Analysis of Historical Rangen Spring Flows

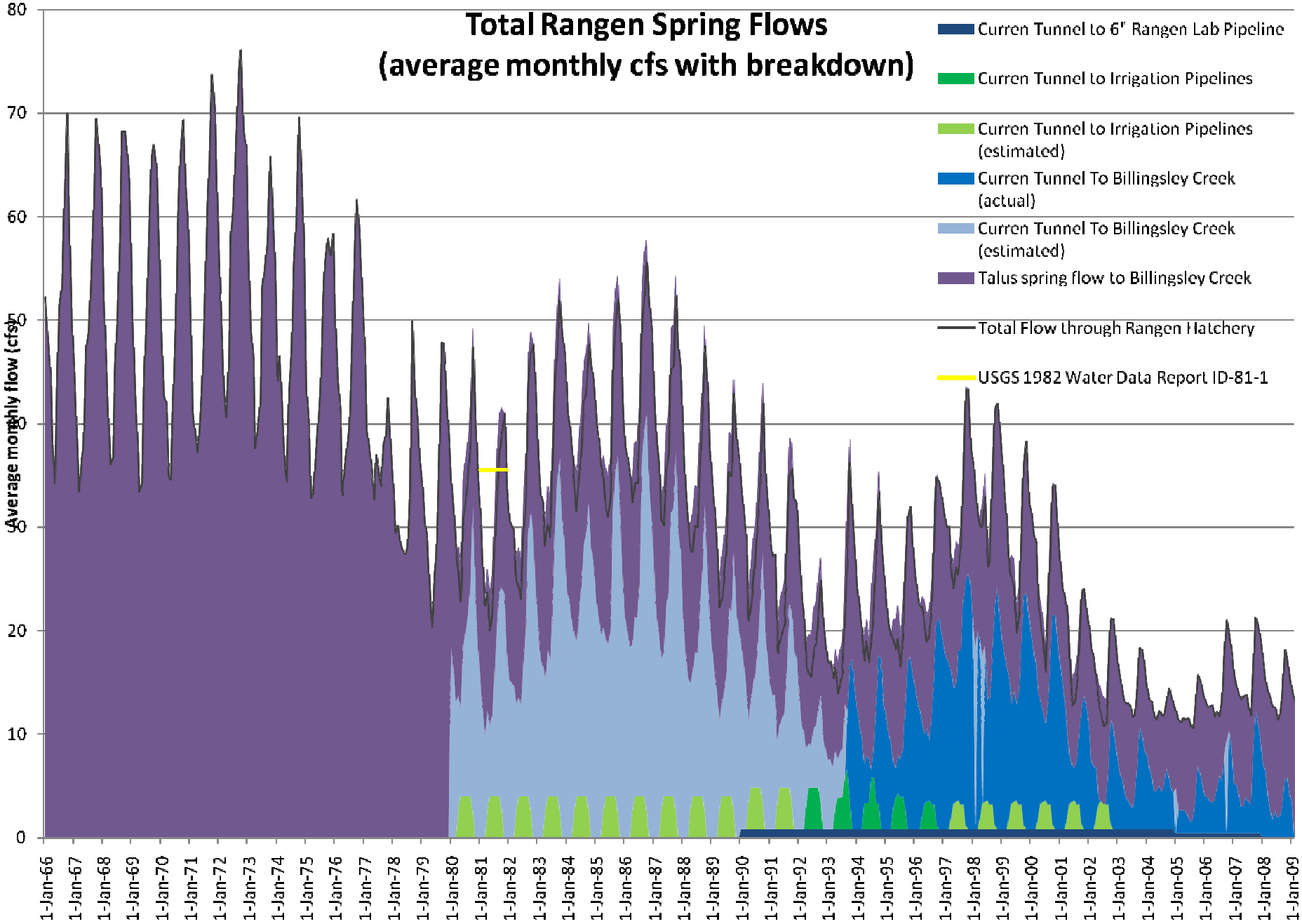
September 21, 2009
ESHMC Meeting, Boise, ID

Jim Brannon
Leonard Rice Engineers

Introduction

- Leonard Rice Engineers
  - Gregg Ten Eyck, Dennis McGrane
  - Wayne Courtney, Rangen Inc.
  - Declining spring flows and valuation
- Dr. Michael McDonald, Dr. Chuck Brendecke

- Before starting the trip, glimpse of where are we going.


Total Rangen Spring Flows
(average monthly cfs with breakdown)
Curren Tunnel to 6" Rangen Lab Pipeline
Curren Tunnel to Irrigation Pipelines
Curren Tunnel to Irrigation Pipelines (estimated)
Curren Tunnel To Billingsley Creek (actual)
Curren Tunnel To Billingsley Creek (estimated)
Talus spring flow to Billingsley Creek
Total Flow through Rangen Hatchery
USGS 1982 Water Data Report ID-81-1
Average monthly flow (cfs)
0
10
20
30
40
50
60
70
80
1-Jan-66
1-Jan-67
1-Jan-68
1-Jan-69
1-Jan-70
1-Jan-71
1-Jan-72
1-Jan-73
1-Jan-74
1-Jan-75
1-Jan-76
1-Jan-77
1-Jan-78
1-Jan-79
1-Jan-80
1-Jan-81
1-Jan-82
1-Jan-83
1-Jan-84
1-Jan-85
1-Jan-86
1-Jan-87
1-Jan-88
1-Jan-89
1-Jan-90
1-Jan-91
1-Jan-92
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
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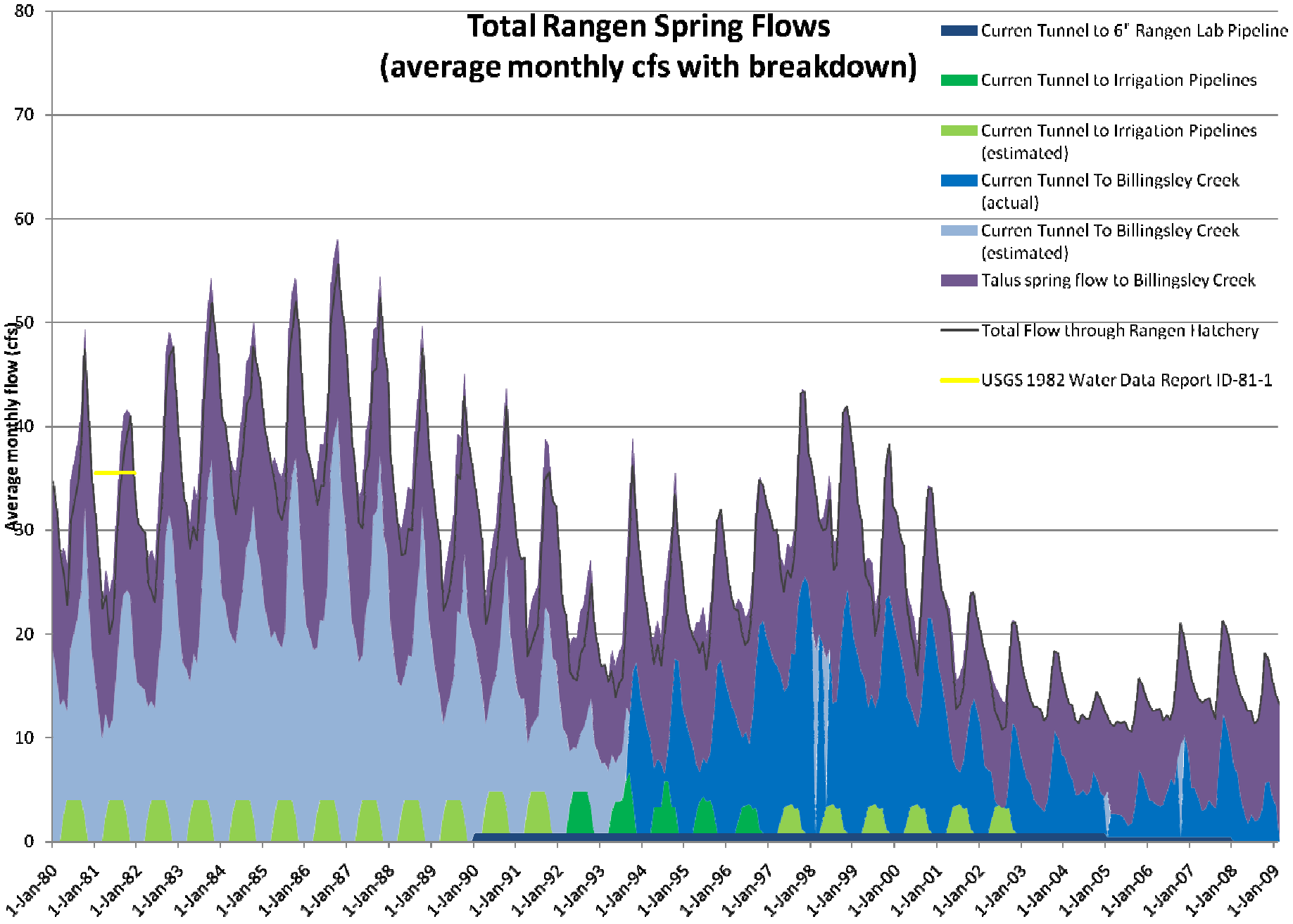
1-Jan-08
1-Jan-09


Total Rangen Spring Flows
(average monthly cfs with breakdown)
Curren Tunnel to 6" Rangen Lab Pipeline
Curren Tunnel to Irrigation Pipelines
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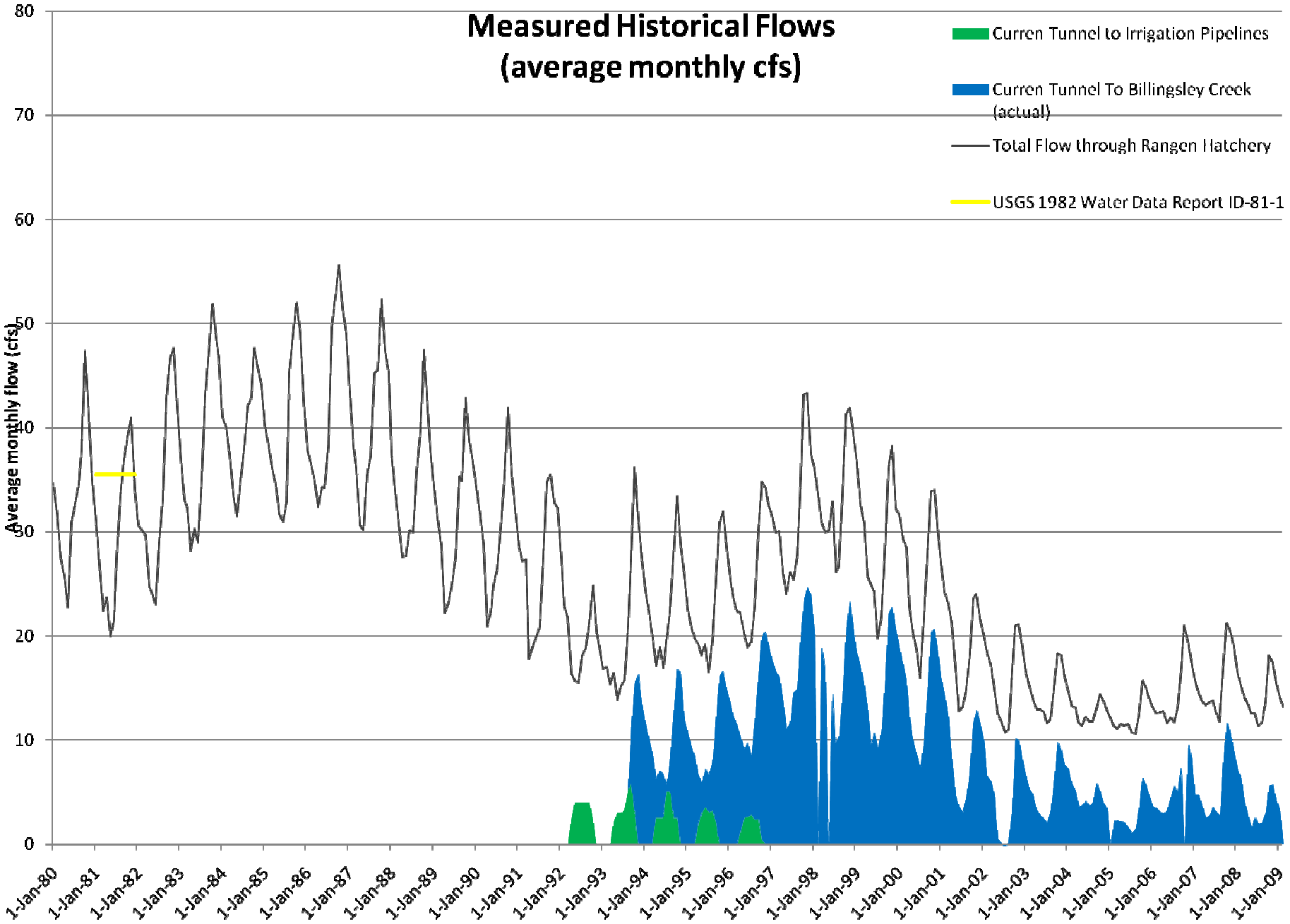
USGS 1982 Water Data Report ID-81-1
Average monthly flow (cfs)
0
10
20
30
40
50
60
70
80
1-Jan-80
1-Jan-81
1-Jan-82
1-Jan-83
1-Jan-84
1-Jan-85
1-Jan-86
1-Jan-87
1-Jan-88
1-Jan-89
1-Jan-90
1-Jan-91
1-Jan-92
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09

AVAILABLE DATA


Measured Historical Flows
(average monthly cfs)
Curren Tunnel to Irrigation Pipelines
Curren Tunnel To Billingsley Creek (actual)
Total Flow through Rangen Hatchery
USGS 1982 Water Data Report ID-81-1
Average monthly flow (cfs)
80
70
60
50
40
30
20
10
0
1-Jan-80
1-Jan-81
1-Jan-82
1-Jan-83
1-Jan-84
1-Jan-85
1-Jan-86
1-Jan-87
1-Jan-88
1-Jan-89
1-Jan-90
1-Jan-91
1-Jan-92
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
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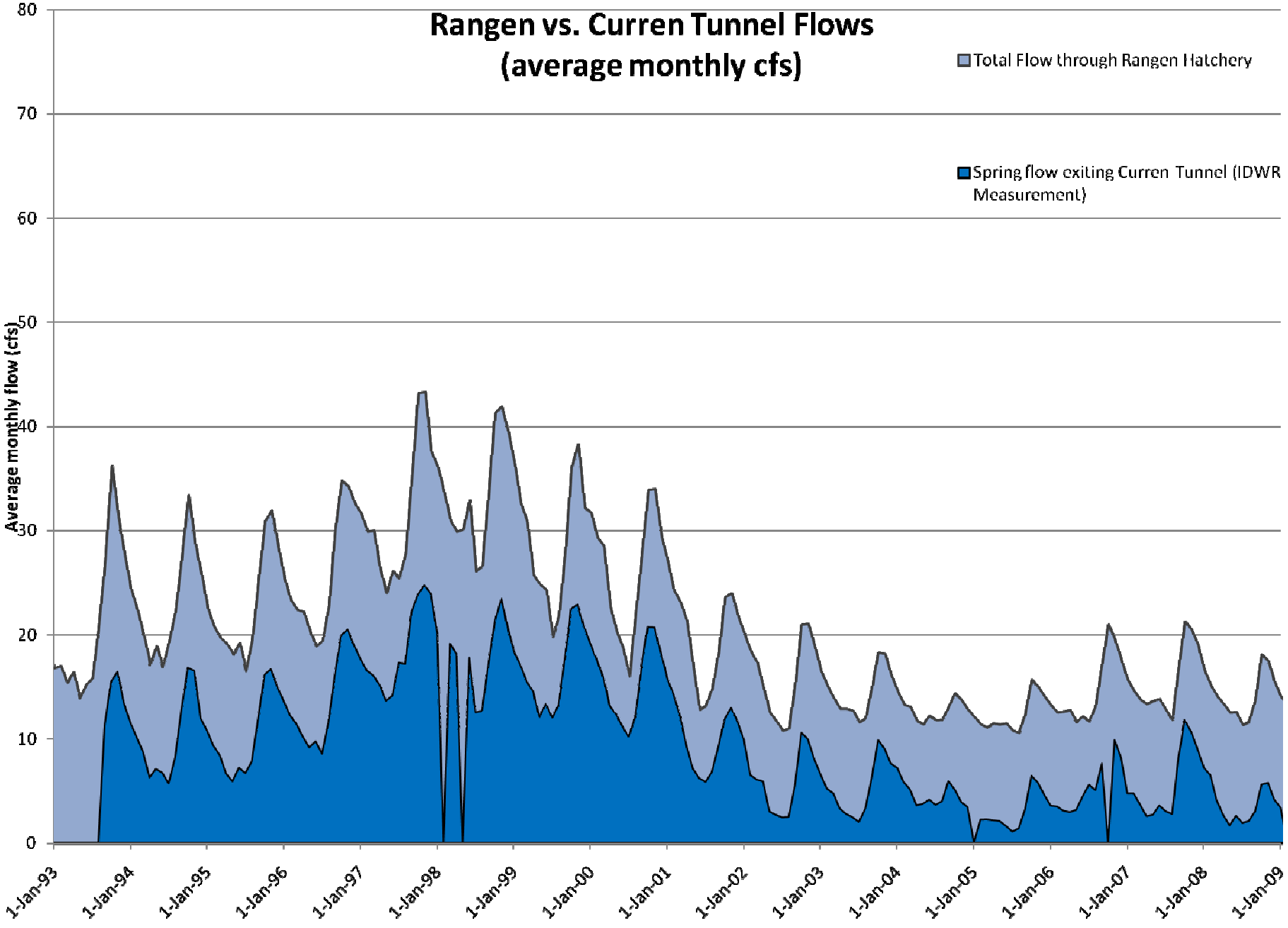
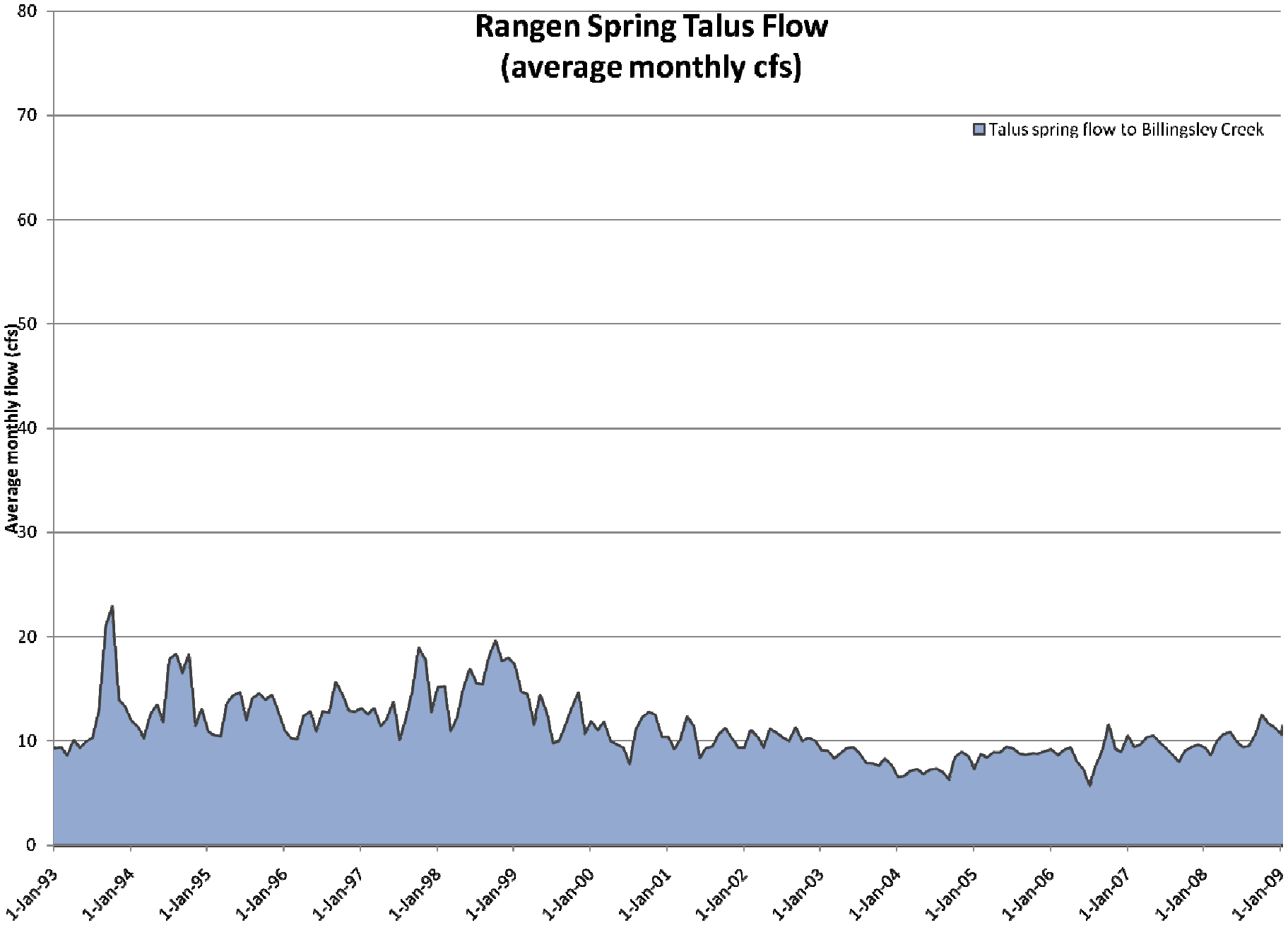
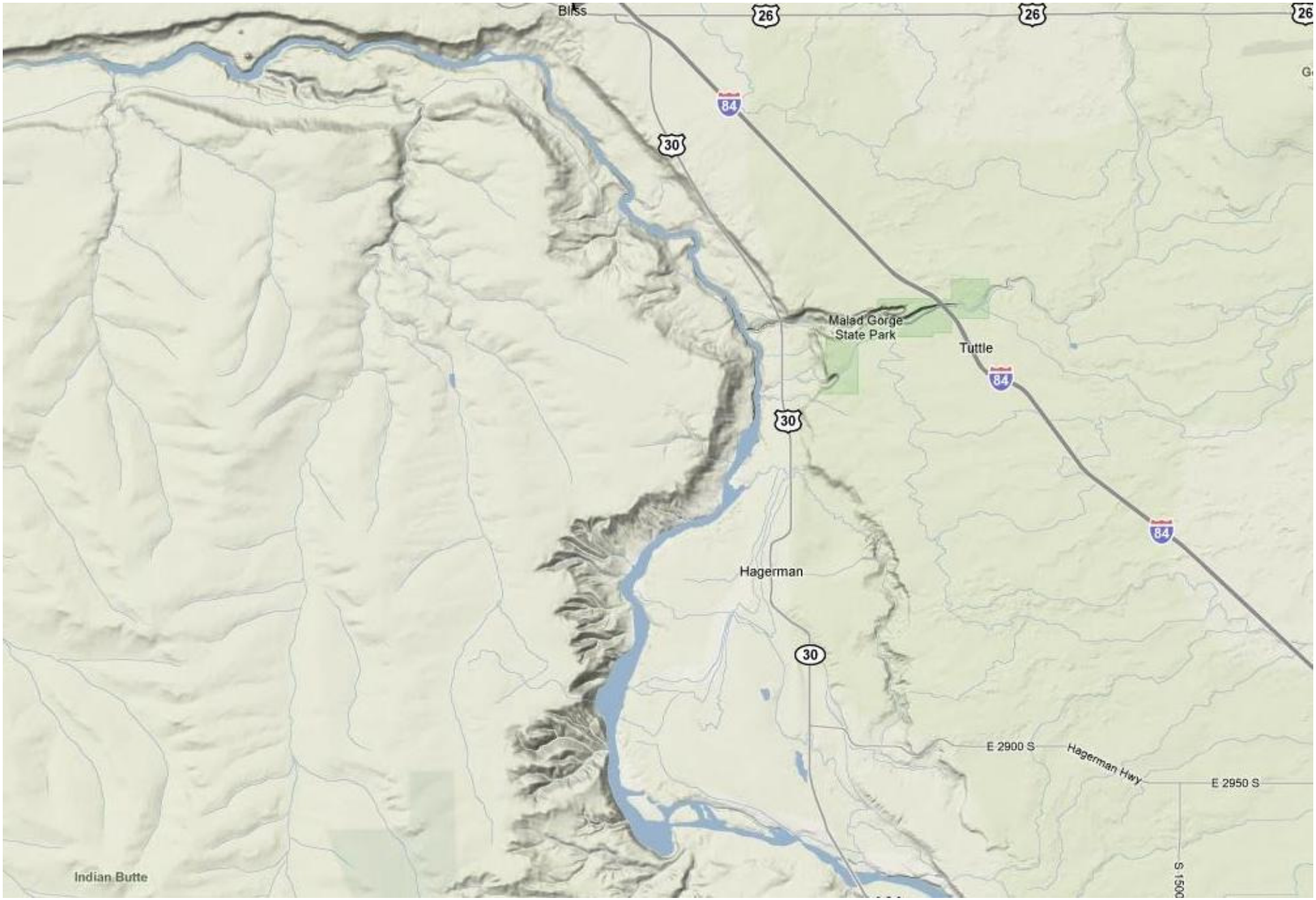
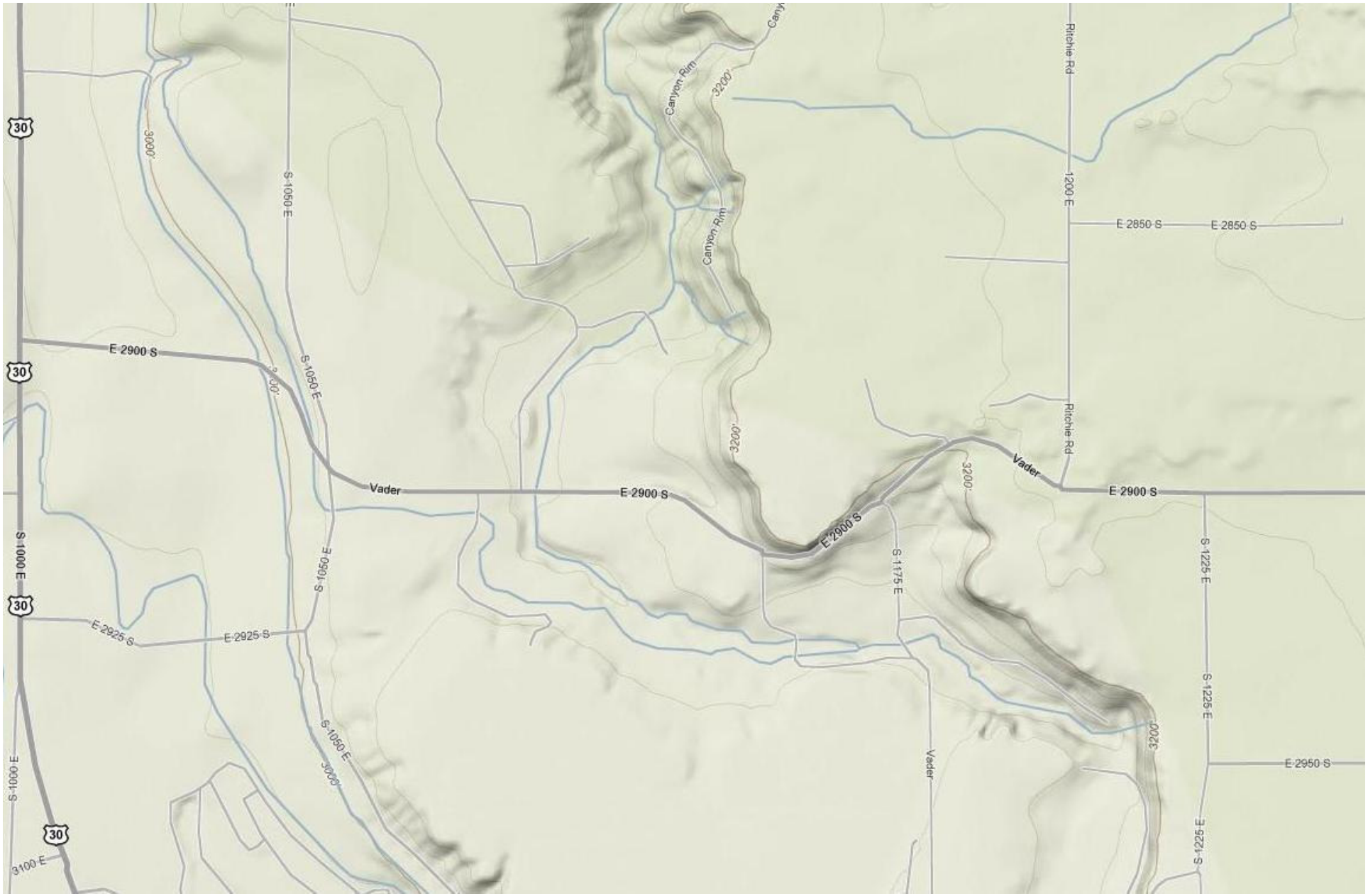
1-Jan-07
1-Jan-08
1-Jan-09

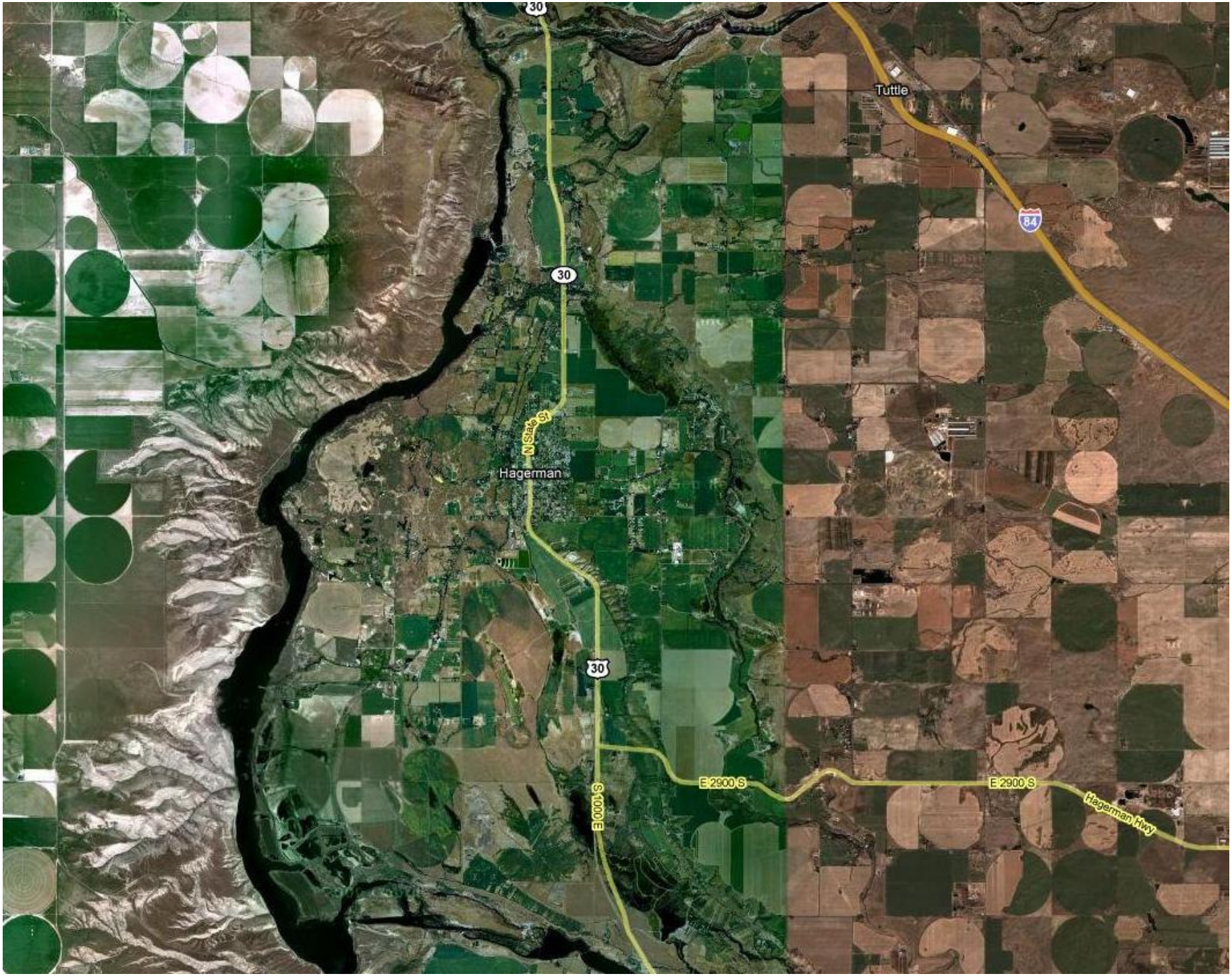

Rangen vs. Curren Tunnel Flows
(average monthly cfs)
Total Flow through Rangen Hatchery
Spring flow exiting Curren Tunnel (IDWR Measurement)
Average monthly flow (cfs)
80
70
60
50
40
30
20
10
0
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09

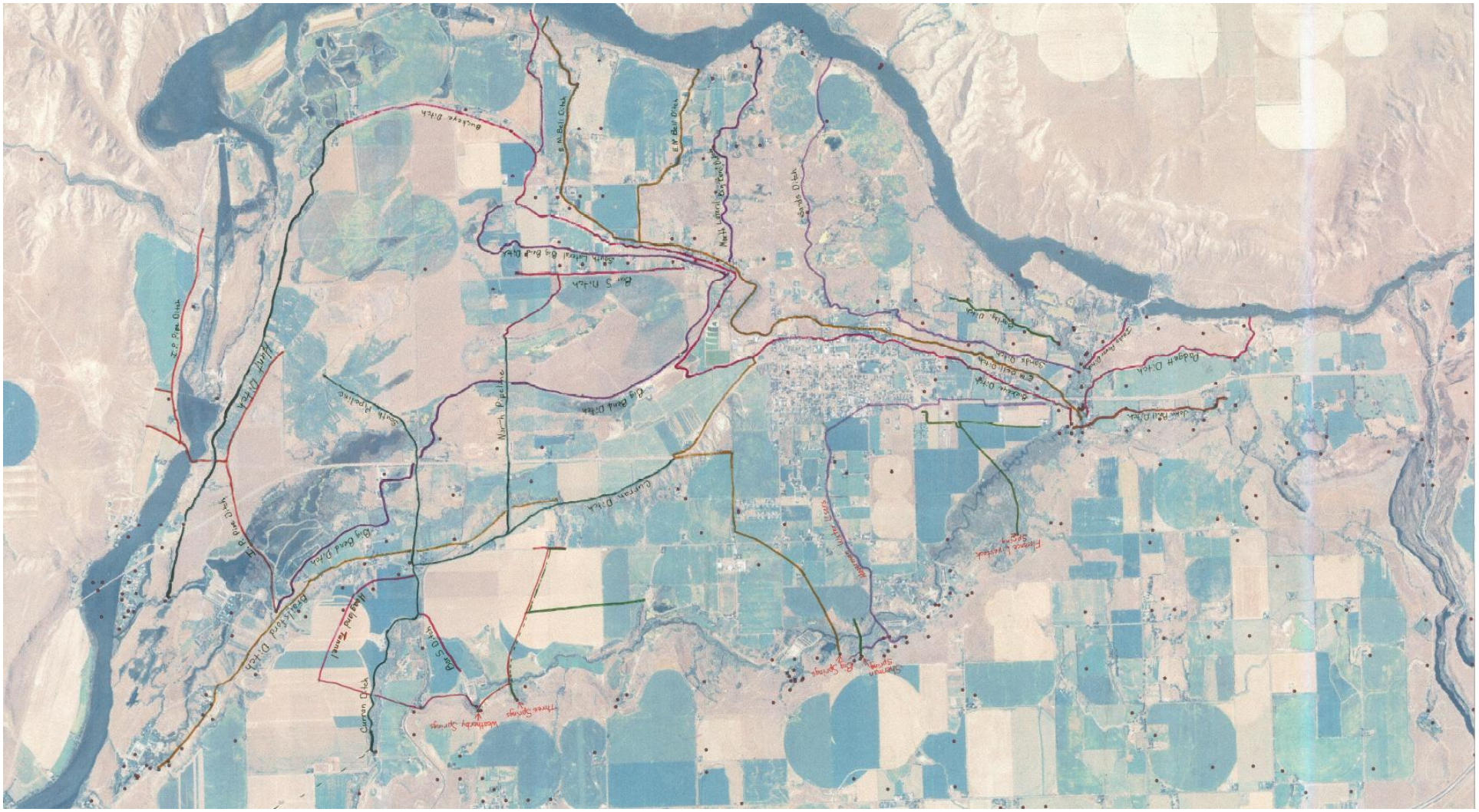

Rangen Spring Talus Flow
(average monthly cfs)
Talus spring flow to Billingsley Creek
Average monthly flow (cfs)
80
70
60
50
40
30
20
10
0
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09

PERSPECTIVE


Bliss
26
26
26
84
30
Malad Gorge
State Park
Tuttle
84
30
84
Hagerman
30
E 2900 S
Hagerman Hwy
E 2950 S
Indian Butte


30
30
30
30
S 1000 E
S 1000 E
3100 E
E 2900 S
E 2900 S
E 2900 S
E 2900 S
E 2925 S
E 2925 S
E 2850 S
E 2850 S
E 2950 S
Vader
Vader
Vader
S 1050 E
S 1050 E
S 1050 E
S 1175 E
S 1225 E
S 1225 E
S 1225 E
1200 E
Ritchie Rd
Ritchie Rd
Canyon Rim
Canyon Rim
3200'
3200'
3200'
3200'
3000'
3000'


30
Tuttle
84
30
N State St
Hagerman
30
S 1000 E
E 2900 S
E 2900 S
Hagerman Hwy

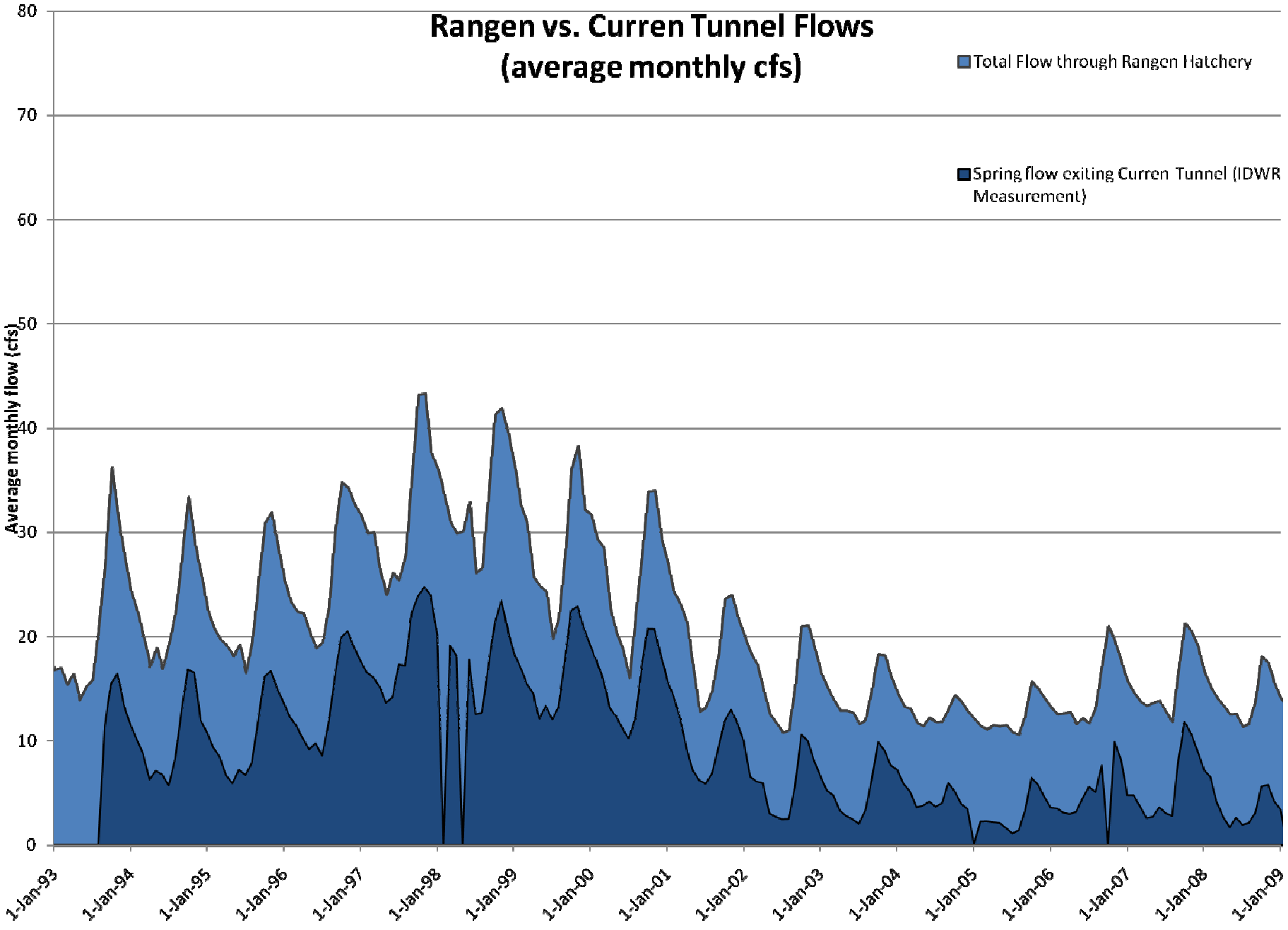

Buckeye Ditch
E.M. Bell Ditch
E.N. Bell Ditch
North Lateral Big Bend Ditch
Sands Ditch
South Lateral Big Bend Ditch
Bar S Ditch
Barlow Ditch
Sands Ditch
E.M. Bell Ditch
Buckeye Ditch
Paddgett Ditch
Jenkins Bell Ditch
Big Bend Ditch
North Pipeline
South Pipeline
Curran Ditch
Hunt Ditch
I.P. Pipe Ditch
Big Bend Ditch
Bradsford Ditch
Haagland Tunnel
Bar S Ditch
Curran Ditch
Weatherby Springs
Three Springs
Big Springs
Sherman Springs
Florence Livestock Spring

E-2900-S
S-1000 E
30

CONFINED
SPACE

But what about the high variation and ratio?

VERY CLOSELY CORRELATED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Total Flow through Rangen Hatchery
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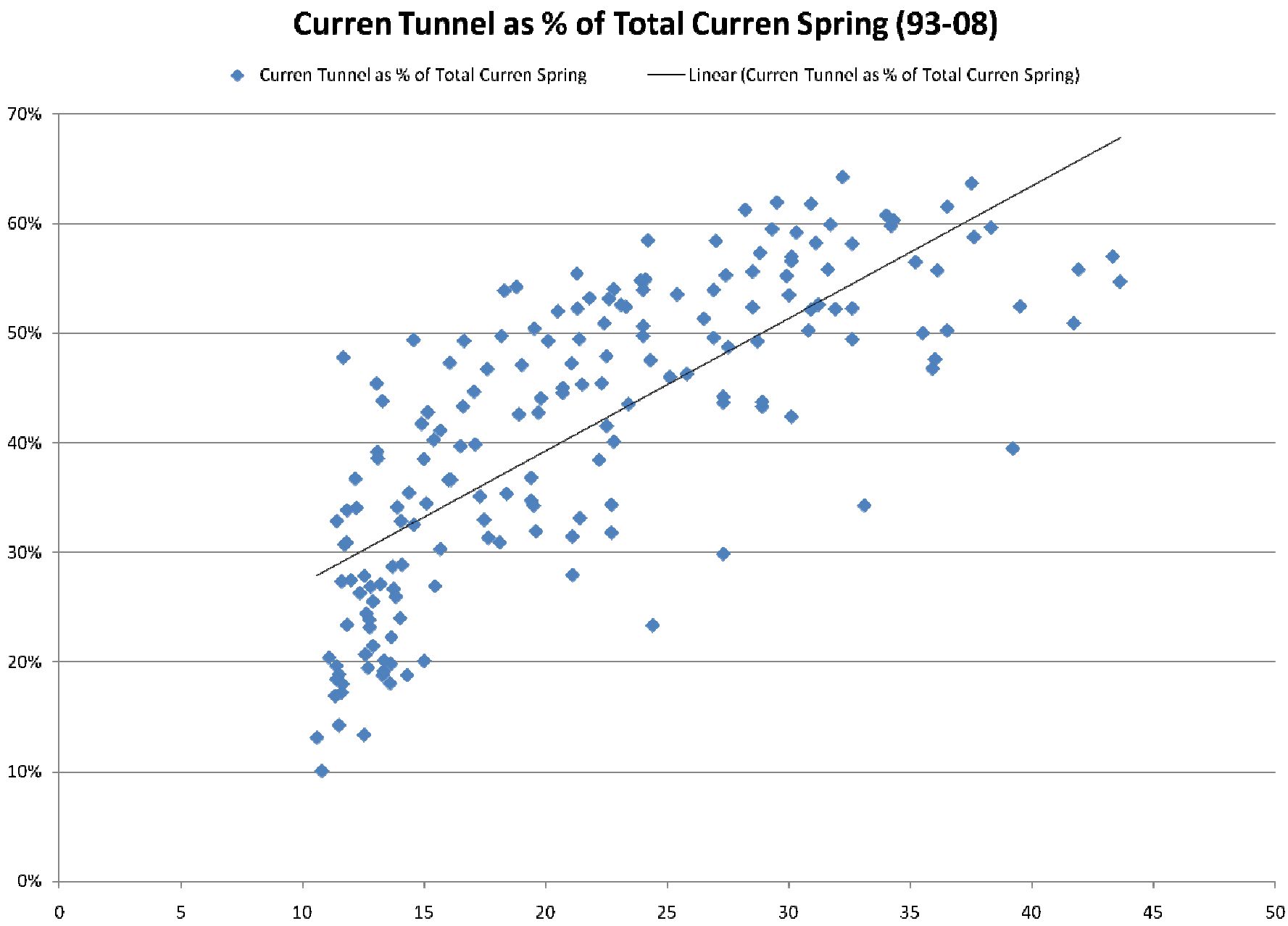
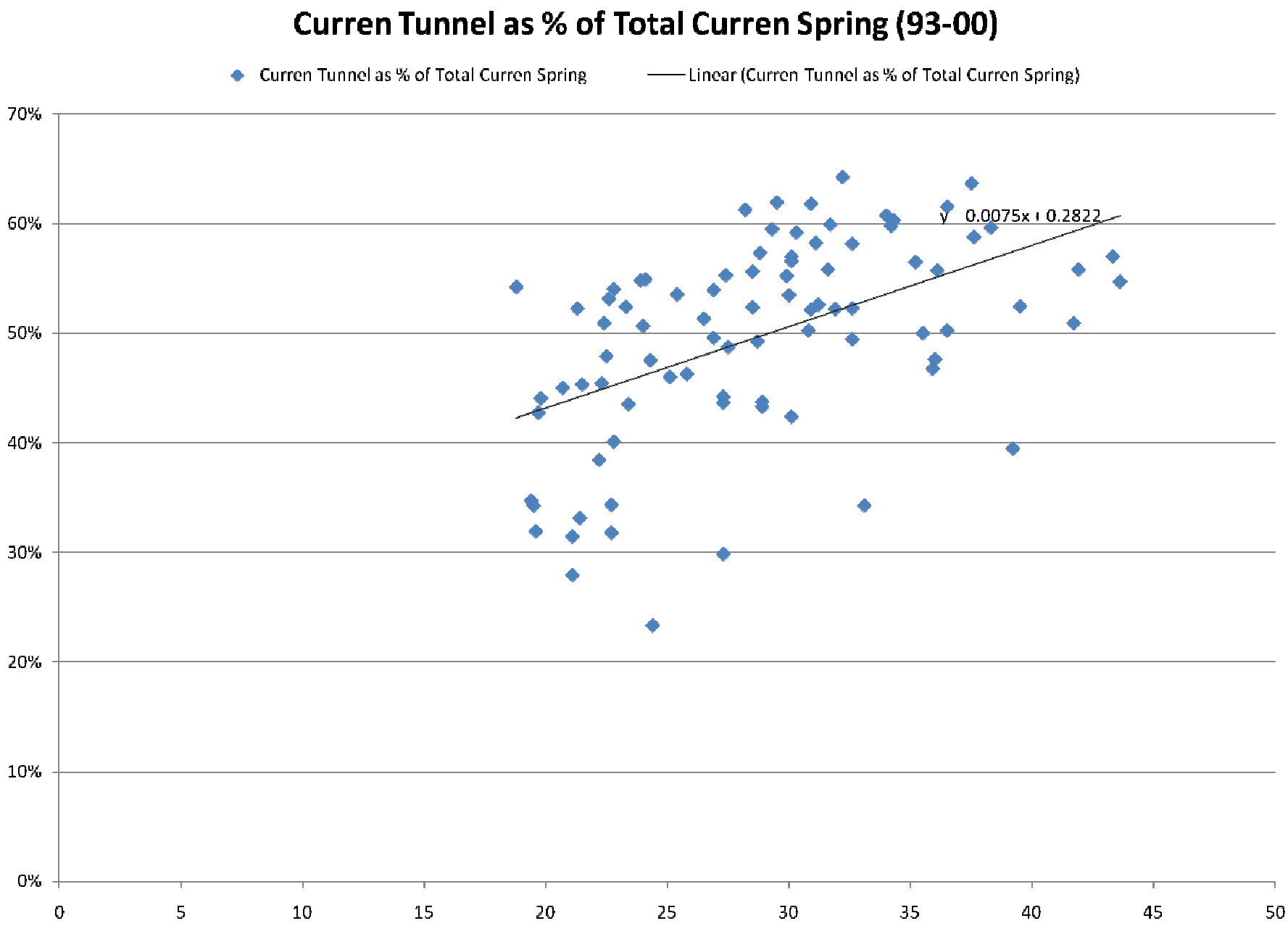
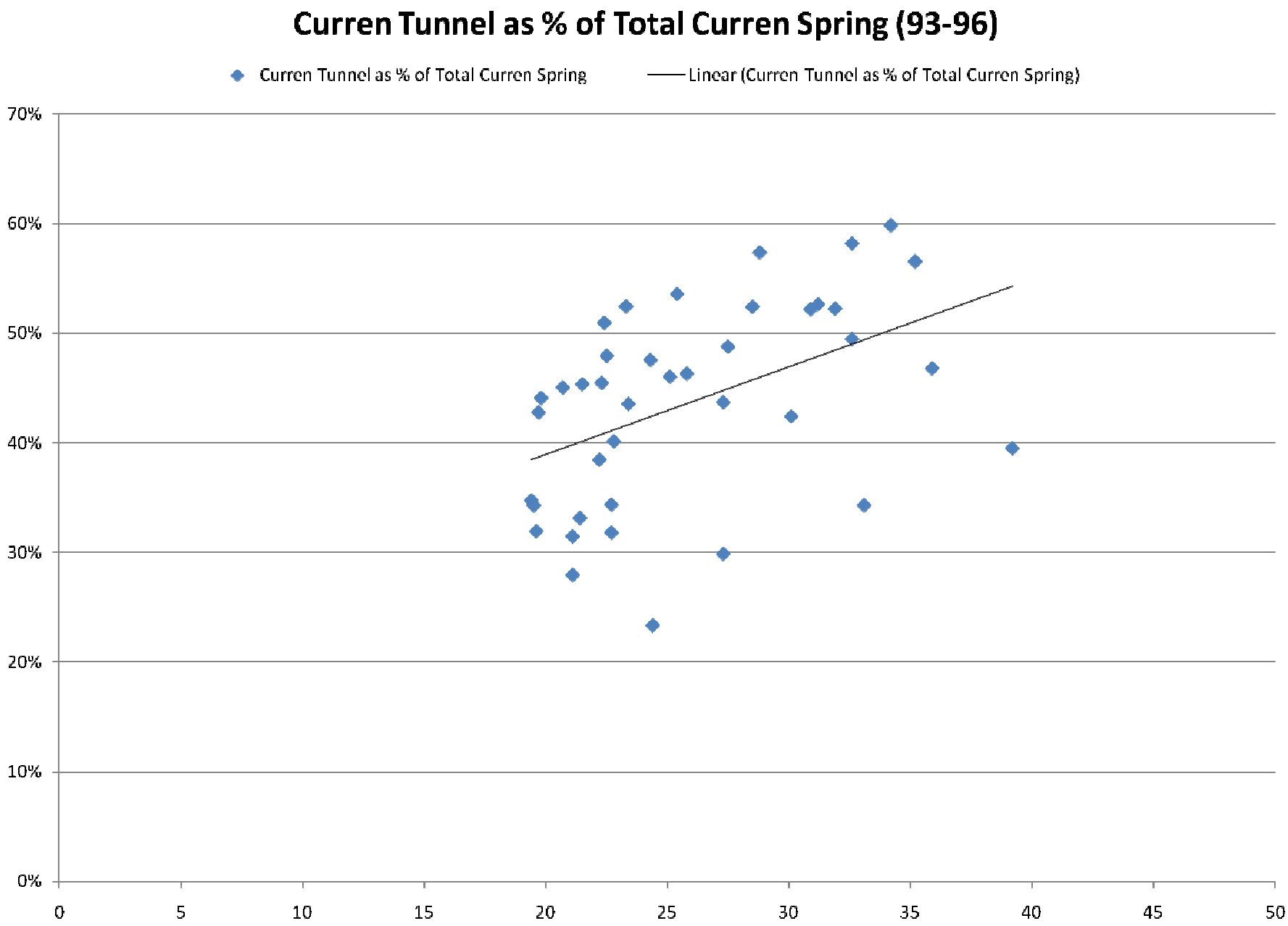
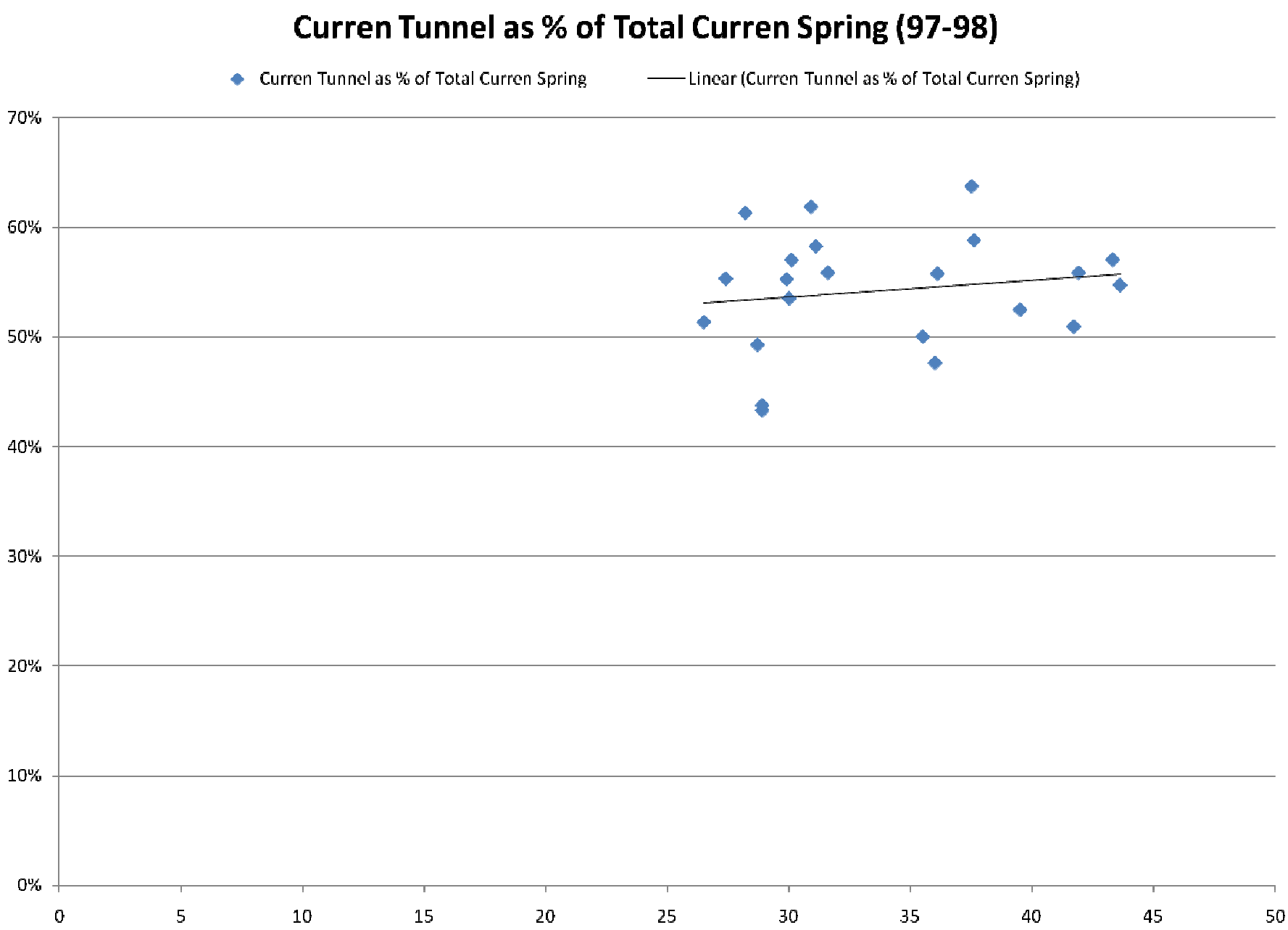
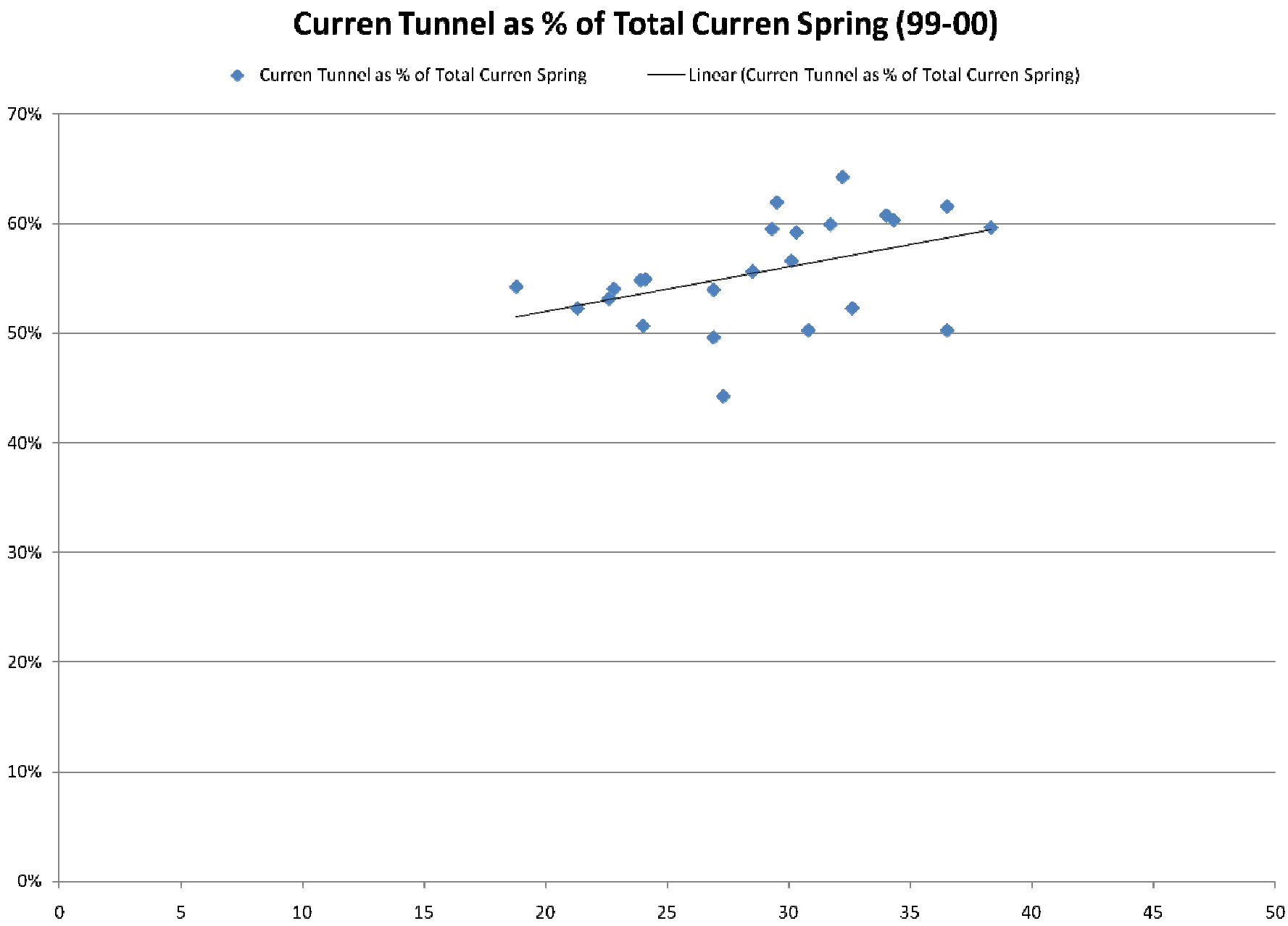
Average monthly flow (cfs)
80
70
60
50
40
30
20
10
0
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09

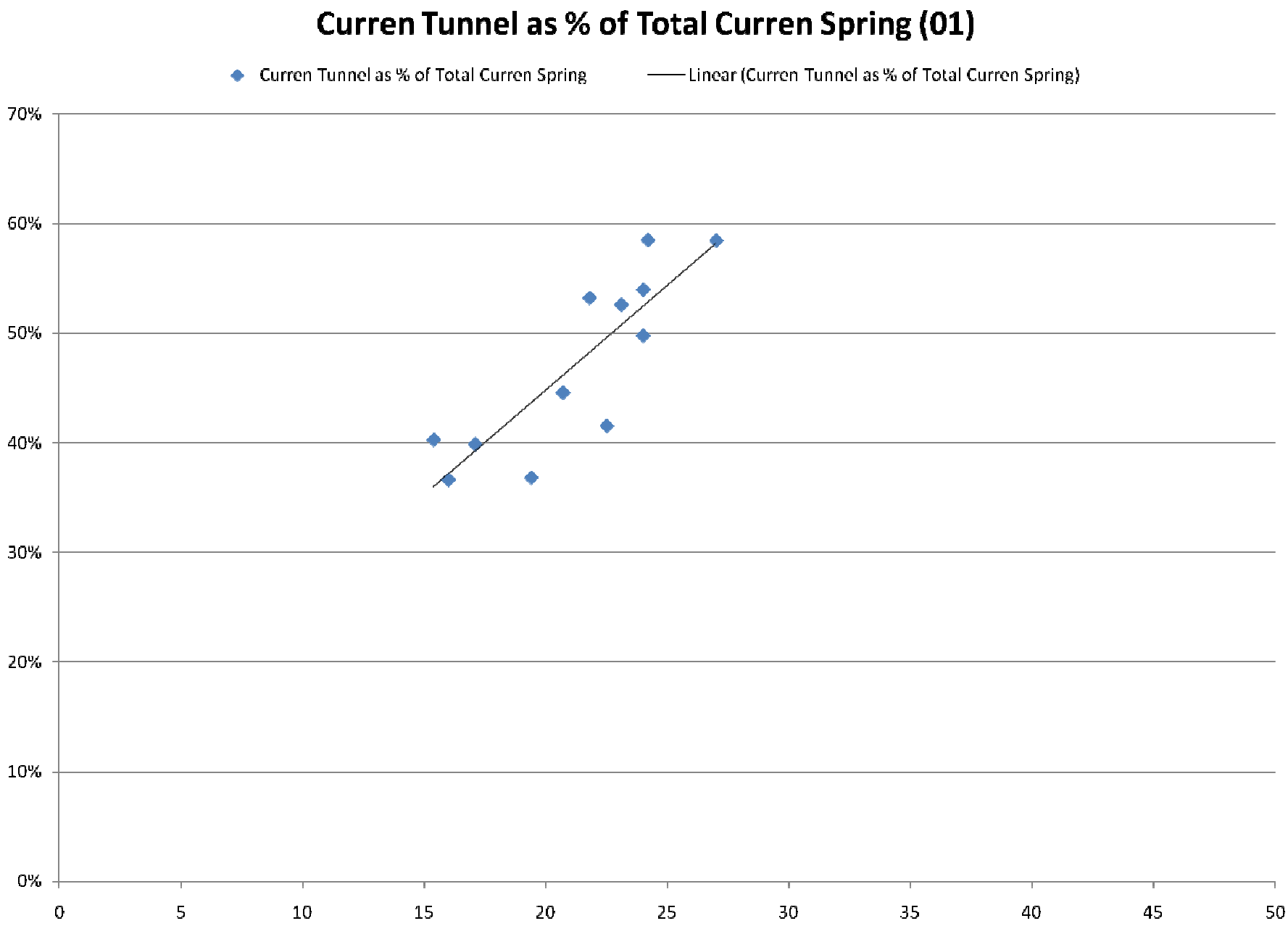

Curren Tunnel as % of Total Curren Spring (93-08)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50

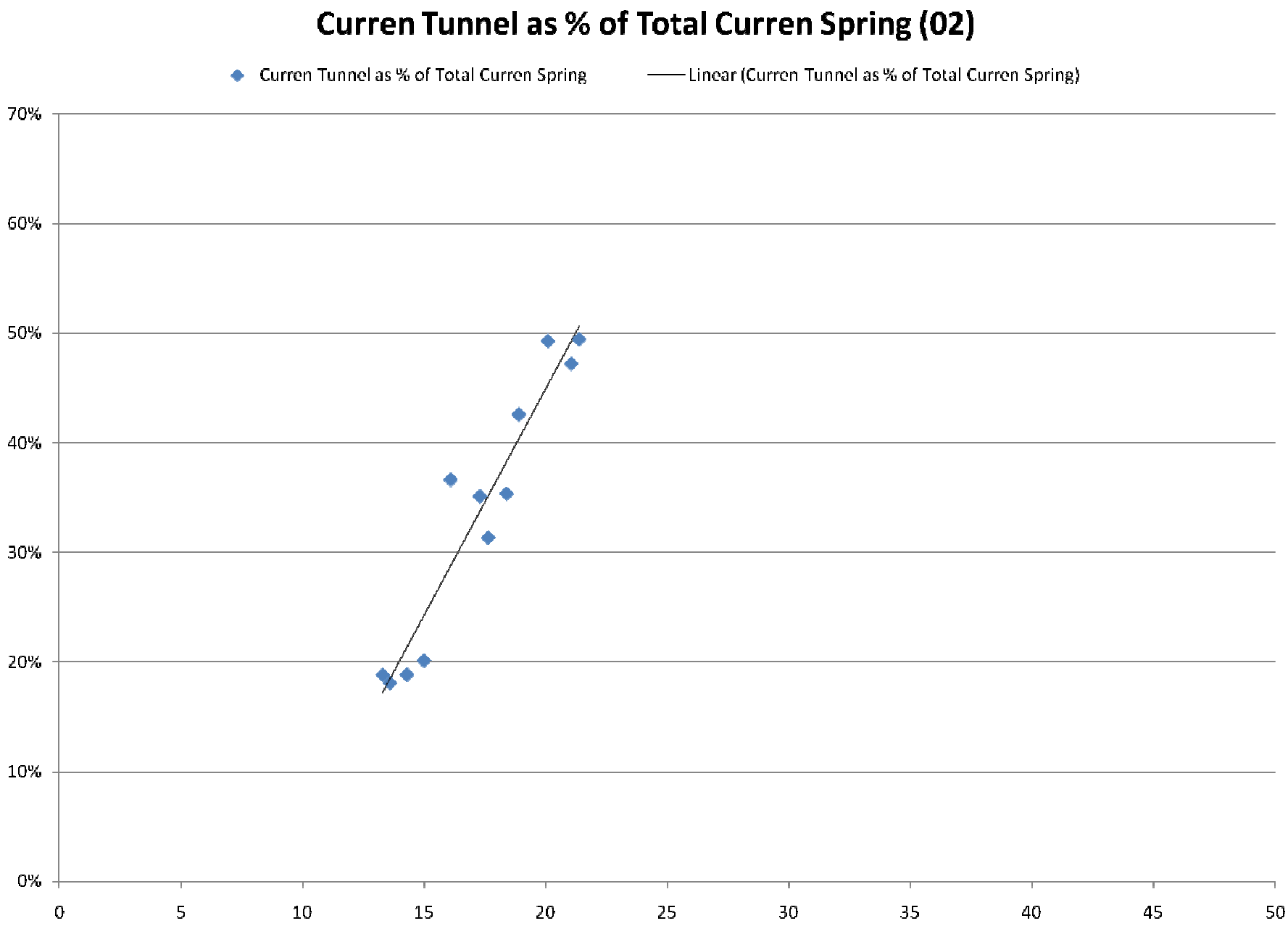

Curren Tunnel as % of Total Curren Spring (93-00)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
y = 0.0075x + 0.2822
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50

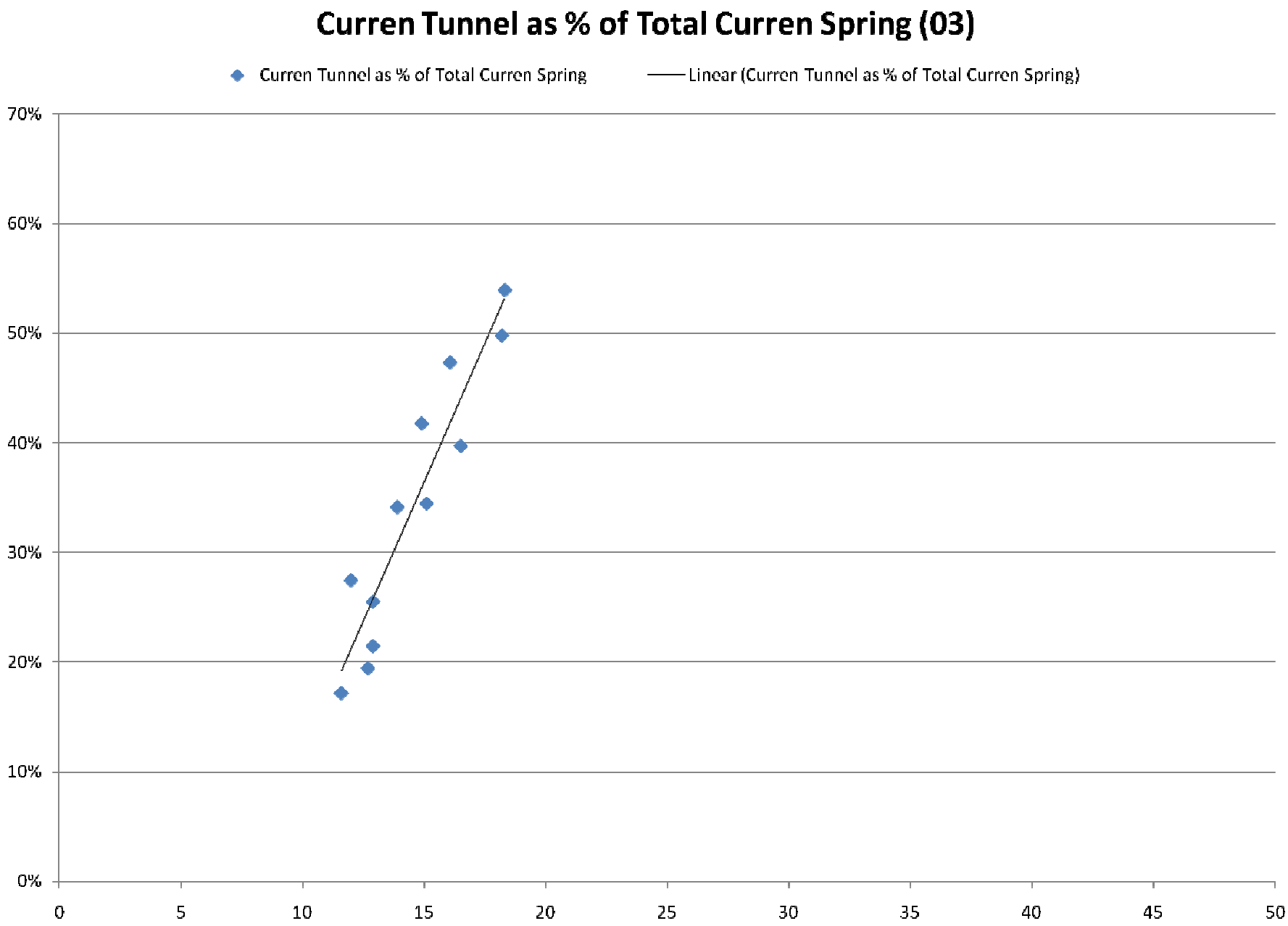

Curren Tunnel as % of Total Curren Spring (93-96)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50

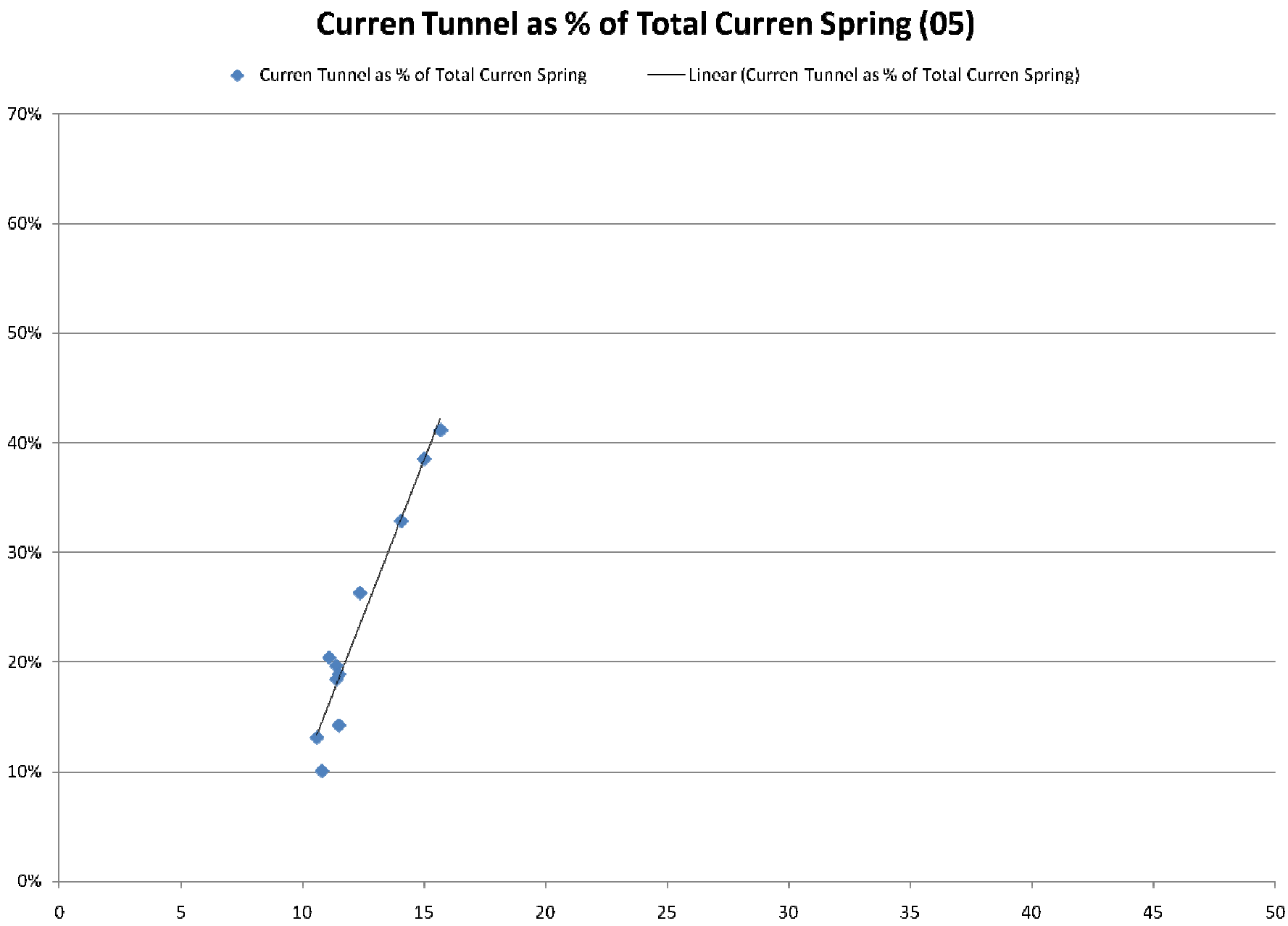

Curren Tunnel as % of Total Curren Spring (97-98)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50


Curren Tunnel as % of Total Curren Spring (99-00)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50


Curren Tunnel as % of Total Curren Spring (01)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50


Curren Tunnel as % of Total Curren Spring (02)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50


Curren Tunnel as % of Total Curren Spring (03)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50


Curren Tunnel as % of Total Curren Spring (05)
Curren Tunnel as % of Total Curren Spring
Linear (Curren Tunnel as % of Total Curren Spring)
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
40
45
50

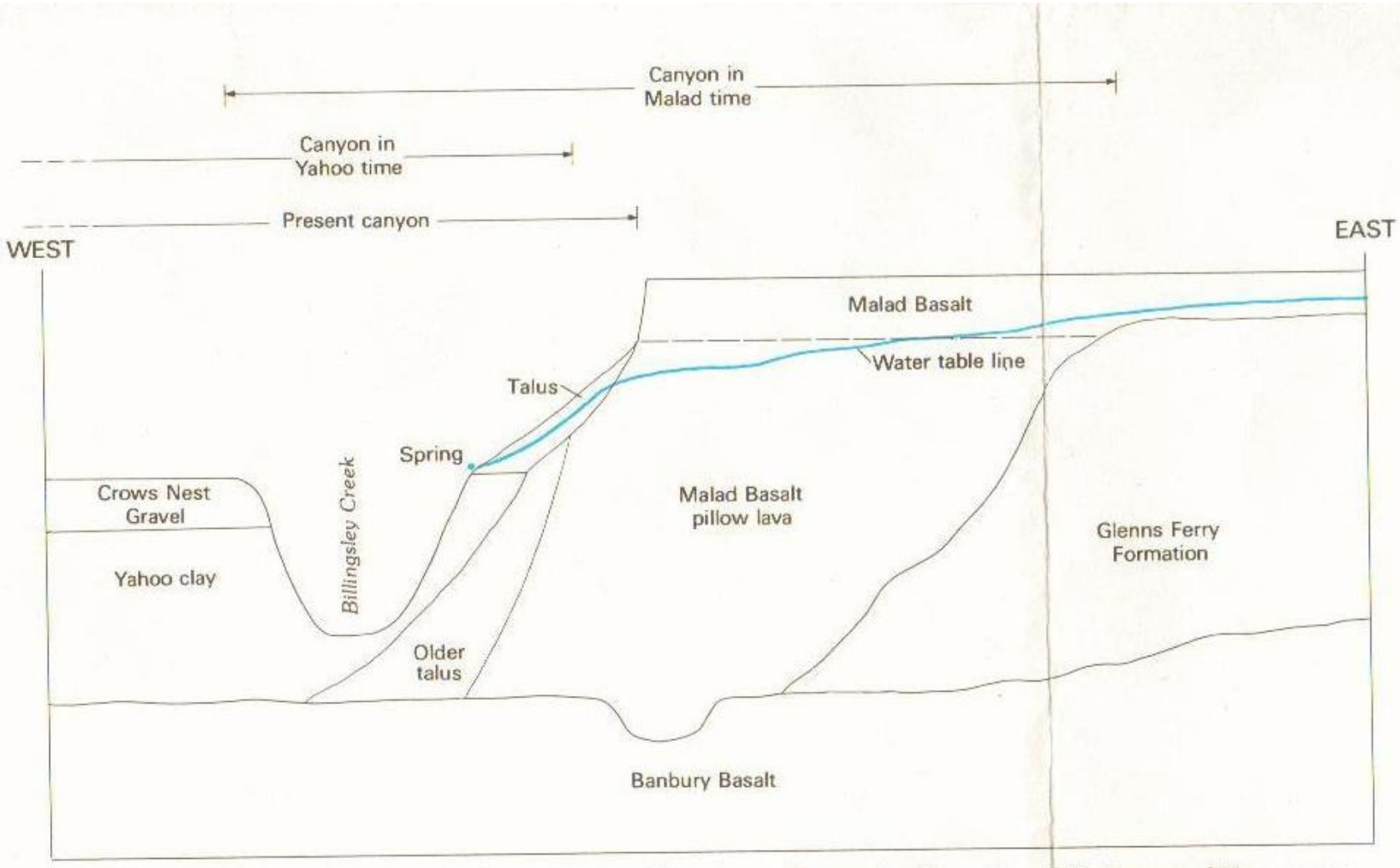
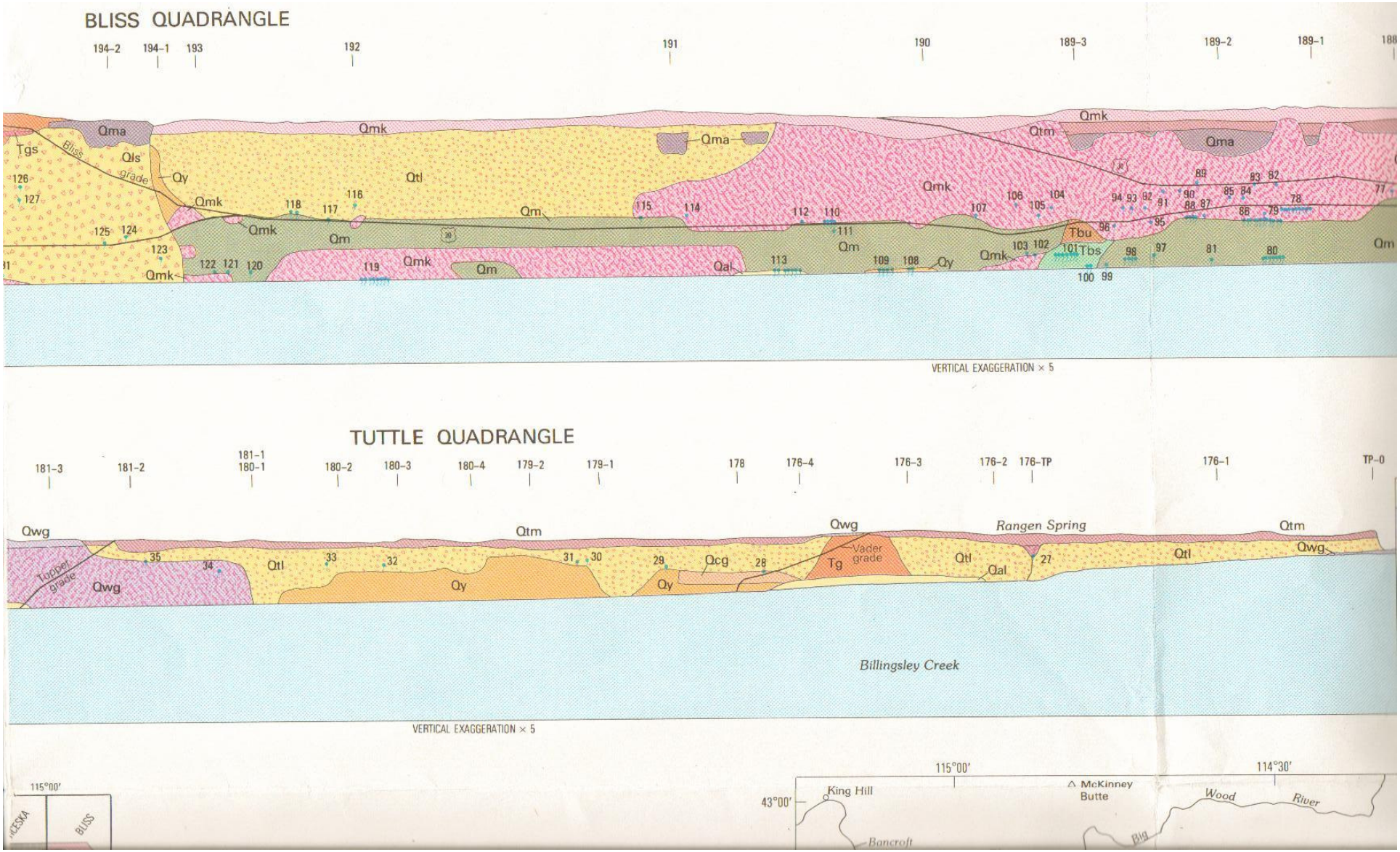
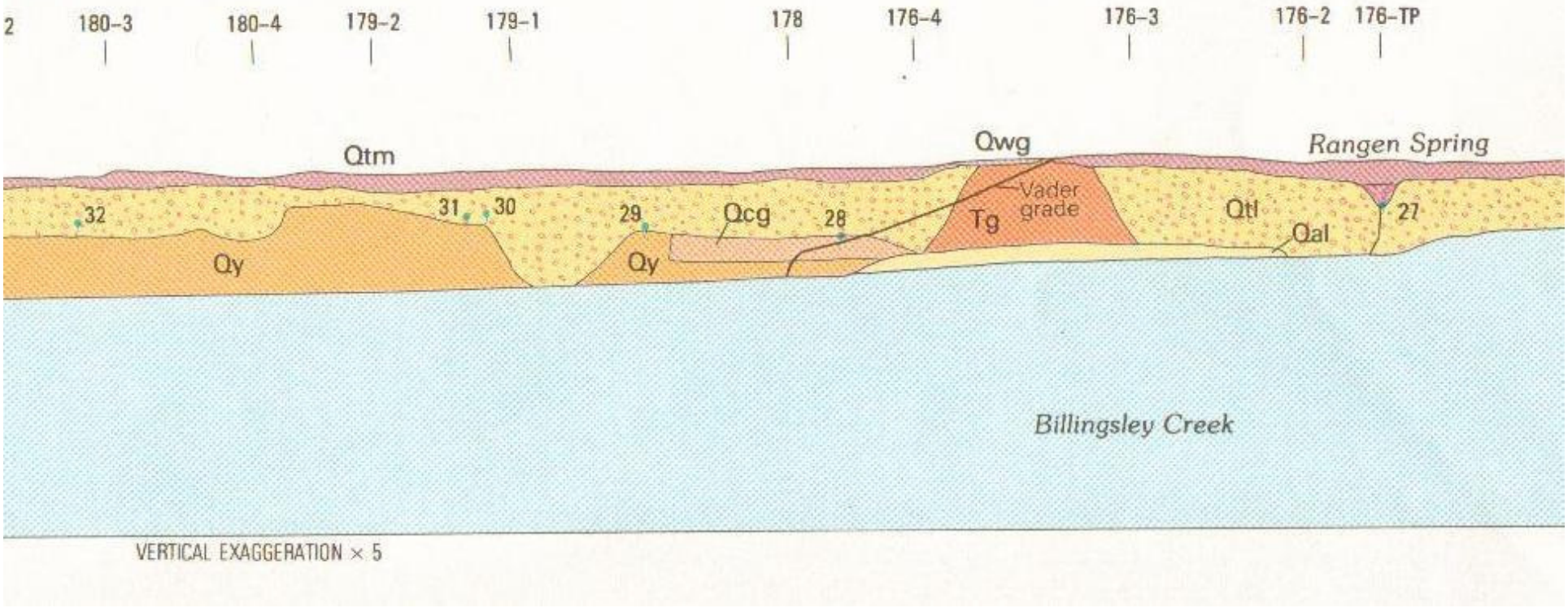


Figure 3. Schematic section of the canyon wall near profile-control location 179–1 east of Hagerman. Section shows the interpretative relation of the confining units of Yahoo Clay and Glenns Ferry sediments to the Malad Basalt canyon filling deposits.


BLISS QUADRANGLE
194–2
194–1
193
192
191
190
189–3
189–2
189–1
Qma
Qmk
Tgs
Bliss
Qls
grade
Qy
Qtl
Qm
Qal
Qmk
Qtm
Tbu
Tbs
Qm
VERTICAL EXAGGERATION × 5
TUTTLE QUADRANGLE
181–3
181–2
181–1
180–1
180–2
180–3
180–4
179–2
179–1
178
176–4
176–3
176–2
176–TP
176–1
TP–0
Qwg
Qtm
Topper
grade
Qtl
Qy
Qcg
Vader
grade
Tg
Qal
Rangen Spring
Billingsley Creek
VERTICAL EXAGGERATION × 5
115°00′
114°30′
43°00′
King Hill
McKinney
Butte
Wood
River
Big
Bancroft
CESKA
BLISS

VERTICAL EXAGGERATION × 5

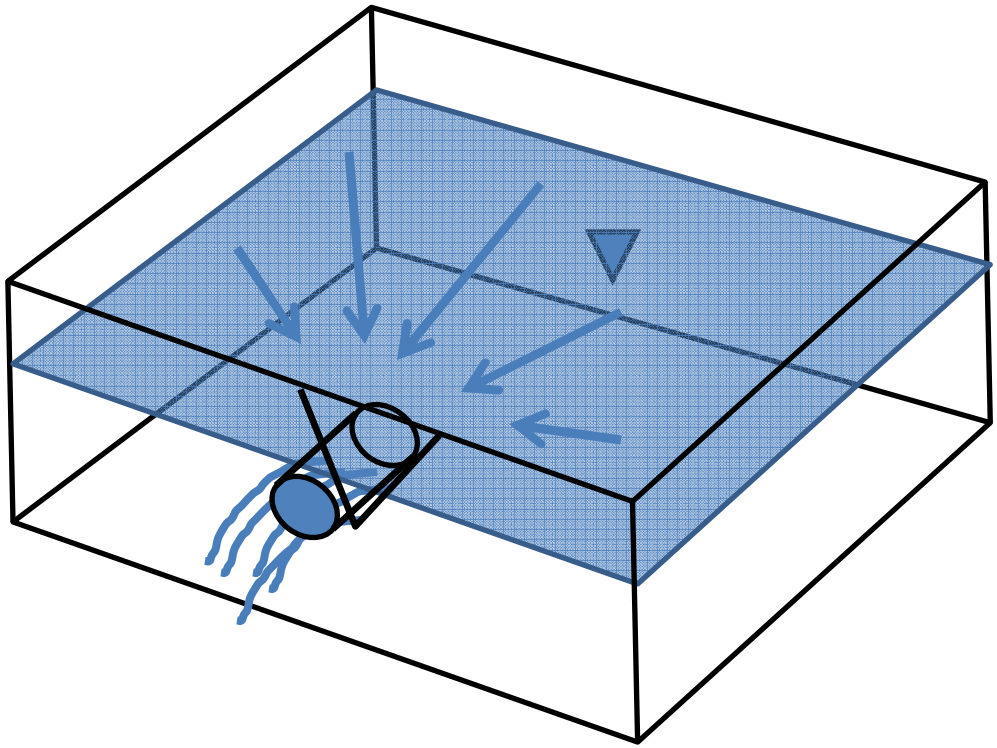
TUTTLE QUADRANGLE



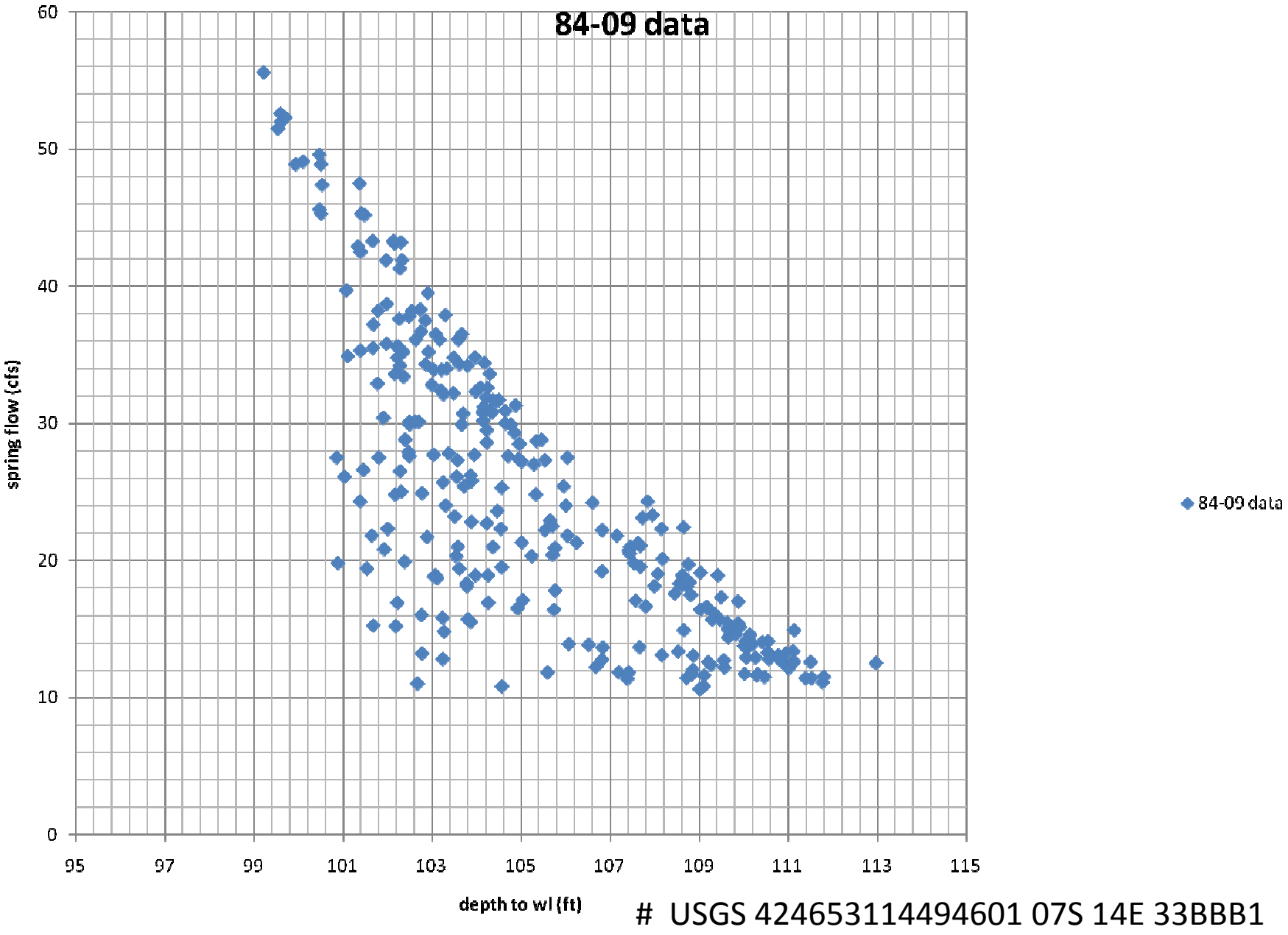
VERTICAL EXAGGERATION × 5

Understanding 1

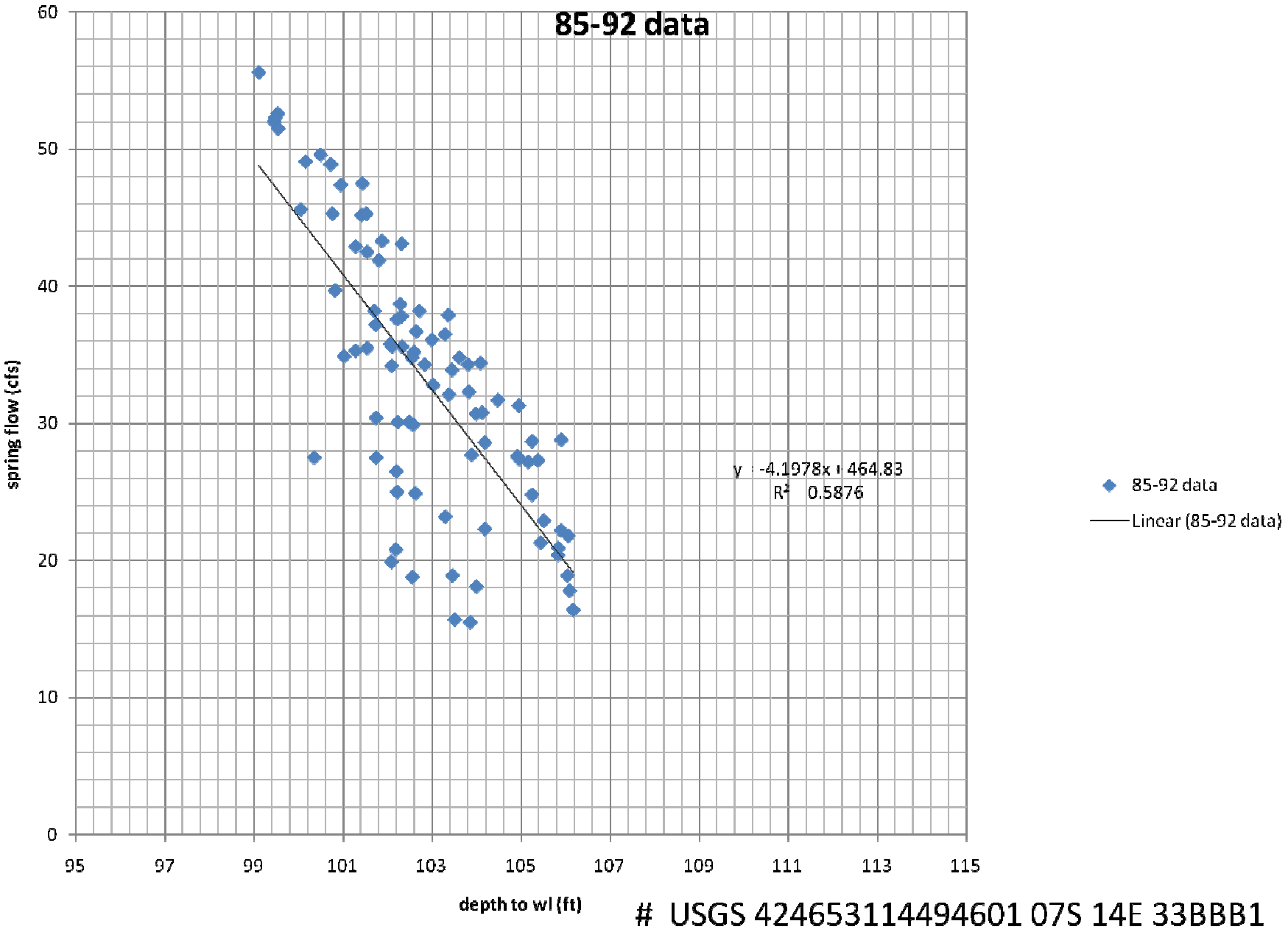
BATHTUB AND A V-NOTCH



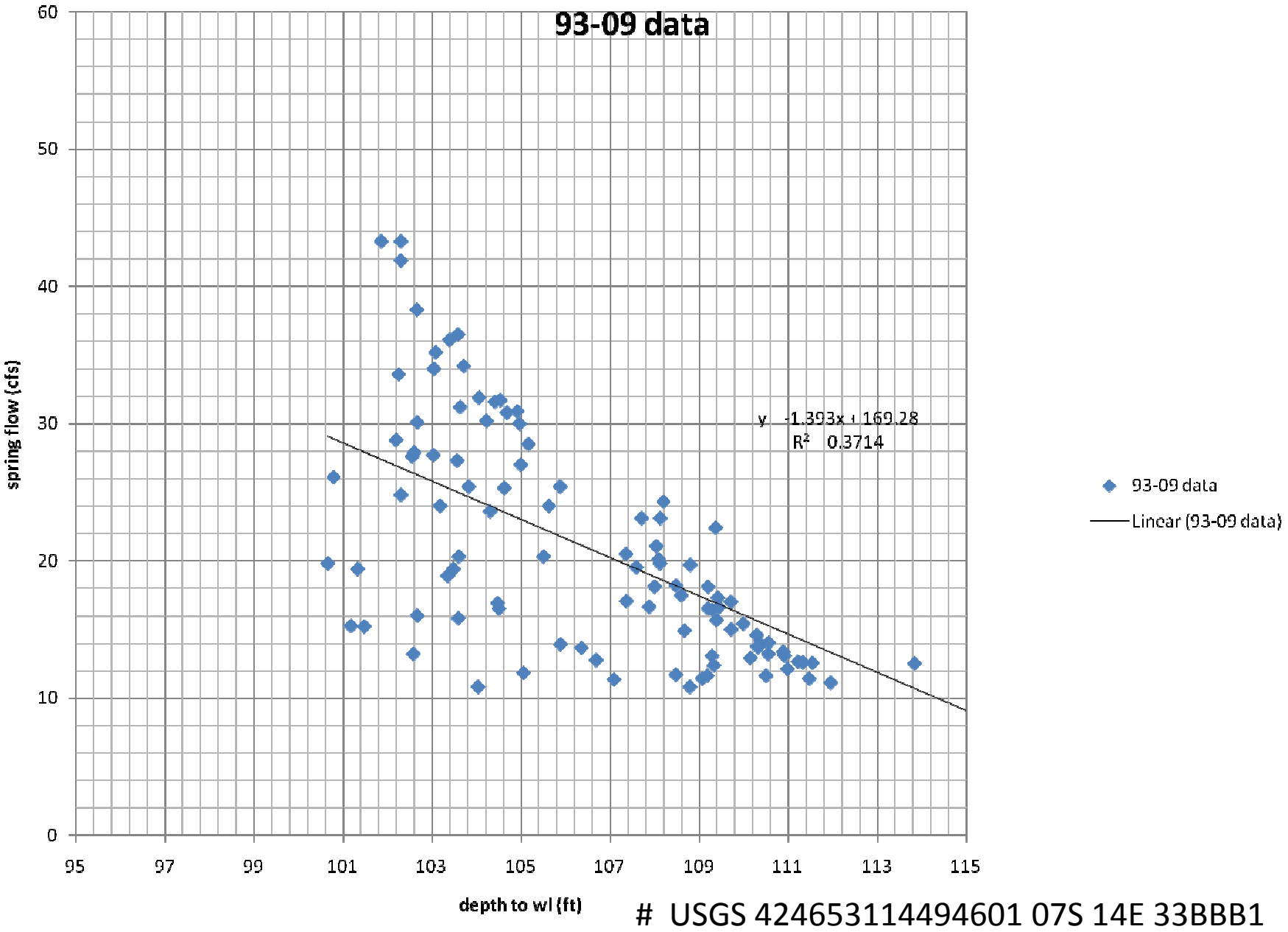
Seems like the hydrographs are indicating some hydrogeologic controls that exhibit faster responses than regional scale aquifer head controls on a notch….



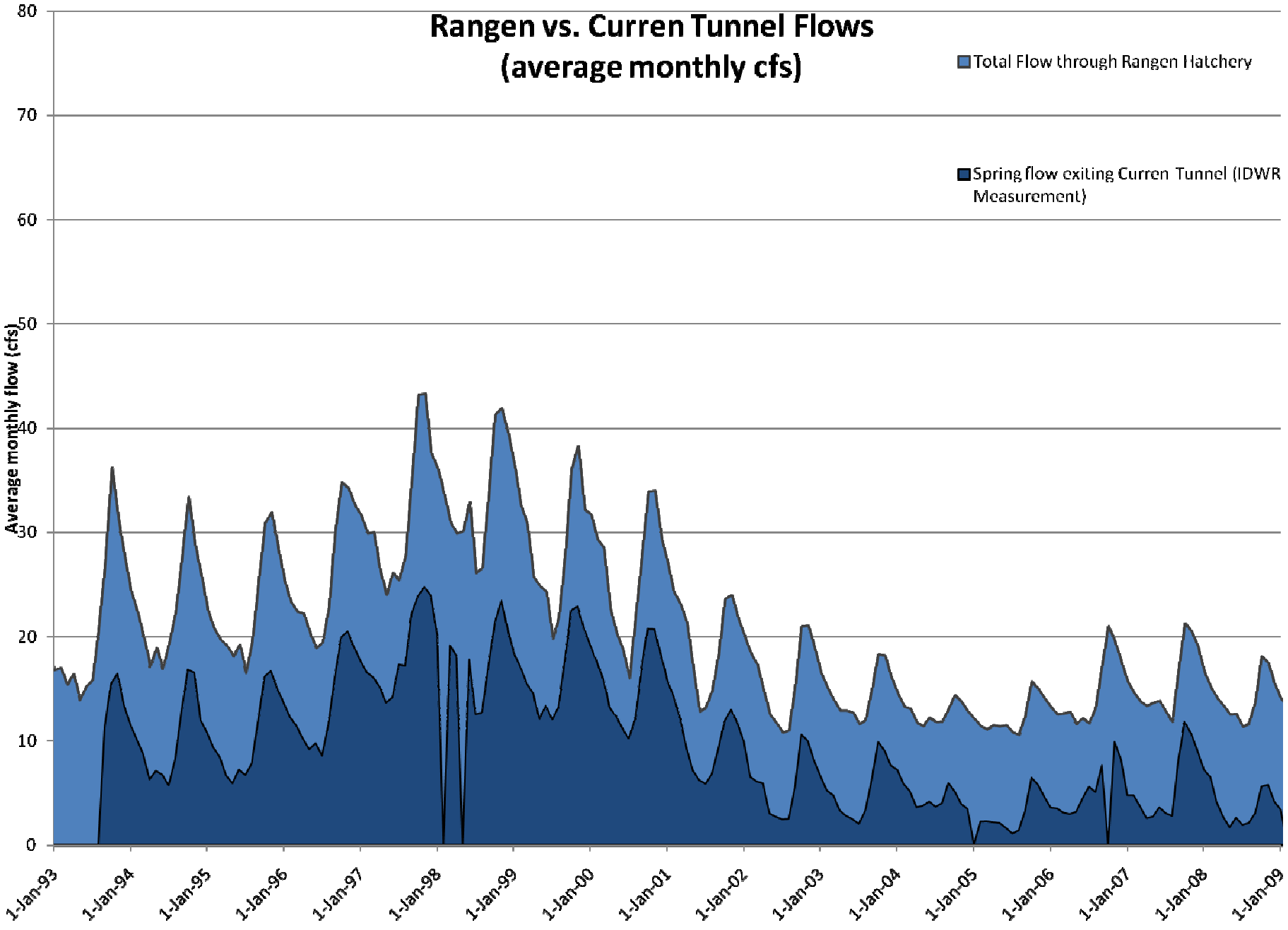
USGS 424653114494601 07S 14E 33BBB1



USGS 424653114494601 07S 14E 33BBB1



USGS 424653114494601 07S 14E 33BBB1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(average monthly cfs)
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Spring flow exiting Curren Tunnel (IDWR Measurement)
Average monthly flow (cfs)
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1-Jan-93
1-Jan-94
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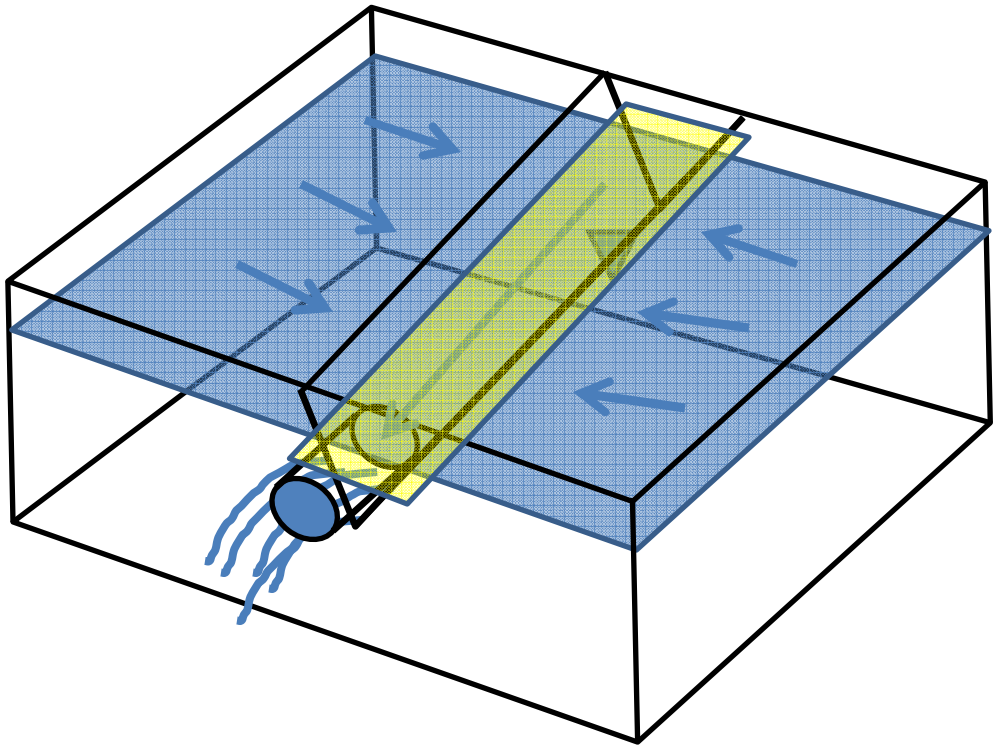
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09

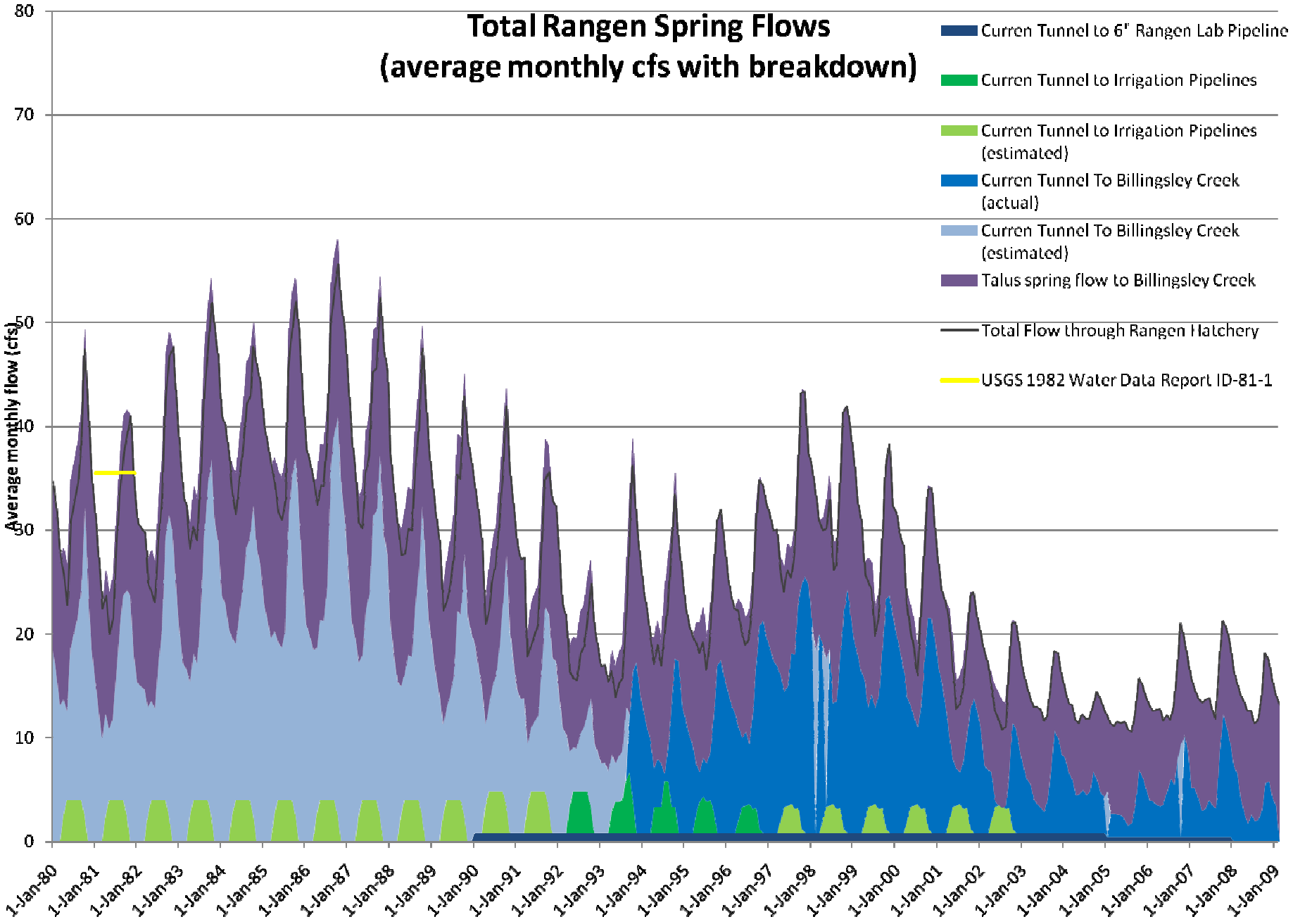
C. Neal Farmer, IDWR, “Review of Hydrogeologic Conditions Located At and Adjacent To the Spring at Rangen Inc.

LOCAL SCALE HIGHLY PERMEABLE CHANNEL



Straight face test…Darcy

A sq ft	dh	dx	K ft/day	cfs
5000	10	600	1000	0.96
5000	10	600	2000	1.93
5000	10	600	4000	3.86
5000	10	600	6000	5.79
5000	10	600	8000	7.72
5000	10	600	10000	9.65
5000	10	600	25000	24.11
5000	10	600	100000	96.45
103680	10	600	1000	20.00
51840	10	600	2000	20.00
25920	10	600	4000	20.00
12960	10	600	8000	20.00
6480	10	600	16000	20.00
3240	10	600	32000	20.00
1620	10	600	64000	20.00
51840	10	600	1000	10.00
25920	10	600	2000	10.00
12960	10	600	4000	10.00
6480	10	600	8000	10.00
3240	10	600	16000	10.00
1620	10	600	32000	10.00
810	10	600	64000	10.00


Total Rangen Spring Flows
(average monthly cfs with breakdown)
Curren Tunnel to 6" Rangen Lab Pipeline
Curren Tunnel to Irrigation Pipelines
Curren Tunnel to Irrigation Pipelines (estimated)
Curren Tunnel To Billingsley Creek (actual)
Curren Tunnel To Billingsley Creek (estimated)
Talus spring flow to Billingsley Creek
Total Flow through Rangen Hatchery
USGS 1982 Water Data Report ID-81-1
Average monthly flow (cfs)
0
10
20
30
40
50
60
70
80
1-Jan-80
1-Jan-81
1-Jan-82
1-Jan-83
1-Jan-84
1-Jan-85
1-Jan-86
1-Jan-87
1-Jan-88
1-Jan-89
1-Jan-90
1-Jan-91
1-Jan-92
1-Jan-93
1-Jan-94
1-Jan-95
1-Jan-96
1-Jan-97
1-Jan-98
1-Jan-99
1-Jan-00
1-Jan-01
1-Jan-02
1-Jan-03
1-Jan-04
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09