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PI/PD Name: Anne E Marteel-Parrish

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☒ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☐

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

Race Definitions:
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Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
White. A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

WHY THIS INFORMATION IS BEING REQUESTED:

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PI/PD Name: Karl Kehm

Gender: ☐ Male ☐ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☒ White

Disability Status: (Select one or more)
☐ Hearing Impairment
☐ Visual Impairment
☐ Mobility/Orthopedic Impairment
☐ Other
☒ None

Citizenship: (Choose one) ☒ U.S. Citizen ☐ Permanent Resident ☐ Other non-U.S. Citizen

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REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☐

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PI/PD Name: Leslie A Sherman

Gender: ☐ Male ☒ Female

Ethnicity: (Choose one response) ☐ Hispanic or Latino ☒ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☒ White

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 09-1

NSF 09-502 **01/22/09**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

EAR - MAJOR RESEARCH INSTRUMENTATION, (continued)

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

0922733

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
01/21/2009	**3**	**06030000 EAR**	**1189**	**022564314**	**01/22/2009 2:08pm S**

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

520591691

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☒ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Washington College

AWARDEE ORGANIZATION CODE (IF KNOWN)

0021089000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Washington College
300 WASHINGTON AVE
CHESTERTOWN, MD. 216201197

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Acquisition of a Quadrupole Laser Ablation ICP-MS for Materials Science, Biology, Earth and Environmental Science and Anthropology at Washington College**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **333,579**	**36** months	**01/01/10**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____

☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
Chemistry

PI/PD FAX NUMBER
410-778-7275

PI/PD POSTAL ADDRESS
300 WASHINGTON AVE
CHESTERTOWN, MD 216201197
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Anne E Marteel-Parrish**	**PhD**	**2003**	**410-778-7795**	**amarteel2@washcoll.edu**
CO-PI/PD **Karl Kehm**	**PhD**	**2000**	**410-778-7711**	**kkehm2@washcoll.edu**
CO-PI/PD **Leslie A Sherman**	**PhD**	**1997**	**410-778-2800**	**lsherman2@washcoll.edu**
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 09-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be dislosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:

(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:

(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Leslie A Sherman**	**Electronic Signature**	**Jan 21 2009 4:38PM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
410-778-2800	**lsherman2@washcoll.edu**	**410-778-7275**

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) - continued from page 1
(Indicate the most specific unit known, i.e. program, division, etc.)

CHE - MAJOR RESEARCH INSTRUMENTATION
BCS - MAJOR RESEARCH INSTRUMENTATION
DBI - MAJOR RESEARCH INSTRUMENTATION

Project Summary

Washington College is a four-year liberal arts college located in Chestertown on the Eastern Shore of Maryland. Founded in 1782, the college strongly identifies with its colonial past and fosters its connection with the Chesapeake Bay region. About 12% of Washington College's 1,300 students major in science. The purpose of this proposal is the acquisition of an Inductively Coupled Plasma-Mass Spectrometer with Laser Ablation (LA-ICP-MS). It is expected that at least 5 faculty members and 23 undergraduate students will use this instrumentation on an annual basis.

Intellectual Merit: The intellectual merit of this proposal is drawn from the following research projects: (1) in the physical sciences: the exploration of benign synthetic pathways for the production of modern electroceramics used in computers, aerospace and telecommunications devices, (2) in the physical sciences/geoscience: the analysis of solar wind elemental ratios in lunar soil grains, and (3) in geoscience: a study of the impacts of prescribed burning on the chemistry of a weathered soil on the mid-Atlantic Coastal Plain, (4) in the biological sciences: a study of the interactions of toxic metals with DNA repair, (5) in social science: trace element sourcing of metal artifacts and lithic materials from archeological sites, and (6) in geo- and environmental science: investigation of heavy metal contamination in bottom sediments in marinas on the Chester River in cooperation with the STEM (Science Technology Engineering and Mathematics) academy of Kent County Public Schools and the Chester River Association in Chestertown.

Broader Impacts: In addition to providing our team members with an essential, in-house, state-of-the-art instrument for conducting original research, the proposal has the following broader impacts: (1) it will create new opportunities for faculty-student collaborative research and experiential learning at Washington College, which will improve recruitment of science majors, and improve research training for students going on to graduate school and industry, (2) it will facilitate scientific outreach to local organizations and schools, thereby promoting scientific research among high school students and citizens in our community, (3) it will enhance our efforts to attract underrepresented groups and women to scientific fields by creating new research opportunities for undergraduates and high school students from diverse backgrounds and (4) it will generate excitement about science on our campus and in our community by promoting the continuing growth of the scientific research culture at Washington College.

The co-PIs and faculty associates that make up our team span the range of disciplines represented by the diverse research agenda in this proposal. In addition to dramatically advancing our individual research pursuits, we anticipate that cooperative use of the NSF-MRI-funded LA-ICP-MS instrument by our team members will foster innovative approaches to ongoing projects and stimulate new directions for collaborative multidisciplinary research. The inevitable synergies that will be generated among our research team members, collaborators and students will enhance the teaching/learning/research environment on campus, helping us to achieve the primary goal of Washington College's current strategic plan, to "enhance the resources supporting active inquiry." Providing unique research opportunities for undergraduate students across science disciplines, inspiring students to go on to graduate schools and industry, and conveying enthusiasm about science among pre-college students and members of our local community are important driving forces for this proposal.

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For font size and page formatting specifications, see GPG section II.C.

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Project Summary (not to exceed 1 page)	1	
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Project Description (Including Results from Prior NSF Support) (not to exceed 15 pages) **(Exceed only if allowed by a specific program announcement/solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**	15	
References Cited	7	
Biographical Sketches (Not to exceed 2 pages each)	10	
Budget (Plus up to 3 pages of budget justification)	6	
Current and Pending Support	2	
Facilities, Equipment and Other Resources	1	
Special Information/Supplementary Documentation	0	
Appendix (List below.) **(Include only if allowed by a specific program announcement/ solicitation or if approved in advance by the appropriate NSF Assistant Director or designee)**		
Appendix Items:		

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Research Activities

The NSF-MRI grant will provide support to acquire an inductively coupled plasma mass spectrometer (ICP-MS) with laser ablation system. Washington College emphasizes undergraduate education through active inquiry and seeks to promote faculty research. The instrument will be used by a multidisciplinary team of faculty members who share a critical need for high sensitivity elemental analysis in order to pursue fundamental research in the geosciences, chemistry, biology, social sciences and environmental sciences. In addition, the instrument will create a wealth of new opportunities to engage undergraduate science students in cutting-edge research on our campus. The ICP-MS lab will also serve as a center for collaborative research and innovative teaching involving our faculty, undergraduate science students, high school science teachers and STEM students from Kent County, and scientists from local environmental organizations. Use of the instrument will positively impact traditionally underrepresented groups, as 70% of Washington College's science students are women, and the Kent County STEM academy draws from a student body that is one-third minorities.

In the previous submission of this proposal, constructive reviewer comments recommended strengthening the intellectual merits, improving the management plan, and clarifying the relationship between proposed research and the relevant NSF directorates that participate in the MRI solicitation. We have seriously considered these issues. This revised proposal includes a more robust management plan. The intellectual merits are more carefully developed, and ties with the relevant NSF directorates have been clarified. The table below summarizes the research projects that will be pursued. Detailed descriptions of these projects follow.

Project (NSF Directorate)	**Faculty and Professionals (Agency)**	**Students (per year)**
(1) Benign-by-design Synthesis of Electroceramics (Mathematics/ Physical Sciences)	Anne Marteel-Parrish Assistant Professor, Department of Chemistry	3
(2) Solar Wind Elemental Ratios in Lunar soils (Mathematics/Physical Sciences, Geosciences)	Karl Kehm Associate Professor, Department of Physics	2
(3) Prescribed Burning Impacts on the Chemistry of a mid-Atlantic Coastal Plain Soil (Geosciences)	Leslie Sherman Associate Professor, Department of Chemistry	3
(4) Interactions of Toxic Metals with DNA Repair (Biological sciences)	Mindy Reynolds Assistant Professor, Department of Biology	3
(5) Sourcing of Prehistoric and Historic Archaeological Metal and Lithic Materials (Social Sciences)	John Seidel Associate Professor, Department of Anthropology	6
(6) Research Outreach: Collaborative studies of trace metals in river sediments. (Geosciences, Biological Sciences)	Anne Marteel-Parrish, Karl Kehm, Leslie Sherman, Mindy Reynolds, John Seidel, Brent Walls (Chester River Assn.), Mary Etta Reedy (Kent Co. Schools)	6+

(1) Green Materials Science and Electroceramics (Anne Marteel-Parrish)

Combining materials science with green chemistry is at the heart of Dr. Marteel-Parrish's research. Applying green chemistry principles to the more environmentally benign synthesis of electroceramics used in computers, aerospace and telecommunications devices will have an unprecedented economical, technical and environmental impact in the electronics industry.

Commercial electroceramic applications cover the broad spectrum from insulators and semiconductors to metalloid conductors, capacitors and superconductors. Over the last four decades a lot of research has been devoted to the synthesis of perovskites of the type ABO_3 such as barium titanate ($BaTiO_3$) and related compounds. Barium titanate is, to date, the most extensively investigated ferroelectric material due to its simple structure, its chemical and mechanical stability, and its ferroelectric properties at and above room temperature. Therefore barium titanate is the major raw material for the production of multilayer ceramic capacitors used in decoupling, filtering, timing, and other applications. Approximately 528 billion units (ca. $15 billion) were produced in 2005 for telecommunications systems, televisions, personal computers, and medical devices.

In a typical multilayer ceramic capacitor, as shown in Figure 1, the ceramic dielectric layer is of doped barium titanate. Even though barium titanate was discovered more than half a century ago, its notoriety is still contemporary. A start up company named EEStor, Electrical Energy Storage, based in Cedar Park, Texas conceived a battery made of high purity barium titanate powder coated with aluminium oxide and glass. This supercapacitor provides enough energy to drive a small car 500 miles and outperforms lithium ion batteries in term of energy density, safety, and cost [2]. Zenn, a Zero Emission No Noise electric car, is a barium titanate battery-operated electric vehicle which costs about a penny a mile to drive. Research is under way to improve the maximum speed for this type of car and make a more dramatic impact on the transportation field.

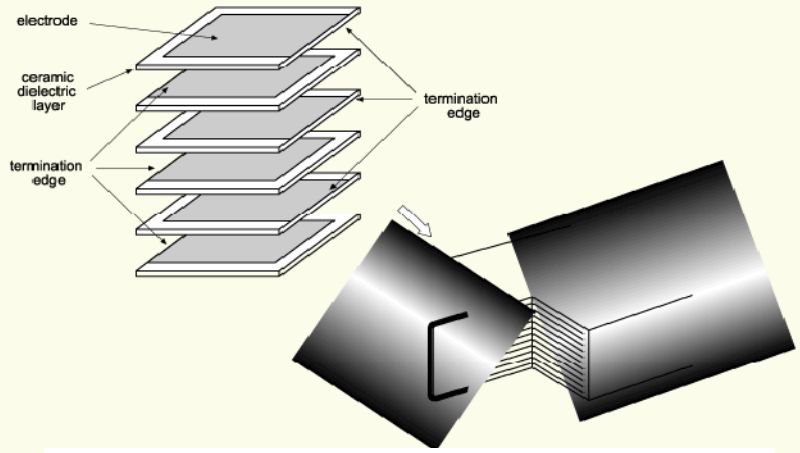

Figure 1: Typical multilayer ceramic capacitor [1]

Most of the processing techniques commonly used in the preparation of $BaTiO_3$ powders do not provide a Ba:Ti ratio of 1:1 but a nonstoichiometric compound and mixture of species rather than a single product [3]. However it is well demonstrated that the properties of ABO_3 ceramics are sensitive to stoichiometry and precise control of composition is required in synthesis. In 1990, Davies and Dutremez described a method of synthesis based on the generation of an ammonium salt of titanium and catechol which then underwent an acid-base reaction with barium hydroxide to form barium titanyl catecholate with ammonia and water as the only by-products [4].

The first goal of this research is to explore the generality of the synthetic method to the production of a range of oxides such as those of tin, zirconium, and hafnium. Barium stannate is used in sensor devices whereas barium zirconate is one of the most inert, stable, corrosion-resistant perovskite employed in superconducting applications. Barium hafnate is commonly found in field

effect transistors. Extension of the catecholate method to the synthesis of molecular precursors to ceramic materials directly from oxides will proceed in high yield and simple isolation steps and will allow good control of stoichiometry and homogeneity. In each case, the catecholate precursors and the final product will be analyzed using IPC-MS coupled with laser ablation. The nature of the compounds involved in the synthesis does not allow for simple dissolution even in harsh acidic environments and therefore prevents the real-time characterization in solution. Previous characterization using ICP-AES (atomic emission spectroscopy) led to inconsistent and misleading data. The laser ablation equipment coupled with ICP-MS will remedy this issue and will provide precise stoichiometric analysis directly from the solid compounds.

It has also been established that for capacitor applications, especially in computers the Curie temperature (T_c) of $BaTiO_3$ (130 °C) must be displaced towards lower temperatures. Above the Curie temperature, the cubic phase of $BaTiO_3$ has a large dielectric constant suitable for applications in electronic circuits while below the Curie temperature, the tetragonal form is suitable for ferroelectric applications. One of the methods to lower T_c is the partial substitution of Ba^{2+} by Sr^{2+} which is achieved through doping. The synthesis of doped barium titanate powders has previously been studied but none of these methods was entirely environmentally benign and did not present any simple control over the stoichiometry [5-14]. X-ray powder diffraction analysis showed the Ba:Sr ratio to be anywhere in the range of 50:50 to 77:23, therefore yielding an ambiguous and varying stoichiometric ratio [15].

The second goal of this research is to develop an environmentally benign method to synthesize doped perovskites $A_xB_{(1-x)}TiO_3$ in which the A:B ratio is under thermodynamic control in the presence of excess reagent. Exposure of a solution of BaX to an excess of solid strontium source, SrX, will result in cation exchange. The extent of the cation exchange is only governed by the ratio of solubility products of BaX and SrX at the temperature of the solution. Although the control of doping level is independent of the initial BaX concentration, this concentration regulates the extent to which the anion, X^{2-}, enters solution. In order to prepare doped perovskites with specific Ba:Sr ratios, a strontium source for which the ratio of solubility products of BaX:SrX has the appropriate value is selected. The conditions at which equilibrium is reached during the doping process will be studied. The first method is a microwave-assisted technique in which only ten percent power is used; the second method uses a centrifuge at room temperature. In both strategies, deionized water is the solvent. It will be of utmost importance to monitor the achievement of the equilibrium stoichiometries using ICP-MS rather than characterize the products at the end. Again the need for laser ablation is crucial as all compounds are not completely soluble in common acidic environments. On the long term, the utility of catecholate precursors will also have an impact in the fabrication of UV-patterning of oxide ceramics which may be converted into thin films through heat treatment. Effectively, barium strontium titanate thin films (as shown in Figure 2) have applications in high-density integrated circuits used in dynamic random access memories and nonlinear optical devices [16]. This research could considerably impact the design of electroceramics present in our daily lives.

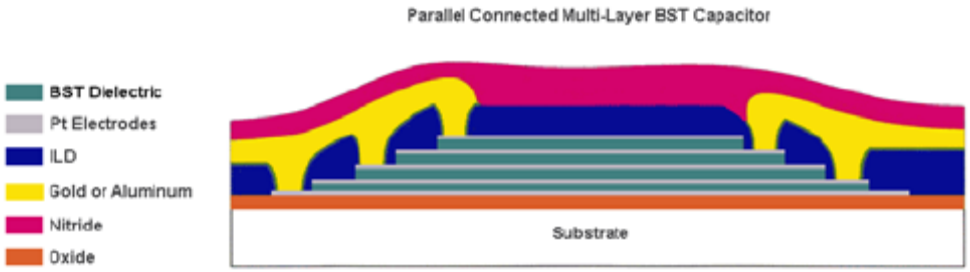

Figure 2: Cross-Section of Barium Strontium Titanate Multi-layer Thin Film Capacitor [17]

(2) Solar Wind Elemental Ratios in Lunar Soil Grains (Karl Kehm)

The composition of the solar wind (SW) reflects the intrinsic elemental abundances in the sun modified, in some cases, by ionization and acceleration processes in the sun's atmosphere [e.g., 1]. The negligible lunar global magnetic dipole [2] allows SW atoms to impinge on the lunar surface where they implant into surface soils. Lunar soils thus preserve an invaluable archive of atoms from the solar atmosphere, and laboratory analyses of lunar sample return material provides a unique view of the SW composition [e.g., 3].

To date, most studies of implanted SW in lunar materials have focused on noble gases because the low background abundance of these elements facilitates detection of the implanted solar component [3]. Solar wind noble gases, for example, saturate the surfaces of some lunar soil grains, particularly in gas-retentive ilmenite [e.g., 4]. Stepped-etching of lunar-soils allows progressive extraction of noble gases by implantation depth [5]. This technique has revealed implantation depth-dependent isotopic fractionation of noble gases [5,6]. Stepped etching has also revealed an apparent secular change in the SW composition, which is so far unexplained [7]. This result was subsequently corroborated by single-grain noble gas measurements of the same lunar soils conducted by K. Kehm and colleagues [8]. These studies focused on mineral separates, including ilmenite and pyroxene, from soils with two different antiquities: one near-surface soil irradiated within the past ~ 100 Ma and another set of soils taken from 2 m depth, irradiated 1000-2000 Ma ago [7, 8]. The results showed (1) an enhancement in Xe/Kr and Xe/Ar compared to expected solar values, which cannot be explained by the well-known overabundance of elements with low first ionization potentials in the SW [e.g., 9], and (2) a long term secular change in the relative abundances of Xe, Kr and Ar in the SW as evidenced by different Xe/Kr and Xe/Ar ratios in the soils that were irradiated at different times [7, 8]. The first observation was attributed to an enhanced ionization time for Xe in the solar chromosphere relative to other elements with similar first ionization potentials (FIP), while the second observation suggested either a temporal change in ionization conditions in the sun or a change in the relative abundance of fast (associated with coronal holes) to normal speed (interstream) solar wind over time [7, 8].

One way to test these hypotheses is to extend abundance measurements to other elements in the SW, which possess differing FIPs, differing inferred ionization times in the solar atmosphere [10], and whose implanted abundances are less susceptible than noble gases to perturbations by diffusive migration on the lunar surface. Of the elements present in significant abundance in the SW, only Cr has been studied in any detail in lunar soil grains by progressive etching and thermal ionization mass spectrometry [11]. More recently, microbeam x-ray fluorescence has been used to determine surface concentrations of transition metals in individual lunar soil grains [12]. ICP spectrometers have inherent advantages over other techniques used in this work. Firstly ICP efficiently ionizes many elements, which facilitates abundance measurements of a large fraction of the periodic table. Secondly ICP-MS instruments offer sub-ppb level sensitivity, which permits measurements of the abundances of low concentration elements.

We propose to use the NSF-MRI-funded single-collector ICP-MS instrument to survey the abundances of measurable elements present in the outer surfaces of selected mineral separates from Apollo soils using offline acid stepped etching. Our initial efforts will focus on transition metal concentrations (e.g., Cr, Mn, Co, Ni, Cu and Zn) in plagioclase grains from previously characterized soils with known irradiation antiquities, 71501 and 79035 from Apollo 17. The transition metals tend to be incompatible in plagioclase (e.g., indigenous Cr is ~ 10 ppm in plagioclase from soils and lunar anorthosites [12, 13]) and span a range of FIP values (~ 6.77-9.39 V). Based on average Ar concentrations in 79035 and 71501 plagioclase [8], and assuming solar abundances [14], we expect an average concentration of ~15 ppm SW Cr in the outer 200 Å of a grain. Since this estimate is based on Ar, which is susceptible to diffusive losses, this is considered a lower limit. Thus, SW Cr

should be detectable as well as perhaps other transition metals.

Several student researchers are expected to participate in different phases of this project including, ICP-MS instrument calibration through repeat analyses of digested plagioclase standards, size separation, magnetic sieving and hand-picking of lunar plagioclase, stepped etching and sample analysis. Lunar materials will be obtained by proposal submission to the Lunar Sample Curator and CAPTEM (Curation and Analysis Planning Team for Extraterrestrial Materials). Sample preparation will be conducted in chemistry labs at Washington College when possible or at the clean chemistry lab at the Carnegie Institution of Washington where researcher Karl Kehm holds a visiting research appointment.

The research we propose is distinct from the ongoing detailed studies of the contemporary solar wind composition, for example by the ACE mission and Genesis spacecraft [e.g., 15, 16], in that lunar soil grains record a time-averaged composition of the solar wind integrated over tens of thousands of years and are thus less sensitive to short term variations in the solar output. More importantly the availability of lunar soils with different irradiation ages provides an opportunity to explore the way the solar wind composition changes over billion-year time scales, which can provide important constraints on models for solar evolution. Extending solar wind composition measurements in lunar soils beyond the noble gases is an important first step in this work, which we hope to achieve through the acquisition of the NSF-MRI-funded quadrupole ICP-MS.

(3) Prescribed Burning Impacts on the Chemistry of a Weathered Mid-Atlantic Coastal Plain Soil (Leslie Sherman)

Grassland restorations have been ongoing in many regions in the United States, primarily to restore natural wildlife habitat and to reduce soil erosion. The restoration sites are often managed by prescribed burning to remove competing woody vegetation and to enhance conditions of growth of the grasses [1-3]. Grassland burns are of a much lower temperature than typical forest fires, but still produce significant quantities of ash. The deposition of the ash on the soil surface after a forest fire is known to produce significant long-term changes in the metal content of the underlying soils [4]. Base cation metals, such as calcium and magnesium, and some trace metals, like iron and manganese, are essential nutrients for plant growth. Therefore, burns can result in a recycling of these metals to the soil and hence can help in the productive growth of forests if the metals are in plant-available fractions of the soil. However, in natural grassland and grassland restorations, changes in metal contents of soils in response to burning have been rare and are usually minor [5-8]. It has been concluded by many that ash has minimal impact on the chemistry of soils of grassland systems.

Although major changes in soil metal concentrations in response to burning of grasslands have not been typically observed, previous results of Sherman et al. suggest that more significant changes can occur in soils that are naturally very low in metal contents [9, 10]. Most grassland studies have been conducted in the Midwest and the Great Plains, where soils are most commonly very fertile. Few grassland restorations have been developed on Northeastern and mid-Atlantic soils, however, which are often highly weathered and hence depleted of metals [11]. After a first-time prescribed burn of a grassland restoration developed on previously cultivated agricultural land in Maryland [12], Sherman et al. observed elevated levels of weak-acid extractable major metals Ca, Mg and K in the soil, a measure of the plant-available fraction (Figure 1) [9]. After 1 year, these cations remained elevated in the soil.

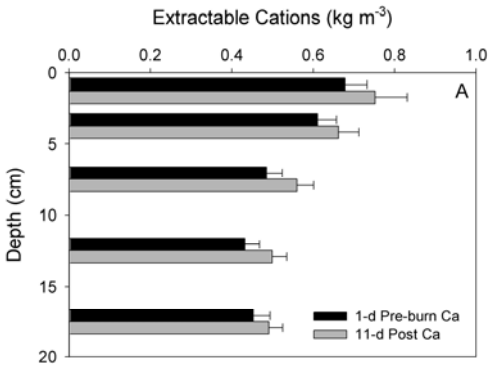

Figure 1: Soil Ca after first prescribed burn of grassland site in Maryland

With nationwide efforts in the U.S. to restore land to native habitats as part of the U.S.D.A. Conservation Reserve Program, the grassland restoration site in Maryland can be an ideal test case for the impacts of prescribed burning on metal cycling in highly weathered soils of grassland systems. The soil at the grassland restoration is formed from mid-Atlantic Coastal Plain parent materials and is a weathered well-drained sandy loam soil (13). The primary clay minerals are kaolinite, illite and hydroxyl interlayered vermiculite (14). The soil is low in organic matter and is slightly acidic and has a low cation exchange capacity (13).

The first goal of the project is to analyze soil samples collected after prescribed burns of the grassland for bioavailable major and trace metals. Trace metal enhancement due to grassland burning has not been reported from other studies, however ash from vegetation burning has been shown to contain significant concentrations of trace metals [15]. Results from a subset of weak-acid soil extracts from the grassland restoration site, sent out for analysis by ICP-OES, showed elevated Fe, Mn, Zn and Cu, suggesting an accumulation of these metals from the repeated burns. Acquisition of an ICP-MS by Washington College would allow measurement of these trace metals in-house for future in-depth work, since the ICP has lower detection limits than those of the atomic absorption spectrophotometer (A.A.) currently owned by the College. Moreover, the small sample volume from soil extracts prohibits measuring the suite of cations of interest for the project using an A.A.

Not only would an ICP-MS allow for measurements of the total bioavailable fraction of major metals and trace metals in the soil of the grassland restoration in Maryland, the instrument would allow for a more in-depth study of the speciation of the metals in the soil. The soil fraction in which the metals are located determines the stability of the metals in the soil system and their availability to plants. Trace metals are more complex than major cations in terms of their interactions in soils. They can undergo cation exchange or specifically adsorb to clay and metal oxide surfaces, can form soluble and insoluble complexes with organic matter, and can form precipitates. Interestingly, studies of experimental additions of trace metals in the soluble phase to soil surfaces indicate a rapid movement of the metals into the exchangeable phase and then into progressively less labile soil fractions [16]. Ash deposited to the soil surface after prescribed burns upon dissolution will release trace metals into the soil solution. An investigation of whether a similar progressive movement of the metals through sequentially more stable fractions will indicate whether metals may accumulate in these soils in the long term.

The second goal of the project therefore will be to determine the fate of these metals with time after burning, by collecting soil samples at bi-monthly intervals after the burns. A sequential extraction will be performed on these samples, to measure the soluble and exchangeable fractions, as well as that associated with oxides and organic matter, using the method recommended in a recent review of extraction techniques for trace metals in soils [17, 18]. Concentrations of the trace metals will be even lower than those in the weak-acid extracts, so an ICP-MS is vital for this analysis. Measurements of soil pH, soil organic matter and cation exchange capacity (CEC) will also be measured. Soil CEC is hypothesized to increase in the short-term due to deprotonation of exchange sites with the elevated pH from ash hydrolysis, as well as due to addition of new cation exchange sites from the ash, which is primarily char carbon, that can have negative functional groups (13). Black carbon, primarily char carbon has been measured throughout the U.S. in historically burned grasslands. [19] Any increase in CEC will enhance the retention of trace metals in the soil.

Not only will the acquisition of ICP-MS by Washington College facilitate the research goals of this project, but it will greatly enhance the opportunities for collaborative student-faculty research. In the past, students have worked on the grassland project using the A.A. for analysis of major metals. One student received funding from the College to travel to University of Arkansas to run her samples on an ICP-MS, however this was an unusual situation. Acquisition of an ICP-MS would allow students to gain invaluable experience with the instrument for research training, not common at a small liberal arts college.

(4) Interactions of Toxic Metals with DNA Repair (Mindy Reynolds)

Massive growth of manufacturing and other economic activities in major industrialized countries has inevitably resulted in an increased flux of heavy metals such as Cr, Ni, and Co into the environment. Heavy metals are the ultimate form of persistent pollutants because they are chemically and biologically indestructible. The effects of these metals are strongly influenced by their intracellular metabolism which creates several reactive intermediates and byproducts. If these products are left unrepaired or misrepaired, they can lead to growth arrest, cytotoxicity, mutations, and apoptosis [1]. Although the hazardous potential of toxic metals is recognized, the mechanisms underlying the repair of metal-induced DNA damage is poorly understood.

Intracellular reduction of Cr(VI) to Cr(III) leads to the extensive formation of Cr-DNA adducts in the form of interstrand crosslinks, DNA-protein crosslinks, and binary and ternary Cr-DNA adducts. The major form of Cr-DNA adducts are ternary adducts, which consist of Cr(III)-mediated DNA crosslinks with glutathione, cysteine, or ascorbate. The formation of these adducts proceeds through the attachment of binary Cr(III)-ligand complexes to DNA phosphates [4-6]. Ternary adducts are several times more potent than binary adducts, and removal is especially important for reduction of Cr-induced toxicity. Despite the large amount of information available on the types of lesions produced by Cr, little is known regarding the repair of individual Cr-DNA lesions by DNA repair mechanisms [2, 3]. Previously, Reynolds and colleagues demonstrated that DNA-bound Cr was rapidly removed by nucleotide excision repair (NER) [7, 8]. Although these experiments identified the importance of NER in removal of Cr damaged DNA, they did not assess rates of repair of individual adducts. Our first goal is to use a mammalian cell culture model to investigate repair rates of three major ternary adducts, such as ascorbate-Cr-DNA, cysteine-Cr-DNA, and glutathione-Cr-DNA. Time-course analysis of DNA-bound Cr have pointed to a potential existence of slowly repairable Cr-DNA adducts. In order to understand this process at the mechanistic level and to identify individual Cr-DNA adducts repaired by NER, we will first form ternary Cr-DNA adducts *in vitro* using previously established methodology. We will then proceed to measure repair of individual adducts in NER-deficient and –proficient mammalian cells [9, 10]. The total amount of bound Cr will be determined by ICP-MS, which has a limit of sensitivity of approximately 1 Cr adduct/10,000 base pairs for 1 μg of DNA [6, 10, 11]. It is hypothesized that since Cr-DNA binding does not cause major structural distortion in DNA [12], then ternary adducts containing larger ligands are likely to be removed by NER at a higher rate. Glutathione-Cr-DNA is the largest Cr adduct, which should make it more easily detectable by NER, thus leading to a more rapid repair. This project represents the first concerted attempt to identify specific Cr adducts recognized and repaired by NER.

Water and soil supplies are simultaneously contaminated with multiple metals. However, most research involves assessment of single metals while few have examined the interactions among various heavy metals during their co-exposure. The reason for this lack of research is the huge investment needed to describe the behavior of single components before a mixture can be interpreted as the net result of their interactions. Cr contamination classically occurs simultaneously with and two other toxic metals, Ni and Co [2]. Previous studies have found that certain heavy metals enhance the effects of other chemicals by disturbing different DNA repair systems [13]. Preliminary studies by M. Reynolds detected that NER-dependent removal of Cr-DNA adducts was inhibited in the presence of Ni(II) ions, suggesting that Cr-DNA damage could be more persistent under conditions of exposure to mixtures of Cr(VI) with toxic divalent metals. Our second goal of this project is to test the hypothesis that co-exposure to Ni(II) and/or Co(II) ions decreases repair of Cr-DNA adducts through inhibition of DNA repair mechanisms. This will include direct comparison of rates of repair of Cr-DNA adducts using ICP-MS in control and Ni/Co-treated in NER-deficient and –proficient mammalian cells at 3-48 hr post-exposure intervals. Most metals exhibit synergism; therefore, we

hypothesize that co-exposure to Ni or Co ions will interfere with NER and thus affect repair of Cr-DNA adducts. This research will be conducted with undergraduate students at Washington College, and it will support faculty-student research for peer-reviewed publications.

(5) Sourcing of Prehistoric and Historic Archaeological Metal and Lithic Materials (John Seidel)

ICP-MS will be used by Washington College's Public Archaeology Laboratory, under the direction of Prof. John L. Seidel, for various projects relating to the sourcing of materials, manufacturing techniques, and trade and exchange. The technique has been effectively used to examine a wide variety of archaeological materials [1]. Two archaeometric projects are proposed here for ICP-MS: analysis of materials from the American Revolution; and analysis of lithics and metals from prehistoric sites in the Chesapeake. Minimally destructive analytical techniques are required, and laser ablation (LA-ICP-MS) therefore is essential.

Revolutionary War materials analysis –Washington College and its partner Monmouth University (NJ) are analyzing materials from a major Revolutionary War site, dating to 1778-1779 at Pluckemin, New Jersey. Excavations of the site's barracks, workshops and warehouses yielded a quarter of a million artifacts, recognized as one of the best collections of period artifacts in the country [2-5]. In a project to fully analyze and conserve the assemblage, several classes of artifacts will profit from LA-ICP-MS analysis, especially metals and ceramics.

An example of metal analysis is provided by two brass belt plates recovered from surface contexts at the site. These engraved plates depict the cannon and flag motif of the Continental Artillery and show the Stars & Stripes, surprisingly rare in Revolutionary War-era art. Given the short occupation of the Pluckemin site, from December of 1778 to June of 1779, the plates should be tightly dated, making them the earliest known depictions of the Stars & Stripes. Dating, however, is complicated by the surface (as opposed to stratigraphic) context of the finds, yielding the possibility that they are inauthentic and were planted on the site. This question can be resolved by comparative analysis of the plates and waste brass excavated from the site's workshops. If the plates are similar in composition to the excavated waste, showing no characteristics of modern brass, then the dating of these unique pieces of American history can be more firmly established (e.g. brass until the late 1700s typically was an alloy of copper and zinc ore [calamine], rather than metallic zinc; more recent brass may contain aluminum, etc.). Manufacture techniques may also be addressed through LA-ICP-MS, such as the apparent "japanning" of surfaces and possible welds on fastening lugs.

Additional analysis will be done on white metal buttons (lead or tin-based alloys) of a type thought by historians to be French. These are suggested as helping to time the arrival of much-needed French supplies to the Americans in the field [2,6,7], an interpretation hinging on stylistic analysis. The hypothesis will be tested by comparing the constituents of these buttons with samples known to be French, from other contexts. Likewise, brass uniform buttons and accoutrements will be examined, many believed to have been manufactured at Pluckemin. Additional work will examine gun parts from an armorer's shop; some may have been manufactured in the field, with others probably forged elsewhere and shipped to the army in a "proto-mass production," signaling the coming of the Industrial Revolution [2,3]. A confirmation of such activities through LA-ICP-MS would require a revision of our understanding of the Continental Army's field capabilities, a view currently dominated by the mythic "bloody footprints in the snow" of the winter at Valley Forge.

Analysis of prehistoric lithics and metals from the Chesapeake region – The Middle Atlantic region shows evidence of ancient human migrations and shifting trade routes that are difficult to understand. Using LA-ICP-MS to investigate the sources of materials associated with these changes may be revealing. Three investigations will be pursued here. The chronologically oldest issue is an apparent de-population of the Chesapeake's Eastern Shore during the Younger Dryas (the cold, dry period following the Bölling/Allerød interstadial, ca 12,700 to 11,500 BP) and subsequent re-

occupation of the region. This depopulation is posited using artifact densities from five counties of Maryland's Eastern Shore as a proxy. Material from the pre-stadial period is numerous, but quantities decline markedly through the height of the Younger Dryas, followed by a dramatic rebound immediately after the Younger Dryas. [8]. The startling paucity of materials dating from the mid-stadial is strong evidence of a much reduced regional population. Many of the Early Archaic, post-stadial materials, which appear to reflect a rebounding population and in-migration, are made of green, metavolcanic tuff (silicifed rhyolite). The closest source of green tuff is thought to be North Carolina, suggesting migration from that region. Comparative analysis of Chesapeake examples with those from North Carolina sources will help resolve the questions of sourcing and migrations.

Later, in the Middle & Late Archaic, a copper tool technology emerged from the western Michigan area, around Lake Superior [9]. The impact of this Old Copper Complex is seen on Maryland's Eastern Shore through copper spear points, indicating trade, cultural diffusion, or migration. However, the origin of the copper itself is unclear, as there are other possible geological sources in Maine and northern New Jersey [10]. Prehistoric Native American copper was utilized directly – there was no melting or alloying, so the copper appears to have had few impurities, with the exception of silver [11,12]. Differing levels of impurities such as Ag, As, Au, Fe, Pb, Sb, and Sn should indicate different sources, a presumption that will be tested in this project. Copper from spear points recovered in Kent County, Maryland and neighboring Delaware will be compared with samples from potential sources to identify their origin, yielding important information on whether it is ideas or materials that are actually being transferred from Michigan to the region.

On the Chesapeake's Middle Woodland period sites, a new projectile point type known as Jacks Reef suddenly appears, often made of a specific chert type traditionally thought to be midwestern in origin and suggesting a possible migration from that area [13]. Several Delmarva Adena sites on the Maryland's Eastern Shore have produced artifacts made of lithic materials visually identified as Ohio Flint Ridge Chalcedony, Ohio Upper Mercer Chert, Indiana Wyandotte Chert, Portsmouth Ohio Pipestone, North Dakota Knife River Flint, and even Arkansas Novaculite. However, these primary quarry connections have never been confirmed. Also, during the latter portion of the Middle Woodland period, lithics apparently from Ramah Bay, on the north coast of Labrador and over 2500 kilometers north of the Delmarva Peninsula, show up in the Chesapeake [14]. These source attributions must be tested, and specific element patterns should allow us to develop signatures for specific chert sources. Using neutron activation analysis, Hoard et al. [15] found that 14 elements in chert samples in their Great Plains study area showed variations linked to different geological sources (As, Ce, Co, Cr, Cs, Eu, Fe, La, Nd, Sb, Sm, U, Yb, and Zn). We will compare samples from possible origin sites such as the Ramah Bay quarry with diagnostic lithic artifact materials from the Sandy Hill and Riverton sites in Maryland, the Frederica site in Delaware, and the Upper Ridge site on Mockhorn Island in Virginia to resolve questions surrounding the Middle Woodland population movements, as well as trade and exchange in the Chesapeake Bay region.

(6) Research Outreach: Collaborative studies of trace metals in river sediments. (Anne Marteel-Parrish, Karl Kehm, Leslie Sherman, Mindy Reynolds, John Seidel, Brent Walls (Chester River Assn.), Mary Etta Reedy (Kent Co. Public Schools))

The Chester River is a tidal tributary of the Chesapeake Bay that drains a ~ 383 mi^2 watershed on Maryland's Eastern Shore. Washington College maintains a boathouse and small marina on the Chester, which are only about a mile from the main campus. This facility provides river access for biology and environmental science education, intercollegiate sports and student recreation. The college is actively planning and has recently received funding from the Hodson Trust to increase its riverfront footprint. Plans include the construction of a new teaching and research

facility on property adjacent to the current boathouse, as well as the acquisition of a new research vessel. The close geographical and historical link between the college and the river continues to create unique opportunities for research and education for our students and faculty. Washington College researchers have ready access to a river that serves as an ideal field area to study the ecological, chemical and environmental processes that affect the entire Chesapeake Bay watershed and tidal river systems in general.

One new area of concern on the Chester is the increased demand for water-oriented recreation on Maryland's Eastern Shore, which is reflected by the presence of 28 marinas in the Chester River Watershed. There is growing evidence that marinas have a negative impact on water quality, disturb fish communities and contribute to the destruction of submerged aquatic vegetation. Of particular concern are toxic contaminants associated with boating, which can include chemicals leached from bottom paints, toxins associated with fuels or septic discharge, as well as toxic species associated with boat cleaning and painting during dry docking that are introduced into the marina by runoff [1]. Copper, in particular, is a common ingredient in anti-fouling bottom paint and is known to be elevated in sediments near marinas [2]. Concentrations of As, Pb and Ni were previously characterized as above "effects range-low" for bottom sediment at various sites on the Chester River [3,4]. Marina sediments may have decades of contamination build-up. The Chester River was reported to be an "area of emphasis" by the Chesapeake Bay Program, however, data on toxics are lacking in certain regions of the river [5].

We propose to establish a broad collaboration between members of our scientific team, the Chester River Association and the STEM academy of Kent County Public Schools to study the sources, distribution and migration of trace metal contaminants in and around marinas on the Chester River using quadrupole ICP-MS. The Chester River Association (CRA) is a nonprofit organization based in Chestertown that is dedicated to promoting stewardship of the Chester River, improving water quality, and educating the public about the health of the Chester River. Co-PI Anne Marteel-Parrish has been a member of the Science and Technology Committee at the CRA for the past 4 years and collaborator Brent Walls serves as the CRA's watershed coordinator. Science students from Washington College have worked closely with members of the CRA in the past, and some of these cooperative projects have served as the basis for senior capstone theses in the Chemistry department. Cooperative research with the CRA is thus a natural extension of existing ties between the college and the CRA. In addition, the CRA's outreach initiatives provide a good way to disseminate the results of our scientific work to the broader public.

Cooperation with the newly-formed STEM academy of the Kent County Public Schools on this project arose from co-PI K. Kehm's participation on the development committee for the STEM academy along with collaborator Mary Etta Reedy, superintendent for curriculum development and chair of the STEM steering committee. The STEM academy is a science magnet program that engages students in an accelerated, project-oriented science and mathematics curriculum. The project we propose will offer STEM students a concrete application of research techniques and applications. The students will participate in sample collection in the field and initial sample processing in the laboratory. Sample extraction and analysis with the ICP-MS will be conducted by undergraduate students. The STEM students will then assist with data analysis and interpretation. Each year a new group of STEM students will plug into the on-going project, in line with the academy's focus on project- based learning.

We anticipate that the opportunity to collaborate with our scientific team and members of the CRA will help to reinforce student interest in science, further their commitment to and success in scientific careers, and educate STEM teachers on current research methods. Furthermore, the potential pairing of our undergraduate research students and local high school STEM students through this project will promote an interest in science education among our undergraduates, as well as provide STEM students with the useful opportunity to interact with older peer mentors who have

made a commitment to careers in science and engineering. It is important to note that students in the STEM academy ideally reflect the ethnic and racial diversity of Kent County (34% minority). Thus, collaboration with the STEM academy will provide a natural avenue for engaging students from underrepresented groups.

The scientific goal of this project is to survey the trace element composition of bottom sediments in and near high traffic marinas on the Chester River for potentially toxic metals such as Cu, As, Pb, Cr and Ni. The sample preparation requires acid digestion following standard methods for sediment analysis [6]. The objectives are to determine (1) the extent to which toxins are concentrated in marinas, (2) the extent to which toxins have been redistributed by tidal motion and currents, (3) the possible presence of uncharacterized heavy metal pollutants at low concentrations (e.g., Cd from paint) and (4) the sources of these contaminants. Once the levels of toxic metals have been determined, these concentrations will be applied to an *in vitro* cell culture model. The goal is to examine rates of cell death and other makers of toxicity to determine how mixtures of metals at concentrations found in sediment samples can alter biological responses. In addition to the scientific insights provided by this study, the information may be valuable for informing environmental policy, such as establishing a priority list of marinas that need to have bottom sediments dredged.

Co-PI Leslie Sherman has extensive experience in soils analysis and field sampling techniques and will supervise sample acquisition and preparation. Washington College students, CRA members and teachers and students from the STEM academy are expected to play a significant role in acquiring samples and performing preliminary sample preparation. Team member Mindy Reynolds will supervise biological aspects of the study, including application of the in vitro cell culture model. The Center for Environment and Society (CES) at Washington College, for which team member John Seidel serves as director, recently received funding from the Department of Education for the construction of a new 46 foot research vessel, which will be utilized in the sampling effort. The vessel has the dual purpose of serving as a platform for research on the Chester River and the Chesapeake Bay, and serving as field classroom for STEM education. The Washington College GIS lab is closely linked to the CES and will play a role in mapping sampling sites and assisting in the spatial interpretation of the trace element data. Trace elements will be measured by ICP-MS by members of our scientific team. We anticipate offering teachers from the STEM academy the opportunity to work alongside members of our team in the laboratory, giving them invaluable experience in the use of ICP-MS. Data will be shared among each of our collaborators, and results will be disseminated through scientific publication and through outreach efforts within the schools, through the CES, and through public education at the CRA.

Description of the research instrumentation and needs

Instrument selection criteria for the ICP-MS at Washington College include the following:

- Instrument capable of ppb or better detection of a large number of elements (including, but not limited to Sn, Ba, Hf, Sr, Ti, Cr, Mn, Co, Ni, Cu, Zn, Ag, As, Au, Fe, Pb, Sb, and Cd) to enable use in a wide variety of scientific projects by researchers in disparate fields.
- Instrument with laser ablation capability to enable measurements on refractory materials, to facilitate minimally destructive measurements on artifacts, and to permit high spatial resolution trace element measurements
- Instrument with a collision/reaction cell to facilitate measurement of elements with significant interferences from gas-related (e.g., ArO in Fe mass region) or matrix-related (e.g., ArCl on ^{75}As) sources
- Instrument that is robust, possesses user-friendly interface, and can be relatively easily maintained with existing resources at Washington College

After presentations from two vendors and consultation with colleagues in the field, our scientific team chose the Fisher Thermo Element X-series II ICP-MS with a 213 nm Tempest II laser ablation system. The X-series II is a bench-top, low maintenance quadrupole ICP-MS that comes standard with a glass bead spray chamber and a concentric nebulizer for analyses of solutions. To facilitate efficient and reproducible throughput of multiple samples with sample-standard bracketing analyses, a CETAC ASX520 autosampler is requested as part of the instrument purchase. The instrument has a sample introduction system (nebulizer+spray chamber) mounted outside the torch box for easy user access, a self aligning torch system and a plug-in detector that facilitates rapid detector replacement. Moreover the ion focusing system and quadrupole are purported never to require cleaning, further reducing maintenance requirements. An additional advantage of this instrument is the "matrix-tolerant" sample and skimmer cones, which enhance stability and minimize argide formation in the source even during aspiration of unprocessed bulk solutions and laser ablation work.

We have also requested a collision cell for this instrument. The collision cell achieves differential suppression of polyatomic interferences compared to analyte ions through collisions between species in the ion beam and gas atoms in the collision cell. The collision cross section is larger for polyatomic species and thus they are more likely to experience scattering collisions in the cell. Matrix-related interferences are molecules derived from the analyte solution itself or formed in the plasma by combinations between matrix ions and gas atoms in the plasma (e.g., MgAr, CaO). Laser ablation work and unprocessed bulk solutions typically have a relatively high yield of matrix-related interferences. Gas-related interferences come from the plasma gas (e.g., ArO, Ar_2) and are particularly pervasive in the first row transition metals, some of which are target elements for study in this proposal. A collision cell will help us to optimize detection limits for elements targeted in our scientific projects.

We are also requesting funds to purchase a Peltier temperature controller for the spray chamber, which will further improve instrument stability and reduce requirements for strict temperature control in the lab space. Currently there are no clean-room facilities or laminar flow benches at the college. However, dust free environments are useful for minimizing contamination in sample containers, sample solutions, vacuum parts, etc. For this reason, we are requesting a Liberty Industries bench-top laminar flow table for the ICP-MS lab. The flow table has 34.5 inches of working height to allow use of a microscope.

As described in the management plan, the new ICP-MS instrument will be housed in a lab in the new John S. Toll Science Center at Washington College. This space has ample room for the ICP-MS and laser ablation systems and a new four foot fume hood. The college will supply funds of $10K to install (1) a four inch exhaust port to the outside capable of 150-200 ft^3/min of flow (2) a new dedicated 30 A 208V circuit with an in-room interrupt breaker (3) gas tank mounts (4) UPS supplies and (5) additional HVAC handling as necessary. Sample preparation including digestion, column chemistry, etc. will be conducted in one of several labs located in the departments of chemistry, physics and biology or in the Washington College Customs House (archaeology).

Impact on research and training infrastructure

The acquisition of an ICP-MS with laser ablation system by Washington College will help in the realization of the research and education goals of the College and specifically initiatives highlighted in its current strategic plan. The plan's central goal is the "enhancement of resources supporting an intensely personalized education of active inquiry" and "experiential learning" with an objective of better preparing students for "success in College and their careers beyond." The presence of the new ICP-MS lab on campus will help to accomplish this goal by dramatically expanding opportunities for scientific research between faculty and students.

Washington College has an established history of providing a research-intensive learning environment for its students. The curriculum in the sciences focuses on integrating research throughout the learning process. The ICP-MS laboratory envisioned by this proposal will be an educational and research resource beyond what is commonly offered at a 4-year undergraduate institution. The breadth and depth of research projects pursued by faculty in all the science departments will be increased and the learning experience of our students will be greatly enhanced. Moreover, the opportunity to use an ICP-MS instrument will help attract and retain science faculty and students, including female and minority students.

Several of our team members have been limited in the scope of several of their research projects and in the initiation of others, due to the absence of an ICP-MS. To date, a few of us have developed collaborative relationships with other institutions in order to access the analytical techniques required to pursue our research. The presence of this instrument will enable us to pursue projects in-house, which saves time and facilitates participation with students.

The expectation for faculty scholarship by the College has increased dramatically in the past 10 years. Having access to an ICP-MS should help in attracting new faculty who are expected to pursue an active research program, and in retention of existing faculty members who will be able to expand their research activities and think more creatively about future lines of inquiry. It is worth noting that 50% of the faculty members in the sciences at Washington College are women. The enhancements in research capability that will result from the acquisition of the ICP-MS will naturally improve the professional productivity of our diverse group of faculty scientists

Science students at Washington College have numerous opportunities for experiential learning and research training. The foremost is our 10-week summer research program. During the internship, students conduct collaborative research with a faculty member, involving a literature review, research design, data collection and analysis, and synthesis leading to a report and a public poster presentation. Secondly, all seniors in the sciences are required to complete a senior capstone project, which is a year-long project with a faculty member, culminating in a thesis and a poster presentation at the College. Many students present the results of their thesis and/or summer research project at national and regional meetings, such as the American Chemical Society meeting, Sigma Xi meetings, and the Green Chemistry and Engineering Conference, and some have published in peer-reviewed journals [1-3]. In addition, in numerous courses in the science curriculum, students have hands-on experience with instrumentation in inquiry-based laboratory exercises, such as in Honors General Chemistry, Instrumental Analysis, Earth and Planetary Systems, and Doing Archaeology.

Acquisition of an ICP-MS will greatly expand extracurricular research opportunities and enhance students' experience in quantitative chemical analyses, better preparing them for the type of instrumentation they will encounter in graduate school and in research positions. Although women are not underrepresented at the College, comprising 70% of our science majors, women are still underrepresented at higher levels in academia and in industry [3]. A sophisticated research experience at the undergraduate level can be invaluable in encouraging women and other underrepresented groups to pursue careers in science and in making them more competitive. Moreover, experience with a state-of-the-art analytical tool is a promising way to recruit students interested in science to Washington College, as well as those not initially interested in science, leading to an increase in the number of students majoring in the biology, chemistry and physics. Recently the Hodson Trust awarded significant funds to Washington College to support a Hodson Science Fellows Program to attract science students to the College by providing the students with research funding to pursue a collaborative project with a faculty member. Expanded research opportunities can help retain promising science students at the College.

Research projects supported by the ICP-MS will also support an objective of the College's strategic plan to implement outreach efforts to recruit and retain African-American and other minority students. The Center for Environment & Society (CES) at Washington College, directed by

one of our team members, Prof. John Seidel, is developing a semester-long, intensive academic program, the Chesapeake Semester, which engages students in interdisciplinary, hands-on study of the estuary. Shorter versions of the Chesapeake Semester will be run for regional high schools and teachers, exposing them to interdisciplinary estuarine study. In the summer of 2008, CES's Geographic Information Systems Laboratory organized its first summer camp in geospatial technology, focusing on the use of GIS to examine environmental spatial data. Oriented to grades 9-12 in inner city and rural areas, the program seeks to engage student populations under-represented in science research at Washington College. In the future, students could assist in specific research activities using ICP-MS, for example the collaborative marina studies project.

The CES also provides an opportunity to disseminate the results of research projects to the public. The Center maintains a close alliance with a major regional museum, the Chesapeake Bay Maritime Museum (CBMM), developing public programs and placing interns with the museum. CBMM is developing a new focus on the environment, and the Center will work with them to incorporate the results of research projects into an exhibit(s), thereby enhancing public scientific and technological understanding. These results also will be incorporated into the public exhibits in the Washington College Public Archaeology Laboratory and in its programs with school groups. In addition, as affiliate faculty to CES, the co-PIs will have the opportunity to present the results of their research through the outreach activities of the Center. These activities will include public lectures sponsored by the CES and the publication of pamphlets describing research outcomes that are written for and made available to members of the public during CES-sponsored public events.

Finally, among our important community outreach efforts is the proposed collaboration between the scientific team, Washington College students, the Chester River Association (CRA) and the Kent County Schools STEM academy to study metal contamination in marina bottom sediments samples using ICP-MS. As described in the project summary, partnership with these organizations will permit us to engage CRA members, undergraduates, and students and teachers from the Kent County STEM program in original scientific research. Existing public outreach efforts through the CRA will facilitate dissemination of research results to the local community. Participation by the STEM program enables us to engage teachers and high school students interested in future careers in science, and to promote an interest in research and science education among our undergraduate participants. Because the STEM academy seeks student membership that reflects the ethnic diversity of the general student population of Kent County schools, this collaboration will further enhance our efforts to generate interest in science among persons from underrepresented groups.

Management plan for ICP-MS and laser ablation (LA) system acquisition

The proposed single collector ICP-MS instrument will be managed by the co-PIs (Anne Marteel-Parrish and Leslie Sherman-Chemistry Dept., Karl Kehm-Physics Dept.) who will oversee day-to-day operation, general upkeep and will coordinate usage. Operators will include our scientific team of co-PIs plus faculty associates (John Seidel-Anthropology and Mindy Reynolds-Biology). From time to time, qualified, well-trained students involved in collaborative research will operate the instrument under the direct supervision of a research team member. In addition, we will encourage expanded use of the instrument among other researchers on campus that have been trained as operators.

Two co-PIs (Kehm and Marteel-Parrish) have extensive experience with ICP-MS instrumentation. Co-PI Kehm has past experience with laser volatilization and ablation systems for mass spectrometry. In addition, Kehm continues to hold a visiting research appointment at the nearby Carnegie Institution of Washington where other researchers and technical personnel with experience in operation and upkeep of ICP-MS instrumentation are available for consultation. One co-PI (Sherman) has used flame AA mass spectrometry extensively for current research projects. In

addition to drawing on expertise and past experience, the three co-PIs will take a 4-day off-site ICP-MS operators course, which is offered through our selected vendor at no additional cost. In addition, Washington College has agreed to fund an additional on-site 3-day training session for the three co-PIs on the use and maintenance of the installed LA-ICP-MS system. Other members of our scientific team will also have the opportunity to participate in the on-site training. There are no dedicated staff-level technicians at Washington College capable of assisting with operation or upkeep of the ICP-MS. Therefore the co-PIs will assume full responsibility for instrument upkeep and management.

We have a cooperative usage management plan, which includes designation of a rotating lab-manager, cooperative allocation of instrument time, and rigorous training of all approved users. Instrument time will be scheduled in four month blocks, corresponding roughly to the duration of fall and spring academic terms and summer months. The schedule will be determined in advance of each block. The three co-PIs will meet tri-annually to determine the usage schedule. Available instrument time will be divided equally among all qualified users.

During each four-month block, one of the co-PIs will be designated as the primary lab manager. The lab manager will oversee the instrument and lab space, perform routine calibration measurements, coordinate with users, and conduct training. Duties will also include maintaining supply stock and monitoring instrument performance. The lab-manager position will rotate among the three co-PIs at the end of each 4-month block.

Our usage plan includes a required training regimen for all users. New faculty users will be required to participate in a two day (cumulative) training class with one of the co-PIs, and must pass an instrument usage and lab safety exam. Although student users must pass the same training course, they will not be permitted to use the instrument unsupervised.

The ICP-MS and LA systems will initially be covered by a one-year warranty, which is offered by the vendors at no extra cost. We are requesting two additional years of extended warranty coverage for the ICP-MS, for a total of three years of extended warranty. This plan includes one preventative maintenance trip per year to service the ICP-MS. Because the maintenance for the LA system is expected to be minimal, we are seeking no additional extended warranty for the LA system. However, the college has agreed to budget the $10K required for possible repairs to the LA system for years two and three of the grant period. Thereafter, Washington College has also agreed to budget up to $15K per year for the following three years (years four, five and six) to cover additional service requirements for either system. For future years, we hope to fund additional service and/or maintenance contracts with external grant money generated by research projects that use the new ICP-MS facility.

The new LA-ICP-MS will be housed in a research lab reserved for the instrument in the recently-completed John S. Toll Science Center at Washington College. This 15’ x 20’ lab has a new four foot SafeAire Fisher Hamilton fume hood, space for gas cylinders mounts, ~ 40 linear feet of epoxy-resin topped lab bench space, a 5’x5’-square center project island, a work sink, eye washes, a first aid station and multiple IT data connections. There is space for the 4’-wide laminar flow bench requested. The college has budgeted up to $10K for additional infrastructure upgrades to the lab, which will include installation of dedicated twin 208 V power outlets, a four-inch gas exhaust port to the outside air, an uninterruptible power supply system and hardware for Argon tanks. We have requested ~$4K per year for operations expenses (see budget) for the first three years as part of this proposal to cover the cost of consumables kits, replacement multipliers and nebulizers, and Ar gas. Additional operations costs for subsequent years will be provided by individual faculty research budgets and external grant support. We anticipate that the availability of the instrument and the research generated from that will greatly enhance future efforts to secure external research grants. However, if external funding is not sufficient, Washington College has agreed to fund operational expenses of up to $4K/year through years four, five and six.

References

(1) Green Materials Science and Electroceramics (Anne Marteel-Parrish)

1. Ceramic Components. http://www.ami.ac.uk/courses/topics/0135_cc/ (accessed Dec 8, 2008).

2. Zero Emissions No Noise Zen. http://www.zenncars.com/ (accessed Dec 8, 2008).

3. Alcock, J.R.; Riley, F.L.; D'Angeli, C.; Thomas, A.G. An evaluation of two barium titanate processing routes, *Br. Ceram. Trans. J.* **1991**, *90*, 152-156.

4. Davies, J.A.; Dutremez, S.G. Electroceramics from source materials via molecular intermediates : $BaTiO_3$ from TiO_2 via $[Ti(catecholate)_3]^{2-}$, *J. Am. Ceram. Soc.* **1990**, *73*, 1429- 1430.

5. Yang, W.; Chang, A.; Yang, B. Preparation of barium strontium titanate ceramic by sol gel method and microwave sintering, *J. Mater. Syn. Proc.* **2002**, *10 (6)*, 303-309.

6. Qi, J. Q.; Wang, Y.; Chen, W. P.; Li, L. T.; Chan, H.L. W. Direct large-scale synthesis of perovskite barium strontium titanate nano-particles from solutions, *J. Solid State Chem.* **2005**, *178 (1)*, 279-284.

7. Arya, P. R.; Jha, P.; Ganguli, A. K. Synthesis, characterization and dielectric properties of nanometersized barium strontium titanates prepared by the polymeric citrate precursor method, *J. Mater. Chem.* **2003**, *13 (2)*, 415-423.

8. Shanker, V.; Ahmad, T.; Ganguli, A.K. Investigation of $Ba_{2-x}Sr_xTiO_4$: structural aspects and dielectric properties, *Bull. Mater. Sci.* **2004**, *27 (5)*, 421-427.

9. Deshpande, S. B.; Khollam, Y. B.; Bhoraskar, S. V.; Date, S. K.; Sainkar, S. R.; Potdar, H. S. Synthesis and characterization of microwave-hydrothermally derived $Ba_{1-x}Sr_xTiO_3$ powders, *Mater. Lett.* **2005**, *59 (2/3)*, 293-296.

10. Wei, X.; Padture, N. P. Hydrothermal synthesis of tetragonal $Ba_{1-x}Sr_xTiO_3$ powders, *J. Ceram. Proc. Res.* **2004**, *5 (2)*, 175-178.

11. Selvam, P.; Kumar, V. Synthesis of nanopowders of $(Ba_{1-x}Sr_x)TiO_3$, *Mater. Lett.* **2002**, *56 (6)*, 1089-1092.

12. Hungría, T.; Algueró, M.; Hungría, A. B.; Castro, A. Dense, fine-grained $Ba_{1-x}Sr_xTiO_3$ ceramics prepared by the combination of mechanosynthesized nanopowders and spark plasma sintering, *Chem. Mater.* **2005**, *17 (24)*, 6205-6212.

13. Walton, R. I. Subcritical solvothermal synthesis of condensed inorganic materials, *Chem. Soc. Rev.* **2002**, *31*, 230-238.

14. Hou, B.; Xu, Y.; Wu, D.; Sun, Y. Preparation and characterization of single-crystalline barium strontium titanate nanocubes via solvothermal method, *Powder Technology*. **2006**, *170 (1)*, 26-30.

15. Davies, J.A. ; Dutremez, S.G. Unpublished results

16. Technology update : Barium Titanate Optical Thin films, *Ceram. Bull.* **1991**, *70*, 204.

17. Bernacki, T. A. ; Koutsaroff, I.P., and Divita Gennum Corporation. Barium strontium titanate thin-film multilayer capacitors, *Passive Component Industry*. September/October **2004**, 11-13.

(2) Solar wind elemental ratios in lunar soil grains (Karl Kehm)

1. Geiss J. (1982) Processes affecting abundances in the solar wind. *Space Sci. Rev*. **33**, 201-217.

2. Russell C.T., Coleman P.J. Jr., and Schubert G. (1974) Lunar magnetic field: Permanent and induced dipole moments. *Science* **186**, 825-826.

3. Wieler R. (1998) The solar noble gas record in lunar samples and meteorites. *Space Sci. Rev.* **85**, 303-314.

4. Nichols R.H. Jr., Hohenberg C.M., Olinger C.T. (1994) Implanted solar helium, neon and argon in individual lunar ilmenite grains –Surface effects and a temporal variation in the solar wind composition. *Geochim. Cosmochim. Acta* **58**, 1031-1042.

5. Wieler R., Baur H., and Signer P. (1986) Noble gases from solar energetic particles revealed by closed system stepwise etching of lunar soil minerals. *Geochim. Cosmochim. Acta* **50**, 1997-2017.

6. Grimberg A., Baur H., Bochsler P., Buhler F., Burnett, D.S., Hays C.C., Heber V.S., Jurewicz A.J.G., and Wieler R. (2006) Solar wind neon from genesis: Implications for the lunar noble gas record. *Science* **314**, 1133-1135.

7. Wieler R. and Baur H. (1995) Fractionation of Xe, Kr and Ar in the solar corpuscular radiation deduced by closed system stepped etching of lunar soils. *Ap. J.* **453**, 987-997.

8. Wieler R., Kehm K., Meshik A.P., and Hohenberg C.M. (1996) Secular changes in the xenon and krypton abundances in the solar wind recorded in single lunar grains. *Nature* **384**, 46-49.

9. Meyer J-.P. (1985) Solar-stellar outer atmospheres and energetic particles, and galactic cosmic rays. *Ap. J. Supp. Series* **57**, 173-204.

10. Marsch E., von Steiger R., and Bochsler P. (1995) Element fractionation by diffusion in the solar chromosphere. *Astron. Astrophys.* **301**, 261-276.

11. Kitts K., Podosek F.A., Nichols R.H.Jr., Brannon J.C., Ramezani J., Korotev R.L., and Jolliff B.L. (2003) Isotopic composition of surface-correlated chromium in Apollo 16 lunar soils. *Geochim. Cosmochim. Acta* **67**, 4881-4893.

12. Kitts K., Sutton S., and Newville M. (2007) Abundance and charge state of implanted solar wind transition metals in individual Apollo 16 and 17 lunar soil plagioclase grains determined in situ using synchrotron x-ray fluorescence. *Lunar. Planet. Sci. Conf. XXXVIII*, # 1106.

13. Palme H., Spettel B., Wänke H., Bischoff A., and Stöffler D. (1984) Early differentiation of the moon: evidence from trace elements in plagioclase. *Proc. Of 15th Lunar Planet. Sci. Conf., JGR* **89**, C3-C15.

14. Anders E. and Grevesse N. (1989) Solar system abundances of the elements. *Geochim. Cosmochim. Acta* **53**, 197-214.

15. Gloecker et al. (1998) Investigation of the composition of solar and interstellar matter using solar wind and pickup ion measurements with SWICS and SWIMS on the ACE spacecraft. *Space Sci. Rev.*, **86**, 497.

16. Burnett et al. (2003) The Genesis Discovery Mission: Return of Solar Matter to Earth. *Space Sci. Rev*. **105**, 509-534.

(3) Prescribed Burning Impacts on the Chemistry of a Weathered Mid-Atlantic Coastal Plain Soil (Leslie Sherman)

1. Collins, S. L., and L. L. Wallace (eds.). 1990. *Fire in the North American Tallgrass Prairies*. University of Oklahoma Press, Norman.

2. Knapp, A. K., J. M. Briggs, D. C. Hartnett, and S. L. Collins. 1998. *Grassland Dynamics: Long-term Ecological Research in Tallgrass Prairie*. Oxford University Press, Inc., Oxford.

3. Risser, P. G., E. C. Birney, H. D. Blocker, S. W. May, W. J. Parton, and J. A. Wiens. 1981. *The True Prairie Ecosystem*. Hutchinson Ross, Stroudsburg.

4. Prasad. M. (ed). 2001. Metals in the Environment: Analysis by Biodiversity. CRC Press, Boca Raton, FL 504 p.

5. Owensby, C. E., and J. B. Wyrill. 1973. Effects of range burning on Kansas Flint Hills soils. *J. Range Manage*. **26**, 185-188.

6. Christensen, N. L. 1976. Short-term effects of mowing and burning on soil nutrients in Big Meadows, Shenandoah National Park. *J. Range Manage*. **29**, 508-509.

7. Ueckert, D. N., T. L. Whigham, and B. M. Spears. 1978. Effect of burning on infiltration, sediment, and other soil properties in a mesquite-tobosagrass community. *J. Range Manage*. **31**, 420-425.

8. Picone, L. I., G. Quaglia, F. O. Garcia, and P. Laterra. 2003. Biological and chemical response of a grassland soil to burning. *J. Range Manage.* **56**, 291-297.

9. Sherman, L. A., K. R. Brye, D. E. Gill, and K. Koenig. 2005. Soil chemistry as affected by first-time prescribed burning of a grassland restoration on a Coastal Plain Ultisol. *Soil Sci*. **170,** 913-927.

10. Sherman, L. A. and K. R. Brye. 2008. Sequential burning effects on the soil chemistry of a grassland restoration on a Coastal Plain Ultisol. *Submitted to Ecol.Restoration.*

11. United States Department of Agriculture (USDA), Farm Service Agency (FSA). 2008. Conservation Reserve Program. http://www.fsa.usda.gov/Internet/FSA_File/aug2008.pdf.

12. Schwartzman, E., L. Zamora, P. Blank, and D. E. Gill. 2002. Grassland restoration on the Eastern Shore of Maryland: Warm-season grass establishment and plant community development at the Chester River Field Research Center, MD 1999-2002. Report to the Sears Foundation and NRCS Wildlife Habitat Management Institute.

13. United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2007. Web Soil Survey. websoilsurvey.nrcs.usda.gov/app/

14. Rabenhorst, M. 2004. Professor of Pedology, University of Maryland. Personal Communication (e-mail, 12/10/04.)

15. Robinson, M. S., J. Chavez, R. Sergio. (2004). Chemical speciation of $PM_{2.5}$ collected during prescribed fires of the Coconino National Forest near Flagstaff, Arizona. Journal of the Air & Waste Management Association. **54** (9)

16. Islander, I.K. and M.B. Kirkham (ed.) (2001). Trace Elements in Soil: Availability, Flux and Transfer. CRC Press, Boca Raton, FL 304 p.

17. Rauret, G., Lopez-Sanchez, J. F., Sahuquillo, A., Rubio, R.,Davidson, C., Ure, A., et al. (1999). Improvement of the BCR three step sequential extraction procedure prior to the certification of new sediment and soil reference materials. Journal of Environmental Monitoring, **1:** 57–61.

18. Rao, C. R. M. A. Sahuquillo and J. F. Lopez Sanchez. (2008) A Review of the Different Methods Applied in Environmental Geochemistry For Single and Sequential Extraction of Trace Elements in Soils and Related Materials Water Air Soil Pollutution **189**:291–333

19. Skjemstad, J. O., D. C. Reicosky, A. R. Wilts and J. A. McGowan. 2002. Charcoal carbon in U.S. agricultural soils. *Soil Science Society of America Journal* 66:1249-1255.

(4) Interactions of toxic metals with DNA Repair (Mindy Reynolds)

1. U.S. EPA. (2000) National Water Quality Inventory Report 305B.

2. ATSDR. (1993) Toxicological profile for chromium. *U.S. Public Health Service*.

3. Baral, A., et al. (2006) Evaluation of aquatic toxicities of chromium and chromium-containing effluents in reference to chromium electroplating industries. *Arch Environ Contam Toxicol*. **50**, 496-502.

4. Zhitkovich, A., V. Voitkun, and M. Costa. (1996) Formation of the amino acid-DNA complexes by hexavalent and trivalent chromium in vitro: importance of trivalent chromium and the phosphate group. *Biochemistry*. **35**, 7275-82.

5. Zhitkovich, A., et al. (2001) Non-oxidative mechanisms are responsible for the induction of

mutagenesis by reduction of Cr(VI) with cysteine: role of ternary DNA adducts in Cr(III)-dependent mutagenesis. *Biochemistry*. **40**, 549-60.

6. Quievryn, G., J. Messer, and A. Zhitkovich. (2002) Carcinogenic chromium(VI) induces cross-linking of vitamin C to DNA in vitro and in human lung A549 cells. *Biochemistry*. **41**, 3156-67.

7. Reynolds, M., et al. (2004) Human nucleotide excision repair efficiently removes chromium-DNA phosphate adducts and protects cells against chromate toxicity. *J Biol Chem*. **279**, 30419-24.

8. O'Brien T, J., et al. (2006) Incision of trivalent chromium [Cr(III)]-induced DNA damage by Bacillus caldotenax UvrABC endonuclease. *Mutat Res*. **610**.

9. Quievryn, G., et al. (2003) Genotoxicity and mutagenicity of chromium(VI)/ascorbate-generated DNA adducts in human and bacterial cells. *Biochemistry*. **42**, 1062-70.
10. Singh, J., et al. (1998) Sensitive quantitation of chromium-DNA adducts by inductively coupled plasma mass spectrometry with a direct injection high-efficiency nebulizer. *Toxicol Sci*. **46**, 260-5.

11. Zhitkovich, A., V. Voitkun, and M. Costa. (1995) Glutathione and free amino acids form stable complexes with DNA following exposure of intact mammalian cells to chromate. *Carcinogenesis*. **16**, 907-13.

12. Blankert, S.A., et al. (2003) Characterization of nonmutagenic Cr(III)-DNA interactions. *Chem Res Toxicol*. **16**, 847-54.

13. Hartwig, A., et al. (2002) Interference by toxic metal ions with DNA repair processes and cell cycle control: molecular mechanisms. *Environ Health Perspect*. **110 Suppl 5**, 797-9.

(5) Sourcing of Prehistoric and Historic Archaeological Metal and Lithic Materials (John Seidel)

1. Speakman, R. J., and H. Neff (eds.). *Laser Ablation-ICP-MS in Archaeological Research*. (University of New Mexico Press, 2005).

2. Seidel, J. L. *The Archaeology of the American Revolution: A Reappraisal & Case Study at the Continental Artillery Cantonment of 1778-1779, Pluckemin, New Jersey.* (Ph.D. dissertation, University of Pennsylvania, 1987).

3. Seidel, J. L. "Military Industry in the New Nation", in *Invisible America*, ed. by M. Leone & N. Silberman. (Henry Holt & Company, New York, 1995).

4. Hunter, R. W., and I. C. G. Burrow. "The Historical Geography & Archaeology of the Revolutionary War in New Jersey", in *New Jersey in the American Revolution,* ed. by B. J. Mitnick. Rivergate Books, Rutgers University Press, New Brunswick, New Jersey, 2005).

5. Veit, R. F. *Digging New Jersey's Past.* (Rutgers University Press, New Brunswick, New Jersey, 2002).

6. Peterson, H. L. *The Book of the Continental Soldier.* (Stackpole Books, Harrisburg, Pennsylvania,1968).

7. Risch, E. *Supplying Washington's Army.* (Government Printing Office, Washington, D.C., 1980).

8. Lowery, D. "Delmarva Paleoindians: Climate, Culture, and Origin." Unpublished paper to be presented at the University of Texas, Austin, Feb. 2008.

9. Martin, S. R. and T. C. Pleger. "The Complex Formerly Known as a Culture: The Taxonomic Puzzle of "Old Copper"", in *Taming the Taxonomy: Toward a New Understanding of Great Lakes Archaeology*, ed.by R. F.Williamson and C. M. Watts. (Eastend Books and the Ontario Archaeological Society, Toronto, Canada, 1999).

10. Levine, M. A. "Native Copper in the Northeast: An Overview of Potential Sources Available to Indian Peoples", in *The Archaeological Northeast,* ed. by M. A. Levine and K. E. Sassaman, and M. S. Nassaney. (Bergin & Garvey, 2000).

11. Friedman, A.M., M. Conway, M. Kastner, J. Milsted, D. Metta, P.R. Fields, and E. Olsen. "Copper Artifacts: Correlation with Source Types of Copper Ores," in *Science*, New Series, Vol. 152, No. 3728:1504-1506 (June 10, 1966).

12. McBroom, P. "Chemistry Probing the Past", in *Science News,* Vol. 94, No. 30:552-553 (November 1968).

13. Fitting, J. E. *Archaeology in Michigan*. (Michigan History Division, Michigan Dept. of State, 1984).

14. Loring, S. " "And They Took Away the Stones from Rama": Lithic Raw Material Sourcing and Eastern Arctic Archaeology", in *Honoring Our Elders: A History of Eastern Arctic Archaeology*, ed. by W. Fitzhugh, S. Loring and D. Odess. (Contributions to Circumpolar Anthropology, 2, Arctic Studies Center National Museum, 2002).

15. Hoard, R. J., J. R. Bozell, S. R. Holen, M.D. Glascock, H. Neff, and J.M. Elam. "Source Determination of White River Group Silicates from Two Archaeological Sites in the Great Plains", in *American Antiquity* 58:698-710 (1993).

(6) Connecting Washington College, the Chester River Association, and the STEM academy through outreach, research experience and engaging students and local community (Anne Marteel-Parrish, Karl Kehm, Leslie Sherman, Mindy Reynolds, Brent Walls)

1. Stammerjohn S., Smith E., Boynton W.R. and Kempt W.M. (1991) Potential impact from marinas and boats in the Baltimore Harbor. *Chesapeake Res. Consort.* Pub. **137**.

2. McGee B.L., Schlekat C.E., Boward D.M. and Wade T.L. (2004) Sediment contamination and biological effects in a Chesapeake Bay marina. *Ecotoxicology* **4**, 39-59.

3. Middle Chester River watershed characterization. (2001), Maryland Department of Natural Resources, p. 12. April 2001.

4. Chesapeake Bay Program. (2002). Ambient toxicity testing in Chesapeake Bay: Year 9- An assessment of the Chester River and Rappahannock Rivers. Environmental Protection Agency, Washington D.C.

5. Chesapeake Bay Program. (1999) Targeting Toxics: A Characterization Report A Tool for Directing Management and Monitoring Actions in the Chesapeake Bay's Tidal Rivers. Environmental Protection Agency, Washington D.C.

6. Standard Methods for the Examination of Water and Wastewater. (1998). 20th edition, American Public Health Association, Washington D.C. p. 3-9.

Impact of infrastructure projects

1. DeCarlo, S.; Harlan, D.; Martin, J.; Sheridan, H.; Marteel-Parrish, A.E. Generality of the environmentally benign catecholate method to the synthesis of barium-based perovskites. Green Chemistry: Letters and Reviews, accepted.

2. DeCarlo, S.; Harlan, D.; Martin, J.; Sheridan, H.; Marteel-Parrish, A.E. Towards a more environmentally benign synthesis of doped barium titanate. Green Chemistry: Letters and Reviews, accepted.

3. Sherman, L.A., K. Brye, D. Gill and K. Koenig. 2005. Soil chemistry as affected by first-time prescribed burning of a grassland restoration on a Coastal Plain Ultisol. Soil Science 170:913-927.

4. Raber, L. 2007. Small increase in women faculty. Chemical and Engineering News. American Chemical Society. December 24, 2007.

Anne E. Marteel-Parrish, Ph.D.
Assistant Professor, Department of Chemistry, Washington College

Professional Preparation

Université des Sciences et Technologies de Lille, Lille, FRANCE	Chemistry/Physics	B.S., 1996
Ecole Polytechnique Universitaire de Lille, Lille, FRANCE	Materials Science	M.S., 1999
University of Toledo, Toledo, OH	Chemistry with Concentration in Materials Science	Ph.D., 2003

Appointments

Washington College	Assistant Professor in Chemistry	2004-present
Washington College	Visiting Assistant Professor in Chemistry	2003-2004
Laboratoire de Métallurgie Physique et de Génie des Matériaux, CNRS, Université des Sciences et Technologies de Lille, France	Research Student	1999

Publications

Most closely related to project:

DeCarlo, S.; Harlan, D.; Martin, J.; Sheridan, H.; Marteel-Parrish, A.E. "*Generality of the environmentally benign catecholate method to the synthesis of barium-based perovskites" in Green Chemistry: Letters and Reviews,* accepted.

DeCarlo, S.; Harlan, D.; Martin, J.; Sheridan, H.; Marteel-Parrish, A.E. "*Towards a more environmentally benign synthesis of doped barium titanate" in Green Chemistry: Letters and Reviews,* accepted.

Marteel, A.E.; Davies, J.A.; Walter, W.O.; Abraham, M.A. "*Green Chemistry and Engineering: Drivers, Metrics, and Reduction to Practice"* in *Annual Reviews: Environment and Resources*, **2003,** *28*, 401-428 (comprehensive review article-invited).

Marteel-Parrish, A.E. *"Towards the Greening of Our Minds: A New Special Topics Course"* in *J. Chem. Ed.*, **2007**, *84* (2), 245-247.

Other publications:

Parrish, D.; Juromski, K; Marteel-Parrish, A.E.; Damavarapu, R.; Zang, M.; Paritosh, D. "*Tris(4-acetamidophenoxymethyl) methanol 0.7-hydrate" in Acta Cryst.*, **2008**, *E64*, o2201.

Bektesevic, S.; Kleman, A.M.; Marteel-Parrish, A.E.; Abraham, M.A. "*Hydroformylation in Supercritical Carbon Dioxide: Catalysis and Benign Solvents*" in *J. Supercrit. Fluids*, **2006**, *38*, 232-241 (comprehensive review article-invited).

Marteel, A.E.; Tack, T.T.; Bektesevic, S.; Davies, J.A.: Mason, M.R.; Abraham, M.A. *"Hydroformylation of 1-hexene in supercritical carbon dioxide: characterization, activity and regioselectivity studies"* in *Environ. Sci. Technol.*, **2003**, *37*(23), 5424-5431.

Marteel, A.E.; Davies, J.A.; Mason, M.R.; Tack, T. Bektesevic, S.; Abraham, M.A. *"Supported platinum/tin complexes as catalysts for hydroformylation of 1-hexene in supercritical carbon dioxide"* in *Catal. Commun.*, **2003**, *4* (7), 309-314.

Tadd, A.R.; Marteel, A.E.; Mason, M.R.; Davies, J.A.; Abraham, M.A.
"Hydroformylation of 1-hexene in supercritical carbon dioxide using a heterogeneous rhodium catalyst.1. Effect of process parameters" in *J. Supercrit. Fluids*, **2003**, *25* (2), 183-196.

Hemminger, O.; Marteel, A.E.; Mason, M.R.; Davies, J.A.; Tadd, A.R.; Abraham, M.A.
"Hydroformylation of 1-hexene in supercritical carbon dioxide using a heterogeneous rhodium catalyst.3. Evaluation of solvent effects" in *Green Chem.*, **2002**, *4* (5), 507-512.

Tadd, A.R.; Marteel, A.E.; Mason, M.R.; Davies, J.A.; Abraham, M.A.
"Hydroformylation of 1-hexene in supercritical carbon dioxide using a heterogeneous rhodium catalyst.2. Evaluation of reaction kinetics" in *Ind. Eng. Chem. Res.*, **2002**, *41* (18), 4514-4522.

Synergistic Activities

- Chair of the subcommittee on Sustainability in the Curriculum at Washington College, Fall 2008
- Recipient of the Younger Chemists Committee American Chemical Society (ACS) Leadership Development Award in December 2007 (only 15 funded awards among 100 applications to attend a Leadership Development workshop in Dallas, TX-January 25-27, 2007)
- Recipient of the America's Registry of Outstanding Professionals Award 2006-2007 and member of Madison Who's Who in September 2008
- Elected member of PKAL F21 (Project Kaleidoscope Faculty of the 21st Century) in 2006
- Commendable award for the Washington College ACS Student Affiliates chapter activities during 2005-2006 (obtained on March 25, 2007) and honorable award for the chapter activities during 2004-2005 (obtained on March 26, 2006) and during 2007-2008 (to be obtained in March 2009)

Collaborators

- Currently writing a textbook in collaboration with Dr. Martin Abraham on "Green Chemistry and Engineering: A Pathway to Sustainability" to be published by John Wiley and Sons, Inc. in January 2010
- Dr. Damon Parrish (Research Scientist at the Naval Research Laboratory, Washington, DC)

Advisors

Dr. Julian Davies, former distinguished professor of chemistry at the University of Toledo, OH
Dr. Mark Mason, University of Toledo, OH
Dr. Martin Abraham, Founding Dean of the STEM College, Youngstown State University, OH

Karl Kehm, Ph.D.
Adrian Reed Associate Professor of Physics and Environmental Studies, Washington College

Professional Preparation

Drake University	B.S. in Physics with honors	1987-1991
Washington University	Ph.D. in Physics	1991-2000
Carnegie Inst. of Washington-DTM	Postdoc in Cosmochemistry	2000-2002

Appointments

Assoc. Prof. of Physics	Washington College	2002-present
Visiting Scientist	Carnegie Inst. of Washington-DTM	2002-present
Visiting Research Fellow	Univ. of Manchester	2004-2005
Postdoctoral Fellow	Carnegie Inst. of Washington-DTM	2000-2002
Adjunct Prof. of Physics	The George Washington Univ.	2001
Graduate Research Asst.	Washington University	1993-2000
Graduate Teaching Asst.	Washington University	1991-1993
Laboratory Instructor	Drake University	1989-1991
Undergraduate Research Asst.	Ames Laboratory, DOE	1990

Relevant Publications (chronological)

Kehm, K., Crowther, S.A., Gilmour, J.D., and Hohenberg, C.M. (2009). Measurements of trapped Xenon in individual interplanetary dust particles from the stratosphere. Meteorit. Planet. Sci., *in press*.

Crowther S.A., Mohapatra R.K., Turner G., Blagburn D.J., Kehm K., and Gilmour J.D. (2008) Characteristics and applications of RELAX, and ultrasensitive resonance ionization mass spectrometer for xenon. *J. Anal. At. Spectrom.*, **23**, 938-947.

Kehm K., Flynn G.J., and Hohenberg C.M. (2006) Noble gas space exposure ages of individual interplanetary dust particles. *Meteorit. Planet. Sci*. **41**, 1199-1217.

Kehm K., Alexander C.M.O'D. and Hauri E.H. (2003) Iron isotope measurements in meteorites using cold plasma ICP-MS. *Geochim. Cosmochim. Acta* **67**, 2879-2891.

Kehm K., Flynn G.J., Sutton S.R., and Hohenberg, C.M. (2002) Noble gases and trace elements in stratospheric dust particles: confirmation of the Zn atmospheric entry heating indicator. *Meteorit. Planet Sci.* **37**, 1323-1335.

Kehm K. and Hauri E.H. (2001) (ABSTRACT) Precise iron isotope measurements using cold plasma ICP-MS. *Goldschmidt* Conf. # 3580.

Meshik A.P., Kehm K., and Hohenberg C.M. (2000) Anomalous xenon from zone 13 Okelobondo. *Geochim. Cosmochim. Acta* **64**, 1651-1661.

Kehm K., Flynn G.J., Hohenberg C.M., Palma R.L., Pepin R., Schlutter D.J., Sutton S.R., and Walker R.M. (1999) (ABSTRACT) A consortium investigation of possible cometary IDPs. *Lunar Planet. Sci. XXX*..

Wieler R., Kehm K., Meshik A.P., Hohenberg C.M. (1996) Secular changes in the xenon and krypton abundances in the solar wind recorded in single lunar grains. *Nature* **384**, 46-49.

Nichols R.H. Jr., Kehm K., and Hohenberg C.M. (1995) Microanalytical laser extraction of noble gases: techniques and applications. In *Advances in Analytical Geochemistry, Vol. 2* (ed. M. Rowe) JAI Press, 119-140.

Kehm K., Hohenberg C.M., and Nichols R.H. Jr. (1994) Xenon isotopic measurements in

Shallowater: in situ pulsed laser volatilization and the search for the carrier of radiogenic Xe-129. *Lunar Planet. Sci. XXV*, 683-684.

Synergistic Activities

- Developed novel technique for precisely measuring iron isotopes using ICPMS that utilizes "cold plasma" spectrometer source conditions to reduce molecular interferences associated with Argides in the Fe mass region.
- Member of the Kent County, Maryland science, technology, engineering and mathematics (STEM) advisory committee. Helping to formulate a projects-based science curriculum plan for middle school students in Kent County.
- Developed the new earth and planetary science curriculum at Washington College. This project included writing over 30 inquiry-based lab projects for undergraduate introductory earth and planetary science students.
- Developed and refined novel techniques for *in situ* extraction of noble gases from natural samples using laser ablation and laser vaporization.
- Co-authored successful proposals for CASE (Co-operative award in science and engineering) and Royal Society Fellowship awards to fund a postdoctoral researcher to study the Xe compositions of individual interplanetary dust grains and presolar grains at the University of Manchester. Received an American Astronomical Society grant and an APS Franklin Research grant to work with collaborators in the United Kingdom on this project.

Recent scientific collaborators, graduate advisors and postdoctoral sponsors (alphabetical)

Dr. Conel Alexander (post-doctoral co-sponsor) Carnegie Institution of Washington, DTM
Dr. Richard Carlson (collaborator) Carnegie Institution of Washington, DTM
Dr. Sarah Crowther (collaborator) School of Earth, Atm. and Env. Sciences, Univ. of Manchester
Dr. George Flynn (collaborator) SUNY-Plattsburg, Dept. of Physics
Dr. Jamie Gilmour (collaborator) School of Earth, Atm. and Env. Sciences, Univ. of Manchester
Dr. Erik Hauri (post-doctoral sponsor) Carnegie Institution of Washington, DTM
Dr. Charles Hohenberg (graduate advisor) Washington University, Dept. of Physics
Dr. Grenville Turner (collaborator) School of Earth, Atm. and Env. Sciences, Univ. of Manchester

Leslie A. Sherman, Ph.D.
W. Alton Jones Associate Professor, Department of Chemistry and Environmental Studies Program, Washington College

Professional Preparation

Carleton College	Mathematics	B.A. 1985
University of Minnesota	Environmental Chemistry	M.S.C.E., 1988
University of Wisconsin	Soil Chemistry	Ph.D. 1997

Appointments

W. Alton Jones Associate Professor, Department of Chemistry and Environmental Studies Program. Washington College. 2006-present.
Assistant Professor, Department of Chemistry and Environmental Studies Program. Washington College. 2000-2006.
Adjunct Assistant Professor, Environmental Studies Program and Senior Lecturer, Department of Chemistry, Providence College. 1997-2000.
Adjunct Instructor, Chemistry, Madison Area Technical College, Truax Campus, 1996-1997.
Research Assistant, Department of Soil Science, University of Wisconsin-Madison, 1992-1997.
Teaching Assistant, Department of Soil Science, University of Wisconsin-Madison, Jan.- June 1996.
Science Teacher with United States Peace Corps, Cameroon, West Africa, 1990 - 1992.
Physical Scientist Program Analyst and Congressional Liaison, National Oceanic and Atmospheric Administration (NOAA), Washington, D.C., Jan.-June 1989.
Marine Science Policy Fellow, National Sea Grant Program, NOAA, Washington, D.C., Jan. 1988 - Jan. 1989.
Research Assistant, Department of Civil and Mineral Engineering, University of Minnesota, 1985-1987.

Publications

Most closely related to project:

Sherman, L.A. and K. Brye, Sequential burning effects on the soil chemistry of a grassland restoration on a Coastal Plain Ultisol. Ecol. Restoration *Submitted for review.*
Ongley, L.K., L. Sherman, A. Armienta, A. Concilio, C. Ferguson Salinas and A. Garcia-Escobar. 2007. Arsenic in the soils of Zimapan, Mexico. Environ. Poll. 145:793-799
Sherman, L.A., K. Brye, D. Gill and K. Koenig. 2005. Soil chemistry as affected by first-time prescribed burning of a grassland restoration on a Coastal Plain Ultisol. Soil Sci. 170:913-927.
Ongley, L.K., A. Armienta, L. Sherman and A. Concilio. 2005. Arsenic and metal contamination in unconsolidated materials, Zimapán, Mexico. Proceedings of the XIII International Conference on Heavy Metals in the Environment, Rio de Janiero, Brazil.

Other publications:

Sherman, L.A. and P. Barak. 2000. The solubility and dissolution rates of dolomite [$CaMg(CO_3)_2$] in Ca-Mg-HCO_3/CO_3 solutions at 25°C and 1 atm CO_2. Soil Sci. Soc. Am. J. 64:1959-1968.
Barak, P., L.A. Sherman, and B.O. Jobe. 1995. Comments on "Design and construction of a personal-computer-based automatic titrator." Soil Sci. Soc. Am. J. 60:630.

Sherman, L.A., L.A. Baker, E. Weir, and P.L. Brezonik. 1994. Sediment pore-water dynamics of Little Rock Lake, Wisconsin: Geochemical processes and seasonal and spatial variability. Limnol. Oceanogr. 39:1155-1171.

Synergistic Activities

Chemistry magic show demonstrations and activities for Garnett Elementary School, 2005, 2008; Friendship Montessori School, 2007; Higher Achievement Program of Baltimore, 2007; Echo Hill Outdoor School Summer Days Math and Science Camp for Girls, 2004 -2006; Amistad Academy, 2004, 2006.

Member of Washington College Project Kaleidoscope Team on utilizing technology in the classroom, 2004-present

Sherman, L. 2003. Celebrating women in science: a look at a small liberal arts college. American Chemical Society Annual Meeting, New Orleans, LA. *Abstracts of Papers*, 225th National Meeting of the American Chemical Society, New Orleans, LA; American Chemical Society, Washington, DC, 2003.

Sherman, L. 2002. Investigating global climate change with Fast Plants: a Laboratory Exercise. Soil Science Society of America Annual Meeting, Indianapolis, IN. *In* Agronomy Abstracts (CD-ROM). ASA, Madison, WI.

Collaborators & Other Affiliations

• Collaborators and Co-Editors.
Armienta, Maria Aurora - Universidad Nacional Autonoma de Mexico
Brye, Kristofor - University of Arkansas – Fayetteville
Concilio, Amy - University of California – Santa Cruz
Garcia-Escobar, A. - National Water Commission of Mexico
Gill, Douglas - University of Maryland-College Park.
Koenig, Kristin - North Carolina State University
Ongley, Lois - Unity College
Prior, Chelsea - Duquesne University
Salinas, C. Ferguson – SRP Environmental

• Graduate Advisors and Postdoctoral Sponsors.
Dr. Phillip Barak, University of Wisconsin-Madison
Dr. Patrick Brezonik, University of Minnesota

• Thesis and Research Students
Tarra Boulden, Caitlin Coates, Hollie Bohle, Kristin Koenig, Kelly McDevitt, Jeanette Minah, Chelsea Prior, Katricia Stevens, Mary Beth Wright

Mindy Reynolds, Ph.D.
Assistant Professor, Department of Biology, Washington College

Professional Preparation

Wheaton College, Norton, MA	Biochemistry/Chemistry	B.A., 1997
Brown University, Providence, RI	Toxicology/Cancer Biology	Ph.D., 2006

Appointments

Washington College	Assistant Professor	2008-present
Salve Regina University	Lecturer, Department of Biology	2007-2008
SOT, Metals Specialty Section	Postdoctoral Representative	2004-2008

Publications

Most closely related to project:

Reynolds M., Peterson E, Quievryn G, Zhitkovich A. Human nucleotide excision repair efficiently removes chromium-DNA phosphate adducts and protects cells against chromate toxicity. *J. Biol. Chem.* 279(29): 30419-30424 (2004).

Peterson-Roth E, Reynolds M., Quievryn G, Zhitkovich A. Mismatch repair proteins are activators of toxic responses to chromium-DNA damage. *Mol. Cell. Biol.* 25(9): 3596-607 (2005).

Zhitkovich A., Peterson-Roth E., Reynolds M. Killing of chromium-damaged cells by mismatch repair and its relevance to carcinogenesis. *Cell Cycle* Aug;4(8):1050-2 (2005).

Reynolds, M., Peterson-Roth, E., Bespalov, I., Johnston, T., Gurel, V., Menard, H., Zhitkovich A., Rapid DNA-Double-strand Breaks Resulting from Processing of Cr-DNA Cross-links by MutS Dimer. *Cancer Research* 69(3) (2009).

Other publications:

Karaczyn A., Ivanov S., Reynolds M., Zhitkovich, A., Kasprzak K., Salnikow, K. Ascorbate Depletion Mediates Up-Regulation of Hypoxia-Associated Proteins by Cell Density and Nickel. *J. Cell. Biochem*. Apr 1;97(5):1025-35 (2006).

Messer, J., Reynolds, M., Stoddard, L., Zhitkovich, A. Causes of DNA single-strand breaks during reduction of chromate by glutathione in vitro and in cells. *Free Radical Biology & Medicine* Jun 1;40(11):1981-92 (2006).

Reynolds, M., Stoddard, L., Bespalov, I., Zhitkovich, A. Ascorbate acts as a highly potent inducer of chromate mutagenesis and clastogenesis: linkage to DNA breaks in G2 phase by mismatch repair. *Nucleic Acids Research* 35(2): 465-476 (2007).

Reynolds, M. and Zhitkovich, A. Cellular vitamin C increases chromate toxicity via a death program requiring mismatch repair but not p53. *Carcinogenesis* 28(7): 1613-20 (2007).
Jiz, M., Wu, HW., Meng, R., Pond-Tor, S., Reynolds, M., Friedman, JF., Olveda, R., Acosta, L., Kurtis J.D. Pilot-scale production and characterization of paramyosin, a vaccine candidate for schistosomiasis japonica. *Infect Immun.* Jul; 76(7); 3164-9 (2008).

Synergistic Activities

1. Harriet W. Sheridan Center for Teaching in Higher Education Consultant (2003-2006). Critiqued and developed pedagogical methods for humanities and science classes
2. Undergraduate research (2004-2008). Supervised independent research projects for 3 undergraduate students, leading to 1 honors thesis.
3. Toxicology course curriculum (2008). Responsible for the development of lecture and laboratory exercises for an upper level toxicology course.
4. Development of Biochemistry Laboratory Manual (2008). Designed and organized the laboratory manual and exercises for an upper level biochemistry course.
5. Member of the SOT committee for the integration of toxicology into undergraduate curriculum (2008-present)

Collaborators

Collaborators in the last 48 months:
Dr. Anatoly Zhitkovich, Brown University
Dr. Jake Kurtis, Brown University
Dr. Konstatin Salnikow, NIH/NCI

Graduate and Postdoctoral Advisor:
Dr. Anatoly Zhitkovich, Brown University

Thesis Advisor and Postgraduate Scholar Sponsor
None

John L. Seidel, Ph.D.
Director, Center for Environment & Society
Lammot Dupont Copeland Associate Professor of Anthropology & Environmental Studies

Professional Preparation

Drew University	BA, Anthropology	1976
University of Pennsylvania	MA, Anthropology	1980
University of Pennsylvania	MA, American Civilization	1981
University of Pennsylvania	PhD, Historical Archaeology	1987

Appointments

2007 – present	*Director*, Center for the Environment & Society, Washington College, Chestertown, Maryland.
2004 – present	*Associate Prof.*, Anthropology & Environmental Studies, Washington College
1998 – 2004	*Asst. Prof.*, Anthropology & Environmental Studies, Washington College
1995 - 1998	*Assistant Vice-President*, Nautical Archaeological Services, R. Christopher Goodwin & Associates, Inc.
1989 - 1995	*Assistant Professor*, Department of Anthropology, University of Maryland, College Park.
1987-1989	*Assistant Professor*, Department of Anthropology, Rutgers University, New Brunswick, New Jersey.
1985-1987	*Instructor*, Department of Classics & Archaeology, Rutgers University.
1984-1985	*Lecturer*, Department of Classics & Archaeology, Rutgers University.

Relevant Publications

Seidel, J. L. "Archaeological Research at the 1778-1779 Winter Cantonment of the Continental Artillery, Pluckemin, New Jersey", *Northeast Historical Archaeology*, Vol. 12: 7-14. 1983.

Seidel, J. L., "'China Glaze' Wares on Sites from the American Revolution: Pearlware Before Wedgwood?", in *Historical Archaeology* Vol. 24, No. 1:82-95. 1990.

Seidel, J. L., "Military Industry in the New Nation", in *Invisible America*, ed. by Mark Leone & Neil Silberman. Henry Holt & Company, New York. 1995.

Seidel, J. L., "'Class Warfare': The American Militia System", in *Invisible America*, ed. by Mark Leone & Neil Silberman. Henry Holt & Company, New York. 1995.

Seidel, J. L., D. Lowery, and W. Miller. *Mapping the Past for the Future: A Cultural Resource Management Geographic Information System & Archaeological Predictive Model for Maryland's Eastern Shore: Cecil, Kent, Queen Anne's, Caroline & Talbot Counties.* GIS data, software, and report. Maryland State Highway Administration, Baltimore, Maryland. 2007.

Other Publications

Seidel, J. L., D. Lowery and T. Davis. *Archaeological Geographic Information Systems (GIS) for Maryland's Upper Eastern Shore: Site Management and Predictive Modeling in Kent & Queen Anne's Counties.* Geographic Information System, data, software and report. Maryland Historical Trust and the Maryland State Highway Administration. 2003.

Seidel, J. L., D. Lowery and T. Davis. *A User's Guide to Maps Delineating Probability Areas for Prehistoric Site Locations and to the Cultural Resource Management GIS for Kent & Queen Anne's Counties, Maryland.* With Darrin Lowery & Tom Davis. Report submitted to the Maryland Historical Trust and the Maryland State Highway Administration. 2003.

Seidel, J. L, and R.C. Goodwin. *The Civil War Steamboat Kentucky: Phase II and III Archaeological Investigations at Site 16BO358, Eagle Bend, Pool 5, Red River Waterway, Bossier Parish, Louisiana.* 2 volumes. U.S. Army Corps of Engineers, Vicksburg District, Vicksburg, Mississippi. 2004.

Watson, A. E., J. L. Seidel, J. Ernstein, and K. Wise. *Heritage Areas Management Plan for the Caroline, Kent, Queen Anne's & Talbot County Heritage Area.* Eastern Shore Heritage, Inc. & the Maryland Heritage Areas Authority. Crownsville, Maryland. 2004

Seidel, J. L. *Submerged Cultural Resources Survey of Portions of the Chester River, Maryland.* Washington College Public Archaeology Laboratory, Chestertown, MD. 2005.

Synergistic Activities

As Associate Director of the University of Maryland's "Archaeology in Annapolis" program from 1990-1993, Seidel directed numerous public archaeology projects in the Historic District of Annapolis, cooperating with local schools, state museums, and city and state agencies. He also developed a Geographic Information System for management of the city's architectural and archeological resources, a system still used by the city's planning and zoning staff. At R. Christopher Goodwin & Assoc., Seidel coordinated a comprehensive cultural resource inventory and management plan for the U.S. Naval Academy, with public interpretation components. From 2001-2003, Seidel served on a Scholars Panel for the Maryland Humanities Council, analyzing several of Maryland's official Heritage Areas, created as part of a state initiative in heritage tourism. The panel provided original research and syntheses to heritage areas, along with interpretive plans for various heritage sites. He also oversaw creation of a public management plan for a five county heritage area on Maryland's Upper Eastern Shore. Seidel was a prime mover in creation of a state-wide consortium of state agencies, museums, and higher education in Maryland, the IMPART program, designed to create collaborations between state agencies and universities (www.impartmd.org); he currently serves as Vice Chair of IMPART.

Seidel has served on the Editorial Board and as Executive Vice-Chair of the Council for Northeast Historical Archaeology, and is a past-President of the Maritime Archaeological & Historical Society. He served on the Advisory Board of the National Aquarium in Baltimore, as a member of the Trust's Advisory Committee on Maryland Archaeology, and on the Governor's Task Force on the Preservation and Enhancement of Maryland's Heritage Resources. Dr. Seidel also sits on the board of the Maryland Heritage Coordinating Council, the Chestertown Historic District Commission, and the Board of Trustees of the Maryland Historical Trust.

Collaborators

Dr. Tom Davis, Director, Cyprus American Archaeological Research Institute, Nicosia
Dr. Julie Ernstein, Assistant Prof., Heritage Resources Program, Northwestern State University
Dr. Susan Langley, State Underwater Archaeologist, Maryland Historical Trust
Dr. Mark Leone, Professor, Dept. of Anthropology, University of Maryland College Park
Mr. Darrin Lowery, Dept. of Geology, University of Delaware
Dr. Wendy Miller, Assistant Prof., Dept. of Geography, SUNY Cortland
Mr. Larry Murphy, Chief, Submerged Resource Unit, National Park Service, Santa Fe, NM

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Washington College

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Anne E Marteel-Parrish

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Anne E Marteel-Parrish - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Karl Kehm - Associate Professor**	0.00	0.00	0.00	**0**	
3. **Mindy Reynolds - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **John Seidel - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Leslie A Sherman - Associate Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Laser Ablation System $ **111,652**					
Thermo Fisher Scientific XSeries II ICP-MS **183,943**					
TOTAL EQUIPMENT				**295,595**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**12,984**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**21,000**	
TOTAL OTHER DIRECT COSTS				**33,984**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**329,579**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**329,579**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **329,579**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Anne E Marteel-Parrish

ORG. REP. NAME*
Leslie Sherman

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Washington College**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Anne E Marteel-Parrish**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Anne E Marteel-Parrish - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Karl Kehm - Associate Professor**	0.00	0.00	0.00	**0**	
3. **Mindy Reynolds - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **John Seidel - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Leslie A Sherman - Associate Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**2,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,000**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,000**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,000**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Anne E Marteel-Parrish**

ORG. REP. NAME*: **Leslie Sherman**

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Washington College

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Anne E Marteel-Parrish

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Anne E Marteel-Parrish - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Karl Kehm - Associate Professor**	0.00	0.00	0.00	**0**	
3. **Mindy Reynolds - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **John Seidel - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Leslie A Sherman - Associate Professor**	0.00	0.00	0.00	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**2,000**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**2,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**2,000**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **(Rate: , Base:)**					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**2,000**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **2,000**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME
Anne E Marteel-Parrish

ORG. REP. NAME*
Leslie Sherman

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
Washington College

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Anne E Marteel-Parrish

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Anne E Marteel-Parrish - Assistant Professor**	0.00	0.00	0.00	$ **0**	$
2. **Karl Kehm - Associate Professor**	0.00	0.00	0.00	**0**	
3. **Mindy Reynolds - Assistant Professor**	0.00	0.00	0.00	**0**	
4. **John Seidel - Associate Professor**	0.00	0.00	0.00	**0**	
5. **Leslie A Sherman - Associate Professor**	0.00	0.00	0.00	**0**	
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	0.00	0.00	0.00	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**0**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**0**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**0**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 295,595**					
TOTAL EQUIPMENT				**295,595**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**16,984**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**21,000**	
TOTAL OTHER DIRECT COSTS				**37,984**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**333,579**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**0**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**333,579**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **333,579**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Anne E Marteel-Parrish

ORG. REP. NAME*
Leslie Sherman

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Acquisition of a Quadrupole Laser Ablation ICP-MS for Materials Science, Biology, Earth and Environmental Science and Anthropology at Washington College

ICP-MS instrumentation	
Thermo Fisher Scientific XSeries II ICP-MS	$136,970
Water chiller	$4,148
HP LaserJet Printer	$742
XSeries II Consumables Kit	$1,440
Two-stage Ar regulator	$961
Cetac ASX520 auto-sampler[1]	$6,386
Peltier spray chamber temperature controller[2]	$4,121
XSeries II Collision cell[3]	$21,091
He/H regulator for collision cell	$1,347
HF resistant sample introduction system[4]	$3,237
Shipping	$3,500
Sub-total for ICP-MS instrument	**$183,943**
Laser ablation system	
213nm Tempest II laser ablation system[5]	$98,600
Laser installation	$4,120
Auto switching for optical and aperture focussing[6]	$5,000
Additional gas kit[7]	$3,003
Xs Nickel skimmer and sample cones[8]	$929
Sub-total for laser ablation system	**$111,652**
Maintenance, training and operational costs for three years	
XSeries II extended warranty x 2 years (1st included w/ purchase)[10]	$21,000
Replacement concentric nebulizer	$585
XSeries II consumables kit ($1440 x 2)[11]	$2,880
Argon gas for 3 years[12]	$6,000
Two replacement electron multiplier detectors ($1,597 x 2)[13]	$3,194
On-site application-specific training for co-PIs (paid by Wash. Coll.)	$0
Sub-total for maintenance and operational costs	**$33,659**
Support equipment	
Liberty model # 4-403-36-48 laminar flow bench w/ light[9]	$4,060
Shipping	$265
Sub-total for laminar flow bench	**$4,325**
Total request	**$333,579**

Budget justification

1. Will permit measurement of large sample-standard suite without requiring constant user interaction. Will enhance precision by normalizing sample introduction, measurement and wash out times.
2. Temperature control of the spray chamber enhances reproducibility by buffering against temperature fluctuations in the room. This reduces possibility that substantial modifications to existing HVAC system will be required. Also temperature control helps to reduce H_2O in the spray chamber, thereby reducing the signal of oxides.
3. The collision cell relies on collision between species in the ion beam and gas atoms in the cell (e.g. He), which are more probable for polyatomic species than for single ions. The result is differential suppression of signal that favors transmission of single ions. The following is a list of a few elements targeted by scientific projects outlined in this proposal with potential significant gas-based or matrix-based polyatomic isobaric interferences given in parentheses: ^{52}Cr (ArO, ArN), ^{55}Mn (ArN), ^{59}Co (ArOH), ^{63}Cu (NaAr) or ^{65}Cu (MgAr, CaOH), ^{60}Ni (MgAr), ^{66}Zn (MgAr). Although interference corrections are possible, optimal detection limits are achieved by interference removal using the collision cell.
4. Inert sample introduction system has a lower blank compared to glass for many elements, can tolerate HF, and has a nebulizer that is more resistant to clogging. Will be used for ultra trace measurements (e.g., solar wind in lunar grains measurements) and for solutions that may generate clogging in the glass nebulizer.
5. Two scientific projects in this proposal focus on the analysis of trace elements in refractory oxides, ceramics, as well as in metal artifacts that require minimally destructive techniques. Laser ablation is required for these projects.
6. Permits laser to be focused either by aperture (optimized for flat energy profile across the beam spot) or optical focusing (optimized for beam spot size) modes.
7. Provides inert gas atmosphere in laser cell, which can enhance signal by a factor of three or more.
8. Ni cones with shape that generates up to 5x signal intensity compared to the Xt cone system. Xt cone system is optimized for high matrix content solutions.
9. Will provide a much-needed dust-free work environment for minimizing contamination to sample containers, sample solutions, vacuum parts, etc. Currently no clean laminar flow tables are available at Washington College.
10. Washington College has no technical instrument-support staff and a limited budget for intermittent capital expenses that may be required in the event of major equipment malfunctions. The extended warranty (first year included with purchase + additional two years = 3 full years) will insure maximum uptime for the instrument for the duration of this grant proposal. For subsequent years, the college has agreed to budget up to $15K per year for instrument maintenance on the ICP-MS and laser ablation systems.
11. Consumables kit includes replacement cones, cone gaskets, torch, torch shield, etc.
12. Based on Ar consumption rates provided by the vendor, we estimate needing a *minimum* of 3 to 4 265-L tanks of Ar per year. The local gas vendor has quoted a price of $575/dewar, which suggests that our Ar costs will be approximately $2000/year at a minimum.
13. Ion detectors on the X-Series II have one to two-year estimated lifetimes. We have budgeted for two replacement multipliers, which should be sufficient for the duration of this proposal (three years).

Current and Pending Support

Center for Environment & Society

Project/Proposal Title: College Science Education Advancement and STEM Education Outreach.
FIE Grant U215K080166
Source of Support: Fund for the Improvement of Education Program, U.S. Department of Education.
Project Location: Washington College
Total Award Amount: $335,043
Starting Date (MM/DD/YY): 09/22/08
Ending Date (MM/DD/YY): 09/22/10
Support Type – Current
Person-months Per Year Committed to the Project – Calendar: 6 months

Project/Proposal Title: Geospatial Education Technology Initiative (STEM)
Source of Support: U.S. Department of Agriculture; partner with Tuscarora Intermediate Unit (PA)
Project Location: Washington College and schools in Tuscarora Intermediate Unit, PA
Total Award Amount: $500,000 ($201,000 to Washington College)
Starting Date (MM/DD/YY): 11/01/08
Ending Date (MM/DD/YY): 10/31/10
Support Type – Current
Person-months Per Year Committed to the Project – Calendar: 12 months

Project/Proposal Title: All – dissemination of results
Source of Support: Center for Environment & Society operating budget
Project Location: Washington College
Total Award Amount: $26,618
Starting Date (MM/DD/YY): 06/01/08
Ending Date (MM/DD/YY): 05/22/09
Support Type - Current
Person-months Per Year Committed to the Project – Calendar: 12 months

Washington College Public Archaeology Laboratory

Project/Proposal Title: Artifact Analysis on the Pluckemin Revolutionary War Artillery Cantonment Collection
Source of Support: Somerset County (NJ) Historic Preservation Trust Fund
Project Location: Washington College, Monmouth University (NJ), Hunter Research (Trenton, NJ)
Total Award Amount: $60,000
Starting Date (MM/DD/YY): 01/15/09
Ending Date (MM/DD/YY): 12/31/09
Support Type - Current
Person-months Per Year Committed to the Project – Calendar: 14 months

Project/Proposal Title: Sourcing of Prehistoric and Historic Archaeological Metal and Lithic Materials
Source of Support: Maryland Higher Education Commission IMPART Undergraduate Assistantships
Project Location: Washington College

Total Award Amount: $3,000
Starting Date (MM/DD/YY): 9/01/09
Ending Date (MM/DD/YY): 12/01/09
Support Type - Current
Person-months Per Year Committed to the Project – Calendar: 2.15 month

Project/Proposal Title: Sourcing of Prehistoric Lithics and Metals
Source of Support: Maryland Historical Trust Non-Capital Grant Program
Project Location: Washington College
Total Award Amount: $30,000
Starting Date (MM/DD/YY): 11/01/09
Ending Date (MM/DD/YY): 10/31/10
Support Type - Pending
Person-months Per Year Committed to the Project – Calendar: 12 months

Project/Proposal Title: Artifact Analysis on the Pluckemin Revolutionary War Artillery Cantonment Collection
Source of Support: Somerset County (NJ) Historic Preservation Trust Fund
Project Location: Washington College
Total Award Amount: $60,000
Starting Date (MM/DD/YY): 01/15/10
Ending Date (MM/DD/YY): 12/31/10
Support Type – Pending
Person-months Per Year Committed to the Project – Calendar: 14 months

Facilities, Equipment, and Other Resources

The Chemistry Department owns and operates an Atomic Absorption Spectrophotometer (Perkin Elmer AAnalyst 100). The instrument was purchased in 2001 with start-up funds for L. Sherman coupled with matching funds from Washington College, an agreement of her hire. The instrument has been heavily used for L. Sherman's research on the soil chemistry of a grassland restoration to measure major cations, as well as in several classes, including Honors General Chemistry, Instrumental Analysis and Environmental Chemistry. However, the high detection limits as compared to an ICP-MS has prevented the study of trace metals in L. Sherman's project and has prohibited the initiation of full-scale research projects focusing on trace metals, of interest in the Departments of Chemistry (L. Sherman, A. Marteel-Parrish), Physics (K. Kehm), Biology (M. Reynolds) and Anthropology (J. Seidel).

ThermoFisher SCIENTIFIC

The world leader in serving science

Michael Plantz, Elemental Sales Specialist
1201 E. Wiley Road
Schaumburg, IL 60173
(847) 628-9202
michael.plantz@thermofisher.com

QUOTATION

Michael Plantz
Number:
Note: Budgetary Quote

Washington College
300 Washington Ave
Chestertown, MD 21620
Attn: Karl Kehm
Tel.: (410)-778-7711
Email: kkehm2@washcoll.edu

Delivery: 8-10 weeks
F.O.B.: Bremen, Germany
Prices Firm: January 30, 2009

Terms: Net 30
Date: January 19, 2009

ITEM	CATALOG NUMBER	DESCRIPTION	TOTAL LIST PRICE
10	4600517	XSeries2 Inductively Coupled Plasma Mass Spectrometer • Integral, 1600W, solid-state crystal controlled 27MHz ICP generator. • Accessible, open architecture sample introduction system using an ambient temperature, glass, impact bead spray chamber and concentric glass nebulizer. • Computer controlled adjustment of the single piece, self-locating torch in x, y and z planes. • Multi-channel, PC controlled, integral peristaltic pump • Computer controlled mass flow controllers on all plasma gas lines (nebulizer, auxiliary and coolant). • PlasmaScreen Plus screened ICP torch provides low ion energy spread and high signal/background • Xt Interface technology providing exceptional matrix tolerance, extended dynamic range at low mass and low polyatomic ion formation. • Unique Protective Ion Extraction, π lens system, providing high ion transmission and ultra low backgrounds. • High performance off-axis quadrupole analyzer providing excellent transmission and abundance sensitivity across the full mass range 2-255amu. • PC controlled, switchable, quadrupole resolution settings. • Unique, 3-stage, vacuum design comprising of a single rotary pump and a single high performance, split-flow turbo pump. • “Plug & Play” AutoRange Plus, discrete dynode electron multiplier detector providing greater than 8 orders of dynamic range via simultaneous analogue/pulse counting detection. • PC with Windows Professional, 19” TFT Flat Screen monitor, keyboard and mouse (requires a printer). • PlasmaLab™ Version 5.X Windows software provides seamless control of the XSeries2 ICP-MS and accessories featuring PlasmaLab Intelligently Controlled Operations (PICO) Technology. • TechConnect™ remote support and diagnostics software.	**$ 136,970**

ThermoFisher SCIENTIFIC

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Michael Plantz, Elemental Sales Specialist
1201 E. Wiley Road
Schaumburg, IL 60173
(847) 628-9202
michael.plantz@thermofisher.com

QUOTATION

Michael Plantz
Number:
Note: Budgetary Quote

20	14448100	Air-cooled Thermo Scientific Neslab Water Chiller (60Hz**)** with tubing	**$ 4,148**
30	840-064400	HP LaserJet Medium Duty Printer 120V, USB cable included	**$ 742**
40	4600531	X Series 2 ICP-MS Consumables Kit. Consists of the following items:	**$ 1,440**
		Ni Sample Cone 1 Ea Skimmer Cone Mtg Screw 4 Ea Xt Skimmer Cone 1 Ea Sampling Cone Gasket 20 Ea O ring Viton 28mm X 1.5mm C/S 2 Ea Seal Oring 6.07 X 1.78 Viton Teflon Coated 2 Ea 0-2 ML/Min Pump Tube YELLOW/ORANGE 1 Pk 0-5 ML Min Pump Tube WHITE/WHITE 1 Pk Teflon Tube 5 M Tube Teflon 1/16OD .02ID 10 Ft 1 Ea Quartz Glass Torch C/W Screen Location 2 Ea Assy Conn 4x6mm Push Fitseal 2 Ea Tube POLYURETH 4mmOD (gas lines) 2 Ea Torch Ag SHIELD FIXED99.95% PURITY 1 Ea Torch Bonnet 1 Ea Oil Ultra Grade 19 1 Ea	
50	13696500	Argon Regulator, Two-Stage	**$ 961**
60	2600361	AutoRange Plus Detector, spare detector mounted in frame	**$ 1,597**
70	4600294	Spare Concentric Glass Nebulizer (0.8ml/min)	**$ 585**
		Sample Handling System	
80	14439300	Cetac ASX520 Auto-sampler, including a set of 4x60 position racks and 14ml tubes.	**$ 6,386**
		Training & Warranty	
90	14423400	Training Course – Basic Operators Course (4 days, a $2,678 value)	**included**

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100	701478500	Warranty (included w/ purchase, one year).	**included**
		XSeries2 Performance Options	
110	4600259	Automated 3rd Generation Collision Cell Technology (CCT^{ED}) Option–Using two computer-controlled mass flow controllers, a combination of any two gases can automatically be introduced into the collision cell to selectively reduce molecular interferences. The ability to utilize Kinetic Energy Discrimination to reduce potential interferences from cell reaction bi-products is a standard feature. The PlasmaLab software will allow automatic optimization of the CCT gas flow via the unique Autotune or Instrument Setup Sample that can be included in every experiment. Switching between CCT and non-CCT operation is fully automatic and is possible within a sample acquisition. This product is protected under various US and international patents, including one or more of the following US patents: US4760253, US5051584, US5352893, US5514868, US5572024. Requires the Peltier (4600291) & Regulator (1600511)	**$ 21,091**
120	4600291	Peltier, temperature controller for the spray chamber. Enables precise control of the spray chamber temperature to eliminate any drift due to fluctuations in the laboratory conditions outside the recommended +/- 2°C per day.	**$ 4,121**
130	1600511	Regulator, Helium/Hydrogen (for use with CCT)	**$ 1,347**
		XSeries2 Total List Price	**$177,206**
		Shipping and Handling	**$ 3,500**
		Laser Ablation Options	
140	NWR-0020-8050	Laser Ablation System with 213nm Tempest II laser. Includes frame grabber, software, transmitted, reflected and flood lighting, sample handling, cross-polarizers, video microscope, built-in energy monitor, cassette sample cell, & internal gas control. Class 1 laser system. Shipping weight 250 lbs. DOES NOT INCLUDE INSTALLATION BUT IS REQUIRED	**$ 98,600**
150	NWR-Option 130	UP213, Installation - North America, Western Europe, Japan, Taiwan, China	**$ 4,120**
160	NWR-0020-312253	Auto-Switching-UP213nm Only	**$ 5,000**
180	4600290	Additional Gas Kit – includes a 0-500ml/min computer controlled, mass flow controller and tubing necessary for addition of a 4th gas stream. Provides He to laser ablation cell	**$ 3,003**
190	4600539	Xs Nickel Interface Kit. Includes nickel Xs skimmer cone and cone tool.	**$ 591**

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200	3600812	Nickel Sample Cone for Xt or Xs Interfaces (Pack of 1)	**$ 338**
		HF Acid-Resistant Sample Introduction System Options	
210	4600359	Inert, single pass, conical impact bead spray chamber kit, includes an inert impact bead spray chamber (4600295), inert elbow and semi-demountable torch body (3600416). Requires a torch injector and an inert nebulizer.	**$ 1,668**
220	4600138	Alumina injector – for use with 4600359	**$ 276**
230	4600356	Burgener, PTFE High Solids Nebulizer – HF resistant, for use with high solid matrices	**$ 1,086**
240	3600730	Polypropylene Elbow. Connection between spray chamber and plasma torch.	**$ 207**
		On-Site Training Options	
250	702-003700	X-Series Operators Training Course delivered at the client's site (3 days). Discounted by value of training voucher included with each XSeries2 system. This is in addition to the 2 days of operational training provided by installation engineer.	**$ 8,923**
		Extended Warranty Options	
260	701478800	Extended Warranty for XSeries2. Extended Warranty Features are: • Unlimited # of demand on-site service visits with a maximum 72-hour response • Engineer labor and travel is included • Priority status for technical support inquiries, response within 2 hours • One (1) Scheduled Preventative Maintenance visit / year • Factory-certified replacement parts included • Software updates, notifications, and TeleConnect™ remote support included • Consumable items (i.e. tubing, torches, cones, detectors) are excluded • $10,500 per year, 2 year max purchased with instrument, 2 years quoted.	**$ 21,000**
		Total List Price for XSeries2 System with Options	**$ 327,700**

NOTE: The purchase of an ICP-MS also includes the services of an engineer to install it. After the installation is complete, our engineer will train your operator in basic operation of the instrument, for up to two (2) days.

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CUSTOMER SUPPORT SERVICES INCLUDED WITH X-SERIES SYSTEM:

· Installation by Thermo Fisher Service Engineers.
· One tuition to the 4 day Thermo Fisher Training Institute Basic Operators training class
· "800" # access with the Thermo Technical Support Center for consultation with hardware and software applications.
.
STANDARD INSTRUMENT WARRANTY
X-Series System - One Year, parts, labor & travel
..
OPTIONAL SUPPORT PLAN EXTENDED WARRANTY - US ONLY
The Support Plan warranty allows you one (1) preventive maintenance visit per year and unlimited emergency on-site visits for problem resolution. Coverage is provided during normal business hours, 5 days a week, 9 hours per day, excluding holidays. A 72-hour or less response time is provided for the on-site emergency visits. The plan also includes consumables as specified by a Thermo engineer during the preventative maintenance visit, repair parts (non-consumable) for the on-site emergency visits, 2-hour technical support response time, automatic case logging, software updates, and access to available online support resources.
.
To place your order and expedite shipment, please fax your Purchase Order with all associated terms and conditions (and tax exemption certificate, if applicable) to FAX #608-273-6882, Attn: Sales Order Entry. All purchase orders must show following Vendor information

Thermo Electron North America LLC,
5225 Verona Road,
Madson WI 53711-4495

Please reference our quotation number on your purchase order and on any correspondence regarding the quotation.

Non-Thermo Electron North America LLC manufacturers may provide their own warranties to you.
SEE THE WARRANTY STATEMENT IN THE PRODUCT DOCUMENTATION FOR THE COMPLETE WARRANTY, AND THE WARRANTY AND EXCLUSIONS ON THE BACK OF THIS FORM.
Prices, warranty, installation and service on the items quoted herein are available only in the United States, and may not be otherwise assigned. Buyer shall pay federal, state and local taxes in addition to the price stated on this order unless buyer gives Thermo Electron North America LLC a signed exemption certificate or direct pay permit. You may fax these documents to us. Your purchase order should also indicate the sales tax status of your order. Buyer shall not export or re-export technical data or products supplied by Thermo Electron North America LLC in violation of applicable export regulations. Buyer who exports from the U.S. products purchased hereunder assumes all responsibility for obtaining any required export authorization and payment of applicable fees.

_____
SIGNATURE

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TERMS AND CONDITIONS OF SALE

UNLESS OTHERWISE EXPRESSLY AGREED IN WRITING, ALL SALES ARE SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS:

1. GENERAL. **Thermo Electron North America LLC** ("Seller") hereby offers for sale to the buyer named on the face hereof ("Buyer") the products listed on the face hereof (the "Products") on the express condition that Buyer agrees to accept and be bound by the terms and conditions set forth herein. Any provisions contained in any document issued by Buyer are expressly rejected and if the terms and conditions in this Agreement differ from the terms of Buyer's offer, this document shall be construed as a counter offer and shall not be effective as an acceptance of Buyer's document. Buyer's receipt of Products or Seller's commencement of the services provided hereunder will constitute Buyer's acceptance of this Agreement. This is the complete and exclusive statement of the contract between Seller and Buyer with respect to Buyer's purchase of the Products. No waiver, consent, modification, amendment or change of the terms contained herein shall be binding unless in writing and signed by Seller and Buyer. Seller's failure to object to terms contained in any subsequent communication from Buyer will not be a waiver or modification of the terms set forth herein. All orders are subject to acceptance in writing by an authorized representative of Seller.

2. PRICE. All prices published by Seller or quoted by Seller's representatives may be changed at any time without notice. All prices quoted by Seller or Seller's representatives are valid for thirty (30) days, unless otherwise stated in writing. All prices for the Products will be as specified by Seller or, if no price has been specified or quoted, will be Seller's price in effect at the time of shipment. All prices are subject to adjustment on account of specifications, quantities, raw materials, cost of production, shipment arrangements or other terms or conditions which are not part of Seller's original price quotation.

3. TAXES AND OTHER CHARGES. Prices for the Products exclude all sales, value added and other taxes and duties imposed with respect to the sale, delivery, or use of any Products covered hereby, all of which taxes and duties must by paid by Buyer. If Buyer claims any exemption, Buyer must provide a valid, signed certificate or letter of exemption for each respective jurisdiction.

4. TERMS OF PAYMENT. Seller may invoice Buyer upon shipment for the price and all other charges payable by Buyer in accordance with the terms on the face hereof. If no payment terms are stated on the face hereof, payment shall be net thirty (30) days from the date of invoice. If Buyer fails to pay any amounts when due, Buyer shall pay Seller interest thereon at a periodic rate of one and one-half percent (1.5%) per month (or, if lower, the highest rate permitted by law), together with all costs and expenses (including without limitation reasonable attorneys' fees and disbursements and court costs) incurred by Seller in collecting such overdue amounts or otherwise enforcing Seller's rights hereunder. Seller reserves the right to require from Buyer full or partial payment in advance, or other security that is satisfactory to Seller, at any time that Seller believes in good faith that Buyer's financial condition does not justify the terms of payment specified. All payments shall be made in U.S. Dollars.

5. DELIVERY; CANCELLATION OR CHANGES BY BUYER. The Products will be shipped to the destination specified by Buyer, F.O.B. Seller's shipping point. Seller will have the right, at its election, to make partial shipments of the Products and to invoice each shipment separately. Seller reserves the right to stop delivery of Products in transit and to withhold shipments in whole or in part if Buyer fails to make any payment to Seller when due or otherwise fails to perform its obligations hereunder. All shipping dates are approximate only, and Seller will not be liable for any loss or damage resulting from any delay in delivery or failure to deliver which is due to any cause beyond Seller's reasonable control. In the event of a delay due to any cause beyond Seller's reasonable control, Seller reserves the right to terminate the order or to reschedule the shipment within a reasonable period of time, and Buyer will not be entitled to refuse delivery or otherwise be relieved of any obligations as the result of such delay. Products as to which delivery is delayed due to any cause within Buyer's control may be placed in storage by Seller at Buyer's risk and expense and for Buyer's account. Orders in process may be canceled only with Seller's written consent and upon payment of Seller's cancellation charges. Orders in process may not be changed except with Seller's written consent and upon agreement by the parties as to an appropriate adjustment in the purchase price therefor. Credit will not be allowed for Products returned without the prior written consent of Seller.

6. TITLE AND RISK OF LOSS. Notwithstanding the trade terms indicated above and subject to the provisions of Section 7 below and to Seller's right to stop delivery of Products in transit, title to and risk of loss of the Products will pass to Buyer upon delivery of possession of the Products by Seller to the carrier; provided, however, that title to any software incorporated within or forming a part of the Products shall at all times remain with Seller or the licensor(s) thereof, as the case may be.

7. SECURITY INTEREST. Seller reserves and Buyer grants to Seller a purchase money security interest in all Products until such time as Buyer fully pays for such Products. Buyer appoints Seller as Power of Attorney to sign and file a financing statement.

8. WARRANTY. Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that Buyer shall (a) promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; and (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions, then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables are expressly excluded from this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

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In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.

9. INDEMNIFICATION.

9.1 By Seller. Seller agrees to indemnify, defend and save Buyer, its officer, directors, and employees from and against any and all damages, liabilities, actions, causes of action, suits, claims, demands, losses, costs and expenses (including without limitation reasonable attorney's fees) ("Indemnified Items") for (i) injury to or death of persons or damage to property to the extent caused by the negligence or willful misconduct of Seller, its employees, agents or representatives or contractors in connection with the performance of services at Buyer's premises under this Agreement and (ii) claims that a Product infringes any valid United States patent, copyright or trade secret; provided, however, Seller shall have no liability under this Section to the extent any such Indemnified Items are caused by either (i) the negligence or willful misconduct of Buyer, its employees, agents or representatives or contractors, (ii) by any third party, (iii) use of a Product in combination with equipment or software not supplied by Seller where the Product would not itself be infringing, (iv) compliance with Buyer's designs, specifications or instructions, (v) use of the Product in an application or environment for which it was not designed or (vi) modifications of the Product by anyone other than Seller without Seller's prior written approval. Buyer shall provide Seller prompt written notice of any third party claim covered by Seller's indemnification obligations hereunder. Seller shall have the right to assume exclusive control of the defense of such claim or, at the option of the Seller, to settle the same. Buyer agrees to cooperate reasonably with Seller in connection with the performance by Seller of its obligations in this Section.

Notwithstanding the above, Seller's infringement related indemnification obligations shall be extinguished and relieved if Seller, at its discretion and at its own expense (a) procures for Buyer the right, at no additional expense to Buyer, to continue using the Product; (b) replaces or modifies the Product so that it becomes non-infringing, provided the modification or replacement does not adversely affect the specifications of the Product; or (c) in the event (a) and (b) are not practical, refund to Buyer the amortized amounts paid by Buyer with respect thereto, based on a five (5) year amortization schedule. THE FOREGOING INDEMNIFICATION PROVISION STATES SELLER'S ENTIRE LIABILITY TO BUYER FOR THE CLAIMS DESCRIBED HEREIN.

9.2 By Buyer. Buyer shall indemnify, defend with competent and experienced counsel and hold harmless Seller, its parent, subsidiaries, affiliates and divisions, and their respective officers, directors, shareholders and employees, from and against any and all damages, liabilities, actions, causes of action, suits, claims, demands, losses, costs and expenses (including without limitation reasonable attorneys' fees and disbursements and court costs) to the extent arising from or in connection with (i) the negligence or willful misconduct of Buyer, its agents, employees, representatives or contractors; (ii) use of a Product in combination with equipment or software not supplied by Seller where the Product itself would not be infringing; (iii) Seller's compliance with designs, specifications or instructions supplied to Seller by Buyer; (iv) use of a Product in an application or environment for which it was not designed; or (v) modifications of a Product by anyone other than Seller without Seller's prior written approval.

10. SOFTWARE. With respect to any software products incorporated in or forming a part of the Products hereunder, Seller and Buyer intend and agree that such software products are being licensed and not sold, and that the words "purchase", "sell" or similar or derivative words are understood and agreed to mean "license", and that the word "Buyer" or similar or derivative words are understood and agreed to mean "licensee". Notwithstanding anything to the contrary contained herein, Seller or its licensor, as the case may be, retains all rights and interest in software products provided hereunder.

Seller hereby grants to Buyer a royalty-free, non-exclusive, nontransferable license, without power to sublicense, to use software provided hereunder solely for Buyer's own internal business purposes on the hardware products provided hereunder and to use the related documentation solely for Buyer's own internal business purposes. This license terminates when Buyer's lawful possession of the hardware products provided hereunder ceases, unless earlier terminated as provided herein. Buyer agrees to hold in confidence and not to sell, transfer, license, loan or otherwise make available in any form to third parties the software products and related documentation provided hereunder. Buyer may not disassemble, decompile or reverse engineer, copy, modify, enhance or otherwise change or supplement the software products provided hereunder without Seller's prior written consent. Seller will be entitled to terminate this license if Buyer fails to comply with any term or condition herein. Buyer agrees, upon termination of this license, immediately to return to Seller all software products and related documentation provided hereunder and all copies and portions thereof.

Certain of the software products provided by Seller may be owned by one or more third parties and licensed to Seller. Accordingly, Seller and Buyer agree that such third parties retain ownership of and title to such software products. The warranty and indemnification provisions set forth herein shall not apply to software products owned by third parties and provided hereunder.

11. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED HEREIN, THE LIABILITY OF SELLER UNDER THESE TERMS AND CONDITIONS (WHETHER BY REASON OF BREACH OF CONTRACT, TORT, INDEMNIFICATION, OR OTHERWISE, BUT EXCLUDING LIABILITY OF SELLER FOR BREACH OF WARRANTY (THE SOLE REMEDY FOR WHICH SHALL BE AS PROVIDED UNDER SECTION 8 ABOVE)) SHALL NOT EXCEED AN AMOUNT EQUAL TO THE LESSER OF (A) THE TOTAL PURCHASE PRICE THERETOFORE PAID BY BUYER TO

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SELLER WITH RESPECT TO THE PRODUCT(S) GIVING RISE TO SUCH LIABILITY OR (B) ONE MILLION DOLLARS ($1,000,000). NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED HEREIN, IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES (INCLUDING WITHOUT LIMITATION DAMAGES FOR LOSS OF USE OF FACILITIES OR EQUIPMENT, LOSS OF REVENUE, LOSS OF DATA, LOSS OF PROFITS OR LOSS OF GOODWILL), REGARDLESS OF WHETHER SELLER (a) HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES OR (b) IS NEGLIGENT.

12. EXPORT RESTRICTIONS Buyer acknowledges that each Product and any related software and technology, including technical information supplied by Seller or contained in documents (collectively "Items"), is subject to export controls of the U.S. government. The export controls may include, but are not limited to, those of the Export Administration Regulations of the U.S. Department of Commerce (the "EAR"), which may restrict or require licenses for the export of Items from the United States and their re-export from other countries. Buyer shall comply with the EAR and all other applicable laws, regulations, laws, treaties, and agreements relating to the export, re-export, and import of any Item. Buyer shall not, without first obtaining the required license to do so from the appropriate U.S. government agency; (i) export or re-export any Item, or (ii) export, re-export, distribute or supply any Item to any restricted or embargoed country or to a person or entity whose privilege to participate in exports has been denied or restricted by the U.S. government. Buyer shall cooperate fully with Seller in any official or unofficial audit or inspection related to applicable export or import control laws or regulations, and shall indemnify and hold Seller harmless from, or in connection with, any violation of this Section by Buyer or its employees, consultants, agents, or customers.

13. MISCELLANEOUS. (a) Buyer may not delegate any duties nor assign any rights or claims hereunder without Seller's prior written consent, and any such attempted delegation or assignment shall be void. (b) The rights and obligations of the parties hereunder shall be governed by and construed in accordance with the laws of the State of Seller's manufacturing location, without reference to its choice of law provisions. Each party hereby irrevocably consents to the exclusive jurisdiction of the state and federal courts located in the county and state of Seller's manufacturing location, in any action arising out of or relating to this Agreement and waives any other venue to which it may be entitled by domicile or otherwise. (c) In the event of any legal proceeding between the Seller and Buyer relating to this Agreement, neither party may claim the right to a trial by jury, and both parties waive any right they may have under applicable law or otherwise to a right to a trial by jury. Any action arising under this Agreement must be brought within one (1) year from the date that the cause of action arose. (d) The application to this Agreement of the U.N. Convention on Contracts for the International Sale of Goods is hereby expressly excluded. (e) In the event that any one or more provisions contained herein shall be held by a court of competent jurisdiction to be invalid, illegal or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions contained herein shall remain in full force and effect, unless the revision materially changes the bargain. (f) Seller's failure to enforce, or Seller's waiver of a breach of, any provision contained herein shall not constitute a waiver of any other breach or of such provision. (g) Unless otherwise expressly stated on the Product or in the documentation accompanying the Product, the Product is intended for research only and is not to be used for any other purpose, including without limitation, unauthorized commercial uses, *in vitro* diagnostic uses, *ex vivo* or *in vivo* therapeutic uses, or any type of consumption by or application to humans or animals. (h) Buyer agrees that all pricing, discounts and technical information that Seller provides to Buyer are the confidential and proprietary information of Seller. Buyer agrees to (1) keep such information confidential and not disclose such information to any third party, and (2) use such information solely for Buyer's internal purposes and in connection with the Products supplied hereunder. Nothing herein shall restrict the use of information available to the general public. (i) Any notice or communication required or permitted hereunder shall be in writing and shall be deemed received when personally delivered or three (3) business days after being sent by certified mail, postage prepaid, to a party at the address specified herein or at such other address as either party may from time to time designate to the other.

Date: January 20, 2009

Liberty Industries, Inc.
133 Commerce St., PO Box 508
E. Berlin CT 06023

Washington College
Att: Karl Kehm
300 Washington Ave
Chestertown, MD 21620
Phone: 410-448-7711
Email: kkehm2@washcoll.edu

From: Greg Bunnell
Phone: 1-800-828-5656 ext. 637
Fax:1-860-828-8879
Email: greg.bunnell@liberty-ind.com
Quote #: 01-GWB-02 Revised

Thank you for the opportunity to quote our Horizontal Table Top Laminar Flow Unit.

Horizontal Laminar Flow Work Station – Table Top Unit with light
Model # 4-403-36-48L, 4 foot wide $4,060.00 each

Construction: ¾" novaply laminated with white high-pressure plastic laminate on exposed surfaces. Interior surfaced sealed to prevent shedding of particulates. Table Top Style has sides and top of work area of ¼" clear acrylic and a work area height of 34.5".

Filtration: A dust guard prefilter, 30% efficient NBS. The final HEPA filter is rated at 99.99% efficient at 0.3 microns and larger. Less than 100 particles per cubic foot. Meets or exceed Federal Standard 209 and IS0-14644-1, Class 100 (ISO 5 Conditions).

Lighting: Fluorescent, 125 ft candle at work surface +/- 20%, light located above the work area.

Blower/Motor High capacity forward curved blower with direct drive blower motor. Fans are statically and dynamically balanced and designed to maintain a constant airflow. 120V / 1 phase/ 60 Hz
NOTE: No installation is included. This Table Top unit is ready to be lifted into place and plugged in after customer removes from crating.

F.O.B.: East Berlin, CT –Freight not included. Freight collect or prepay & add.
*****Freight is estimated at $$265.00 to Chesterton, MD.***
This is an estimate only and is subject to change at time of shipment. This is for standard delivery to a loading dock. No inside delivery.

Terms: We suggest 40% with order, 40% prior to shipment and 20% Net 30 days with approved credit.

Please note all payment terms are subject to the terms and conditions as shown on Attachment A (enclosed) and, as such, are included as part of this quotation. Lead-time is estimated at 5 week (s) after receipt of approved signed drawings. (Drawings are issued after receipt of purchase order.) Lead-time is quoted as an estimate only. Due to fluctuations in backlog, actual delivery dates cannot be assigned until order is received, or appropriate drawings are returned to us approved. Lead-time is based on our current backlog and may be different when order is placed. ***Pricing valid for thirty (30) days.***

If you have any questions or require clarification, please feel free to contact me directly at 800-828-5656 ext . 637.

ATTACHMENT A

LIBERTY INDUSTRIES, INC.
The Cleanroom People

CONDITIONS: Past due accounts will be subject to a service charge of 1.5% per month. The buyer agrees that in the event of default by nonpayment of his overdue account, will be liable for collection charges, including reasonable attorneys' fees.

TAXES: Taxes related to the sale of merchandise by ***Liberty Industries, Inc.*** are the sole responsibility of the purchaser. No tax is charged by ***Liberty Industries, Inc.*** or responsible to be paid to ***Liberty Industries, Inc.***

RETURNS: No equipment may be returned for credit without first receiving permission from ***Liberty Industries, Inc.*** to do so. All requests should be addressed to the company at 133 Commerce Street, East Berlin, Connecticut 06023. If approval is granted, a 15% return handling charge, 10% restocking charge, and freight will be made during the warranty period to cover inspection, testing, special handling and accounting expenses. **NO** returns on custom manufactured goods will be allowed.

POSTPONEMENT of DELIVERY or CANCELLATION: A postponement of delivery dates of strictly standard merchandise on order may be arranged only with approval of the ***Liberty Industries, Inc.*** main office at 133 Commerce Street, East Berlin, Connecticut. Such postponements will not exceed forty-five (45) days from the original date of shipment. The company considers all orders received as firm commitments and, as such, not subject to cancellation. Cancellation of any orders will not be accepted until specifically approved by the President of ***Liberty Industries, Inc.*** If approved, cancellations will be subject to a cancellation charge of 25% or, in the case of manufactured goods, the cost of time, including engineering and material, which has been put into the specific job to date. **No cancellations will** be **allowed on custom manufactured goods or special ordered merchandise, which has been either purchased or put into production.** On those items for which prepayments have been received, an internal credit will be issued to your account, no cash refund. Seller does not issue cash refunds. Credit towards future purchases will be issued upon Seller's approval of merchandise returns. We hereby certify that these goods were produced in compliance with all applicable requirements of Sections 6, 7 and 12 of the Fair Labor Standards Act, as amended, and the regulations and orders of the United States Department of Labor issued under Section 14 thereof.

All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Prices are based on cost and conditions existing on date of quotation and are subject to change by the Seller before final acceptance.

Freight shall be FOB Shipping Point, prepaid and add, or collect.
If special requirements are required for Common Carrier shipments, such as a truck with a lift gate, it is the responsibility of the buyer to inform seller at time of order.

Typographical and stenographic errors subject to correction. The purchaser agrees to accept either overage or shortage, not in excess of 10% to be charged pro-rata. The purchaser assumes liability of patent and copyright infringement when goods are made to Purchasers specifications. When quotation specifies material to be furnished by the Purchaser, ample allowance must be made for reasonable spoilage and material must be suitable quality to facilitate efficient production.

Conditions not specifically stated herein will be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller.

WASHINGTON COLLEGE
FIRST COLLEGE CHARTERED IN THE NEW NATION

OFFICE OF THE PRESIDENT

January 13, 2009

Office of Integrative Activities
Major Research Instrumentation Program
National Science Foundation, Room 1270
4201 Wilson Boulevard
Arlington, VA 22230

Dear Madam or Sir:

Pursuant to your requirements, it is my pleasure to certify that Washington College is a non-Ph.D. granting institution. Washington College is an undergraduate college offering baccalaureate and three master's level degrees, but no doctoral programs.

We appreciate the opportunity to compete for an NSF grant under the Major Research Instrumentation Program and we hope this letter provides you with sufficient documentation of the College's status.

With best regards,

Baird Tipson
President

BT/plw

WASHINGTON COLLEGE
FIRST COLLEGE CHARTERED IN THE NEW NATION

December 16, 2008

Office of Integrative Activities
Major Research Instrumentation Program
National Science Foundation, Room 1270
4201 Wilson Boulevard
Arlington, VA 22230

Dear Grants Officer,

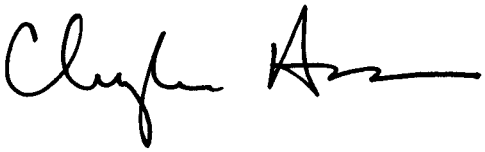
I am writing in support of the grant proposal from co-PIs Karl Kehm, Anne Marteel-Parrish and Leslie Sherman of Washington College for the acquisition of an ICP-MS for environmental, earth and materials science research.

As the proposal details, the instrumentation requested will facilitate research in several disciplines, including collaboration across scientific disciplines, collaboration between students and faculty, and partnerships between Washington College and an area environmental group and between the College and the new STEM academy of our local public school system. Washington College's mission explicitly emphasizes undergraduate research, and that emphasis is reflected in the required senior capstone research project that all graduates complete. Receipt of this grant would allow the College to acquire equipment that is suitable, indeed essential, for the research we conduct, but not practical to acquire within our ordinary capital budgets.

Washington College is committed, however, to providing the infrastructure, supplies and maintenance required to use the equipment most effectively. Toward that end, we have authorized the budgetary support discussed in detail in the application. This support includes approximately $10,000 of infrastructure renovation to prepare the laboratory for the ICP-MS. It also includes establishing a fund at $10,000 per year for service to the laser ablation system (in years 2-3), to be increased to $15,000 in subsequent years to ensure that both pieces of equipment experience very minimal downtime. In addition, the College is committed to supplementing faculty development funds up to $9,000 to support on-site individualized training for the faculty who will be working with the ICP-MS and laser ablation system. Budgetary support also includes operating budget increases of $4,000 per year for consumables in the years following the grant.

The submitted proposal has the full support of Washington College. I thank you for your consideration.

Sincerely,



Christopher Ames
Provost and Dean of the College

To: NSF MRI Coordinator

By signing below I acknowledge that I am listed as a collaborator and/or instrument user on this MRI proposal, entitled "Acquisition of a Quadrupole Laser Ablation ICP-MS for Materials Science, Biology, Earth and Environmental Science and Anthropology at Washington College", with Leslie Sherman, Karl Kehm, and Anne Marteel-Parrish as the Principal Investigators. I agree to perform the tasks assigned to me, as described in the proposal, and I commit to provide or make available the resources therein designated to me.

Signed: Brent Walls (Chester River Association)

Date: 01/05/2009

KENT COUNTY PUBLIC SCHOOLS
215 WASHINGTON AVENUE * CHESTERTOWN, MARYLAND 21620 * PHONE 410-778-1595
FAX # 410-778-6193

January 5, 2009

To: NSF MRI Coordinator

By signing below I acknowledge that my organization is listed as a collaborator and/or instrument user on this MRI proposal, entitled "Acquisition of a Quadrupole Laser Ablation ICP-MS for Materials Science, Biology, Earth and Environmental Science and Anthropology at Washington College", with Leslie Sherman, Karl Kehm, and Anne Marteel-Parrish as the Principal Investigators. I agree that our organization will perform the tasks assigned to us, as described in the proposal, and I commit to provide or make available the resources therein designated to our organization.

Mary Etta Reedy, Assistant Superintendent
Department of Education Services
Kent County Public Schoo