Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supplementary Information

Comparing the Fate of Pristine and Wastewater-Aged Gold Nanoparticles in Freshwater

Mark C. Surette[1,2], Campbell J. McColley[1], and Jeffrey A. Nason[1*]*

[1] School of Chemical, Biological and Environmental Engineering
Oregon State University, 116 Johnson Hall, 105 SW 26th St., Corvallis, OR 97331

[2] Current Address: ORISE Postdoctoral Research Participant at U.S. EPA Center for
Environmental Measurement and Modeling
109 T.W. Alexander Drive, Research Triangle Park, NC 27709

* Corresponding Author: Jeff.Nason@oregonstate.edu
* Corresponding Author: Surette.Mark@epa.gov

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Characterization of Pristine AuNPs

The manufacturer reported specifications and measured characteristics of the pristine AuNPs is provided in Table 1 (main text). The values were determined as follows:

Core Diameter (D_c): Manufacturer reported specification. Measured via transmission electron microscopy (TEM) using a JEM-1010 TEM (JEOL).

Intensity-weighted Hydrodynamic Diameter ($D_{h,0}$): Measured in triplicate via dynamic light scattering (DLS) at 1 mg Au/L in pH-adjusted (pH ≈7.4) 1 mM KCl (prepared in 0.2 µm filtered 18.2 MΩ-cm Nanopure water [DDI; Barnstead]) using a 90-Plus Particle Size Analyzer (Brookhaven Instrument Corporation). Each replicate measurement (*n* = 3) was performed for 3-minutes.

Electrophoretic Mobility (μ_E): Measured in triplicate via phase analysis light scattering (PALS) at 5 mg Au/L in pH-adjusted (pH ≈7.4) 1 mM KCl (prepared in 0.2 µm filtered DDI water) using a ZetaPALS (Brookhaven Instrument Corporation). Each replicate measurement (*n* = 5) was performed for 30 cycles. Details on the conversion of the measured μ_E to modelled zeta potential (ζ) are provided in the next section.

Surface Plasmon Resonance (λ_{SPR}): Measured via ultraviolet-visible light spectroscopy (UV-Vis) at 5 mg Au/L in 0.02 µm filtered DDI water using an Orion AquaMate 8000 (Thermo Scientific). Each replicate measurement (*n* = 3) was performed at λ = 400 – 800 nm at a scan rate of 1 nm/s using a 10 mm light-path quartz cuvette (VWR International).

Zeta Potential Calculation in Simple Electrolyte Solution (1 mM KCl)

The measured μ_E, reported in Table 1 (main text), were converted to ζ according to Henry (1931) with the correction $f_1(\kappa a)$ applied according to Ohshima (1994), resulting in the following equation:

$$\zeta = \frac{3\mu_E\eta}{2\epsilon_w f_1(\kappa a)} = \frac{3\mu_E\eta}{2\epsilon_w\left(1+\frac{1}{2\left[1+\frac{\delta}{\kappa a}\right]^3}\right)} \tag{S1}$$

Where:

$$\delta = \frac{2.5}{1+2e^{-\kappa a}} \tag{S2}$$

The definition of the variables in Equations S1 and S2, along with their corresponding values, are shown in Table S1.

Table S1. Inputs used to calculate ζ from μ_E.

Input	**Value**[a]	**Source**
Permittivity in Water (ϵ_w)	6.95 $x10^{-10}$ C^2/J-m	Known – H_2O
Medium Dynamic Viscosity (η)	1 $x10^{-3}$ N-s/m^2	Known – H_2O
Ohshima Fitting Parameter (δ)	1.31 – 1.32	Calculated per Hunter (2001)
Debye Length (κ)	0.104 nm^{-1}	Calculated per Benjamin & Lawler (2013)
Particle Radius (a)	7.7 nm	Measured (Table 1 – Main Text)

[a] All values at 25 °C.

Properties of Willamette River Water

Samples of the Willamette River water used in the batch experiments were obtained on February 25, March 5, and March 15, 2019 and were characterized according to the methods described in *Standard Methods for the Examination of Water and Wastewater, 22nd Edition* (American Public Health Association et al., 2012). All analyses were performed in triplicate and were completed according to their method-specific holding times. All samples that were collected for analysis of the dissolved fraction were filtered within 3 hours after collection. Samples that were collected for total metals analysis were acid-preserved immediately upon collection. Samples that were collected for dissolved metals analysis were first filtered (using pre-washed filters) and then acid-preserved immediately following filtration. A summary of the results and the associated *Standard Methods* are provided in Table S2.

Table S2. Summary of Willamette River water quality parameters/characteristics used in the batch tests.

Parameter	**Feb. 25th (PEG)**	**March 5th (bPEI)**	**March 15th (COOH)**	**Units**	**Method**
Total Organic Carbon (TOC)	2.55 ± 0.06	1.65 ± 0.07	1.44 ± 0.09	mg C/L	Method 5310-B
Dissolved Organic Carbon (DOC)	2.47 ± 0.04	1.63 ± 0.04	1.49 ± 0.06	mg C/L	
Dissolved Cations					
Ca^{2+}	4.18 ± 0.22	5.11 ± 0.02	5.02 ± 0.46	mg/L	Method 3125
Mg^{2+}	1.85 ± 0.08	2.18 ± 0.26	2.31 ± 0.12	mg/L	
Na^+	4.10 ± 0.12	4.91 ± 0.56	4.60 ± 0.15	mg/L	
K^+	0.93 ± 0.08	0.79 ± 0.17	0.87 ± 0.19	mg/L	
Fe^{3+}	0.02 ± 0.05	0.04 ± 0.07	0.10 ± 0.41	mg/L	
Dissolved Anions					
F^-	N/D	N/D	0.66 ± 0.40	mg/L	Method 4110-C
Cl^-	3.16 ± 0.84	3.03 ± 0.39	3.44 ± 0.98	mg/L	
NO_2^-	N/D	N/D	N/D	mg/L	
NO_3^-	1.79 ± 0.48	2.15 ± 0.17	3.19 ± 0.59	mg/L	
PO_4^{3-}	N/D	N/D	N/D	mg/L	
SO_4^{2-}	4.07 ± 0.97	3.35 ± 0.20	3.54 ± 0.37	mg/L	
HCO_3^-	24.76	29.20	28.29	mg/L	Method 2320
pH	7.39	7.32	7.22		Probe
Total Suspended Solids (TSS)	104.6 ± 5.2	13.7 ± 11.2	11.3 ± 6.3	mg/L	Method 2540-D
Total Alkalinity	20.31	23.20	23.95	mg/L as $CaCO_3$	Method 2320
Total Hardness	18.06 ± 0.87	22.26 ± 0.54	21.3 ± 2.22	mg/L as $CaCO_3$	Method 2340-B

Error bars indicate ± 95% confidence interval (*n* = 3).

Table S3. Concentration of ionic species in synthetic river water.

Dissolved Cations	**Concentration**	**Units**	Dissolved Anions	**Concentration**	**Units**
Ca^{2+}	4.77	mg/L	Cl^-	4.09	mg/L
Mg^{2+}	2.11	mg/L	NO_3^-	4.27	mg/L
Na^+	7.46	mg/L	SO_4^{2-}	5.19	mg/L
K^+	3.5	mg/L	HCO_3^-	25.44	mg/L

Properties of Wastewater Matrix

Samples of the primary clarifier effluent used to age the ENMs for the batch experiments were obtained on February 26, March 6, and March 16, 2019. A second round of sampling was completed in October 2020 to age the ENMs used in some of the supplementary analytical experiments (as described in main text). The aquatic chemistry of the filtered wastewater matrix (prepared according to the procedure described in the main text) was determined according to the methods described in *Standard Methods for the Examination of Water and Wastewater, 22nd Edition* (American Public Health Association et al., 2012). All analyses were performed in triplicate and were completed according to their method-specific holding times. A summary of the results and the associated *Standard Methods* are provided in Table S4.

Table S4. Summary of primary clarifier effluent water quality parameters/characteristics used in the batch tests.

Parameter	**Feb. 26th (PEG)**	**March 6th (bPEI)**	**March 16th (COOH)**	**Units**	**Method**
Dissolved Organic Carbon (DOC)	10.2 ± 0.87	16.42 ± 0.61	17.66 ± 0.48	mg C/L	Method 5310-B
Conductivity	523.0	574.0	570.0	μS/cm	Probe
Ionic Strength	8.4	9.2	9.1	mM	Calculated [a]
pH	6.87	7.08	7.61		Probe
	Dissolved Cations				
Ca^{2+}	15.69 ± 2.17	23.70 ± 1.6	23.02 ± 1.02	mg/L	Method 3125
Mg^{2+}	6.63 ± 0.94	11.0 ± 0.91	11.10 ± 0.84	mg/L	
Na^{+}	21.96 ± 2.51	49.12 ± 4.32	50.36 ± 3.39	mg/L	
K^{+}	3.90 ± 0.77	11.15 ± 1.33	9.51 ± 0.90	mg/L	
Fe^{3+}	0.05 ± 0.07	0.12 ± 0.05	0.14 ± 0.07	mg/L	
	Dissolved Anions				
F^{-}	N/D	4.86 ± 0.19	6.98 ± 5.6	mg/L	Method 4110-C
Cl^{-}	23.13 ± 6.38	50.14 ± 5.94	50.55 ± 6.89	mg/L	
NO_2^{-}	N/D	N/D	N/D	mg/L	
NO_3^{-}	7.69 ± 11.55	6.13 ± 0.38	43.10 ± 5.22	mg/L	
PO_4^{3-}	N/D	9.64 ± 0.3	8.78 ± 1.04	mg/L	
SO_4^{2-}	18.05 ± 2.0	27.8 ± 2.53	25.69 ± 1.64	mg/L	
NH_4^{+}	13.53 ± 2.49	30.19 ± 1.22	36.43 ± 0.54	mg/L	Spectroquant Ammonium Cell Test Kit

Error bars indicate ± 95% confidence interval (*n* = 3)

[a] Calculated using I = 1.6 x10^{-5} × S.C.[6]

Testing and Storage of Tangential-Flow Filtration Cartridge

Testing. The ability of the 100 kDa molecular weight cut-off (MWCO) tangential-flow filtration (TFF) membrane to trap the AuNPs within the retentate was tested per the following:

1) A 250 mL sample containing the AuNPs was prepared by dispersing the COOH-AuNPs in the filtered wastewater matrix to C_{NP} = 1.0 mg/L (V_{WW}= 245 mL; V_{NP} = 5 mL).
2) Immediately upon dosing, 1 mL sample aliquots were collected in triplicate via calibrated pipette and transferred to separate 7 mL perfluoroalkoxy alkane (PFA) vails to measure the initial solution concentration. The remainder of the dispersion was incubated for ≈30 minutes.
3) After the incubation period, the AuNP/wastewater dispersion was circulated through the TFF cartridge according to the procedure described in the main text.
4) Upon completion of the concentration/separation process, 1 mL sample aliquots were collected from the TFF retentate in triplicate via calibrated pipette and transferred to separate 7 mL PFA vails to measure the final solution concentration.
5) The vessel containing the TFF permeate was briefly mixed via gentle shaking and 5 mL sample aliquots were collected in triplicate via calibrated pipette and transferred to separate 7 mL PFA vails to measure the permeate concentration.
6) All the samples were digested in fresh *aqua regia* (3:1 $HCl:HNO_3$) according to the procedure detailed below and analyzed via inductively-coupled plasma mass spectrometry (ICP-MS).

The results, shown in Table S5, indicate that ≈99% of the AuNP mass was retained within the TFF system.

Table S5. Concentration of COOH-AuNPs in TFF permeate.

	Average Concentration (µg/L)
Initial Solution	1,135.4 ± 344.8
Final Solution (Retentate)	5,886.1 ± 312.5
Permeate	12.5 ± 8.7

Error bars indicate ± 95% confidence interval (*n* = 3).

Storage. Prior to each use, the TFF cartridge was flushed with ≥ 500 mL of DDI water and then drained before the AuNP/wastewater dispersion was circulated. After each use, the TFF cartridge was cleaned by continuously circulating a solution of 0.5 M NaOH (prepared in DDI water) through the TFF cartridge for >30 minutes followed by flushing the TFF cartridge with ≥ 500 mL of DDI water. After draining, the TFF cartridge was filled with a 10% ethanol (EtOH) solution (prepared in DDI water) and stored at 4 ^{o}C in the dark.

Verification of Aged AuNP Sizes after Overnight Storage

After aging each AuNP type, the intensity-weighted hydrodynamic diameter (D_h) of the aged AuNPs was measured. Samples were analyzed in triplicate at C_{NP} = 1 mg Au/L in either filtered river water or TFF permeate by combining 2.4 mL of the selected matrix with 0.6 mL of the aged AuNP dispersion. After overnight storage (<12 hours), the D_h of the aged AuNPs was measured again in 0.2 µm-filtered DDI water at C_{NP} = 1 mg Au/L. Each replicate measurement (*n* = 3) was performed for 3-minutes. The results, summarized in Table S6, indicate negligible changes in D_h after overnight storage.

Table S6. Intensity-weighted hydrodynamic diameter (D_h) of aged AuNPs measured before and after overnight storage.

Surface Coating	**D_h Before Storage – Filtered River Water (nm)**	**D_h Before Storage – TFF Permeate (nm)**	**D_h After Storage – DDI water (nm)**
PEG	113.6 ± 7.7	116.4 ± 8.6	127.2 ± 4.1
COOH	250.5 ± 16.2	229.3 ± 3.7	255.4 ± 4.0
bPEI	216.1 ± 4.1	194.8 ± 3.2	215.3 ± 14.9

Error bars indicate ± 95% confidence interval (*n* = 3).

Batch Experimental Method

An illustration depicting the batch experimental method is shown in Figure S1. For each AuNP type, four different groups of batch experiments were performed: pristine AuNPs in raw river water, aged AuNPs in raw river water, aged AuNPs in filtered river water, and pristine AuNPs in filtered river water. Each group included six replicates of the selected AuNP type/matrix combination, as well as two controls—raw river water centrifuged at 3,500 rpm (≈2,200*g* RCF) for 5 minutes (referred to herein as centrifuged river water) and DDI water.

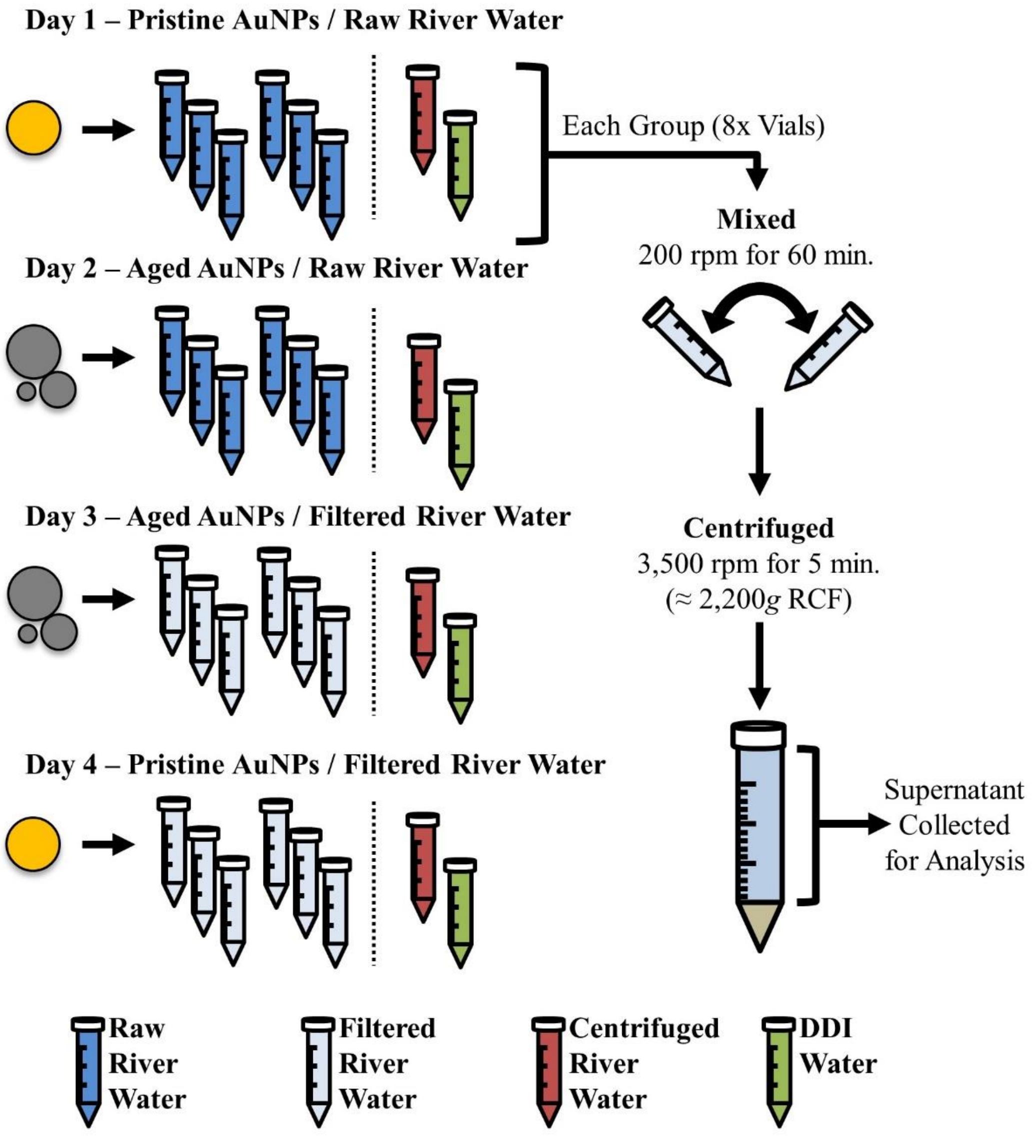

Figure S1. Illustrative example of experimental approach performed for each AuNP type.

Digestion Technique

Once all sample aliquots were generated for a given batch, each aliquot was acid-digested according to the following procedure:

1. Each aliquot, contained within either a 7 mL perfluoroalkoxy alkane (PFA) vial or a 100 mL polytetrafluoroethylene (PTFE) beaker, was placed on a hot plate, uncapped, and heated at 200^{o}C to evaporate off the water. The PFA vials were used for the small sample aliquots (5 mL) and the PTFE beakers were used for the large sample aliquots (30 mL).
2. Once a small amount of residue remained (≤ 1 mL), freshly-prepared *aqua regia* (3:1 ultrapure HCl:HNO_3) was added to each vessel and heated at 200 ^{o}C to evaporate off the *aqua regia*. The amount of *aqua regia* added to each vessel was as follows: 4 mL (3 mL:1 mL HCl: HNO_3) to the PFA vials and 8 mL (6 mL:2 mL HCl: HNO_3) to the PTFE beakers.
3. When a small drop of *aqua regia*/residue remained, the vessels were removed from the hot plate and allowed to cool to room temperature.
4. After cooling to room temperature, each sample was transferred to a pre-weighed 15-mL (PFA) or 50-mL (PTFE) polypropylene centrifuge tube (Falcon™, BD Biosciences). Each digestion vessel was triple-rinsed with ≈2% *aqua regia* (diluted using DDI water), with the rinsate transferred between each rinsing step.
5. After the final rinsing, each polypropylene centrifuge tube was re-weighed and the total, final volume was determined gravimetrically. The tubes were stored at 4 ^{o}C in the dark (in ≈2% *aqua regia*) until analysis via ICP-MS.

Digestion Technique – Spike/Recovery Testing

To verify that the digestion technique resulted in adequate recovery (>90%) of the pristine and aged AuNPs, a spike/recovery test was performed. The intent of the spike/recovery test was to mimic the experimental procedure used in the batch experiments but generate a 'worst-case' scenario where no model ENMs are removed via centrifugation after mixing in the raw river water. To simulate this, samples of the pristine or aged AuNPs were spiked into samples of the centrifuged river water before digestion.

1. Six 15-mL polypropylene centrifugation vials (Falcon™, BD Biosciences) were each filled with 12 mL of raw river water and centrifuged at 3,500 rpm (≈ 2,200x*g* RCF) for 5 minutes.
2. Immediately following centrifugation, an 8-mL sample of the supernatant was collected from each vial, transferred to a single, separate 50-mL polypropylene centrifugation vial, and gently mixed. This constituted the centrifuged river water and was used to prepare all subsequent samples.
3. Using 7-mL PFA vials, 5-mL samples containing the centrifuged river water were prepared in triplicate and dosed to a target initial AuNP concentration ($C_{NP,initial}$) of 250 µg/L using either the pristine or the aged COOH-AuNPs (aged immediately prior to use).
    a. For the pristine COOH-AuNPs, 4.975 mL of centrifuged river water was combined with 0.025 mL of the pristine COOH-AuNP dispersion. The concentration of the pristine COOH-AuNP stock dispersion was separately measured by preparing duplicate 5-mL samples containing DDI water dosed to C_{NP} = 250 µg/L.
    b. For the aged COOH-AuNPs, 4.875 mL of the centrifuged river water was combined with 0.125 ml of the aged COOH-AuNP/wastewater dispersion. The concentration of the aged COOH-AuNP/wastewater dispersion was separately measured, as reported in Table S5 (Final Solution – Retentate).
    c. Three separate 7-mL PFA vials were prepared containing only the centrifuged river water and were used to quantify the background Au concentration in the river water.

4. All nine PFA vials were then acid digested according to the procedure outlined above and analyzed via ICP-MS.

The background Au concentration within the centrifuged river water was 11.4 ± 8.26 µg/L. The results of the samples spiked with the pristine and aged COOH-AuNPs are summarized in Table S7. To calculate the percent recovery, the actual dosing concentrations were re-calculated based on the measured concentrations of the COOH-AuNP stock dispersion ($C_{stock} = 45.0 \pm 1.6$ mg/L; $n = 2$) and the aged COOH-AuNP/wastewater dispersion ($C_{retentate} = 5.90 \pm 0.31$ mg/L; $n = 3$). The results indicate good recovery was obtained for both the pristine and aged COOH-AuNPs. Thus, the digestion technique was considered adequate to digest the samples collected during the batch experiments.

Table S7. Measured AuNP concentration and percent recovery of pristine and aged COOH-AuNPs in centrifuged river water.

Sample	Actual AuNP Dosing Concentration (Calculated) (µg/L)	Recovered AuNP Concentration (Measured) (µg/L)	Average Percent Recovery (%)
Pristine	224.8	259.1 ± 43.5	115.3 ± 19.4
Aged	147.2	145.0 ± 11.1	98.5 ± 7.5

Error bars indicate ± 95% confidence interval (*n* = 3).

Supporting Analytics – Pristine and Aged AuNPs in Various Media

The characteristics of the pristine AuNPs were measured in DDI water and 0.2 µm filtered river water, while the aged AuNPs were measured in the DDI water, 0.2 µm filtered river water and TFF permeate. Due to the lower concentration of the aged AuNP/wastewater dispersion (≈ 5 mg Au/L; see Table S5), each sample was prepared at ≈1 mg Au/L.

DLS: The intensity-weighted hydrodynamic diameter (D_h) of the pristine AuNPs was measured over time via time-resolved dynamic light scattering (TR-DLS). Duplicate samples were prepared at 1 mg Au/L and measured immediately after dosing using a 90-Plus Particle Size Analyzer (Brookhaven Instrument Corporation). Each sample was analyzed via 120 measurements, each 15 seconds long (≈30 minutes). The D_h of the aged AuNPs was also measured by TR-DLS at ≈1 mg Au/L in triplicate via 240 measurements, each 15 seconds long (≈60 minutes).

PALS: The electrophoretic mobility (μ_E) was measured via phase analysis light scattering (PALS). Triplicate samples of the pristine AuNPs were prepared at 5 mg Au/L while the aged AuNPs were prepared at ≈1 mg Au/L. Upon addition of the AuNPs to the media, the samples were allowed to incubate for ≈ 20 – 30 minutes, and then measured using a ZetaPALS (Brookhaven Instrument Corporation). Each replicate measurement (n = 5) was performed for 30 cycles.

UV-Vis: The surface plasmon resonance (λ_{SPR}) was measured via ultraviolet-visible light spectroscopy (UV-Vis). Triplicate samples of the pristine AuNPs were prepared at 5 mg Au/L while the aged AuNPs were prepared at ≈1 mg Au/L. Upon addition of the AuNPs to the media, the samples were allowed to incubate for ≈ 20 – 30 minutes, and then measured using an Orion AquaMate 8000 (Thermo Scientific). Each replicate measurement (n = 3) was performed at λ = 400 – 800 nm at a scan rate of 1 nm/s using a 10 mm light-path quartz cuvette (VWR International).

TR-DLS of Pristine AuNPs in Filtered River Water

Time-resolved dynamic light scattering (TR-DLS) was used to assess the colloidal stability of the pristine AuNPs in filtered river water. The intensity-weighted hydrodynamic diameter (D_h) of the AuNPs was measured for ≈30 minutes and the extent of aggregation ($D_{h,30}/D_{h,0}$) was calculated. Values of $D_{h,30}/D_{h,0} \approx 1.0$ denote particle stability whereas $D_{h,30}/D_{h,0} > 1.0$ indicates aggregation. The results are shown in Figures S2 and Figure 2a (main text).

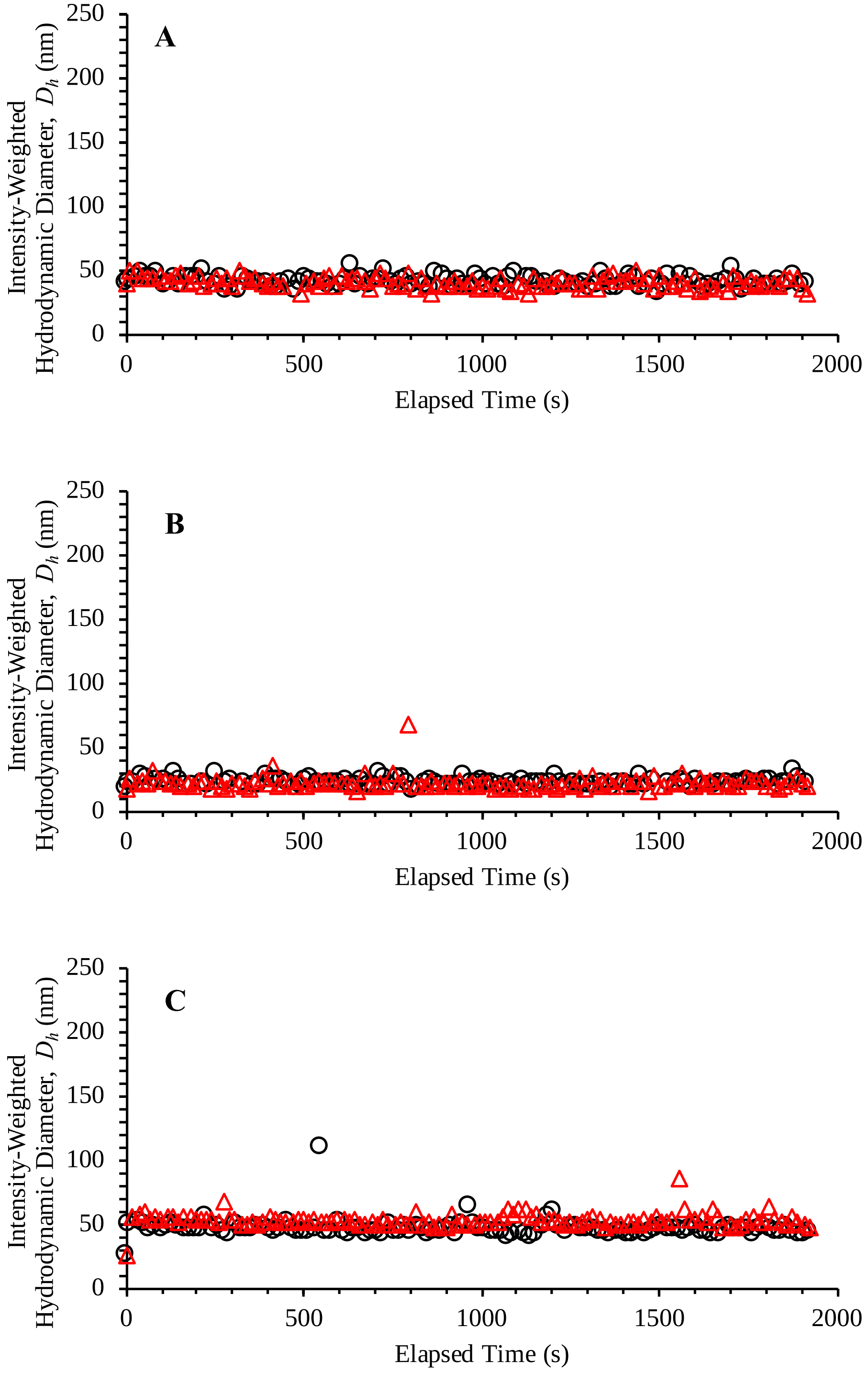

Figure S2. Intensity-weighted hydrodynamic diameter (D_h) as a function of time for pristine (a) PEG-AuNPs, (b) COOH-AuNPs, and (c) bPEI-AuNPs in filtered river water.

Intensity-weighted Hydrodynamic Diameter of Aged AuNPs in Various Media

The intensity-weighted hydrodynamic diameter (D_h) of the aged AuNPs was measured in DDI water, filtered river water, and TFF permeate, according to the procedures described previously. Due to the lower concentration of the aged AuNP/wastewater dispersion (≈ 5 mg Au/L; see Table S5), each sample was prepared at ≈1 mg Au/L.

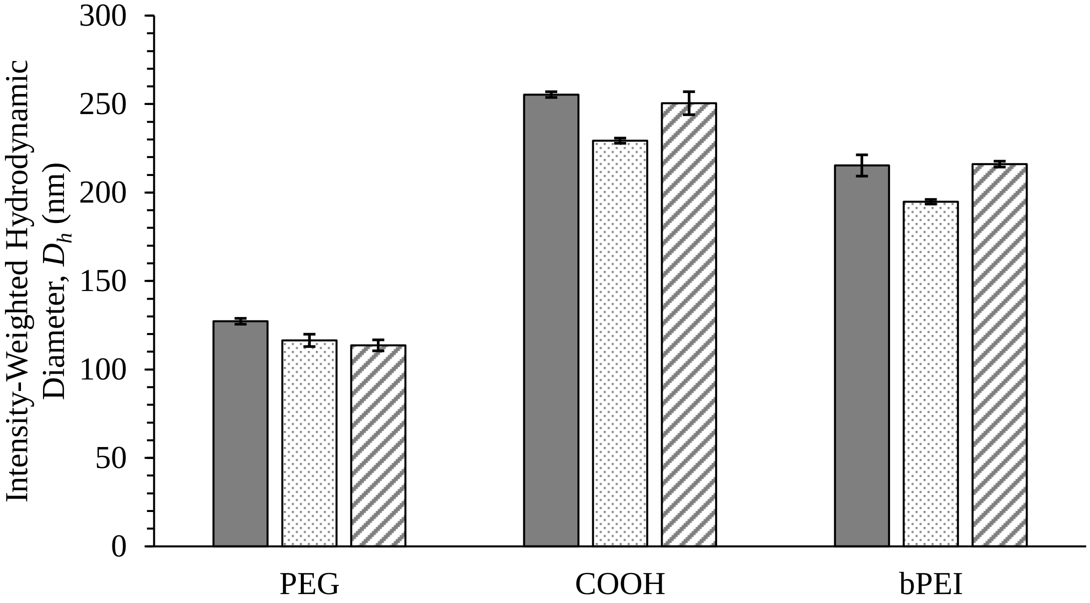

Figure S3. Intensity-weighted hydrodynamic diameter of each aged AuNP type ($D_{h,aged}$) in DDI water (solid); TFF permeate (dotted); and filtered river water (hashed). Error bars indicate ± 1 S.D. (n = 3).

UV-Vis Spectra of Pristine and Aged AuNPs in Various Media

The background-corrected and normalized UV-Vis spectra for the pristine and aged AuNPs were generated according to the procedures described previously.[7] Briefly, for each UV-Vis measurement, the background-corrected UV-Vis spectrum was generated by subtracting the blank-corrected background spectrum (measured prior to the addition of the AuNPs) from the UV-Vis spectrum measured after the addition of the AuNPs. The background-corrected and normalized (A/A_{max}) UV-Vis spectrum was generated by dividing the background-corrected absorbance at each wavelength (A) by the maximum absorbance (A_{max}) that was measured. A moving average ($n = 5$) was then applied to smooth the data. Due to the broadness of the UV-Vis spectra, in particular the aged COOH-AuNPs, the λ_{SPR} were identified at the approximate mid-point of the peak. The UV-Vis spectra for each AuNP type/form in each of the media tested are shown in Figure S4.

The UV-Vis spectra (Figure S4) were then evaluated for changes in λ_{SPR} and an increase in the full-width at half-max (FWHM) of the peak at λ_{SPR}. These features are typically observed when AuNPs aggregate and/or the local dielectric permittivity (ϵ_r) near the AuNP surface is altered, which occurs following changes to the molecular structure of the engineered surface coating or from the adsorption of NOM.[8,9] To calculate the full-width at half-max (FWHM), the wavelengths where $A/A_{max} = 0.5$ were identified. In all cases, this only occurred at a single wavelength $>\lambda_{SPR}$. As such, the FWHM was set to this wavelength and no further data treatment was performed. The measured λ_{SPR} are reported in Table S8 and the calculated FWHMs are reported in Table S9.

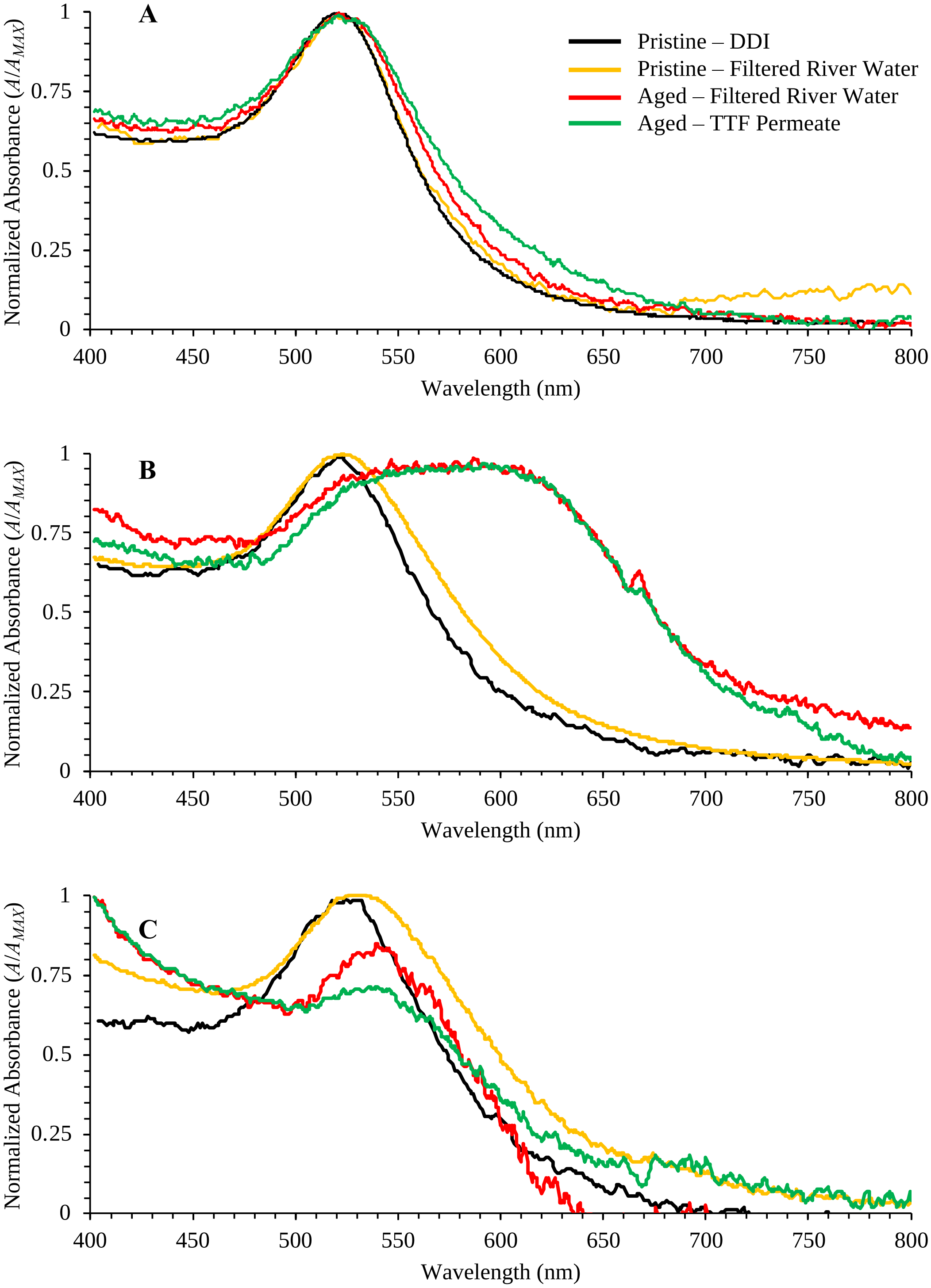

Figure S4. Average background-corrected and normalized (A/A_{max}) UV-Vis spectra of (a) PEG-AuNPs, (b) COOH-AuNPs, and (c) bPEI-AuNPs in various media.

Table S8. Surface plasmon resonance (λ_{SPR}) of pristine and aged AuNPs in various media.

Surface Coating	**Pristine AuNPs**		**Aged AuNPs**	
	DDI Water (nm)	**Filtered River Water (nm)**	**Filtered River Water (nm)**	**TFF Permeate (nm)**
PEG	519.2 ± 1.9	518.8 ± 2.2	521.7 ± 0.7*	521.2 ± 3.6
COOH	518.5 ± 5.4	522.2 ± 1.4	574.5 ± 28.0*	580.3 ± 11.1*
bPEI	521.5 ± 2.2	529.6 ± 0.7*	538.0 ± 1.2*	532.8 ± 7.9*

Error bars indicate ± 95% confidence interval (n = 3).

* Indicates significant difference relative to λ_{SPR} measured in DDI water ($\alpha = 0.05$; two-way t-test; n = 3).

Table S9. Full-width at half max (FWHM) of pristine and aged AuNPs in various media.

Surface Coating	**Pristine AuNPs**		**Aged AuNPs**	
	In DDI Water (nm)	**In Filtered River Water (nm)**	**In Filtered River Water (nm)**	**In TFF Permeate (nm)**
PEG	559	559.5	566.5	574.5
COOH	564	579.5	673.5	673
bPEI	571	599	578.5	575

SEM Micrographs of Pristine AuNPs in Raw, Centrifuged and Filtered River Water

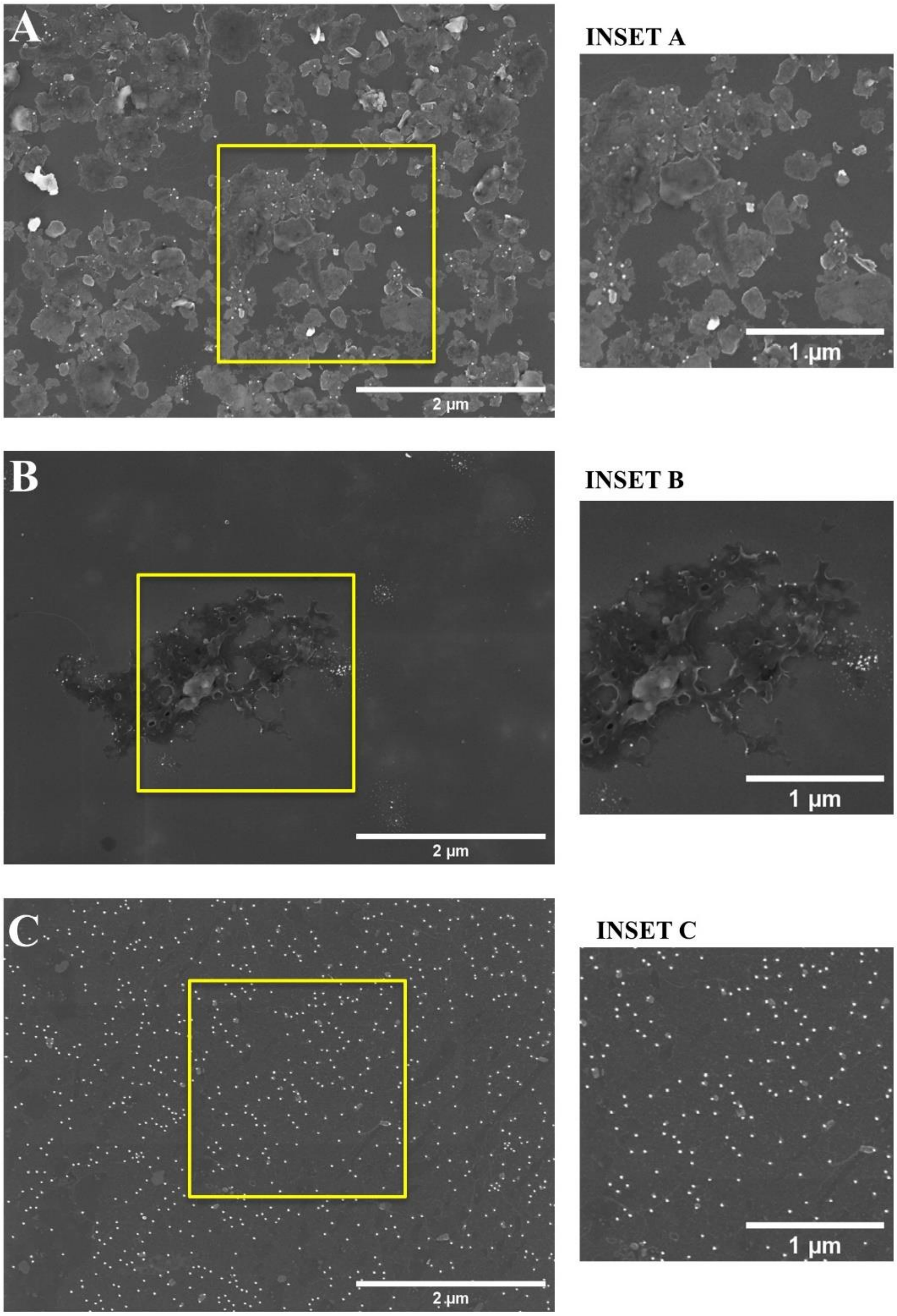

Figure S5. SEM micrographs of pristine PEG-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

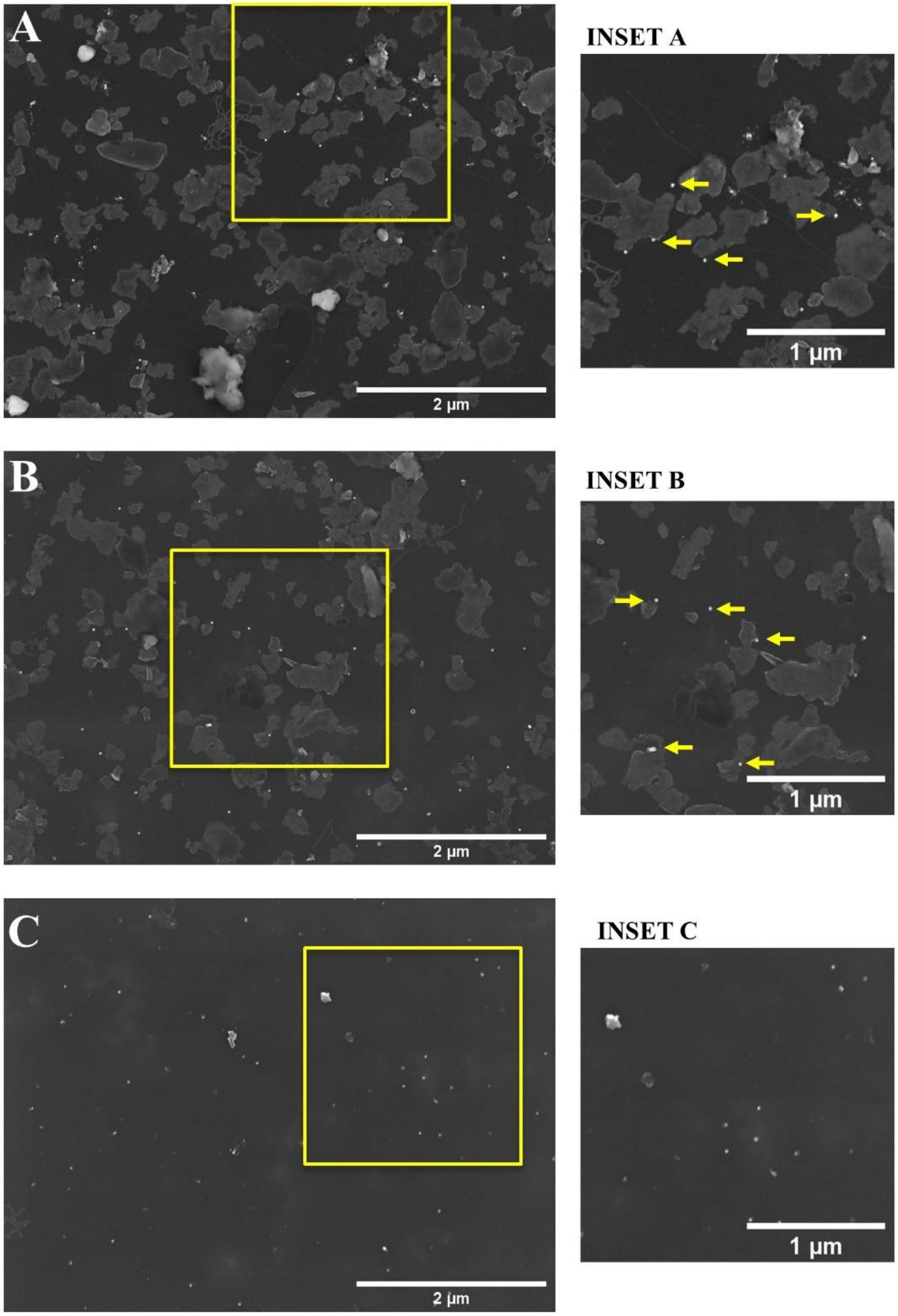

Figure S6. SEM micrographs of pristine COOH-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

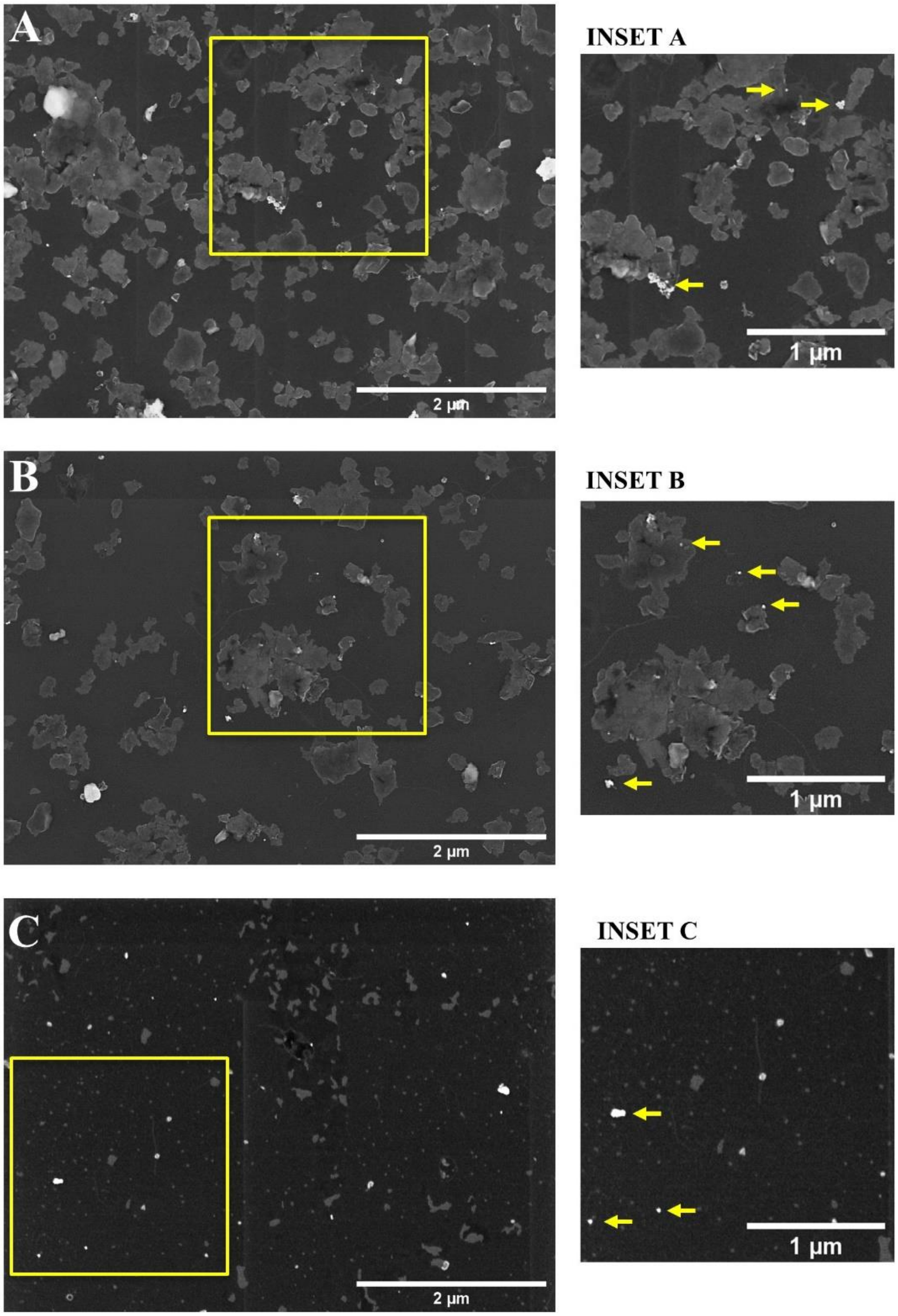

Figure S7. SEM micrographs of pristine bPEI-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

SEM Micrographs of Aged AuNPs in Raw, Centrifuged and Filtered River Water

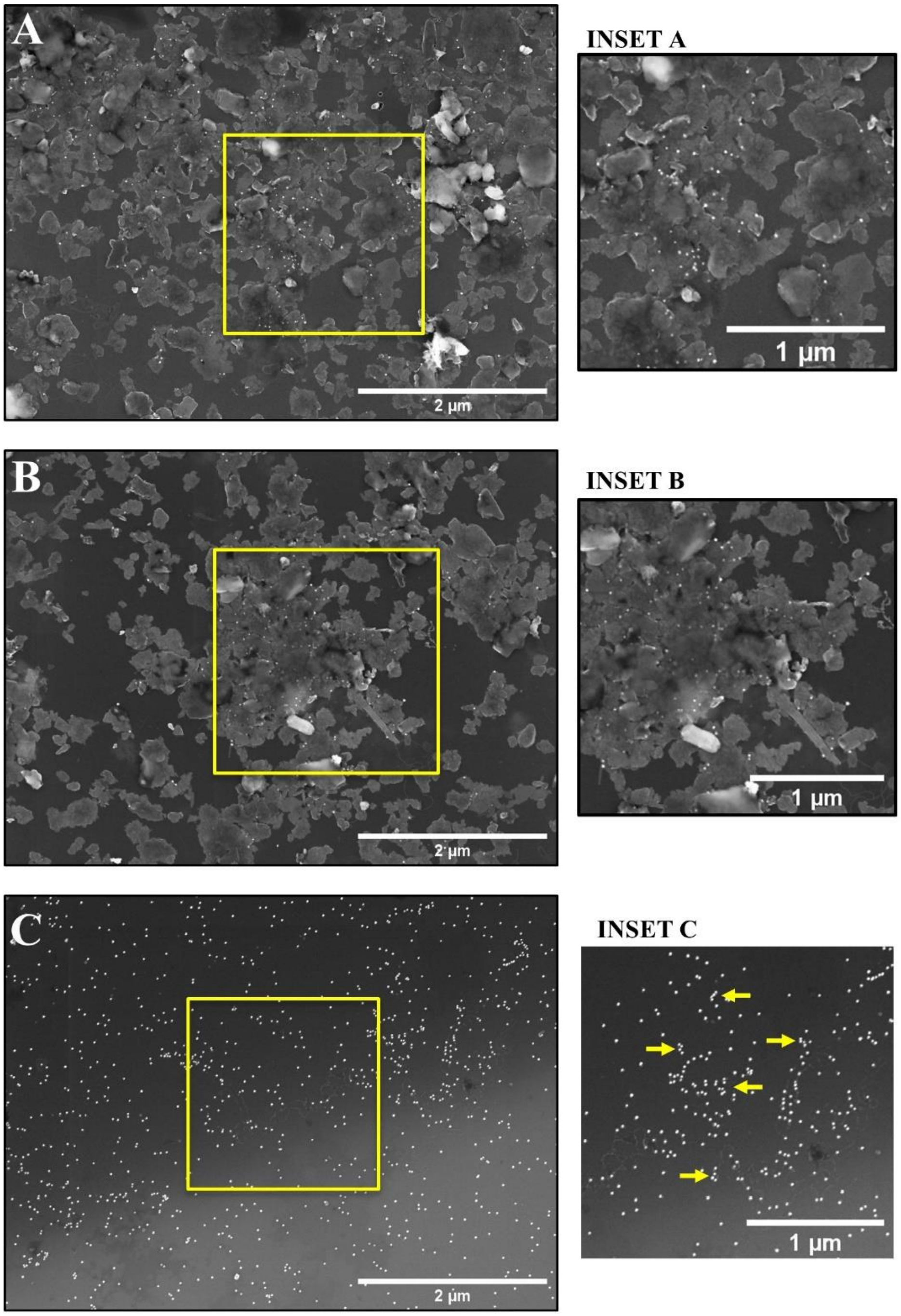

Figure S8. SEM micrographs of aged PEG-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

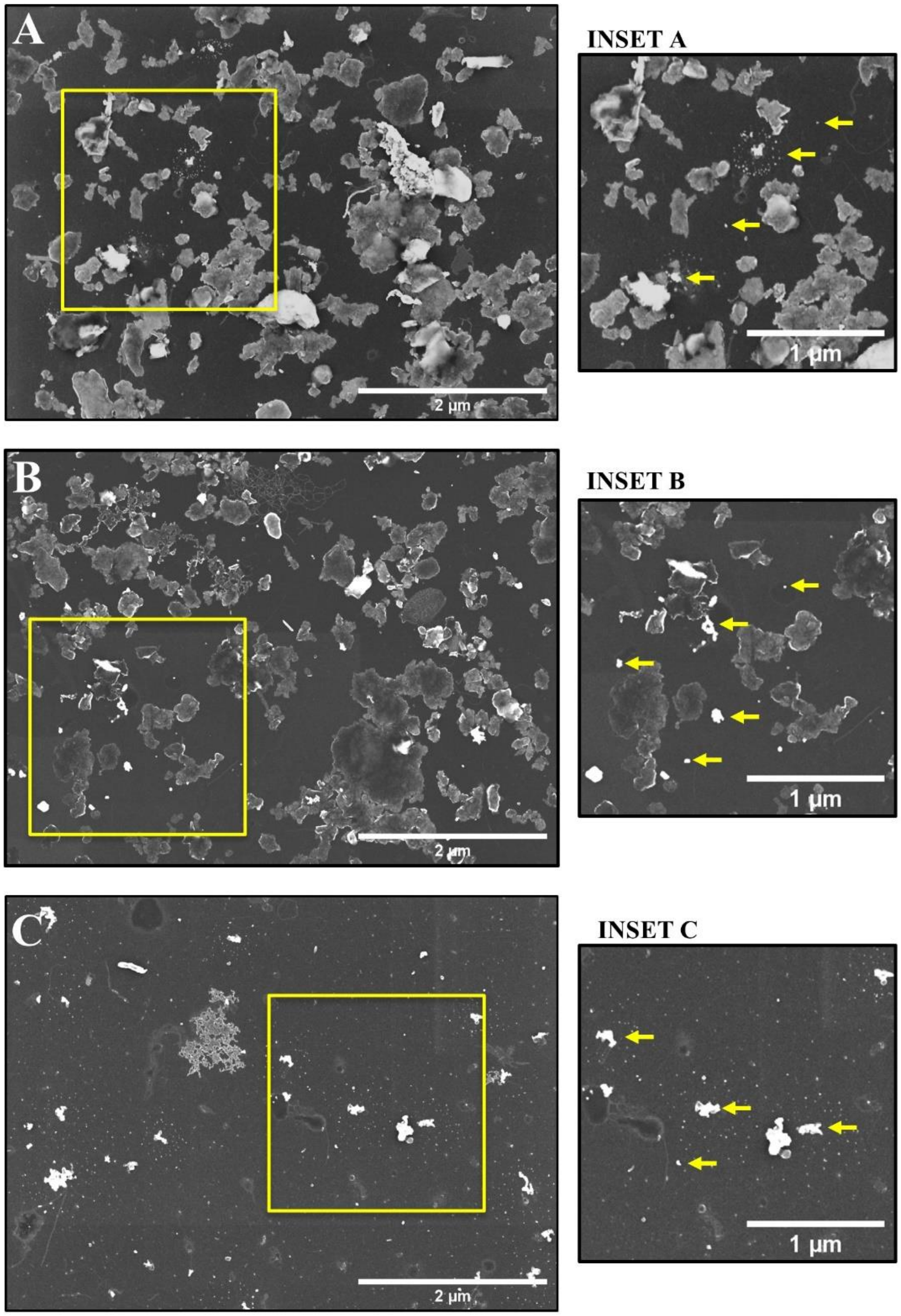

Figure S9. SEM micrographs of aged COOH-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

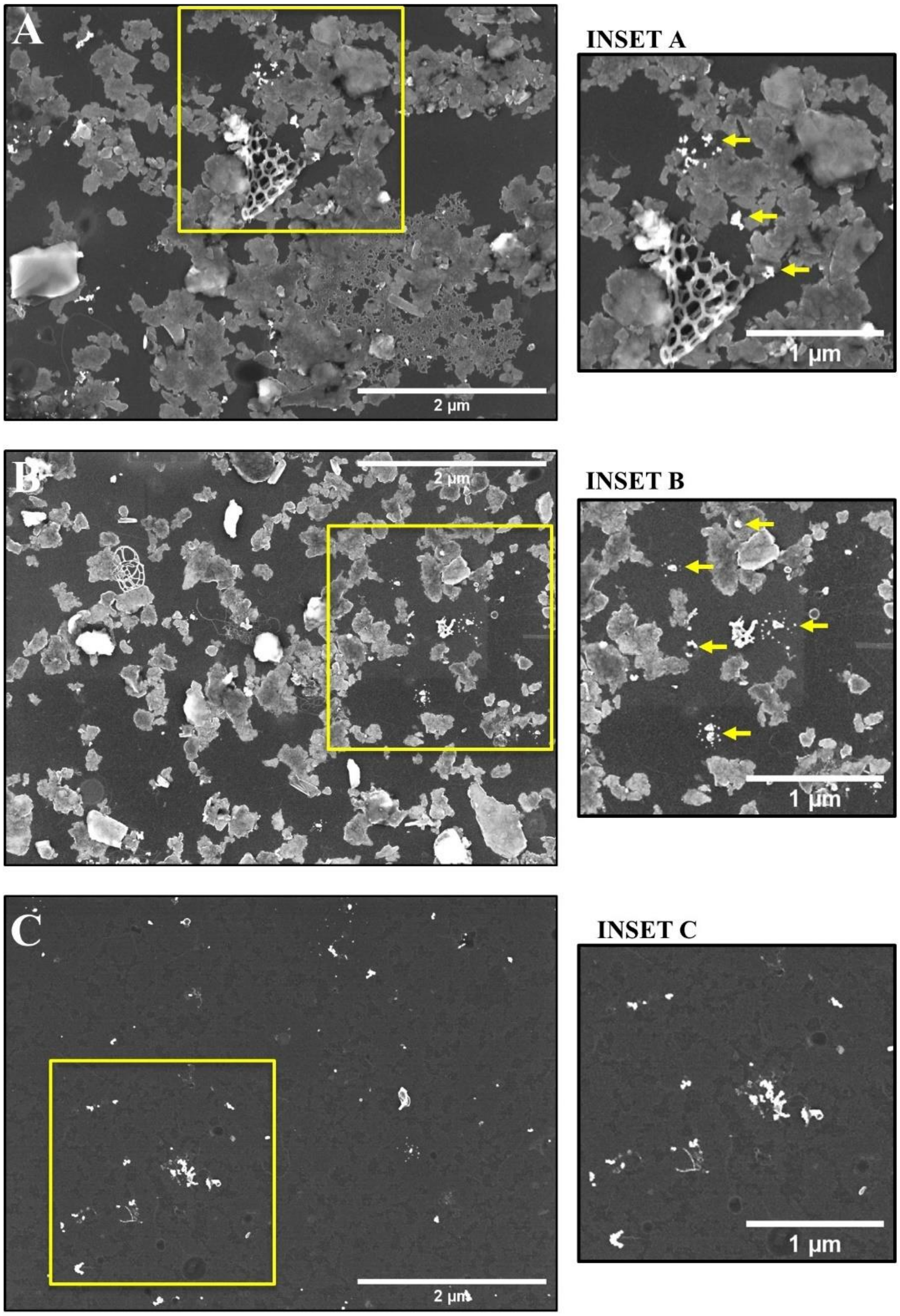

Figure S10. SEM micrographs of aged bPEI-AuNPs in (a) raw, (b) centrifuged, and (c) filtered river water.

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