Transperineal implantation of ^{125}I and ^{103}Pd brachytherapy seeds has become an accepted method for the treatment of early-stage carcinoma of the prostate. These isotopes are low-energy photon emitters with an energy range between 20 to 36 keV. The effect of material heterogeneities is very strong at low photon energies due to the atomic number dependence of the photoelectric effect. This study is designed to evaluate the effects of patient specific heterogeneities on the calculated dose distribution from transperineal implantation of ^{125}I. The Monte Carlo code MCNP4B was used to model and benchmark the absolute dose distribution from a ^{125}I brachytherapy seed (model 6711). Comparison with previous measurements and calculations is excellent. Based upon the physical source model the total photon intensity and differential energy spectrum were evaluated as a function axial position along the source. This spectral and intensity data was reformatted to produce probability distributions for sampling from a virtual line source of the same length. The virtual source model and a modified version of MCNP4B is then used for simulating arbitrary brachytherapy source configurations within a patient specific CT-based lattice geometry. Dose-volume histograms were calculated for the prostate and rectal treatment volumes to quantitatively evaluate the influence of subtle tissue heterogeneities. The Monte Carlo calculations predict a lower dose to the prostate and rectum treatment volumes using the CT-based geometry versus a conventional water simulation geometry.