Olympic Canoe Slalom - Whitewater Venue

Technical Requirements for Recirculating Courses

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These technical requirements are to guide the design for the whitewater canoe course and should underpin the venue construction budget to deliver a scheme that is sustainable and provides a legacy in operational, financial, environmental and sport terms.

Green Design Objectives

These technical requirements are to be reviewed and developed with respect to site and geotechnical information during the scheme design stage. A preliminary operational programme of use for the facility should be developed which will inform decisions on the user numbers and scale of provision required.

The pumps serving the canoe course will require a substantial power supply. The course design is to be developed to enable multiple programming options related to a graduated power usage profile.

The carbon footprint of the facility, where possible, should be minimised in terms of both construction and operation with respect to the following considerations:

1. Optimum siting and orientation for the facility
2. Low energy consumption through:-
   - High thermal insulation
   - High efficiency heating and lighting installations
   - Managed pump start-up and operation (soft start, variable flow drives etc.)
   - Well designed channel hydraulics to ensure managed hydraulic energy loss.
   - Improved operational outcomes and costs through commitment to functional design
   - Natural ventilation
3. Use timber only from properly managed sources
4. Use low energy, low impact materials
5. Incorporation of clean auxiliary energy sources (hydro, solar, wind etc.) where possible.
6. Consider an ecological landscape design
7. Include recycling facilities
8. Avoid over specification
9. Specify low maintenance materials

Olympic Whitewater Canoe Course Objectives

The Whitewater Canoe Course shall meet the all requirements set out in the, ICF Technical Specifications Manual and shall be in accordance with the IOC Technical Manual on Venues. The quality of the whitewater is to be of a standard suitable for Olympic and future international level whitewater canoeing events, while providing a robust legacy for the sport.

The performance specifications relate to those aspects that are required for the delivery of dynamic whitewater as an acceptable finished product in the Olympic channels when the specified flow of water is supplied respectively. The quality and characteristics of whitewater in each channel shall achieve a consistent standard for all targeted uses.

The Olympic whitewater channels shall be designed to effectively serve a variety of uses and user groups during both Olympic related and Legacy operations. The channels will support high-level Canoe/ Kayak Slalom training and competition prior to and during the Olympic Games. In Legacy operations, it will support a commercial rafting operation, along with a variety of recreational paddling and dedicated sport activities. As a guide, it should be designed for a minimum capacity of 15-20 rafts and approximately 40 canoes/ kayaks to utilize the course simultaneously but could potentially accommodate more depending on operational/ programming decisions.

The additional channel requirement will also support high-level Canoe/ Kayak Slalom training and warm-up requirements prior to and during the Olympic Games. In Legacy operations, will support a variety of paddling based instructional, recreational, and dedicated sport activities.

The additional channel length will be designed for a capacity of approximately 20 canoes/ kayaks to utilize this section course simultaneously, but could potentially accommodate more depending on operational/ programming decisions.

The standard of whitewater required for the Olympic Competition channel section is Grade 3 whitewater but may also include Grade 4 whitewater features.

Grade 3 whitewater includes rapids with moderate-sized (1-2m), irregular waves and "stoppers" that may be difficult to avoid. Complex manoeuvres in fast current and skilled boat control in tight passages are often required. Large waves or "stoppers" may be present, but can usually be avoided. Strong eddies and powerful current effects can be found. Eddies may be missed while attempting to swim into them.

The standard of whitewater required for the training channel is Grade 1 - 2.

Grade 2 whitewater includes straightforward rapids through clear channels with regular, small waves and "stoppers" (less than 1m) and calm eddies. Some manoeuvring may be required, but obstacles and medium-sized waves and "stoppers" are easily missed by trained paddlers. Swimming into eddies may require moderate effort.

The "International Scale of River Difficulty" and International "River Grading System" are additional resources that describe varying degrees of whitewater characteristics.

Specifications:

Water

Pumps

- 1 additional pump to be specified to design redundancy into the water delivery system.
- Variable Flow Drives (VFD's) must be included on all pumps to adjust and tune to required flow.
- Soft Starters, as required, to be designed in to reduce electrical draw on start up.
- PLC's to be included and Global Control Program to central location for system control.

Flow:

- Flow must be designed in the range 8 – 16m^3/s (in special circumstances flows above or below this range is possible with the consent of the Technical Delegate)
- While flow has been specified above in the range 8 -16m^3/s, the flow must be adequate to achieve appropriate quality whitewater features as approved by ICF Technical Delegate.
- ICF accepts salty, treated and fresh water as suitable for whitewater slalom competition.
- Water at a minimum must be 'secondary contact' quality, that is, suitable for boating and other such activities as referenced by the World Health Organisation (WHO) guidelines for water quality. Local water quality standards will take precedence but at no time should the water quality standard be less than that required by WHO guidelines.
- Maximum upstream flow (eddy flow) velocity must not exceed 1.5m/s.

Depth:

- Nominal depth in centred flow 1,500mm
- Minimum depth in hydraulic features 600mm
- Minimum depth in eddies 1000mm
- In no section or pond should the flow of water top the highest point of the channel wall in static or dynamic state.

Channel

Gradient:

- A maximum of 2%* gradient over the length of the competition course.
- For example the hydraulic head must not exceed 2meters of fall/lift for every 100meters of channel length.

Channel Floor:

- A maximum 2 step drops (no greater than 800mm) over competition length.

Width:

- A nominal width of 10m at channel floor.
- Cross-section of channel must be designed to ensure minimal surging and enhance the dissipation of aerated water and vortex conditions.

Construction:

- Channel to be constructed of reinforced concrete of appropriate thickness. Construction techniques can include formed in-situ concrete, pre-cast concrete and/or shot-concrete or sprayed concrete.
- A 'fit for purpose' Damp Proof Geotextile Membrane (HDPE Liner or equivalent) must be installed under all reinforced concrete including lake, head and tail ponds and channel positioned on an appropriately engineered bed which includes a suitable drainage solution.

Length:

- The minimum length for the competition course is 200m, the maximum length is 400m measured from the start line to the finish line down the centre-line of the course. As a recommendation for the Course Designers, the course should be navigable for K1M in a time close to 90 seconds.
- The competition course must allow a minimum of 50m after the finish line to allow adjustment of start/finish areas (minimum length of channel is 250m).
- To ensure that the course design encompasses the ICF Slalom Rules there must be no less than 15 meters and no more than 25 meters clear/ straight flow from the last, expected, designed gate position (of the competition slalom gates) to the finish line.
- An additional channel ("training channel") requirement of minimum100m must be designed into the facility either as increased length or an additionally constructed shorter course to provide adequate warm up/down areas for athletes during competition.
- It is recommended that a 200m "training channel" will be of much greater value to legacy operations with only a small additional capital cost.

** Expressing Hydraulic Gradient as a percentage does not limit creativity in design but builds in a safeguard against excessive hydraulic lift and power consumption.*

** Where the length of the competition channel described in The ICF Slalom Rules differs from the length described in this document, then the length specified within The ICF Slalom Rules takes precedence.*

Whitewater Channel

- Access for Truck and Crane to service and maintain pumps and pump-station.
- Vehicle access is required to internal island area of both courses. In this instance acceptable vehicle access is considered 4WD Golf Cart style.
- 2.5m wide engineered vehicle access border to run along the inside curve of both courses
- Drainage plan to ensure sheet water runoff and channel undercutting and erosion is minimised.
- Minimum radius of 75 mm in any plane shall be used for exposed external corners. The channel shall be constructed without any abrupt surface irregularities.
- In all cases in the channels where it is possible for venue users to abrade themselves or impact against channel walls or pre-fabricated items, a satisfactory surface finish (steel trowel finish) must be provided to minimize the risk of injury. This is particularly important for watercraft users who may be travelling quickly in the channel and can brush against wet surfaces causing serious grazing type injuries.
- An acceptable finish fit for all formed or pre-fabricated items within the channels that channel users could come in contact with, including underwater surfaces must be provided. For concrete surfaces, hand-steel trowelled finish or the equivalent is required. This standard of uniform smoothness and evenness of finish shall apply to all exposed formed and unformed surfaces within the channel.
- Transition surfaces connecting changing cross section types within the channel shall be gradual and prepared in such a manner as to prevent sharp corners or abrupt projections.

Start/Stilling Pond

- The Start pond must hold an adequate quantity of water to enable quietening of the pump outflow from hydraulic riser to ensure even and consistent flow exiting the start pond.
- Outflow from the Start Pond into the competition channel must be line with the direction of the constructed channel. Water flow must not enter the competition channel obliquely to the direction of the channel.
- 4.5m wide gangways along at least one side of the pool, engineered to allow access by vehicles and pedestrians, narrowing to 2.5m (pedestrians) and 4.5m (emergency/other vehicles) respectively either side of the competition course.
- The design of the start pond* must take into account the start position for Olympic competition and must not advantage or disadvantage right or left side canoe.
- Provisions to be made for quiet entry and exit to the Start Pond without impacting the competition start requirement.
- Access to the start pond by a conveyor belt must deliver kayaks and canoes into a calm area of the pond that does not interfere with the start position during competition.
- A control weir must be created between the top pond and the whitewater channels, which provide the ability to constrict the entrance into each of the channels so that an operating depth of 1.5m is achieved in the top ponds.

Finish Pond/ Pump Intakes

- If a separate bottom pond is designed then it must hold an adequate quantity of water to ensure quietening of the outflows from the tail of the whitewater course to enable even and consistent flow into the pumps.
- Provision to be made for a space at the end of the course, for disembarkation and Competition boat control.
- The distance from the end of the channel to the pump intakes should be no less than 100m to allow for the dissipation of hydraulic energy and enable smooth and consistent flows into the pump intakes.
- Computational Fluid Dynamic (CFD) hydraulic modelling must be completed to ensure optimal hydraulic inflows to pump intake bays to ensure efficient pump operation and required course flow requirements are met.

Course Reservoir/Flat Water Lake

- A recommended minimum lake size is dependent on the length of the channel(s), the number of channels and the amount of water in circulation during operations as a guide a reservoir of 10,000m^2 (1.5m average depth) for water storage, flat-water warm-up and legacy access is appropriate.
- In all instances a maximum of 400mm drawdown must not be exceeded when one or all courses are in operation. Additional drawdown is possible in unique circumstances by approval of the ICF Technical Delegate.
- Other considerations when developing lake size include environmental, water treatment options and local planning regulations.
- A minimum water depth of 1000mm when one or all courses are in operation.
- Bottom surface of lake and lake/finish pond interface must be designed to ensure that hydraulic scouring of the lake floor does not occur.

Conveyor

The Olympic course boat conveyor(s) will start within the bottom pond and rise at a gradient straight in the horizontal plane, pass over the start pool perimeter wall and then slope down into the start pool. The conveyor(s) will incorporate a vertical curve at the peak to avoid an abrupt transition between up and down slopes (preventing damage to long rigid kayaks/canoes). The design of the conveyor must ensure that there is adequate friction to ensure that kayaks and/or canoes do not slip or slide off the belt once they have loaded.

The conveyor(s) must be designed to return all water from loaded rafts, canoes and kayaks, back into the bottom or top ponds. Additionally the design of the conveyor must ensure that there are no hand, foot, body, craft or equipment entrapment points.

Conveyor Specifications	
Slope	Notionally - 1:5
Duty	Canoes, Kayaks, Rafts
Belt Width	2m
Clear Width Along Belt	2.6m
Clear Loading/unloading Width	3m
Load capacity	100kg/m

Whitewater Features

Positioning of constrictions and/or flow obstruction within the channel must maintain the flow towards the centre line of the channel. Where possible flow must not be directed into the walls of the channel nor should any single constriction or flow obstruction deflect the main flow of water from a path nominally in the centre of channel. Should any constriction deflect flow from the midline of the course then a compensating deflection must be installed to redirect and maintain the flow to the midline of the channel.

Constrictions leading to the main drops must deliver the flow of water parallel with the direction of the channel and allow an area of increased depth prior to the constriction at the entrance to the drops.

Eddies

Coincident with constriction points, the groins and obstacles will form adjacent eddies just downstream and at the side of the channel constriction. An eddy is an area of water that is contrary to the main current and often has a recirculating flow pattern within it. Typically an eddy will either have no downstream component of velocity, or it may have a measurable upstream velocity. Any resultant upstream eddy flow may be no more than 1.5m/s. The eddies in both the Olympic channels are intended to enable canoes and/ or rafts to remain stationary at the side of the channel, out of the main current.

A minimum water depth in eddies of not less than 1000mm must be achieved in all areas. Throughout the Olympic channels the channel walls need to be broadened to allow for medium sized eddies (capable of holding several canoes/ kayaks) an upstream velocity of not greater than 1.5m/s should not be exceeded in any eddy.

Access and Egress

The design of the Olympic channels shall provide a means of access to and egress from the channel at regular intervals. These access and egress points shall be located within eddies to allow users and rescue staff to enter or exit the channel effectively and safely, without the need to stop the flow of water, particularly in the case of swimmer rescue. Access and egress points shall be designed so as not to present a hazard to users of the whitewater.

The design shall provide for access to and egress from the start pool by steps that are adjacent to an area of the start pool that must be minimally affected by currents. Steps shall also be provided for a canoeist in eddies after each major hydraulic feature or at least once in both the first and second halves of the course. The steps must be designed such that canoes/ kayaks can be positioned along the length of the steps in acceptably stable water.

Gate Suspension System

Provision of a cable suspension system to support slalom gates for competition and training. The Gate Suspension System includes the cross-channel wire tensioning and adjustment system that will be used to suspend wires and slalom gates over the channel. The entire system must be a proven and accepted international standard. (The OGOC will normally provide the Olympic Competition Gates as sports equipment.)

The design shall provide for support posts to be set along both sides of the Olympic channels at approximately 10m intervals (or at a space agreed with the ICF Technical Delegate). These posts will support cables that shall be mechanically tensioned at a maximum of every 40m (or at a spacing agreed by the ICF Technical Delegate). The posts must be set back an adequate distance from the channel edge to allow sufficient access to gates. The cables shall be suspended approximately 2.2m above the top of the channel edge, while at all times a minimum of 2.5m above water level.

The posts must be robust enough and installed in such a manner so as not to move when full tension is put on the cable. Each run of cable must be robust enough to withstand full tensioning sufficient to carry the load of up to 12 slalom gate kits and cross-channel suspension wires. Tensioning shall be sufficient to ensure no more than 50mm of sag between posts.

The type and quality of materials and hardware components shall be appropriate for characteristic weather conditions (usually aluminium or stainless steel) and for the successful performance of the gate suspension system in general. The posts, cables, cross-channel wires, and all associated hardware shall be able to continue to function acceptably without significant deterioration, for the designed life of the facility.

The longitudinal cables carrying the cross-channel wires shall be installed so that it is possible to position a slalom gate above any point on either channel. As much as is practicable, the cables shall run parallel to their counterpart on the opposite side of the channel.

The cross-channel wire tensioning and adjustment system must utilise a sport-proven mechanism, able to perform quick release/ positioning functions.

A flat-water gate system to be designed into the lake at a location that does not interfere with normal operational or competition requirements and is situated away from the normal circulation areas of the courses.

Scoreboards

A minimum of two video boards must be used at the Event. The main spectator board (video board) must be placed in a high visibility area that is visible to as many people as possible. Another dedicated board must also be visible to coaches and Team Leaders when they are at the Results Posting Area adjacent to the finish.

A scoreboard (double line board) must be placed in a position that is highly visible to athletes at the immediate completion of their competition run.

Spectators

For the Whitewater Course, provision needs to be made for 5000 permanent legacy seats, with clear unobstructed sightlines to the entire field-of-play, video boards and scoreboards. (These 5,000 legacy seating positions can be grassed banks or constructed permanent tiered seating).

Games time spectator seating is to be increased to a minimum of 15,000. Constructed banks around the perimeter of the course must be engineered to allow erection of an additional 10,000 constructed grandstand seats.

Seating allowance (accessible seating) shall be made for spectators with a disability, and visually impaired spectators

All elevated grandstand-viewing positions shall be designed such that views are not adversely affected by any general standing positions in front of the constructed seated viewing position.

Circulation and Accessibility

Cross channel access points can be no greater than 100m apart. Channel underpasses are an acceptable alternative channel crossing solution. Bridges over the channel must be low profile and should not interrupt spectator viewing or TV and Broadcast operations.

Suitably engineered vehicle access must be included to allow heavy vehicle access to the inside of the course and to the pump station to maintain and service pumps and infrastructure. Roads and sufficient car parking are required to adequately service the venue in competition mode and in legacy recreation mode.

Direct access for athletes and officials from the start to finish is required. A footpath is also required to follow the entire length of the course on both sides of the channel.

The start and finish zones must be connected by a mechanical conveyor belt.

Air and Water Quality

The air must be pure and clean and not polluted by factories and roads in the vicinity.

The ICF accepts salty, treated and fresh water as suitable for whitewater slalom competition. Water at a minimum must be 'secondary contact' quality, that is, suitable for boating and other such activities as referenced by the World Health Organisation (WHO) guidelines for water quality. Local water quality standards will take precedence but at no time should the water quality standard be less than that required by WHO guidelines.

Of note:

1. There are no predetermined absolute water quality standards that will serve all such projects equally.
2. Microbiological standards can be applied on the basis of existing published criteria, but should be developed so as to be project specific.
3. Physical and chemical standards can be based on existing published criteria, but with a 'tolerable' limit if any exceed recommended limits.
4. Adequate consideration of local environmental factors must be included in the design of water quality guidelines.
5. Water quality aesthetic considerations need to be reflective of the requirements for water clarity.
6. Proposed water quality guidelines and objectives should incorporate project stakeholders input and objectives.
7. An analysis of source water supply samples must be included in determining the need for control of phosphates, iron, manganese or other particulate/ chemical contaminant.
8. Additional provision for removing suspended solids may be required.
9. A backwash retrieval process is recommended to mitigate water loss.
10. Adequate provision for site water runoff control needs to be included in the venue design.
11. Adequate provision for algae control and removal.

Technology

Conduit and cabling suitable for legacy communications, public address, data and power, must be included in the course design.

Cabling for sport timing and scoring, ensuring the ability to move the start and finish positions 50meters upstream or downstream from designed positions.

Additionally installation of a wireless LAN system for communications and data transfer is required.

Provision for Sport Video Judging to be included.

Note: 1. AC power cables cannot be accommodated in the same conduit.

2. These cables would be supplemented by Olympic technology partners in the delivery of contractual Olympic Service Requirements for the Olympic Overlay

Security

External lighting to meet safety and security specifications of the host country are required.

Flood lighting should be installed to allow competition, training and recreation to continue after nightfall.

Permanent Buildings

Suitable administration and storage facilities for the long-term operation and maintenance of the site are recommended. A guide to facilities and size requirements is outlined

Administration Building

A 1000m2 building to include administration offices, reception, meeting rooms and retail as well as facilities for catering, change rooms and toilets, first aid, cleaning.

Storage Facility

A 250m2 building for storage of canoes, kayaks, rafts, equipment, machinery etc.

Storage for a minimum of 75 canoes.

Storage rack to be constructed from weather treated tubular steel, incorporating adjustable cross- bearers into the design, allowing for larger/smaller vessels to be stored in the same space.

Workshop

A 70m2 room for repair and maintenance of canoes, kayaks, rafts, equipment, machinery etc.

Aspect	Design Considerations
Surface Finish	1. No hand, foot, body entrapment points 2. Minimum 75mm radius in any plane 3. Uniform smoothness (steel trowel finish) 4. No surface irregularities, exposed aggregate, sharp and or protruding edges.
Access/Egress Points	1. Adjacent to area of Start, at least in 3 areas within the channel and at finish pond. 2. Minimally affected by currents 3. Do not present a hazard to users 4. Allow a Kayak to fit along the steps/platform to allow safe embark/disembarkation
Tuning System	1. Lockable 2. Allows Hydraulic Requirements to be achieved 3. Able to be repositioned to allow alteration of characteristics 4. Workmanship in Accordance with Industry Standards 5. Maintain Effective function for life of facility 6. 5 Year Warranty against breakage and defects 7. No foot/hand/body entrapment points 8. Allows easy location and relocation in all static water depths 9. Exposed base plate receptacles enclosed 10. Smooth troweled finish across all channel finishes 11. Movement ability of 1m upstream and 2m laterally adjustable obstacle heights - 300mm - 1300mm. 12. UV stable 13. Robust to with stand expected impacts (full rafts + kayak noses) 14. Anchor systems must be guaranteed to perform in the environment that the course has been situated and understanding the water treatment solution adopted.
Groyne System	1. No foot, hand, body entrapment points 2. Fits flush to channel edge 3. Exhibits no un-designed Gaps and arrests water flow 4. All gaps greater than 20mm to be baffled with appropriate solution 5. Adequately secured in place
Start Pool and weir	1. 1.5m Deep 2. 200-300mm freeboard 3. Control weir at exit of start pond

Course	1. Competition Course a minimum of 200m plus 50m after the finish for end of competition technical requirements. 2. Flows a maximum of $16m^3$ 3. 10m average width at channel floor 4. Surge limiting design using trapezoidal channel shape and or other energy venting design over the length of course. 5. Maximum gradient 2%
Eddies	1. Minimum water depth of 1000mm above channel floor. 2. Exhibit minimal surging 3. Upstream flow of less than 1.5m/sec
Water /Flow depth	1. A Nominal depth of 1500mm along centre line 2. At flow constriction points a minimum of 600mm 3. Minimum depth of 1000mm in eddies 4. No Overtopping of walls
Features	1. Maximum water surface change of 1m across the features 2. Features to be acceptably stable and exhibiting minimal surging 3. The course has one or more features which allow tuning to create: • Green waves • Recirculating waves • Consistently breaking waves
Gate Suspension System	1. Able to position a slalom gate at any point above both competition and training channels. 2. Each 40m section able to carry and function as required with 12 separate slalom gates 3. Able to hold transverse channel wires 2.5m above flowing water level. 4. Notionally posts 10m apart 5. No more than 50mm sag between posts 6. Separate flat-water training gate system positioned in a section of the lake away from the competition or operational areas.