PLAYWAY WATER

Document Version 1.1

Contents

Introduction

During the development of our water system we have put a lot of care to make it like Unity itself. It's very rich in features, but still friendly in use, practical and multiplatform. By using it, you can create outstandingly looking fluids on all devices ranging from cheap mobile phones to gaming PCs.

We have developed and tested this system thoroughly for months in few projects, but as new features are added, bugs may appear. If you will experience any problems or would like to suggest a feature, please contact me at mbartniczak (at) gmail.com. I will be glad to help.

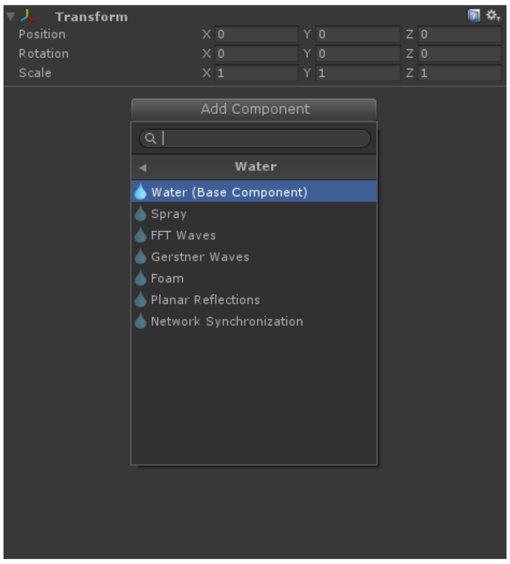
Please remember that all mobile platforms support is currently a BETA. Bugs are to be expected on them and they may not work at all for you at the current state.

Getting started

We strongly recommend to start by analyzing the sample scene located at "PlayWay Water/Samples/Galleon Demo.unity". It will present you some of the ways to use our water system in real-world situations.

To add functional water to your scene, you have to perform three steps below.

Create Water Component



Transform

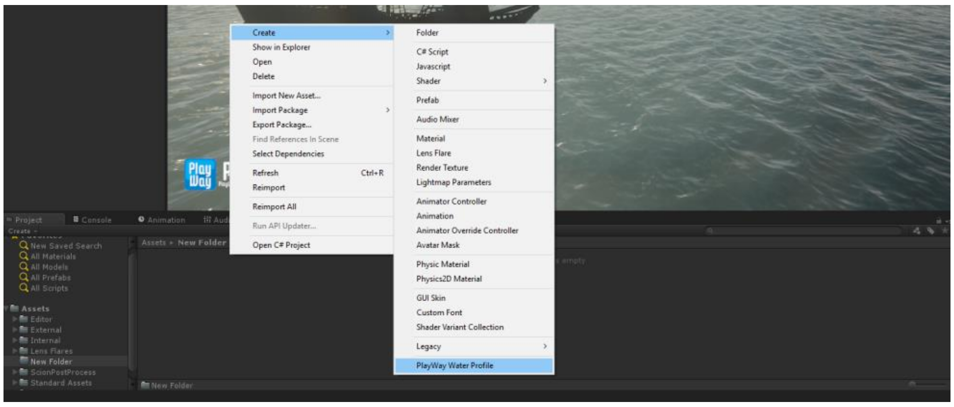
Position	X 0	Y 0	Z 0
Rotation	X 0	Y 0	Z 0
Scale	X 1	Y 1	Z 1

Create empty game object and add Water component. You can do so by selecting "Water/Water (Base Component)" in the menu presented on the left. Few additional components will be added along with it by default. You may remove them later if you don't need them.

This and all other water-related components control the process of rendering the water. In their inspectors you define purely technical means like the type of meshes to use, how reflections should be produced etc.

Water Profile

Next thing to do is to assign some Water Profile to the water that you have just created. You may use one of the default profiles located in your assets library at "PlayWay Water/Samples/Profiles" or create new ones by choosing "Create/PlayWay Water Profile".



Water profiles are the place to define your water look and feel – colors, intensities, wave types etc. It's the artists domain.

Profiles are similar in concept to materials, but they may be blended together at runtime and also describe some non-material properties like types of waves produced by the simulation or the physical density.

Water Camera

Each camera that is supposed to see water needs "Water Camera" component for that. You may add it by selecting "Water/Water Camera" in Unity's component menu.

Although it could be done automatically for each camera in scene, we have wanted to make that a conscious decision for few reasons. Beyond that it allows you to configure a few settings per camera.

Editor cameras are the exception to this rule and are automatically included for the water rendering.

See it working

You should see your water now. Hit "Play" to see how it animates.

Quality and performance

If you don't get decent enough FPS at the default settings on your target platform, don't worry. You may fix that in few ways.

Performance depends on the methods used to render water, which in turn are driven by the settings. As most settings may be set in few places, a final value actually used is always determined by choosing the lowest one of these:

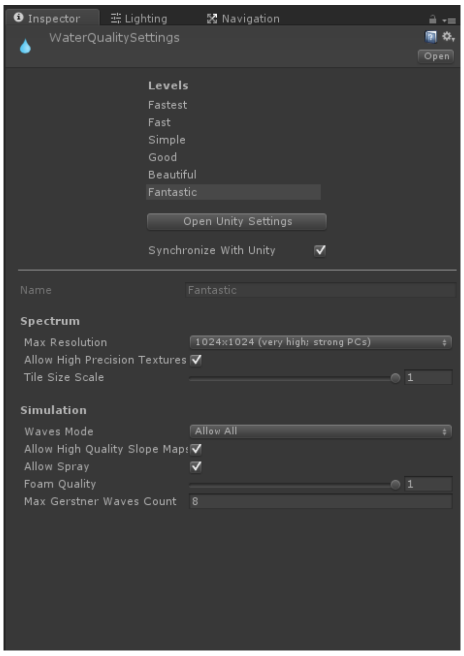
- Individual water component setting.
- Global water quality setting.
- The best setting that the current hardware may support.

Individual component settings allow you differentiate desired quality level for each fluid. For example, you will generally want to use advanced simulation methods for oceans, but keep them simple for puddles etc.

Global settings allow you to put some global limits for all fluids in your application depending on the target hardware.

Global quality settings

You may get to them by selecting "Edit/Project Settings/Water".



Levels
Fastest
Fast
Simple
Good
Beautiful
Fantastic

Open Unity Settings

Synchronize With Unity ✓

Name Fantastic

Spectrum
Max Resolution: 1024x1024 (very high; strong PCs)
Allow High Precision Textures ✓
Tile Size Scale: 1

Simulation
Waves Mode: Allow All
Allow High Quality Slope Maps ✓
Allow Spray ✓
Foam Quality: 1
Max Gerstner Waves Count: 8

Water quality settings are organized just like the Unity quality settings. You have few quality levels defined here and for each of them you may customize some performance-related settings.

By default, names, order and current quality level selection are synchronized between Unity settings and the PlayWay Water, but you may choose to not do so.

Spectrum - Max Resolution: All simulations will be performed at most at this resolution. It's performance-critical setting.

Spectrum – Allow High Precision Textures: Determines if high precision textures (32 bit floating point per channel) may be used, if supported by the target hardware. As of 1.1 there isn't much point in using it unless paired with extremely high simulation resolutions like 1024.

Spectrum – Tile Size Scale: Allows you to globally scale tile size of all water simulations. Setting it below 1.0 will increase quality and compensate drawbacks of using small simulation resolution, but will make the repeating pattern of water more noticeable.

Simulation – Waves Mode:

- Allow All – All types of simulations are allowed (FFT or Gerstner).

- Allow Slope FFT – Gerstner waves (low-quality) are allowed and used as a fallback to FFT. FFT may be used only to generate high-quality water normal maps. Supported on all platforms.
- Allow Gerstner - Gerstner waves (low-quality) are allowed and used as a fallback to FFT.
- Disallow All – No waves will be produced.

Simulation – Allow High Quality Slope Maps: It is very taxing for performance, but barely noticeable. You may consider enabling it on the highest quality level though.

Simulation – Allow Spray: Determines if "Water Spray" component is allowed on this quality level.

Individual water settings

These are the settings that you find on each water-related component inspector. Following chapters describe them in detail.

Hardware limitations

Actually used settings may still be lower than what you have chosen, when target hardware puts some limits.

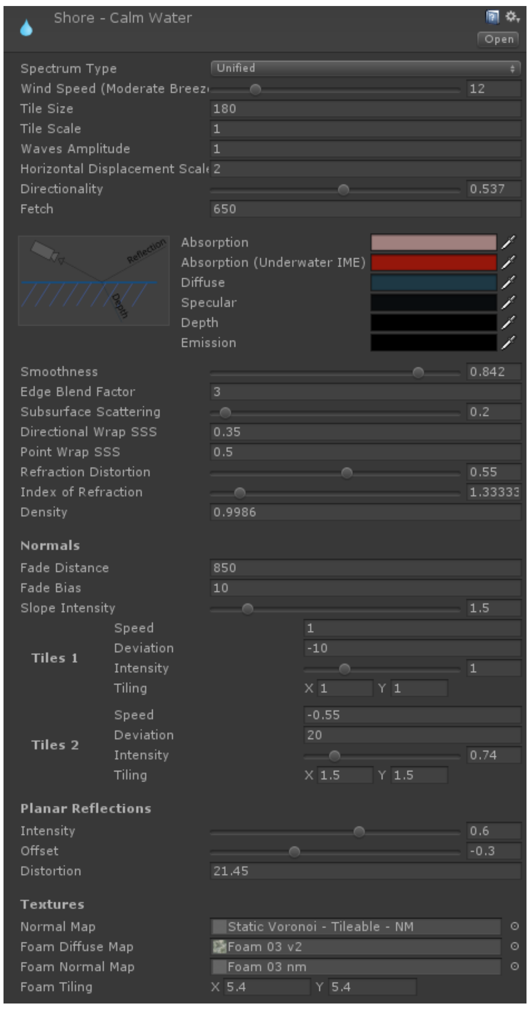
Please refer to the table below for the hardware-limited features. It will give you a general idea of platform limitations, but please keep in mind that some devices may be an exception from this classification.

SHADER MODEL	PLATFORMS	FEATURES
SM 5.0	Most desktops and new consoles	Tesselation, spray, FFT waves displacements and normals, improved microfacet model, high precision textures.
SM 3.0	Old desktops, consoles and most mobile platforms	FFT waves displacements and normals, high precision textures
SM 2.0	Extremely old desktops and many mobile platforms	FFT waves normals.

Other features are generally not platform-limited.

Water profiles

Water profiles determine the look and feel of the fluid. The best way to understand and correctly configure its parameters is to just play with them a bit and see their effects. Nevertheless, their descriptions are below.



```
Shore - Calm Water

Spectrum Type                       Unified
Wind Speed (Moderate Breez          12
Tile Size                           180
Tile Scale                          1
Waves Amplitude                     1
Horizontal Displacement Scal        2
Directionality                      0.537
Fetch                               650

Absorption
Absorption (Underwater IME)
Diffuse
Specular
Depth
Emission

Smoothness                          0.842
Edge Blend Factor                   3
Subsurface Scattering               0.2
Directional Wrap SSS                0.35
Point Wrap SSS                      0.5
Refraction Distortion               0.55
Index of Refraction                 1.33333
Density                             0.9986

Normals
Fade Distance                       850
Fade Bias                           10
Slope Intensity                     1.5
            Speed                   1
Tiles 1     Deviation               -10
            Intensity               1
            Tiling                  X 1     Y 1
            Speed                   -0.55
Tiles 2     Deviation               20
            Intensity               0.74
            Tiling                  X 1.5   Y 1.5

Planar Reflections
Intensity                           0.6
Offset                              -0.3
Distortion                          21.45

Textures
Normal Map                          Static Voronoi - Tileable - NM
Foam Diffuse Map                    Foam 03 v2
Foam Normal Map                     Foam 03 nm
Foam Tiling                         X 5.4   Y 5.4
```

Spectrum Type: Two spectrum types are currently implemented: Phillips (legacy) and Unified (recommended).

Wind Speed: Wind speed in knots. Hint on the left will display its Beaufort classification.

Tile Size: Determines area of water simulation in real world units. Use low values (180 or lower) if your cameras won't get higher than 20 meters above the water surface (FPS games etc.). Try higher values if your cameras operate naturally on heights above the 20 meters (RTS games) to reduce tiling.

Directionality: Eliminates waves moving against the wind. Should be 0 for oceans.

Fetch: It is the length of water in meters over which a wind has blown. Usually a distance to the closest land in the direction opposite to the wind.

Absorption: How much light of each color (R, G and B) should be absorbed per meter by the water volume.

Absorption (Underwater IME): Same as above, but used by the underwater image effect.

Edge Blend Factor: Controls water fading near the intersections with other geometry.

Subsurface Scattering: How much light should be scattered back from the underwater. Should be set high in profiles with small and medium waves, low in profiles with big waves.

Directional Wrap SSS: Crude approximation of subsurface scattering. Use it along with with the full volumetric scattering defined above to get the best results. This setting is used for directional lights.

Point Wrap SSS: Same setting, but for point lights.

Refraction Distortion: Determines refraction distortions intensity.

Index of Refraction: Refer to the sources around the web to find the correct value for the fluid you need. Should be set to 1.33333 for water.

Density: Physical density. Dense fluids apply stronger forces to objects moving through them.

Normals – Fade Distance and Bias: Water gets really noisy at a distance and SMAA or FXAA won't handle that. This parameters will let you fade water's normals to avoid this problem.

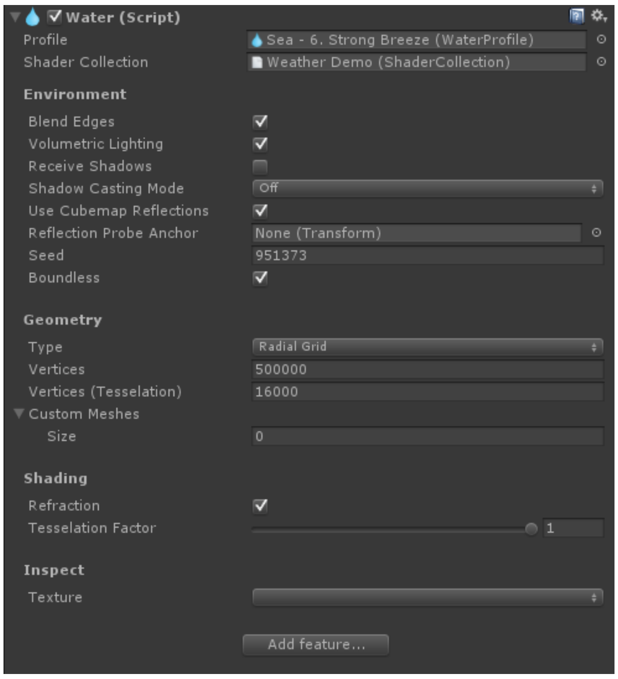
Normals – Slope Intensity: Intensity of wave normal when using FFT.

Normals – Tiles: Define parameters of two normal map tiles used by the shader.

Planar Reflections – Offset: Vertical offset of the planar reflection. Fixes some common artifacts produced by them.

Components overview

Water



Water (Script)

Profile	Sea - 6. Strong Breeze (WaterProfile)
Shader Collection	Weather Demo (ShaderCollection)
Environment	
Blend Edges	✓
Volumetric Lighting	✓
Receive Shadows	
Shadow Casting Mode	Off
Use Cubemap Reflections	✓
Reflection Probe Anchor	None (Transform)
Seed	951373
Boundless	✓
Geometry	
Type	Radial Grid
Vertices	500000
Vertices (Tesselation)	16000
Custom Meshes	
Size	0
Shading	
Refraction	✓
Tesselation Factor	1
Inspect	
Texture	

Add feature...

Environment

Blend Edges: Makes shader softly mask water near intersections with other geometry. You can control range of this blending in a water profile.

Receive Shadows: If checked, water will receive shadows from main directional light. That light needs to have WaterShadowCastingLight component attached to it. If water is opaque (blend edges off, refraction off) shadow receiving will work for all lights and no additional steps are necessary.

Use Cubemap Reflections: Determines if reflection probes should be used to render reflections on water. May be used in conjunction with other methods of generating reflections.

Seed: Setting it to 0 makes water behave differently at each run. Other values make it predictable. It is useful for cutscenes, network games etc.

Wind Direction Pointer: Transform that points the wind direction with its Z-axis.

Boundless: Should the water be considered endless in all directions? Used by physics etc. to determine where the water is. If you won’t check it, you should create game objects with colliders and WaterVolumeAdd component to specify water volume for proper physics and underwater effect detection.

Geometry

Type: Possible values are Radial Grid, Projection Grid, Uniform Grid and Custom Meshes. Radial grid is the recommended geometry type. It is flat radial grid placed on the sea level, covering field of view as closely as possible. Projection Grid may be a good choice for platforms not supporting tessellation but creates noticeable artifacts at horizon. Due to having many drawbacks, this method may be removed in upcoming versions. Uniform grid is used by some internal effects and not recommended in regular use. Custom meshes is the geometry of choice if you plan to create small fluids like puddles. It gives you exact control over vertex count and surface area of fluid.

Vertices: Determines vertex count of water if not using custom mesh.

Vertices (Tesselation): Same setting, but used for systems with tessellation support. You want it to be lower as tessellation puts lots of well distributed additional vertices.

Shading

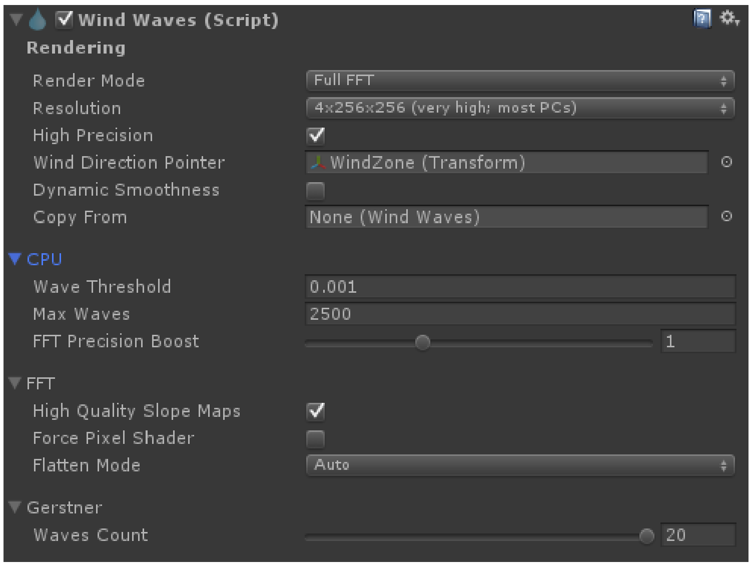
Tesselation Factor: How many vertices should be added by tessellation. It is recommended to set it to 1.0 and control this by global water quality settings.

Inspect

You may choose most of the water maps here and observe how their contents change in time.

Wind Waves

Produces wind waves on the water surface. Always use it for seas, oceans and lakes. It may also be useful for other water bodies.



Wind Waves (Script)

Rendering

Render Mode	Full FFT
Resolution	4x256x256 (very high; most PCs)
High Precision	✓
Wind Direction Pointer	WindZone (Transform)
Dynamic Smoothness	
Copy From	None (Wind Waves)

CPU

Wave Threshold	0.001
Max Waves	2500
FFT Precision Boost	1

FFT

High Quality Slope Maps	✓
Force Pixel Shader	
Flatten Mode	Auto

Gerstner

Waves Count	20

Render Mode:

Full FFT – Fast Fourier Transform is used to render displacements and (optionally) slopes.

Gerstner and FFT Slope – Gerstner is used to render displacement and slopes. Result is overlayed with FFT slopes.

Gerstner - Gerstner is used to render displacement and slopes.

Resolution: Determines quality of waves simulation, foam and spray. Performance-critical. Quality-critical.

High Precision: Described in detail in Global Quality Settings.

Wind Direction Pointer: Transform that points the wind direction with Z axis.

Dynamic Smoothness: Makes water smoothness depend on the angle and distance to camera in a physically correct manner. If water in your game is viewed from predictable perspectives (like in RTS games) you may disable this and just set water smoothness correctly.

Copy From: If set a wind wave spectrum of other Wind Waves component is used, making this instance a lot faster. It is not recommended to use more than 1-3 Wind Waves that do not copy its spectrum from somewhere else.

CPU

Wave Threshold: How small waves should be considered by the CPU. Lower values may make physics computations more precise, but also decrease performance. Default setting is pretty low actually. There is little to no reason to decrease it further.

Max Waves: How many waves from the spectrum may be used by the CPU.

FFT Precision Boost: It is recommended to keep it at 1 as it is optimal setting. If you prefer to keep CPU less occupied you can set it to 0, but physics precision will suffer a bit.

FFT

High Quality Slope Maps: Described in detail in Global Quality Settings.

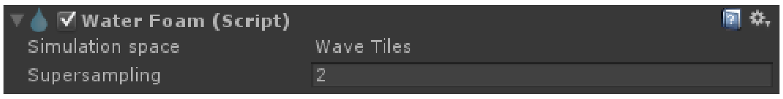
Force Pixel Shader: Disables FFT generation through compute shaders. Not recommended as compute shaders are a lot faster.

Gerstner

Waves Count: How many waves should be used by this method.

Water Foam

Produces foam.



Water Foam (Script)

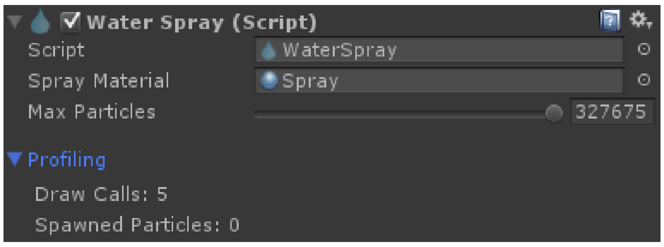
Simulation space	Wave Tiles
Supersampling	2

Simulation Space: Determined automatically. If you don't have WaterOverlays attached to your water object, "Wave Tiles" are used, otherwise camera overlay space is used for foam simulation. Please read corresponding tooltips to learn about pros and cons of both methods.

Supersampling: Simulation resolution multiplier. Recommended: 2.

Water Spray

Produces spray when wave gets too big and breaks. Greatly improves storms.

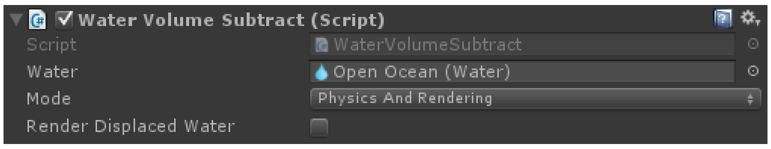

Water Spray (Script)
Script WaterSpray
Spray Material Spray
Max Particles 327675
Profiling
Draw Calls: 5
Spawned Particles: 0

Spray Material: Material used by the spray particles. Default (and recommended) material is located at: “PlayWay Water/Samples/Materials/Spray.mat”.

Max Particles: How many particles at most should be simulated. Set it as low as possible. Multiplicities of 65535 are recommended.

Water Volume Subtract

Removes water from the insides of attached colliders. Does that for both rendering and physics. Use it for boats, submarines, closed bottles etc. to remove not wanted water.


Water Volume Subtract (Script)
Script WaterVolumeSubtract
Water Open Ocean (Water)
Mode Physics And Rendering
Render Displaced Water

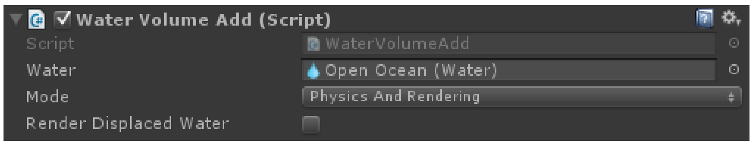
Water: Water that should be affected.

Mode: Lets you choose to disable just water physics (buoyancy etc.) inside this collider or to disable it along with removing water inside this collider from rendering.

Render Displaced Water: Lets you render water behind the subtractive volume. An example of use may be a glass bottle that displaces a sea water using subtractive volume. If you won’t use this setting there will be a hole in water behind it. That’s fine as long as your object is opaque (ships etc.). Use only if necessary as it adds to render calls.

Water Volume Add

Adds water to the insides of attached colliders. This is one way to specify where your water is if you won’t make it boundless. Use it to create a glass of water, a puddle etc.


Water Volume Add (Script)
Script WaterVolumeAdd
Water Open Ocean (Water)
Mode Physics And Rendering
Render Displaced Water

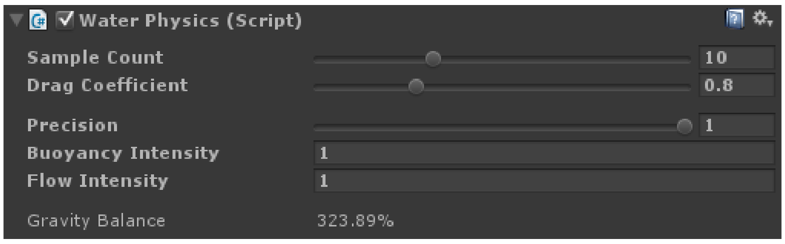
Water: Water which should be affected.

Mode: Lets you choose to enable just water physics (buoyancy etc.) inside this collider or to enable it along with adding water inside this collider for rendering. Don't use "Physics and Rendering" mode if not necessary as it affects performance.

Render Displaced Water: Lets you render water on the border of attached colliders (not just the surface). Useful if your water is inside a transparent container etc.

Water Physics

Simulates drag and buoyancy forces applied by the fluids on the attached object.


Water Physics (Script)

Sample Count	10
Drag Coefficient	0.8
Precision	1
Buoyancy Intensity	1
Flow Intensity	1
Gravity Balance	323.89%

Sample Count: How many sample points should be used to apply forces.

Drag Coefficient: Determines how much drag force should be applied to the object. For details, please refer to the Wikipedia page on the subject. It will be partially automated in the future.

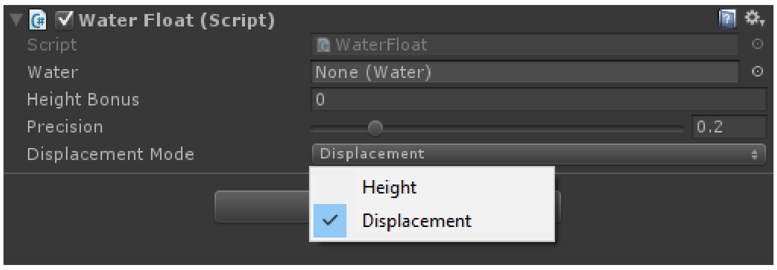
Precision: Keep it low for objects bigger than most waves. Set it higher when imprecisions arise on small objects.

Buoyancy Intensity: Scale buoyancy force applied to the object. May be useful for beach balls and other objects with extremely low density as PhysX time step may be too high to handle them correctly.

Flow Intensity: Scale flow force applied directly by water waves.

Water Float

Makes object float on water without use of physics.


Water Float (Script)

Script	WaterFloat
Water	None (Water)
Height Bonus	0
Precision	0.2
Displacement Mode	Displacement

Height Bonus: Vertical offset to the object position.

Precision: Keep it low for objects bigger than most waves. Set it higher when imprecisions arise on small objects.

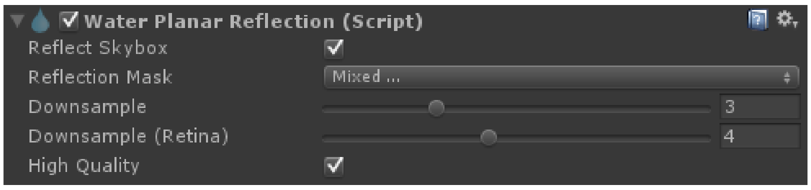
Displacement Mode:

Displacement – Object will follow the original point on water in all directions. Recommended.

Height – Object will move only vertically. Some imprecisions may arise during extremely choppy weather.

Planar Reflections

Generates planar reflections on the surface. Very precise, but works well only for relatively calm water. You may tune its intensity in water profiles for each weather. This component is expected to be improved in the near future. New settings will appear.


Water Planar Reflection (Script)

Reflect Skybox	✓
Reflection Mask	Mixed ...
Downsample	3
Downsample (Retina)	4
High Quality	✓

Reflection Mask: Choose layers which should get reflected.

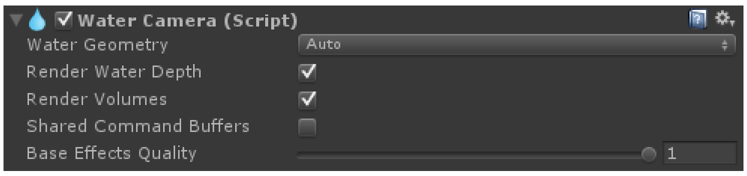
Downsample: Downsampling factor of the screen resolution. Planar reflections should be blurred anyway, so there is no reason to use a full resolution (1).

Downsample (Retina): Same setting, but used for screens with very high DPI.

High Quality: Hurts performance, but produces physically correct reflections near horizon.

Water Camera

Renders water on camera along with all other screen-space data.


Water Camera (Script)

Water Geometry	Auto
Render Water Depth	✓
Render Volumes	✓
Shared Command Buffers	
Base Effects Quality	1

Water Geometry: Allows you to override water geometry used by the water to render. Useful for internal effects which, for example, won't work with projected grid.

Render Water Depth: Renders water depth into Unity's native depth map. Recommended.

Render Volumes: Renders data used by subtractive volumes.

Shared Command Buffers: This component extensively uses command buffers. Check this option if you also use your own.

Base Effects Quality: Water has a pretty smooth shape so it's often safe to render it's depth in a lower resolution than the rest of the scene. Although the default value is 1.0, you may probably safely use 0.5 and gain some minor performance boost. If you will encounter any artifacts in masking or image effects, set it back to 1.0.

Common Issues

Vignette on water and weird look

Cause: Your water is set to use reflection probes, but there are no valid reflection probes around. If you have them in your scene please double check if they are correctly baked.

Solution: Either disable “Use Cubemap Reflections” on Water component or add valid reflection probes to your scene.

Mysterious colliders

PlayWay Water internally uses trigger colliders near camera and objects with enabled water physics to detect when they get close to a water body without hurting performance. To ensure that this won’t affect your game:

- Ensure that their layer is excluded from Lens Flares occlusion (it is by default).
- Exclude this layer from all your scripting raycasts.

By default all water colliders are placed on layer 1 (TransparentFX). You can change this in “Edit / Project Settings / Water”.

If you use UFPS from the Asset Store, please open vp_Layer.cs and add this layer to ignore list. There may be some other assets that may have issues with this. It is always easily fixable – please contact us to get a support.

Unstable ships

Cause: PhysX computes center of mass with assumption that body density is constant. This is correct most of the time, but not a case for ships. In real world, ships are balanced to have their center of mass as low as possible to gain stability.

Solution:

- Click “Materialize Center of Mass” context menu item on ship’s rigid body.
- Find center of mass object among ship children in scene hierarchy.
- Move it down.

Workflows

Boundless water

- Enable “Boundless” toggle and set radial grid geometry on Water component.
- Don’t use additive water volumes on it.
- Use subtractive water volumes to remove water from ships etc. that move through it.
- Attach WindWaves component.

Smaller water bodies

- Disable “Boundless” toggle and use custom mesh geometry on Water component.
- Link your custom water mesh to a field in Water inspector. A default Unity plane is often a good choice.
- Use additive water volumes with “Physics” mode to specify where your water is.
- If you want your custom geometry to be masked just to the insides of your collider (like inside of a glass of water), use “Physics and Rendering” mode on your additive water volume. Don’t use this mode for lakes and puddles as the “extra” geometry will land below terrain anyway.
- **Always prefer custom mesh geometry for small water bodies. Using “radial grid” will make water try to render everywhere else just to mask itself and hurt performance.**

Sun shadows on water

- Enable “Receive Shadows” toggle on Water component.
- Attach WaterShadowCastingLight component to your main directional light.

Compound colliders with water physics

- Add each collider to a separate object as a child of your RigidBody.
- Attach WaterPhysics component to each of them. They will correctly affect root RigidBody.
- PhysX also works fine with this workflow and uses these colliders correctly for RigidBody collisions.

Many water objects

- Water objects are culled correctly – don’t worry about it.
- If you use WindWaves component though, each water object will perform its own waves simulation. It is expensive.
- To solve this you may keep one water to perform simulation and assign it to “Copy From” field of all other water objects to copy simulation results to them.
- Each water will still have its own unique waves. What they will share is general waves look.

Update Notes

Updating from 1.0 to 1.1

- You will have to click “Update” button on each water in your project. This will remove all deprecated components and replace them with the new ones.
- From now on WaterWavesFFT and WaterWavesGerstner components are deprecated and replaced by the WindWaves component.
- Some of the Water component properties has been moved to WindWaves.
- Resolution, High Precision, Wave Threshold (CPU), Max Waves (CPU) properties will reset. It’s normally not an issue as there is only occasionally a reason to modify them and it’s best to let quality settings override theirs values.
- From now on there are four water maps instead of only one. That means that 512x512 simulation will run 2- 3 times slower, but will also look a lot better than before.
- If you have removed or commented out [ImageEffectOpaque] line in the GlobalFog component, restore it as it is no longer necessary to make it work correctly with water as of Unity 5.3.