February 27, 1998

Sludge Research Program

The bulk of the following proposal was developed starting in 1988 by a research panel reporting to the Maine Board of Environmental Protection (MEBEP). The proposal was developed to address concerns raised by the Natural Resources Council of Maine (NRCM) over an application by International Paper (IP) to land-spread pulp and paper mill sludges in the State.

Program development occurred through negotiations between NRCM, IP, and scientists from government and acedemia. MEBEP accepted the proposal with attendant funding and oversight provisions, making IP's sludge spreading permit contingent on completion of required research and analysis. Work began to fulfill the program.

Within a short period of time, the independent scientists co-chairing the research committee resigned because elements within the paper industry refused to cooperate fully and to allow adequate peer review of internal research reports. International Paper withdrew its permit application in the early 1990's. Currently, no permits are going forward until the research program goals are met.

Agencies and academics indicated in brackets were proposed for specific research tasks in 1988.

Reach for Unbleached Canada has revised the program for 1998 in light of new knowledge and scientific concern about the endocrine disruptive functions of compounds which may be present in pulp and paper mill sludge.

RESEARCH OBJECTIVES

I. ANALYTICAL METHOD DEVELOPMENT

A. Develop analytical methods for characterizing the major classes of low molecular-weight chlorinated organic compounds in paper mill sludge (chlorinated phenolics, neutrals, and acids).

Research Study

Characterization of Low Molecular-Weight Chlorinated Compounds in Sludge (EMSECO, 205 Alewife Brook Parkway, Cambridge, MA).

Discussion: As a precursor to the development of many of the proposed research programs, verifiable analytical techniques need to be completed for major classes of low molecular weight (LMW) chlorinated organic compounds potentially present in sludge. Selected indicator compounds will be chosen from each of the major clauses of LMW chlorinated compounds to serve as verifiable standards to

demonstrate the ability of the methodology to extract these classes of compounds. In addition, the research will evaluate extraction procedures which may result in better recovery of LMW chlorinated organic compounds. It is important to note that the analytical methods are not focussed on identifying specific high molecular weight chlorinated organic compounds or naming all LMW compounds, but rather on specified indicator compounds thought to be representative of low molecular weight classes.

B. *Evaluate the ability to accurately measure the total amount of chlorinated organic material in paper mill sludge.*

Research Study

Total Organic Chloride (ToCl): Assessment of Environmental Behaviour (Overcash, North Carolina State University)

Discussion: The use of a generalized analysis like ToCl may have several problems including the difficulty of confirming the accuracy of the analysis and the corresponding environmental fate. It is thus necessary to examine in more detail an aggregate characterization such as ToCl when applied to a type of waste and the terrestrial system. This work will focus on evaluating the usefulness and applicability of ToCl measurements to the pulp and paper sludge waste stream and possible improvements to the methodology.

C. *Determine acceptable analytical methods to establish the presence of HMW, LMW, and non-chlorinated endocrine disrupting/genotoxic chemicals in pulp mill sludge.*

A. Determine non-lethal parametres to measure endocrine disruption and/or genotoxicity

1. Characterize total endocrine disrupting potential in sludge
2. Isolate and identify all possible endocrine disrupting constituents
3. Evaluate possibility of unidentified constituents continuing to cause endocrine disruption

II. Environmental Fate of Chlorinated Organic, Non-Chlorinated Organic and Endocrine Disrupting Chemicals in Sludge

A. Analyze paper mill sludge for the presence of low molecular-weight chlorinated organic material

Research Study

Using methods developed above, analyze individual pulp and paper mill sludges for the presence of low molecular weight chlorinated organic compounds and ToCl.

Discussion: A sampling program for chlorinated organic compounds will be conducted based on methodologies developed above to:
(1) analyze for specific indicator compounds;
(2) screen for the presence of other low molecular-weight chlorinated organic compounds; and
(3) analyze for total organic chloride (ToCl).

B. *Determine the rate at which HMW chlorinated compounds are decomposed and whether LMW chlorinated organic compounds are persisting or accumulating under conditions reflective of forest and agricultural soil environments.*

Research Study

1. Land Treatment of Pulp and Paper Mill Sludge - Organic Assimilation (Overcash, North Carolina State University)
Discussion: In this study Overcash will compare the degradation of lignin with chlorinated lignin to establish the relative rates of decomposition and confirm whether the greater body of lignin decomposition knowledge represents useful information for understanding overall decomposition rates of chlorinated lignin compounds. The study also will measure the decomposition of selected LMW chlorinated compounds typically occurring in sludge. These will be added to soil in sufficient concentrations to directly determine the rate of parent compound loss over time.

2. Determine the Fate of Selected Sludge Components and Breakdown Products (Tatersall Smith, University of New Hampshire)
Discussion: Using sludge amended soil microcosms in the natural environment reflective of forest and agricultural soil environments, researchers will monitor the fate and movement of chlorinated organic material in sludge from pulp and paper mills. The study will analyze soil and leachate using methodologies developed to:
(1) analyze specific indicator compounds;
(2) screen for the presence of other low molecular-weight chlorinated organic compounds; and
(3) analyze for total organic chloride (ToCl). Samples will be archived pending the completion of the methodology development work indicated above.

3. Highmoor Farm Chlorinated Organics Study (Dr. Larry Zibilske, University of Maine in Orono and ENSECO)
Discussion: Preliminary work was conducted in 1987 on corn and soil matrixes at Highmoor Farm. Using new methods developed under the ENSECO study above, the researchers propose to :
(1) analyze for specific indicator compounds;
(2) screen for the presence of other low molecular-weight chlorinated organic compounds; and
(3) analyze for total organic chloride (ToCl). The researchers propose to characterize sludge extensively at the time of application and monitor soil/sludge matrixes over an eight to ten month period in agricultural research plots previously amended with sludge.

C. *Analyze actual mill sludge for genotoxic and endocrine disrupting constituents and potential*

1. Scan sludge for known endocrine-disrupting constituents.

2. Determine if sludge without identifiable endocrine disruptors continues to have endocrine disrupting effects
(1) Determine breakdown (and/or microbial assembly) products of endocrine disruptors in sludge
(2) Determine sorption, mobility, effects in soil and water, etc. for endocrine disruptors and their breakdown/assembly products

III. Effects On Wildlife

A. Assess the ability of robins or other indicator species like eagles to bioaccumulate dioxin in eggs.

Research Study

Evaluate the validity of research in Wisconsin that assessed the bioaccumulation of Dioxin in robins' eggs, and of the recent US Fish & Wildlife research on TEQ accumulation and effects in bald eagles in Maine.
Discussion: Extensive research has been carried out in Wisconsin focussed on the impact of sludge on wildlife, particularly wild birds. In the summer of 1988 this study focussed on the bioaccumulation of Dioxin by robins into eggs. Because of unusual weather conditions, the validity of this study needs to be assessed for Maine and successfully repeated if necessary. Similarly, 1996 research on the impact of dioxin (TEQ) bioaccumulation on eagles may have more direct bearing on the issues at hand.

B. *Determine if there is an effect, either negative or positive, on plant or animal communities on sludge amended forest land.*

Research Study

Monitor the population density and occurrence of plant and animal species in areas affected by sludge spreading.
Discussion: A monitoring study would involve sending biologists and soil specialists familiar with local flora and fauna, including micro-flora and micro-fauna to estimate population densities through sweep net samples, sherman trapping, transect plant counts and observations. Censuses should be 1 year before sludge is spread on a particular site and conducted at least once a year at the same time of year. The procedures should be reproduced with experimental plots matched with an appropriate control site.

C. Determine genotoxic and/or reproductive impact on local flora and fauna

IV: Assessment of Various Composting Measures on Sludge Toxicity

A. Identify and test common and experimental sludge composting methods

B. *Determine relative value of composting methods on the parameters identified above*