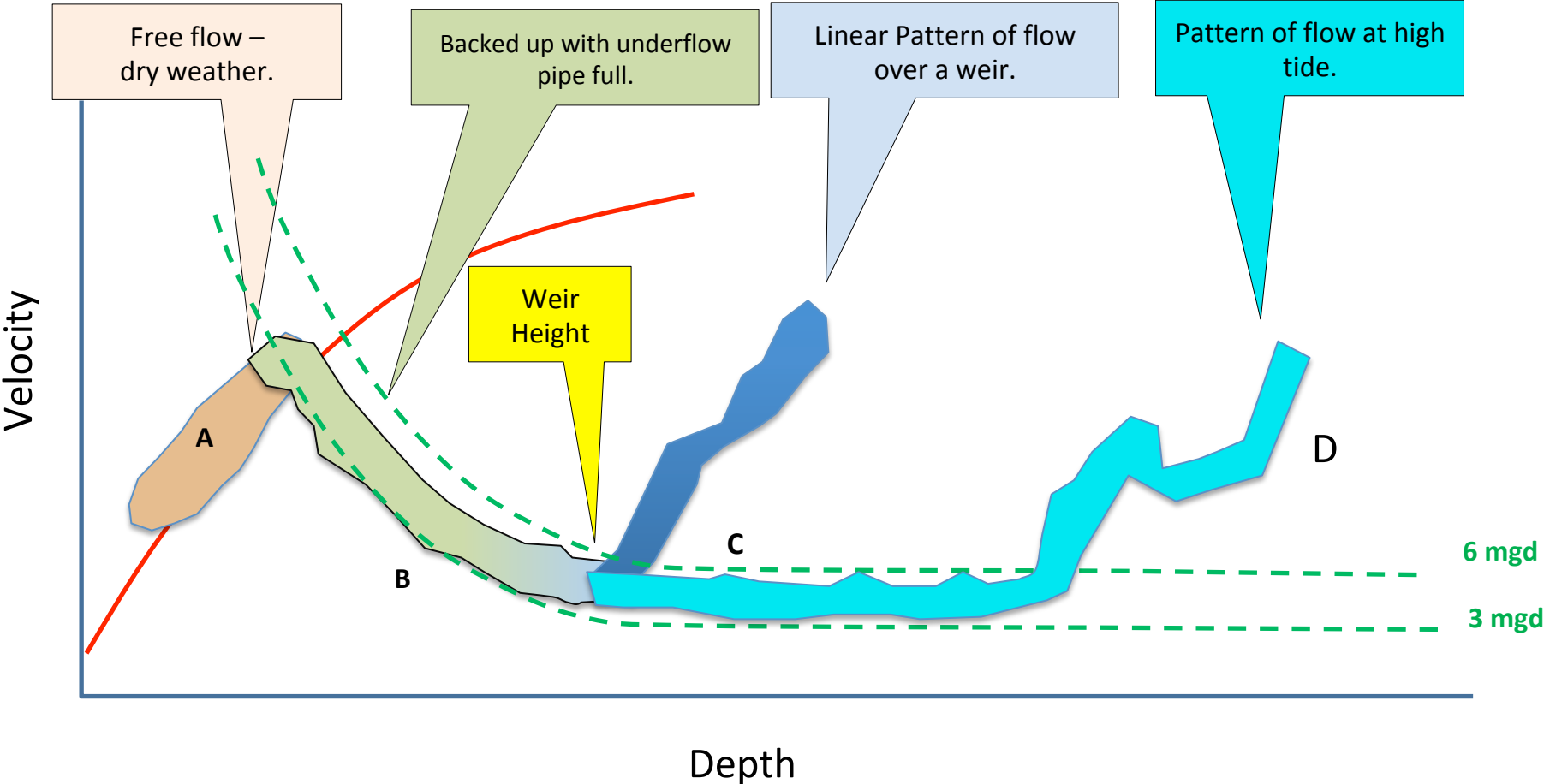


Incoming Line

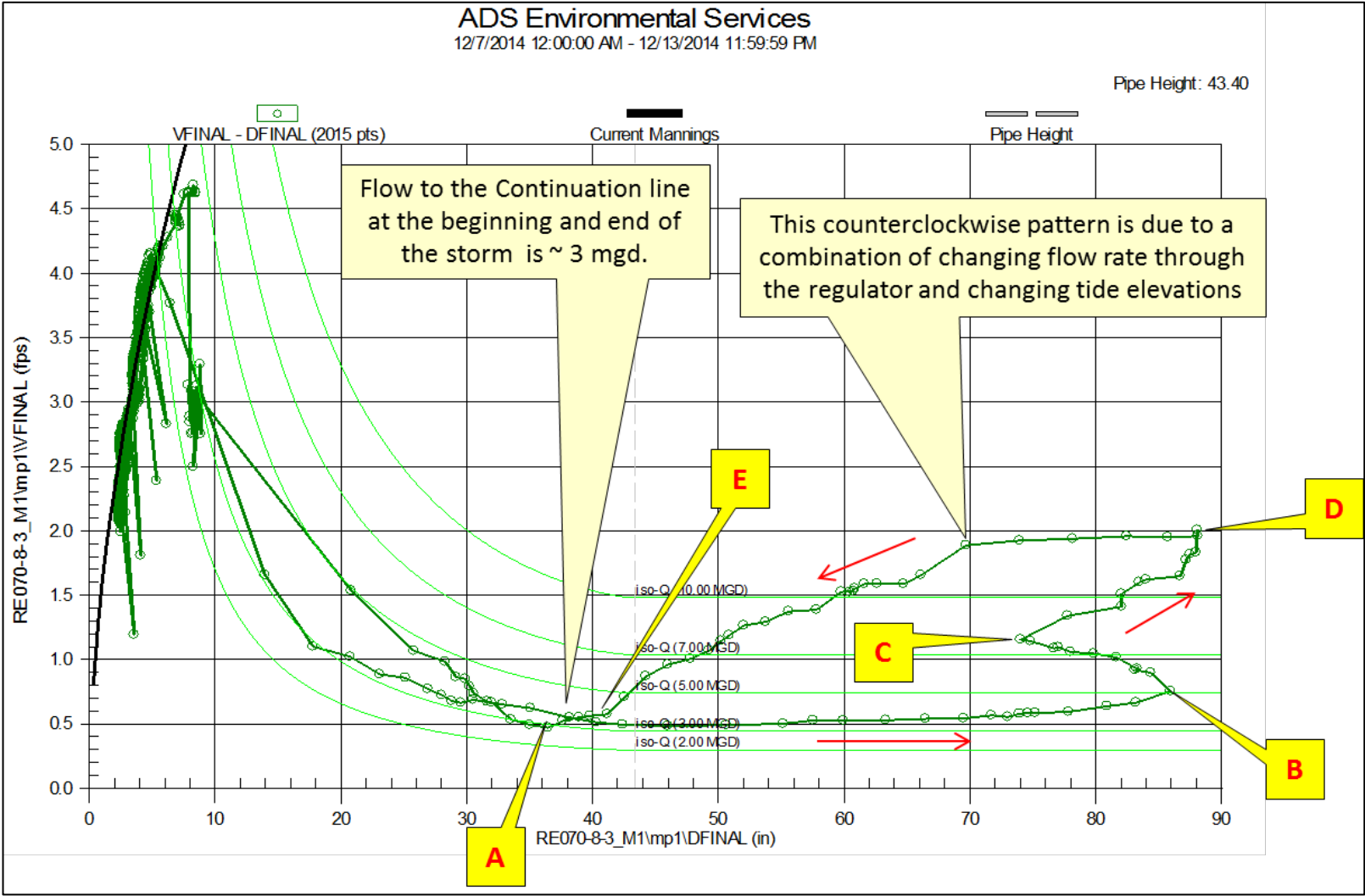
Quantifying CSO Events



Quantifying CSO Events



Quantifying CSO Events



Even More Useful Ways to Use a Scattergraph

Scattergraph Principles and Practice



Patrick L. Stevens, P.E. and Kevin L. Enfinger, P.E.
ADS Environmental Services
4940 Research Drive • Huntsville, Alabama 35895 • www.adsenv.com

Overview
The scattergraph is a powerful tool that displays depth and velocity data from a sewer flow monitor. The resulting patterns have characteristics that provide insight into the conditions within a sewer. The flow monitor data also have direct patterns that show the performance of the flow monitor itself to be evaluated.

This poster is designed as an educational resource for wastewater professionals, including operators, engineers, and managers. It provides a collection of scattergraphs, along with a brief explanation of what can be learned from each. These patterns are descriptive and practical applications are included, increasing both engineering and operational job skills.

Several important scattergraph tools are presented and discussed throughout this poster, including the Design Method, the Lateral-Gut Method, and the Reverse-Flow Method, along with 30-CPH, use and backflow limit. The combination of these tools makes it easy to determine the Conditioned Capacity of a sewer.

The scattergraphs in this poster were selected from thousands of flow monitor data collected by ADS each year. The flow monitor data include flow data for 15 days in a month ranging from 15 to 150 cph. The data are presented in a way that makes them easy to understand and apply. The poster is designed to be a practical reference for wastewater professionals and to be a valuable tool in the field.

Additional Resources
A good place to get additional information on the scattergraphs is available at www.adsenv.com/scattergraphs, including technical publications, technical examples, and other reference materials.

Additional Resources
The ADS EnviroLink is a free online resource that offers wastewater professionals a wealth of information on the sewerage system. The ADS EnviroLink is a free online resource that offers wastewater professionals a wealth of information on the sewerage system. The ADS EnviroLink is a free online resource that offers wastewater professionals a wealth of information on the sewerage system.



ADS EnviroLink & ADS EnviroLink

1. Manning Equation

The Manning Equation is an empirical relationship between flow rate and pipe diameter. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient. The Manning coefficient is a measure of the roughness of the pipe. The Manning Equation is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

2. Design Method

The Design Method is a method for determining the flow rate in a pipe based on the pipe diameter and the Manning coefficient. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

3. Lateral-Gut Method

The Lateral-Gut Method is a method for determining the flow rate in a pipe based on the pipe diameter and the Manning coefficient. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

4. Reverse-Flow Method

The Reverse-Flow Method is a method for determining the flow rate in a pipe based on the pipe diameter and the Manning coefficient. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

5. Comparison of Three Applications of the Manning Equation

The Manning Equation is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient. The three applications of the Manning Equation are the Design Method, the Lateral-Gut Method, and the Reverse-Flow Method. The three applications of the Manning Equation are the Design Method, the Lateral-Gut Method, and the Reverse-Flow Method.

6. Comparison of Constant and Varying Roughness Coefficient

The Manning Equation is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient. The Manning coefficient is a measure of the roughness of the pipe. The Manning Equation is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

7. 30-CPH Limit

The 30-CPH Limit is a limit on the flow rate in a pipe. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

8. Under Accumulation

The Under Accumulation is a condition where the flow rate in a pipe is less than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

9. Backflow

The Backflow is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

10. Backflow and Surge

The Backflow and Surge is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

11. Backflow and Surge with 30-CPH Limit

The Backflow and Surge with 30-CPH Limit is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

12. Combined Sewer

The Combined Sewer is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

13. Sanitary Sewer Overflow (Upstream)

The Sanitary Sewer Overflow (Upstream) is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

14. Sanitary Sewer Overflow (Downstream)

The Sanitary Sewer Overflow (Downstream) is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

15. Sanitary Sewer Overflow from Overflow Pipe

The Sanitary Sewer Overflow from Overflow Pipe is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

16. Reverse Flow

The Reverse Flow is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

17. Combined Sewer Overflow (End Wall)

The Combined Sewer Overflow (End Wall) is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

18. Combined Sewer Overflow (Side Wall)

The Combined Sewer Overflow (Side Wall) is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

19. 30-CPH Limit

The 30-CPH Limit is a limit on the flow rate in a pipe. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

20. Under Accumulation

The Under Accumulation is a condition where the flow rate in a pipe is less than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

21. Backflow

The Backflow is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

22. Hydraulic Jump

The Hydraulic Jump is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

23. Under Jump

The Under Jump is a condition where the flow rate in a pipe is less than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

24. Drifting Depth Sensor

The Drifting Depth Sensor is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

25. Drifting Velocity Sensor

The Drifting Velocity Sensor is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.

26. Official Bird of Collection Systems

The Official Bird of Collection Systems is a condition where the flow rate in a pipe is greater than the design flow rate. It is used to calculate the flow rate in a pipe given the pipe diameter and the Manning coefficient.



Thanks for Listening

Matthew Brown

Business Development Manager

2566566385

MBrown3@idexcorp.com