BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
	)	
WATER QUALITY STANDARDS AND	)	
EFFLUENT LIMITATIONS FOR THE	)	R08-9
CHICAGO AREA WATERWAY SYSTEM	)	(Rulemaking - Water)
AND THE LOWER DES PLAINES RIVER:	)	
PROPOSED AMENDMENTS TO 35 Ill.	)	
Adm. Code Parts 301, 302, 303 and 304	)	

PRE-FILED TESTIMONY OF THOMAS GRANATO
AQUATIC LIFE USES AND CRITERIA

My name is Thomas Granato, and I am the Assistant Director of Research and Development managing the Environmental Monitoring and Research Division at the Metropolitan Water Reclamation District of Greater Chicago. I have been employed by the District for over 20 years and have held progressively responsible positions, including head of the Biosolids Utilization and Soil Science Section, and Coordinator of Technical Services. I have been Assistant Director of R&D for the past three and one half years. The EM&R Division houses the District's Wastewater Treatment Process Research Section, the Biosolids Utilization and Soil Science Section, the Analytical Microbiology and Biomonitoring Section, the Aquatic Ecology and Water Quality Section, and the Radiochemistry Section, which collectively house approximately 70 environmental scientists and engineers, soil scientists, biologists, microbiologists, chemists, radiation chemists, biostatisticians and other technical personnel. Over this time period I have been directly involved in the planning, development, management and administration of the many research studies that the District has undertaken to support the Chicago Area Waterways Use Attainability Analysis.

This testimony summarizes and concludes each main topic of the District's testimony with regard to aquatic life use and criteria issues. The District believes that IEPA relied on incorrect assumptions and reached faulty conclusions concerning aquatic life use designations

and associated criteria for the CAWS. Instead of pursuing this rulemaking now, IEPA should wait for necessary studies being conducted by the District to be completed. These studies will provide information necessary to make scientifically supported decisions concerning appropriate water quality standards for the CAWS. However, if the rulemaking does move forward before those studies are complete, the District urges significant revisions to assure that the use designations and criteria for the CAWS are technically and legally supportable.

Aquatic Use Summary and Conclusions

As an active stakeholder, the District has appreciated the opportunity to provide the majority of the environmental data that have been assessed in the CAWS UAA. Research projects and studies regarding the UAA have been initiated by the District either on our own accord or on the request of IEPA. The District is concerned that IEPA has filed its proposal for R08-09 before the results of these crucial studies were available. The IEPA has chosen to formulate use designations and proposed standards for the CAWS, despite being aware that certain studies they have requested have not yet been completed.

We feel strongly that the results of all of the studies conducted for or in association with the UAA must be available and assessed before IEPA can make informed and scientifically supportable decisions about the uses and standards that are applicable to the CAWS. For parameters for which there is little or no science available, it would be counter-productive to set arbitrary standards while we await the results of ongoing research. Related to the aquatic life standards, the District's Habitat Evaluation and Improvement Study will provide extensive data on the physical habitat and the aquatic life potential in the CAWS at many more locations than were assessed in the UAA report. Since 2001, the District has been collecting biological and physical habitat data throughout the CAWS on a 4-year cycle for our Ambient Water Quality Monitoring Program. In other words, all 59 stations (28 of which are in the CAWS) are sampled

within four years. As the data were being analyzed from the first two sampling cycles, it became apparent that additional stations in the CAWS should be evaluated to adequately characterize the aquatic environment. This habitat evaluation study will fill in these gaps, determine what physical habitat modifications would be required to achieve a sustainable fish community in the CAWS, and also synthesize and compare District chemical water quality data to tolerance levels of the fish species expected to colonize the CAWS if habitat improvements were implemented. This is necessary to replace the approach that IEPA took, which was based on insufficient habitat and biotic index data, and which was derived from indices that are not appropriate for use in the CAWS and which were calculated incorrectly.

The definition and basis for the proposed aquatic life use designations was never adequately explained by the IEPA. One of the confusing aspects of the CAWS UAA report is that it contains language that is inconsistent with the proposed standards. For instance, the CAWS UAA report refers to the Aquatic Life Use Designations in categories, including Modified Warm-water Aquatic Life (MWAL) and Limited Warm-water Aquatic Life (LWAL). IEPA's proposed aquatic life use designations, however, do not mention these classifications, nor do they explain how they are related to Aquatic Life Use A and B, terms that are introduced in the UAA proposal for the CAWS.

Between the 2004 CAWS UAA draft report and the 2007 issuance of the final report, no new data were assessed. All of the water quality, sediment quality and biological data described in the UAA report was collected prior to or during 2002. During 2001-2007, the District has collected a wealth of sediment chemistry, sediment toxicity, and benthic invertebrate data in the CAWS as part of the Ambient Water Quality Monitoring Program. However, none of information was considered when IEPA designated Aquatic Life Uses. Essentially, it appears

that only fish Index of Biotic Integrity (IBI) percentile was used to classify waterways into Aquatic Life Use A or B. Given the more extensive database now available for sediment and benthic invertebrates and the soon-to-be completed CAWS Habitat Evaluation and Improvement Study, the IEPA should consider these factors and their implications for the Aquatic Life Use designations in the CAWS.

Furthermore, the Agency did not adequately account for the unique characteristics of the CAWS that significantly differentiate it from other General Use waters. Hydraulic limitations such as flow reversals, slow water velocity and the effects of wet weather present challenges not faced by most natural waterbodies. The ecological community in the CAWS also is substantially impaired by poor habitat, including low quality substrate, little or no sinuosity, poor riffle and pond development and low gradients. The CAWS substrate alone will prevent any further improvements in water quality from translating to a better macroinvertebrate community and will not likely result in improvements in aquatic life use. Without suitable habitat pattern and diversity, sustainable aquatic populations will not be established even with improvements in water quality.

If this rulemaking moves forward despite the data gaps, the Aquatic Life Uses should be revised to more appropriately reflect the nature of the CAWS and the aquatic community to be protected. For example, the Calumet-Sag Channel, which is a deep-draft, steep-walled channel, should be classified with other deep-draft, steep-walled channels in Aquatic Life Use B. Bubbly Creek, which is stagnant during dry weather and inundated with combined sewer overflow from the Racine Avenue Pumping Station during wet weather, does not reasonably fit within either of IEPA's proposed aquatic life uses. Bubbly Creek is unique in that it is a side fork and is therefore not used for fish passage through the Chicago Area Waterway System. To this end, the

District recommends a narrative DO standard for Bubbly Creek that prevents fish kills and maintains aesthetics (*e.g.*, prevents nuisance odors). This would be appropriate until such time as the sediments are capped, removed or remediated and the frequency of discharge at Racine Avenue Pumping Station is diminished sometime after 2024. If a numerical DO standard is deemed imperative, then the IPCB should consider the testimonies of Drs. Paul Freedman and Marcelo Garcia as a basis for such a standard.

Aquatic Criteria Summary and Conclusions

The District is very concerned that the IEPA's proposal establishes standards to protect aquatic life that are inappropriate for the proposed uses in the CAWS, and which would require the expenditure of significant resources to implement flow augmentation and supplemental aeration projects that ultimately could not guarantee achievement of the proposed standards. We therefore urge the Board not to adopt the agency's proposal.

Despite the unique highly-managed, manmade characteristics of the CAWS, and despite IEPA's indication that the aquatic life uses are designed to protect tolerant or intermediately tolerant species, the agency has proposed criteria that are virtually identical to those applicable to General Use waters in the case of dissolved oxygen and are more stringent than General Use waters in Cook County for cyanide. This is not reasonable, because the General Use standards apply to natural waters where intolerant sensitive species must be protected. The Agency proposed that Aquatic Life Use A waters be required to meet standards proposed to protect early life stages of fish, such as smallmouth bass, which cannot succeed in the CAWS due to lack of appropriate habitat. The Agency's proposed cyanide standard was based on protection of cold water species such as rainbow trout, which are not present in the CAWS. Without a clear link between the standards and protection of appropriate organisms, the agency's proposal is not justified.

While the Agency has applied the General Use numerical criteria to the CAWS, it has failed to also apply the narrative dissolved oxygen standard that was recently adopted for General Use waters to the CAWS. The Agency gave no consideration to developing a similar standard for the inherently quiescent reaches of the CAWS. The Agency stated in the recently adopted General Use waters rulemaking that it is not reasonable to expect to attain the dissolved oxygen standard that was set for General Use waters everywhere and that "[t]here are isolated areas where the physical and chemical and biological circumstances are such that you cannot maintain that standard."[1]

As a result, the dissolved oxygen criteria proposed by IEPA would require implementation of flow augmentation and supplemental aeration projects, even in isolated areas of the CAWS that are quiescent due to their physical circumstances. However, even if implementation of these projects could be accomplished in all areas of the CAWS, the Agency has provided no direct evidence that the proposed criteria could be achieved. The Agency particularly failed to consider the prolonged effects of wet weather on dissolved oxygen levels in all parts of the CAWS, particularly in Bubbly Creek. If this rulemaking proceeds, the proposal should be revised to incorporate wet weather standards and eliminate the seven-day average dissolved oxygen criterion. In addition, the chronic cyanide criterion should be revised to reflect protection of species actually present (or intended to be present) in the CAWS. The resulting chronic cyanide standard that is developed for the CAWS should not be more restrictive than the General Use standard currently applicable to Cook County.

Finally, the District has serious concerns about the feasibility and the significant costs of such an uncertain undertaking. It is simply not practicable to install supplemental aeration

[1] R04-25 at Tr. 4, pg 61-62.

stations of the size necessary to achieve 100 percent compliance with the proposed dissolved oxygen criteria and still maintain certain recreational uses in and around some parts of the CAWS . For example, to build a diffused-air instream aeration station that delivers DO to meet the proposed DO standards could require installing diffusers in an area the length of a football field, in which the rising air bubbles in the water could make this area unsafe for passing hand-powered boats. The implementation of flow augmentation for the upper NSC would likely require the construction of a 4.5 mile, 7-foot diameter pipeline along the waterway, which would disrupt transportation and recreation in the surrounding communities including trenching across many streets, CTA railway tracks, a golf course, Ladd Arboretum and miles of walking trails.

Furthermore, the costs associated with implementation of DO enhancement processes are significant: $525 million in capital costs and $6.9 million in annual operation and maintenance costs. Based upon the District's limitations and restrictions on generating revenues to fund programs, funding such an expenditure would require legislative action, a voter referendum, or significantly reducing funding of existing District programs.

Installation and operation of technology necessary to comply with proposed aquatic life uses and criteria would result in substantial environmental impacts in the form of energy usage, air emissions (including greenhouse gasses) from power generation and transportation of raw and waste materials, and land usage. For example, the total energy required for operation of dissolved oxygen enhancement technologies is estimated at 74.2 million kWh/yr, which will increase the District's total energy consumption by 13.5 percent. These environmental impacts must be taken into consideration in determining appropriate requirements.

Conclusion

In conclusion, the CAWS was created largely by the District for purposes other than sustaining aquatic life use, long before the Clean Water Act was conceived or passed into law.

Nevertheless, the District has expended considerable resources and has undertaken many ambitious engineering projects, such as building some of the world's largest wastewater treatment plants and developing and implementing TARP to improve water quality in the CAWS. These water quality improvements will no doubt continue as TARP is completed. The District shares the goal of its fellow UAA stakeholders to continuously improve Chicago's aquatic environment, both the CAWS and Lake Michigan. However, the District cannot support the proposal that the IEPA has put before you in this rulemaking. That proposal has focused solely on addressing further improvements in chemical water quality, requires higher dissolved oxygen concentrations and lower concentrations of many chemical constituents than are currently required, and has ignored the many inherent physical limitations the CAWS has, which prior testimony has shown will prevent the chemical water quality improvements that the Agency seeks from supporting improved aquatic life use. With the potential cost of compliance measured in the hundreds of millions of dollars, standards that are based on incomplete, inappropriate and incorrect data are unacceptable.

I appreciate the opportunity to present this testimony today, and encourage the Board to reject IEPA's proposal as premature, without sufficient scientific basis, unattainable, and inappropriate to protect the CAWS.

Respectfully submitted,

By: Thomas Granato

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EDUCATION

Ph. D. North Carolina State University 1987. Environmental Soil Science
M.S. University of Illinois 1984. Soil Chemistry
B.S. University of Illinois 1981. Agricultural Science

EXPERIENCE

Assistant Director of Research and Development, Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, March 2005 to present

- Head of the Environmental Monitoring and Research (EM&R) Division, direct research activities of six sections including Wastewater Treatment Process Research Section, Biosolids Utilization and Soil Science Section, Aquatic Ecology and Water Quality Section, Analytical Microbiology and Biomonitoring Section, Radiochemistry Section, and Statistical Support Section.
- Responsible for preparation and administration of EM&R Division budget for 70 employees and supporting facilities.
- Responsible for assignment, tracking, review and approval of all assignments received by EM&R Division.
- Responsible for focusing staff on relevant research to improve District operations, reduce operating costs and ensure regulatory compliance.
- Provide back-up administration and supervision to the R&D Department in the absence of the Director and represent R&D Department at executive level meetings.
- Managing District research program supporting Illinois EPA Chicago Area Waterways Use Attainability Analysis study and nutrient standard develop (projects include quantitative microbial risk assessment, epidemiological study of secondary contact recreation on waterways, habitat evaluation and restoration study, studies of non-point sources of bacterial indicators to waterways, studies to develop design criteria for effluent disinfection, full scale P removal effects on water quality in receiving stream, effectiveness of permeable pavement and development of sustainable streetscapes to reduce stormwater entry to combined sewers)
- Chair Illinois Water Environment Association Biosolids Committee
- Managing Editor, Water Environment Research (January 2007 to present)

Coordinator of Research, Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, May 2004 to March 2005

- Coordinate assignments and review work for four sections in the Environmental Monitoring and Research Division including 25 employees (Stickney & Fulton Co.)
- Coordinate preparation and administration of EM&R Division budget for seven sections and 70+ employees
- Review 80+ monitoring reports for U. S. EPA, IEPA, and IL Emergency Management Agency regulations and permits
- Manage R&D Department activities related to researching and supporting biosolids processing and use
- Serving on MWRDGC Management and Leadership Development Program Steering Committee
- Completed Intergovernmental Executive Development Program (Fall 2004- Sponsored by City of Chicago Department of Personnel and City Colleges of Chicago)

Soil Scientist III, Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, Jul. 1998-May 2004

- Manage Land Reclamation & Soil Science Section Including 17 Employees (Stickney & Fulton Co.)
- Manage U. S. EPA 40CFR Part 503 and IEPA permit compliance monitoring programs – Provide tech support on regulatory compliance for biosolids processing and use
- Design and implement research on land application of biosolids, fate of trace elements and nutrients, suitability of plant species for growth in biosolids
- R&D Department representative for biosolids marketing meetings and projects
- Serve on two project review committees for Water Environment Research Foundation
- MWRDGC Trainer - Supervisory Skills and Management Practices Program
- Serve on Advisory Board, Environmental Science Studies Program, Environmental Institute, Loyola Univ.

Soil Scientist II, Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, Jul. 1988-Jun. 1998.

- Managed Stickney Soils Laboratory (6 employees)
- Research Project Manager, projects included: NuEarth vegetable garden study, PCBs and priority pollutant uptake by corn and vegetables, study of background trace element and radionuclide concentration in Illinois soils, characterization of trace elements in street dusts and urban soils, determining phytotoxic threshold Zn concentration in grass and vegetable leaves, determining tolerance of grasses, native plants to salinity and NH_3-N; suitability for growth in biosolids, determining nature of biosolids salinity.
- Research Programs Featured in Water Quality International Jan/Feb 1998 Issue
- Served on Biosolids Marketing Committee
- Served on Committee Utilized By U.S. EPA to Revise Proposed Part 503 Regulation Prior to Promulgation
- Prepared Comments, Position Papers on all Aspects of U.S. EPA Part 503 Rulemaking
- Served On Two Project Review Committees For Water Environment Research Foundation

Post-Doctoral Research Associate, University of Illinois, Department of Agronomy, Nov. 1987-Jun. 1988

- Managed project team studying reclamation of explosives contaminated soils at Joliet Army Ammunition Plant and acquired U.S. Army Toxic & Hazardous Materials Agency certification for HPLC analysis of explosives residues.

AWARDS, COMMENDATIONS, INVITED PAPERS

- Invited to Speak at Water Environment Association of Ontario Biosolids Conference, Toronto, Canada, Oct 2007
- Invited to Speak at American Society of Agronomy Special Symposium, Indianapolis, IN, Nov. 2006
- Invited to Chair Session at WEF Biosolids Specialty Conference, Nashville, TN April 2005
- Invited to Speak at American Society of Agronomy Special Symposium, Seattle, WA Nov. 2004
- Invited to Present Seminar to Dept. Natural Resources & Environmental Sci., U. IL., Urbana, April 2004
- Invited to Speak at Central States Water Environment Association Education Seminar, Madison, WI, April 2004
- Invited to Speak before Illinois Soil Classifiers Association, Naperville, IL, February 2004
- Received Assoc. Metropolitan Sewerage Agencies Research and Technology Award, June 2001
- Invited onto Program Committee USEPA Region 5 Innovative Biosolids Use Annual Symposia, Sept. 2000, 2001
- Invited to Speak before Illinois Dunesland Preservation Society, October 2000
- Invited to Present Seminar to Dept. Soil & Environmental Sci., U. California, Riverside, March 1999
- Served on Program Committee for 4th International Conference on Biogeochemistry of Trace Elements, June 1997
- Commendation For 5 Years Service, Symposium Judge, Chicago Public Schools Science Fairs, March 1997

- Invited to Present Paper on Final Part 503 Regulations to Lake Michigan Water Analysts, January 1993
- Editor's Citation For Excellence in Manuscript Review Journal of Environmental Quality 1992
- 1st Annual Best Paper Award Presented by Illinois Water Environment Association, March 1990
- Invited to Present Paper on Proposed Part 503 Regulations to Lake Michigan Water Analysts, January 1990
- Outstanding Graduate Teaching Assistant N.C. State Agricultural Institute 1985

REPORTS, PUBLICATIONS, PRESENTATIONS

- Co-authored two book chapters
- Authored/Co-Authored 31 R&D Department research reports or comprehensive regulatory comment documents
- Authored/Co-Authored 23 research articles published in scientific journals or conference proceedings
- Presented over 50 technical papers at local, regional, national, and international conferences and meetings

PROFESSIONAL SOCIETY MEMBERSHIPS

- Water Environment Association/Illinois Water Environment
- Association Soil Science Society of America/American Society of Agronomy
- American Chemical Society

REPORTS, PUBLICATIONS, ABSTRACTS, PRESENTATIONS

MWRDGC REPORTS:

Dennison, S. G., G. K. Rijal, and T. C. Granato. 2007. Fecal Coliform Densities in the Chicago Waterway Sustem During Dry and Wet Weather 2004-2006. Report 07-79, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Zmuda, J. T., R. A. Gore, Z. Abedin, and T. C. Granato. 2006. The Effect of Secondary Sewage Treatment on the Total Numbers and Percentages of Antibiotic Resistant Fecal Coliforms in Raw Sweage Entering the Seven Water Reclamation Plants of the Metropolitan Water Reclamation District of Greater Chicago. Report 06-32, Research anc Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Hundal, L., S., A. C. Cox, P. Lindo, G. Tian, T. C. Granato, and B. Sawyer. 2005. Use of Biosolids for Establishing Vegetation at the USX Steel Mill Slag Brownfield In Chicago: A Research and Demonstration Project. Report 05-06, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T. C., O. Dennison, and G. Knafl. 2004. Determination of Phytotoxic Zinc Thresholds in Leaves of Grasses and Food and Fiber Crops. Report 04-23, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Khalique, A., A. Cox, T. C. Granato, and R. I. Pietz. 2004. Radioactivity in Biosolids-Amended Soil and Uptake by Corn. Report 04-22, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Lindo, P., A. Cox, and T. C. Granato. 2004. Biosolids Chemical Characteristics. Report 04-21, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Cox, A., T. C. Granato, C. Carlson, and R. I. Pietz. 2004. Reclamation of the St. David, Illinois, Coal Refuse Pile with Biosolids and Other Amendments: Effects on Chemical Composition of Coal Refuse, Forage and Surface Runoff Water.. Report 04-13, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Pietz, R. I., Z. Abedin, T. C. Granato, and C. Carlson. 2004. Corn Yields and Nutrient Composition During Long-Term Biosolids Applications to Calcareous Strip-Mine Soil. Report 04-12, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T. C., A. Cox, O. Dennison, and R. I. Pietz. 2004. An Investigation of Salinity in Biosolids Generated by the Metropolitan Water Reclamation District of Greater Chicago. Report 04-3, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T. C., Z. Abedin, O. Dennison, S. Zumpano, R. I. Pietz, P. Tata, and C. Lue-Hing. 2003. Trace Element Concentrations in Street Dust and Surface Soils in the Drainage Basins of the Stickney and Calumet Water Reclamation Plants. Report 03-21, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Cox, A., G. Tian, and T. C. Granato. 2003. A Survey of Characteristics of Topsoils Marketed in the Chicago Metropolitan Area. Report 03-19, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T. C., R. I. Pietz, C. R. Carlson, P. Tata, C. Lue-Hing, and G. Knafl. 2001. Mineralization of Organic Carbon Does Not Produce a "Time Bomb Effect" in Biosolids-Amended Soil. Report 01-15, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Nelson, S. N., T. C. Granato, C. R. Carlson, R. I. Pietz, and P. Tata. 2001. Elevated Nitrate-N Concentrations in Groundwater at Field 10, Fulton County, Illinois. Report 01-9, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T.C., R.I. Pietz, C.R. Carlson, G. Knafl, and C. Lue-Hing. 1999. Effect of Time After Cessation of Biosolids Applications on Uptake of Cadmium, Copper, Nickel and Zinc into Corn Leaves and Grain. Report 99-23, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T.C., R.I. Pietz, O. Dennison, P. Tata, D.R. Zenz, and C. Lue-Hing. 1998. An Evaluation of the Suitability of Grass Species and Varieties for Germination and Growth in Biosolids. Report 98-26, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Pietz, R.I., R. Johnson, R. Sustich, T.C. Granato, P. Tata and C. Lue-Hing. 1998. A 1996 Sewage Sludge Survey of the Association of Metropolitan Sewerage Agencies Members. Report 98-4, Research and Development Department, Metropolitan Water Reclamation District of Greater Chciago.

Lue-Hing, C., P. Tata, T. Granato, R. Sustich, R. Johnson, R. I. Pietz. 1998. Sewage Sludge Survey. Association of Metropolitan Sewerage Agencies, Washington, D.C.

Pietz, R. I., T. C. Granato, J. Gschwind, J.G. Anderson, D.R. Zenz, R. Hill and C. Lue-Hing. 1996. Petition to the Illinois Pollution Control Board for an Adjusted Standard to Use Air-Dried Sludge as a Substitute for Soil in the Final Protective Layer of Nonhazardous Waste Landfills, (AS 95-4). Report 96-9, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Pietz, R. I., T. C. Granato, J. G. Anderson, D. R. Zenz, R. Hill, and C. Lue-Hing. 1996. Beneficial Use of Municipal Sludge as a Final Protective Vegetative Cover on Nonhazardous Waste Landfills. Report 96-12, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Granato, T. C., R. I. Pietz, J. Gschwind, and C. Lue-Hing. 1995. Mercury in Soils and Crops from Fields Receiving High Cumulative Sewage Sludge Applications: Validation of USEPA's Risk Assessment for Human Ingestion. Report 95-12, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Pietz, R. I., T. C. Granato, C. R. Carlson, Jr., J. Gschwind, D. R. Zenz, and C. Lue-Hing. 1994. Reclamation of the St. David, Illinois Coal Refuse Pile with Sewage Sludge and Other Amendments. Report 94-12, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago, 1994.

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Webber, M. D., R. I. Pietz, T. C. Granato, R. L. Hong-You,, B.A. MacGillivray, M. L. Svoboda, and G. A. O'Connor. 1991. Organic Priority Pollutants in Soil and Vegetation from the St. David Coal Refuse Pile Reclamation Site. Report prepared for the Metropolitan Water Reclamation District of Greater Chicago, Environment Canada, Wastewater Technology Centre, Burlington, Ontario, Canada.

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Lue-Hing, C., D. R. Zenz, T. C. Granato, J. Gschwind, R. I. Pietz, K. C. Rao, and J. B. Murray. 1991. Use of Case-By-Case Permitting for Dedicated Beneficial Use Sites Under 40 CFR Part 503: A Proposal of the Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

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Lue-Hing, C., D. R. Zenz, T. C. Granato, R. I. Pietz, D. Taylor, D. Landis, R. Oberst, R. Case, and T. Garrett. 1991. Comments of the Association of Metropolitan Sewerage Agencies on the Notice of Availability of Information and Data from the National Sewage Sludge Survey and Request for Comments (Federal Register, November9, 1990 pp. 47210-47283), Association of Metropolitan Sewerage Agencies, Washington, DC.

Lue-Hing, C., D. R. Zenz, T. C. Granato, J. Gschwind, and J. Murray. 1990. Utilization of Municipal Sludge as Daily and Final Cover at Municipal Solid Waste Landfills, Response to USEPA Proposed Part 503 Sludge Regulations (Standards for the Disposal of Sewage Sludge, Federal Register, February 6, 1989, pp. 5746-5902), Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

Lue-Hing, C., D.R. Zenz, T. C. Granato, and R. I. Pietz. 1989. Comments of the Association of Metropolitan Sewerage Agencies on the Proposed Standards for the Disposal of Sewage Sludge (Federal Register, February 6, 1989, pp. 5746-5902), Association of Metropolitan Sewerage Agencies, Washington, DC.

Lue-Hing, C. , D. R. Zenz, T. C. Granato, R. I. Pietz, K. C. Rao, and J. Gschwind. 1989. Comments of the Metropolitan Water Reclamation District of Greater Chicago on the Proposed Standards for the Disposal of Sewage Sludge (Federal Register, February 6, 1989, pp. 5746-5902). Research and Development Department, Metropolitan Water Reclamation District of Greater Chicago.

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of biosolids application. Journal of Environmental Quality: 37: 1497-1500.

Oskouie, A. K., D. T. Lordi, T. C. Granato, and L. Kollias. 2008. Plant-specific correlations to predict the total VOC emissions from wastewater treatment plants. Atmospheric Environment 42: 4530-4539.

Koo, B.J., A. C. Chang, A. L. Page, T. C. Granato, and R. H. Dowdy. 2008. Assessing Long-Term Plant Availability of Biosolids-borne Heavy Metlas Accumulated in Cropland Soils. In: Proceedings of Water Environment Federation 21st Annual Residuals and Biosolids Management Conference, Philadelphia, PA.

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