E-Coustic Solutions
Noise Control ● Sound Measurement ● Solutions
Community ● Industrial ● Residential ● Office ● Classroom ● HIPPA Oral Privacy
P.O Box 1129, Okemos, MI, 48805
rickjames@e-coustic.com
Richard R. James
Principal
Tel: 517-507-5067
Fax: (866) 461-4103

2006 BASELINE NOISE STUDY
FOR
RESIDENTS FOR SOUND ECONOMICS AND PLANNING
UBLY, MICHIGAN
JANUARY 22, 2007

Introduction

This report presents the findings and recommendations from a study conducted to determine Community Response and Land Use Compatibility of the Noble Thumb Windpark. Data for this study was collected from three properties located near Ubly, Bingham Township, Huron County, Michigan. The study evaluated the Land Use Compatibility and Community Response to the changes that would occur in the Ubly and Bingham Township soundscape after installation of industrial scale wind turbines by Noble Environmental Power LLC. The study was conducted at the request of the Residents for Sound Economics and Planning (RSEP). Three members of RSEP offered access to their properties and residences to permit the collection of study data. The study was conducted in accordance with the methods and procedures of national and international standards for assessing Land Use Compatibility and Community Response for new sound emitters introduced into a community. These standards include, but are not limited to, the current versions of American National Standards (ANSI) S12.9-2005 "*Quantities and Procedures for Description and Measurement of Environmental Sound (Part 4-Noise Assessment and Prediction of Long Term Community Response and Part 5-Sound Level Descriptors for Determination of Compatible Land Use.*)" [1] and ISO 1996-2.2 (1987 and 2005 Draft) "*Acoustics -- Description and measurement of environmental noise -- Part 2: Acquisition of data pertinent to land use*."

Information collected at the three sites included sound level tests outdoors and inside the study participant's homes. Outdoor tests were for the purpose of establishing baseline profiles of background sounds. The study used the predicted values for post-installation sound levels from the turbines at each of these properties provided in the Site Plan Review Application to Huron County Planning Board on Behalf of Bingham Township by Noble Thumb Windpark I, LLC. This study is referred to as the 'Noble Study' in the remainder of this report. A copy of the relevant sections of the Noble study is attached.

Description of Test Sites

The Baseline Noise Study outdoors data collection was conducted over a three day period in June of 2006. The study periods were:

- the evening and night of June 12,
- the day, evening and night of June 13, and
- the day of June 14, 2006.

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[1] The author of this study (Richard R. James) was a voting member of the ANSI Accredited Standards Committee S12, Noise which provides final approval of the most recent versions of these and other ANSI standards subject to S12 oversight. S12 also provides oversight for ISO standards that may apply to the U.S.. Mr. James voted to approve the current versions of these standards.

Data was collected for the purpose of analyzing A-weighted sound levels, $L_{(10,90 \text{ and } eq)}$ statistics, and 1/1 and 1/3 un-weighted octave band sound pressure levels. Instruments were set to perform the necessary analysis and storage using one minute increments. Sampling results were collected and stored for each test period. Data was sampled and collected using Type 1, Precision Integrating Sound Level Meters (ISLM) designed for environmental monitoring in Land Use Compatibility studies and meeting all relevant ANSI standards test instruments. In addition, video and audio data was also collected to document baseline conditions. Audio data was collected using a calibrated Digital Audio Tape recorder connected to the analog output of the ISLM.

Not all data was for the purpose of establishing background sound levels for Land Use Compatibility. Additional data was collected inside the residences of the study participants for the purpose of establishing a baseline for interior background sound levels and to assess current low-frequency sound levels (infrasound) inside the homes. Interior sound testing was conducted in June and November of 2006. This data is peripheral to this report.

Weather conditions on all three days were partly cloudy with winds out of the East Northeast. Conditions were very good for collecting background sound levels. Weather was overcast with a light breeze 6-10 knots. The temperature was in the low 60's with cooler weather in the evenings and nights.

- Monday was mostly sunny with a high temperature of 74.
- Tuesday was partly cloudy with temperatures ranging from a low of 54 to a high of 77.
- Wednesday was mostly sunny with the temperature ranging from a low of 57 to a high of 76.

Site 1. (The Nowak farm: Located just north of Ubly on N. Washington St. on the west side of the road (Highway 19)).
Meter location was in the backyard of the house between the barn and the cornfield. Data collection was conducted on the afternoon of June 13. Wind speed was 4-10 mph from the East. Data was also collected beginning at 7:56 pm for evening conditions. The wind speeds were 2-5 mph from the East-Northeast. At 8:39 pm the winds were reduced with periodic gusts of 2-4 mph from the East-Northeast. At 11:10 pm the overnight test was started. Instruments were collected and read-out in the morning of the 14th.

Site 2. (The Tabaczynski residence: Located approximately one mile north of Ubly on the west side of Highway 19 in a residential development.)
Winds were East Northeast 3-9 mph. Sampling started in the late afternoon of June 13. At 6:48 pm the wind speed was 3-6.5 mph. Sampling for evening and night conditions started at 10:04 pm on June 13, 2006. The winds were 1-2.5 mph from the East Northeast. Wind speed and direction was also checked at 10:05 pm, and at 10:55 pm. There were no changes in direction or speed. Instruments were collected and read-out in the morning of the 14th.

Site 3: (The Weber farm: Located west of Verona Road just west of the Bingham Township line.)
Sampling started at Site 3 on the evening of June 12. Winds were similar to the other two study sites. The study was completed on June 14, 2006 with follow-up daytime sampling at Site 3.

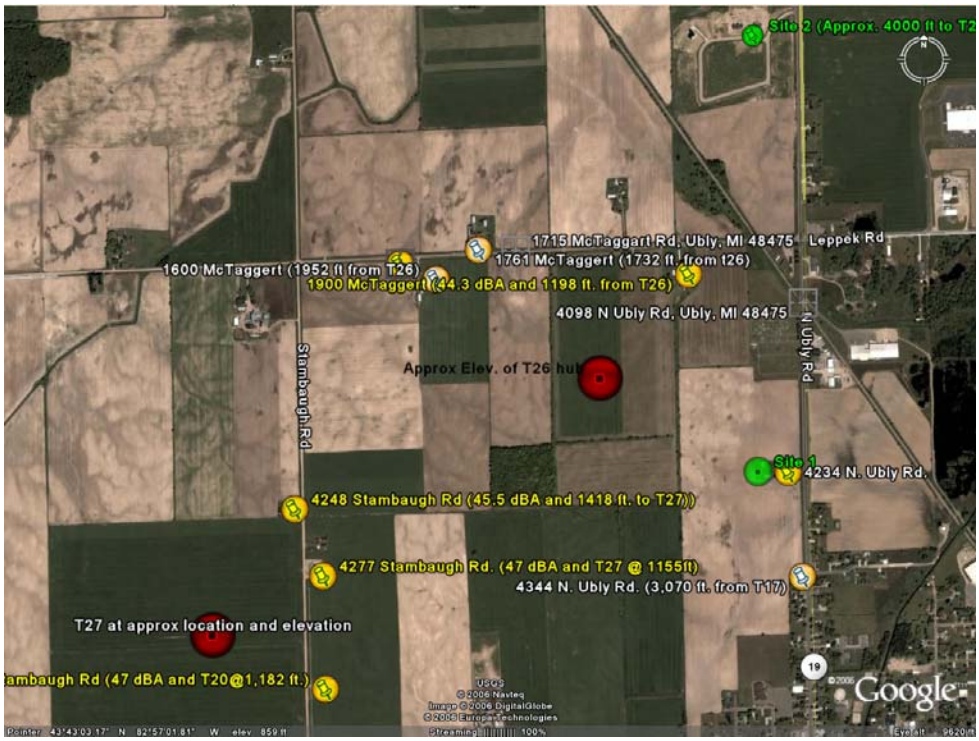

Figure 1-Overview of Test Sites 1 and 2 showing approximate location of wind turbines and predicted sound levels from Noble Study.

Figures 1 and 2 show the locations of the test sites (green), the approximate location of turbines (red), and predicted sound levels from the Noble Study submitted to Huron County as part of its permitting process.

Figure 2-Site 3, 3901 Verona Rd. looking west across Verona road towards approximate location of nearest turbine.

Siting Guidelines in Michigan

When contemplating new standards for wind turbines in the State, Michigan's Energy Office asked Lawrence Technological University to research the noise issue and present their findings to Michigan's Wind Working Group. This study group included representatives of many different interest groups in Michigan, but did not include any members with expertise in community noise or acoustics. In spite of this limitation the group did produce useful recommendations for the State and should be considered a resource for communities considering installing wind turbines. They submitted it to the State with the recommendation that the State seek the assistance of an acoustical expert to implement the suggestions. Unfortunately, the State did not follow this guidance and issued the: "Michigan Wind Energy System Siting Guidelines" which was distributed to counties and townships in Michigan. A copy of draft #8 of this document which was issued October 12, 2005 is included as an attachment to this study. The State guidelines are very similar to the "Huron County Wind Energy Conversion Facility Overlay Zoning Ordinance" with respect to sound level limits and guidelines. A copy of the Huron County Ordinance is also attached.

The sound levels and procedures in the State and Huron County documents are seriously flawed. They do not follow the recommendations of the Lawrence Tech study group nor do they follow generally accepted methods used by acoustical experts. The upper bounds of acceptable sound levels from the turbines are set extremely high and standard acoustical definitions are altered to make it easier to meet the sound level requirements. But, as a gauge of how lenient the guidelines in the Michigan and Huron County ordinance are with respect to sound emissions, if the full latitude permitted in the ordinance was used by the proposed Windpark, the soundscape in Ubly and the adjacent areas of Bingham Township would be noisier than most dense urban communities at night. Considering that Bingham Township and much of Huron County is rural these guidelines are inappropriate in that they do not account for the quieter background soundscape in rural areas nor do they account for the "…. greater expectation for and value placed on "peace and quiet" in quiet rural settings. In quiet rural areas, this greater expectation for "peace and quiet" may be equivalent to up to 10 dB."[2]

Study Concepts

The process of assessing community response to a new source of sound uses sound level data collected from the affected properties to define the existing soundscape. Once these values are known they are converted into a single number descriptor (L_{dn}) that is used to benchmark the soundscape against other communities. Predicted sound levels from the new source of sound (turbine sound levels from the Noble Study) are then introduced into the process and the difference between the current and proposed soundscape used to assess how compatible the new sound source will be after it is implemented. The ANSI and ISO standards used to determine Land Use

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[2] ANSI S12.9 (2005) Appendix F states:

F.3.4.1 In newly created situations, especially when the community is not familiar with the sound source in question, higher community annoyance can be expected. This difference may be equivalent to up to 5 dB.

F.3.4.2 Research has shown that there is a greater expectation for and value placed on "peace and quiet" in quiet rural settings. In quiet rural areas, this greater expectation for "peace and quit" may be equivalent to up to 10 dB.

F.3.4.3 The above two factors are additive. A new, unfamiliar sound source sited in a quiet rural area can engender much greater annoyance levels than are normally estimated by relations like equation (F.1). This increase in annoyance may be equivalent to adding up to 15 dB to the measured or predicted levels.

Compatibility and Community Response to a new sound source are developed from many years of acoustical studies conducted for other communities and how the people in those communities reacted to the new source of sound. They are also constantly updated to account for new findings.[3] The ANSI and ISO standards provide methods to adjust the findings from the study sites to another community (in this case Ubly) for which the community response is desired. Using the methods and tables of correction factors in the standards it is possible to predict how the people in the community will react to new sounds.

Some of the technical terms used in assessing community response to sounds are provided in the following table. These were taken from the Lawrence Tech documents and are in general agreement with ANSI and ISO standards.

Table 1
Commonly Used Indicators And Their Meanings

Indictor		Meaning		Comments
Lmax		The maximum sound level measured.		Usually expressed in dBA_{max}
Leq		Equivalent continuous sound. An average sound energy for a given time		The average of the time-varying sound levels measured. It is not the arithmetic average.
L10		Sound level exceeded 10 percent of the time. Generally considered to be the sound level that will annoy most people.		This is very similar to the value used in the Michigan and Huron County Ordinance for establishing 'ambient' sound levels. Used in this study.
L90		Sound level exceeded 90 percent of the time. Generally considered to be a measure of ambient background noise.		This is the value used to evaluate 'ambient' sounds in ANSI and ISO standards.
Ldn		Day-night average sound level, or the average sound level for a 24-hour period		Computed using sound levels from day, evening and nighttime ambient background sound levels. Used in this study.

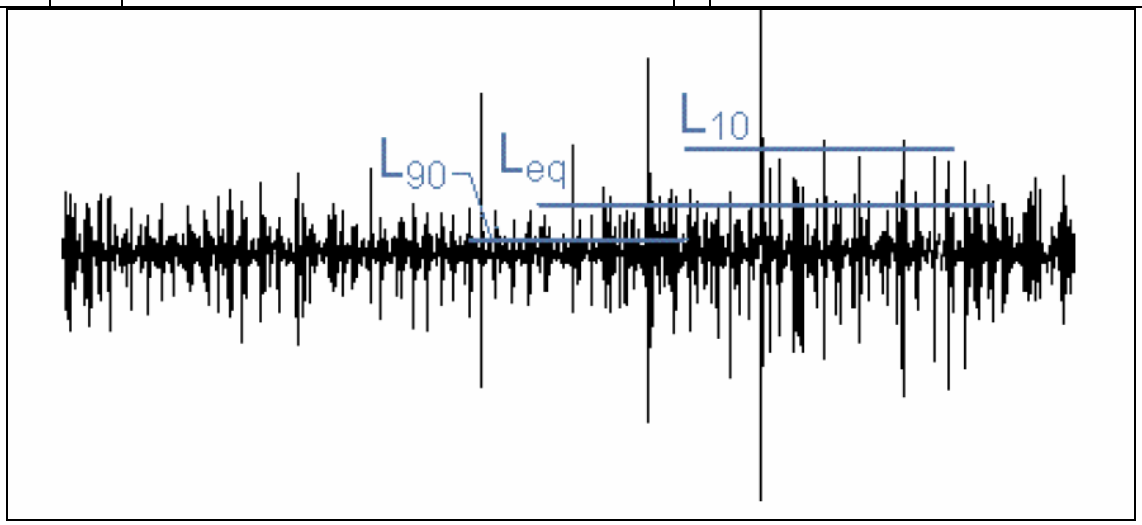


Figure 3 shows how sound levels vary over 1.5 minutes, and shows the relationship between L_{10}, Leq, and L_{90}.

[3] It should be noted that the Noble study used the 1971 and other early versions of these standards, not the current standards. The early standards were more lenient than current standards and thus under-predict community annoyance.

Study Findings

The study found that the existing background (ambient) sound levels (L_{90}) at all three sites were significantly lower than the sound levels reported in the Noble Study. For the purpose of a Land Use Compatibility and Community Response analysis the background (ambient) sound levels are those sounds that are part of the natural soundscape for each of the sites. If the new sound is transient then it is appropriate to include other transient sound sources in the calculation of L_{dn} especially if they are frequent enough to create a quasi-steady state condition often referred to as 'Urban Hum.' However, in a quiet rural community where the short term (transient) sources of sound are not sufficient to create this effect and the new source of sound will also be steady state when operating, short term events are usually excluded. This is because most of the time the rural and small town soundscape is composed of naturally occurring sounds of nature. These sounds form a steady background that is present whenever a transient sound does not mask it. Since the nature of the new source of sound (wind turbines) will be relatively steady during its operation it is appropriate to judge it against the steady background ambient.

The sounds of the turbines, at locations where they are louder than the naturally occurring sounds, will become the dominant sound in the soundscape during the times when sounds of vehicles and other sources of short term sounds are not present.

Table 2-Study Findings for Test Sites and Calculated Ldn for each Site

Site	Description	dB(A) Ambient (Huron County*) L(day)	L(evening)	L(night)	Baseline L_{dn} (1)
Site 1	Farm-North Edge of Ubly	33	33	29	36.3
Site 2	Residential-Sub-Division	32	31	27	34.6
Site 3	Farm-Rural	32	24	23	32.4

*Data in this chart is based upon reviewed and selected field data. Final values are the ambient sound levels for day, evening, and night periods calculated as defined ANSI S12.9 and ISO 1996. Data that was excluded was: (1) collected for a different purpose; (2) contained artifacts created by people or activities in the vicinity of the data collection instruments; or (3) contained data caused by non-typical events including vehicle and airplane pass-bys.

Table 2 shows the results of the June 2006 tests. The day. evening and nighttime sound levels that create the ambient soundscape were included in the test data and the data processed to yield a single number representing each of those time periods. The table also shows the computed Day-Night Level or L_{dn} which is used in the next step to determine community response. It should be noted that the L_{dn} values may be higher than the day, evening and nighttime ambient because the calculation places a 10 decibel penalty on nighttime sound to account for people's greater expectation of quiet at night.

The findings of this study showing daytime and evening ambient sound levels in the 31 to 33 dBA range and nighttime levels in the 23 to 29 dBA range are at variance with the sound levels reported as the existing sound levels in Bingham township area by Noble. Noble's study (Tables 3 and 4 included in attachment) shows daytime sound levels at sites deemed to be noise sensitive ranging from the low 40's to mid 50's (dBA (L_{eq})). Night time sound levels are shown as being in the low 30's to mid 40's (dBA (L_{eq})). One explanation for this difference is that the Noble study was reporting average sound levels (L_{eq}) which included the effects of transient sounds and not the ambient background (L_{90}) sounds as would be used in studies that comply with recent versions of ANSI and ISO standards. This difference is significant in that it permitted Noble to draw the conclusion that noise would not be a significant issue when the turbines are installed.

Using the data from the study and the procedures in ANSI S12.9 to adjust the L_{dn} for the presence of the wind turbines and community characteristics results in the data shown in Table 3.

Table 4
ANSI S12.9 Adjustments for Community Characteristics and Predicted Sound Levels of Wind Turbines

Site	Description	Baseline L_{dn} (1)	Predicted Turbine Noise (Noble Data) (6)	ANSI S12.9 Correction Factors (2)		L_{dn} with Turbines at Predicted Sound Level (5)		Perceived Change dBA
				Unfamilar Sound Correction Factor (3)	Rural Correction Factor (4)			
Site 1	Farm-North Edge of Ubly	36.3	41.3	5	10	**62.7**	L_{dn}	**26.5**
Site 2	Residential-Sub-Division	34.6	No Data	5	10	No Data		No Data
Site 3	Farm-Rural	32.4	43.2	5	10	**64.6**	L_{dn}	**32.2**

(1) Ldn=10*LOG10((1/24)*(15*10^((Ld+Cf)/10)+9*10^(((Ln+Cf)+10)/10)))

(2) Per ANSI S12.9-2005 Part 4: Quantities and Procedures for Description and Measurement of Environmental Sound- Part 4: Noise Assessment and Prediction of Long-Term Community Response. Annex F-Estimated percentage of a population highly annoyed as a function of adjusted day-night schedule.

(3) F.3.4.1 In newly created situations, especially when the community is not familiar with the sound source in question, higher community annoyance can be expected. This difference may be equivalent to up to 5 dB.
(4) F.3.4.2 Research has shown that there is a greater expectation for and value placed on "peace and quiet" in quiet rural settings. In quiet rural areas, this greater expectation for "peace and quiet" may be equivalent to up to 10 dB.

(5) F.3.4.3 The above two factors are additive. A new, unfamiliar sound source sited in a quiet rural area can engender much greater annoyance levels than are normally estimated by relations like equation (F.1). This increase in annoyance may be equivalent to adding up to 15 dB to the measured or predicted levels.

(6) Noble Study Tables of predicted sound levels.

Using Noble's predicted average sound levels the introduction of the turbines will increase ambient sound levels by 10-15 dBA or more for residents close to town or main roads (Sites 1 and 2) during the evening and night time; and 15-20+ dBA or more for the residents who are in the more rural areas (Site 3). Since the current regulation permits sound levels of 50 dBA and the predicted sound levels in Noble's study are for a 1.5 MW turbine there is nothing in the current regulation that would prevent Noble from installing larger turbines and bump the sound emissions up to the 50 dBA limit.

Noble's assertion that the turbine sounds may be at least partially masked by wind noise are true. But it is not true for low wind speeds or when high wind gradients are present. The data collected

for this study was during wind conditions of 3-9 mph. So the rustling of leaves, etc. that would mask the WTG was included in the samples. According to several sources, surface winds of 3-9 mph would have been sufficient to power the WTG's because the wind speed increases considerably at the height of the hub and blades over what is measured on the ground. This is truer at night when winds tend to decrease considerably at ground level, but remain adequate at the blade height to power the turbines.

There is also a condition that occurs when temperatures at the ground level are different from the temperature at the hub/blade height where the sounds of the turbine and its blades are directed downward toward the ground. This condition would make the sound levels at the residence higher than Noble's predicted values.

Nighttime levels in the homes are expected to be in the low to mid 20 dBA range based on the tests conducted inside the residences of the study participants. The turbines would set the outdoor background sound levels approximately 20 dB higher (steady sound of 40-45 dBA) than the naturally occurring nighttime sounds and thus could cause sleep interference. This would be especially true for people who leave windows open in the evening and nighttime.

Conclusions

Community Response

Based on the analysis presented in Table 4 it would be expected that over 10% of the community in Bingham Township or in adjacent townships that are affected by the turbines would be 'Highly Annoyed.' A much higher percentage would be 'Annoyed.' This would be a serious 'cost' to the community in terms of interpersonal relationships as well as dollars.

This is the classification that indicates the high expectation of law suits against the utility, landowners who have leased land for the turbine installations and against local governmental agencies. By way of comparison, the community would perceive the noise from the turbines as being in the same category as a busy urban commercial district or residential areas adjacent to interstate highways.

Land Use Compatibility

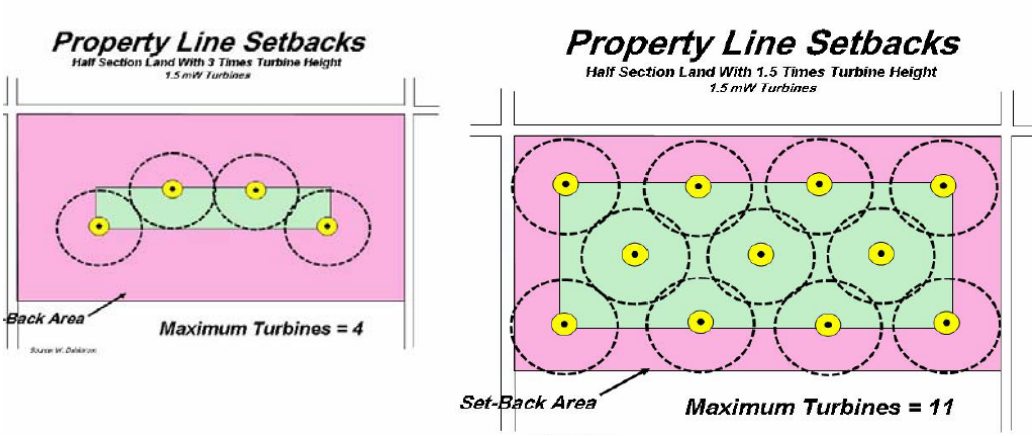
Based on the findings the Wind Park as proposed by Noble is not compatible with the community.

Recommendations

1. The sound level limits given in the Huron County Ordinance should be reconsidered in light of the incorrect use of sound level descriptors and limits. The day and night time limits should be based upon an independent study of the ambient background sound levels in the community and not upon an arbitrary level such as the 50 dBA level provided in the Ordinance.
    a. the regulation be changed to read that the turbines cannot exceed the ambient sound level (L_{90}) plus 5 dBA or 50 dB whichever is less, during the evening and night hours. This limit would apply to any operating or weather condition at the nearest non-lessee property line.
    b. The provision for tones should remain but be benchmarked against the new definition of ambient conditions.

c. Ambient levels should be defined as the L_{90} statistical descriptor and determined for both daytime and nighttime conditions at all sites that may be impacted by the WindPark turbines.

2. Alternate Siting arrangements for the turbines should be considered and if possible mandated in the ordinance that condense the turbines into smaller areas with buffer zones to protect adjacent property owners from the negative effects of the turbines. The shot-gun approach for Siting used in Bingham by Noble scatters the turbines over the township. Most other Wind Farms place the turbines in a line or arrays as shown below:



This reduces the number of people who are adversely affected.

3. The ordinance should have provisions for landowners who are adjacent to turbines but did not enter into the lease arrangement to challenge the siting and enter into a separate legal agreement permitting the sound levels. The Wind Park will change the nature of the community and the people who are adjacent deserve a voice in the process and if they do accept the negatives they should have a legal agreement that binds the utility and the receiving landowner that passes on to future landowners.

This concludes the report.

By:

Richard R. James, INCE
Principal Consultant
January 22, 2006

Attachments