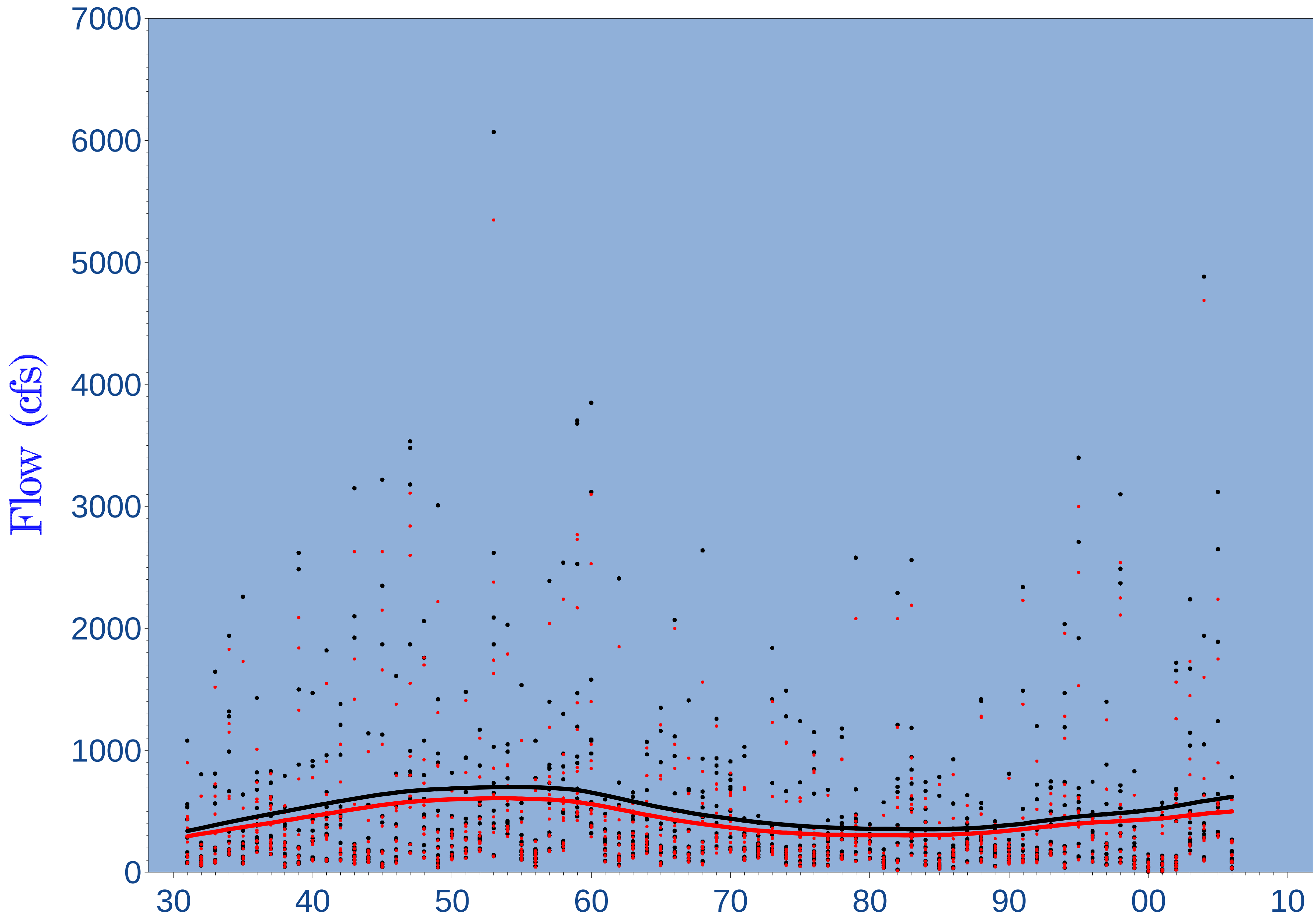


Figure 5.1 Monthly minimum (red) and 10th percentile (black) flow over time at the Peace River at Arcadia

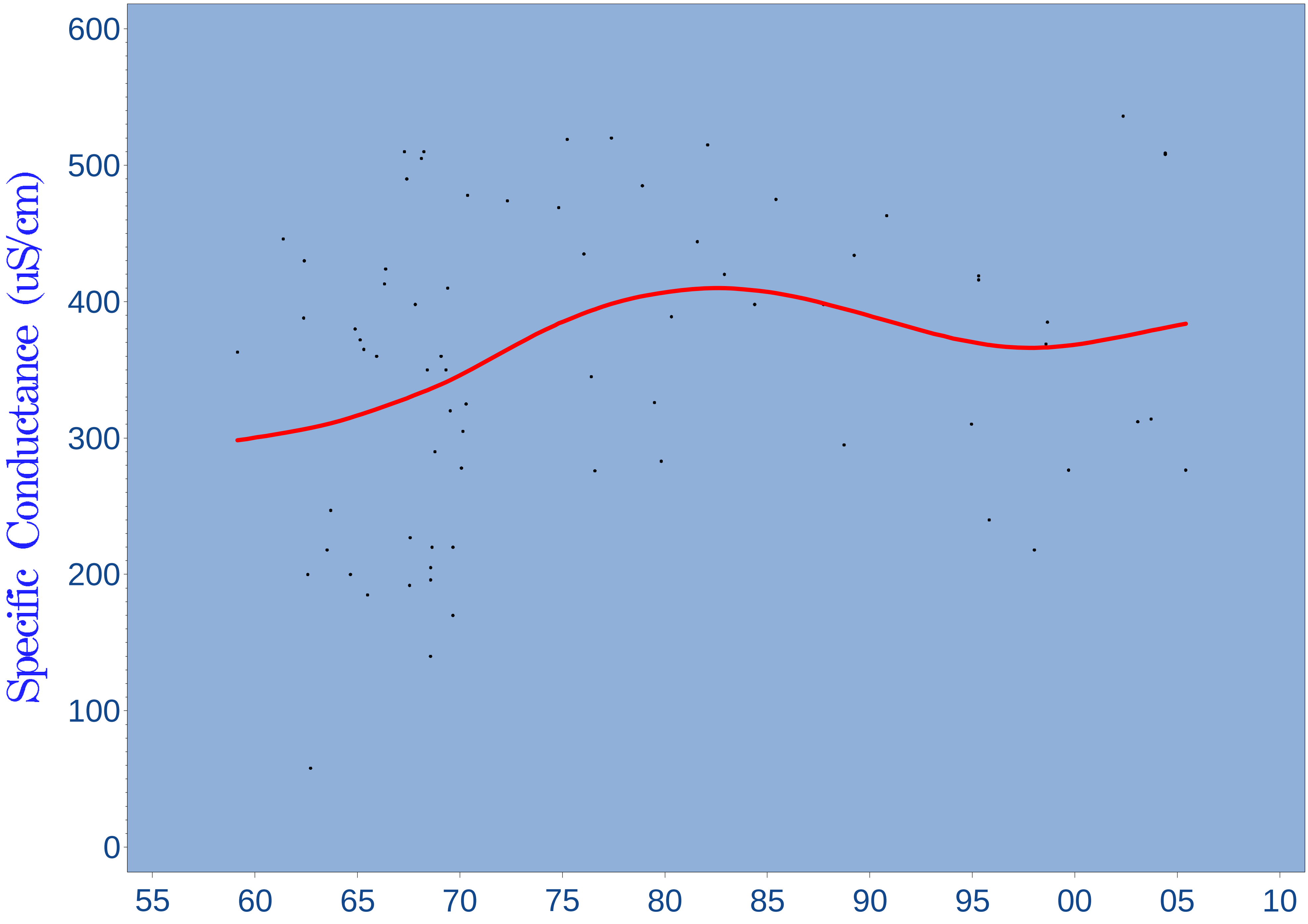


Figure 5.2 Specific conductance over time in the Peace River at Arcadia during low flows (<10th percentile)

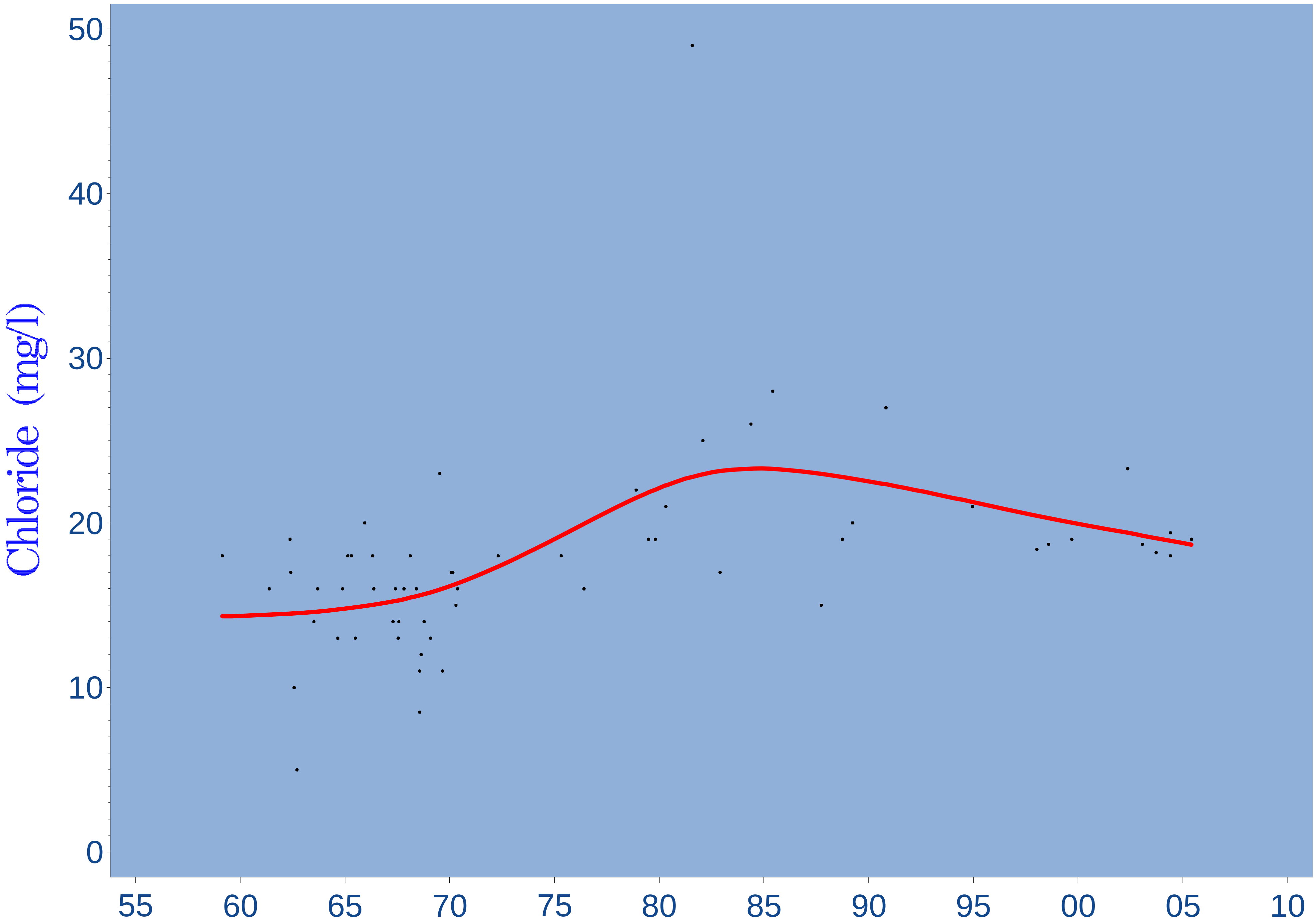
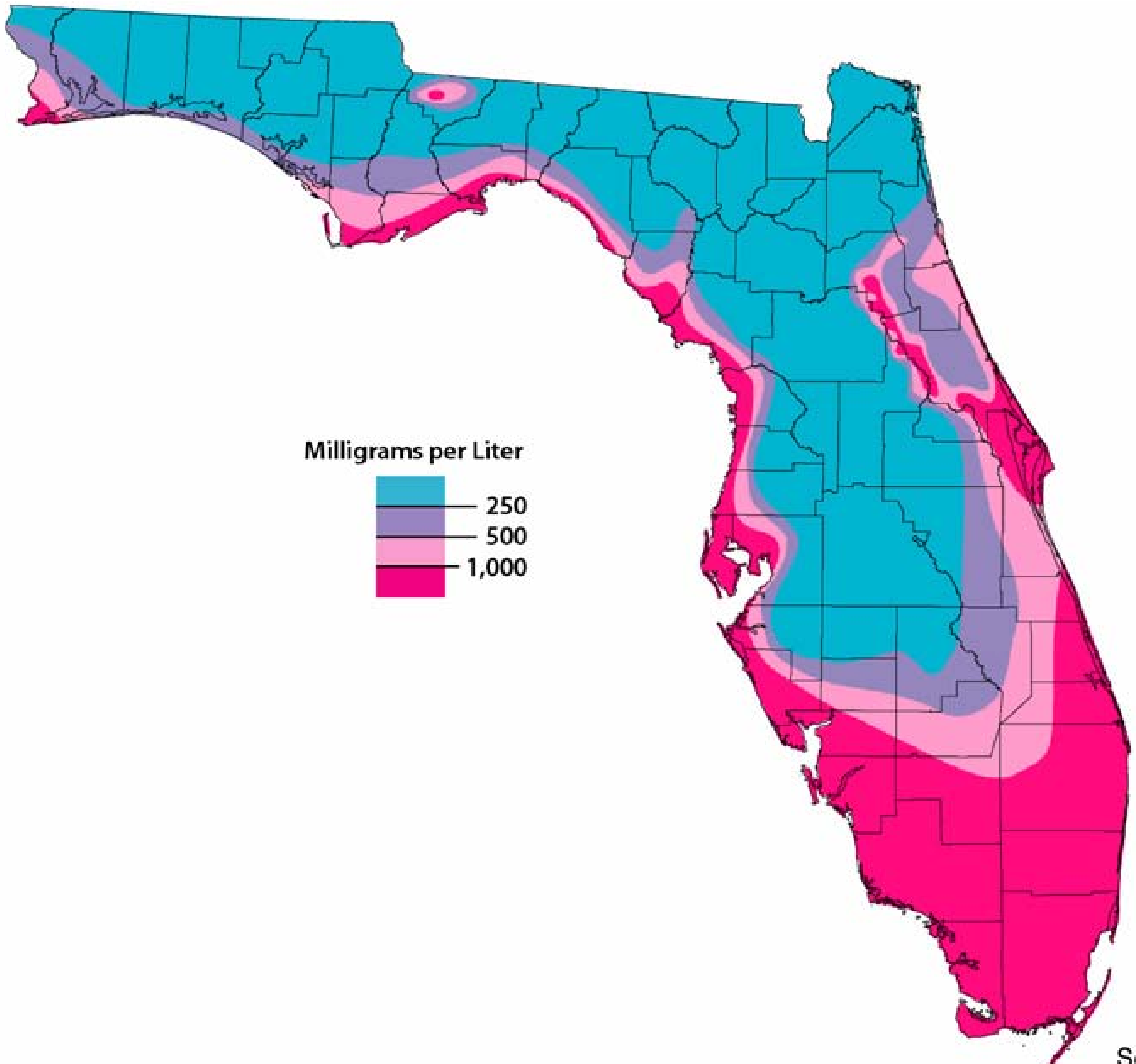


Figure 5.3 Chloride concentration over time in the Peace River at Arcadia during low flows (<10th percentile)

Chloride Concentration in the Upper Floridan Aquifer



Source USGS

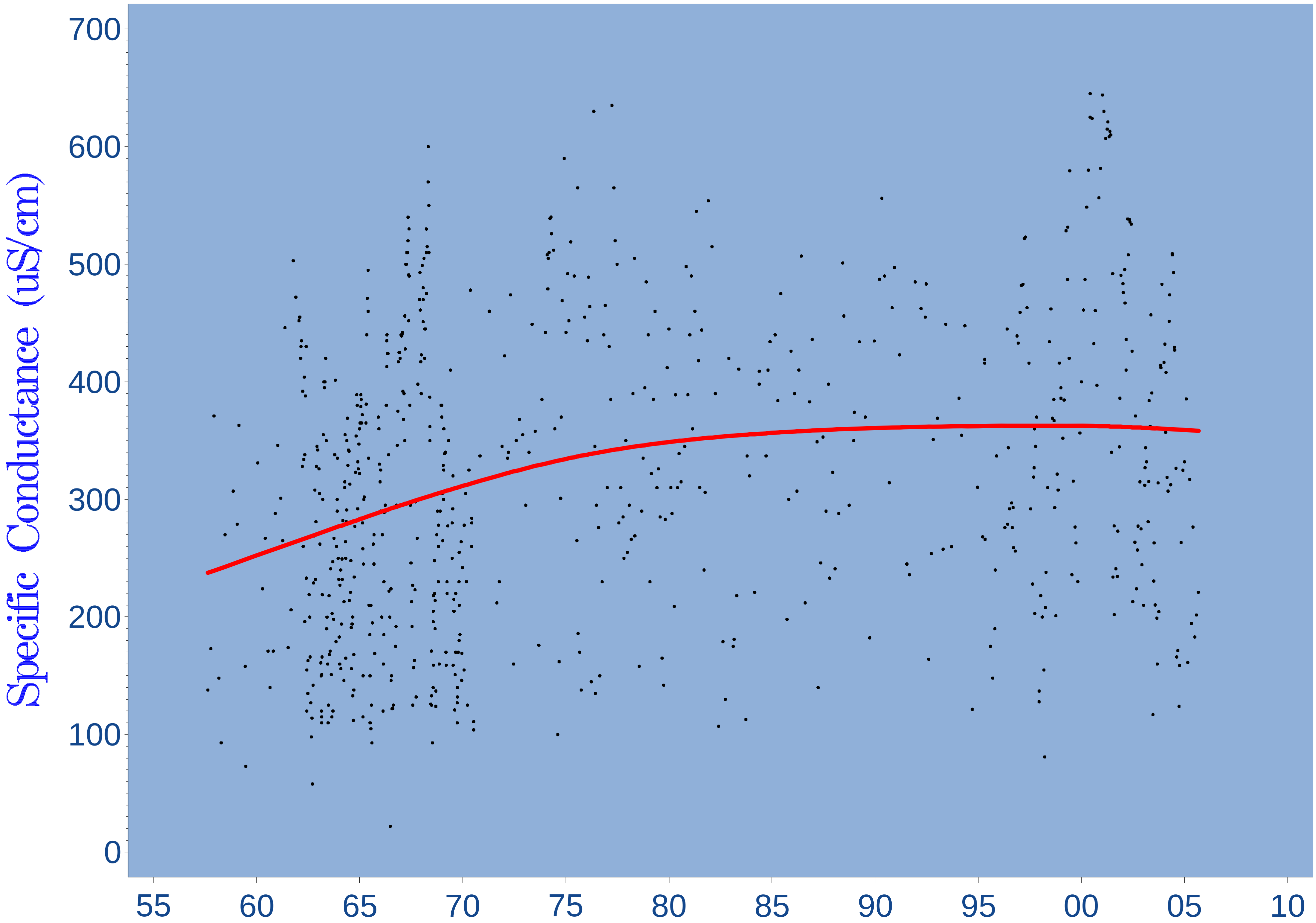


Figure 5.5 Specific conductance over time in the Peace River at Arcadia (all flows)

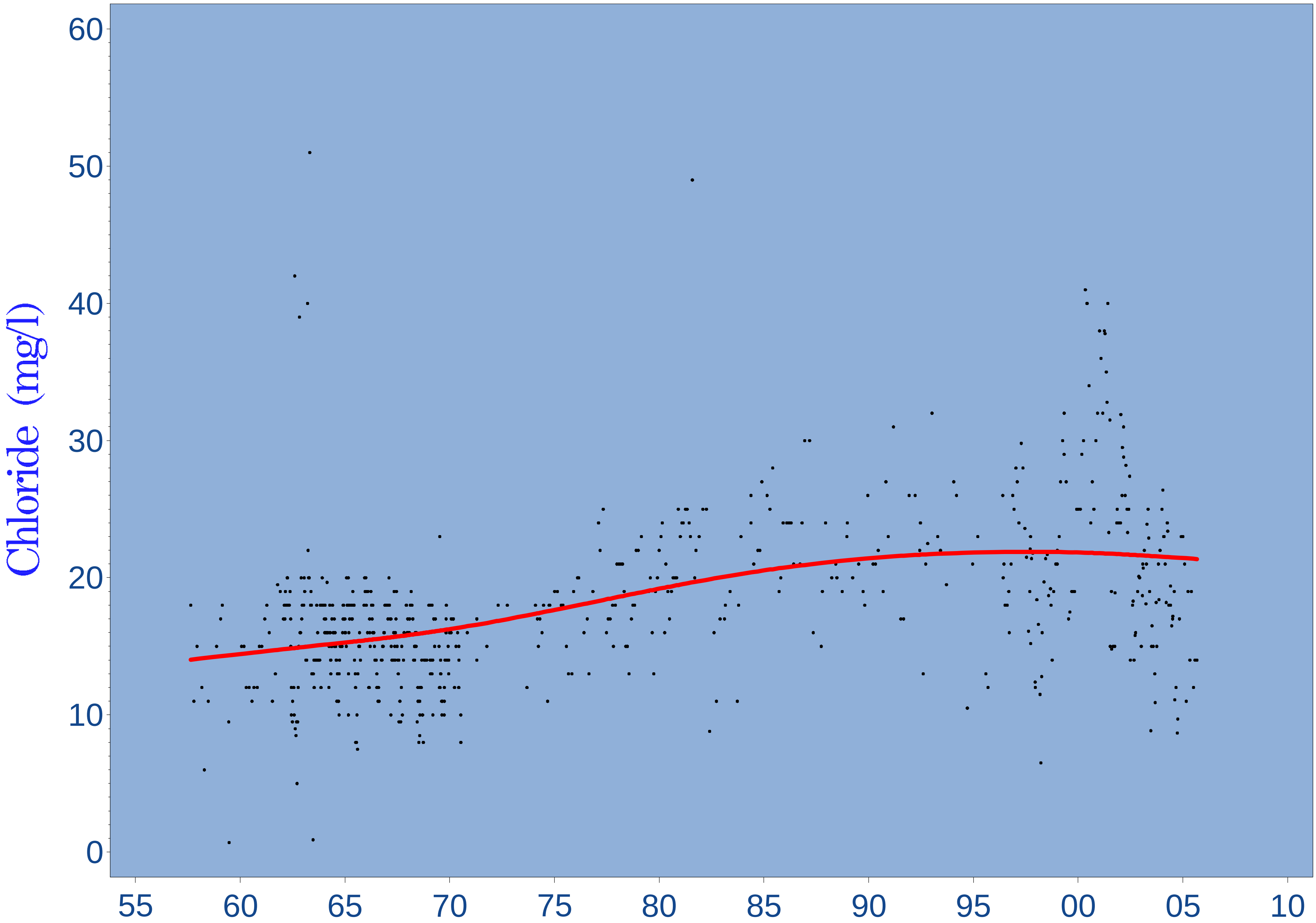


Figure 5.6 Chloride concentration over time in the Peace River at Arcadia (all flows)

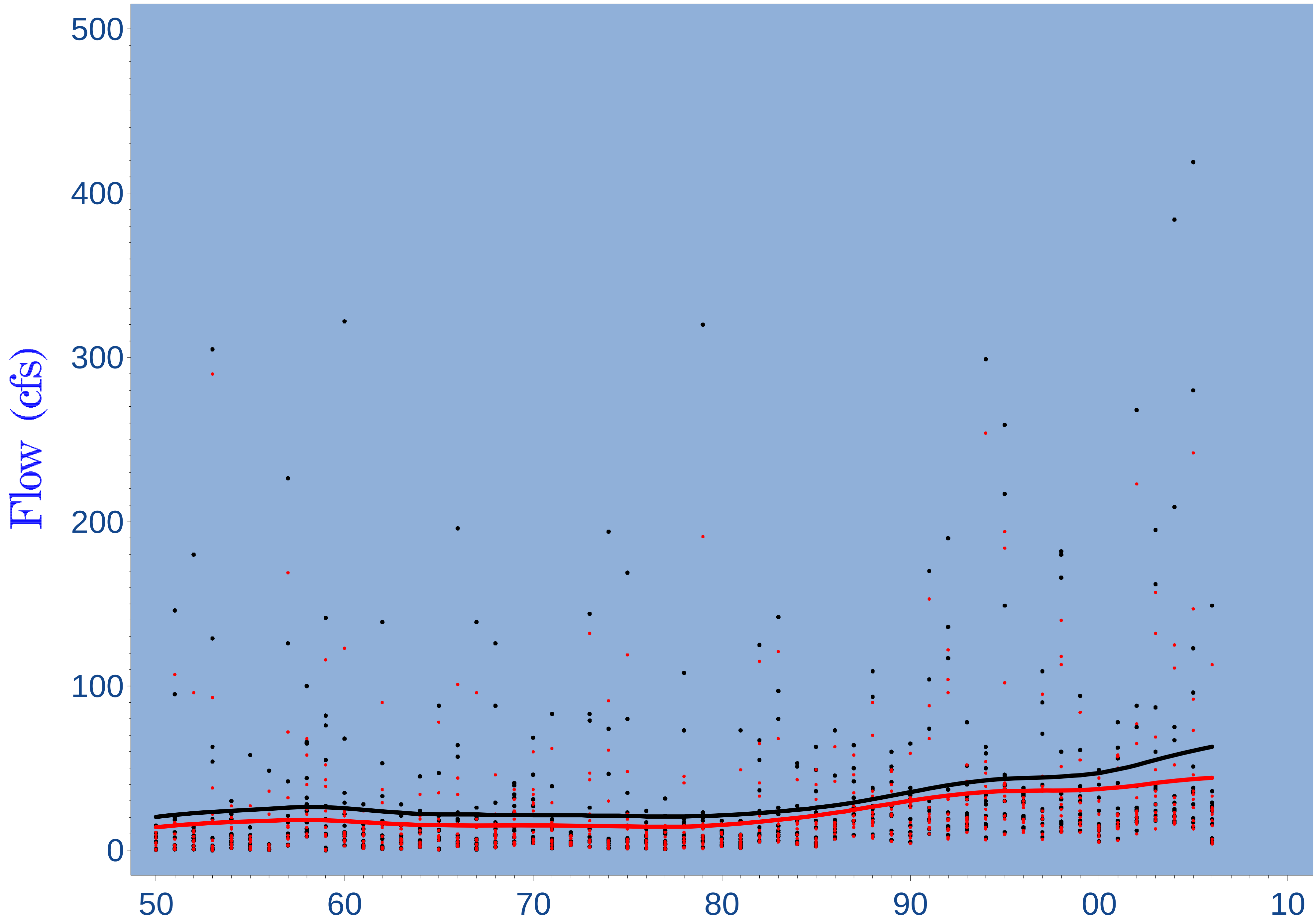


Figure 5.7 Monthly minimum (red) and 10th percentile (black) flow over time in Joshua Creek

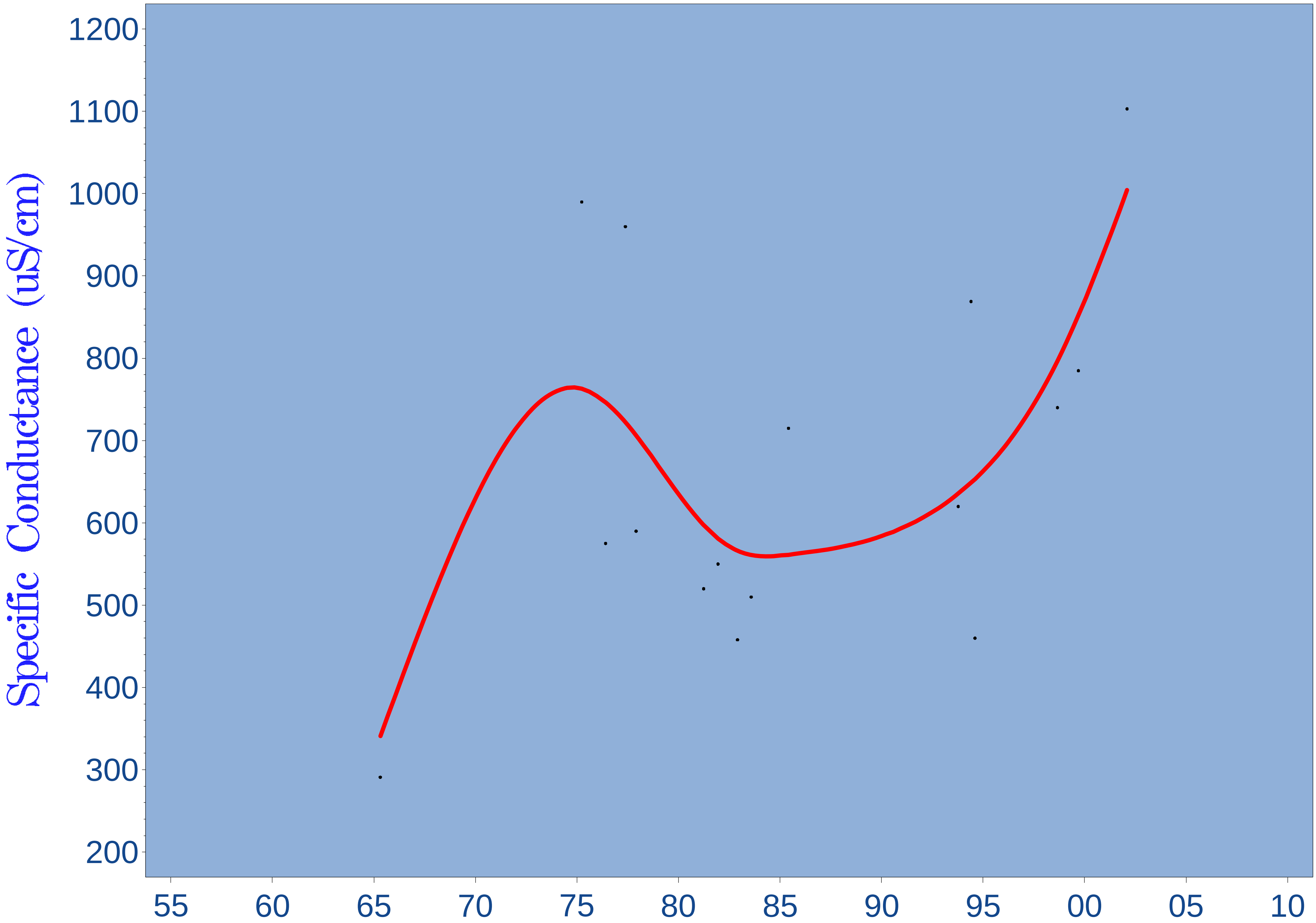


Figure 5.8 Specific conductance over time in Joshua Creek during low flows (<10th percentile)

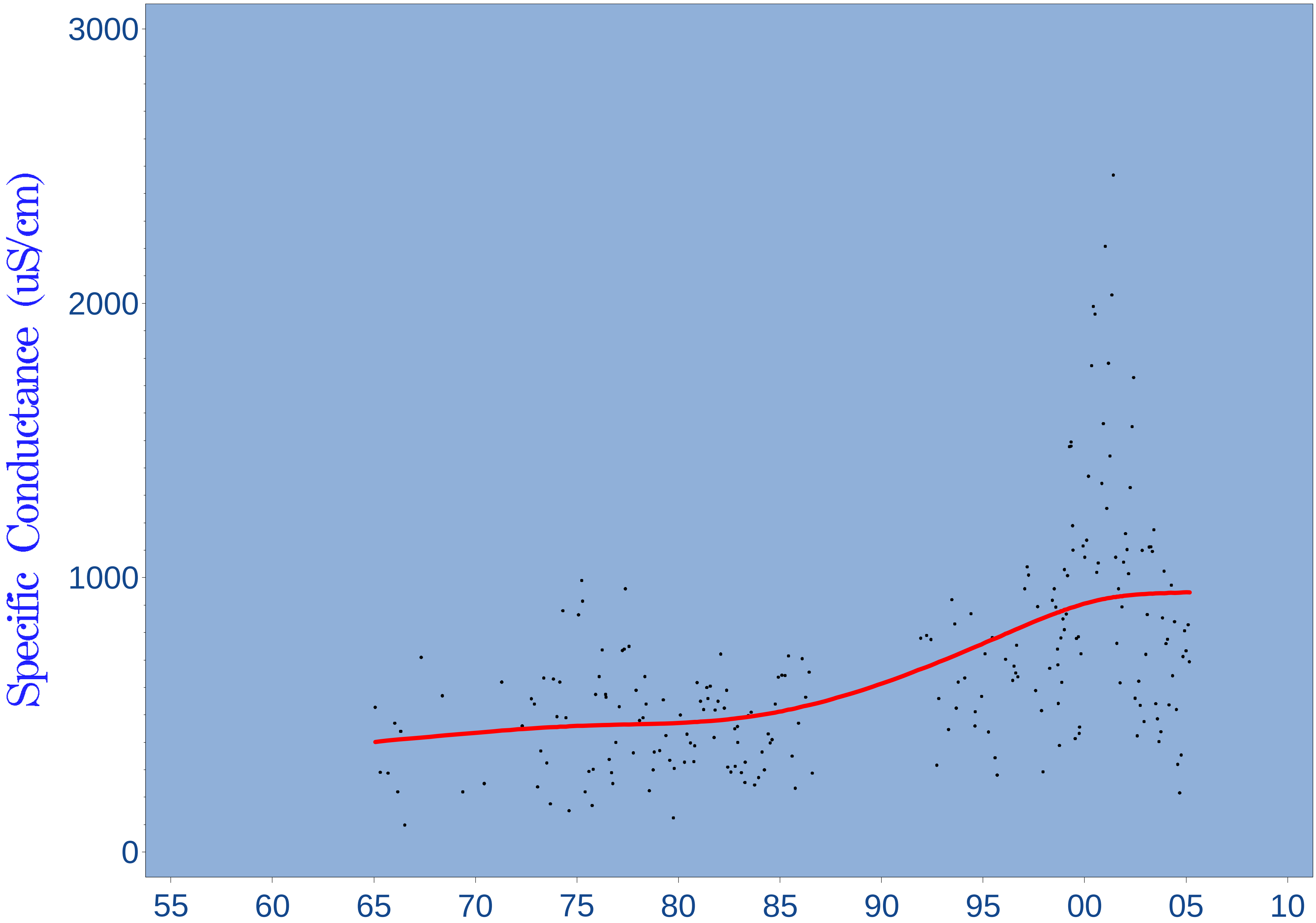


Figure 5.9 Specific conductance over time in Joshua Creek (all flows)

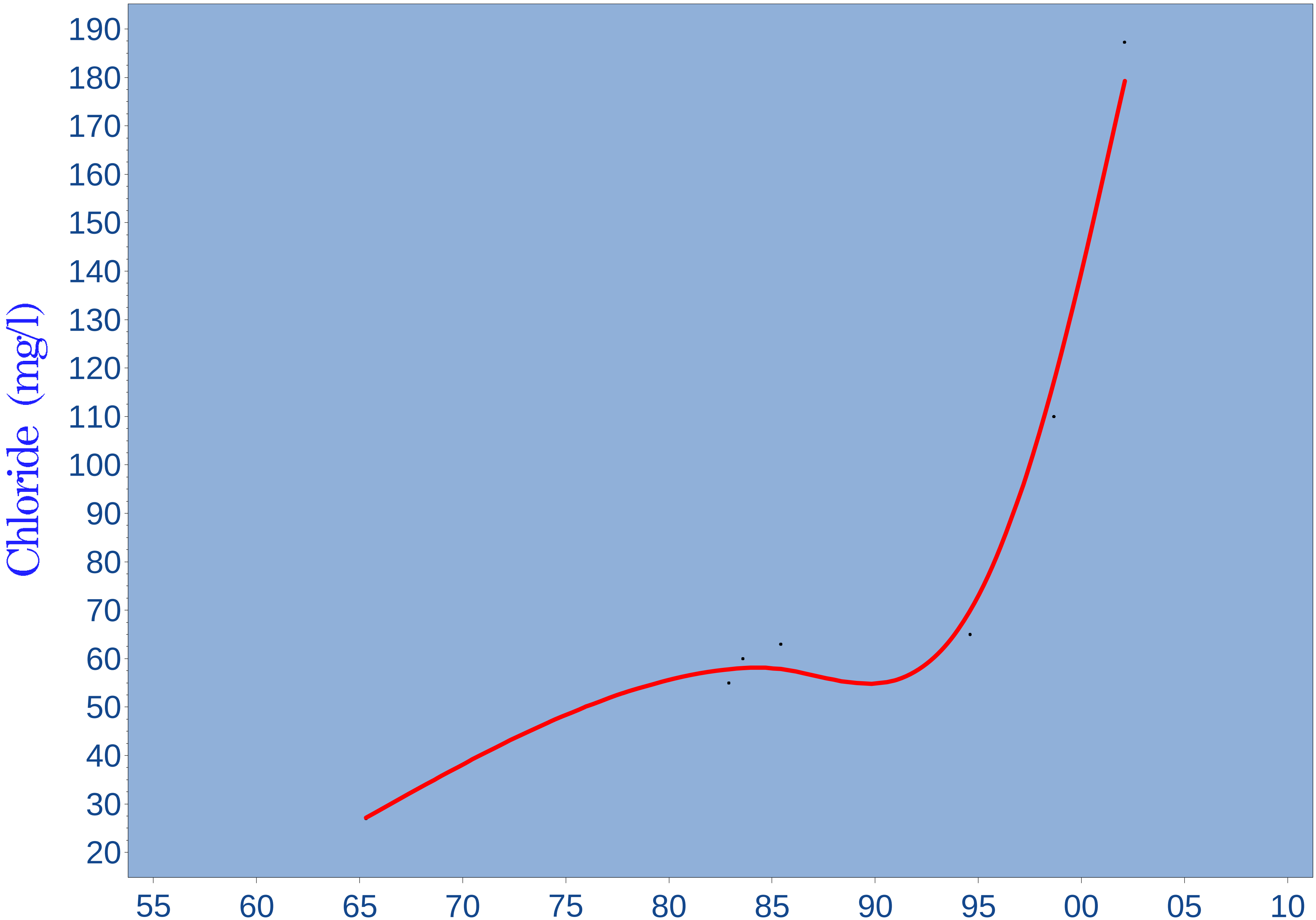


Figure 5.10 Chloride concentration over time in Joshua Creek during low flows (<10th percentile

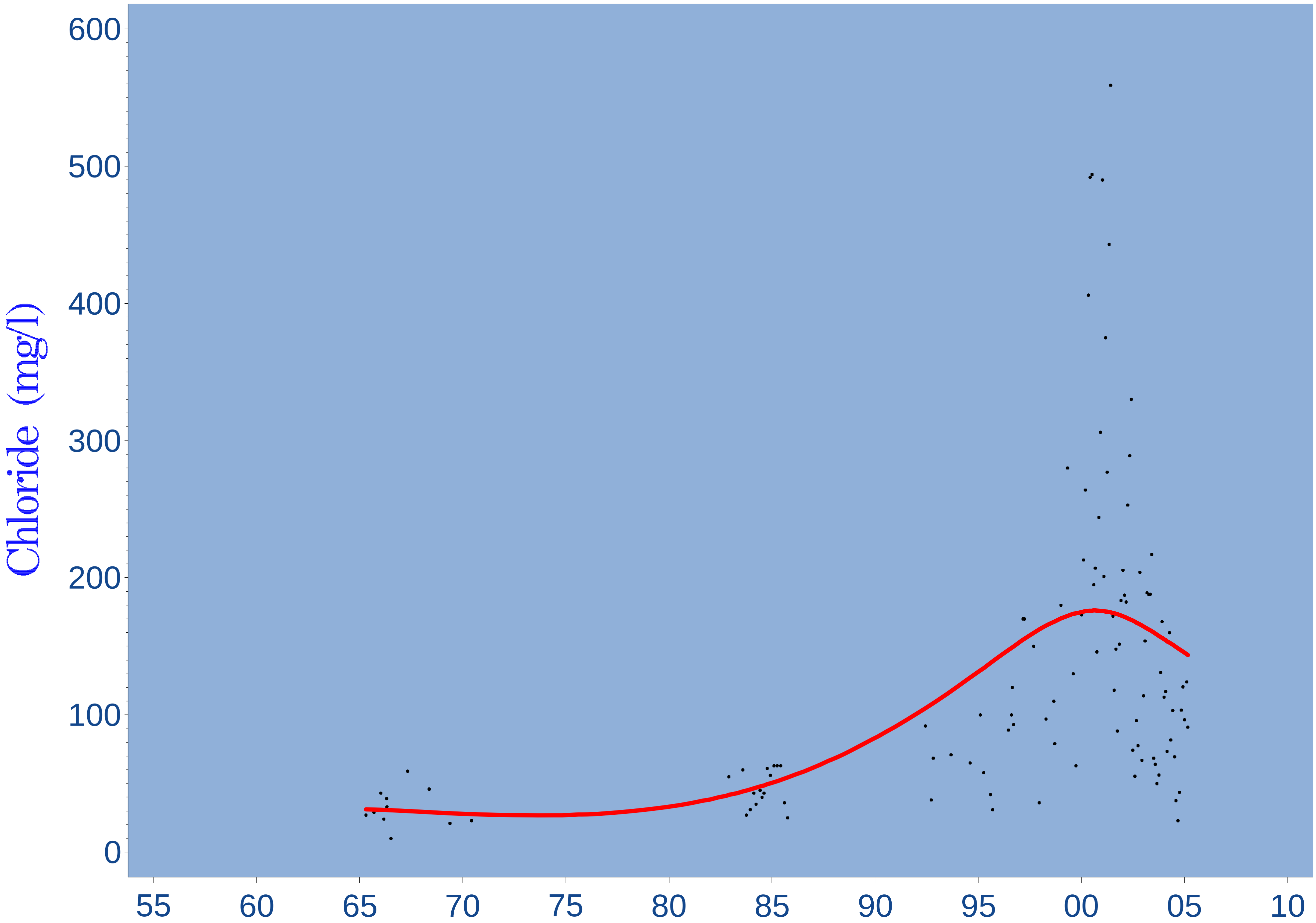


Figure 5.11 Chloride concentration over time in Joshua Creek (all flows)

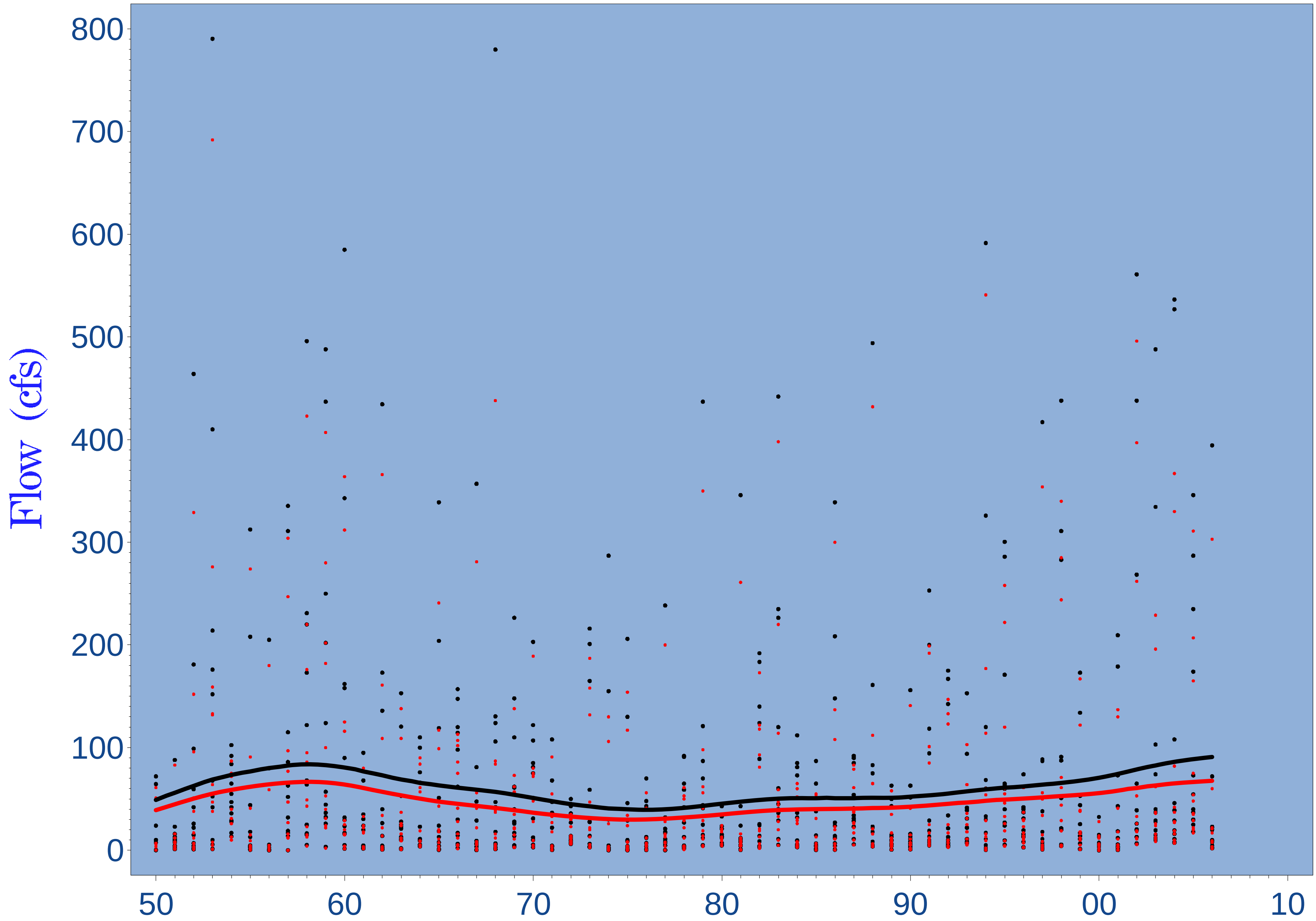


Figure 5.12 Monthly minimum (red) and 10th percentile (black) flow over time in Horse Creek

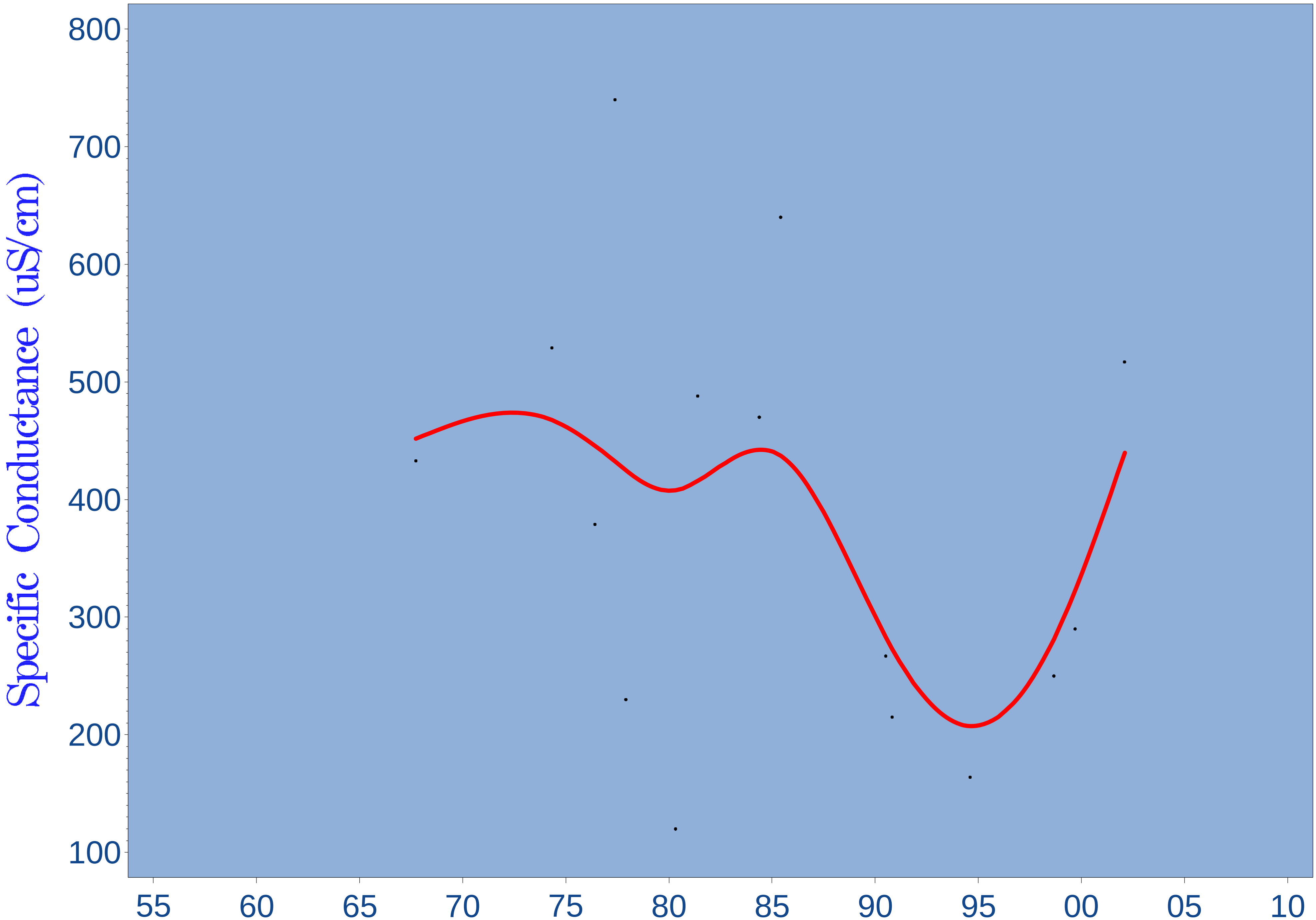


Figure 5.13 Specific conductance over time in Horse Creek during low flows (<10th percentile)

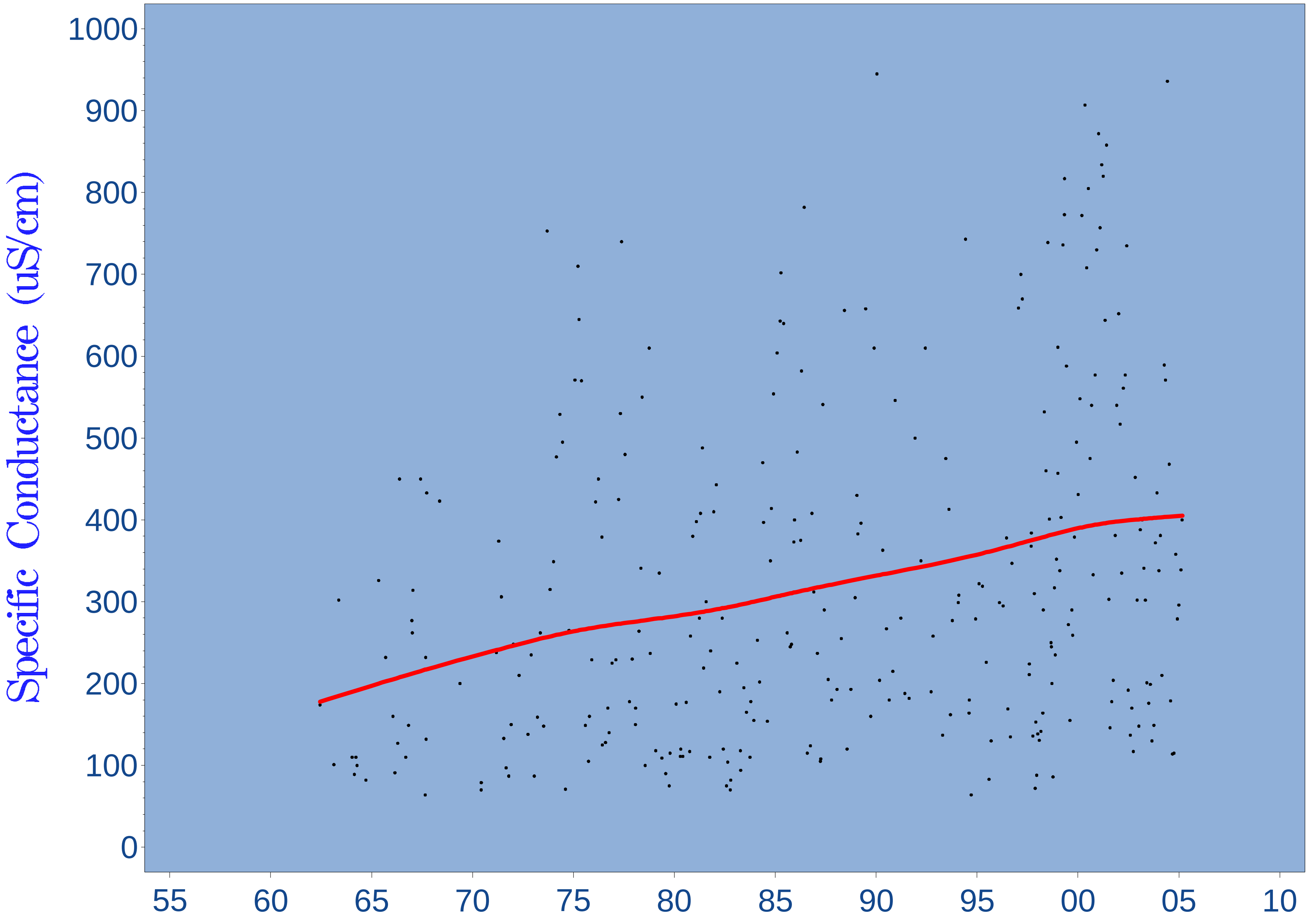


Figure 5.14 Specific conductance over time in Horse Creek (all flows)

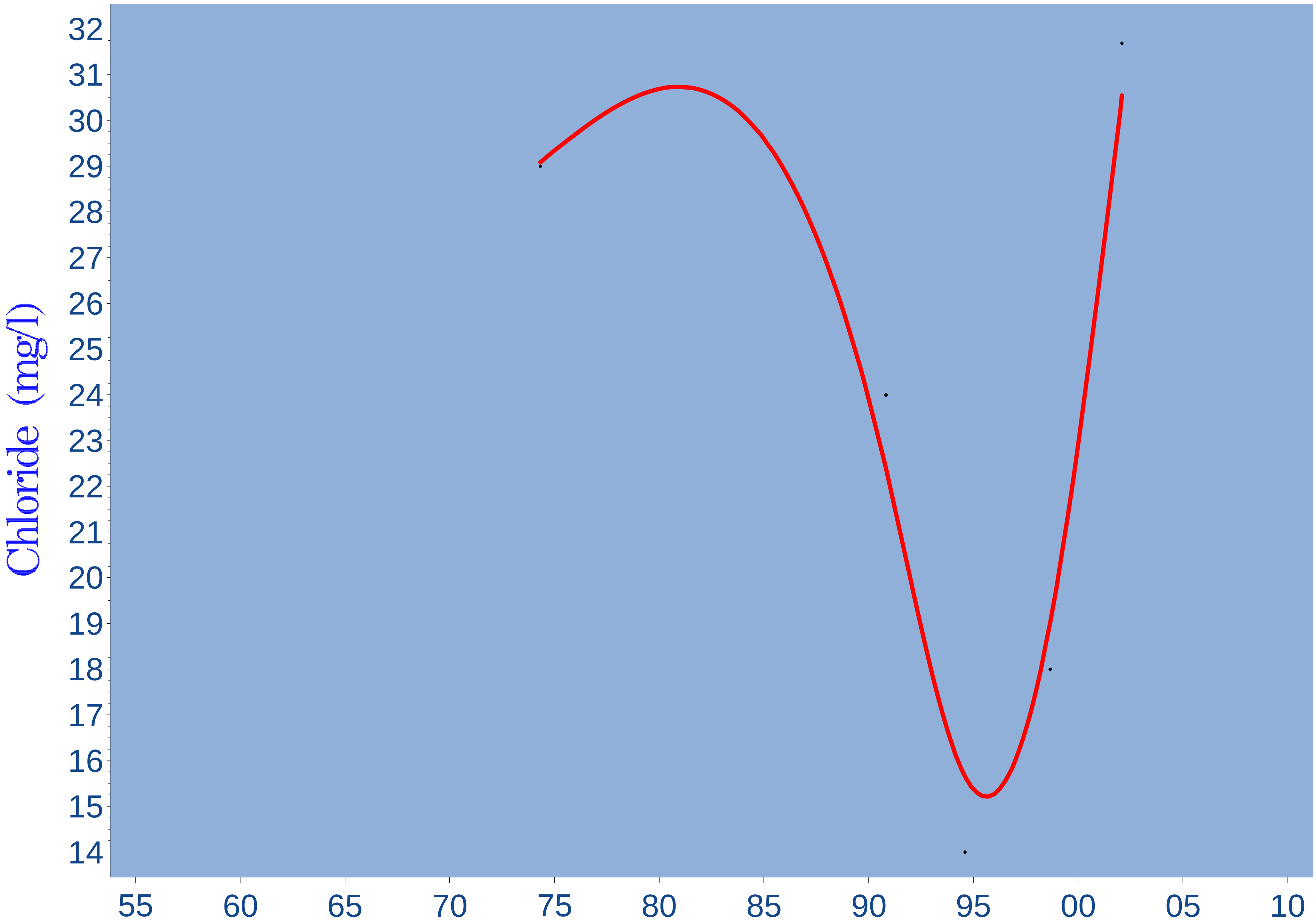


Figure 5.15 Chloride concentration over time in Horse Creek during low flows (<10th percentile)

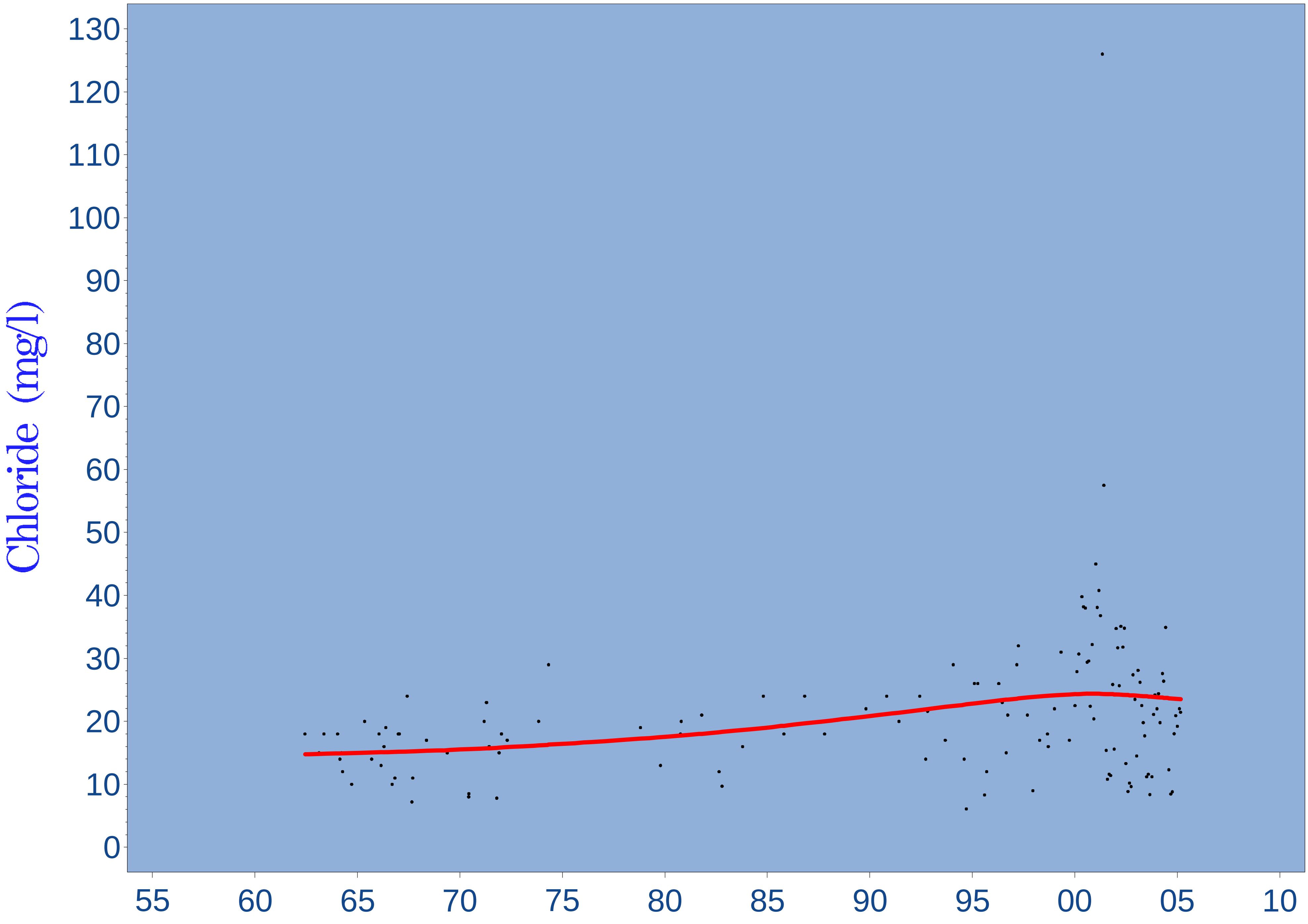


Figure 5.16 Chloride concentration over time in Horse Creek (all flows)

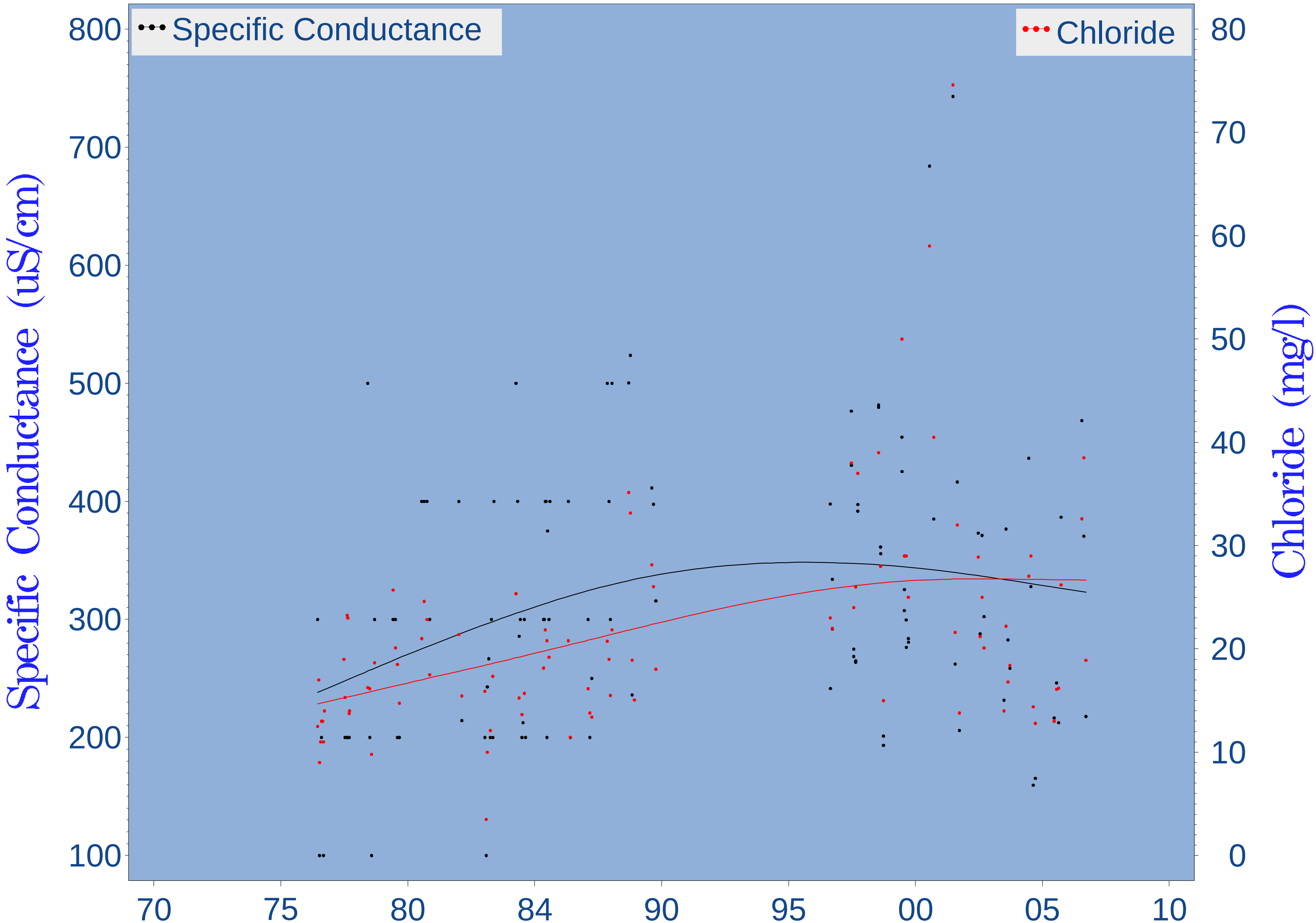


Figure 5.17 Wet Season(June-Sept) specific conductance and chloride over time at RK 30.4

Low flow (<130 cfs) data removed from RK 30.4 dataset

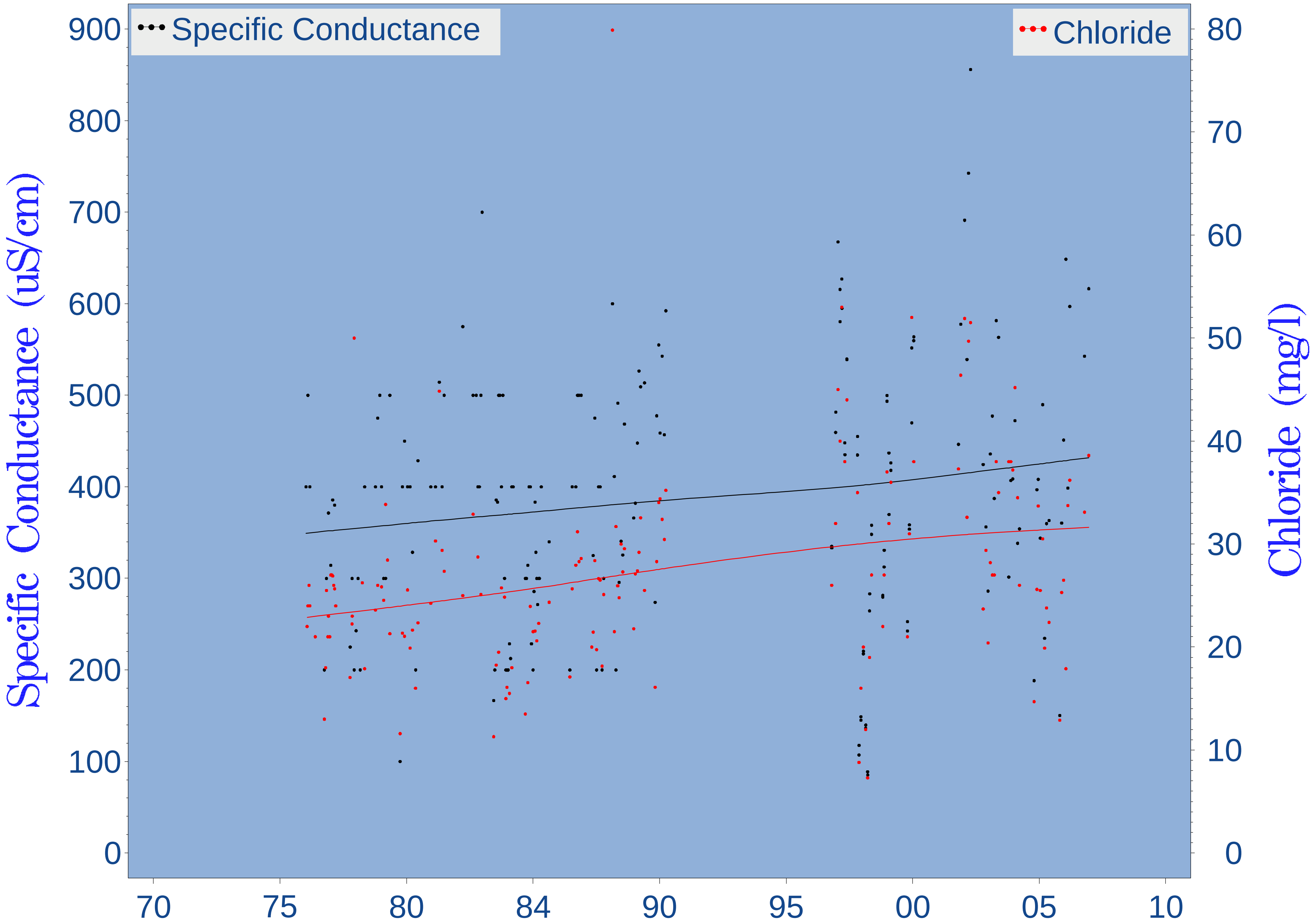


Figure 5.18 Dry Season(Oct-May) specific conductance and chloride over time at RK 30.4

Low flow (<130 cfs) data removed from RK 30.4 dataset

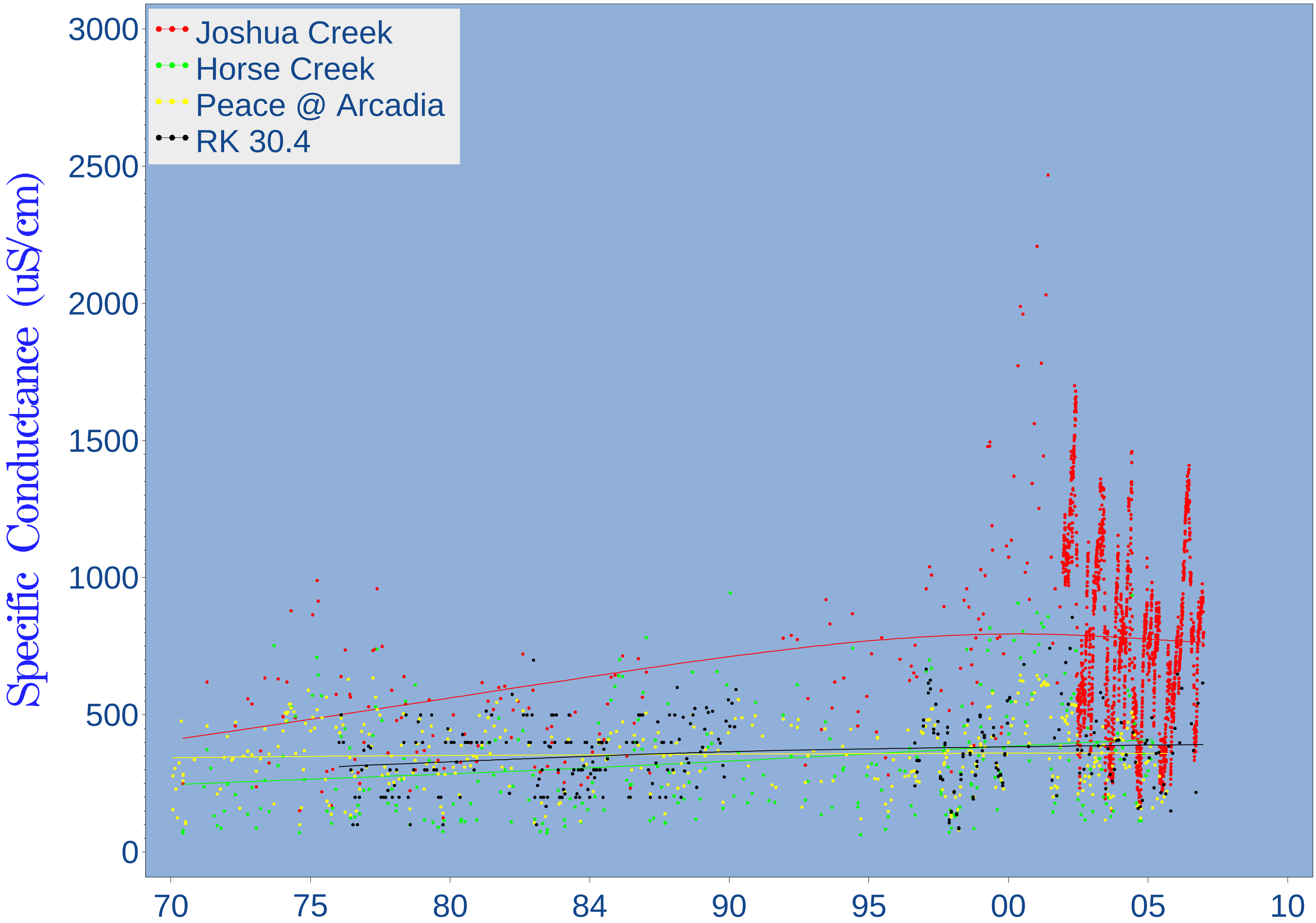


Figure 5.19 Specific conductance over time at sampled stations

Peace River at Arcadia, Joshua Creek, Horse Creek, RK 30.4

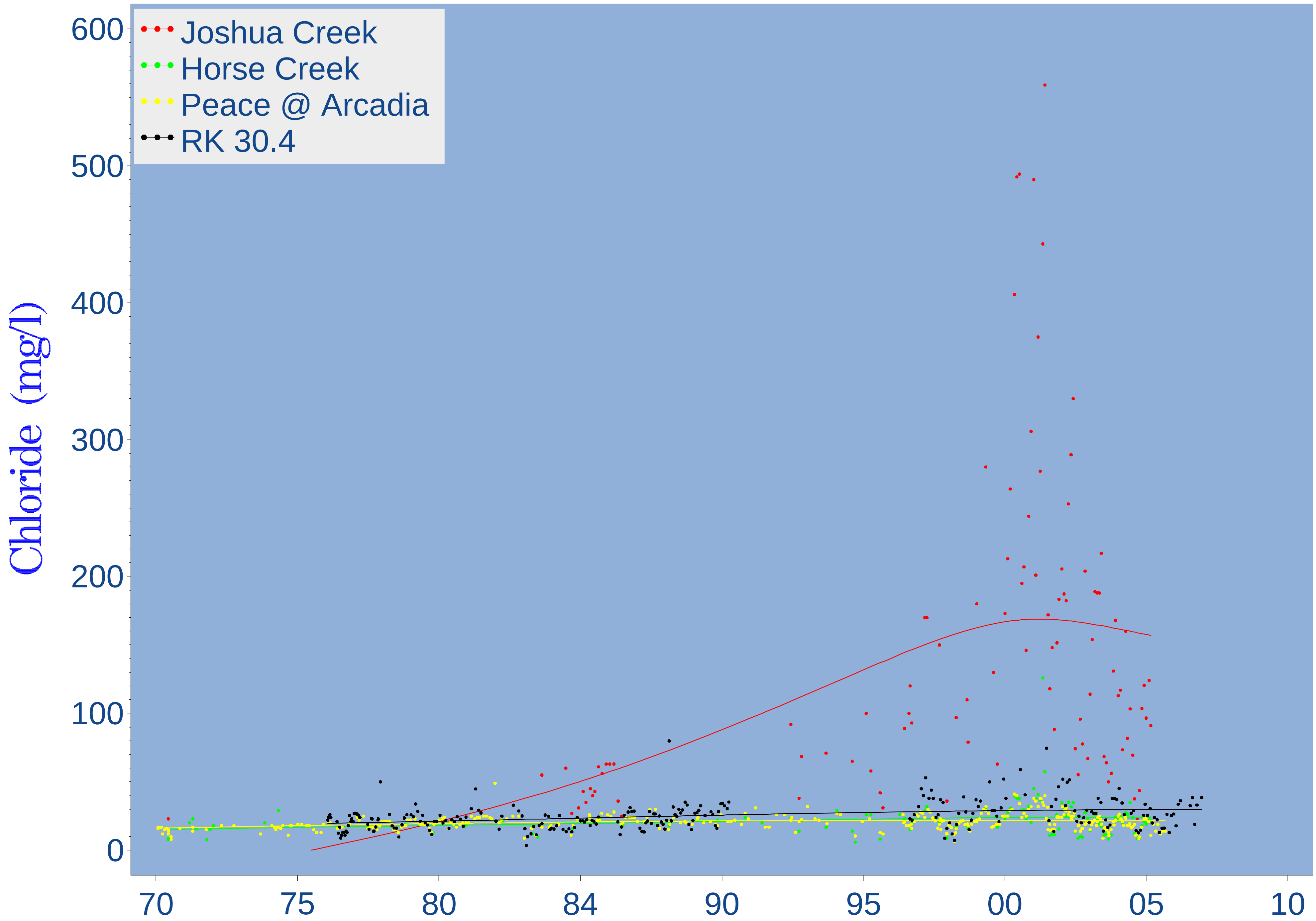


Figure 5.20 Chloride concentration over time at sampled stations

Peace River at Arcadia, Joshua Creek, Horse Creek, RK 30.4

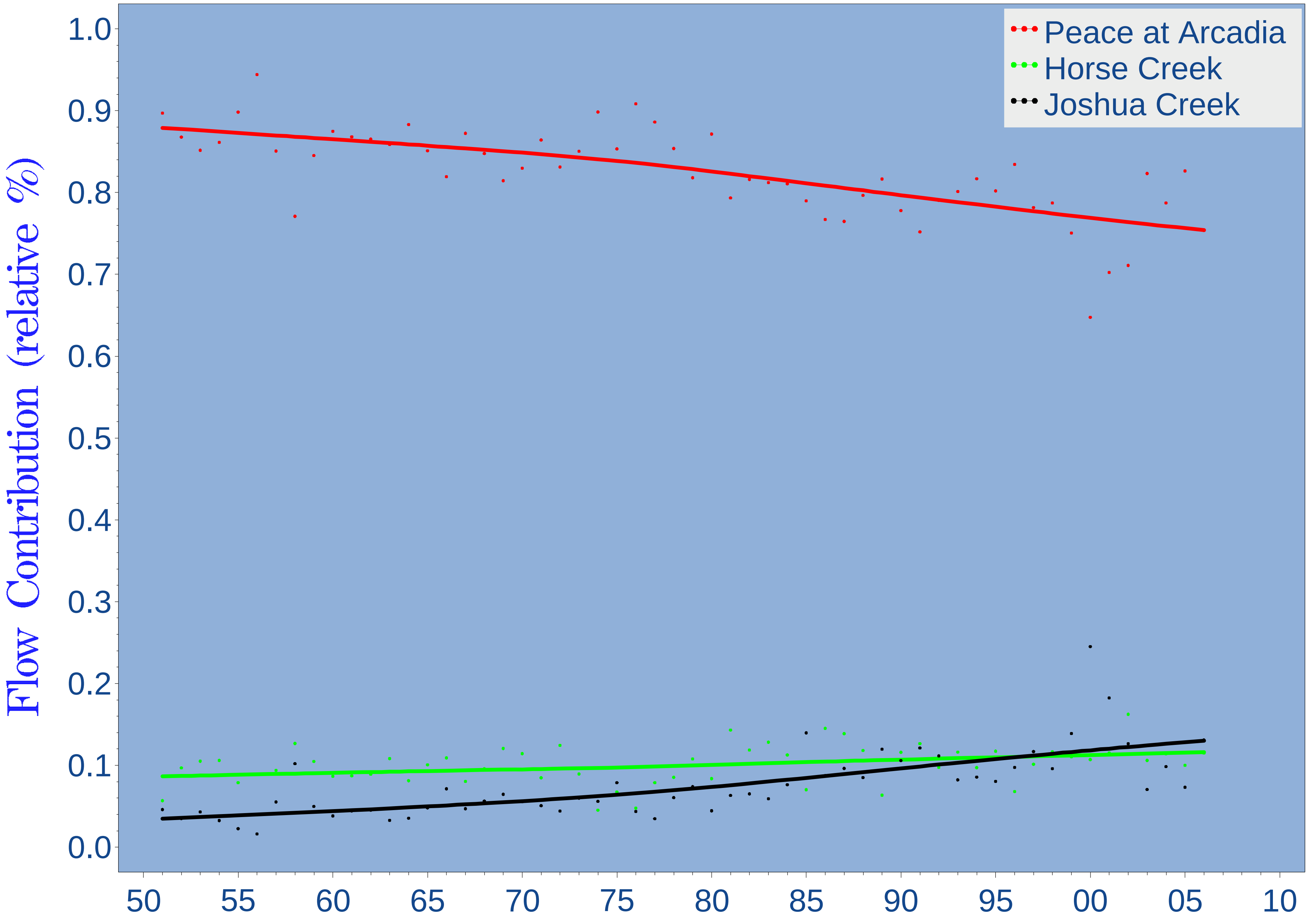


Figure 5.21 Peace River at Arcadia, Joshua Creek, and Horse Creek relative flow contributions over time

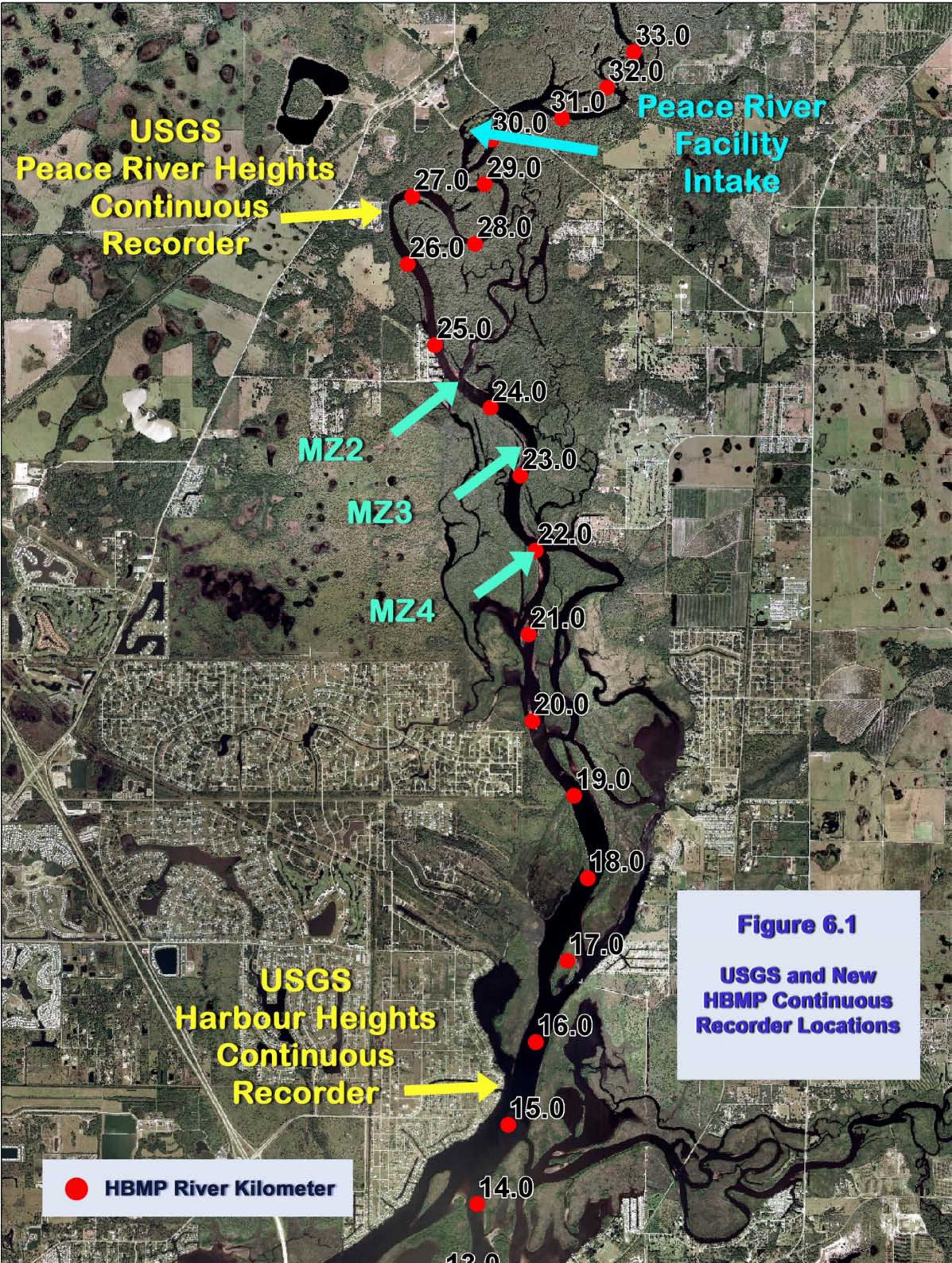


Figure 6.1

USGS and New HBMP Continuous Recorder Locations

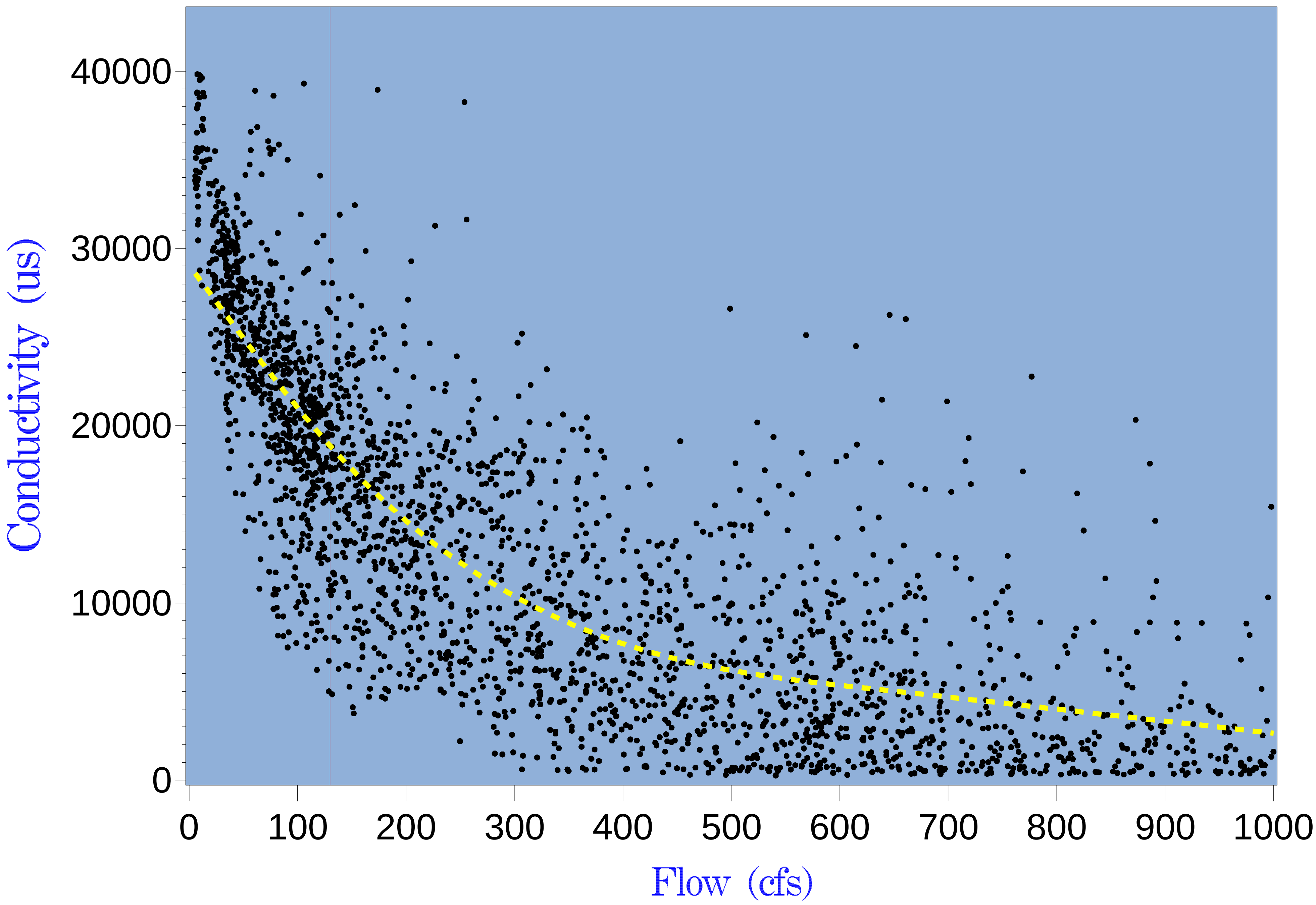


Figure 6.2 Recorder surface conductivity at river kilometer 15.5 versus flow

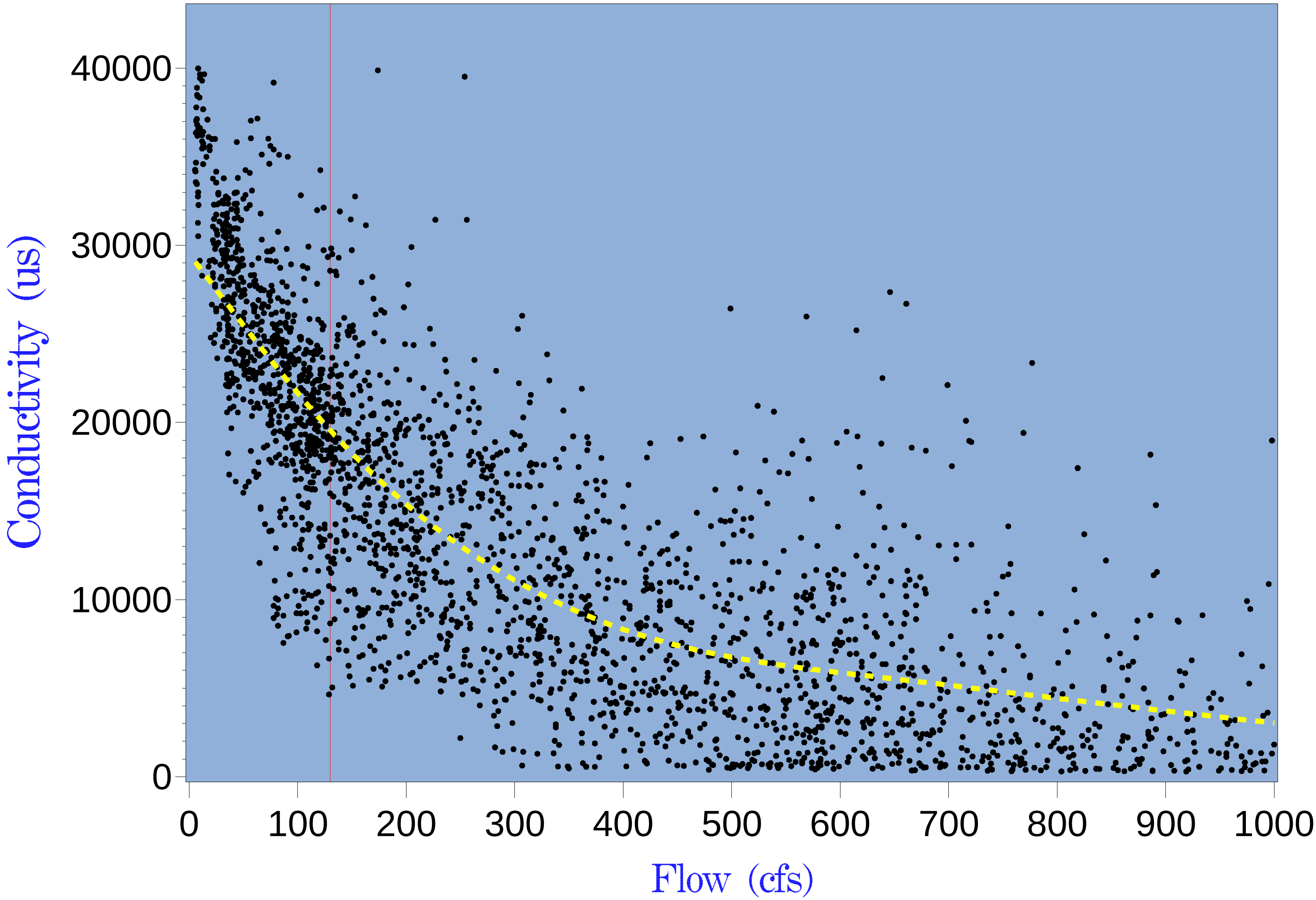


Figure 6.3 Recorder bottom conductivity at river kilometer 15.5 versus flow

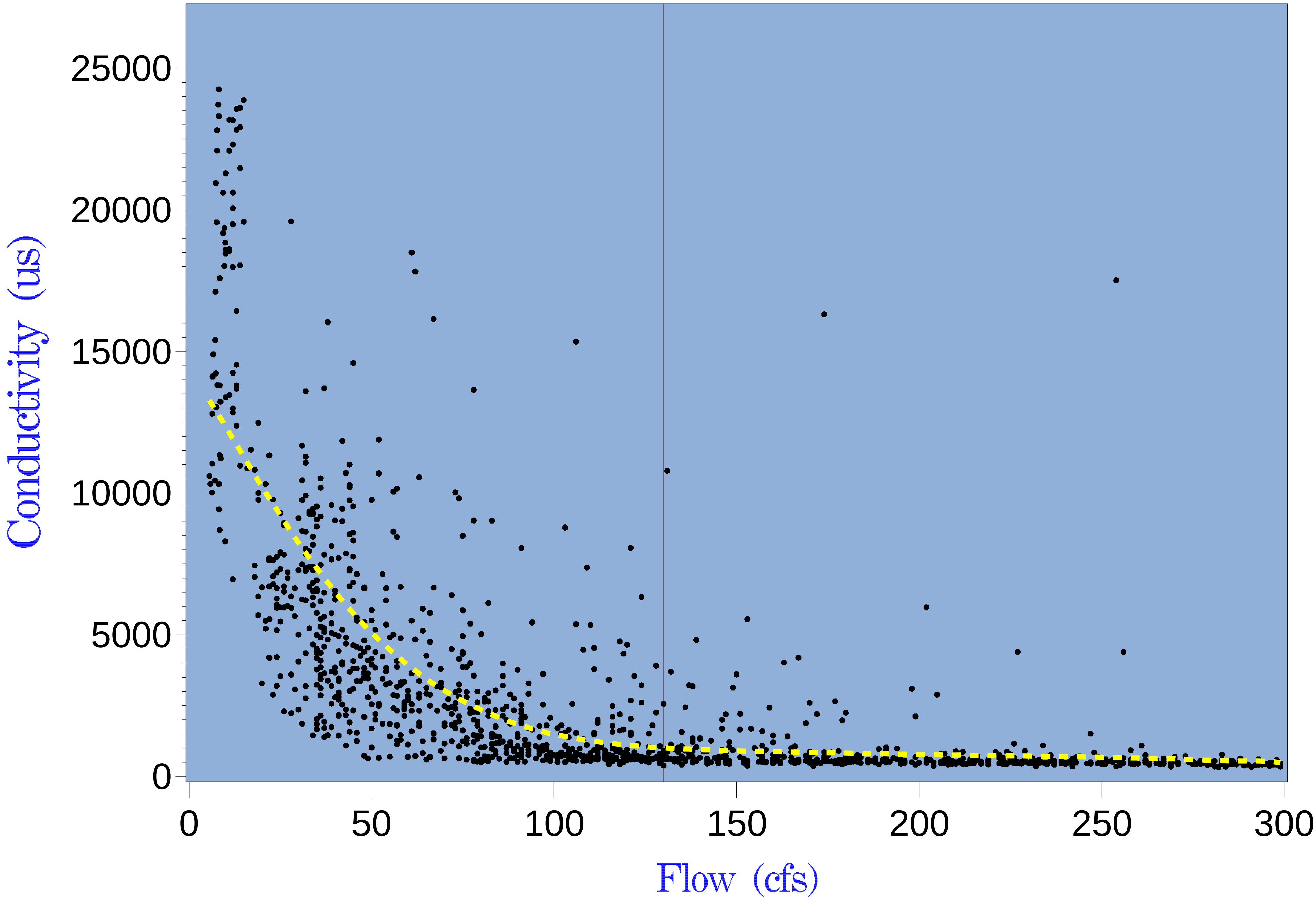


Figure 6.4 Recorder surface conductivity at river kilometer 26.7 versus flow

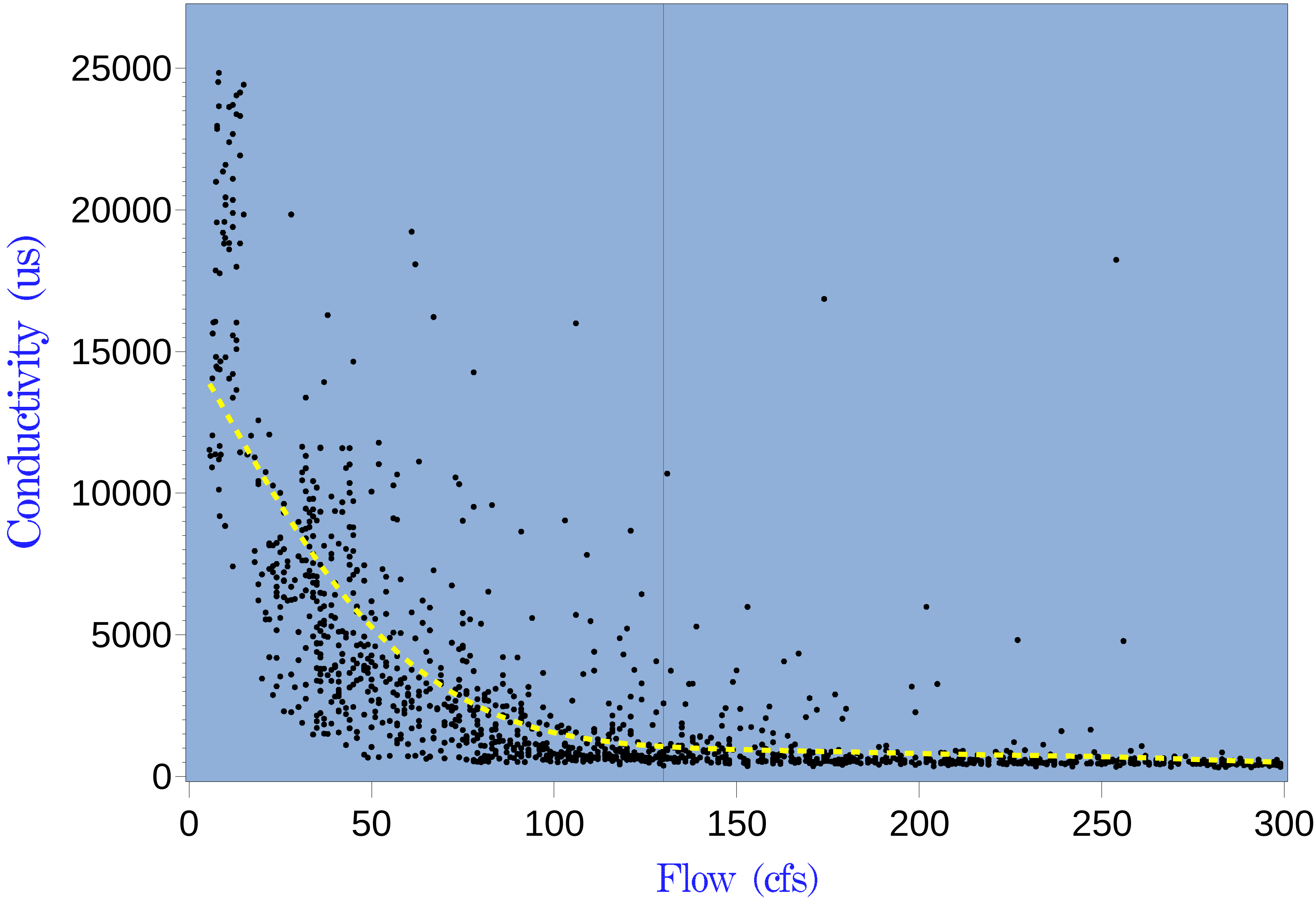
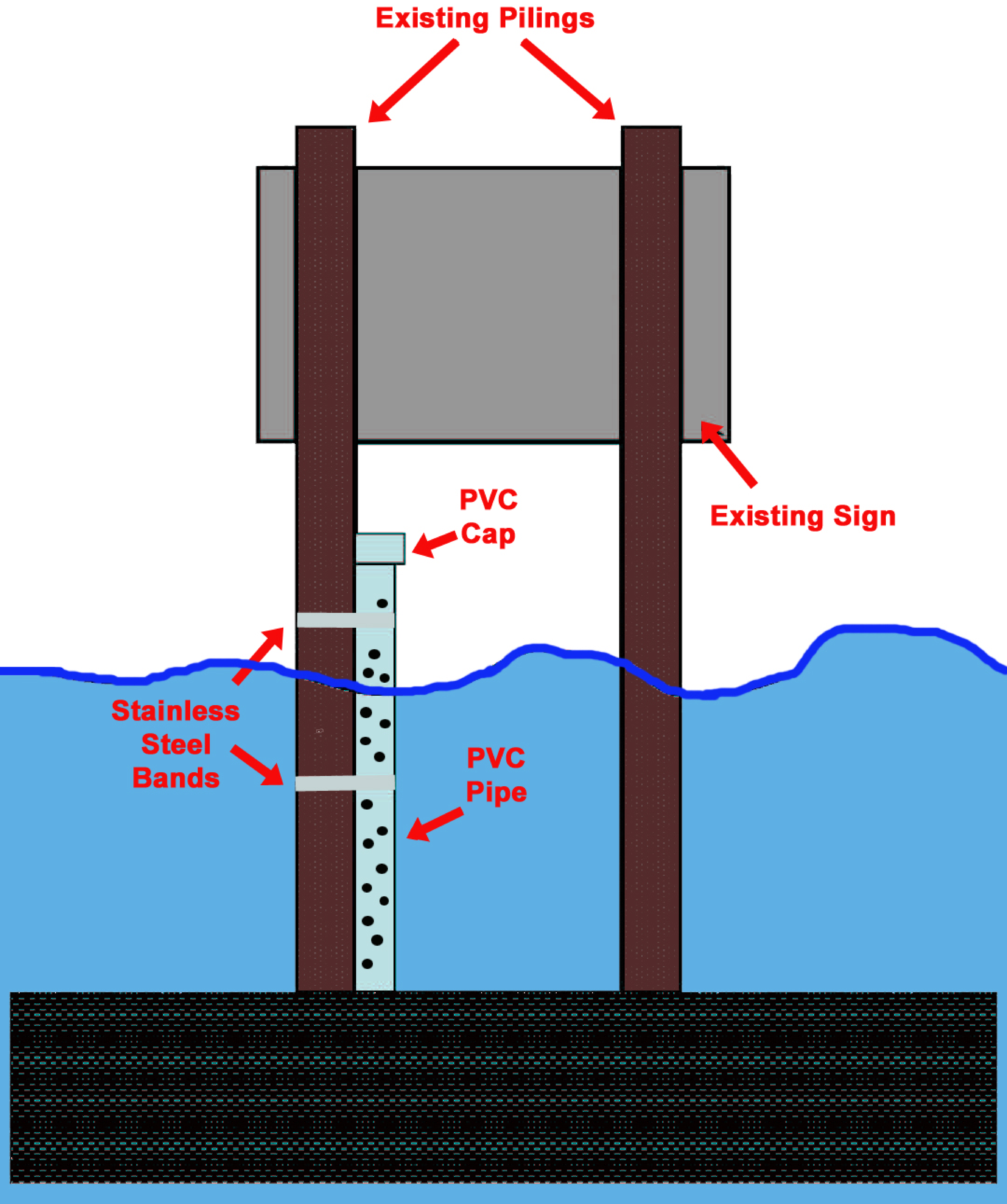


Figure 6.5 Recorder bottom conductivity at river kilometer 26.7 versus flow

Figure 6.6
Diagram of Attachement to Existing Manatee Speed Zone Sign



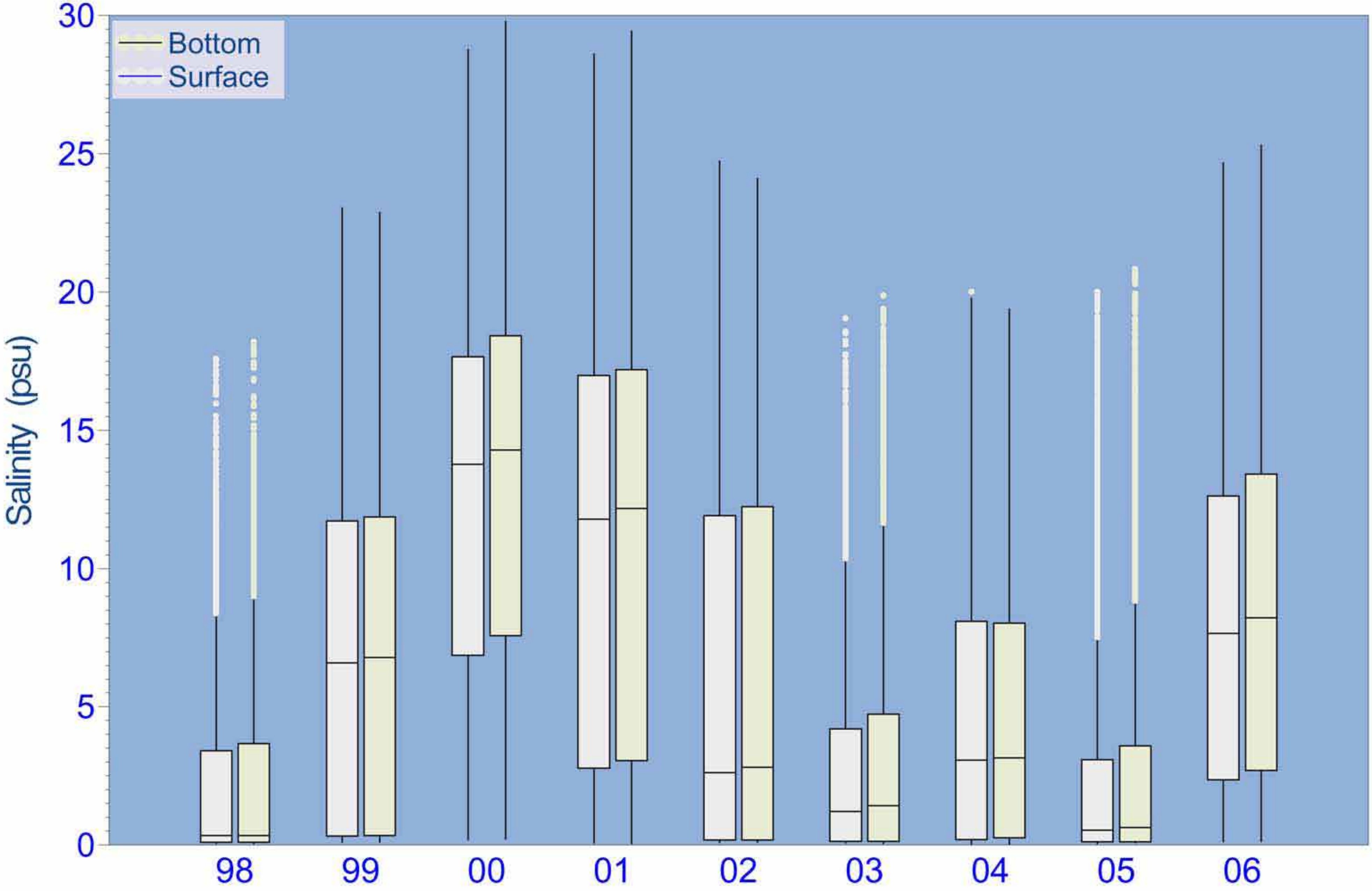


Figure 6.7 Box and whisker plots of annual salinity variability at the USGS Harbour Heights gage (RK 15.5)

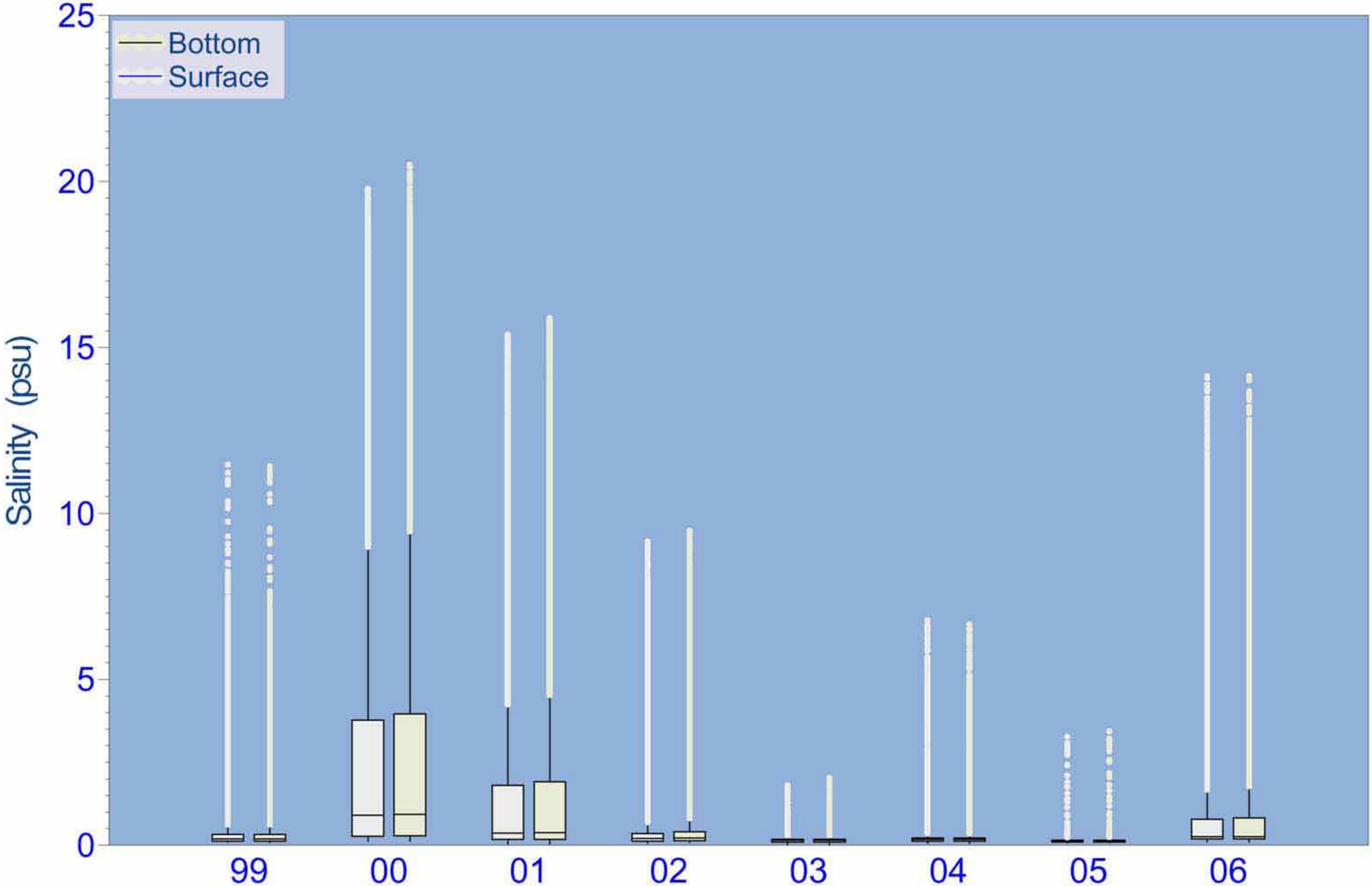


Figure 6.8 Box and whisker plots of annual salinity variability at the USGS Peace River Heights gage (RK 26.7)

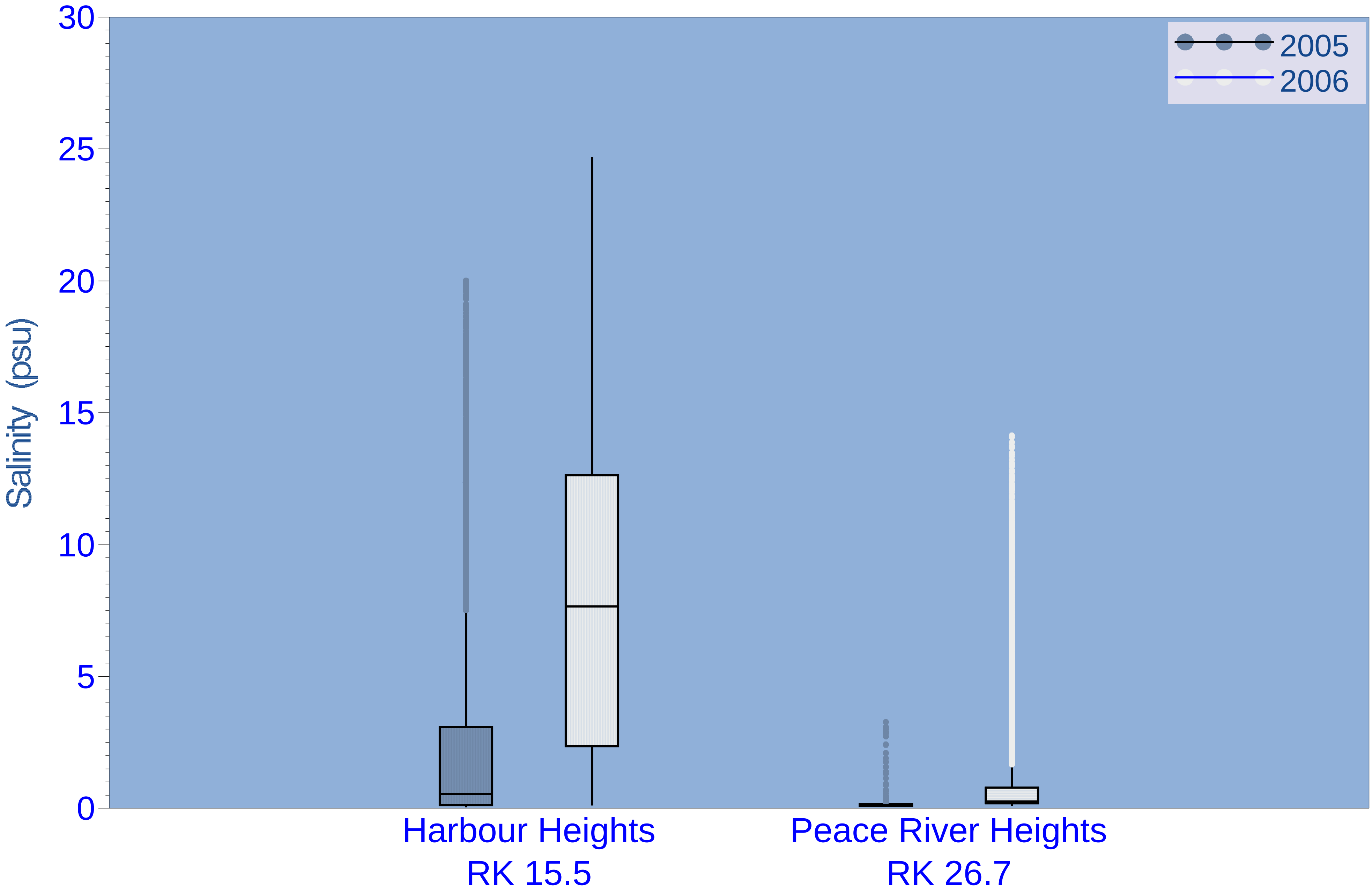


Figure 6.9 Comparisons of annual salinity variability between 2005 and 2006 at the USGS Harbour Heights gage (RK 15.5)

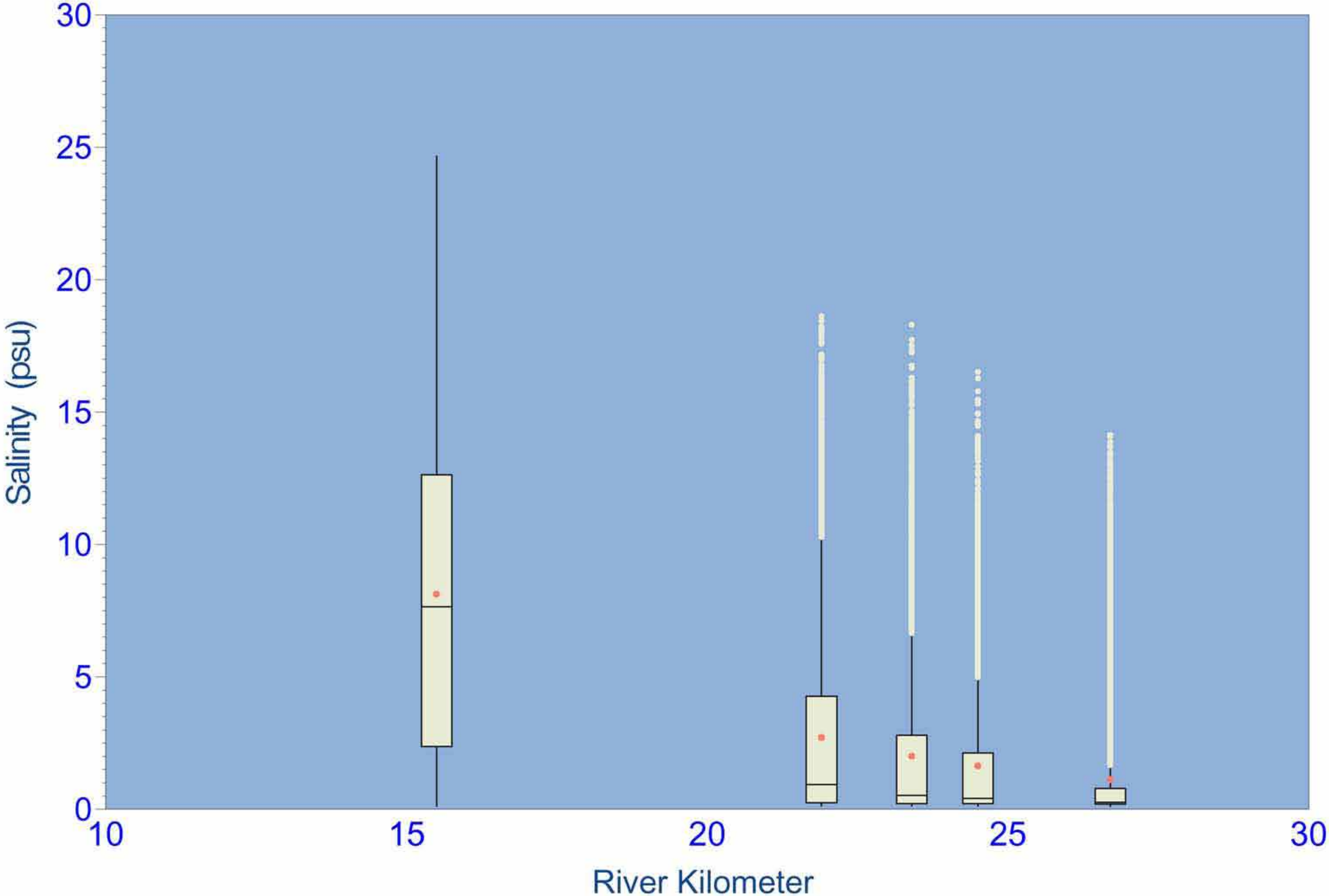


Figure 6.10 Box and whisker plots of salinity variability in 2006 at the five continuous recorders

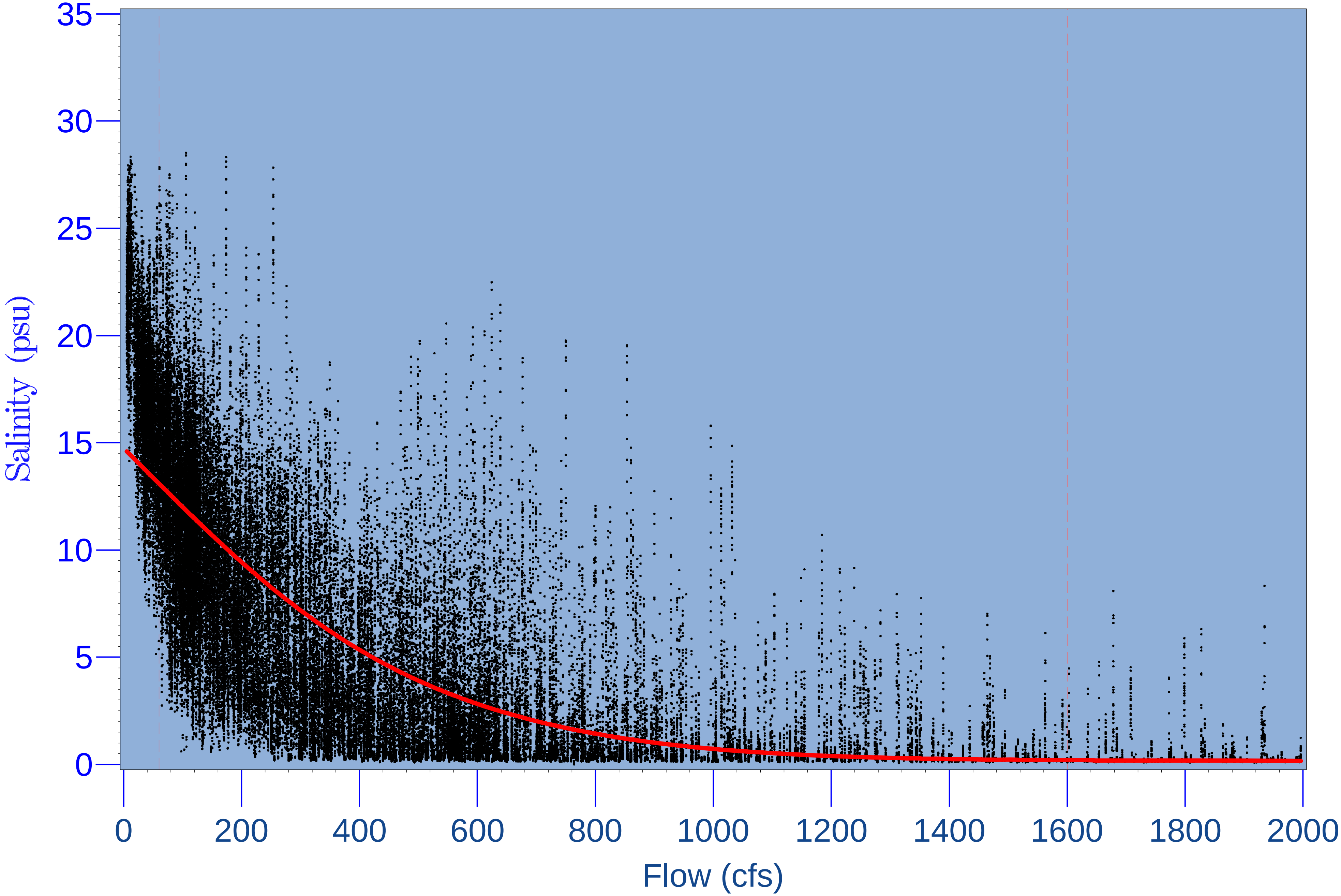


Figure 6.11 Surface salinity at USGS Harbour Height gage (RK 15.5) versus Peace River at Arcadia flow

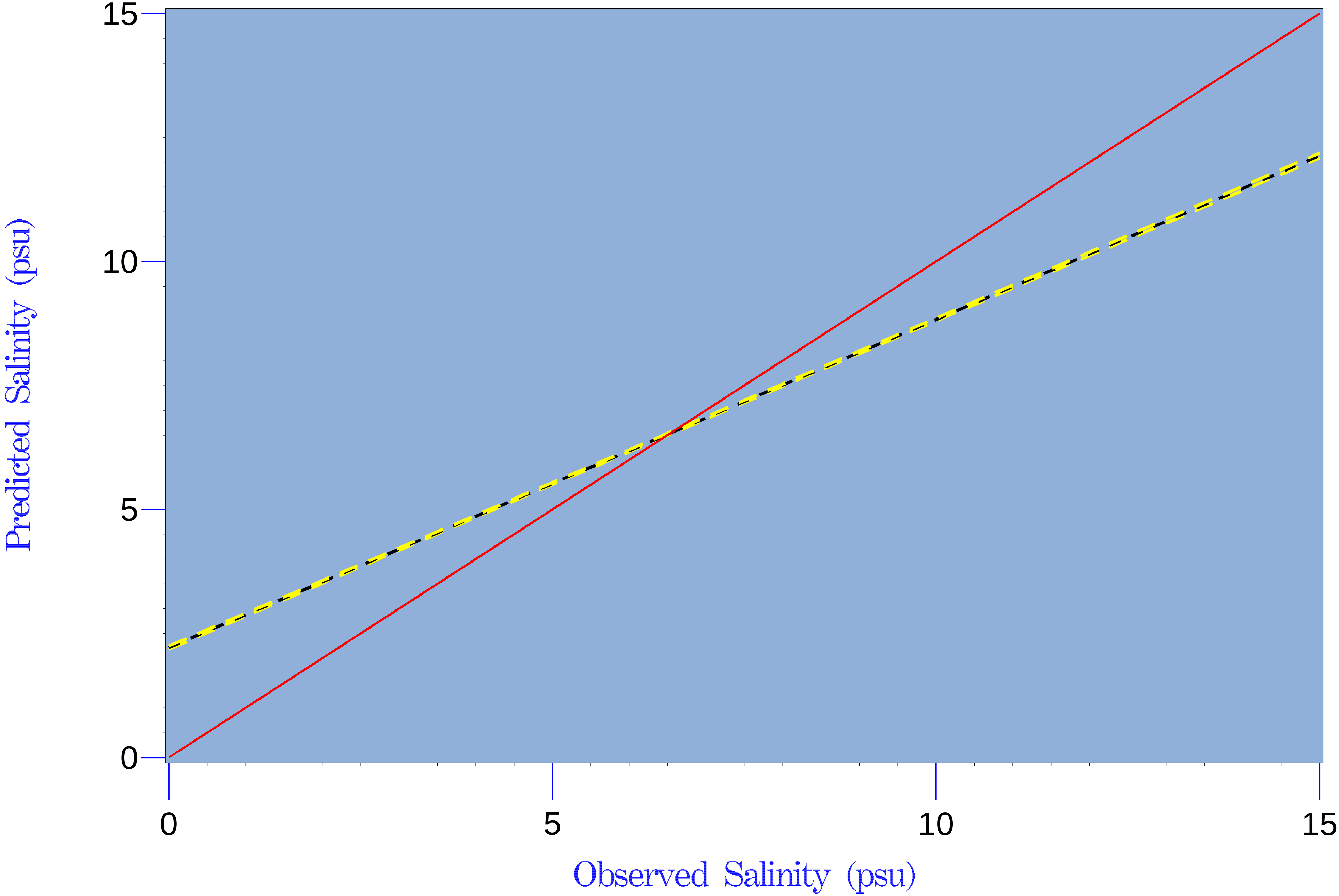


Figure 6.12 Predicted versus observed of modeled surface salinity at Harbour Heights (RK 15.5)

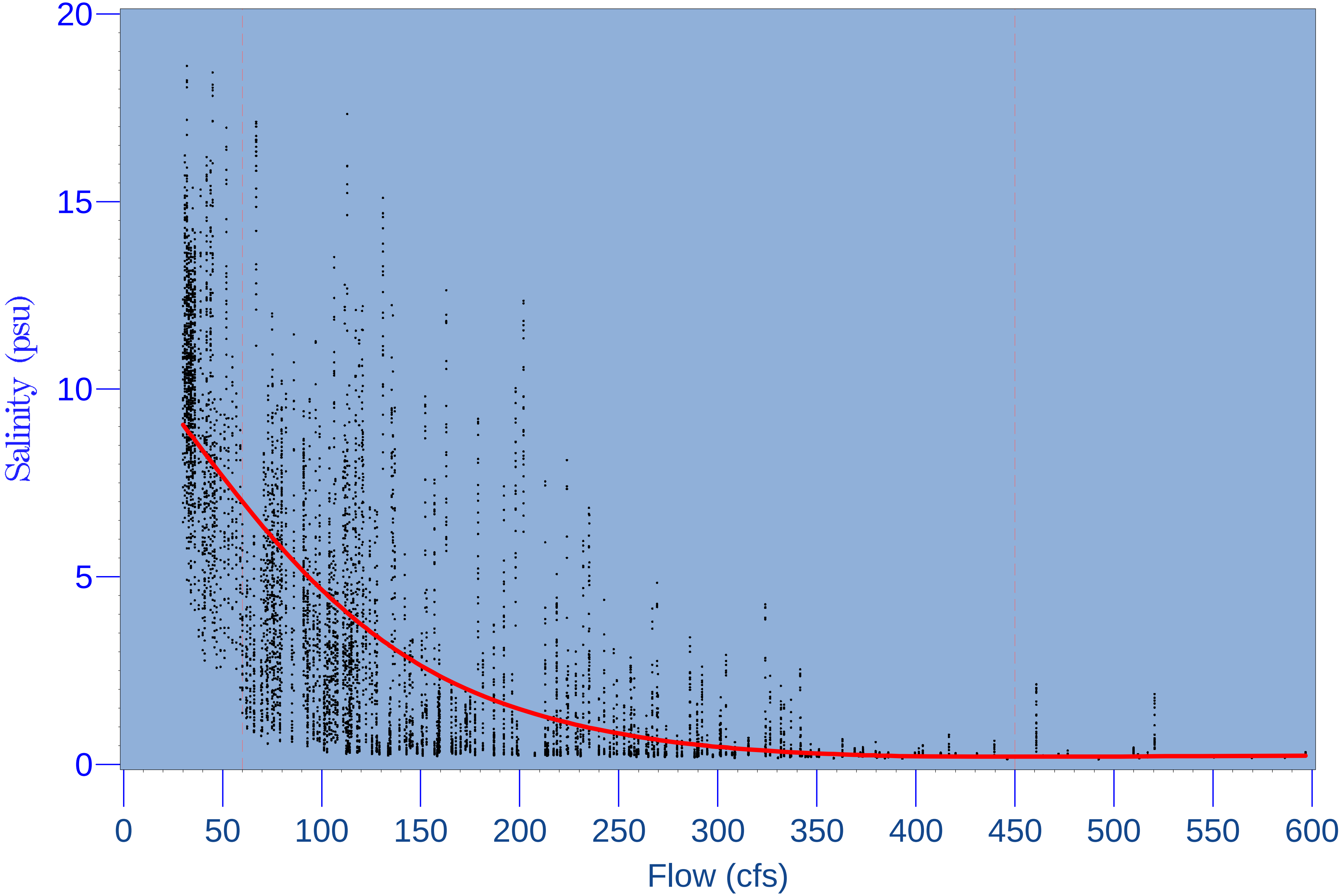


Figure 6.13 Surface salinity at MZ4 gage (RK 21.9) versus Peace River at Arcadia flow

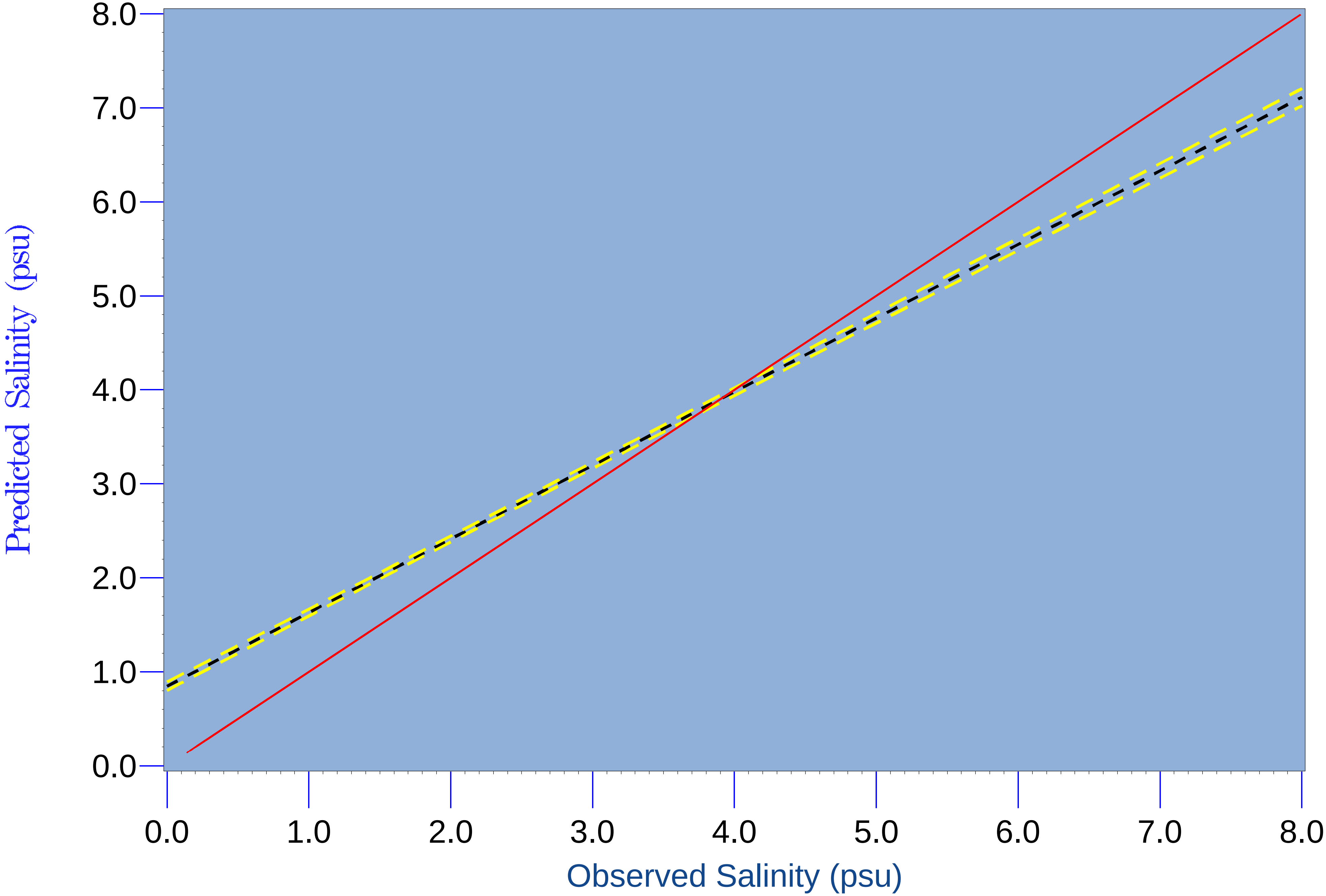


Figure 6.14 Predicted versus observed of modeled surface salinity at MZ4 Peace River HBMP gage (RK 21.9)

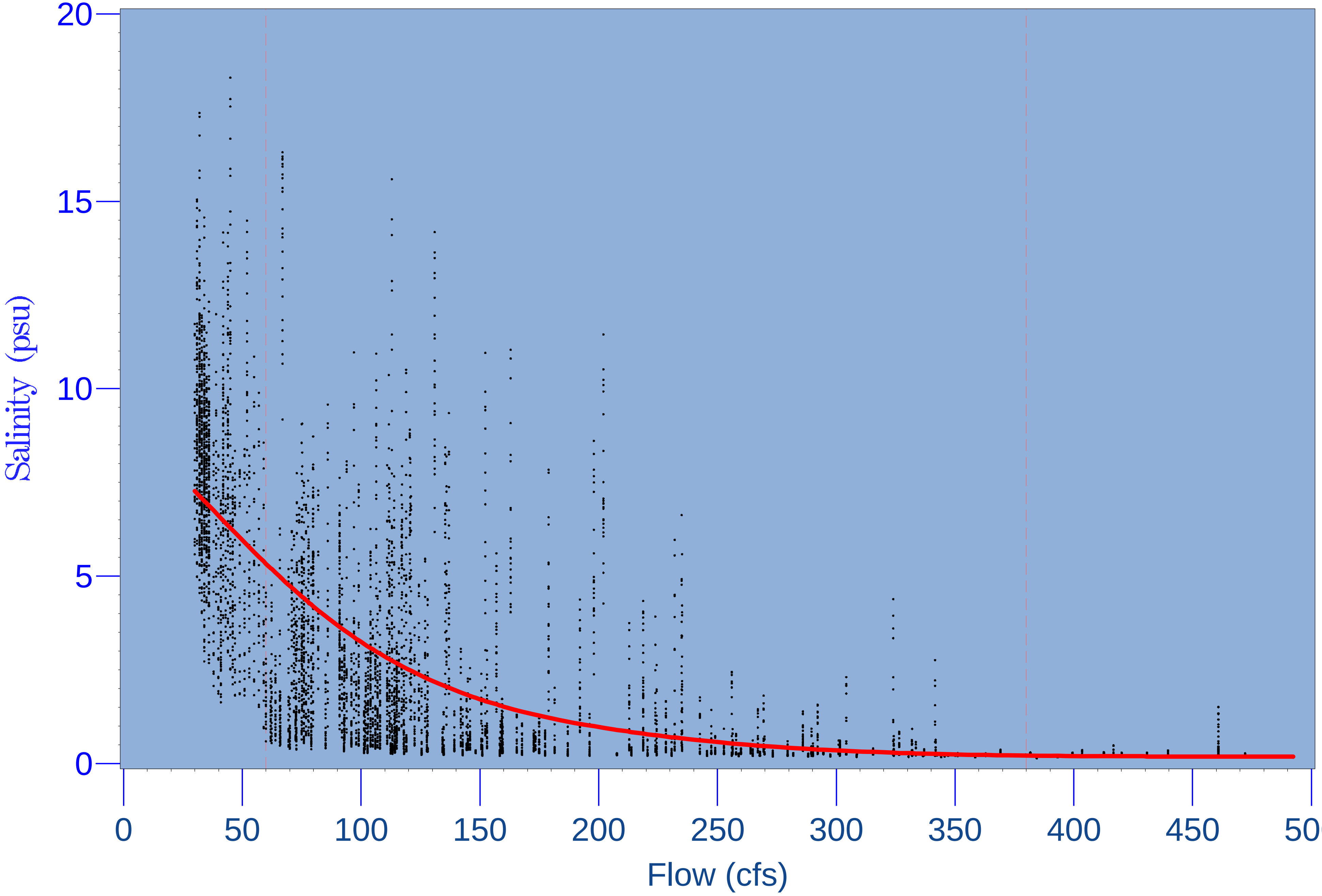


Figure 6.15 Surface salinity at MZ3 gage (RK 23.4) versus Peace River at Arcadia flow

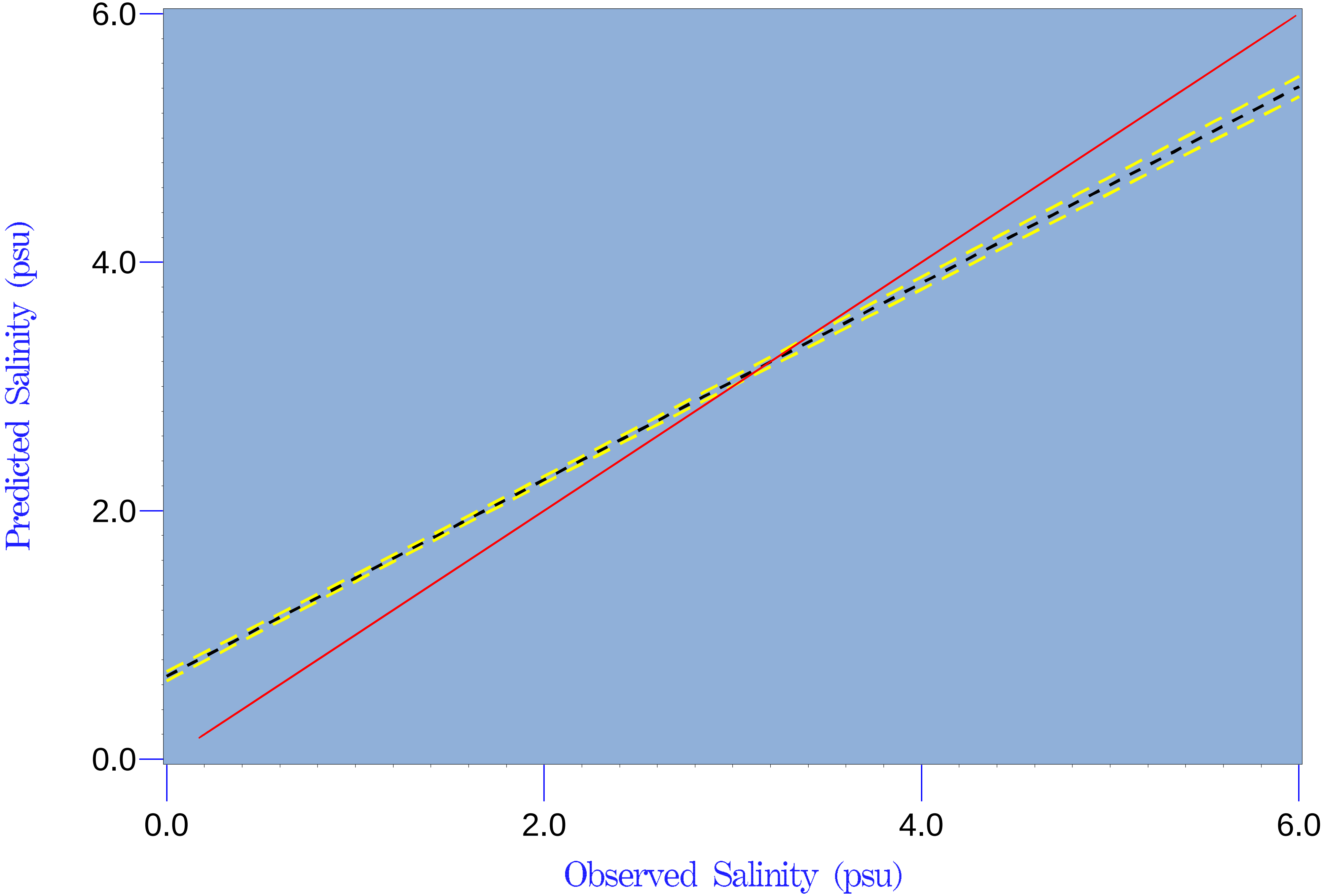


Figure 6.16 Predicted versus observed of modeled surface salinity at MZ3 Peace River HBMP gage (RK 23.4)

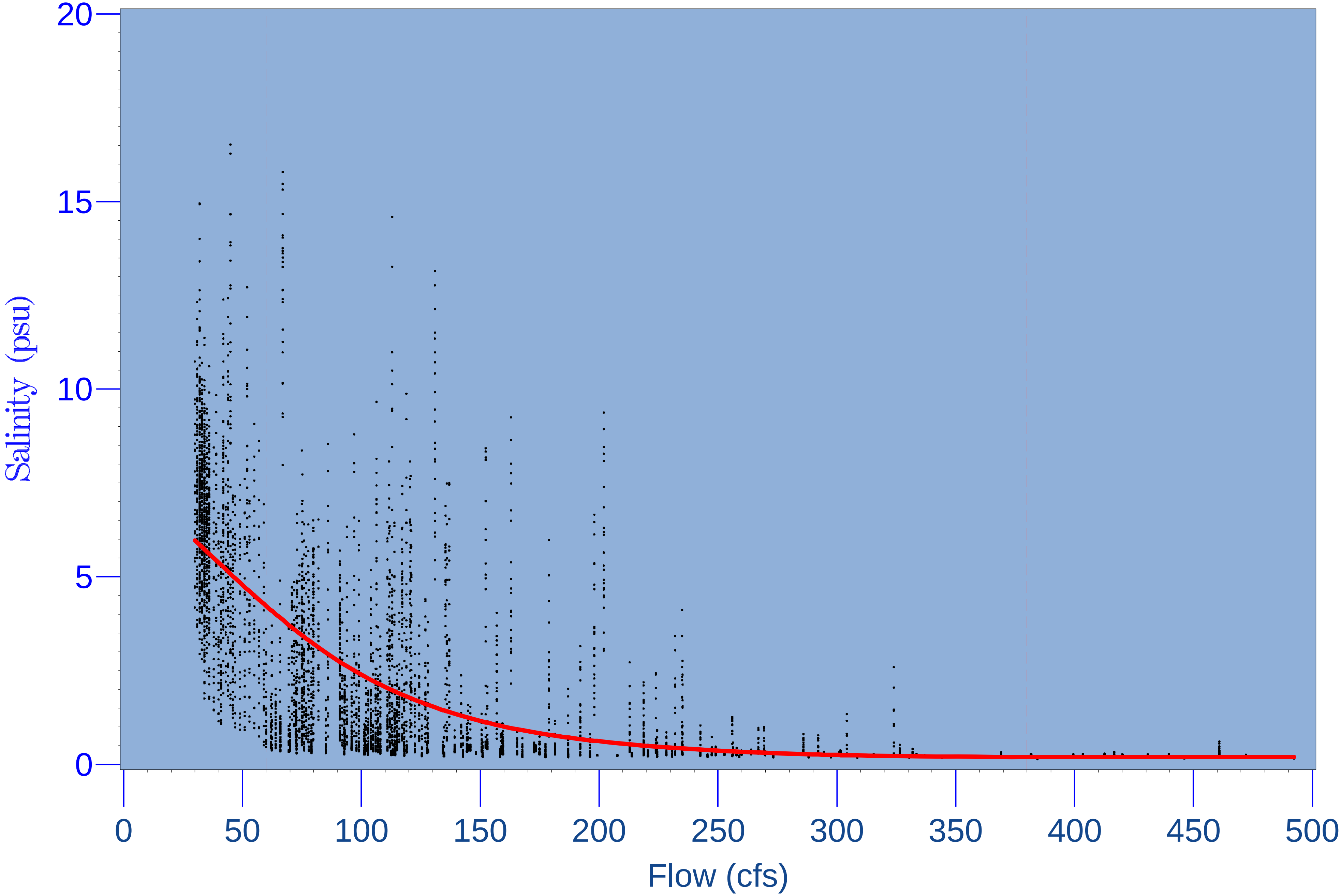


Figure 6.17 Surface salinity at MZ2 gage (RK 24.5) versus Peace River at Arcadia flow

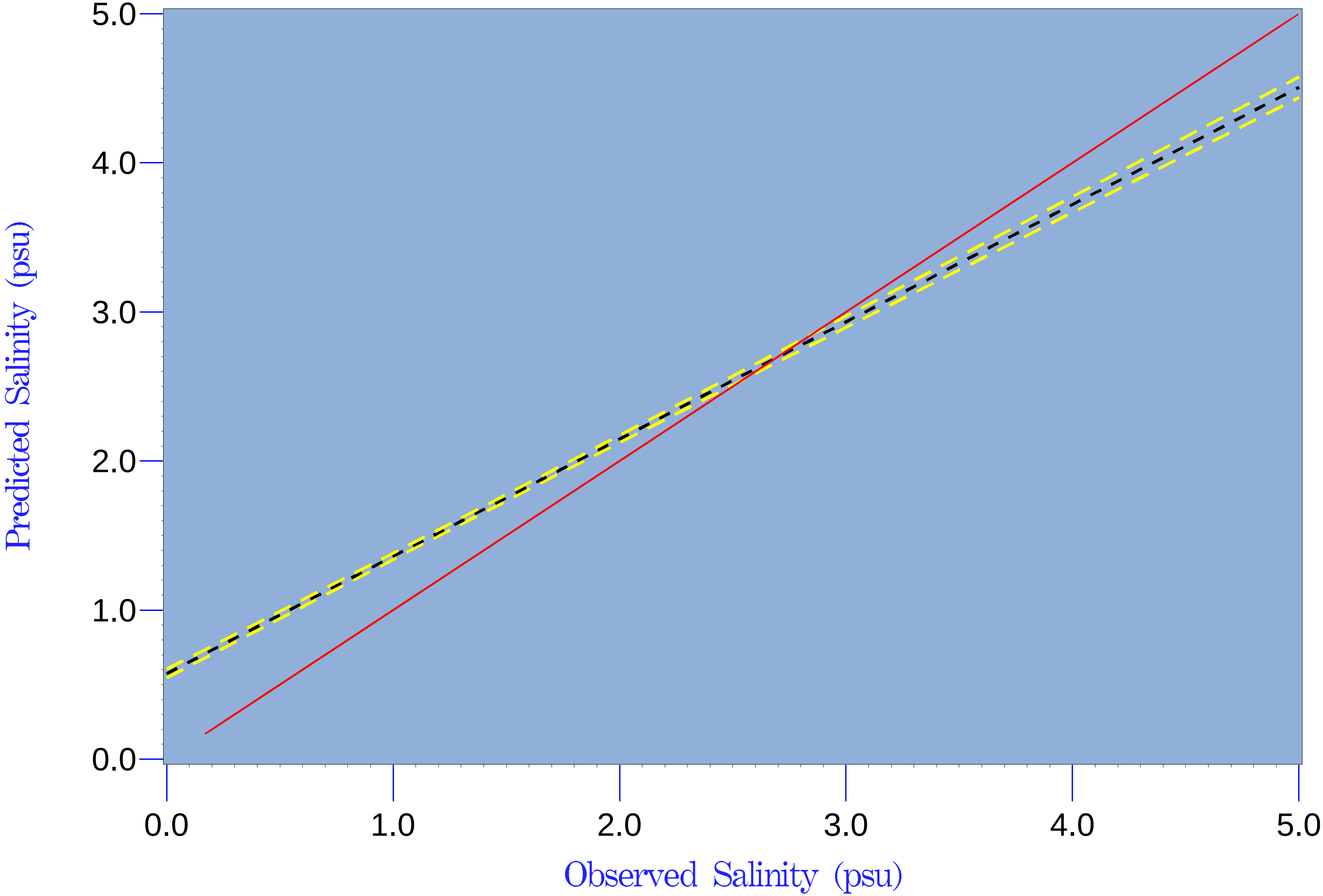


Figure 6.18 Predicted versus observed of modeled surface salinity at MZ2 Peace River HBMP gage (RK 24.5)

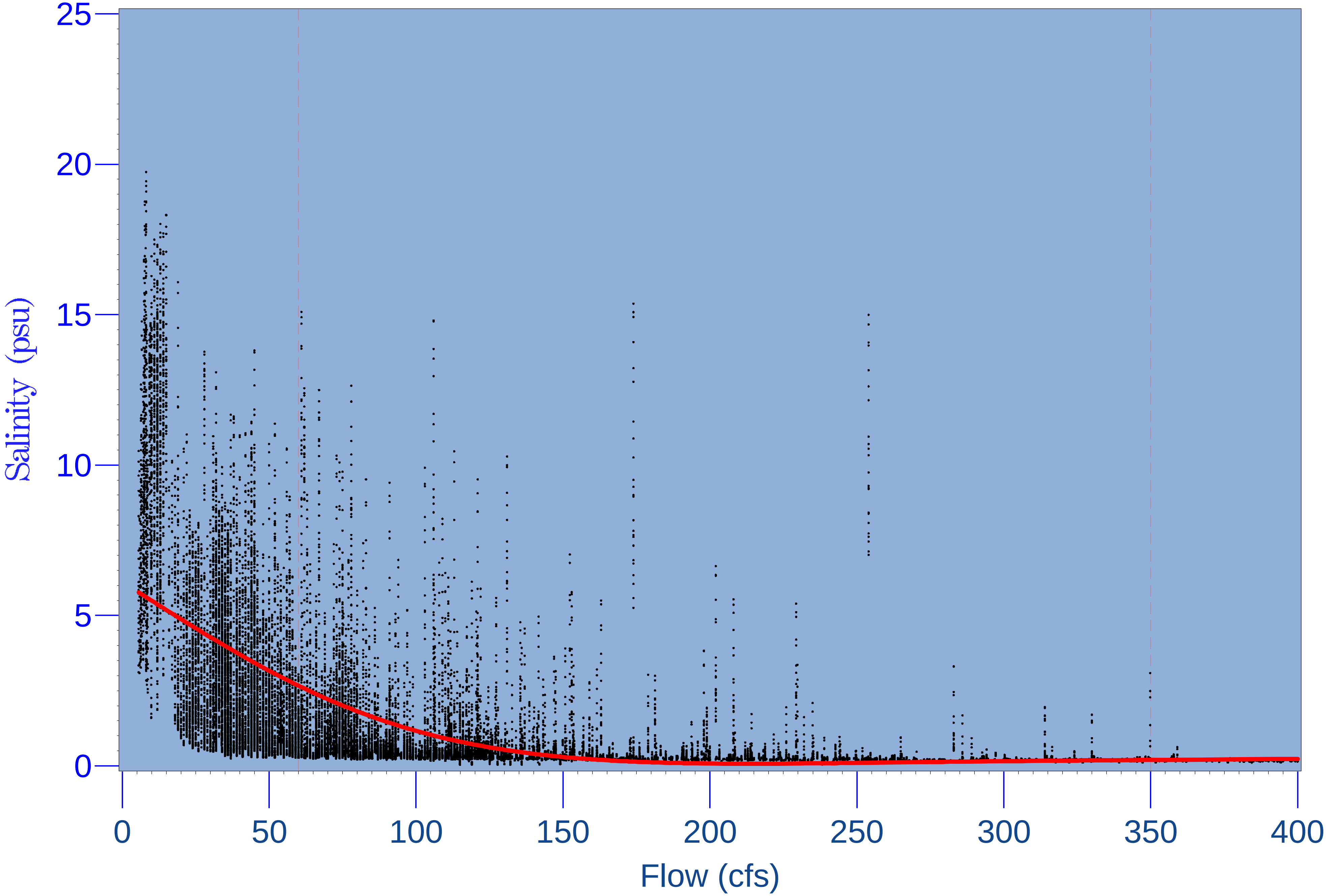


Figure 6.19 Surface salinity at USGS Peace River Heights gage (RK 26.7) versus Peace River at Arcadia flow

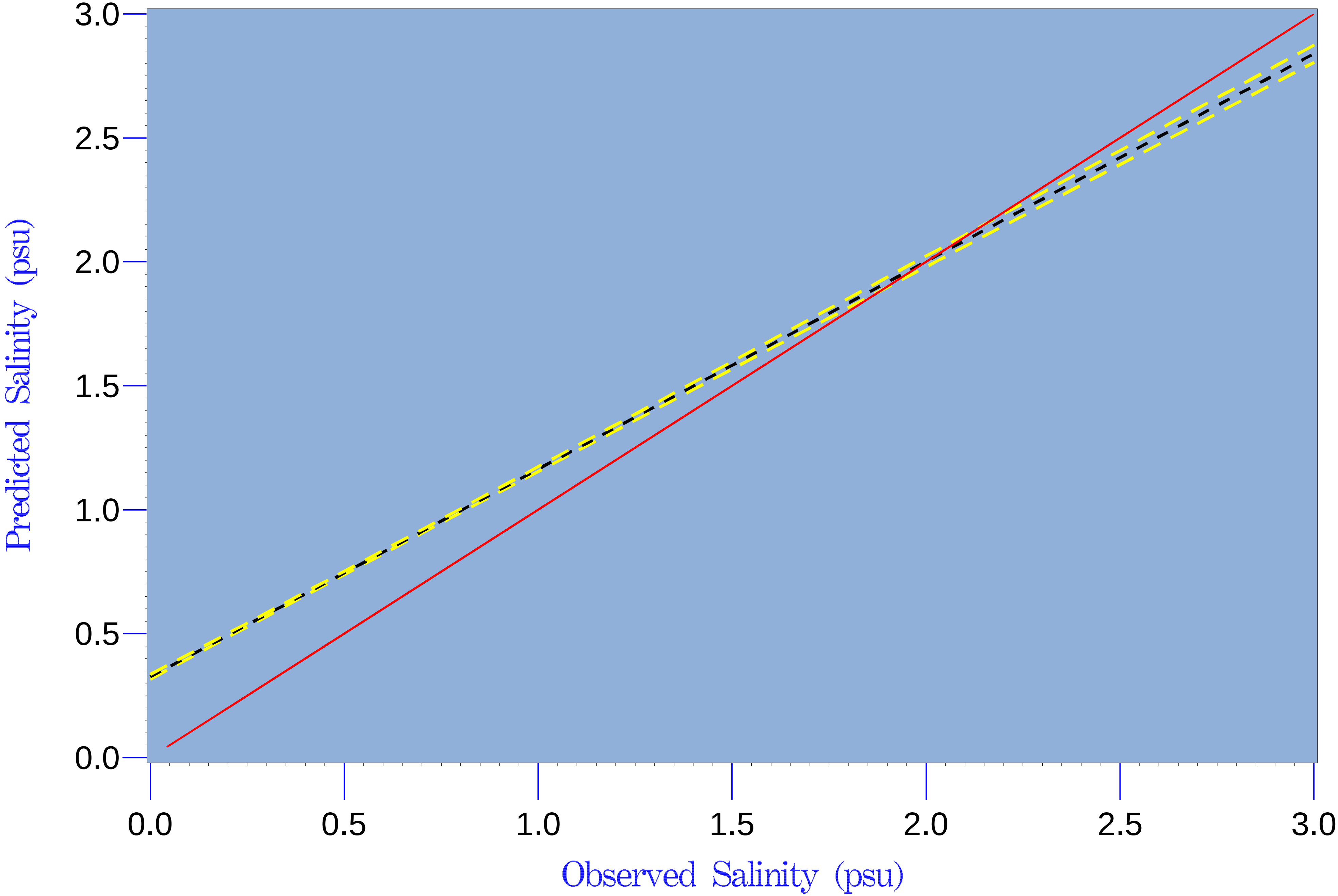


Figure 6.20 Predicted versus observed of modeled surface salinity at Peace River Heights (RK 26.7)

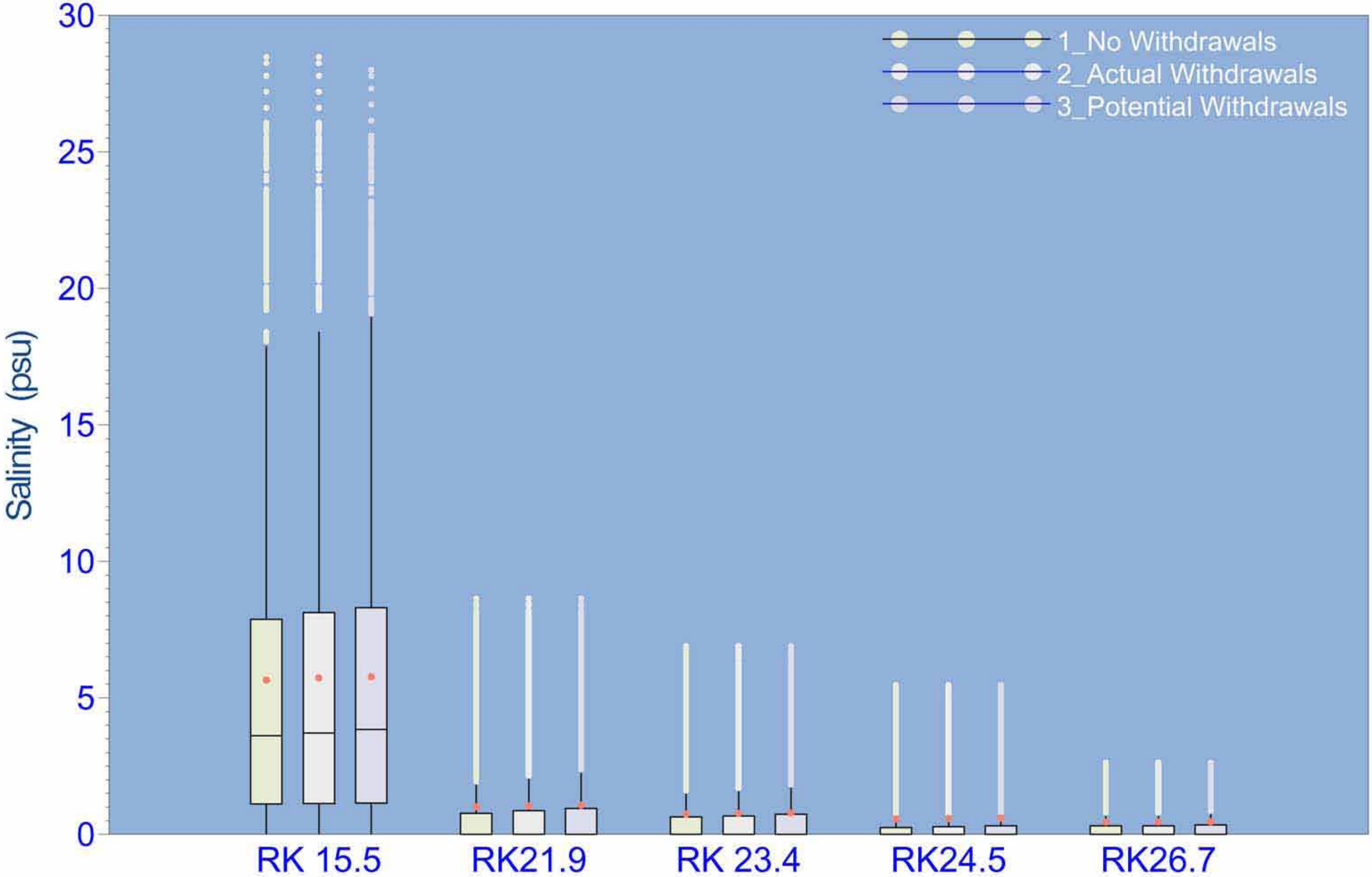


Figure 6.21 Box and whisker plots of salinity variability during 1998 at the continuous recorders

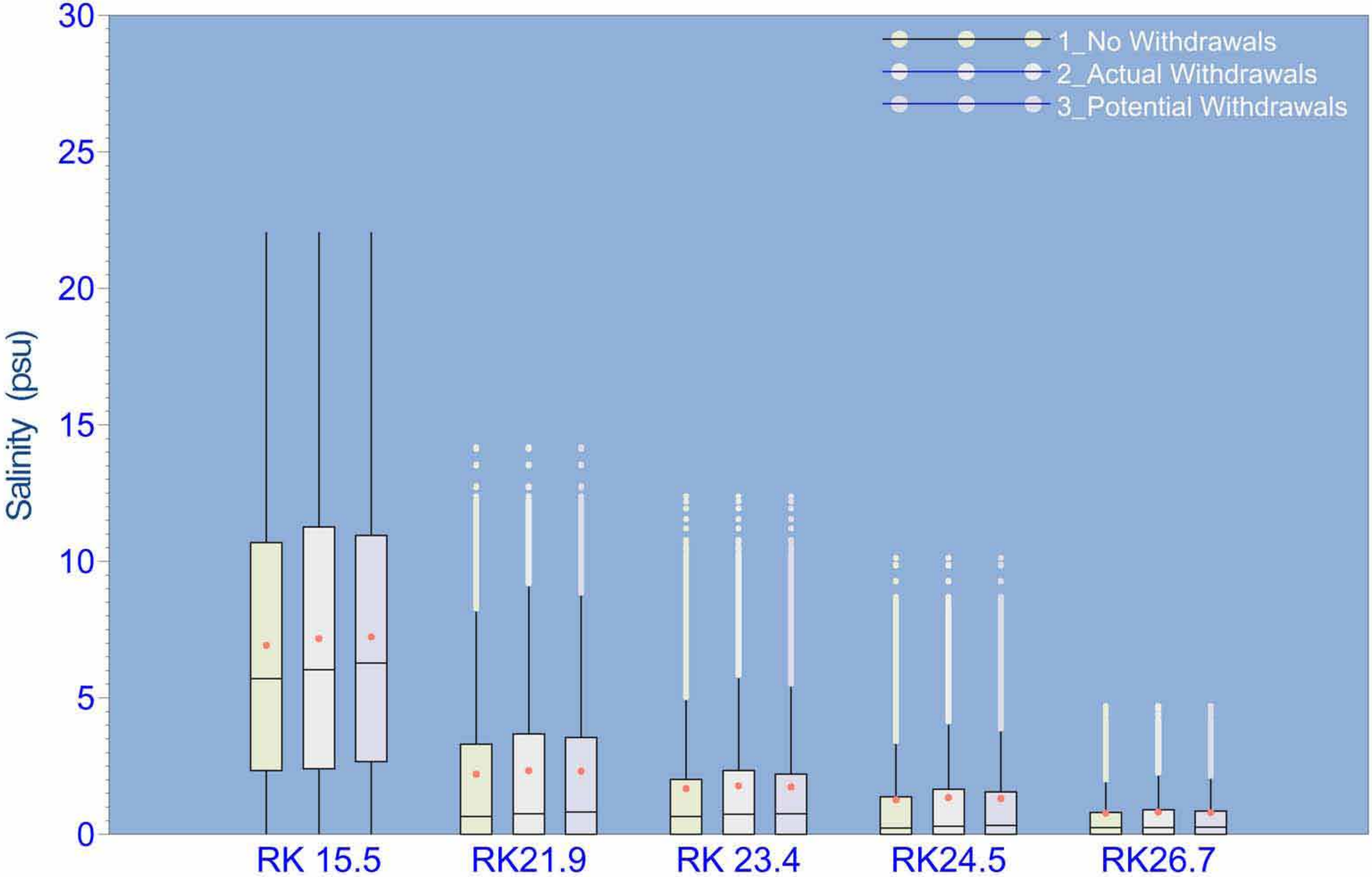


Figure 6.22 Box and whisker plots of salinity variability during 1999 at the continuous recorders

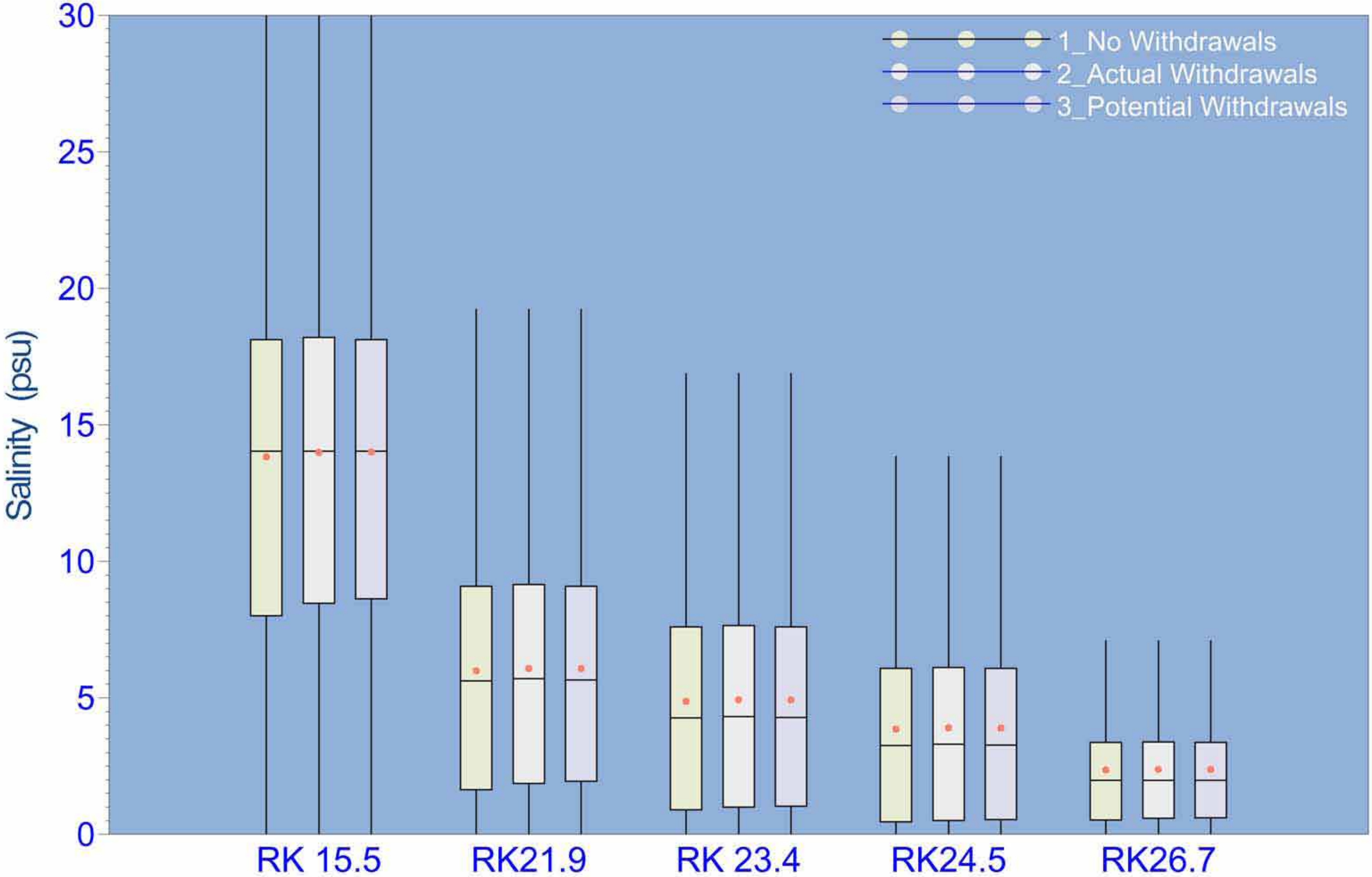


Figure 6.23 Box and whisker plots of salinity variability during 2000 at the continuous recorders

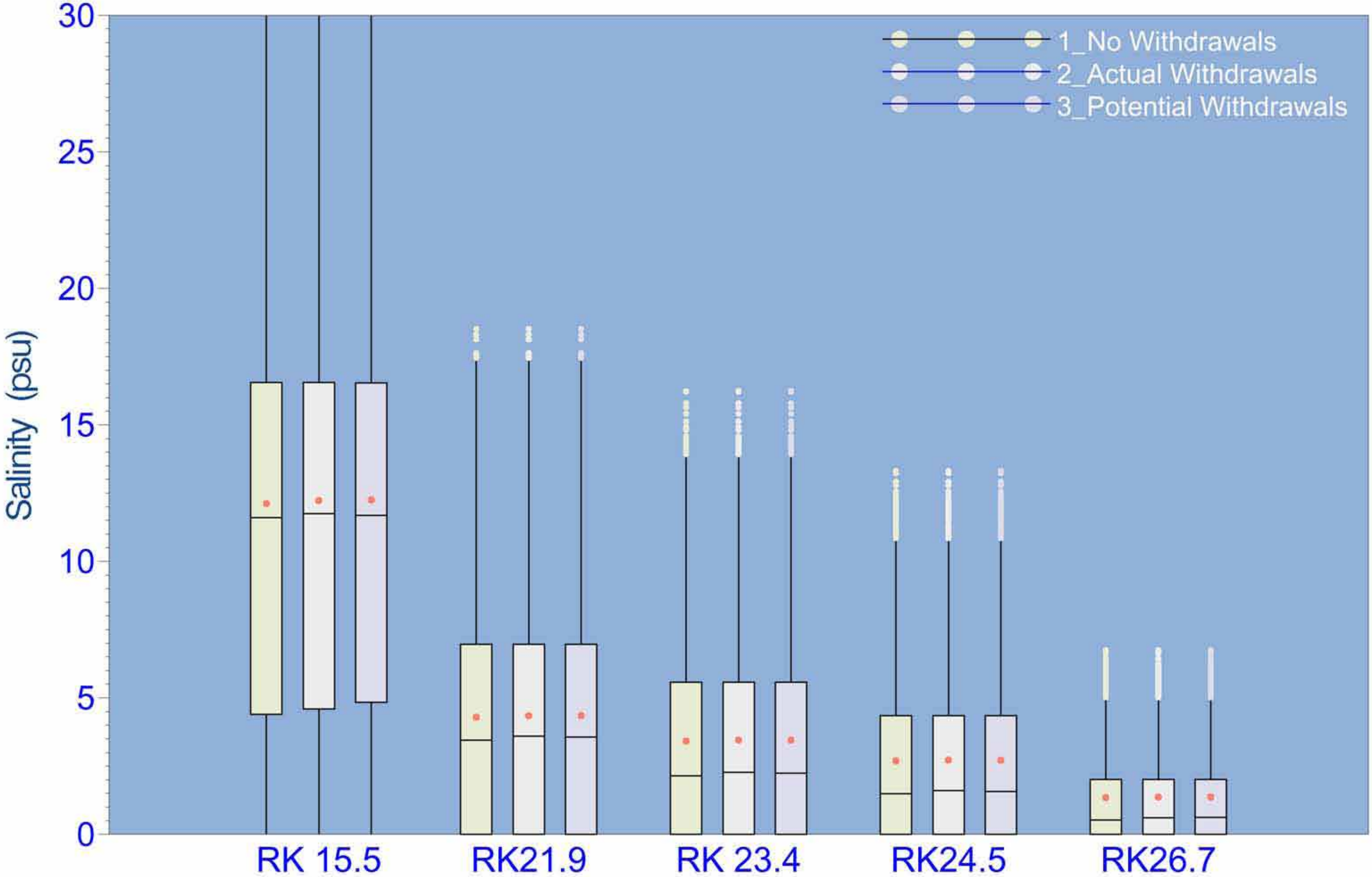


Figure 6.24 Box and whisker plots of salinity variability during 2001 at the continuous recorders

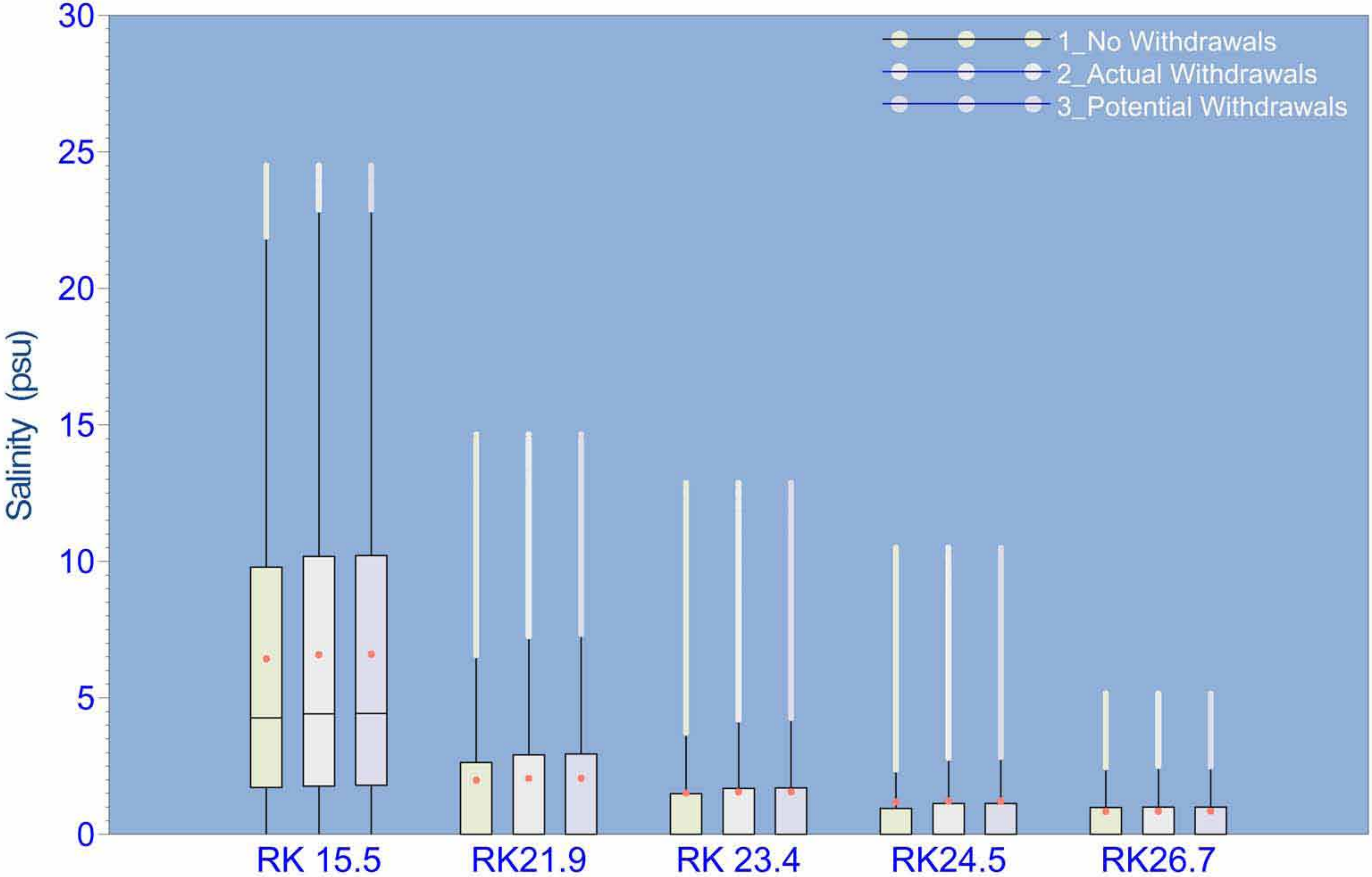


Figure 6.25 Box and whisker plots of salinity variability during 2002 at the continuous recorders

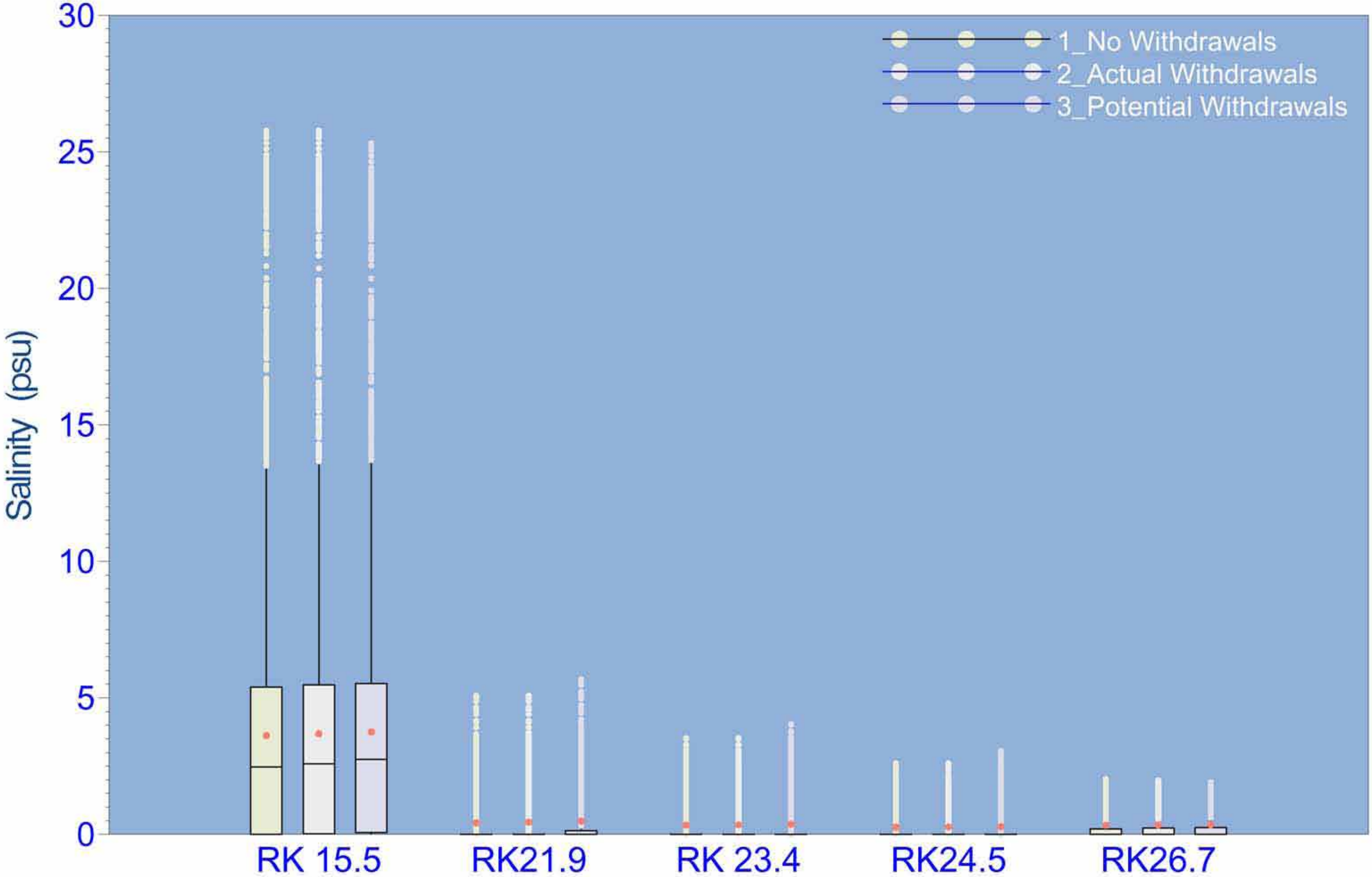


Figure 6.26 Box and whisker plots of salinity variability during 2003 at the continuous recorders

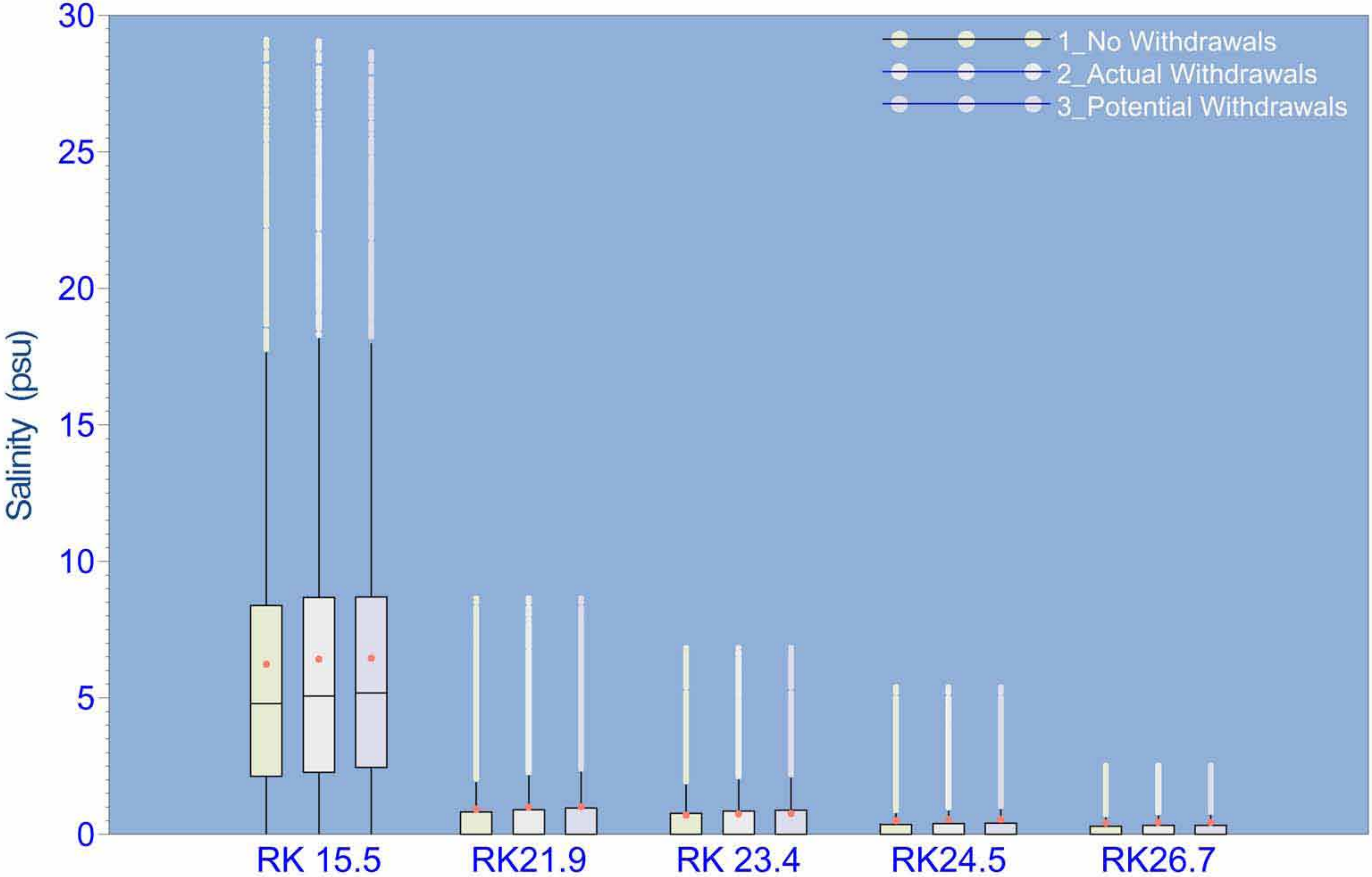


Figure 6.27 Box and whisker plots of salinity variability during 2004 at the continuous recorders

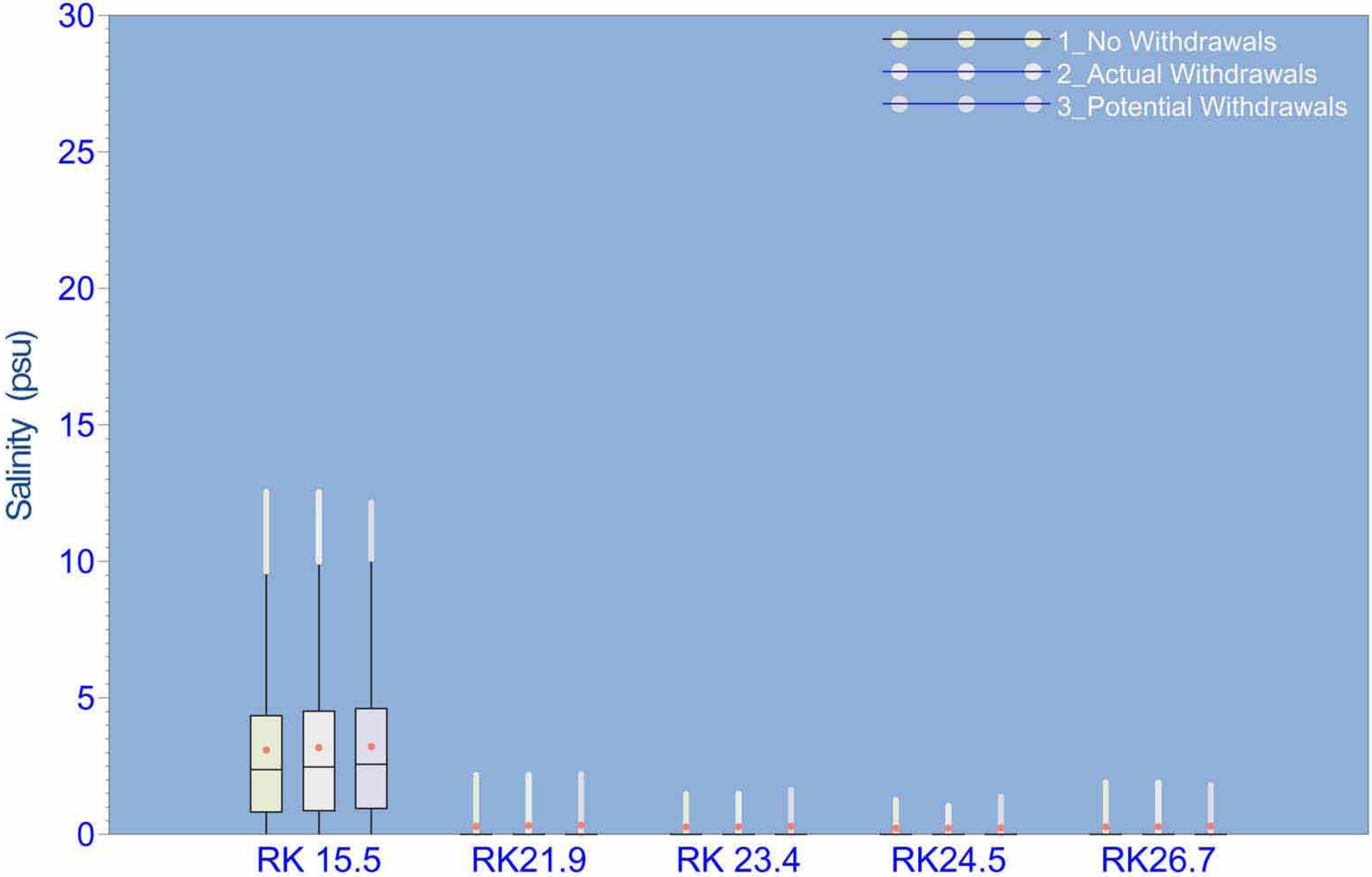


Figure 6.28 Box and whisker plots of salinity variability during 2005 at the continuous recorders

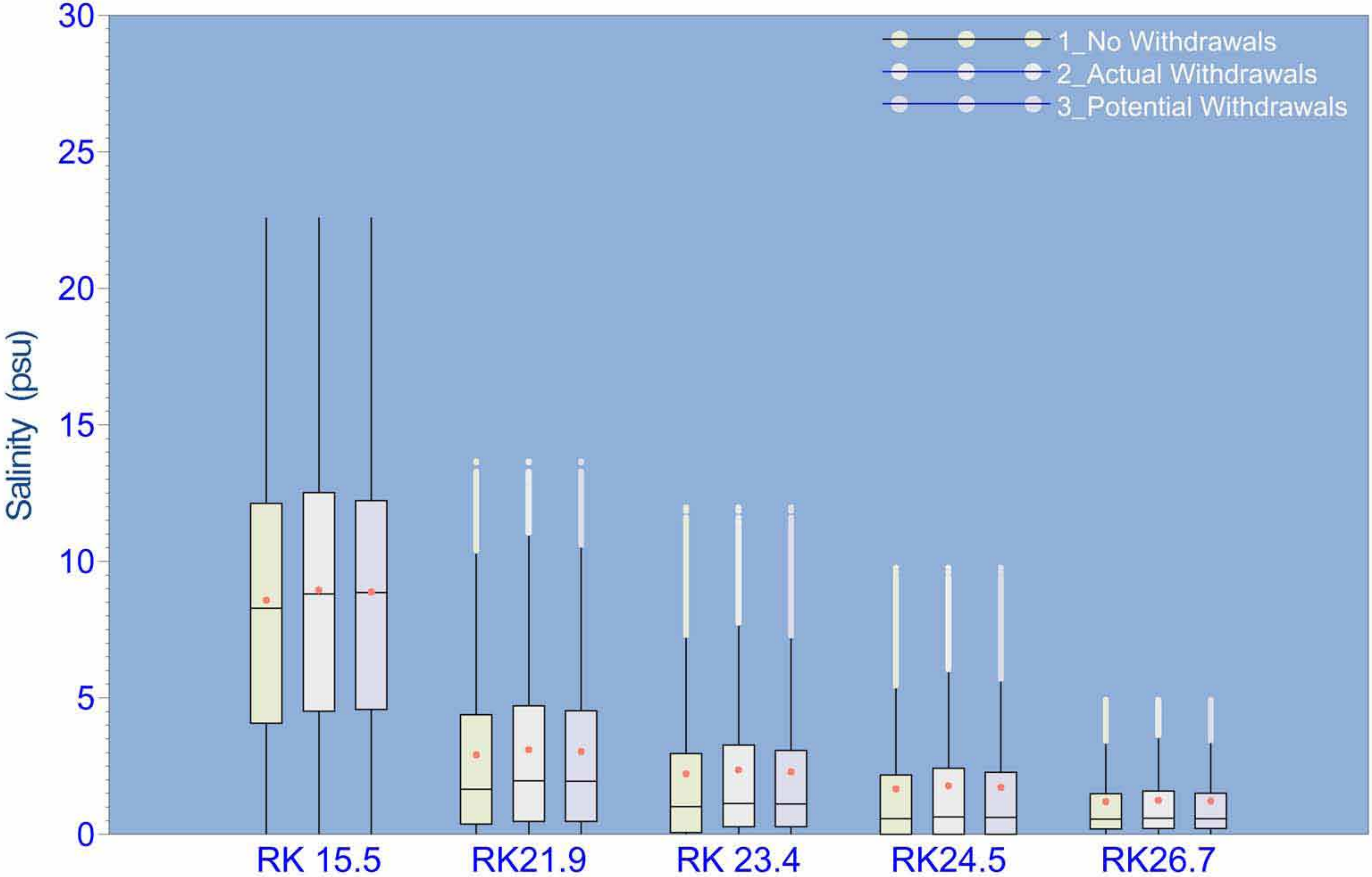


Figure 6.29 Box and whisker plots of salinity variability during 2006 at the continuous recorders


Photo 6.1

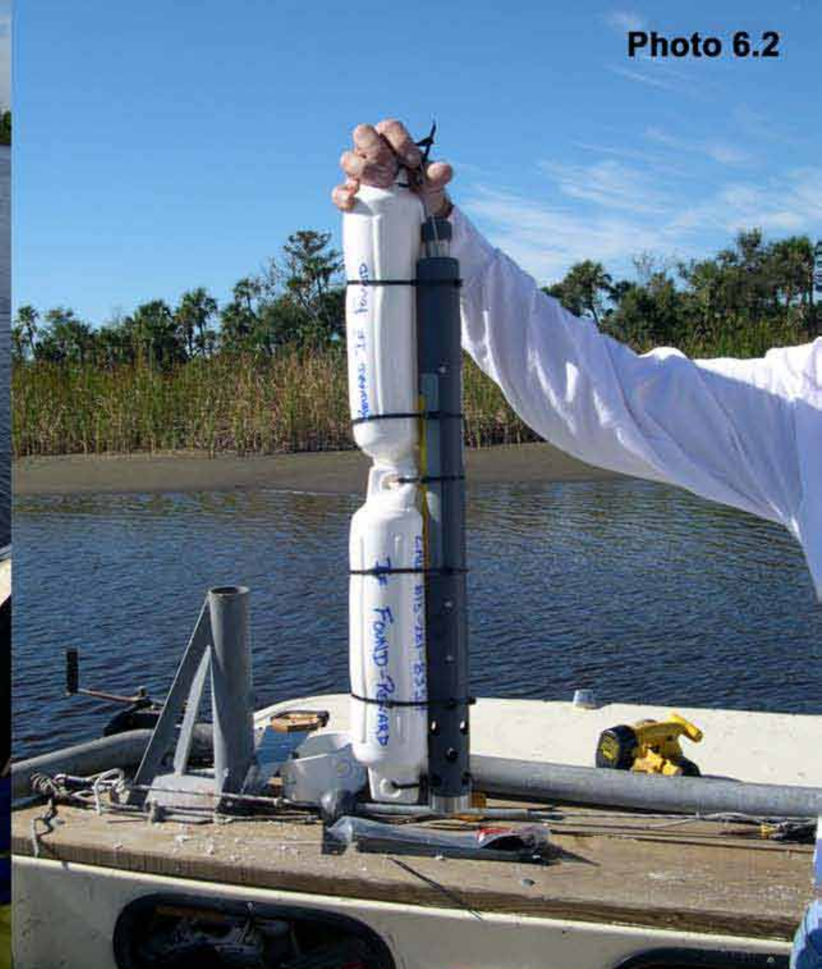


Photo 6.2


Photo 6.3

Photo 6.4

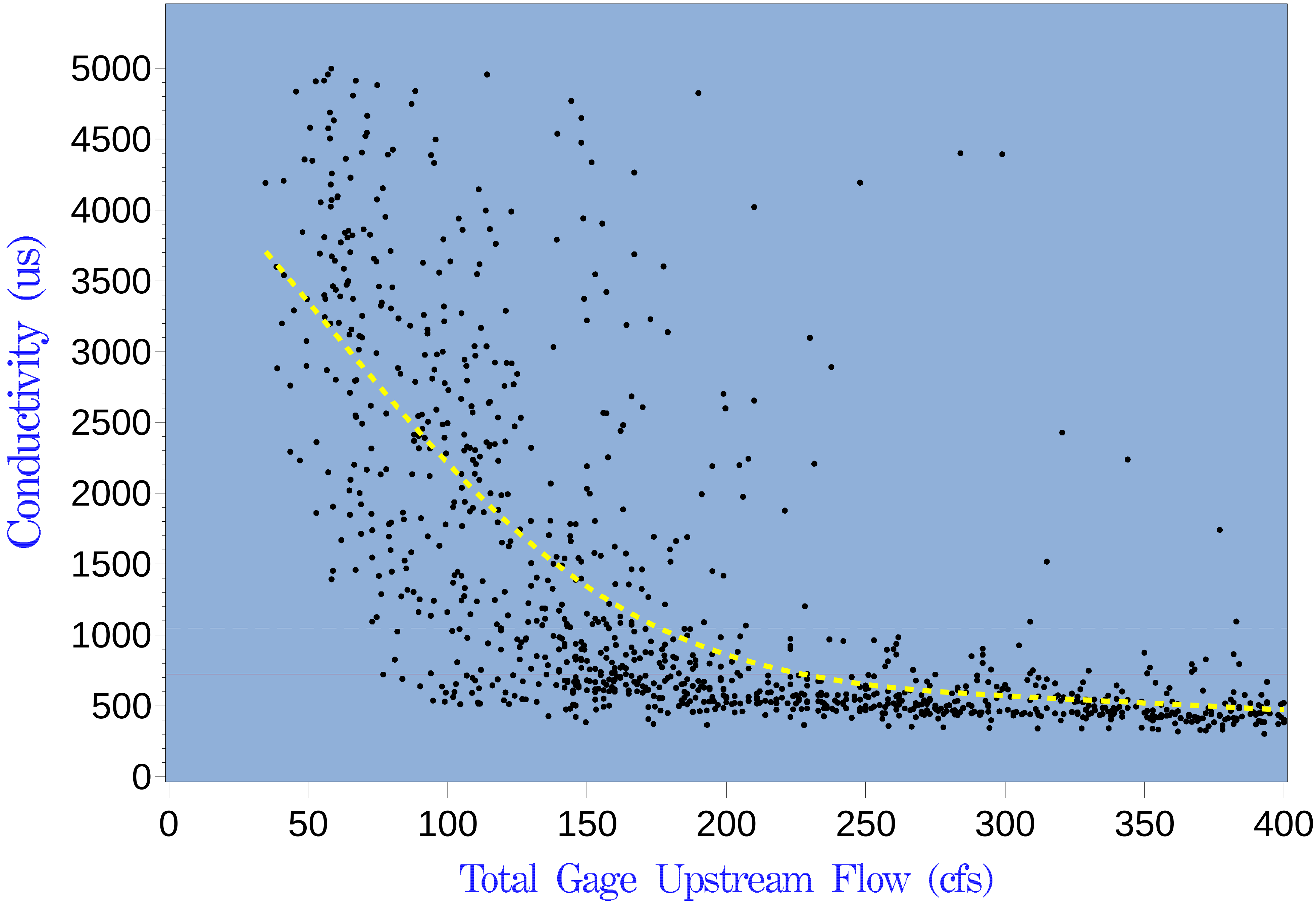
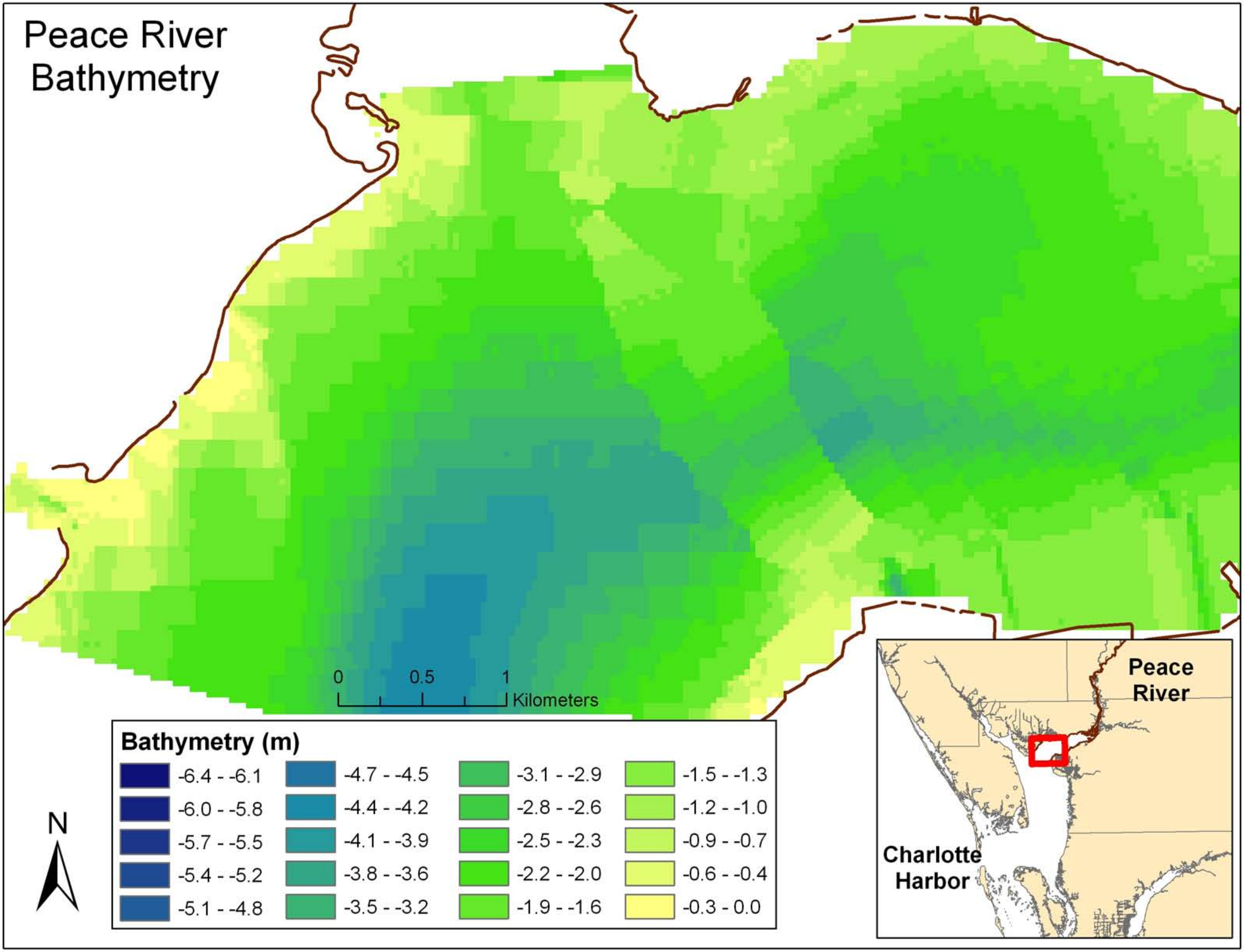
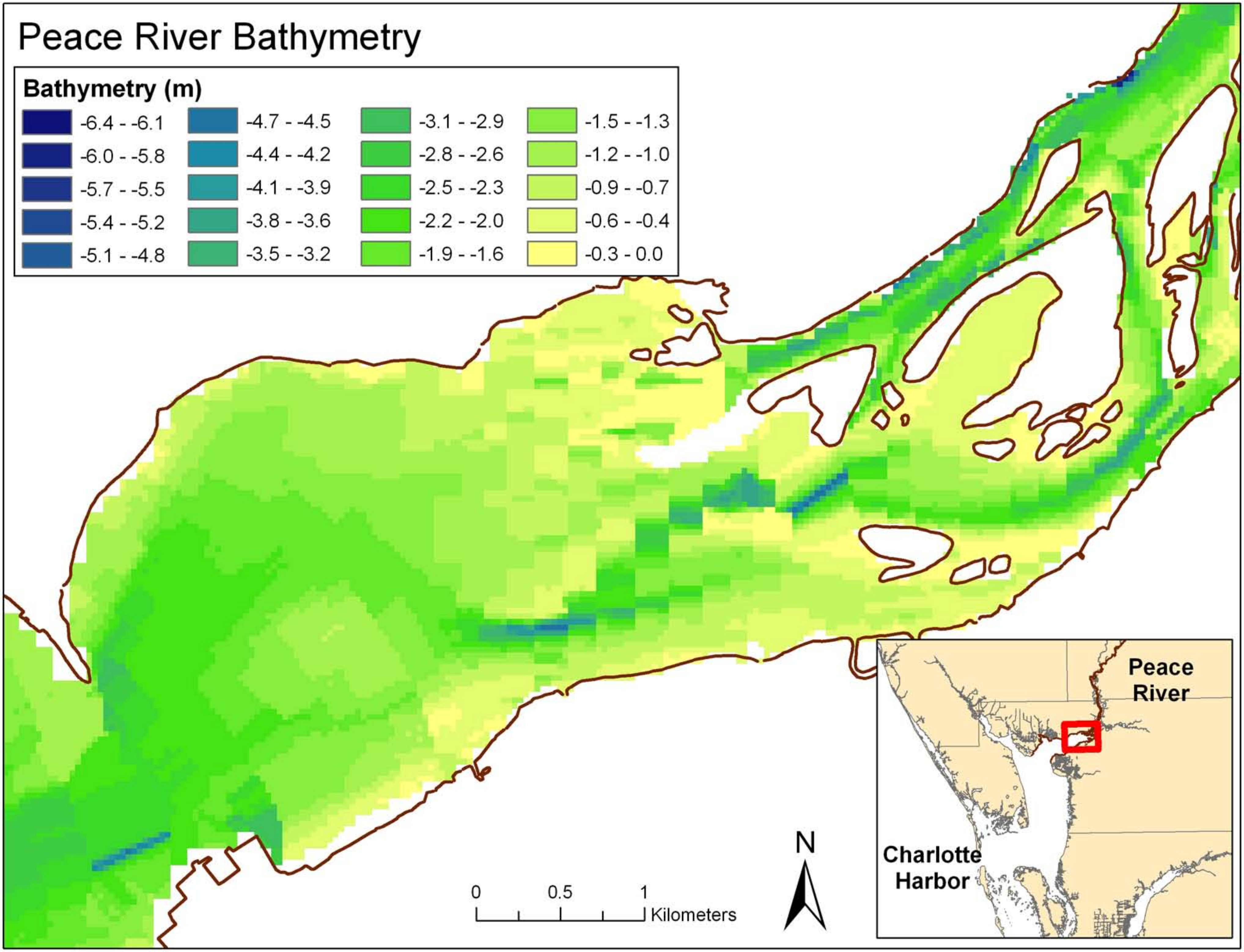
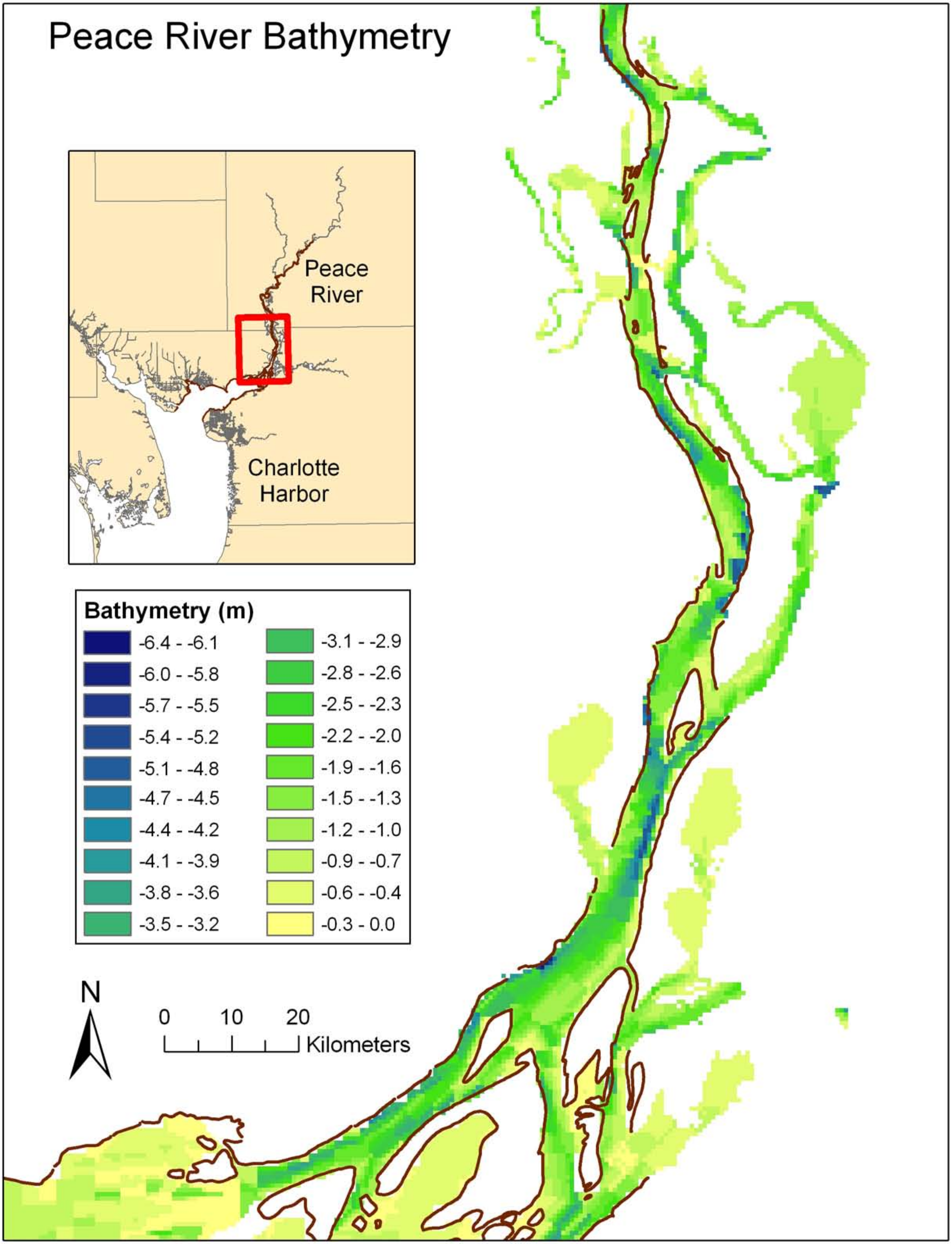


Figure 7.1 Recorder surface conductivity at river kilometer 26.7 versus flow


Peace River
Bathymetry
0
0.5
1
Kilometers
Bathymetry (m)
-6.4 - -6.1
-6.0 - -5.8
-5.7 - -5.5
-5.4 - -5.2
-5.1 - -4.8
-4.7 - -4.5
-4.4 - -4.2
-4.1 - -3.9
-3.8 - -3.6
-3.5 - -3.2
-3.1 - -2.9
-2.8 - -2.6
-2.5 - -2.3
-2.2 - -2.0
-1.9 - -1.6
-1.5 - -1.3
-1.2 - -1.0
-0.9 - -0.7
-0.6 - -0.4
-0.3 - 0.0
N
Peace
River
Charlotte
Harbor


Peace River Bathymetry
Bathymetry (m)
-6.4 - -6.1
-6.0 - -5.8
-5.7 - -5.5
-5.4 - -5.2
-5.1 - -4.8
-4.7 - -4.5
-4.4 - -4.2
-4.1 - -3.9
-3.8 - -3.6
-3.5 - -3.2
-3.1 - -2.9
-2.8 - -2.6
-2.5 - -2.3
-2.2 - -2.0
-1.9 - -1.6
-1.5 - -1.3
-1.2 - -1.0
-0.9 - -0.7
-0.6 - -0.4
-0.3 - 0.0
0
0.5
1
Kilometers
N
Peace River
Charlotte Harbor


Peace River Bathymetry
Peace River
Charlotte Harbor
Bathymetry (m)
-6.4 - -6.1
-6.0 - -5.8
-5.7 - -5.5
-5.4 - -5.2
-5.1 - -4.8
-4.7 - -4.5
-4.4 - -4.2
-4.1 - -3.9
-3.8 - -3.6
-3.5 - -3.2
-3.1 - -2.9
-2.8 - -2.6
-2.5 - -2.3
-2.2 - -2.0
-1.9 - -1.6
-1.5 - -1.3
-1.2 - -1.0
-0.9 - -0.7
-0.6 - -0.4
-0.3 - 0.0
N
0 10 20
Kilometers

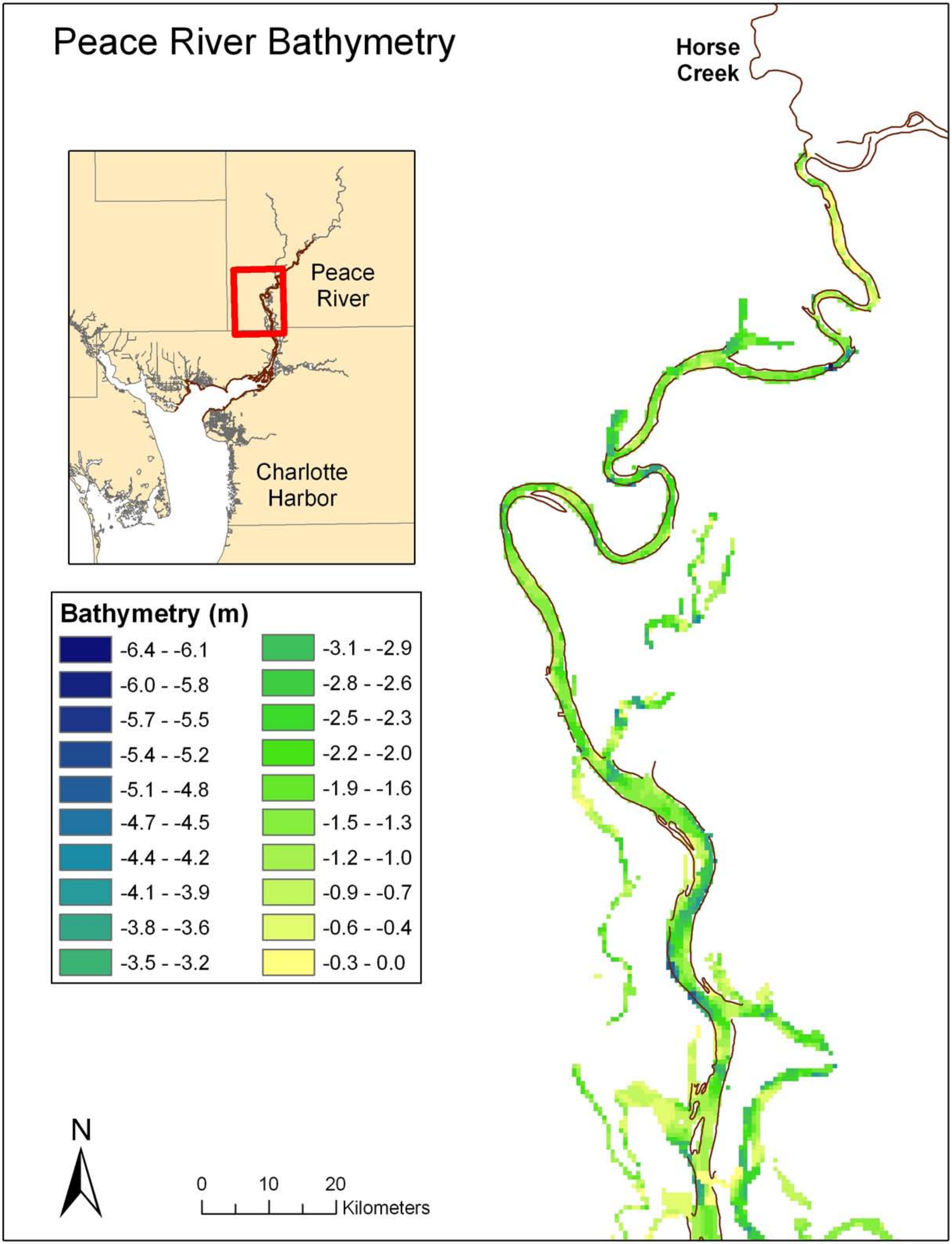

Peace River Bathymetry
Horse Creek
Peace River
Charlotte Harbor
Bathymetry (m)
-6.4 - -6.1
-6.0 - -5.8
-5.7 - -5.5
-5.4 - -5.2
-5.1 - -4.8
-4.7 - -4.5
-4.4 - -4.2
-4.1 - -3.9
-3.8 - -3.6
-3.5 - -3.2
-3.1 - -2.9
-2.8 - -2.6
-2.5 - -2.3
-2.2 - -2.0
-1.9 - -1.6
-1.5 - -1.3
-1.2 - -1.0
-0.9 - -0.7
-0.6 - -0.4
-0.3 - 0.0
N
0 10 20 Kilometers

Figure 9.1 Conceptual Model of Impact of Surface Water Withdrawals

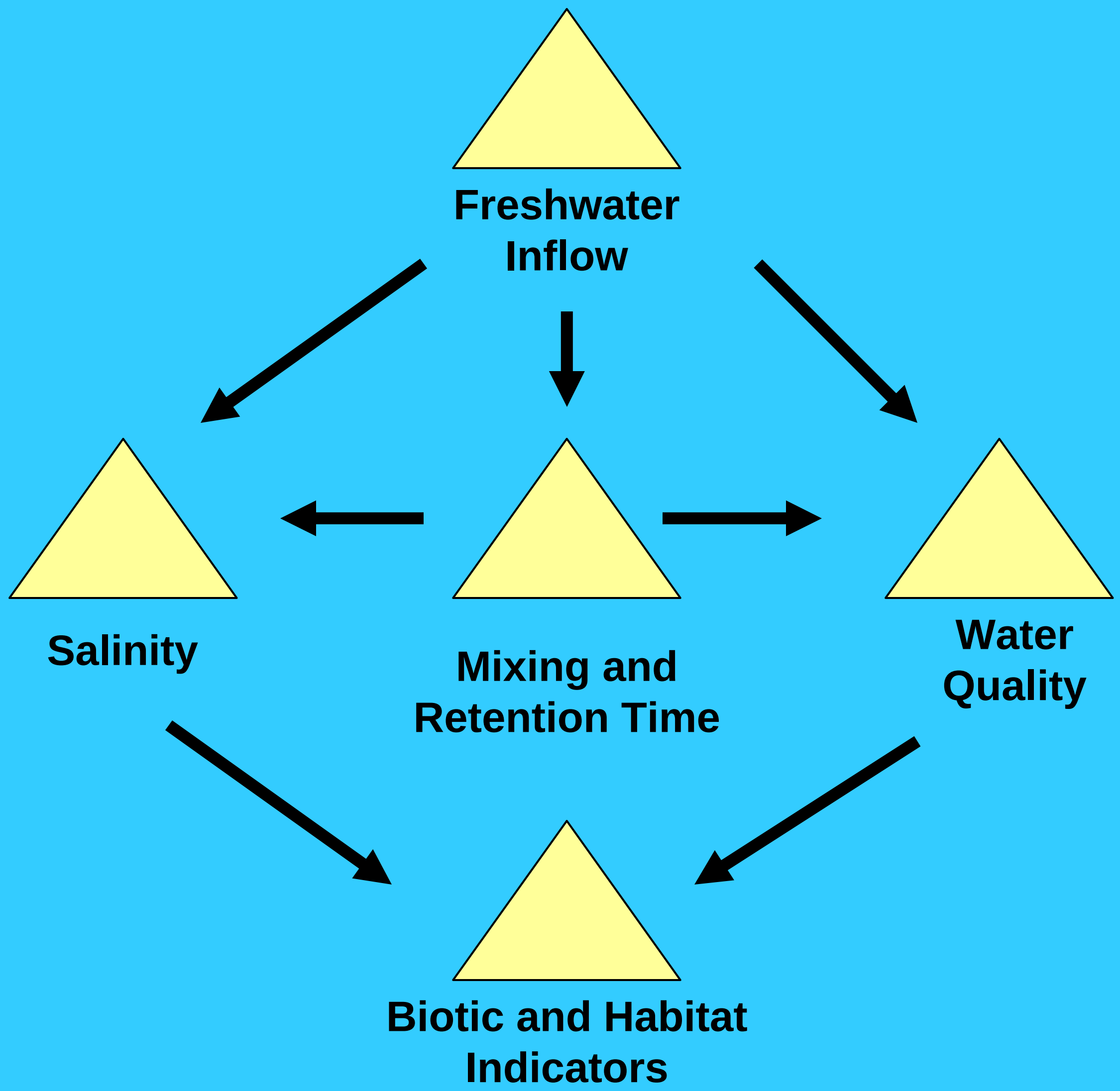


Figure 9.2 Conceptual Illustration of a Salinity Target Range

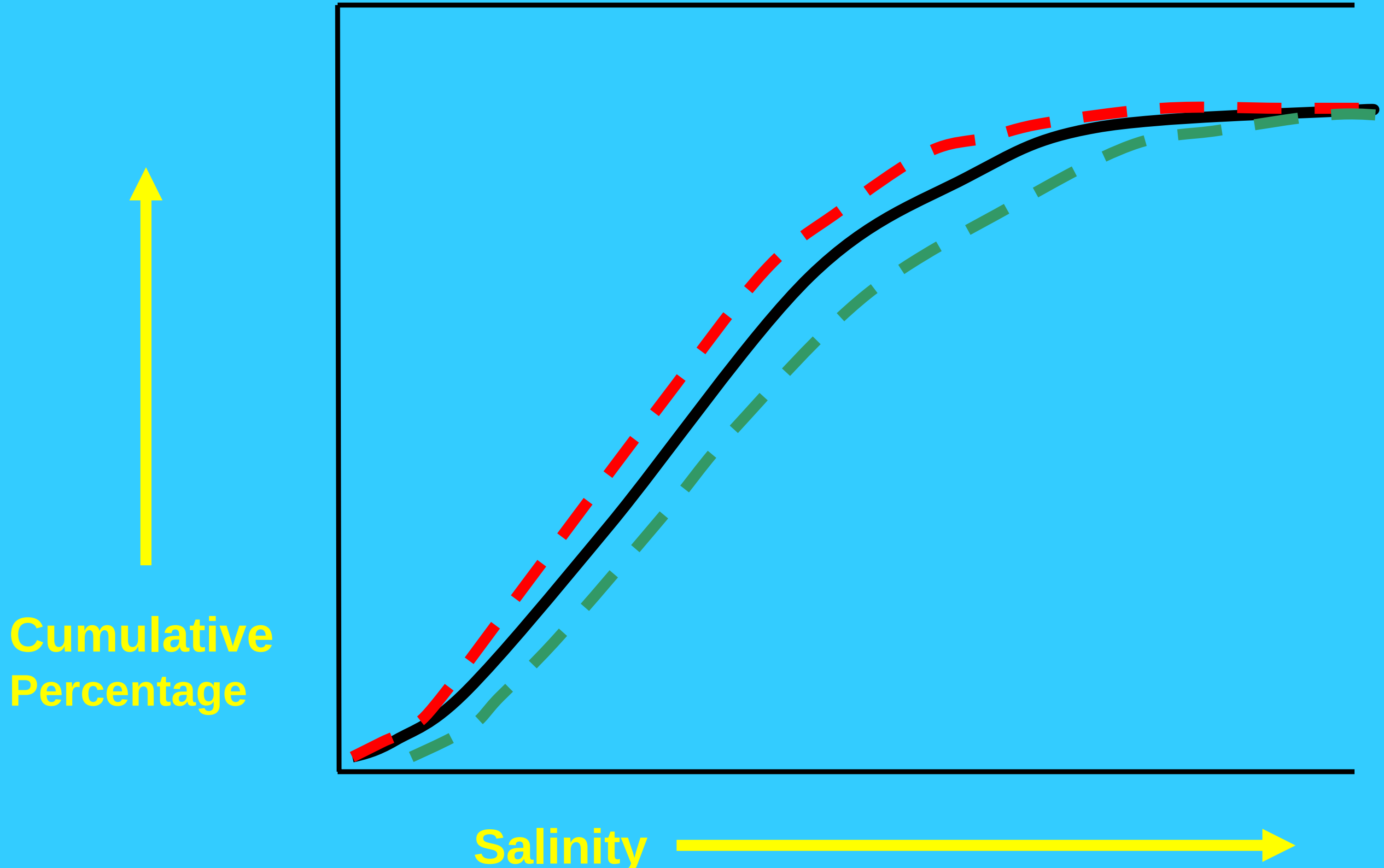


Figure 9.3 Conceptual Design Tree for Evaluating Changes

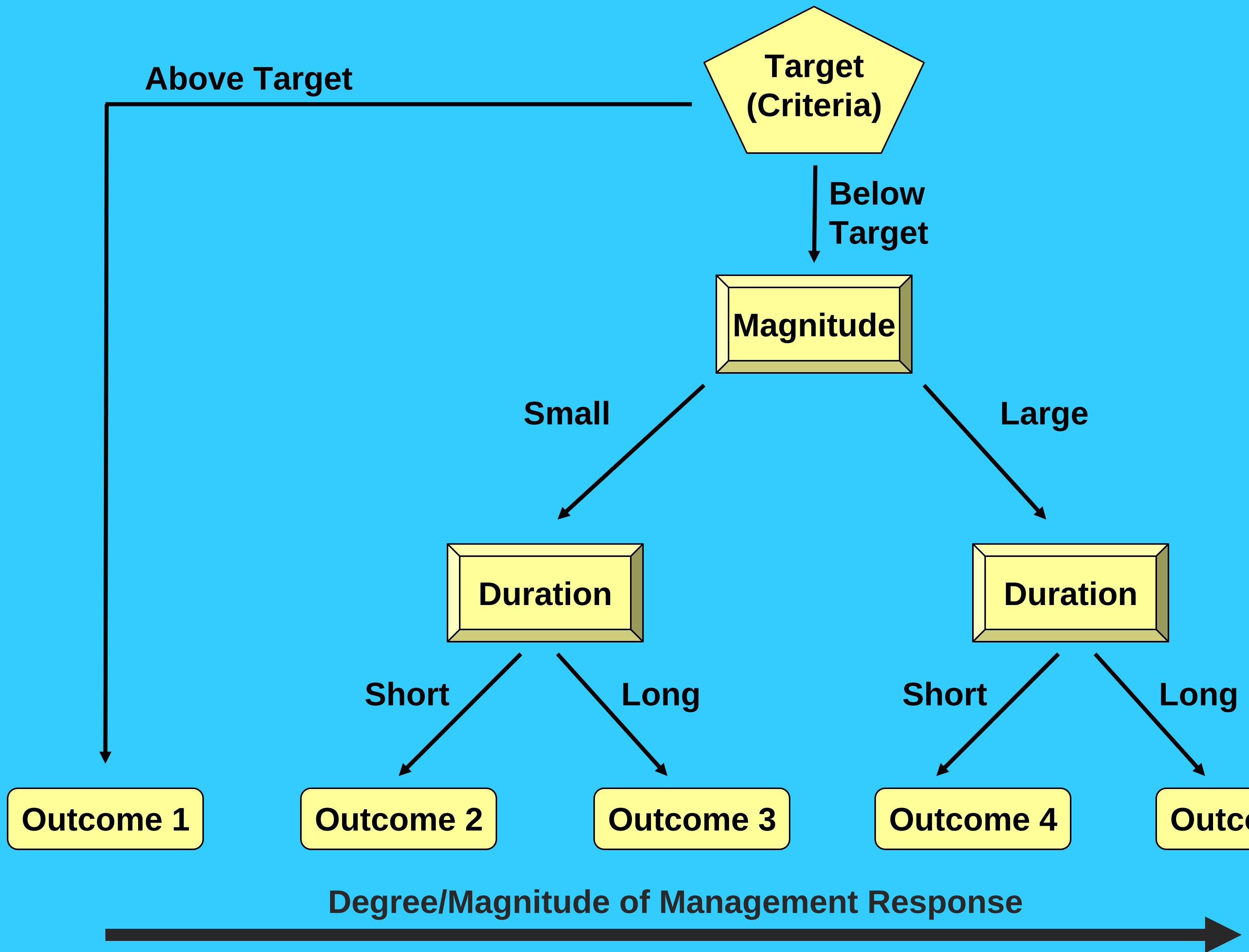
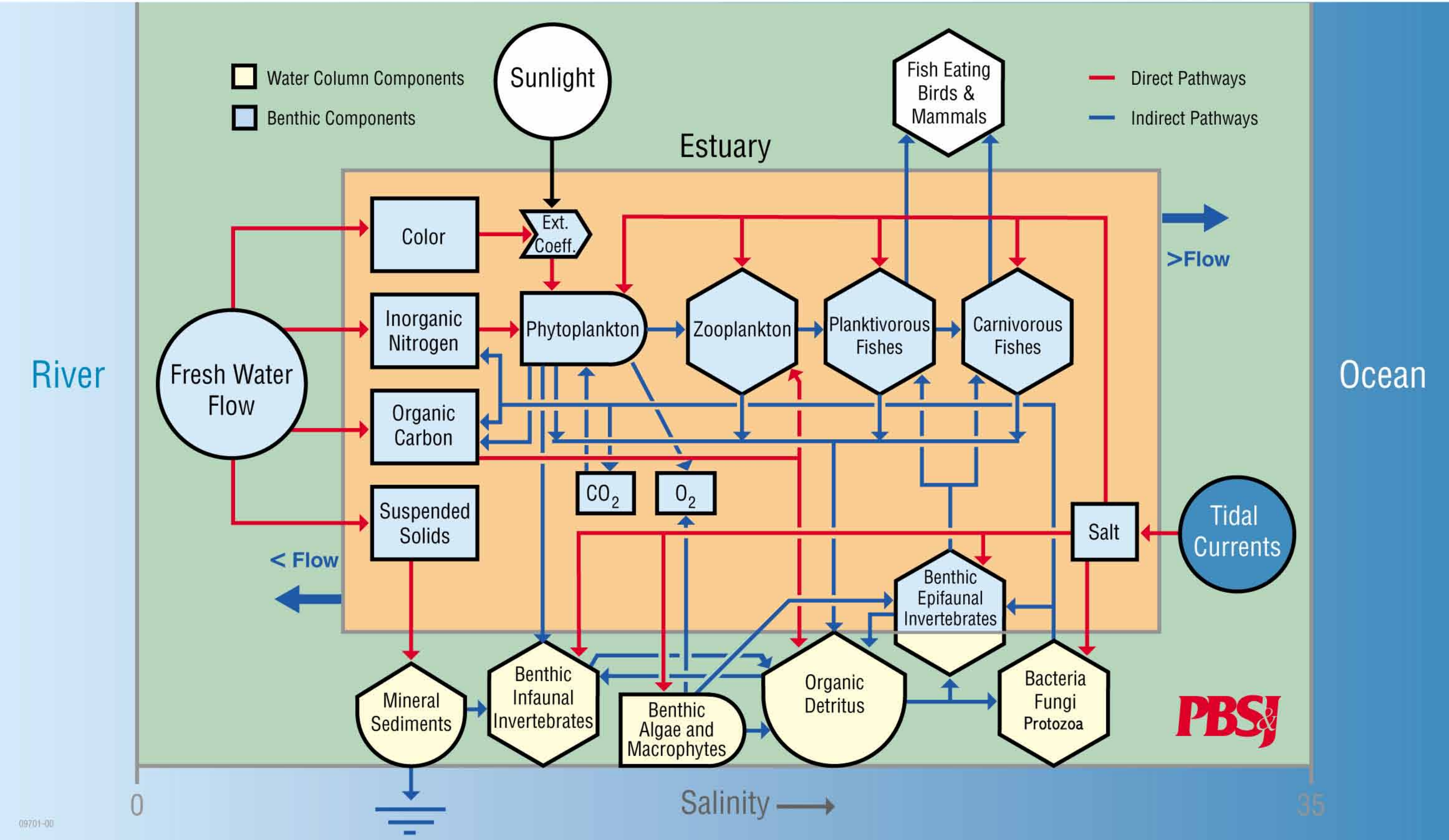
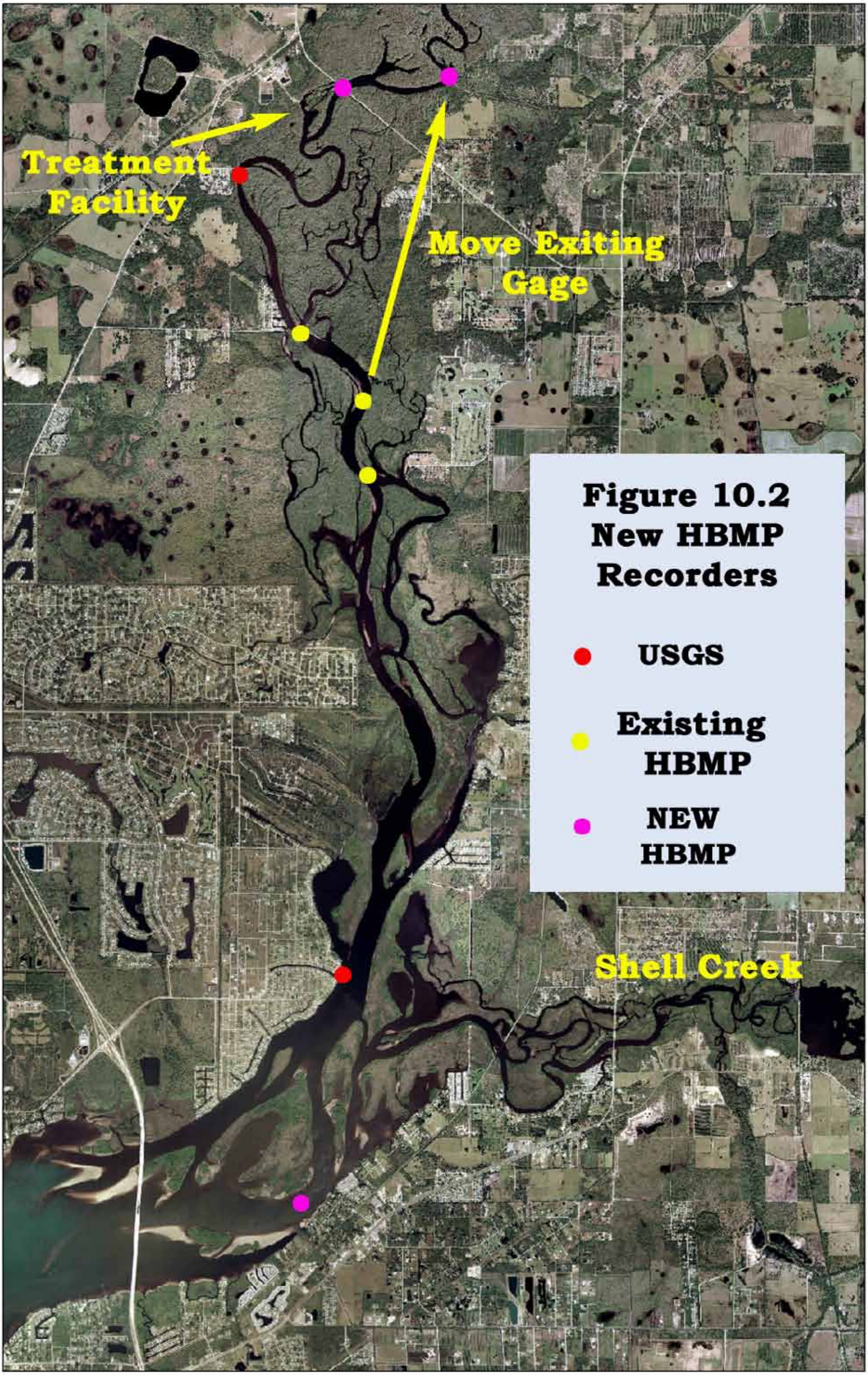


Figure 10.1
Conceptual Model of the Peace River Estuarine System

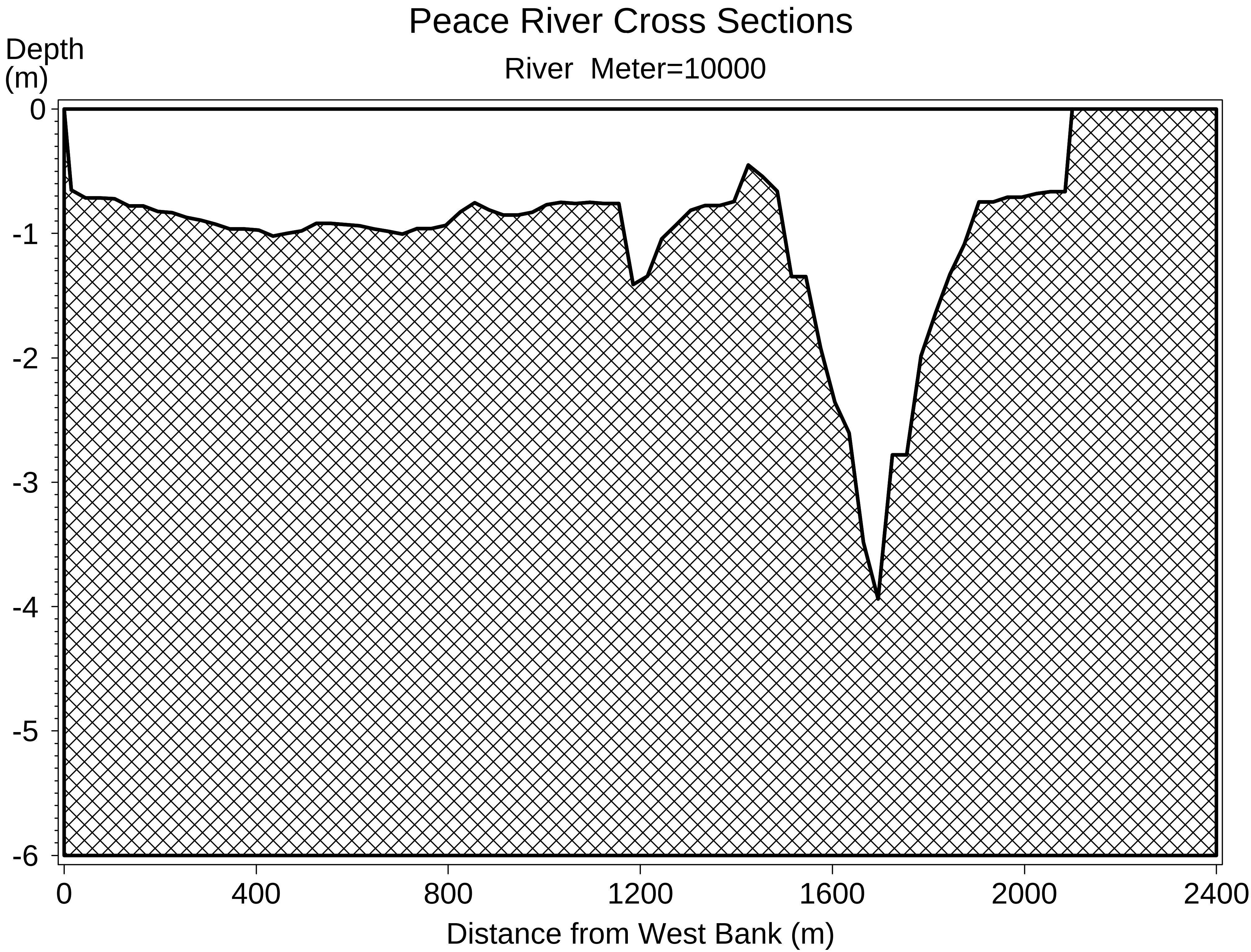


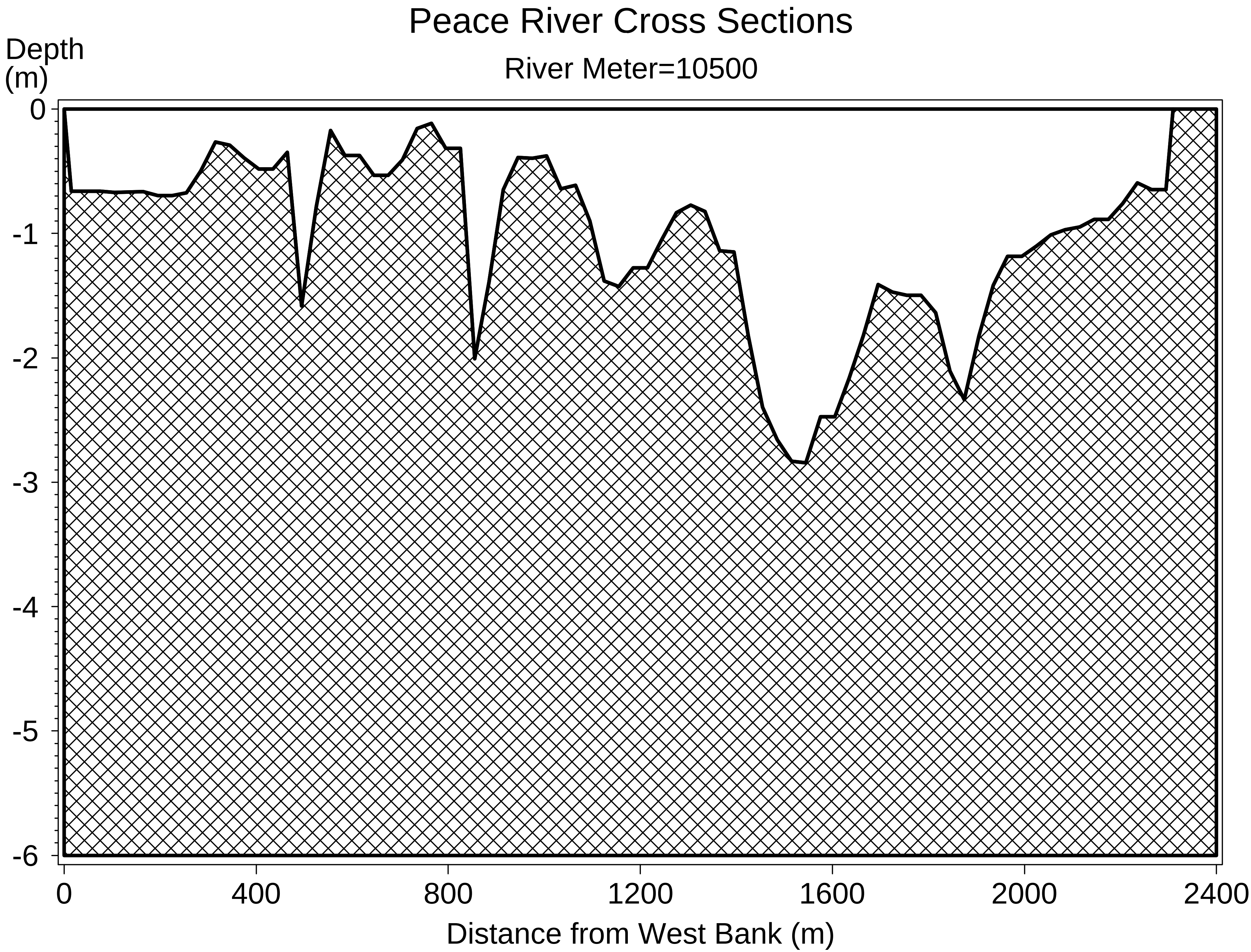

Treatment Facility
Move Exiting Gage
Figure 10.2
New HBMP Recorders
USGS
Existing HBMP
NEW HBMP
Shell Creek

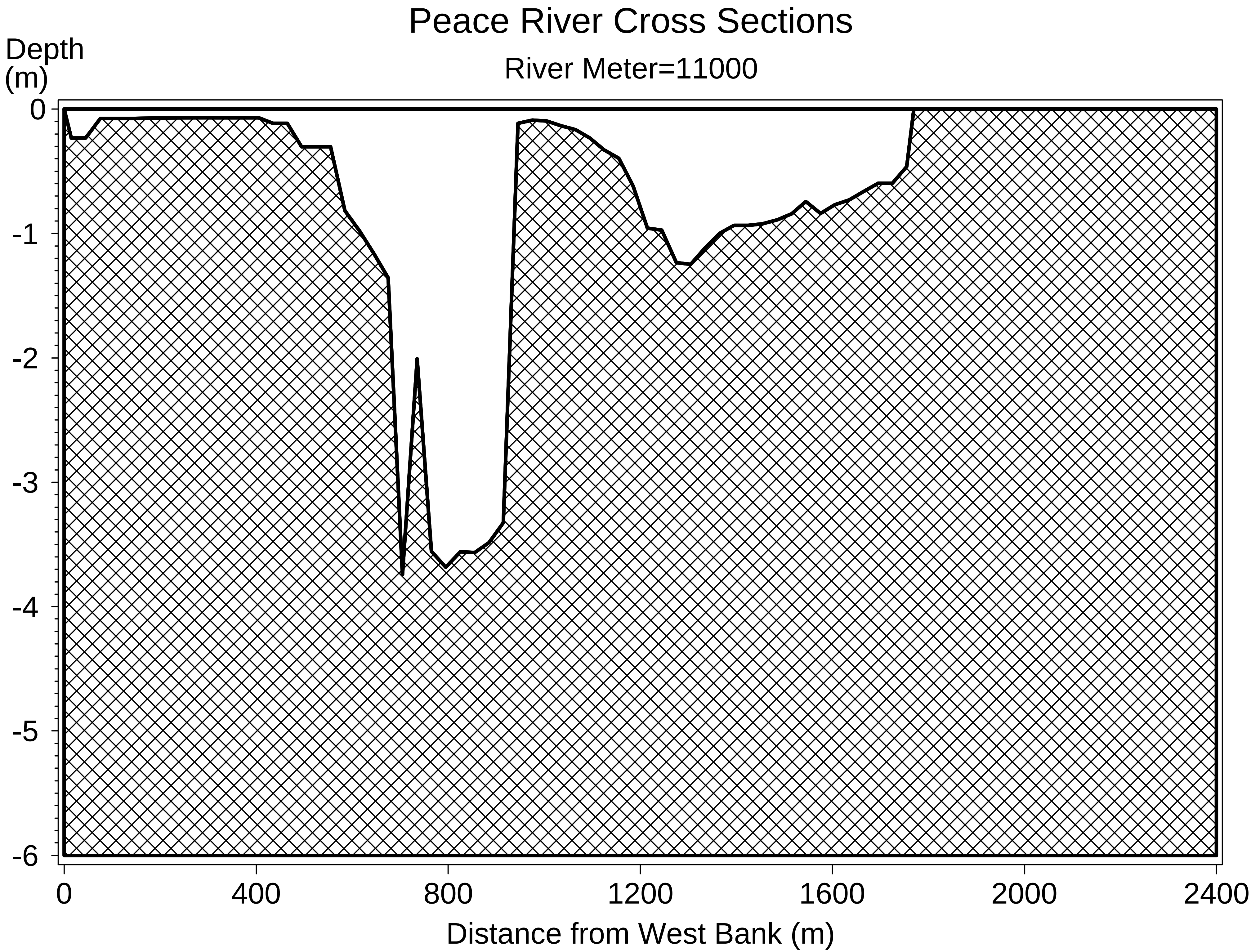
2006 HBMP
Comprehensive Summary Report

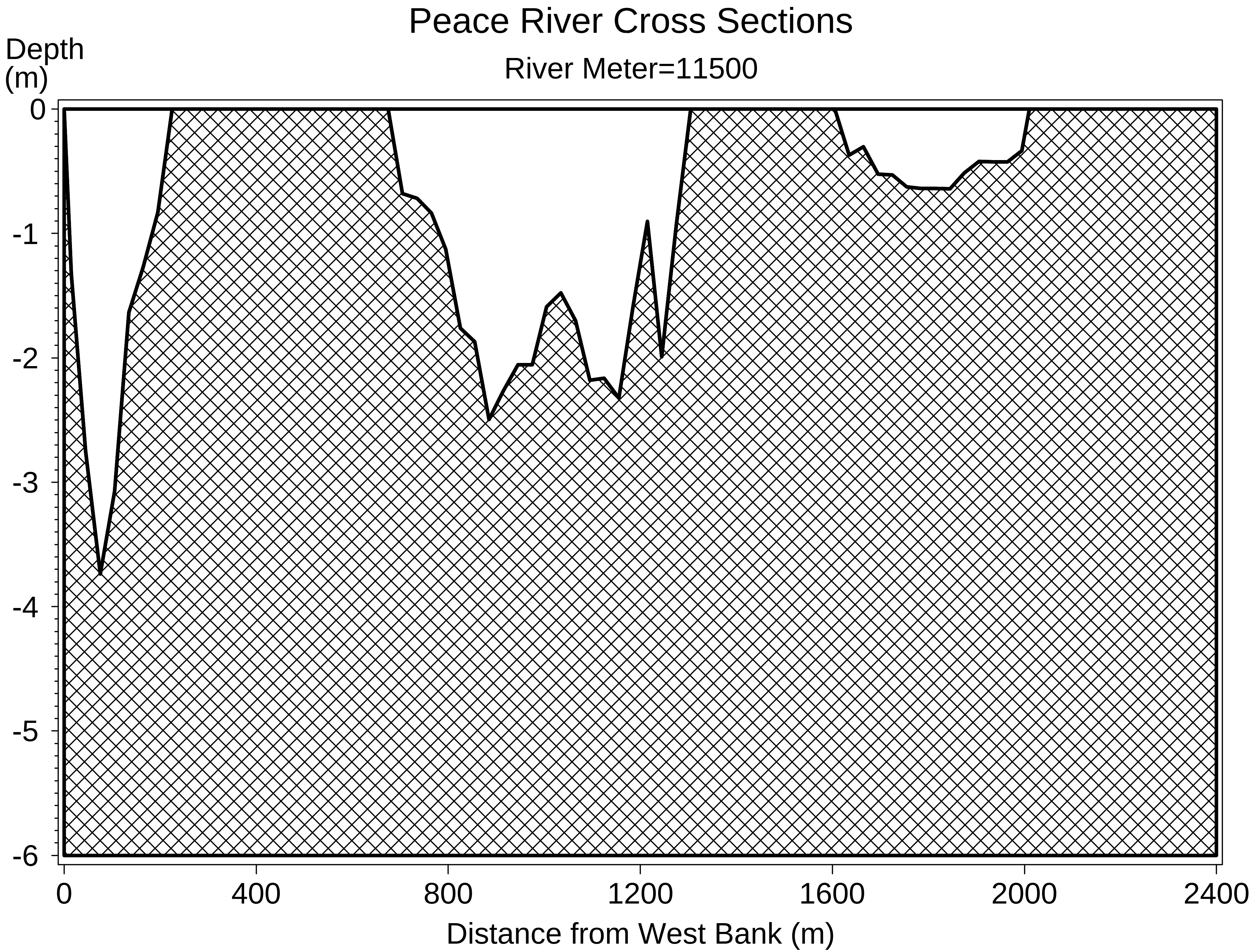
Appendix A - River Cross Sections

Transect profile plots between River Kilometers 10.0 (1000 meters) and 34.0 (34000 meters) at 0.5 (500 meter) intervals

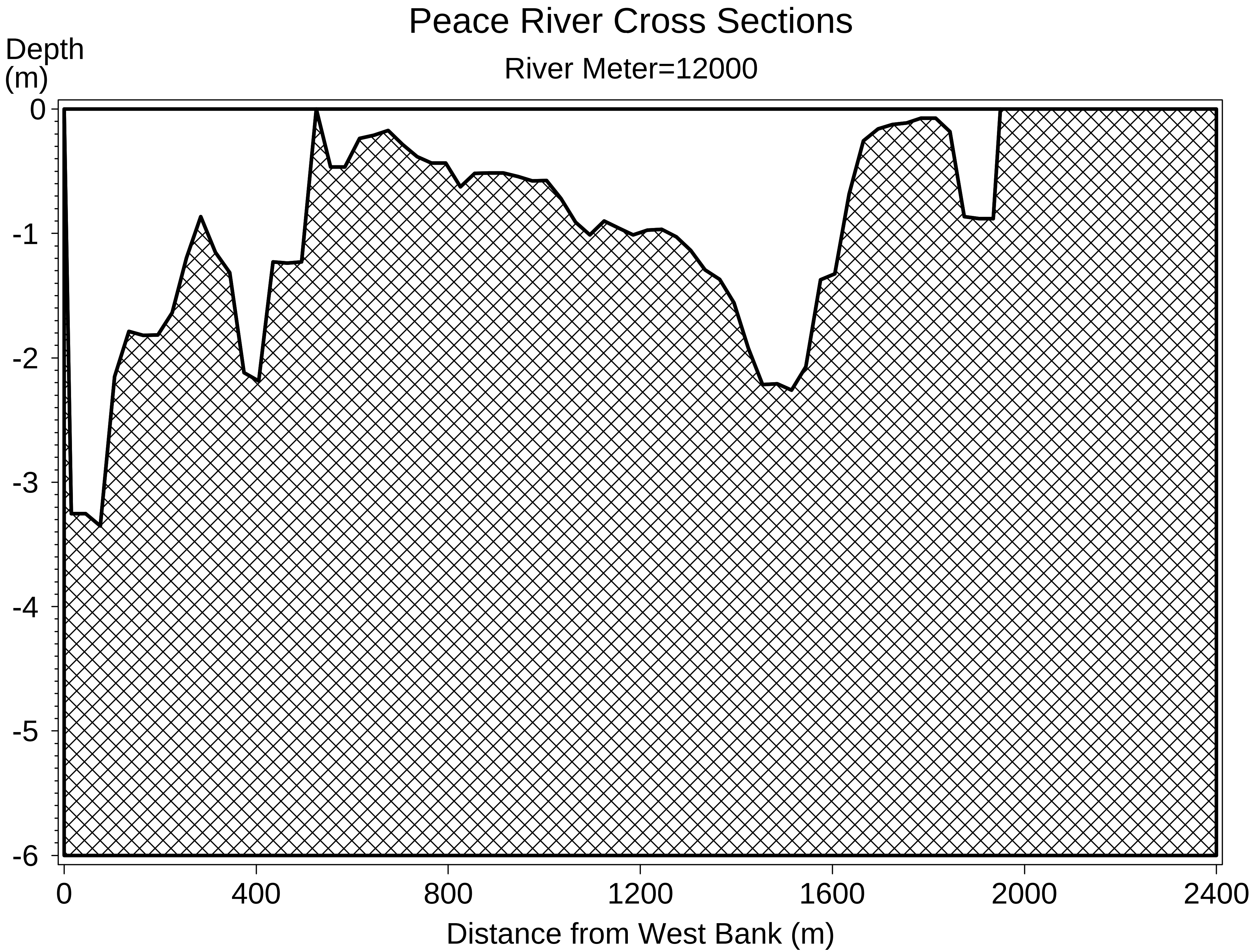

Peace River Cross Sections
River Meter=10000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)

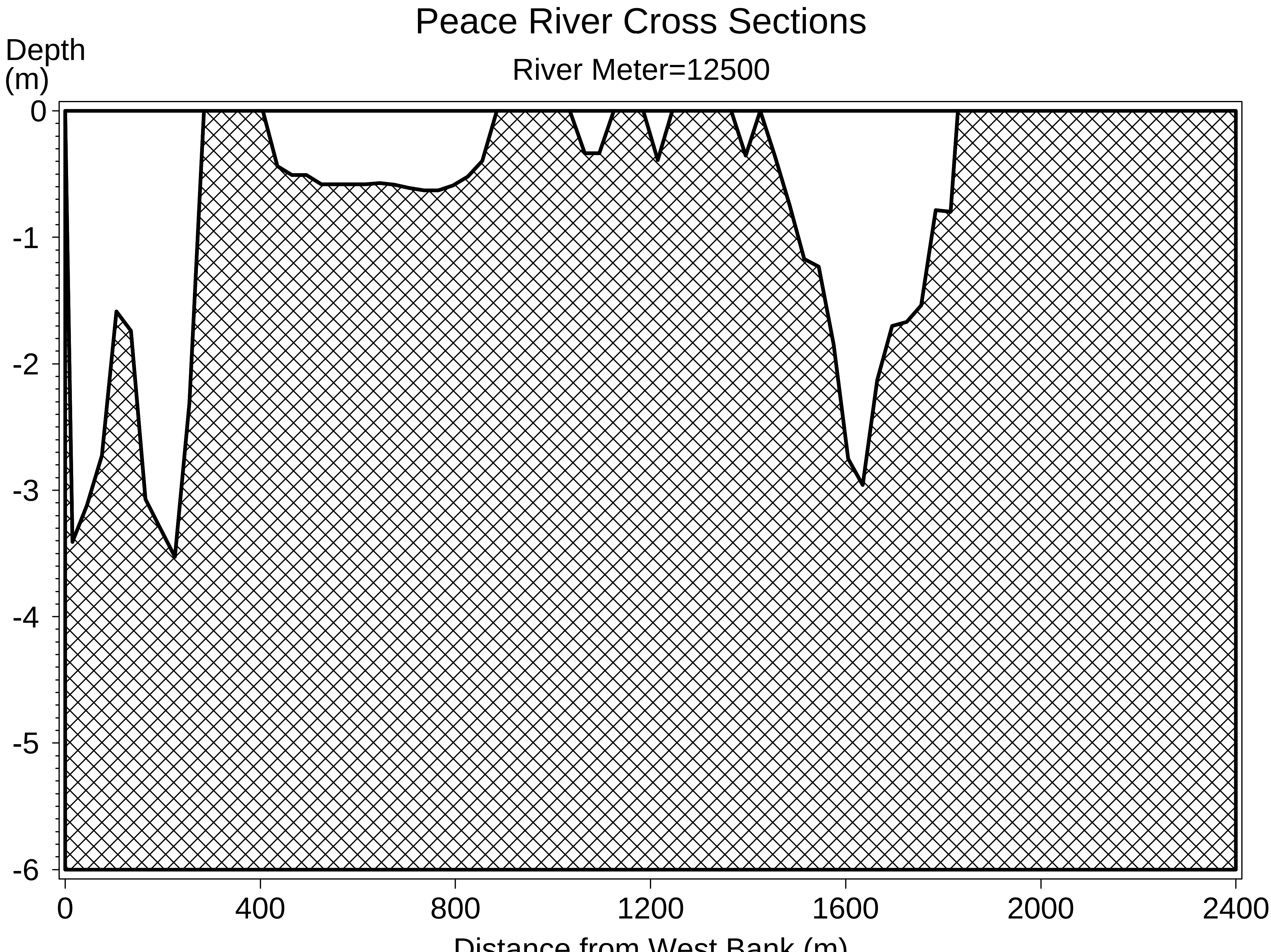

Peace River Cross Sections
River Meter=10500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)

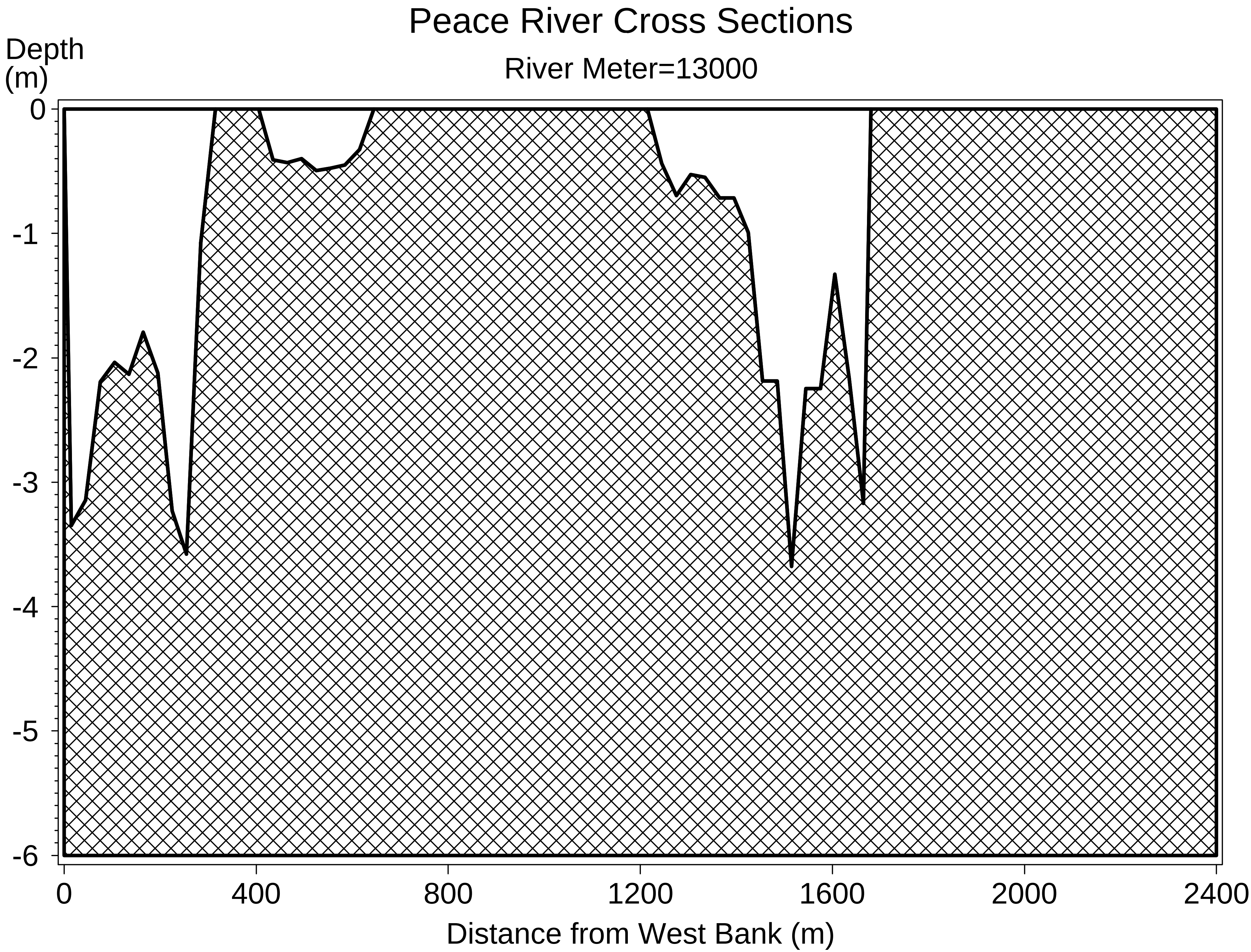

Peace River Cross Sections
River Meter=11000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)



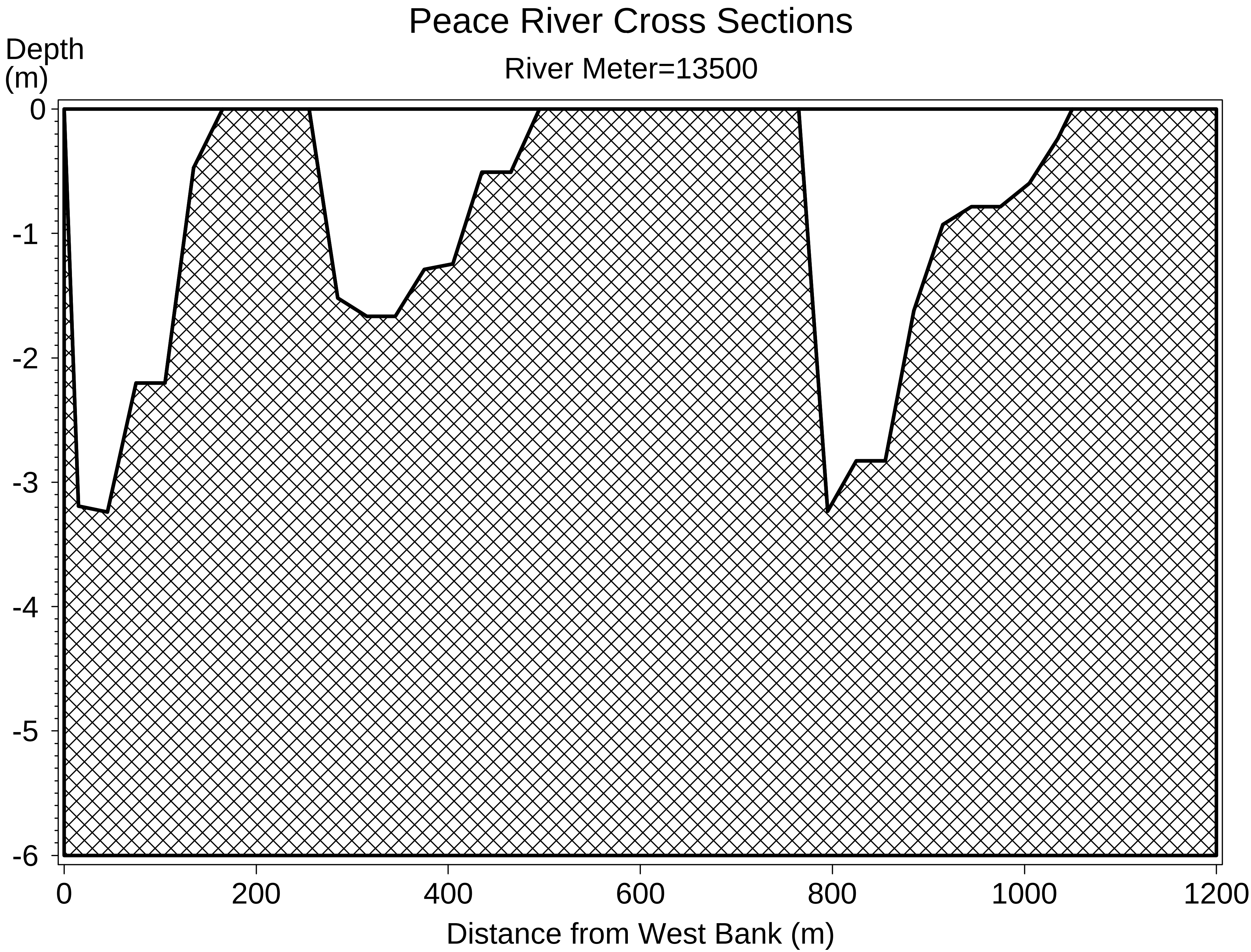
Peace River Cross Sections
River Meter=11500
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)

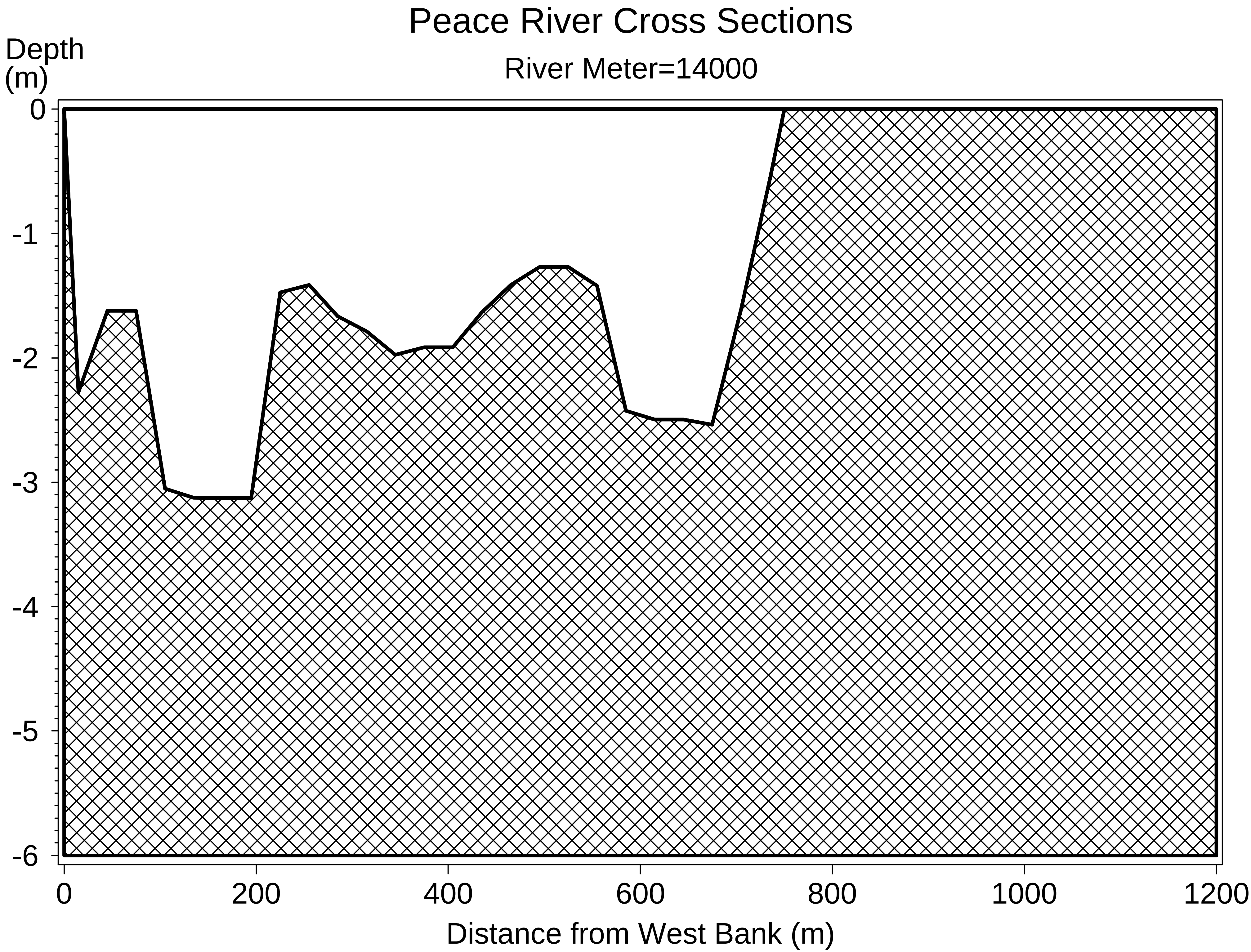

Peace River Cross Sections
River Meter=12000
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)


Peace River Cross Sections
River Meter=12500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)



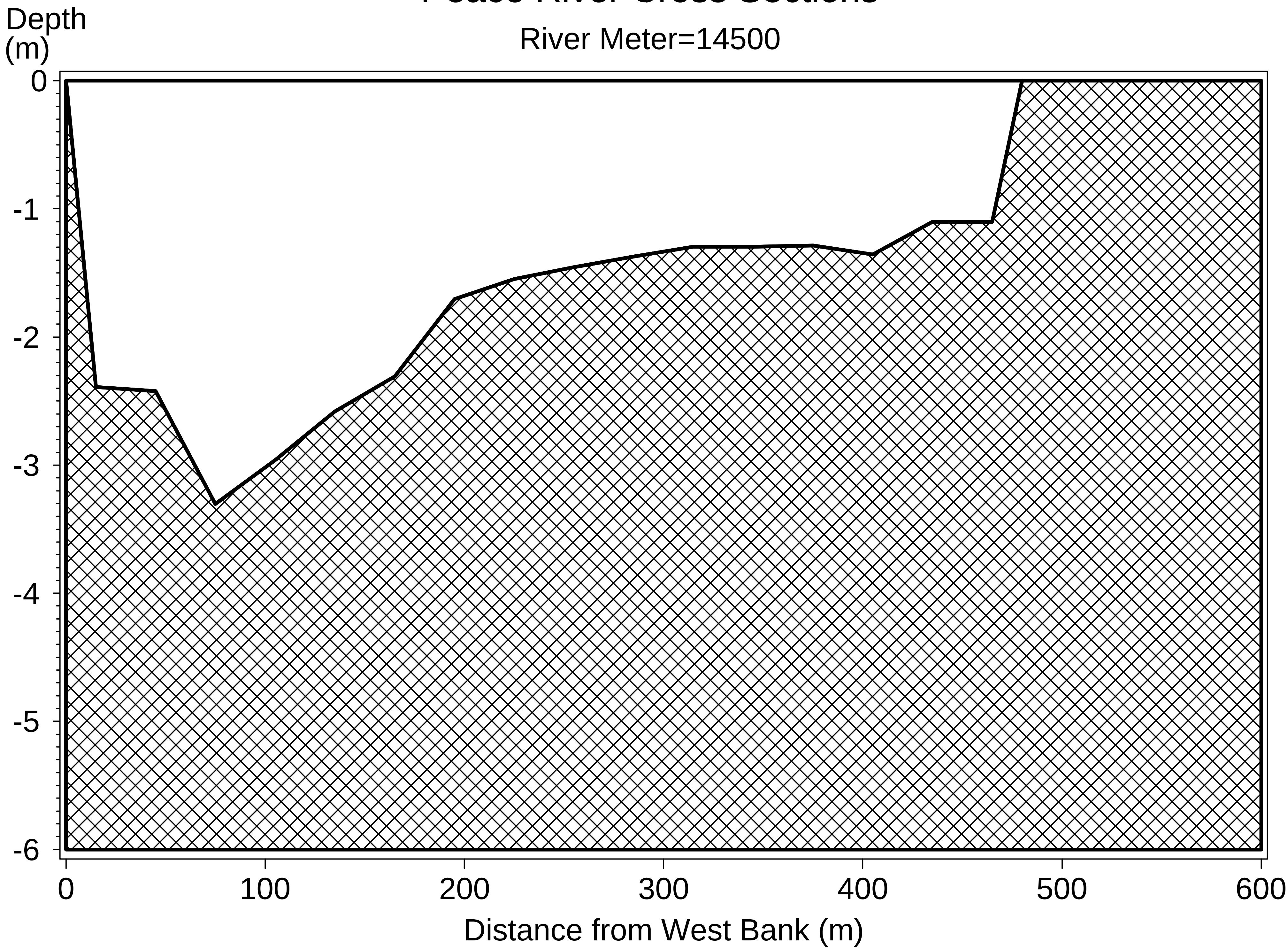
Peace River Cross Sections
River Meter=13000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
400
800
1200
1600
2000
2400
Distance from West Bank (m)

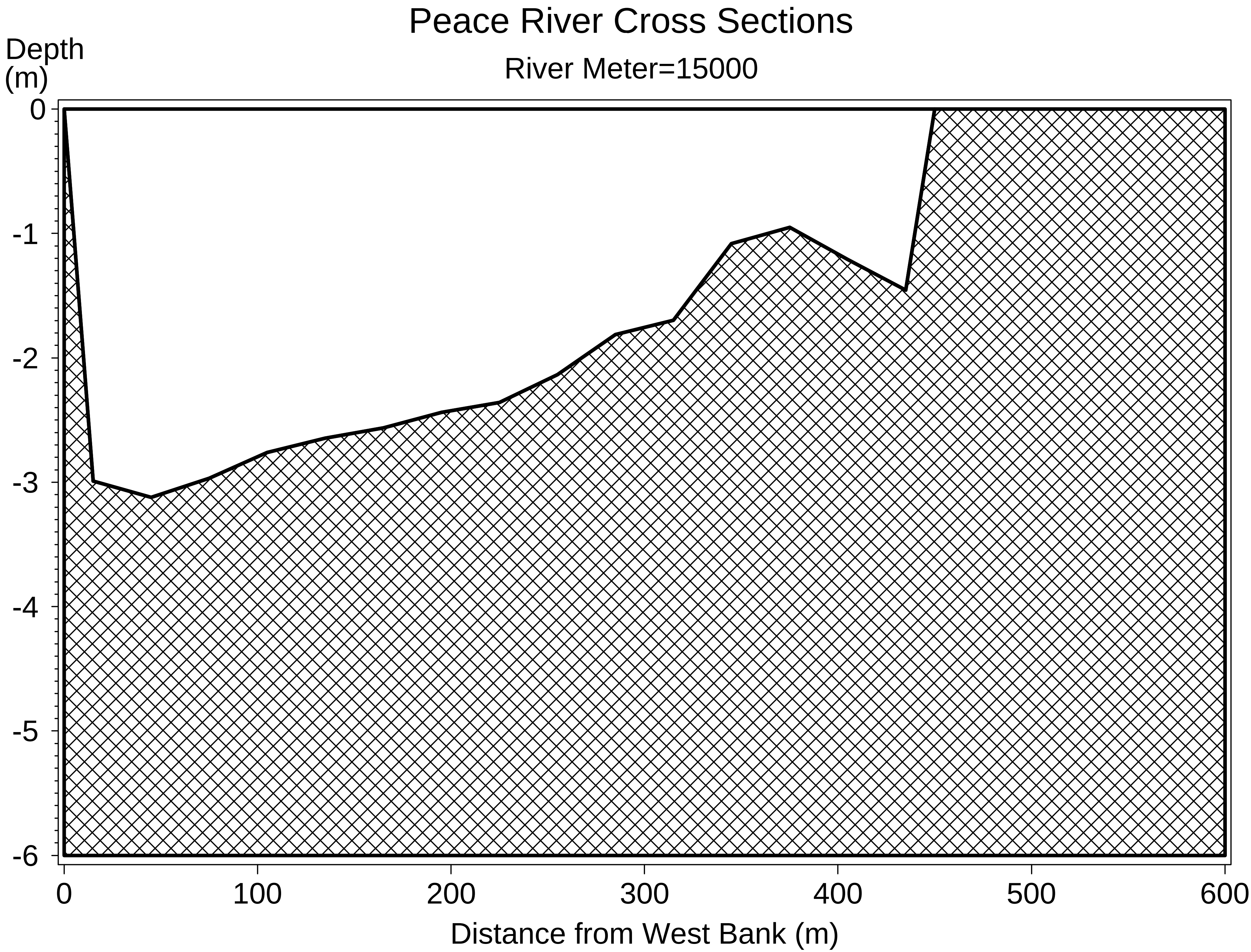

Peace River Cross Sections
River Meter=13500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
200
400
600
800
1000
1200
Distance from West Bank (m)

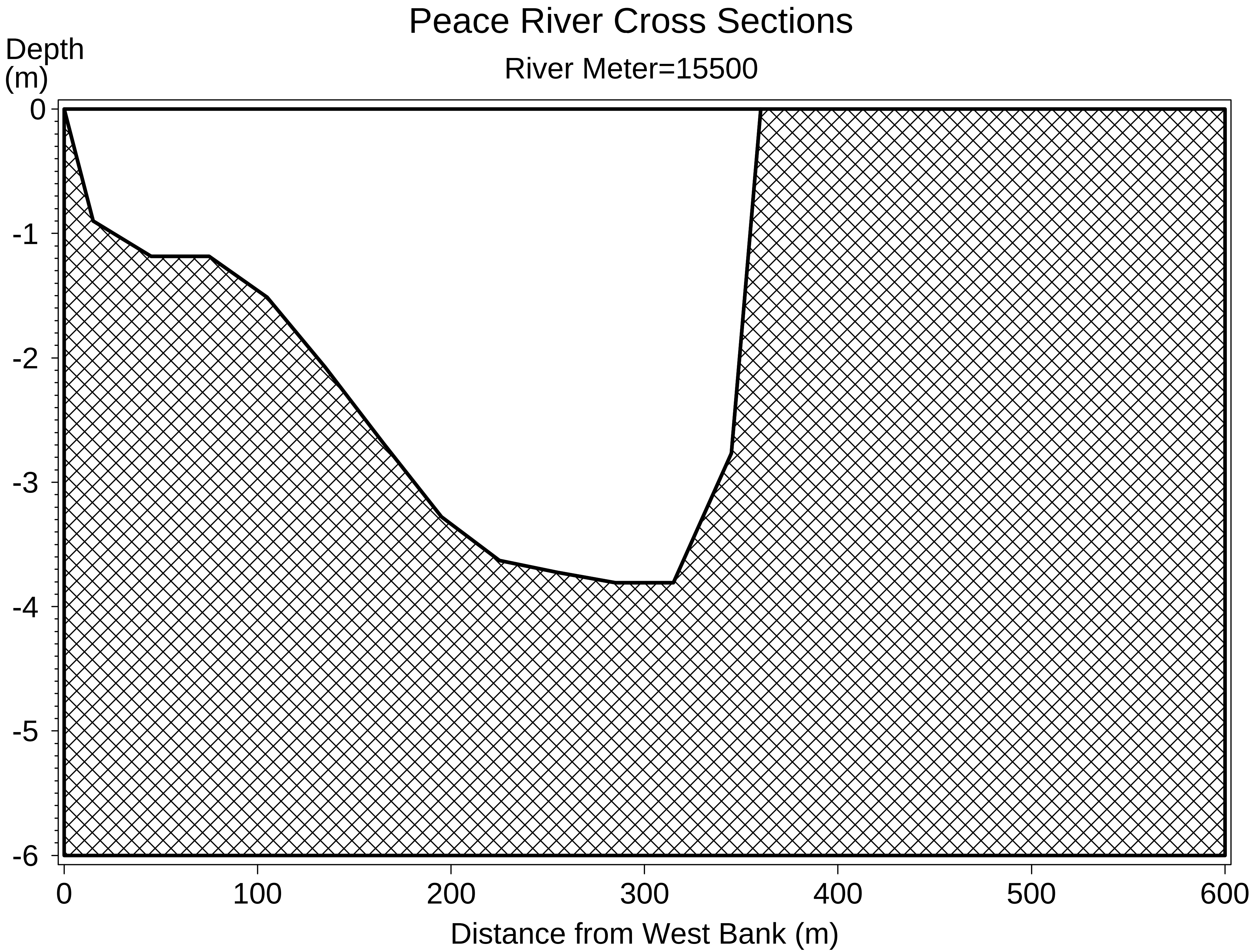

Peace River Cross Sections
River Meter=14000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
200
400
600
800
1000
1200
Distance from West Bank (m)

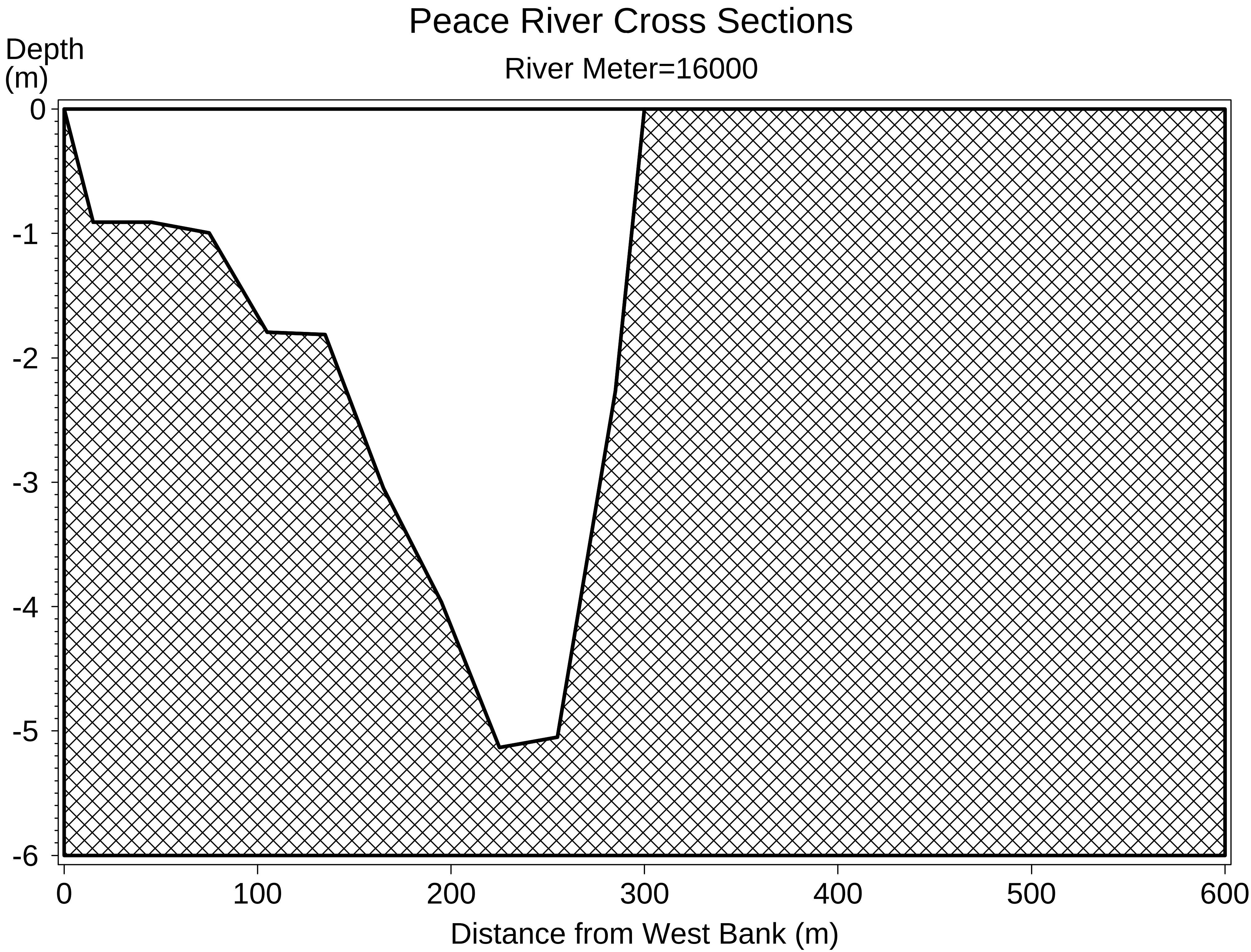
Peace River Cross Sections

River Meter=14500

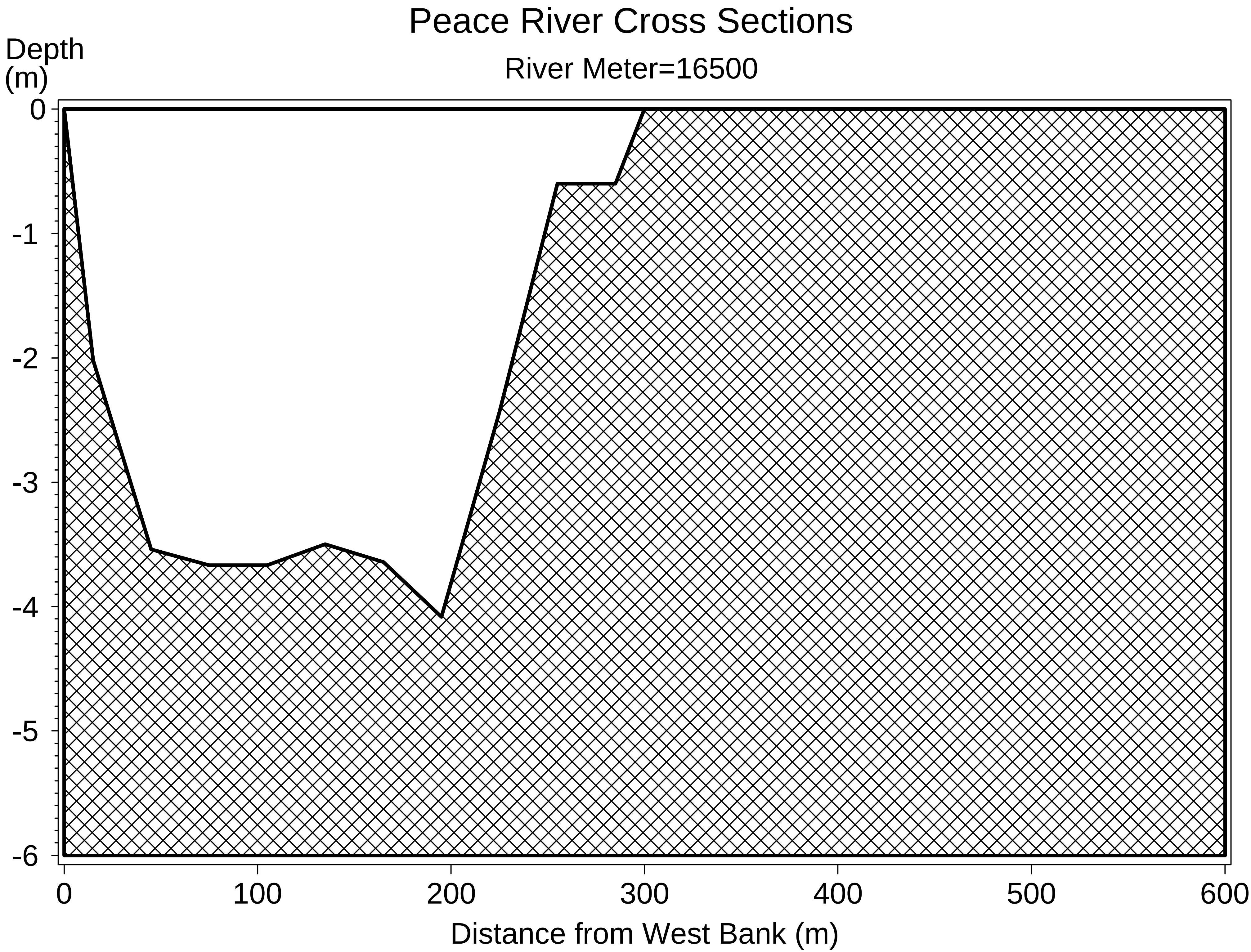


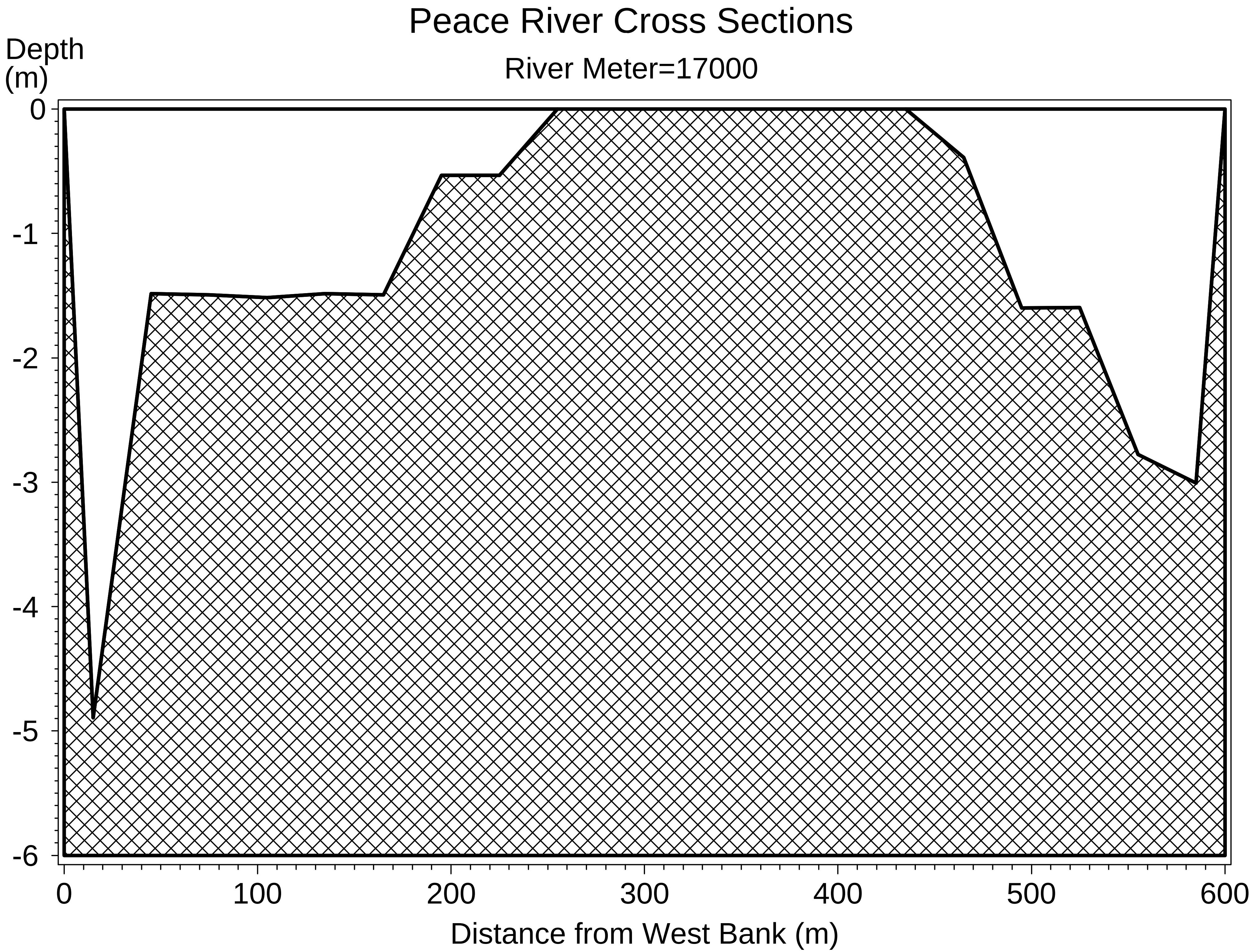

Peace River Cross Sections
River Meter=15000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)

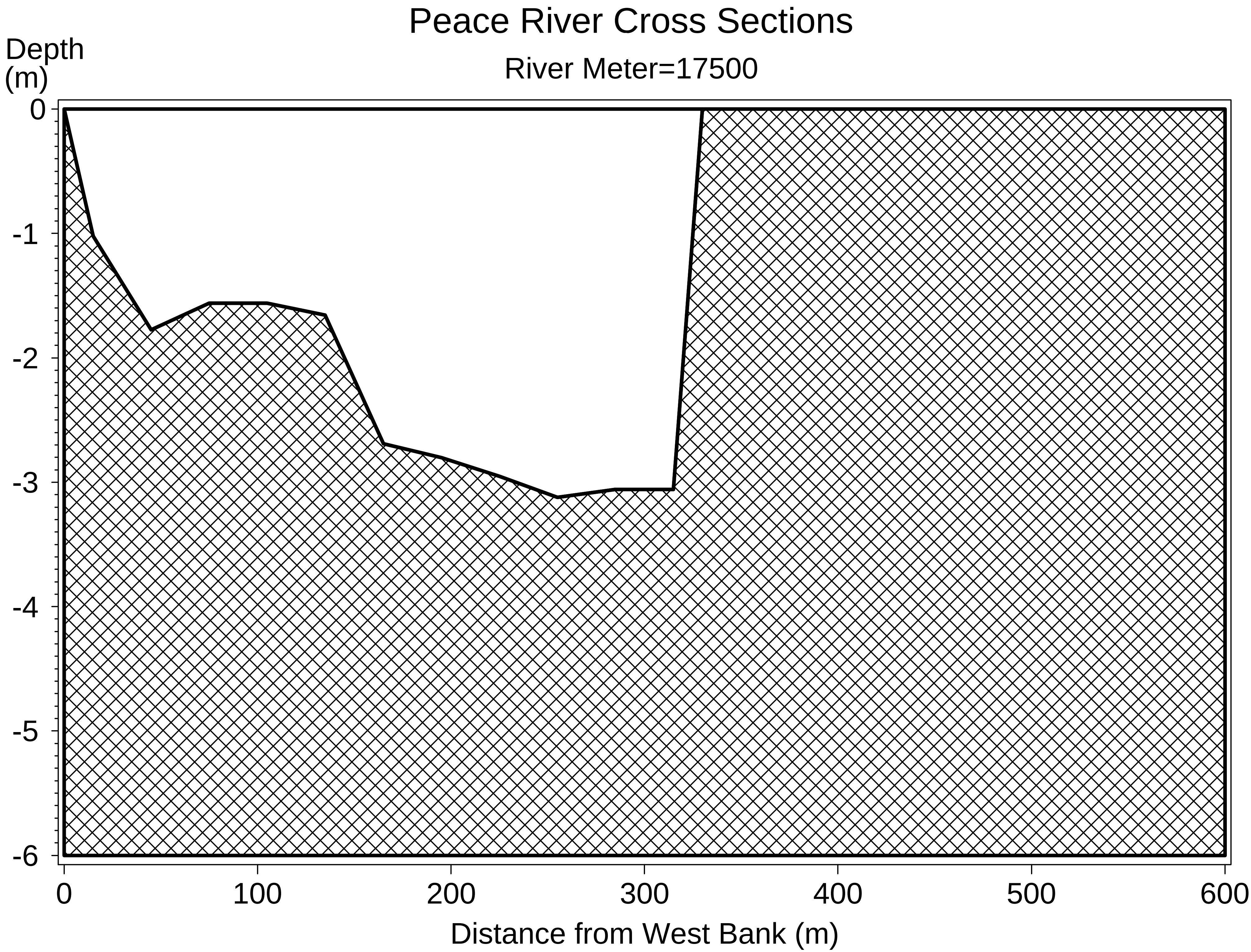

Peace River Cross Sections
River Meter=15500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)



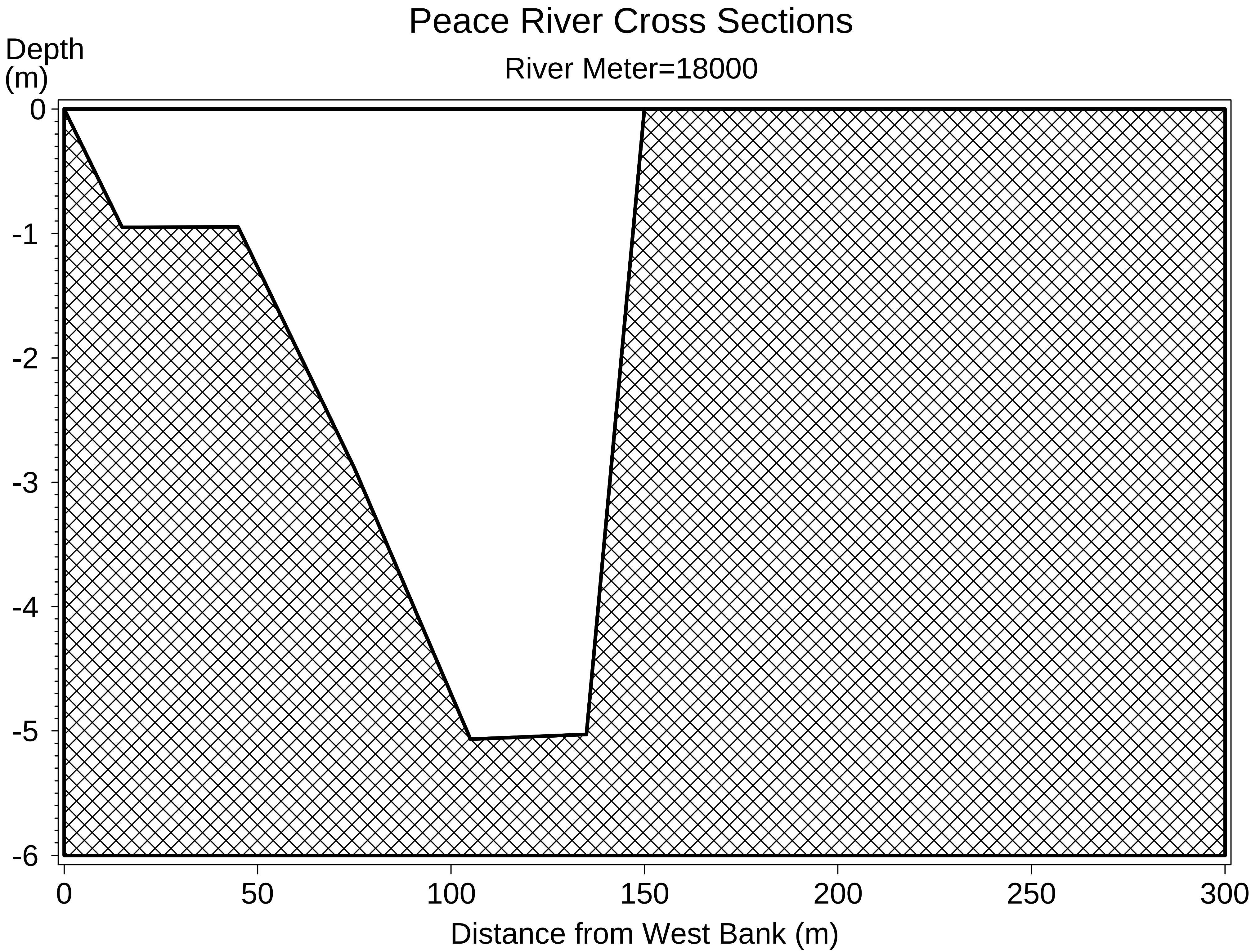
Peace River Cross Sections
River Meter=16000
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)

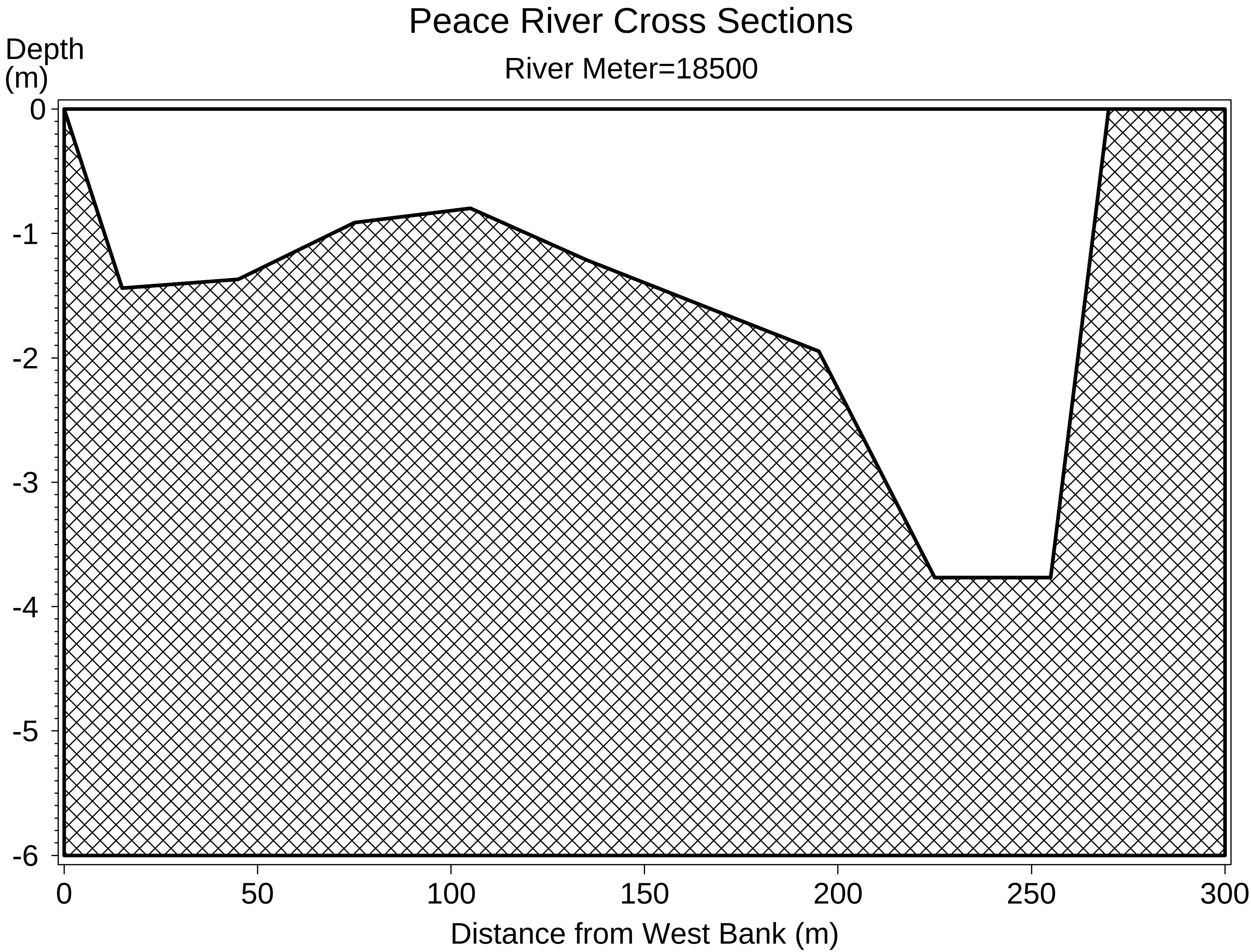

Peace River Cross Sections
River Meter=16500
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)

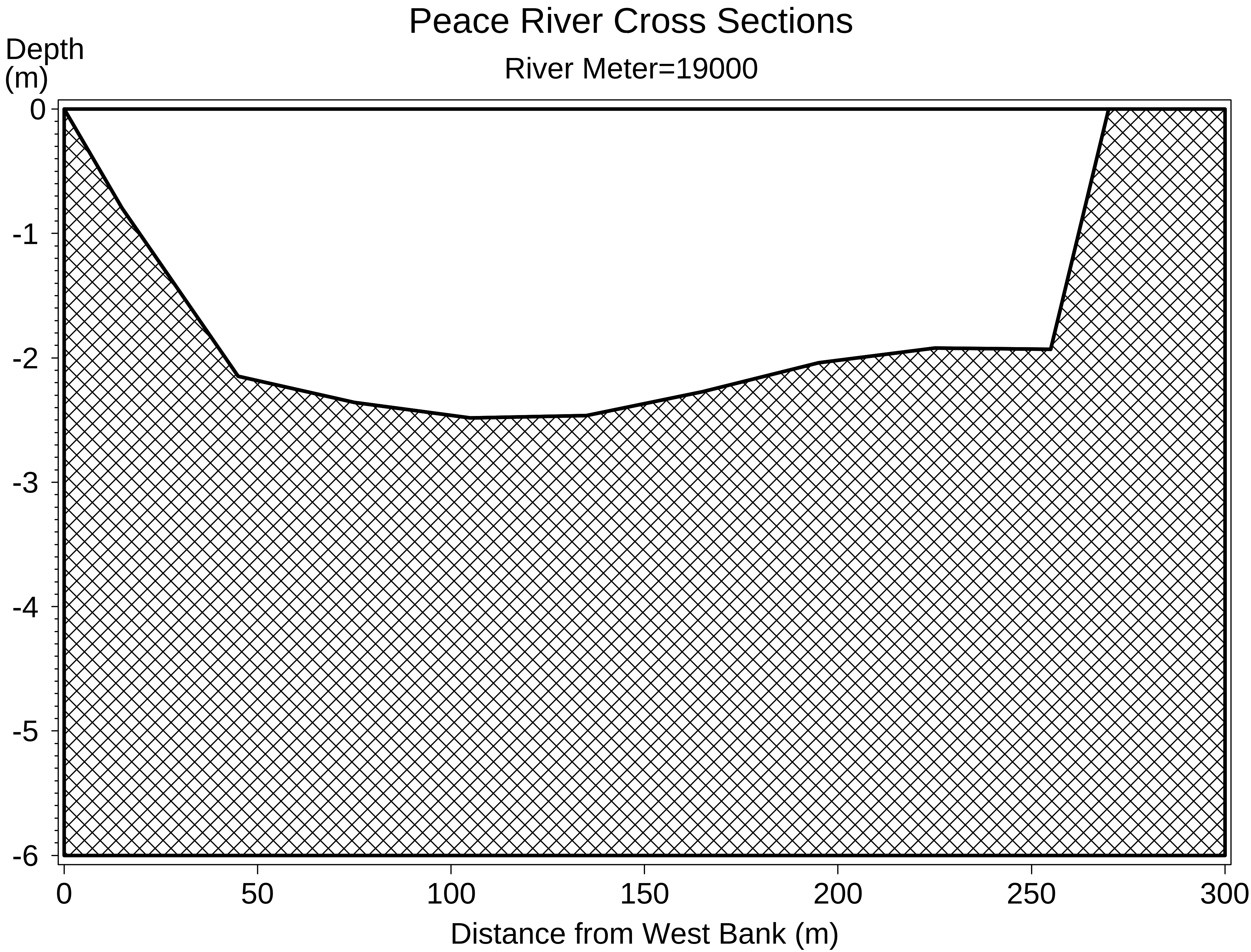

Peace River Cross Sections
River Meter=17000
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)



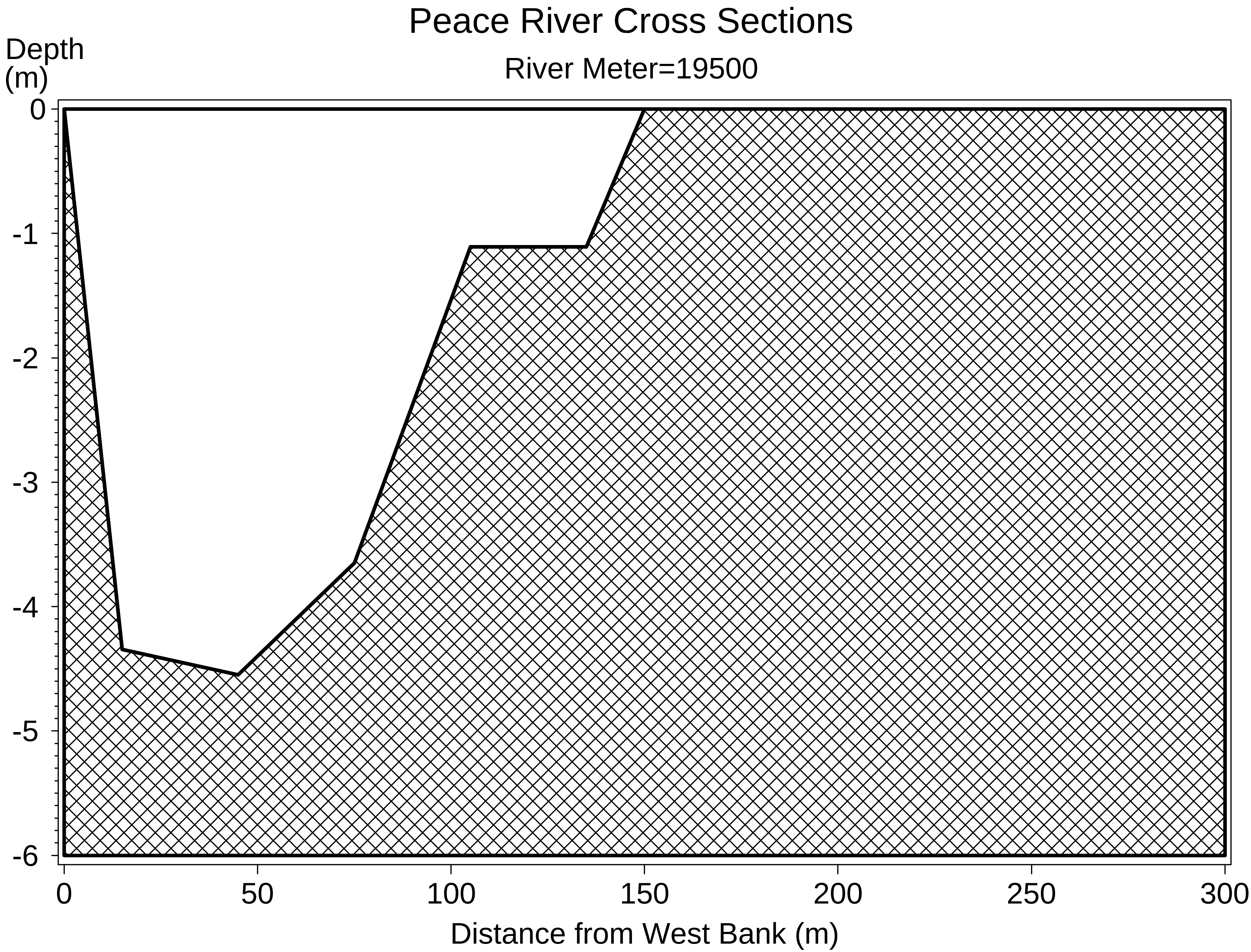
Peace River Cross Sections
River Meter=17500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
100
200
300
400
500
600
Distance from West Bank (m)


Peace River Cross Sections
River Meter=18000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

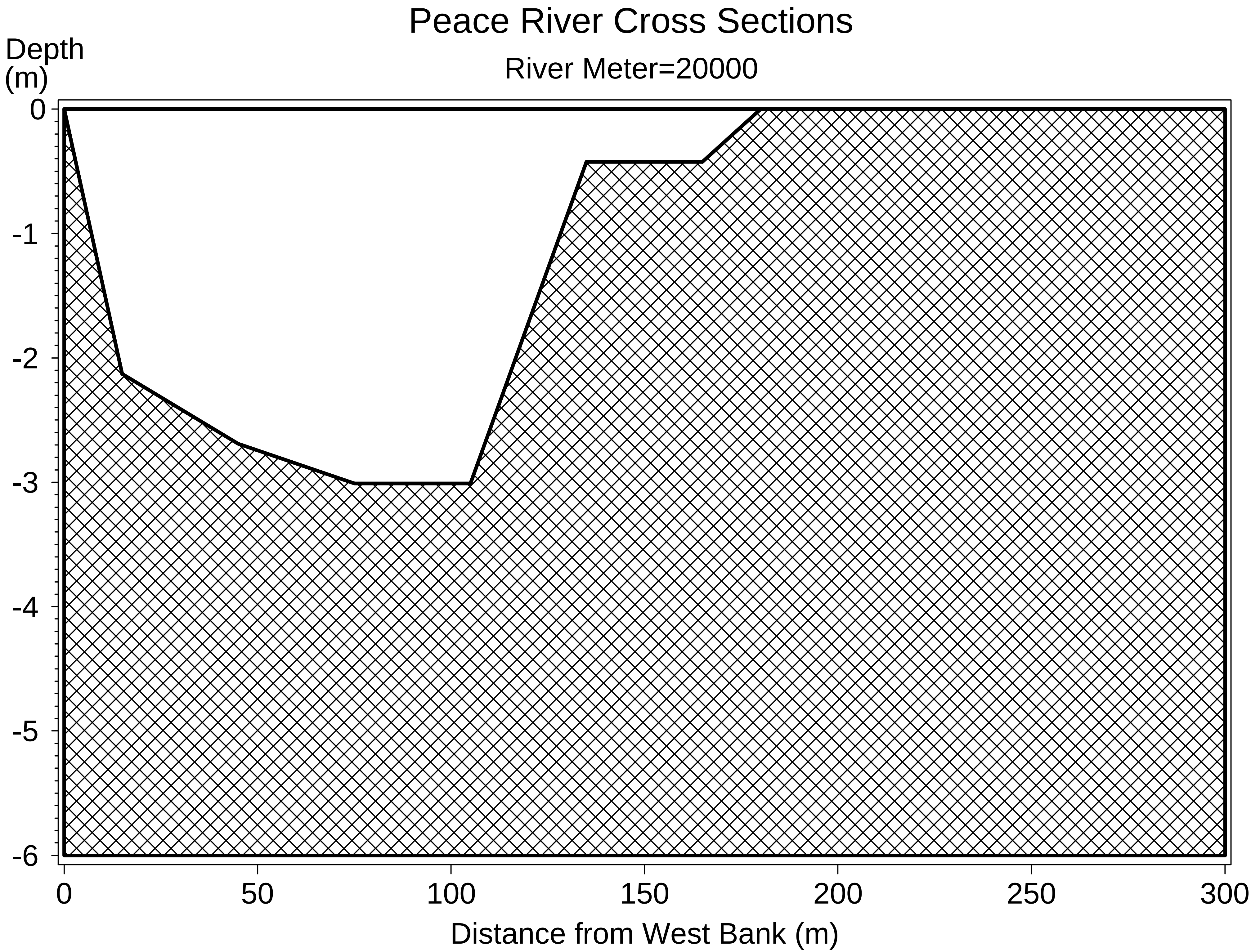

Peace River Cross Sections
River Meter=18500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)



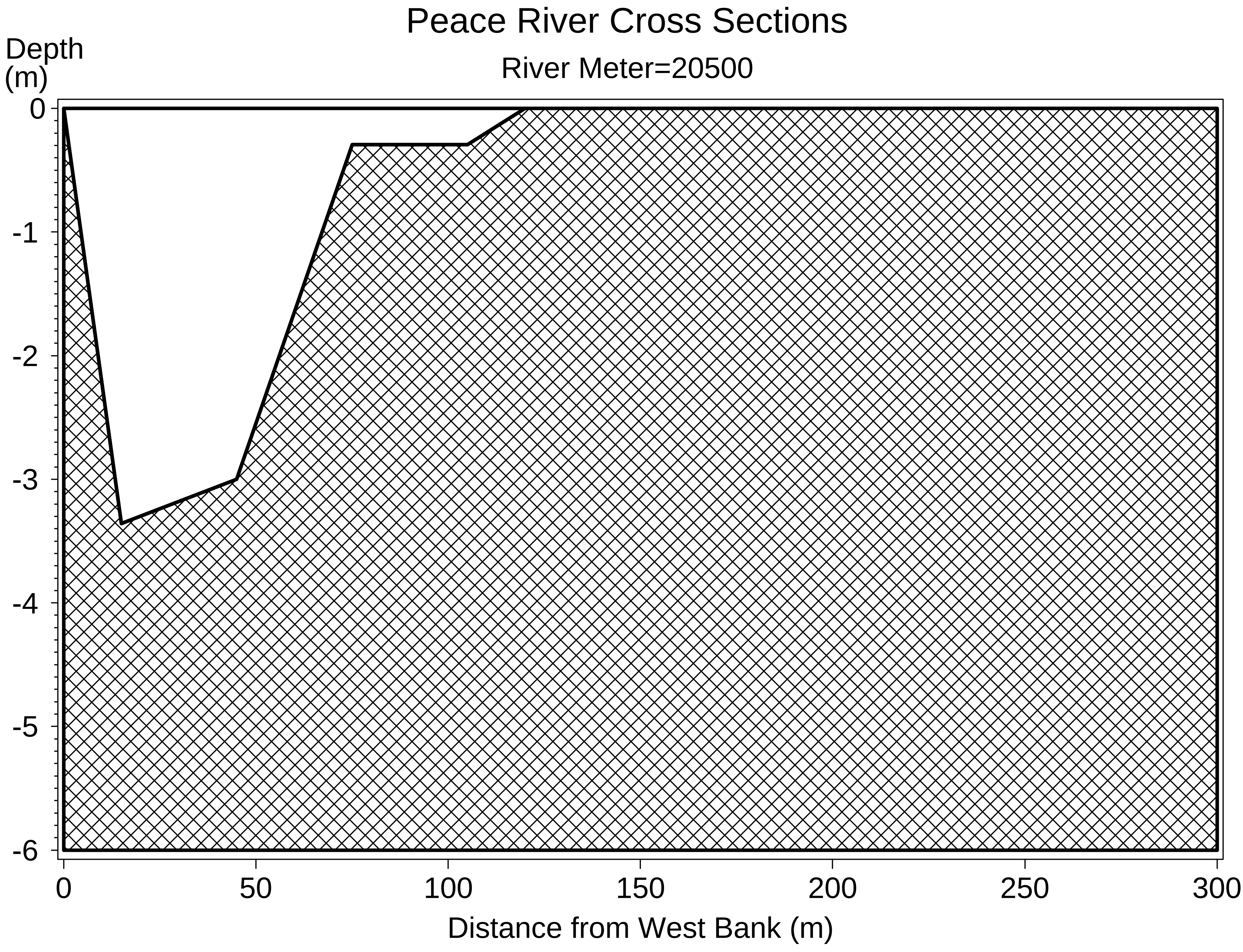
Peace River Cross Sections
River Meter=19000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

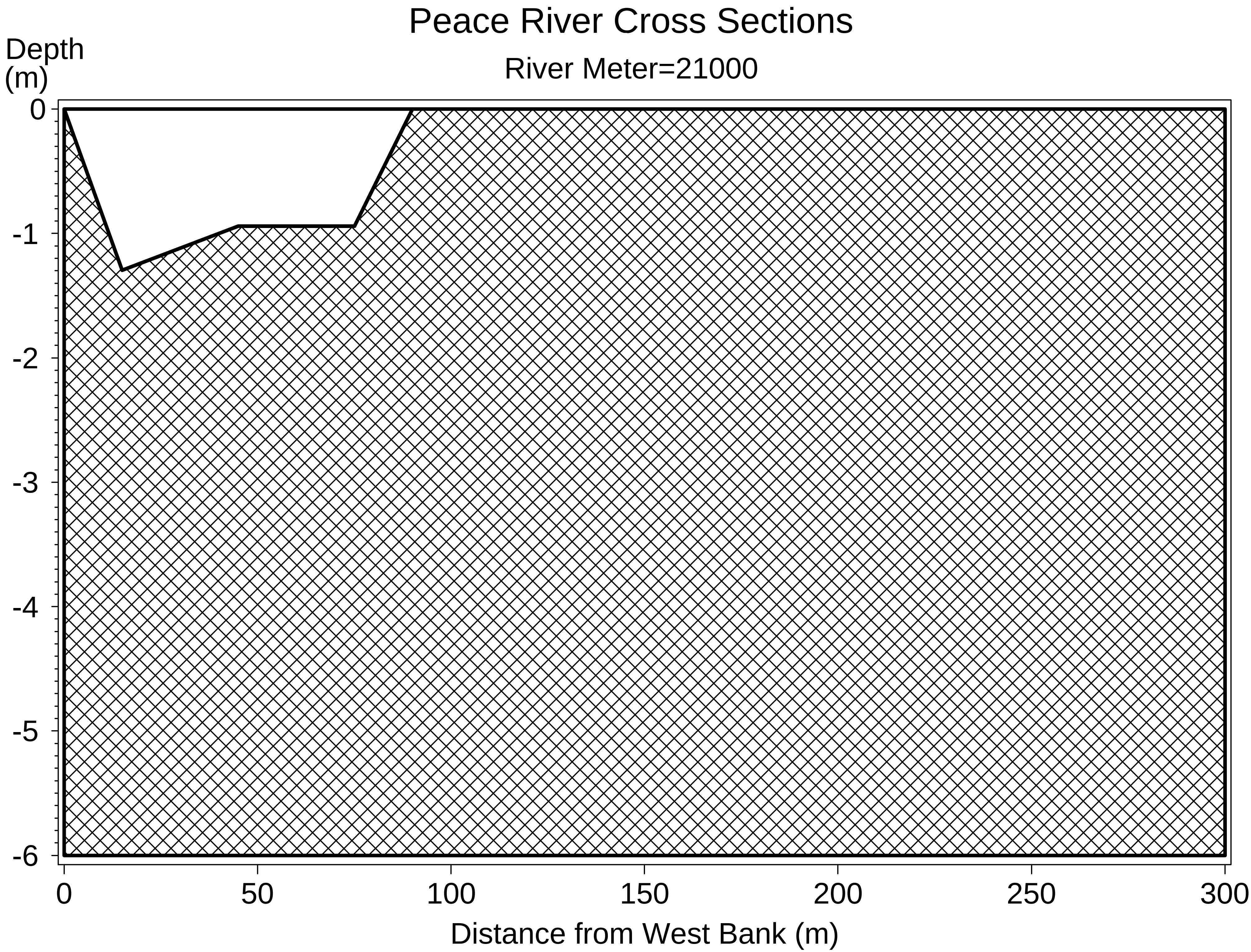


Peace River Cross Sections
River Meter=19500
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

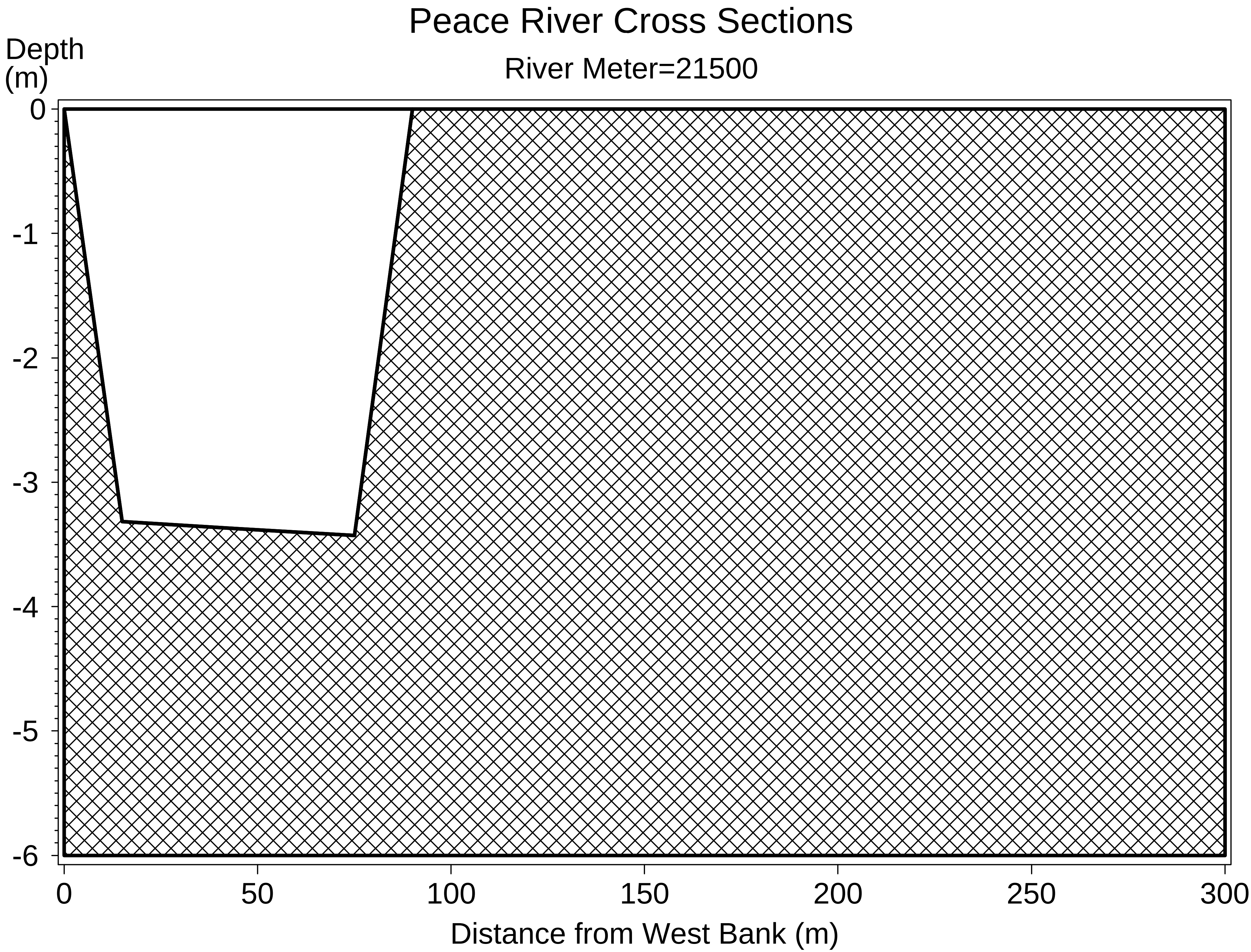


Peace River Cross Sections
River Meter=20000
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

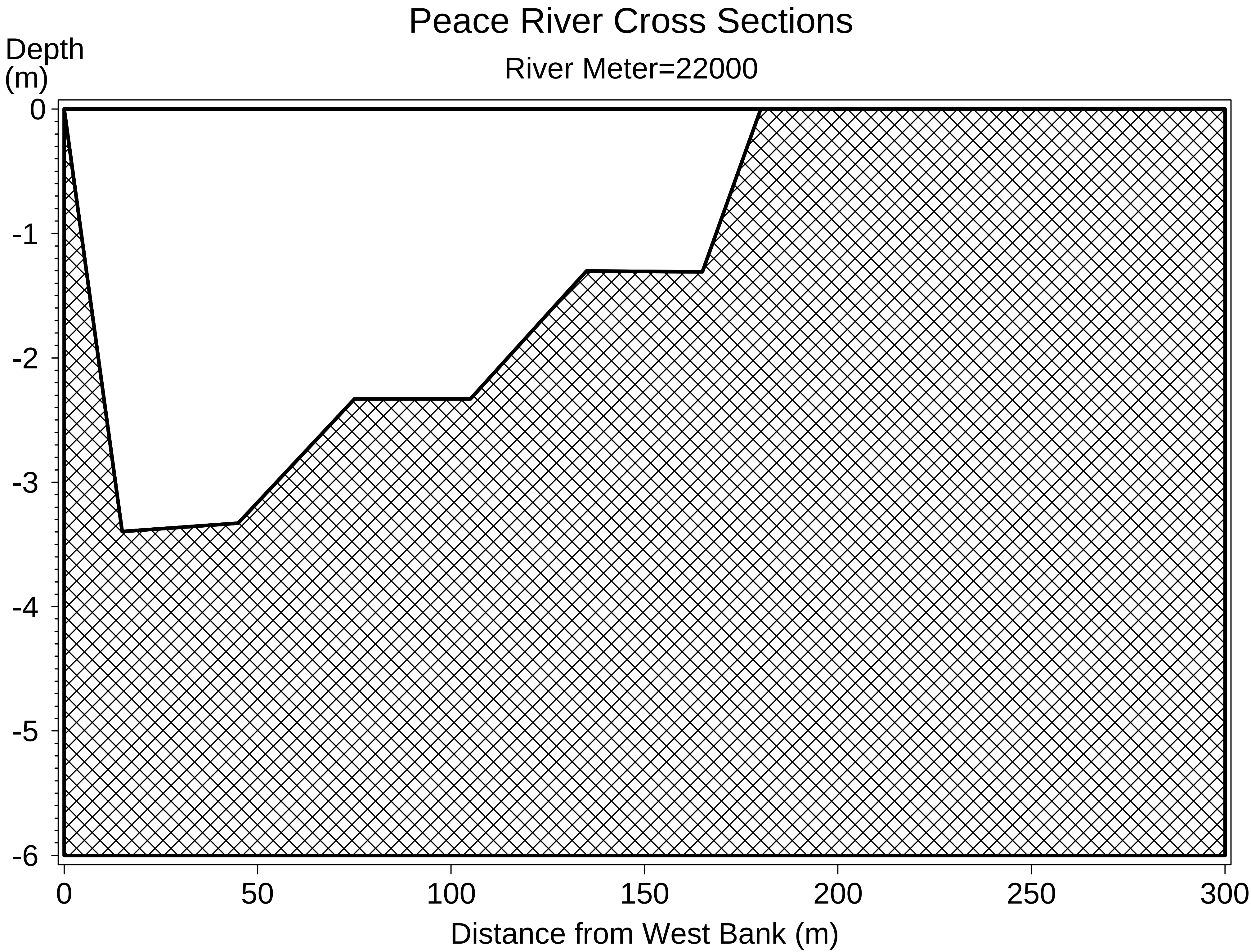

Peace River Cross Sections
River Meter=20500
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

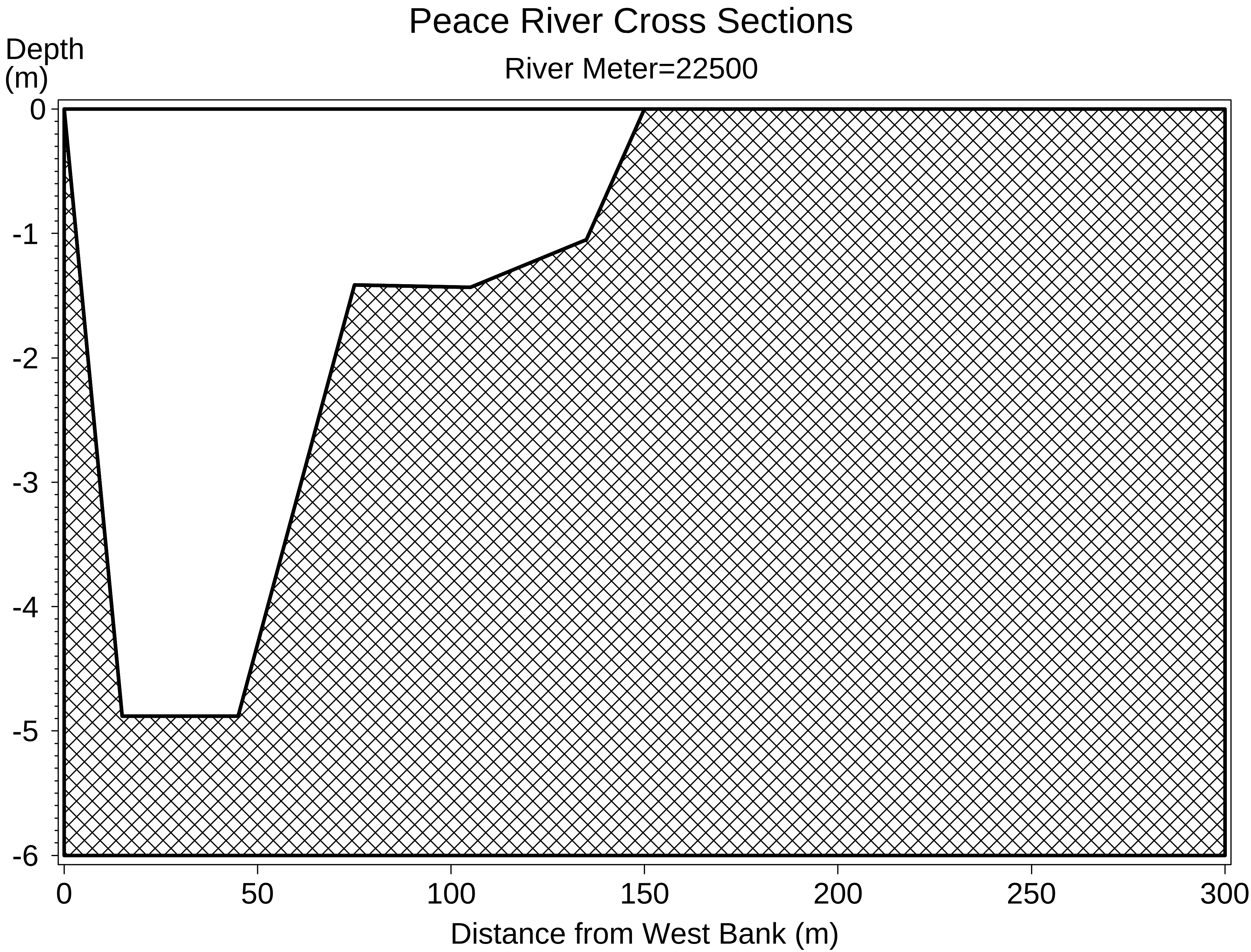


Peace River Cross Sections
River Meter=21000
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

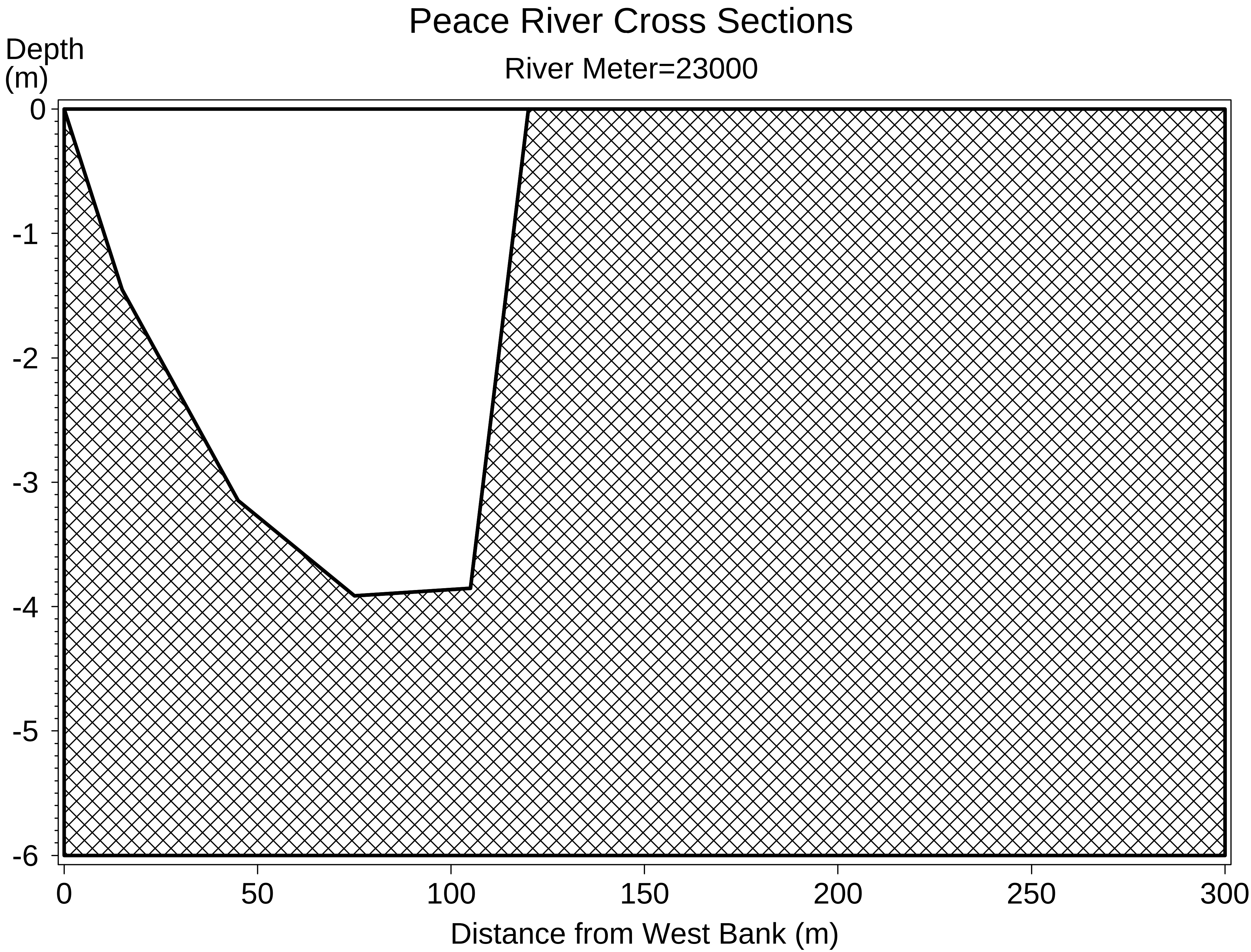


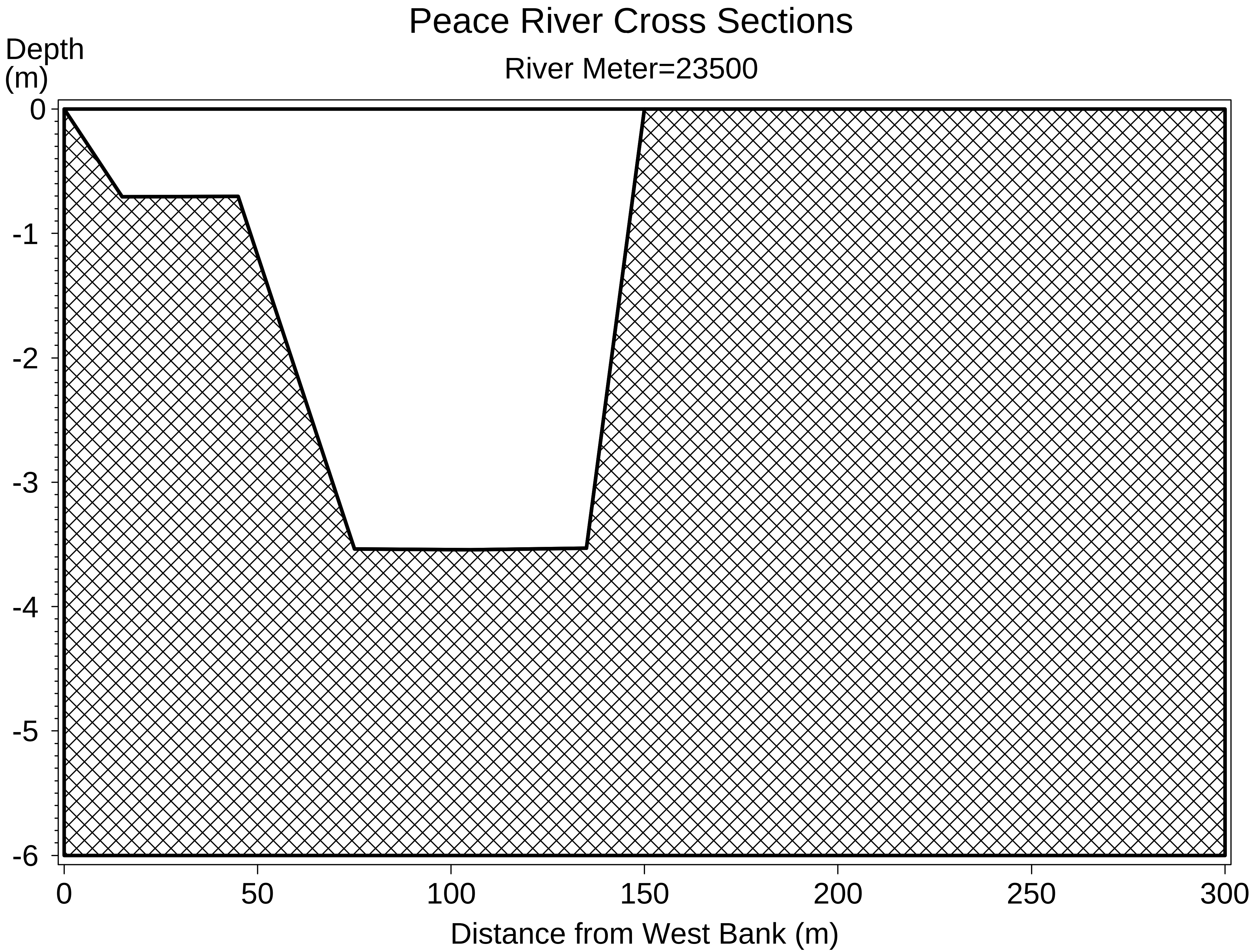
Peace River Cross Sections
River Meter=21500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)


Peace River Cross Sections
River Meter=22000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)



Peace River Cross Sections
River Meter=22500
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

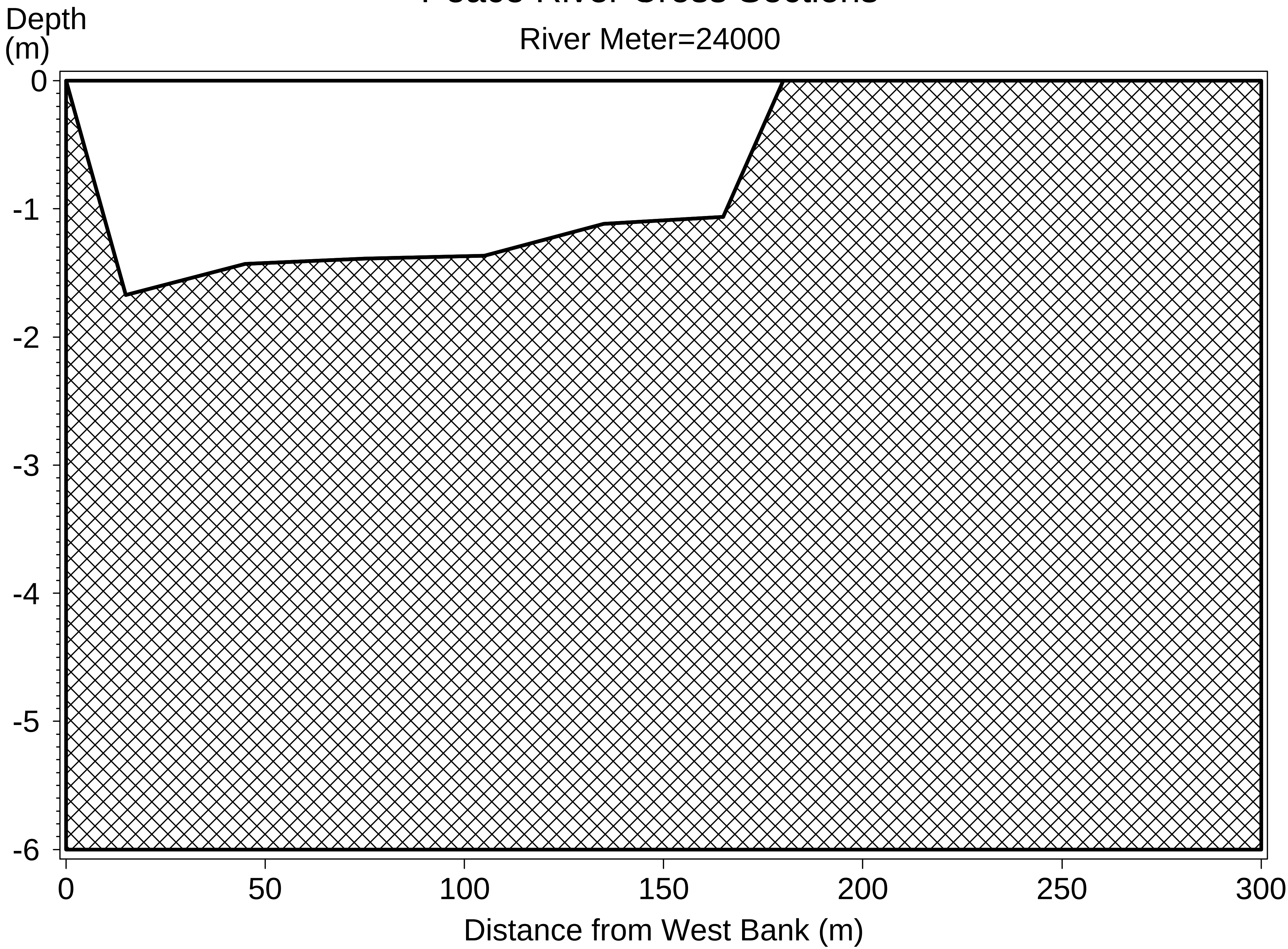

Peace River Cross Sections
River Meter=23000
Depth (m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

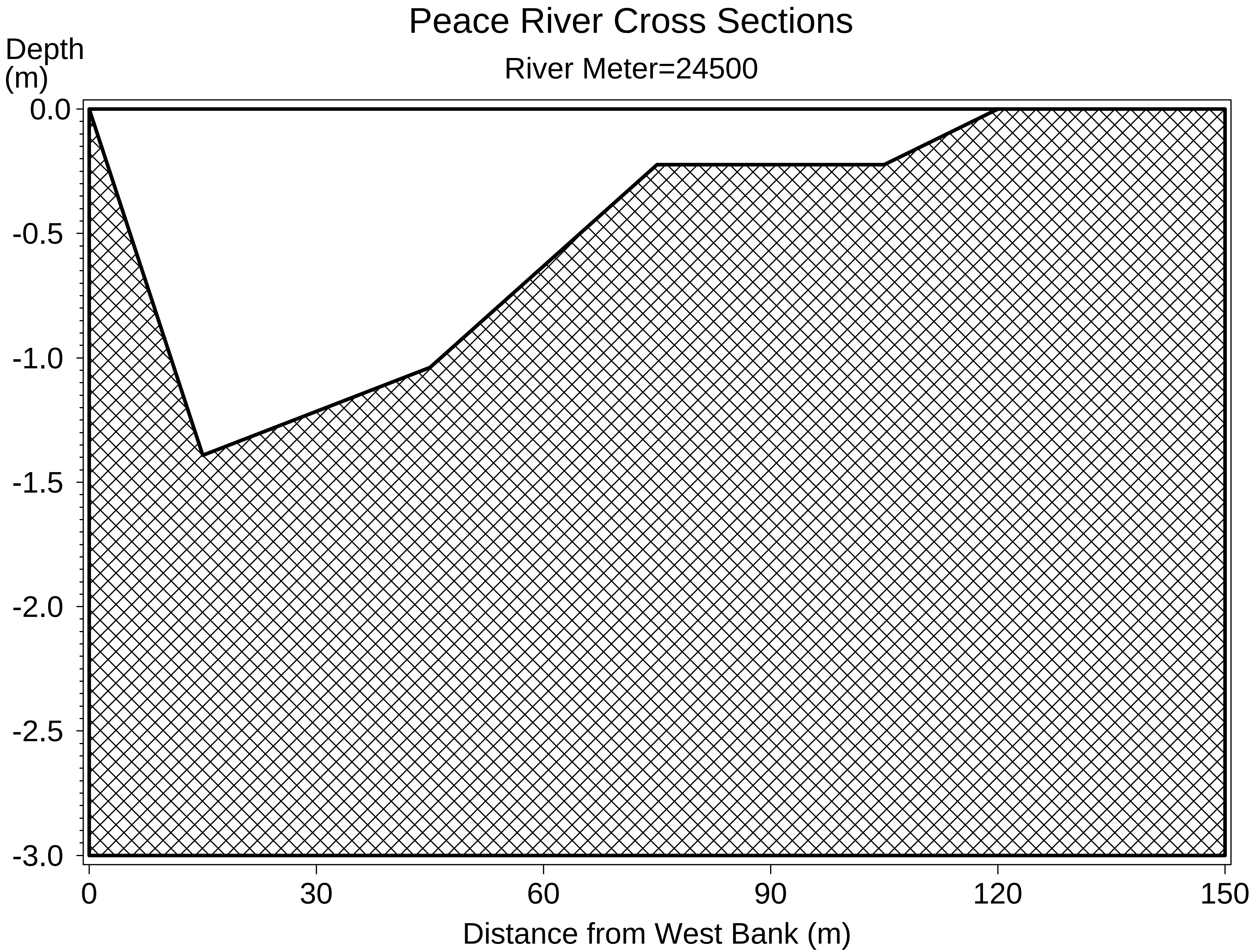


Peace River Cross Sections
River Meter=23500
Depth
(m)
0
-1
-2
-3
-4
-5
-6
0
50
100
150
200
250
300
Distance from West Bank (m)

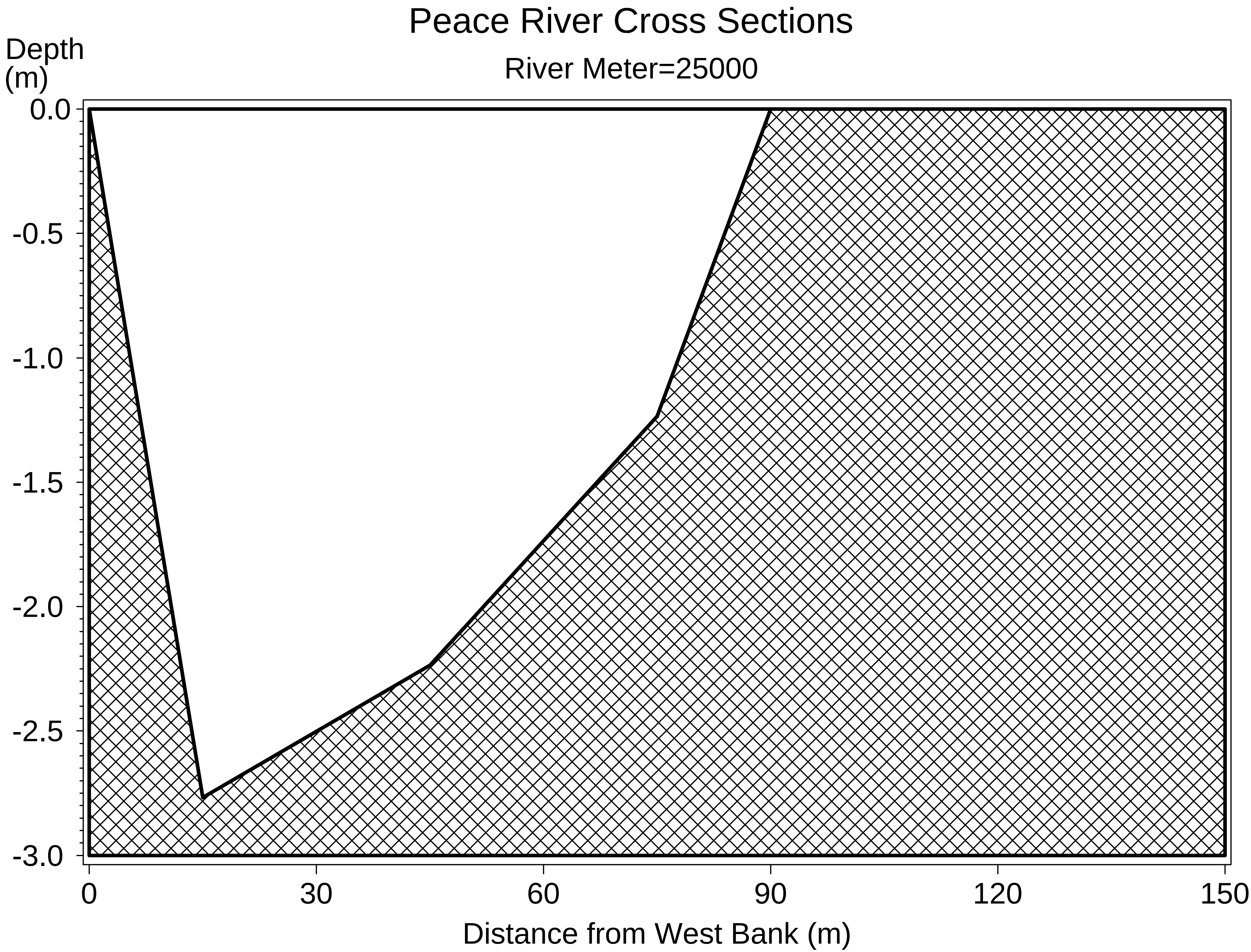
Peace River Cross Sections

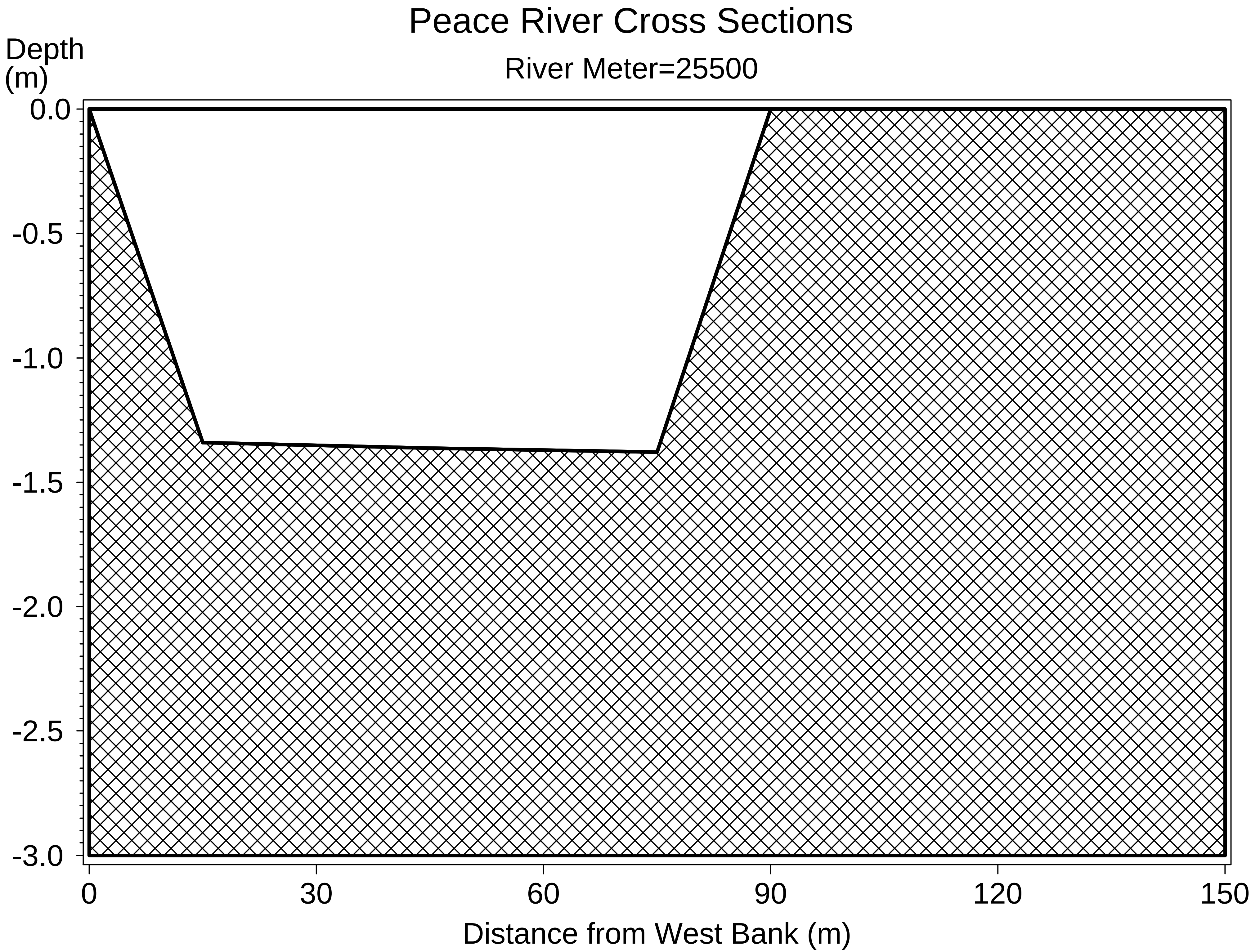
River Meter=24000

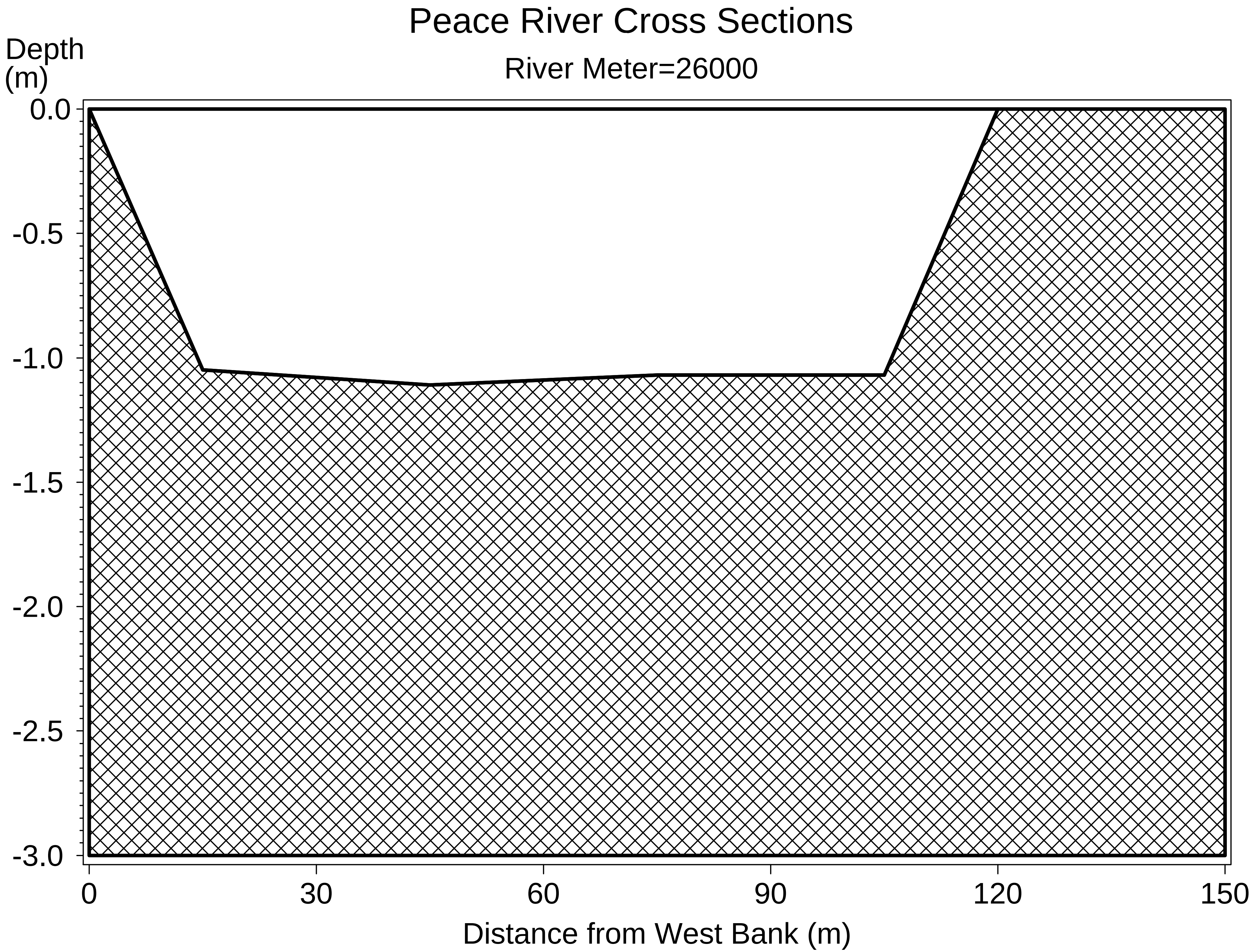


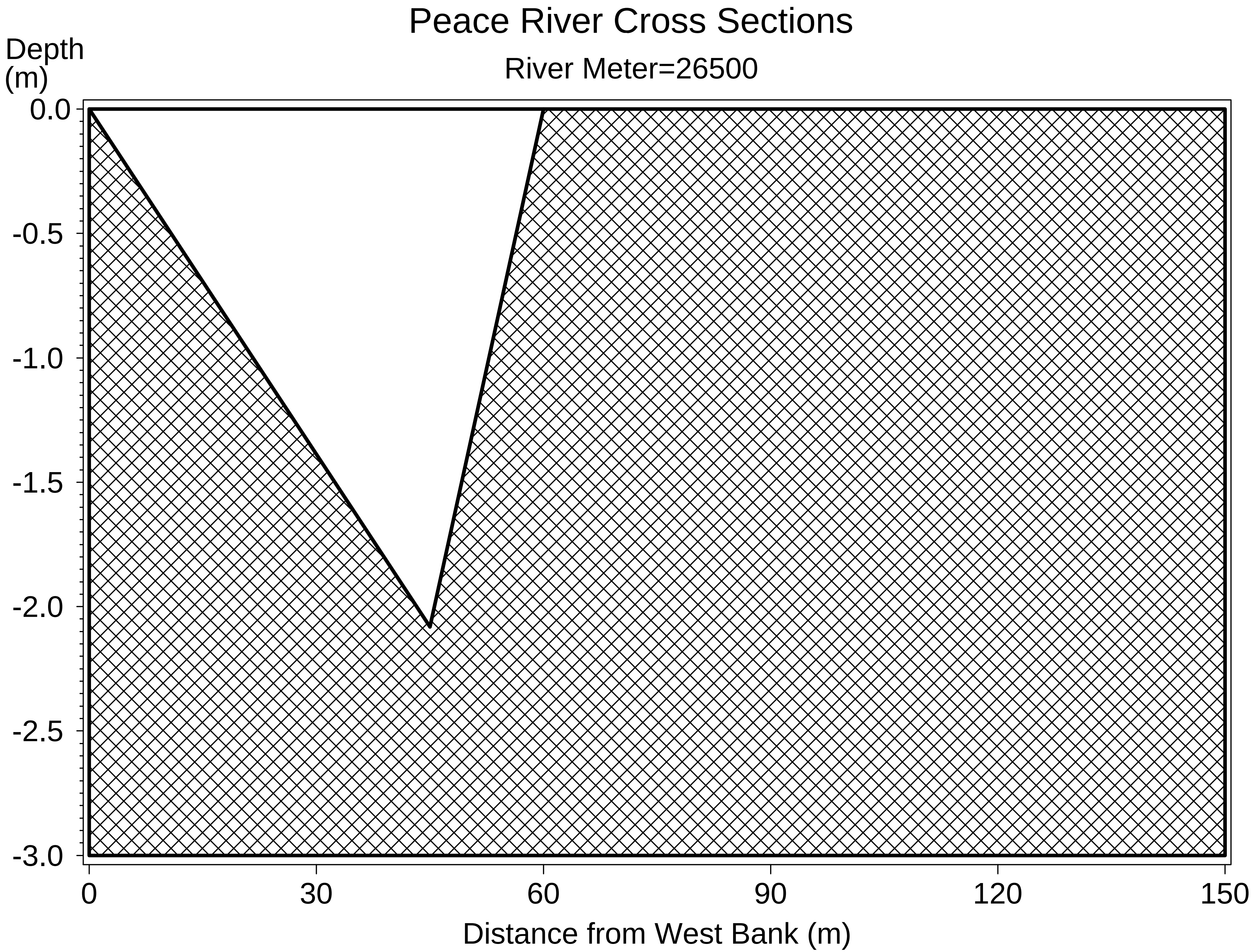


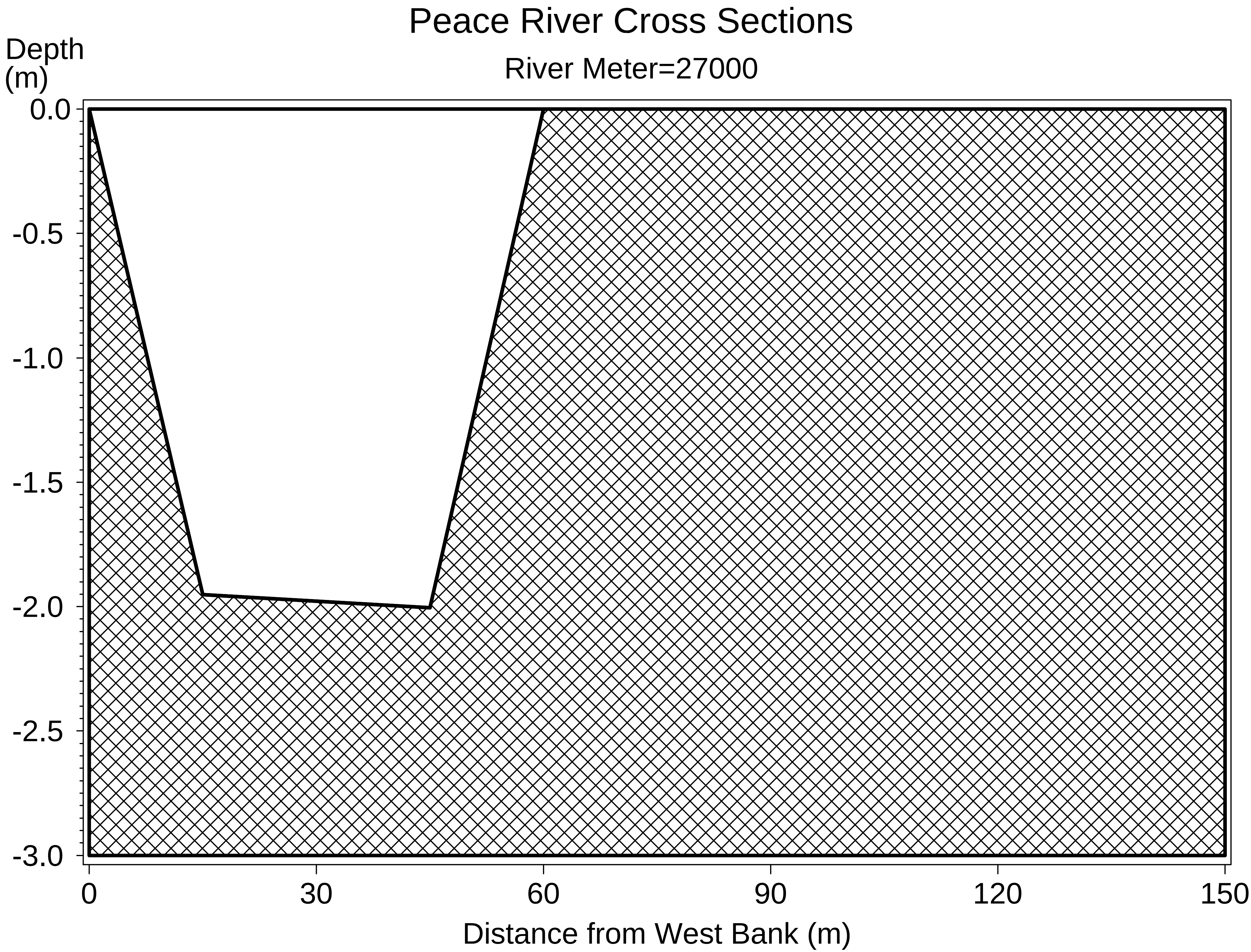
Peace River Cross Sections
River Meter=24500
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)

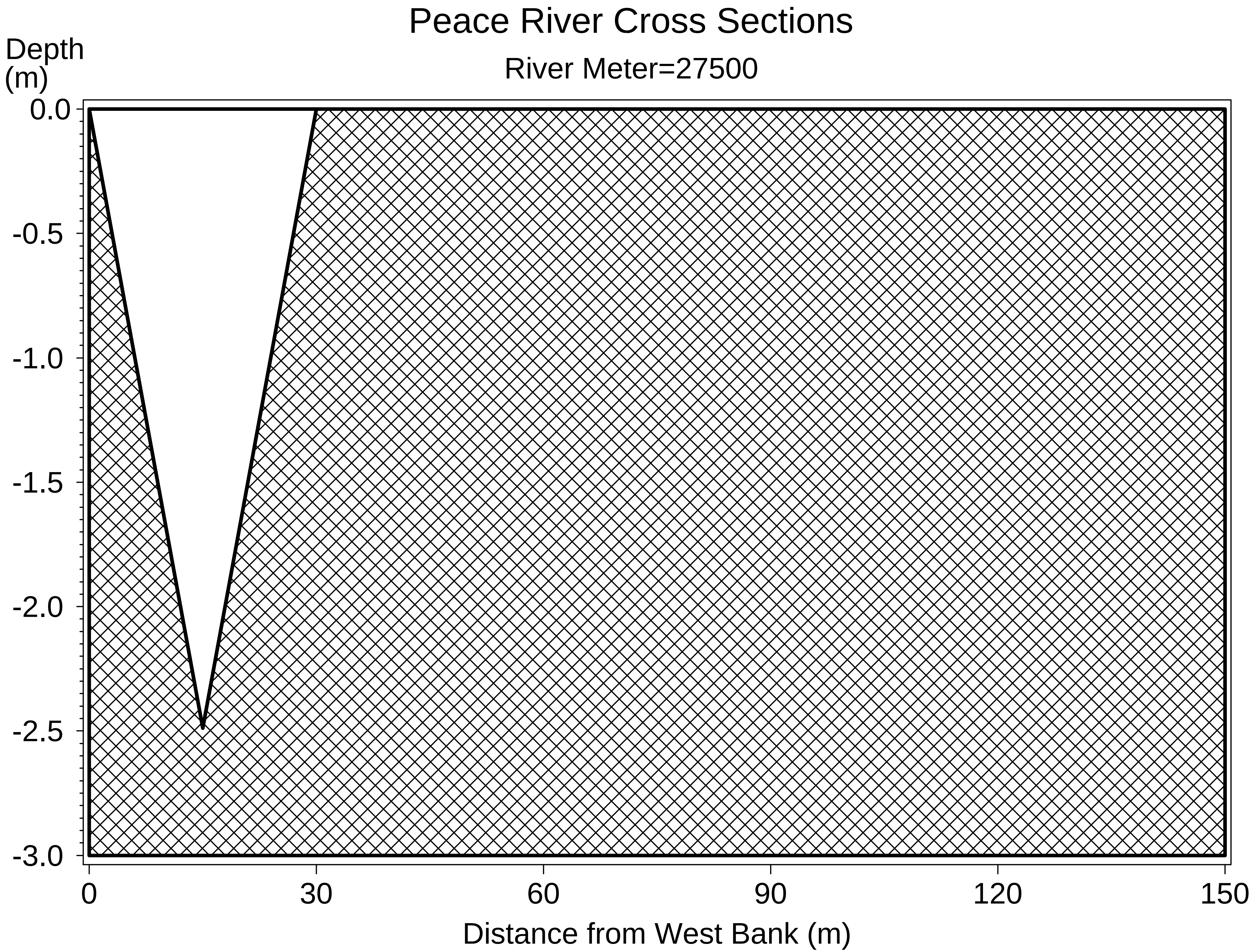

Peace River Cross Sections
River Meter=25000
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)


Peace River Cross Sections
River Meter=25500
Depth
(m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)

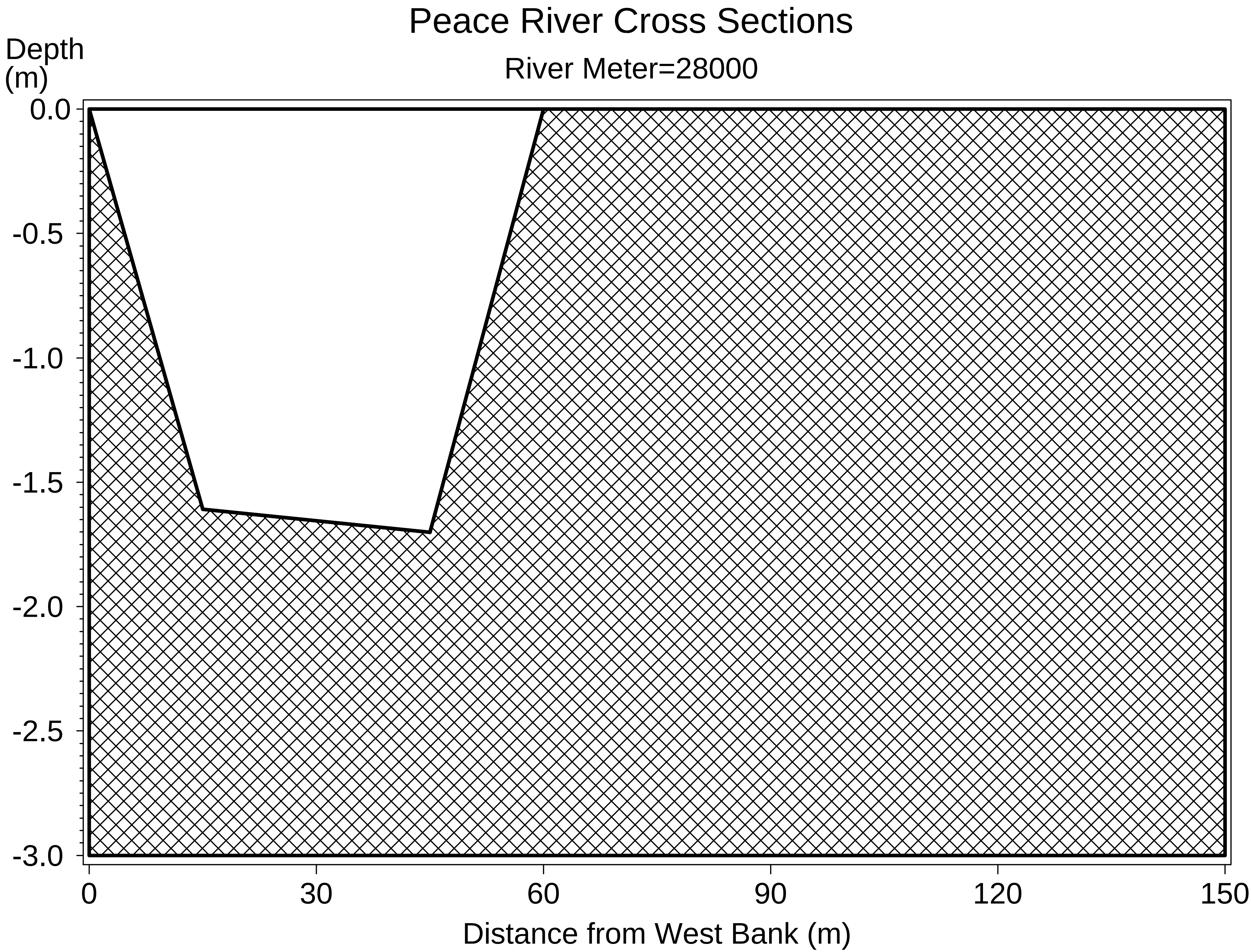

Peace River Cross Sections
River Meter=26000
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)

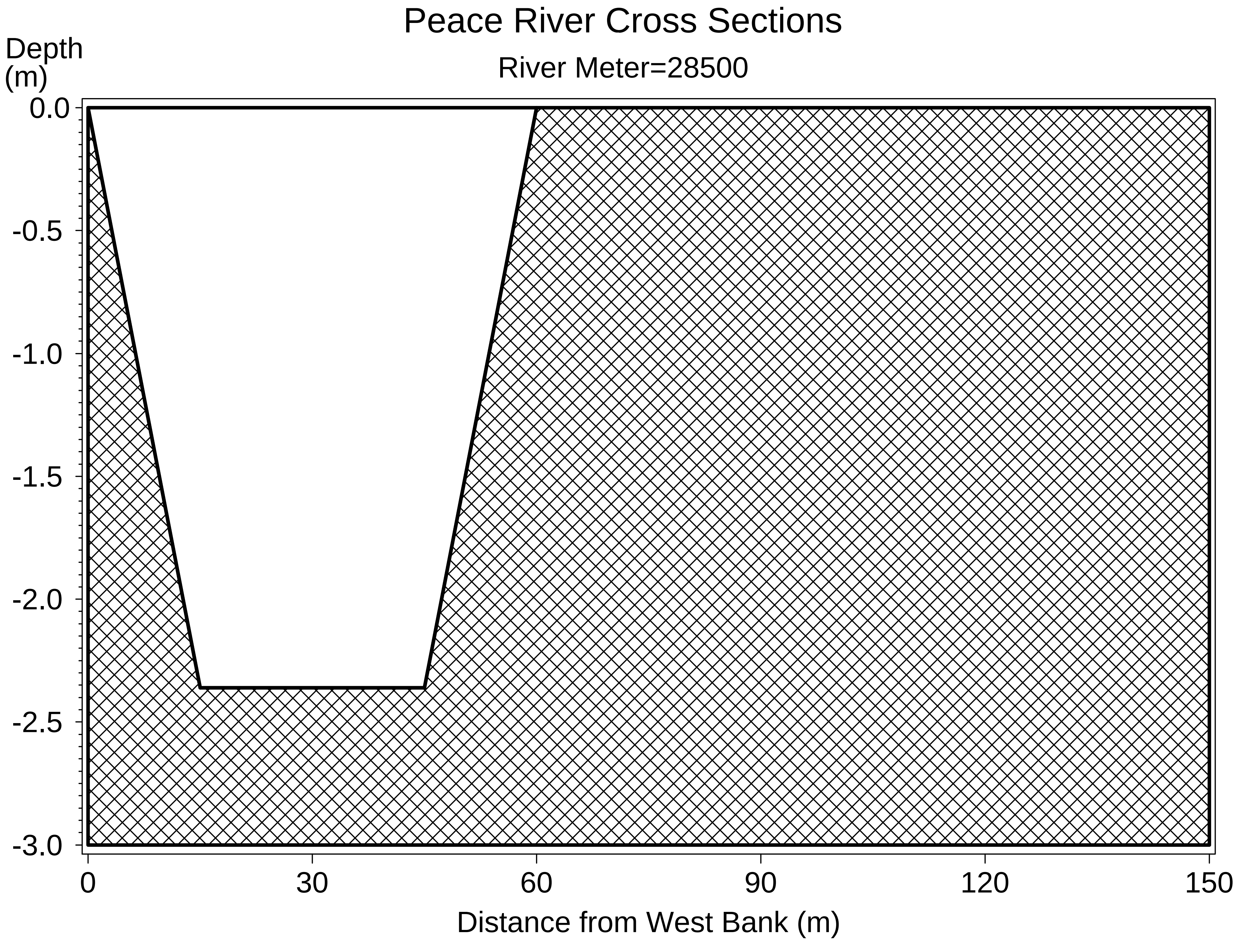

Peace River Cross Sections
River Meter=26500
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)


Peace River Cross Sections
River Meter=27000
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)

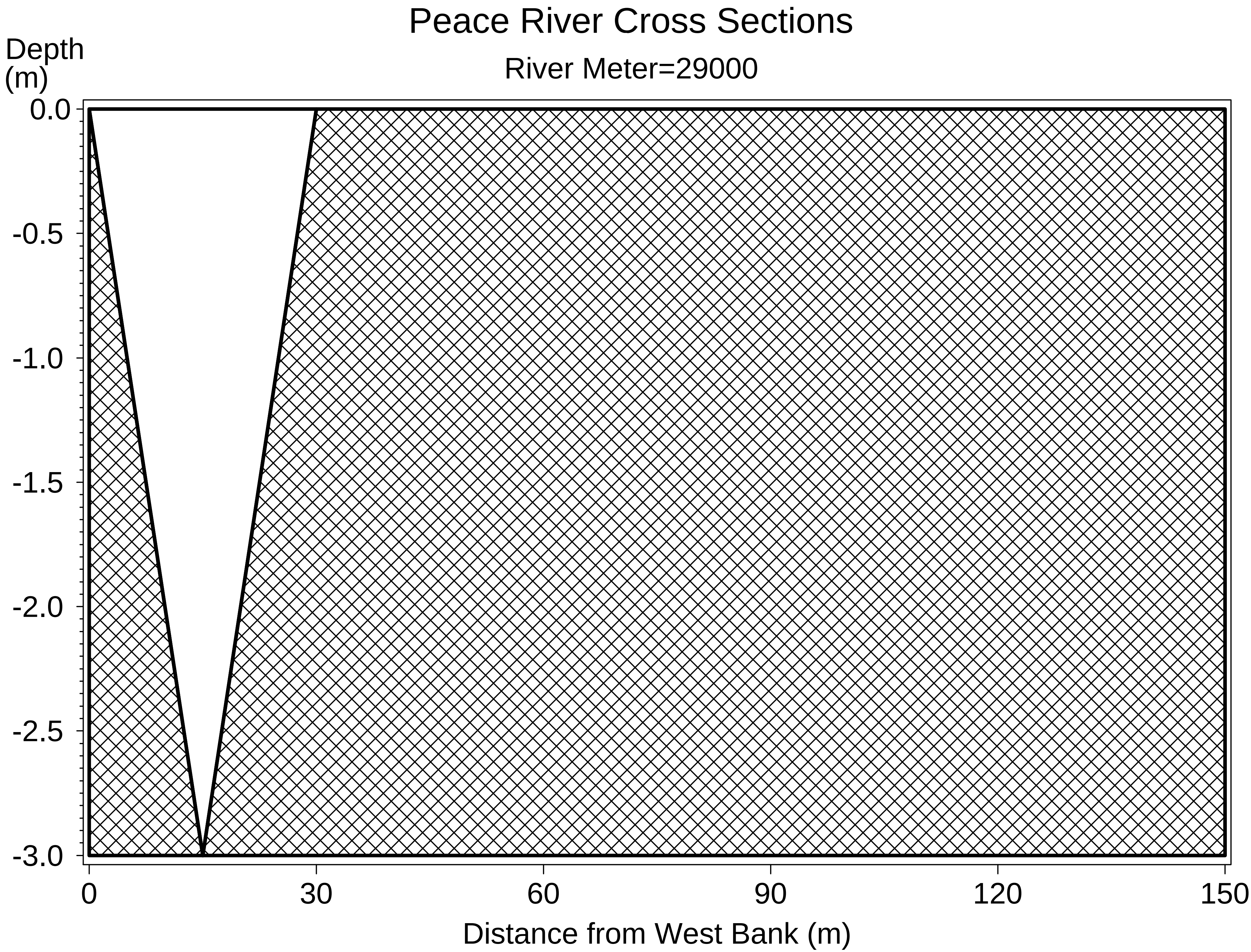


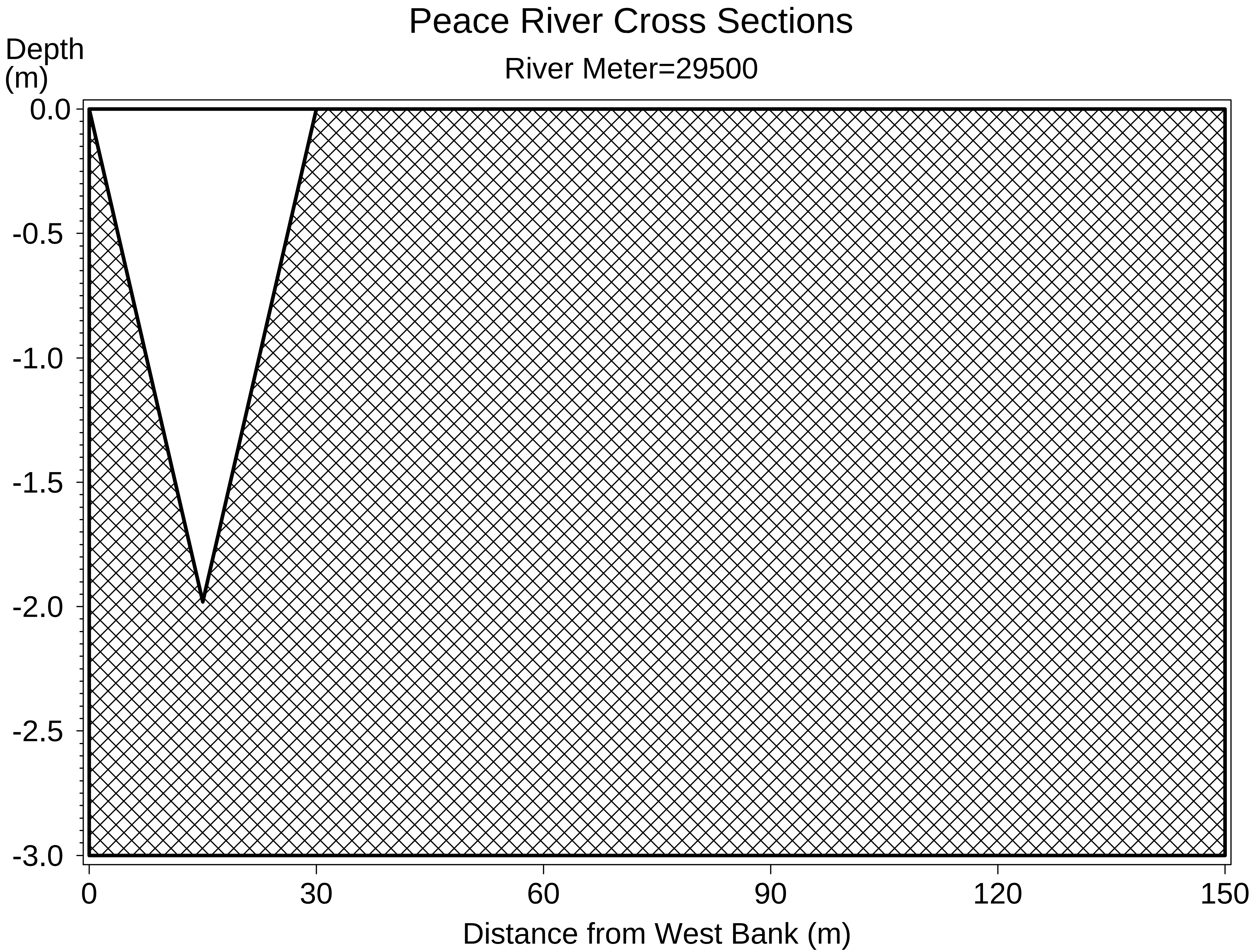
Peace River Cross Sections
River Meter=27500
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)


Peace River Cross Sections
River Meter=28000
Depth
(m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)

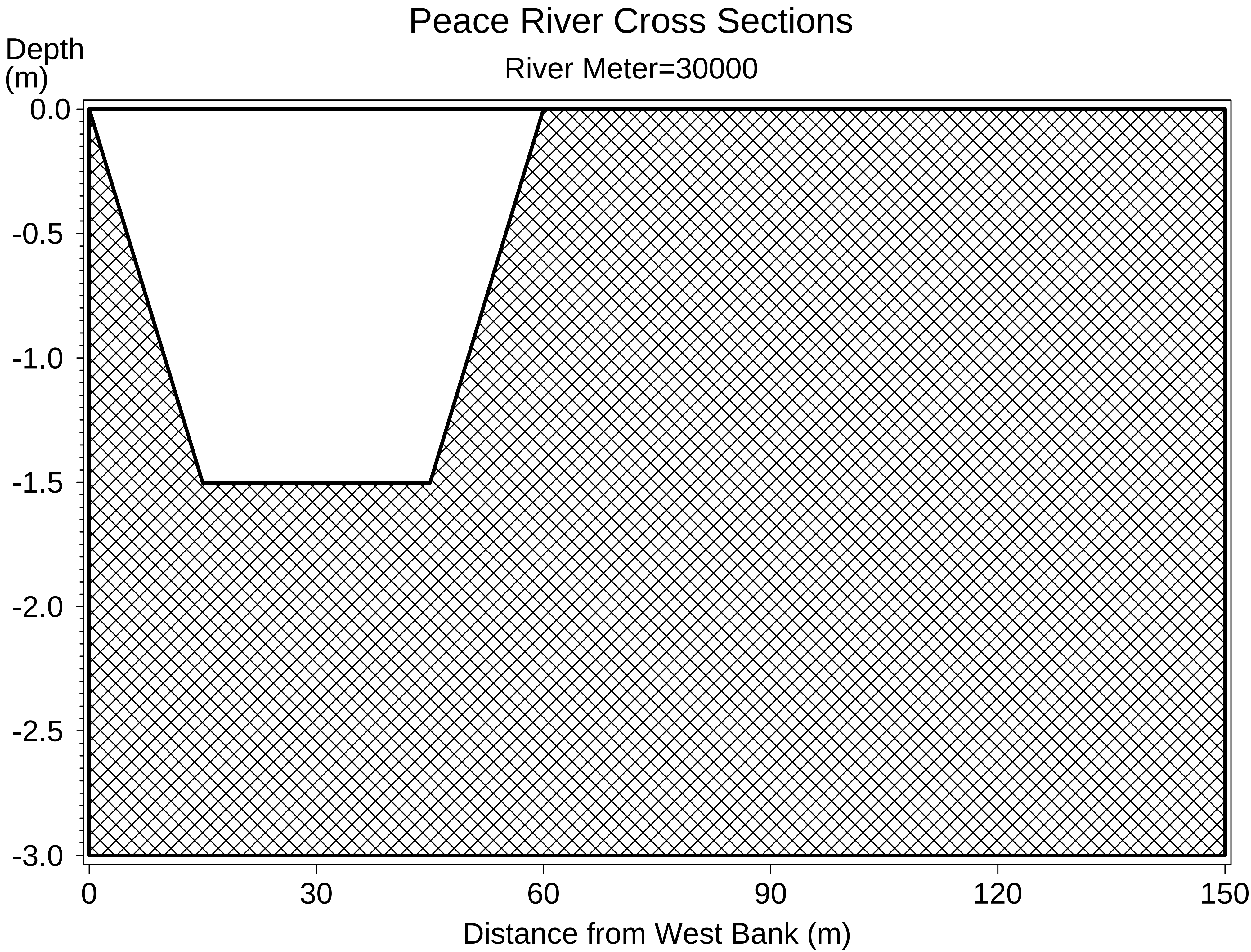


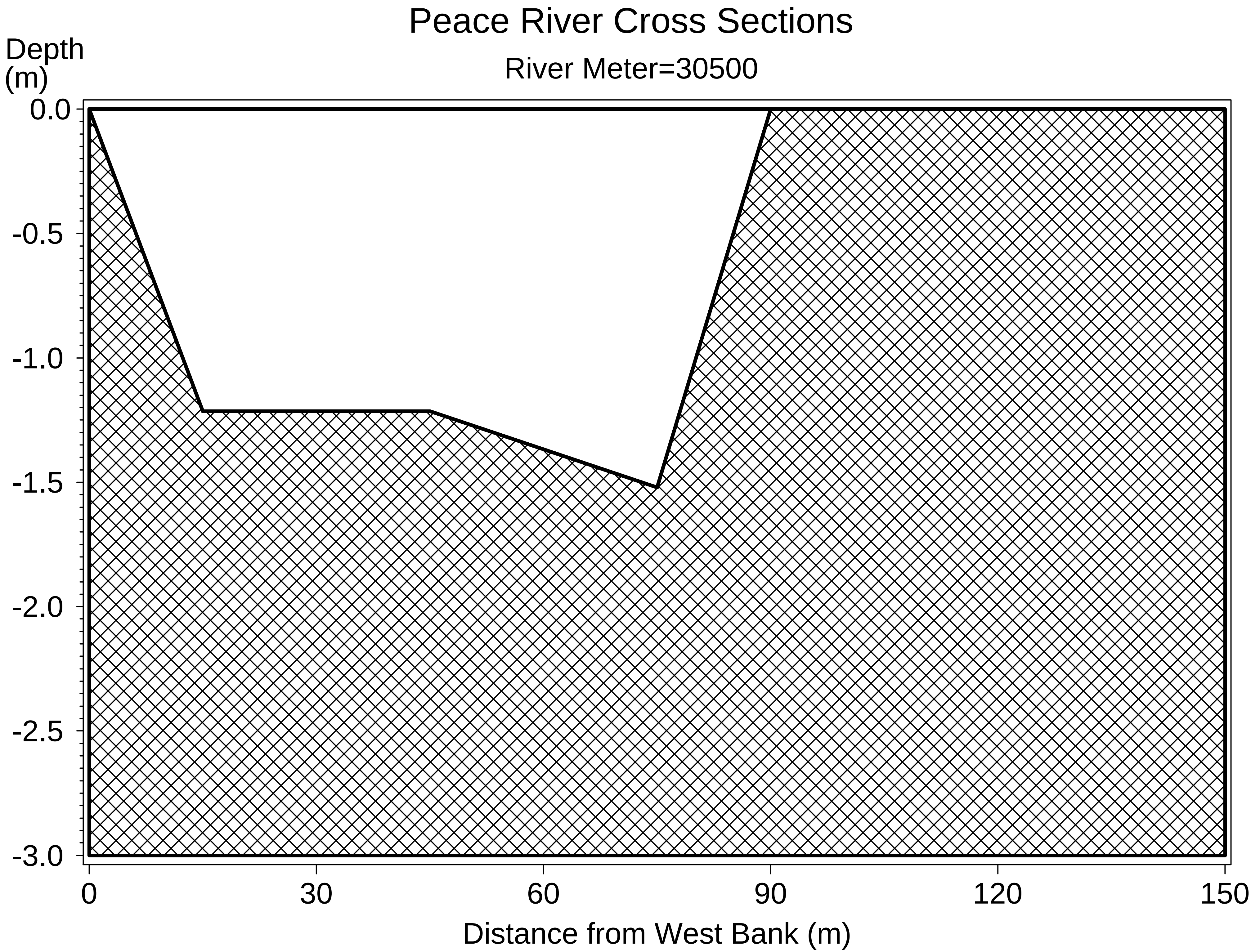
Peace River Cross Sections
River Meter=28500
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)


Peace River Cross Sections
River Meter=29000
Depth (m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)



Peace River Cross Sections
River Meter=29500
Depth
(m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)


Peace River Cross Sections
River Meter=30000
Depth
(m)
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
0
30
60
90
120
150
Distance from West Bank (m)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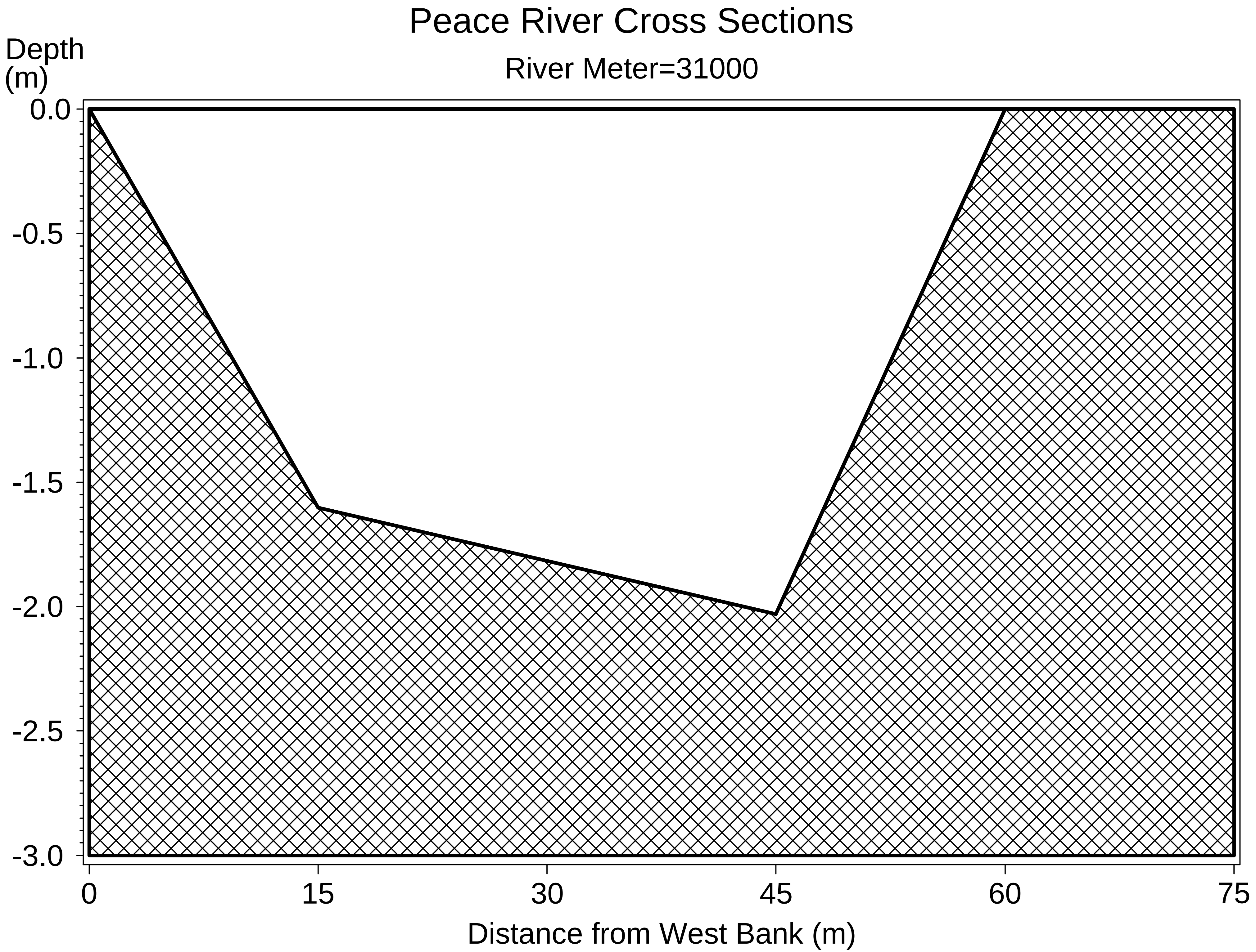
60
90
120
150
Distance from West Bank (m)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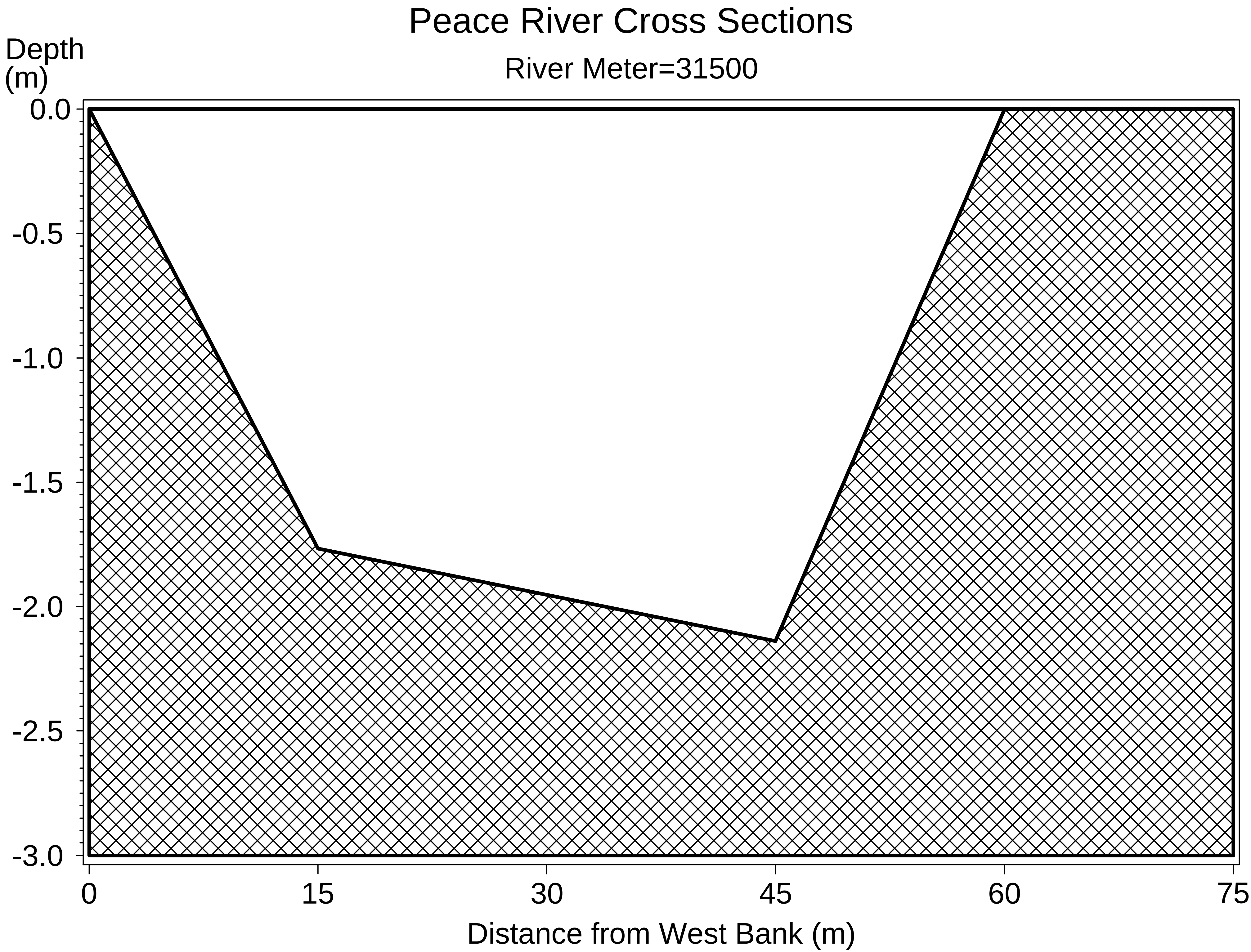
60
75
Distance from West Bank (m)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(m)
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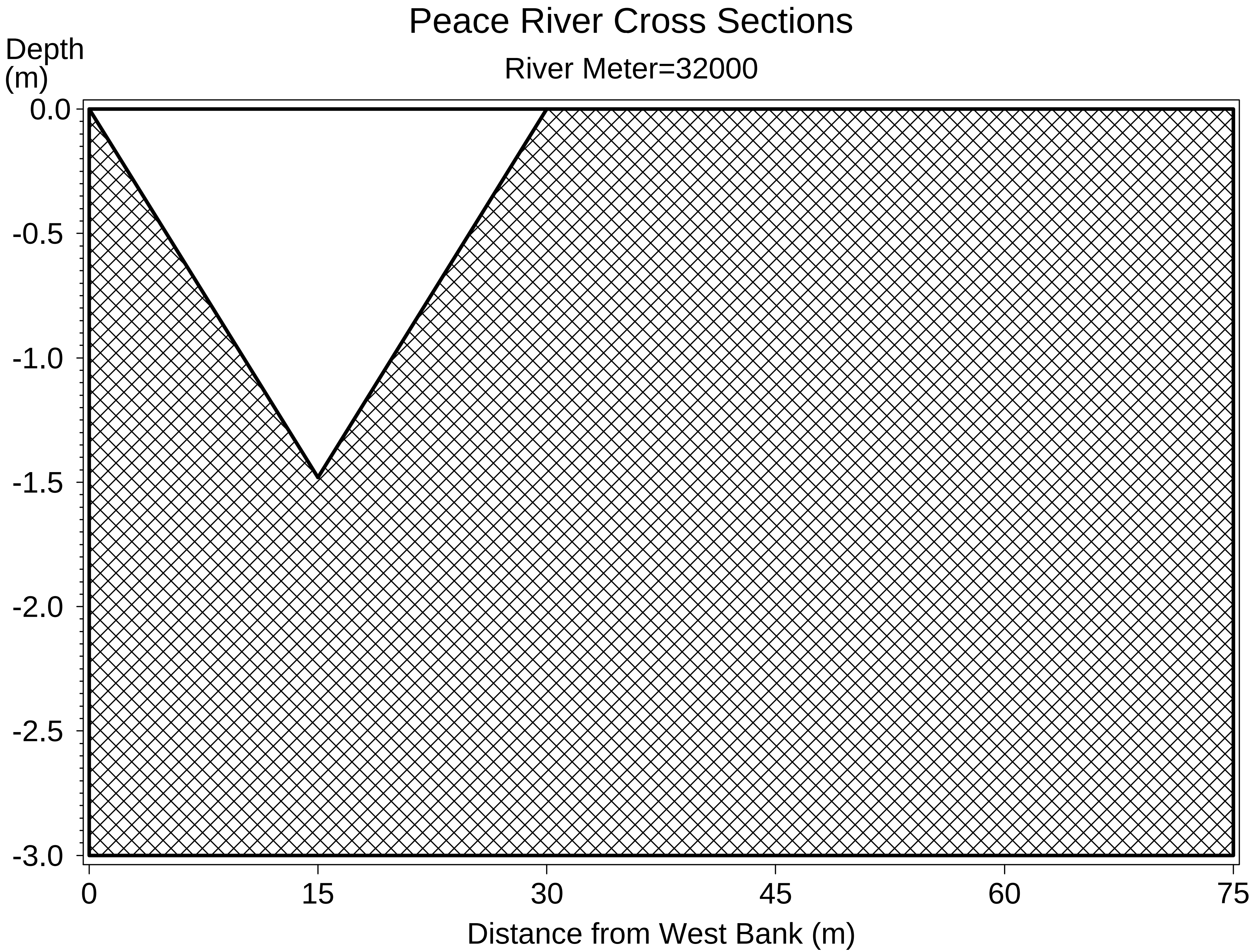
15
30
45
60
75
Distance from West Bank (m)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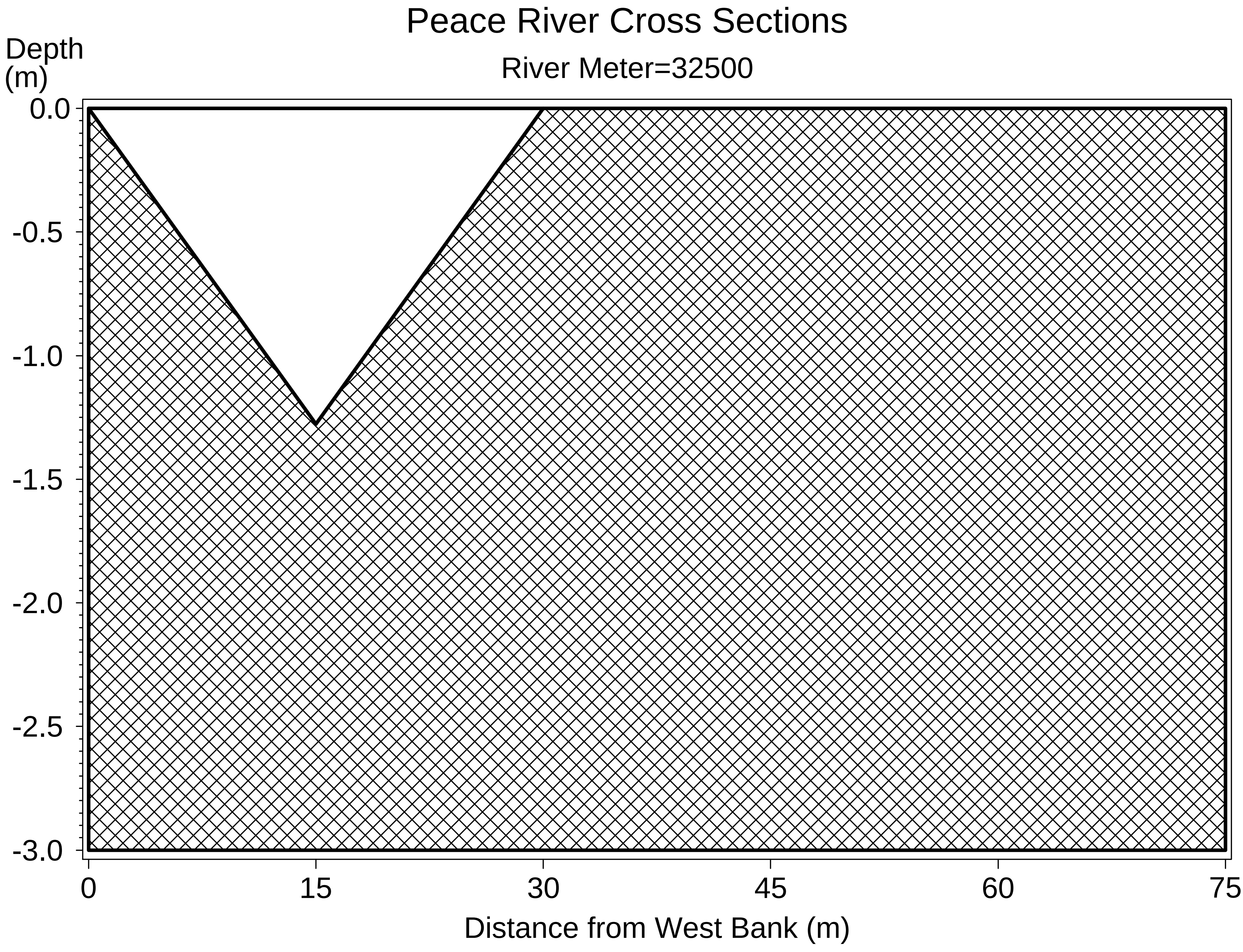
0
15
30
45
60
75
Distance from West Bank (m)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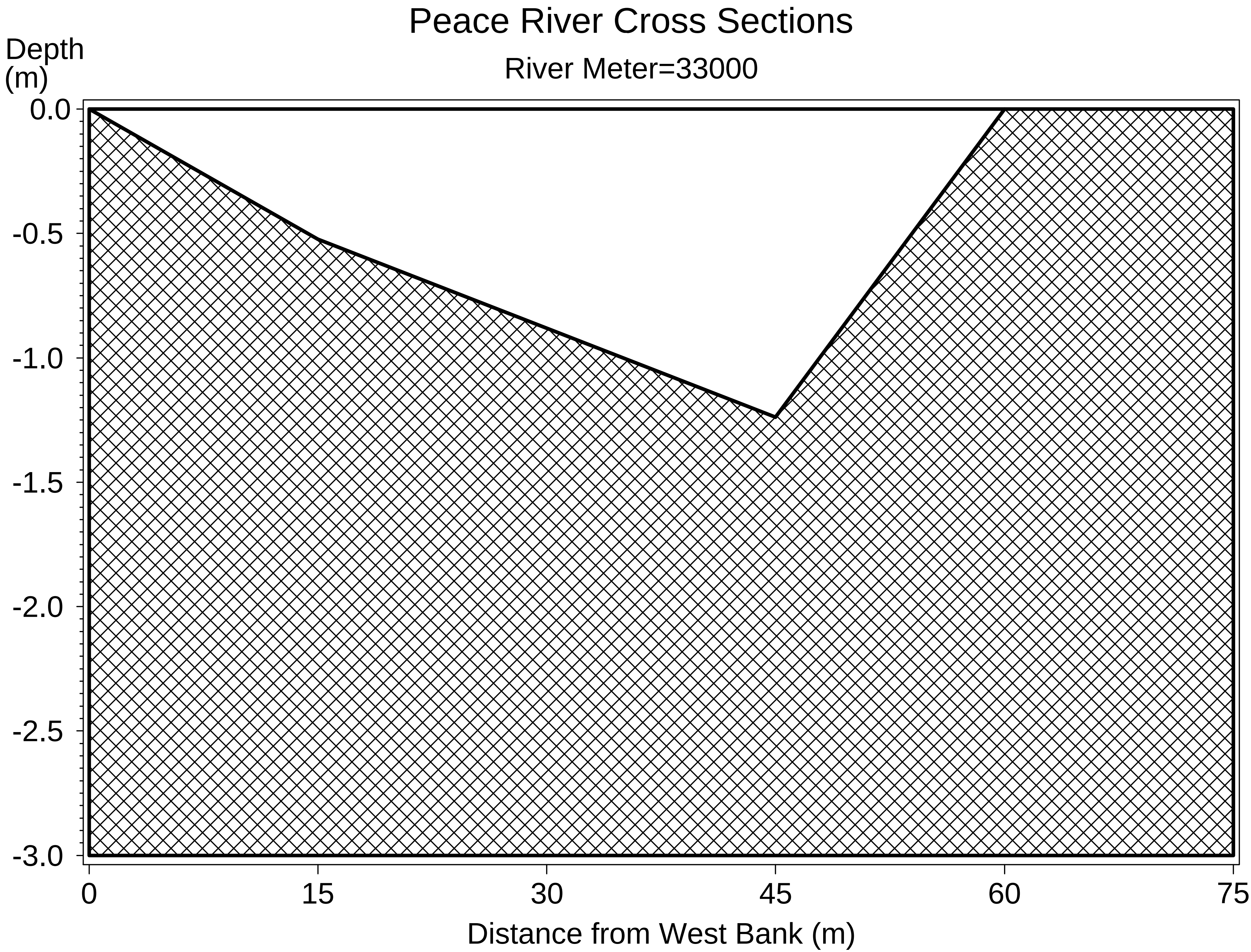
0
15
30
45
60
75
Distance from West Bank (m)



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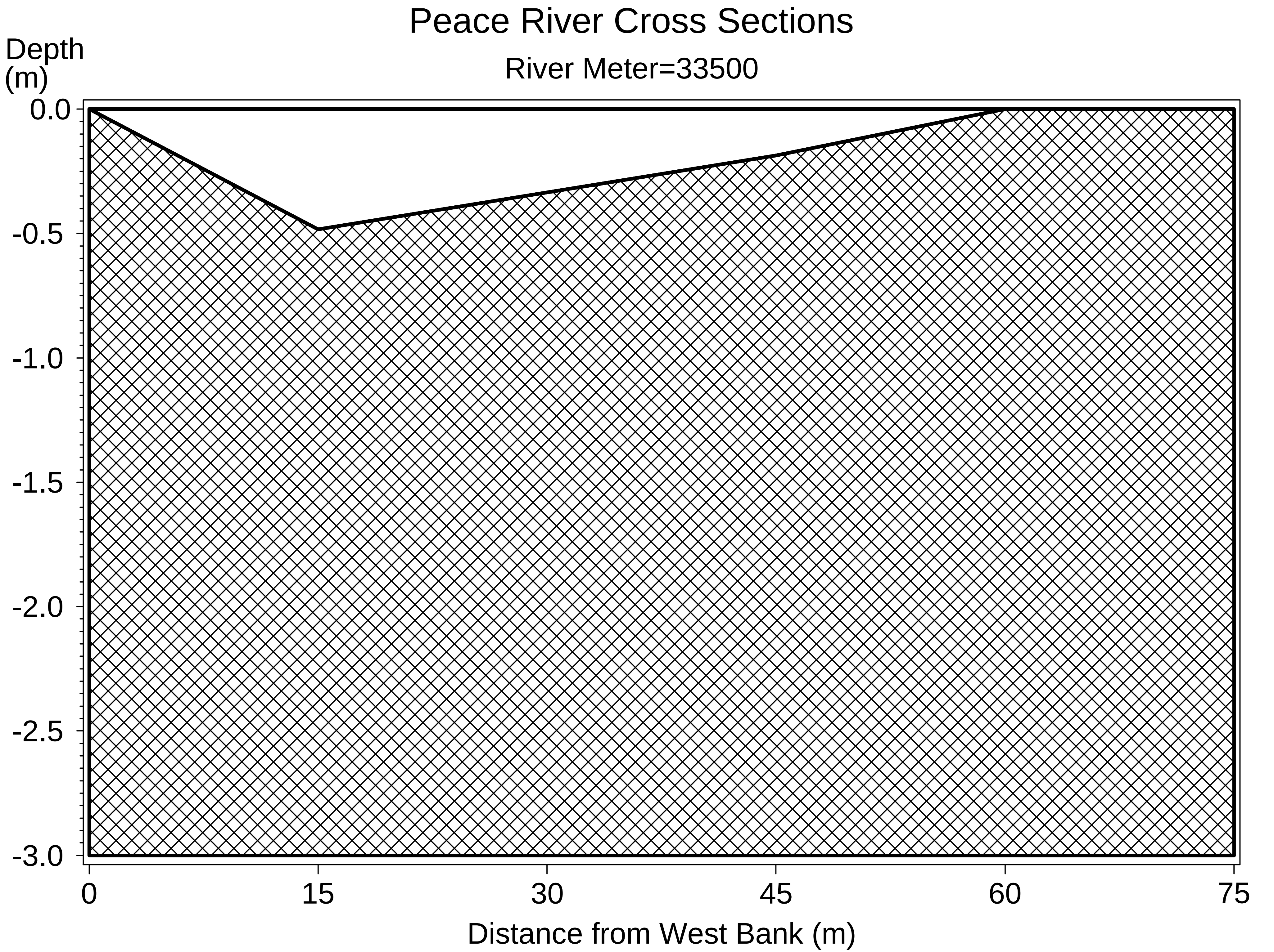
-1.5
-2.0
-2.5
-3.0
0
15
30
45
60
75
Distance from West Bank (m)



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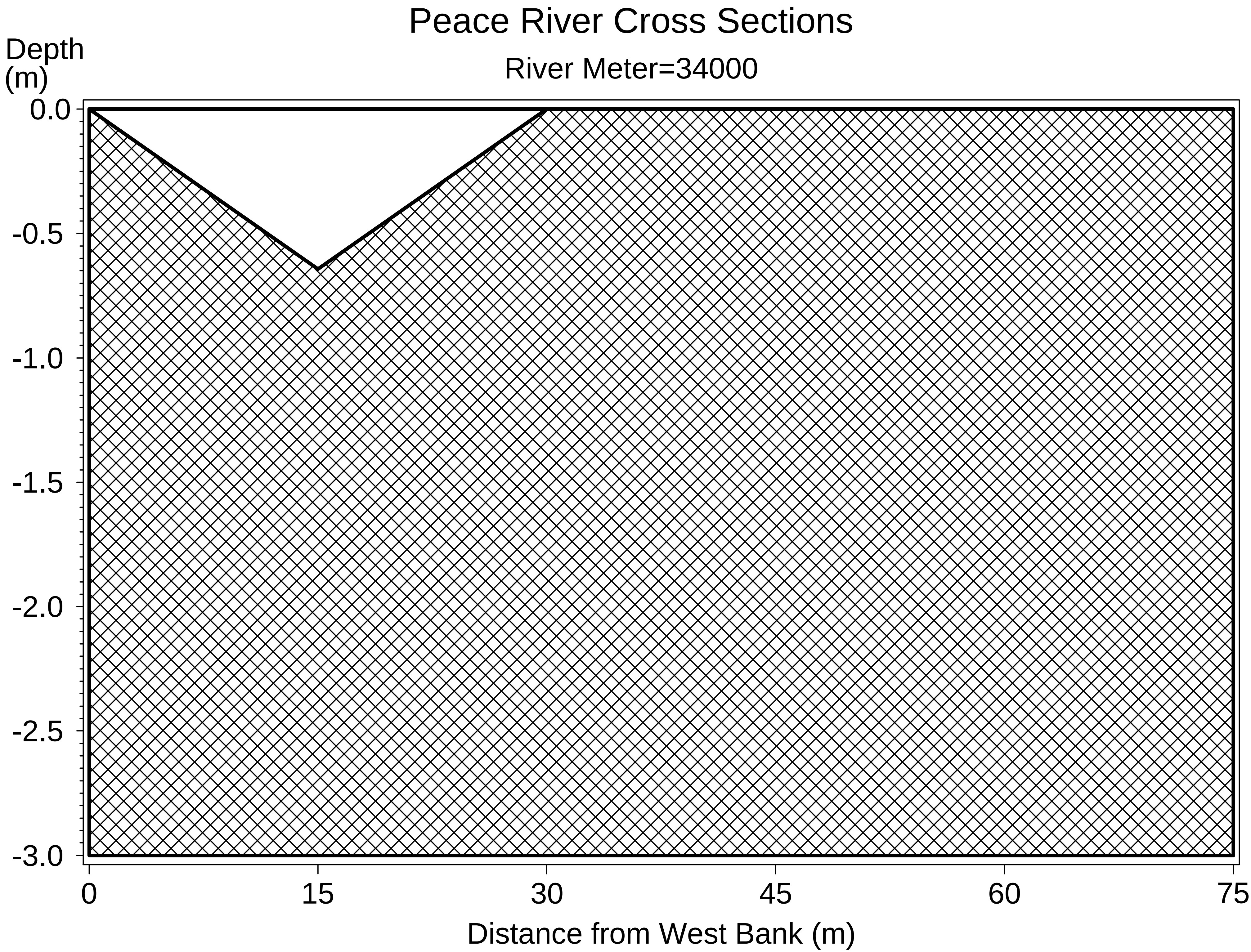
60
75
Distance from West Bank (m)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(m)
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-3.0
0
15
30
45
60
75
Distance from West Bank (m)

2006 HBMP
Comprehensive Summary Report

Appendix B – Scientific Review Panel Comments

Tom Fraser, Ph.D. Comments

Along with the Table 1.1 listing the permits issued and the significant characteristics, perhaps another table with the operational construction upgrades to the Peace River Water Treatment Plant (PRWTP) would be helpful.

The lower flows of freshwater will almost always be subject to the maximum withdrawals with the latest expansion of the PRWTP. Above 1500 cfs of inflow the tidal river complex will be fresh. Any potential biological responses to high flows withdrawals will generally be in Charlotte Harbor and in coastal waters– areas not subject to any monitoring. The mass of graphs and tables form the basis of descriptive summaries and analysis by statistical procedures. Identification of salinity zones or regions with differing salinity variability caused by inflow below 1390 cfs (130 cfs threshold limit + 1390 cfs upper withdrawal rate at 10%) need to be made. Perhaps starting about 500 cfs and stepping down by a reasonable increment in an initial identification process for the tidal river covers most of the dry season.

The purpose of this analysis, if it proves to be of value, is to concentrate biological monitoring in two general regions of the tidal river complex: (1) in a upstream region where the salinity structure is more stable but shows substantial change in surface area/ volume with flow/withdrawals and (2) in the general area of higher variability in salinity, perhaps around Harbor Heights. The 2006 report has described the gradient of salinity variability between tidal freshwater field and the transition from tidal river to harbor.

Perhaps most of future biological monitoring should be confined to the dry season, leaving the physical and chemical monitoring on a year round basis. If so, then species to consider should have short life spans which can be completed several times within the tidal reach during the dry season, subject to limited advection into (tide, motile) or out (residence time, motile) of the tidal reach. Possible groups include algae, estuarine benthic or motile organisms, both animal groups need to be relatively low on the food web.

Any new or refined monitoring to test the efficacy of new withdrawal schedules and any new thresholds for the tidal Peace River (Permit requirements, established Minimum Flows and Levels) cannot avoid combining the actual withdrawals from Shell Creek by Punta Gorda Water Treatment Plant into any analyses. Combining monitoring programs run under the same/duel contracts by a single contractor/subcontractors is self evident for technical comparability and a reasonable action to assure SWFWMD that withdrawals programs are not harming the ecology and biological integrity of the tidal Peace River and Charlotte Harbor.

Chlorophyll a

Real-time transects mapping chlorophyll would be useful before color interferes with the compensation depth.

Reports

Data reports ought to contain data and appropriate simple inspection graphics to identify outlier data, valid and erroneous, and raw data trends. These reports should be done every year, sent to SWFWMD and available, if requested, in electronic form by interested parties.

The dry season flow frequencies used here are examples used for discussion of possible approaches for analytical reports. Analytical reports ought to be scheduled based on the flow history of freshwater inflow or the lack of withdrawals (say 75% or greater of a dry season) during severe droughts. Dry years and dry seasons with substantial withdrawals falling on the low side the median interval with a probability such as 1 dry season in 10 dry seasons based on some period of record (long-term record, 20 year moving average, etc.) should be analyzed at the end of that dry season or year. Dry seasons falling the low side of the median such as 1 dry season in 3 dry seasons or wetter than the median should be reported every 5 years. Dry seasons with virtually no withdrawals should have the report delayed (almost a dry season baseline). These reports ought to have only the pertinent graphics and tables supporting analyses testing the actual withdrawals for trends toward harm caused by withdrawals.

Excutive summarys conveying the important points should be continued.

Potential modifications to existing withdrawal schedule

A low-flow cutoff should be present and affect surface withdrawals for the entire river basin in order to maintain the largest year-round permanent estuary south of the Suwanee River estuary. There is a natural cutoff at the intake for PRTWP caused by rising salinities at flows less than 90-100 cfs at Arcadia depending on preceding salinities and tides. It does not matter if Horse or Joshua Creeks' flows are actually added in or not, because these flow additions were always there at the lower flows. This is an action without much meaning, except when more coastal or small regional rains increase flows to these creeks but not for flows above Arcadia in the Peace River. The protective low flow of 130 cfs at Arcadia was arrived at through detailed examination. I believe that the 130 cfs cutoff already includes effects of Horse and Joshua Creeks (just not overt addition to determine cutoff). If base flows in the Peace River disappeared years ago masked by human discharges, now eliminated, then the augmented base flows of Shell, Joshua and Horse Creek may suffer the same fate. Such changes might return the original ratios of inflow from the Peace River compared with the to creeks.

Little or no work of consequence has been done to suggest what effects a sliding scale at higher flows (what threshold?) might have in Charlotte Harbor or coastal waters. Until there is a combined MFL high flow analysis for Charlotte Harbor and coastal waters, and an associated monitoring program established, this idea deserves to remain a distant option. We know that there will be little or no measurable effects during high flows in the tidal Peace River where all PRWTP's effort is concentrated, ergo, do it with existing information – is anathema to me. The high flows into Charlotte Harbor and along coastal waters are important to the production of wet season estuarine/marine communities not associated with the deeper stratified zone (not stratified in the lower harbor) and to the commercial and recreational economies of Charlotte and Lee Counties.

The first flushes of increasing flow to the tidal Peace River may need more protection. An analysis of the date frequencies for rising flow in the late spring/early summer should be examined. This period of time is also when the PRWTP is often looking hard to get on the river after a long dry season. An examination of the effects of a short delay or a higher cutoff on reliable plant operation should be part of any analysis.

The descending limb of flow at the end of the wet season results in increasing the residence time. Ultimately, such water may be productive within the harbor during the fall and early winter. An analysis of the candidate period of time, general residence time, decline in water color for all of Charlotte Harbor and productivity should be done.
Extending the potential reach of influence by sliding the scale of withdrawals at higher flows implies a broader area to be examined with all of its complexities. Maybe the future fate of this large, barrier island estuary will be a closing the circle begun in 1976 by myself and a few others at the Environmental Quality Laboratory: trying to monitor the entire system as the PRWTP requires more water to supply demand for a growing population.

Subsequent Additional Comments by Tom Fraser

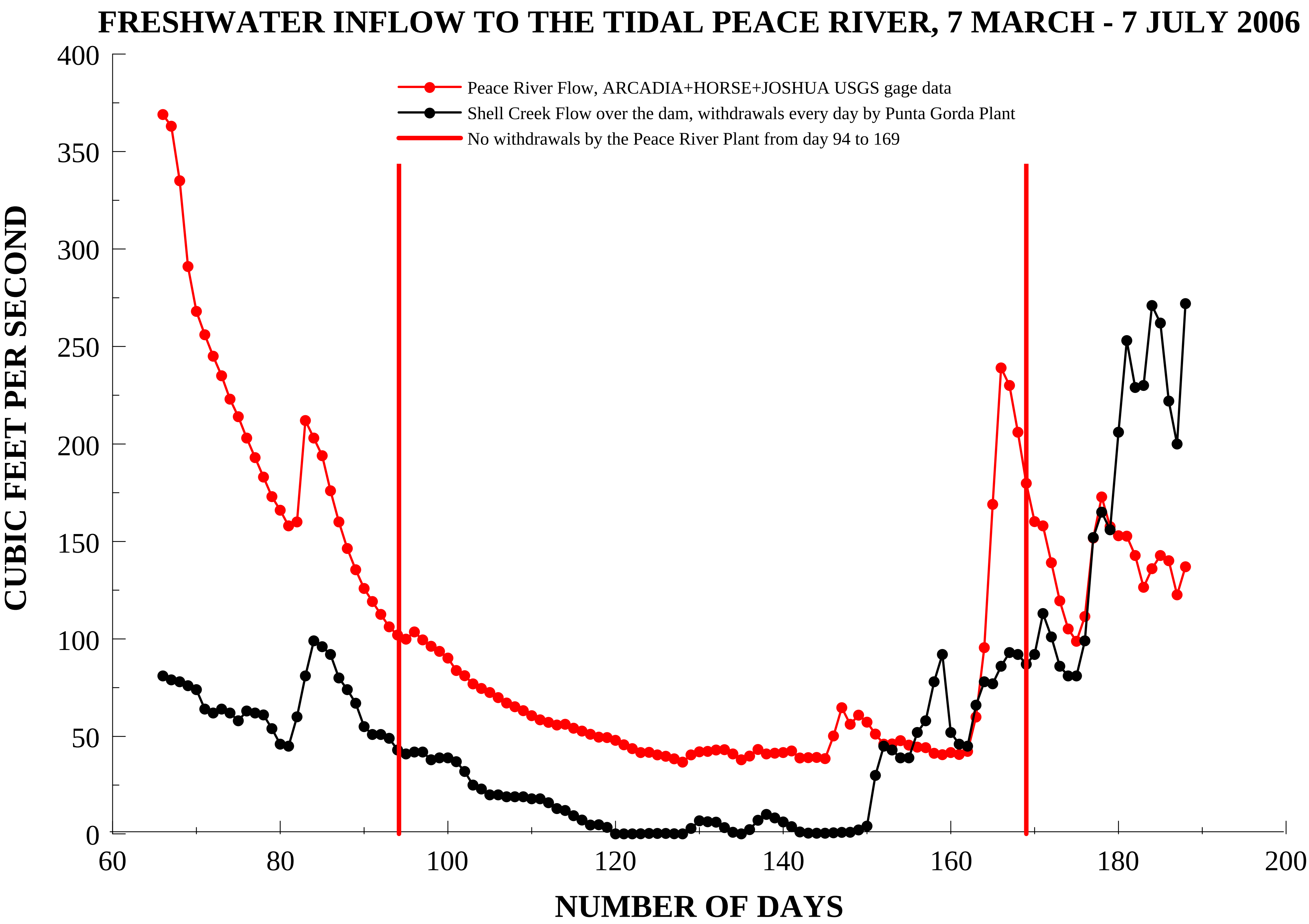
As part of reading the 2006 HBMP suumary report, I thought it might be worth while to examine a declining period of flow and the fraction of water that was withdrawn by the Peace River Water Treatment Plant (PRWTP) and by the Punta Gorda Water Treatment Plant (PGWTP). Attached are two plots. One shows the combined daily gaged flows for Horse Creek, Joshua Creek and the Peace River at Arcadia contrasted with Shell Creek flows. The PRWTP was off the river for an extended period while the PGWTP continued to withdraw water. The second graph shows the fractional volume of water withdrawn by the PRWTP compared with the two upstream creeks and the Peace River. Adding PGWTP into the mix with all of the freshwater sources suggests to me that it is not possible to reasonably ignore the potential effects of withdrawals from Shell Creek on the tidal Peace River/upper Charlotte Harbor.

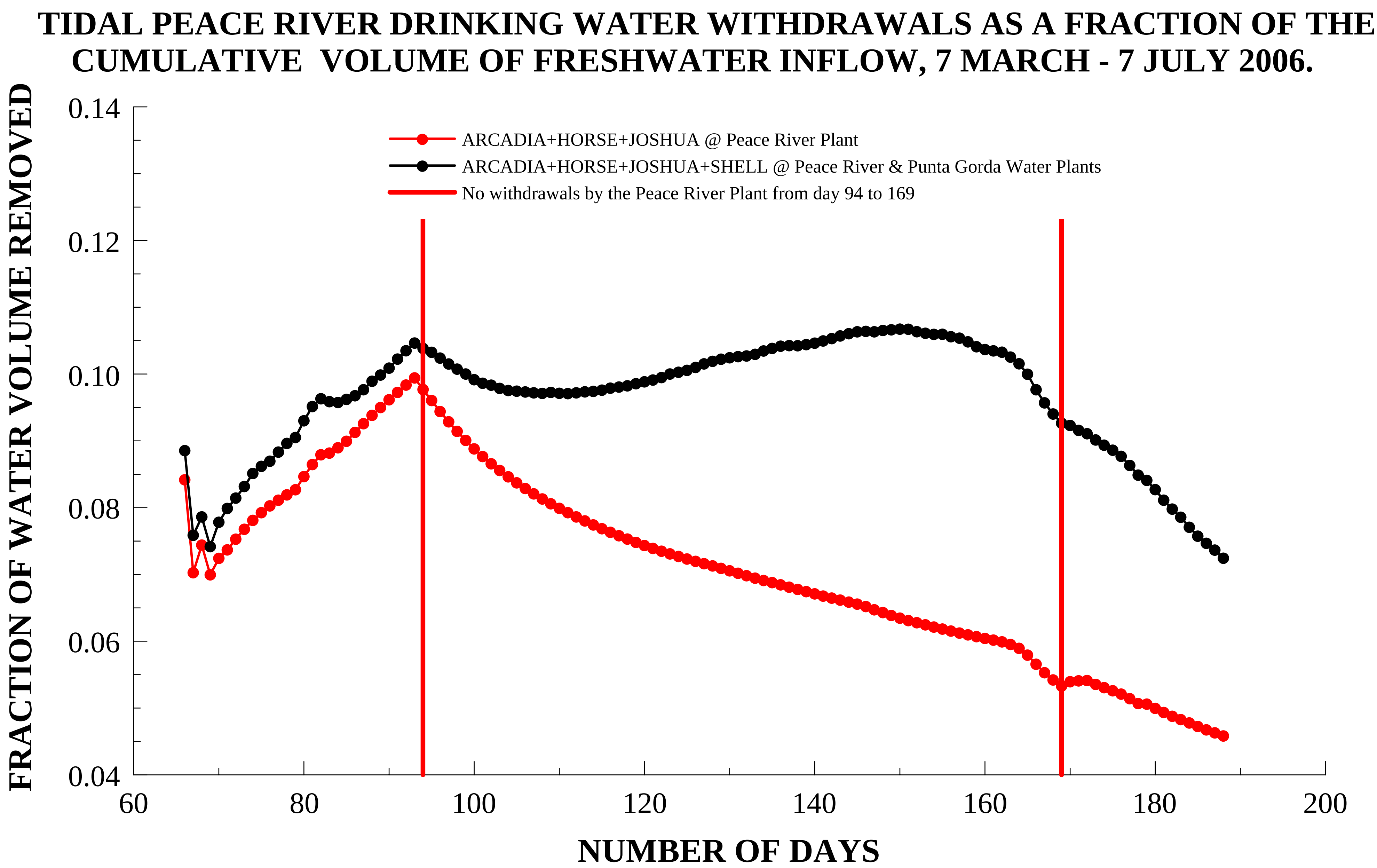
I have used the accumulation of freshwater to the tidal system because none of this water will leave the upper half of Charlotte Harbor until high flows occur and perhaps a portion of the tidal river as the result of increasing residence time caused by the descending limb of freshwater flow – and increasing volumes removed for drinking water to supply growth.

As the ability to withdraw greater fractions of water at higher flows from either or both WTPs, perhaps likely cumulative effects from taking greater volumes earlier and lesser volumes later on extended (or rapidly) descending limbs of flow will become greater than at present.

It would appear that PGWTP may need to be on a similar percent of flow withdrawal regime rather than a completely different pattern to simplify possible detection of trending toward adverse effects or significant harm.

I am not sure how the HBMP can operate independently of the monitoring program for Punta Gorda. This issue may need some exploration by the staff of the two WTPs and SWFWMD.


FRESHWATER INFLOW TO THE TIDAL PEACE RIVER, 7 MARCH - 7 JULY 2006
CUBIC FEET PER SECOND
NUMBER OF DAYS
Peace River Flow, ARCADIA+HORSE+JOSHUA USGS gage data
Shell Creek Flow over the dam, withdrawals every day by Punta Gorda Plant
No withdrawals by the Peace River Plant from day 94 to 169
0
50
100
150
200
250
300
350
400
60
80
100
120
140
160
180
200


TIDAL PEACE RIVER DRINKING WATER WITHDRAWALS AS A FRACTION OF THE CUMULATIVE VOLUME OF FRESHWATER INFLOW, 7 MARCH - 7 JULY 2006.
FRACTION OF WATER VOLUME REMOVED
0.14
0.12
0.10
0.08
0.06
0.04
ARCADIA+HORSE+JOSHUA @ Peace River Plant
ARCADIA+HORSE+JOSHUA+SHELL @ Peace River & Punta Gorda Water Plants
No withdrawals by the Peace River Plant from day 94 to 169
60
80
100
120
140
160
180
200
NUMBER OF DAYS

Perhaps the Panel may desire a discussion of this issue by SWFWMD and consultants while new additions or refined changes to the existing monitoring plan are contemplated.

Joan Browder, Ph.D. Comments

I read the comprehensive summary review with great interest, although my interest lagged as I encountered a lot of repetitive material and the report seemed endless. From the point of view of a reviewer, a better organization of the document would have been to have the recommendations and the summary at the beginning rather than at the end. That aside, my comments follow.

I like the approach of reporting salinity and other water quality parameters in terms of fixed stations and isohalines. The two approaches are complementary and yielded mutually supportive results. The daily, seasonal, and interannual salinity variability in the Lower Peace River is evident from the presentation.

The influence of nitrogen, phosphorous, and color on phytoplankton (chlorophyll a concentrations) was well described in text and figures. Ernst Peeble's publications (separate from this report) help to relate the spatial and temporal changes in chlorophyll a to the fauna by showing that bay anchovy followed the chlorophyll maximum.

The Facility has done a good job of examining the spatial and temporal variability of salinity in the river and has shown that the chief effects of the present pumping strategy on the salinity pattern has been on the part of the river near the plant, both upstream and downstream.

The pumping test indicated that the change in salinity near the facility amounted to no more than about 0.5 psu. I didn't note the rate of pumping, but I assume that a bigger salinity change could occur with a higher pumping rate. While a 0.5 psu change seems small, the change may be ecologically relevant in the limnetic area of the river in the vicinity of the plant, where salinity is ordinarily 0-0.5 psu. There may be organisms thriving at <0.5 psu that would decline with a 0.5 psu salinity rise. Pumping test results also indicated that the greatest salinity change was upstream from the facility. The flow of the Peace River apparently maintains a limnetic environment in the vicinity of the Facility and the diversion of river water by the plant may reduce this protection. Critical life stages or prey species important to estuarine faunal populations may require the 0-0.5 psu habitat of the river. Obviously maintenance of a 0-0.5 habitat in the vicinity of the plant intake area is vital to the plant as well. Monitoring of the part of the river near the Plant should be continued, and biological indicators should be added.

The Facility is only one of many activities that have changed the flow structure of the river. I agree with other panel members that it is essential to manage the Peace River flows and withdrawals as a whole and not the Plant withdrawals in isolation.

Hydrodynamic and statistical models are essential to water management. Nevertheless, I am somewhat suspicious of an MFL approach that develops thresholds rigorously based upon predictions of a hydrodynamic or statistical model. Models that predict salinity as a function of freshwater flow always seem to fall short of predicting the salinity extremes, under-estimating highs and over-estimating lows. Therefore, it is important to take this shortcoming of the models into account and add a margin for error when translating model predictions into management actions.

The Facility should retain the withdrawal approach that they have used effectively for many years, making any modifications based on its own history, monitoring, and experiments. Furthermore, the Facility should always include biological indicators as part of its monitoring program. Because living organisms integrate the entire suite of water quality conditions as they vary in time and space, the status of plants and animals characteristic of the area is the best indication of ecosystem health and effective water management.

Fred Holland, Ph.D. Comments

- **Caveats on Comments:** I skimmed the entire report including many figures and tables; however, I focused my detailed review on the Report Summary and Chapters 9 and 10 with an emphasis on ensuring that the information in other parts of the report supported the recommendations in these chapters. It simply was not possible to review the ~1,500 pages in detail. To the degree possible I verified the important comments made in the Report Summary but probably did not check them all. As all of you know, I also have limited local knowledge and direct experience with the Peace River ecosystem and Southwestern Florida coastal ecosystems. As a result my comments are mainly related to the:

    - Scientific approach and methods used including implications of inherent assumptions;

    - Evaluating the basis in ecological sciences for methods, findings and interpretations; and

    - Implications of findings and interpretations to ecological processes and cumulative environmental impact of freshwater withdrawals to the Peace River ecosystem.

    - **Overview and Relevance:** The Draft 2006 HBMP Comprehensive Summary Report contains a comprehensive summary of HBMP data for the Peace River Facility over the last 30+ years. It is a plethora of useful and interesting information. Because of its monographic length and attention to detail it will undoubtedly be a “key” source document for the Peace River ecosystem referenced to for years to come. Most importantly, the report provides a relatively complete summary of critical information for assessing Facility impacts on the physical, chemical, and biological aspects of the lower Peace River/upper Charlotte Harbor ecosystem. A major limitation of the report is that the report does not contain a concise summary of the degree to which Facility water permit has protected the lower Peace River/upper Charlotte Harbor ecosystem. The Report Summary is about 60 pages long. The HBMP Scientific Review Panel may want to consider recommending development of a brief summary (10 pages or less with figures) summarizing Facility effects (or the lack thereof). In its present form, this document will be difficult for non-technical audiences to read and understand. It is simply too long, redundant, and tedious. I particularly found it difficult to review figures and tables while reading the text.

- **Comments on Chapter 10 - Proposed Monitoring Design Modifications to the Existing Long-term HBMP Elements:**

  HBMP Monitoring Objectives: I agree with and support the multiple objectives that have evolved for the HBMP over the years. However, in the report summary and future reports, I think these multiple objectives should be condensed into one major objective that *cost effectively and specifically* addresses the requirements of the SFWMD water use permit and water use needs followed by multiple secondary objectives or goals that address the broader ecosystem scale questions. This would be easier for the non-technical readers to understand and assist everyone focusing on the "key" issues relevant to the water use permit and facility needs. In several places in this report I found what I felt was this kind of statement: e.g., "to provide *the District* with sufficient information to determine if water quality characteristics and biological communities of the lower Peace River/upper Charlotte Harbor estuarine system *have been, are being, or may be significantly impacted* by permitted facility withdrawals". In my mind the key works have been highlighted.

  Below I provide several examples of some of the many goals and objectives I found in the Report Summary and Chapter 1. This plethora of objectives was confusing to me. Keeping the list of objectives consistent and simple would make the program and report much more interpretable.

  - To determine whether the biological communities of the lower Peace River/upper Charlotte Harbor estuarine system have been, are being, or may be adversely impacted by permitted freshwater withdrawals by the Authority's water treatment facility (page RS-2 & 1-20).

  - To evaluate the consequences and significance of natural changes in salinity, water quality and biological characteristics inherently associated with seasonal changes in freshwater input as related to the health of the fauna and flora of the lower Peace River/upper Charlotte Harbor estuarine system (page 1-2).

  - To determine if freshwater withdrawals by the Peace River Facility can be shown to have measurable impacts or result in quantifiable alterations of the biological communities of the lower Peace River/upper Charlotte Harbor estuarine system (page 1-2)

  - Evaluate key relationships between ecological characteristics and freshwater inflows, and determine whether the biological health and productivity of the estuary are showing signs of stress related to natural periods of low freshwater inflow or potential negative influences of Facility withdrawals (page 1-20)

- Assess the presence or absence of long-term trends for important HBMP variables (page 1-20).

- Evaluate the overall HBMP design and make recommendations regarding implementing modifications (page 1-21).

- Assess the presence or absence of adverse ecological impacts and determine the influence Facility withdrawals may have contributed to such impacts (page 1-21).

- Evaluate the potential environmental impacts that may be associated with additional future increased withdrawals from the river and the feasibility of increased water supplies (page 1-21).

- Assess and evaluate the effectiveness of the withdrawal schedule for preventing adverse environmental impacts(page 1-21).

- To provide the District with sufficient analyses of the HBMP data to date to assure that the withdrawal schedule is providing adequate continuing resource protection (page 1-21).

HBMP Design Criteria: I support the design criteria identified on page RS-57 and 10-2 and the discussions associated with the design criteria that note the need for *short term studies to address specific questions* and *the flexibility required to incorporate modifications required to address changing environmental and regulatory conditions*. Over the long term I suggest that this be represented as a fourth design criteria such as: the design of the HBMP provide opportunities for short-term studies and modifications, both enhancements and deletions, to address specific issues that may arise during the permit review process or to streamline and focus monitoring and assessment activities. Flexibility and short term studies are every bit as important as good indicators, appropriate boundaries, and measurement of changes.

Indicators of Environmental Change: Figure 10.1 is a critical element for identification of key indicators of environmental change and should be the basis used to identify critical indicators. This figure is a major step forward in this process and should be presented early in the Report Summary in my opinion. Because this figure and the information is so important, it is critical that the direct and indirect linkages as well as elements of this figure be discussed/reviewed in detail. I feel that an important missing element of the conceptual diagram is the connection between flow (volume and rate) and current and historical land uses. At some point a table/matrix summarizing the indicators by category (critical, desirable, potential) that have been or are currently measured and the indicator criteria they represent or address (e.g., spatially responsive, unambiguously interpretable, etc.) probably should be developed. I am also concerned that food web linkages are shown as indirect linkages. This figure needs considerable discussion at the next meeting of the HBMP Scientific Review Panel.

Scientific Peer Review Recommendations: The summary of recommendations and suggestions made by the Scientific Peer Review Committee appear to be accurate and in general agreement with my notes. I continue to support the following recommendations: (1) focus on assessing changes and trends in key physical, chemical and biological indicators that are directly related to Facility water withdrawals; (2) discontinue monitoring elements that have not shown useful results (e.g., vegetation mapping); (3) addition pumps tests are not needed at this time; and (4) continuous salinity monitoring should be continued at especially near the Facility intake and slightly upstream.

Proposed HBMP Sampling Design Modifications/Additions: I support the following sampling design modifications:

- Additional continuous salinity monitoring. Proposed locations appear to be reasonable.
- Reduced reporting including dropping the three year mid-term reports. Currently the reporting schedule produces much redundant information. Future five year reports should include more synthesis and focus on recommendations for future activities and assessment of Facility impacts on key indicators and less repetitive with Annual Reports. I recommend that future summary reports focus on addressing long term ecosystem scale issues and impacts relative to the lower Peace River/upper Charlotte Harbor. I also would be in favor on more frequent topic specific short reports that could be reviewed and discussed by the HBMP Scientific Peer Review Panel over conference calls.
- Specific focus reports to address emerging issues of concern.
- Clearly identify the physical and biological indicators that are at risk to Facility future operations including mechanisms. This is where the conceptual model is fine tuned and a narrative describing the mechanisms and linkages is developed. Development of this narrative is a critical future element that still needs to be completed.
- Focus on the geographical regions of the river/estuary where the changes in critical indicators from water withdrawals would be expected to experience the greatest impact from future Facility operations.

I would like to discuss the following proposed elements with the Scientific Review Panel via a conference call or at our next meeting before they are implemented or supported:

- Chlorophyll a phytoplankton biomass measurement. I support modernization of phytoplankton monitoring to include synoptic *in situ* measurements but have concerns about the sampling design proposed for this new element. The proposed monthly synoptic chlorophyll monitoring may not provide any more useful information that *less frequent* measurements made 2-4 times per year during critical flow regimes (e.g., rising wet period hydrograph, peak hydrograph, declining wet period hydrograph, low flow hydrograph). Monthly measurements could miss these key dynamic periods and would probably be more expensive to collect. I am not sure what the value of multiple synoptic measurements of phytoplankton during the relative long dry period provides.

- **Report Summary:** While the summary of the Peace River Facility water use permit on pages RS-1 and RS-2 is useful it does not contain statements about the proportion of the regional demand that the Peace River Facility would be or is expected to meet over the short and long term. This is critical information because it is a basis for developing withdrawal limits etc.

  The last sentence of the first paragraph on page RS-1 probably should include a few caveats. This summary conclusion does not in my opinion accurately represent technical findings and discussions of the Scientific Peer Review Panel as I remember them. Comments relative to the Facility having no effect on predicted or measured changes in salinity distributions is just not quite right and is too strong. Salinity effects of 0.1-0.3 psu were measured using existing monitoring data. However, due to natural variation in salinity in the lower Peace River/upper Charlotte Harbor estuary and a lack of a conceptual or theoretical basis of the consequences of changes in salinity of this magnitude to ecosystem processes and services, the ecological consequences of such small but measurable changes are difficult to evaluate and nearly impossible to predict. The summary statement made by Michel et al. (1975) which was: "slight salinity increases, above the naturally occurring values of low flow periods, should add little additional stress to the plants and animals of the study area" are in my opinion still correct and more informative. In summary, changes in salinity have occurred because substantial amounts of freshwater are being withdrawn from the system, but the changes in salinity distributions do not appear to be of a magnitude that they can easily be measured using monitoring approaches given the size and dynamic nature of the lower Peace River/Upper Charlotte Harbor ecosystem. Because the consequences of freshwater withdrawals are exceedingly difficult to directly measure in the freshwater/saltwater transition zone of an esturary, the evaluation and predicting the impacts of the effects of withdrawals on salinity distributions is probably best evaluated using hydrographic models. Hydrographic modeling may also provide a reliable tool for assessing the magnitude of potential ecological impacts (e.g., such models could be used to estimate the volume of water/area of habitat that would be expected to have modified salinity distributions under proposed or existing withdrawal scenarios). Most importantly the models allow a range of withdrawal scenarios to be evaluated. Development and discussion of the potential consequences of various withdrawal scenarios may provide the most reliable tool for comparing and quantifying potential adverse harm resulting from long term withdrawal activities. However, the District and Facility management should be careful not to "throw the baby out with the bathwater" and to transition current and historical monitoring and assessment activities into a model based assessment approach. It is also critical the model be calibrated and validated and has be subjected to the Peer Review Process that includes modelers and ecologists.

- **Overview of Water Use Permits and HBMP Monitoring Program**: This chapter provides a through summary of the various withdrawal permits and associated monitoring activities and approaches. Table 1-3 provides a concise summary of major monitoring efforts. It would be a useful addition to the Report Summary. It tells the story better than the words provided.

- **Master Water Supply Plan & Amount of Water Available from the Peace River and other Sources**: This discussions of the Regional System Reliability Model and Master Water Supply Plans provided valuable information about future demand and potential sources. Hopefully, the water supply plan will be discussed at the next meeting of the HBMP Scientific Review Panel including order of magnitude cost estimates. In general, the demand projections appear to provide strong justification for the new Peace River Facility off-stream reservoir as well as the need to explore collaboration with other water supply entities. The discussion on pages 1-7 and 1-8 appear to suggest that from 2009-2012 when the new Peace River Facility's 6 billion gallon off-stream reservoir is completed the ability of the Authority to meet the projected water demand is less than the desired 95% during extreme low flow conditions. In addition, alternative sources other than the Peace River will need to be found after 2013. Some potential new sources are identified but it is not clearly stated what proportion of the demand the Peace River will be expected to meet. Most importantly, I could not find a clearly articulated statement whether there would or would not be adequate water available from the Peace River to meet its expected proportion of the long term demand. Such a statement would be useful because it would provide a point of departure for future discussions.

- **Chapter 2 - Summary of Recent Relevant Reports:** This chapter appears complete.

- **Chapter 3: Status and Trends in Regional Rainfall, Flows, and Facility Withdrawals.**

  This is an important Chapter that provides context for much of the rest of the report. Hopefully the many graphical summaries and analyses in this chapter will not have to be repeated before the next five year report. The Scientific Peer Review Committee probably needs to spend some time deciding which hydrologic analyses should be updated and included in future five year summary reports at our next meeting. This level of detail probably does not need to be repeated every five years.

  Hydrologic Alterations: Dispersed throughout Chapter 3 and to some degree the report are comments that suggest much of the long term variance in freshwater inflow and hydrology cycles are the result of changes in land use patterns including agriculture, urbanization, and mining. Relevant land use and other relevant information about the magnitude and proportion of these changes in freshwater inflow patterns, particularly groundwater and surface runoff that may be associated major sources are, however, not provided or easy to find in the report. The implication of these discussions is that changes in flow from agriculture and mining have offset changes in groundwater inflow. It also appears that the relative changes in different watersheds have resulted in changes in the relative proportion of each watershed to overall flow patterns as well as seasonal flow distributions.

The discussions of the effects on flow changes due in land use changes, particularly urbanization, appears to be undervalued especially the contribution changes in imperviousness, particularly road construction. These changes are known to have large changes on the volume and rate of stormwater runoff and freshwater inflows. Figure 4.2 suggests that the percent of urban land in the watershed has almost doubled since 1979 and is approaching a level (10%) where large and potentially adverse changes in the volume and rate of flow would be anticipated.

It is also evident that water withdrawals from Shell Creek are approaching a magnitude what when considered cumulatively with the Peace River Facility has the potential to alter salinity patterns in the braided critical nursery area of the lower Peace River. Coordination and collaboration between these two withdrawal sources in a critical topic that should be discussed by the Scientific Peer Review Panel in the future.

- **Climatic Alterations**: The discussions and analyses of the effects of long term changes in climate ((ENSO, AMO, rainfall patterns, hurricanes) are insightful and provide useful context for understanding long term trends in flow. I am, however, more concerned about the alterations to freshwater inflow associated with increases in groundwater pumping due to agriculture, increased volume and rate of flow from urban stormwater runoff, and the pollutants these sources of water may contain. The level of effort devoted to evaluation of climatic trends should be discussed by the Scientific Peer Review Panel and the potential focus of work in this area defined. Almost nothing in the report discusses concerns about the quality of the water and what is being done to ensure it meets drinking water criteria.

- **Trends in Freshwater Flow**: The value of these extensive analyses was not apparent. How will these extensive analyses assist in understanding if the conditions of the permit are protective of the lower Peace River/upper Charlotte Harbor ecosystem and related human uses? What do these analyses suggest about the sustainability of the Peace River as a source of human water supply?

- **Chapter 4: Status and Trends in Hydrological Water Quality Indicators in the Lower Peace River/Upper Charlotte Harbor Estuarine System**

  The discussions in this chapter relative to status and trends for water quality indicators are complex and interesting. The chapter, however ,lacks synthesis. The “so what” questions are simply not addressed. For example, P levels have declined mainly due to decreases in P mining; N levels have increased from a range of sources; water color has been shown to be related to flow; Chl a and other biological patterns have both decreased and increased depending upon location and time. Little synthesis of how this is related to Facility withdrawals or the overall health of the lower Peace River/upper Charlotte Harbor ecosystem is provided. These discussions should be related back to the conceptual model. In its current state this is just a lot of interesting data but it is not clear what it all means. I suggest a tabular summary of these data be developed by indicator and summary element and at the next meeting of the HBMP Scientific Peer Review Panel with the purpose of defining what all of these data mean and how they might best be synthesized in a manner useful to the District, Facility management, Panel, and the Public.

- **Chapter 5: Influences of Increasing Conductivity in the Lower Peace River Watershed**

  The information and graphical summaries provided in this Chapter provide convincing evidence that anthropogenic changes in land and water use have resulted in long term changes in the conductance of several major tributaries of the Peace River. The timing/trend of the increases in conductivity varied among watersheds (Peace above Arcadia, Joshua Creek watershed, Horse Creek near Arcadia). Convincing evidence was provided that suggest the increases are probably related to long term changes in water and land use, particularly the shift from pasture to more intensive agriculture. The current levels of specific conductance and TDS are below values that would affect Facility operations; however, if this trend continues conductance and TDS may become an issue in the future during extreme low flow periods. The continuous recorders which are scheduled for deployment in the vicinity and above the Facility should provide additional information about the severity of this issue. I recommend that the HBMP use the existing data to forecast or project when (at what decade in the future) conductance levels in the vicinity of the Facility intakes will adversely affect Facility water use processing.

- **Chapter 6: Salinity/Flow/Withdrawal Relationships at the Continuous Recorders:** The graphical summaries and analyses presented in Chapter demonstrate the value of semi-continuous measurements in quantifying natural variability and assessing the effects of Facility withdrawals on salinity distributions. Tables 6.3 and 6.4 are good summaries of year-to-year and spatial dynamics in salinity distributions. Statistical model fitting and development approaches were appropriate and sound. These summaries clearly demonstrate the value of the continuous measurements programs for charactering natural salinity dynamics and for forecasting potential impacts of Facility withdrawals. The information provided in this Chapter again support that Facility withdrawals have small (0.1-0.5 psu) but predictable effects on the salinity distributions. It seems unlikely that these changes are of a magnitude or spatial or temporal extent that would impact ecosystem processes or biological distributions.

- **Chapter 7: Evaluation of Existing Withdrawal Schedule and Assessment of the Effectiveness in Limiting Potential Impacts:** The information presented in this Chapter and throughout other parts of this report indicates that the permits and withdrawal schedules imposed on the Facility over the 20+ years of operations have effectively limited effects on salinity distribution of the lower Peace River/upper Charlotte Harbor ecosystem. Working with the Scientific Peer Review Panel the Facility has identified a number of alternative approaches for limiting future effects and at the same time meeting anticipated increases in the demand for freshwater by limiting withdrawals (e.g., based limits on the combined flows of upstream tributaries, use a sliding scale that allows the Facility to withdraw greater amounts under high flow periods). The District has, however, proposed to limit future withdrawals using a hydrodynamic model, *a priori* defined habitat strata, spatial metrics or indicators of habitat change, and seasonal considerations. Previously comments from the

Scientific Peer Review Panel were solicited and provided to the District for consideration. Until the responses of the District have responded to the previous comments I have nothing additional to add. I stand by my previous comments on the proposed minimum flows and levels (Attached).

- **Chapter 8 - Peace River Morphometric Analysis:** The data presented in this Chapter should have great future value for assessing the impacts of climatic, extreme events and water use changes on river bathymetry and vegetation distributions.

- **Chapter 9 - Significant Environmental Change**: The information in this Chapter provide regulatory guidance (strategies, approaches, management responses, and definitions) for evaluating changes and water use impacts for the lower Peace River/upper Charlotte Harbor ecosystem. This information is very useful for design and development of future HBMP activities and I generally agree with and support the information in this Chapter.

Specific Comments: Provided by page and line number. I did not have time to do this for the entire report.

Page No.	**Para. No.**	**Comment**
RS-4	2	This paragraph seems to just be hanging out there and is not linked to the rest of the discussion. Its purpose is not clear.
RS-12	4	This bullet implies that there has been an increase in yearly variation in recent times. The figure suggests to me that the increased variance in among year variability began in the late 1940s and has stayed relatively constant through the current period.a
RS-16	Fig 3.370	Legend on this figure is impossible to read.
1-1	4	The words “these initial models” in final sentence of this paragraph is not clear. What models? What does the words “these” refer to? The models are apparently discussed in the following paragraph.
1-1	5	The initial conclusion reached my Michel et al. 1975 are in my opinion a “better and more accurate” summary statement that the one provided in the opening statement of this report.
1-4	1	The last sentence of this paragraph which is similar to the last sentence in the opening paragraph of the report is not quite true. Some systematic changes in salinity have been measured and predicted but the available state of knowledge do not suggest they result in anything but small harm to the fauna and flora and

		little addition risk to the long term health of the lower Peace River/upper Charlotte Harbor estuarine system.
1-6	2	Figure 1.4 and the contents of this paragraph do not provide a clear discussion of future demand for freshwater that the Peace River Facility will be expected to address. A figure and discussion that are easier to understand should be provided. I doubt the Public could understand what this paragraph and figure.
1-8	Tab 1-3	This is a very concise summary of monitoring efforts.
3-2	Figure 3-1	If the 9 drainage areas were slightly different shades of brown they would much easier to see.
10-4	Fig 10-1	The legend for water column and benthic components appears to be reversed (i.e., water column components are shade blue not white. In addition I feel the direct and indirect linkages (e.g., between fish eating birds and mammals as well as benthic invertebrates and phytoplankton and carnivorous fish) are not correct. All linkages and the conceptual diagram need to be discussed and reviewed in detail with the peer review panel. This should be a lengthy discussion because this is a key figure.
10-4	Fig 10-1	The conceptual diagram needs to show the linkages between volume and rate and land use/anthropogenic activities. It also does not show any linkages with emergent vegetation. Is this because there never was one and the historical monitoring of this was unnecessary or because the facility related changes in hydrology/flow are not of a magnitude that are likely to causes changes. If this diagram had been developed at the start of the study maybe vegetation never would have made the indicator list.

Additional Comments on the Proposed Minimum Flows and Levels for the Lower Peach River and Shell Creek Draft Report and the Associated Scientific Review Panel Meeting held on December 4-5, 2007

The Southwest Florida Water Management District has been legislatively mandated to establish minimum flows and levels (MFL) for the steams and rivers (including estuaries) within its boundaries. Minimum flows are currently defined by appropriate statute as "the minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area". The proposed minimum flows and levels for the lower segment of the Peace River (from the Arcadia gauge, including Joshua Creek, Horse Creek and Shell Creek to Charlotte Harbor) were discussed in the draft report entitled "Proposed Minimum Flows and Levels for the Lower Peach River and Shell Creek". A meeting of the Scientific Review Panel, an advisory group established by the Peace River/Manasota Regional Water Supply Authority as a requirement of their permit, was held on December 4-5, 2007, to review and discuss this report and related studies (including a study conducted from December 2006-May 2007 to evaluate the impact of Authority withdrawals on short term changes in water quality given a natural estuarine background of tides and weather. The meeting was held in Bradenton, FL.

Because I have limited local knowledge and direct experience with the Peace River ecosystem and Southwestern Florida coastal ecosystems my comments are mainly related to the:

- Scientific approach and methods used for the above cited studies including implications of inherent assumptions;

- Evaluating the basis in ecological sciences for methods, findings and interpretations relative to the above studies; and

- Implications of findings and interpretations of study results to ecological processes and cumulative environmental impact of freshwater withdrawals to the Peace River ecosystem.

The percent-of-flow approach was used to ensure the natural flow regime of the river was maintained in a manner with protected ecosystem integrity with limited reduction, mainly damping, in the freshwater inflow into the downstream estuary and adjacent coastal ocean. This is a scientifically based approach which is designed to minimize stress and disturbance to natural flows and associated biota. The withdrawn water was used as a potable water supply. Establishment of the appropriate percent-of-flow withdrawal rates was based upon an understanding of climatic and anthropogenic influences on historic and current flow regimes and conditions required to maintain the ecological integrity of the source waterbody, including:

- Identification of a low flow threshold below which no withdrawals are allowed,

- Defining biologically relevant habitat strata (e.g., salinity zones) to ensure ecosystem integrity and associated processes are protected,

- Identification of ecologically appropriate metrics that quantify changes in habitat strata,

- Definition of within year (seasonal) assessment periods (i.e., seasonal "blocks") for which it was critical to maintain the " specific flows" to sustain water resources and critical ecological processes, and

- Description and application of analytical methods for quantifying habitat change including establishing: (1) study area boundaries, (2) the baseline period for minimum flow determination, (3) analysis/modeling period, and (4) appropriate and reasonable scenarios for minimum flow determination.

It was not possible to define a low flow threshold for the lower Peace River and Shell Creek using ecological criteria and the available data. The operational low flow threshold established for the lower Peace River was ultimately designated as the flow required to maintain freshwater (salinities <0.5 ppt) at the Peace River/Manasota Regional Water Supply Authority intake. The operational low flow threshold for Shell Creek was that required to maintain a 2 ppt salinity habitat strata with in the study boundaries for Shell Creek. The 2 ppt criteria for Shell Creek was assumed to be a habitat criteria appropriate for sustaining the integrity of valued ecological resources, including fish and shellfish populations in this ecosystem. I recommend that the 2 ppt criterion for Shell Creek be expanded to include some minimum amount of this habitat.
The 2 ppt threshold has scientific basis in ecological science but without a specific criterion to define the amount of this critical habitat required to sustain valued ecological functions and services the value of this threshold is unclear.

The minimum flow criterion of a 15% reduction in critical habitat from baseline conditions was established as the level resulting in significant ecosystem harm. This determination was based on analyses and studies for the upper freshwater, free flowing Peace River (Gore et al. 2002). This is particularly problematic since the amount of critical habitat loss that may cause significant ecological harm in a tidal estuary is not tightly linked to changes in water level which seems to be the major basis for the 15% threshold in Gore et al. 2002. Unfortunately, no scientific justification was provided for applying the 15% habitat loss criterion to the tidal reaches of the lower Peace River and Shell Creek, and I am not aware of any studies that suggest a 15% loss in any habitat (abundant or rare) does not result in ecological harm. I am also not aware of any evidence that suggests that estuarine populations, communities, and ecosystems have adaptive processes that allow them to compensate for habitat losses in this range. A final concern with establishment of the 15% threshold value for critical habitat is that because it has no scientific basis it must include a safety factor. Even in well understood engineering systems and processes that have far less social, economic and ecological consequences than freshwater withdrawals society requires safety factors (e.g., bridge and road construction). No evidence was presented that a safety factor was incorporated into this study (e.g., uncertainty estimates were not provided). I recommend a range of threshold values be evaluated (e.g., 5%, 10%, 15% and 20%). The lower values may be more appropriate for rare habitats and include an undefined safety factor and the higher values may be more appropriate for abundant, widespread habitats and high flow periods where a safety factor may not have a great a value.

The scientific justification for the three salinity strata/habitats that are defined in the report could be expanded. It would be especially beneficial if they were specifically related to critical functions of representative important biota or ecological functions (e.g., fishery nursery and feeding/spawning grounds, productive shellfish grounds, critical mangrove habitat) in the Peace River ecosystem. In addition, it is important that the salinity thresholds established for these salinity-based habitats have both upper and lower threshold values. Establishment of upper and lower boundaries for the salinity strata has important implications in the development of estimates of the spatial extent and temporal persistence of these habitats discussed below.

Three habitat assessment metrics were defined: (1) volume of water less than a critical salinity threshold (representing the amount fish nursery habitat); (2) the bottom area less than a critical salinity threshold (representing the amount of productive feeding areas); and (3) the shoreline length less than a given salinity (representing the amount of shallow vegetated refuge habitat). It is important to note that the percent of rare habitats that provide unique ecosystem services (e.g., nursery habitat) that can be loss without ensuing impairment to ecosystem process may be much less than that the amount of abundant habitats which can be impaired without loss of critical ecosystem functions. The message here is rare habitats that may need to be evaluated using different "rules" than abundant habitats (similar to the way society has chosen to treat rare and endangered species). The value of rare habitats that have unique roles to ecosystem process far exceeds their abundance. For example, for low salinity nursery habitat (2-5 ppt), which appears to be rare in the lower Peace River, it may be desirable to maintain 50% or more of the historical amount of this habitat.

Seasonally specific assessment periods were identified by mimicking historical hydrologic cycles as closely as possible. The selected blocks correspond to periods of high (June 26-Oct 26), moderate (April 20-June 25), and low (Oct 27-April 19) flows ensuring the natural water budget of the region is mimicked in all seasons. Maintaining the natural flow regime, although somewhat damped, should sustain the ecological conditions to which the indigenous fauna and flora and ecological processes are adapted. Division of the year into flow periods is an excellent approach for ensuring natural flow cycles and the associated ecological processes are sustained for future generations of humans and organisms, while at the same time meeting some of societies potable water needs.

A regression model was used to estimate the daily salinity at any point within Shell Creek as a function of flow and other confounding variables. This model accounted for ~82% of the measured variation in salinity distributions. The boundary of the Shell Creek study area extended from the dam in the headwaters near the junction of the Peace River following the channel. Braided portions of lower Shell Creek were not included in the model. The baseline and model period for Shell Creek was from 1966-2004. Model scenarios evaluated ranged from 1-100% flow reductions at 1% increments. Cumulative frequency distribution (CDF) plots were used to evaluate the spatial extent (volume) and temporal persistence (% of days) of the biologically relevant salinity strata < 2ppt for Shell Creek.

Estimates of the maximum percent flow reduction for Shell Creek required to protect 85% of the critical habitat (only volume <2ppt) calculated using the normalized area under the curve for each modeled scenario relative to the baseline scenario by seasonal block (1,2, & 3) for low and high flow conditions are shown in Table 1. The shaded estimates represent withdrawals that are sufficiently large that they would seem to have a high probability of resulting in significant and undefined ecosystem changes. No information was present for determining if these changes would be harmful. Withdrawals at these levels approach being considered diversions in my opinion and would likely result in substantial reductions in basic system process such as primary productivity. The 85% number is of particular concern. I also have concerns about the loss of

35% of important low salinity habitat in the June to October period. If this equates to loss of 35% of the fishery production for this habitat it is simply too large without some evidence that the spawning and nursery habitat can compensate for this loss.

Table1: Estimates of allowable reductions for Shell Creek projected to result in protection of 85% of the amount of critical habitat (defined as the volume less than 2 ppt) by seasonal block for high and low flow conditions.

Block	Median Flow (cfs)	Allowable Percent Reduction in Flow	
		Low Flow Condition	High Flow Condition
Block 1 (April 20-June 25)	84	10%	23%
Block 2 (October 27-April 19)	98	18%	42%
Block 3 (June 26-October 26)	424	35%	85%

A hydrodynamic model was used to estimate the response of the lower Peace River to variation in freshwater flows and various withdrawal scenarios. The baseline model period for the lower Peace River was 1996-1999. The scenarios evaluated for the lower Peace River included the baseline period, and 10%, 20%, 24%, 28% and 30% reductions. Cumulative frequency distribution (CDF) plots were used to evaluate the spatial extent (area, volume, length) and temporal persistence (% of days) of the biologically relevant salinity strata <2 ppt, < 5 ppt, > 15 ppt and from 8-16 ppt in the lower Peace River.

Estimates of the maximum percent flow reduction for the lower Peace River required to protect 85% of the critical habitat (volume <2ppt) calculated using the normalized area under the curve for each modeled scenario relative to the baseline scenario by seasonal block (1,2, & 3) for low and high flow conditions are summarized in Table 2. These area appear to be in ranges not likely to result in substantial ecosystem changes independent of losses of the amount of critical habitat (e.g., changes in primary productivity or fish assemblage distributions. When entrainment losses from entrainment and impingement of power plants exceed 20% of the young of the year or spawning stock of a representative important fish population, regulators frequently take action to reduce losses.

Table 2: Estimates of maximum allowable flow reductions in the lower Peace River projected to result in protection of 85% of the amount of critical habitat (defined as either area, volume, and/or shoreline length less than 2ppt, 5ppt, or 15 ppt) by seasonal block for high and low flow conditions.

Block	Median Flow (cfs)	Allowable Percent Reduction in Flow	
		Low Flow Condition	High Flow Condition
Block 1 (April 20-June 25)	221	10%	26%
Block 2 (October 27-April 19)	330	14%	21%
Block 3 (June 26-October 26)	1370	12%	15%

The major concerns identified with the process used to estimate allowable flow reductions are:

- No estimates of uncertainty were associated with the calculations and results of allowable withdrawals or the habitat loss estimates. It is thus unclear what level of safety has been incorporated into the calculations.

- Estimates of the allowable withdrawals were not conducted independently for the critical habitat between 2-5ppt for the Lower Peace River. This "rare" and ecologically important habitat should be evaluated independently of other habitats. A 15% loss in this habitat may be too much to allow.

- The process used to estimate allowable withdrawal rates did not evaluate the impacts on critical habitats and ecosystem integrity in Charlotte Harbor. Under some conditions this may impact the amount of critical high salinity habitats.

Other concerns identified with the report include:

- The conceptual linkage between allowable withdrawals and MFL to water quality and ecosystem condition is not clear. Therefore it is not clear what parameters would be monitored in the future to demonstrate that significant ecological harm has not occurred? In short, how would the District or the Authority ever prove that they were not causing harm in an adjudicated proceeding in the future? Because most of the projected ecological and physical/chemical impacts of future withdrawals are based on salinity impacts, estimates of the projected impacts of various withdrawal scenarios on salinity distributions at specific places (transitional areas) and representative important biota that require specific salinities to sustain their populations would be one monitoring approach that should be evaluated. The monitoring and assessment effort that is implemented definitely needs to include some ecological/biological indicators (higher organisms). Ecological indicators will assess the impacts of interacting and additive impacts of multiple stressors (e.g., increased withdrawals plus drought plus extreme events such as a chemical spill).

- The long-term historical monitoring program and data base compiled for the lower Peace River is a legacy of the Peace River/Manasota Regional Water Supply Authority and the District. This monitoring program and data base is essential for demonstrating that significant harm to the lower Peace River ecosystem have not resulted from previous and future withdrawal regimes. Failure to make conceptual linkages between future and historical monitoring efforts would be a travesty.

- It is critical that the corporate memory of the scientific staff that have a long history of scientific studies in the Peace River ecosystem and the associated data base they have compiled be maintained. It is critical that this knowledge be transferred to future generations. This transfer has not occurred to date.

- The Peace River is a braided estuary, which is somewhat unique to Florida and the Southeast. The hydrodynamic modeling process used to estimate the influence of freshwater inflows on the braided portions of this unique ecosystem needs to be carefully evaluated. These braided sections have great value as habitat and for storage of water. It was not clear if these values were accounted for fully in the current hydrodynamic model.

- The inclusion of the Horse and Joshua creeks flows into the process used to estimate allowable withdrawal rates was confusing. This had not been discussed previously by the Scientific Panel and appears to require additional justification and explanation. This inclusion may be perfectly reasonable it just was not explained in a manner that I understood.

- In a similar manner inclusion of "worse case" and unrealistic 83% allowable withdrawal rates for Shell Creek into the analysis for the lower Peace River was difficult to understand and seem unreasonable. How can 83% of a habitat be loss without a proportional decline in productivity of biota associated with that habitat being impaired? It seems doubtful that an 83% withdrawal will ever be allowed for Shell Creek or anyplace else given the current state of knowledge. Thus, the current assessment for the lower Peace River does not reflect reality.

- I have no comments on the "pump test" that were not made orally during the meeting. These include:

    - Estimation of changes is salinity distributions at specific places with the pumps on and off,
    - Deployment of instruments and testing above the intake system to assess effects of pumps on upper reaches.

Gary Powell, Ph.D. Comments

By way of beginning this review, let me say that I recently received notice of Dr. Bill Dunson's resignation from the Scientific Review Panel. While we did not always agree on all things physical, chemical or biological, he was instrumental in calling the Panel's attention to near-field environmental impacts that might be missed by focusing too far downstream in the Charlotte Harbor estuarine system. In addition, I would like to thank Panel Member Dr. Tom Frazer for the graphical analyses of declining streamflows and fractional withdrawals from the Peace River and Shell Creek. This work indicates that it may not be possible to ignore the effects of Shell Creek diversions in future monitoring and analyses of the lower Peace River and upper Charlotte Harbor.

General Comments--The overall goal of the HBMP is to monitor physical, chemical and biological conditions in the lower Peace River and upper Charlotte Harbor estuarine ecosystem for the purpose of evaluating any negative ecological impacts from the Water Supply Facility's operations, both permitted maximum and actual raw water diversions.

The Draft 2006 HBMP Report (1425 pp.) contains a much-appreciated comprehensive summary of HBMP data from 2006 back to the beginning three decades ago. An incremental report from the previous report (2004 HBMP report) would not have been nearly as informative or as easy to understand. Originally requested by the Scientific Review Panel, the Draft 2006 HBMP Report includes a historic summary of the Peace River Facility's water use permits (Table 1.1). This is an example of where the Authority and its contractors have done a good job of responding to the Panel's comments and recommendations.

My understanding of the present situation is that the March 1996 permit allows the Facility to divert 10% of the flow of the lower Peace River, up to a maximum 90 mgd (139 cfs), as long as streamsflows upstream at Arcadia are above the 130 cfs cutoff. However, as a practical matter, the Facility's current pump diversion capacity is only about 44 mgd (68 cfs) and its water treatment capacity is an even lower 24 mgd (37 cfs). Moreover, when streamflows drop below about 100 cfs, salinity intrusion during such low-flow (drought) periods rapidly makes the lower river too salty for use as a potable water supply.

In an effort to keep up with growing regional water demands, The Authority is currently completing a Facility expansion that includes increasing its pump capacity to 90 mgd (139 cfs), doubling its water treatment capacity to 48 mgd (74 cfs), and constructing a 6 billion gallon surface water reservoir to provide an operational buffer against days when streamflows are too low to allow diversion of raw river waters. By continuously conducting the HBMP to watch for any negative environmental impacts, as well as planning and developing additional water supply capacity as needed, the Authority is acting as a responsible regional water supply authority.

The fact that average annual gauged streamflows above the Facility are about 796 mgd (1233 cfs) would suggest that primary detectible impacts are going to be limited to near-field changes in salinity and perhaps some lower food chain responses under all but the most dire drought conditions. Indeed the previous (2004) HBMP Report estimated that salinity changes would be on the order of 0.1–0.5 psu, which would make them virtually undetectable against a background of high natural variability of freshwater inflows, Gulf tidal flows and salinities in the lower river and upper Charlotte Harbor. This is why the Panel recommended (December 2007) deployment of continuous-recording water quality meters in the vicinity of the Facility, both upstream and downstream. This provides another example where the Authority and its contractors exhibited a timely response to the Panel's recommendations by installing three additional recorders on May 14, 2008.

Specific Comments--The Panel's original concerns about deleterious effects on the availability and utilization of prime estuarine nursery habitats, which are located downstream of the Facility, mostly in the braided portion of the lower river, does not appear to be an issue of major concern at his point in the HBMP. However, the problem is confounded by other water withdrawals, such as those taken from a major tributary of the lower Peace River, namely Shell Creek, by the Punta Gorda Water Treatment Plant. Even relatively small streamflow withdrawals can add up to something significant when more than one are involved in the same watershed. It seems logical for the Panel to recommend that monitoring programs in the river and its tributaries be fully coordinated to ensure that the data are complementary and comparable for future analyses.

As planned expansions occur, the actual quantities of water diverted from the lower river by the Facility will begin to approach the theoretical maximums in the Facility's water use permit, as amended. Further, the numbers will certainly begin to tighten in future dry periods when water demands may require most or all of the permitted maximums withdrawals. This sets up a worst case scenario where the greatest water need comes at a time of least water availability in the tidal river portion of the estuary. The Authority's recent experience over the last year or so with "drought" and emergency Executive Orders (SWFWMD August 13, 2007, as amended) should help determine the floor of manageable river withdrawal schemes. Further, as long as the allowable river diversions are going to be based in part on streamflow gauging at Arcadia, the Authority may find that the "provisional" data from this simple water level stage recorder, which itself may have error in the ±10% range, is not good or timely enough. The best existing technology for accurately measuring flow in a confined channel is the Acoustic Doppler Current Profiler or instrument variations including Acoustic Doppler Velocimeters, which can be deployed to log and send data back to the Facility at almost any time interval (e.g., every 15 minutes) using remote data transmission protocols. This would provide near real-time data to managers and operators at the Facility.

A series of statistical models developed since the 1980s have established that Facility impacts on riverine salinities are generally less than 0.5 psu. As a result, most of the early HBMP studies could not identify ecologically significant physical, chemical or biological responses from Facility operations because the natural variations of freshwater inflows are orders of magnitude greater. A welcomed improvement involves the District's plans to apply its hydrodynamic (circulation) and conservative mass (salinity) transport model to the estuarine system, running Peace River withdrawals first and Shell Creek withdrawals second, to get a more comprehensive picture of water diversion impacts. This should include runs under historic, existing and potential future conditions in order to see where we have come from, where we are, and where we are going. In my opinion, one of the most important objectives added to the HBMP's status and trends analyses has been the effort to evaluate impacts from planned future Facility expansions, as these are both realistic and large enough to show actual impacts on local river conditions.

While the analyses of natural variations in rainfall runoff and resulting streamflows from the global climatic influences of El Nino Southern Oscillations, Atlantic Multidecadal Oscillations and the cycles of tropical storms and hurricanes are quite interesting scientifically, the loss of groundwater seeps and springs from excessive pumping of the Upper Floridan Aquifer are more troubling because of the intimate connections between ground and surface water systems that were destroyed as the potentiometric surface of the aquifer dropped tens of feet below the river bed after the 1960s. This is why moving water users off the aquifer, where practical, and onto surface water supplies that are not so occult is seen as a beneficial development. While groundwater withdrawals have reduced flows in the upper Peace River, the subsequent wastewater discharges from groundwater sources by agricultural and mining operations have augmented streamflows in the lower river basin, especially in the tributaries where seasonally intermittent flows have given way to continuous flows throughout the year.

Peace River water quality seems to be most affected by the previously mentioned mining of Miocene deposits rich in phosphates, the wastewater discharges of highly mineralized groundwaters (mostly from agricultural operations), and the nonpoint nutrient (nitrogen) loadings from agricultural and urbanized areas. Fortunately, the frequent instances of low (hypoxic) dissolved oxygen (DO) concentrations in the upper river are largely absent in the lower river at present, primarily because of physical dilution and the implementation of better regulatory measures. Nevertheless, the magnitude of water quality changes was still greatest in Joshua, Shell and Horse creeks, which are all important tributaries of the lower Peace River that contribute to the health and productivity of estuarine nursery habitats.

During low flow periods, primary (plant, mostly phytoplankton) production in the water column of the lower Peace River and upper Charlotte Harbor seems to be limited by available nitrogen, as opposed to phosphate or even the silica that is needed by diatoms and foraminifera. However, as flows increase, phytoplankton is clearly limited by reduced light penetration as the humic coloration of the water darkens. Of course, high river flows can also "washout" plankton into Charlotte Harbor.

On the other hand, high flows during the summer wet season can induce low DO (< 2 mg/L) conditions as greater vertical stratification of salinity reduces water column mixing. This creates potential violations of Florida's state water quality standards, which contain DO criteria that call for an instantaneous minimum of 4 ppm and a daily average of not less than 5 ppm (4 and 5 mg/L DO concentration, respectively). This standard may be practical and scientifically appropriate for inland freshwaters, but it is problematic in warm shallow estuaries with high biological productivity. For example, with 100% saturation of 25ºC (77ºF) freshwater (0 psu) at sea level atmospheric pressure (760 mm), the DO concentration is 8.4 mg/L, declining to 6.2 mg/L when both salinity and temperatures are high (35 psu at 30ºC or 86ºF), and this is for sterile water with no biological or chemical oxygen demand. If the coastal waters are alive with biota and contain any pollutant runoff, then there is no way to consistently maintain DO concentrations above 4 mg/L at night when plants switch from O2 production (i.e., sunlight-driven photosynthesis) to O2 consumption (i.e., plant respiration).

Most fishes and macro-invertebrates that are adapted to live in shallow tropical or sub-tropical coastal estuaries are also adapted to tolerate the low (~2 mg/L) DO concentrations that frequently occur in these warm waters at night. However, they generally require DO saturation to be above 30% for continued survival, which at 30ºC is equivalent to ~2.5 mg/L DO. Waters below 30% saturation are referred to as "hypoxic," a condition that induces great physiological stress and mortality in most aquatic animals. When hypoxia occurs, most free-swimming organisms will stop using the area's habitats.

Another troubling observation involves increases in chlorophyll-a concentrations from phytoplankton "blooms" since 2004 at levels not seen in these waters over the past couple of decades. The Authority's consultant suggests that "other water quality constituents not monitored by the HBMP, but having the same source as the observed phosphorus increases, are responsible." However, it is more likely that frequent streamflows that are high enough to increase loadings of the limiting nutrient, nitrogen, but low enough to avoid serious light limitation from water coloration, are responsible for the observed phytoplankton blooms. The ability of phytoplankton to exhibit "luxury" uptake of nitrogen above their immediate need for growth and reproduction also plays a role in this matter.

Statistically significant increases of Chlorophyll-a are reported over the 1984-2006 interval, especially in the two higher salinity zones, while the highest concentrations were reported in the two intermediate zones. This would indicate that the phytoplankton are responding to increased nutrient loadings with growth peaks ("blooms") which are then being washed downstream and sustained by their aforementioned capacity for "luxury" uptake of nutrients.

Conductivity (read: salinity) at Arcadia has also increased over time, especially from about the 1960s through the 1980s. This time interval coincides with large mining discharges of highly mineralized groundwaters. Since the declines in groundwater springs and seeps have been more or less offset by agricultural discharges of groundwaters since then, there is a potential for future trouble if these agricultural discharges are substantially reduced without restoring base flows from the upper basin. The main problem is the resulting shift of Gulf salinity intrusion upstream in the lower river, which will certainly increase the number of days when the Facility can not make withdrawals because the river waters are too salty. This impact on Facility operations can be somewhat ameliorated by "blending" water from the river intake with freshwater water previously stored in the Authority's above and below ground reservoirs, to produce potable water with acceptable drinking water quality.

During low-flow (drought) periods, the Facility's expanded capacities in the future have the potential to increase the salinity intrusion even more. This is why the Panel recommend the initiation of "pump tests" both before and after any such expansions. The first such test was completed a couple years ago before Facility expansions were begun. Subsequently, it was determined that the Facility's pumps had no noticeable effect on the local river reach other than a very slight increase in salinity during the incoming (flood) portion of the tidal cycle. No effects were observed during the ebb tide. As a result, the Authority's contractor concludes that the Facility's operations have not caused any "pronounced, sustained or systematic" changes in salinity or habitat structure. This conclusion would be more comforting if it is confirmed by post-expansion pump tests and high-resolution modeling of the near field impacts in future HBMP efforts.

Conceptual models are not just short-hand illustrations for communicating with the public. They are actually quite important in understanding the major linkages among the physical, chemical and biological elements of the particular ecosystem being studied. Any errors in the conceptual models can be magnified in the subsequent analysis and interpretation of data. This is why I carefully inspected the conceptual models presented in Chapter 9 of the 2006 HBMP report, including the conceptual impact of river withdrawals, salinity target ranges, the decision tree for evaluating changes, and the overall estuarine ecosystem model. While these are not as detailed as some I have either reviewed or prepared myself, I have determined that they are adequately accurate without becoming a "spaghetti bowl" of crossing and intersecting lines that somewhat defeats their purpose.

Sometimes, the legal meaning of important terms is not consistent with scientific concepts. They may even limit the opportunity for appropriate management responses. Such was the case here when the District's rules referred to identifying "adverse impacts," which the Panel felt was a little late in the process of trying to avoid deleterious effects on ecological health and productivity of the river and estuary. As a result, the District changed the standard to "significant environmental change," a lower threshold for timely remedial actions and adaptive management. This proactive approach is again another instance where the Authority and the District have responded appropriately to the Panels recommendations.

In addition, I agree completely with the integrated design elements of the revised HBMP, particularly the continued effort to select better and more appropriate ecosystem indicators, to focus on identified reaches of the lower river where impacts are most likely to be observed, and to sample them with enough intensity to assure detection of any changes. Further, the HBMP must continue to provide the monitoring data needed to calibrate and exercise higher level analyses, such as the high-resolution modeling of circulation and salinity patters under historic, existing, and potential future conditions in the lower river. The addition of more continuous recorders, as recommended by the Panel, is an important improvement to the monitoring scheme that greatly increases the ability to utilize numerical models for evaluating future management scenarios.

Monthly monitoring of chlorophyll-a is currently included at both fixed and moveable sampling stations in the lower river. However, the Panel has previously commented on the availability of new methods for this monitoring, such as in-situ fluorometry. The only technical drawback involves correcting for water coloration, but this is a tractable problem that should not limit the use of this method to produce more timely data on the river. Indeed, since the technique is less expensive and faster than older methods, it should also be possible to collect additional data during times of interest in between the regular monthly sampling. This capability for event-based sampling has the potential of greatly improving our understanding of the ecosystem's primary production by phytoplankton.

Reporting of the Authority's HBMP data to the District has included annual data reports, three-year midterm reports, and the more comprehensive five year interpretive reports. Since a lot of data and understanding of the lower river's ecology has been gained over the last three decades of HBMP work, this reporting schedule now seems somewhat overblown. At this point, I would consider submitting annual or bi-annual data reports with the more comprehensive analytical reports occurring every five years. I was pleased to notice that that the Authority's contractor has recommended keeping the annual data reports and the five year comprehensive summary reports, while dropping the midterm reports. I agree with this recommendation as long as the Authority reserves the right to also produce specialty reports, such as the "pump test" report, as needed or requested by the Panel.