Hydraulics Component Overview of the BC Hydro Fish Entrainment Study

PROGRESS AND ONGOING ANALYSIS OF HUGH KEENLEYSIDE DAM FIELD DATA

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Overview

- Introduction and Objectives
- Locations of study
  - Completed and upcoming studies
- HLK field measurements
  - Temperature measurement and analysis

Introduction

- What is fish entrainment?
- Fish pass through dam
  - High velocity near intake
  - Selective withdrawal increased velocity

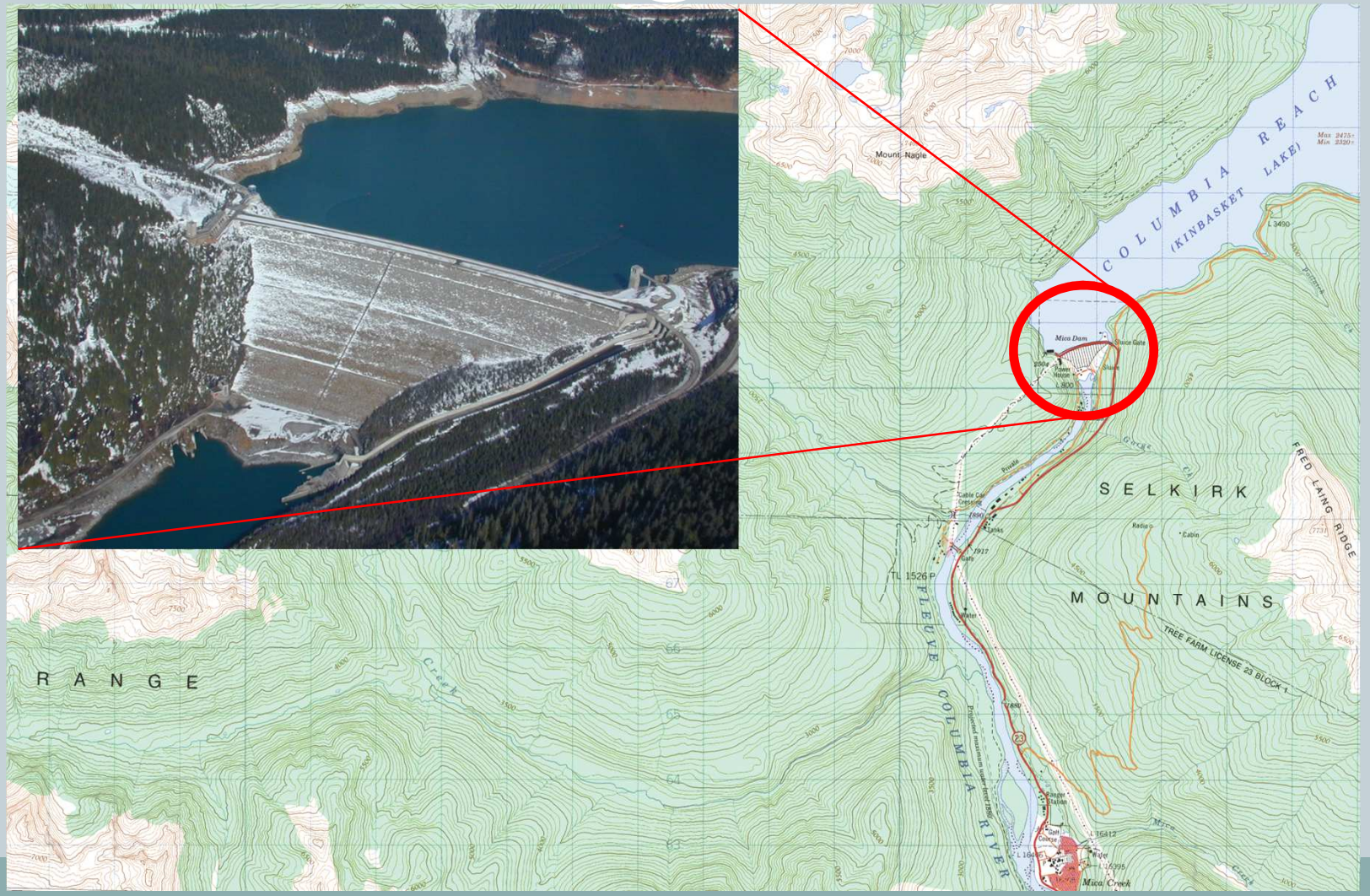
Objectives

- Overall: combine hydraulic and biological research to develop general methods for assessing fish entrainment risk
- Hydraulic: velocity field and thermal stratification CFD modelling, field measurements for model validation

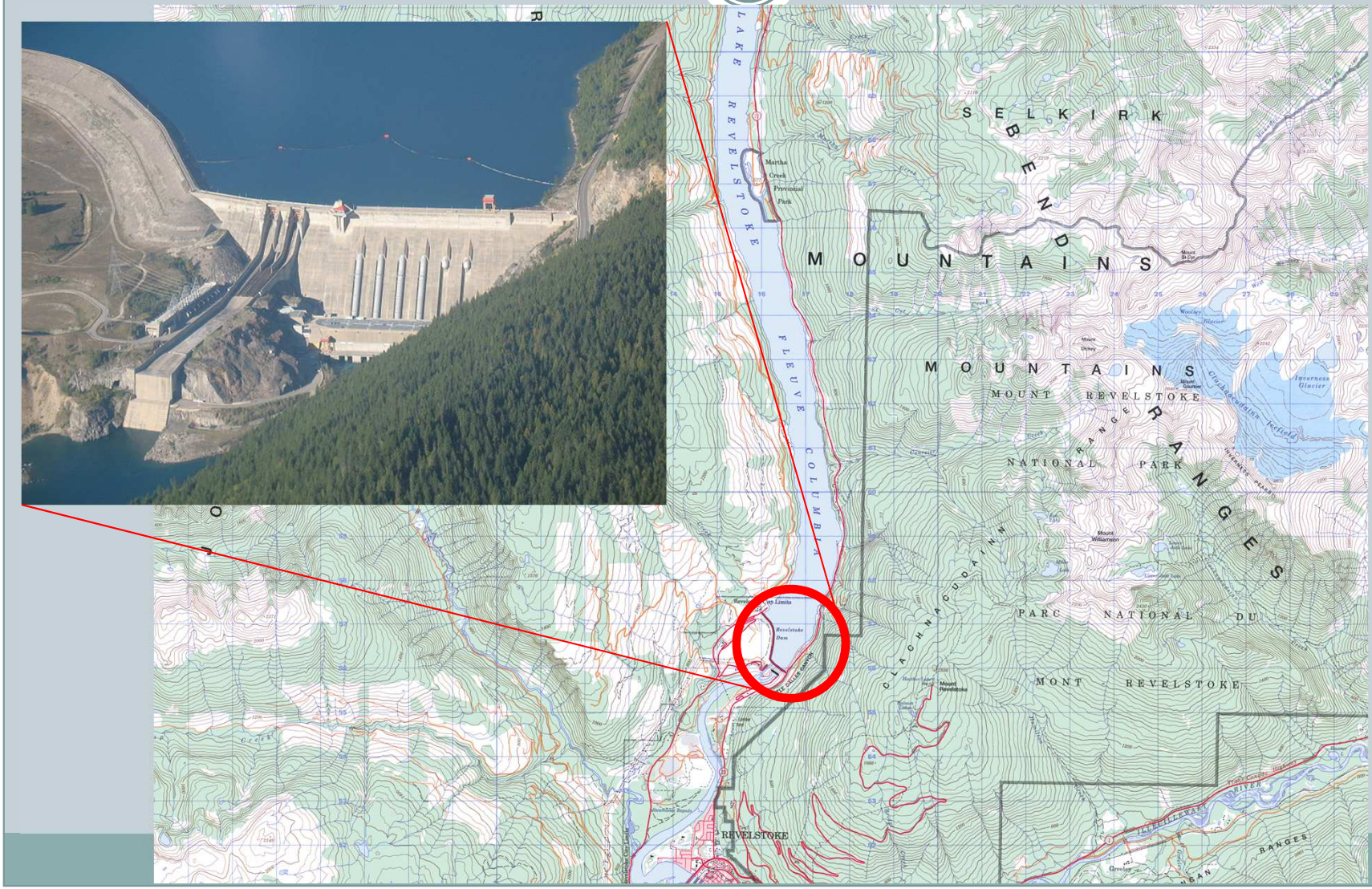
Locations

- Four reservoirs
  - Columbia River:
    - Mica Dam
    - Revelstoke Dam
    - Hugh Keenleyside Dam
  - Bull River:
    - Aberfeldie Dam

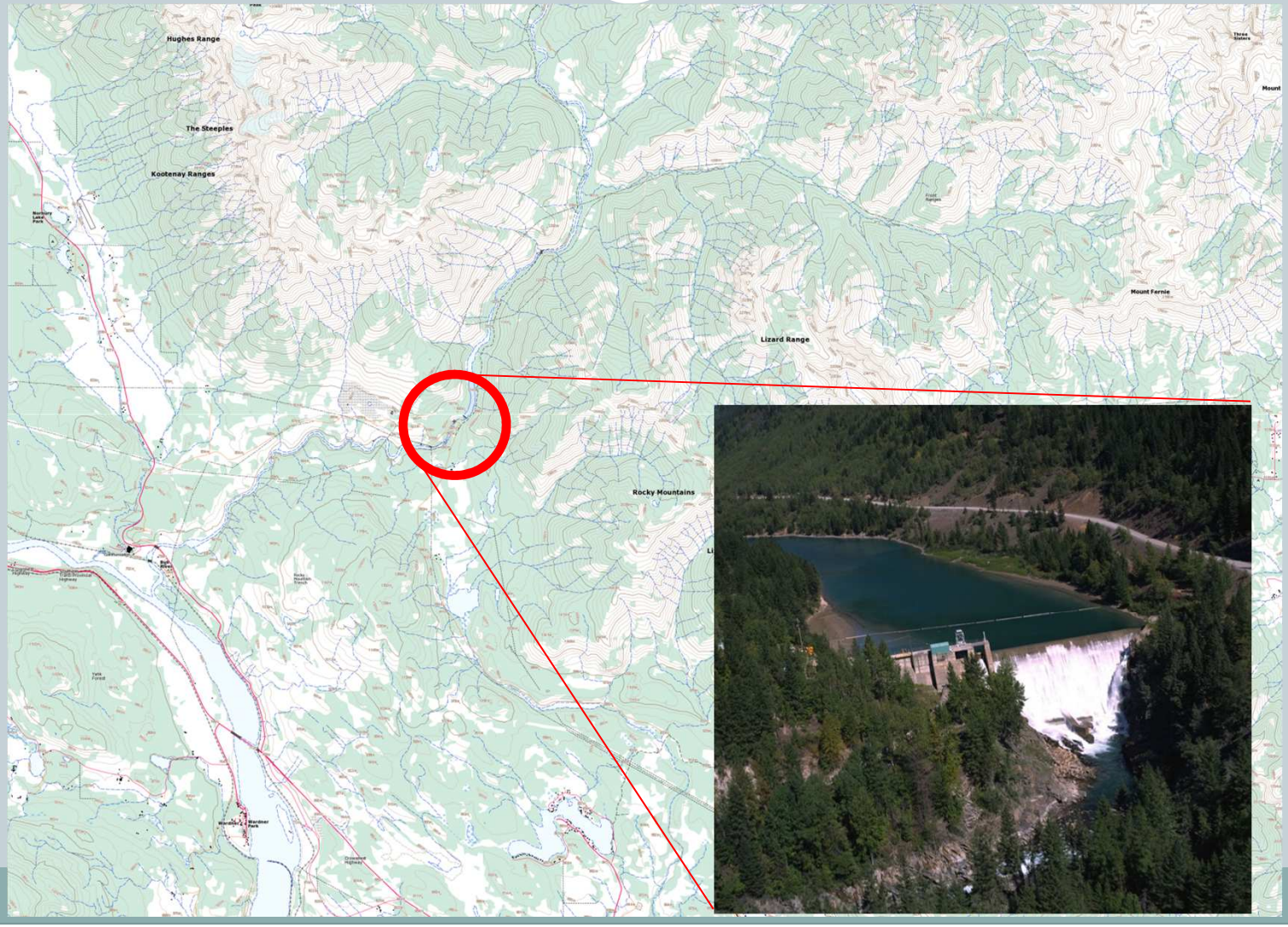
Mica Dam


Mount Nagle
COLUMBIA REACH
(KINBASKET LAKE)
Mica Dam
Sluice Gate
Power House
Slipway
SELKIRK
MOUNTAINS
FRED LAING RIDGE
TREE FARM LICENSE 23 BLOCK 1
TL 1526 P
FLEUVE COLUMBIA RIVER
RANGE
Mica Creek

Revelstoke Dam



Aberfeldie Dam



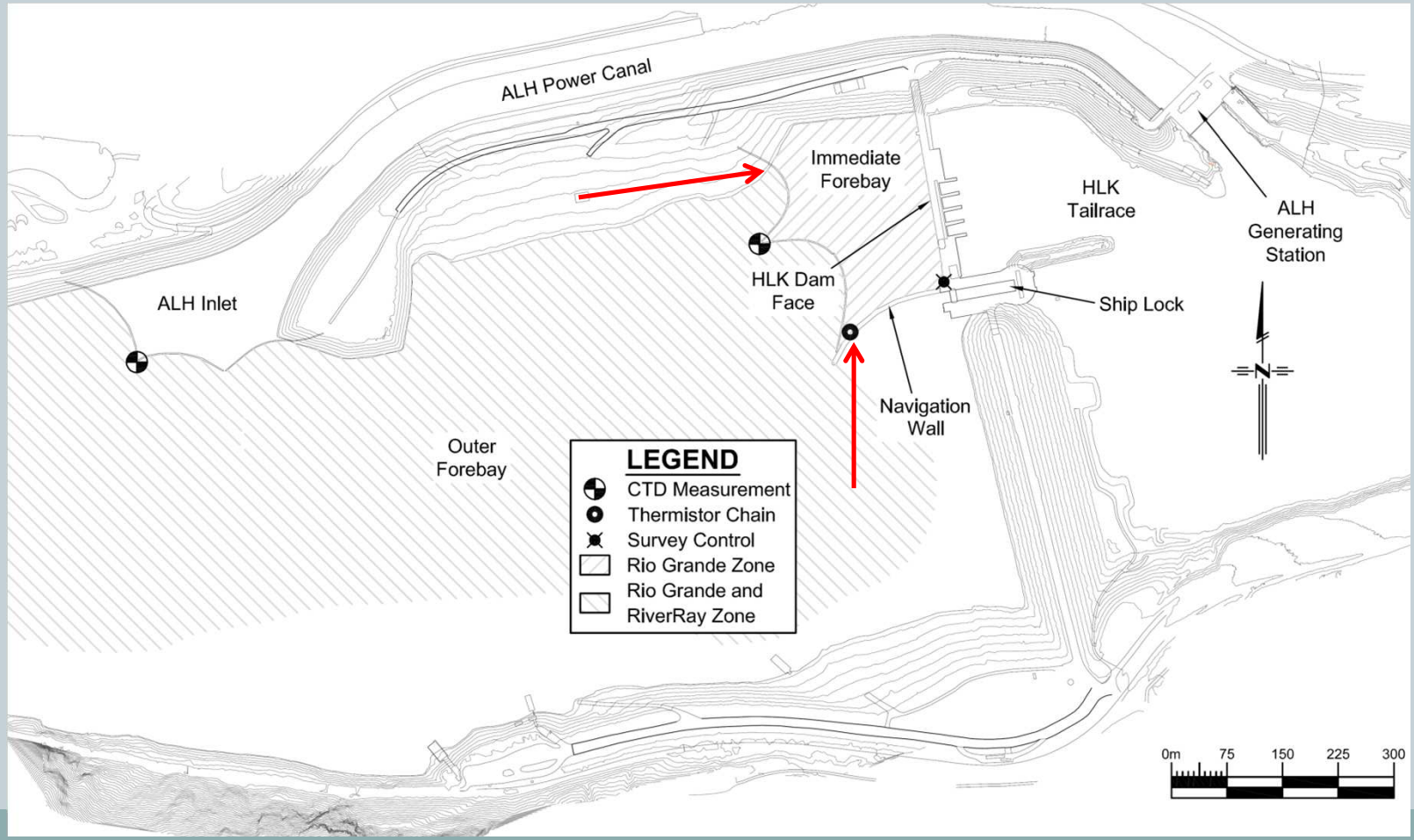
Hugh Keenleyside Dam

HLK Field Work

- Velocity
  - ADCP measurements
- Temperature
  - Thermistor chain measurements

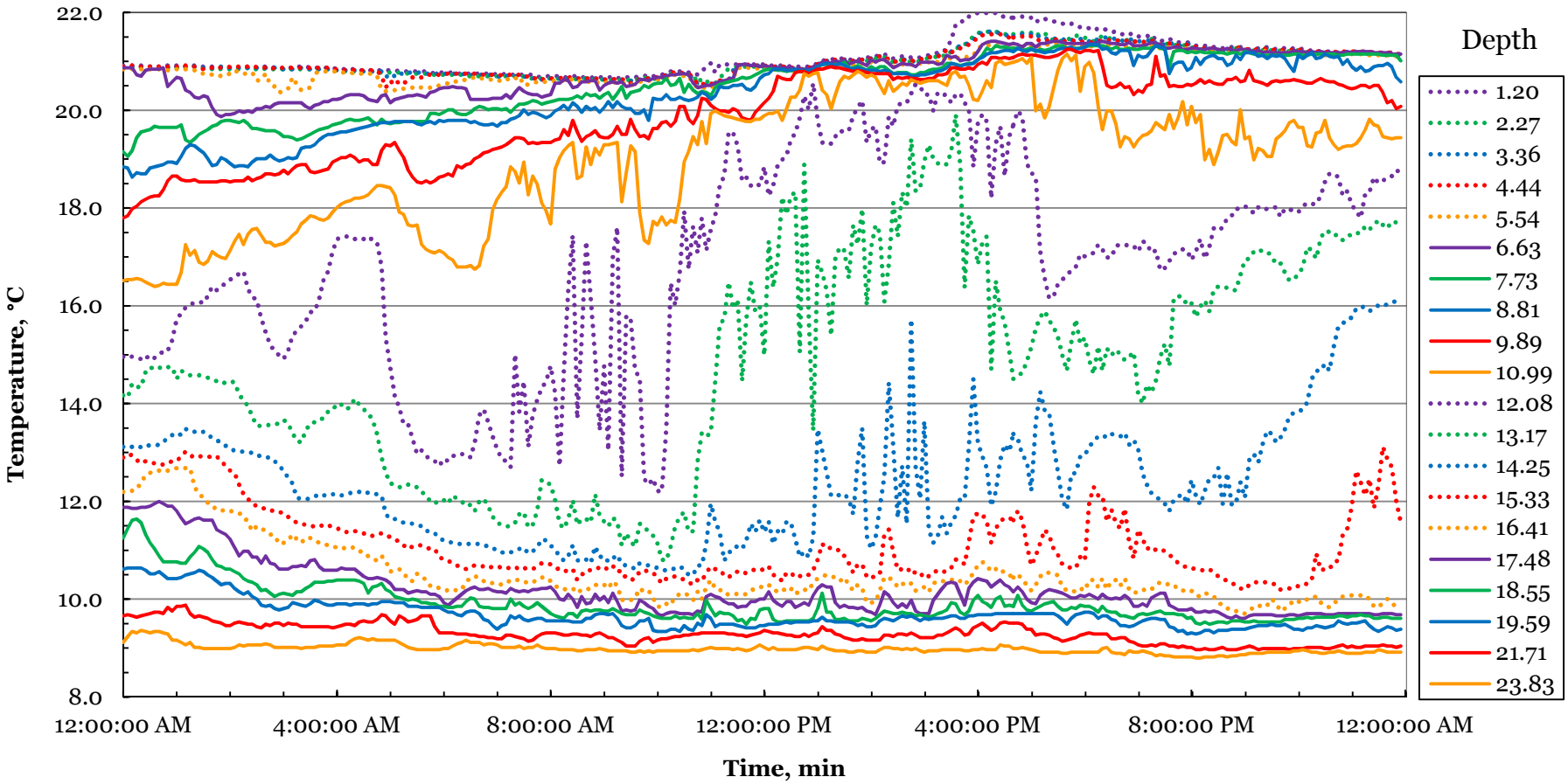
HLK Field Work

- HLK plan view



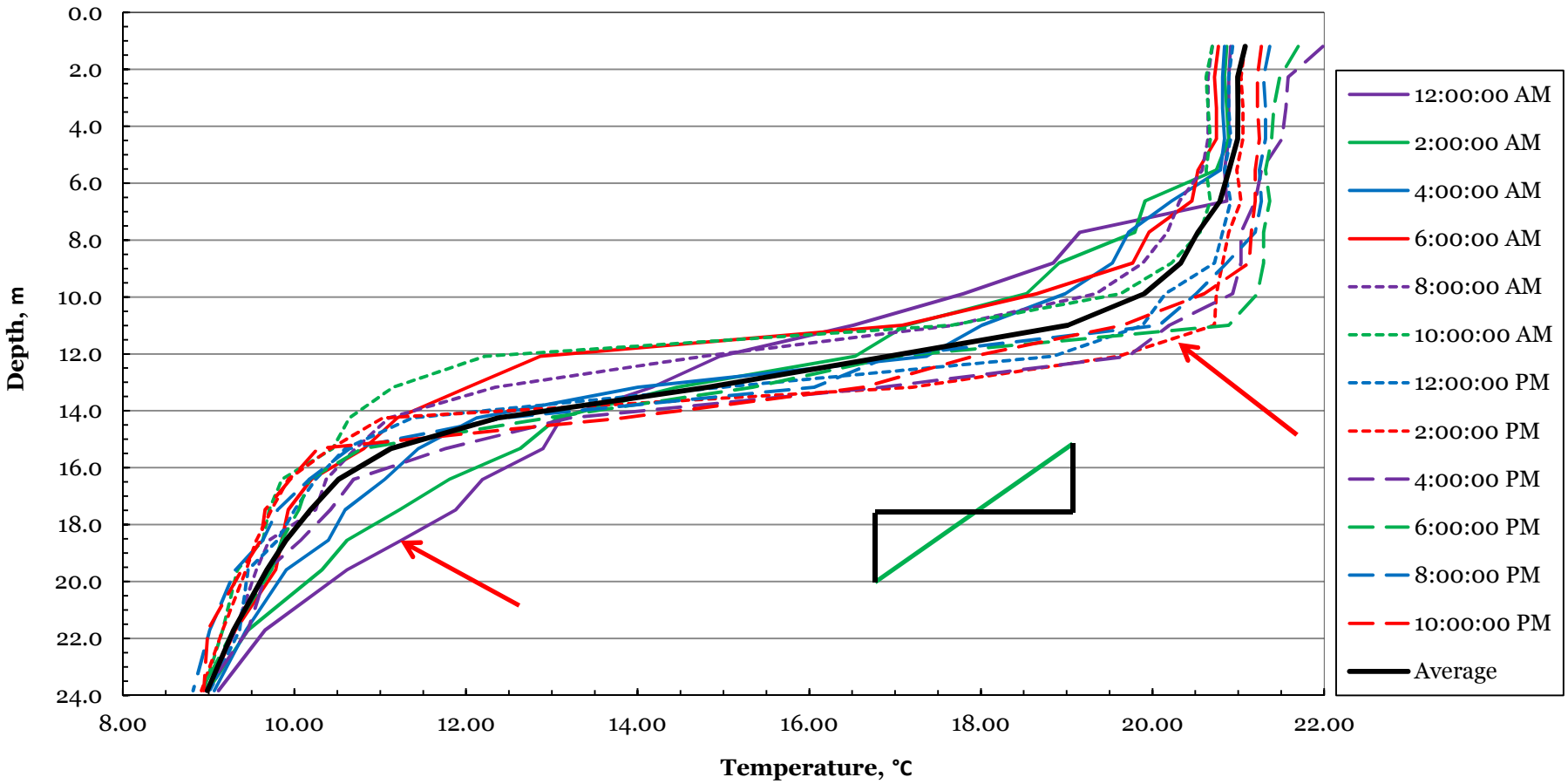
Temperature Measurements

- Daily fluctuations – temperature vs. time



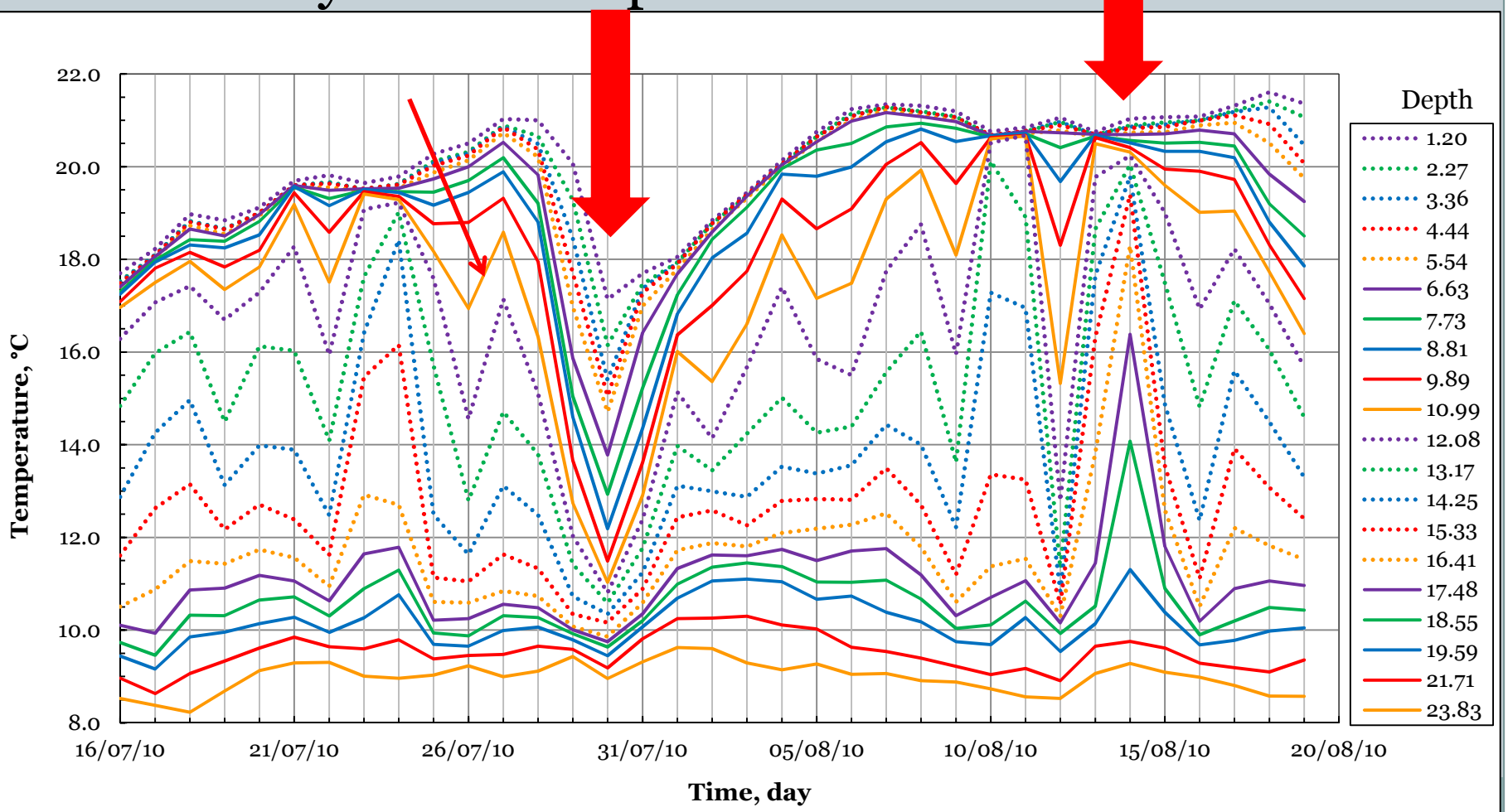
Temperature Measurements

- Daily fluctuations – depth vs. temperature



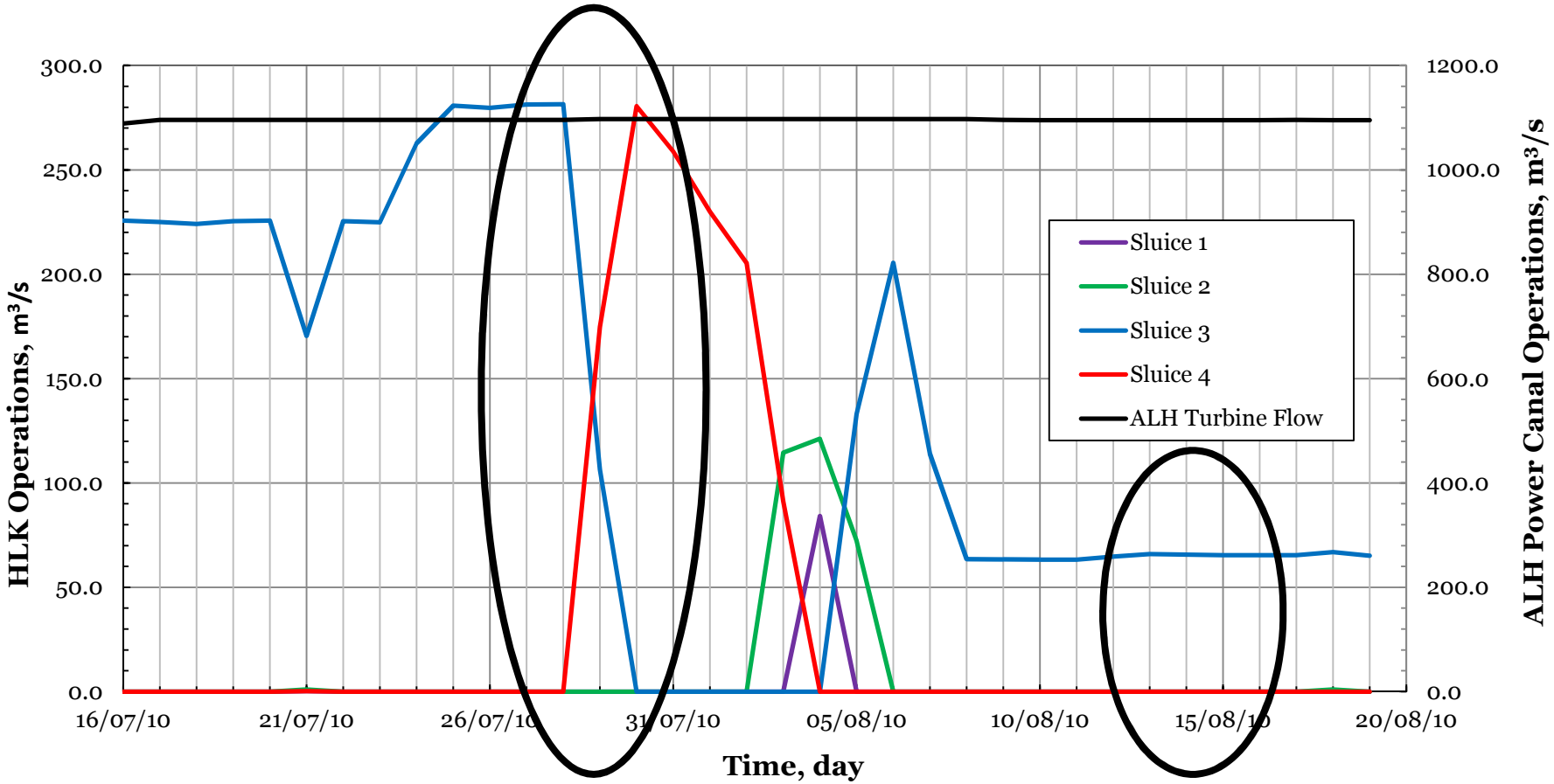
Temperature Measurements

- Mean daily water temperature



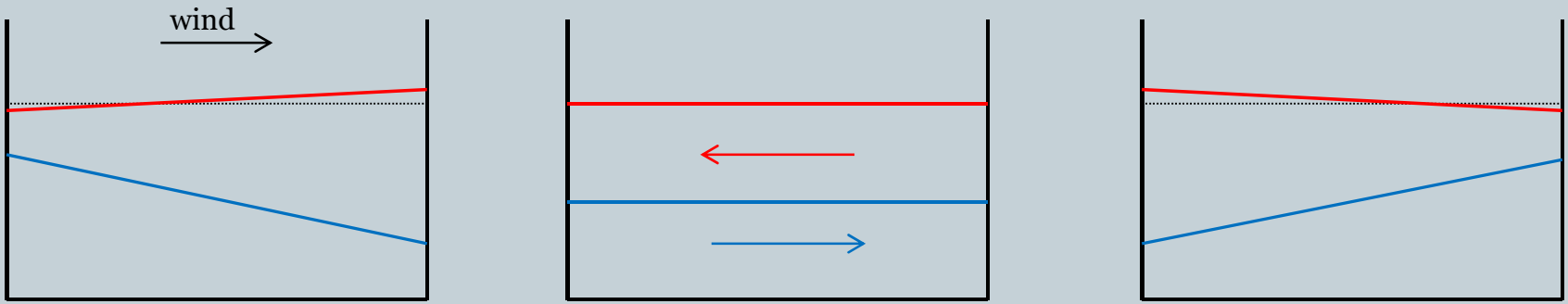
Field Conditions

- HLK and ALH mean daily flow



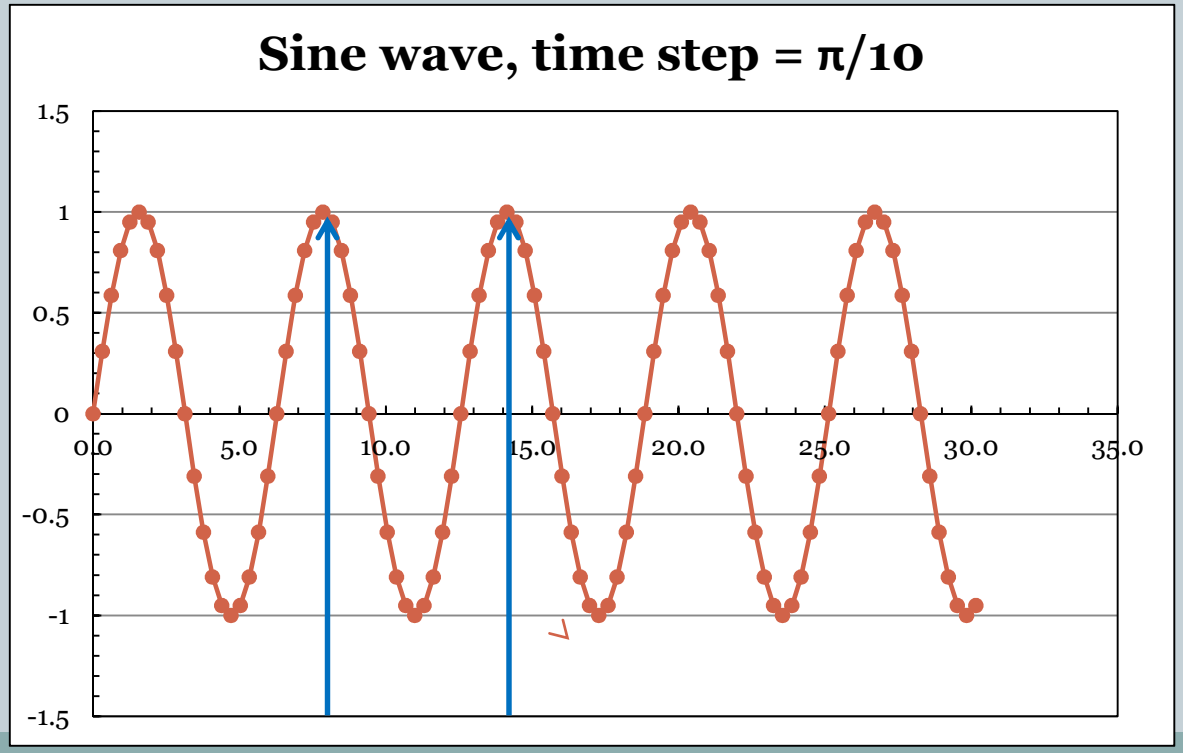
Reservoir Dynamics

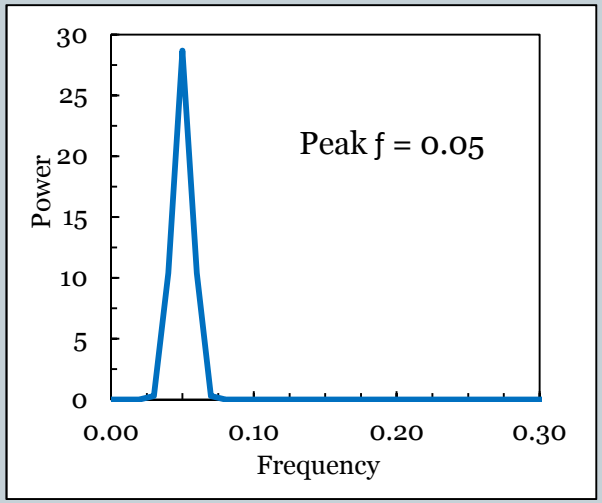
- Seiche effects
  - Wind driven fluctuations
  - Hydropower operation change driven fluctuations
- Stratification during summer months
  - Causes internal seiche



Spectral Analysis

- Measure of fluctuations
- Determines dominant frequency of a time series



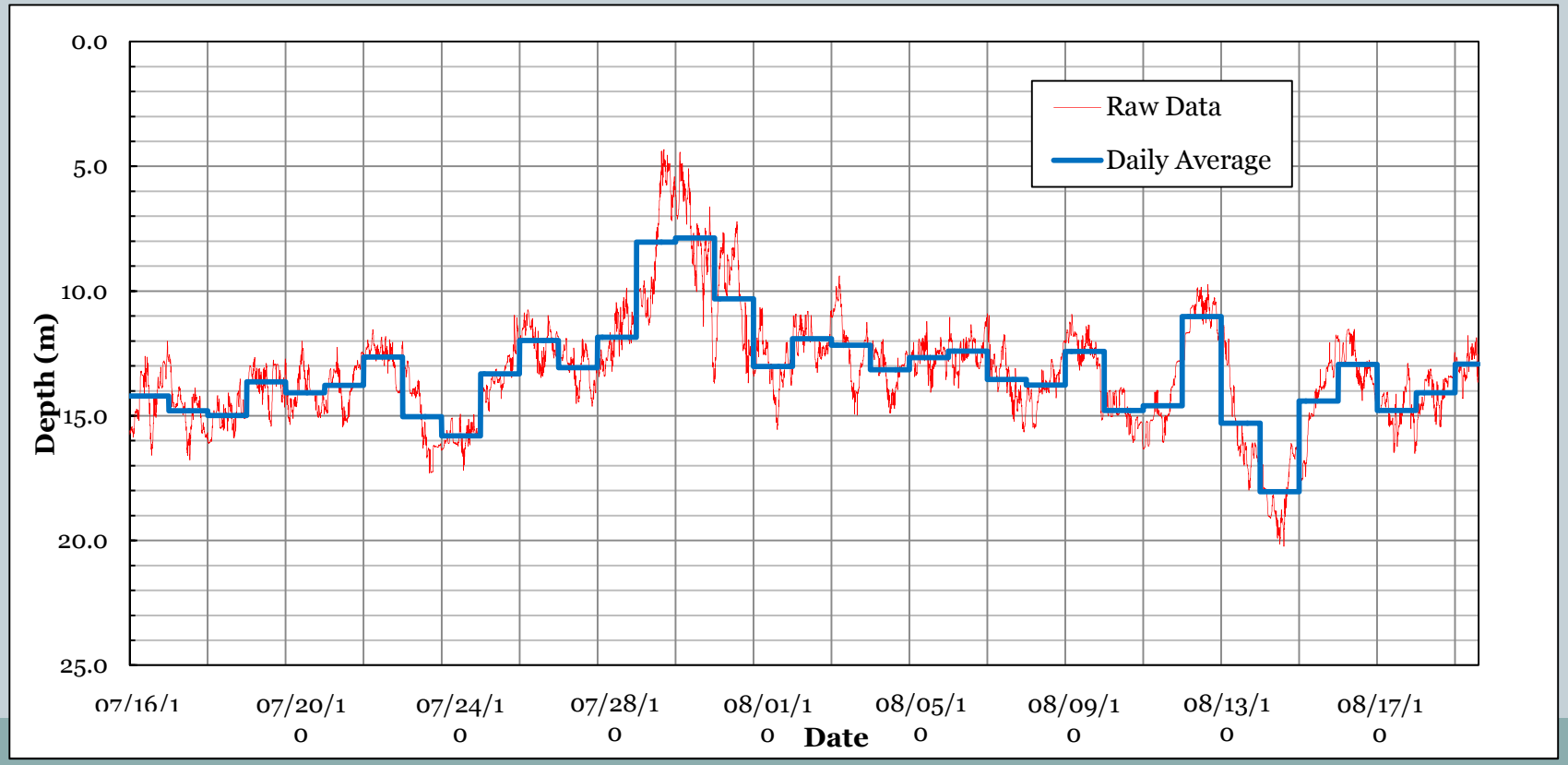


$T = 1/f = 20$

$20 \times (\pi/10) = 2\pi$

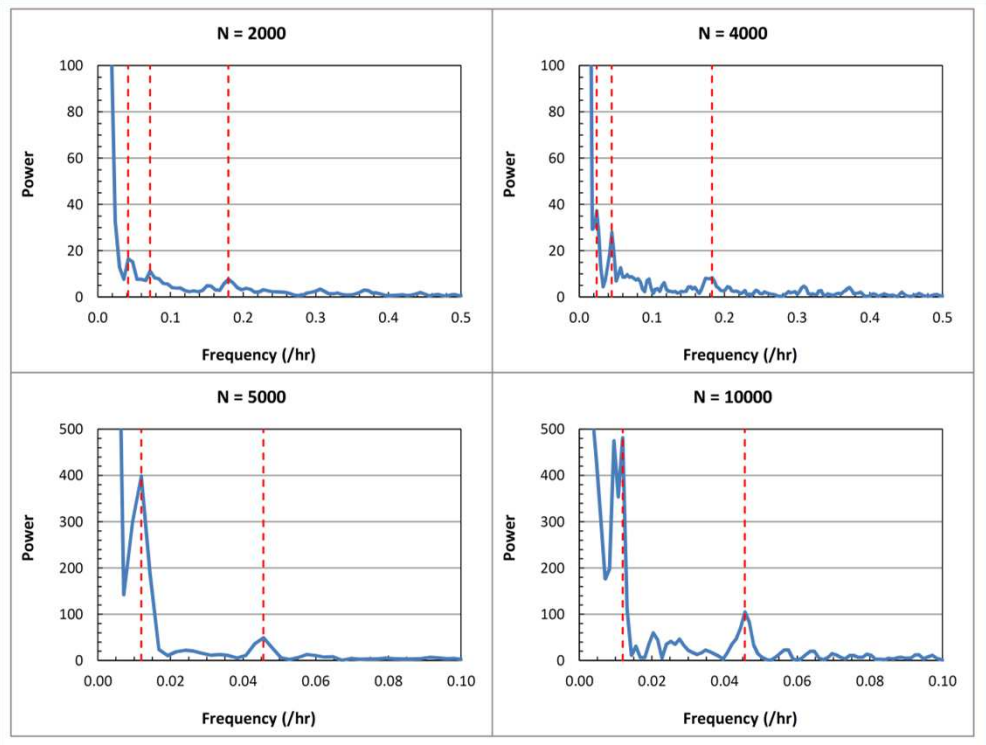
Spectral Analysis

- Developed thermocline depth time series
- 35 days of temperature data



Spectral Analysis

- Dominant oscillation frequencies and periods



N	Frequency (/hr)	Period	
		(hours)	(days)
2000	0.042	23.8	-
	0.072	13.9	-
	0.18	5.6	-
5000	0.012	83.3	3.5
	0.046	21.9	-

Theoretical Calculations

- Thermocline depth oscillation
- Numerous assumptions
  - Rectangular cross section
  - Average epiliminion/hypoliminion depths and temperatures
  - Reservoir length

Theoretical Calculations

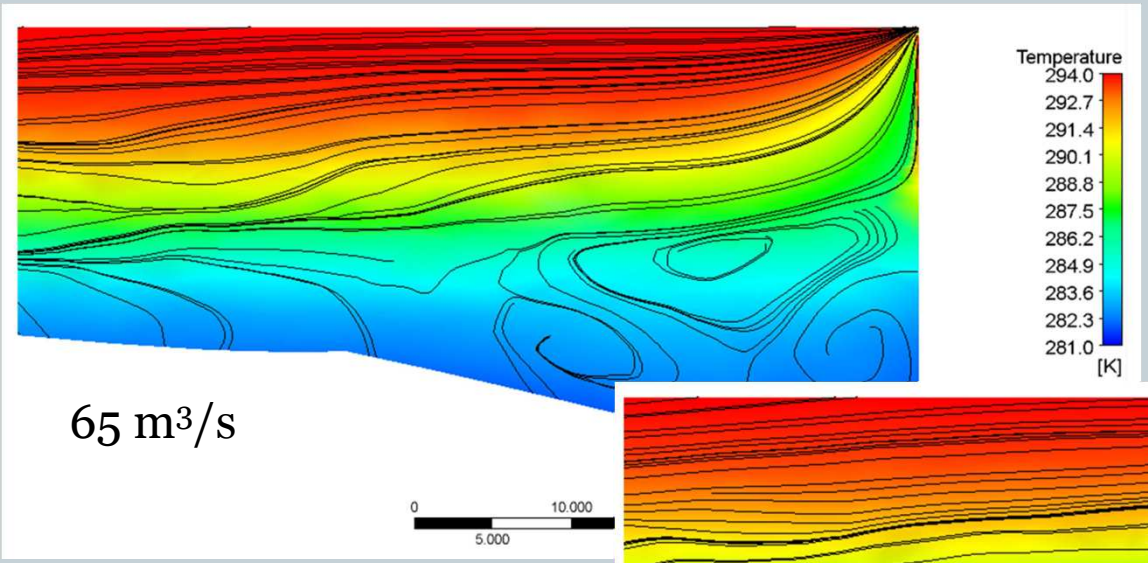
Upstream Boundary Location	Description	Distance Upstream (km)	Thermocline Oscillation Magnitude (m)	Thermocline Oscillation Period
Burton	Located at the major bend where the lake turns from south to west	95	6.69	4.32 d
Deer Park	Located at the major bend where the lake turns from south to east	22	1.55	24.0 hrs
Syringa Narrows	Located at the lake narrowing upstream of the HLK facility near Syringa Creek trail	7.5	0.53	8.16 hrs

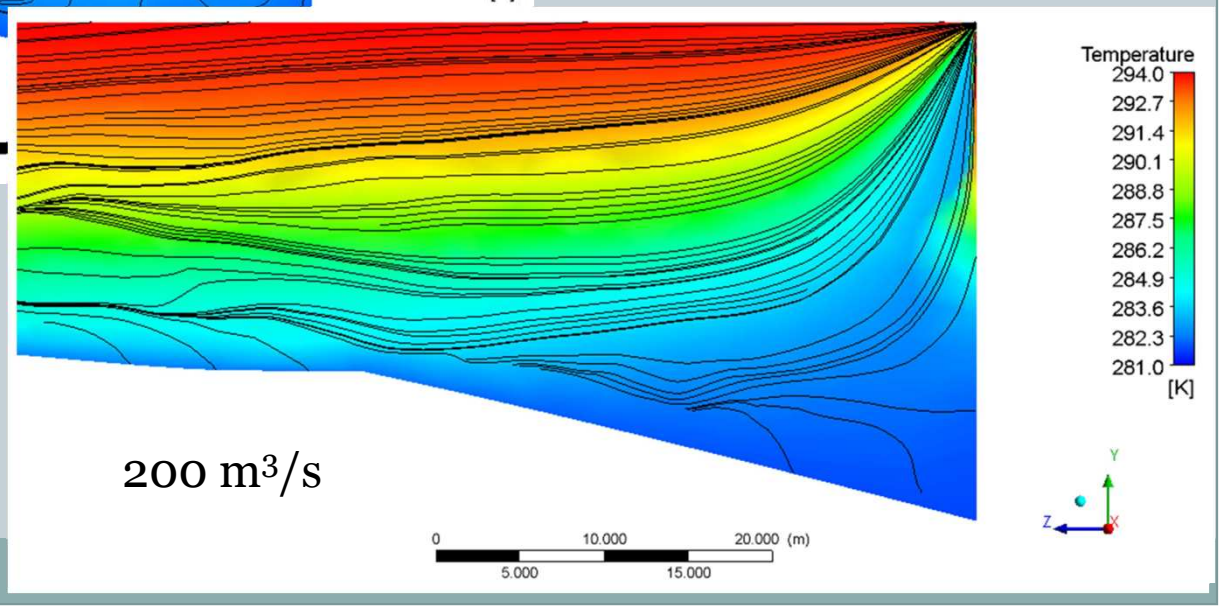
Critical Discharge

- Discharge required to overcome buoyancy forces from thermal gradient
- Calculations with idealized, two layer reservoir
- Point sink solution (Craya)
- Spillway critical discharge = 244 m^3/s
- Field work spillway discharge = 65 m^3/s

Critical Discharge

- Computational fluid dynamics model





Thank You

- Questions?