Best Management Practices (BMPs) in stormwater treatment are a suite of treatment alternatives to deal with pollutant removal problems from stormwater runoff. Biosorption-activated media (BAM) that are green sorption media due to the use of recycled materials have shown excellent nutrient removal as an effective BMP by enhancing physicochemical and microbiological processes. In this study, Iron-Filling Green Environmental Media (denoted as IFGEM-3) and Advanced Green Environmental Media 1 and 2 (denoted as AGEM-1 and AGEM-2) were produced and tested for their adsorption capacities as well as removal and recovery potential for phosphate, nitrate, and ammonia against natural soil (baseline) collected from a stormwater retention basin in Ocala, FL. A set of isotherm and column tests were conducted at room temperature with varying contact times. The two media with the best adsorption performances were further tested to determine life expectancy. The green sorption media characteristics and adsorption behaviors were further analyzed and realized by using a few existing isotherm models. Collected data of physical properties such as hydraulic conductivity, porosity, surface area, and density help justify the comparative results. The results showed that AGEM-2 has the highest average nitrate removal efficiency (76.55%) when compared to IFGEM-3 (39.0%) and AGEM-1 (33.67%). Furthermore, IFGEM-3, AGEM-1 and AGEM-2 achieved the highest phosphate removals immediately after 30 minutes of contact time. It is indicative that IFGEM-3, AGEM-1 and AGEM-2 media all produced ammonia and that production consistently increased as contact time increased. However, AGEM-2 generated an average of 35.22% more ammonia than IFGEM-3 and AGEM-1 suggesting it can be utilized as a soil amendment further. Natural soil showed no nutrient removal, however. The maximum adsorption capacities (q_{max}) derived by the isothermal test at high influent concentrations of 2mg/L phosphate and 2mg/L nitrate were found to be less than the q_{max} obtained from the column tests for IFGEM-3 and AGEM-2 with respect to nitrate. IFGEM-3 and AGEM-2 were further tested with respect to nitrate for their maximum adsorption capacities and their life expectancies via column tests. The results indicated that AGEM-2 has a longer life expectancy and a higher adsorption capacity than IFGEM-3, which is consistent with the isotherm results. It is recommended that AGEM-2 be selected for nutrient removal in future stormwater treatment based on its better adsorption performance and recovery potential.