Due to their widespread application in consumer products, elemental titanium (e.g., titanium dioxide, TiO2) and silver (Ag), also in nanoparticulate form, are increasingly released from households and industrial facilities to urban wastewater treatment plants (WWTPs). A seven-day sampling campaign was conducted in two full-scale WWTPs in Trondheim (Norway) employing only primary treatment. We assessed the occurrence and elimination of Ti and Ag, and conducted size-based fractionation using sequential filtration of influent samples to separate particulate, colloidal and dissolved fractions. Eight-hour composite influent samples were collected to assess diurnal variations in total Ti and Ag influx. Measured influent Ti concentrations (up to 290μgL−1) were significantly higher than Ag (<0.15–2.1μgL−1), being mostly associated with suspended solids (>0.7μm). Removal efficiencies ≥70% were observed for both elements, requiring for one WWTP to account for the high Ti content (~2gL−1) in the flocculant. Nano- and micron-sized Ti particles were observed with scanning transmission electron microscopy (STEM) in influent, effluent and biosolids, while Ag nanoparticles were detected in biosolids only. Diurnal profiles of influent Ti were correlated to flow and pollutant concentration patterns (especially total suspended solids), with peaks during the morning and/or evening and minima at night, indicating household discharges as predominant source. Irregular profiles were exhibited by influent Ag, with periodic concentration spikes suggesting short-term discharges from one or few point sources (e.g., industry). Influent Ti and Ag dynamics were reproduced using a disturbance scenario generator model, and we estimated per capita loads of Ti (42–45mg cap−1 d−1) and Ag (0.11mg cap−1 d−1) from households as well as additional Ag load (14–22gd−1) from point discharge. This is the first study to experimentally and mathematically describe short-term release dynamics and dry-weather sources of emissions of Ti and Ag in municipal WWTPs and receiving environments.