ANNEX 1-C

PROPOSED OPERATING FLOWS AND LEVELS AND INUNDATION MAPPING
WANATANGO FALLS HYDRO PROJECT

Report

PROPOSED
OPERATING FLOWS AND LEVELS
Wanatango Falls Hydro Project

A Report to: Xeneca Power Development Inc.
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ACKNOWLEDGEMENT AND AUTHENTICATION

The Conceptual Operation Plan chapter of the Environmental Assessment (EA) document was prepared under the direction of Xeneca Power Development Inc (Xeneca Power). Xeneca Power acknowledges the assistance and input from ORTECH Consulting Inc. (ORTECH) and R.J. Burnside & Associates Limited.

The Conceptual Operation Plan document was prepared under the direction of Xeneca Power.

The main participants responsible for completing the Conceptual Operation Plan chapter of the EA document were:

NAME	POSITION	RESPONSIBILITIES
Xeneca Power Development Inc.		
Nava Pokharel	Senior Project Manager	Project Management and Coordination
ORTECH Consulting Inc.		
Uwe Roeper	Principal	Overall development and preparation of the Operation Plan including the plant operating parameters; Figure 1
Scott Manser	Senior Project Manager	
R.J. Burnside & Associates Limited		
Dan Miller, P.Eng. Tim Lozon	Project Manager, Senior Water Resources Engineer Water Resources Engineer	Preparation of HEC RAS related modelling, figures and tables.

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1 OPERATIONS PLAN

This section describes how the facility will be operated on an on-going basis. Discussed are the mode of operation, the potential effects on the river, the seasonal considerations and the proposed operating rules and target limits.

The Operations Plan proposed herein was based on various background studies listed below and further referenced in the bibliography of the environmental assessment document:

1. Lidar Survey: detailed topographic mapping of the upstream and downstream river reach.
2. Conceptual Design: drawings of the structures as conceptually proposed for the project.
3. Hydrology Study: an analysis of the natural river flows.
4. Bathymetric Study: a field study of water depths upstream and downstream of the project location and a spot measurement of flows required for hydraulic model calibration.
5. Hydraulic Study: a detailed hydraulic engineering analysis was carried out under separate cover (i.e. a 1-dimentional HEC-RAS model) to better understand the various hydraulic parameters relevant to assess operational and environmental matters.
6. Erosion Survey: a desktop survey of upstream locations that could be sensitive to future shoreline erosion after the project is built.
7. Environmental Field Studies: studies of environmental areas and aspects of interest as documented in other parts of this environmental assessment.

It is noted the operations plan presented herein is based on the conceptual engineering design information and environmental information as it was available at the time of writing. The final engineering design or other information that becomes available over time may require minor adjustments to this plan to ensure that the objectives of mitigation and limiting impacts as contemplated herein are met.

1.1 Mode of Operation

The electricity generated from this project has been contracted to the Ontario Power Authority under a FIT Contract. The terms and conditions of the FIT Contract encourage the facility to generate electricity when needed most in Ontario, between the hours of 11:00 a.m. and 7:00 p.m. on business days. The mode of operation takes into account the objective of building and operating the project in an environmentally sensible manner, while trying to achieve the socio-economic objective of generating power when it is needed in the Province.

It is proposed to operate the facility as a “modified run-of-river” generating facility. During certain times, a facility would operate at the same rate as the natural flow in the river (i.e. “run-of-river”) with no variation in upstream water levels due to operation and no man-made variation in downstream flows from those experienced naturally. At other times, a facility would “modify” the natural flow in the river by storing some of the natural river flow during night time and/or weekend hours to be used during daytime hours (i.e. on business days from 11:00 a.m. to 7:00 p.m.) when the need for electricity in the Province is greater.

Run-of-river operation would occur during two (2) types of natural flow conditions:

1. When natural river flows are greater than the maximum turbine capacity (Q_{Tmax}): Since the natural flow exceeds the amount of water that can be processed through the turbine, any excess water is bypassed through the spillway structure. The combined flow of the water used in the turbine to generate electricity and the water bypassed over the spillway equals the natural flow. This situation occurs primarily during spring thaw run-off conditions and during major storm events in the spring, summer and fall.

2. When natural flows are so low that any available water must be released downstream to protect the environment: The flow in this situation is typically too low to generate electricity. This situation occurs primarily in late summer and late winter when natural flows are typically very low. This situation may also occur during certain years when spring run-off flow is unusually low and the amount of water available is needed downstream to protect the environment.

Modified run-of-river operation would occur during moderate and low flows when the natural flow in the river is below the maximum turbine flow capacity (Q_{Tmax}) but above the minimum flow required to protect the environment (Q_{EA}). During these flow conditions, some of the natural river flow during nighttime and/or weekend hours can be stored and used to produce electricity during daytime hours. There are two modes of modified operation as follows:

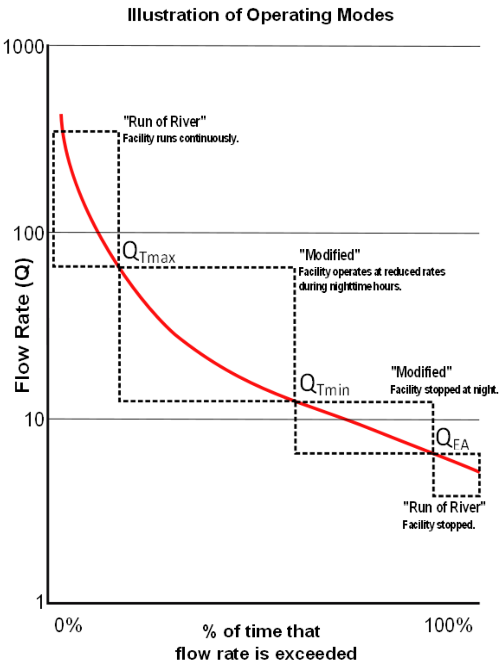
1. Facility runs at reduced rate at night: When natural river flows are moderate (i.e. between the minimum (Q_{Tmin}) and the maximum (Q_{Tmax}) rate of turbine capacity), the facility runs continuously, but some of the water is saved during nighttime and/or weekend hours. This operation results in downstream flows that are smaller than natural river flows during nighttime and/or weekend hours and larger than natural river flows during daytime hours when electricity use is higher. However, the minimum flow in this mode of operation is not less than the minimum turbine capacity (Q_{Tmin}).

2. Facility is stopped at night: When natural river flows are low (i.e. below the minimum turbine capacity (Q_{Tmin})), the facility will need to stop operation during some nighttime hours and save water until operation is again possible. The lower the natural river flow, the longer the period of stoppage will be. When the facility operates, it operates at a rate less than maximum turbine capacity (Q_{Tmax}). To ensure that the downstream river reach receives enough water flow to protect the environment (Q_{EA}), the appropriate amount of water is released through a bypass while the turbine operation is stopped.

The figure below illustrates the mode of operation that occurs depending on the amount of natural flow in the river.

An important factor in modified run-of-river operation is the availability of storage upstream of the facility. As described in the project description section of the environmental assessment, the amount of storage created as part of the project is very limited. To achieve the objective of building a project with limited environmental impact, the conceptual design of the facility limits the height of structure, the depth and the area of inundation upstream. Consequently, the amount of storage available for operation is inherently limited in relation to the natural flow in the river, thereby limiting the storage to a few hours during moderate and low flows. The ability to use this storage is further constrained by environmental constraints outlined in other parts of the environmental assessment document. It is the limited storage that differentiates modified run-of-river projects from hydroelectric projects that create large storage reservoirs with the ability to store water for weeks or seasons to "peak" when seasonal periods of hot or cold spells raise the need for extra electricity production. Typically, modified run-of-river projects have significantly less environmental impact than peaking hydroelectric projects.

Figure 1
Operating Modes



2 UPSTREAM STORAGE EFFECTS

During periods of moderate and low flows when the facility operates in modified run-of-river operation mode, water levels upstream of the facility will fluctuate from daytime to nighttime hours. Water levels will rise during the night as production is reduced below the natural rate of river inflow. Conversely, water levels will fall during the next business day as production is increased above the natural rate of river inflow. The fluctuations can affect:

1. Shoreline Erosion
2. Aquatic Habitat
3. Civil Structures & Private Property

2.1 Shoreline Erosion

The fluctuation in daily water levels upstream can increase the amount of shoreline erosion that would occur without modified operation. A small amount of shoreline erosion occurs naturally in the river; however, accelerated and persistent shoreline erosion is undesirable for the following reasons:

1. Natural shoreline vegetation cannot establish where accelerated erosion occurs on an ongoing basis.

2. Shoreline aquatic habitat can be affected negatively in the immediate area around the erosion location.
3. In extreme cases, erosion can cause an increase in the overall sediment load in the river with the potential for secondary effects on water turbidity and aquatic conditions.

For significant and persistent acceleration of shoreline erosion to occur, two (2) conditions must coincide:

1. Slope: the slope of the ground must be steep at the location where it intersects the shoreline of the inundated area upstream of the facility.
2. Soil Material: the soil material must be susceptible to erosion (i.e. this depends on the type of soil material and can range from negligible for rock to very high for pure silt with negligible clay content and cohesion).

An erosion survey was completed along the upstream shoreline to identify those locations where the potential for erosion may exist after inundation. The proposed mitigation is to:

1. Limit the maximum daily fluctuations of upstream water levels: The operating plan parameters proposed herein for daily fluctuation have been chosen to be less than the amount of seasonal and inter-annual fluctuation that has been occurring naturally over time in the upstream river reach prior to the construction of the project. By limiting the daily fluctuation, vegetation will naturally establish at the shoreline immediately above the narrow range of daily fluctuation and thereby limit erosion potential.
2. Limit the rate of change of upstream water level change: Rapid changes in shoreline water level can increase erosion. Where pore water in the soil dissipates too quickly, pore pressure can loosen soil grains and cause loss of stability in the soil structure, thereby enhancing erosion. By limiting the rate of change, this erosion mechanism is avoided.
3. Monitoring: The locations where the potential for erosion has been identified in the erosion survey will be inspected and assessed in year one (1) and year five (5) of the operation to document if and/or to what degree erosion has occurred.
4. Mitigation Follow up: Where monitoring reveals significant erosion and the potential for adverse environmental effects, further monitoring and/or mitigation strategies will be developed as required.

Based on the erosion survey completed, the potential for significant erosion is deemed to be limited. The above approach is believed to reasonably address this matter as it relates to safe and environmentally responsible operation of the project.

2.2 Aquatic Habitat Upstream

Daily fluctuation of water levels during periods of modified run-of-river operation may impact certain sensitive aquatic habitat at the upstream shoreline area. The existence and extent of any sensitive aquatic habitat areas have been documented as part of the environmental field studies that are presented in other sections of this environmental assessment document. The impact of daily water level fluctuation is typically very limited but specific effects can include such things as:

1. Effects on fish spawning in shallow water areas along the shoreline where daily fluctuations are significant in relation to the typical water depth.
2. Effects on water mammal habitat such as beaver houses where significant water level fluctuations create unfavorable conditions in shallow areas.
3. Movement of ice causing sediment scouring, sediment movement or turbidity at affected shoreline locations.
4. Effects on avian nests, typically found in shallow water areas only.

The significant aquatic habitat issues identified in the field studies were reviewed and considered in developing this operating plan. Also considered was the time of year when various habitat activities occur. To reduce the potential for negative habitat impact upstream during a modified run-of-river operation, the following step was taken in developing the specific operating parameters proposed herein:

1. Limit the maximum daily fluctuations of upstream water levels: The operating plan parameters proposed herein for daily fluctuation have been chosen to be less than the amount of seasonal and inter-annual fluctuation that has been occurring naturally over time in the upstream river reach prior to the construction of the project. This step does not eliminate the potential for effects but it limits the potential extent of impact to the point possible while still maintaining the socio-economic benefit of shifting some electricity production to times when electricity usage is high in the Province.

Combined with the steps taken in the conceptual design to limit the environmental footprint of the project, the proposed operating parameters are believed to avoid significant impacts on upstream habitat associated with the project.

2.3 Civil Structures and Private Property

Civil structures are man-made structures, such as bridges, roads, transmission lines, water intakes, boat launches and docks. Private property includes any leased, deeded, eased or owned real property (i.e. land). During the conceptual engineering design of the project, the upstream area that could be affected by the project and by inundation was reviewed. A static inundation map was created to identify potential sites of concern where the upstream inundation of the project could affect civil structures. Where the potential for effects on civil structures exists, steps were taken in the conceptual design to avoid or minimize impacts. These matters are discussed in other sections of this document.

In developing the operating plan, the additional effect created by modified operation of the project was assessed. Extensive hydraulic modeling was carried out as part of the HEC-RAS Study to evaluate the following:

1. Upstream water levels during various natural river flows and under operating conditions.
2. Backwater effects beyond the static inundation considered in the conceptual design work.
3. The upstream distance from the facility to where the flood levels and inundation will not be affected by the project.

4. Mapping of the estimated natural High Water Mark (i.e. the visible demarcation left in the vegetated shoreline from repeated annual flooding).
5. Any upstream locations where the facility operation could impact the natural High Water Mark.

A map, and an accompanying summary table, showing the various inundation levels that occur during various flood stages is attached to this document. The figure below shows a river profile of the water depths for pre- / post- construction and for various flows. The river profile clearly shows how far upstream the backwater effect extends. More detailed information is contained in the HEC-RAS Study referenced at the start of this section.

Xeneca has taken reasonable steps to ensure that civil structures and private property will not be impacted beyond what already occurs naturally or as specifically agreed with relevant parties on a bilateral basis. Any stakeholder with a concern about upstream impacts on any specific civil structures and/or private property is encouraged to review the available study information and/or contact Xeneca for additional clarification and bilateral discussion as necessary.

In addition to the above, the following steps were taken in developing the proposed operating parameters for the Project:

1. Set the maximum upstream operating water level: The maximum upstream operating water level was carefully set based on the results of the HEC-RAS Study to specifically avoid infringing on the pre-construction High Water Mark at any civil structure or private property. More specifically, the proposed operating values were reviewed to ensure that any backwater effect does not exceed the natural High Water Mark in areas where the potential for impact exists.
2. Limit the maximum daily fluctuations of upstream water levels: The operating plan parameters proposed herein for daily fluctuation were reviewed to ensure that impact on civil structures would not be a concern.
3. Manage flood events to minimize backwater effects: During flood passage where the natural flow exceeds the maximum turbine capacity (Q_{Tmax}), the facility will be operated to minimize flood impacts upstream by operating the spillway, turbine and bypass structures accordingly.
4. Spillway and bypass design: The spillway and bypass structures will be sized and designed to provide the amount of flood passage capacity required to meet the objectives of the operating plan. This step will be assessed in more detail at a later time in the detailed engineering design stage.

Figure 2

Project Name: Xeneca FIT Contract- Headpond Inudation mapping
Project No.: PCG019617
Site: 12_Wanatango Falls
River: Frederick House River
Designed by: T.Lozon
Checked by: D.Miller
Date Created: 28-Jun-11

Note
-Column headings starting with 'A-PR' represent proposed conditions flood elevations with a weir crest elevation of 257.5
-Column headings starting with 'B-PR' represent proposed conditions flood elevations with a weir crest elevation of 259.0

BURNSIDE
R. J. Burnside & Associates Limited

Figure #5-Site #12 Wanatango Falls- Existing Conditions vs Proposed Conditions

General Data / Validation vs LIDAR Flow Comparison

Survey Section#	Burnside X-Sec ID	Distance from Dam (m)	Validation Flow(m3/s)	Validation HEC-Ras Water Elev (m)	LIDAR Water Elev (m)	Validation Difference (m)
Limits of Mapping	590	9838.37		258.57	259.25	-0.68
	585	9725.03		258.55	258.75	-0.2
	580	9417.52		258.5	258.75	-0.25
	575	9157.30		258.43	258.75	-0.32
	570	8719.18		258.2	258.75	-0.55
	565	8471.34		257.97	258.25	-0.28
	560	8157.24		257.64	257.75	-0.11
	555	8128.96		257.64	257.75	-0.11
	550	7714.86		257.64	257.75	-0.11
	545	7133.29		257.64	257.75	-0.11
	540	6945.49		257.64	257.75	-0.11
	535	5943.13		257.64	257.75	-0.11
	530	5542.65		257.64	257.75	-0.11
	525	5193.91		257.64	257.75	-0.11
	520	4817.81		257.63	257.75	-0.12
	515	4609.87		257.63	257.75	-0.12
	510	4151.21		257.63	257.75	-0.12
	505	3625.48		257.63	257.75	-0.12
	500	3329.19		257.63	257.75	-0.12
	439	3058.07		257.63	257.75	-0.12
	437	2860.26		257.63	257.75	-0.12
	425	1966.87		257.63	257.75	-0.12
	418	1341.65		257.63	257.75	-0.12
SS-4	415	1042.36		257.63	257.75	-0.12
	413	933.65		257.63	257.75	-0.12
SS-3	412	855.13		257.63	257.75	-0.12
	411.5	822.18		257.62	257.75	-0.13
	411	789.59		257.21	257.75	-0.54
	410.5	757.80		255.56	256	-0.45
	410	722.91		255.72	256	-0.28
SS-2	408	589.92		255.72	256	-0.28
SS-1	405	404.09		255.72	256	-0.28
	403	340.41		255.72	256	-0.28
	402	310.37	5.00	255.72	256	-0.28
	401	278.86		255.72	256	-0.28
	400	255.07		255.72	256	-0.28
SS0	206	221.08		255.29	255.5	-0.21
	205	149.56		255.29	255.5	-0.21
	204	51.14		255.29	255.5	-0.21
	203	16.61		255.28	255	0.28
	201	0.00		254.29	254.5	-0.21
	200	-57.55		253.55	254	-0.45
	132	-135.53		250.81	251	-0.19
SS1	131	-151.32		250.81	251	-0.19
	130	-199.19		250.68	250.5	0.18
SS2	129	-267.07		250.32	250.5	-0.18
	128	-310.91		250.28	250.5	-0.22
	127	-355.17		250.26	250.5	-0.24
	126	-406.75		250.27	250.5	-0.23
	125	-450.39		250.26	250.5	-0.24
	124	-512.31		250.26	250.5	-0.24
	123	-561.32		250.21	250.5	-0.29
	122	-644.31		249.82	250	-0.18
SS3	121	-659.97		247.25	249.5	-2.25
	120	-675.22		247.82	249	-1.18
	119	-698.11		247.79	249	-1.21
	118	-759.15		247.82	248	-0.18
	116	-849.58		247.82	248	-0.18
	115	-916.21		247.82	248	-0.18
	114	-939.43		247.82	248	-0.18
	112	-1092.32		247.82	248	-0.18
	110	-1232.26		247.81	248	-0.19
	109	-1281.15		247.81	248	-0.19
	108	-1325.95		247.81	248	-0.19
	106	-1483.86		247.8	248	-0.2
	104	-1626.58		247.8	248	-0.2
	100	-1924.13		247.78	248	-0.22

Long Term Average Flow (LTAF) Comparison

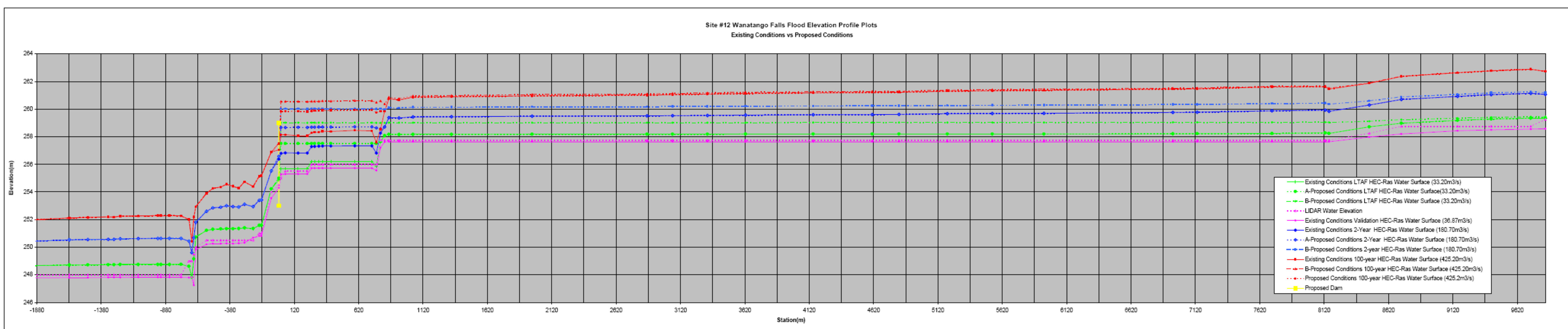
Burnside X-Sec ID	LTAF Flow(m3/s)	EX- LTAF Water Elev (m)	A-PR- LTAF Water Elev (m)	B-PR- LTAF Water Elev (m)	A-LTAF Water Elev Difference (m)	B-LTAF Water Elev Difference (m)
590		259.34	259.34	259.45	0	0.11
585		259.34	259.34	259.45	0	0.11
580		259.27	259.27	259.4	0	0.13
575		259.18	259.18	259.34	0	0.16
570		258.98	258.98	259.23	0	0.25
565		258.71	258.71	259.12	0	0.41
560		258.24	258.24	259.04	0	0.8
555		258.27	258.27	259.05	0	0.78
550		258.24	258.24	259.04	0	0.8
545		258.22	258.22	259.04	0	0.82
540		258.21	258.21	259.04	0	0.83
535		258.2	258.2	259.03	0	0.83
530		258.2	258.2	259.03	0	0.83
525		258.2	258.2	259.03	0	0.83
520		258.19	258.19	259.03	0	0.84
515		258.19	258.19	259.03	0	0.84
510		258.19	258.19	259.03	0	0.84
505		258.19	258.19	259.02	0	0.83
500		258.18	258.18	259.02	0	0.84
439		258.18	258.18	259.02	0	0.84
437		258.18	258.18	259.02	0	0.84
425		258.18	258.18	259.02	0	0.84
418		258.17	258.17	259.02	0	0.85
415		258.17	258.17	259.02	0	0.85
413		258.16	258.16	259.01	0	0.85
412		258.17	258.17	259.02	0	0.85
411.5		258.08	258.08	259	0	0.92
411		257.64	257.64	259	0	1.36
410.5		255.86	257.5	259	1.64	3.14
410		256.21	257.51	259.01	1.3	2.8
408		256.21	257.51	259.01	1.3	2.8
405		256.21	257.51	259.01	1.3	2.8
403		256.21	257.51	259.01	1.3	2.8
402	33.20	256.21	257.51	259.01	1.3	2.8
401		256.21	257.51	259.01	1.3	2.8
400		256.2	257.51	259.01	1.31	2.81
206		255.68	257.5	259	1.82	3.32
205		255.68	257.51	259.01	1.83	3.33
204		255.68	257.51	259.01	1.83	3.33
203		255.68	257.51	259.01	1.83	3.33
201		254.87	254.99	254.99	0.12	0.12
200		254.23	254.23	254.23	0	0
132		251.59	251.59	251.59	0	0
131		251.58	251.58	251.58	0	0
130		251.35	251.35	251.35	0	0
129		251.4	251.4	251.4	0	0
128		251.35	251.35	251.35	0	0
127		251.34	251.34	251.34	0	0
126		251.34	251.34	251.34	0	0
125		251.32	251.32	251.32	0	0
124		251.3	251.3	251.3	0	0
123		251.22	251.22	251.22	0	0
122		250.72	250.72	250.72	0	0
121		249.16	249.15	249.16	-0.01	0
120		247.82	247.82	247.82	0	0
119		248.62	248.62	248.62	0	0
118		248.76	248.76	248.76	0	0
116		248.75	248.75	248.75	0	0
115		248.75	248.75	248.75	0	0
114		248.75	248.75	248.75	0	0
112		248.75	248.75	248.75	0	0
110		248.75	248.75	248.75	0	0
109		248.73	248.73	248.73	0	0
108		248.73	248.73	248.73	0	0
106		248.72	248.72	248.72	0	0
104		248.71	248.71	248.71	0	0
100		248.67	248.67	248.67	0	0

2-year Flow Comparison

Burnside X-Sec ID	2-year Flow(m3/s)	EX- 2-year Water Elev (m)	A-PR- 2-year Water Elev (m)	B-PR- 2-year Water Elev (m)	A-2-year Water Elev Difference (m)	B-2-year Water Elev Difference (m)
590		261.06	261.06	261.18	0	0.12
585		261.14	261.14	261.25	0	0.11
580		261.04	261.04	261.17	0	0.13
575		260.92	260.92	261.07	0	0.15
570		260.7	260.7	260.89	0	0.19
565		260.29	260.29	260.6	0	0.31
560		259.83	259.83	260.36	0	0.53
555		259.93	259.93	260.43	0	0.5
550		259.88	259.88	260.4	0	0.52
545		259.77	259.77	260.34	0	0.57
540		259.76	259.76	260.33	0	0.57
535		259.69	259.69	260.29	0	0.6
530		259.68	259.68	260.28	0	0.6
525		259.66	259.66	260.27	0	0.61
520		259.61	259.61	260.24	0	0.63
515		259.6	259.6	260.24	0	0.64
510		259.59	259.59	260.23	0	0.64
505		259.56	259.56	260.21	0	0.65
500		259.54	259.54	260.2	0	0.66
439		259.52	259.52	260.19	0	0.67
437		259.51	259.51	260.18	0	0.67
425		259.48	259.48	260.16	0	0.68
418		259.44	259.44	260.14	0	0.7
415		259.43	259.43	260.13	0	0.7
413		259.35	259.35	260.08	0	0.73
412		259.38	259.38	260.1	0	0.72
411.5		258.71	258.7	259.96	-0.01	1.25
411		258.26	258.56	260.02	0.3	1.76
410.5		256.82	258.64	260	1.82	3.18
410		257.33	258.71	260.03	1.38	2.7
408		257.34	258.71	260.03	1.37	2.69
405		257.32	258.7	260.03	1.38	2.71
403		257.32	258.7	260.03	1.38	2.71
402	180.70	257.31	258.7	260.02	1.39	2.71
401		257.3	258.69	260.02	1.39	2.72
400		257.28	258.69	260.02	1.41	2.74
206		256.81	258.66	260.01	1.85	3.2
205		256.81	258.68	260.02	1.87	3.21
204		256.83	258.67	260.02	1.84	3.19
203		256.79	258.67	260.02	1.88	3.23
201		256.37	256.58	256.58	0.21	0.21
200		255.53	255.53	255.53	0	0
132		253.42	253.42	253.42	0	0
131		253.39	253.39	253.39	0	0
130		252.94	252.94	252.94	0	0
129		253.1	253.1	253.1	0	0
128		252.91	252.91	252.91	0	0
127		252.94	252.94	252.94	0	0
126		253	253	253	0	0
125		252.9	252.9	252.9	0	0
124		252.85	252.85	252.85	0	0
123		252.6	252.6	252.6	0	0
122		251.8	251.8	251.8	0	0
121		250.69	250.69	250.69	0	0
120		249.6	249.6	249.6	0	0
119		250.44	250.44	250.44	0	0
118		250.63	250.63	250.63	0	0
116		250.63	250.63	250.63	0	0
115		250.63	250.63	250.63	0	0
114		250.63	250.63	250.63	0	0
112		250.62	250.62	250.62	0	0
110		250.61	250.61	250.61	0	0
109		250.57	250.57	250.57	0	0
108		250.57	250.57	250.57	0	0
106		250.55	250.55	250.55	0	0
104		250.53	250.53	250.53	0	0
100		250.43	250.43	250.43	0	0

100-year Flow Comparison

Burnside X-Sec ID	100-year Flow(m3/s)	EX- 100-year Water Elev (m)	A-PR- 100-year Water Elev (m)	B-PR- 100-year Water Elev (m)	A-100-year Water Elev Difference (m)	B-100-year Water Elev Difference (m)
590		262.73	262.73	262.75	0	0.02
585		262.88	262.88	262.9	0	0.02
580		262.77	262.77	262.79	0	0.02
575		262.63	262.63	262.65	0	0.02
570		262.36	262.36	262.38	0	0.02
565		261.86	261.86	261.9	0	0.04
560		261.45	261.45	261.51	0	0.06
555		261.62	261.62	261.67	0	0.05
550		261.6	261.6	261.66	0	0.06
545		261.46	261.46	261.53	0	0.07
540		261.45	261.45	261.52	0	0.07
535		261.36	261.36	261.43	0	0.07
530		261.33	261.33	261.41	0	0.08
525		261.29	261.29	261.37	0	0.08
520		261.21	261.21	261.29	0	0.08
515		261.2	261.2	261.28	0	0.08
510		261.17	261.17	261.25	0	0.08
505		261.12	261.12	261.21	0	0.09
500		261.08	261.08	261.17	0	0.09
439		261.05	261.05	261.14	0	0.09
437		261.01	261.01	261.1	0	0.09
425		260.96	260.96	261.06	0	0.1
418		260.89	260.89	260.98	0	0.09
415		260.86	260.86	260.96	0	0.1
413		260.65	260.65	260.76	0	0.11
412		260.76	260.76	260.86	0	0.1
411.5		259.85	259.85	260.37	0	0.52
411		258.54	259.83	260.59	1.29	2.05
410.5		257.59	259.74	260.49	2.15	2.9
410		258.42	259.92	260.6	1.5	2.18
408		258.45	259.93	260.61	1.48	2.16
405		258.38	259.9	260.58	1.52	2.2
403		258.39	259.9	260.59	1.51	2.2
402	425.20	258.33	259.88	260.57	1.55	2.24
401		258.31	259.87	260.57	1.56	2.26
400		258.27	259.86	260.56	1.59	2.29
206		258.06	259.82	260.54	1.76	2.48
205		258.06	259.85	260.55	1.79	2.49
204		258.14	259.84	260.55	1.7	2.41
203		258.13	259.83	260.55	1.7	2.42
201		257.05	257.5	257.5	0.45	0.45
200		256.9	256.9	256.9	0	0
132		255.17	255.17	255.17	0	0
131		255.14	255.14	255.14	0	0
130		254.39	254.39	254.39	0	0
129		254.73	254.73	254.73	0	0
128		254.28	254.28	254.28	0	0
127		254.41	254.41	254.41	0	0
126		254.57	254.57	254.57	0	0
125		254.35	254.35	254.35	0	0
124		254.27	254.27	254.27	0	0
123		253.89	253.89	253.89	0	0
122		252.94	252.94	252.94	0	0
121		252.19	252.19	252.19	0	0
120		250.42	250.42	250.42	0	0
119		252	252	252	0	0
118		252.27	252.27	252.27	0	0
116		252.28	252.28	252.28	0	0
115		252.28	252.28	252.28	0	0
114		252.28	252.28	252.28	0	0
112		252.26	252.26	252.26	0	0
110		252.25	252.25	252.25	0	0
109		252.18	252.18	252.18	0	0
108		252.19	252.19	252.19	0	0
106		252.15	252.15	252.15	0	0
104		252.12	252.12	252.12	0	0
100		251.98	251.98	251.98	0	0



Daily fluctuations in upstream water levels can have several implications related to ice cover. Rising and falling water levels can create and subsequently fill cracks in the ice cover, resulting in significant forces on structures, which must be considered in the structural design. During thawing conditions and spring break-up, the release of ice over the structure can contribute to downstream ice jams.

The extent of ice related impacts will be more fully assessed during the detailed engineering stage of the facility. The assessment will consider, where practical, adjustments to the normal operating plan for the duration of ice breakup that minimizes the risk of downstream ice jams.

3 DOWNSTREAM FLOW EFFECTS

During periods of moderate and low flows when the facility operates in modified run-of-river operation mode, the flows downstream of the facility will vary from certain daytime to nighttime hours. At certain nighttime hours (i.e. outside of the hours of 11:00 a.m. to 7:00 p.m. on business days), flows will be substantially lower than natural river flows. At certain daytime hours (i.e. during the hours of 11:00 a.m. to 7:00 p.m. on business days), flows will be greater than natural river flows.

The variability in flow can be significant from an area immediately downstream of the facility to a distance downstream where the variability in flow is attenuated by the presence of a lake or confluence with another significant tributary (the “Variable Flow Reach”). Within the Variable Flow Reach, water depth, flow velocity and wetted perimeter will change from daytime to nighttime while the modified operation is occurring.

The degree of variability depends on the mode of operation and the difference between the daytime and nighttime flow. While the facility is operating continuously, but at a reduced rate at night, the amount of water discharged at all times is very significant. Also, the rate of variability is in the same general range where daytime flow is typically not more than four (4) times larger than nighttime flow. Under continuous operation, the potential for environmental impact is limited as flows will be substantial enough at all times for most environmental requirements.

While the facility is operating intermittently (i.e. stopped at certain times at night), the variability in the flow can be large. The amount of water released at night is only the minimum amount required to protect the environment. The minimum amount released while operating is at least the minimum turbine capacity (Q_{Tmin}) or more. The difference in this mode of operation can result in daytime flows that are 10+ times larger than at nighttime. Out of the four (4) operating modes, it is this mode that warrants the greatest consideration for operations planning.

In this mode, the variability can affect:

1. Aquatic Habitat
2. Navigation
3. Public Safety & Civil Structures
4. Ice scour

3.1 Downstream Aquatic Habitat

The daily variability in flow during modified operation may impact certain sensitive aquatic habitat in the Variable Flow Reach downstream of the facility. Examples of possible concerns include:

1. Effects on fish spawning and foraging.
2. Effects on benthic organisms in the river sediment.

The significant aquatic habitat issues that were identified in the field studies were reviewed and considered in developing the operating plan. To reduce the potential for impact in the Variable Flow Reach during intermittent operations, the following approach was taken in setting operating parameters:

1. Timing of Event: Special attention was given to the timing of aquatic habitat events and the relationship to the range of natural flows that could occur during that period. Where intermittent operation could occur during those periods, the bypass flow provided while the facility is stopped was given special consideration.
2. Sizing of bypass flows: Bypass flows were considered in the context of the associate water depth, flow velocity and wetted perimeter in the Variable Flow Reach. The objective is to minimize the amount of water released during times when the facility is stopped, while providing enough water to minimize stress on the aquatic environment.
3. Controlled ramping of flows: To minimize the sudden release of water that occurs during start up, a ramping procedure was put into place. The ramping procedure requires the facility to start at minimum turbine capacity (Q_{Tmin})and gradually ramp up output to the desired operating rate.
4. Limiting maximum turbine flow (Q_{Lim}): During intermittent operation, the turbine flow was set to not exceed an upper limit to minimize the amount of flow variability that occurs on a daily basis.

The proposed operating parameters and objectives are believed to avoid significant impacts on the downstream habitat associated with the project.

It should be noted that the operating parameters for turbine flows depend on the final design and equipment selected at construction. Some variation in the related parameters can occur, however, the objectives of the mitigation and environmental flows (Q_{EA}) provided would not change.

3.2 Navigation

Navigation impacts could result during times of modified run-of-river operation in the Variable Flow Reach. During certain hours, the flows and water depths would be lower than normal. During certain hours, the flows and water depth would be greater than normal.

The river is not used for commercial navigation but sporadically for recreational canoeing. This matter is being addressed through the stakeholder consultation process. It should be recognized that intermittent operation would occur only during low flows, most of which occur during the winter months when the river is frozen and not navigable.

3.3 Public Safety & Civil Structures

Public safety considerations could arise due to variability in flows and the rate of change in flows and levels in the Variable Flow Reach. Possibly affected could be recreational uses such as camping, fishing or hiking at the edge of the river in this area. The effect on uses is being assessed as part of the public stakeholder consultation associated with the environmental assessment process.

The scope of the potential change in water flows due to intermittent operation was addressed in the HEC-RAS Study referenced earlier in this operations plan. The model provides information about the water depth at various flows, including an assessment of the changes in flows and water depths that occur during an intermittent operations event. The expected water flow changes are included in the section on the proposed operating flows and levels presented below.

It should be recognized that intermittent operation would only occur during low flows, most of which occur during the winter months when the river is frozen and recreational uses are limited. Safety issues that are identified will be addressed through an awareness plan once the facility goes into operation.

The civil structures are not expected to be affected by the changes in daily flows related to the modified operation. The range of flows associated with the daily variation of turbine discharge is well within the range of flow for which civil structures are designed. The maximum downstream river flows associated with maximum turbine capacity (Q_{Tmax}) are in the range of normal river flows and well below the flood flows experienced during spring freshet or major rain events. Impacts on civil structures and private property located in the Variable Flow Reach downstream of the facility are not anticipated.

3.4 Ice Scour

Ice scour can occur where water levels fluctuate during the winter months and where soft river bottom sediments exist. The action of broken ice wedging into the river sediments and moving up and down with repeated water level fluctuations can disturb certain shoreline habitat such as benthic organisms or winter spawned fish eggs.

To address the matter the following considerations were made:

1. In most sections of the Variable Flow Reach, the river bed consists of hard bedrock that is not sensitive to ice scour. Soft sediments exist primarily at the higher lying shorelines and in deeper sections of the river and in pools where slow moving water has allowed local deposition of soft sediments. The dispersed nature of the soft sediments suggests that ice scour is limited to certain areas or sections of the Variable Flow Reach.

2. The greatest potential for ice breakage and ice scour exists when the difference in daytime and nighttime flow is the greatest (i.e. during intermittent operation). This situation occurs when natural river flows are low, primarily during the winter. At these low flows, the higher lying river bank sections, where soft sediment is primarily found are not affected. This limits the areas of interest to locations where soft sediments occur in the primarily rocky river bed.

The above considerations suggest that the potential for significant impact related to ice scour in the prevailing river bed conditions is limited. However, it is difficult to predict the exact potential for ice scour. To address this matter, the following mitigation strategy is proposed:

1. A monitoring location with soft sediments and potential for ice scour will be established prior to construction in an accessible area of the Variable Flow Reach.
2. The monitoring location will be documented with photographs taken during low flows in late summer.
3. The monitoring location will be assessed for visible effects of ice scour after year 1 and year 5 of operation (i.e. during low flows in late summer). The assessment will be documented with photographs.
4. The monitoring location will be assessed in the winter while modified operation is ongoing in year 1 and year 5 to determine if and how much ice breakage and wedging occurs.
5. Based on the results of the assessment, the operating plan will be adjusted to mitigate where a significant adverse effect is determined to occur as a result of modified operation.

3.5 Water Management Plan

The Lakes and Rivers Improvement Act provides for the creation of Water Management Plans for operating facilities where such plans are deemed necessary by the regulatory authority. The purpose of these plans is to ensure operation practices are consistent with other uses of the river and public safety objectives. Where a regulatory authority requests the creation of a Water Management Plan for the facility, or incorporation of the facility in any existing Water Management Plan, Xeneca will facilitate the regulatory requirements as required.

With respect to the operations plan presented herein, it is contemplated that this plan and associated studies, once finalized through the environmental assessment process would form the basis for any Water Management Plan as it relates to the facility.

4 SEASONAL OPERATIONS

Environmental protection requirements vary significantly depending on the time of year. Operating parameters have to be set accordingly to address these changing requirements throughout the year.

For operating purposes, operating seasons can be defined in various ways, including calendar seasons, periods of consistent meteorological conditions and periods of special environmental significance. The approach used in this operating plan divides the year into the following operating seasons:

1. Spring Freshet: The spring freshet period begins with the rapid increase in the spring snow melt flow on the hydrograph of average annual flows and ends with the leveling off of flows after flood waters have receded. The period coincides with increases in water temperature and flows that trigger various aquatic activities in the river.

2. Summer Low: The summer low period begins with the end of the freshet and lasts until the upward inflection that occurs on the hydrograph of average annual flows in early fall. The period typically exhibits warm water temperatures and a high degree of activity in the entire food chain. Flows are generally low but highly variable, depending on rainfall events.

3. Fall Freshet: The fall freshet begins with the upward inflection on the hydrograph of average annual flows and ends with the leveling off of flows after the freshet flows have receded. The period exhibits decreasing water temperatures and moderate flows. The insect activity has become minimal due to cool air temperatures above the water and the associated food chain activity is slowing down.

4. Winter Low: The winter low period begins with the end of the fall freshet and finishes when the spring freshet starts. Water and air temperatures are cold. Most water surfaces freeze during this period and various fish and aquatic species either hibernate or seek deeper waters such as pools and lakes. Flows are generally low and decrease gradually but continuously until spring freshet.

The start and end dates for the above operating seasons have been picked from the hydrograph of average annual flows (see figure below) and summarized in the following table. A flow excedence curve is provided for each season.

Table 1

Seasonal Hydrological Periods	
Spring	April 16th - June 1st (46 days)
Summer	June 2nd - September 1st (92 days)
Fall	September 2nd - November 1st (61 days)
Winter	November 2nd - April 15th (166 days)

Wanatango

As shown on the hydrograph, flows vary substantially for the same day from one year to the next. While the hydrograph of the average annual flow provides a reasonable representation of the typical start and end times for each operating season, the actual start and end times will vary every year. This weather related aspect means that calendar dates can only serve as approximations of the actual timing of natural events. For the purposes of the operating plan, the start and end dates in the table will be used to govern the operation until a better technique for defining the start and end date becomes available.

Figure 3

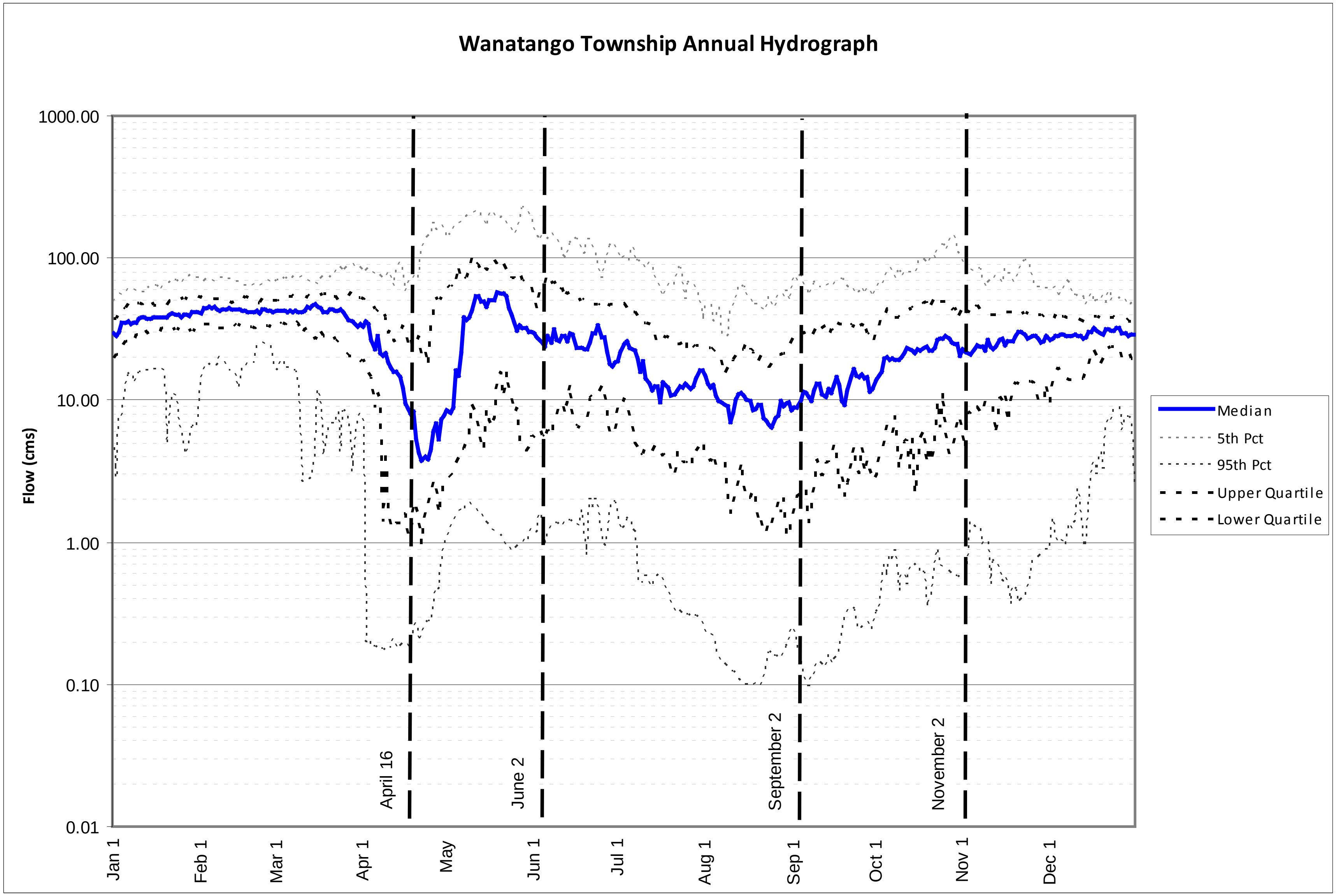
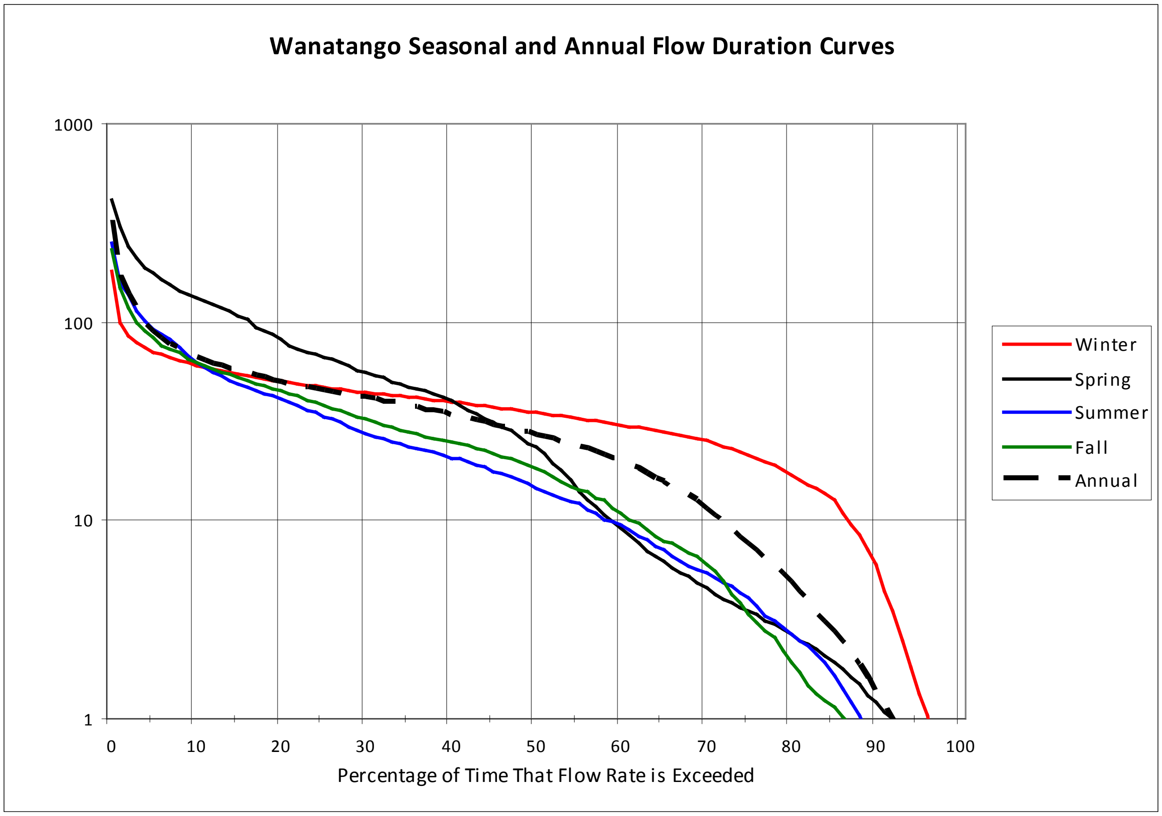

Wanatango Township Annual Hydrograph
Flow (cms)
1000.00
100.00
10.00
1.00
0.10
0.01
Jan 1
Feb 1
Mar 1
Apr 1
May
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Nov 1
Dec 1
April 16
June 2
September 2
November 2
Median
5th Pct
95th Pct
Upper Quartile
Lower Quartile

Figure 4



5 PROPOSED OPERATING FLOWS AND LEVELS

This section summarizes the proposed operations parameters for the project. In selecting the operations parameters, the environmental aspects outlined in the previous sections were considered so as to provide a reasonable balance among operational constraints, environmental aspects and mitigation of possible impacts. Different operating parameters are proposed for each of the ecological seasons to reflect different needs and mitigation objectives for various times of the year.

It should be noted that changes in upstream levels and downstream flows related to operation occur only when the facility is in modified run-of-river operations mode. While the facility is in run-of-river mode and subject to the amount of natural flow in the river, the upstream levels will be maintained at a constant level and downstream flows will equal the natural flow in the river.

5.1 Upstream Operation Parameters

The operating parameters that can be used to mitigate upstream impacts are:

1. Maximum Daily Fluctuation of Upstream Water Levels: Under normal operation and during normal river flows, upstream water levels can be controlled as required by the rate of electricity production and hence water use. In modified run-of-river facilities, a portion of the normal river flow is typically stored during nighttime hours causing water levels to rise upstream until the rate of production is increased again during daytime hours when electricity demand is higher. The limiting factor is the range of daily water fluctuation that is deemed acceptable in the inundated area upstream of the facility. The proposed operating parameters set a maximum range of upstream water levels during normal operation to mitigate upstream impacts.
2. Rate of upstream water level change: To a limited degree, the rate of change of upstream water levels can be managed by the rate of electricity production during operating hours. The possible production rates range from the minimum turbine flow (Q_{Tmin}) to the maximum turbine flow (Q_{Tmax}). The limiting factor is the rate of rise or fall that is deemed acceptable to protect shoreline habitat.
3. Minimum Upstream Operating Water Level: The minimum upstream operating water level is the water level below which no power is generated during normal operations. It should be noted that the need to provide environmental flows may result in drops of upstream water levels below the minimum water level even if no power is generated. This situation can occur during prolonged periods of drought and cannot be controlled by plant operation.
4. Maximum Upstream Operating Water Level: The maximum upstream operating water level is the water level beyond which water is bypassed through the spillway during normal operations to avoid further water level rise upstream. It should be noted that during flood conditions water levels may rise above this level due to natural factors. It is noted that various engineering documents or drawings may refer to this level as the Normal Operating Level (NOL) or the Full Supply Level (FSL).

The proposed operating parameters for upstream water levels are provided along with the downstream operating parameters I the following section. Operating parameters are provided for each of the operating seasons discussed above. The maximum and minimum normal operating levels are applicable except during flood and drought events as described in the section on special event operation elsewhere in this document.

The following figures show the amount of storage available and the amount of time required to fill the available storage (i.e. to raise level 1 metre) at various flow conditions. As is apparent, the amount of available storage is small. At low flow conditions it takes longer to fill the storage, illustrating that the limited storage available is most useful at low flow conditions.

Figure 5

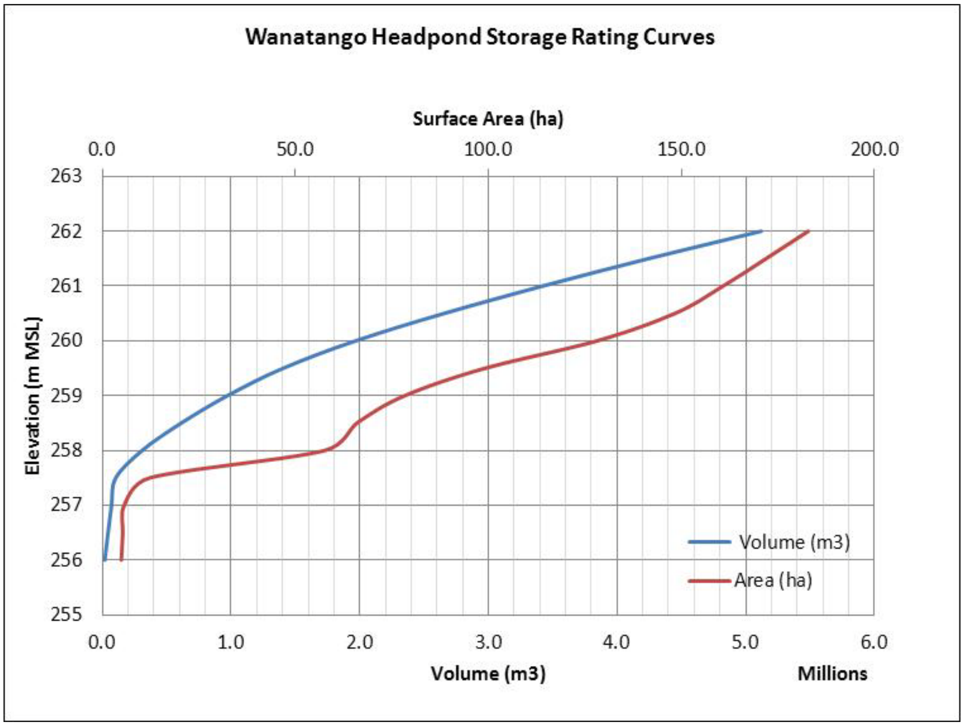
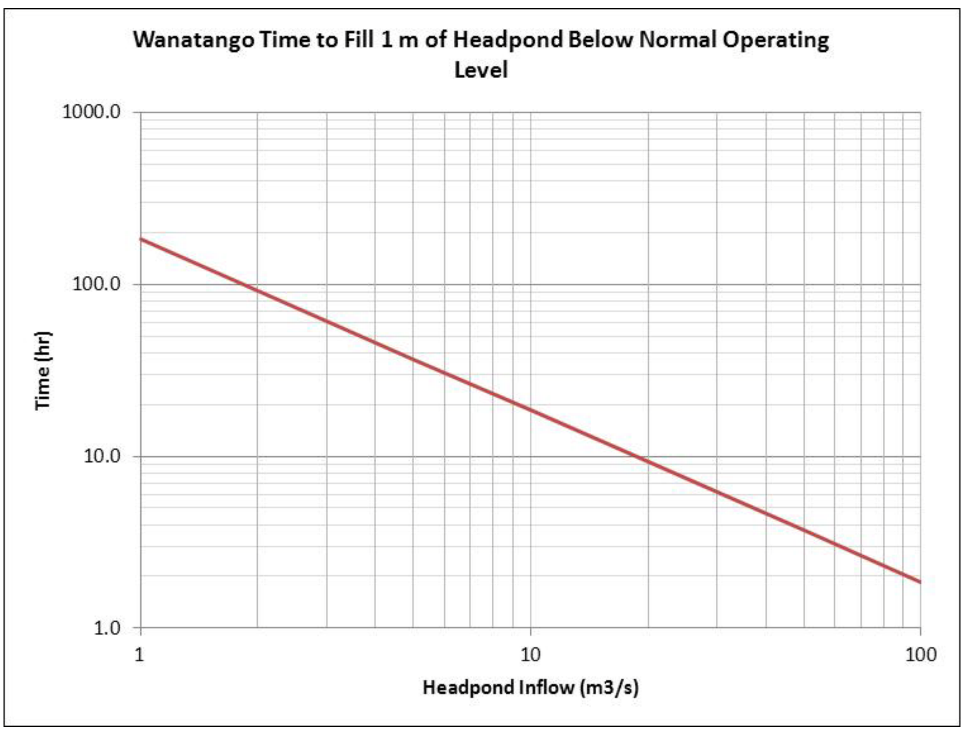


Figure 6



5.2 Downstream Operation Parameters:

The operating parameters that can be used to mitigate downstream impacts are:

1. Upper Turbine Limit (Q_{TL}): The maximum amount of flow generated by the facility operation while intermittent turbine operation is occurring. The turbine(s) can be operated in a range of flows and outputs ranging from the flow associated with the minimum turbine capacity (Q_{Tmin}) to the maximum turbine capacity (Q_{Tmax}). Where it is desirable to minimize the difference between daytime and night-time flows, the upper limit of turbine operation can be set as an operating parameter. Setting the upper limit has to take into account that the turbines do not operate very efficiently below roughly 65% of their maximum capacity (Q_{T65}).
2. Turbine Ramp Time: The time during which a turbine is taken to the desired operating flow (Q_{OP}). Turbine start up involves going from stopped operation to minimum turbine flow (Q_{Tmin}) in a very short period of time. Once the turbine is operating, the turbine capacity can be increased gradually to the desired operating flow (Q_{OP}). By increasing the flow gradually, some downstream impacts can be reduced.
3. Turbine Down Ramp Time: The time during which a turbine is taken down to minimum turbine flow (Q_{Tmin}) prior to shut down. By decreasing the flow gradually some downstream impacts can be reduced.
4. Environmental Flow (Q_{EA}): The amount of flow that is provided to the Variable Flow Reach during intermittent operation when the turbine is stopped. It should be noted that the environmental flow provided through operations cannot be larger than the natural flow upstream in the river.
5. Compensatory Bypass Flow (Q_{Comp}): The amount of flow that is provided at all times to the very short river reach between the containment structure and the powerhouse tailrace outflow. This flow is only relevant where the final design involves a separation between the containment structure and the powerhouse tail water outflow and where this design creates a section of reach that is by-passed. This flow is not applicable where the final design involves a close coupled design where the powerhouse tailrace outlet is immediately downstream of the containment structure. Where this parameter is applicable it is independent of the facility operation mode or status.

The proposed operating parameters for downstream flows are provided in Table 3. Operating parameters are provided for each of the operating seasons and relate primarily to an intermittent operation (i.e. when natural flows in the river are low but still above the minimum environmental flow (Q_{EA})). This mode of operation is most likely to occur in late summer and during the winter.

Table 2

Acronym	Description	Project & Streamflow Conditions (m^3/s)			
		Spring	Summer	Fall	Winter
Q_{99}	Streamflow exceeded 99% of time	0.2	0.1	0.1	0.2
Q_{95}	Streamflow exceeded 95% of time	0.7	0.3	0.3	1.3
Q80	Streamflow exceeded 80% of time	2.6	2.7	1.9	17.0
Q50	Streamflow exceeded 50% of time	23.3	14.6	18.3	35.0
Q20	Streamflow exceeded 20% of time	81.3	40.6	45.2	50.2
Q_{EA}	Downstream environmental flow target	No Int. Op.	2.0	2.0	5.0
Q_{COMP}	Compensatory flow (between tailrace and dam)	2.0	1.0	1.0	1.0
Q_{TMAX}	Maximum turbine capacity	50.0			
Q_{Tmin}	Minimum turbine flow	15.0			
Q_{TL}	Limited turbine flow - modified ROR	32.5			
LTAF	Long term annual flow, average annual mean	33.2			
Q_{MED}	Median streamflow value	27.0			
7Q2	2 year return period 7-day-average-low flow	0.43			
7Q10	10 year return period 7-day-average-low flow	0.14			
7Q20	20 year return period 7-day-average-low flow	0.11			
Q_{HWM}	Streamflow corresponding to high water mark *	160			
Q1:2	High streamflow event; occurrence of 1 in 2 yr	180			
Q1:100	High streamflow event; occurrence of 1 in 100 yr	467			

Notes:
Flow percentile information based upon period of record
Low flow statistics based upon Gumbel distribution, High streamflow events (instantaneous) based upon General Extreme Value (GEV)
cms - cubic meters per second, m3/s
Qin - instantaneous river inflow, cms
* Value obtained from field observation and Hydraulic modeling
No Int. Op. - No intermittent operation

Seasonally, the predicted frequency for each of the operating modes is provided in the following table.

Table 3: Operating Mode Occurrence by Season

		Spring	Summer	Fall	Winter	Annual
Flood Flow	>QTmax	33%	15%	16%	21%	20%
Moderate Flow	>QTmin	21%	35%	38%	61%	46%
Low Flow	<QTmin	45%	49%	45%	17%	33%
Very Low Flow	<QEA	1%	1%	1%	1%	1%
		100%	100%	100%	100%	100%

The following graphs illustrate the relationship between flow and water depth, water velocity and wetted perimeter at a typical cross-section downstream. A drawing of the cross-section associated with the data is shown in the figure below. The relationships were derived from the HEC-RAS Study for various cross-sections downstream in the Variable Flow Reach. A river profile shown below illustrates how water depth varies from one location to another along the Variable Flow Reach. The HEC-RAS Study document should be consulted for further information about specific locations of environmental interest.

Figure 7

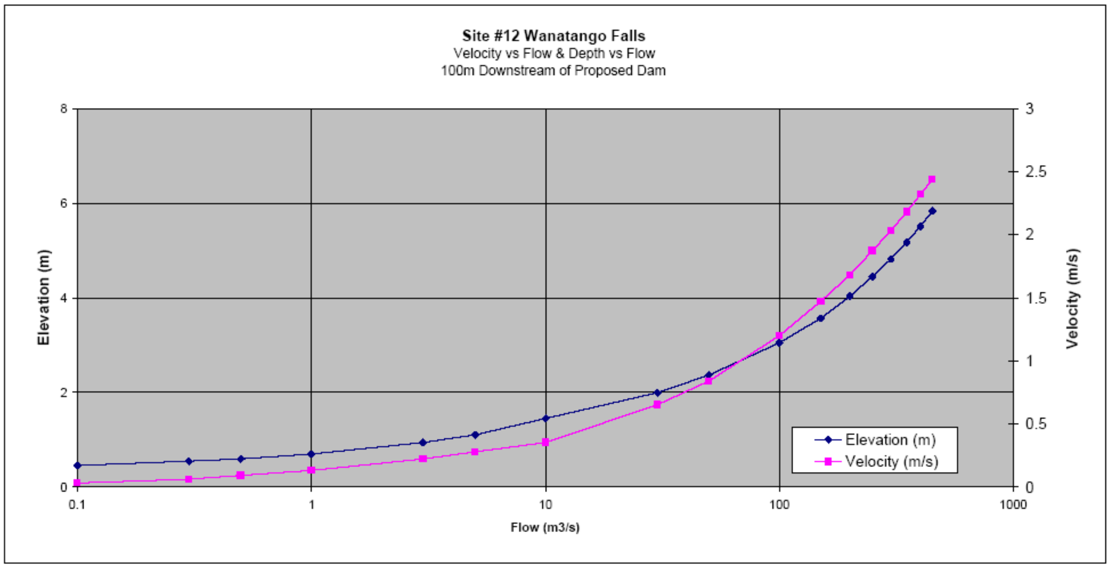


Figure 8

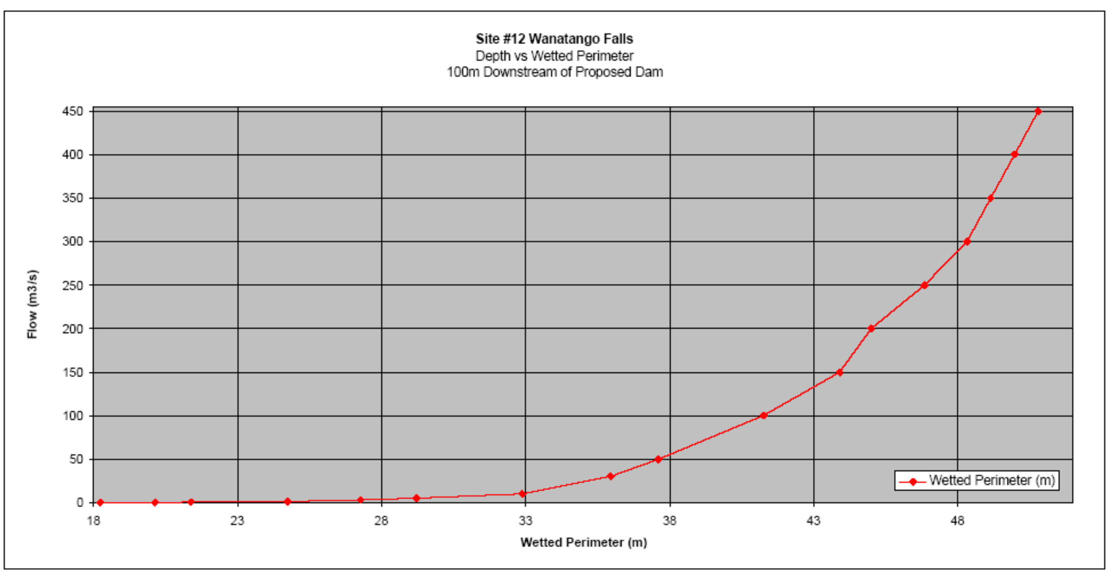


Figure 9

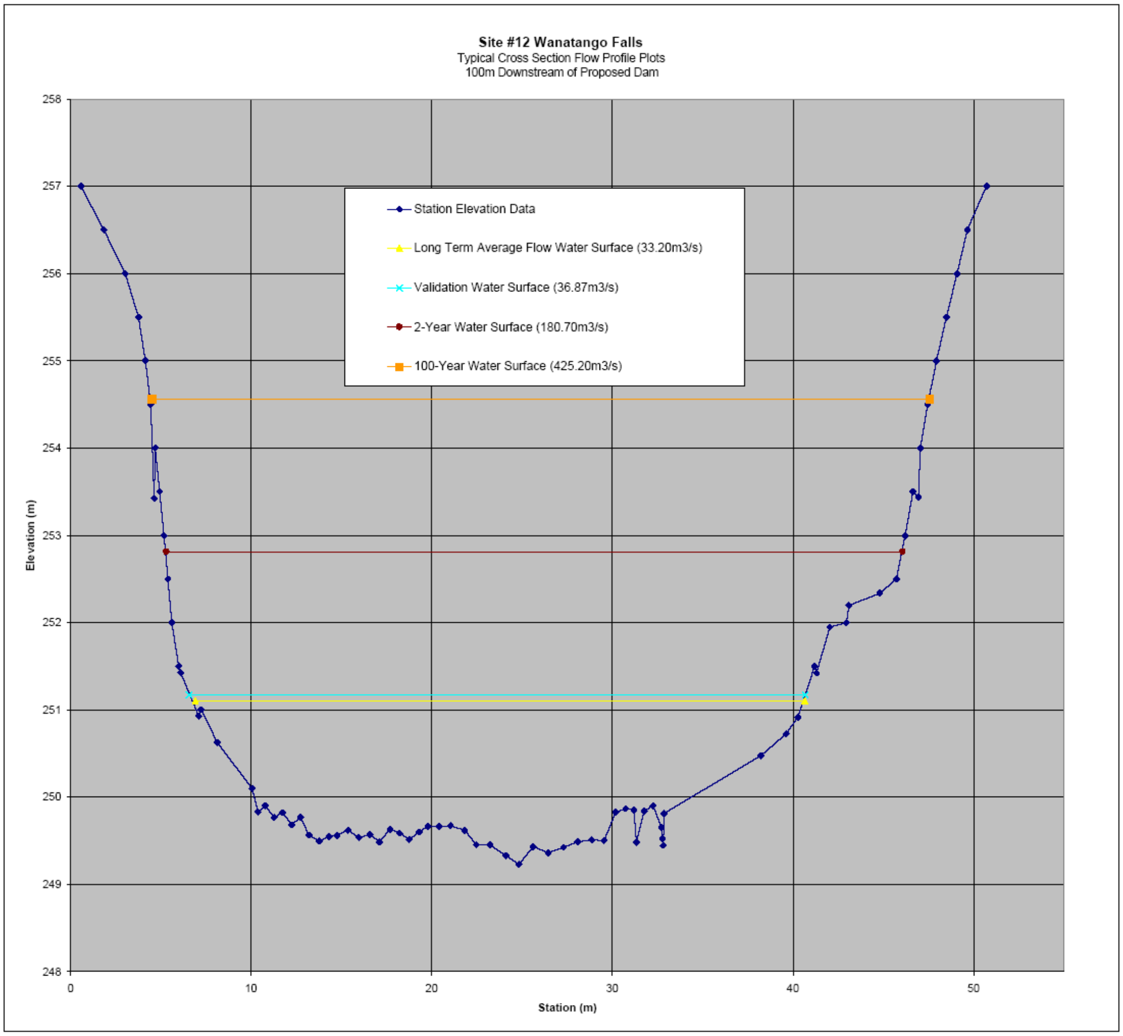

Site #12 Wanatango Falls
Typical Cross Section Flow Profile Plots
100m Downstream of Proposed Dam
Station Elevation Data
Long Term Average Flow Water Surface (33.20m3/s)
Validation Water Surface (36.87m3/s)
2-Year Water Surface (180.70m3/s)
100-Year Water Surface (425.20m3/s)
Elevation (m)
Station (m)
258
257
256
255
254
253
252
251
250
249
248
0
10
20
30
40
50

Figure 10

Project Name: Xeneca FIT Contract- Headpond Inudation mapping
Project No.: PCG019617
Site: 12_Wanatango Falls
River: Frederick House River
Designed by: T.Lozon
Checked by: D.Miller
Date Created: 2/16/2011

BURNSIDE [The Difference is our People]

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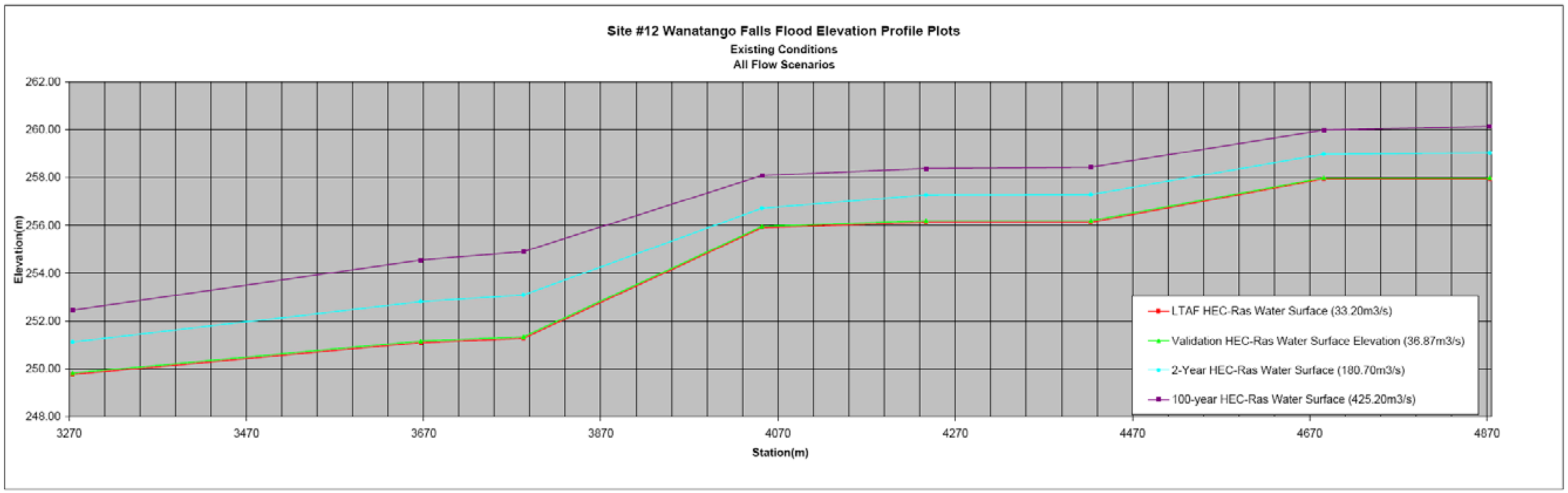
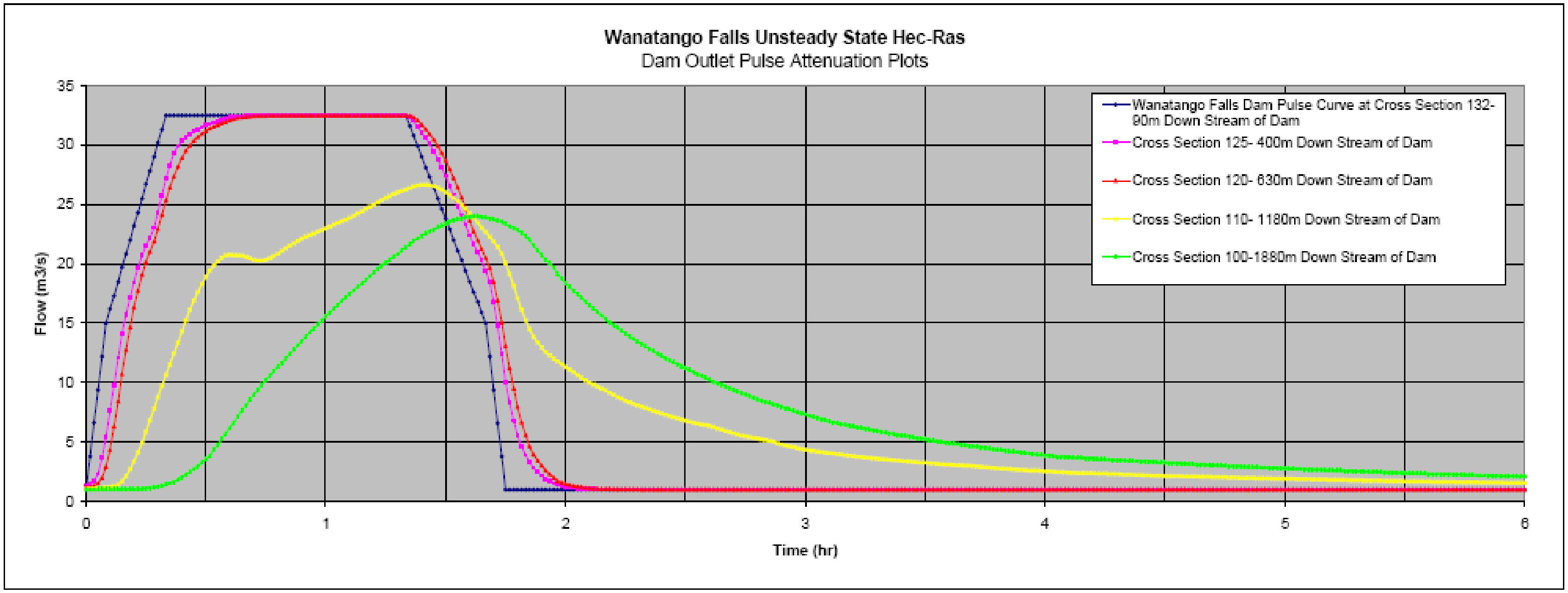
Site #12- Wanatango Falls- HEC-Ras Hydraulic Modelling Results

General Data			Calibration		Long Term Average Flow		Validation		2-Year		100-Year	
Survey Section#	Burnside X-Sec ID	Cumulative Length (m)	Calibration Flow (m3/s)	Calibration Water Elev (m)	LTAF Flow(m3/s)	LTAF Water Elev (m)	Validation Flow (m3/s)	LIDAR Water Elev (m)	2-year Flow(m3/s)	2-year Water Elev (m)	100-Year Flow(m3/s)	100-Year Water Elev (m)
-4	415	4873.05	2.00		33.20	257.94	36.87	257.98	180.70	259.03	425.20	260.14
-3	412	4685.82				257.94		257.98		258.98		259.98
-2	408	4422.96				256.13		256.20		257.29		258.44
-1	405	4237.13				256.13		256.20		257.27		258.38
0	210	4051.82				255.90		255.95		256.72		258.08
1	131	3782.81				251.28		251.35		253.09		254.90
2	129	3667.06				251.10		251.17		252.81		254.56
3	121	3274.16				249.77		249.83		251.13		252.46



The figure below illustrates a typical operating cycle during intermittent operation, including the rapid increase in flow during start-up, the gradual increase in flow from minimum turbine flow (Q_{Tmin}) to 65% turbine capacity (Q_{T65}), a 1 hour run time and gradual shut down. The figure also illustrates the attenuation of the flow as the water moves downstream in the Variable Flow Reach.

Figure 11: Unsteady State Flow Curve



5.3 Special Event Operation

During special events, such as floods, droughts and safety emergencies, it will be necessary to deviate from the normal operating parameters to manage flows and mitigate impacts.

Normal Flood Operation: Normal flood events are defined as event flows that exceed the maximum throughput capacity of the plant (Q_{Tmax}) up to and including the one in two year flood event level ($Q_{1:2}$). Flood events of this magnitude are normal occurrences in the river and present little concern for safety or environmental impacts. During these periods, the facility is operated to manage water levels upstream below the maximum upstream operating water level where possible. This is achieved by allowing any water that is in excess of the maximum turbine capacity (Q_{TMAX}) to bypass the facility through the spillway and by operating the spillway and the power generation in a manner that achieves this objective.

High Flood Operation: High flood events are defined as events that exceed the one in two year flood event level (Q_2) but are within the safe design level of the facility. Flood events of this frequency occur only infrequently over the life of the facility. The emphasis on operation is on ensuring public safety. This is typically achieved by allowing any water that is in excess of the maximum turbine capacity (Q_{Tmax}) to bypass the facility through the spillway and by operating the spillway and the power generation in a manner that achieves this objective.

Extreme Flood Operation: Extreme flood events are defined as events at which the facility cannot be attended safely by operators and where the risk of flooding of the generation equipment is possible. The emphasis on operation is on ensuring public and operator safety. Where advance warning is received that an extreme event may occur, the facility will be prepared in advance of the flood peak to maximize the ability to pass water and provide minimal obstruction to the passing flood waters.

The inundation map and river profile referenced in the section on “Upstream Storage Effects” shows the water depths and extents for various flood conditions. The objective of flood operation for the spillway, turbine and bypass is to ensure that the backwater effect is minimized and kept within the projected distance limits.

It should be recognized that the facility is not designed to mitigate the effects of naturally occurring events such as floods and droughts. However, there are circumstances where the existence of the facility can either aid in managing a special event or pose an additional risk. The flood risk aspects are managed, in part, through the government approval under the Lakes and Rivers Improvement Act of the engineering plans and specifications for the design of the facility. The purpose of this process is to ensure that the flood passage capacity of the facility is adequate and that the risk to property and public safety is duly considered. This aspect of the approval process will be dealt with after the environmental assessment process is completed and when the detailed engineering design has been finalized.

Where the operation of the facility requires co-ordination with other facilities and government agencies, Xeneca will work collaboratively with those entities on a bilateral or group basis to ensure that operating objectives are met. Examples of areas and events where coordination is required include where:

1. Normal facility operation impacts other facilities or uses on the river system;
2. Flood flow events pose risks to property or public safety;
3. Drought flow events pose risks to aquatic habitat or water uses downstream.

6 SUMMARY DISCUSSION ON OPERATIONS

The Wanatango facility has effects on upstream water levels and downstream flows. This operating plan considers these effects and sets operating objectives and parameters that minimize potential impacts on the environment and recreational uses.

The facility will operate as a "modified run-of-river" facility. In this mode of operation, the amount of water passed through the facility over a period of several days is equal to the natural run of the river flows. However, on a short term basis, flows are reduced (i.e. modified) at night and on weekends to allow more electricity to be produced during weekdays when electricity demand is high.

The ability to modify flow is directly dependent on the available storage. However, the available storage and generator size have been limited in the project design to minimize the environmental footprint. Due to this constraint, modified operation of the facility is typically constrained to low flow periods, when the inflow rate is slow and the amount of available storage is useable.

Most of the year, the facility will operate continuously; however, when natural flows fall below the minimum turbine capacity, operation becomes intermittent. Low flow conditions occur primarily during the winter and late summer. Intermittent operation creates the greatest potential for impacts on downstream uses.

Key operating objectives and parameters in this pan relate to the following:

1. The headpond will be operated in a narrow operating range to mitigate potential shoreline and habitat impacts.
2. The upstream flows are heavily regulated by an existing and manually operated control structure upstream (i.e. Frederick House Lake Control Dam) and dictate water available for facility operation. Resulting man-made flows are highly irregular.
3. 2.0 km Downstream Reach: It was recognized that variable flows associated with intermittent operation will affect a long river reach. Spawning and foraging habitat exists in this reach for Walleye, Sauger and Lake Sturgeon. The following operations objectives will apply to mitigate impacts:
    a. Spring Operation: No intermittent operation will occur during this period to protect spawning and other habitat considerations.
    b. Summer Operation: Possible intermittent operation can occur but with minimum flows set at a level that considers significant habitat activity during this period. Consideration was given to flow velocities, water depths and wetted perimeter in

the downstream reach. Ramp rates were set to minimize sudden changes of flows.

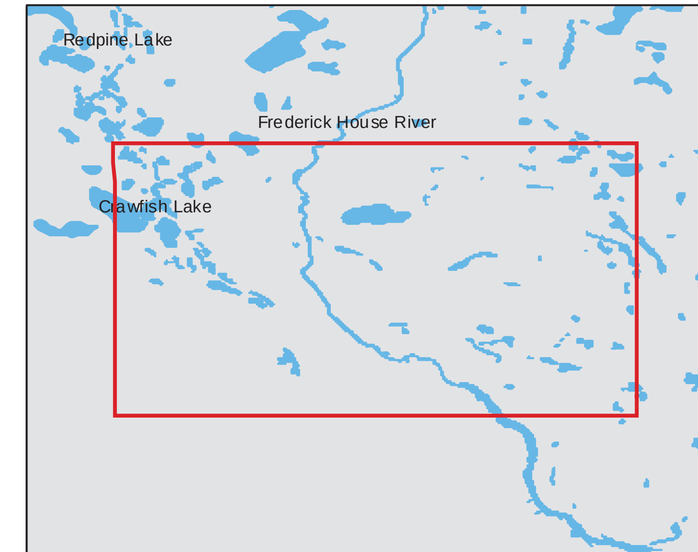
c. Fall Operation: Minimum flows are set at a level that reflects reduced habitat activity. Ramp rates were set to minimize sudden changes in flow.

d. Winter Operation: Minimum flows are set at a level that reflects minimal habitat activity in the shallow reaches. Ramp rates were set to minimize sudden changes in flow.

4. Tailrace Area: A significant spawning site exists at the base of the falls where the tailrace will be located. The final design of the tailrace will ensure that the value of this habitat is preserved. The flows proposed for the downstream reach (see above) also mitigate possible impacts in the tailrace area. Opportunity may exist to enhance this habitat during construction using excavated rock material from the powerhouse.
5. Bypassed Reach: Flows at the site bifurcated around and island, creating a long bypassed reach that has benthic habitat. The proposed design and operation will provide flows to maintain the benthic habitat in the bypassed reach.
6. Private Property: The facility operation and operating level are constrained by private property located upstream. The operating parameters have been carefully set to ensure that private property will not be affected. At the time of writing, efforts are underway to acquire these property rights. If successful, the operating plan and inundation extent will require amendment.

Attachment 1: Wanatango Falls Hydro Project Headpond Inundation Mapping (12 pages)

Wanatango Falls - Floodlines (Existing & Proposed) - Key Map



River Stations
Major Contours
Minor Contours
Existing Conditions LTAF Flood Elevation
Proposed Conditions LTAF Flood Elevation
Existing Conditions HWM Flood Elevation
Existing Conditions 2 Year Flood Elevation
Existing Conditions 100 Year Flood Elevation
Proposed Conditions 2 Year Flood Elevation
Proposed Conditions 100 Year Flood Elevation

0 500 1,000 2,000 Meters

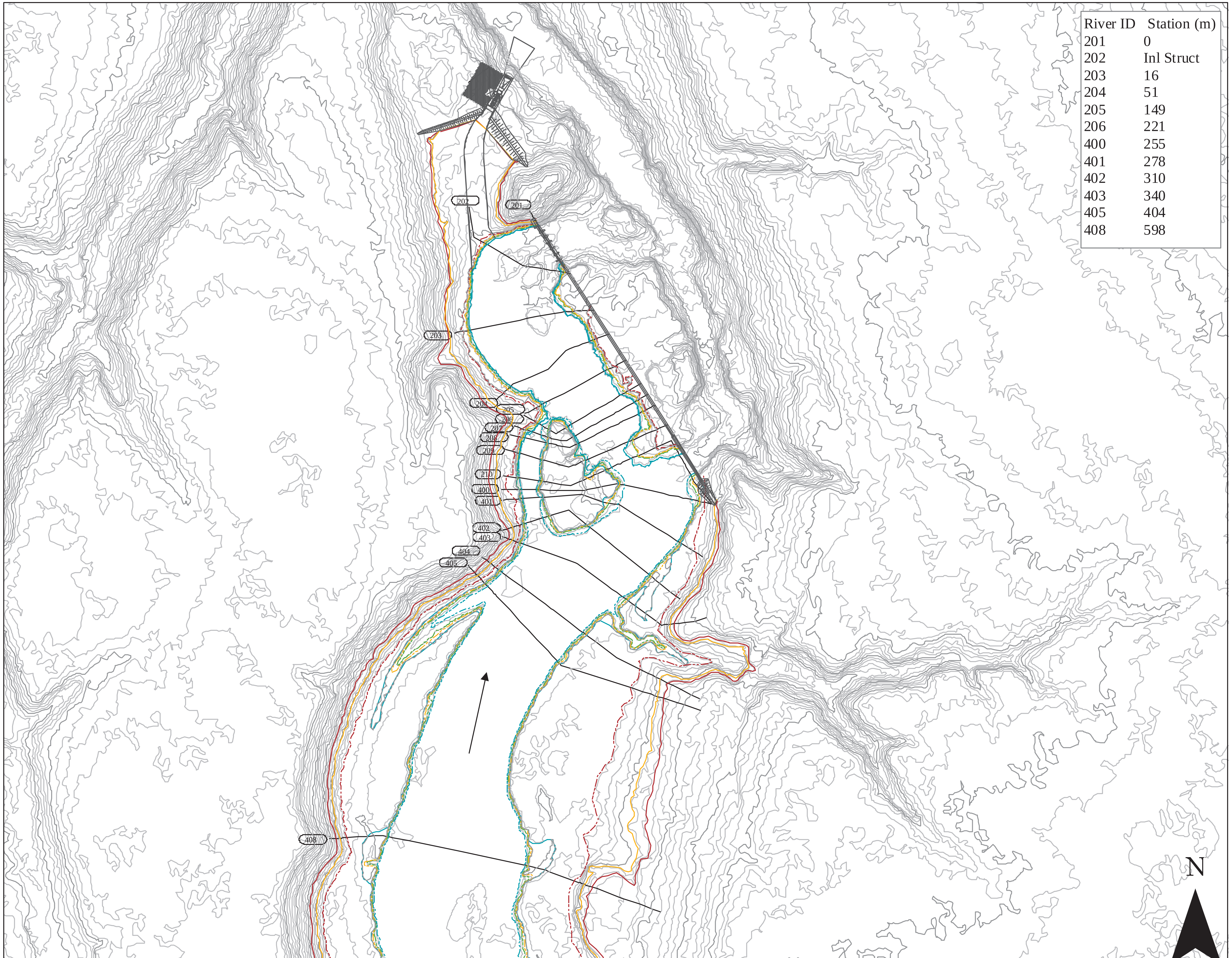
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:42300
Preliminary Plan Only

Key Map

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)



River ID	Station (m)
201	0
202	Inl Struct
203	16
204	51
205	149
206	221
400	255
401	278
402	310
403	340
405	404
408	598

- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

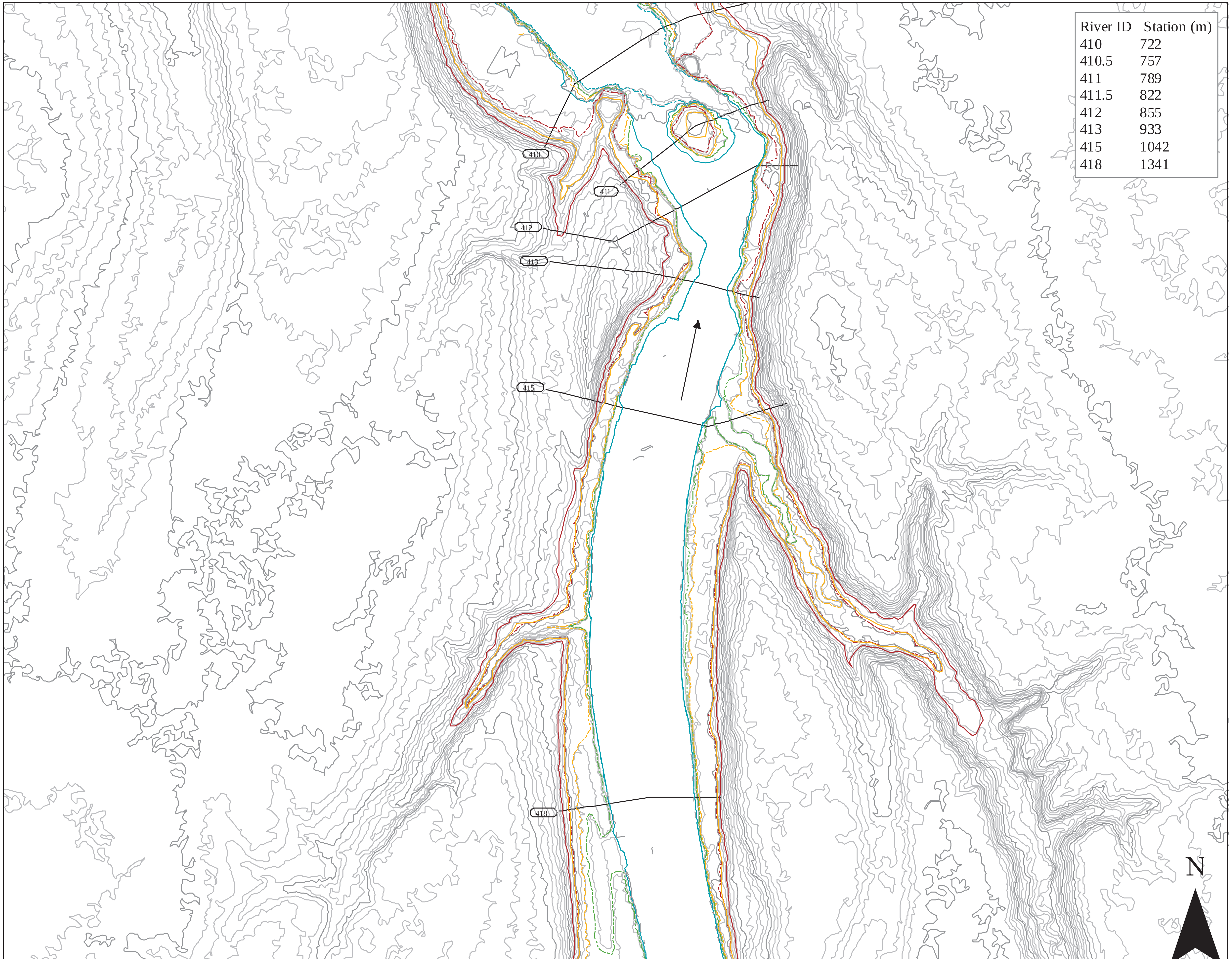
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Map 1

Wanatango Falls - Floodlines (Existing & Proposed)



River ID	Station (m)
410	722
410.5	757
411	789
411.5	822
412	855
413	933
415	1042
418	1341

River Stations
Major Contours
Minor Contours
Existing Conditions LTAF Flood Elevation
Proposed Conditions LTAF Flood Elevation
Existing Conditions HWM Flood Elevation
Existing Conditions 2 Year Flood Elevation
Existing Conditions 100 Year Flood Elevation
Proposed Conditions 2 Year Flood Elevation
Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

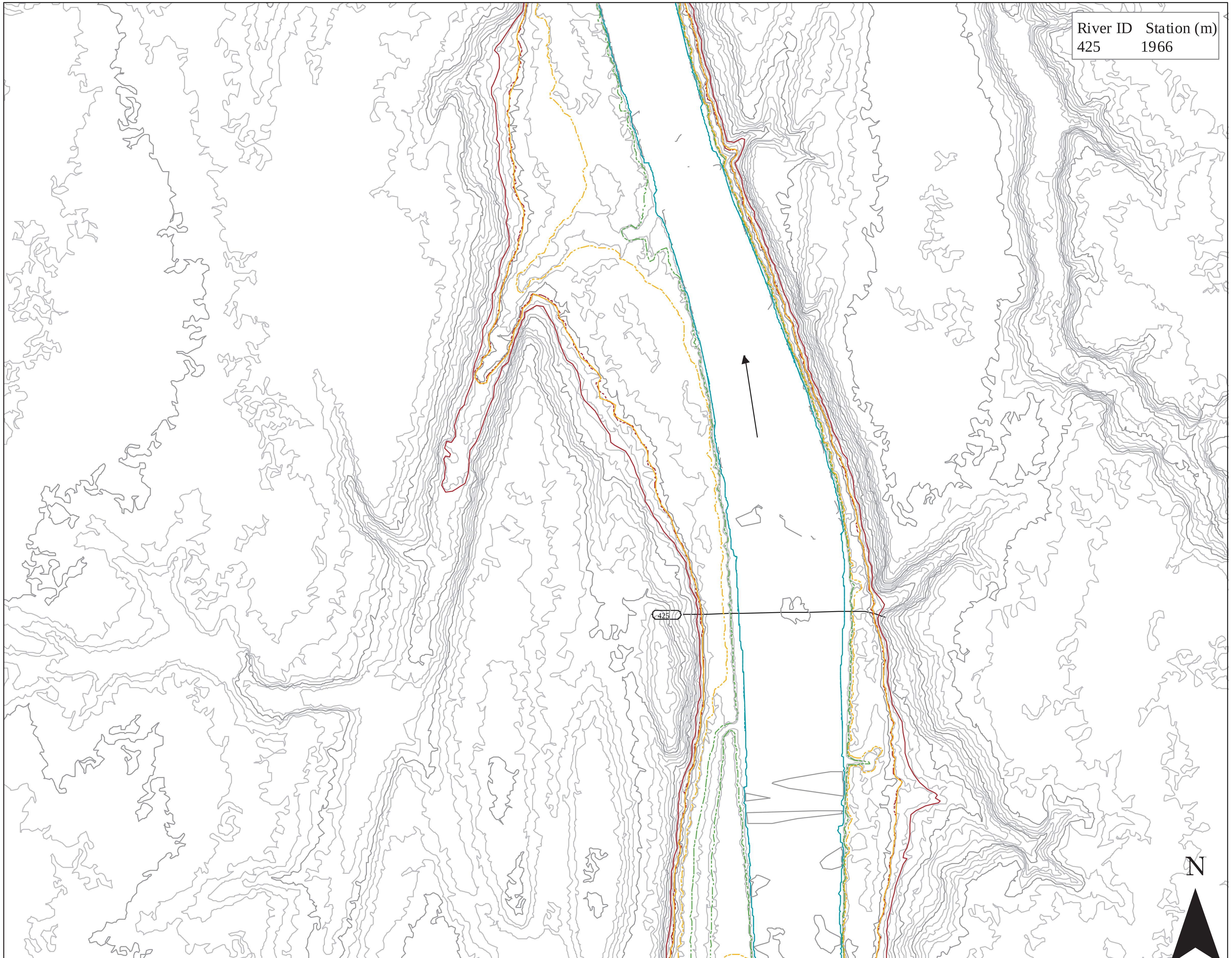
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Map 2

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)



- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

ORTECH Environmental

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Zone 17
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Preliminary Plan Only

Map 3

Prepared By:
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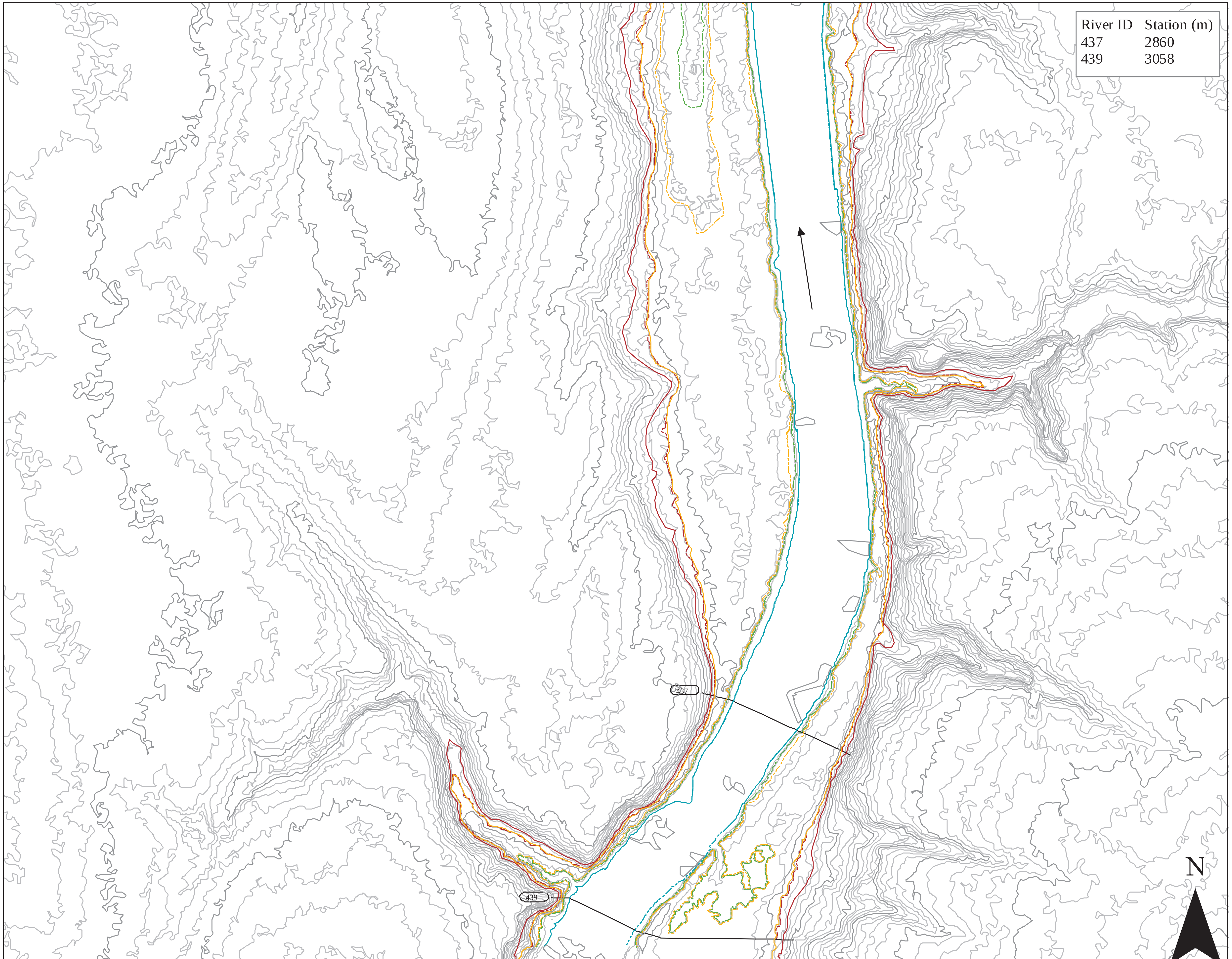
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)



River ID	Station (m)
437	2860
439	3058

- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
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- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

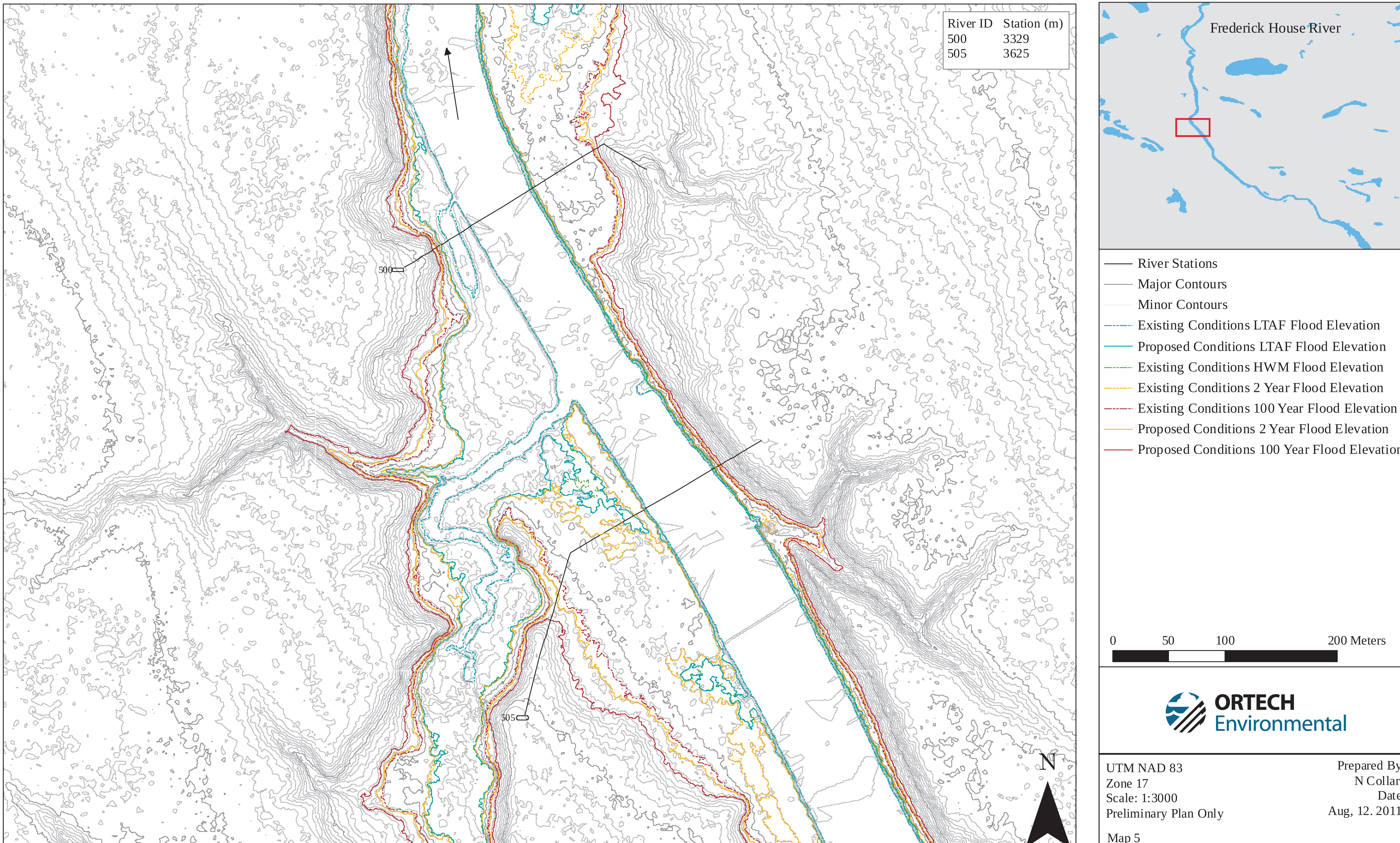
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Map 4

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)



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Zone 17
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Preliminary Plan Only

Map 5

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)

River Stations
Major Contours
Minor Contours
Existing Conditions LTAF Flood Elevation
Proposed Conditions LTAF Flood Elevation
Existing Conditions HWM Flood Elevation
Existing Conditions 2 Year Flood Elevation
Existing Conditions 100 Year Flood Elevation
Proposed Conditions 2 Year Flood Elevation
Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

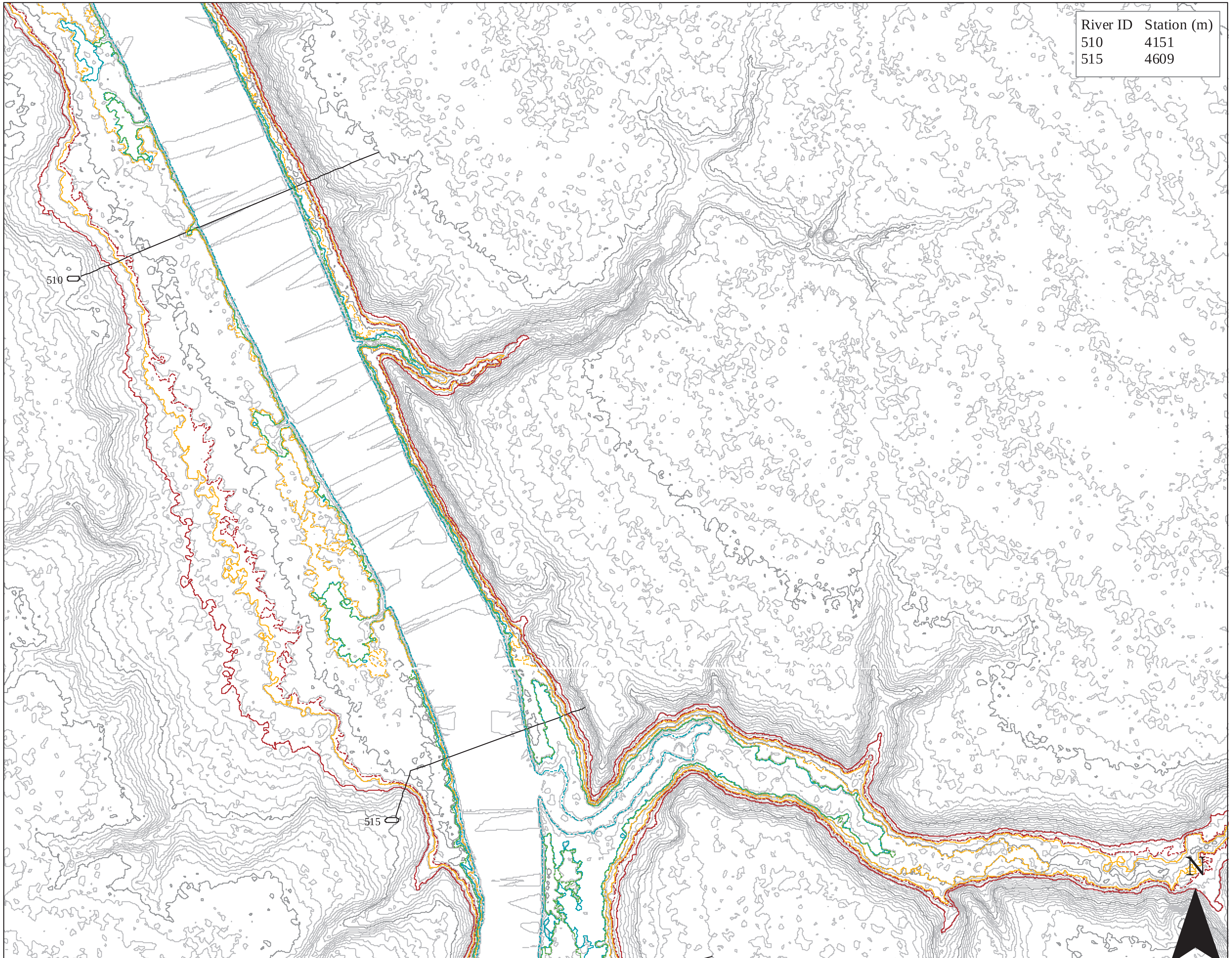
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Map 5A

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Wanatango Falls - Floodlines (Existing & Proposed)



- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Map 6

Wanatango Falls - Floodlines (Existing & Proposed)

- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

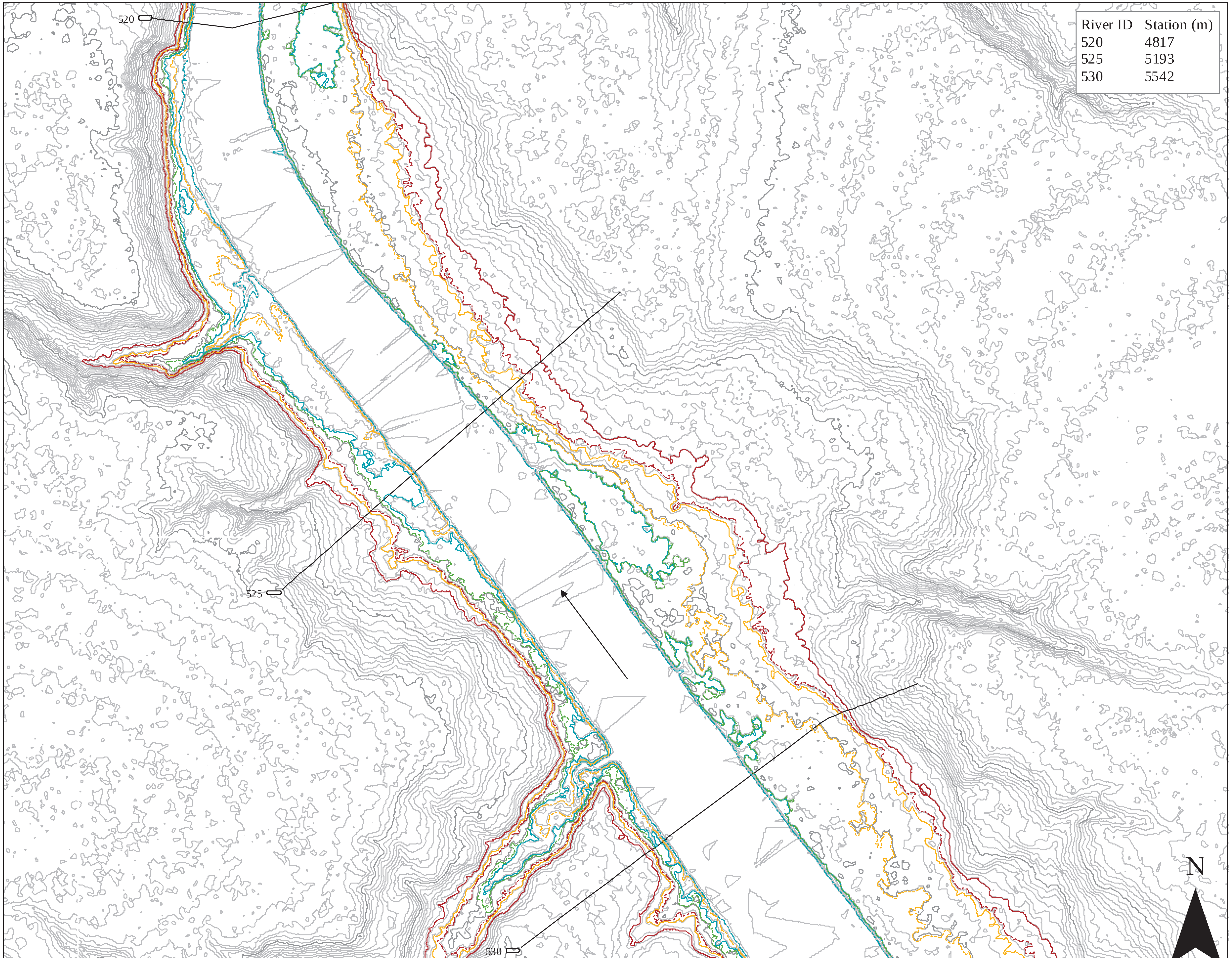
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Map 6A

Wanatango Falls - Floodlines (Existing & Proposed)



River Stations
Major Contours
Minor Contours
Existing Conditions LTAF Flood Elevation
Proposed Conditions LTAF Flood Elevation
Existing Conditions HWM Flood Elevation
Existing Conditions 2 Year Flood Elevation
Existing Conditions 100 Year Flood Elevation
Proposed Conditions 2 Year Flood Elevation
Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

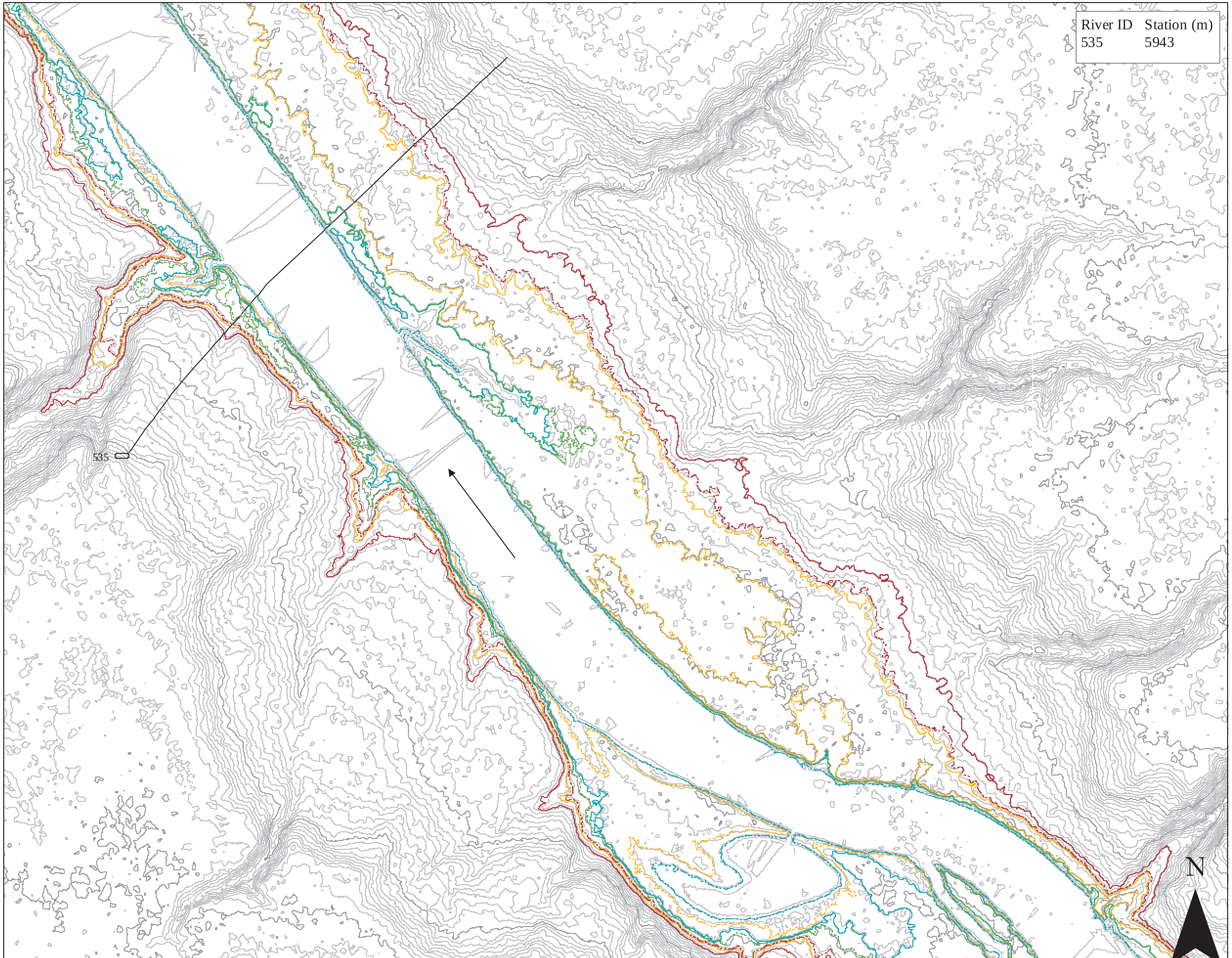
ORTECH Environmental

UTM NAD 83
Zone 17
Scale: 1:3000
Preliminary Plan Only

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Map 7

Wanatango Falls - Floodlines (Existing & Proposed)



- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

ORTECH Environmental

UTM NAD 83
Zone 17
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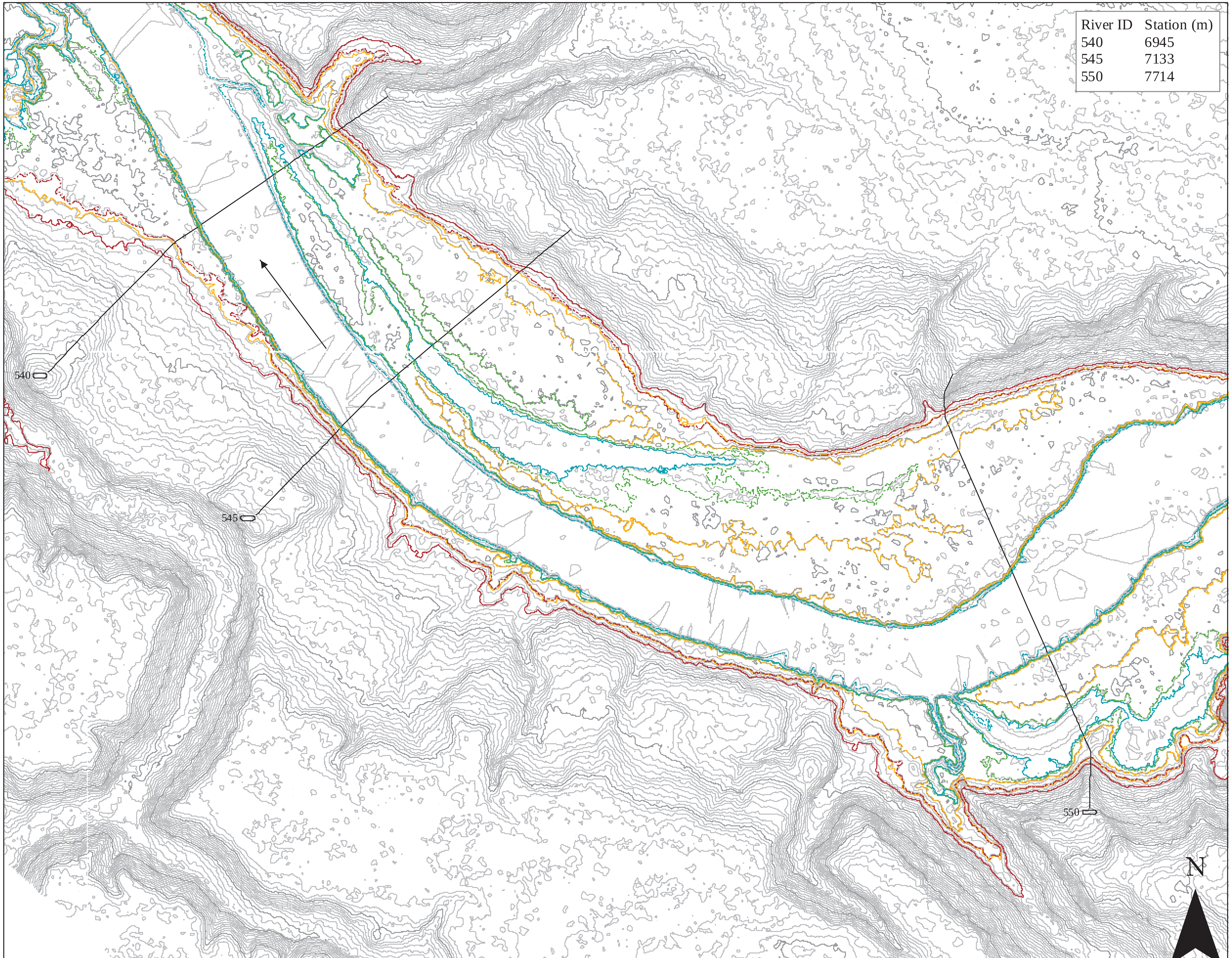
Preliminary Plan Only

Prepared By:
N Collard
Date:
Aug, 12. 2011.

Map 8

Wanatango Falls - Floodlines (Existing & Proposed)



River ID	Station (m)
540	6945
545	7133
550	7714

- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
- Proposed Conditions LTAF Flood Elevation
- Existing Conditions HWM Flood Elevation
- Existing Conditions 2 Year Flood Elevation
- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

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UTM NAD 83
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Map 9

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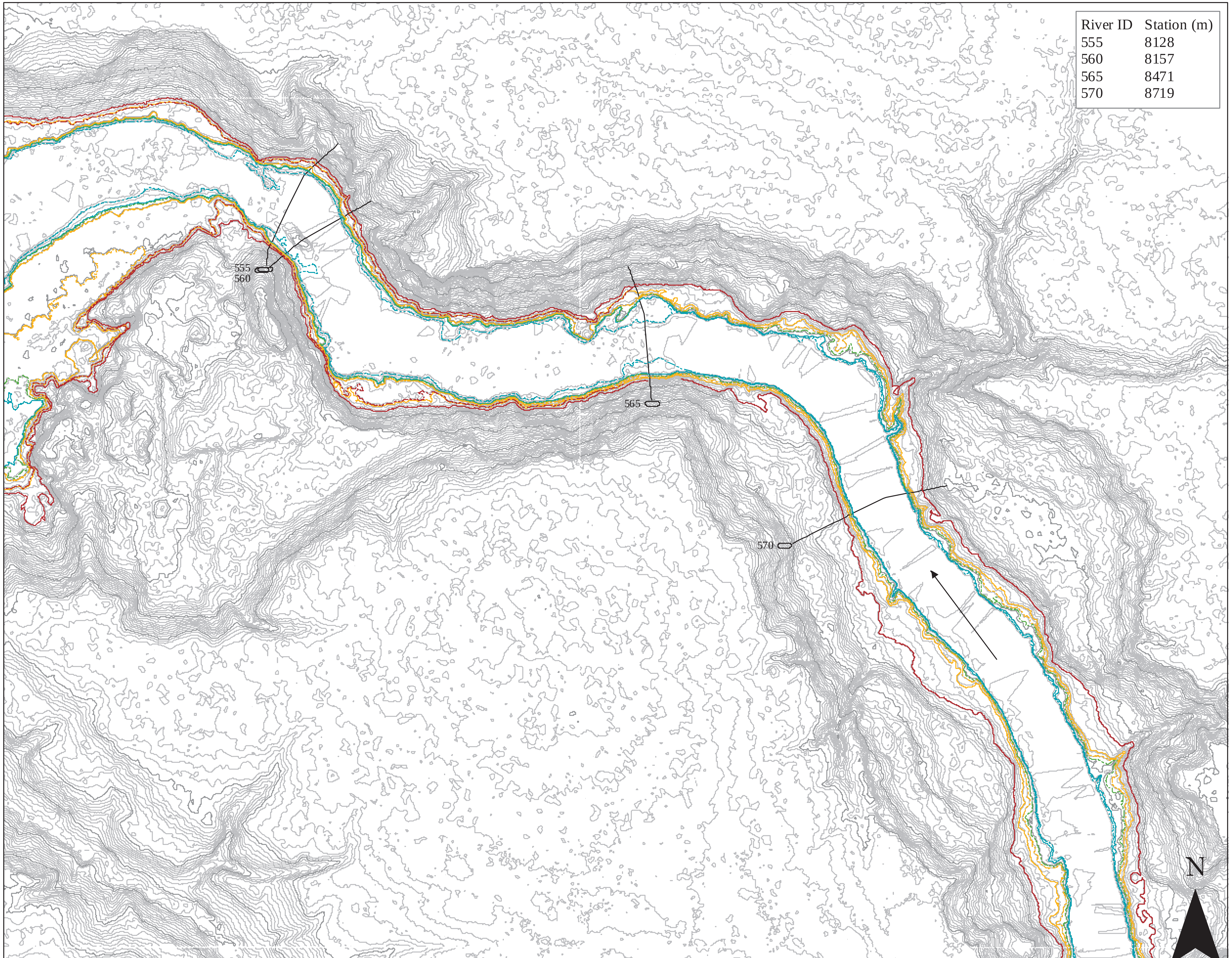
Wanatango Falls - Floodlines (Existing & Proposed)



River ID	Station (m)
555	8128
560	8157
565	8471
570	8719

- River Stations
- Major Contours
- Minor Contours
- Existing Conditions LTAF Flood Elevation
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- Existing Conditions 100 Year Flood Elevation
- Proposed Conditions 2 Year Flood Elevation
- Proposed Conditions 100 Year Flood Elevation

0 50 100 200 Meters

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Map 10

Wanatango Falls - Floodlines (Existing & Proposed)