This work is dealing with almost-compact embeddings of function spaces, in particular, the class of classical and weak Lorentz spaces with a norm given by a general weight fuction is studied. These spaces are not Banach function spaces in general, thus the almost-compact embedding is defined for more general sturctures of rearrangement-invariant lattices. A general characterization of when an r.i. lattice is almost-compactly embedded into a Lorentz space, involving an optimal constant of a certain continuous embedding, is proved. Based on this theorem and appropriate known results about continuous embeddings, explicit characterizations of mutual almost-compact embeddings of all subtypes of Lorentz spaces are obtained.