

## INTERACTIVE COMMUNITY EVALUATION OF SURFACE SOIL CONTAMINANTS IN THE LEWISTON PORTER SCHOOLS

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**Abstract:** Using public participation in planning and execution and GIS methods for analysis (<http://www.buffalo.edu/~gardella/lewport>) community members collaborated with students and faculty from the University at Buffalo (SUNY) and engineers from the US Army Corp of Engineers to evaluate concerns about potential pollution on the campus of the Lewiston Porter Schools ([www.lewport.wnyric.org](http://www.lewport.wnyric.org)) in western New York. The 400 acre campus consists of five schools and a community building built on land adjacent to several sites of concern to citizens, parents and staff. These sites were developed from the former Lake Ontario Ordnance Works (LOOW), site, a 2500 acre WWII TNT plant.. Since the 1940s, the LOOW site was used for US military borane fuel plants and Nike missiles. Present uses are the Chemical Waste Management hazardous waste site and the Niagara Falls Storage Site (NFSS), for high level radioactive waste (Radium K65). The School Board asked the UB-ESI to convene a public participation process to review past studies, design and execute a campus soil sampling program to evaluate potential contamination and exposure, combine all results with other public information into GIS contamination maps for the community to understand and recommend further courses of action for the school district. Using citizen initiated historical research, community, school organizations and citizen action groups were engaged to evaluate potential radioactive and chemical pollution on campus land. The collaboration produced a sampling plan based on potential leaks or pollutant movement and exposure risk. Two limited areas of contamination were detected using GIS methods; major sources of radioactive and toxic contamination on the site were not found. A GIS public access database was developed for continued community use.

## INTRODUCTION

While space has been the fundament for all geographical enquiries for centuries, it is also true that the geographic perspective may escape many who are used to other paradigms. This lack of geographic awareness is not limited to communities of the general populace or policy makers but also pervades the academic community, which has its own paradigmatic inertia to overcome before assimilating foreign ideas and technologies. There exist a plethora of analytical contexts which will benefit immensely from conceptual and task models that depend on *geographic space* as an analytical framework for conducting social and environmental research.

In this era of IT domination, GIS holds the key to multi-disciplinary solutions of many socio-environmental problems that have so far been inadequately addressed within a non-geographic framework. As Seiber (2002) writes, Geographic Information Systems (GIS) can assume the ubiquitous role as a technology to "present a visually compelling image of an issue and quickly analyze data from disparate sources. However, GIS are such flexible technologies that they assume different roles (e.g. cartographic tools, spatial databases, decision making tools, education assets etc.) depending on the context of use. For the purpose of the study reported in this paper, we conceived GIS primarily as portals of spatial awareness—i.e., teaching general populace to appreciate that "*where-ness*" matters in most social and environmental investigations. The public, however, need not care about the specific spatial technology in use, as long as they ask the right spatial questions and maintain a healthy rate of geographic information consumption. Hence, we subscribe to the philosophy of decoupling the communication process from the technology, thus promoting task oriented discussions as opposed to technology centered planning.

In this paper, we present a surface soil contamination study that used the spatial analytical framework at all stages of analyses. As we will discuss later, previous studies conducted for the same community have not appreciated enough the power of geographic maps and spatial analysis while communicating facts and concepts to the community. In each section of this paper we focus on how we sought to increase geographic awareness at each stage of our study. The use of GIS was crucial during data collection, information analysis and communication of results. However, the noteworthy aspect of the study is not that GIS methodologies were used—rather, it is the implicit two-way communication that the local community members had with GIS through the geographic information they volunteered and also consumed, that is much more interesting. We highlight the philosophy and the details of this process in the rest of this paper.

## PUBLIC PARTICIPATION MODEL

Leitner et al. (2002) present five dimensions along which to evaluate conceptual models of GIS availability. Before we locate this study in their penta-dimensional space, we would like to assert two facts:

- a) In this study and in future studies, we do not intend to expose the community to the technology itself; our model of public participation instead focuses on *geographic information dissemination*;
- b) GIS have been criticized often by social scientists for failing to take into account qualitative data. Human discourse is inherently vague and not amenable to scientific

analysis; but as Goodchild (2002) writes it is loaded with semantic nuances that precise but rigid systems like GIS are unable to incorporate. Hence we try to incorporate both 'hard' (directly stored in GIS) and 'soft' (e.g. verbal accounts) data in our spatial analysis of community related issues. As we will see later, anecdotal evidence was in fact the backbone of our soil sampling plan.

With these facts in mind, it becomes easy to differentiate our public participation model from others in use. To use the framework provided by Leitner et al, the communication structure we depend upon can be said to have radial connectivity, since we act as the GIS expertise node, from which information radiates to other communities in the Western New York area. There is no direct interaction with GIS that we foresee for most people; however, the opportunity for people to access geographic data exists and is indeed encouraged. We believe in the community-university partnership model, and hence we prefer that people are trained to think spatially rather than be restricted by the particular GIS technology being used. The University at Buffalo is a GIS powerhouse that can support any geographic analysis demand made by the community (provided there is some ongoing collaboration between the two).

This study was initiated by the Lewiston-Porter community, based on reports of similar studies conducted by one of the authors (JAG) who is a faculty member of the University at Buffalo a founding associate of the UB Environment & Society Institute (UB-ESI). The university is therefore considered to be neutral in its assessment; the major stakeholders are the local communities with the university staff being indirect stakeholders either through contractual involvement or through academic expertise provided.

All data that are used are deemed public information, fit to be used for future analysis and for re-interpretation by other agencies. One of the emphatic concerns has been to provide unequivocal support for dissemination of geographic information in different modes so that the public is convinced of the transparency of the process and can find itself in the midst of the analysis throughout the study. We strongly believe in prolonged use of collected data, and are continually striving to emplace mechanisms that promote quick assessment of data that the community paid for in the first place. It is unfortunate that data are sometimes treated by many organizations as proprietary or too technical for public consumption. We oppose that mindset and are working assiduously to dispel such notions from both the public's and the officials' minds.

Readers are directed to the citizen participation ladder that was first proposed by Weidermann & Femers (1993) (as reported by Weiner, Harris & Craig, 2002) wherein the individual 'rungs' correspond to (lowest to highest rung):

- i) public's right to know;
- ii) informing the public;
- iii) public's right to object;
- iv) public participation in defining objectives and relevant actors;
- v) public participation in risk assessment and final recommendations and
- vi) public participation in final decision.

This conceptual ladder came to our notice after the completion of this project, but is still referred to here as it perfectly represents our own conceptual model of the role of the community in social and environmental projects carried out by outside agencies. This approach is also

reflected in the International Association for Public Participation (IAP2) Core Values (<http://www.iap2.org/corevalues>) which state:

1. the public should have a say in decisions about actions that affect their lives.
2. public participation includes the promise that the public's contribution will influence the decision.
3. the public participation process communicates the interests and meets the process needs of all participants.
4. the public participation process seeks out and facilitates the involvement of those potentially affected.
5. the public participation process involves participants in defining how they participate.
6. the public participation process communicates to participants how their input affected the decision.
7. the public participation process provides participants with the information they need to participate in a meaningful way.

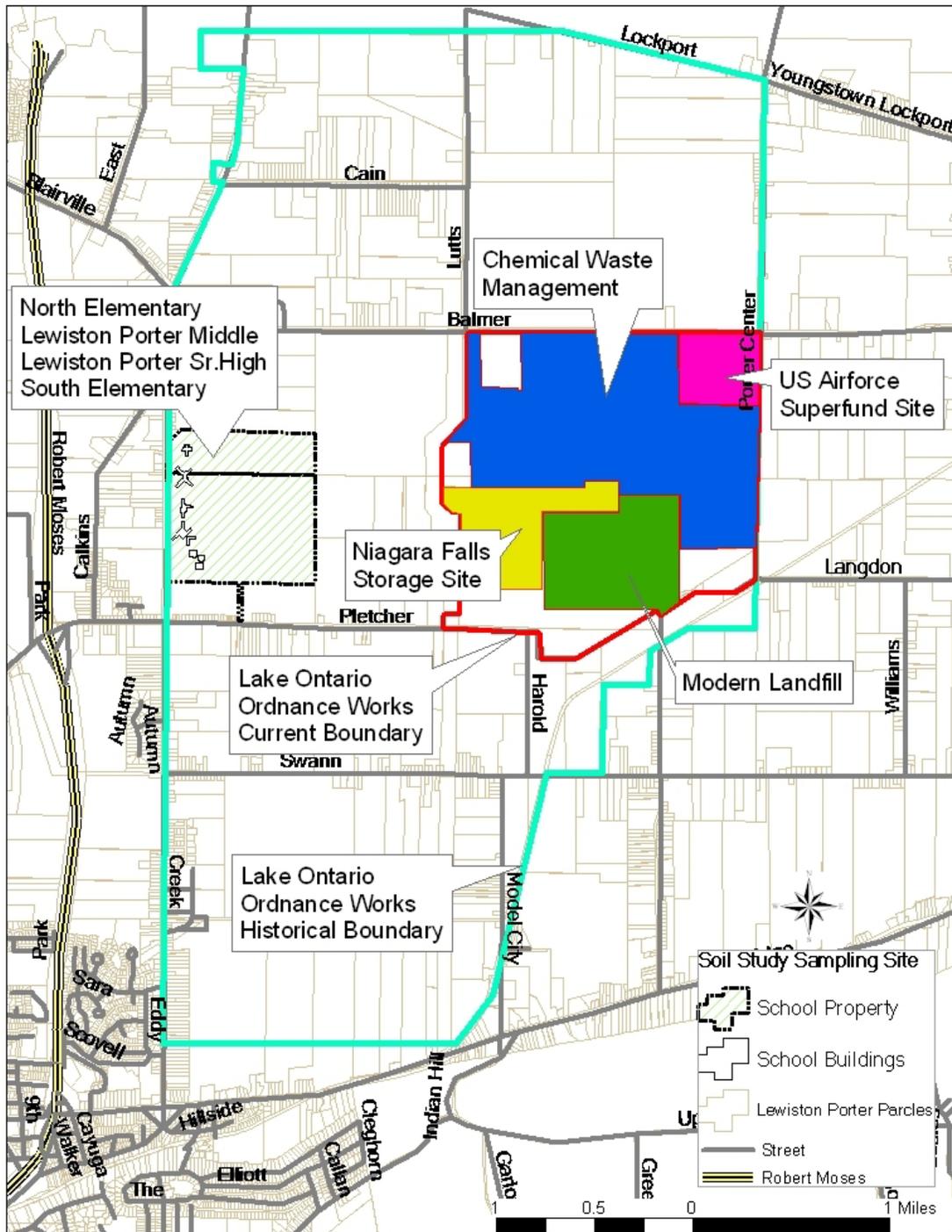
The design of the public input process in this project sought to follow these principles.

## **CASE STUDY**

### **1. Lewiston-Porter Site History**

The Lewiston Porter Schools in Youngstown (Niagara county in western NY) were built on land adjacent to several sites which were developed from the former Lake Ontario Ordnance Works (LOOW), a WWII era TNT plant that covered approximately 7500 acres (Figure 1). Since the 1940s, the area has no longer been Department of Defense (DOD) property; government and private landowners have used the property for various activities, such as high efficiency fuel plants, jet engine testing facilities, a NIKE missile facility, chemical and radioactive waste storage facilities, municipal and hazardous waste landfills, and testing of experimental communications equipment (USACE, 2002). Present uses are the Chemical Waste Management hazardous waste site and the Niagara Falls Storage Site (NFSS), for high-level radioactive waste. A large number of remedial investigations to assess the environmental impact of these waste management facilities have been conducted in the past in this area by the US Army Corp of Engineers (USACE), the US Department of Energy (USDOE), Chemical Waste Management Inc. (CWM), Modern Disposal Inc. and the Town of Youngstown. During one such investigation of the NFSS site (Pletcher Road, Youngstown), under the Formerly Utilized Sites Remedial Action Program (FUSRAP) program, the USACE (Buffalo District) performed a background gamma radiation study on the Lewiston Porter school property to obtain comparative measures of background (naturally occurring base level) radioactivity in the local area. The results of the study were interpreted to indicate that radiation levels were typical of any built property such as the school.

FIGURE 1  
LEWISTON-PORTER SCHOOL &  
NEIGHBORING WASTE MANAGEMENT FACILITIES



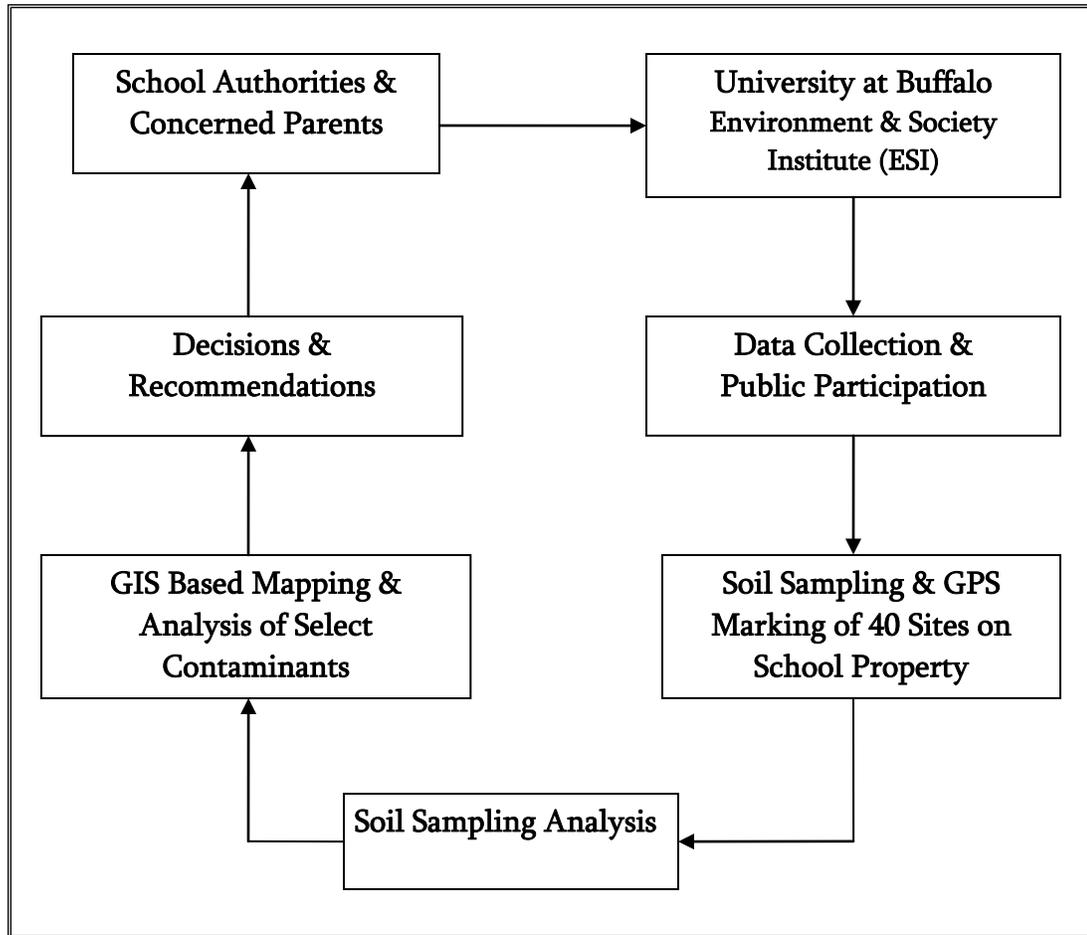
## **2. Project Introduction and Goals**

In the summer of 2003, at the request of the Lewiston Porter Board of Education, (Acting Superintendent) Don Rappold and present Superintendent Whitney Vantine, UB ESI faculty member Joseph A. Gardella Jr. prepared a plan to survey the Lewiston Porter Schools campus for potential soil contamination and to involve the public in evaluation, analysis and public outreach about the testing and results. The plan takes advantage of previous soil sampling projects accomplished by the District, and cooperation from the US Army Corp of Engineers (USACE) in coordinating results from this study with previous data taken off the campus. Public participation was managed by a stakeholders listening group, evaluating community concerns and developing plans for soil sampling. Following that consultation process, soil samples were taken from 40 spots on and near the school campus. The PI, the Superintendent and members of the Board of Education met several times and identified six tasks for the Lewiston Porter Schools project.

- 1) review the testing and results that have been done to date by the district;
- 2) survey the community with the help of a stakeholder listening group, including residents, parents, staff and teachers about specific knowledge and concerns regarding the Holmes site;
- 3) meet with US Army Corp of Engineers regarding the Lake Ontario Ordnance Works (LOOW) site and Niagara Falls Storage Site (NFSS) monitoring programs.
- 4) advise the district concerning the gaps that are presented in our knowledge and prioritize and identify the testing that should be done;
- 5) advise the district as to what labs or other parties would be appropriate for the particular testing at issue;
- 6) help interpret the results of the testing for the Board and community.

During this project, GIS truly proved to be an enabling technology by integrating modern surveying data with historical evidence and anecdotal information collected from the local residents. In the rest of this paper we present how we coupled GIS technology to promote public participation. Citizens virtually themselves developed a soil sampling plan to detect surface contaminants and then we ensured a transparent communication of results through easily interpretable thematic maps. This is novel for the community since, partly because of the technical nature of contaminant studies and partly due to monolithic traditional agency-wide regulations and personnel attitudes, none of the previous studies had considered using a public participation model for remedial investigations. Public health issues were raised by the community throughout this project but were considered outside the scope of the work, and have been a focus of follow up work. The project workflow, which will be detailed in the rest of this paper, is presented in Figure 2.

FIGURE 2  
WORK FLOW DIAGRAM



### 3. Creating Geographic Awareness

English & Feaster (2003) provide a five-step geographic enquiry setup for developing community GIS projects. We had a similar plan in that we elicited a number of geographic questions by stressing that location is an integral part of the soil sampling study. Previous studies had focused mostly on the nature of the contaminants and while they did provide schematic maps, they failed to really capitalize on the impact that intuitively made maps can have on people's reasoning. In fact, to the best of our knowledge, none of the previous studies had prepared orientation maps of the area, *prior* to the analyses. Since we believe in promoting geographic understanding in communities, we intended that people visualize the geographic setting of the campus and its juxtaposition with other sites being simultaneously investigated by the USACE.

We therefore began by creating a digital database which was populated with 2 ft. resolution satellite imagery data downloaded from the NY state GIS clearinghouse and with TIGER files (spatial data from US Census Bureau) providing property and road network information. The

high resolution images were instrumental in outlining the school buildings and recreation grounds to enable direct identification of locations of interest from maps. These GIS data were then combined with previous studies, including those done by the Lewiston Porter Schools and data from the USACE LOOW database and the Niagara Falls Storage Site (NFSS) databases. Aerial photographs (in paper form) from before 1942 were consulted to resolve claims about erstwhile waste processing establishments that could have contributed to the contamination of the site in the past.

After the preliminary round of data collection, a strategy to overlay the 2 ft. resolution satellite imagery of the school campus with property line information and prominent 'cultural' data like roads and landmarks was developed. Maps were kept simple and designed to help people visualize the school campus and its juxtaposition with other remedial investigation sites. These maps were distributed at community meetings before any consultation about the soil sampling design was made. The arrangement in Figure 3 (below) was the basis of many maps.

Once the public had been initiated with such maps, we began to conduct public meetings for collecting anecdotal evidence about the site to narrow down the geographic area of investigation and honor citizen's claims about historically polluted sites. Public participation through online and paper surveys helped generate considerable historical data about the school campus. A sense of 'place' began to emerge out of these initial map-mediated efforts, which was very instrumental in delineating the final geographic area and the preferred list of contaminants to be sampled for. The next section details our experience with the public prior to soil sampling.

#### **4. Public Consultation and Input**

After the announcement of the study at a Lewiston Porter School Board meeting in January, 2003 a contract was approved for May 2003. The stakeholders listening committee comprising parents, teachers and school board members was formed. A series of five public meetings were held in June and July to raise questions and deal with potential sampling plans for the studies. Vital information on any historical knowledge about the school campus was solicited from community members for our study. Surveys were provided at every meeting and were also posted on our website <http://www.acsu.buffalo.edu/~gardella/lewport> for public access and input. Surveys were also available at Lewiston Public Library.

These surveys were anonymous and provided important clues about where to sample for contaminants. Surveys were collated and analyzed to develop a series of questions relevant to the community at risk. We provide below a few examples of the kinds of concerns voiced in these surveys and how they affected the geographic nature of our enquiry by identifying specific areas of interest:

- i) A community member, who has been living in the area for eight years, was concerned about lead, arsenic, and mercury contamination near playgrounds and areas close to the primary and intermediate school, where she stated children frequently play. She also requested retesting of "hot spots" that the USACE identified in previous studies.
- ii) A former student referred to an outbreak of different types of cancers that staff and students developed in the summer of 1992. He believed that the outbreaks might have been a result of construction work and uprooting of contaminated soils near the North Elementary building.

FIGURE 3  
SATELLITE IMAGE & OVERLAID SOIL SAMPLING SITES



- iii) The most detailed input came from an Environmental Toxicologist and concerned parent, who was however concerned about the contamination on school campus; instead she was curious about the districts past pesticide use and in particulates from diesel fumes due to truck traffic. The range of her suggestions combined spatial, toxicological, and residential concerns. Her insight was most valuable in choosing sampling sites. She recommended that sampling be focused around areas of highest exposure to students, faculty and staff—athletic fields, playgrounds and areas where children have outdoor activities during recess. Her main concern was exposure in children who play on bare soil surfaces and their vulnerability to dermal and inhaled pesticides that the school uses during school season. She also included statements about the US Army Topographical Engineering Center's inability to positively identify, from aerial photographs, 4 anomalous mounds that were present in 1944, but not in earlier photographs taken when the land was being farmed. Her research indicates that the Department of Defense (DOD) took control of this property in 1942—two years before the mounds were photographed. Interestingly, the results of a surface soil sample taken on one of those soil mounds between the north elementary and the former primary building showed all metals at background concentration, and some elevated concentrations of polycyclic aromatic hydrocarbons (PAHs are largely the result of incomplete combustion of fossil fuels, and have multiple sources).

## 5. Soil Sampling

The surveys were useful in establishing trust between us and the local community. Carrying this trust over required that we determine the sampling sites as suggested by the community members. Sampling sites were therefore chosen by a coalition of community members during two extensive walkovers of the campus. 40 sample locations (that was what the budget allowed for) at 2” depth were subsequently distributed over all identified zones of interest (roadside, playgrounds, thickets behind the school etc.). A portable Global Positioning System (GPS) unit was used to georeference the selected sites for future mapping of results. A minimum sampling interval of 30 m was enforced by us to preempt sample location overlaps, since GPS measurements are liable to error (5-10 meters). What should be noted here is that the final choice of sites was a result of collective decision making with both citizens and us participating as partners; while we provided expertise to avoid too unscientific a choice of sites, they focused on covering the ground based on all anecdotal evidence gleaned from surveys. Previous studies could not have been said to so participatory in nature.

Point samples were collected by UB staff along with representatives from Waste Stream Technology (WST), Buffalo, NY (chosen from a lost of 3 contractors after soliciting tenders). Figure 3 (above) displays the sampling sites marked by black point symbols. Samples were immediately shipped to WST to be tested using standard EPA analysis methods for elements and metals, semi-volatile organic compounds (including polyaromatic hydrocarbons, PAHs), pesticide residues and Polychlorinated Biphenyls (PCBs). According to the USACE report (2002) *"Boron, lithium, and explosives are the DOD "marker compounds" for the investigation of the former LOOW property; i.e., the presence of these compounds, if reported, is attributable to DOD use of the property. It is known that DOD use of the property involved these compounds,*

*whereas it is believed that non-DOD entities did not use these compounds".* Therefore, boron and lithium analyses were added to the standard EPA lists of priority pollutants. To monitor residual contamination from K-65, cesium was used as a marker analyte, and added to the list of analytes.

## **6. Communication of Results**

The map of results (Figure 5) highlights one area where elevated levels of Arsenic and PAHs were detected near the northernmost building on campus, the Community Resource Center. Concentrations of PCBs and other organic compounds, such as pesticide residues, were below detection limits in a majority of samples, and were detected at trace levels mainly in roadside samples. Other priority pollutants of concern (heavy metals, organic compounds) were detected at typical soil background levels. Lithium (a marker used by the USACE for LOOW activity) was detected at various concentrations across campus, and became a second mapping project of concern to the community, as what constituted background levels is not clearly defined. Further discussion of the lithium results is provided below.

Extensive public consultation was done in the months following the release of results, to design maps of the key results. There were concerns about PCBs being deposited by CWM; however results showed that the campus had non-detectable PCB levels. Since Lead levels were high only alongside roads they were attributable to leaded gas emissions from road traffic and not considered for remediation. The areas of contamination were not located on the athletic field, which was a concern for the School Board District because they were planning on constructing a new athletic field. Interestingly the presence of Arsenic could not be attributed to the NFSS or LOOW sites; hence it was suspected that it was residue from pesticides used for an apple orchard that may have been present before the land was donated to the school. The evidence for such a farm is however not conclusive.

Mapping these results was critical for communication and determination of remediation. The results were presented in a series of maps; special care was taken to color code values to communicate the level of contamination. Maps of the study area are still posted at the site website for downloading by the public. Final reports were also posted for public review and comments. Subsequent public meetings were utilized to flesh out ideas about how to propose a remediation plan. Again, it was a public mediated decision, and not a unilateral decision by environmental chemists only. The public was also educated about clean up standards and methods so that they could understand our eventual recommendations; many of their concerns regarding action levels, contaminants at sites outside the campus and soil sampling quality were addressed successfully.

The results from the Lithium analysis are a good case example of the community participation in the follow up to the analysis results. Community members had expressed concern about the information from Lithium concentrations to the USACE. The Army Corp provided extensive databases of their analyses of soil contamination on the two sites that they monitor and other sites where they had taken data near the schools. These data were integrated into the mapping results and allowed us to determine that arsenic levels were elevated compared to the sites outside the campus.

Lithium results were important as a measure of activity on the LOOW site; yet, lithium itself is not a priority pollutant or health concern. Background levels for this element are not well

established and the USACE proposed background level had not gained confidence in the community. Thus, we set out to establish i) the background level of lithium, ii) what constituted an elevated level and iii) whether there were elevated levels on campus. The results are shown in the map below (Figure 4). A casual inspection of the map indicates a distribution of higher lithium concentrations on the eastern part of campus. But consultative meetings with the stakeholders listening group and the USACE staff and a review of existing literature established that all observed Lithium values were at background level. We concluded therefore that there was no region with elevated lithium levels on the campus. This fact combined with the lack of detection of boron and cesium, allayed concerns about K-65 or LOOW activities leaving residual contamination on the portions of campus that were analyzed.

This sustained process of community consultation, where all stakeholders received equal respect, was in strict contrast to previous meetings where the USACE after determining results just informed the community of its recommendations. Not surprisingly, because of our open approach and participatory interpretation of results, we were quite successful in building the confidence of the community through our. Moreover, the use of the maps and a permanent GIS database, created by the project, gave the community a powerful set of analytical tools for present and future use.

## **7. Conclusions and Recommendations**

UB will continue to assist the community to map out contaminated areas and consult the community on further actions needed in the remediation process. A limited follow-up soil study using GIS mapping techniques was recommended to establish the extent of current contamination levels and to plan for remediation.

1. Phase II sampling: Use radial spoke sampling design (Figure 5, below) to collect 15 geo-probe soil samples at 4 different depths totaling 60 additional geo-probe soil samples. The objectives would be to:
  - a. determine the boundaries of Arsenic contamination.
  - b. determine the depth of Arsenic contamination
  - c. sample for PCBs and PAHs at a subset of samples below surface
2. Contract with an excavation consultant to propose a remediation plan.
3. Continue public participation in remediation planning.
4. The GIS Database developed by the Lewiston Porter Soil Study project should be turned over to the RAB for updates and future community use. The University at Buffalo will house the mapping programs as a public service to the community. As the USACE Niagara Falls Storage Site (NFSS) data is updated and validated, the database will be updated for the RAB's use.

FIGURE 4  
GIS ANALYSIS OF LITHIUM CONCENTRATIONS ON AND NEAR LEWPORT SCHOOLS CAMPUS

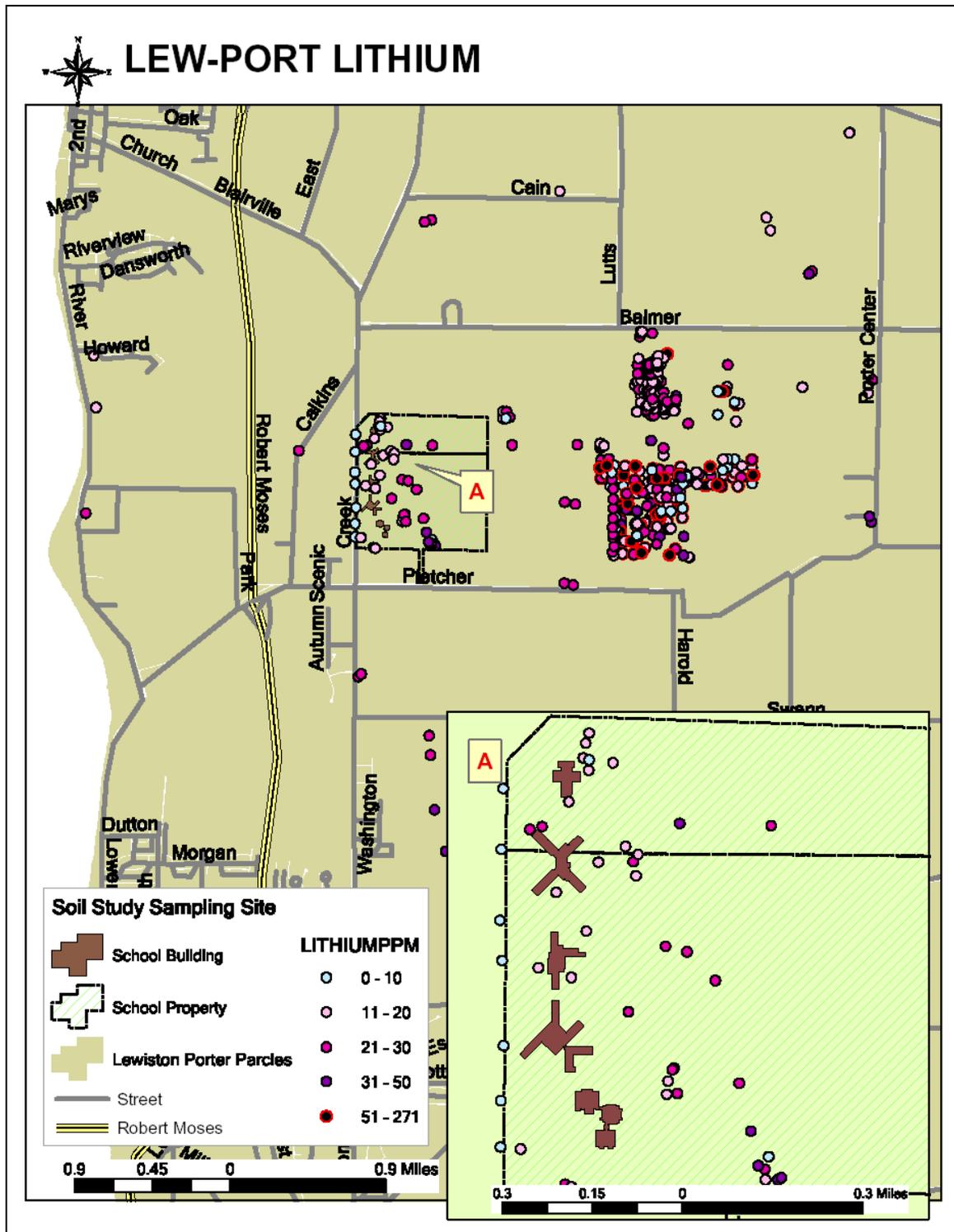
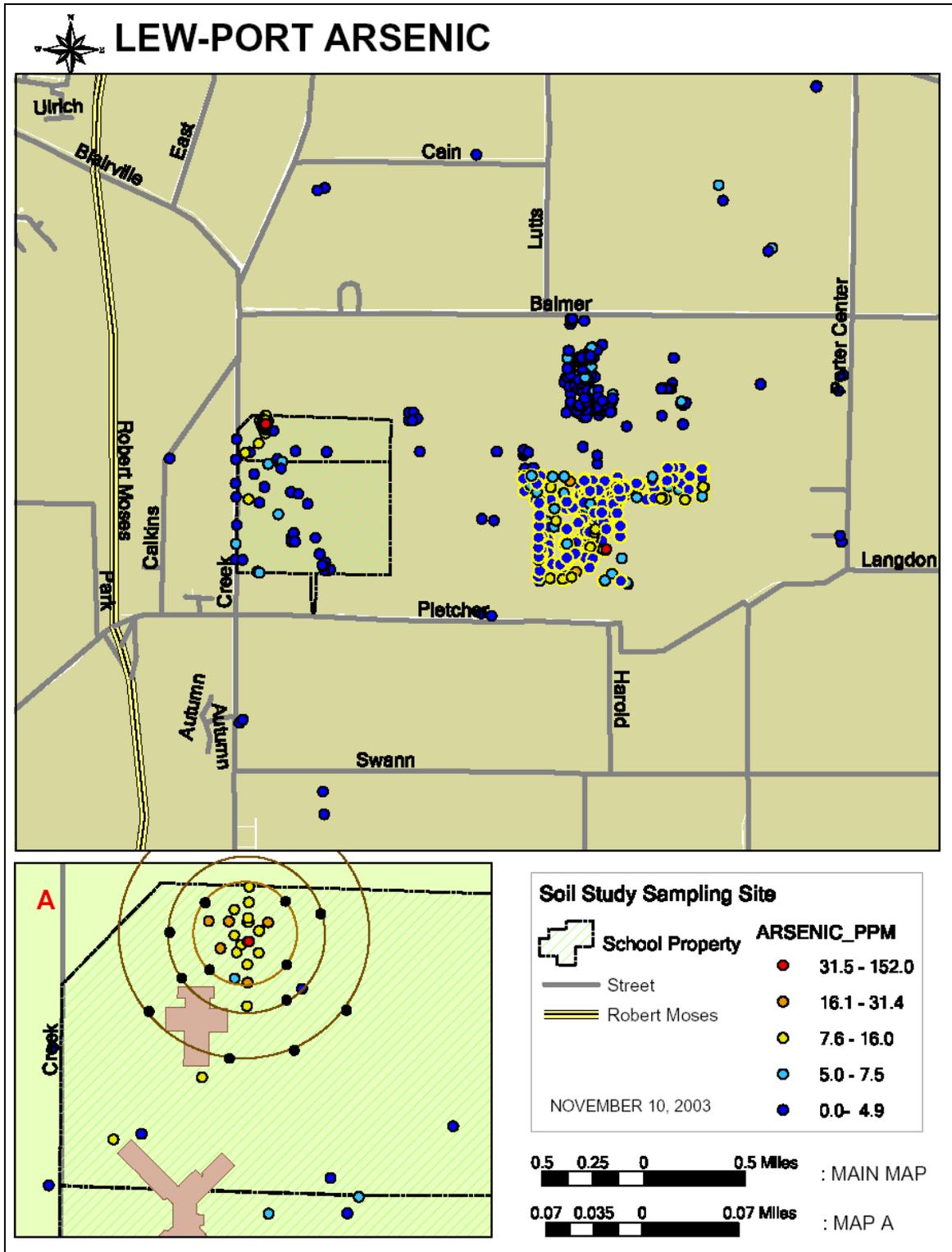


FIGURE 5  
 PROPOSED RADIAL SPOKE SAMPLING FOR PHASE II (PART A / LOWER)



## **FINAL COMMENTARY**

### **1) Public Participation**

In order for public participation to work in environmental studies, true collaboration and partnership must be accomplished between all constituents (e.g. concerned citizens, federal agencies, private corporations and other concerned parties). Federal agencies and centers of research must become aligned with the needs and desires of the community. All too often, federal agencies have been ridiculed for masking the true process of public participation. Public participation requires that the community's needs be addressed in an open, timely and organized manner. Often, the public participation process exposes two extremes—community members who are content with the status quo of their environment on one side, and on the other, skeptics with extremist views about government conspiracies and hidden agendas. In this study, it was our obligation to answer both the extremist and moderate members of the community. Our intent was to facilitate a system where open dialogue between community members and federal agencies could occur to find answers to the concerns of contamination on the school grounds. One of the benefits of having the University at Buffalo's (ESI) as a contractor in this environmental study it was deemed untainted by political ideologies; nobody stood to make personal benefits in embarking on this public participation venture. Therefore it can always serve as a neutral intermediary for the community, CWM, USACE as well as other federal and private agencies.

We were able to demonstrate through this project that public participation truly works, when residents most affected are allowed to participate in the decision-making process. The reason why dissatisfaction and lack of trust is a major concern in most environmental health issues involving public partnerships is that the affected community is not welcomed in the planning to the remediation stages of the process. The questions that the community wants answered never become the focal point of most studies. Typically, public meetings are called to announce final recommendations only. As a result, regardless of the outcome of the study, community members will not be satisfied because they were never involved in the planning stages.

The strength in our study was that members of the community were welcomed to provide any information on contaminants that they were most concerned about. Also, they were asked to provide any information on the geographic location of contaminants or historical information regarding contamination activity in the Lew-Port school property. We have created a website so that members of the community could provide us with information on-line as well as to receive the most up-to-date information regarding the progress of the project. Members of the community had the opportunity to contact the PI of the study via e-mail or by phone if they had any inquiries.

## **2) GIS and Geostatistics**

There are some important lessons while depending on GIS as our technical tool to structure the spatial decision making process. One of our initial goals was to augment our map based analysis with more objective geostatistical analysis. Since no widespread contamination was determined, we did not need to conduct such analyses. However, as we realize now, our sampling plan was not designed to support such analyses. Probabilistic geostatistical techniques like kriging depend on the spatial autocorrelation structure captured by the empirical variogram; this variogram is sensitive to the spatial sampling and gives best results when grid sampling is used (Webster & Oliver, 2001). Since it is financially prohibitive to arrange for additional samplings, in future analyses we plan to conduct preliminary geostatistical analyses of available sites to pre-determine areas of high uncertainty. It is however not necessary that previous studies will be available or the public's proposed site-list correlate with areas of high uncertainty. In that case, serious discussion of budgetary constraints, relevancy of historical accounts, personal preferences, and most importantly sampling to support spatial statistics is required. This is something that we were unable to plan for in this study but were fortunate enough to escape the consequences of –on account of background level soil contamination.

Another important point that we have learned from this study, and some others conducted in other localities, is the total apathy to spatial statistics by all agencies. As mentioned before, they are even loath to produce maps for visual communication of ideas and results. While maps are good for subjective assessment, GIS and spatial statistics form a sophisticated toolset that can be used by experts from universities or contracting agencies (community members should not be expected to master such techniques). We strongly advocate a mixture of qualitative (e.g. maps, anecdotes) and quantitative (e.g. geostatistics) methods in all environmental contamination studies (e.g. air, groundwater, soil sampling).

It should however be kept in mind that experts should not fall prey to underestimating the public's importance to such studies, as is observed when experts get involved with too sophisticated set of tools. For example, geostatistical results are notoriously difficult to interpret by even practicing experts; hence they should be pre-processed and presented at a level that does not leave the general populace dissatisfied or even suspicious. Regardless of the advancement of science and technology, if the people who stand to gain from it are left out of the loop, we cannot really hope to translate such progress into large-scale social development.

## **3) Exemplary Community Participation Level**

We conclude our paper on an optimistic note by congratulating the community in Lew-Port for its sincerity and consolidated stand. Members were very diligent in trying to find the answers to their questions. We had the pleasure to work with individuals who work for federal agencies and have children in the school district. Their altruism in providing assistance to our study definitely shows that true public participation can and does occur. The citizens in Lewiston and Porter towns have shown that when there is a problem in their community, citizens, federal and private agencies alike can mobilize for the general good of the public. The lessons learned from the Lew-Port Soil Study could become a national model for other communities, showing that true collaboration can be accomplished.

## ACKNOWLEDGMENTS

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## REFERENCES

- English, K.Z. & Feaster, L.S. (2003). *Community Geography: GIS in Action*. ESRI Press.
- Goodchild, M.F.. Foreword. In *Community Participation and Geographic Information Systems* (eds. D. Weiner, T.M. Harris & W.J. Craig), Taylor and Francis.
- Seiber, R.E. (2002). Geographic Information Systems in the environmental movement. In *Community Participation and Geographic Information Systems* (eds. D. Weiner, T.M. Harris & W.J. Craig), Taylor and Francis, pp. 153-172.
- Leitner, H., McMaster, R.B., Elwood, S., McMaster, S. & Sheppard, E. (2002). Models for making GIS available to community organizations: dimensions of difference and appropriateness. In *Community Participation and Geographic Information Systems* (eds. D. Weiner, T.M. Harris & W.J. Craig), Taylor and Francis, pp. 37-52.
- US Army Corp of Engineers (USACE-Baltimore) (2002). Report of Results for Phase II Remedial Investigation at the Lake Ontario Ordnance Works (LOOW), Niagara County, New York, Volume I, February, 2002.
- Webster, R. & Oliver, M.A. (2001). *Geostatistics for Environmental Scientists*. John Wiley & Sons, Chichester, England.
- Weidemann, I. & Femers, S. (1993). Public participation in waste management decision making: analysis and management of conflicts. *Journal of Hazardous Materials*, Vol 33, pp. 355-368.
- Weiner, D., Harris, T.M. & Craig, W.J. (2002). Community Participation and Geographic Information Systems. In *Community Participation and Geographic Information Systems* (eds. D. Weiner, T.M. Harris & W.J. Craig), Taylor and Francis, pp. 3-16.