FREMONT WEIR FISH PASSAGE

FOLDED OPTION PROOF OF CONCEPT

Prepared for:

State & Federal Contractors Water Agency

Prepared by:

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INTRODUCTION

In response to the Department of Water Resources' (DWR) Final Engineering Report on the Fremont Weir Fish Passage Proof of Concept, Moffatt & Nichol sought to develop and alternative fish passage design that would accomplish the project goals with a more compact footprint and alleviate to a certain extent the problem of fish delay as flow is cut off to each of the three separate passage channels. The concept present herein, utilizing four gated passage channels oriented in series, is similar to the concept proposed in the Final Engineering Report comments. Instead of the three parallel channels, this concept has four gates of varying invert elevations that connect via three ~900 ft long trapezoidal channels. At each gate discharge location, the transition from one channel to another is facilitated with a wide, low-velocity resting pool. Additionally, the location of the inlet gates through the Fremont Weir are shifted upstream along the Sacramento River to a point approximately 4000 ft from the weir's eastern limit in order to enhance the downstream passage of migrating fish at a location near the outside of a river bend. A plan view, profile view, and gate profiles are attached in Appendix A. Appendix C gives the approximate structure location along the Fremont Weir. The proposed demonstration project would only include gate 2 construction. This memorandum details the calculations and modeling work that were performed to prove that the alternative concept could still accomplish the goals of the project under the given constrains.

FISH PASSAGE CRITERIA

Fish passage criteria for the concept were adopted from the DWR Final Engineering Report. Based on published salmonid criteria and studies of sturgeon swimming ability, the design was conceived the goal of limiting average channel velocities to below 6 ft/s and water depths to greater than 2 ft. It is assumed that the velocity criteria is conservative, as roughness elements in the channels will reduce near-bank and near-bed velocities to much lower than the channel average.

SUMMARY OF HYDRAULIC MODELING

To investigate the concept, a one-dimensional hydraulic model was created using HEC-RAS. The section of the model stretching from Tule Pond to the downstream boundary, ~2500 ft upstream from I-5 was constructed so that profiles and velocities were approximately equal to those in the DWR version of the model. Several alternative geometries were then created to simulate the situation when each gate would be open. Each gate geometry was then run for discharges ranging from 1000 cfs down to 20 cfs. Appendix B gives plots of water surface profile, velocity profile, and depth profile for each geometry and for all modeled flows. For each run, a plot giving the full model profile and a plot zoomed in only on the fish passage structure are given. For all cases, the maximum velocity criteria is met, and the minimum depth criteria is met for all flows over 400 cfs.

The table below gives the estimated minimum flows in each channel after the lower gate has closed and the current gate has just opened. Note that this is conservative, as it assumes the lower gate is closed as soon as the upstream water surface elevation reaches the culvert top elevation. The lower gate could still be open when the culvert is submerged, with some risk of greater than 1000 cfs velocity. Alternatively, the lower gate could remain open partially to augment the lower flows coming from the upper gate.

Table 1: Flows after gate transitions

Gate	invert elevation (ft NAVD88)	ws elevation at 1000 cfs	approx. lowest flow after lower gate is closed (cfs)
1	10	17.77	n.a.
2	16	21.92	200
3	22	27.98	200
4	26.8	31.74	500

The pools at each gate landing are adequately sized to dissipate the energy from the incoming culverts and channels according to the Energy Dissipation Factor (EDF) criteria. This specifies a maximum ratio of energy flux to pool volume.

APPENDIX A

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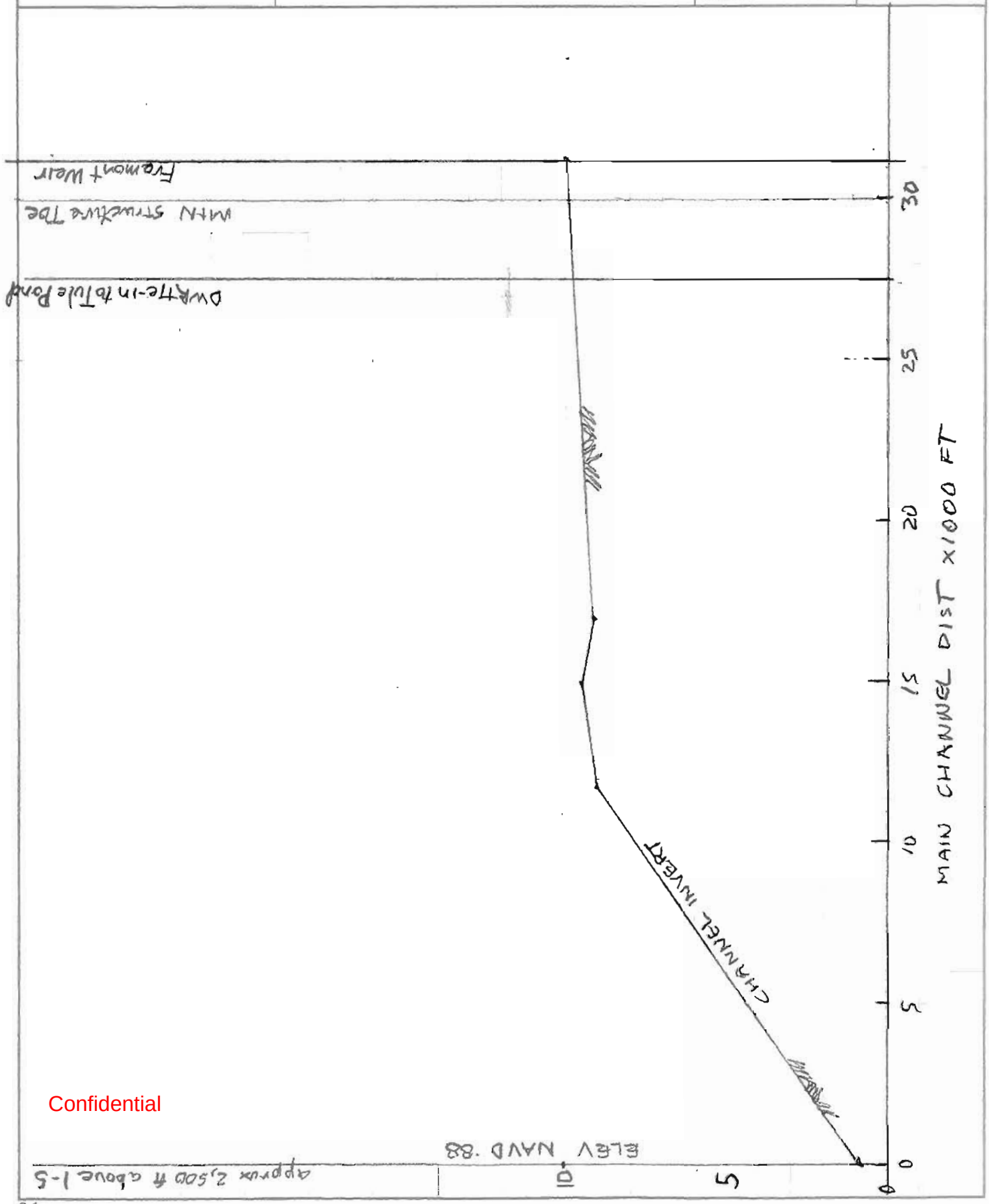
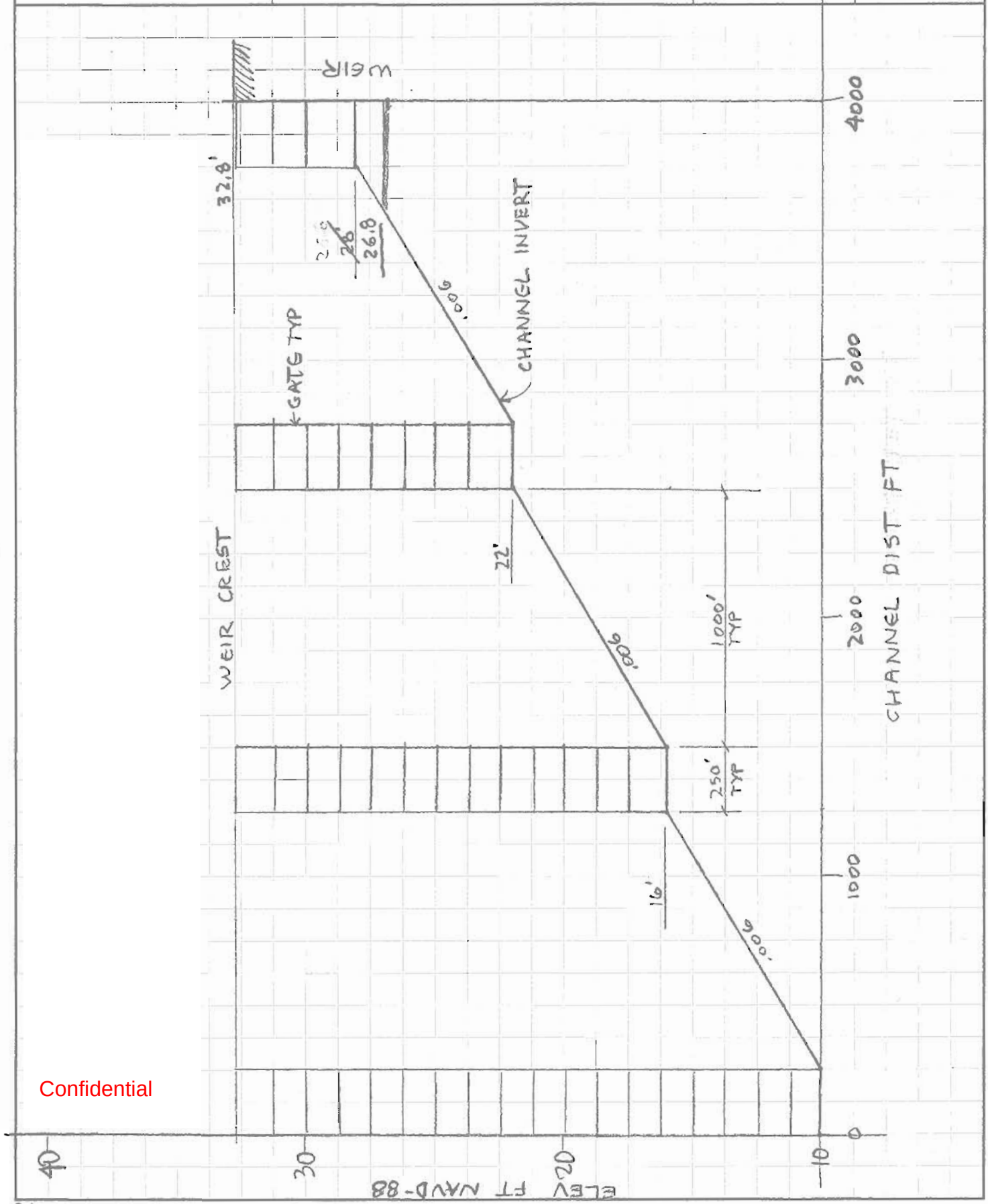
CLIENT	SFCWA	JOB NO.	
PROJEC	YOLO WETLANDS	SHEET 1	OF
DESIGN FOR	FREMONT WEIR	DESIGNER PD	DATE 10-19-12
		CHECKER	DATE



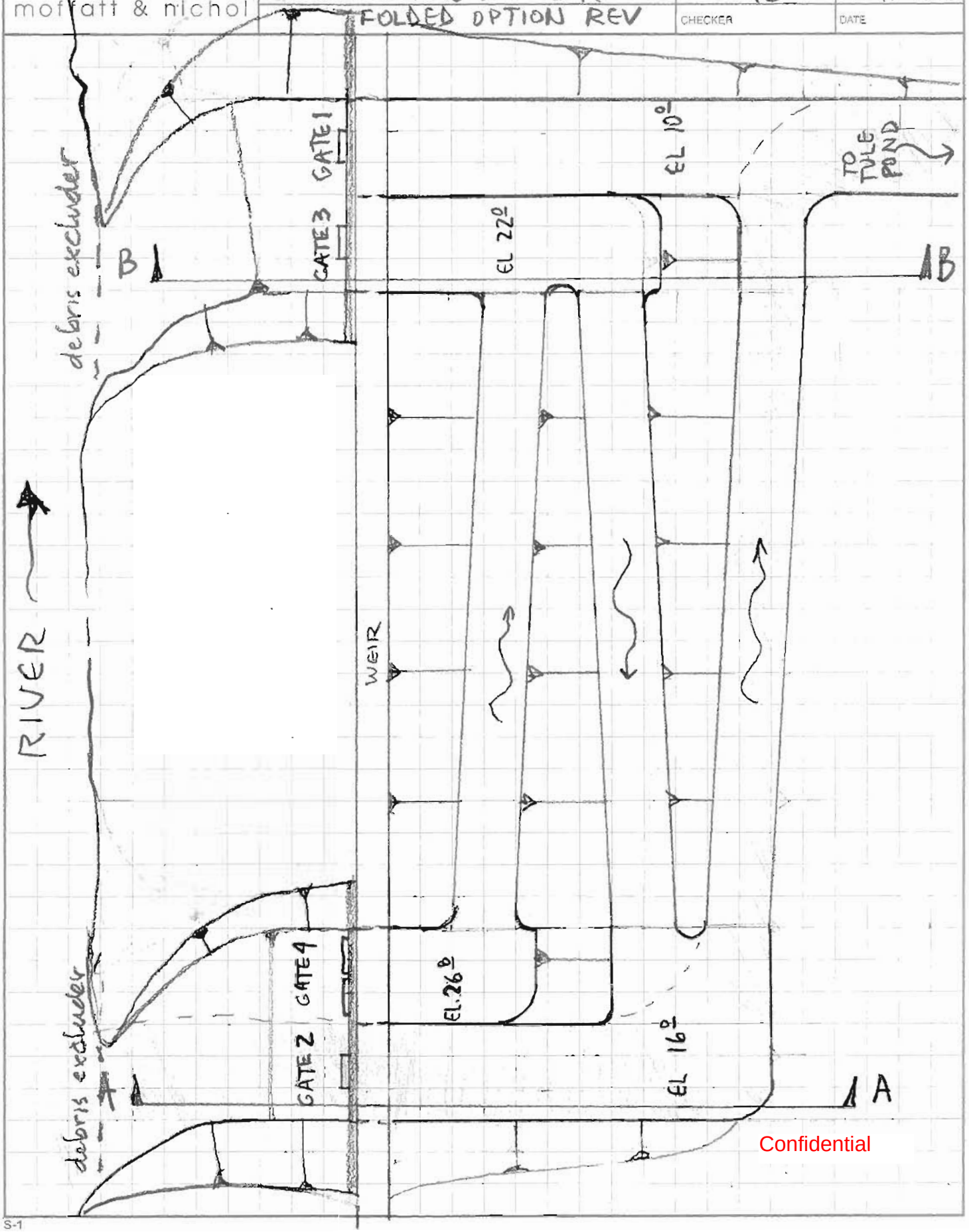
moffatt & nichol

CLIENT	SFCWA	JOB NO	
PROJECT	YOLO WETLANDS	SHEET 2	OF
DESIGN FOR	FREMONT WEIR	DESIGNER AD	DATE 10-19-12
		CHECKER	DATE



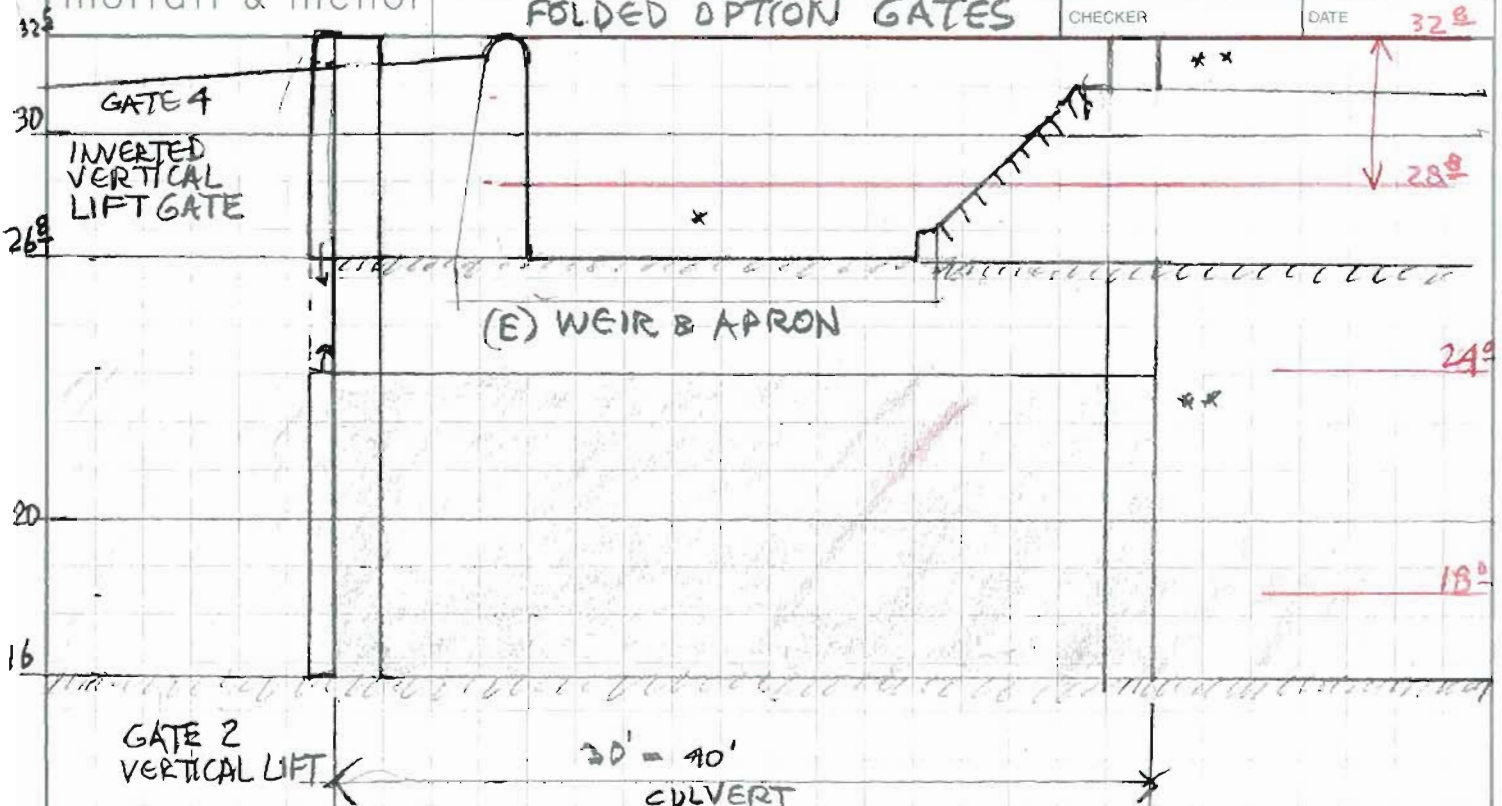
moffatt & nichol

CLIENT	SFCWA	JOB NO.	
PROJECT	YOLO WETLANDS	SHEET 5	OF
DESIGN FOR	FREMONT WEIR FOLDED OPTION REV	DESIGNER PD	DATE 10-30-12
		CHECKER	DATE

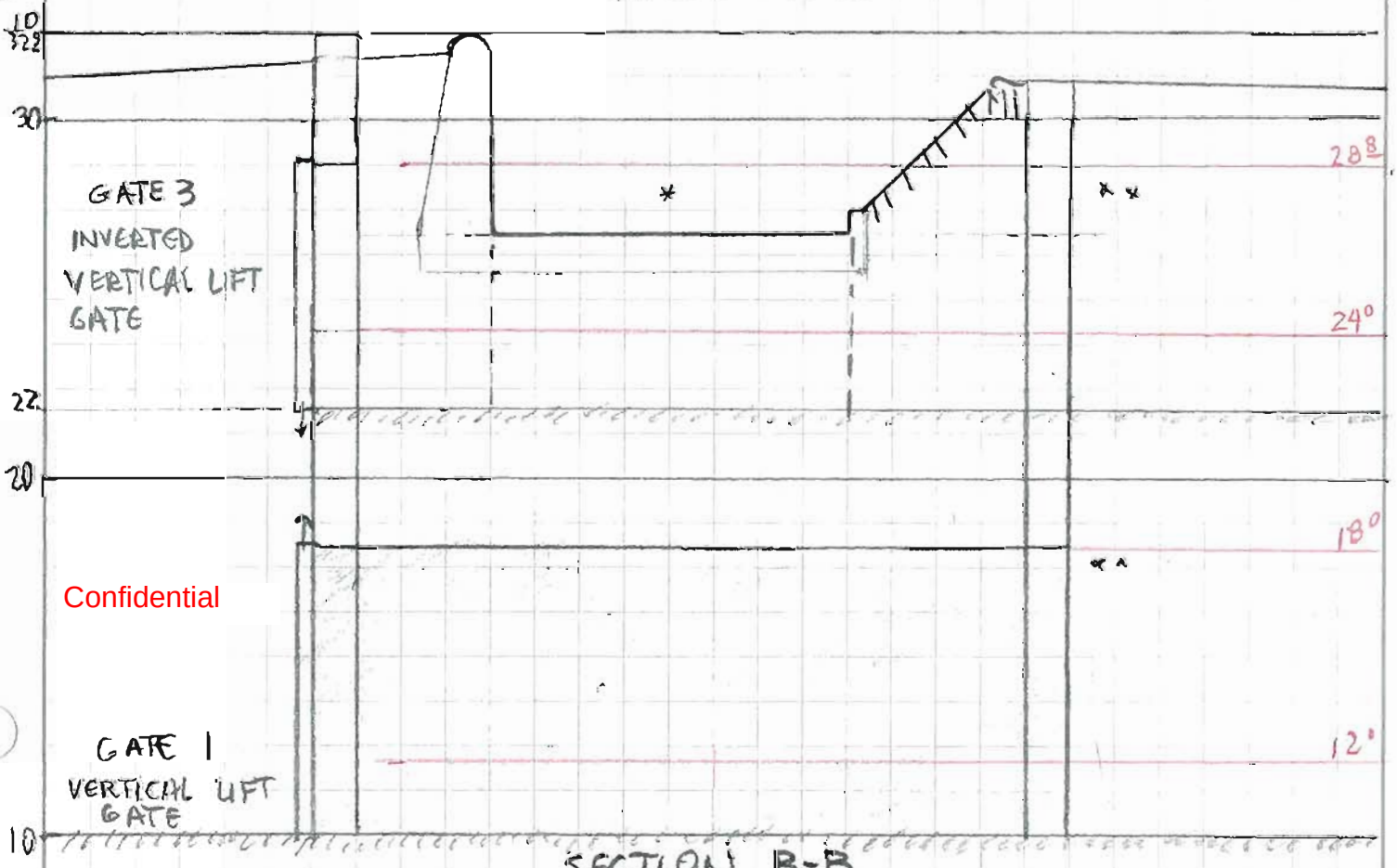


moffatt & nichol

CLIENT	SFCWA	JOB NO	
PROJECT	YOLO WETLANDS	SHEET 6	OF
DESIGN FOR	FREMONT WEIR	DESIGNER RD	DATE 10-30-12
	FOLDED OPTION GATES	CHECKER	DATE



SECTION A-A

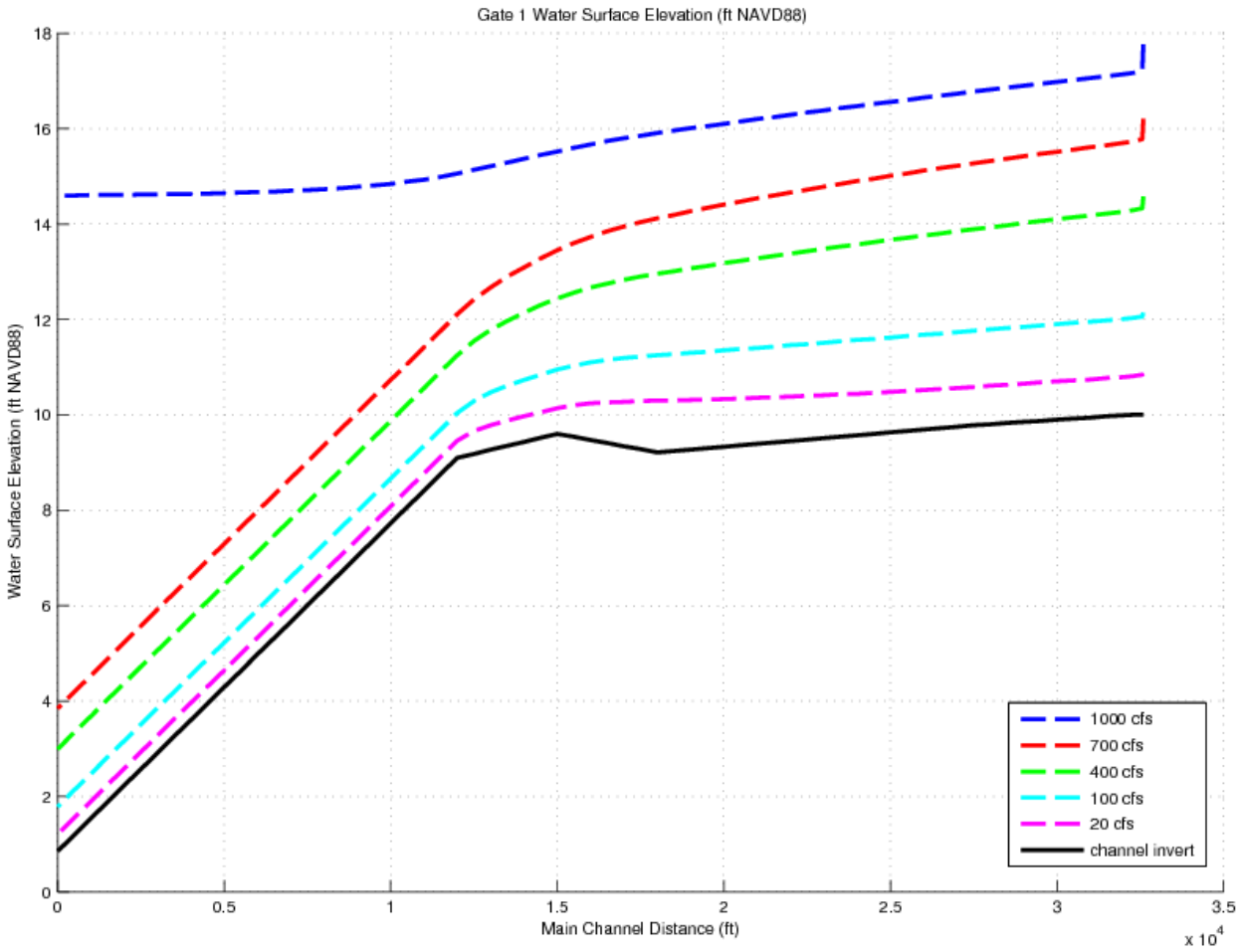


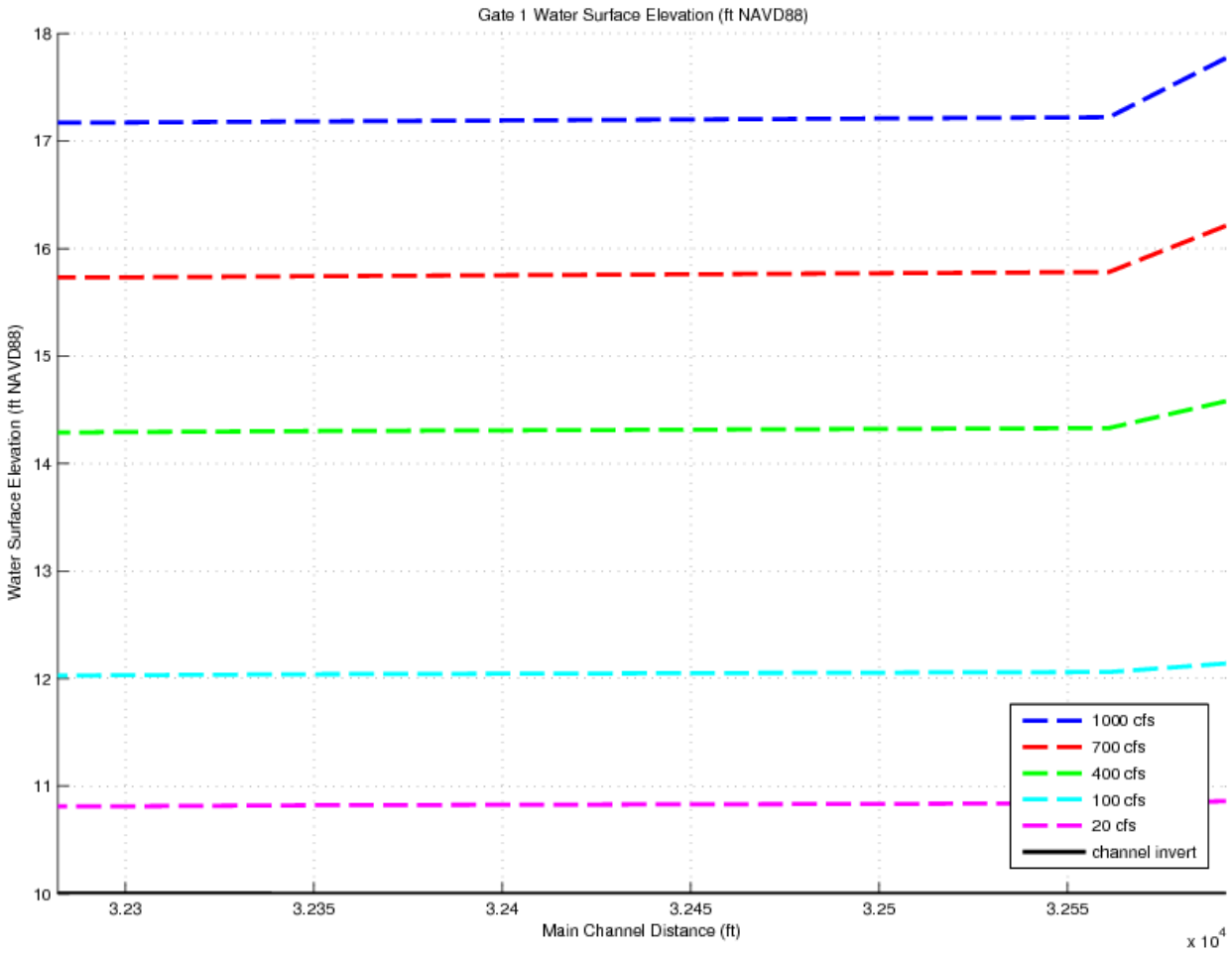
SECTION B-B

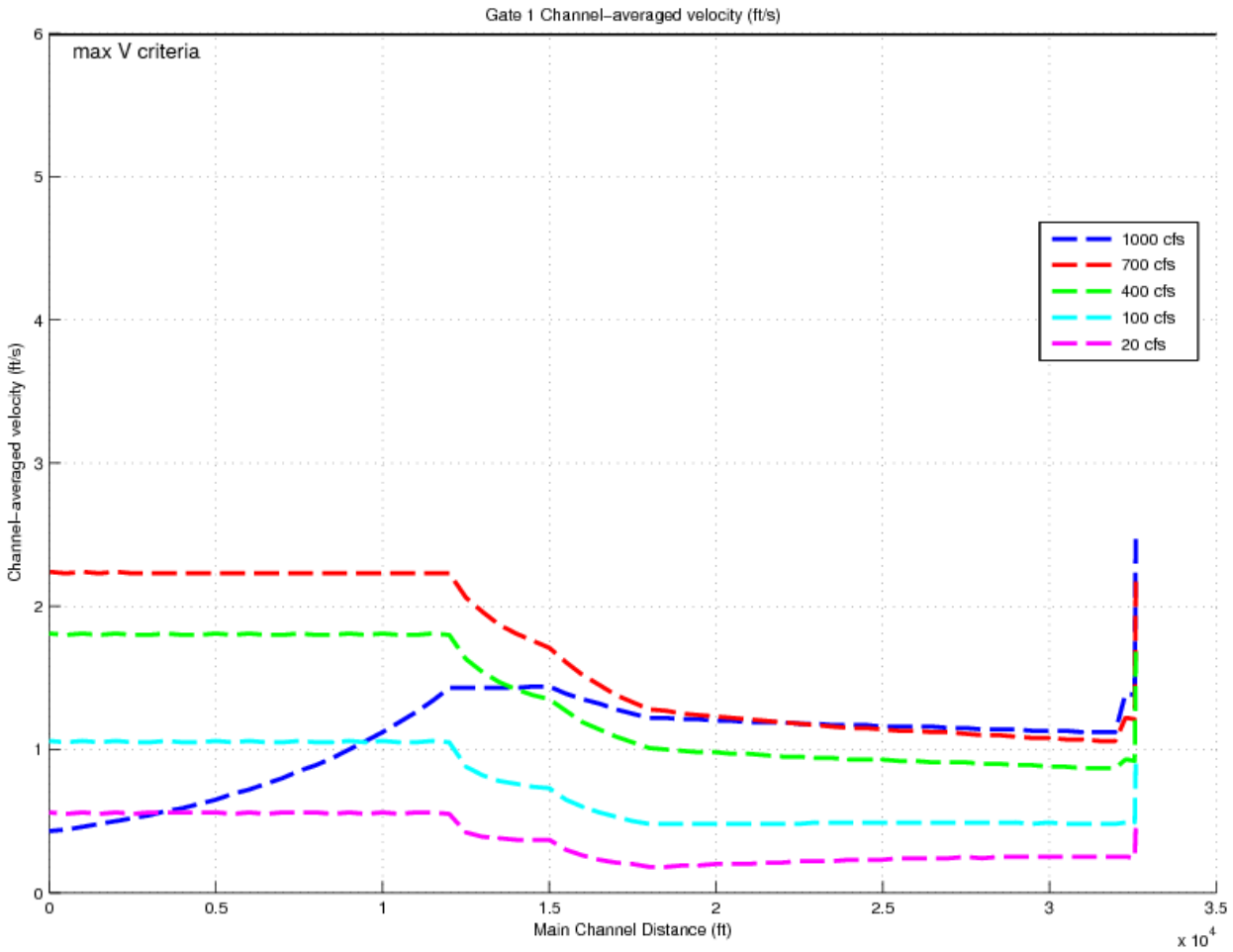
S-1 STOP LOGS CAN BE SUBSTITED AT EACH GATE

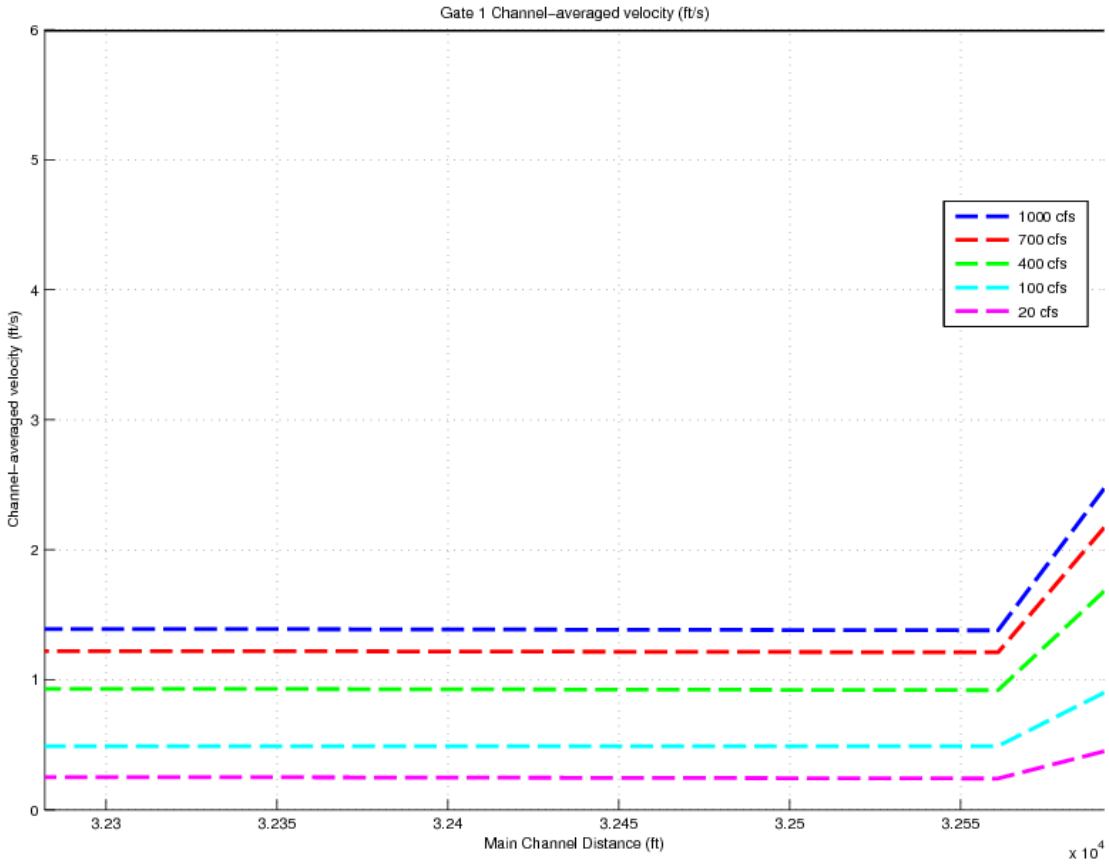
** emergency stoplog closure (redundancy)

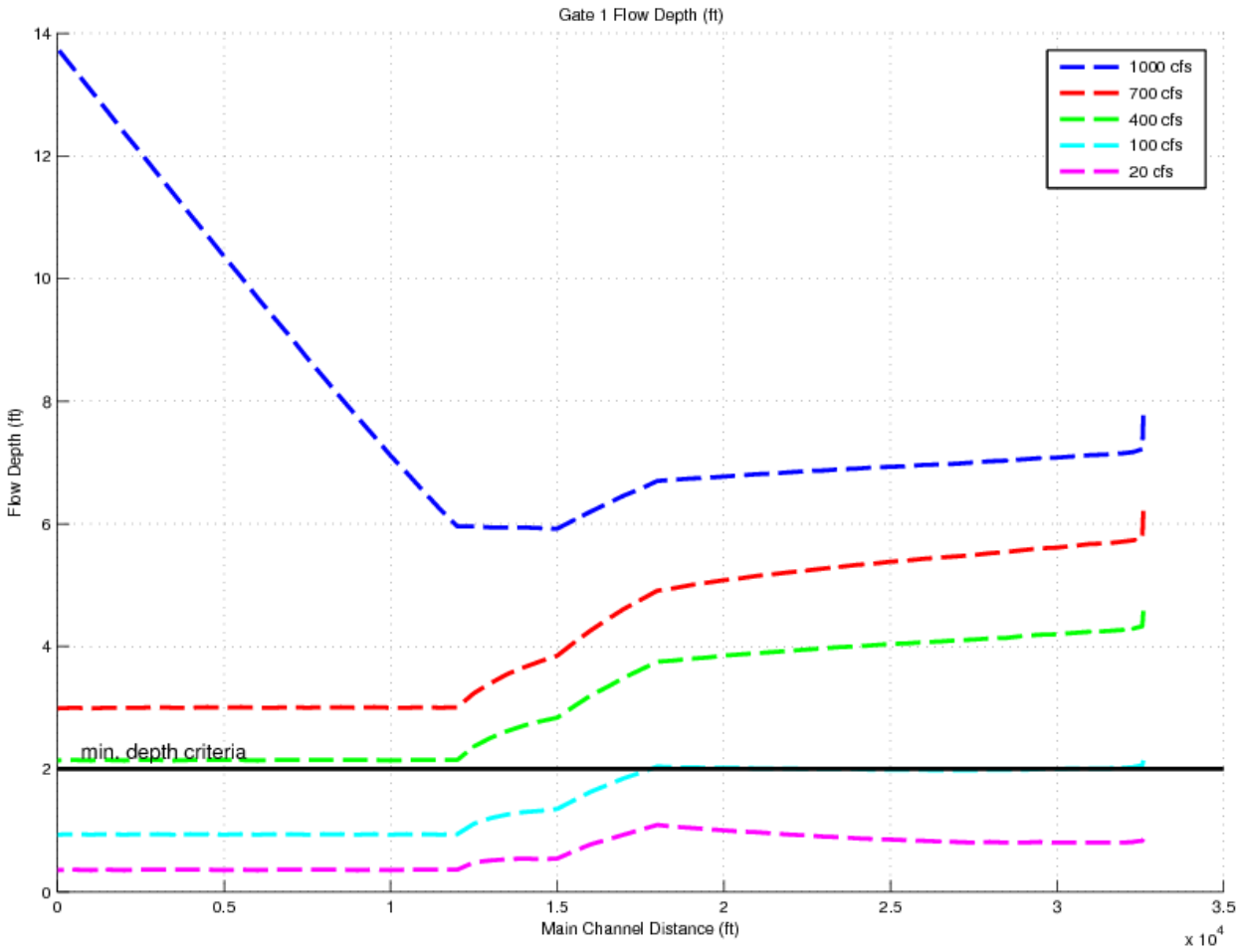
APPENDIX B

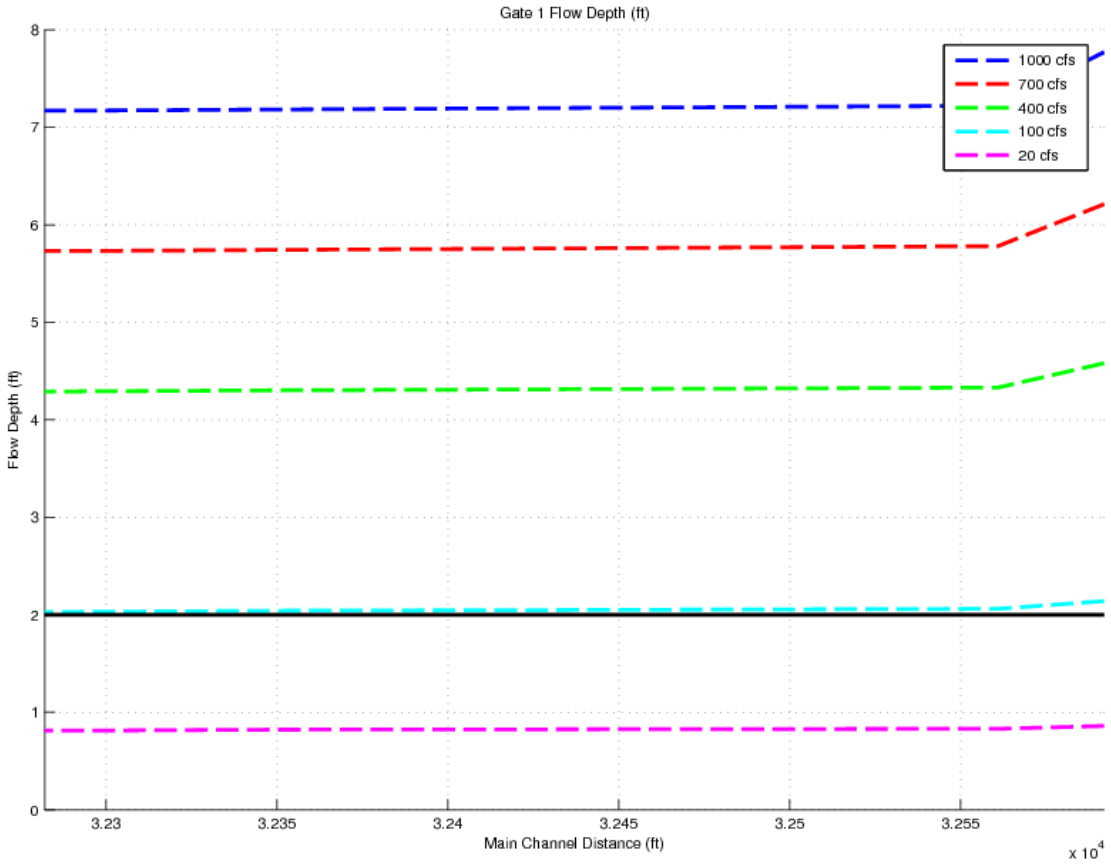

Gate 1 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
Main Channel Distance (ft)
x 10^4
0
2
4
6
8
10
12
14
16
18
0
0.5
1
1.5
2
2.5
3
3.5
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

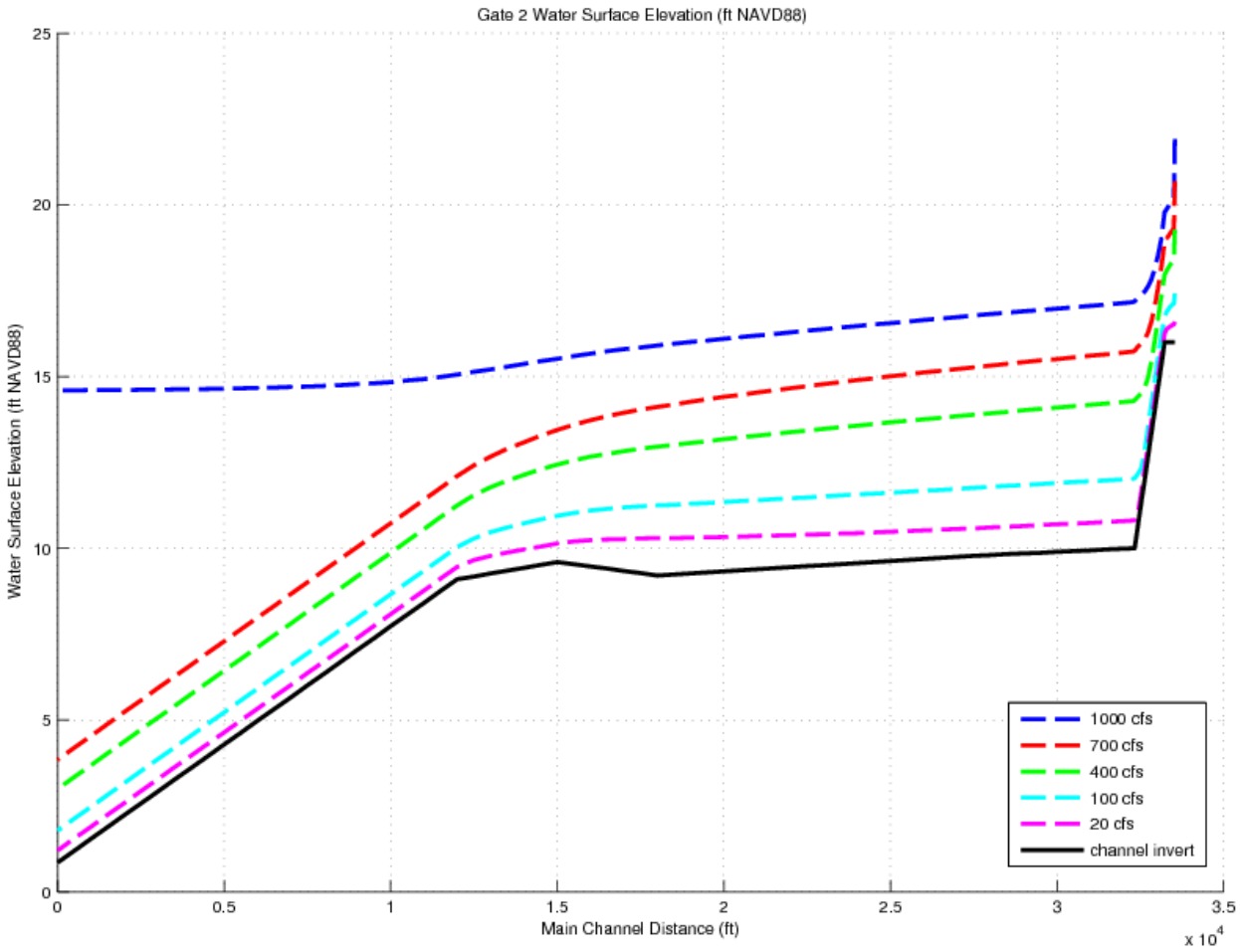

Gate 1 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
18
17
16
15
14
13
12
11
10
3.23
3.235
3.24
3.245
3.25
3.255
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

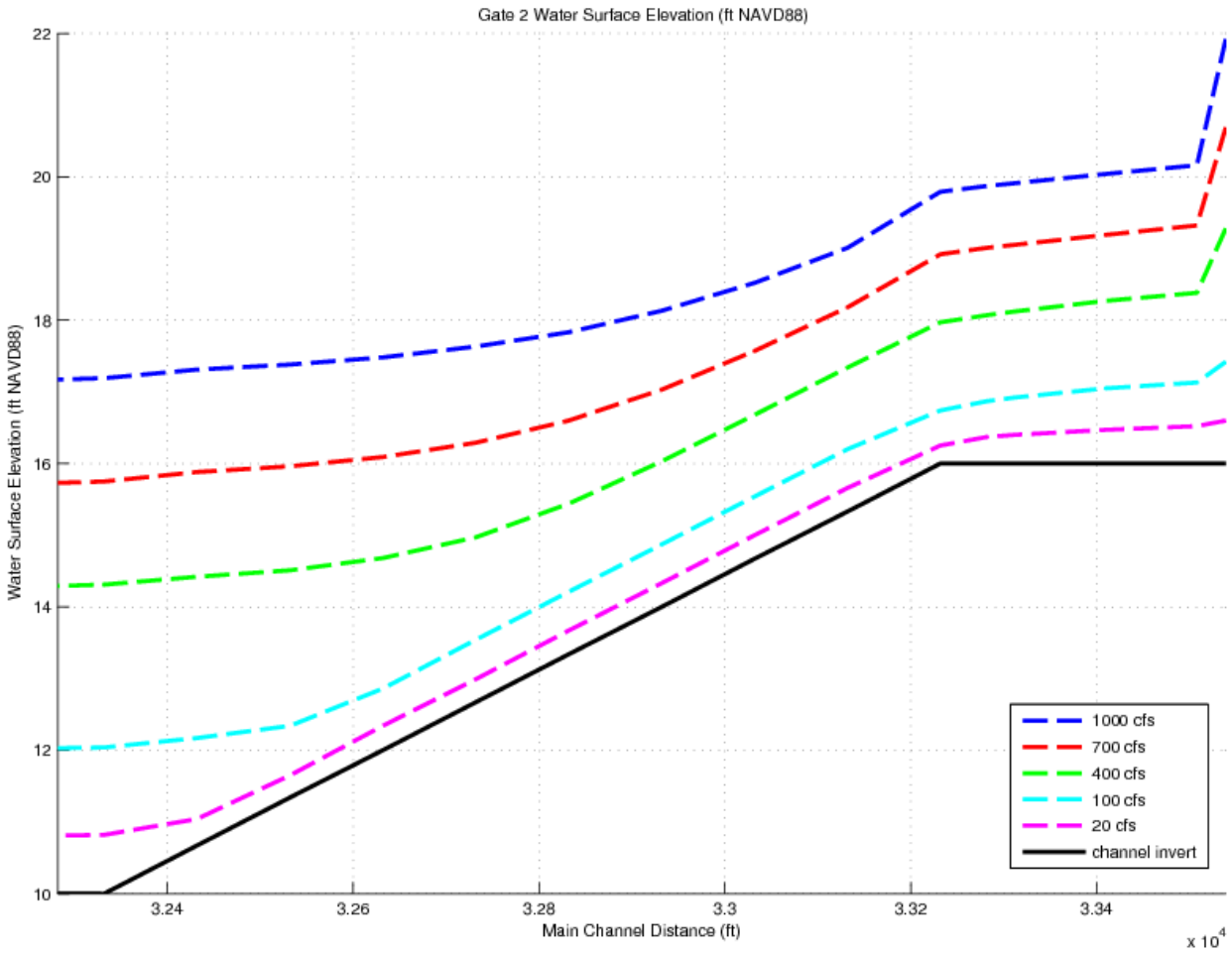

Gate 1 Channel–averaged velocity (ft/s)
max V criteria
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
0.5
1.5
2.5
3.5

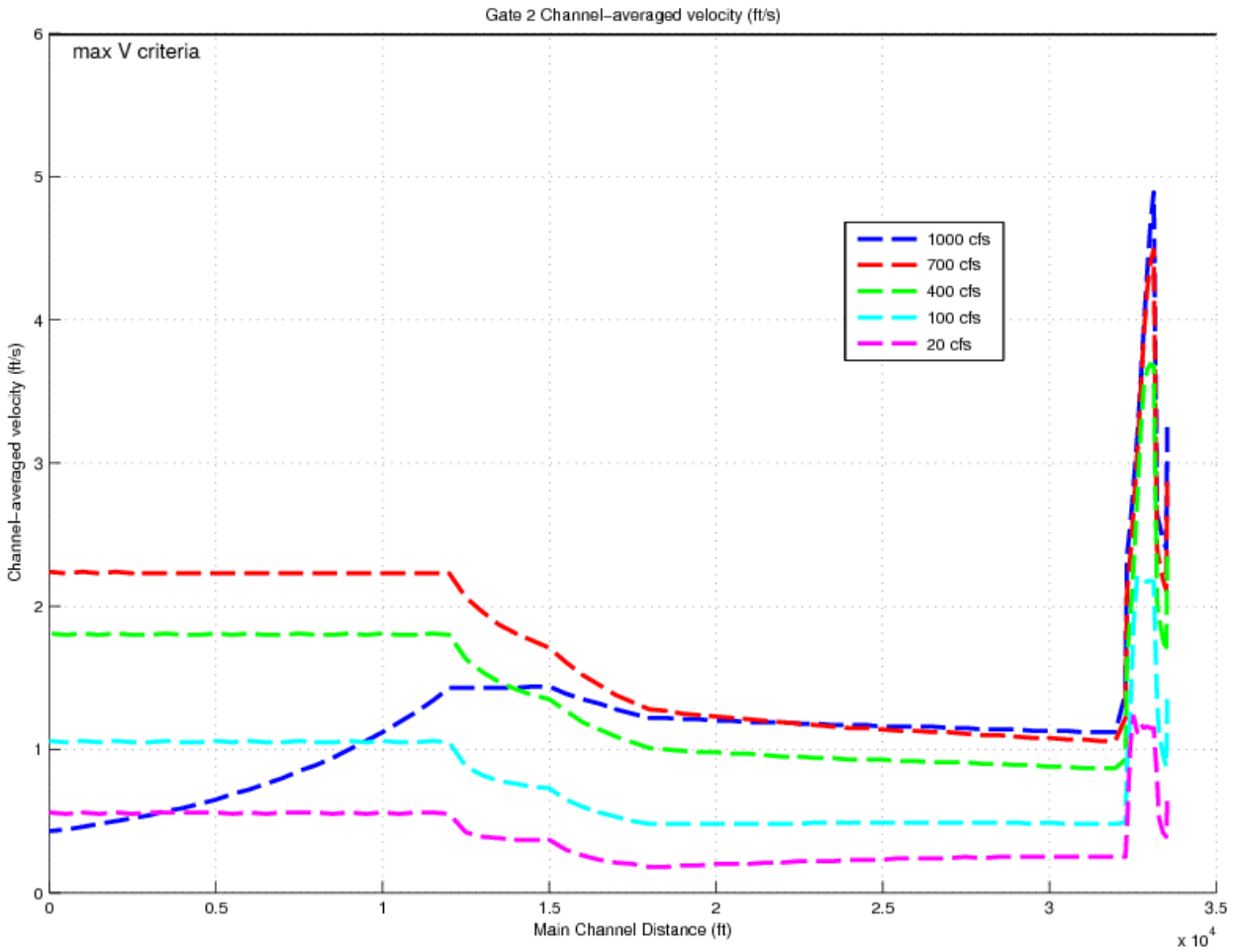

Gate 1 Channel–averaged velocity (ft/s)
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
0
1
2
3
4
5
6
3.23
3.235
3.24
3.245
3.25
3.255

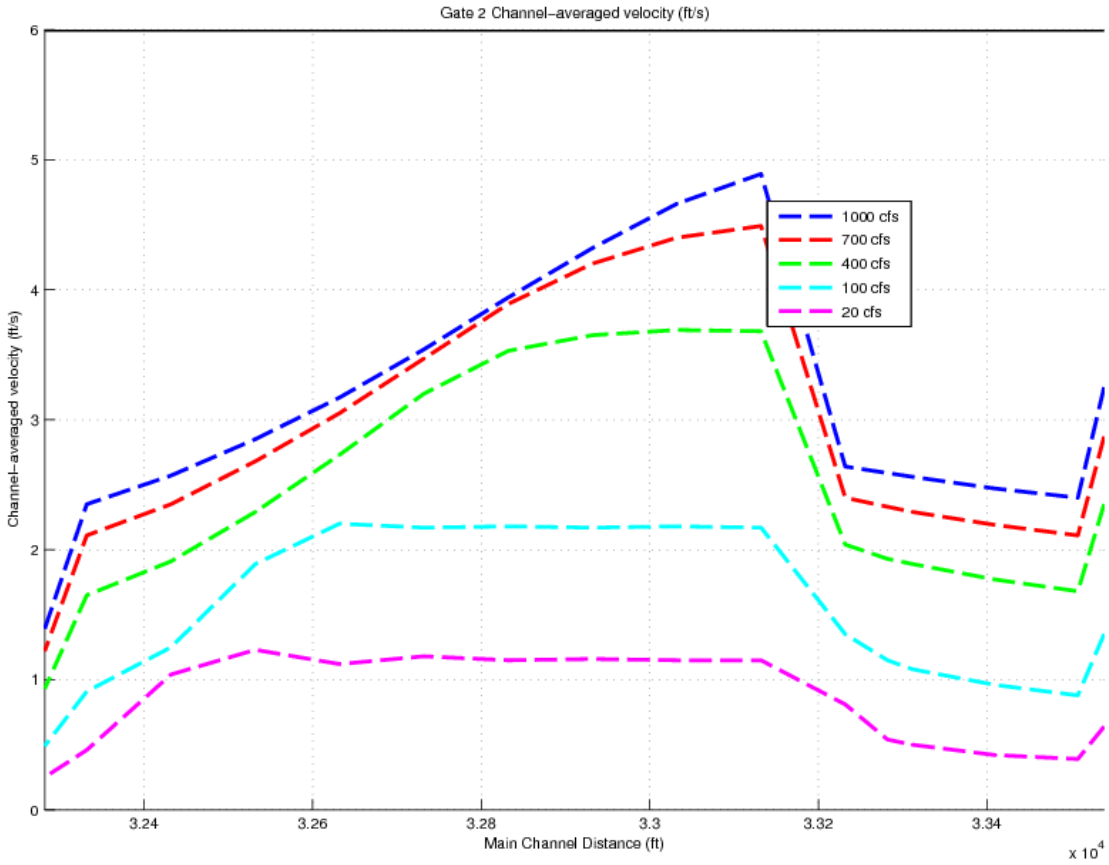

Gate 1 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
min. depth criteria
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
2
4
6
8
10
12
14
0
0.5
1
1.5
2
2.5
3
3.5

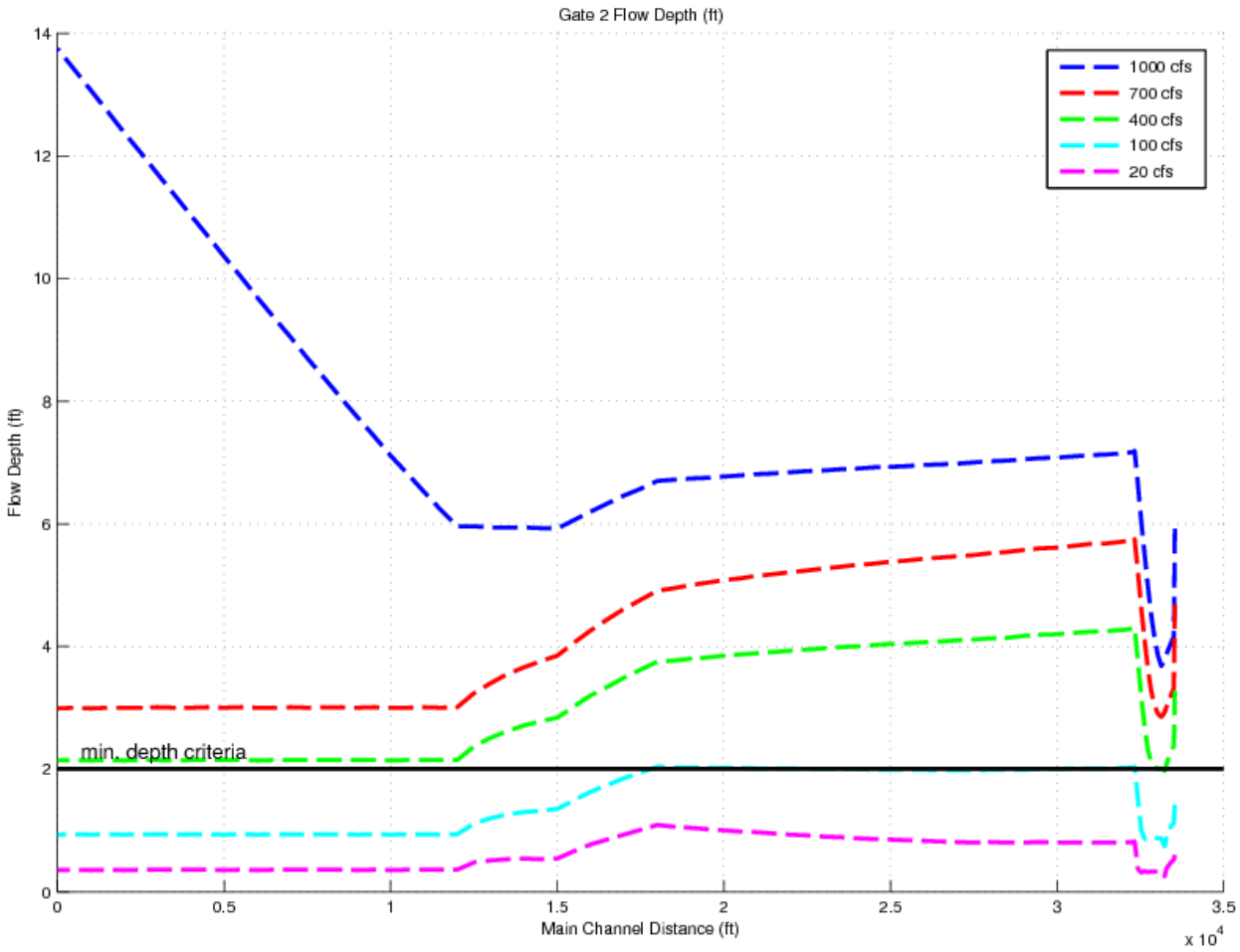

Gate 1 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
7
8
3.23
3.235
3.24
3.245
3.25
3.255

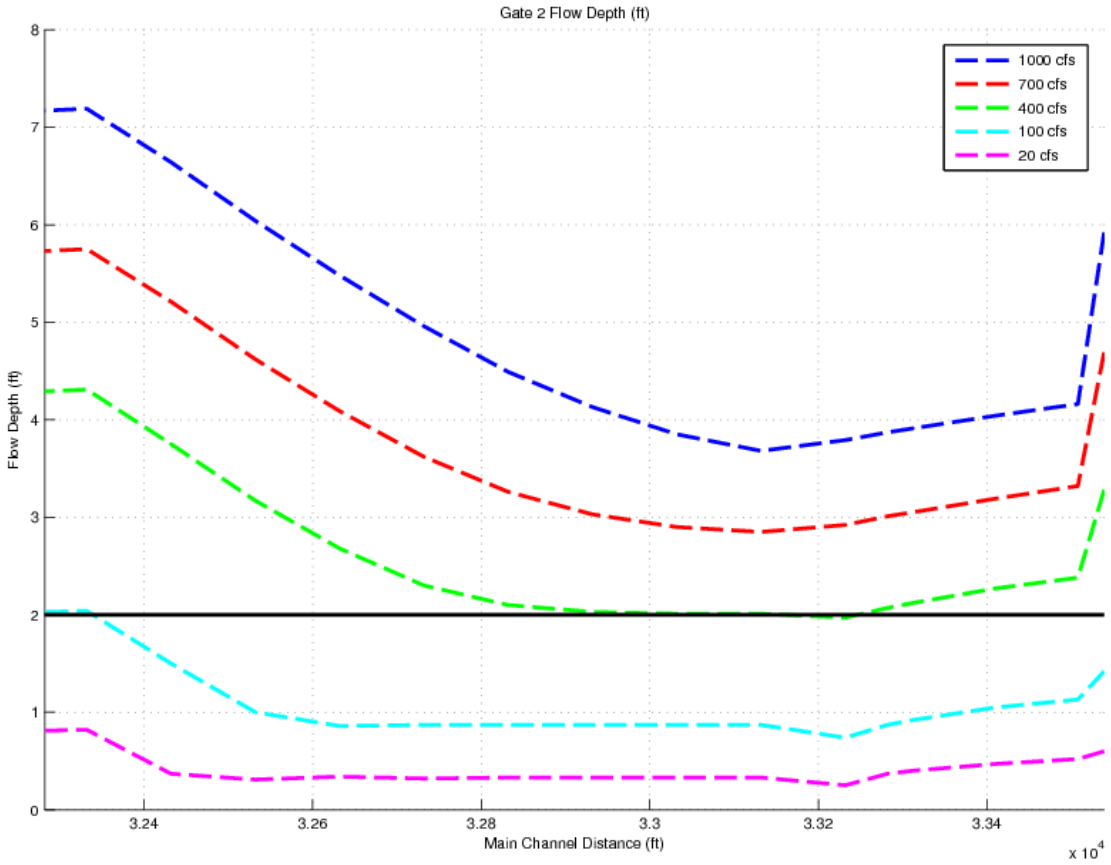

Gate 2 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
Main Channel Distance (ft)
x 10^4
0
5
10
15
20
25
0
0.5
1
1.5
2
2.5
3
3.5
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

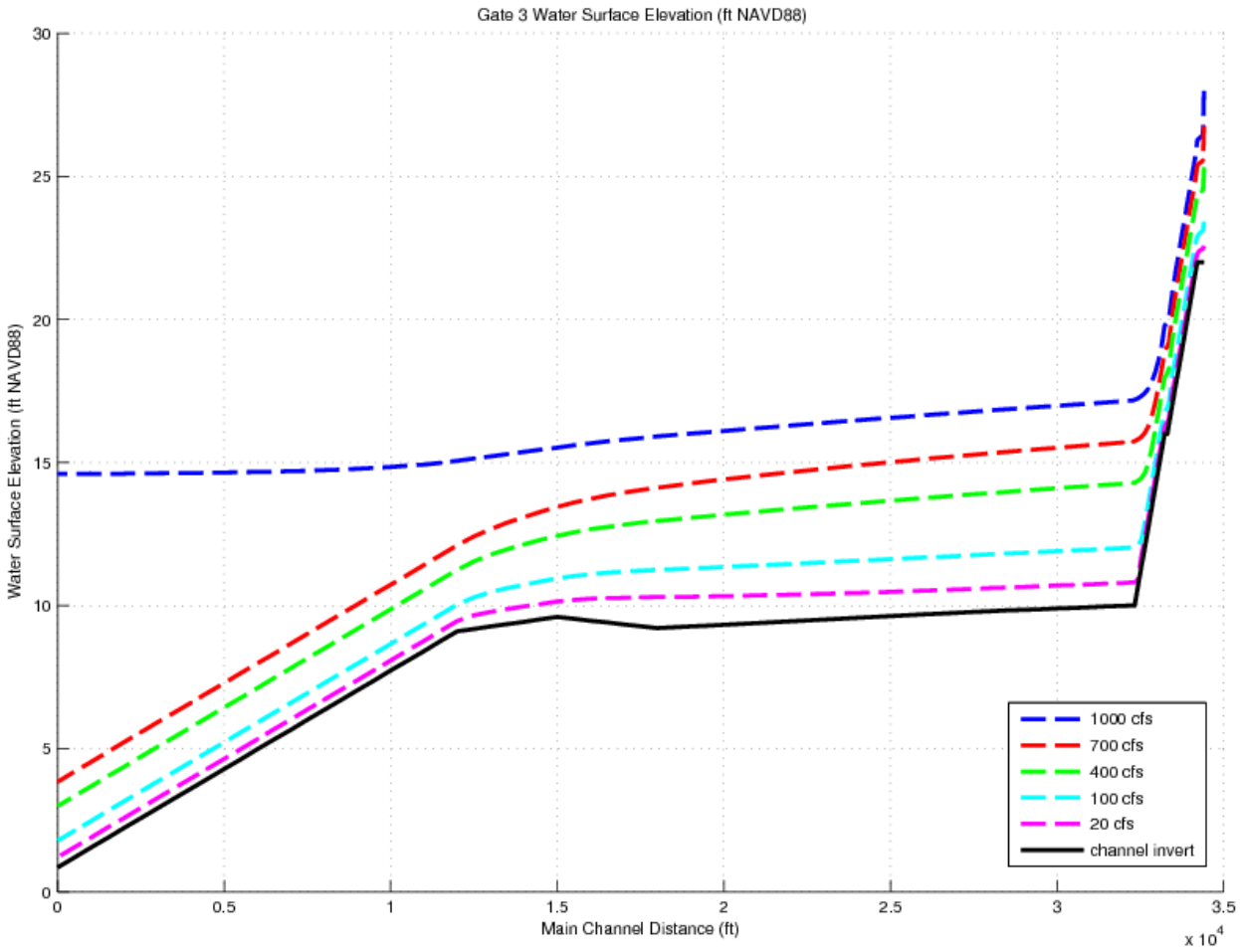

Gate 2 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
22
20
18
16
14
12
10
3.24
3.26
3.28
3.3
3.32
3.34
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

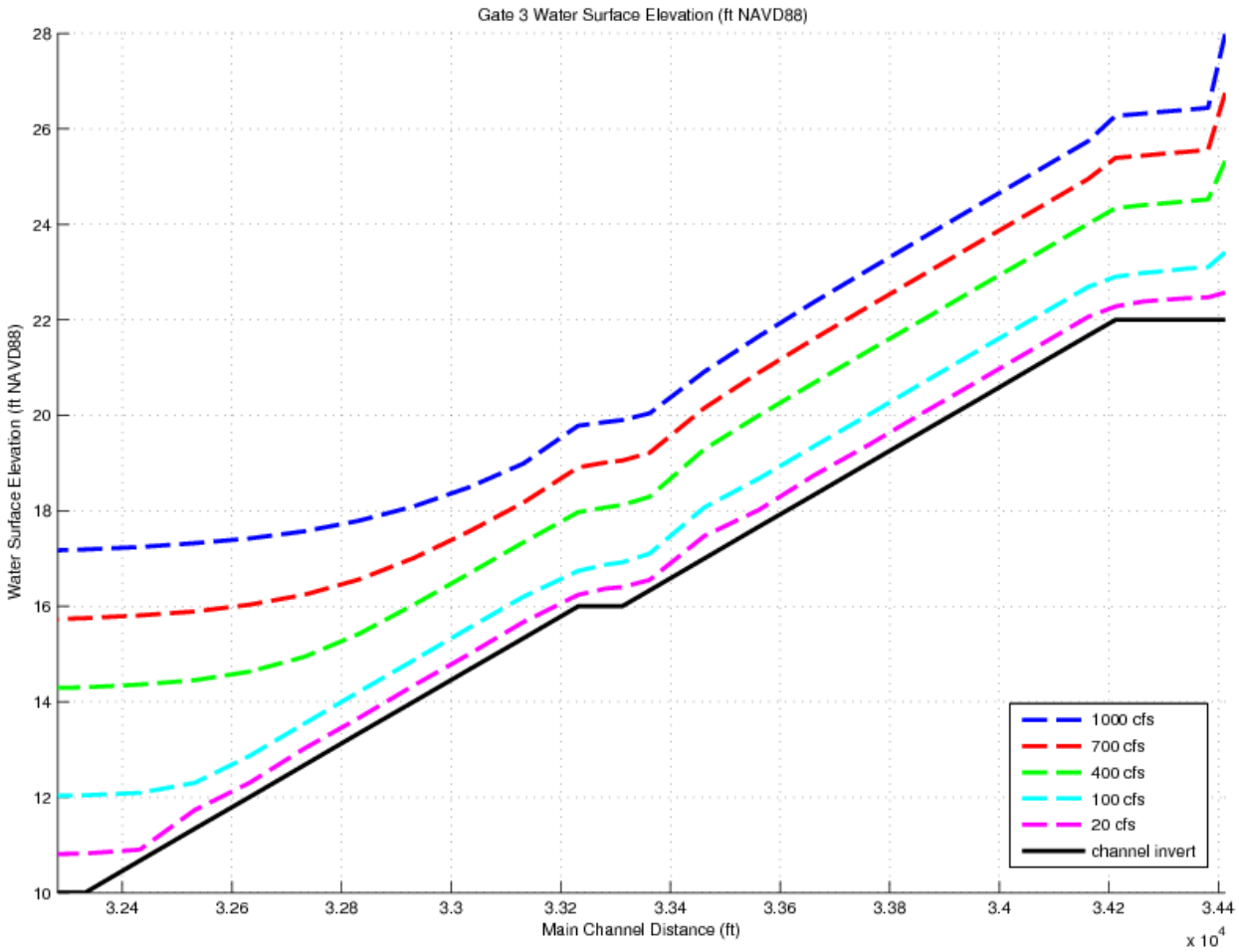

Gate 2 Channel–averaged velocity (ft/s)
max V criteria
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
0
0.5
1
1.5
2
2.5
3
3.5
1
2
3
4
5
6

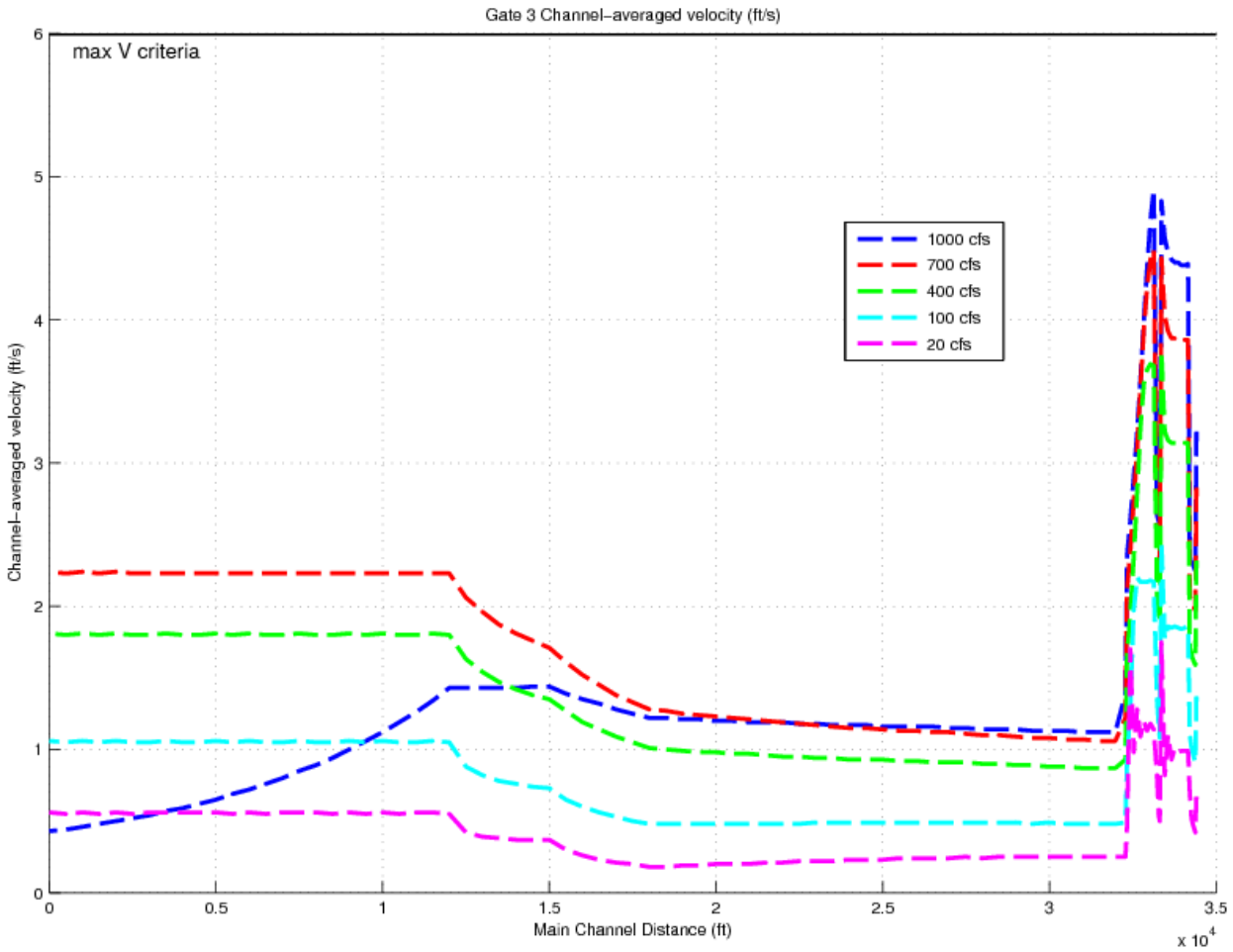

Gate 2 Channel–averaged velocity (ft/s)
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
0
1
2
3
4
5
6
3.24
3.26
3.28
3.3
3.32
3.34

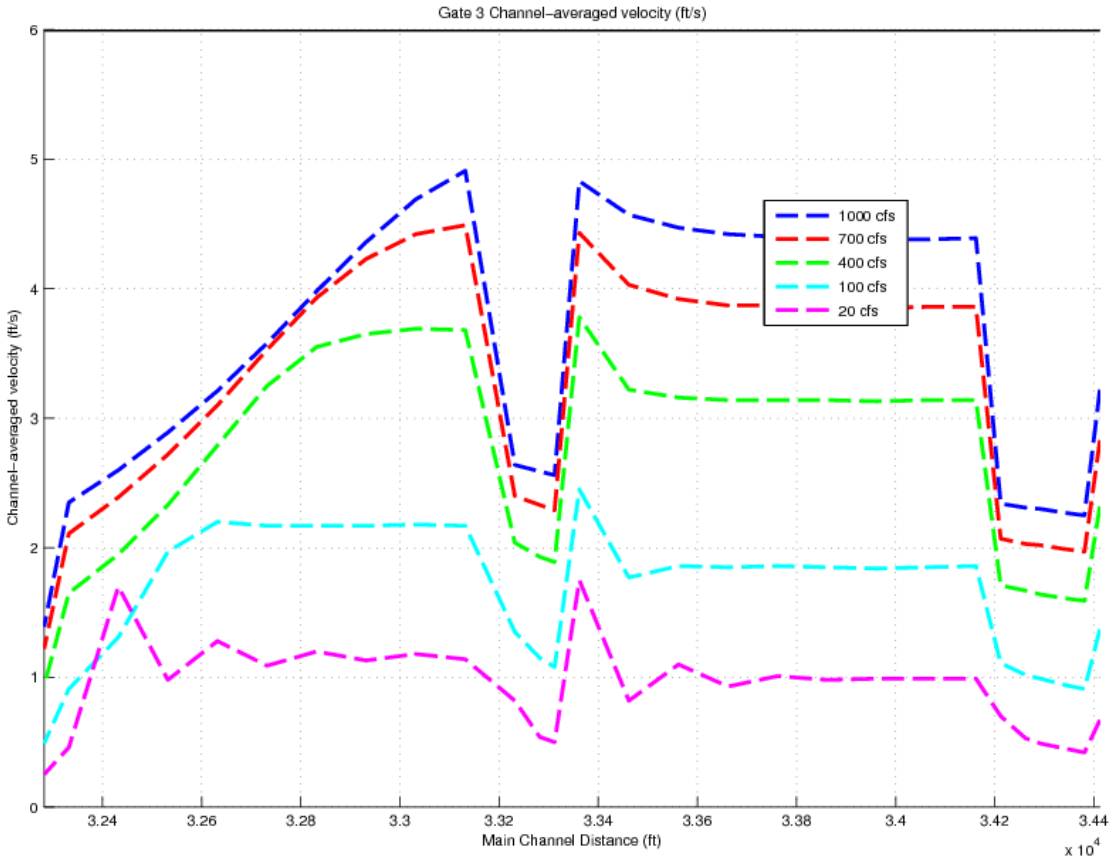

Gate 2 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
min. depth criteria
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
2
4
6
8
10
12
14
0
0.5
1
1.5
2
2.5
3
3.5

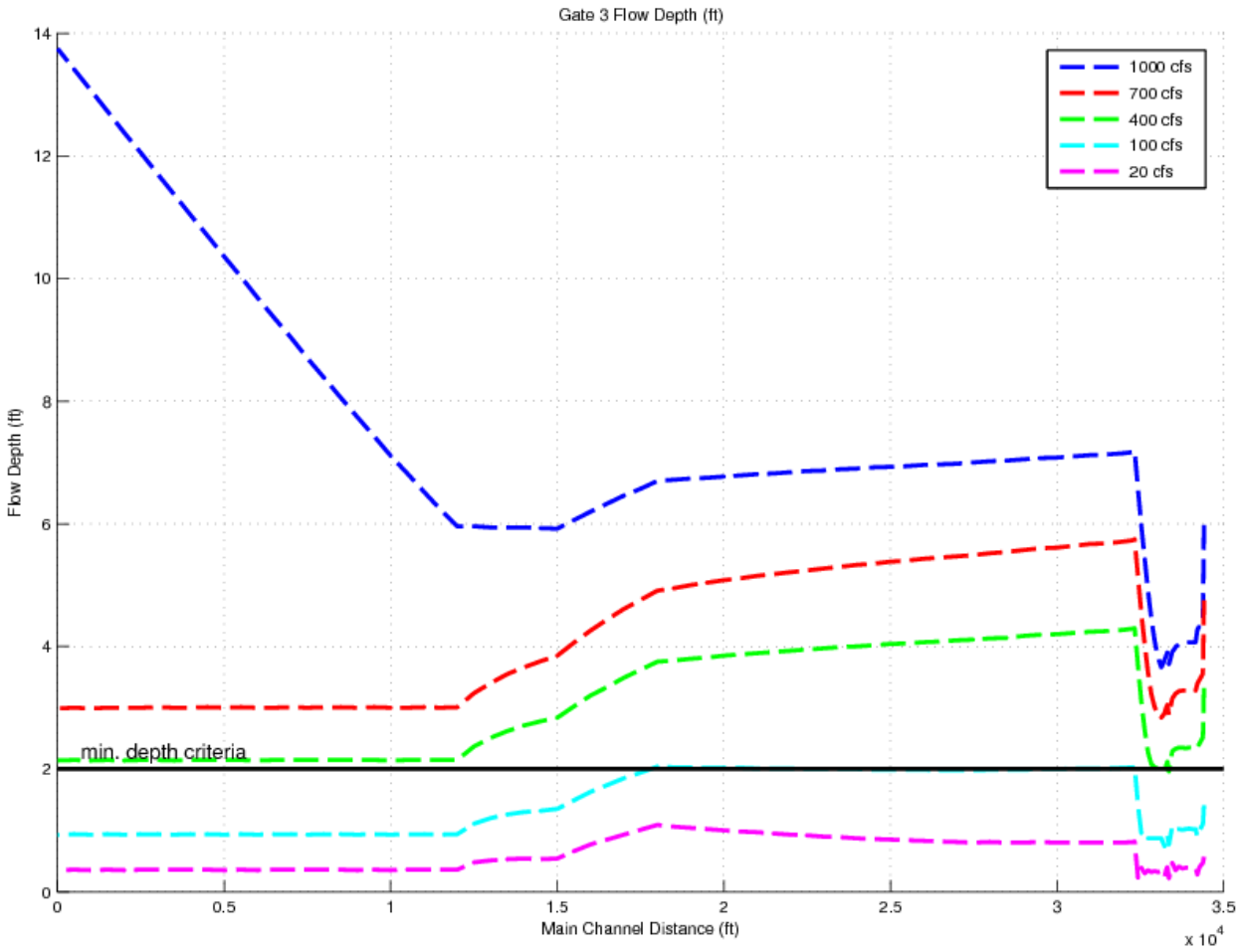

Gate 2 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
7
8
3.24
3.26
3.28
3.3
3.32
3.34

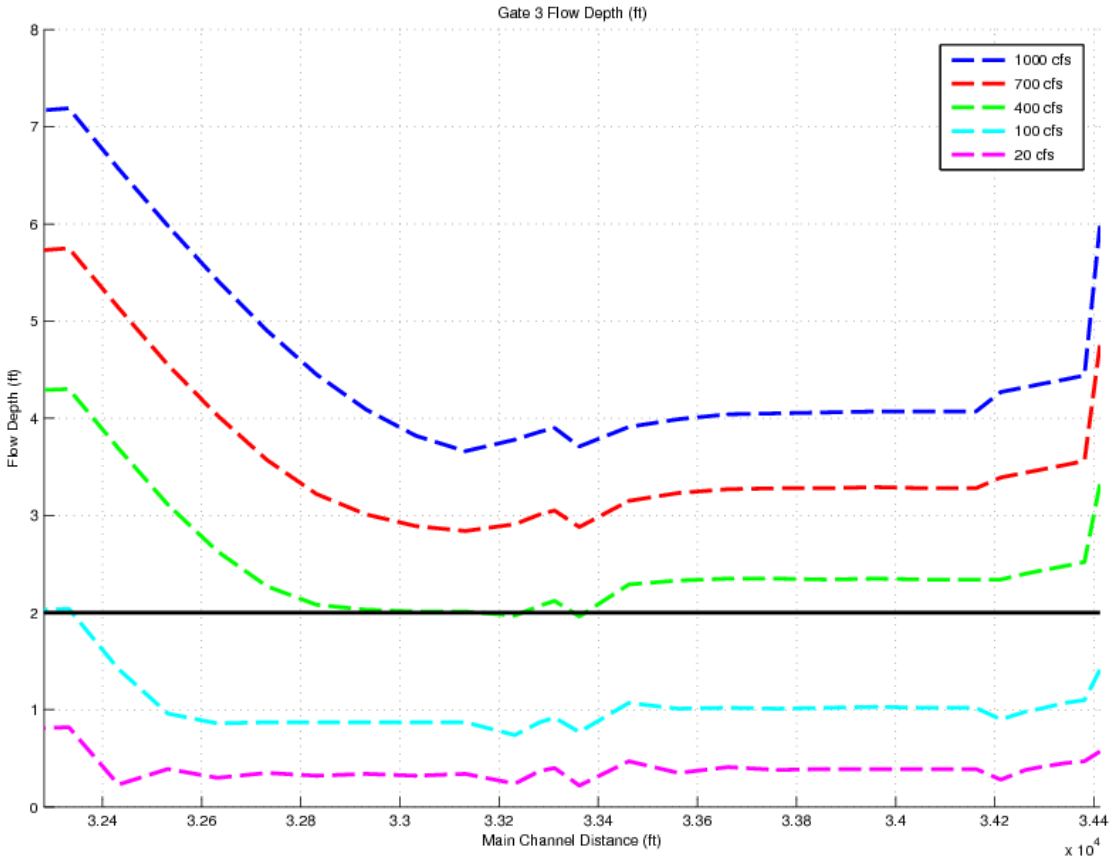

Gate 3 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
Main Channel Distance (ft)
x 10^4
0
5
10
15
20
25
30
0.5
1
1.5
2
2.5
3
3.5
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

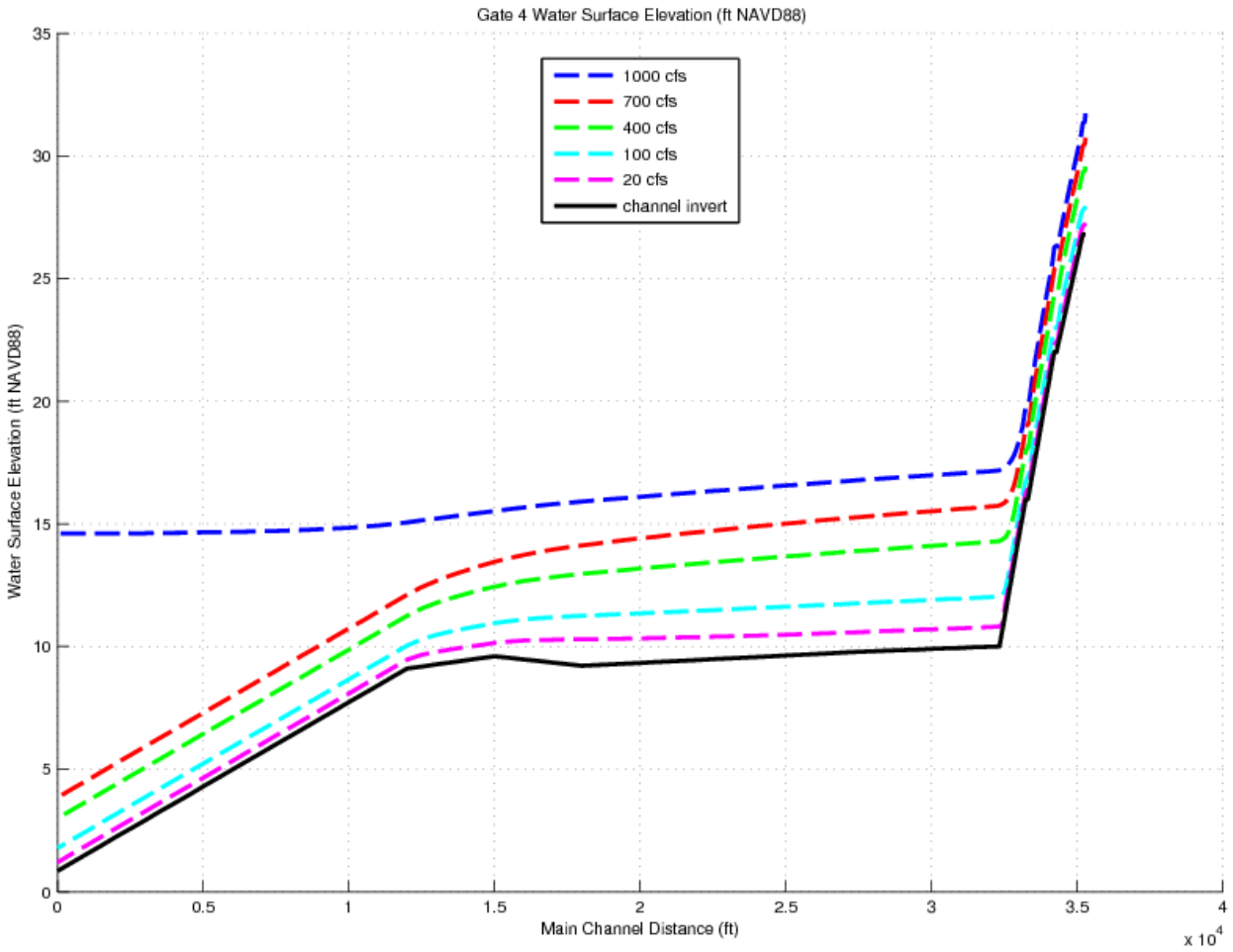

Gate 3 Water Surface Elevation (ft NAVD88)
Water Surface Elevation (ft NAVD88)
28
26
24
22
20
18
16
14
12
10
3.24
3.26
3.28
3.3
3.32
3.34
3.36
3.38
3.4
3.42
3.44
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert

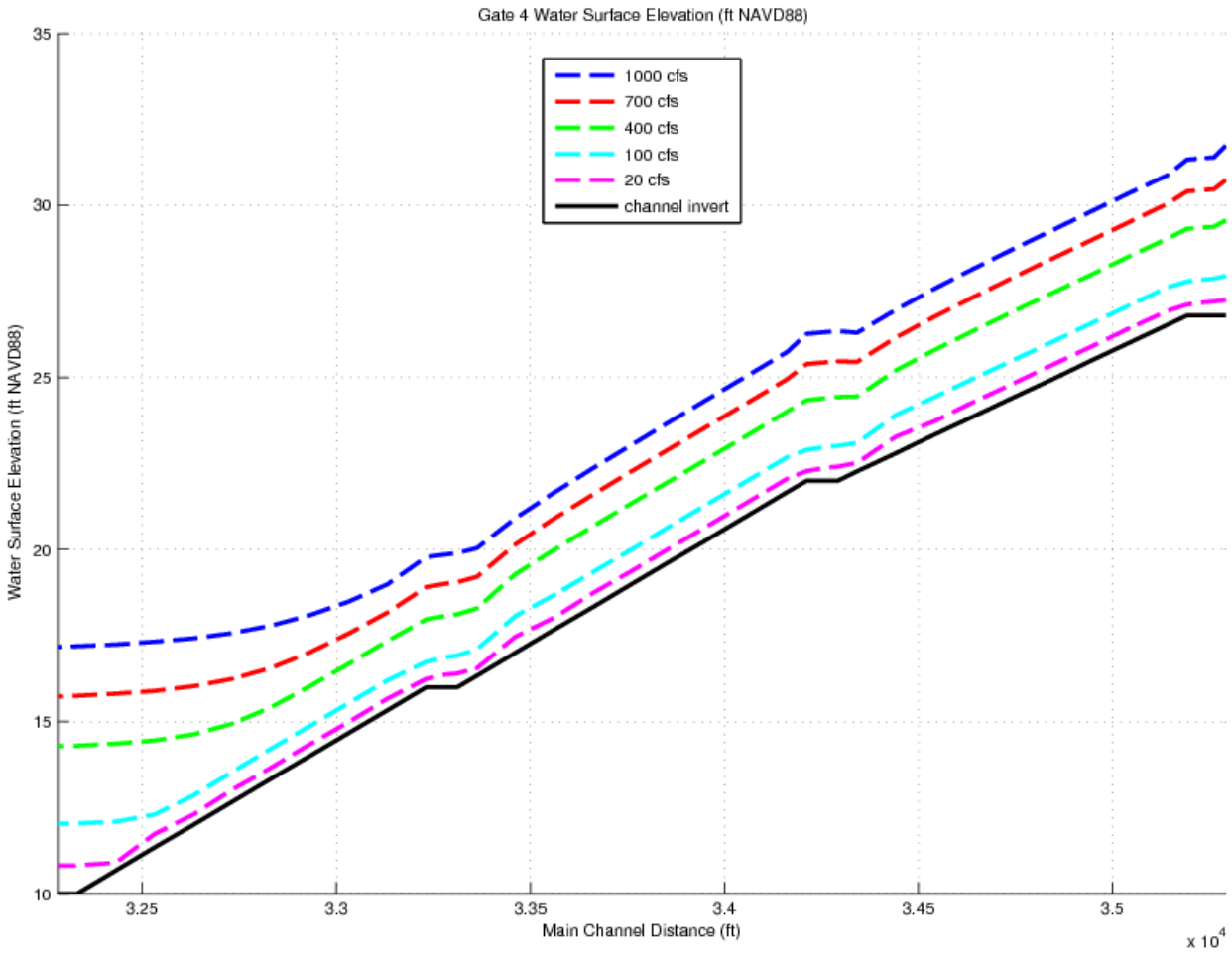

Gate 3 Channel–averaged velocity (ft/s)
max V criteria
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
0.5
1.5
2.5
3.5

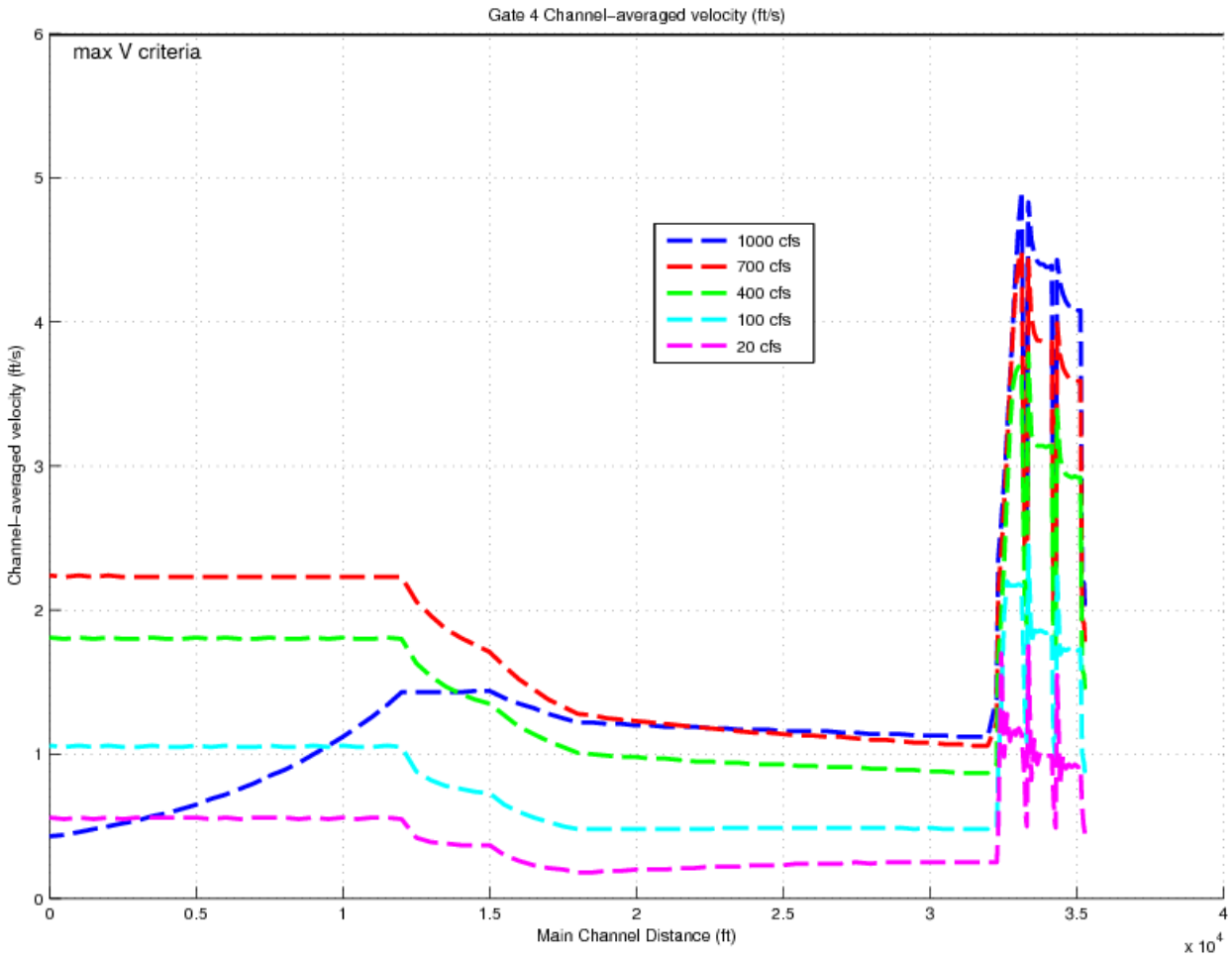

Gate 3 Channel–averaged velocity (ft/s)
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
0
1
2
3
4
5
6
3.24
3.26
3.28
3.3
3.32
3.34
3.36
3.38
3.4
3.42
3.44

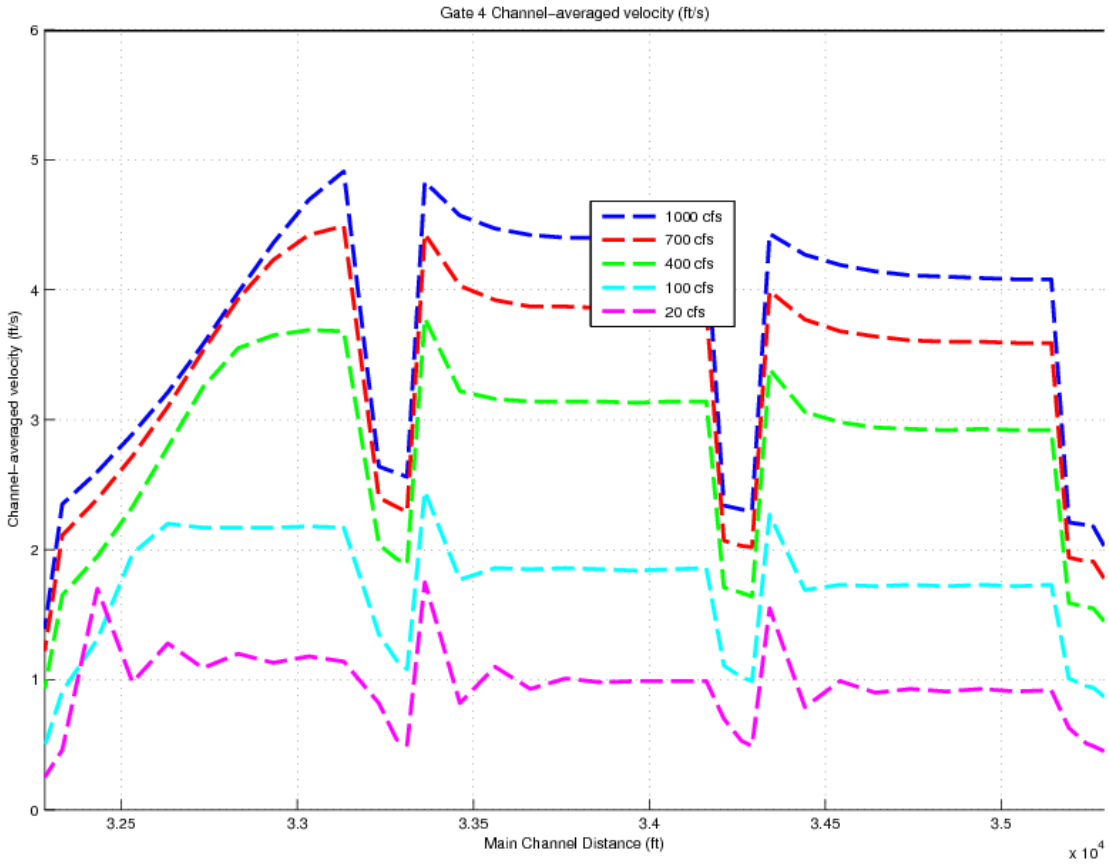

Gate 3 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
min. depth criteria
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
2
4
6
8
10
12
14
0
0.5
1
1.5
2
2.5
3
3.5

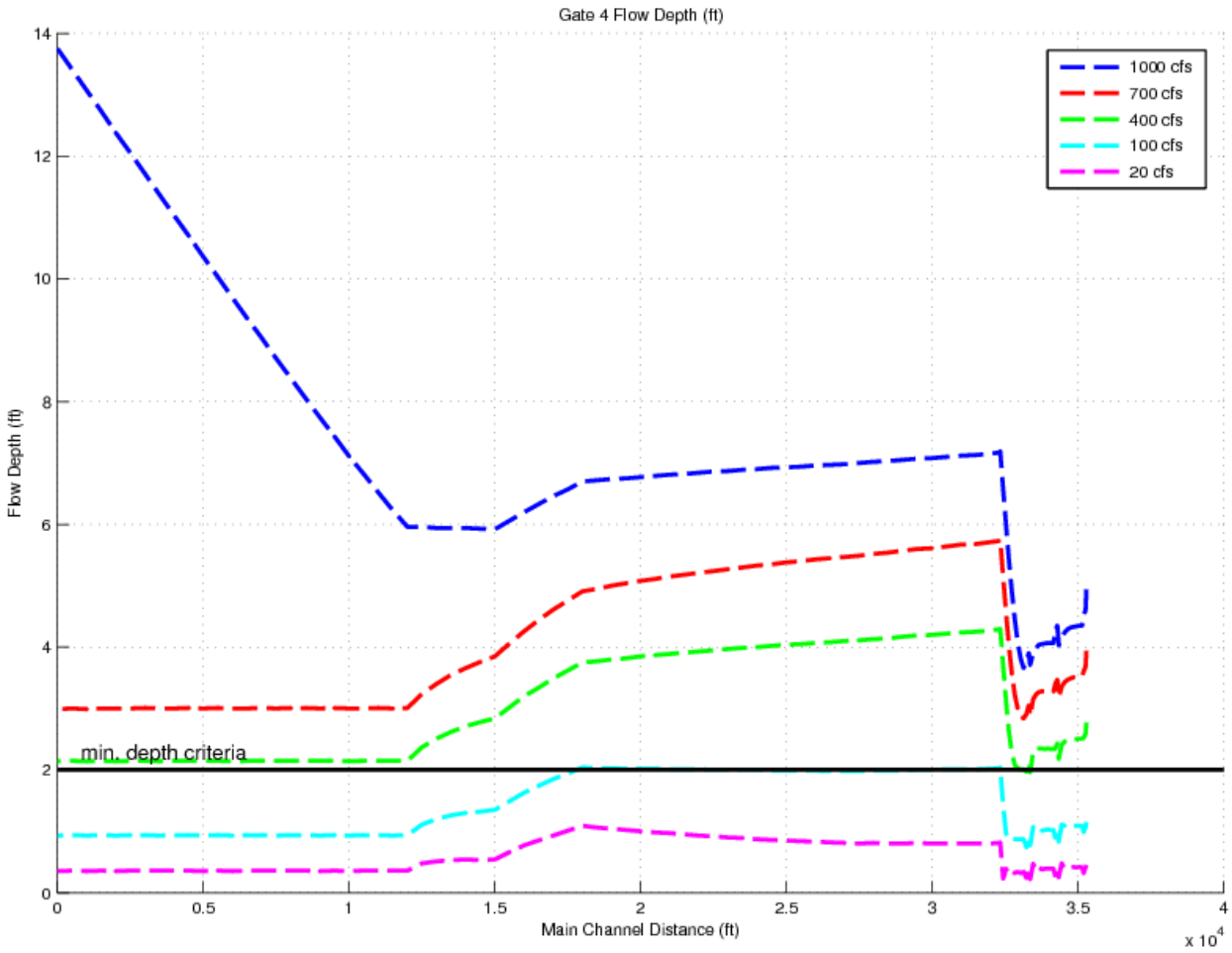

Gate 3 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
7
8
3.24
3.26
3.28
3.3
3.32
3.34
3.36
3.38
3.4
3.42
3.44

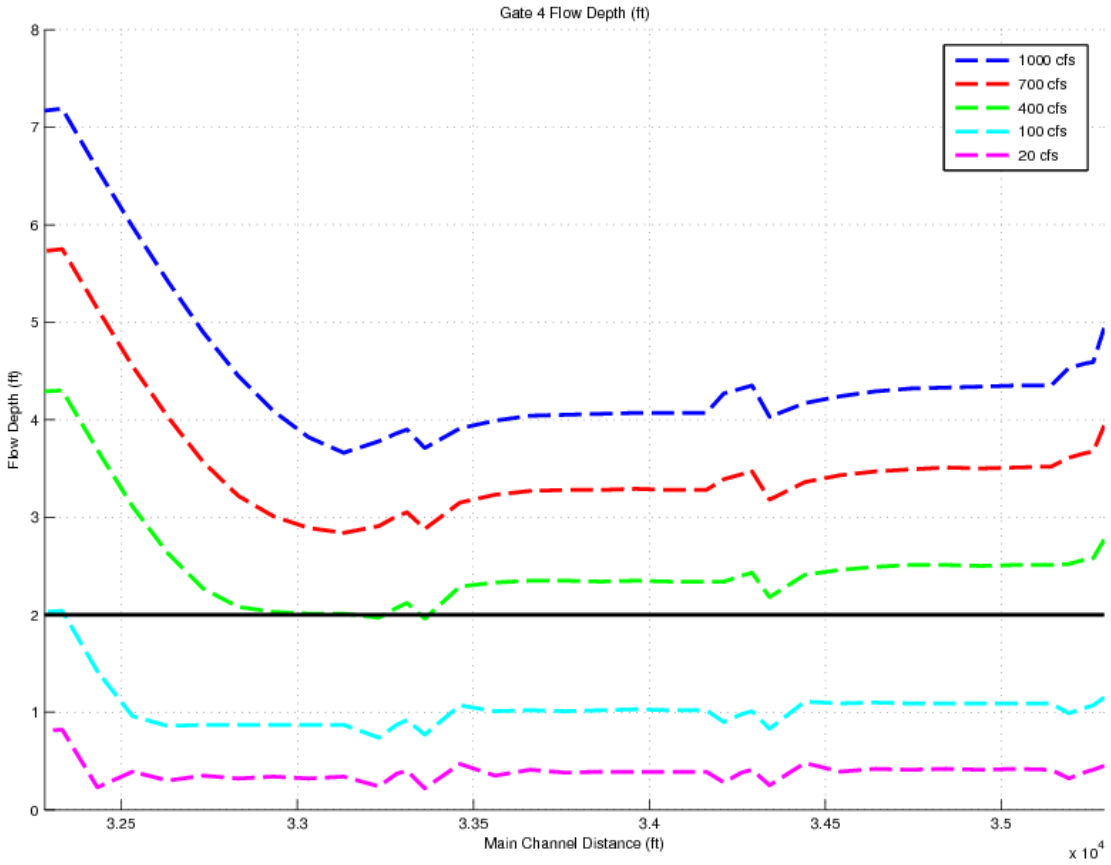

Gate 4 Water Surface Elevation (ft NAVD88)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert
Water Surface Elevation (ft NAVD88)
Main Channel Distance (ft)
x 10^4
0
5
10
15
20
25
30
35
0
0.5
1
1.5
2
2.5
3
3.5
4


Gate 4 Water Surface Elevation (ft NAVD88)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
channel invert
Water Surface Elevation (ft NAVD88)
Main Channel Distance (ft)
x 10^4
35
30
25
20
15
10
3.25
3.3
3.35
3.4
3.45
3.5


Gate 4 Channel–averaged velocity (ft/s)
max V criteria
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
0.5
1.5
2.5
3.5


Gate 4 Channel–averaged velocity (ft/s)
Channel–averaged velocity (ft/s)
Main Channel Distance (ft)
x 10^4
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
0
1
2
3
4
5
6
3.25
3.3
3.35
3.4
3.45
3.5


Gate 4 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
min. depth criteria
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
2
4
6
8
10
12
14
0
0.5
1
1.5
2
2.5
3
3.5
4


Gate 4 Flow Depth (ft)
1000 cfs
700 cfs
400 cfs
100 cfs
20 cfs
Flow Depth (ft)
Main Channel Distance (ft)
x 10^4
0
1
2
3
4
5
6
7
8
3.25
3.3
3.35
3.4
3.45
3.5

APPENDIX C

Confidential

Google earth

feet 4000
km 1

764'/in