East Fork Lewis River Temperature TMDL 2005 Project Summary

Environmental Assessment Program

Dustin Bilhimer

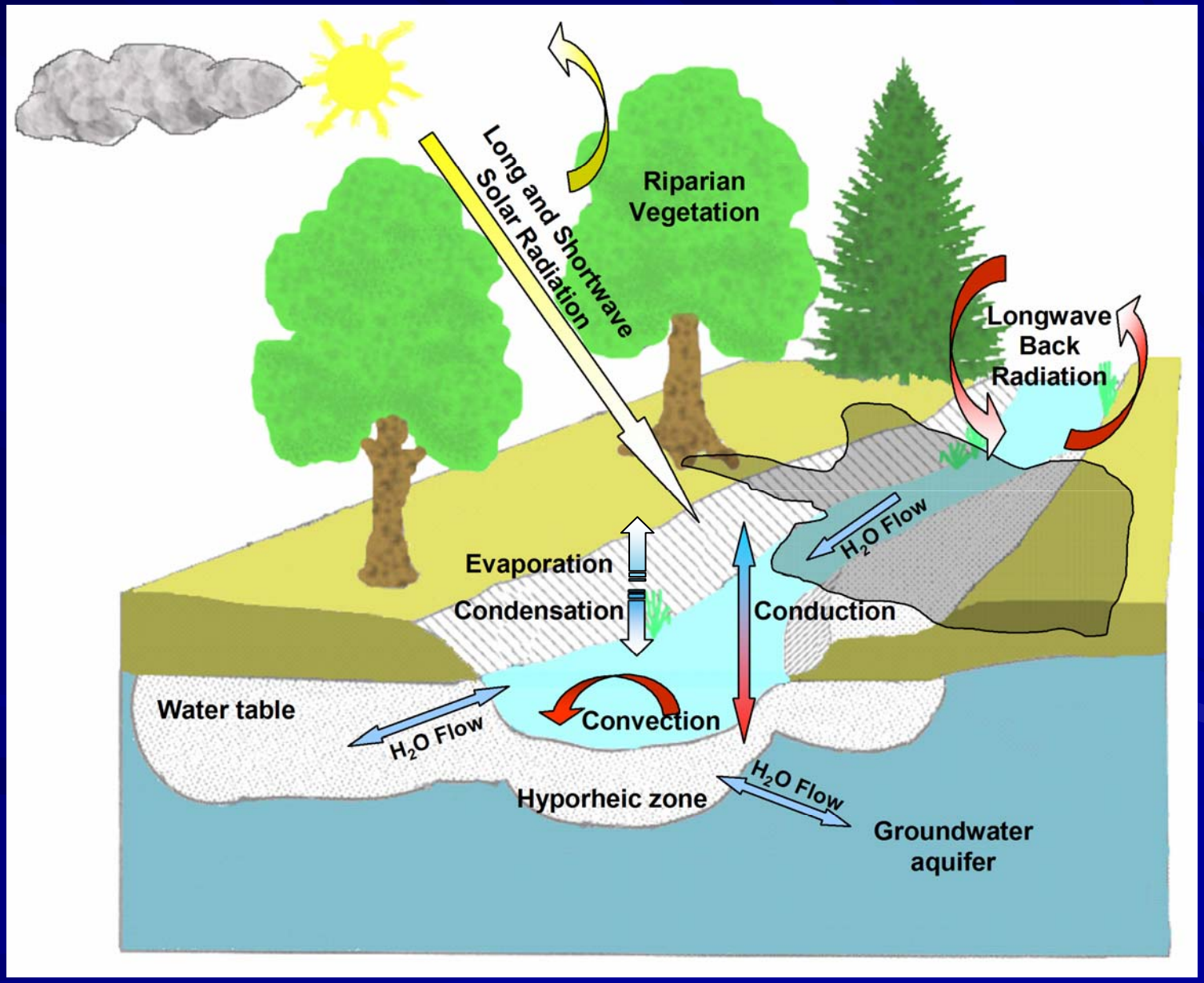
Presentation Topics

- Review the Monitoring Locations
- Climate Data for 2005
- Streamflow
- Preliminary Groundwater Findings
- Temperature Data
- Other Field Data Collection
- Next Steps/Potential Outcomes

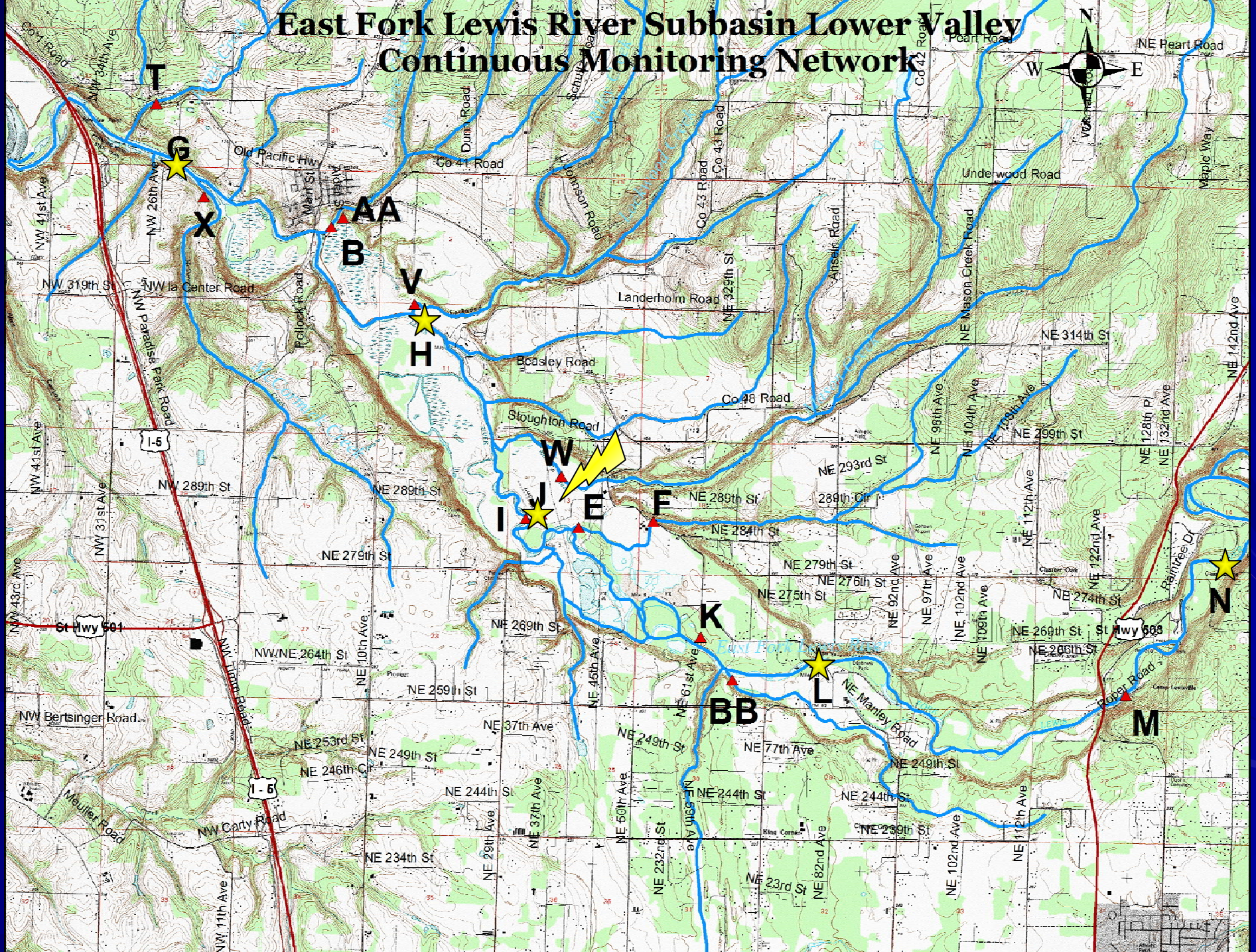
Clean Water Act 303(d) listings

Waterbody	Listing ID	Parameter	Category	Year of 303(d) listing	Description
Lewis River, E.F.	6588	Temperature	5	1998, 1996, 2004	Ambient WQ station 27D090 at Daybreak Park
Lewis River, E.F.	37824	Temperature	5	2004	EF Lewis above Nicholls Creek
Lewis River, E.F.	**7817**	**Temperature**	**2**	**1998,1996**	**Pollack Road**
Lockwood Creek	**7820**	**Temperature**	**2**		**Lockwood Cr Rd station**
McCormick Creek	**7821**	**Temperature**	**2**	**1998,1996**	**NW LaCenter Rd station**

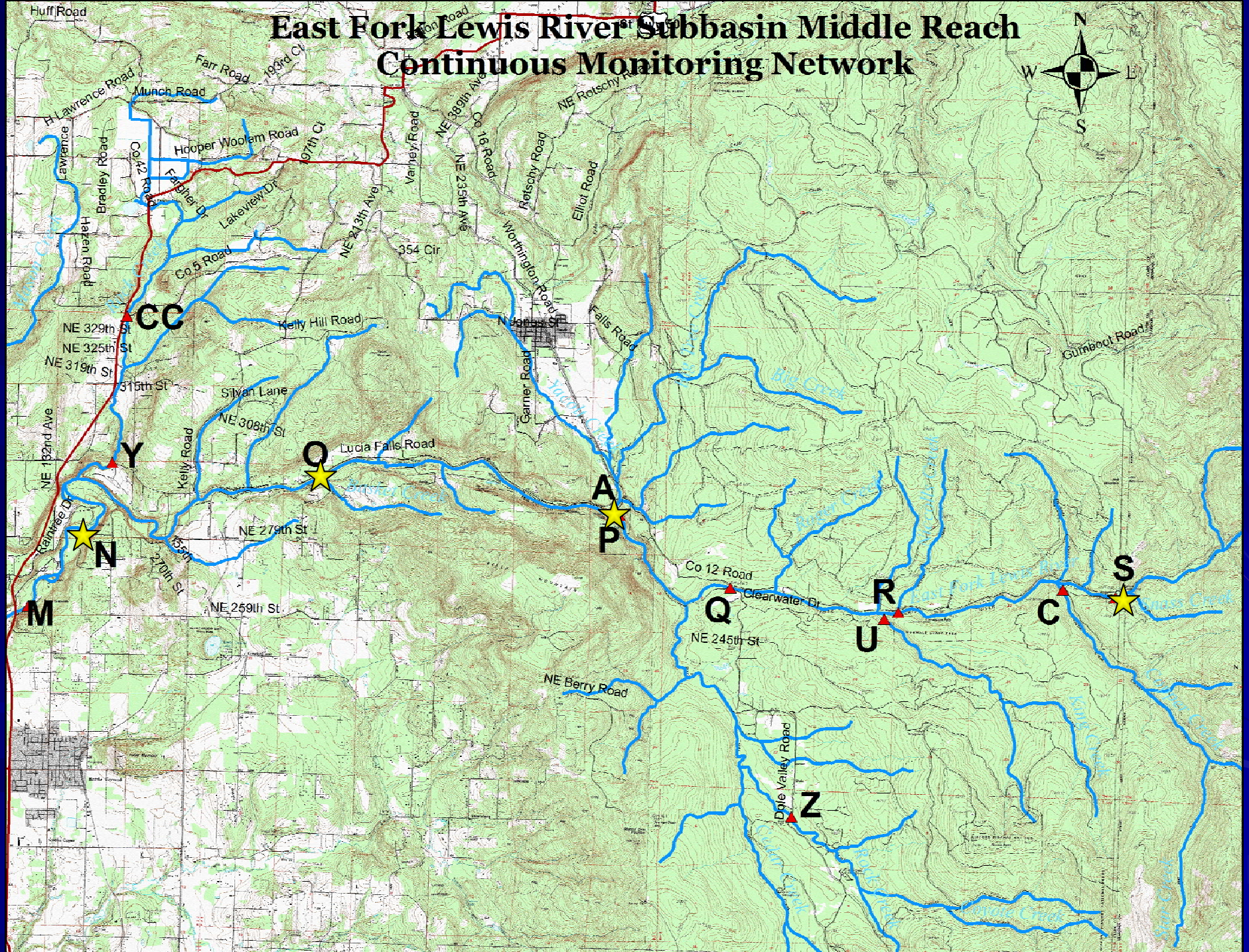
Quick Review of Stream Heating Processes



East Fork Lewis River Subbasin Lower Valley Continuous Monitoring Network

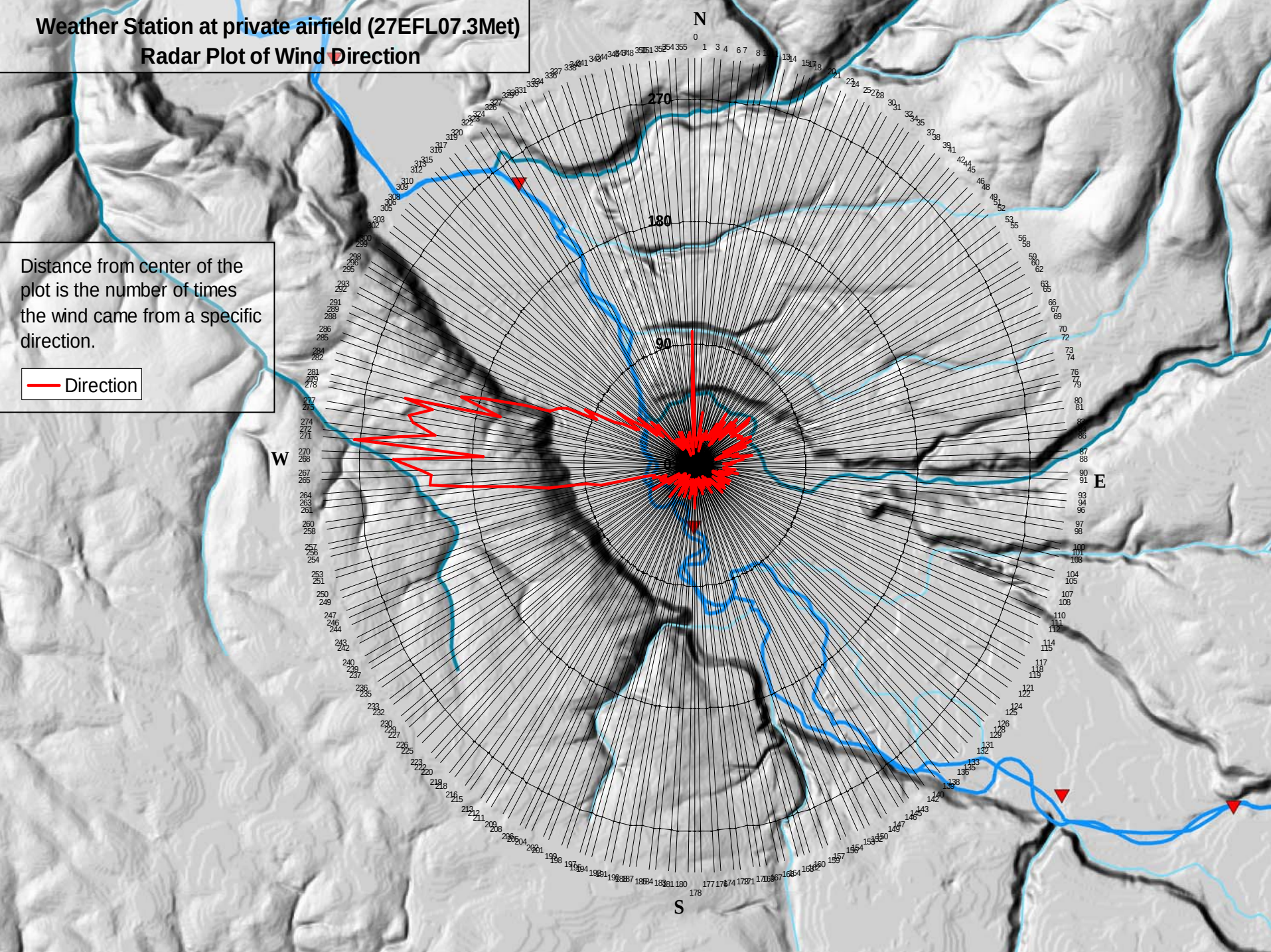


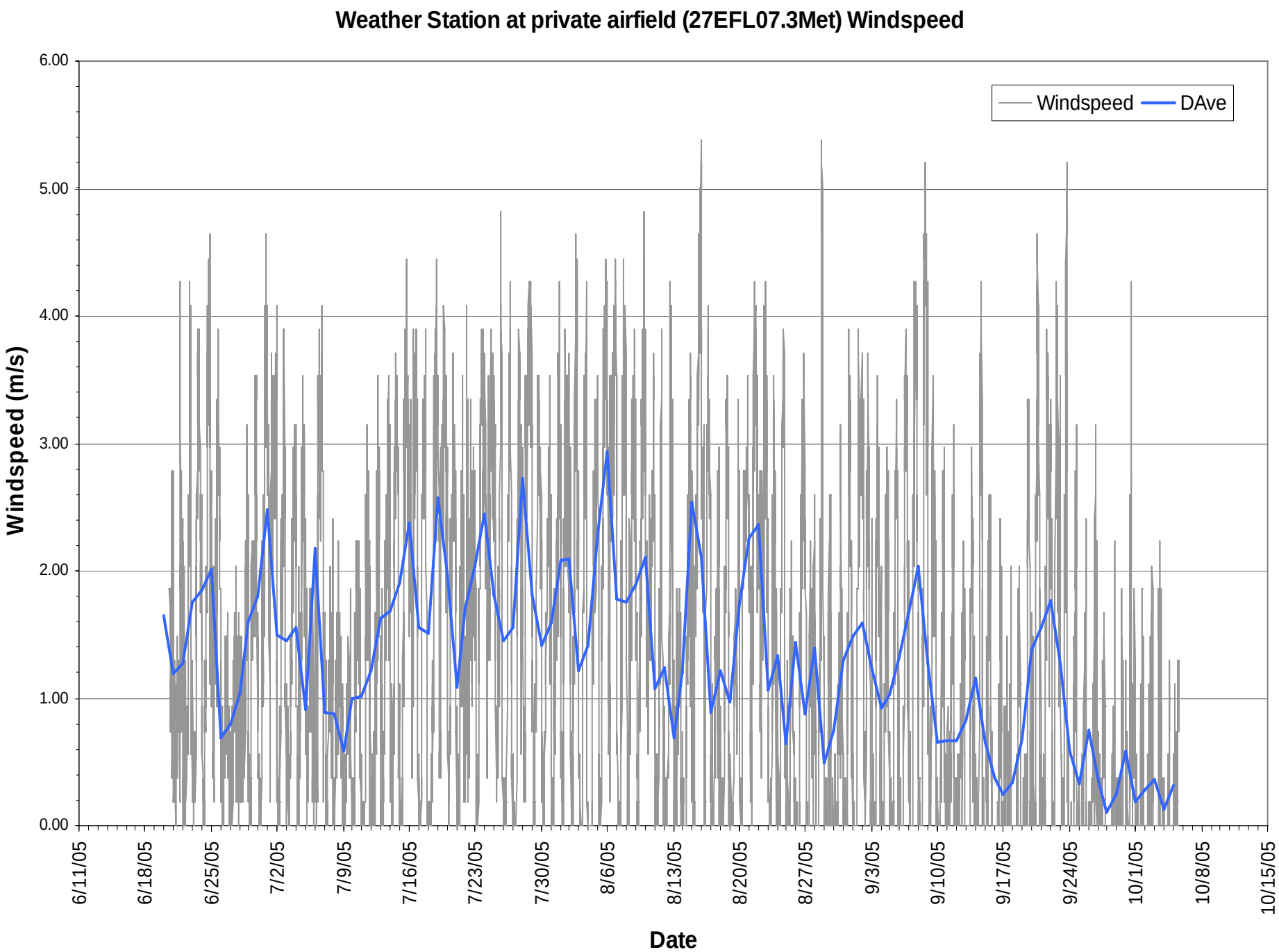
East Fork Lewis River Subbasin Middle Reach Continuous Monitoring Network

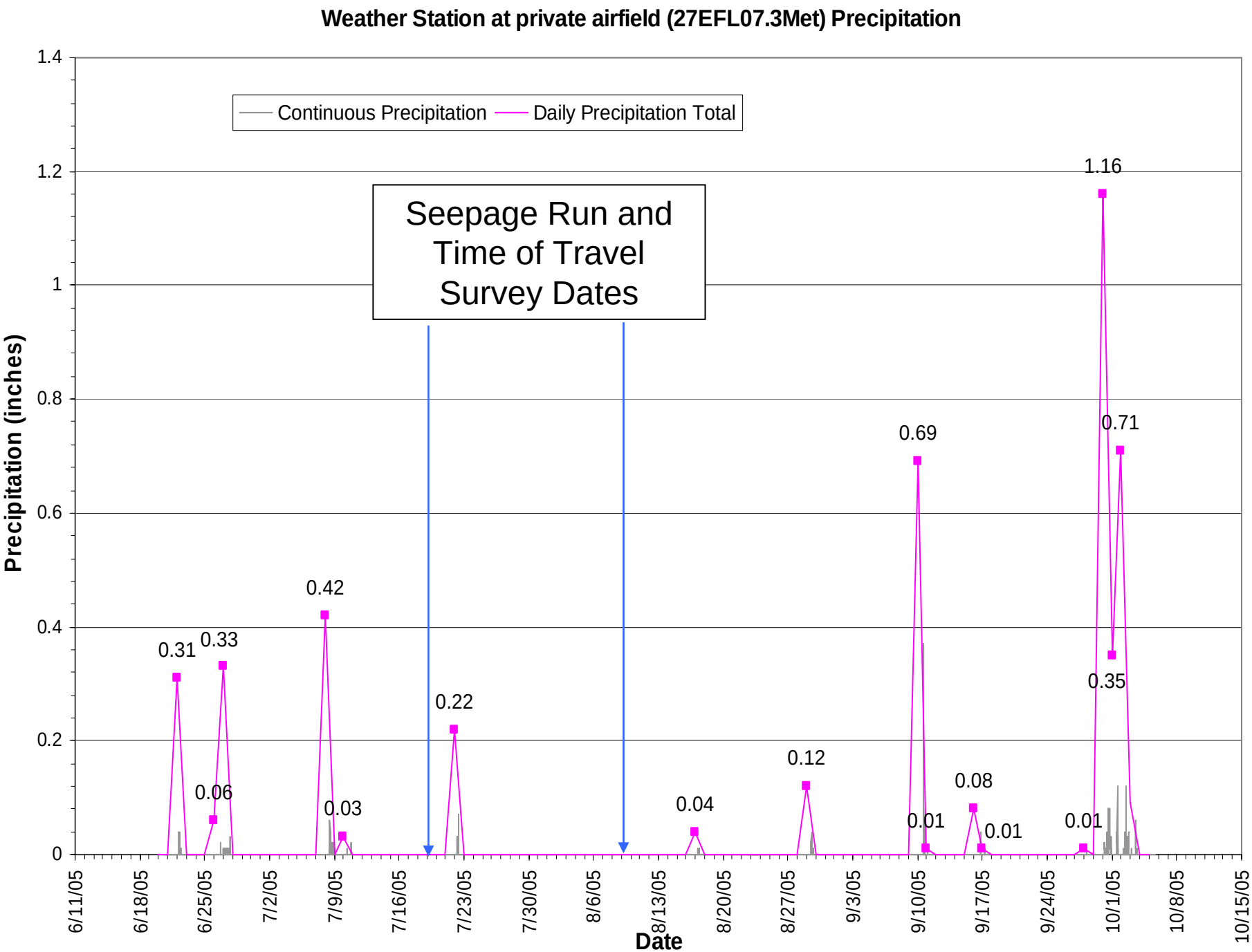


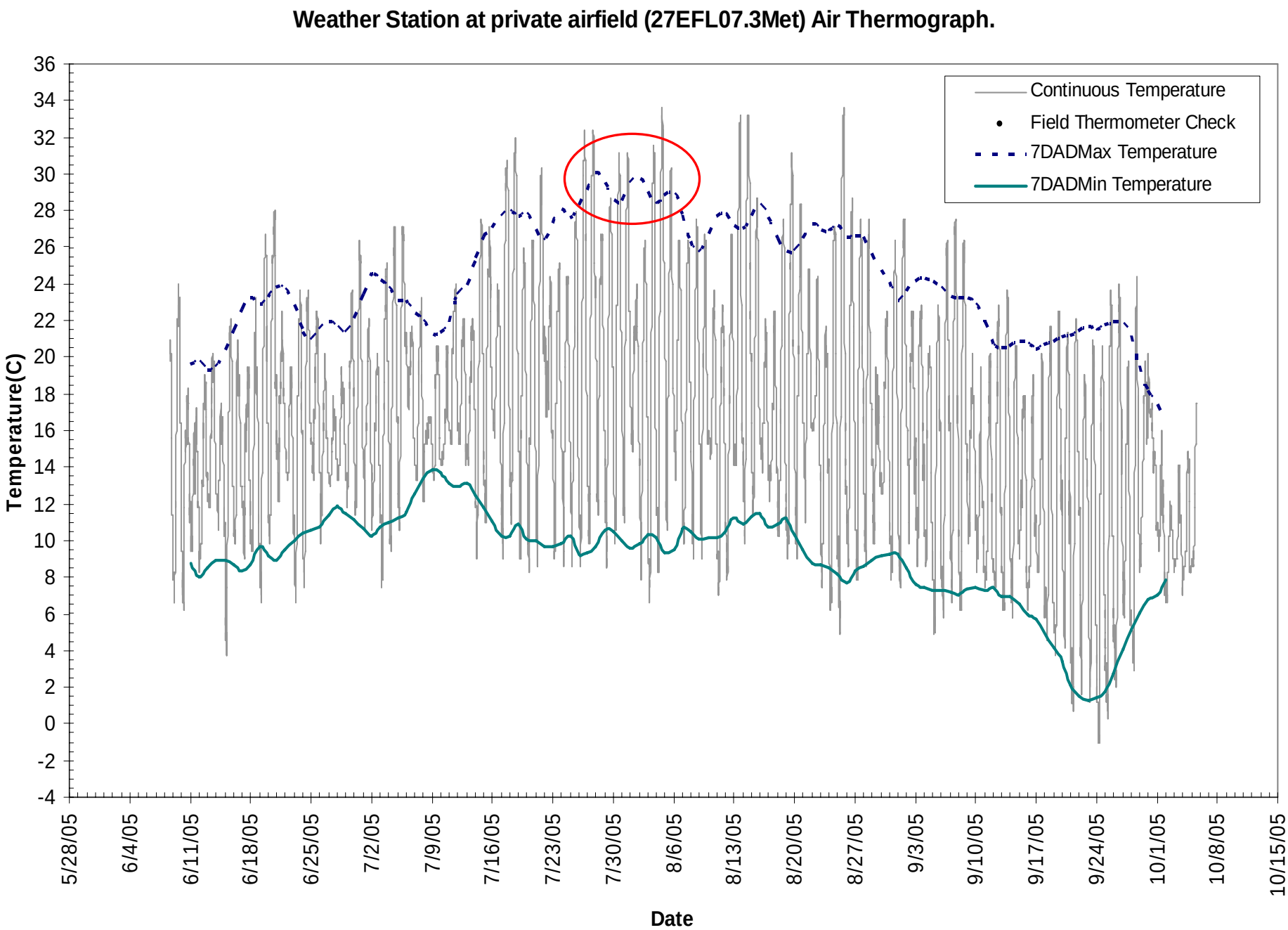
Climate Data

Weather Station at private airfield (27EFL07.3Met)
Radar Plot of Wind Direction



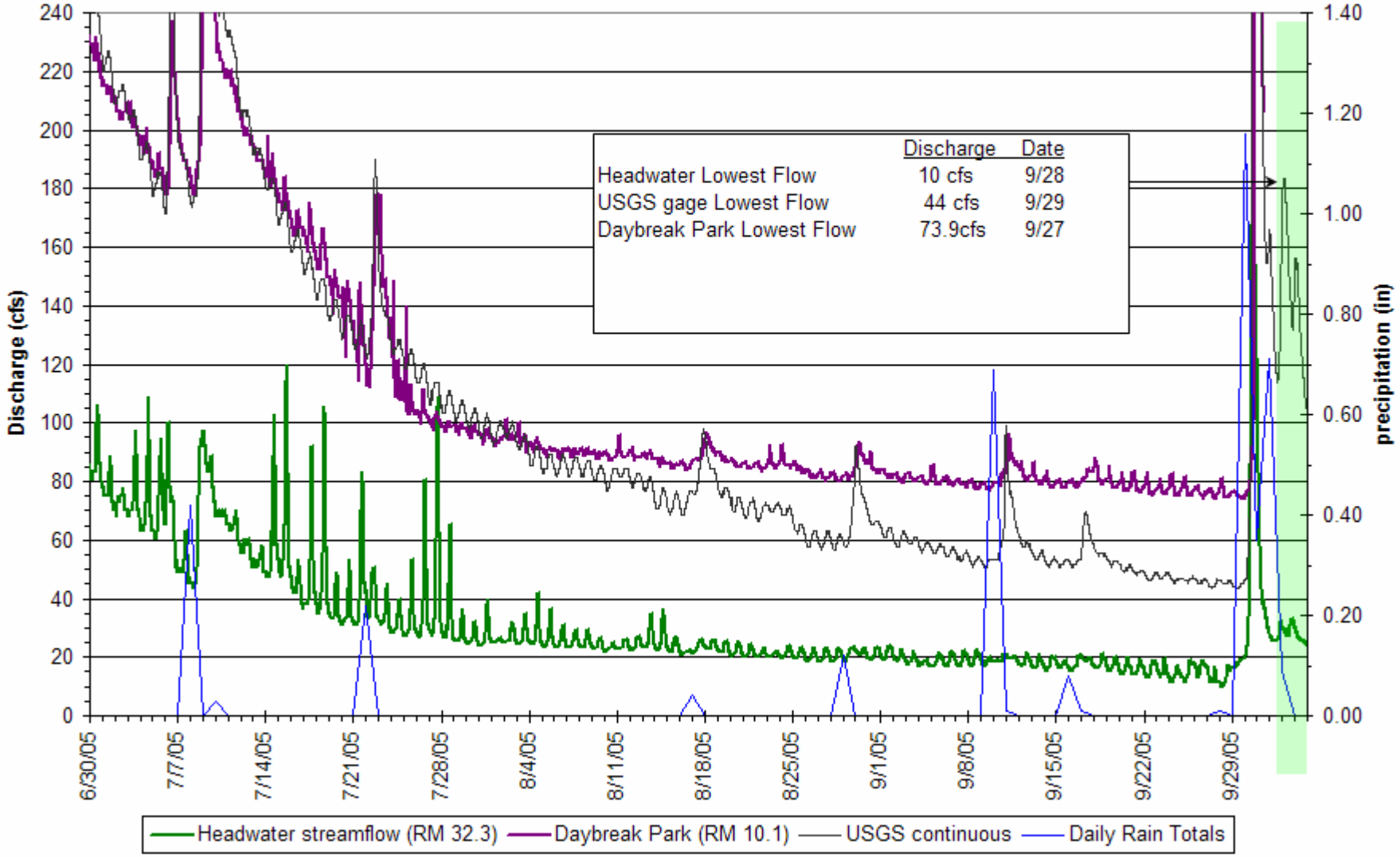

Weather Station at private airfield (27EFL07.3Met) Windspeed
Windspeed
DAve
Windspeed (m/s)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
6/11/05
6/18/05
6/25/05
7/2/05
7/9/05
7/16/05
7/23/05
7/30/05
8/6/05
8/13/05
8/20/05
8/27/05
9/3/05
9/10/05
9/17/05
9/24/05
10/1/05
10/8/05
10/15/05
Date


Weather Station at private airfield (27EFL07.3Met) Precipitation
Continuous Precipitation
Daily Precipitation Total
Seepage Run and Time of Travel Survey Dates
Precipitation (inches)
Date
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.31
0.33
0.06
0.42
0.03
0.22
0.04
0.12
0.69
0.01
0.08
0.01
0.01
1.16
0.71
0.35
6/11/05
6/18/05
6/25/05
7/2/05
7/9/05
7/16/05
7/23/05
7/30/05
8/6/05
8/13/05
8/20/05
8/27/05
9/3/05
9/10/05
9/17/05
9/24/05
10/1/05
10/8/05
10/15/05

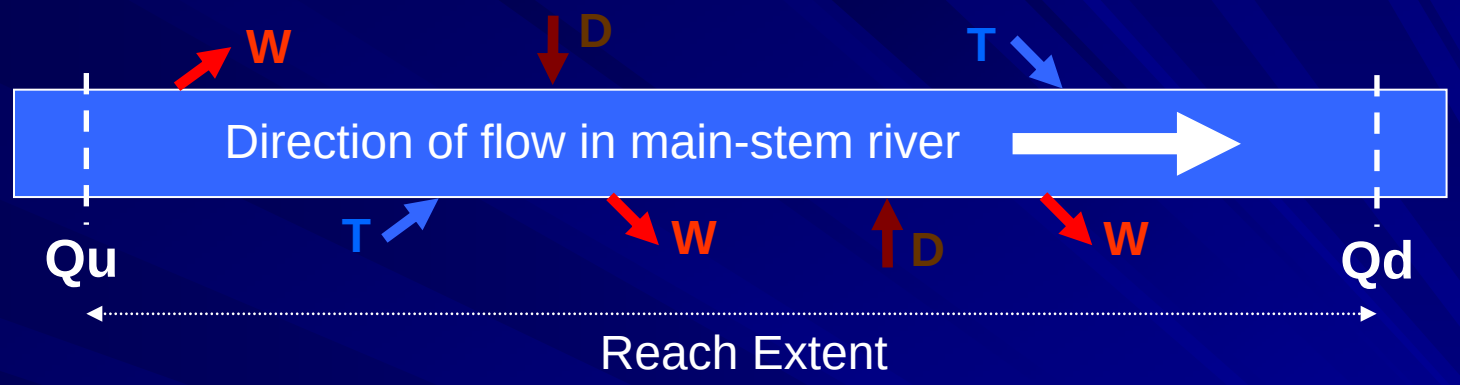

Weather Station at private airfield (27EFL07.3Met) Air Thermograph.
Continuous Temperature
Field Thermometer Check
7DADMax Temperature
7DADMin Temperature
Temperature(C)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
5/28/05
6/4/05
6/11/05
6/18/05
6/25/05
7/2/05
7/9/05
7/16/05
7/23/05
7/30/05
8/6/05
8/13/05
8/20/05
8/27/05
9/3/05
9/10/05
9/17/05
9/24/05
10/1/05
10/8/05
10/15/05
Date

Streamflow and Preliminary Groundwater Results

Timing of Baseflow



Example Mass Balance Calculation for a Hypothetical Seepage Reach



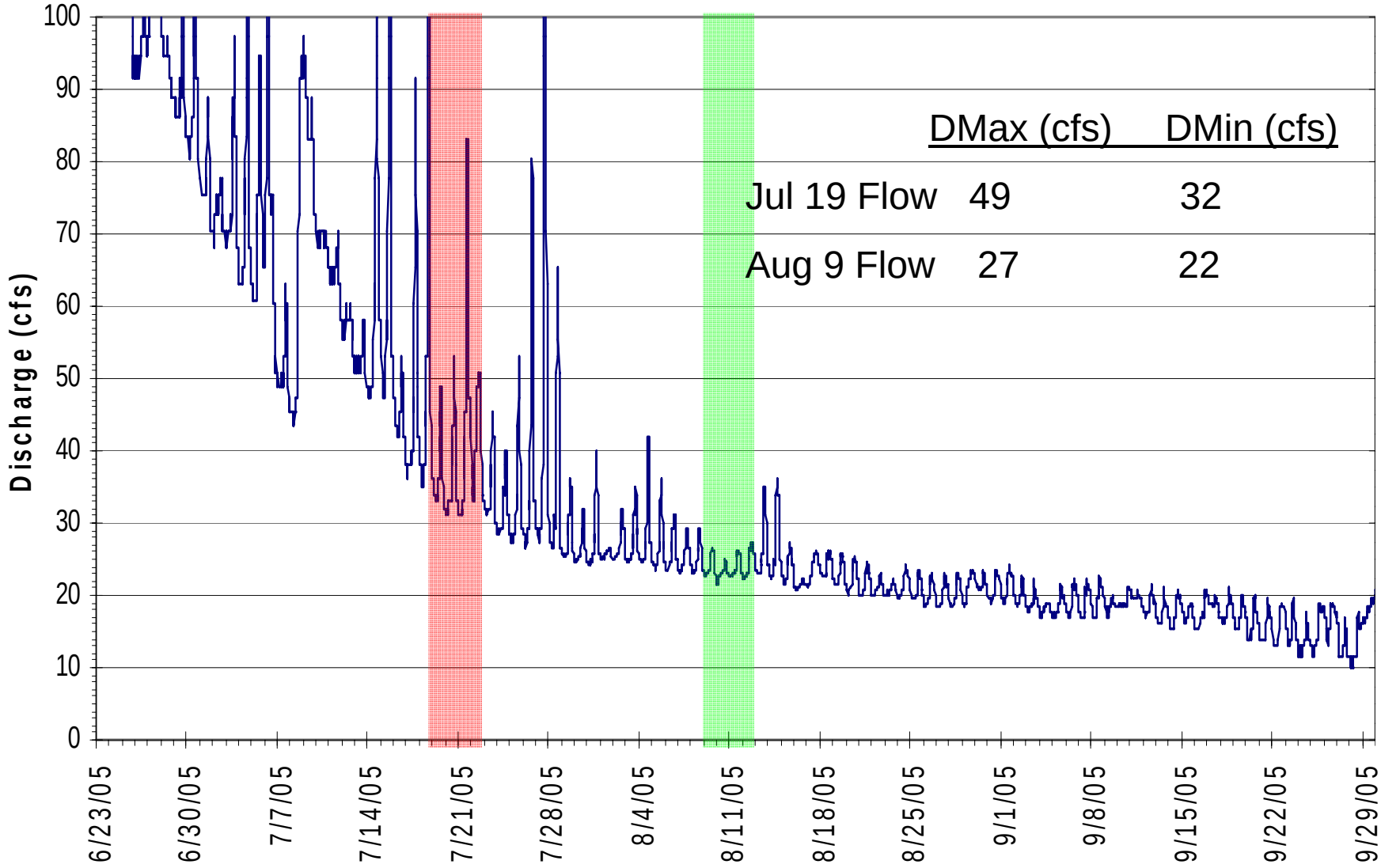
For the seepage reach shown above, the **NET** volume of water exchanged between the river and ground water (Qn) can be described as:

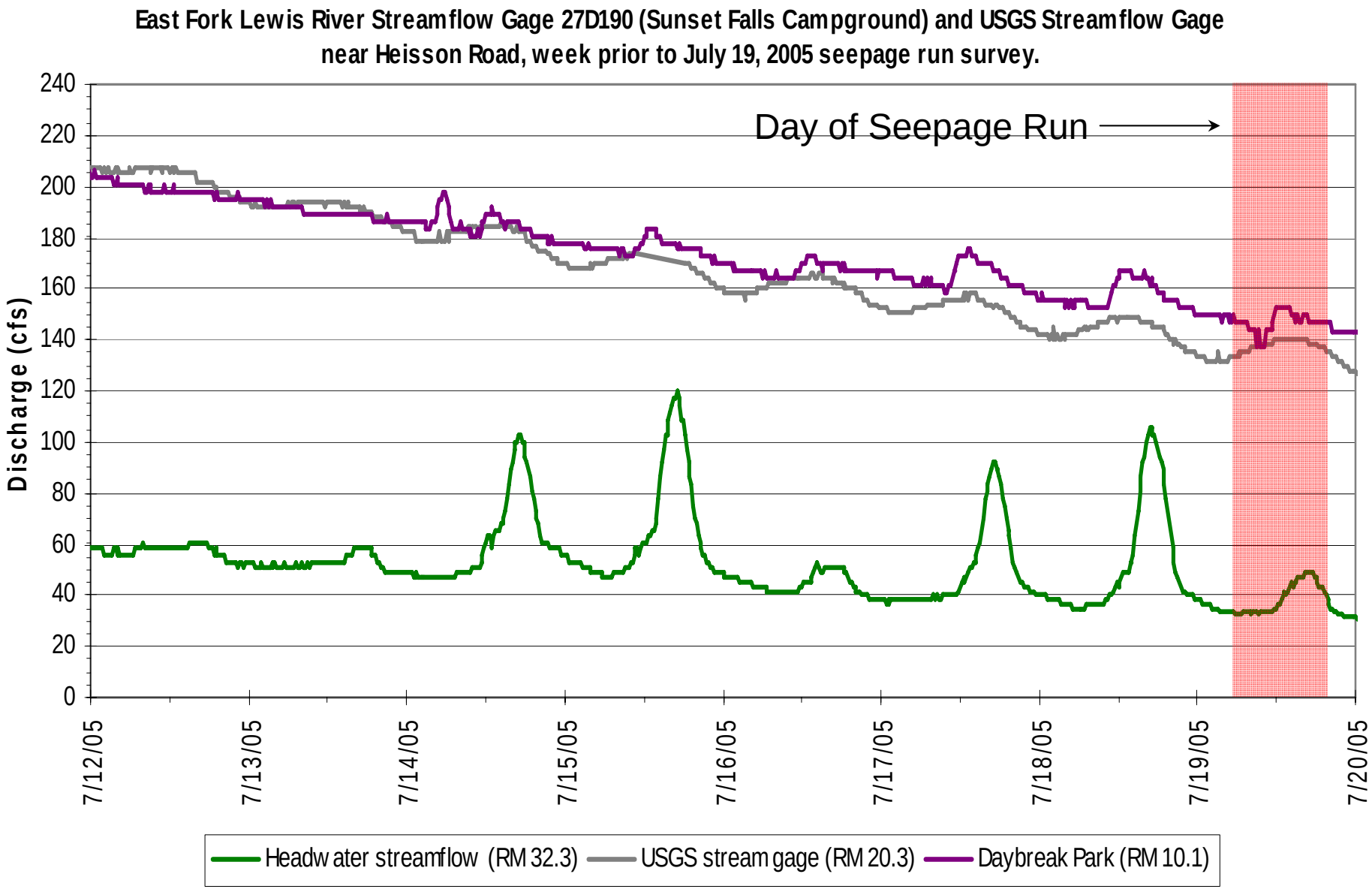
$$Qn = Qd - Qu - \Sigma T - \Sigma D + \Sigma W \text{ ; Where}$$

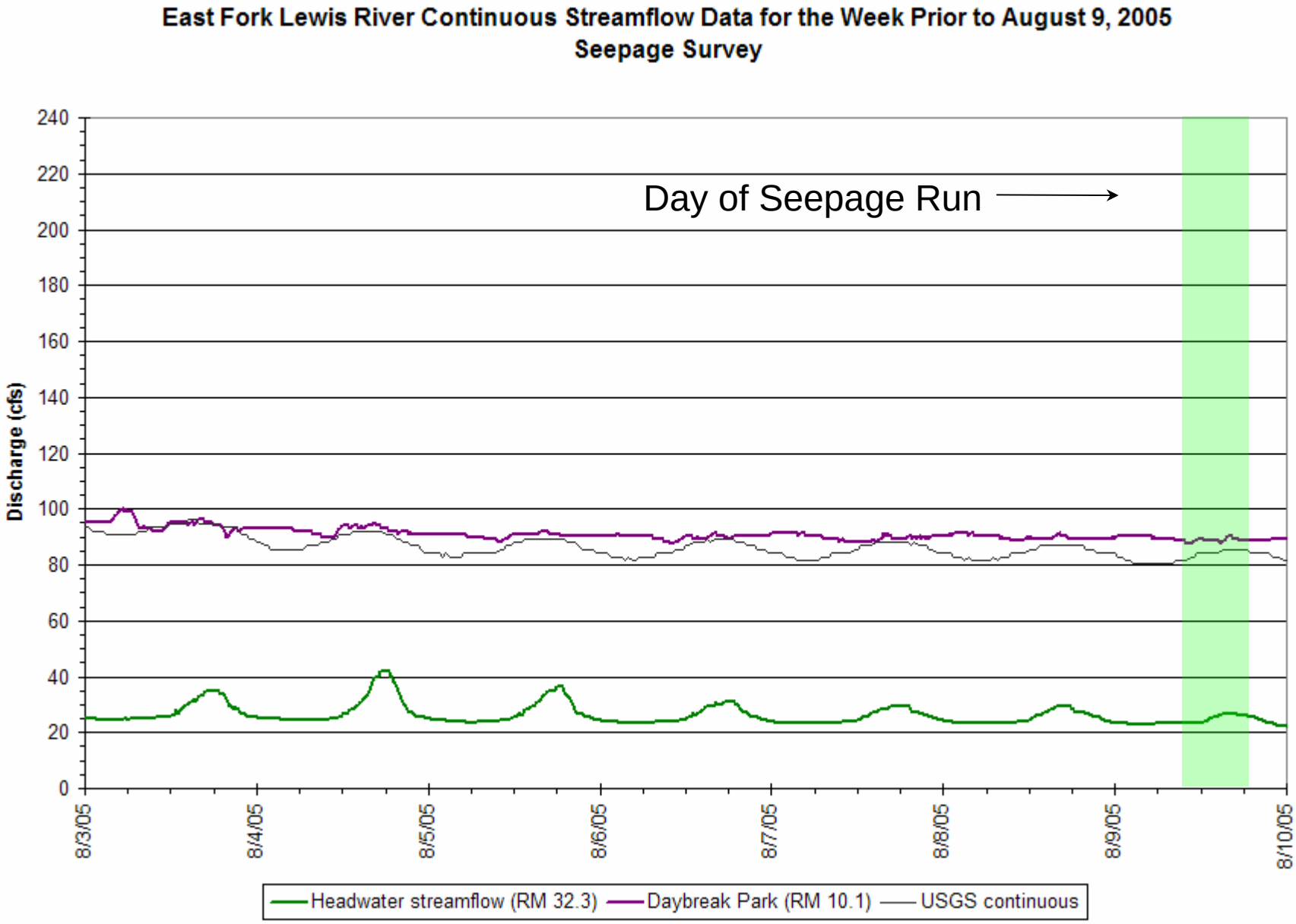
Qd = The discharge measured at the downstream seepage transect (ft3/s);
Qu = The discharge measured at the upstream seepage transect (ft3/s);
ΣT = The sum of tributary inputs to the main stem river (ft3/s);
ΣW = The sum of artificial withdrawals from the main stem river (ft3/s); and
ΣD = The sum of point discharges to the main stem river (ft3/s).

Positive values of Qn suggest that groundwater discharge caused the river flow to increase across the seepage reach. Negative values of Qn suggest that the river lost water to groundwater storage across the seepage reach.

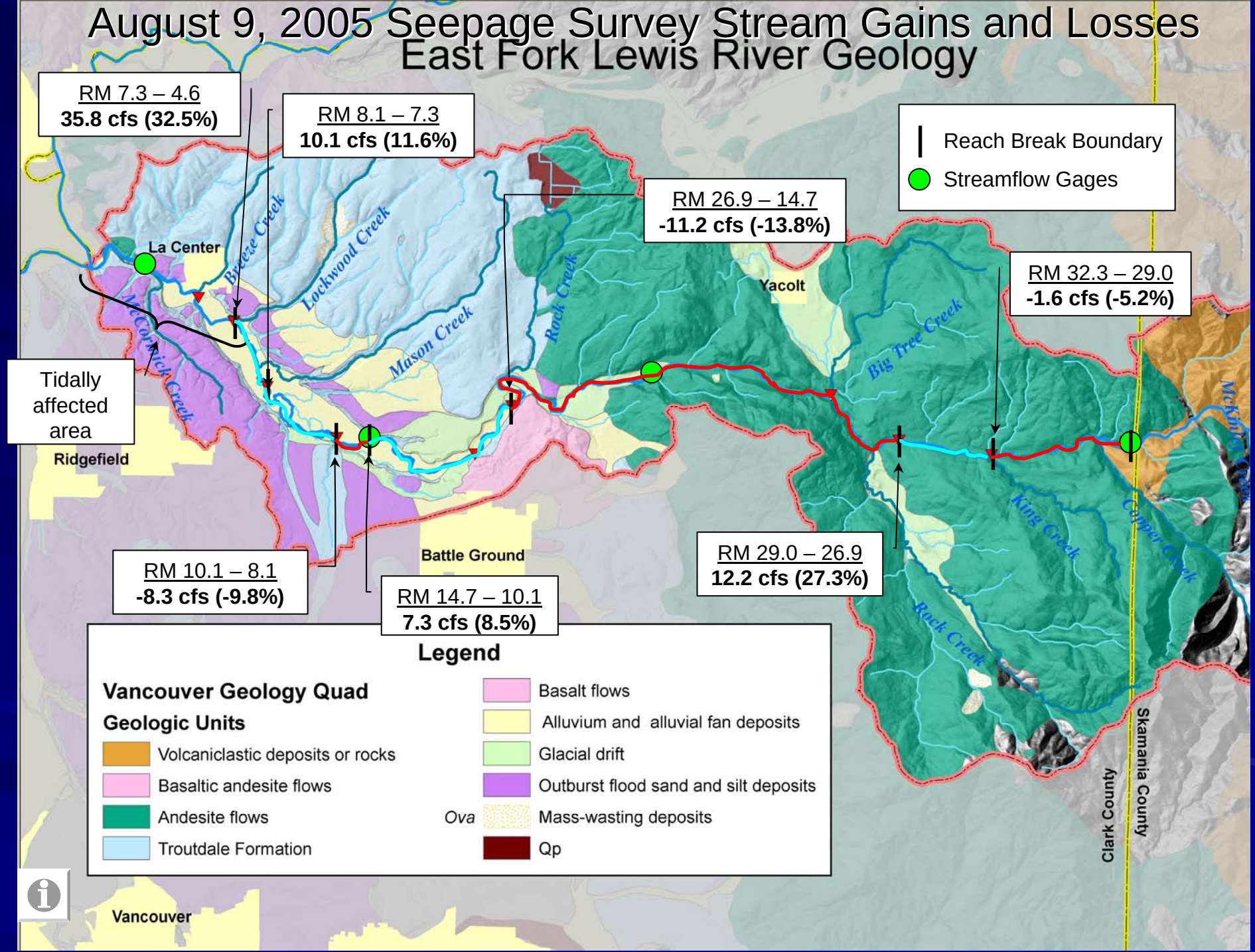
East Fork Lewis River Streamflow Gage 27D190 at Sunset Falls Campground.



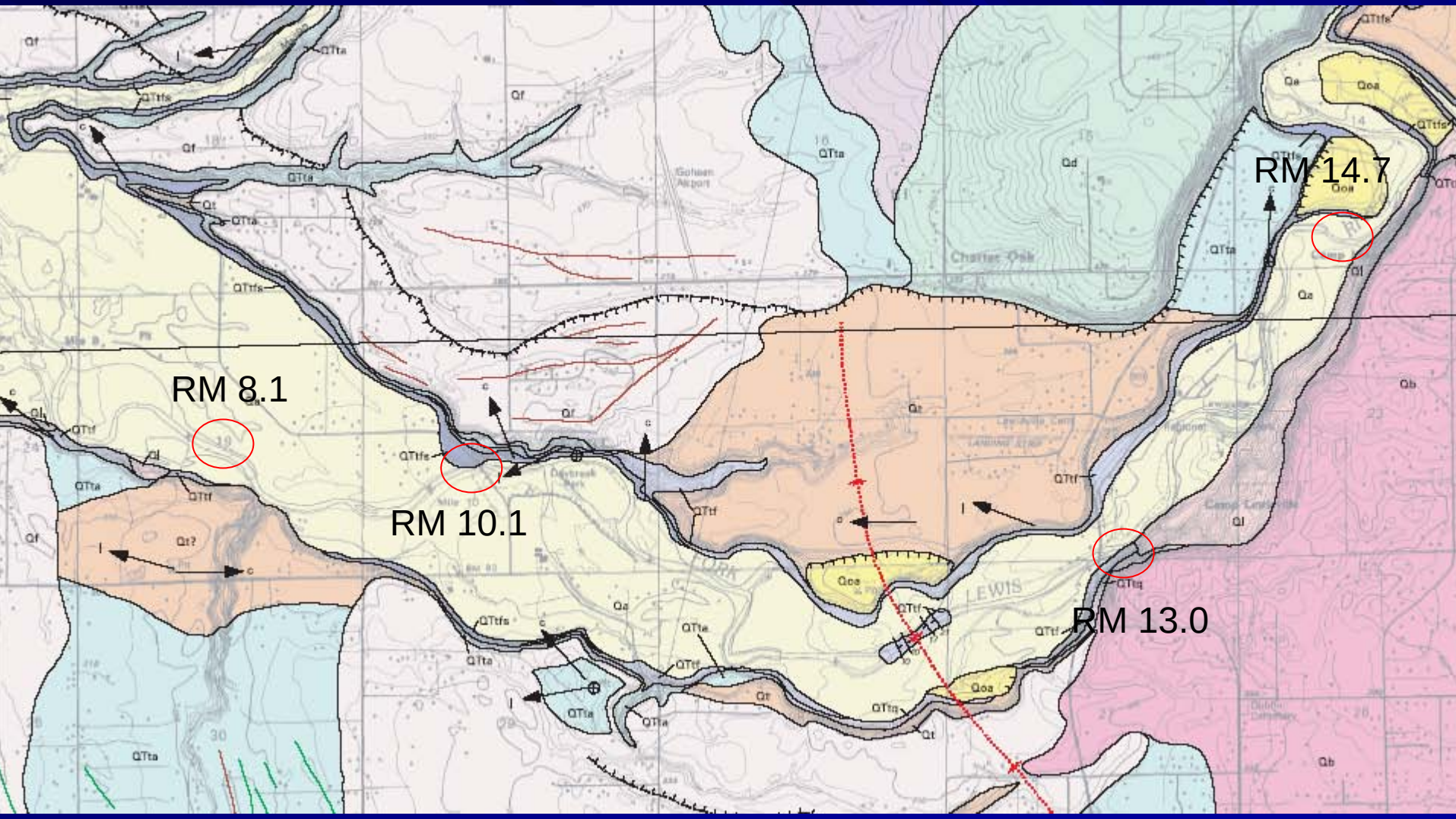

East Fork Lewis River Streamflow Gage 27D190 (Sunset Falls Campground) and USGS Streamflow Gage near Heisson Road, week prior to July 19, 2005 seepage run survey.
Day of Seepage Run
Discharge (cfs)
240
220
200
180
160
140
120
100
80
60
40
20
0
7/12/05
7/13/05
7/14/05
7/15/05
7/16/05
7/17/05
7/18/05
7/19/05
7/20/05
Headwater streamflow (RM 32.3)
USGS stream gage (RM 20.3)
Daybreak Park (RM 10.1)

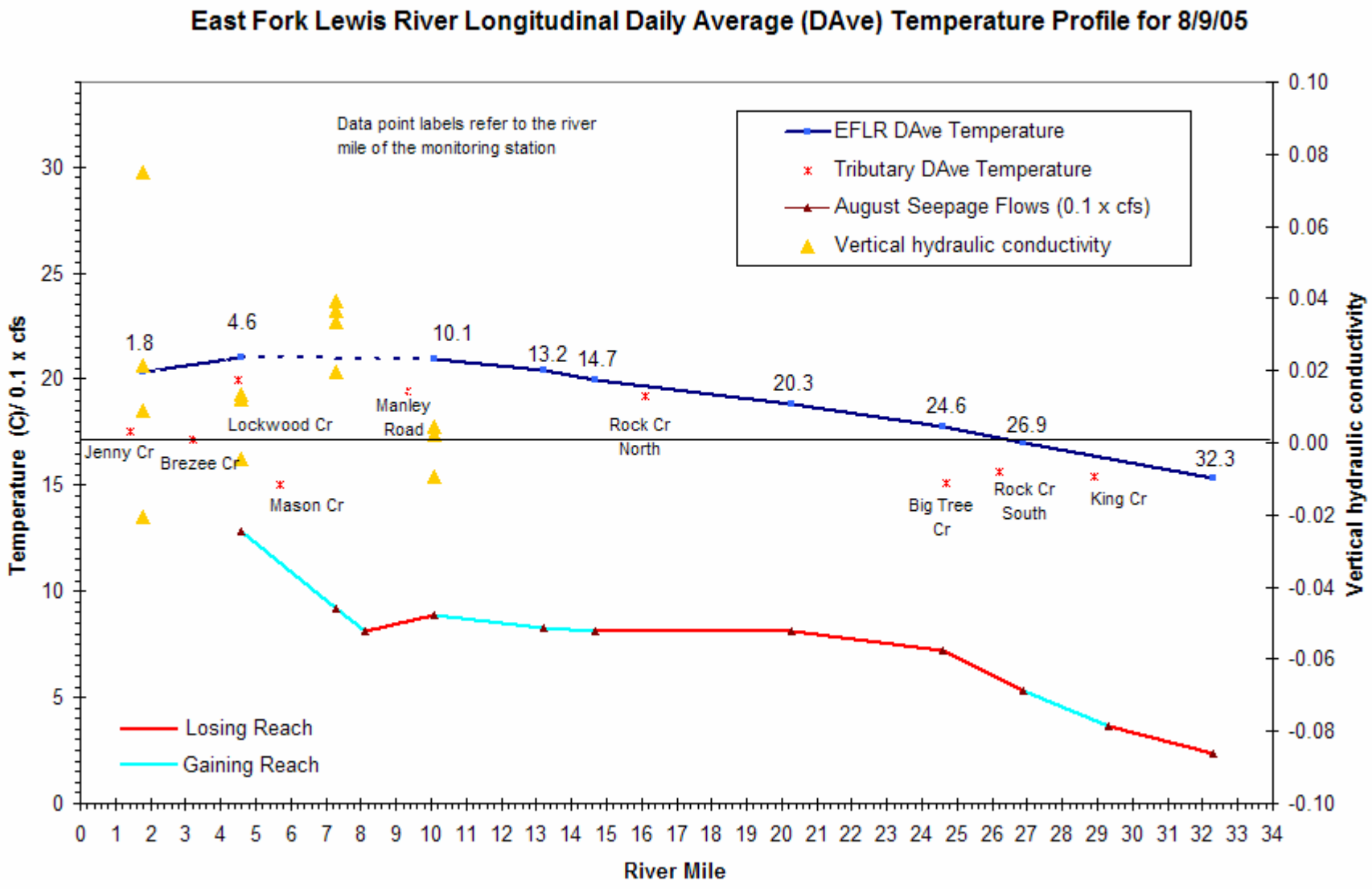

East Fork Lewis River Continuous Streamflow Data for the Week Prior to August 9, 2005
Seepage Survey
Day of Seepage Run
Discharge (cfs)
240
220
200
180
160
140
120
100
80
60
40
20
0
8/3/05
8/4/05
8/5/05
8/6/05
8/7/05
8/8/05
8/9/05
8/10/05
Headwater streamflow (RM 32.3)
Daybreak Park (RM 10.1)
USGS continuous

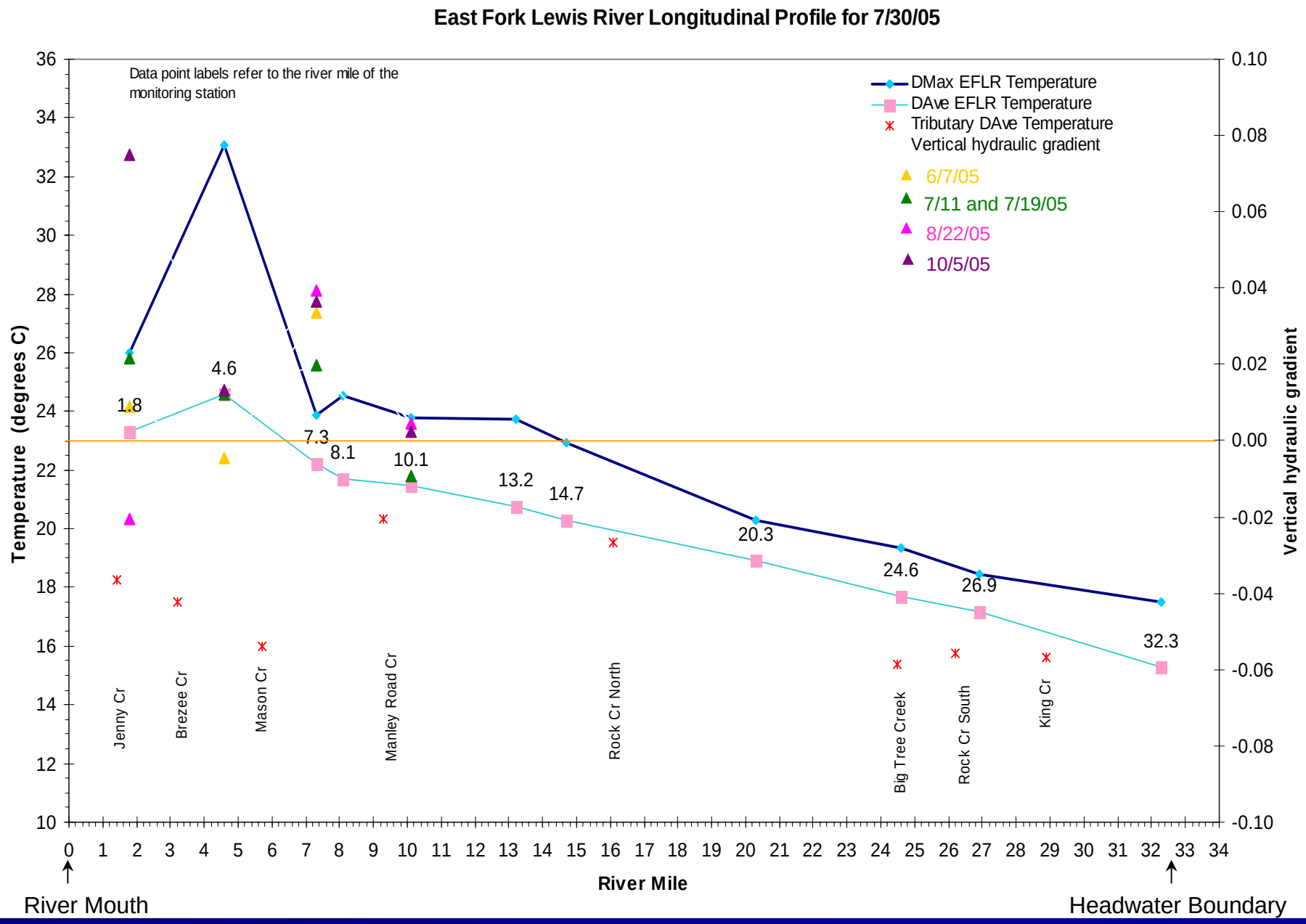
August 9, 2005 Seepage Survey Stream Gains and Losses
East Fork Lewis River Geology



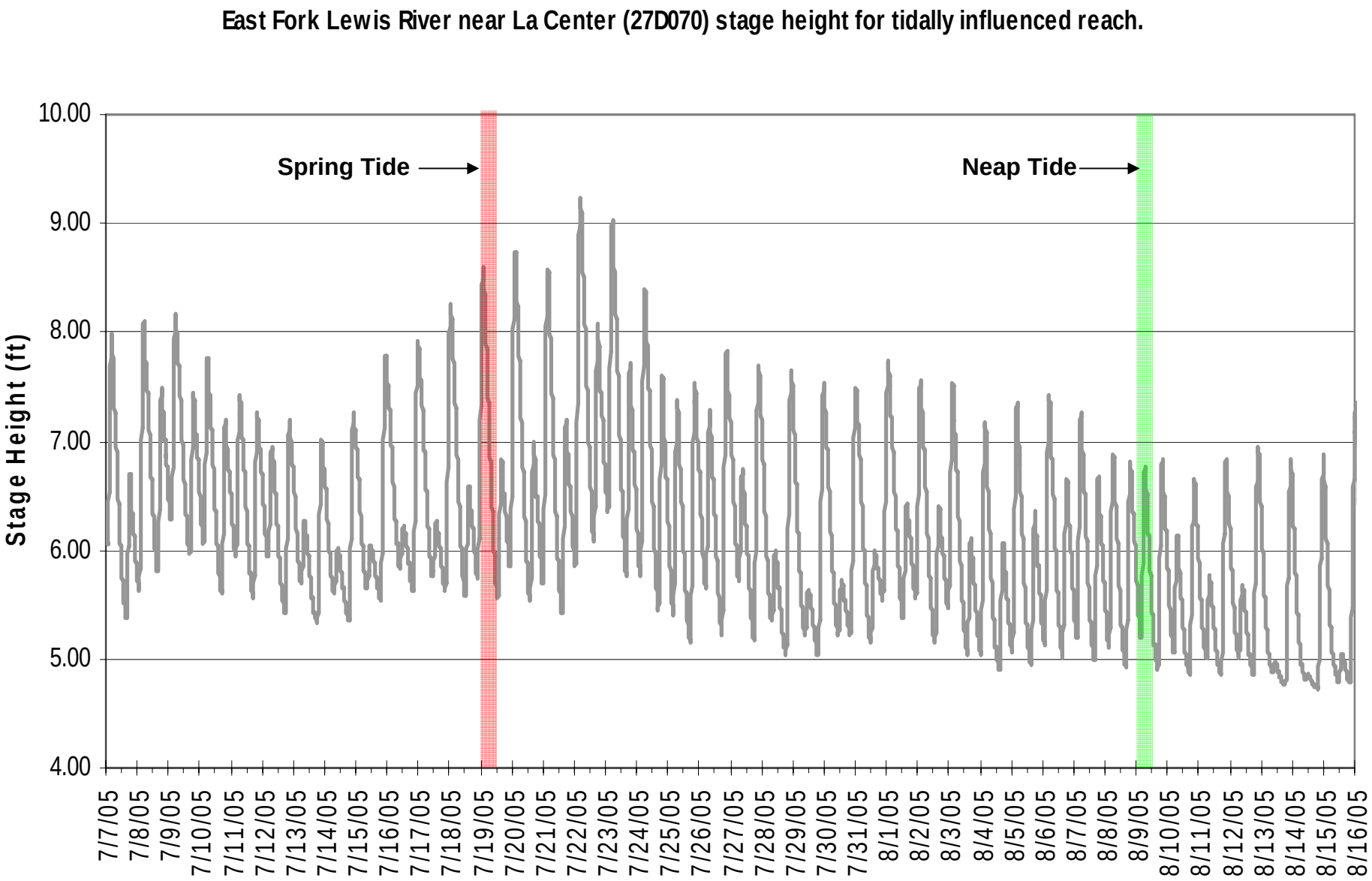
2002 USGS Geology Map of the Battle Ground 7.5 minute Quadrangle



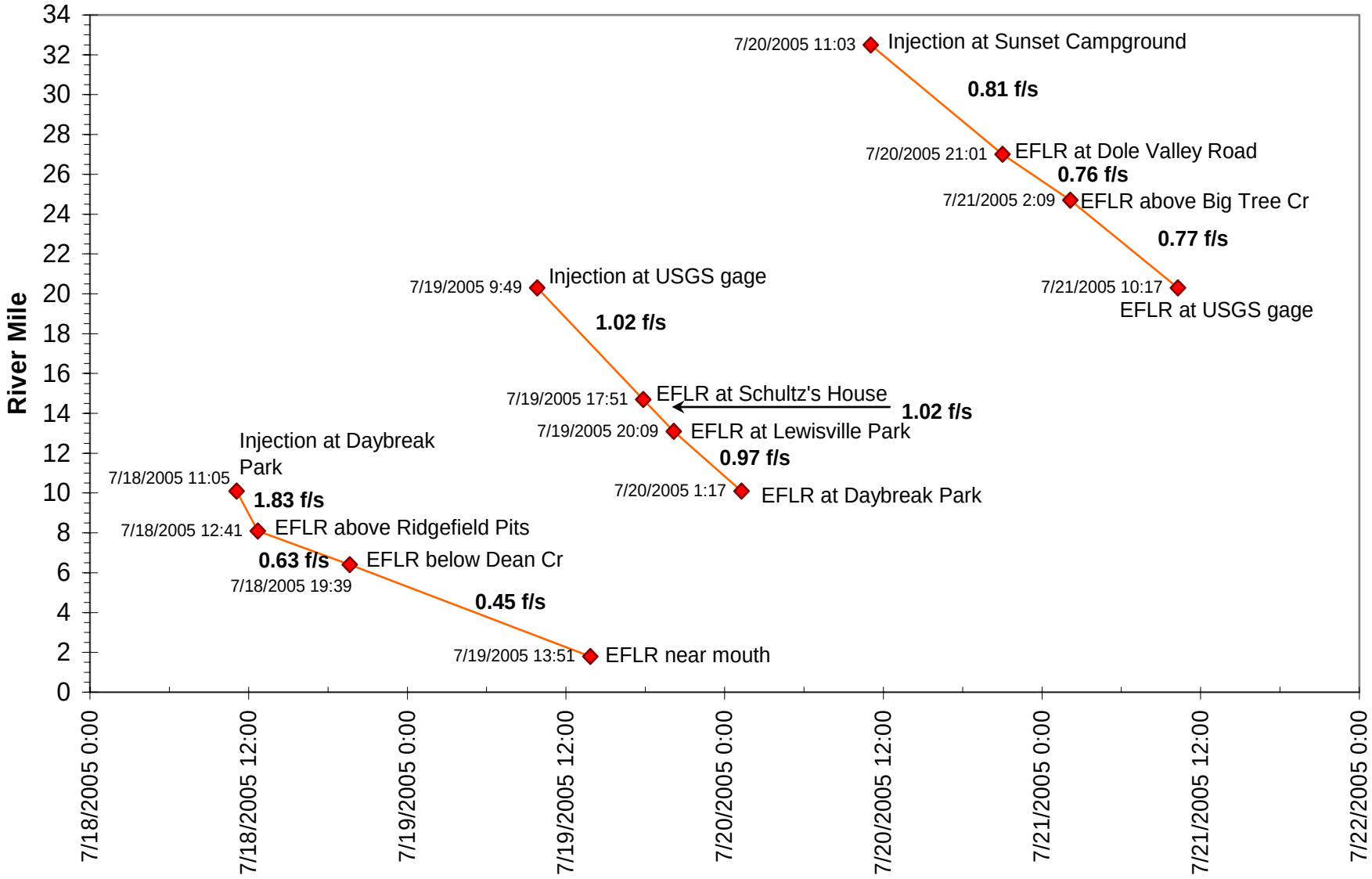

East Fork Lewis River Longitudinal Daily Average (DAve) Temperature Profile for 8/9/05
Data point labels refer to the river mile of the monitoring station
EFLR DAve Temperature
Tributary DAve Temperature
August Seepage Flows (0.1 x cfs)
Vertical hydraulic conductivity
1.8
4.6
10.1
13.2
14.7
20.3
24.6
26.9
32.3
Jenny Cr
Brezee Cr
Lockwood Cr
Mason Cr
Manley Road
Rock Cr North
Big Tree Cr
Rock Cr South
King Cr
Losing Reach
Gaining Reach
Temperature (C)/ 0.1 x cfs
Vertical hydraulic conductivity
River Mile


East Fork Lewis River Longitudinal Profile for 7/30/05
Data point labels refer to the river mile of the monitoring station
DMax EFLR Temperature
DAve EFLR Temperature
Tributary DAve Temperature
Vertical hydraulic gradient
6/7/05
7/11 and 7/19/05
8/22/05
10/5/05
Temperature (degrees C)
Vertical hydraulic gradient
River Mile
1.8
4.6
7.3
8.1
10.1
13.2
14.7
20.3
24.6
26.9
32.3
Jenny Cr
Brezee Cr
Mason Cr
Manley Road Cr
Rock Cr North
Big Tree Creek
Rock Cr South
King Cr
River Mouth
Headwater Boundary

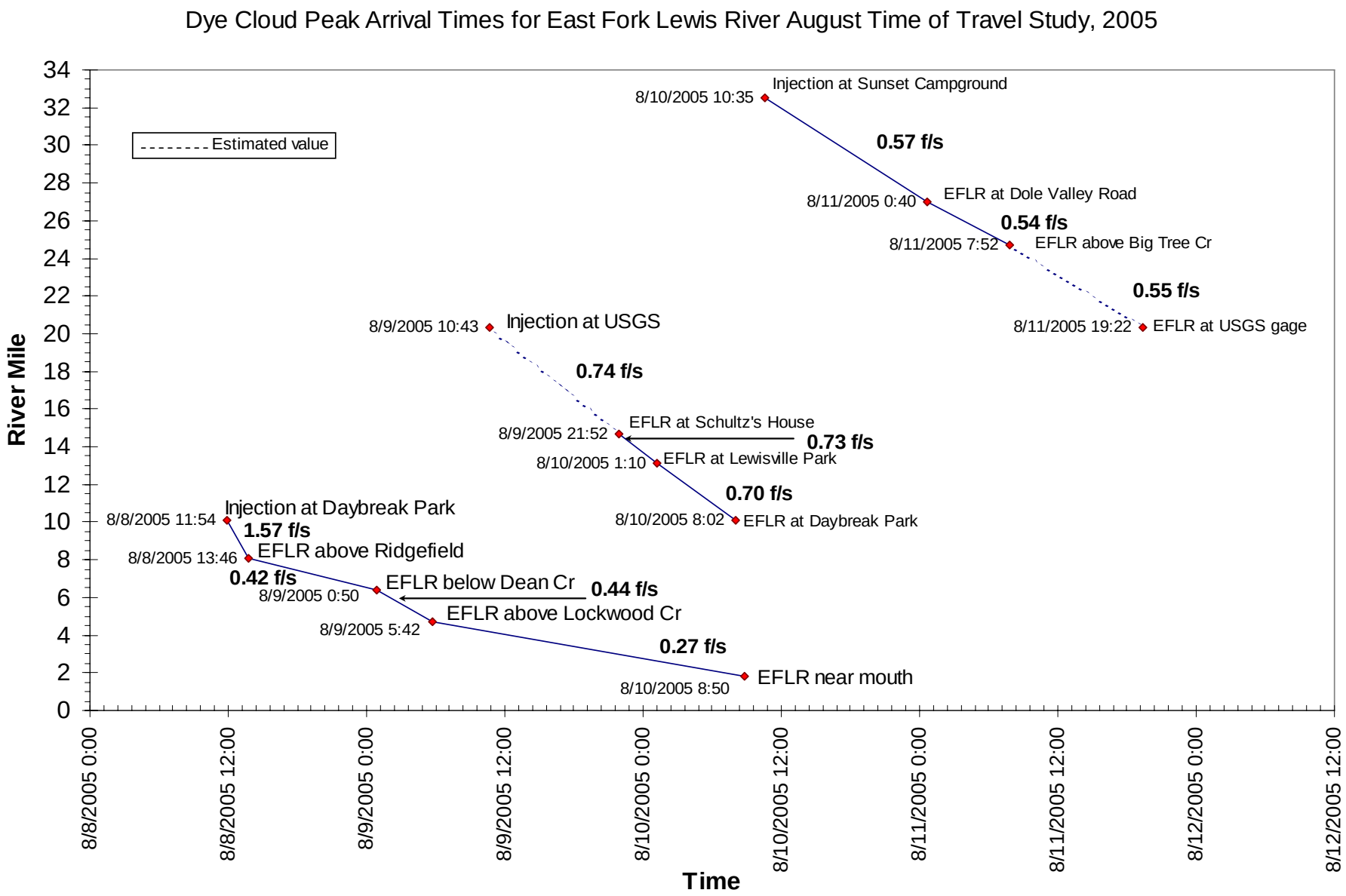
Time of Travel Dye Study Timing with Tidal Cycle



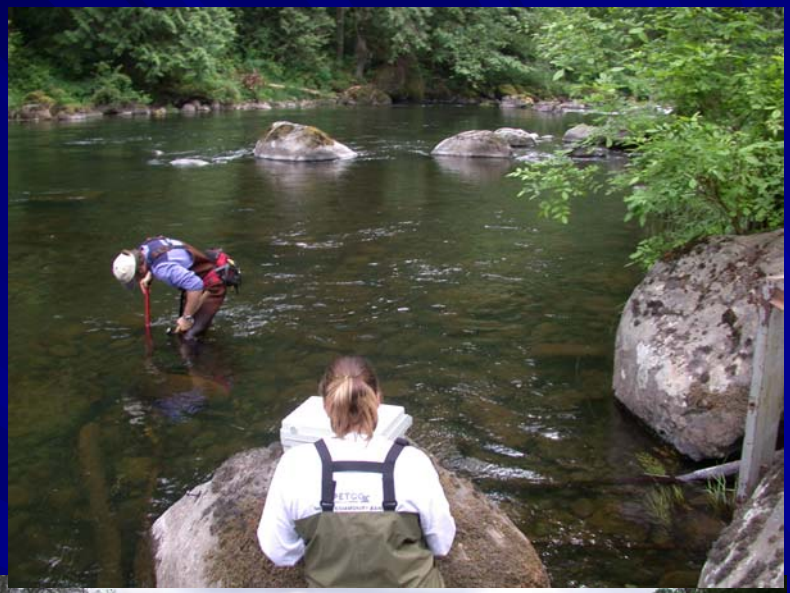
July Time of Travel Dye Study Results



August Time of Travel Dye Study Results

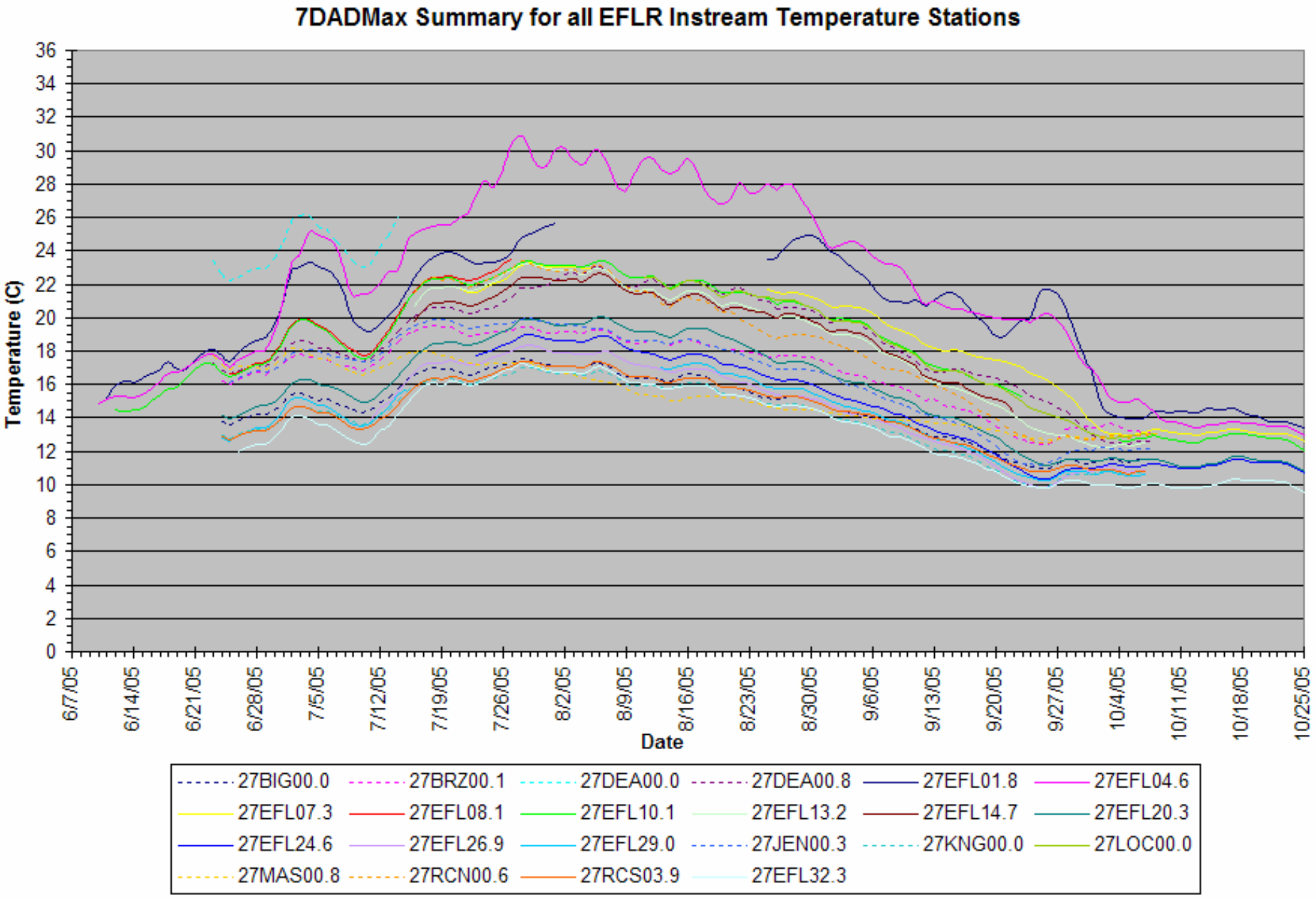


Continuous Temperature Data

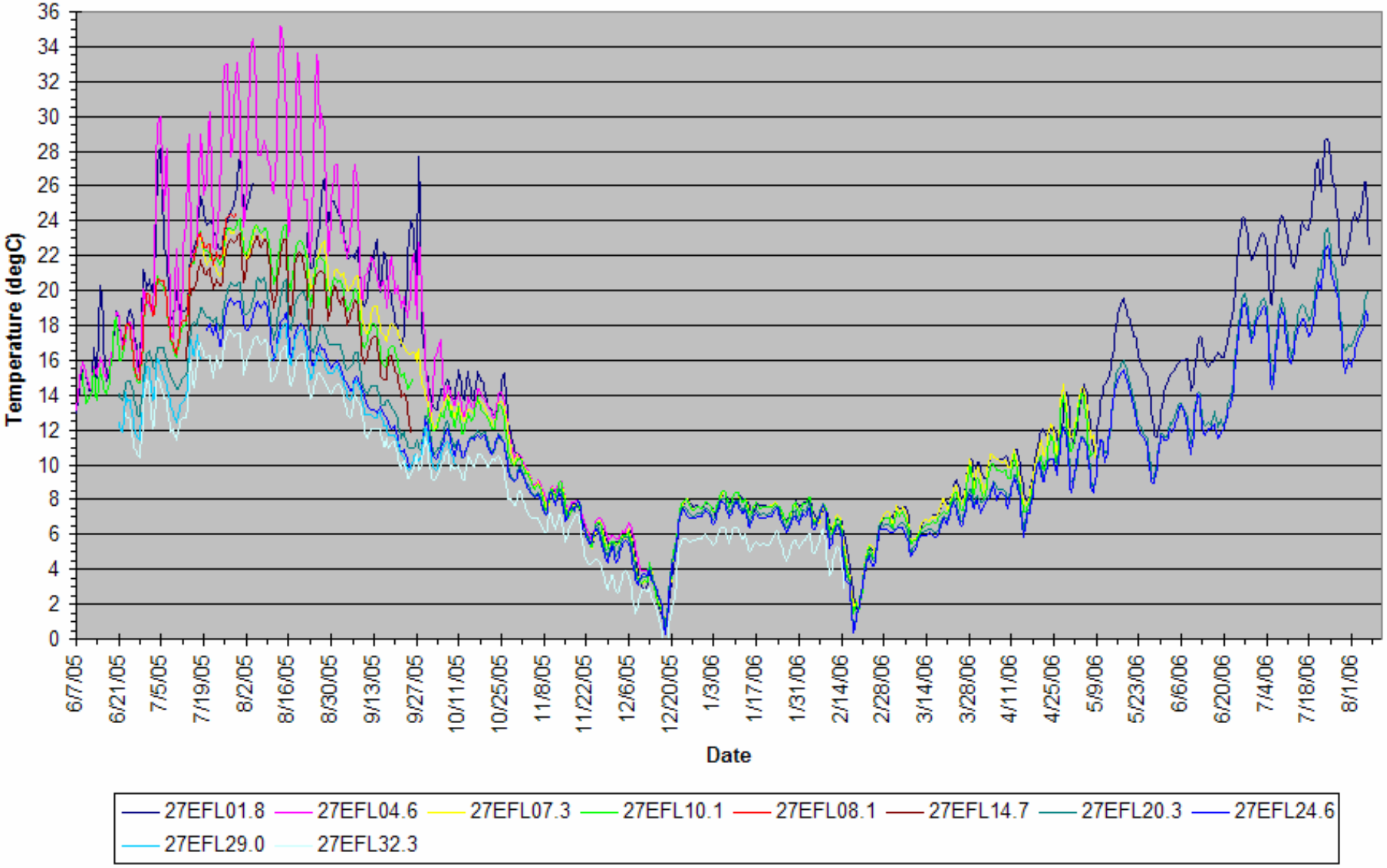


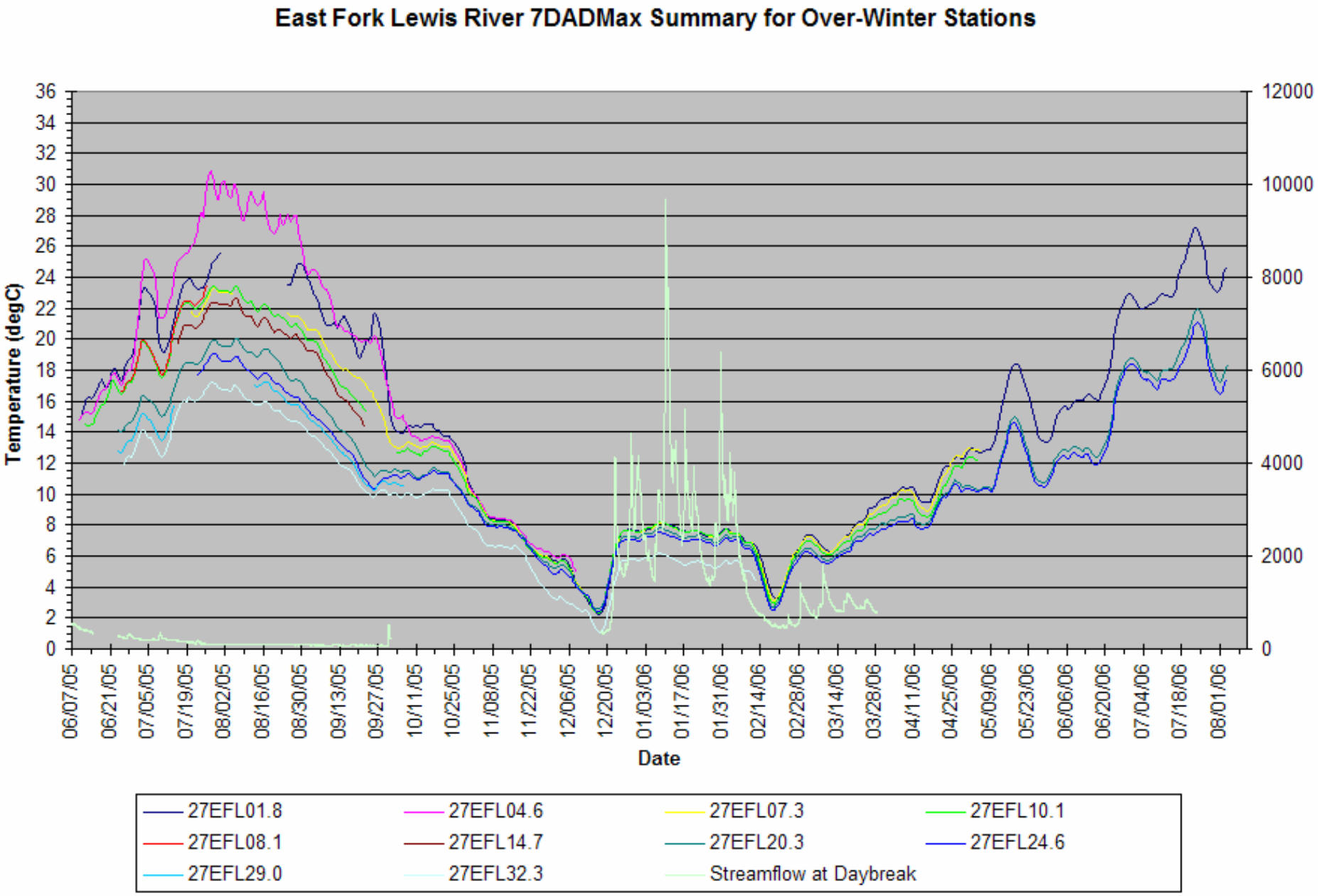
Waterbody Reach	Aquatic Life Uses	Temperature Standard Highest 7 DADMax
EFLR from mouth to Mason Creek	Salmonid Spawning, Rearing, and Migration	17.5ºC (63.5ºF)
EFLR from Mason Creek to Moulton Falls, including tributaries	Core Summer Habitat	16ºC (60.8ºF)
EFLR from Moulton Falls to headwaters	Core Summer Habitat	16ºC (60.8ºF)

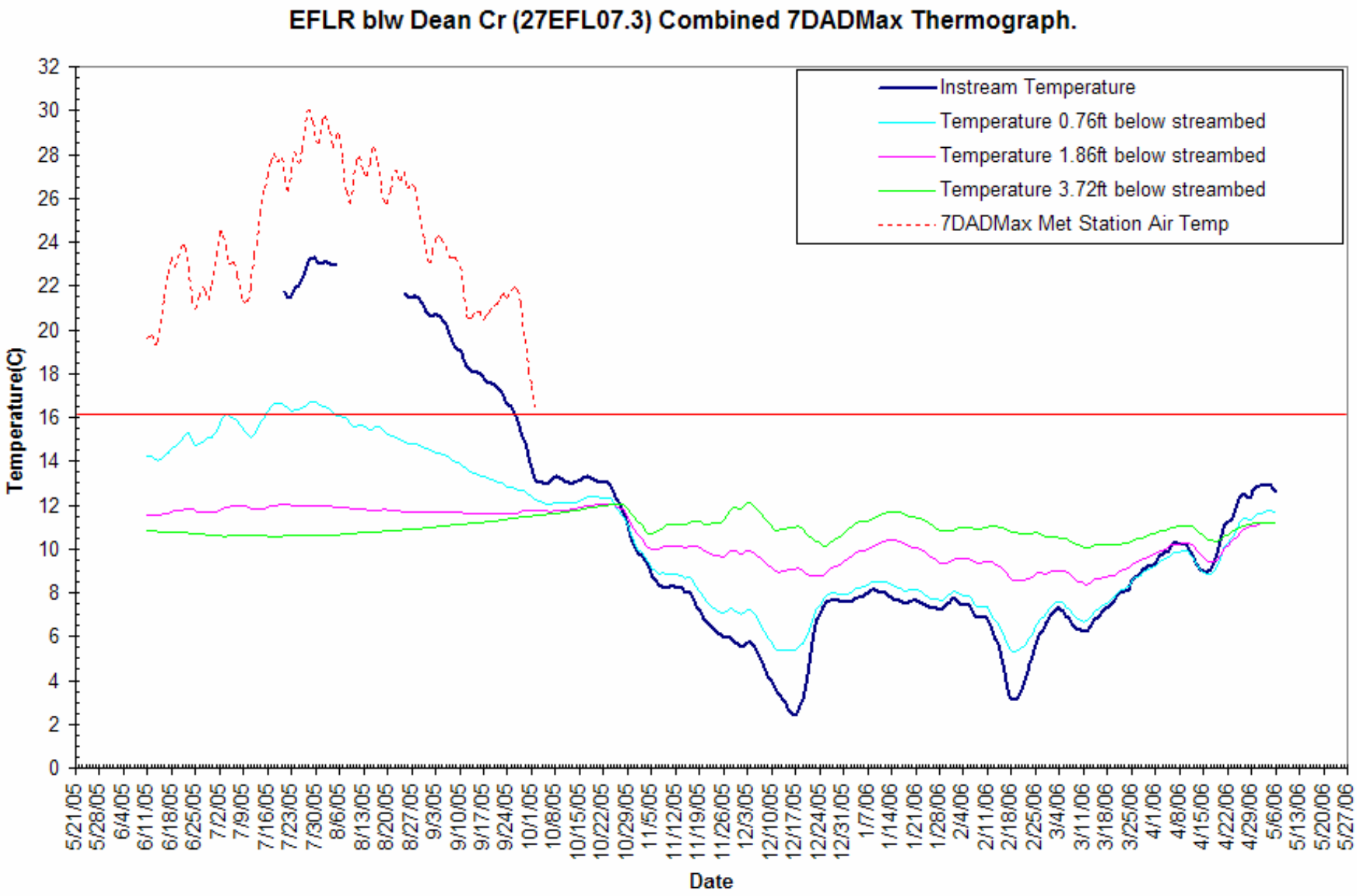
Core summer salmonid habitat. The key identifying characteristics of this use are summer (June 15 – September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and sub-adult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids.

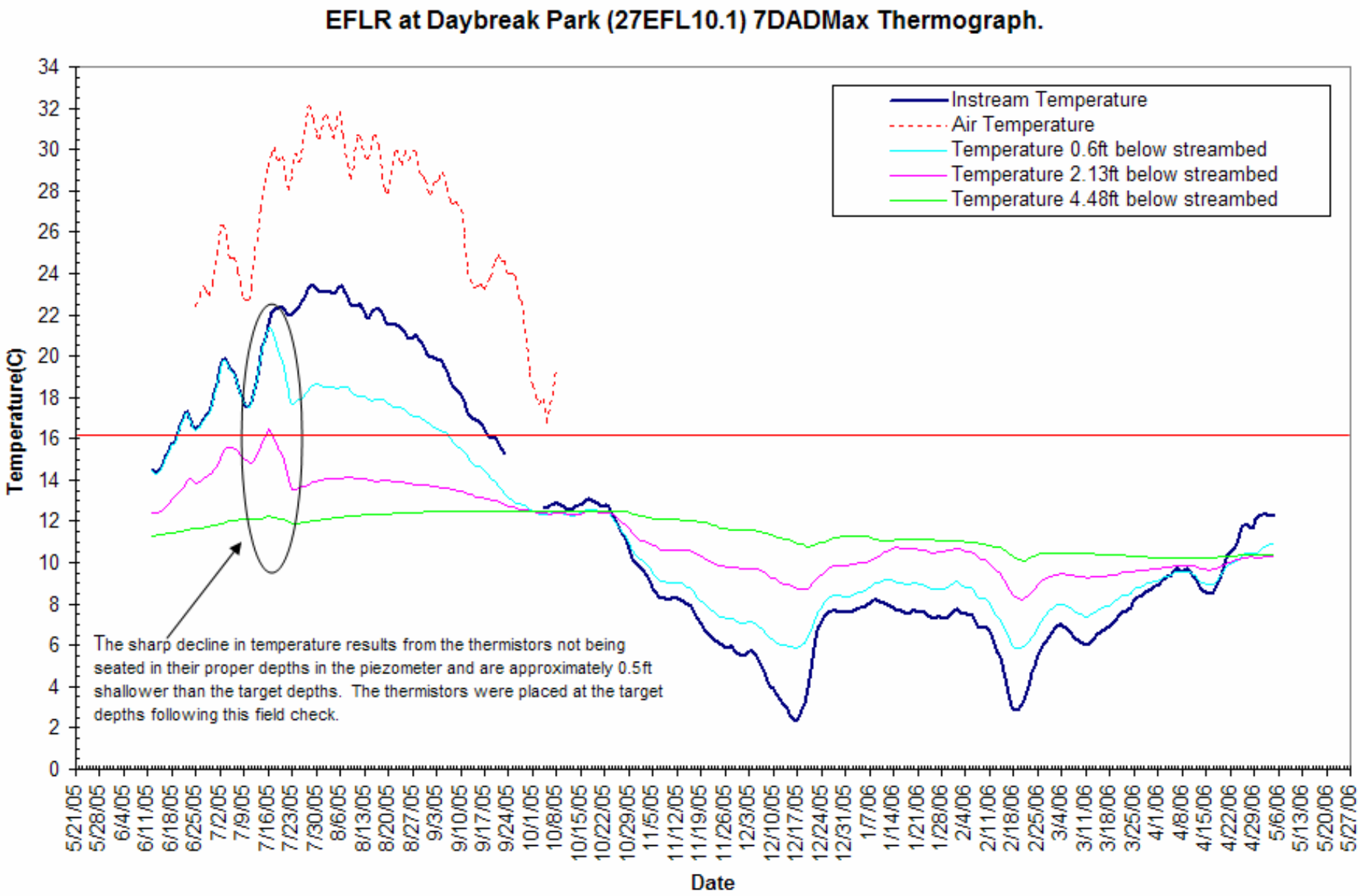

7DADMax Summary for all EFLR Instream Temperature Stations
Temperature (C)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
6/7/05
6/14/05
6/21/05
6/28/05
7/5/05
7/12/05
7/19/05
7/26/05
8/2/05
8/9/05
8/16/05
8/23/05
8/30/05
9/6/05
9/13/05
9/20/05
9/27/05
10/4/05
10/11/05
10/18/05
10/25/05
Date
27BIG00.0
27BRZ00.1
27DEA00.0
27DEA00.8
27EFL01.8
27EFL04.6
27EFL07.3
27EFL08.1
27EFL10.1
27EFL13.2
27EFL14.7
27EFL20.3
27EFL24.6
27EFL26.9
27EFL29.0
27JEN00.3
27KNG00.0
27LOC00.0
27MAS00.8
27RCN00.6
27RCS03.9
27EFL32.3

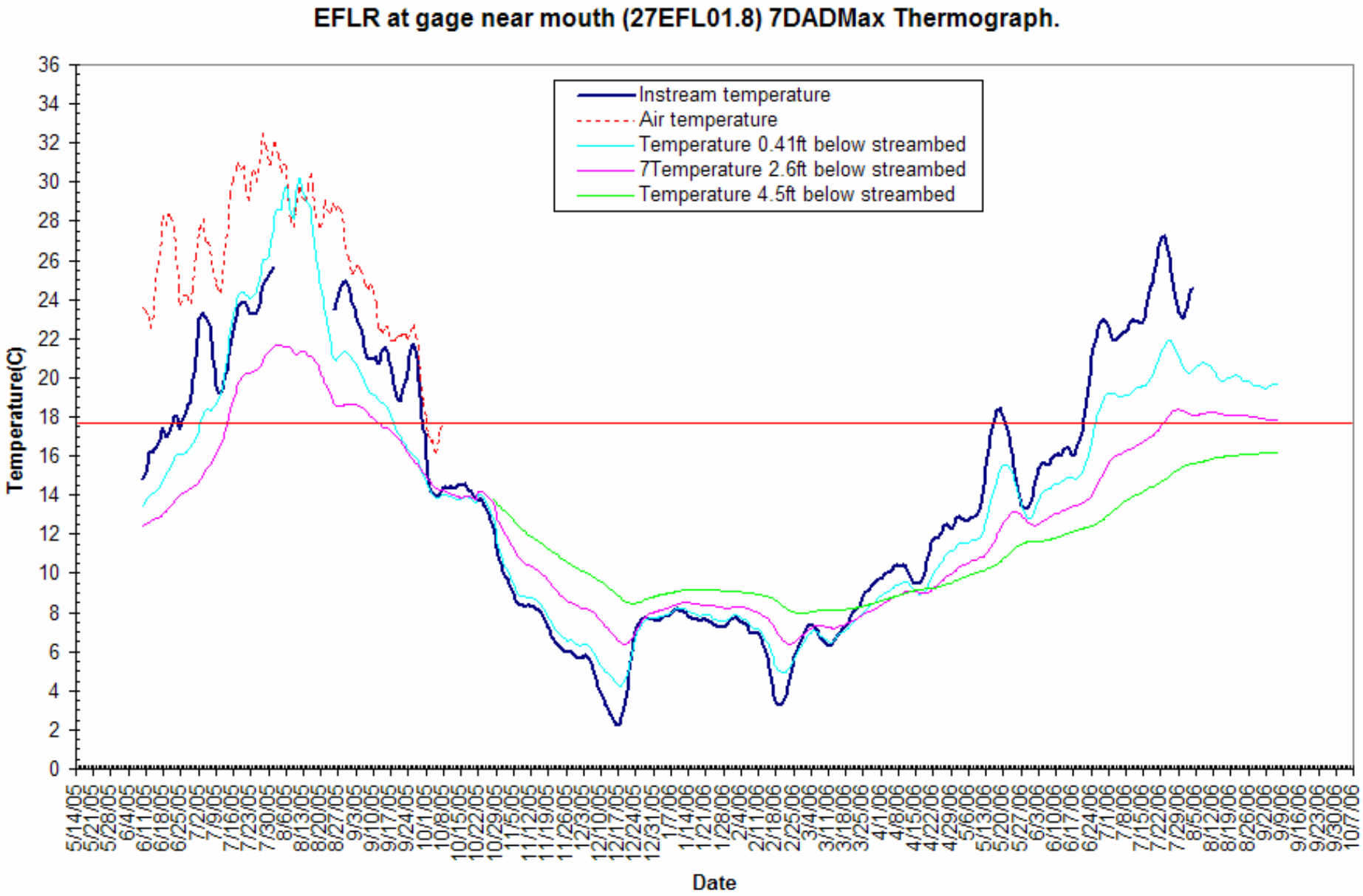
Daily Maximum Temperatures for Over-Winter Stations on the East Fork Lewis River

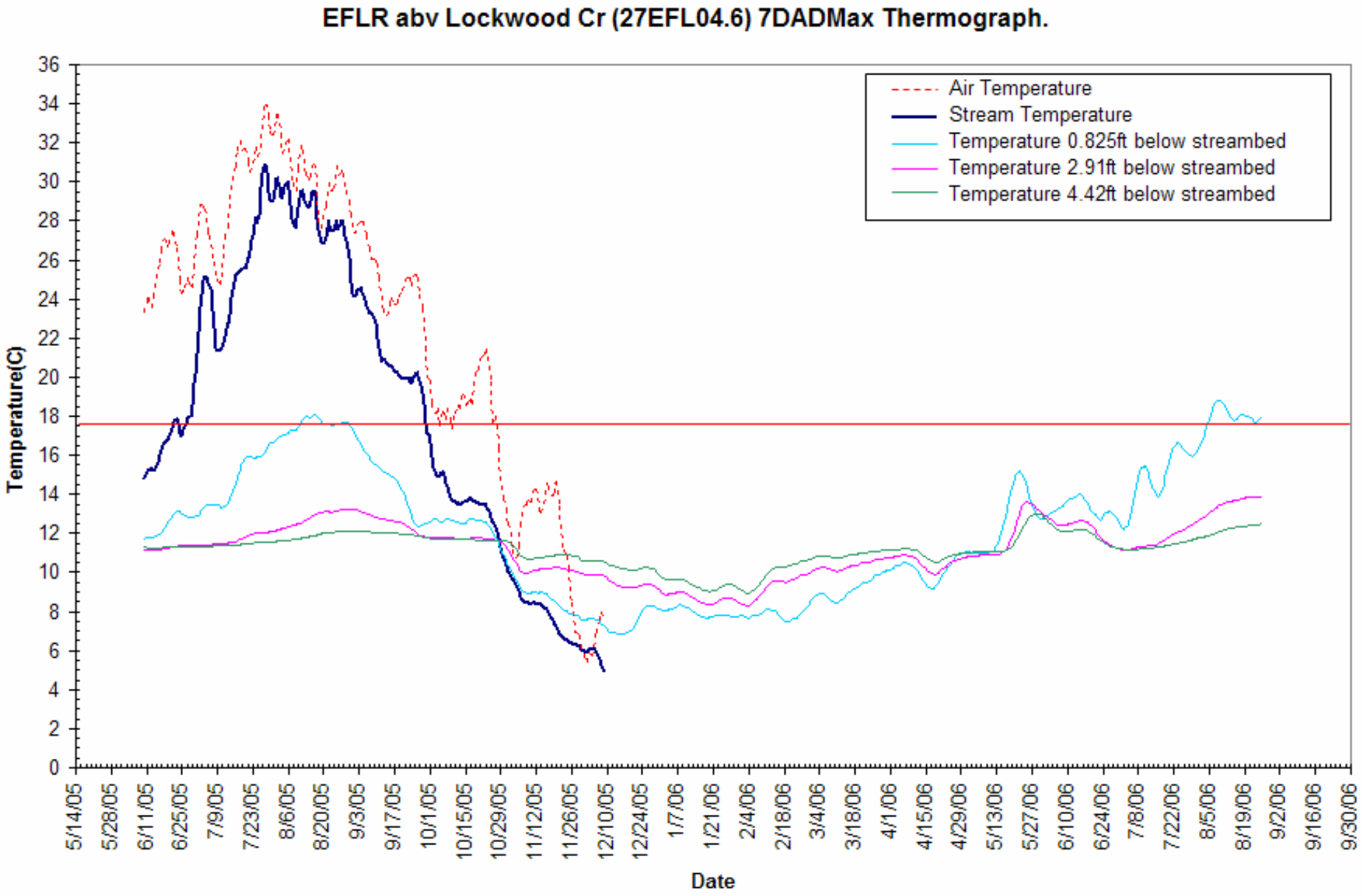



East Fork Lewis River 7DADMax Summary for Over-Winter Stations
Temperature (degC)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
12000
10000
8000
6000
4000
2000
0
06/07/05
06/21/05
07/05/05
07/19/05
08/02/05
08/16/05
08/30/05
09/13/05
09/27/05
10/11/05
10/25/05
11/08/05
11/22/05
12/06/05
12/20/05
01/03/06
01/17/06
01/31/06
02/14/06
02/28/06
03/14/06
03/28/06
04/11/06
04/25/06
05/09/06
05/23/06
06/06/06
06/20/06
07/04/06
07/18/06
08/01/06
Date
27EFL01.8
27EFL04.6
27EFL07.3
27EFL10.1
27EFL08.1
27EFL14.7
27EFL20.3
27EFL24.6
27EFL29.0
27EFL32.3
Streamflow at Daybreak

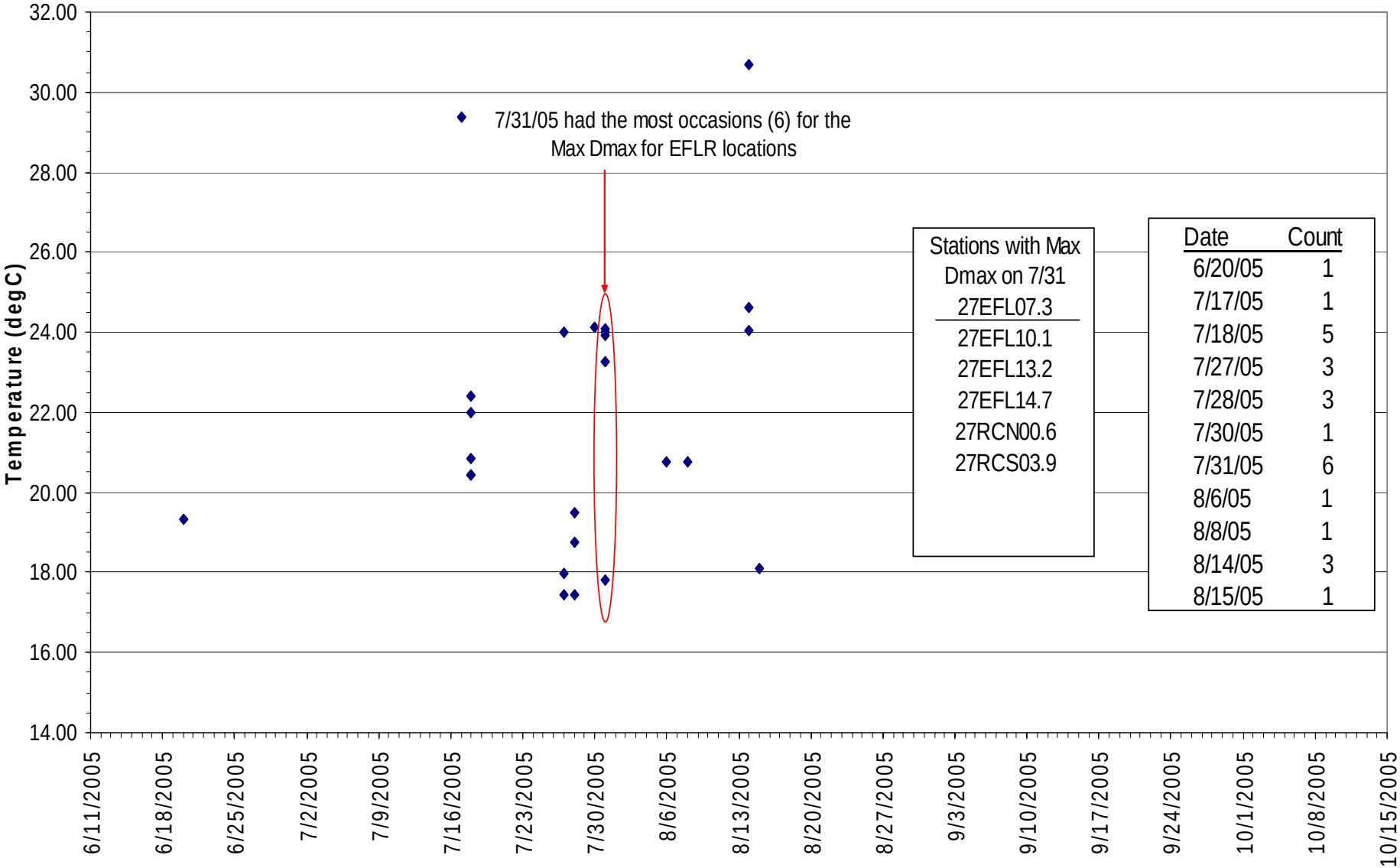

EFLR blw Dean Cr (27EFL07.3) Combined 7DADMax Thermograph.
Instream Temperature
Temperature 0.76ft below streambed
Temperature 1.86ft below streambed
Temperature 3.72ft below streambed
7DADMax Met Station Air Temp
Temperature(C)
Date
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
5/21/05
5/28/05
6/4/05
6/11/05
6/18/05
6/25/05
7/2/05
7/9/05
7/16/05
7/23/05
7/30/05
8/6/05
8/13/05
8/20/05
8/27/05
9/3/05
9/10/05
9/17/05
9/24/05
10/1/05
10/8/05
10/15/05
10/22/05
10/29/05
11/5/05
11/12/05
11/19/05
11/26/05
12/3/05
12/10/05
12/17/05
12/24/05
12/31/05
1/7/06
1/14/06
1/21/06
1/28/06
2/4/06
2/11/06
2/18/06
2/25/06
3/4/06
3/11/06
3/18/06
3/25/06
4/1/06
4/8/06
4/15/06
4/22/06
4/29/06
5/6/06
5/13/06
5/20/06
5/27/06


EFLR at Daybreak Park (27EFL10.1) 7DADMax Thermograph.
Instream Temperature
Air Temperature
Temperature 0.6ft below streambed
Temperature 2.13ft below streambed
Temperature 4.48ft below streambed
Temperature(C)
Date
The sharp decline in temperature results from the thermistors not being seated in their proper depths in the piezometer and are approximately 0.5ft shallower than the target depths. The thermistors were placed at the target depths following this field check.

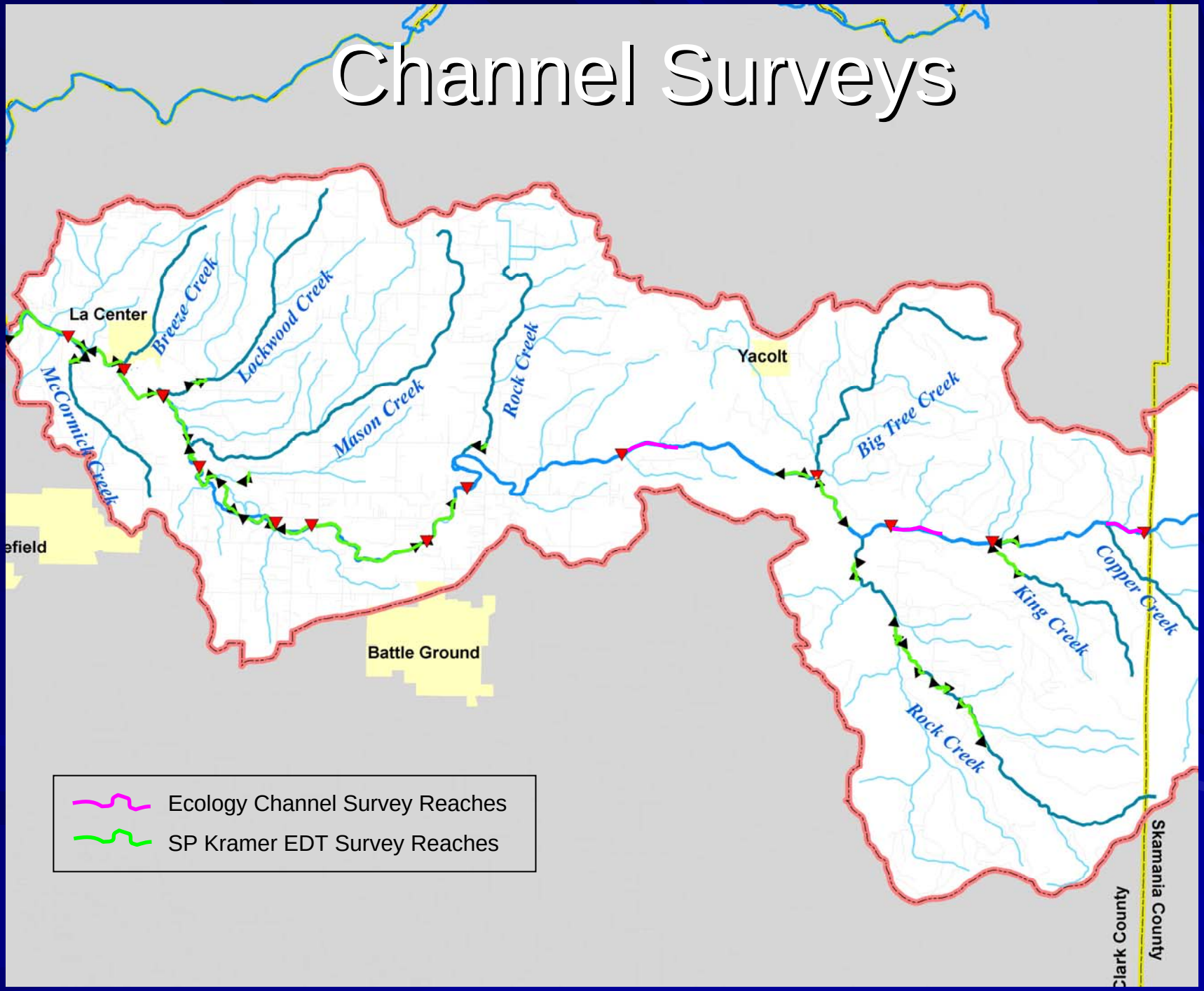

EFLR at gage near mouth (27EFL01.8) 7DADMax Thermograph.
Instream temperature
Air temperature
Temperature 0.41ft below streambed
7Temperature 2.6ft below streambed
Temperature 4.5ft below streambed
Temperature(C)
Date


EFLR abv Lockwood Cr (27EFL04.6) 7DADMax Thermograph.
Air Temperature
Stream Temperature
Temperature 0.825ft below streambed
Temperature 2.91ft below streambed
Temperature 4.42ft below streambed
Temperature(C)
Date
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
5/14/05
5/28/05
6/11/05
6/25/05
7/9/05
7/23/05
8/6/05
8/20/05
9/3/05
9/17/05
10/1/05
10/15/05
10/29/05
11/12/05
11/26/05
12/10/05
12/24/05
1/7/06
1/21/06
2/4/06
2/18/06
3/4/06
3/18/06
4/1/06
4/15/06
4/29/06
5/13/06
5/27/06
6/10/06
6/24/06
7/8/06
7/22/06
8/5/06
8/19/06
9/2/06
9/16/06
9/30/06

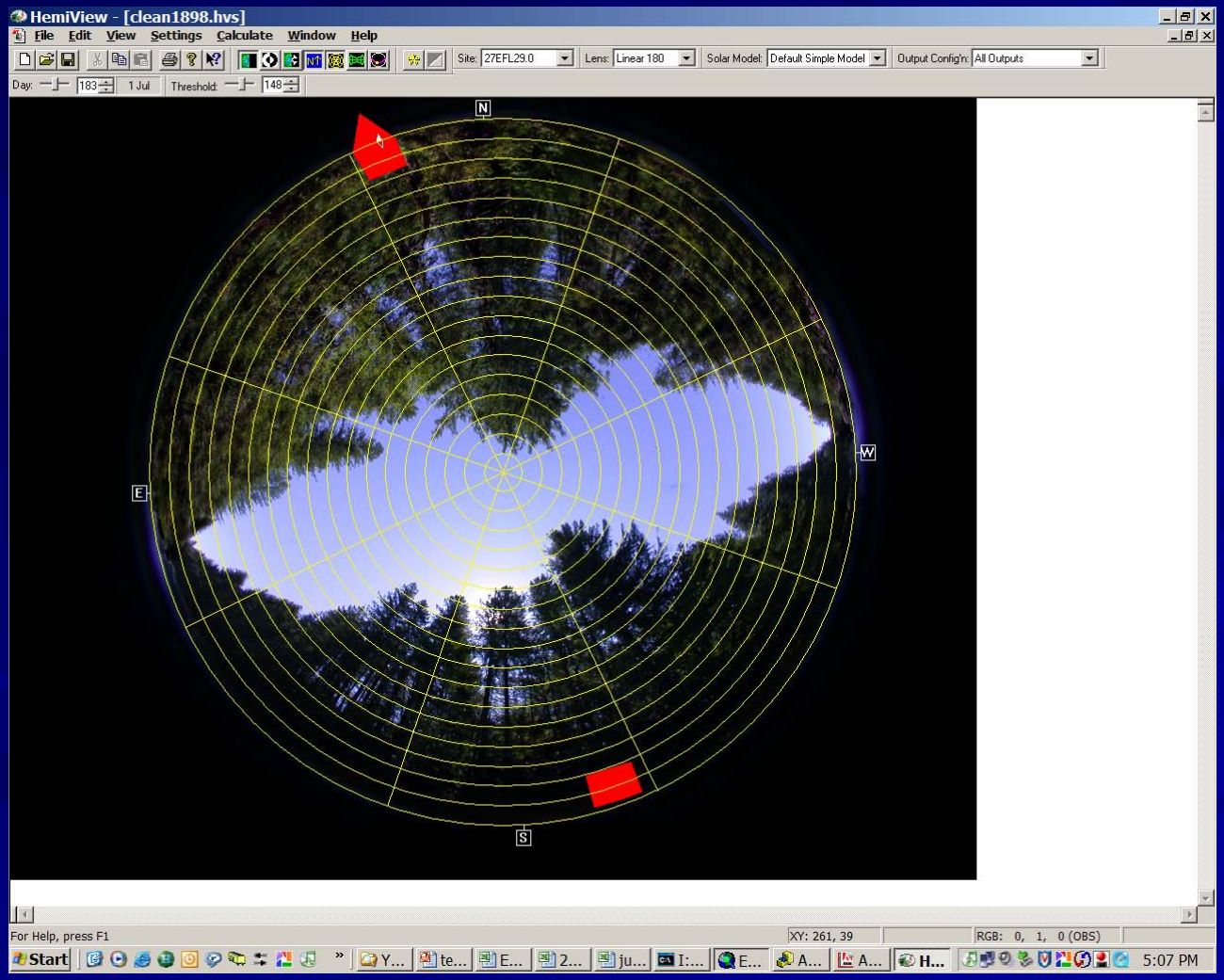
Estimation of the Critical Period using the Maximum Dmax Instream Temperatures for all Monitoring Stations in the East Fork Lewis TMDL



Channel Surveys

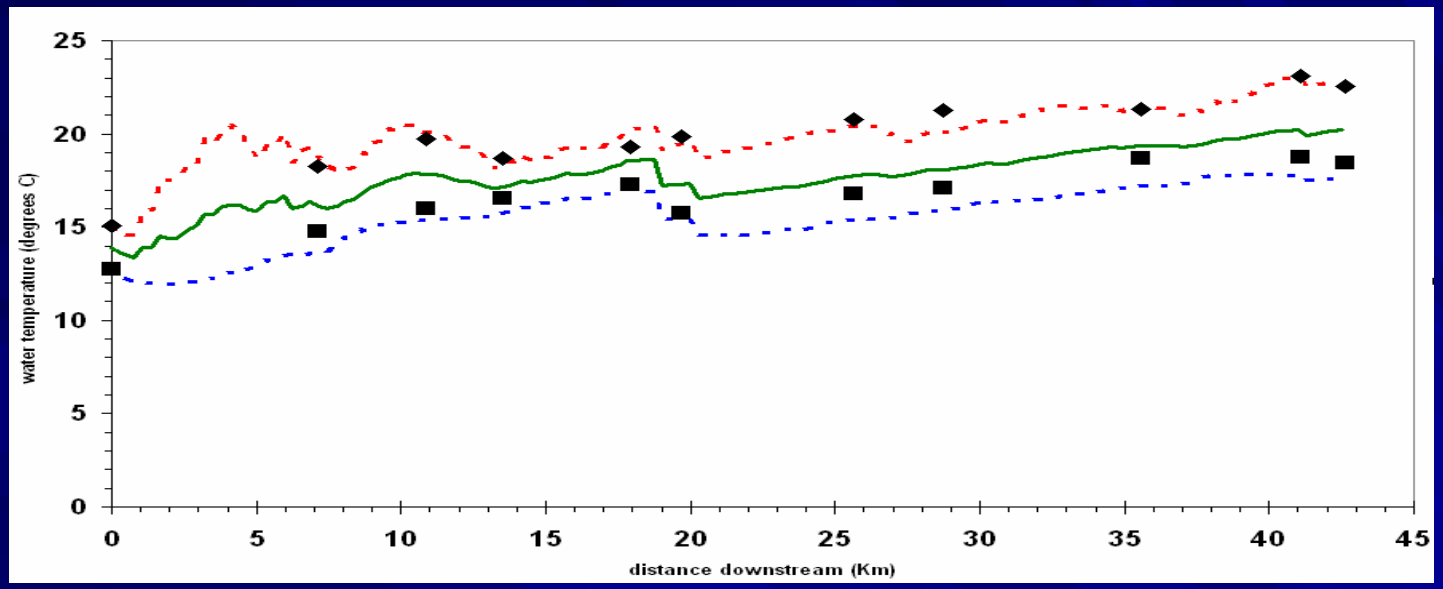


Hemispherical Photography



- Pictures taken at representative locations for riparian vegetation types
- Pictures were processed using Hemiview software
- The picture at the left shows a grid that Hemiview uses to calculate canopy density similar to a densiometer.

Next Steps/Potential Outcomes



QUAL2Kw

Models for Temperature TMDLs

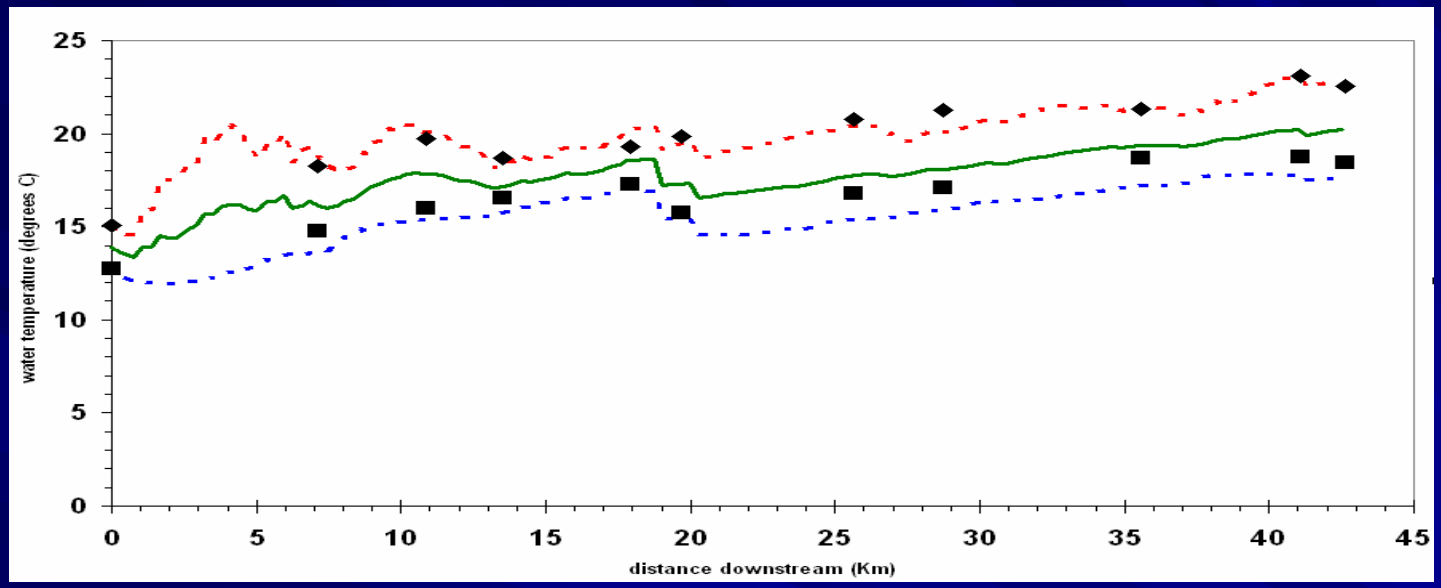
- Shade
  - A tool for estimating shade from riparian vegetation.

QUAL2Kw

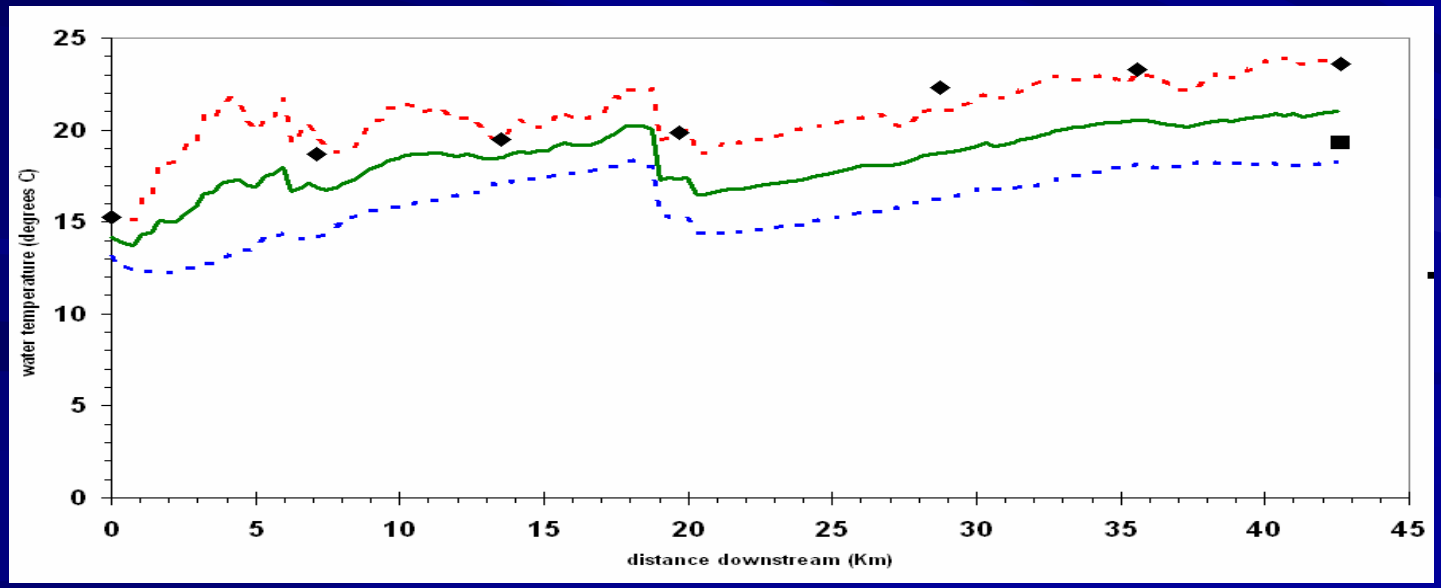
- QUAL2Kw
  - A modeling framework for simulating river and stream water quality.

Model Outcome – *Current Conditions*

QUAL2Kw

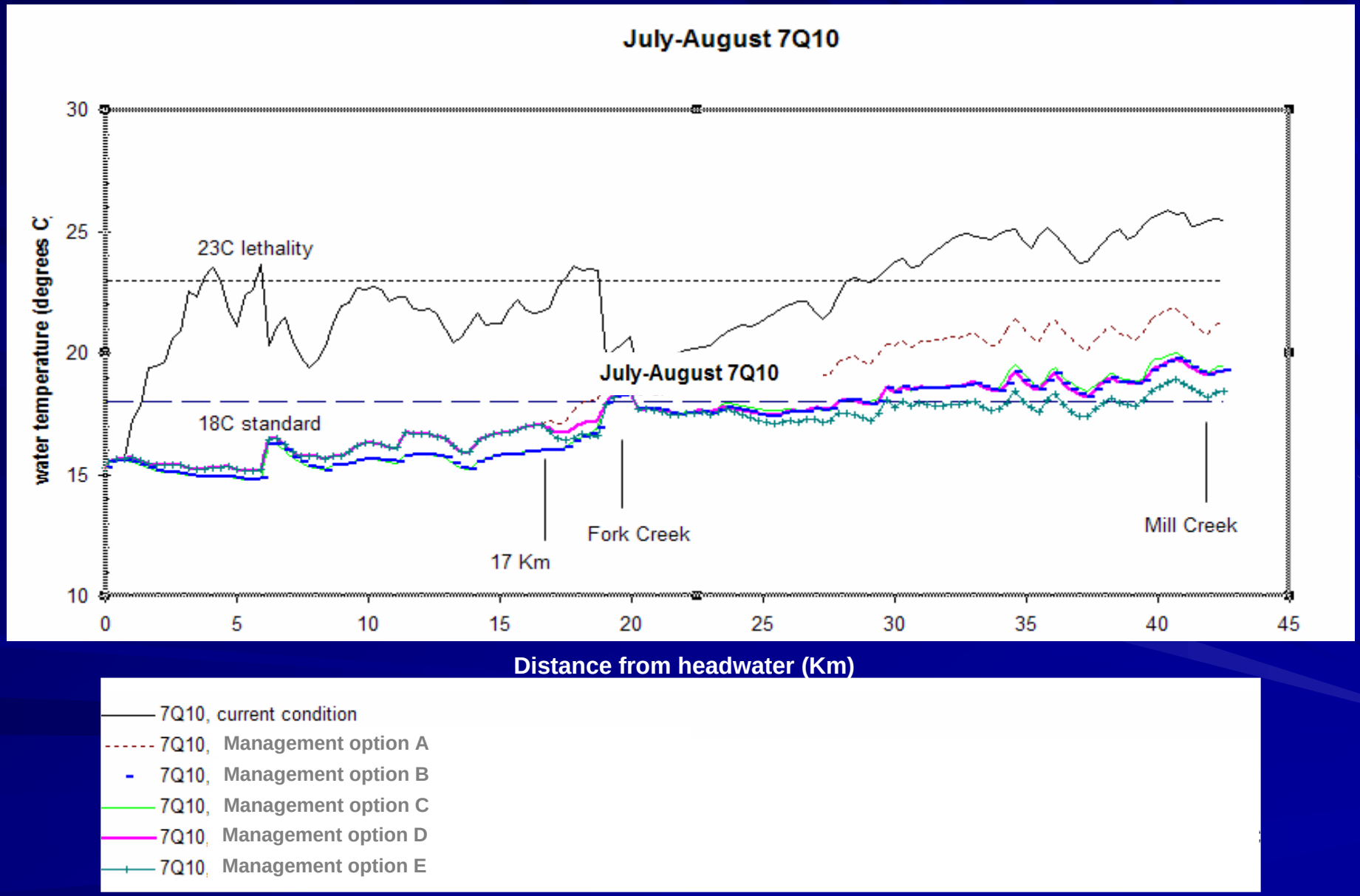


Calibration period



Verification period

Model Outcome – *Management Strategies*



Possible Management Strategies and Recommendations

- Load Allocations
  - Effective shade (increase riparian vegetation)
- Wasteload Allocation
  - 0.3 deg C increase at mixing zone boundary
- Management activities that would reduce the loading of sediment to the surface waters from upland and channel erosion
- Activities to increase the supply of large woody debris
- Voluntary water conservation measures to increase instream flow

Final Technical Report

- Temperatures observed during 2005
- Modeled temperatures for an average and "reasonable worst-case condition" for:
  - Existing stream characteristics
  - With "system-potential" shade
  - Variations in streamflow
  - Variations in channel width
- Comparisons to standards
- Load and Wasteload Allocations
- Implementation Strategies

THE END