

An aerial photograph of a creek corridor. A yellow path follows the creek's course, and a blue area is highlighted on the right side of the creek. The background is a dark green gradient.

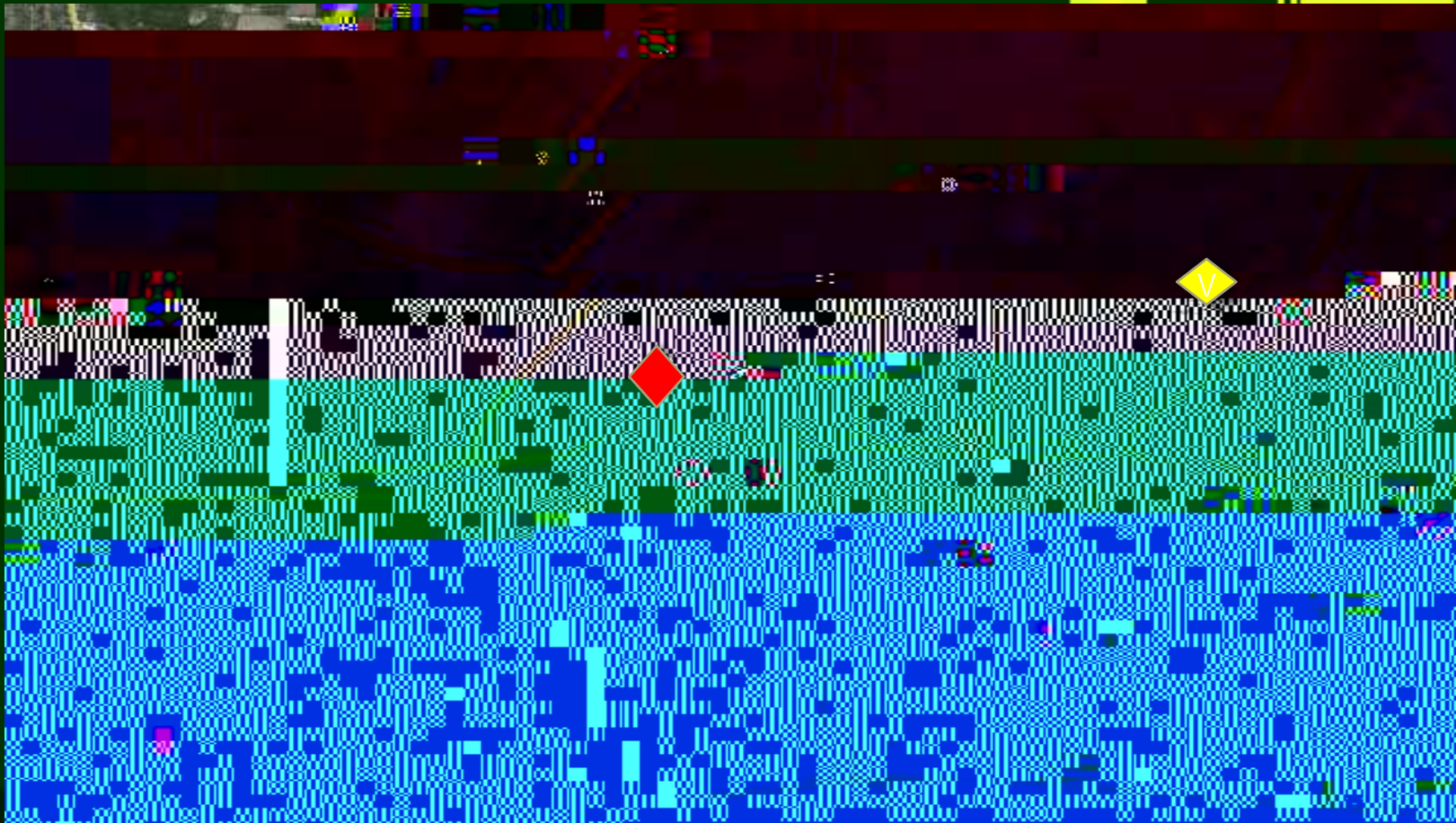
Beaver Creek Corridor Design and Analysis

By: Alex Previte

Overview

- Introduction
- Key concepts
- Model Development
- Design
- Accuracy
- Conclusion

Refresh

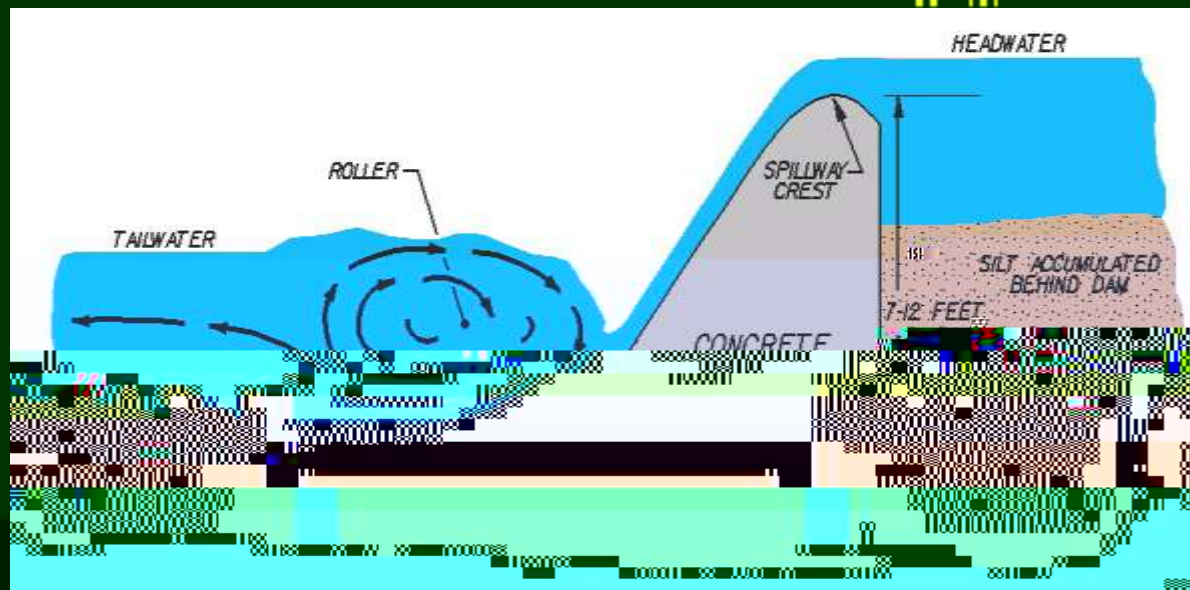


- ◆ = Beaver Creek Site
- ◆ = Wittenberg

Introduction

- Low head dam : small overflow dam used to alter the flow characteristics of a river or stream

- Dangers:
 - Drowning
 - Alter Ecosystem
 - User Friendly:
Kayaking

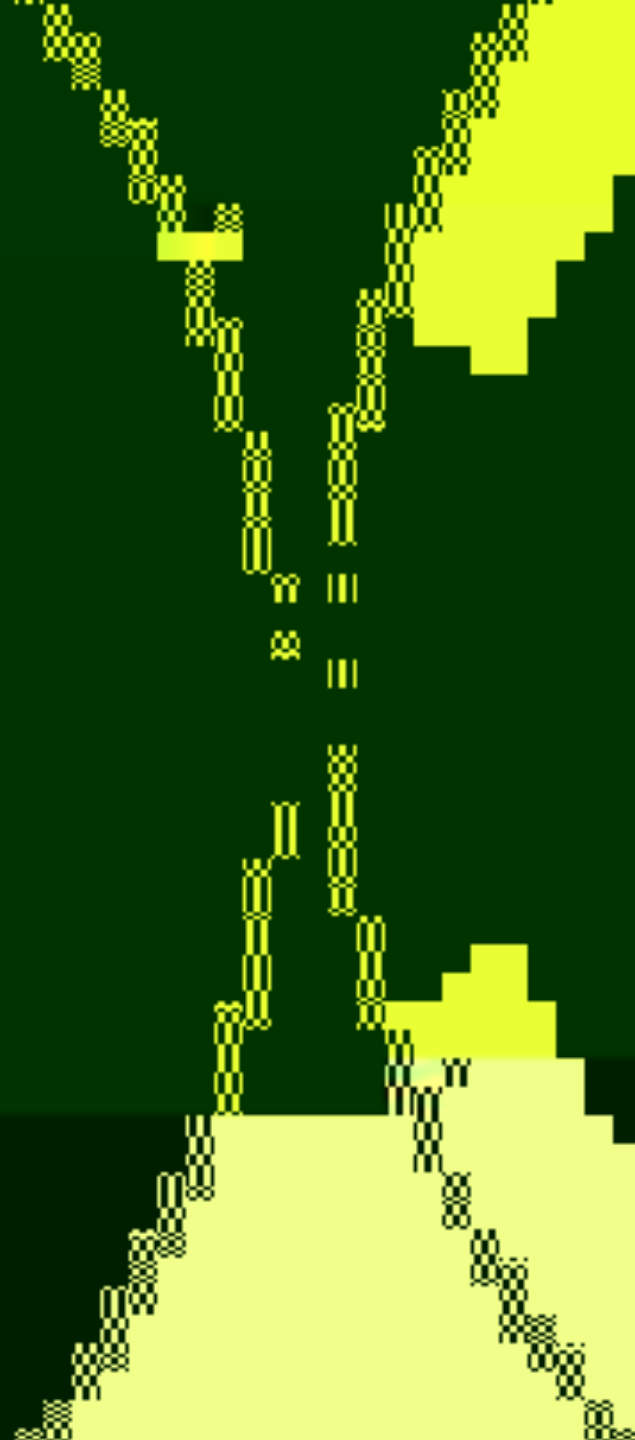


Introduction

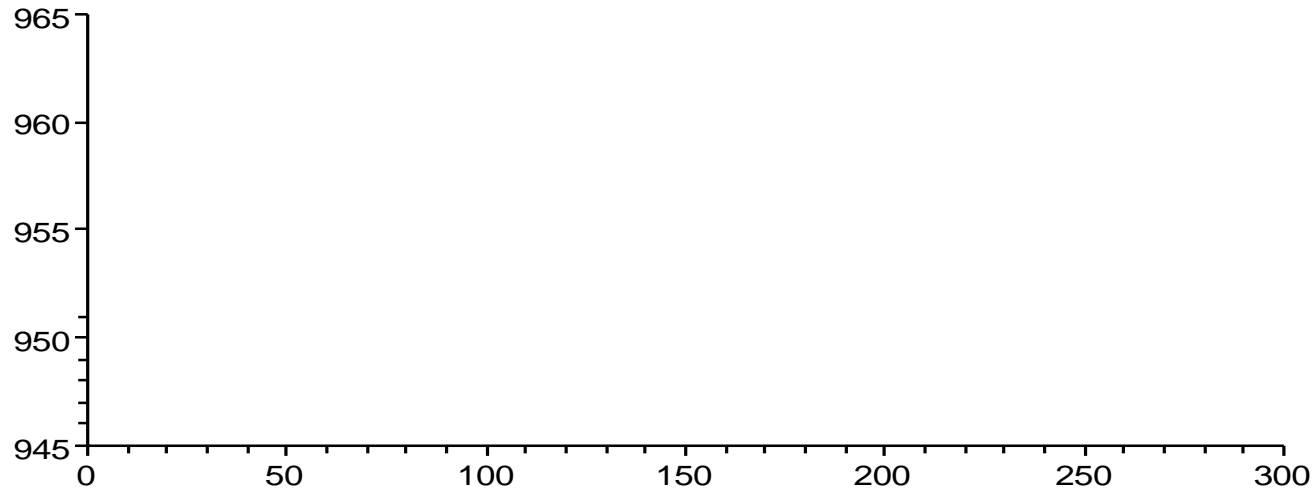
- HEC-RAS
 - Hydrologic Engineering Centers River Analysis System
- Computer program
- Used for analyzing rivers and streams
- Able to compute flow characteristics given certain parameters

Profile Plot

- Geometry profile
 - Data taken over 300 Ft (horizontally)
 - Contour (Color) ally

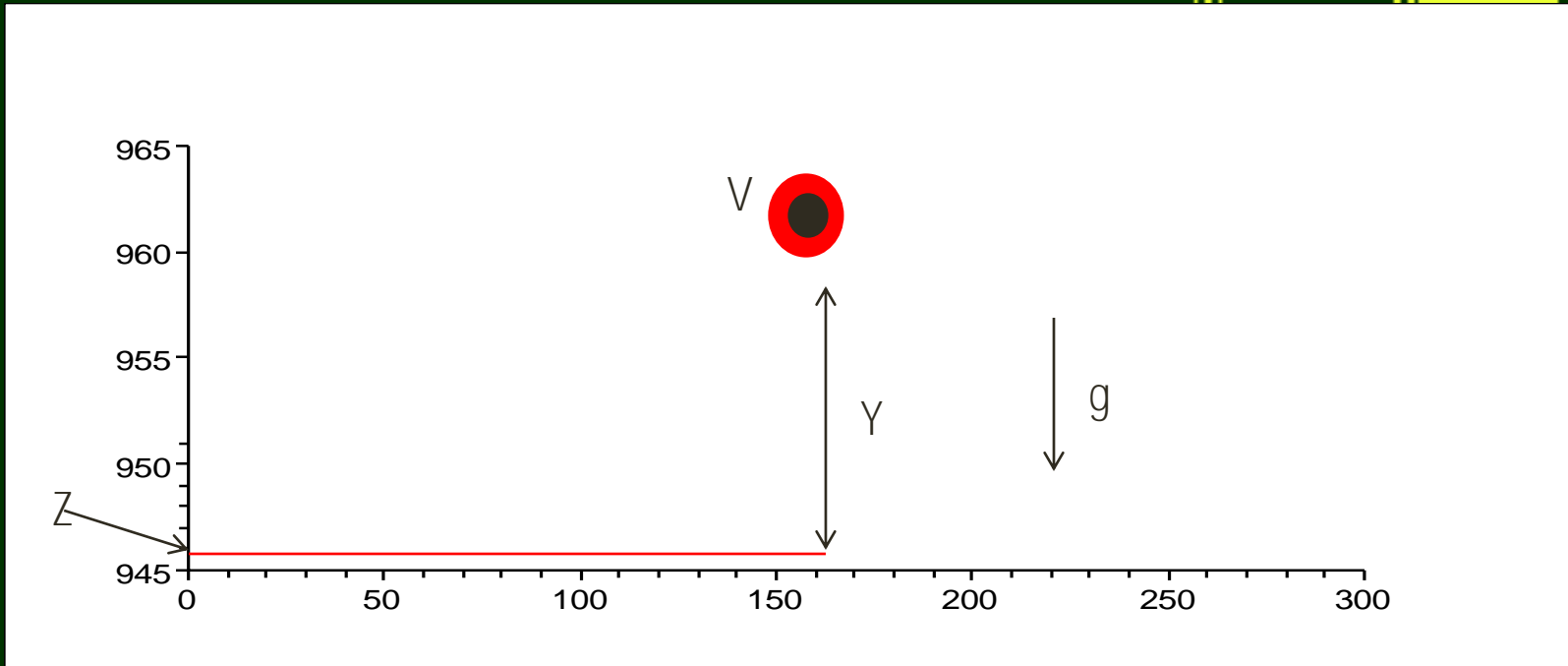


Cross-Section



- X-axis = Horizontal width of River Station
- Y-axis = Elevation above sea level
- ● = Bank Station marker
- Contour = shape of creek bed at that station
- Stage Height (Y) = Distance from channel bottom to surface

Energy Equation



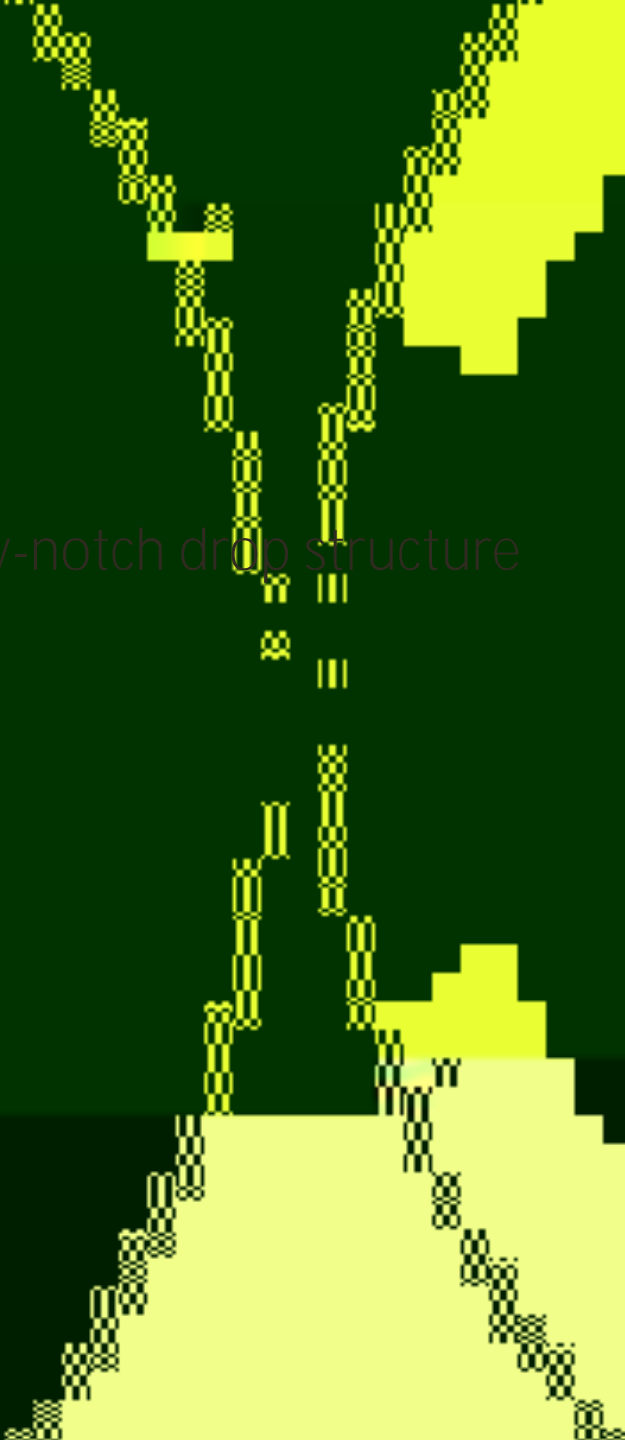
a_1, a_2 = Velocity weighting coefficients (error in average velocity)

h_e = Energy head loss

$$Z_2 + V_2 + \frac{a_2 V_2^2}{2g} = Z_1 + V_1 + \frac{a_1 V_1^2}{2g} + h_e$$

Development

- Determine and adjust Manning n value
- River bank adjustment
- One low-head dam replaced by a single v-notch drop structure
- Hydraulic Jump
 - Subcritical to supercritical



Manning Equation

- Equation: $V = \frac{1.49}{n} R^{2/3} S^{1/2}$

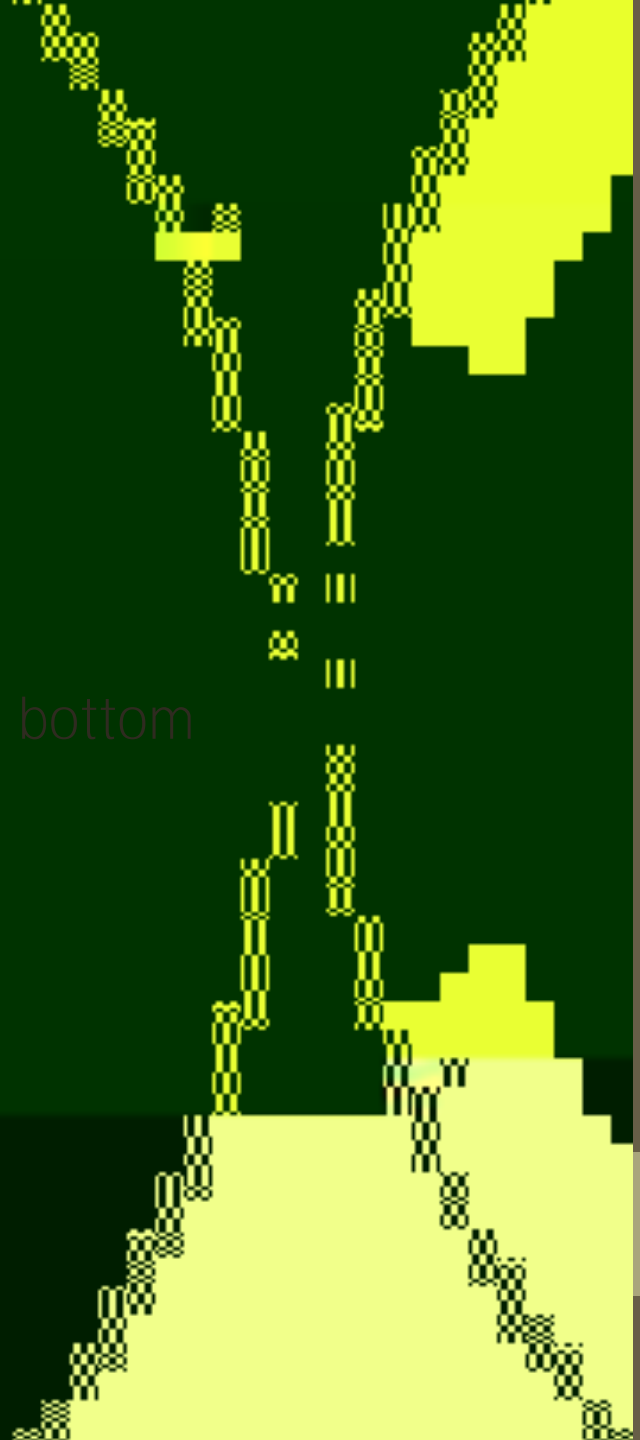
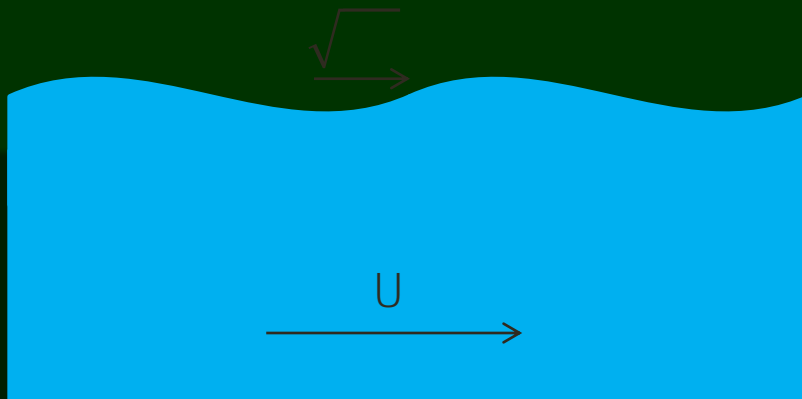
Manning N

- Similar to coefficient of friction
- Shows the resistance to fluid flow
- Higher n means more resistant to flow

MANNING COEFFICIENTS FOR CHANNELS				
Channel	Smooth	Normal	Time of Channel and Discharge in	Notes
Natural streams—minor streams (top width at floodstage ≤ 100 -ft)				
1. Main Channels				
stone, no riffs or deep pools	0.025	0.030	0.035	a clean, straight, full
0.035	0.040	0.045	0.050	stream, no rocks, boulders, or debris
0.045	0.050	0.055	0.060	stream, no rocks, boulders, or debris
0.055	0.060	0.065	0.070	stream, no rocks, boulders, or debris
0.065	0.070	0.075	0.080	stream, no rocks, boulders, or debris
0.075	0.080	0.085	0.090	stream, no rocks, boulders, or debris
0.085	0.090	0.095	0.100	stream, no rocks, boulders, or debris
0.095	0.100	0.105	0.110	stream, no rocks, boulders, or debris
0.105	0.110	0.115	0.120	stream, no rocks, boulders, or debris
0.115	0.120	0.125	0.130	stream, no rocks, boulders, or debris
0.125	0.130	0.135	0.140	stream, no rocks, boulders, or debris
0.135	0.140	0.145	0.150	stream, no rocks, boulders, or debris
0.145	0.150	0.155	0.160	stream, no rocks, boulders, or debris
0.155	0.160	0.165	0.170	stream, no rocks, boulders, or debris
0.165	0.170	0.175	0.180	stream, no rocks, boulders, or debris
0.175	0.180	0.185	0.190	stream, no rocks, boulders, or debris
0.185	0.190	0.195	0.200	stream, no rocks, boulders, or debris
0.195	0.200	0.205	0.210	stream, no rocks, boulders, or debris
0.205	0.210	0.215	0.220	stream, no rocks, boulders, or debris
0.215	0.220	0.225	0.230	stream, no rocks, boulders, or debris
0.225	0.230	0.235	0.240	stream, no rocks, boulders, or debris
0.235	0.240	0.245	0.250	stream, no rocks, boulders, or debris
0.245	0.250	0.255	0.260	stream, no rocks, boulders, or debris
0.255	0.260	0.265	0.270	stream, no rocks, boulders, or debris
0.265	0.270	0.275	0.280	stream, no rocks, boulders, or debris
0.275	0.280	0.285	0.290	stream, no rocks, boulders, or debris
0.285	0.290	0.295	0.300	stream, no rocks, boulders, or debris
0.295	0.300	0.305	0.310	stream, no rocks, boulders, or debris
0.305	0.310	0.315	0.320	stream, no rocks, boulders, or debris
0.315	0.320	0.325	0.330	stream, no rocks, boulders, or debris
0.325	0.330	0.335	0.340	stream, no rocks, boulders, or debris
0.335	0.340	0.345	0.350	stream, no rocks, boulders, or debris
0.345	0.350	0.355	0.360	stream, no rocks, boulders, or debris
0.355	0.360	0.365	0.370	stream, no rocks, boulders, or debris
0.365	0.370	0.375	0.380	stream, no rocks, boulders, or debris
0.375	0.380	0.385	0.390	stream, no rocks, boulders, or debris
0.385	0.390	0.395	0.400	stream, no rocks, boulders, or debris
0.395	0.400	0.405	0.410	stream, no rocks, boulders, or debris
0.405	0.410	0.415	0.420	stream, no rocks, boulders, or debris
0.415	0.420	0.425	0.430	stream, no rocks, boulders, or debris
0.425	0.430	0.435	0.440	stream, no rocks, boulders, or debris
0.435	0.440	0.445	0.450	stream, no rocks, boulders, or debris
0.445	0.450	0.455	0.460	stream, no rocks, boulders, or debris
0.455	0.460	0.465	0.470	stream, no rocks, boulders, or debris
0.465	0.470	0.475	0.480	stream, no rocks, boulders, or debris
0.475	0.480	0.485	0.490	stream, no rocks, boulders, or debris
0.485	0.490	0.495	0.500	stream, no rocks, boulders, or debris
0.495	0.500	0.505	0.510	stream, no rocks, boulders, or debris
0.505	0.510	0.515	0.520	stream, no rocks, boulders, or debris
0.515	0.520	0.525	0.530	stream, no rocks, boulders, or debris
0.525	0.530	0.535	0.540	stream, no rocks, boulders, or debris
0.535	0.540	0.545	0.550	stream, no rocks, boulders, or debris
0.545	0.550	0.555	0.560	stream, no rocks, boulders, or debris
0.555	0.560	0.565	0.570	stream, no rocks, boulders, or debris
0.565	0.570	0.575	0.580	stream, no rocks, boulders, or debris
0.575	0.580	0.585	0.590	stream, no rocks, boulders, or debris
0.585	0.590	0.595	0.600	stream, no rocks, boulders, or debris
0.595	0.600	0.605	0.610	stream, no rocks, boulders, or debris
0.605	0.610	0.615	0.620	stream, no rocks, boulders, or debris
0.615	0.620	0.625	0.630	stream, no rocks, boulders, or debris
0.625	0.630	0.635	0.640	stream, no rocks, boulders, or debris
0.635	0.640	0.645	0.650	stream, no rocks, boulders, or debris
0.645	0.650	0.655	0.660	stream, no rocks, boulders, or debris
0.655	0.660	0.665	0.670	stream, no rocks, boulders, or debris
0.665	0.670	0.675	0.680	stream, no rocks, boulders, or debris
0.675	0.680	0.685	0.690	stream, no rocks, boulders, or debris
0.685	0.690	0.695	0.700	stream, no rocks, boulders, or debris
0.695	0.700	0.705	0.710	stream, no rocks, boulders, or debris
0.705	0.710	0.715	0.720	stream, no rocks, boulders, or debris
0.715	0.720	0.725	0.730	stream, no rocks, boulders, or debris
0.725	0.730	0.735	0.740	stream, no rocks, boulders, or debris
0.735	0.740	0.745	0.750	stream, no rocks, boulders, or debris
0.745	0.750	0.755	0.760	stream, no rocks, boulders, or debris
0.755	0.760	0.765	0.770	stream, no rocks, boulders, or debris
0.765	0.770	0.775	0.780	stream, no rocks, boulders, or debris
0.775	0.780	0.785	0.790	stream, no rocks, boulders, or debris
0.785	0.790	0.795	0.800	stream, no rocks, boulders, or debris
0.795	0.800	0.805	0.810	stream, no rocks, boulders, or debris
0.805	0.810	0.815	0.820	stream, no rocks, boulders, or debris
0.815	0.820	0.825	0.830	stream, no rocks, boulders, or debris
0.825	0.830	0.835	0.840	stream, no rocks, boulders, or debris
0.835	0.840	0.845	0.850	stream, no rocks, boulders, or debris
0.845	0.850	0.855	0.860	stream, no rocks, boulders, or debris
0.855	0.860	0.865	0.870	stream, no rocks, boulders, or debris
0.865	0.870	0.875	0.880	stream, no rocks, boulders, or debris
0.875	0.880	0.885	0.890	stream, no rocks, boulders, or debris
0.885	0.890	0.895	0.900	stream, no rocks, boulders, or debris
0.895	0.900	0.905	0.910	stream, no rocks, boulders, or debris
0.905	0.910	0.915	0.920	stream, no rocks, boulders, or debris
0.915	0.920	0.925	0.930	stream, no rocks, boulders, or debris
0.925	0.930	0.935	0.940	stream, no rocks, boulders, or debris
0.935	0.940	0.945	0.950	stream, no rocks, boulders, or debris
0.945	0.950	0.955	0.960	stream, no rocks, boulders, or debris
0.955	0.960	0.965	0.970	stream, no rocks, boulders, or debris
0.965	0.970	0.975	0.980	stream, no rocks, boulders, or debris
0.975	0.980	0.985	0.990	stream, no rocks, boulders, or debris
0.985	0.990	0.995	1.000	stream, no rocks, boulders, or debris

Froude Number

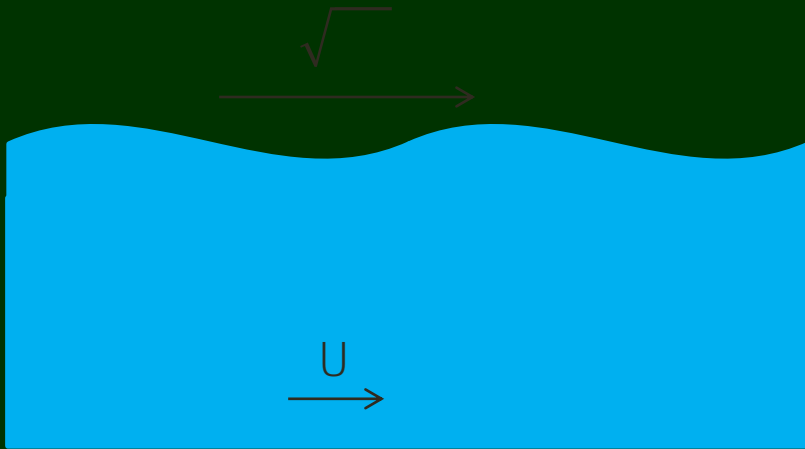
- Froude Number $Fr = \frac{U}{\sqrt{gh}}$
- U = Velocity of flow
- g = Acceleration of gravity
- h = Depth of flow relative to the channel bottom
- \sqrt{gh} = Wave velocity
- Unitless



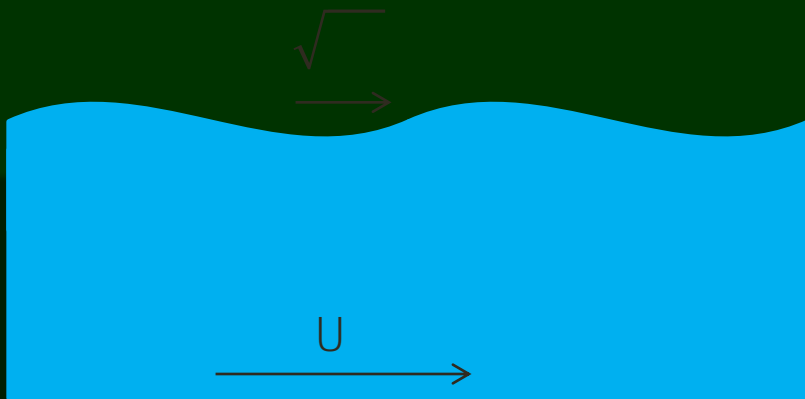
Supercritical and Subcritical Flow

- Is the Froude number $>$ or $<$ than 1?
 - $Fr > 1$ = Supercritical
 - $Fr < 1$ = Subcritical
- Supercritical When flow velocity is greater than wave velocity
- Subcritical When flow velocity is less than wave velocity
- Hydraulic Jump Occurs when a flow at high velocity discharges into a zone that can't sustain that high wave velocity.

Sub or Supercritical Flow



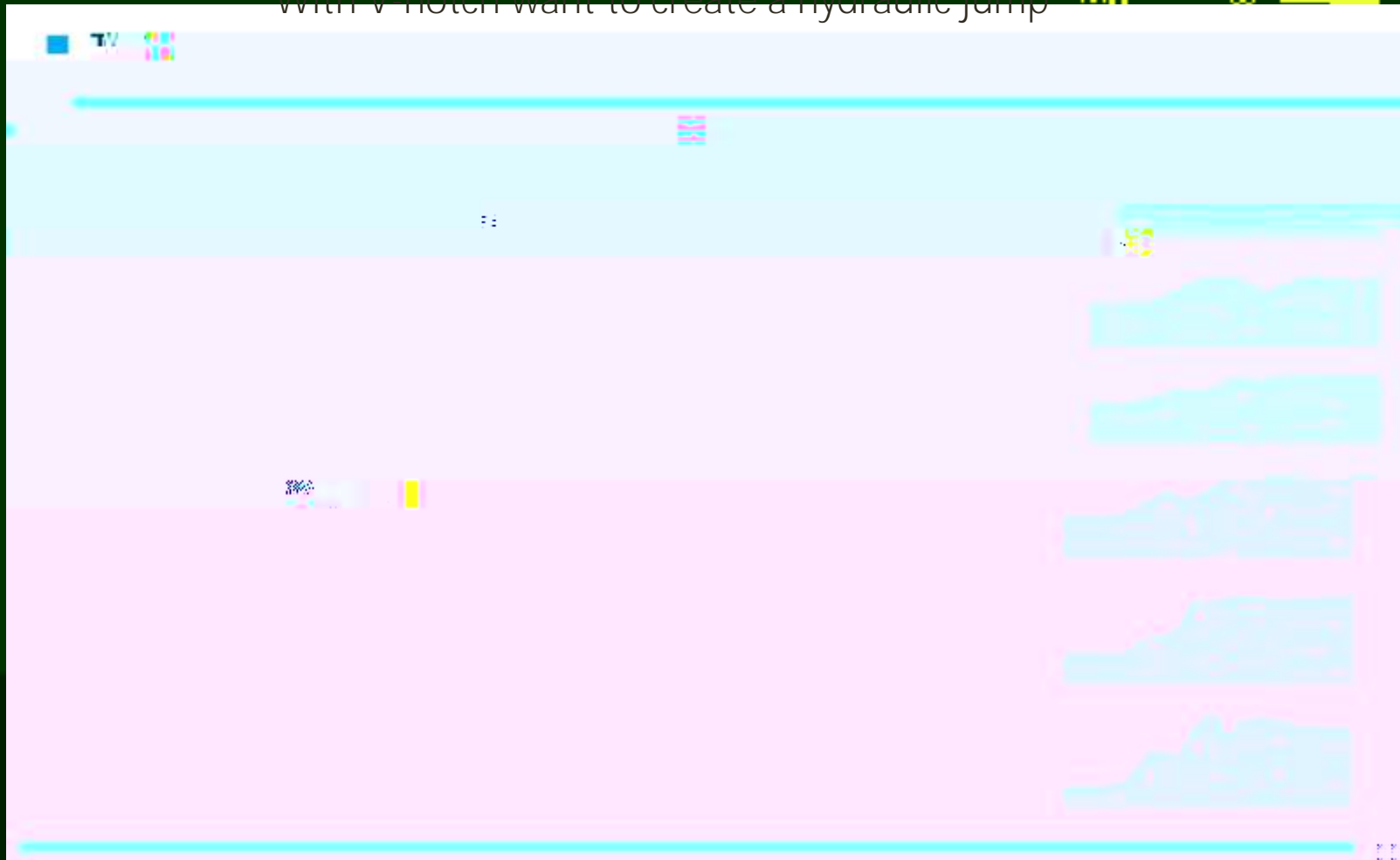
- Subcritical Flow



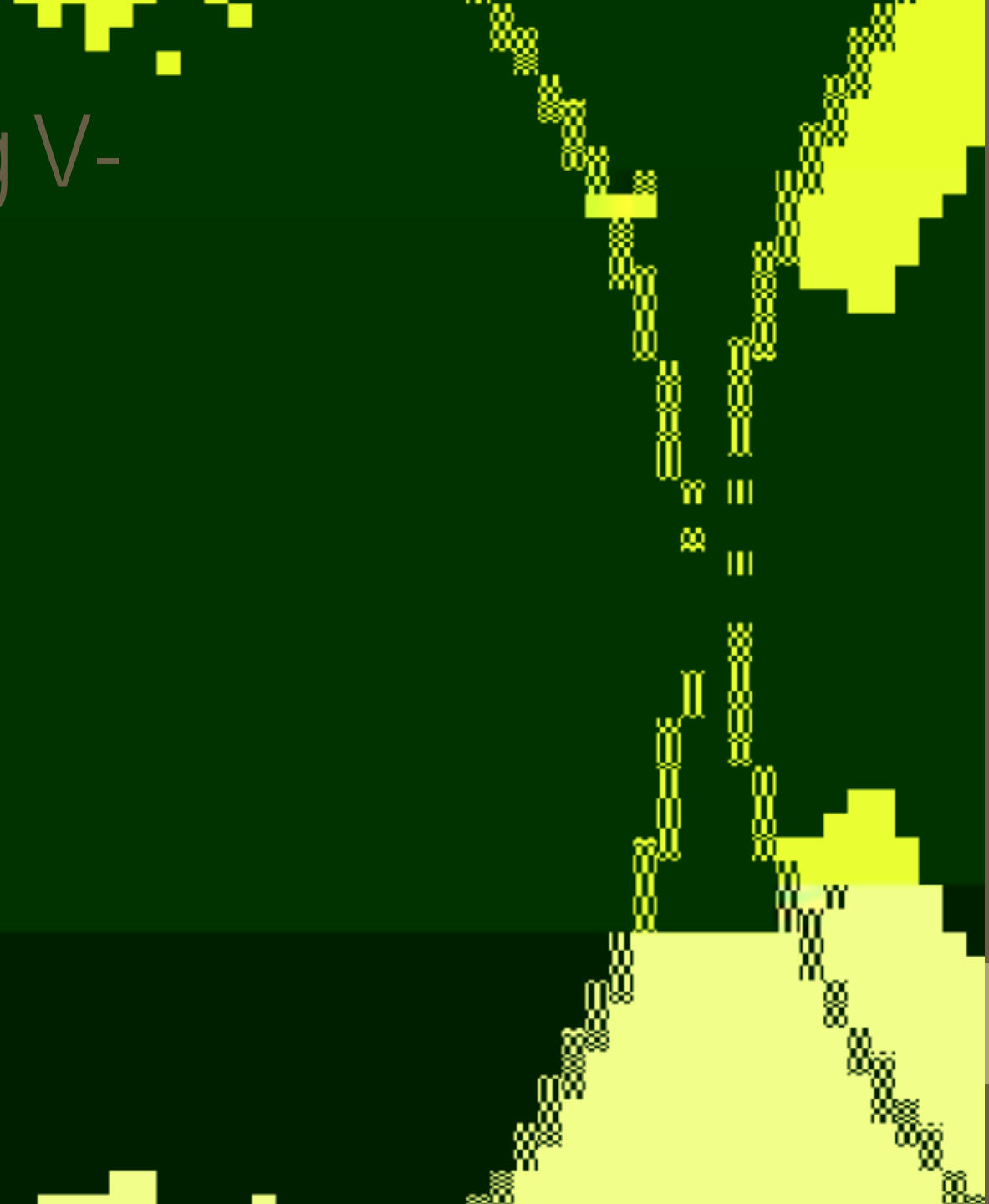
- Supercritical Flow

Hydraulic Jumps

With V notch want to create a hydraulic jump

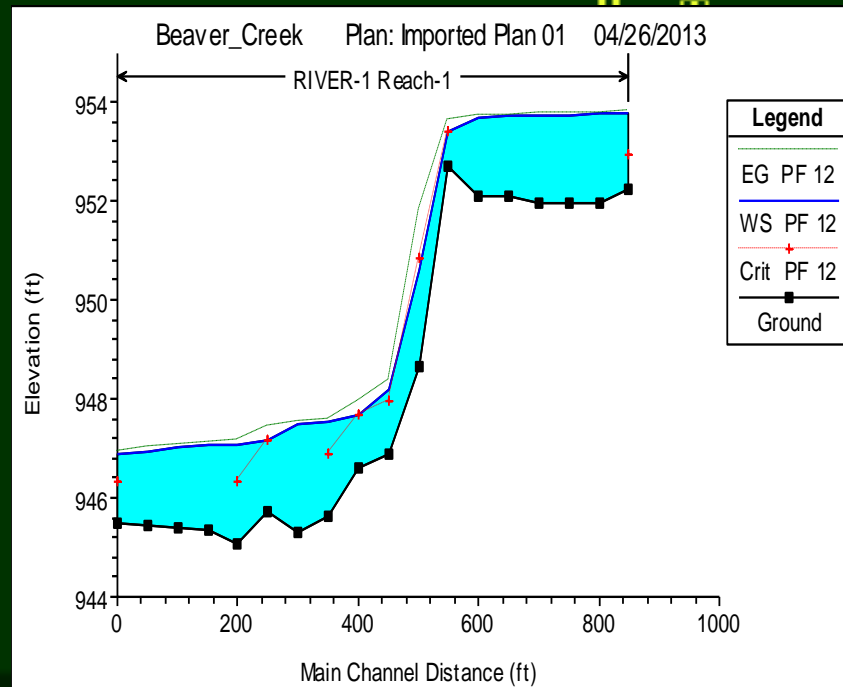


Designing V-



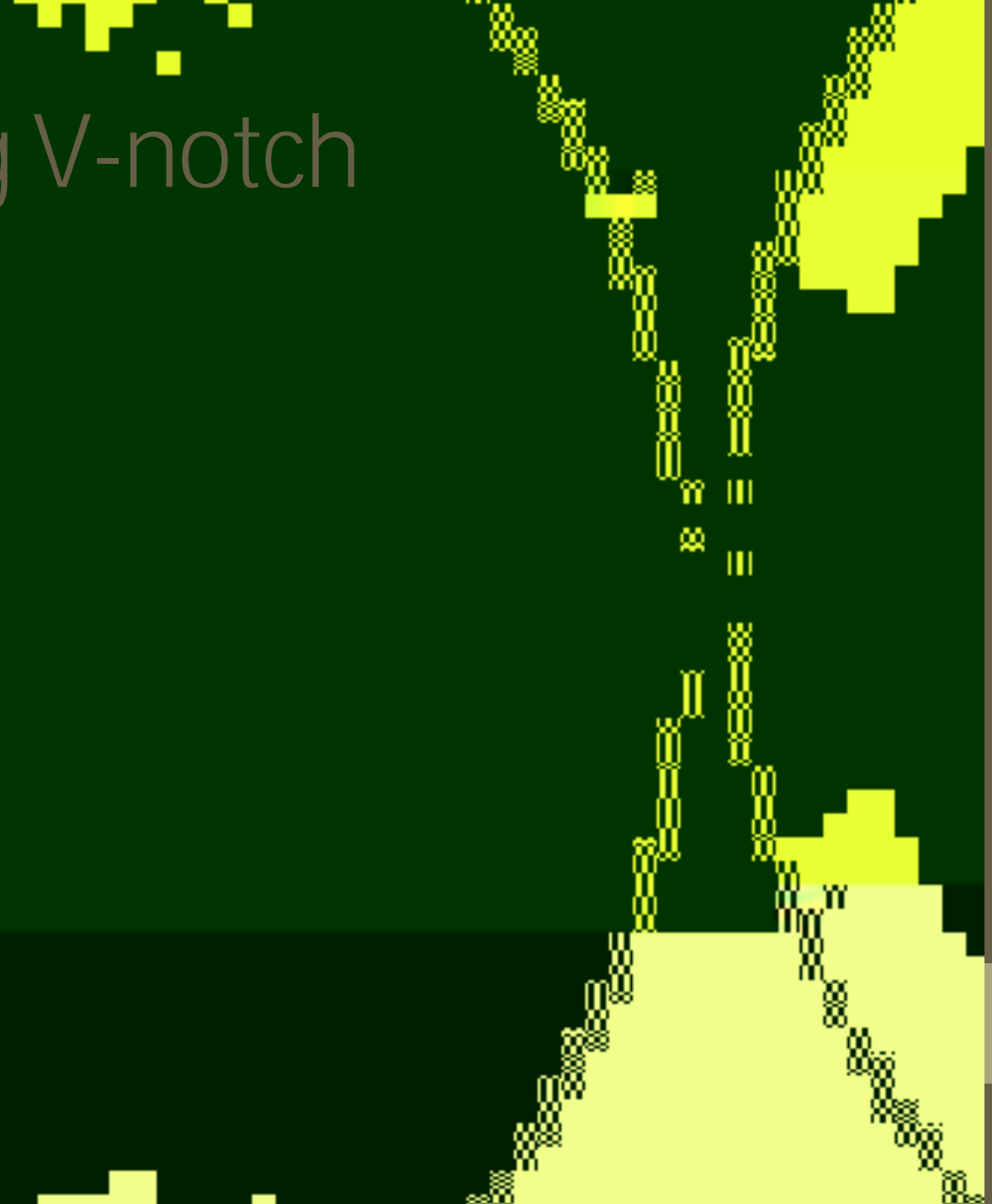
Designing V-notch

- Flow Prior to dam is subcritical
- $Fr < 1$
- Supercritical flow over the dam
- $Fr > 1$
- Not safely passable by kayak or canoe



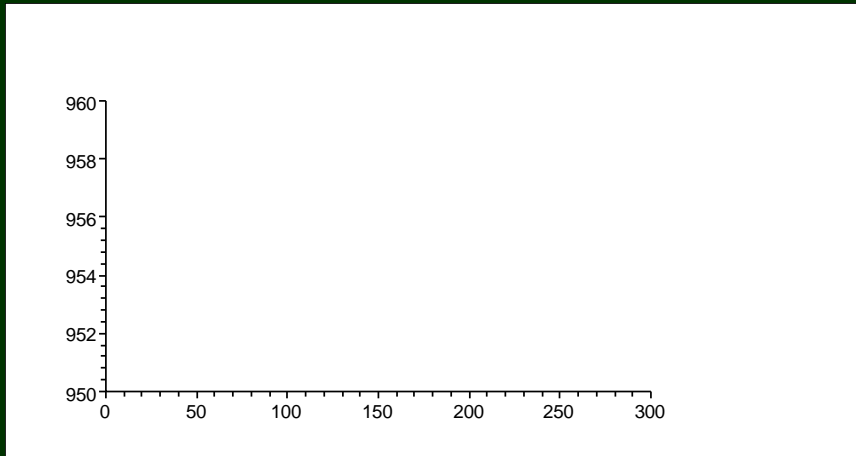
Designing V-notch

- 0



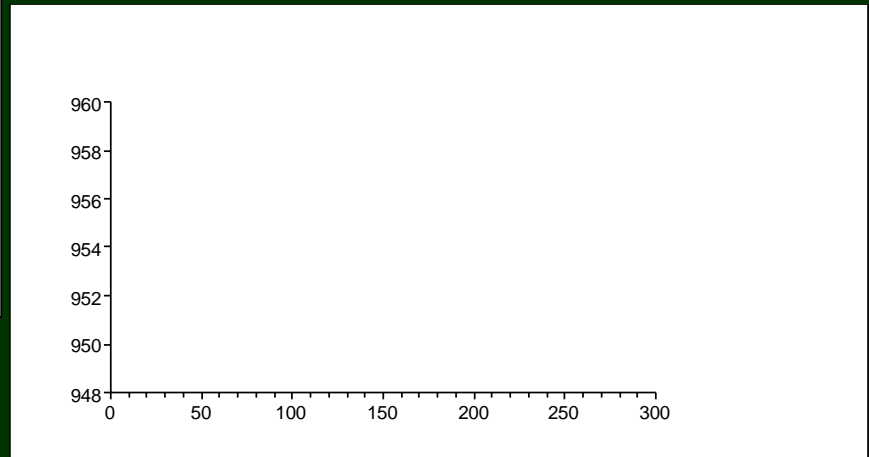
Hydraulic Jump

- Constant Q (93 cfs)



- Stage height at V-notch is 1.43 ft.

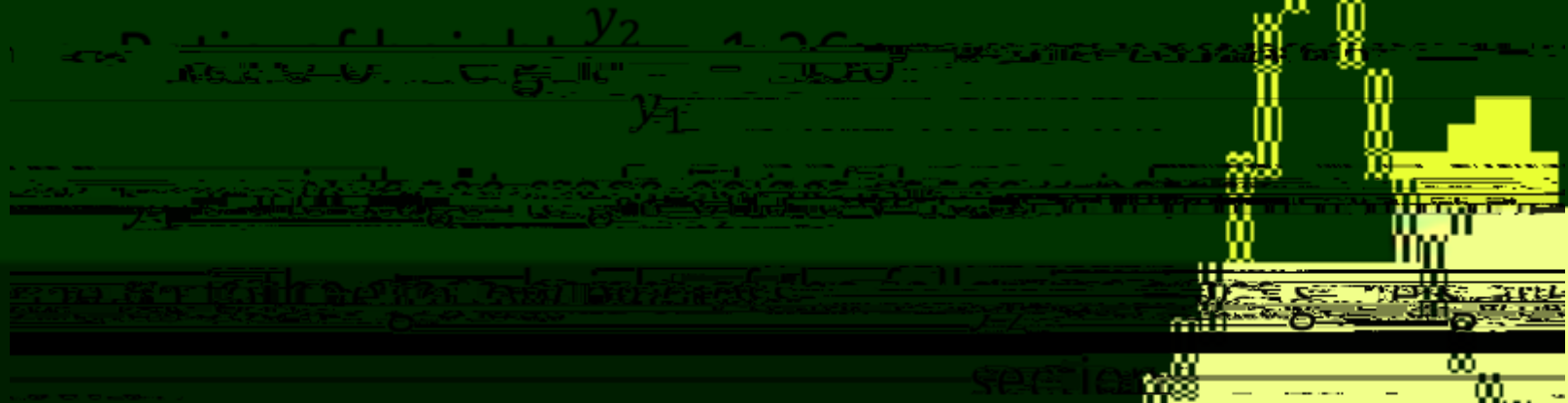
- Stage height of cross-section following V-notch is 1.94 ft.



- Hydraulic jump?

Hydraulic Jump

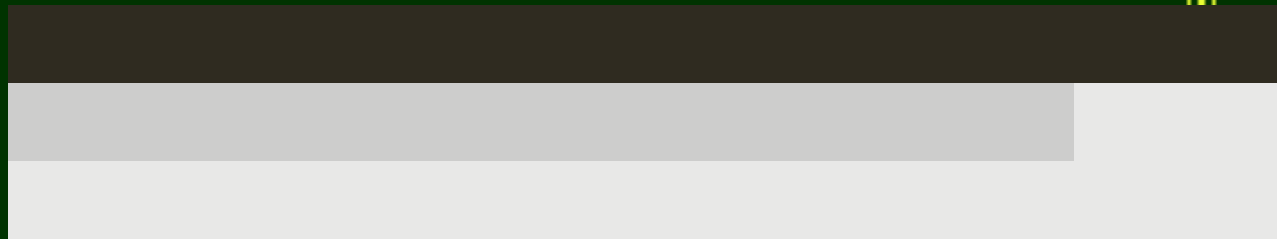
- Ratio of height — = 1.36
 - is the stage height of the v-notch
 - is the stage height of the following cross-section
 - Success!
 - Created an undulant jump or rapid which is passable by both canoe and kayak



Success!

Hydraulic Jump

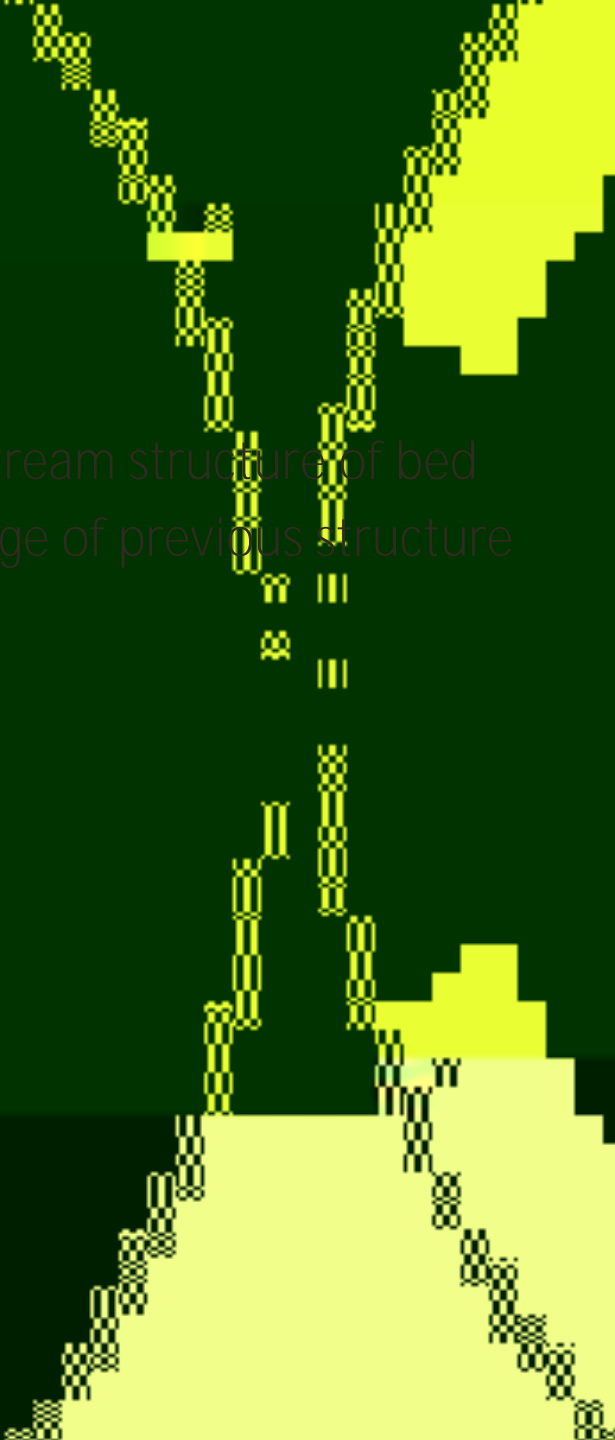
- Is the model consistent?



- $F_1 > 1$, $F_2 < 1$
- Supercritical to subcritical flow
- Indeed our structure has a Hydraulic jump

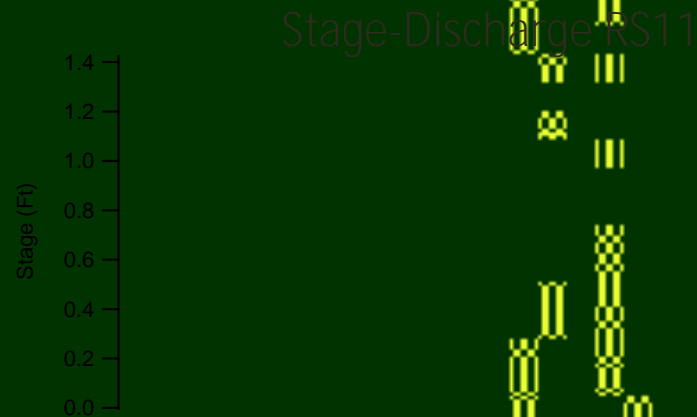
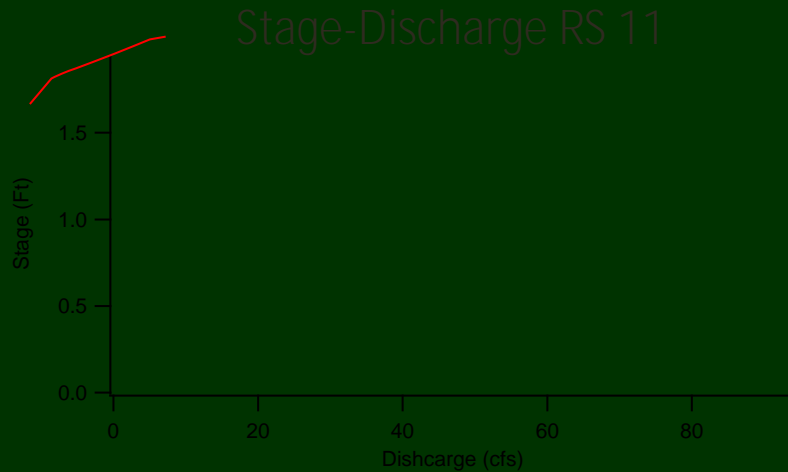
Model Accuracy

- Is stage height unreasonably high?
 - Uncharacteristic flow can damage downstream structure of bed
 - Must be consistent with the stage discharge of previous structure
 - Offset rating curves for comparison



Stage-Discharge Curve

- Pre Modification
- Post Modification



Conclusion

- HEC-RAS modeling to create modification to creek
- Model was consistent
- Dam modifications are possible

Acknowledgements

- Dr. George
- Dr. Williams

Questions?

