Case Study
HEC-RAS Model Utilization for Fish Habitat Assessment Studies

Dr. AhmadReza Ghavasieh and Ion Corbu
Corbu Consulting

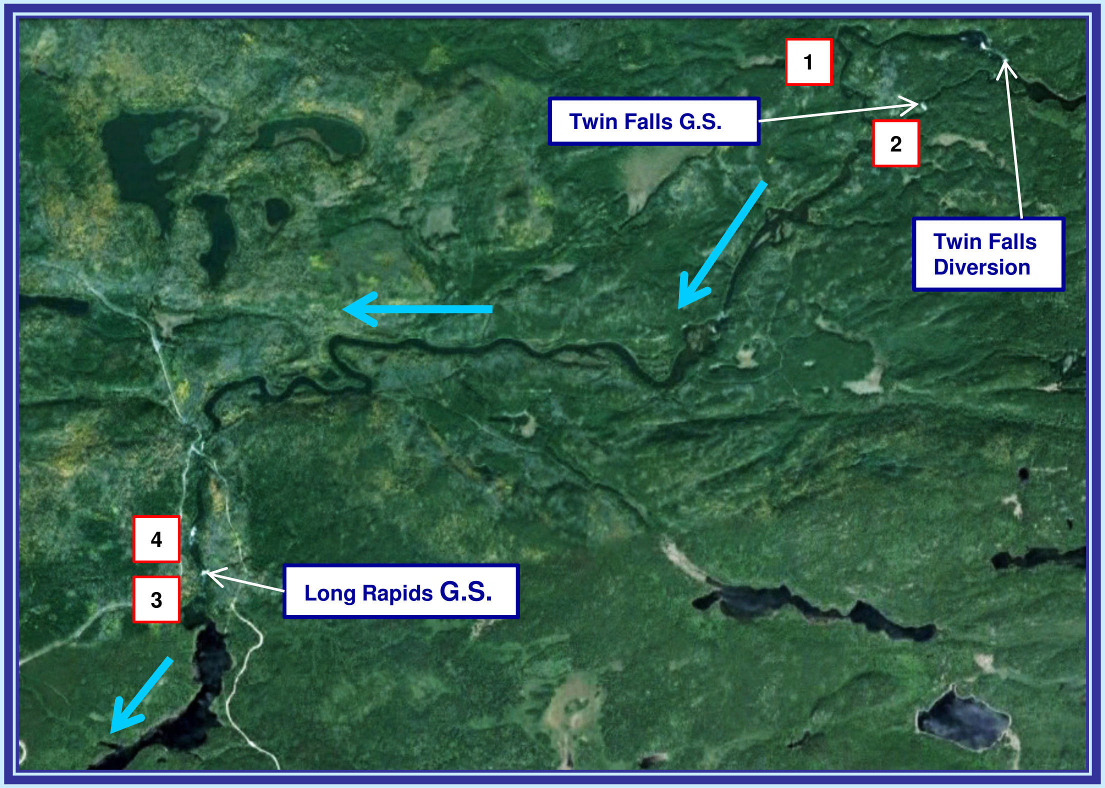
Agenda

1. Introduction
2. Field Investigations
3. HEC-RAS Model Overview
4. Use of HEC-RAS for fish habitat studies
5. Conclusions

Note: Material for the presentation was provided by courtesy of AXOR

Namewaminikan Hydro Project Location

Development Sites

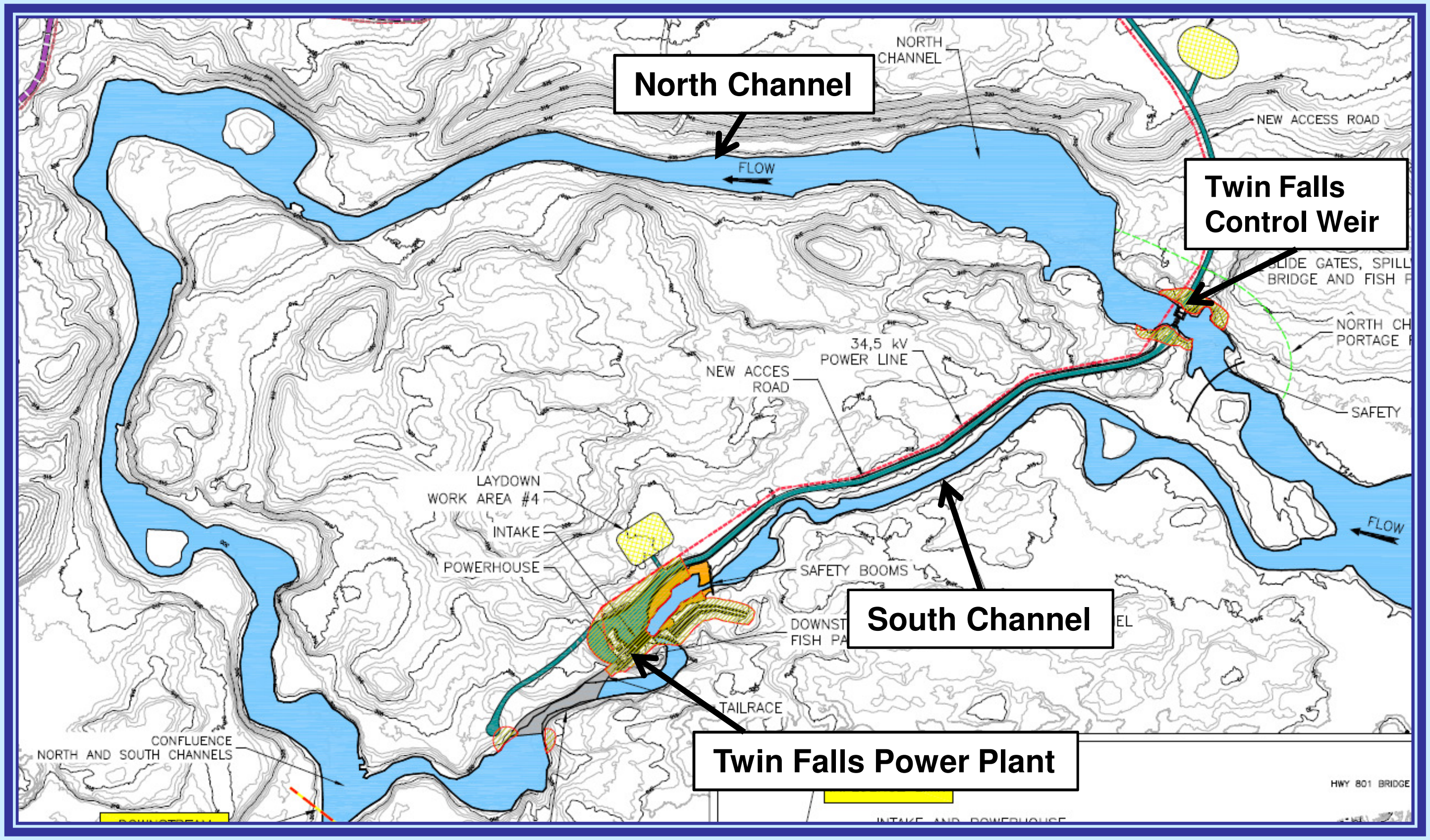


River sections studied for fish habitat loss/gain in post development conditions:

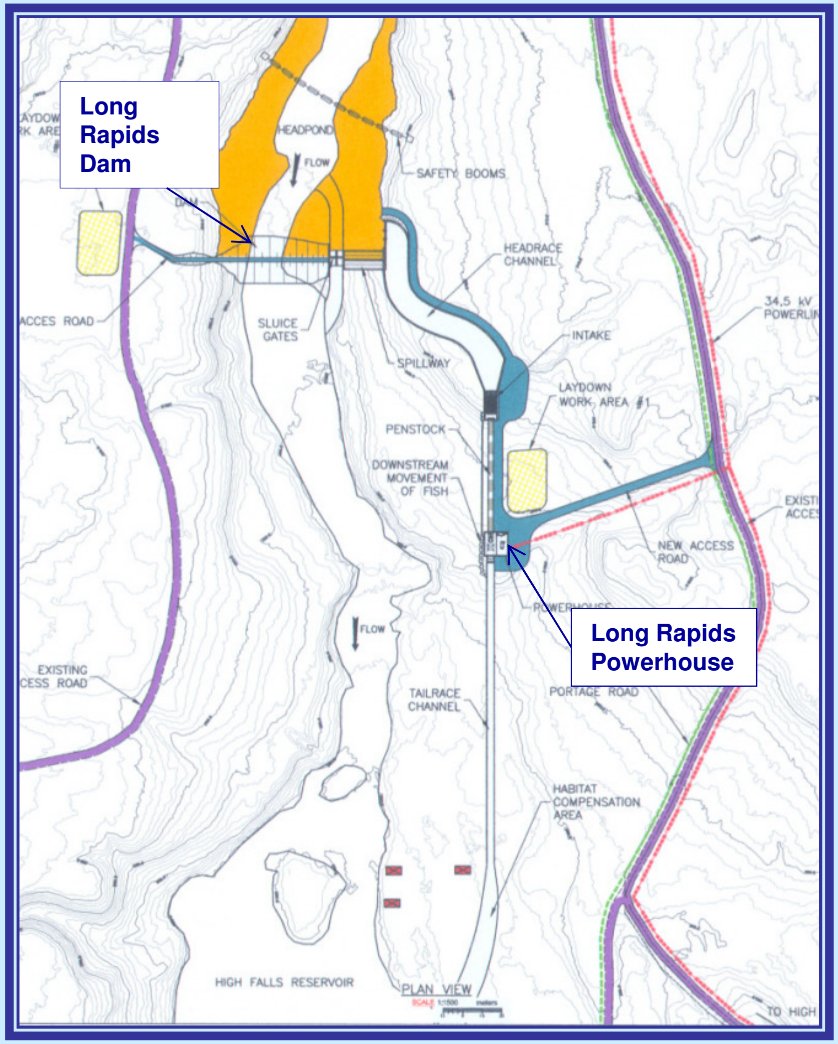
1. **Twin Falls North Channel – downstream of the control weir**
2. **Twin Falls South Channel – downstream of the hydroelectric power plant**
3. **Long Rapids – downstream of the dam**
4. **Long Rapids – upstream of the dam**

Map Source: Google earth

Twin Falls Site Characteristics



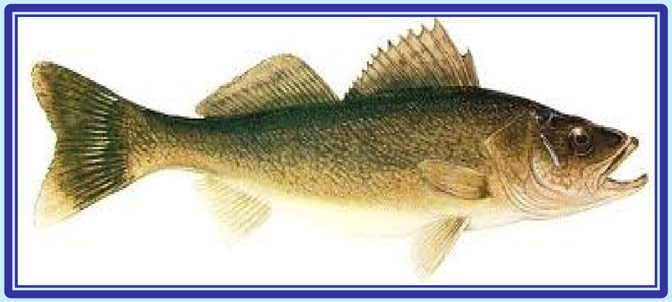
Long Rapids Site Characteristics



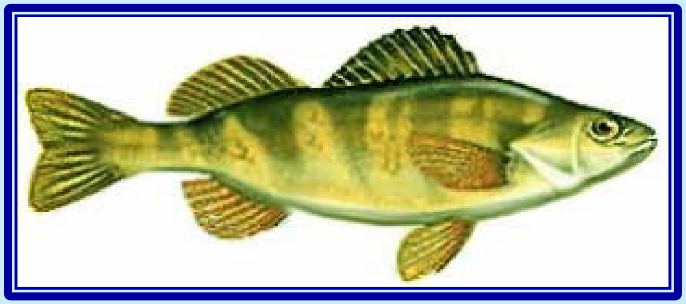
Field Investigations

- Fish and Fish Habitat
- Topography, Bathymetry, and LiDAR surveys
- Aerial Photographs
- Hydrologic Measurements

Fish Species in Namewaminikan River



Walleye

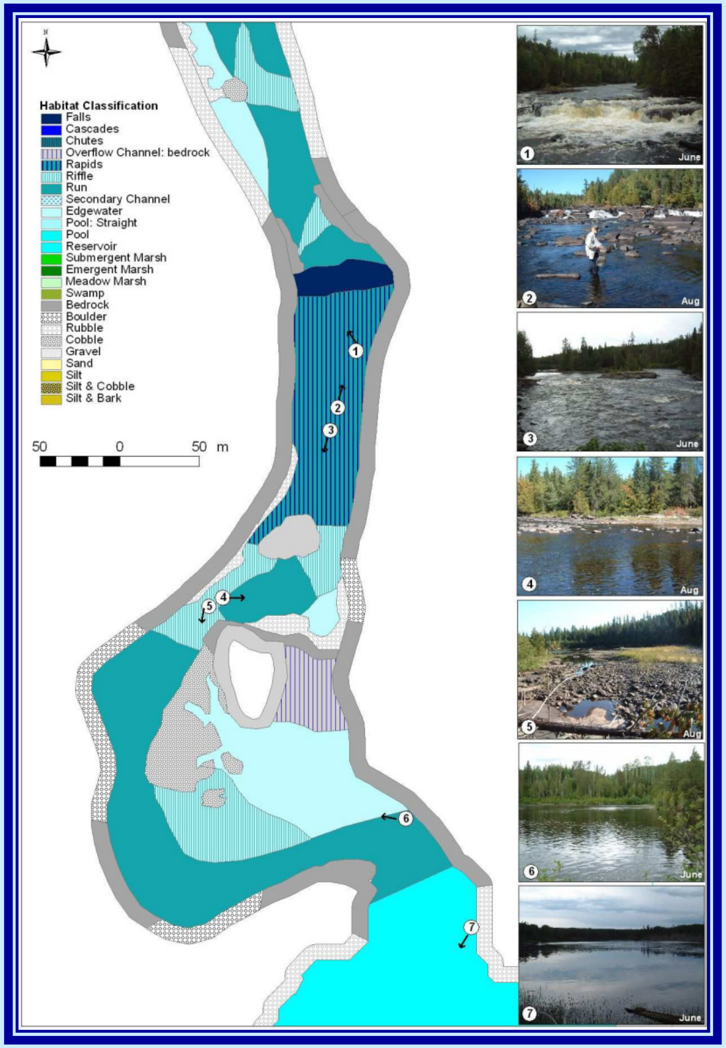


Yellow Perch

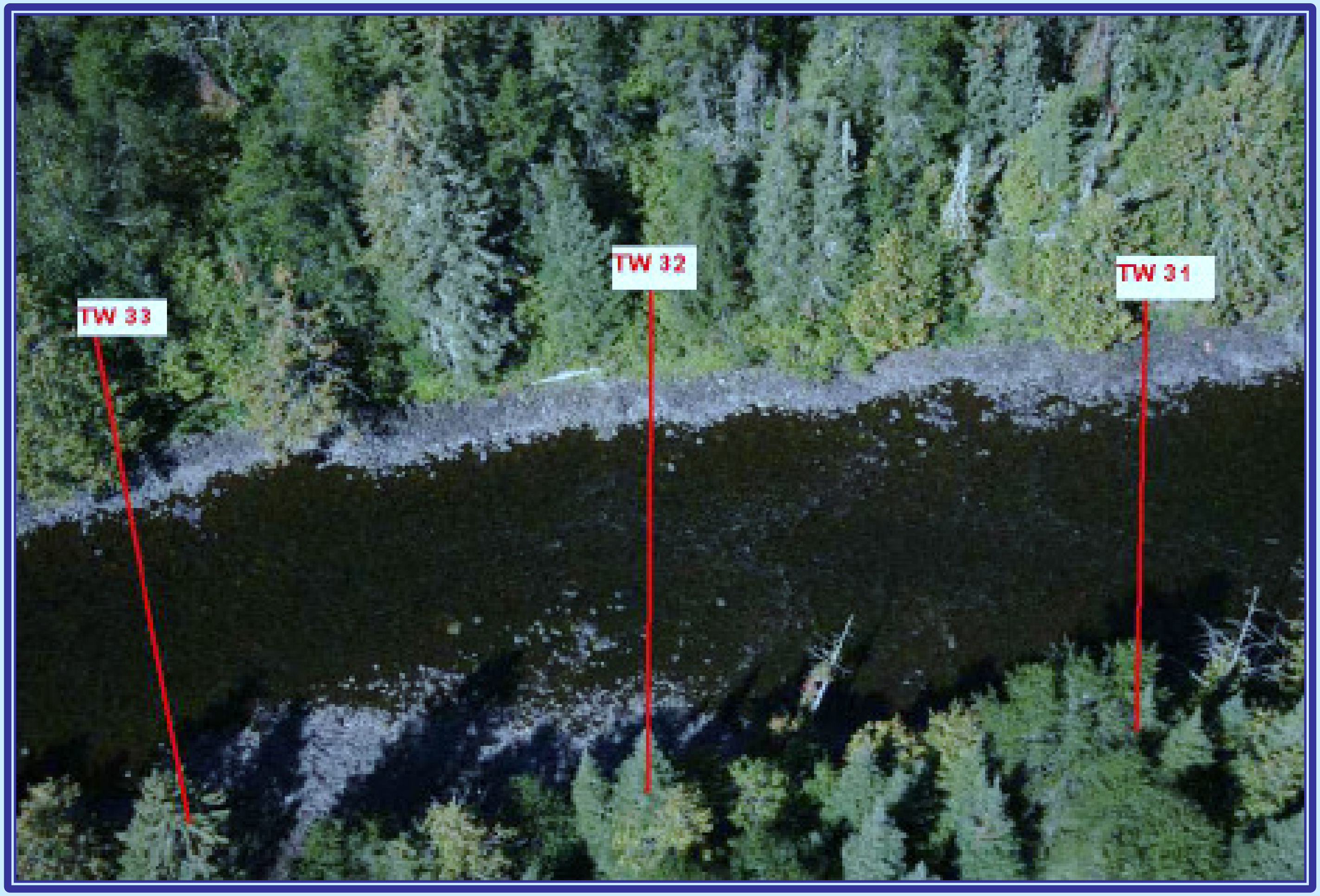
Northern Pike

White Sucker

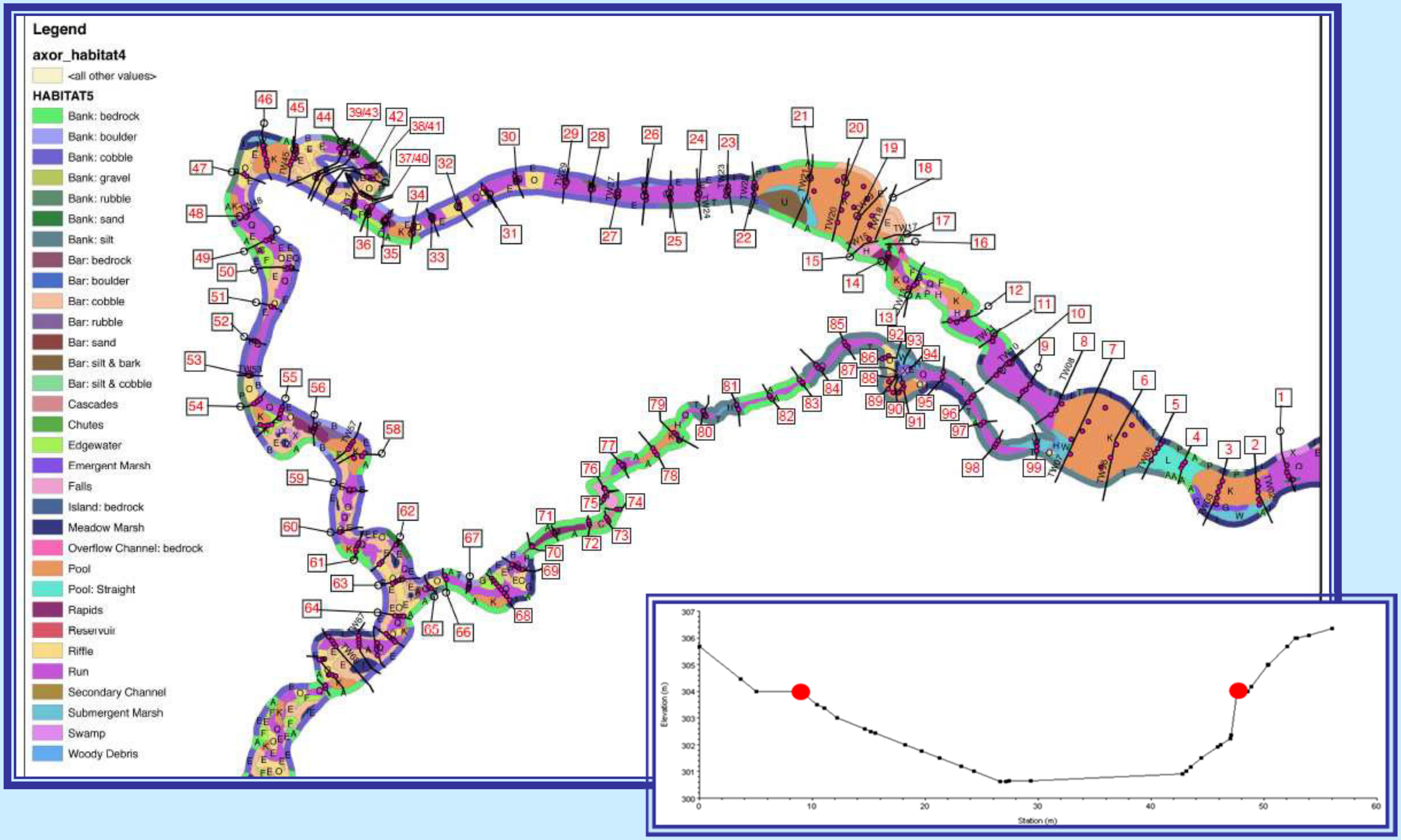
Example of Habitat Mapping



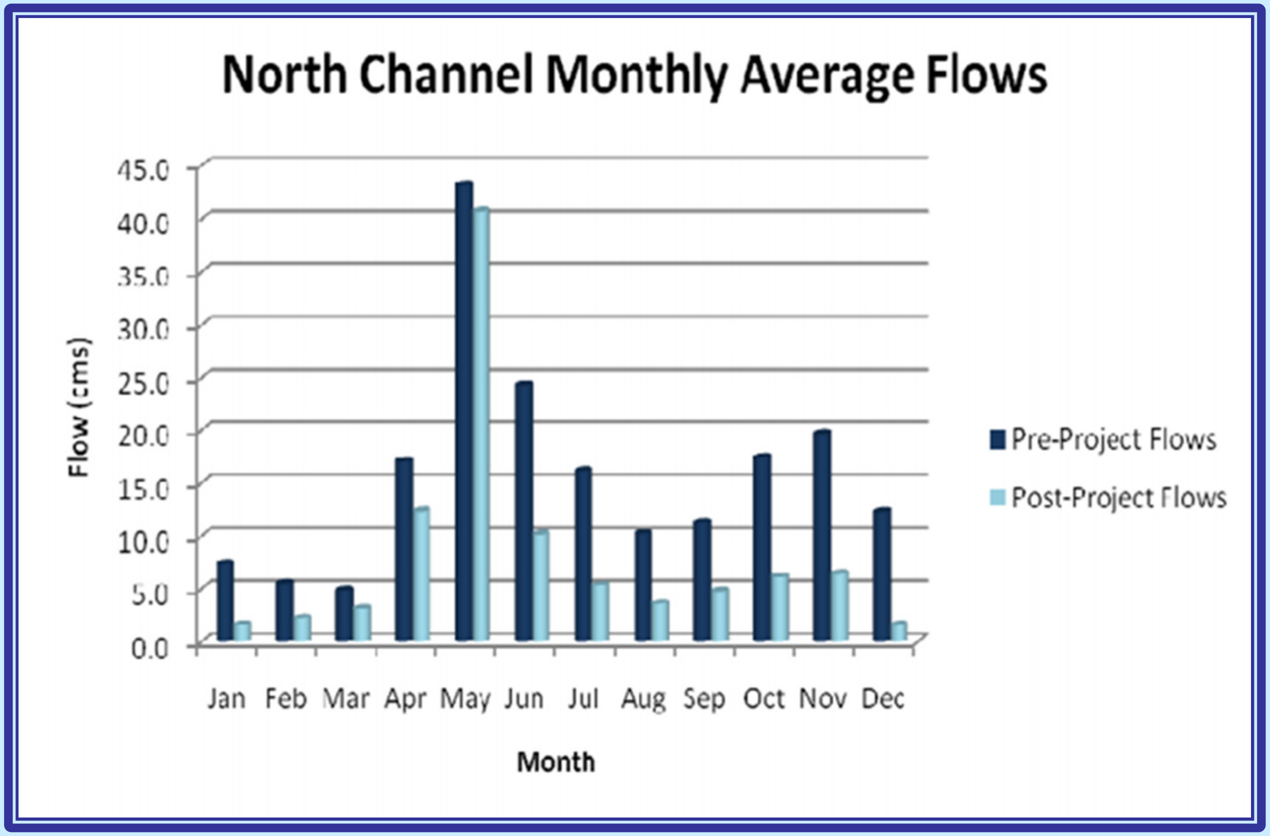
Aerial photo with overlay of X-Sections



Twin Falls Site with X-Sections



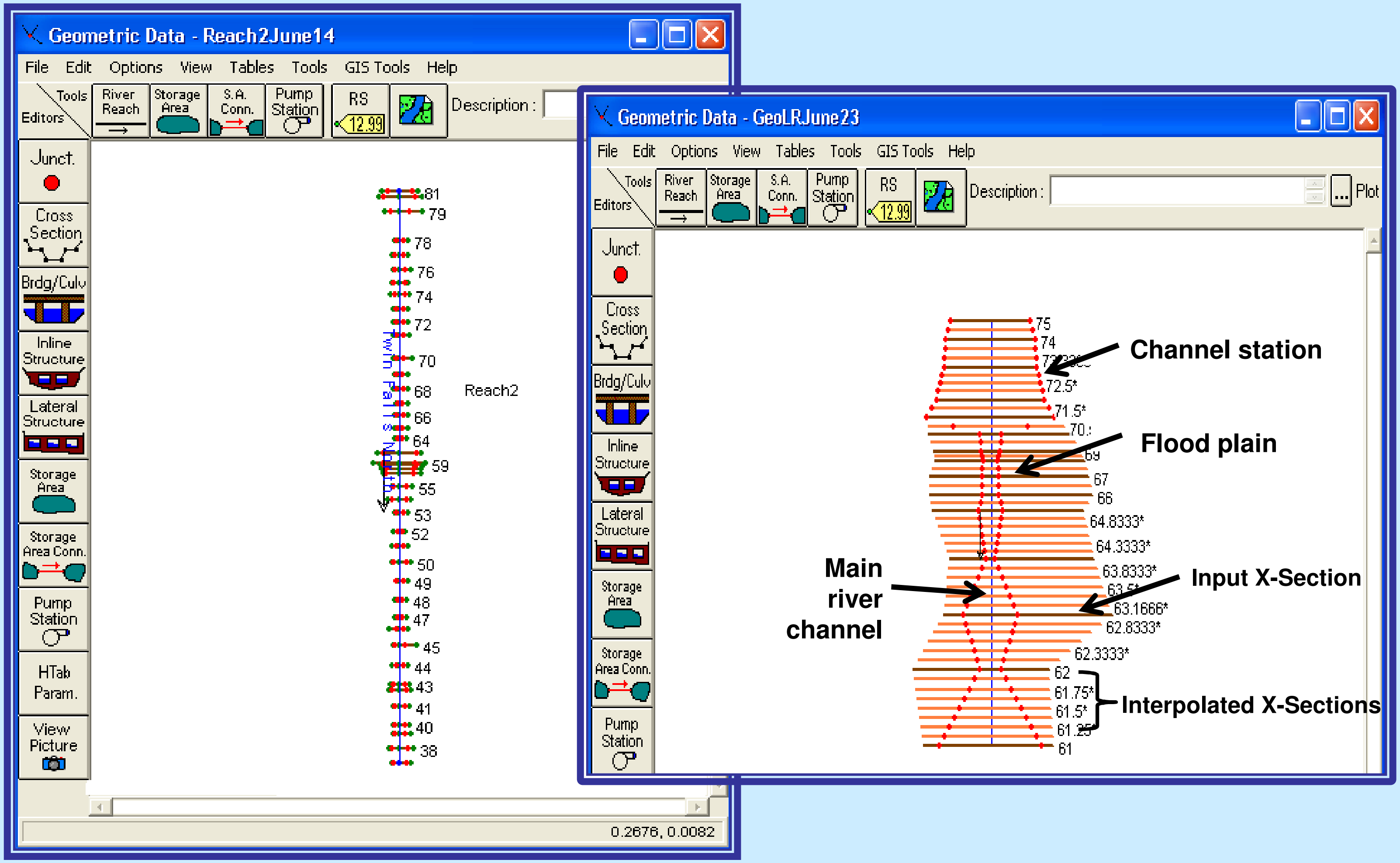
Hydrology


North Channel Monthly Average Flows
Flow (cms)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
Pre-Project Flows
Post-Project Flows

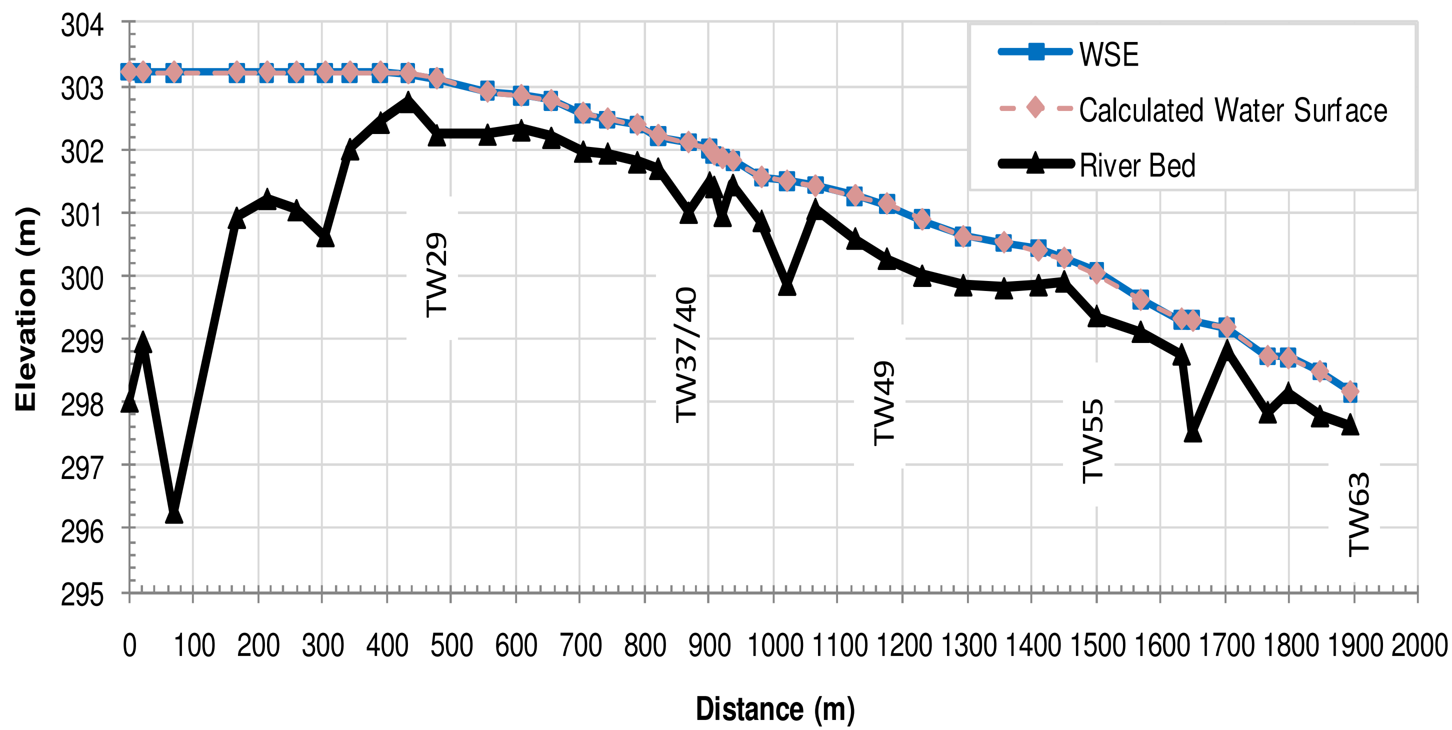
HEC-RAS Model Setup

- Preparing the GIS files with X-Section geometry
- Elimination of model-incompatible X-Sections
- Eliminating excess points in X-sections
- Defining channel stations
- Assuming initial Manning Coefficient values
- Interpolating between X-sections
- Stability tests
- Model calibration

HEC-RAS representation of X- Sections



Model Calibration

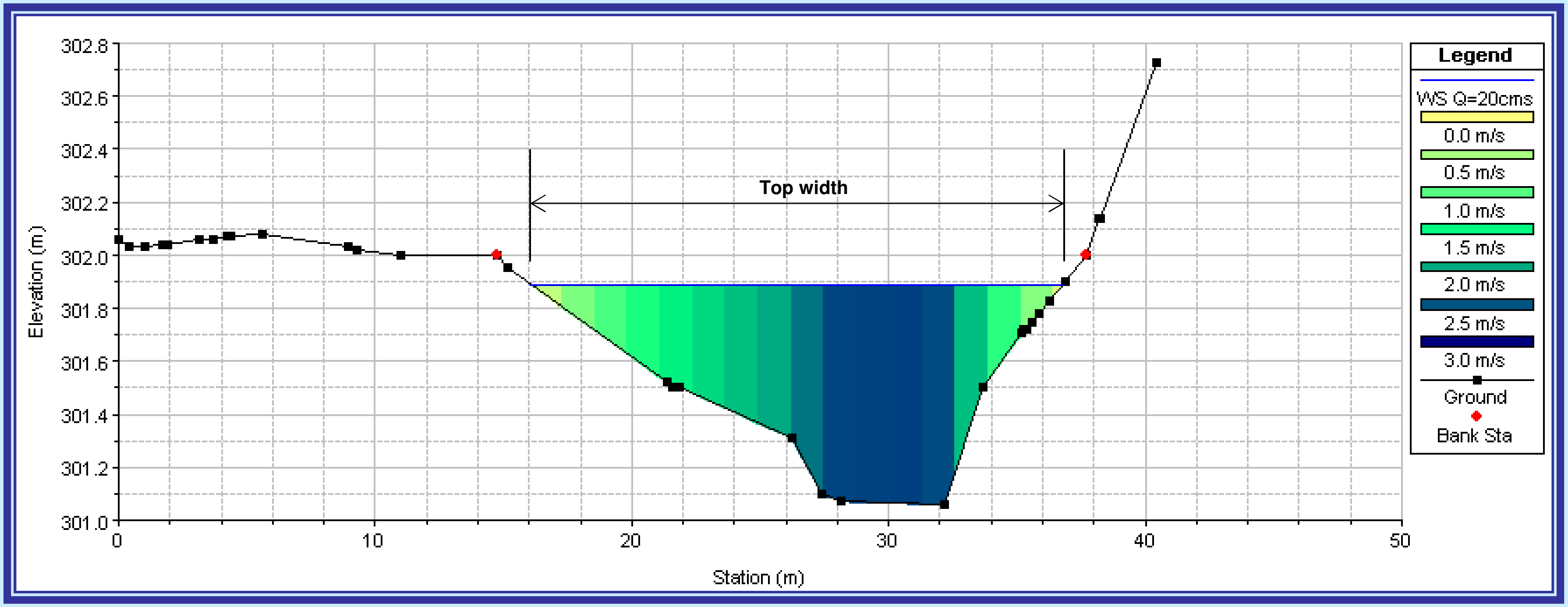


Example of model output

River Station	Flow depth (m)	Velocity (m/s)	Flow Area (m^2)	Top Width (m)	Froude Number
TW34	0.32	0.26	3.80	17.32	0.18
TW35	0.36	0.34	2.99	16.89	0.25
TW36	0.31	0.55	1.82	15.97	0.52
TW37/40	0.78	0.08	12.14	30.22	0.04
TW38/41	0.27	0.48	2.09	14.16	0.40
TW42	0.27	0.44	2.29	10.56	0.30

Note: The highlighted columns will be used in the fish habitat study

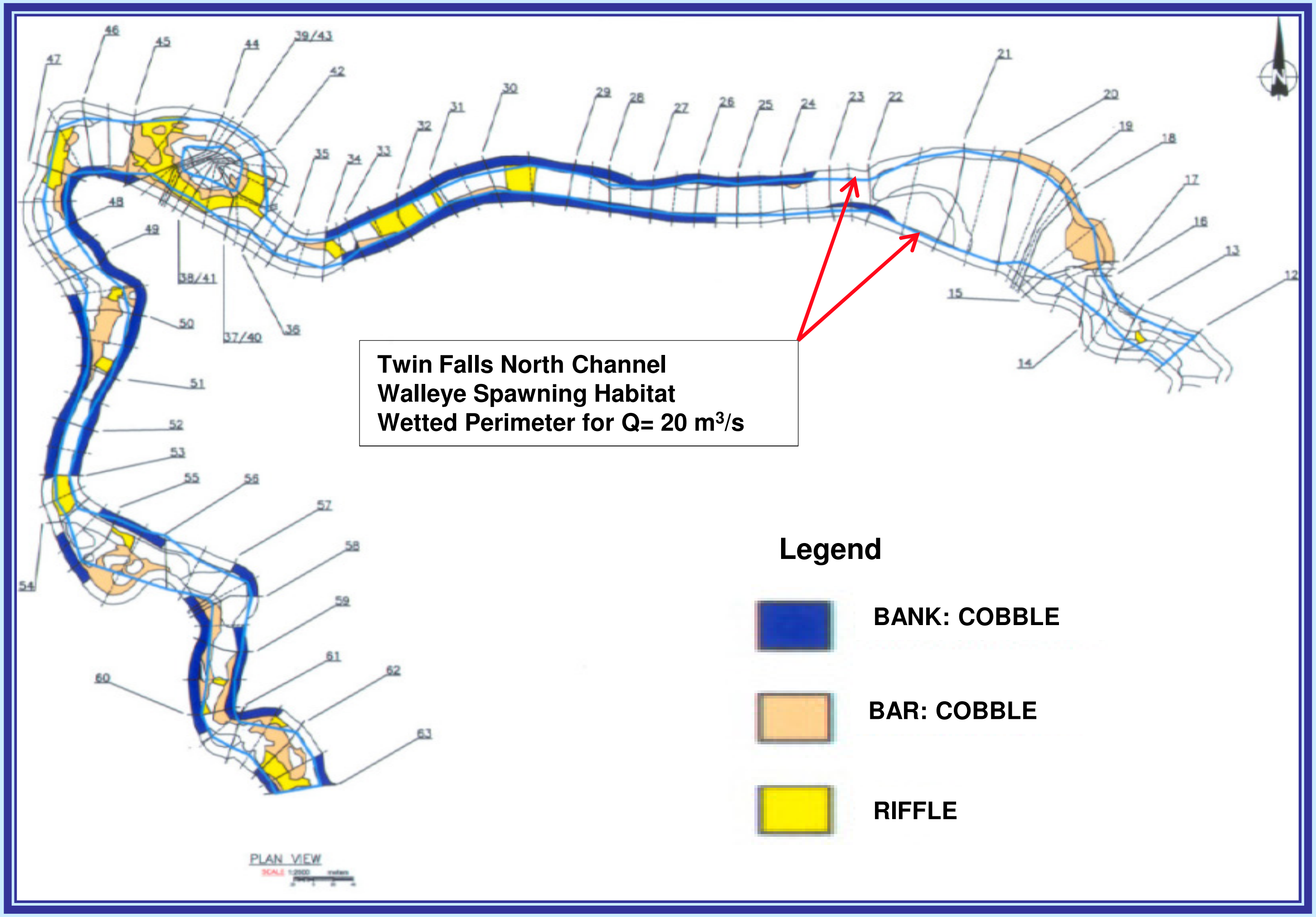
HEC-RAS X-Section with velocities



X-Section TW-47; Q= 20 m^3/s

The HEC-RAS flow distribution option was used to determine velocities and hydraulic depth in each "slice" of each X-Section.

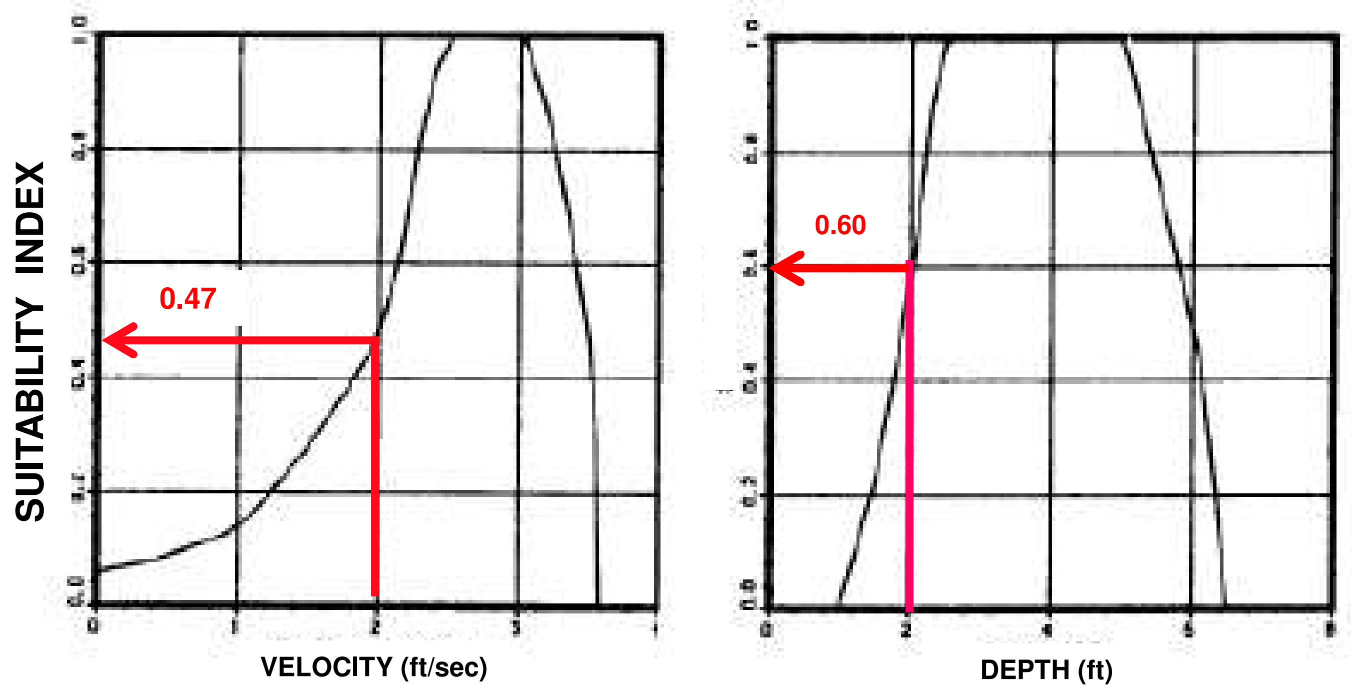
HEC-RAS use for calculating wetted areas



Flows for loss/gain habitat analysis

Walleye life stage habitats	Period	Median Pre-project flows (m^3/s)	Median Post-project flows (m^3/s)
Spawning habitats	Mid-April to Mid-May	34.3	20.6
Adult habitats	End of June to end of October	10.7	2
Juvenile habitats	End of June to end of October	10.7	2

Suitability Index Curves: Spawning Habitat



Fish Habitat Study Methodology

1. **Run HEC-RAS for selected walleye habitats in pre and post development conditions**
2. **Use model generated velocities and depths for each vertical slice to produce the corresponding Suitability Indices SI_v, Si_d**
3. **Calculate the Average SI for each slice of each X-Section**
4. **Calculate the Global SI (GSI) for each X-Section**
5. **Determine the Habitat Surface Area (HSA) for each X-Section**
6. **Calculate the product of GSI*HSA for each X-Section**
7. **Calculate the overall Suitability Area for the given river reach and habitat**
8. **Determine the post development loss/gain in habitat Suitability Areas**

Fish Habitat Study Results

Selected Habitats	Pre-project conditions		Post-project conditions		Habitat loss/gain area (m^2)
	Median flow (m^3/s)	Habitat area (m^2)	Median flow (m^3/s)	Habitat area (m^2)	
Spawning	34.3	12,425	20.6	9,092	-3,333
Adult	10.7	16,983	2.0	16,356	-627
Juvenile	10.7	17,778	2.0	15,363	-2,415

Result: A habitat compensation plan is required

Estimated MIFs

Season	Period	Walleye life stage	Twin Falls MIFs (m^3/s)
Early Spring	Mid-April to Mid-May	Spawning	5
Late Spring	Mid-May to end of June	Incubation and larval drift	3.5
Summer / Fall	End of June to end of October	Nursery/Adult and Juvenile rearing	2
Winter	November to Mid-April	Overwintering	1

HEC-RAS was run with the above MIF values. The model generated water depths and velocities in each vertical slice of each river X-section and confirmed that the estimated MIF flows are adequate for meeting walleye requirements.

Conclusions

- HEC-RAS is a robust tool for simulating hydraulic conditions in open channels
- HEC-RAS can be used reliably for fish habitat studies and represents a good fit when used in conjunction with the Habitat Suitability Indices (HSI) methodology
- HEC-RAS can be used to confirm the seasonal MIFs estimates which protect fish resources and the entire aquatic ecosystem, year-round
- This study indicated that the proponent is required to provide a fish habitat compensation plan to mitigate the expected habitat losses in this reach of the river

Thanks

- The authors would like to thank Namewaminikan Hydro and AXOR Group staff, for the numerous significant contributions made to the studies referred to in this presentation

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- More information can be obtained from:

  - Ion Corbu, Corbu Consulting: icorbu@corbuconsulting.com
  - Simon Gourdeau, Namewaminikan Hydro: gourdeau@axor.com