

Visualization Insider

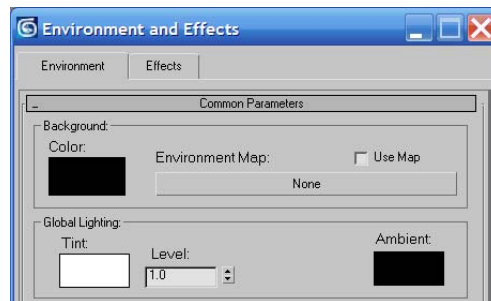
A Little 'Background' Information

Creating Backgrounds for 3D Scenes

Backgrounds are a critical part of just about every type of 3D scene. Although they are a relatively simple element to add to a scene, backgrounds can just as easily be a source of frustration and problems for 3ds Max users. There are two main types of backgrounds – those created with geometry and those created by use of the Environment Map channel. Both have advantages and disadvantages over the other and both can be broken into several subcategories. The following discussion explains each of these categories and subcategories and looks at methods to implement each type of background.

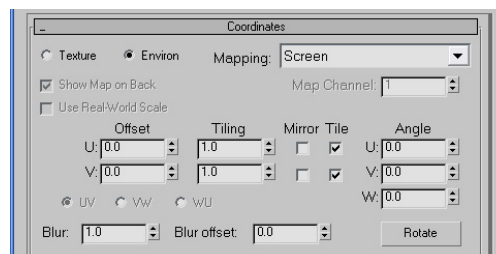
Environment Channel Backgrounds

This is the simplest type of background to implement, yet often the most difficult to make look good. It is nothing more than using a color or a map in a fixed orientation. By default, 3ds Max uses a black color swatch in the Environment and Effects dialog box to provide a black background. This type of background is a poor choice regardless of the color, but black is particularly bad even for test renders because of how it can hide the boundaries of an object.

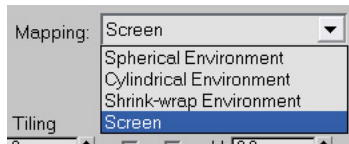


If you load a map into the Environment Map channel, you are telling 3ds Max to override the background color and display the map to the extents of the rendered window, regardless of how large the rendered image may be. The main advantage of using the Environment Map channel is that it's quick and easy to implement. Using a single color for a background is not realistic, and therefore, maps are really the only acceptable alternative. By default, any map you load stays fixed in the background, so manipulation of their tiling and placement is usually required. Furthermore, when an additional rendering of the same building is taken from a different view, the background placement would have to be adjusted to keep the sequence of images believable. In the images below, the background image alone ruins the believability of the sequence.

To adjust the placement and tiling of a background image in the Environment Map, you will need to load an instance of the map into the Material Editor and adjust the Offset and Tiling Parameters in the Coordinates rollout, shown below. To load an instance, drag the map from the Environment Map channel into any sample slot of the Material Editor and choose the Instance option. When you do, the Coordinates rollout should look like the image below, with the Environ option selected and Mapping set to Screen.



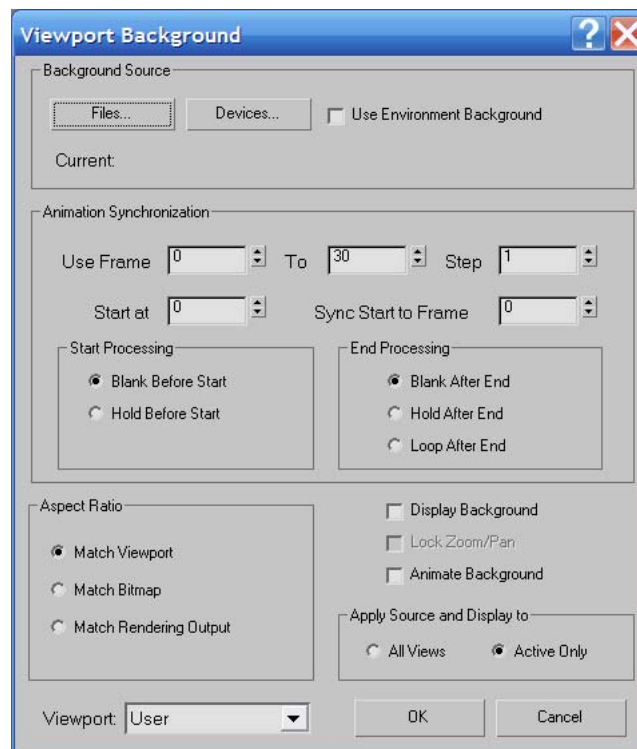
When you click on the Mapping drop-down option, you'll see a total of four options appear, as shown below. Each of these options provides a unique way for the map to be placed in the background. Let's look at the differences of each type, but before we do, let's first look at a feature that can significantly improve your ability to work with background images.



In the View menu, there is an option to open the Viewport Background dialog box, which is also available with the keyboard shortcut Alt+B. This dialog box provides some additional controls not available through the Material Editor. At the top of the dialog box is an option that allows you to use the environment map as the source of the background and a button that allows you to specify a different source for the background.

In the Animation Synchronization section are controls for implementing animated backgrounds. At 3DAS, we've never had a project that needed an animated background and even if someday we did, we would not use the controls in this dialog box because of its extremely limited flexibility. We would instead use a geometry based background and the controls in the Material Editor to precisely control the placement and playback of the animation.

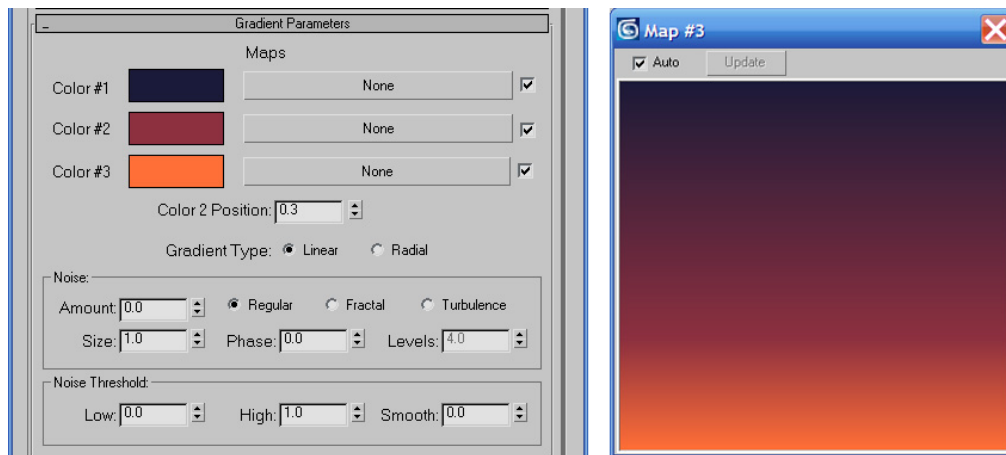
The only other feature in this dialog box that we find useful is the Display Background option, which is the feature that actually tells 3ds Max to display the background in the viewport. This option, along with the Use Environment Background option should be the only features you need to use if you decide to use a bitmap in the environment channel.



Screen

The default Screen option places the map to the extent of the rendered view. This option is suitable for single renderings, and if the background image is of a high enough resolution, you can use the Offset and Tiling parameters to zoom into one area of the background for one view and pan to a different portion of the same background image for a different view.

Because the background is a fixed image when a map is used in the environment channel, you can not use this type of background with animations. One choice you do have with the Screen option is to use a gradient map. In the left image below, a gradient map is used as a background to simulate a sky just after sunset. Since the image only changes in the vertical direction, you do have the option to make this the background of an animation;- so long as the camera's vertical orientation doesn't change at all. This restriction makes using a Target Camera impossible unless the target stays at the exact same elevation as the camera throughout the entire animation. If this restriction is acceptable, then a gradient map is a possible alternative to the next three environment types. There are 3 clear advantages to this type of background. One is that it can be set up in just a few seconds. The 2nd is that you don't have to worry about the resolution of the map as you would if you were using a bitmap. The third is that it renders faster than any other type of background where a bitmap is used.



Spherical Environment

The Spherical Environment option wraps a map around an infinitely large virtual sphere that surrounds your scene. The primary benefit of this option is that you see a different part of your map every time your view changes. The primary disadvantage is that a background image can easily look distorted the higher up in the sky you look if it's not an image created for specifically for use as a spherical background. In the first image below, there is no distortion built into the image and as a result, when this image is placed as a spherical background, it will appear distorted the farther up and down you look in your scene (though looking down is really of no concern). The second image below shows what you see if you look straight up. A seam is evident and the clouds in the sky are stretched and distorted.



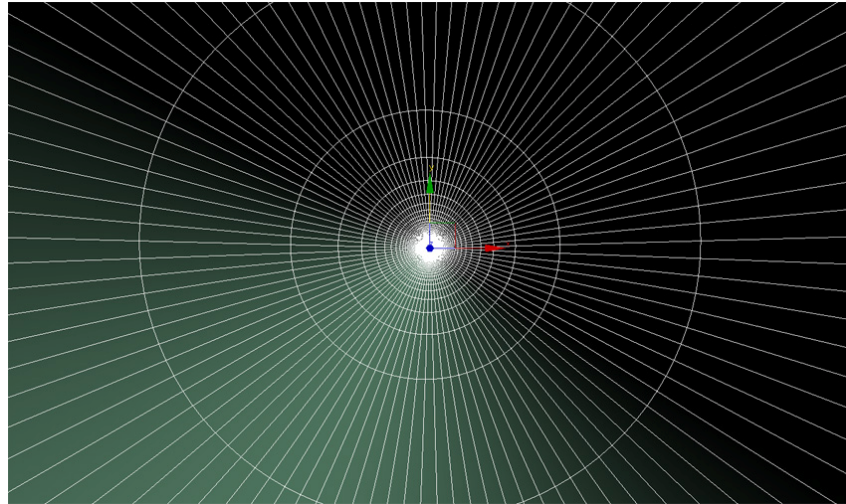


In the first image below, you can clearly see distortion built into the image as a result of the panoramic camera that captured it. The second image shows what you would see looking straight up in the sky, and as you can see, there is no distortion.



Cylindrical Environment

The Cylindrical Environment option wraps a map around an infinitely large virtual cylinder that surrounds your scene. The problem with this particular type of mapping is that all images are going to have some noticeable distortion because an infinitely large cylinder means that the top of the image will be infinitely far away. The image below shows the inside of an extremely long cylinder (with normals flipped) whose tops vanishes into infinity. If you imagine an image of any kind mapped onto this cylinder, the top of the image would wrap around to a single point that diverges off to infinity. For this reason, we don't recommend this mapping type.



Shrink-Wrap Environment

The Shrink-Wrap Environment option wraps the map around an infinitely large virtual sphere so that all four corners of the map wrap around and meet at the same point. This mapping type creates more distortion than spherical mapping but the one benefit of using it is that it has only one point where a seam is noticeable. If the mapping is adjusted so that this point occurs below ground where it won't be seen, then using this mapping type might be an option for you.

Placement of Environment Maps

Environment maps are often difficult to work with because the only way to quickly see the effects of adjustments you make is through a viewport. You will find that in order for a bitmap look good as an environment map, it must be of a high enough resolution or it must be tiled. If you decide to use the Spherical Mapping option, which is the best possible option for animations or for projects where multiple rendered views are needed, the bitmap that you use should be approximately eight times larger than the final rendered output. The reason for this is that the typical camera used has approximately a 45 degree field of view and sees only one-eighth of the 360 degrees with which the environment has been stretched to. Therefore, that one-eighth segment should be at least as high a resolution as the final rendered output.

In the spherical bitmap image shown below, the bitmap contains 9000 pixels in the horizontal direction and 2300 pixels in the vertical direction. Such a large resolution image is necessary when it is stretched to cover an entire spherical background.



If a bitmap doesn't contain enough pixels in either direction to provide a sharp background, then your only choice is to tile the map. If you tile a bitmap twice, you are telling 3ds Max to stretch the bitmap through 180 degrees of the environment (both vertically and horizontally) and therefore

the bitmap has to only be twice as high in resolution to look as sharp. The problem with tiling, however, is that you have to be careful to keep the seams (caused by tiling) out of view. This will often prevent you from being able to look around very much in a horizontal direction and also prevent you from looking very high in the sky.

Unless you use the perfect type of bitmap image, tiling the background is almost always going to be a necessity. Because tiling and placement of a background map is so much more difficult with only the viewport background image as a guide, use of maps in the environment channel is rarely an acceptable choice for us at 3DAS. Instead, we create our backgrounds through the use of geometry.

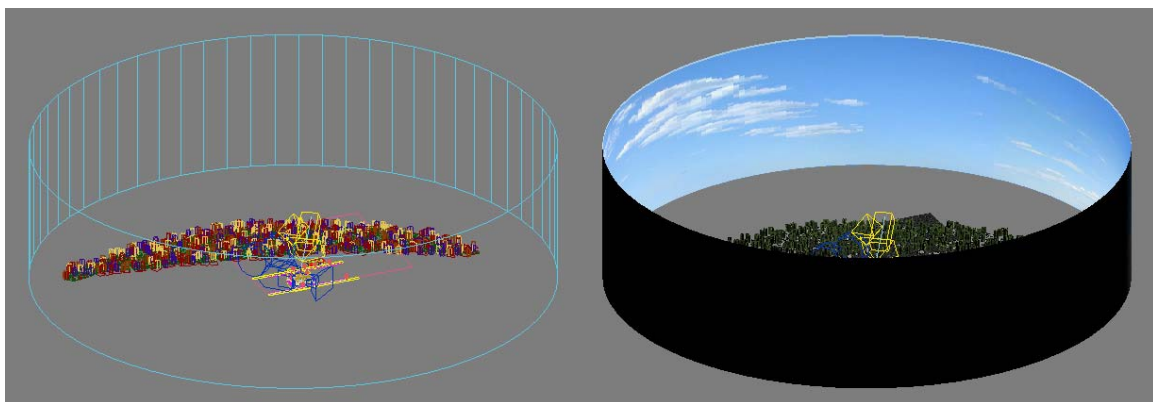
Geometry Based Backgrounds

The background types that have been discussed so far have all been those created through the Environment Map channel. Geometry based backgrounds are those where a map (to represent the background) is placed on geometry. This type of background is by far the most widely preferred in our industry, and for good reason. Although it requires more than simply loading a map into the environment channel, it is actually far easier to work on a background using geometry as a guide than it is to using the viewport background image as a guide. Placement and tiling of the map becomes much easier using an object like this, rather than having to do it through the use of a viewport background. Using an object, you can use the viewport navigation controls to quickly move around and see all areas of the map and any problems that may exist.

There are three primary types of geometry used as background objects: hemispherical objects, cylindrical objects and angular objects. The following discussion describes how each type can be used.

Cylindrical Environment Objects

A cylindrical environment object is nothing more than a cylinder whose top and bottom faces have been removed and whose remaining face normals have been inverted so that the cylinder is visible from the inside. In the image below, such a cylinder is shown surrounding an entire 3D scene and the image of a background is placed on the cylinder so that it's seen behind the other 3D objects.



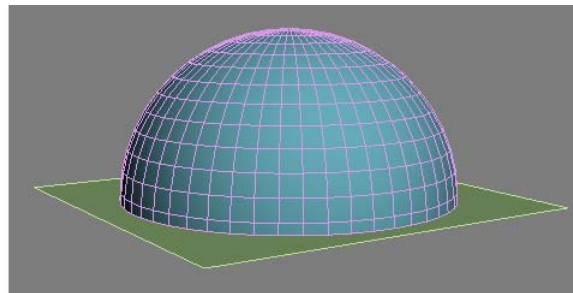
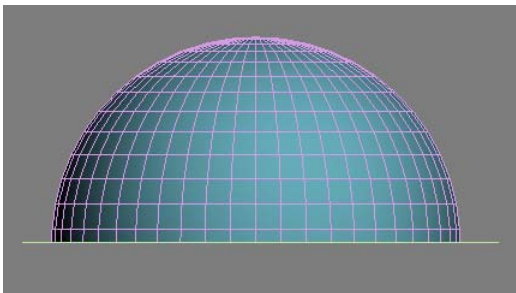
The primary advantage of using this type of geometry object for backgrounds is that there is no distortion of the map placed on the object. This advantage probably makes it the most commonly used background type. The first image below shows the bitmap that was used on the cylinder and the second shows the final rendering with the bitmap used on the cylinder in the background.



The primary disadvantage of using a cylinder as a background object is that if your camera looks high enough into the sky, it would eventually see the top of the cylinder and the environment channel background color behind it. Obviously, this is not acceptable, but most 3D scenes don't require the camera to look so high up into the sky. In the rendering example above, the camera can only see the bottom half of the cylinder and would have to look much higher up to see the top of the cylinder. When it is necessary to see so high up into the sky, the best option you have is a hemispherical background object.

Hemispherical Objects

Like the cylinder background object, a hemispherical background object is nothing more than half of a sphere whose face normals have been inverted so that the object is visible from the inside. When such an object is scaled large enough to surround an entire scene of objects, it can serve as a great type of background. In the image below, a hemisphere is placed on a plane representing the ground, thus creating the possibility of a 3D scene, completely sealed from the view or affect of the background channel.

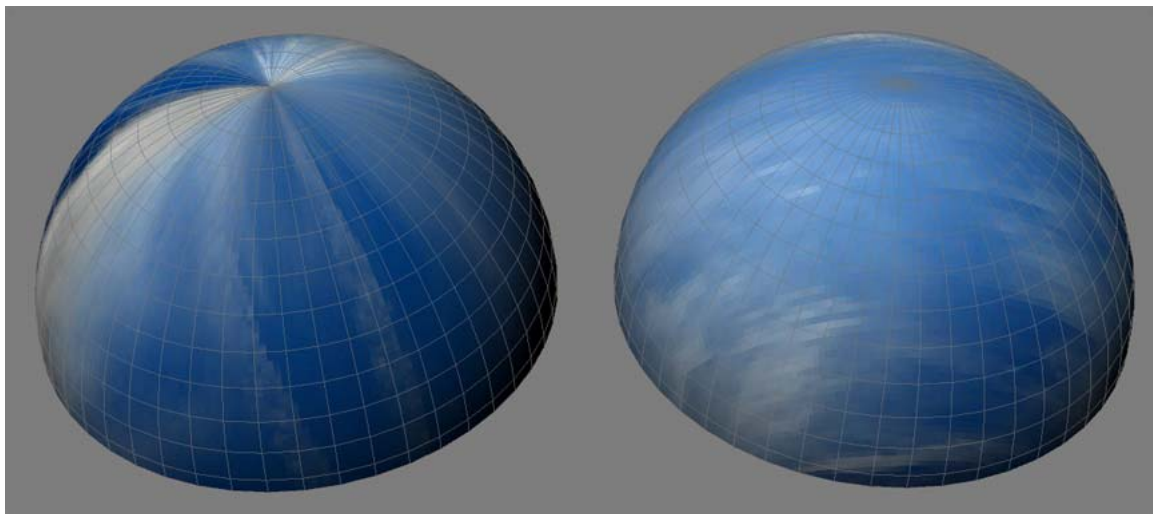


When you place the hemispherical object in your scene, you should ensure that it completely surrounds the objects in your scene with the one exception of the object that represents the ground stretching out to the horizon. In the image above, you can see that the ground extends beyond the limits of the hemisphere, and therefore, there should be no gaps between the 2 objects through which the environment background can be seen. This of course assumes that the base of the hemisphere rests on the ground rather than floating above it.

Background objects and the ground do not have to join to form a completely sealed environment, as shown above. Depending on camera placement and other objects that obscure the background object and background color, you may have your background object floating above, penetrating through or much larger than the ground object in your scene. The important thing to remember is to keep the environment background color hidden from view at all times. This applies to any geometry type you use as a background.

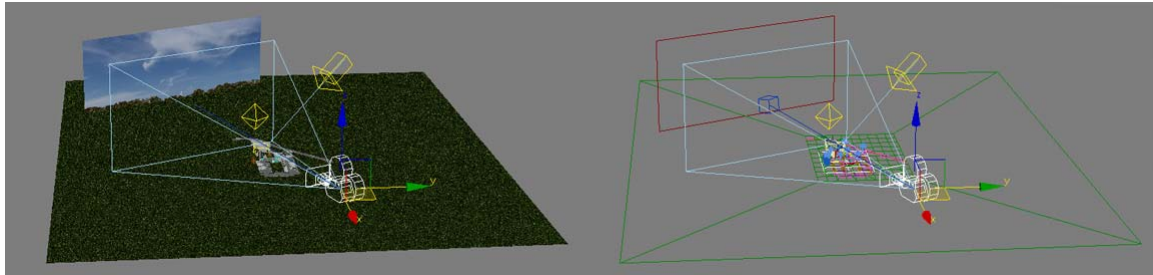
Just like spherical environment maps, hemispherical objects require the use of properly constructed bitmaps. But unlike spherical environment maps, which are stretched from directly above to directly below, hemispherical objects only require maps to be stretch half as far, and therefore, lead to far less distortion of the bitmap. And just like spherical environment maps, hemispherical objects also require the use of high resolution bitmaps, otherwise the background will appear much grainier and more pixilated than other objects in your scene.

When a non-spherical bitmap is used on a spherical object, as shown in the left image below, severe distortion can result, thereby negating the real benefit of using a spherical object in the first place. However, even when a proper spherical bitmap is used, a curving look can appear in the bitmap, as shown in the right image. This effect is difficult to avoid and is more prevalent in bitmaps with more clouds visible. Notice also that no trees or ground objects are visible in either image. As mentioned, this is because the curving effect that would make these parts of the bitmaps look bad. It is for these reasons that many in the visualization industry don't use spherical objects as a background object. In just a moment, we will see where the true benefit in using spherical background objects lies.



Angular Objects

Angular background objects are background object types that only cover a certain angle of the scene. Unlike spherical and cylindrical object types, they do not provide a background for an entire 360 degree view. They can be something as simple as a single polygon, as shown below, or an extruded arc that covers a larger field of view.

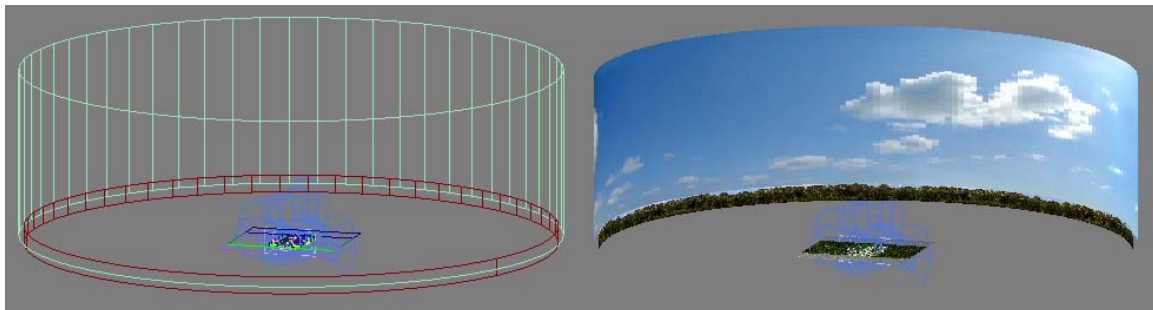


The primary advantage of this type of background object is that it is very quick and easy to setup. You can create a polygon with the same aspect ratio as the bitmap you want to use on it and then simply scale and position the object so that it covers the entire field-of-view for the camera you want to render.

The primary disadvantage is that you cannot easily use a single background object for multiple rendered views or animations. Because of this disadvantage, it would only be practical to use this background object type if you knew beyond any doubt that your final product was going to be a single rendered view. You could actually use more than one of these object types for different rendered views, as long as you use differing bitmaps to prevent the same background from being seen for multiple views.

Using Multiple Background Objects

You are not confined to using one background object type to produce a nice background. Sometimes you might find it useful to combine two different bitmaps to provide the look you want to achieve i.e., one bitmap for the sky and a second bitmap for the land. Below, in the left image, you can clearly see that 2 objects were used in the background of this scene. In the image on the right, you can see that one represented the sky and one represented the land, or more specifically, the trees. To mask the sky in the image showing the trees, an alpha channel had to be used. Two objects were used in this scene because we wanted a certain look for the trees in the background and did not have the appropriate image that contained the both the trees and sky we wanted. We could have created such an image in Photoshop using the combination of both bitmaps, however, we found it just as easy to use this method.



Illuminating Backgrounds

Just like other objects in your scene, background objects must be illuminated. You can choose to illuminate your backgrounds with the same lights that illuminate your other objects, however, this method is not recommended. The best way to illuminate a background is with a single omni light, centered within the background object and which only affects the background object and no other objects. There are two advantages of using this method. First, an omni light casts an equal amount of light in all directions and therefore, all parts of the background object would be illuminated the same, unlike a direct light, a sunlight system, or any other light type that you use to illuminate the objects in your scene. The second advantage is that you can control the illumination of your background without affecting other objects in your scene, and vice-versa. Both of these advantages are extremely important to creating realistic backgrounds.

Backgrounds in Reflection

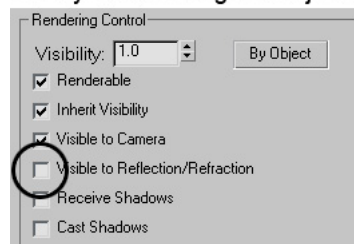
It was mentioned earlier that spherical objects are often difficult to use because of distortion and curving that usually occurs with the bitmap image. For this reason it is not the preferred background object type. However, there is one very nice benefit of using spherical background object types. Whenever you use a cylindrical or angular background object type, you have to be careful not to show the top of the cylinder or the background color beyond. But you have to be just as careful so that they don't show up in the reflections in your scene. Often, you will have a background object that works great as the background, but because of the position of your camera and the direction it looks, the reflections in your scene may make using that object unacceptable.

The simple solution is to use a cylindrical or angular object for the background image and a spherical object for the background reflections. This means that you see a different background object in reflections than you see directly through your camera. This is probably the most preferred type of background setup in visualizations.

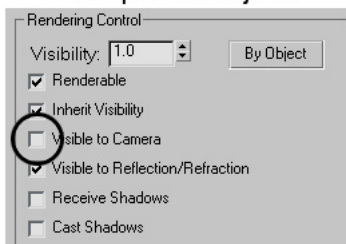
To use this method follow these 2 simple steps:

- In the Object Properties dialog box of cylindrical / angular background objects, disable the **Visible to Reflection/Refraction** option.
- In the Object Properties dialog box of spherical objects, disable the **Visible to Camera** option

For Cylindrical / Angular Objects



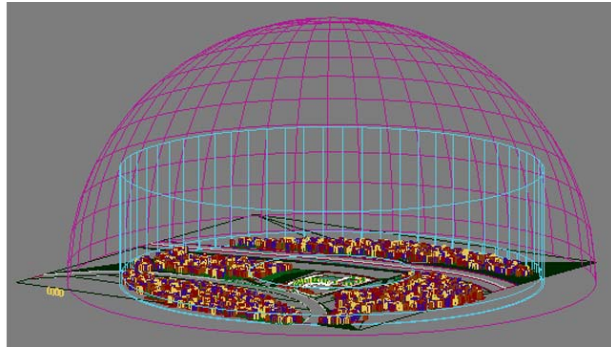
For Spherical Objects



The main reason that this is a good way to setup your background is that you will see undistorted maps directly through your camera and you won't see the edges of your cylindrical/angular background objects or the background color, no matter where you look. While the spherical object type is not always suitable as a background object because of the distortion and curving effect previously mentioned, these effects are almost usually unnoticeable in the reflections in your scene.

You can even choose to use a different bitmap for your spherical reflections than you use on your cylindrical / angular objects. In the image below, you see a lake in the foreground which has only a small amount of reflection enabled. The bitmap being reflected in the lake (the spherical object reflection) is actually a different bitmap than what is placed on the cylindrical object. This was done to provide a deeper blue to the lake than would have been possible if the other bitmap (on the cylinder) had been reflected.

Even though reflections are barely visible, because of the angle at which you are viewing the lake, the top of the cylinder used to hold the background bitmap would be clearly visible in the lake's reflections. Instead of allowing this occur, we simply turned off the **Visible to Camera** option for the spherical object, and turned off the **Visible to Reflections** for the cylindrical object.



The importance of using two background object types like this is also very apparent when you look up at the windows of a building, such as in the image below. Here again, the top of a cylinder background object might clearly be visible.



Other Considerations

Whether you use one object for your background or multiple objects, it's important to remember to turn off the Cast Shadow option for your background geometry. There is no reason why your background objects need to cast shadows so it is good practice to disable shadows for these type of objects.

If you use global illumination, pay careful attention to the effect that your background object have on the illumination of all the objects in your scene, because it will be significant.

Make sure you use enough faces in the creation of your background objects. Using too few will make facets appear. Relative to the rest of your scene, the background object has a negligible affect on rendering times and refresh rates so you shouldn't skimp on this object.

Summary

Backgrounds are an immensely important part of almost every 3D scene. Whether you just see the background itself, reflections of the background, or the effects of the background through global illumination, this particular part of a 3D scene must be done correctly to achieve a convincing and realistic look. Especially for exterior scenes, where backgrounds can often comprise half of what is seen in a rendering, the importance of an effective background simply can't be overestimated. This discussion has only brushed the surface of some of the important considerations and methods of implementing great backgrounds. Like all areas of 3D, your ability to explore other methods is limited only by your imagination.