RAS 12970

State of New Jersey

JON S. CORZINE
Governor

OFFICE OF THE ATTORNEY GENERAL
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Director

DOCKETED
USNRC

January 26, 2007 (12:18pm)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Docket No. 40-7102-MLA

January 26, 2007

via email and first class mail
Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
Attention: Rulemakings and Adjudications Staff

Re: Petition for Hearing on the Shieldalloy Metallurgical Corporation (License No. SMB-743) Decommissioning Plan (Docket No. 04007102)

Dear Staff:

This office represents the New Jersey Department of Environmental Protection ("NJDEP"). Please be advised that the Curriculum Vitae of Michael Malusis, Ph.D., was inadvertently ommitted from certain copies of NJDEP's Petition for a Hearing. The specific versions omitted included those versions sent electronically and the paper copies sent to the General Counsel and to Shieldalloy. Therefore, I am providing copies of Dr. Malusis' Declaration, report, and Curriculum Vitae. Please also be advised that because a faxed version of the Declaration of Timothy Disbrow was previously provided, I am now enclosing the original and two copies.

Sincerely yours,

STUART RABNER
ATTORNEY GENERAL OF NEW JERSEY

By: Andrew D Reese
Andrew D. Reese
Deputy Attorney General

Template = SECY-018

SECY-02

Encl.

c: **via first class mail**
David R. Smith, Radiation Safety Officer
Shieldalloy Metallurgical Corporation
12 West Boulevard
PO Box 768
Newfield, New Jersey 08344-0768

via email and first class mail
Office of the General Counsel
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STUART RABNER
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Attorney for Petitioner

By: Andrew D. Reese
Deputy Attorney General
(609) 292-1509

Docket No. 04007102

IN RE PETITION FOR A HEARING on the SHIELDALLOY METALLURGICAL CORP. DECOMMISSIONING PLAN, pursuant to 10 C.F.R. § 2.309 and 42 U.S.C. § 2239(a)(1)(A)

DECLARATION OF MICHAEL A. MALUSIS

DECLARATION OF MICHAEL A. MALUSIS

Under the penalty of perjury, I, MICHAEL A. MALUSIS, hereby declare:

The attached assessment regarding the long-term technical viability of the proposed on-site consolidation and capping of radioactive waste at the Shieldalloy Metallurgical Corporation (SMC) facility, Newfield, NJ is true and accurate. The attached Curriculum Vitae is also true and accurate.

DATE: 1/15/07

Michael A. Malusis

Michael A. Malusis, Ph.D.,
Consulting Geotechnical and Geoenvironmental Engineer

15 Hawthorne Drive
Lewisburg, PA 17837
(570) 412-2069 Fax (570) 577-3415

January 15, 2007

Kenneth W. Elwell, Senior Deputy Attorney General
State of New Jersey
Office of the Attorney General
Department of Law and Public Safety
Division of Law
25 Market Street
PO Box 093
Trenton, NJ 08625-0093

Subject: Technical Assessment of proposed on-site consolidation and capping of radioactive waste at the Shieldalloy Metallurgical Corporation (SMC) facility, Newfield, NJ

Dear Mr. Elwell:

I am pleased to provide the following assessment to the State of New Jersey (the State) regarding the long-term technical viability of the proposed on-site consolidation and capping of radioactive waste at the Shieldalloy Metallurgical Corporation (SMC) facility, Newfield, NJ. This assessment was conducted in accordance with the signed Scope of Services.

1.0 INTRODUCTION

The assessment provided herein has been developed based upon my review of relevant documents provided by the State. These documents include the following:

(1) *SMC Decommissioning Plan for the Newfield Facility,* Rev. 1a, Section 5, "Dose Modeling Evaluations" (55 pages);

(2) *SMC Decommissioning Plan for the Newfield Facility,* Rev. 1, Appendix 19.4, "Distribution Coefficients and Leachability" (7 pages);

(3) *June 30, 2006 Letter from SMC to the U.S. Nuclear Regulatory Commission, re: "Follow-up to the March 9, 2006 Meeting and Response to USNRC Letter of January 26, 2006" and accompanying Attachment 1 (13 pages);*

(4) *June 30, 2006 Letter from SMC to the U.S. Nuclear Regulatory Commission,* Appendix D, "Groundwater Modeling Memo" (11 pages);

(5) *SMC Decommissioning Plan for the Newfield Facility,* Rev. 1a, Table 17.5, "Partition Coefficients" (1 page);

(6) March 2, 1987 laboratory report submitted by Century Laboratories, Inc. to SMC (Report No. F0358), re: EP Toxicity test results for 16 slag samples (19 pages);

(7) *June 30, 2006 Letter from SMC to the U.S. Nuclear Regulatory Commission,* Appendix F, "Revised Chapter 8 Sections" (3 pages);

(8) *SMC Decommissioning Plan for the Newfield Facility,* Rev. 1, Figures 18.2, 18.6, 18.7, and 18.8 (4 pages);

(9) *SMC Decommissioning Plan for the Newfield Facility,* Rev. 1, Appendix 19.9, "Environmental Report", Sections 1 (13 pages), 3.3 (8 pages), and 3.4.1.2 (~4 pages); and

(10) TRC Environmental Corporation (2006). *Engineered Barrier Design Calculations.* TRC Project No. 26770-0100, June 2006.

In addition, the following documents were consulted to support this assessment:

(11) U.S. EPA (1989). *Stabilization/Solidification of CERCLA and RCRA Wastes: Physical Tests, Chemical Testing Procedures, Technology Screening, and Field Activities.* EPA/625/6-89/022, Cincinnati, OH;

(12) U.S. EPA (1992). *Technical Resource Document: Batch-Type Procedures for Estimating Soil Adsorption of Chemicals.* EPA/530-SW-87-006-F, Washington, D.C;

(13) ASTM (1993). Standard Test Method for Distribution Ratios by the Short-Term Batch Method, *ASTM D4319-93*, American Society for Testing and Materials, Philadelphia, PA;

(14) Holtz, R.D. and Kovacs, W.D. (1981). An Introduction to Geotechnical Engineering. Prentice-Hall, Upper Saddle River, NJ, 733 p.;

(15) Sharma, H.D. and Lewis, S.P. (1994). Waste Containment Systems, Waste Stabilization, and Landfills. John Wiley and Sons, New York, NY, 588 p.;

(16) SC&A, Inc. (1999). Special Five-Year Review Report for Denver Radium Site, S.W. Shattuck Chemical Operable Unit #8, City and County of Denver, State of Colorado. Web link: ftp://ftp.epa.gov/r8/shattuck/Special5YrReviewOU8Only.pdf;

(17) Koerner, R.M. (1999). Designing with Geosynthetics. 4th Ed., Prentice-Hall, Upper Saddle River, NJ, 761 p.;

(18) Waugh, W.J. (2001). Uranium Mill Tailings Covers: Evaluating Long-Term Performance. *Proceedings, 2001 International Containment and Remediation Technology Conference*, Orlando, FL, Jun. 10-13, Florida State University, Talahassee, FL, http://www.containment.fsu.edu/cd/content/pdf/244.pdf; and

(19) Waugh, W.J. (2004). Design, Performance, and Sustainability of Engineered Covers for Uranium Mill Tailings. *Workshop Summary Report, Joint Workshop on Long-Term Monitoring of Metals and Radionuclides in the Subsurface: Strategies, Tools, and Case Studies*. http://www.cistems.fsu.edu/PDF/waugh.pdf.

All of the documents listed above are cited by number within the text (italicized and in boldface), where appropriate.

Due to the limited time available to perform this review and the disorganized, piecemeal nature of the latest version of the Decommissioning Plan (i.e., some portions are Rev. 1, other portions are Rev. 1a, and some of the Rev. 1 sections have not been updated to reflect changes made in Rev. 1a), it is possible that some key information in the documents has been overlooked. In addition, it is possible that relevant documents other than those listed above may contain information that would influence the outcome of this assessment. Therefore, I reserve the right to modify the opinions rendered herein upon identification of such information. My review and subsequent assessment was focused on the geotechnical and environmental aspects of the proposed cover system, waste materials, and underlying strata within the proposed consolidation area footprint based solely on consideration of the documentation above. No independent geotechnical, hydrologic, or contaminant fate and transport calculations or modeling were performed as part of this assessment.

2.0 TECHNICAL ASSESSMENT

As stated above, this assessment is focused on the long-term geotechnical and environmental performance of the proposed on-site consolidation/capping remedy for the Newfield facility. In summary, this proposed remedy includes the consolidation of all residual radioactive materials (~50,000 m^3 of coarse slag and fine baghouse dust) and additional debris (~15,000 m^3) within the existing Storage Yard at the Newfield facility and construction of a soil cover over the consolidated materials. Radionuclides of concern within the radioactive waste include isotopes of radium (Ra-226 and Ra-228), uranium (U-238 and U-234), and thorium (Th-228, Th-230, and Th-232) ***(2)***.

Upon review of information contained in the documents listed above and consideration of this information in context with the proposed remedial action, I have several concerns regarding the viability of the consolidation/capping approach for long-term protection of human health and the environment. These concerns primarily are related to three general aspects: (1) the location of the proposed consolidation area and the properties of the underlying soils; (2) the chemical properties and leaching behavior of the waste materials, and (3) design, construction, and performance considerations for the soil cover. Specific concerns regarding each of these three aspects are identified below.

2.1 Location and Soil Conditions

According to Rev. 1 of the Decommissioning Plan ***(8)***, the proposed consolidation area covers approximately 3.6 acres within the existing Storage Yard on the eastern side of the Newfield facility. The consolidation area is underlain by a relatively thin vadose (unsaturated) zone consisting of approximately 2.5 meters (~8 feet) of native fine to coarse sand and gravel deposits, followed by a saturated zone layer consisting primarily of coarse sand with little to trace silt *(1)*. The hydraulic conductivity of the native vadose zone material is estimated at 0.017 m/yr (5.4 x 10^{-8} cm/s) *(1)*. This reported value is a gross underestimate, i.e., the value is representative of a clay-rich soil and is not remotely representative of a relatively clean sand/gravel layer. The true hydraulic conductivity of this layer likely ranges between 10^{-1} and 10^{-3} cm/s based on the reported texture ***(14)***. As a result, water that infiltrates through the waste material will also infiltrate easily through the vadose zone and into the underlying saturated zone, carrying those contaminants that leach from the waste mass. The hydraulic conductivity of the saturated zone is estimated at 16,000 m/yr (i.e., 0.05 cm/s) *(1)*, consistent with that expected for a coarse sand aquifer. These hydraulic properties, in addition to the relatively thin vadose zone layer and the absence of an engineered liner system beneath the waste, are not favorable for long-term protection of the groundwater pathway.

In addition to the above, it appears that the current justification for the proposed remedy relies upon the ability of the vadose zone and saturated zone soils to provide attenuation (i.e., adsorption) of the contaminants of concern. For example, the distribution coefficients (K_d) assigned to the vadose zone and saturated zone layers are the same as those assigned to the waste material itself *(5)*. Thus, the soils underlying the waste are assumed to hold the contaminants to the same extent as the waste material. However, no sorption tests apparently have been performed to verify that the underlying soil formations exhibit adsorption capacity for the contaminants of concern. Moreover, the underlying soils consist primarily of sand, gravel, and little to trace silt. There is no mention of any clay within these soils, other than the occasional, discontinuous clay lenses in the lower portion of the Cohansey Sand formation *(9)*. As a result, the vadose zone and saturated zone materials are largely inert (i.e., do not participate in ion exchange reactions) and may provide little, if any, attenuation of inorganic contaminants (both radioactive and non-radioactive species) that leach from the waste mass. In this case, K_d would be close to zero. The importance of this consideration, at least in the saturated zone, is shown in the groundwater modeling study performed by TRC Consultants in November 2005, in which the authors note that the model results are highly sensitive to decreases in the distribution coefficient *(4)*. For example, the K_d value assigned to the saturated zone for Ra-226 in the MODFLOW model was 48, a value similar to the value assigned to the contaminated zone, unsaturated zone, and saturated zone in the RESRAD model (i.e., $K_d = 53$) *(5)*. The simulated maximum concentration of Ra-226 and associated annual dose at an adjacent water supply well at year 1,000 were estimated at 3.43 pCi/L and 1.87 mrem/yr, respectively. However, reduction of the saturated zone K_d by 50 % resulted in nearly an order-of-magnitude increase in the maximum dose (i.e., 17.10 mrem/yr). Thus, the potential lack of attenuation capacity within the soils underlying the consolidation area has significant implications with regard to the adequacy of the proposed remedy for long-term protectiveness of the groundwater pathway.

According to the Decommissioning Plan *(1)*, exclusion of the groundwater pathway is justified on the basis that the groundwater beneath the site is "not a potable water supply", and that the groundwater would not be utilized for drinking in the future because "a source of municipal water is readily available." However, these lines of reasoning do not represent a long-term viewpoint with regard to groundwater protection. The Newfield/Vineland area is relatively populated and is likely to become considerably more populated over the next 1,000 years and beyond. Given that the half-lives of most of the radionuclides of concern within the waste are on the order of thousands to billions of years, these assumptions regarding potability of the groundwater and use of the groundwater as a drinking supply may be valid in the short-term but are speculative for the duration over which the remedy will need to remain protective. In addition, my understanding is that significant efforts are ongoing to remediate the existing groundwater contamination to below federal drinking water standards.

Finally, according to the Environmental Report ***(9)***, a surface water feature (i.e., the Hudson Branch) originates just to the east of the Newfield facility and is fed by groundwater discharge in times of no or low precipitation. The Hudson Branch flows through portions of the Newfield facility and subsequently through a combination of undeveloped, residential, and agricultural areas until it joins with the Burnt Mill Branch that feeds the Burnt Mill Pond. Also, according to (9), the Burnt Mill Pond is surrounded by residences and likely is used for recreational purposes (e.g., fishing). There does not appear to be any consideration, at least in the documents reviewed as part of this assessment, regarding the potential for leached contaminants from the waste mass to enter the Hudson Branch and subsequent surface water bodies due to either groundwater discharge or a surface flooding. It is noted that, under a Probable Maximum Flood (PMF) scenario, the peak water surface elevation would be approximately five feet above the southern toe of the waste pile ***(10)***.

2.2 Waste Properties

According to Rev. 1 of the Decommissioning Plan ***(9)***, the proposed remedial action includes "on-site stabilization of the residual radioactivity, followed by long-term control." It should be noted that the term "stabilization" traditionally refers to a waste treatment process designed to reduce leachability of the waste ***(11, 15)***, as has been applied in other on-site radioactive waste disposal remedies *(e.g., **16**)*. No such treatment process is proposed as part of this remedy. Rather, it appears that this proposed remedy places heavy reliance on a limited leachability testing program to demonstrate that "there is marked resistance to leaching" from the waste materials ***(1)***.

To the best of my knowledge based on the information provided, the only tests performed to date to evaluate the leachability of waste materials representative of those that remain on site include the following:

- two EP Toxicity tests performed in 1987 on samples of ferrocolumbium slag to evaluate leaching of non-radioactive metal species ***(6)***;
- one Toxicity Characteristic Leaching Procedure (TCLP) test performed on the slag to evaluate leaching of the radium, uranium, and thorium isotopes ***(2)***;
- two TCLP tests performed on samples of the baghouse dust to evaluate leaching of the radium, uranium, and thorium isotopes ***(2)***; and

- three short-term batch tests (reportedly performed in accordance with *13*) on slag samples to determine distribution coefficients (K_d) for the radium, uranium, and thorium isotopes *(2)*.

In each of the TCLP tests, the combined concentration of leached radium isotopes (i.e., Ra-226 and Ra-228 combined) easily exceeded the Maximum Contaminant Level (MCL) of 5 pCi/L established in the National Primary Drinking Water Regulations (see www.epa.gov/safewater/ contaminants/index.html). The combined radium concentration in the leachant from the TCLP test on the slag was 6,660 pCi/L (more than 1,000 times the MCL), and the combined radium concentrations in the leachant from the two TCLP tests on the baghouse dust were 32.6 pCi/L and 19.39 pCi/L *(2)*. In addition, the EP Toxicity tests performed on the ferrocolumbium slag samples in 1987 indicate that the slag releases barium (Ba) at concentrations in excess of the drinking water MCL of 2 mg/L. Leached Ba concentrations from the two slag samples were 14 and 23 mg/L *(6)*. While it is acknowledged that the population would not be directly exposed to undiluted leachate, the above results cause concern regarding potential degradation of the groundwater due to release of contaminants from the waste.

There are some significant overall limitations associated with the leaching tests that also warrant consideration. First, the testing is not comprehensive. For example, no tests appear to have been conducted on the baghouse dust to evaluate the potential for leaching of non-radioactive contaminants (e.g., heavy metals). Considering that the baghouse dust represents approximately 20 % of the radioactive waste volume to be disposed, the lack of characterization of this material is noteworthy. Second, the number of leaching tests performed is insufficient to assess potential variability in the leaching behavior of the waste materials and establish statistical confidence that the test results are representative of the waste mass as a whole. Third, the leached concentrations reported in *(2)* and *(6)* may not represent equilibrium conditions. The standard test durations for the TCLP and EP Toxicity tests are 18 and 24 hours, respectively *(15)*. No demonstration apparently has been performed to verify that these testing durations are sufficient to allow equilibrium conditions to be established between the liquid and solid phases (i.e., to allow the leaching process to reach completion). Longer extraction times would result in higher leached concentrations if equilibrium had not been established in these tests. Finally, tests such as the TCLP and EP Toxicity tests are single extraction tests and, alone, may not provide an accurate representation of long-term leaching behavior *(11, 15)*.

Regarding test duration, a similar concern exists for the short-term batch tests used to determine K_d values for the waste mass. According to *(2)*, the K_d tests were performed in accordance with ASTM D4319 *(13)*. This test method, in actuality, is designed to yield the distribution ratio, R_d, of a contaminant between the liquid and a solid phases. While K_d and R_d both represent the ratio between the concentration of a contaminant sorbed onto the solid phase to the concentration of the contaminant in solution, K_d reflects the specific case in which equilibrium has been achieved between the liquid and solid phases and is valid only for ion exchange-adsoprtion reactions. In order to apply R_d to field situations, the assumption that $K_d = R_d$ is necessary *(13)*. However, the test method specifically states, "This is a short-term test and the attainment of equilibrium in this test is not presumed, although this may be so for certain systems (for example, strictly interlayer ionic exchange reactions of clays" *(13)*. The cited condition regarding ion exchange reactions in clays is not applicable to the slag and baghouse dust. Ion exchange reactions are probably not responsible for the release of contaminants from the waste, because the occurrence of such reactions implicitly requires that the waste materials are negatively charged and, thus, exhibit cation exchange capacity. There are no indications that this is the case. If equilibrium conditions were not achieved, then the values of K_d used in the RESRAD model are actually R_d values that are higher than true K_d values (i.e., unconservative overestimates of the true K_d values). Also, since none of the specific testing details (e.g., contact times, extractant fluid used in the tests, and environmental conditions such as pH, temperature, redox potential, and specific conductance) were reported in *(2)*, any further assessment of the validity of the tests results is not possible. The reported K_d values should be treated with caution.

Additional note: Although ASTM D4319 was cited as the test method used to determine the reported values *(2)*, the test procedure is actually an adsorption test procedure (i.e., the contaminants are introduced in the liquid phase and partition to the solid phase) and not a leaching test procedure. Further explanation is necessary regarding how these tests were actually performed.

2.3 Cover System

According to Section 5 of the Decommissioning Plan *(1)*, the soil cover will consist of "a thick layer of unimpacted native soil, topsoil, rock, and vegetation brought onto the site." My understanding is that the plan now includes only a 1-m thick soil layer and an overlying 3-inch to 6-inch layer of crushed stone *(8)* to address long-term erosion concerns *(7)*. Revision 1 of the plan also included a geomembrane beneath the soil layer. However, although inclusion of a geomembrane is still mentioned in various portions of the documentation reviewed as part of this assessment, the geomembrane apparently has been removed from the plan because "the geomembrane was deemed unessential" *(3)*. The proposed cover is to be constructed with 3:1 (H:V) side slopes and a top surface slope of 4 % *(8)*.

Section 5 *(1)* also states that the groundwater exposure pathway can be excluded, in part because the cover "is designed to prevent rainwater infiltration into the consolidated material." This statement does not appear to have been justified to any reasonable extent. For example, a considerable amount of analysis has been performed to demonstrate that the crushed rock surface will provide long-term protection against erosive forces *(10)*. However, erosion protection is not sufficient to prevent infiltration and subsequent release of contaminants into the subsurface. The plan currently appears to be devoid of consideration regarding the hydraulic performance of the cover. No specifications have been provided for the index properties (i.e., grain size distribution, Atterberg limits, activity, etc.) and hydraulic conductivity of the soil layer, no evaluation of candidate borrow sources has been documented, and no specifications for placement of the soil layer are included. In addition, no justification is provided for the use of a surface runoff coefficient as high as 0.8 (i.e., 80 % of the precipitation runs off) *(1)* or an evapotranspiration rate of 24 inches per year *(1)* for a cover with a crushed rock surface and no vegetation. Surface runoff likely will be a negligible component of the water balance for this cover (although some lateral subsurface drainage may occur at the interface between the rock and soil layer along the side slopes, depending on the cover soil properties), and transpiration by plants will be nil.

In addition to the above, other considerations such as slope stability, soil development, and root intrusion do not appear to have been considered in this plan. Slope stability is a potential concern in the short- and long-term due to the proposed 3:1 side slopes, the lack of information provided regarding the cover soil requirements and the potential for at least a portion of the cover to be inundated based on the PMF scenario ***(10)***. Soil development and root intrusion have been shown to be problematic in UMTCRA-type covers such as that proposed in this plan (e.g., see ***18, 19***) and have the potential to cause an increase in hydraulic conductivity of a soil cover by several orders of magnitude over the long term ***(19)***. According to ***(19)***, long-term hydrologic isolation of buried wastes at arid and semi-arid sites is favorable because the relatively low precipitation, high potential evapotranspiration, and thick unsaturated soils reduce the reliance on a low hydraulic conductivity. These characteristics of semi-arid and arid sites clearly are not applicable to southern New Jersey, in general, and the Newfield site, in particular.

3.0 CONCLUSIONS AND RECOMMENDATIONS

In summary, my review of the proposed on-site consolidation, capping, and long-term disposal of residual wastes at the SMC Newfield facility indicates that there are several limitations associated with the current plan, and these limitations may have serious implications regarding the long-term protectiveness of this approach. The identified limitations include:

- climate and subsurface soil conditions that are not favorable for long-term isolation of the waste and protection of the groundwater exposure pathway;
- gross underestimation of the hydraulic conductivity of the vadose zone;
- uncertainty regarding the attenuation capacity of the subsurface soils for the contaminants of concern;
- absence of an engineered lining system under the waste mass;
- potential for contaminant migration into surface water as a result of groundwater discharge or flooding scenarios;
- potential future use of the local groundwater as a drinking water supply, considering adjacent development, future growth, and current groundwater remediation activities;
- leached concentrations of contaminants from the waste that exceed federal drinking water standards;
- lack of chemical analysis for non-radionuclides in the baghouse dust;

- multiple uncertainties and limitations related to the leachability testing program (i.e., the low number of tests performed, short test durations, and applicability of the test results for representing long-term leaching behavior);

- uncertainty regarding the validity of the distribution coefficient (K_d) values reported for the waste materials;

- lack of consideration of multiple aspects of the cover system pertaining to long-term hydrologic (infiltration) performance (e.g., material requirements, borrow evaluation, construction requirements;

- potential for the hydrologic performance of the cover to be compromised in the long term due to issues such as pedogenesis and invasion by deep-rooted vegetation.

I recommend that each of these issues be given serious consideration when evaluating the potential long-term effectiveness of this remedy. The proposed on-site consolidation/capping approach bears some resemblance to the S.W. Shattuck remedy in Denver, Colorado that was challenged in an EPA five-year review ***(16)*** for similar issues as those raised herein (e.g., vulnerability of the cover to long-term degradation, potentially inadequate protection of groundwater). The Shattuck waste ultimately was removed and disposed off site. The proposed remedy for this site perhaps should be evaluated in context with the outcome at the Shattuck site.

I appreciate the opportunity to provide these services to the State and look forward to discussing this assessment with you. If you have any questions regarding this report, please contact me at (570) 412-2069 or mam028@bucknell.edu.

Sincerely,

Michael A. Malusis, Ph.D., P.E.

cc: Andrew Reese, State of NJ
Jennifer Goodman, State of NJ

Curriculum Vitae For
MICHAEL A. MALUSIS
(latest update: 01/08/2007)

WORK:
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Bucknell University
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15 Hawthorne Drive
Lewisburg, PA 17837
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EMPLOYMENT:

Bucknell University, Department of Civil and Environmental Engineering, Lewisburg, PA
Assistant Professor (July 2005 – present)

Sentinel Consulting Services, LLC, Englewood, CO
Principal and Senior Engineer/Project Manager (October 2003 – June 2005)

GeoTrans, Inc., Westminster, CO
Senior Engineer/Project Manager (August 2000 – October 2003)

PROFESSIONAL REGISTRATION:

Professional Engineer #37734, Colorado (2003 - present)

EDUCATION:

Ph.D. (Aug. 2001), Civil Engineering, Colorado State University, Fort Collins, CO
Dissertation: *Membrane Behavior and Coupled Solute Transport Through a Geosynthetic Clay Liner*
Advisor: Professor Charles D. Shackelford

M.S. (Aug. 1995), Civil Engineering, Colorado State University, Fort Collins, CO
Thesis: *Stabilization of Metal-Bearing Wastes Using Chain-Structure Clay Admixtures*
Advisor: Professor Charles D. Shackelford

B.S. (summa cum laude, May 1993), Civil Engineering, Bucknell University, Lewisburg, PA
Advisor: Professor Jeffrey C. Evans

TEACHING AND RESEARCH INTERESTS:

Teaching: Undergraduate-level engineering courses, including statics, mechanics of materials, geotechnical, and transportation engineering. Undergraduate elective and/or graduate level geotechnical and geoenvironmental engineering courses with emphasis on waste containment, *in situ* remediation, contaminant transport, soil-liquid interactions, unsaturated flow, and laboratory measurement of geotechnical, hydraulic, and solute transport properties of soil.

Research: Enhanced waste containment barriers; alternative earthen final covers; geo-environmental sustainability.

HONORS AND AWARDS:

- Bucknell University Scholarly Development Grant (Summer 2006)
- Colorado Graduate Fellowship, Colorado State University (annually, 1994-1998)
- President's Award for Distiguished Academic Achievement, Bucknell University (1993)
- Oliver J. Decker Prize, Bucknell University (1993)
- William Bucknell Prize, Bucknell University (1993)
- Christensen Award, Bucknell University (1993)
- Tau Beta Pi National Engineering Honor Society (1992)

TEACHING EXPERIENCE:

Spring 2006: Department of Civil and Environmental Engineering, Bucknell University
Introduction to Transportation Engineering (CENG 330; team-taught with R.G. McGinnis)
Enrollees: 36   Sections: 2 lecture, 2 laboratory   Avg. evaluation score: 4.54/5.00

Environmental Geotechnology (CENG 451/651)
Enrollees: 23   Sections: 1 lecture, 1 laboratory   Avg. evaluation score: 4.55/5.00

Senior Design Project Team (CENG 491), 3 students
Project Title: *Soil Cover Design for In-Situ Waste Containment at the Rocky Mountain Arsenal Shell Disposal Trenches*

Fall 2005: Department of Civil and Environmental Engineering, Bucknell University
Introduction to Soil Mechanics (CENG 350; W-2 course)
Enrollees: 39   Sections: 1 lecture, 3 laboratory   Avg. evaluation score: 4.79/5.00

Summer 2000: Department of Civil Engineering, Colorado State University
Combined Statics and Mechanics of Materials for Non-Engineers (CE358)

Fall 1999: Department of Civil Engineering, Colorado State University
Advanced Soil Mechanics Laboratory (CE655)

Fall 1998: Department of Civil Engineering, Colorado State University
Statics for Non-Engineers (CE256)

Summer 1997: Department of Civil Engineering, Colorado State University
Statics for Engineers (CE260)

Fall 1995: Department of Civil Engineering, Colorado State University
Advanced Soil Mechanics Laboratory (CE655)

Spring 1995: Department of Civil Engineering, Colorado State University
Soil Mechanics Laboratory (CE450)

RESEARCH PROJECTS:

Oct. 2005 – Present: Department of Civil and Environmental Engineering, Bucknell University
Project Title: *COLLABORATIVE RESEARCH: Enhanced Clay Membrane Barriers for Sustainable Waste Containment*
Funding Source: National Science Foundation ($94,598); collaborative proposal between Bucknell University (M. Malusis, PI; J. Evans, Co-PI) and Colorado State University (C. Shackelford, PI)

June 2006 – Present: Department of Civil and Environmental Engineering, Bucknell University
Project Title: *Activated Carbon-Amended Geosynthetic Clay Liners*
Funding Source: none

June 2006 – Present: Department of Civil and Environmental Engineering, Bucknell University
Project Title: *Geomembrane-Clay Nanocomposites for Enhanced Waste Containment*
Funding Source: Bucknell University (Undergraduate Summer Research Award, J. Padgett ['07 CHEG], Summer 2006)

July 2005 – Present: Department of Civil and Environmental Engineering, Bucknell University
Project Title: *Laboratory Investigation of Moisture Retention in Model Soil-Bentonite Slurry Wall Backfills*
Funding Source: Bucknell University (Scholarly Development Proposal, Summer 2006; CEE Department Chiloro Award for Half-Time Summer Research, N. Woodward ['07 CENG], Summer 2006)

July 2005 – Present: Department of Civil and Environmental Engineering, Bucknell University
Project Title: *Membrane Behavior in a Geosynthetic Clay Liner Exposed to Organic Solutes*
Funding Source: Bucknell University (Michael Baker Research Award, J. Scalia ['07 CENG], Summer 2006)

Jan. 1997 – May 2000: Department of Civil Engineering, Colorado State University
Project Title: *Coupled Solute Migration Through Clay Barrier Materials*
Funding Source: National Science Foundation

Jan. 1996 – Dec. 1996: Department of Civil Engineering/Department of Chemical and Bioresources Engineering, Colorado State University
Project Title: *Bioremediation in the Engineering Curriculum: A Module-Based Approach*
Funding Source: National Science Foundation

May 1996 - Aug. 1996: Department of Civil Engineering/Department of Chemical and Bioresources Engineering, Colorado State University
Project Title: *Microbial Transport in Soils*
Funding Source: Camp Dresser and McKee, Inc. (Denver, CO)

Jan. 1995 - Apr. 1995: Department of Civil Engineering, Colorado State University
Project Title: *Alternative Landfill Cover Demonstration*
Funding Source: Sandia National Laboratories (Albuquerque, NM)

Sept. 1993 - Dec. 1994: Department of Civil Engineering, Colorado State University
Project Title: *Use of Floridin Clay Products for Stabilization and Compatibility Applications*
Funding Source: The Floridin Company (Quincy, FL) and the National Science Foundation

ENGINEERING/CONSULTING EXPERIENCE:

- *Michael A. Malusis, Consulting Civil Engineer, Lewisburg, PA (July 2005 – Present)*

  Rocky Mountain Arsenal (RMA), Commerce City, CO - Technical expert representing Colorado Department of Public Health and Environment (CDPHE) in oversight of design and construction of over 400 acres of RCRA-equivalent, alternative earthen final covers (AEFCs) and chemical compatibility testing program for a proposed soil-bentonite cutoff wall utilizing a new salt-resistant bentonite.

- *GeoTrans, Inc./Sentinel Consulting Services, LLC, Denver, CO (August 2000 – June 2005)*

  Selected Projects:
  Canon City Milling Facility, Canon City, CO – Technical expert representing the Colorado Department of Public Health and Environment (CDPHE) in assessment of the regulatory conformance and technical viability of existing waste containment and leak detection systems for primary and secondary radioactive tailings impoundments.

  Rocky Mountain Arsenal (RMA), Commerce City, CO - Technical expert and project manager representing Colorado Department of Public Health and Environment (CDPHE) in oversight of ongoing remedial efforts, including oversight of the design of an enhanced triple-lined hazardous waste landfill and negotiation of full-scale design requirements for over 400 acres of RCRA-equivalent, evapotranspirative covers.

  Confidential Client, Denver, CO – Project manager for geotechnical investigation and design in support of commercial land development. Work included subsurface field investigation and sampling, geotechnical stability analysis, geotechnical testing, foundation design, and AASHTO pavement design.

  Hidden Glenn Landfill, Napa, CA – Geotechnical design analysis, including static and pseudo-static (seismic) slope stability analysis of multi-layer landfill cover system.

  Tri-State Generation and Transmission Association, Westminster, CO – Geotechnical design for a fly ash disposal facility expansion in western Colorado. Work included hydraulic evaluation of subgrade materials within footprint of proposed impoundment and development of a design and operations (D&O) report and permit application for the facility.

  Stanton County Landfill, Johnson City, KS – Combined HELP/Multi-Med infiltration, flow, and contaminant transport analysis for a municipal landfill.

  Battle Mountain Resources, Inc., San Luis, CO – Geotechnical design for water treatment pond at a mine site. Work included field geotechnical testing and construction QA/QC during placement of compacted clay and geomembrane liner.

  Phelps-Dodge, Inc., Hurley, NM – Unstaturated flow modeling effort to estimate generation of acid-rock drainage (ARD) from mine spoils.

  Motive Power, Boise, ID - Field oversight of Fenton's reagent injection for *in situ* treatment of chlorinated hydrocarbons at a locomotive remanufacturing facility.

PUBLICATIONS:

Journals/Special Publications - Refereed

Malusis, M.A. and Scalia, J. (2007). Hydraulic Conductivity of an Activated Carbon-Amended Geosynthetic Clay Liner. ASCE Geotechnical Special Publication (submitted on 7/24/06; currently in review).

Malusis, M.A. and Benson, C.H. (2006). Lysimeters versus Water-Content Sensors for Performance Monitoring of Alternative Earthen Final Covers. *Unsaturated Soils 2006*, ASCE Geotechnical Special Publication No. 147, Vol. 1, 741-752.

Malusis, M.A. and Shackelford, C.D. (2004). Explicit and Implicit Coupling during Solute Transport Through Clay Membrane Barriers. *Journal of Contaminant Hydrology*, 72, 259-285.

Malusis, M. A. and Shackelford, C. D. (2004). Predicting Solute Flux through a Clay Membrane Barrier. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 130(5), 477-487.

Malusis, M.A., Shackelford, C.D., and Olsen, H.W. (2003). Flow and Transport through Clay Membrane Barriers. *Engineering Geology*, 70(3-4), 235-248.

Malusis, M.A. and Shackelford, C.D. (2002). Coupling Effects During Steady-State Solute Diffusion through a Semi-Permeable Clay Membrane. *Environmental Science and Technology*, 36(6), 1312-1319.

Malusis, M.A. and Shackelford, C.D. (2002). Chemico-Osmotic Efficiency of a Geosynthetic Clay Liner. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 128(2), 97-106.

Malusis, M.A. and Shackelford, C.D. (2002). Theory for Reactive Solute Transport through Clay Membrane Barriers. *Journal of Contaminant Hydrology*, 59(3-4), 291-316.

Malusis, M.A., Shackelford, C.D., and Olsen, H.W. (2001). Laboratory Apparatus to Measure Chemico-Osmotic Efficiency Coefficients for Clay Soils. *ASTM Geotechnical Testing Journal*, 24(3), 229-242.

Shackelford, C.D., Malusis, M.A., Majeski, M.J., and Stern, R.T. (1999). Electrical Conductivity Breakthrough Curves. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, 125(4), 260-270.

Conference Publications - Refereed

Shackelford, C. D., Malusis, M. A., and Olsen, H. W. (2003). Clay Membrane Behavior for Geoenvironmental Containment, *Soil and Rock America Conference 2003* (Proceedings of the joint 12th Panamerican Conference on Soil Mechanics and Geotechnical Engineering and the 39th U. S. Rock Mechanics Symposium), P. J. Culligan, H. H. Einstein, and A. J. Whittle, eds., Verlag Glückauf GMBH, Essen, Germany, Vol. 1, 767-774.

Malusis, M. A., Shackelford, C. D., and Olsen, H. W. (2001). Flow and Transport through Clay Membrane Barriers. *Geoenvironmental Engineering, Geoenvironmental Impact Management, Proceedings of the 3rd BSA Conference on Geoenvironmental Engineering*, Edinburgh, Scotland, September 17-19, 2001, R. N. Yong and H. R. Thomas, eds., Thomas Telford Publ., London, UK, 334-341.

Malusis, M.A. and Shackelford, C.D. (2001). Modeling Contaminant Transport Through Clay Membrane Barriers. *Proceedings, 2001 International Containment and Remediation Technology Conference*, Orlando, FL, Jun. 10-13, Florida State University, Talahassee, FL, 146-149.

Malusis, M.A., Adams, D.J., Reardon, K.F., Shackelford, C.D., Mosteller, D.C., and Bourquin, A.W. (1997). Microbial Transport in a Pilot-Scale Biological Treatment Zone. *Proceedings,* *4th International Symposium on In Situ and On Site Bioremediation*, New Orleans, LA, April 28-May 1, 1997, Vol. 4, pp. 559-564.

Malusis, M.A. and Shackelford, C.D. (1997). Modeling Biodegradation of Organic Pollutants During Transport through Permeable Reactive Bio-Walls. *Proceedings, 1997 International Containment Technology Conference and Exhibition*, St. Petersburg, FL, Feb. 9-12, 1997, pp. 937-944.

Archival Magazines - Refereed

Shackelford, C.D., Malusis, M.A., and Olsen, H.W. (2001). Clay Membrane Barriers for Waste Containment. *Geotechnical News*, 19(2), 39-43.

Book Chapters

(contributing author) Sleep, B.E., Shackelford, C.D., Parker, J.C., et al. (2006). Modeling of Fluid Transport through Barriers. Chapter 2, *Barrier Systems for Environmental Contaminant Containment and Treatment*, C.C. Chien, H.I. Inyang, and L.G. Everett, eds., CRC Press, Boca Raton, FL.

Conferences - Nonrefereed

Shackelford, C. D., and Malusis, M. A. (2002). Clay Membrane Behavior and Coupled Solute Diffusion. *Proceedings, Chemico-Mechanical Coupling in Clays; From Nano-Scale to Engineering Applications*, June 28-30, 2001, Maratea, Italy, Swets and Zeitlinger, Lisse, 289-296.

FORMAL PEER REVIEWS:

Journal and Special Publication Manuscripts

July 2006: Haque, A., Kabir, E., and Bouazza, A. Cyclic filtration apparatus for testing subballast under rail track. Submitted for publication in *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE (Contacted by R. Sharma, Louisiana State University, on 7/9/06; comments submitted on 7/28/06).

July 2006: Spinelli, L.F., Schnaid, F., Selbach, P.A., and Bento, F.M. Biological effects on the structure of soil particles in a soil-gasoline artificially contaminated microcosm. Submitted for publication in *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE (Contacted by R. Sharma, Louisiana State University, on 7/9/06; comments submitted on 7/28/06).

January 2006: Chmiel, G. and Fritz, S.J. Concentration-dependent diffusion in hyperfiltration systems. Submitted for publication in *Geochimica et Cosmochimica Acta* (Contacted by GCA Editorial Office on behalf of Associate Editor Eric Oelkers on 1/03/2006; comments submitted on 2/10/2006).

October 2005: Shafer, D.S.,Young; M.H., Zitzer, S.F., McDonald, E.V., and Caldwell, T.G. Coupled Environmental Processes in the Mohave Desert and Implications for ET Covers as Stable Landforms. Submitted for Publication in *Unsaturated Soils 2006*, Geotechnical Special Publication 147 (Contacted by session editor C.D. Shackelford, Colorado State University; comments submitted on 10/17/2005).

October 2005: Stockdill, D., Jorgenson, R.R., and Obermeyer, J.E. Case History and Regulatory Aspects of a Final Cover Performance Evaluation Involving Conventional and

Evapotranspirative Cover Designs. Submitted for Publication in *Unsaturated Soils 2006*, Geotechnical Special Publication 147 (Contacted by session editor C.D. Shackelford, Colorado State University; comments submitted on 10/14/2005).

July 2004: Neupane, D., Bowders, J.J., Loehr, J.E., and Bouazza, A. Field Performance of an Asphalt Barrier Test Pad. Submitted for Publication in *GeoFrontiers 2005*, Geotechnical Special Publications 130-142 and GRI-18 (Contacted by GeoFrontiers 2005 conference session organizer C.D. Shackelford, Colorado State University; comments submitted on 7/28/2004).

Book Chapters

September 2005: Dominijanni, A. and Manassero, M. Osmosis and Solute Transport Through Geosynthetic Clay Liners. Submission for publication as a chapter in the book entitled *Geosynthetic Clay Liners in Waste Containment Applications*, A. Bouazza and J. Bowders, eds., A.A. Balkema (Taylor Francis) (Contacted by co-editor A. Bouazza, Monash University, Australia; comments submitted on 9/04/2005).

Grant Proposals

February 2006: Hatfield, K., Annable, M.D., and Clark, C.J. Collaborative Florida-Brazilian Investigation of Subsurface Mass Flows. Submitted to National Science Foundation (NSF) Geoenvironmental Engineering and Geohazard Mitigation Division (Contacted by R. Fragaszy, NSF Program Manager; comments submitted on 02/13/06).

PROFESSIONAL AFFILIATIONS:

- Member, ASCE, including the Geo-Institute and the Pennsylvania chapter (2006)
- Member, American Society for Testing and Materials (ASTM)

SERVICE:

University Level

- Faculty member of Board of Review on Academic Responsibility (2006 – present)
- Faculty representative of Composition Council (2006 - present)
- Representative of First-Year Faculty Working Group, Bucknell University (2005 – 2006)
- Representative of CEE Department at Bucknell open houses (2005 – present)

Department Level

- CEE Department Liaison to the Writing Center, Bucknell University (2006 - present)
- CEE Department Library Liaison, Bucknell University (2005 - present)
- CEE Senior Field Trip Chaperone, Bucknell University (2005)

External

- Member, ASTM Committee D18 on Soil and Rock (2005)

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Attorney for Petitioner

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Docket No. 04007102

IN RE PETITION FOR A HEARING on the SHIELDALLOY METALLURGICAL CORP. DECOMMISSIONING PLAN, pursuant to 10 C.F.R. § 2.309 and 42 U.S.C. § 2239(a)(1)(A)

DECLARATION OF TIMOTHY DISBROW

I, TIMOTHY DISBROW, hereby declare as follows:

1. Attached please find my resume, which is incorporated into this Declaration by reference.

2. I am familiar with the portions of the Shieldalloy Decommissioning Plan ("DP") which pertain to the proposed cap. Based upon my experience with landfill caps in New Jersey, vegetation will likely grow over time on the cap as proposed by the DP. Vegetation will likely grow due to wind-borne deposits of soil and seed that land on the cap. Large rooted vegetation

such as trees, if allowed to grow, will likely infiltrate the radioactive waste below the proposed cap. Large rooted vegetation may cause additional water infiltration into the radioactive waste. The vegetation that grows on the cap will need to be mowed three or more times per year to prevent large rooted vegetation from infiltrating the cap.

3. Groundwater should be monitored to detect any leaching of nuclides. Groundwater monitoring is especially necessary for the DP's proposed design since there is no liner underneath the waste.

4. Sufficient financial assurance should be posted to ensure the long-term care and maintenance of the disposal facility and the environment for the duration that the waste remains a radioactive hazard. Maintenance of the cap includes mowing three or more times per year as discussed above in paragraph 2. Also, settlement and animal burrowing commonly occurs on caps. Therefore, maintenance will also include inspections approximately four times per year and repairing any settled areas or animal burrows.

I certify that the foregoing statements made by me are true. I am aware that if any of the foregoing statements made by me are willfully false, I am subject to punishment.

DATE: 1/16/07

Timothy Disbrow

21 Woodcrest Drive, Mount Holly, NJ 08060
609-267-6453 tim.disbrow@dep.state.nj.us

Timothy W. Disbrow

1988 to present NJDEP, Solid and Hazardous Waste Management Program
Bureau of Solid and Hazardous Waste Permitting South
PO Box 414, 401 E. State St., Trenton, NJ 08625

Experience

2005 to present
Hazardous Site Mitigation Specialist I

Site Remediation Program case management – manage multi-media contamination projects subject to "Department Oversight of the Remediation of Contaminated Sites" (NJAC 7:26C). Review reports submitted pursuant to the Technical Rules for Site Remediation (NJAC7:26E) involving Preliminary Assessments, Site Investigations, Remedial Investigations and Remedial Actions. Organize and lead team meeting with Technical Coordinator and Geologist. Issue correspondence and approvals as needed, under own signature. Assess feasibility of proposed remedial action plan designed to be protective of human health and environment. Attend public meeting to convey technical issues to officials and residents relating to site investigations and cleanups. Organize, coordinate and participate in performance of emergency/nonemergency remedial actions requiring expertise in management of hazardous and nonhazardous substance and wastes. Organize, supervise and review the conduct of sampling, assessments, investigations, cleanup plans, closure and post-closure procedures to determine presence and degree of impact or damage caused to the environment or public health by improper hazardous and nonhazardous substance or waste disposal methods. Interact with the regulated community, the public, contractors and other government agencies regarding management of hazardous/nonhazardous wastes.

1988 to 2005
Principal Environmental Engineer – Waste Management

Landfill case management – review technical and environmental documents related to landfills along with coordination and oversight of review by other programs. Conduct public participation in the form of notices, public meetings and hearings. Responsible for ensuring compliance with permit submittal requirements, construction oversight and certifications and approving landfill closure and post-closure compliance. On-going review of environmental monitoring data, escrow fund release requests and financial plan reviews. Served as acting section chief for two separate 6-month periods in the 1990's.

1983 to 1988 NJDEP, Division of Solid and Hazardous Waste
Trenton, New Jersey

Engineer-in-training, Assistant Env. Engineer and Senior Environmental Engineer

(Same as landfill case management above.)

1981 to 1982 Self-employed subcontractor for local manufacturing business doing work for the Federal Government and private industry.

1973 to 1980 NJ Bell Telephone Company
Trenton, New Jersey

Assistant Manager

Supervised a group of computer specialists doing software implementation, converting mechanical switching systems to computerized switching systems. Duties involved budget planning, employee evaluations, technical report writing and workload scheduling. (1977 to 1980)

Field Engineer

Plan, design and oversight of construction of poles, cables, manholes and underground conduit. (1973 to 1977)

Education

1967 to 1972 Brown University, Providence Rhode Island
BS in Civil Engineering
BA in Liberal Arts

1986 to 1988 New Jersey Institute of Technology, Newark, New Jersey
24 credits in graduate level studies in Environmental and Geotechnical Engineering

STUART RABNER
ATTORNEY GENERAL OF NEW JERSEY
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Attorney for Petitioner

By: Andrew D. Reese
Deputy Attorney General
(609) 292-1509

IN RE PETITION FOR A HEARING on)
REQUEST FOR DECOMMISSIONING)
FOR SHIELDALLOY METALLURGICAL)
CORPORATION, NEWFIELD, NJ,)
pursuant to 10 C.F.R. §2.309)
and 42 U.S.C. §2239(a)(1)(A))

CERTIFICATION OF SERVICE

I, Andrew D. Reese, hereby certify that on January 26, 2007, I caused a true copy of the Declaration, report, and Curriculum Vitae of Michael Malusis and the Declaration of Timothy Disbrow to be sent by first class mail, and where indicated by an asterisk by electronic mail, upon the following parties:

Shieldalloy Metallurgical Corporation
12 West Boulevard
Newfield, NJ 08344-0768
ATTN: David R. Smith
Radiation Safety Officer

*Office of the General Counsel
U.S. Nuclear Regulatory Commission
One White Fling North
11555 Rockville Pike
Rockville, MD 20852-2738

I certify that the foregoing statements made by me are true. I am aware that if any of the foregoing statements made by me are wilfully false, I am subject to punishment.

Andrew D. Reese

Dated: January 26, 2007