Packwood Hydroelectric Project

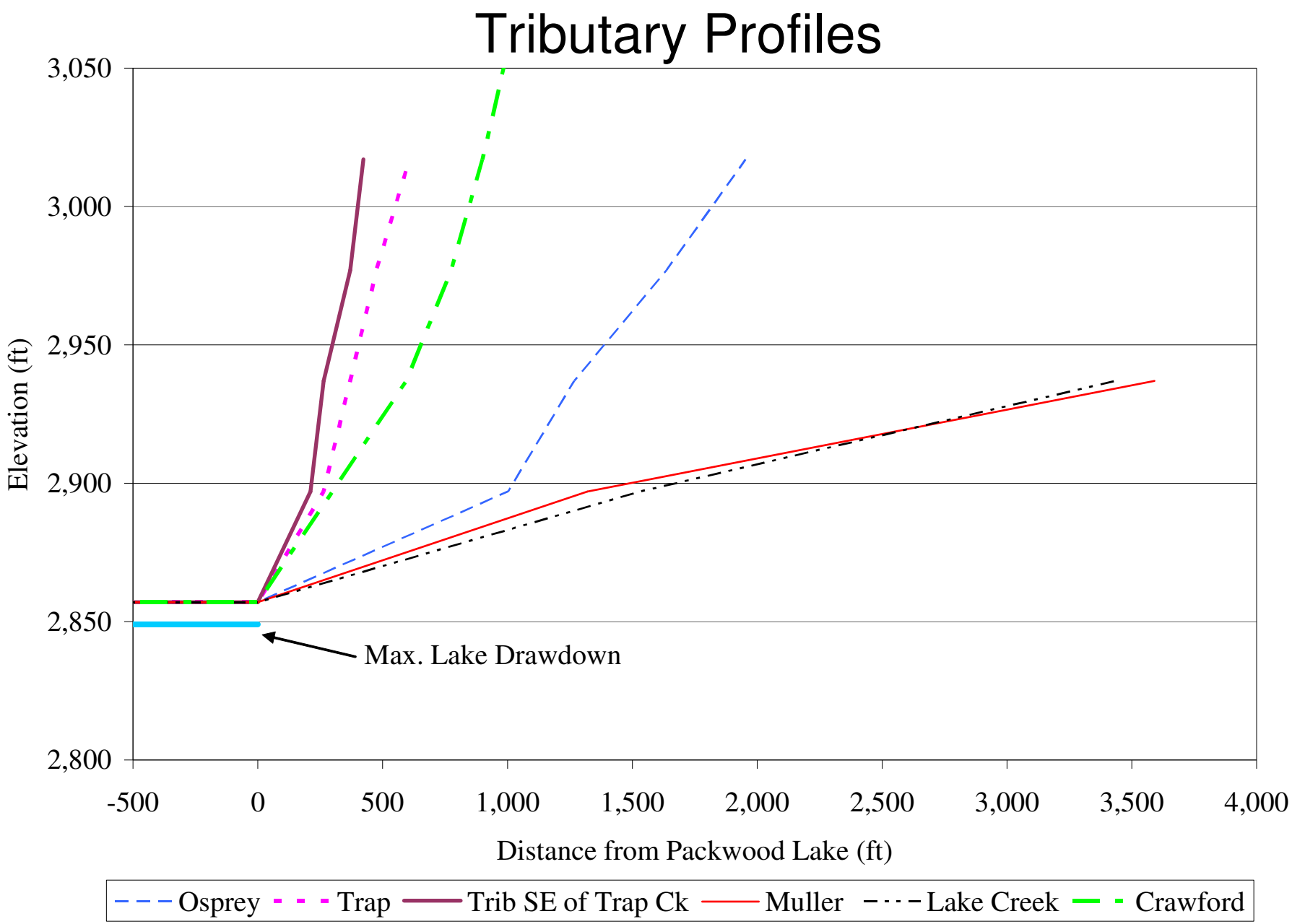
Stream Connectivity in Packwood Lake Tributaries

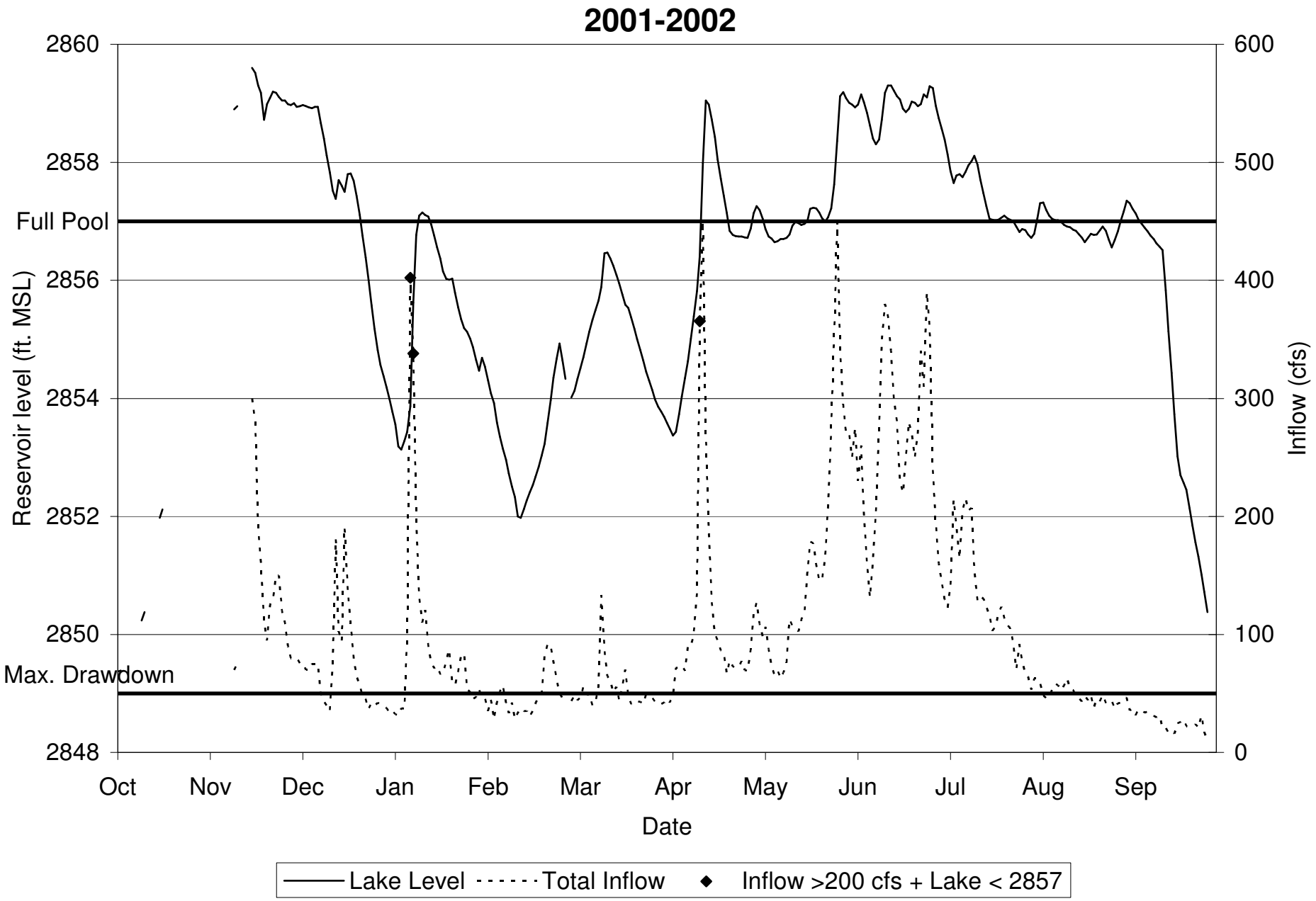
12/3/07

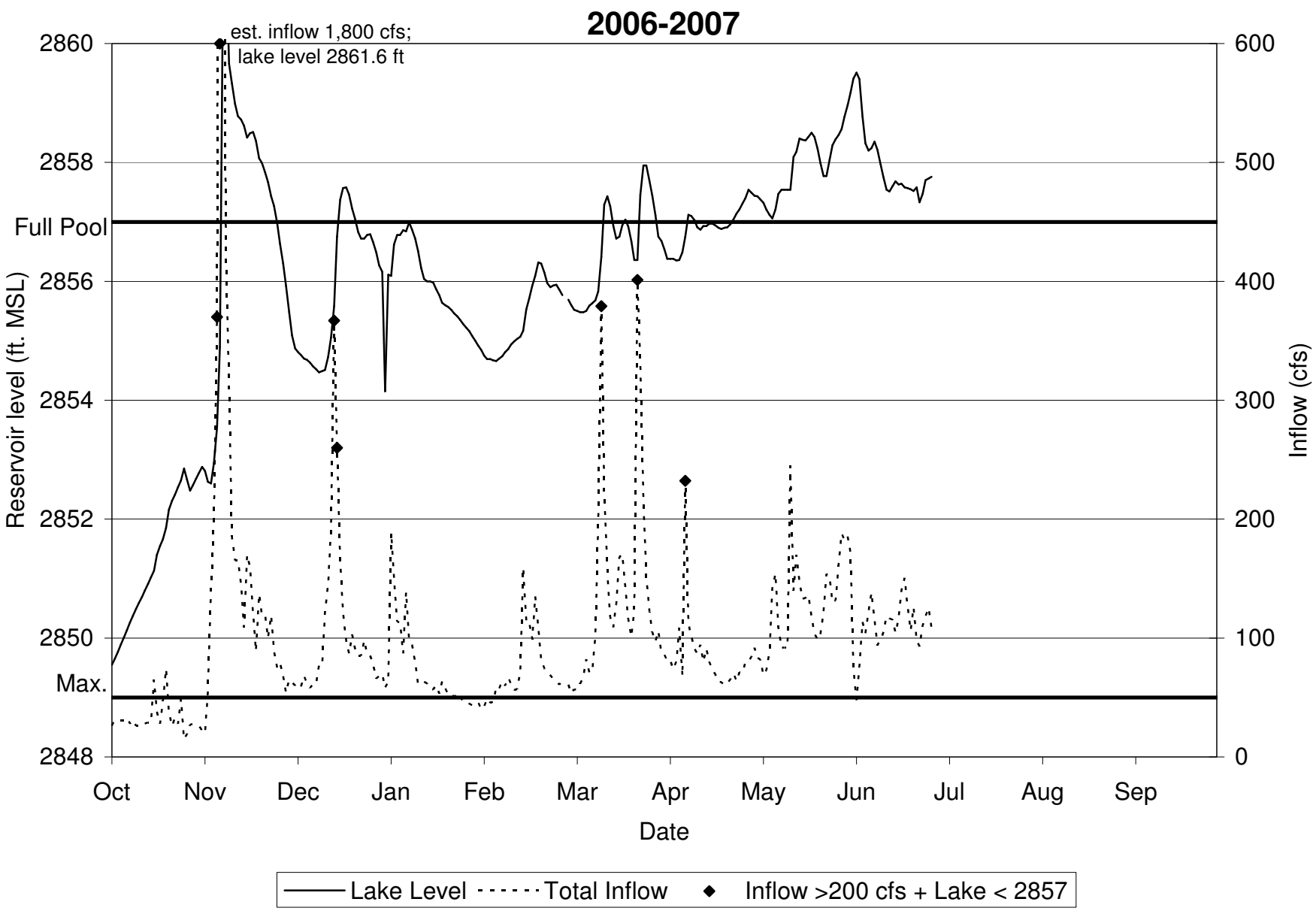
Risk of Headcutting in Tributary Streams

- Project-related headcutting could occur if:
  - Lake elevation is below full pool
    - ***AND***
  - Tributary discharge is high enough to initiate bedload transport
- Peak flows occur during either
  - Fall/winter rain-on-snow events
  - Spring snowmelt

- Packwood Lake fills quickly during peak flow events, limiting length of time the base level is lowered
- Geomorphic setting of tributaries:
  - Lake Creek, Mueller – low gradient channels in old glacial valley; Lake Creek has higher sediment/water load, Mueller has low sediment/water load
  - Other tribs – alluvial fans (active, depositional areas, channel jumps)


Tributary Profiles
3,050
3,000
2,950
2,900
2,850
2,800
Elevation (ft)
Max. Lake Drawdown
-500
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Distance from Packwood Lake (ft)
Osprey
Trap
Trib SE of Trap Ck
Muller
Lake Creek
Crawford


2001-2002
2860
2858
2856
2854
2852
2850
2848
Full Pool
Max. Drawdown
Reservoir level (ft. MSL)
600
500
400
300
200
100
0
Inflow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Lake Level
Total Inflow
Inflow >200 cfs + Lake < 2857


2006-2007
est. inflow 1,800 cfs;
lake level 2861.6 ft
2860
2858
Full Pool
2856
2854
2852
2850
Max.
2848
600
500
400
300
200
100
0
Reservoir level (ft. MSL)
Inflow (cfs)
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Date
Lake Level
Total Inflow
Inflow >200 cfs + Lake < 2857

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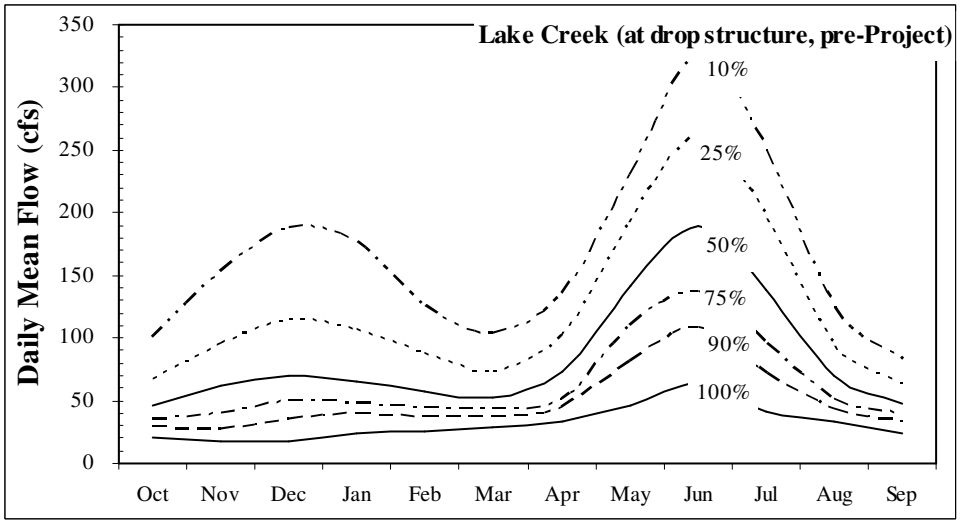
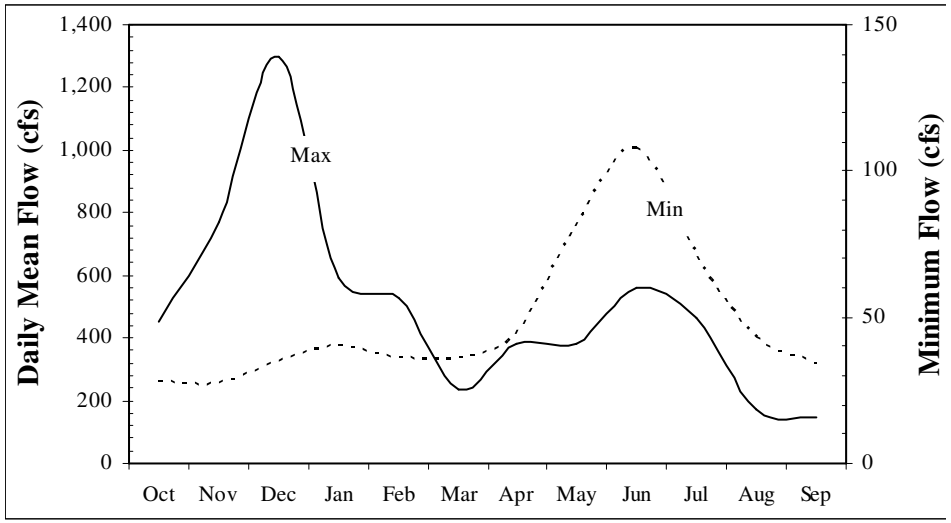
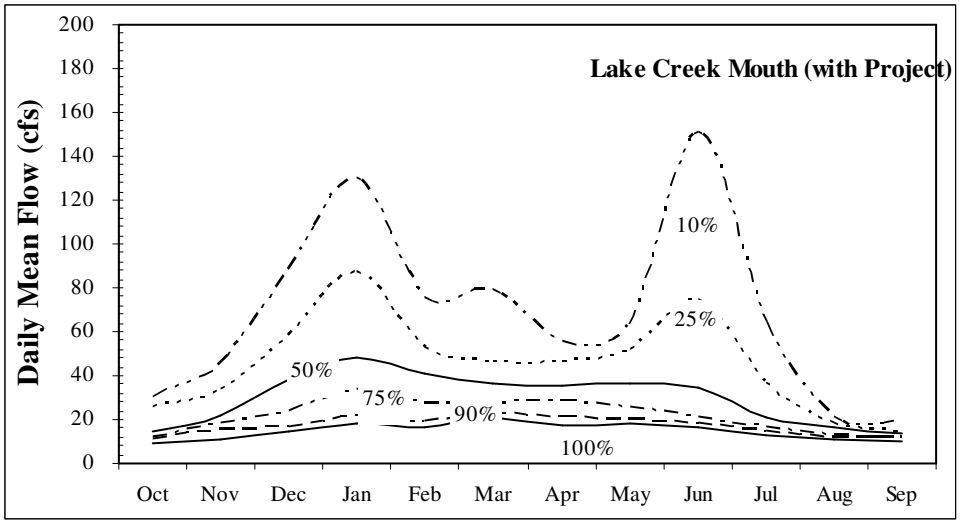
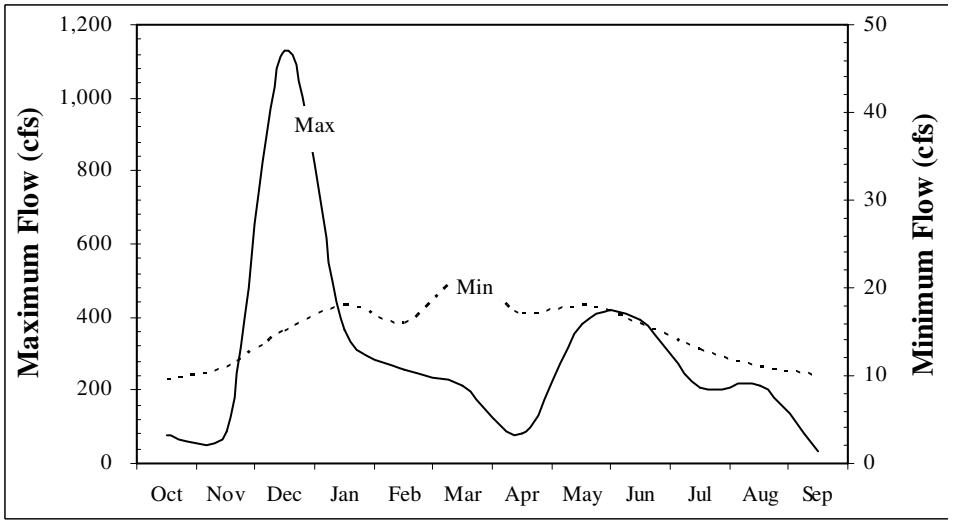
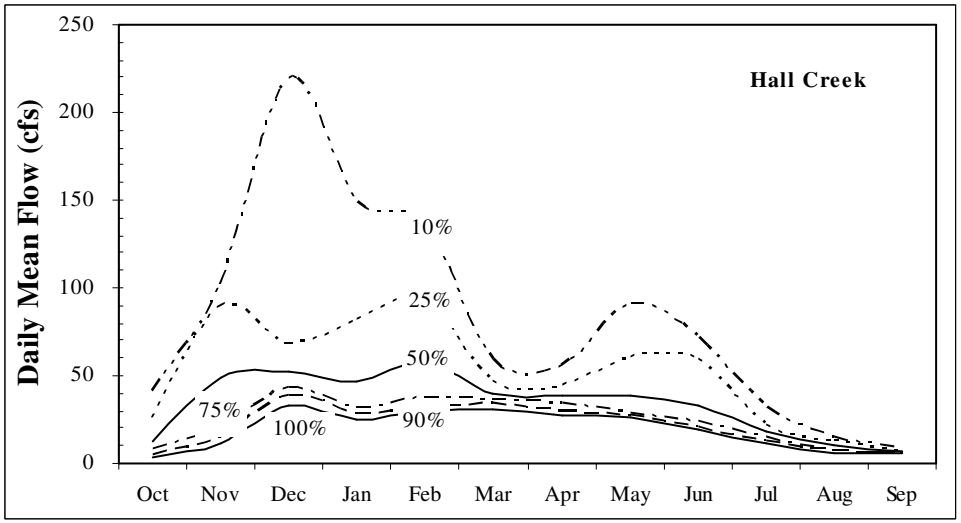
Peak Flow Timing

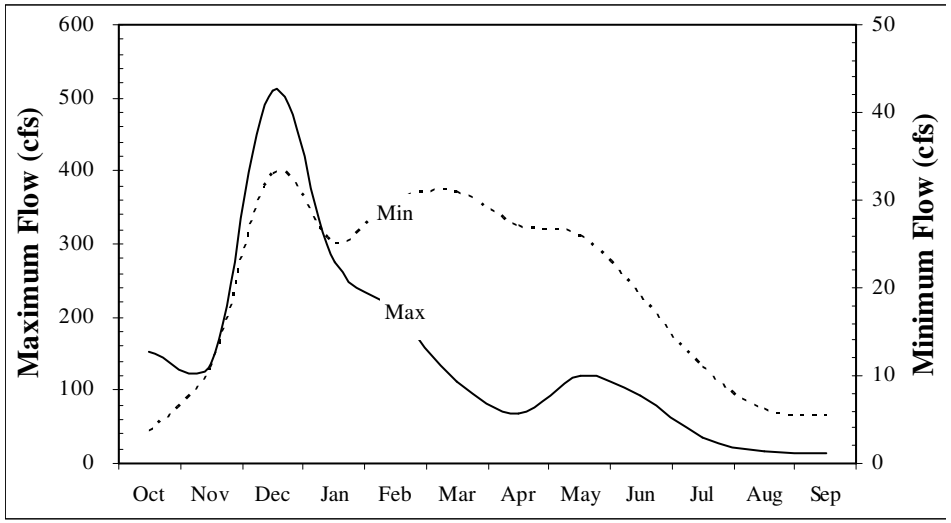


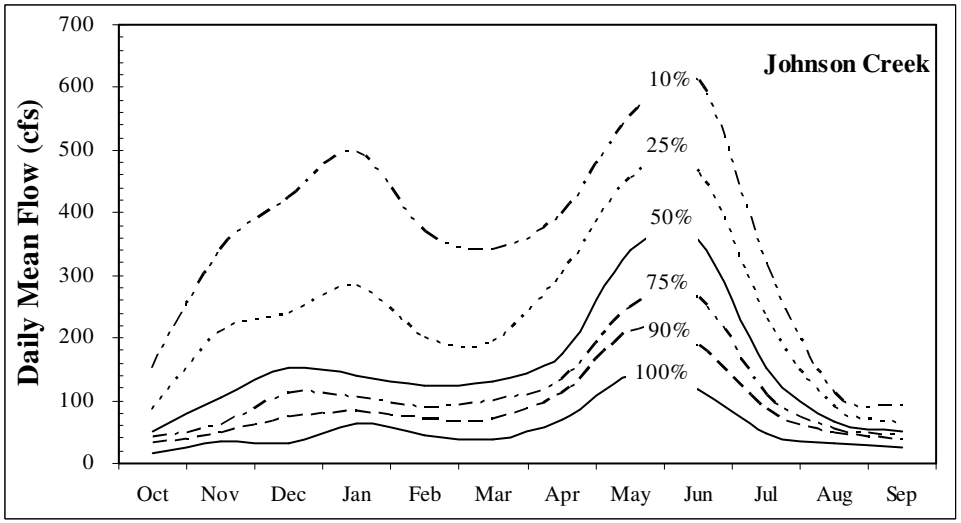


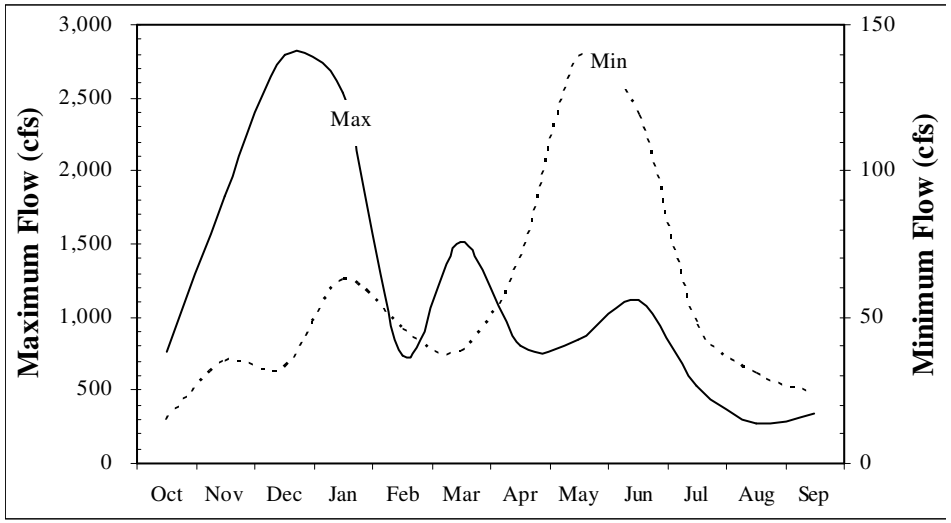




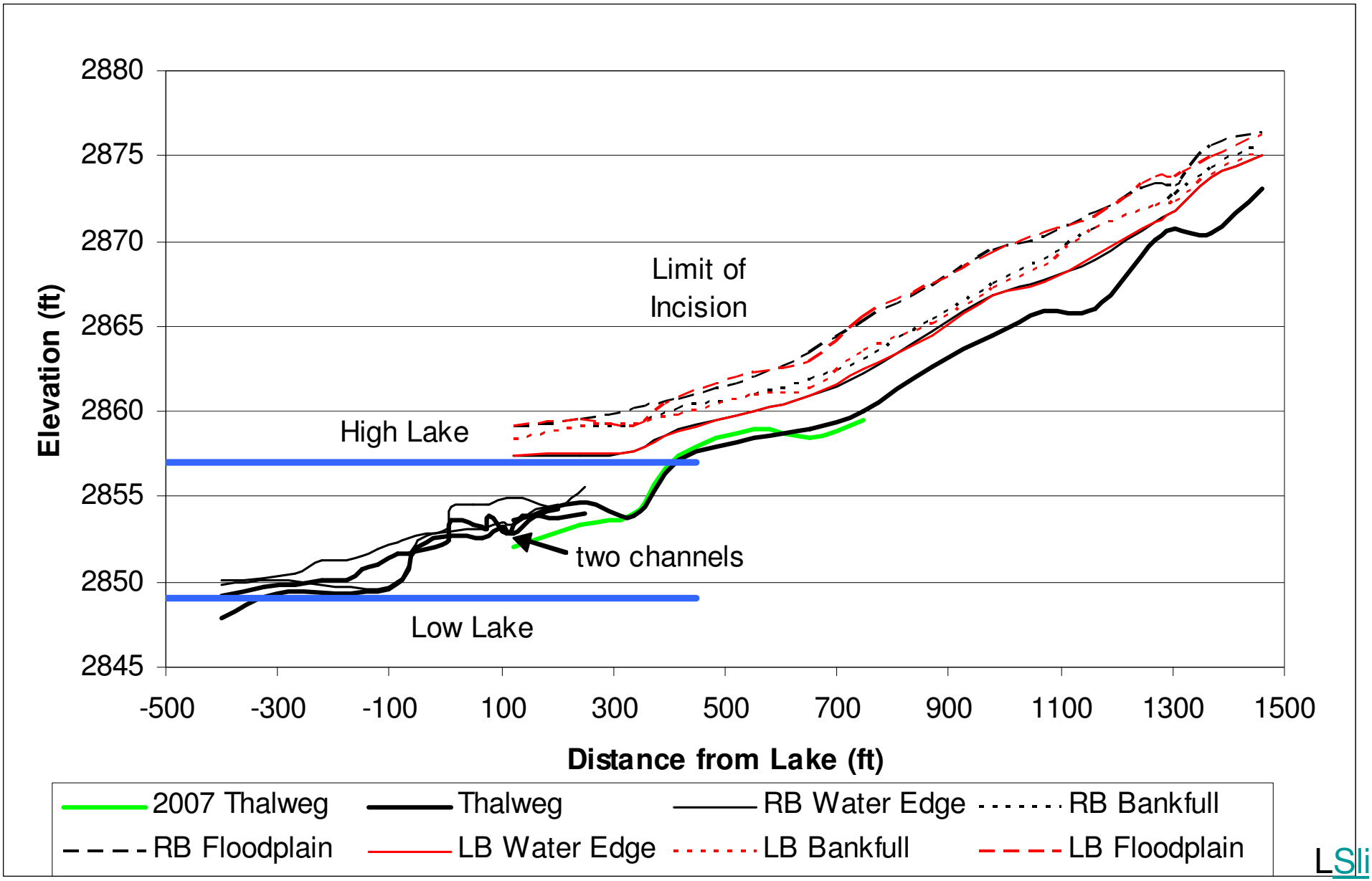

Hall Creek
Daily Mean Flow (cfs)
250
200
150
100
50
0
10%
25%
50%
75%
90%
100%
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Maximum Flow (cfs)
600
500
400
300
200
100
0
Minimum Flow (cfs)
50
40
30
20
10
0
Min
Max
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Johnson Creek
Daily Mean Flow (cfs)
700
600
500
400
300
200
100
0
10%
25%
50%
75%
90%
100%
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep


Maximum Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
Minimum Flow (cfs)
150
100
50
0
Max
Min
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

Lake Creek



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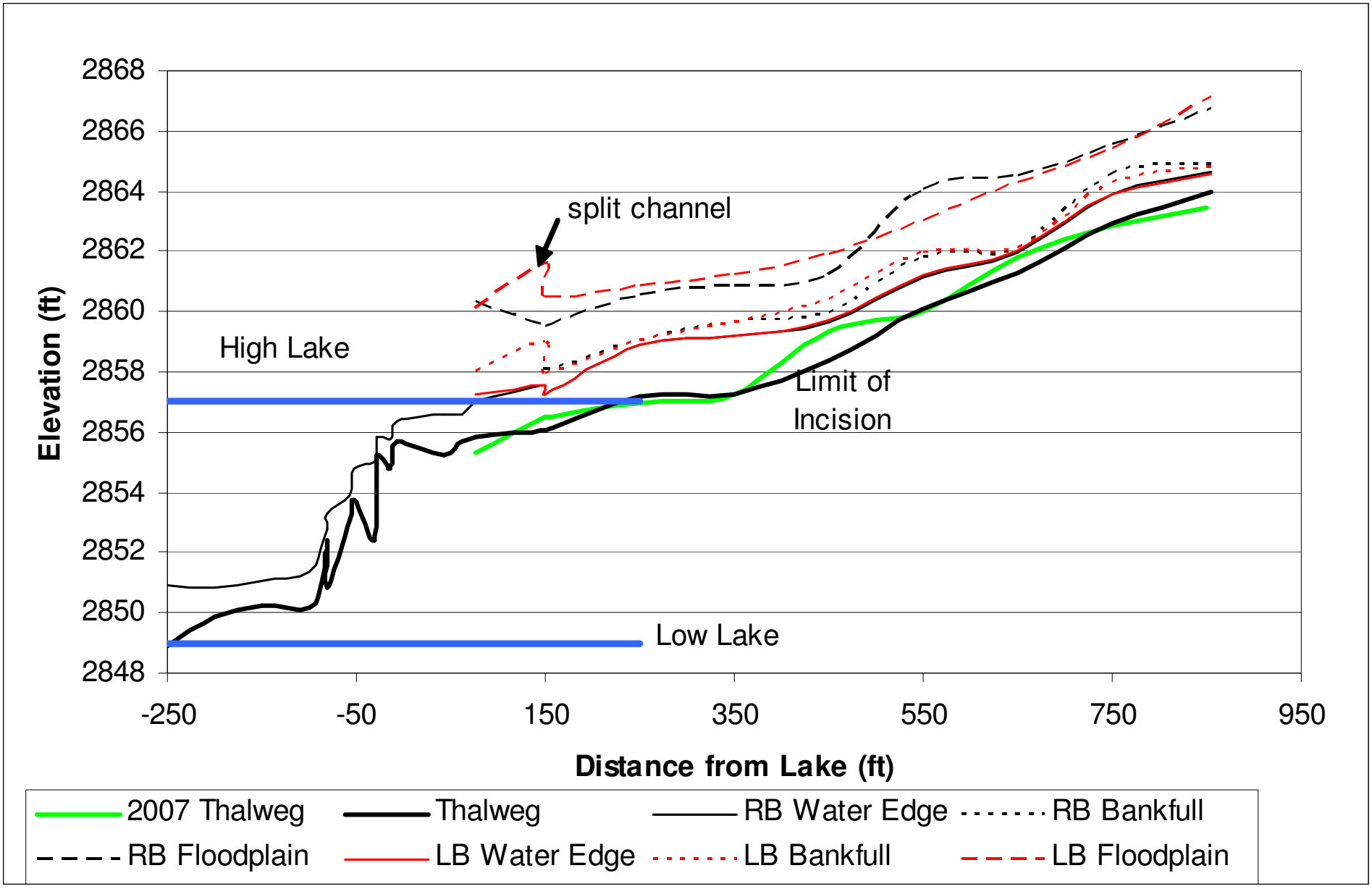
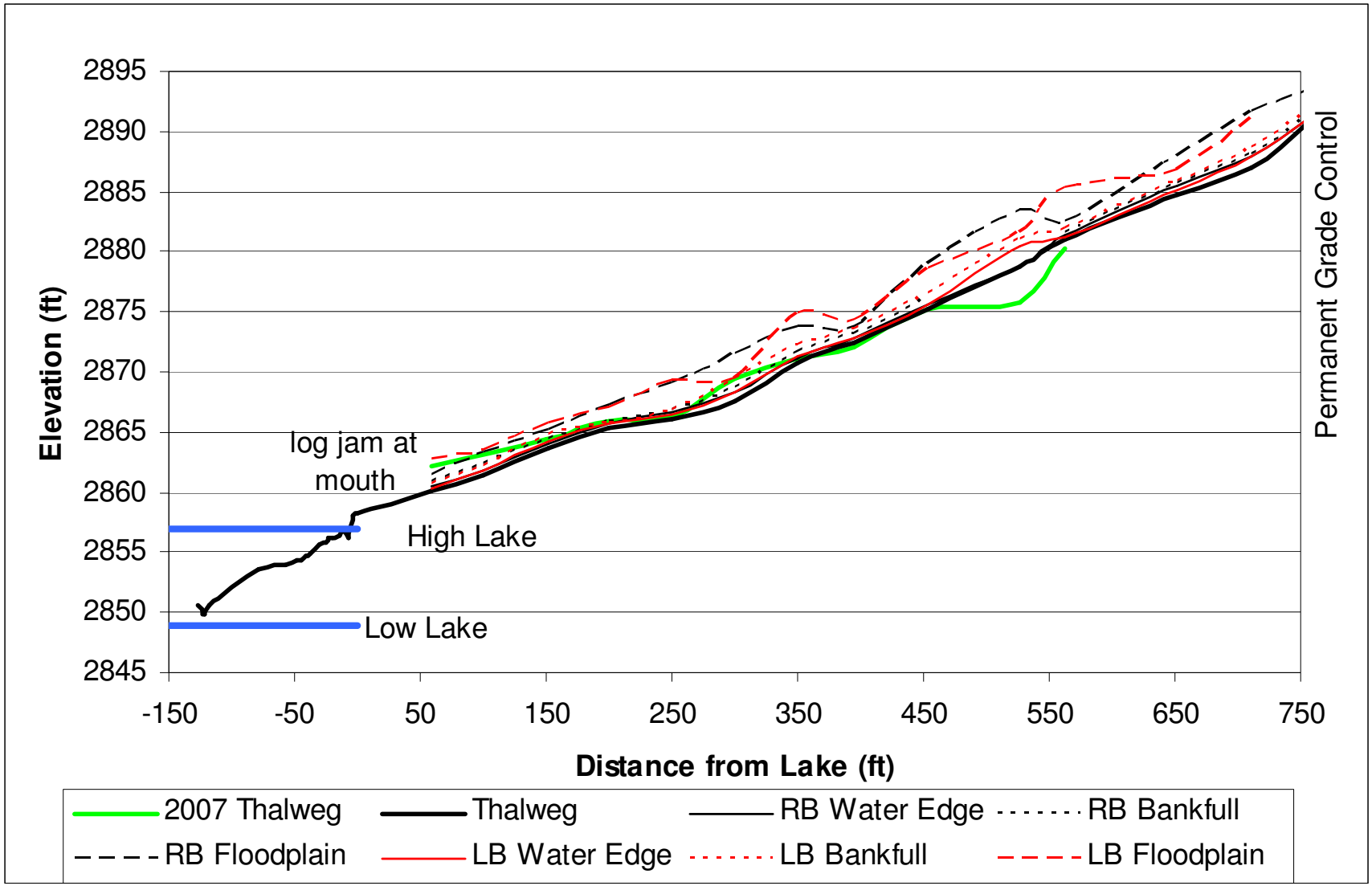
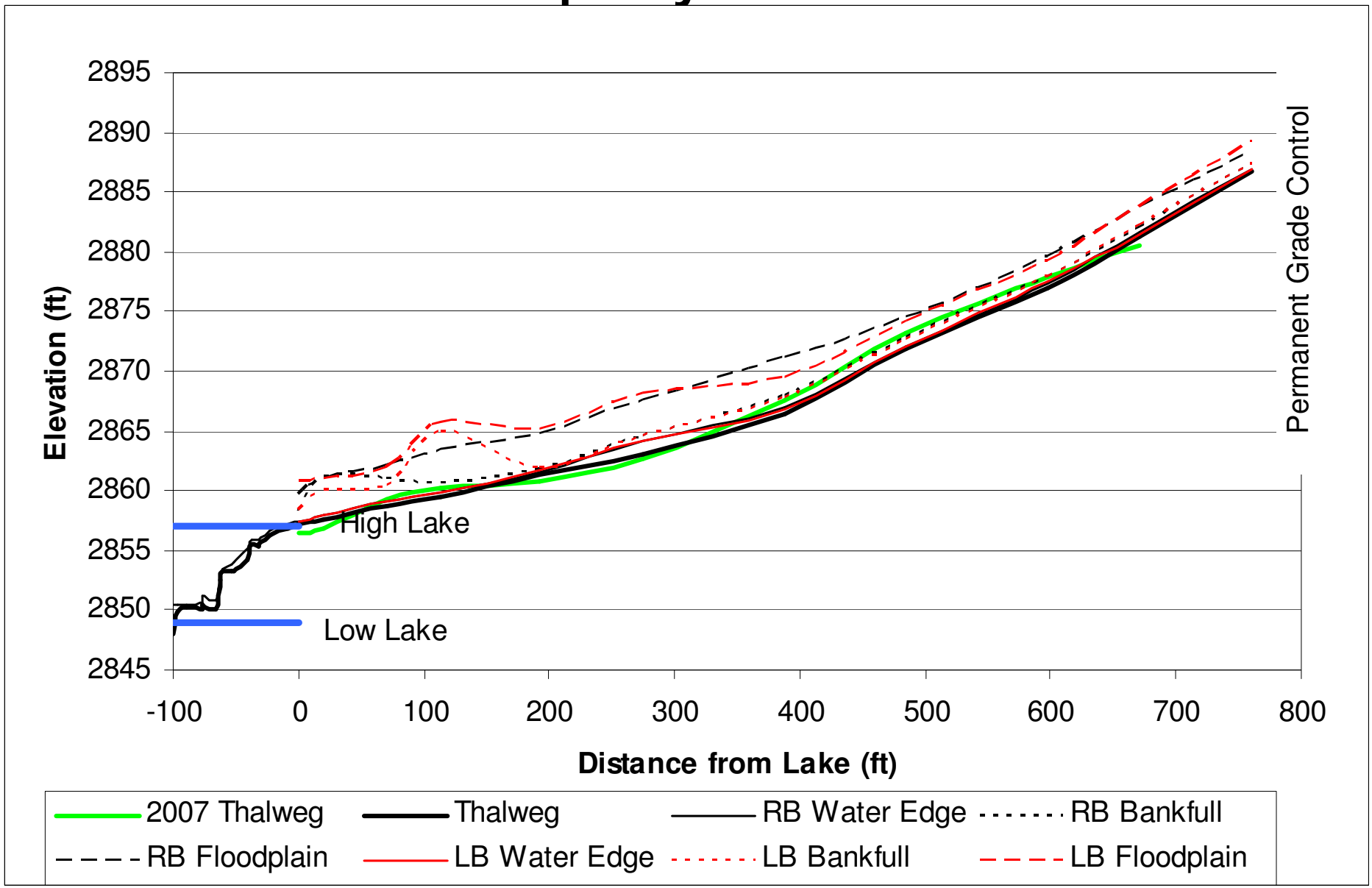
Mueller Creek



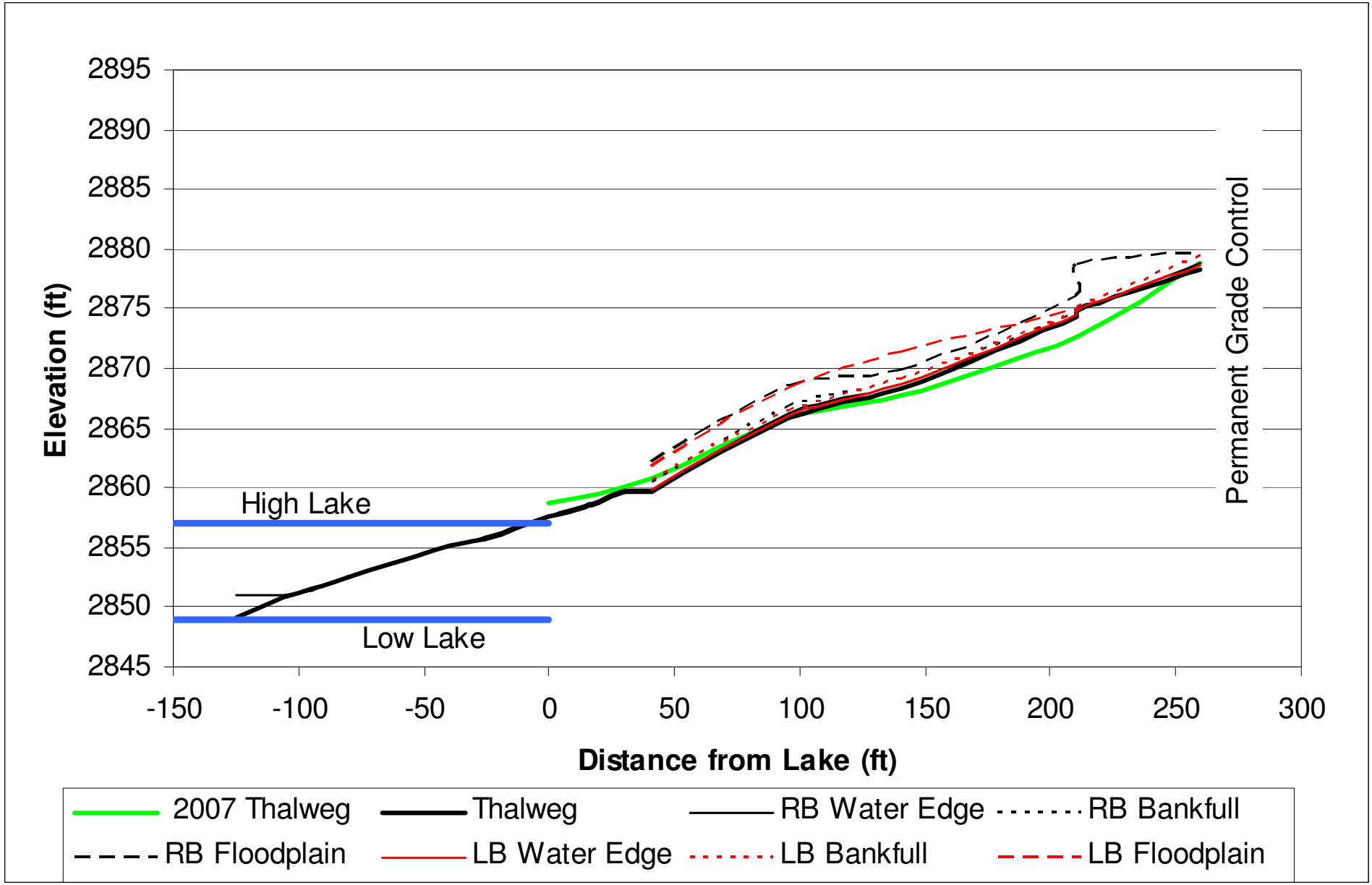
Crawford Creek



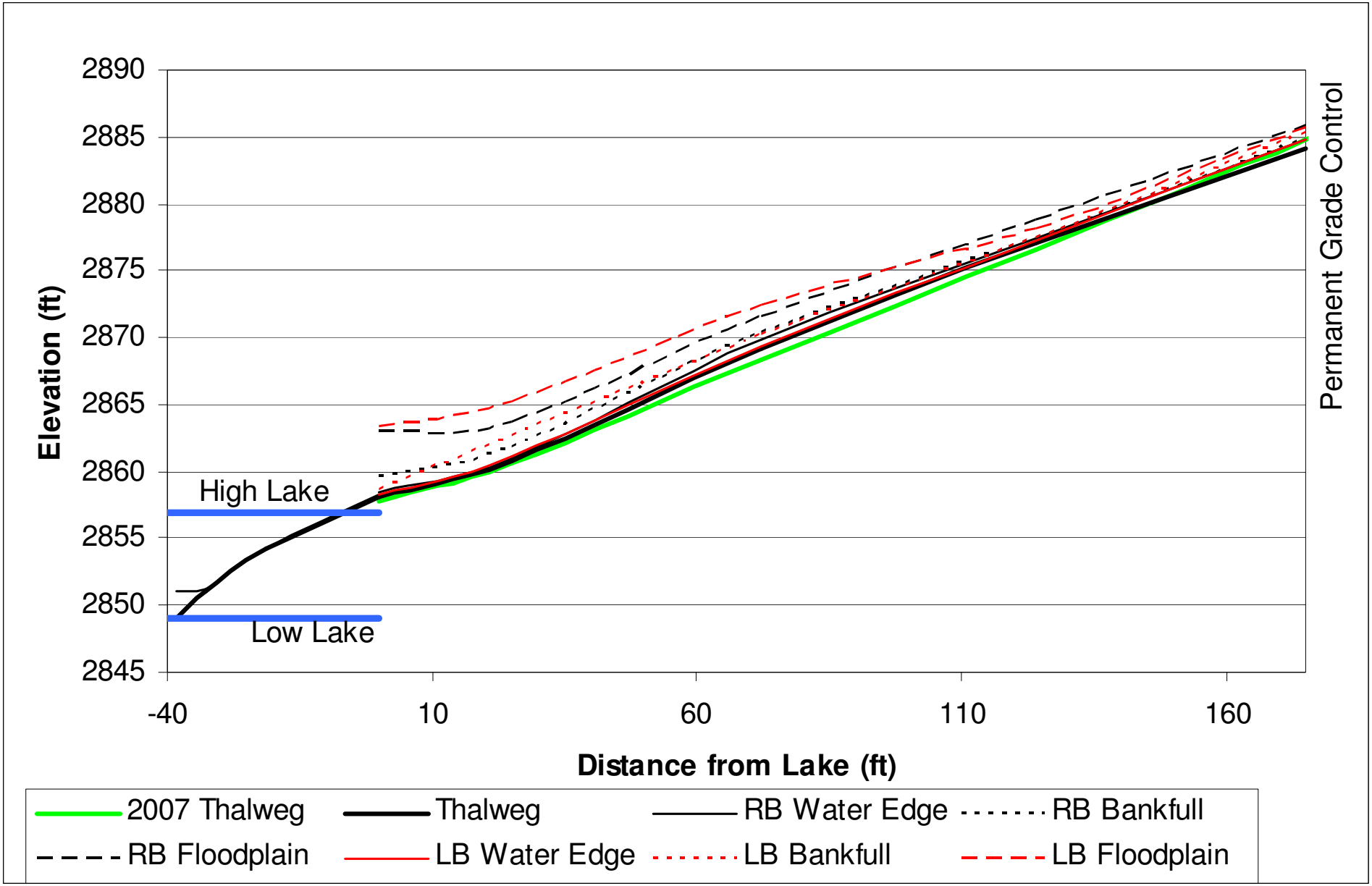
Osprey Creek



Trapp Creek


2895
2890
2885
2880
2875
2870
2865
2860
2855
2850
2845
Elevation (ft)
High Lake
Low Lake
Permanent Grade Control
-150
-100
-50
0
50
100
150
200
250
300
Distance from Lake (ft)
2007 Thalweg
Thalweg
RB Water Edge
RB Bankfull
RB Floodplain
LB Water Edge
LB Bankfull
LB Floodplain

SE Trapp


2890
2885
2880
2875
2870
2865
2860
2855
2850
2845
Elevation (ft)
High Lake
Low Lake
-40
10
60
110
160
Distance from Lake (ft)
Permanent Grade Control
2007 Thalweg
Thalweg
RB Water Edge
RB Bankfull
RB Floodplain
LB Water Edge
LB Bankfull
LB Floodplain

Determination of Risk of Headcutting under Different Operational Regime

- Timing of drawdown, peak flows
- Magnitude of drawdown
  - Currently peak flows increase lake elevations quickly due to low storage volumes

Table 5.1 Water Depth Characteristics of Tributaries that Empty Directly into Packwood Lake (drawdown zone and area above drawdown zone)

Stream	Mean Depth (ft)	Number of measure-ments	Min. Depth (ft)	Max. Depth (ft)	Max Elevation (ft)	Max Depth above drawdown zone (ft)
Osprey Creek	**0.44**	**23**	**0.10**	**0.98**	**2858.23**	**0.32**
Trapp Creek	**0.16**	**9**	**0.10**	**0.30**	**2859.60**	**0.20**
Tributary SE of Trapp Creek	**0.20**	**5**	**0.05**	**0.30**	**2860.00**	**0.25**
Mueller Creek	**1.05**	**23**	**0.20**	**2.60**	**2858.90**	**1.00**
Upper Lake Creek – Right Channel	**0.32**	**11**	**0.10**	**0.60**	**2858.1**	**0.10**
Upper Lake Creek – Left Channel	**0.87**	**19**	**0.50**	**1.40**	**2858.04**	**0.20**
Crawford Creek (dry)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

Packwood Lake Elevation