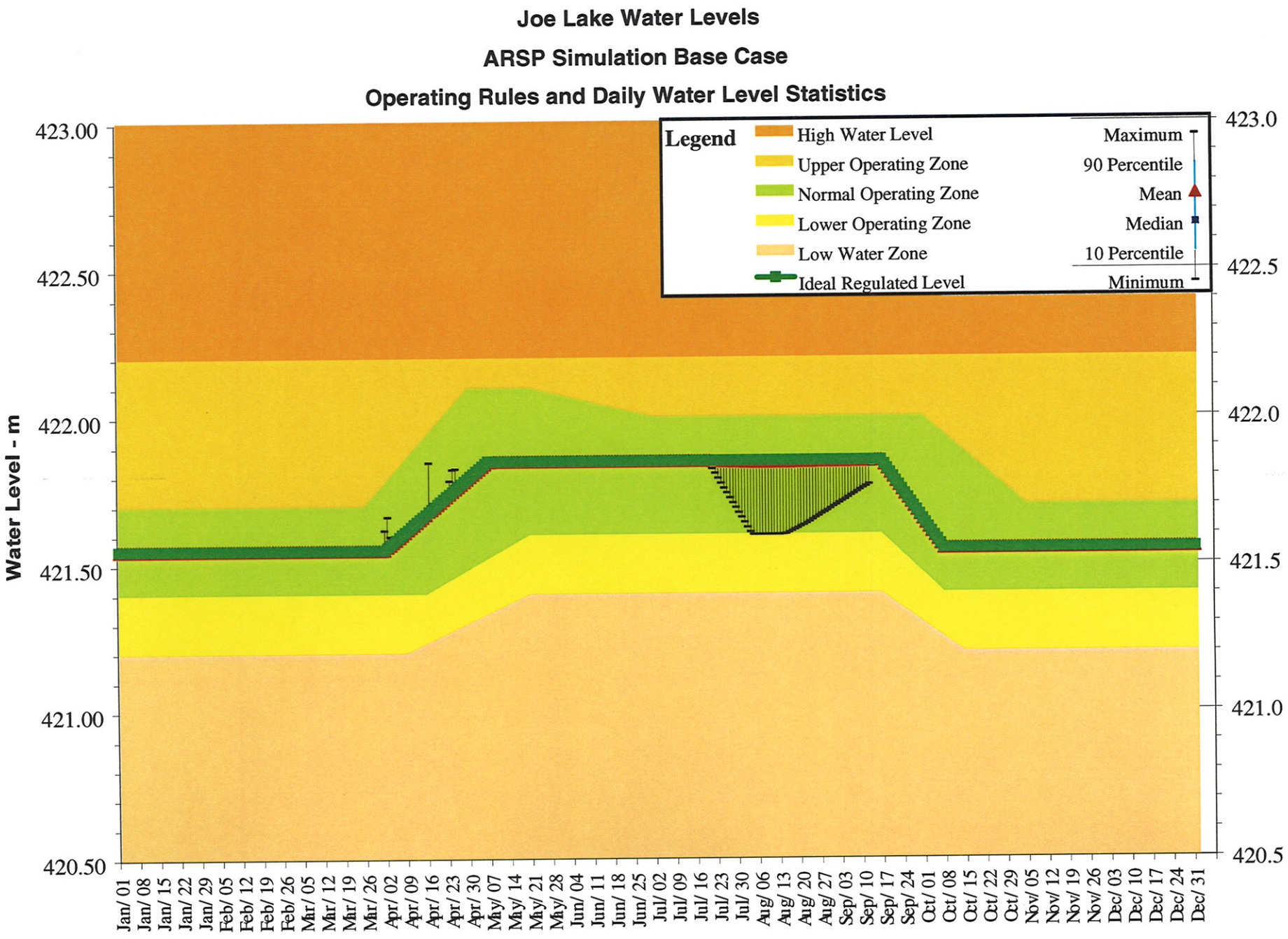
Appendix F

Option Development Process
ARSP Modeling and Analysis
of Lake Levels and River Flows

- **ARSP Base Case**
- **ARSP Case One**
- **ARSP Case Two**

Joe Lake


Joe Lake Water Levels
ARSP Simulation Base Case
Operating Rules and Daily Water Level Statistics
Legend
High Water Level
Upper Operating Zone
Normal Operating Zone
Lower Operating Zone
Low Water Zone
Ideal Regulated Level
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Water Level - m
423.00
422.50
422.00
421.50
421.00
420.50
423.0
422.5
422.0
421.5
421.0
420.5
Jan/ 01
Jan/ 08
Jan/ 15
Jan/ 22
Jan/ 29
Feb/ 05
Feb/ 12
Feb/ 19
Feb/ 26
Mar/ 05
Mar/ 12
Mar/ 19
Mar/ 26
Apr/ 02
Apr/ 09
Apr/ 16
Apr/ 23
Apr/ 30
May/ 07
May/ 14
May/ 21
May/ 28
Jun/ 04
Jun/ 11
Jun/ 18
Jun/ 25
Jul/ 02
Jul/ 09
Jul/ 16
Jul/ 23
Jul/ 30
Aug/ 06
Aug/ 13
Aug/ 20
Aug/ 27
Sep/ 03
Sep/ 10
Sep/ 17
Sep/ 24
Oct/ 01
Oct/ 08
Oct/ 15
Oct/ 22
Oct/ 29
Nov/ 05
Nov/ 12
Nov/ 19
Nov/ 26
Dec/ 03
Dec/ 10
Dec/ 17
Dec/ 24
Dec/ 31

Joe Lake Water Levels
ARSP Simulation Base Case

Peak Water Levels	
HWZ	422.2
No of Days in Exceedance	0
No of Years Exceeded	0
Maximum WL	421.85

Time of spring peak levels before April 30	
Percentile	0.90
Peak percentile WL	421.80
Date of peak	30-Apr
Tolerance	0
Tolerated WL	421.80
Date tolerated exceeded	30-Apr

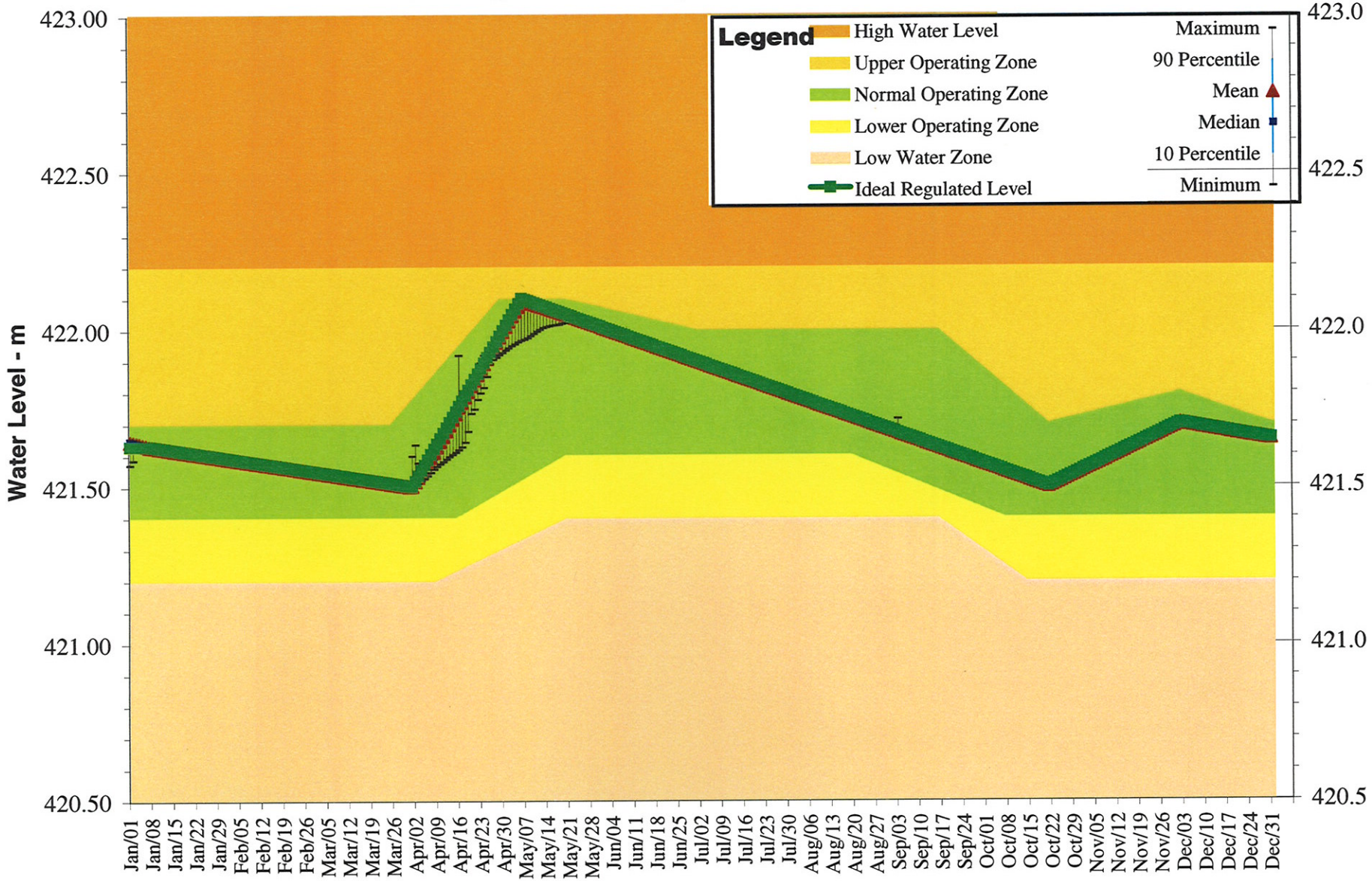
Summer recreation levels Jun-15 to Sep-30	
90 and 10 percentile range	
Max 90%	421.85
Min 10%	421.65
Range	0.20

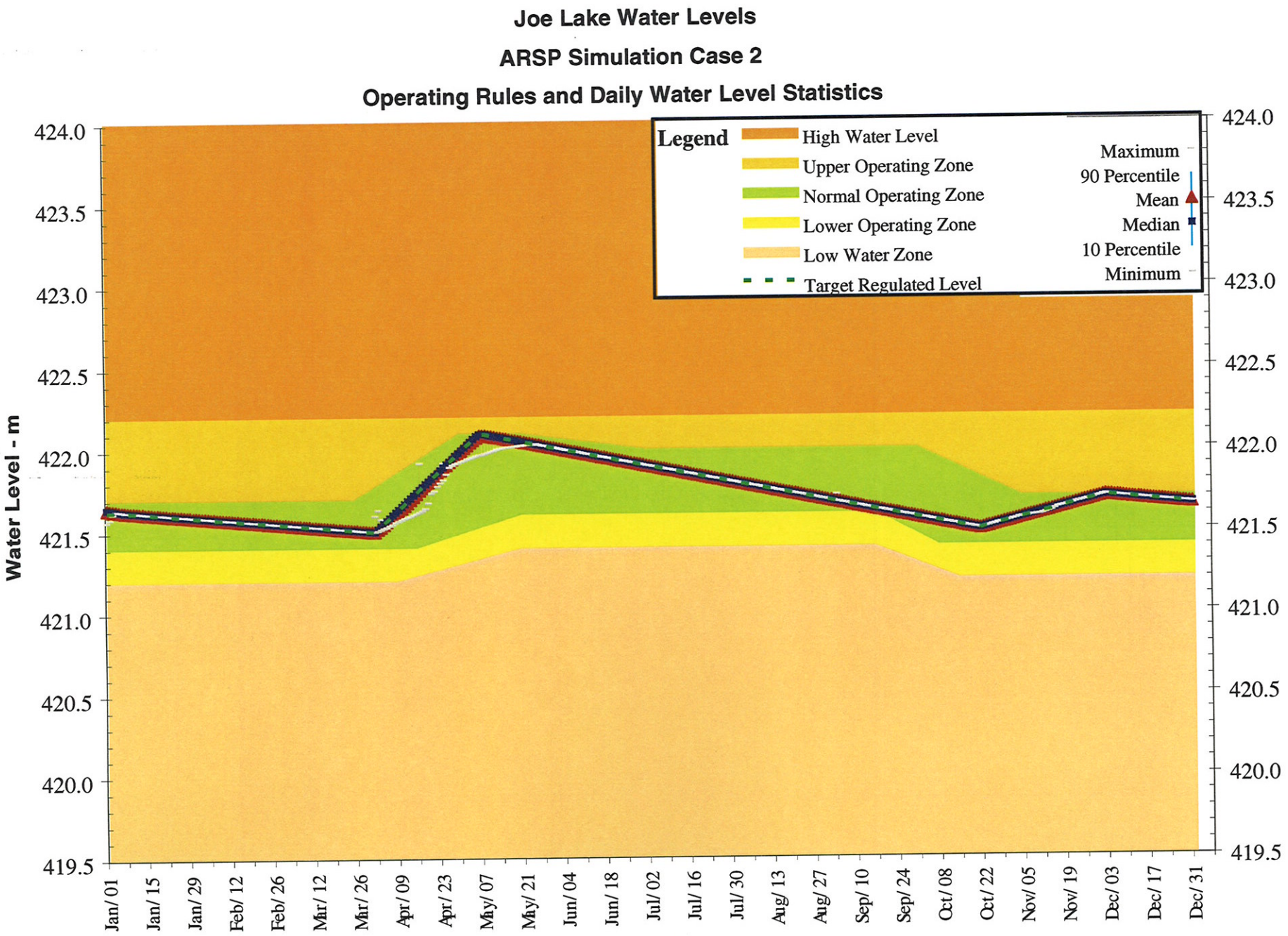
Median range	
Max Median	421.85
Min Median	421.65
Range	0.20

Joe Lake Water Levels

ARSP Simulation Case 1

Operating Rules and Daily Water Level Statistics




Joe Lake Water Levels
ARSP Simulation Case 2
Operating Rules and Daily Water Level Statistics
Legend
High Water Level
Upper Operating Zone
Normal Operating Zone
Lower Operating Zone
Low Water Zone
Target Regulated Level
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Water Level - m
424.0
423.5
423.0
422.5
422.0
421.5
421.0
420.5
420.0
419.5
Jan/ 01
Jan/ 15
Jan/ 29
Feb/ 12
Feb/ 26
Mar/ 12
Mar/ 26
Apr/ 09
Apr/ 23
May/ 07
May/ 21
Jun/ 04
Jun/ 18
Jul/ 02
Jul/ 16
Jul/ 30
Aug/ 13
Aug/ 27
Sep/ 10
Sep/ 24
Oct/ 08
Oct/ 22
Nov/ 05
Nov/ 19
Dec/ 03
Dec/ 17
Dec/ 31

Joe Lake Water Levels
ARSP Simulation Case
2

Peak Water Levels	
HWZ	422.2
No of Days in Exceedance	0
No of Years Exceeded	0
Maximum WL	422.10

Time of spring peak levels before April 30	
Percentile	0.90
Peak percentile WL	422.00
Date of peak	30-Apr
Tolerance	0
Tolerated WL	422.00
Date tolerated exceeded	30-Apr

Summer recreation levels Jun-15 to Sep-30

90 and 10 percentile range

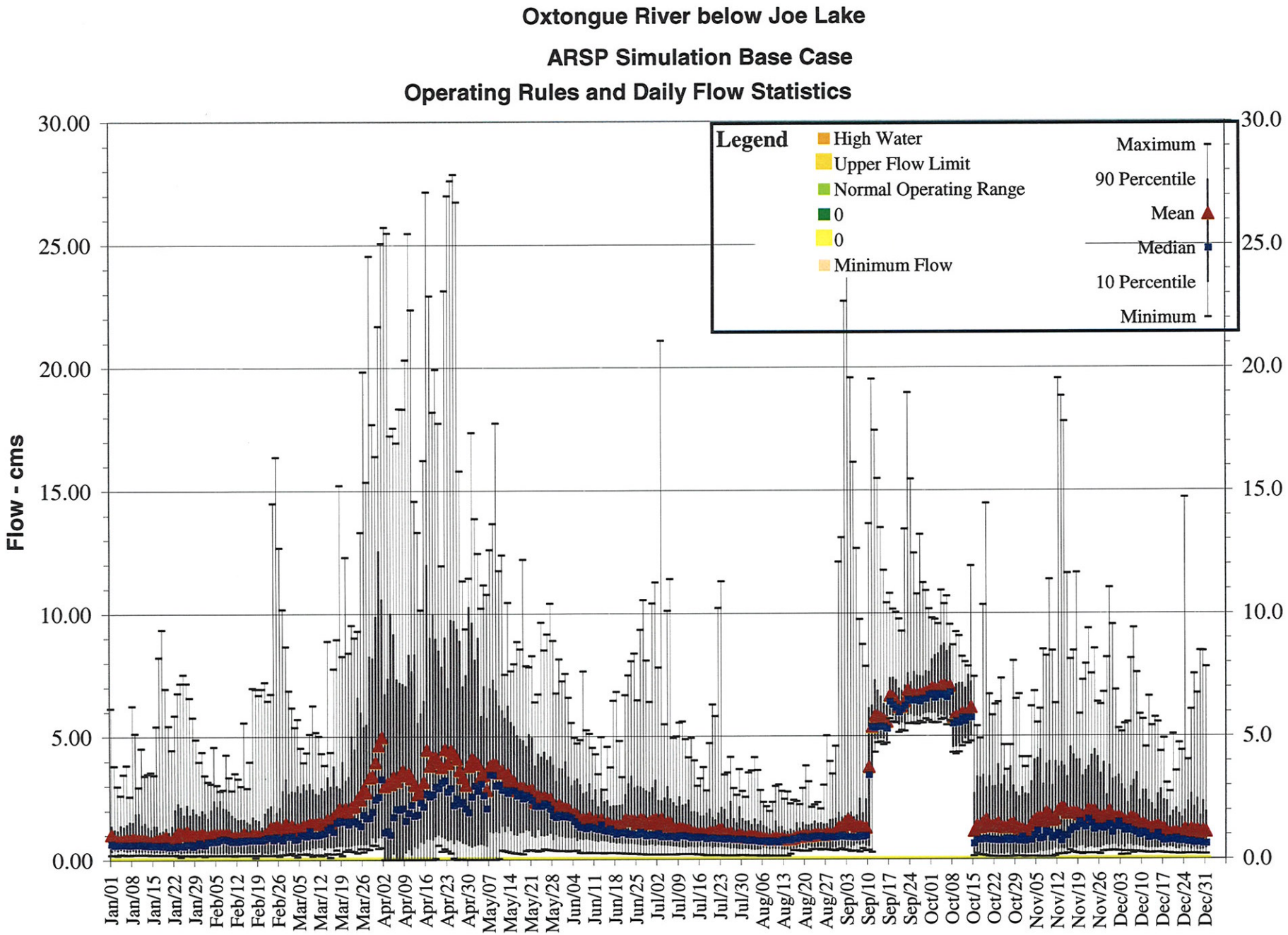
Max 90%	421.96
Min 10%	421.58
Range	0.38

Median range

Max Median	421.96
Min Median	421.58
Range	0.38

Spring Peak Water Level

Maximum - 50 yr Average	422.09
Date - 50 yr Average	7/May
Summer Average Level	421.79


Oxtongue River below Joe Lake
ARSP Simulation Base Case
Operating Rules and Daily Flow Statistics
Legend
High Water
Upper Flow Limit
Normal Operating Range
0
0
Minimum Flow
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Flow - cms
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jan/01
Jan/08
Jan/15
Jan/22
Jan/29
Feb/05
Feb/12
Feb/19
Feb/26
Mar/05
Mar/12
Mar/19
Mar/26
Apr/02
Apr/09
Apr/16
Apr/23
Apr/30
May/07
May/14
May/21
May/28
Jun/04
Jun/11
Jun/18
Jun/25
Jul/02
Jul/09
Jul/16
Jul/23
Jul/30
Aug/06
Aug/13
Aug/20
Aug/27
Sep/03
Sep/10
Sep/17
Sep/24
Oct/01
Oct/08
Oct/15
Oct/22
Oct/29
Nov/05
Nov/12
Nov/19
Nov/26
Dec/03
Dec/10
Dec/17
Dec/24
Dec/31

Flow Evaluation

Yellow cells indicate values that can be changed for analysis

Oxtongue River below Joe Lake
ARSP Simulation Base Case
Daily Flows Model Results 1951 to 2000

Walleye Spawning

Min Flow **0** m^3/s Achieved 100% of time

No of days above minumum flow

First half of season		*Last half of season*		*For whole season*	
Min	13 days	Min	24 days	Min	37 days
Avg	24.48 days	Avg	24 days	Avg	48.48 days
Years Provided	94%	Years Provided	100%	Years Provided	94%

From flow duration curve

%	Flow	*No of days*
99%	0.10 m^3/s	*min flow is achievd*
95%	0.59 m^3/s	37 days

90% *percentile peak flow*
7 m3/s

Summer Minimum 7-day Flow

	Maximum	0.99 m^3/s
	Minimum	0.14 m^3/s
90%	Percentile	0.80 m^3/s
10%	Percentile	0.36 m^3/s
	Median	0.61 m^3/s
	Mean	0.60 m^3/s

Maximum Flows

Regulatory Flood Outflow — No of years exceeded — Maximum Daily Flow

N/A	m³/s	0	28.14 m³/s

Minumum Flows

Min Daily flow	*7-day minimums*		
0.00 m³/s	2	10	20 return period
	-yr 7Q2	-yr 7Q10	-yr 7Q20
	0.33	0.06	0.01 m³/s

Summer Fluctuations

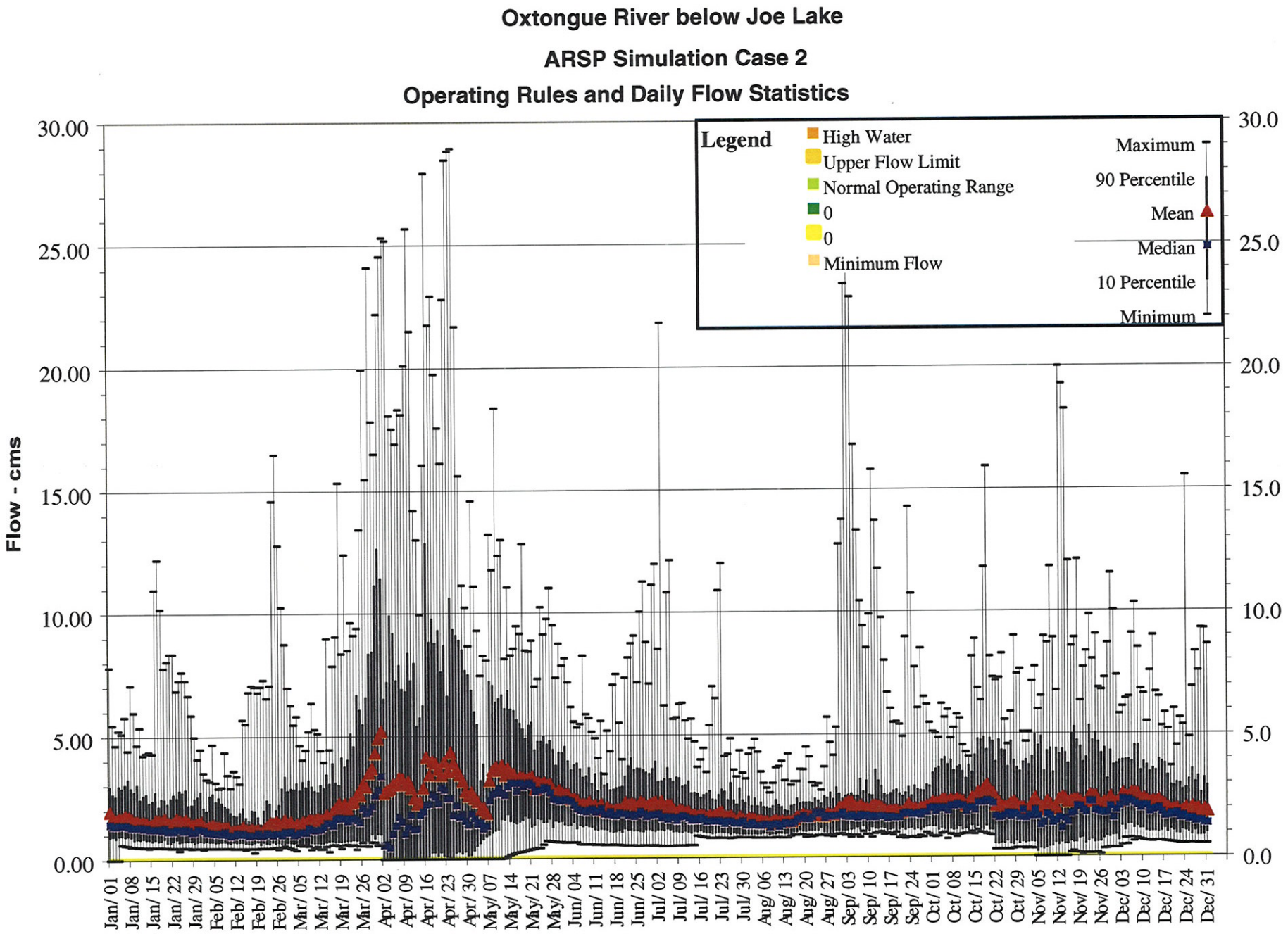
Delta Flow	Average number of daily flow fluctuations per year		
1	7.22		
3	1.44		
5	0.36		
>0.4875	15.88	0.5	ratio of summer median

Water Usage

Median Flow		*10% Percentile*	
summer m³/s	winter m³/s	summer m³/s	winter m³/s
1.33	0.97	0.52	0.00

Power Generation

	Quarter				
	1	2	3	4	Annual
Flow	1.33	2.74	2.25	2.22	2.14 m³/s


Oxtongue River below Joe Lake
ARSP Simulation Case 2
Operating Rules and Daily Flow Statistics
Legend
High Water
Upper Flow Limit
Normal Operating Range
0
0
Minimum Flow
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Flow - cms
30.00
25.00
20.00
15.00
10.00
5.00
0.00
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jan/ 01
Jan/ 08
Jan/ 15
Jan/ 22
Jan/ 29
Feb/ 05
Feb/ 12
Feb/ 19
Feb/ 26
Mar/ 05
Mar/ 12
Mar/ 19
Mar/ 26
Apr/ 02
Apr/ 09
Apr/ 16
Apr/ 23
Apr/ 30
May/ 07
May/ 14
May/ 21
May/ 28
Jun/ 04
Jun/ 11
Jun/ 18
Jun/ 25
Jul/ 02
Jul/ 09
Jul/ 16
Jul/ 23
Jul/ 30
Aug/ 06
Aug/ 13
Aug/ 20
Aug/ 27
Sep/ 03
Sep/ 10
Sep/ 17
Sep/ 24
Oct/ 01
Oct/ 08
Oct/ 15
Oct/ 22
Oct/ 29
Nov/ 05
Nov/ 12
Nov/ 19
Nov/ 26
Dec/ 03
Dec/ 10
Dec/ 17
Dec/ 24
Dec/ 31

Flow Evaluation

Yellow cells indicate values that can be changed for analysis

Oxtongue River below Joe Lake
ARSP Simulation Case
2
Daily Flows Model Results 1951 to 2000

Walleye Spawning

Min Flow **0** m³/s Achieved 100% of time

No of days above minumum flow

First half of season

Min	5	days
Avg	22.72	days
Years Provided	72%	

Last half of season

Min	23	days
Avg	23.98	days
Years Provided	98%	

For whole season

Min	28	days
Avg	46.7	days
Years Provided	72%	

From flow duration curve

%	Flow		*No of days*			
99%	-	m³/s	*min flow is achievd*		*90%*	*percentile peak flow*
95%	0.24	m³/s	28	days	6	m3/s

Summer Minimum 7-day Flow

	Maximum	1.54	m³/s
	Minimum	0.48	m³/s
90%	Percentile	1.37	m³/s
10%	Percentile	0.88	m³/s
	Median	1.12	m³/s
	Mean	1.11	m³/s

Maximum Flows

Regulatory Flood Outflow		No of years exceeded	Maximum Daily Flow	
N/A	m³/s	0	28.94	m³/s

Minumum Flows

Min Daily flow		*7-day minimums*			
		2	10	20	return period
		-yr 7Q2	-yr 7Q10	-yr 7Q20	
0.00	m³/s	0.26	0.00	0.00	m³/s

Summer Fluctuations

Delta Flow	Average number of daily flow fluctuations per year		
1	6.92		
3	0.64		
5	0.30		
>0.7865	10.16	0.5	ratio of summer median

Water Usage

Median Flow		*10% Percentile*	
summer	winter	summer	winter
m³/s	m³/s	m³/s	m³/s
1.74	1.41	1.02	0.00

Power Generation

	Quarter				Annual	
	1	2	3	4		
Flow	1.72	2.83	1.80	2.19	2.13	m³/s