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CRANDON PROJECT

DIRECT TESTIMONY OF EXXON WITNESSES

BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

APPLICATION OF EXXON CORPORATION FOR PERMITS TO BUILD AND OPERATE AN UNDERGROUND MINING AND ORE CONCENTRATING COMPLEX LOCATED IN FOREST COUNTY, WISCONSIN	IH-86-18

VOLUME III

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TESTIMONY OF DR. GERALD J. LAUER

PART II: SURFACE WATER BIOLOGICAL IMPACTS

Q. Dr. Lauer, in your earlier testimony you provided us with a baseline description of the surface waterbodies in the vicinity of the proposed Crandon Project mine. What will be the subject of your testimony today?

A. I will discuss the potential impacts of the construction and operation of Crandon Project facilities on the streams and lakes in the Crandon Project area. My testimony will cover several subjects. First, I will discuss the potential impacts on aquatic life resulting from the actual construction of Crandon Project facilities. Second, I will discuss the potential impacts on aquatic life resulting from changes in the net water quantity in area lakes and streams caused by mine dewatering. Third, I will assess the potential changes in the quality of the water in area lakes and streams resulting in the discharge of treated mine water to Swamp Creek and the discharge of ground water into various creeks and lakes pursuant to Exxon's Hydrologic Impact Contingency Plan.

Q. Dr. Lauer, what do you mean by changes in the "net water quantity" of lakes and streams?

A. As you have already heard from Dr. Djafari and Mr. Schroeder, the dewatering of the mine will lower the ground water table in the immediate vicinity of the mine and will create the potential for reducing the flows of certain area creeks and streams and lowering the levels of several lakes in the area. As Mr. Schroeder has discussed, however, Exxon has proposed various measures to ensure that the flows of creeks and streams and the surface elevations of lakes do not decline below certain specified levels as a result of mine activities. These proposals are set forth in Exxon's Hydrologic Impact Contingency Plan. When I refer to impacts on aquatic life resulting from changes in the "net water quantity" of area waterbodies, I mean impacts that might result with Exxon's Contingency Plan in place and assuming that the various contingency measures are implemented.

Q. Dr. Lauer, before proceeding with your analysis, would you briefly review the scope of your evaluation work and your assessment of the baseline conditions with respect to area lakes and streams?

A. Yes, sir. Exxon requested that EA compile information on the baseline conditions of surface waterbodies and aquatic life in the vicinity of the proposed project sufficient to serve as a basis for assessing potential impacts resulting from the construction and operation of the proposed mine/mill project.

Under my direction, EA staff gathered baseline information on the physical, water quality, and biological characteristics of these waterbodies. In order to evaluate impacts, we also reviewed and considered those aspects of project construction and operation, including the Reclamation Plan and Hydrologic Impact Contingency Plan, that are relevant to the waterbodies in the vicinity of the proposed project. These waterbodies are shown in EXHIBIT 243. They include Skunk Lake, Duck Lake, Deep Hole Lake, Little Sand Lake, Oak Lake, Rolling Stone Lake, Hemlock Creek, Swamp Creek upstream and downstream of Rice Lake, Hoffman Spring and Creek, Creek 12-9, Martin Spring and Creek 11-4, and Pickerel Creek.

Q. Dr. Lauer, let us first explore the potential impacts on aquatic life related to the construction of Crandon Project facilities. What are the potential impacts?

A. There is some potential for impacts resulting from several discrete construction activities. However, I should emphasize at the outset that the mine/mill site and the Mine Waste Disposal Facility and its neighboring facilities will be situated far enough from streams and lakes in the area so that direct impacts associated with onsite construction will be negligible. For example, one of the criteria used to select the mine/mill site was that it be at least 1,000 feet from any lake.

Some impacts are possible, however, as a result of sedimentation and turbidity associated with the following Exxon construction activities: laying the water discharge pipeline to Swamp Creek and installing the discharge structure adjacent to Swamp Creek; building the access road from State Highway 55 to the mine/mill site; building the railroad spur from the existing Soo Line to the mine/mill site; and installing various contingency facilities such as water discharge pipelines and discharge structures.

Q. Let us examine these areas of possible concern one at a time.

First, what are the potential impacts to Swamp Creek resulting from the installation of the water discharge pipeline and discharge structure?

A. The potential impacts on Swamp Creek from installation of the water discharge pipeline and discharge structure are excavation of the stream bank to install the discharge structure, and the potential for siltation of the stream bottom and increased turbidity of the water due to surface runoff. Excessive siltation on the stream bottom could adversely affect the bottom dwelling invertebrates, periphyton, and fishes in the affected area. Excessive turbidity in an extensive reach might adversely affect light penetration and photosynthesis by plants, and reduce the suitability of habitat for sensitive and sight-feeding fishes.

Q. What are the likelihood and scope of such potential impacts?

A. We believe that any such impacts would be negligible. Let me here refer to EXHIBIT 305, which illustrates the water discharge pipeline and the discharge structure. As you can see, only a small amount of land will need to be disturbed to lay the pipeline. As Mr. Schroeder testified earlier, Exxon has committed to use temporary erosion-control measures such as sheet piling, straw, and filter fabric silt traps during construction to minimize erosion and sediment runoff into the stream. Following construction, the disturbed soil surface will be revegetated to provide permanent protection against erosion into the stream. Moreover, the discharge structure will be on the stream bank so no disturbance of the stream bed will be necessary. Some disturbance of the stream bed and turbidity will occur when the rip-rap is added to stablilize the stream bank at the point of discharge. However, this disturbance will be so localized and temporary that it will not appreciably affect the fish or macroinvertebrate communities in Swamp Creek.

Q. What about potential impacts resulting from the construction of the access road and the railroad spur?

A. In answering that question we need to consider both the nature of the construction activities and the degree to which organisms in Swamp Creek are sensitive to turbidity and sedimentation. With respect to the nature of the construction activities, let me here refer you back to EXHIBIT 201, which illustrates the locations of the access road and railroad spur. The locations of these facilities will ensure that the disturbance of Swamp Creek is minimal. Criteria used in selecting the proposed routes included the number of stream crossings, distance to adjacent streams, and the type of stream affected. For example, one alternative route for the railroad spur was rejected because it would require crossing Swamp Creek at three places. Similarly, one alternative route for the access road was rejected because it would have crossed two Swamp Creek tributaries in areas that provide potential spawning areas for brook trout. The sites ultimately selected for the access road and rail spur will require that two bridges be constructed over the upper reaches of Swamp Creek. Local impacts at the two stream crosses should be minimal because the bridges will completely span the stream so that the stream bed itself will not be disturbed. Moreover, the preventive and mitigative measures that Exxon will take will make it unlikely that runoff from the road bed or rail bed will be of any significance.

Q. What preventive and mitigative measures are you referring to?

A. These are rigid erosion-control measures throughout site preparation and construction that will be taken to prevent excessive erosion of silt and turbid water into Swamp Creek. These include use of appropriate combinations of slope control, diversion ditches, retention basins, berms, sheet piling, hay matting, filter fabric, rip-rap, concrete abutments, and wingwalls to control and minimize erosion. Mitigation measures include grading, seed bed preparation, and reestablishing vegetative cover for permanent control of erosion.

Q. To what extent are the organisms in Swamp Creek sensitive to turbidity and sedimentation?

A. As discussed more extensively in reports we prepared, which appear in the record as EXHIBITS 171 and 173, we identified each fish species in Swamp Creek and then, using life history data reported in the literature, classified each species as sensitive to turbidity/sedimentation, non-sensitive, or intermediate. We found that about three-quarters of the entire Swamp Creek fish community is either not sensitive or is intermediate in its sensitivity to turbidity/sedimentation. This information is summarized in Table A of Part II of my prefiled written testimony.

Similarly, about three-quarters of the community in upper Swamp Creek falls into the same two categories. Most fishes in Swamp Creek are, therefore, not sensitive to turbidity and sedimentation.

Q. What about the sensitive species?

A. The five sensitive species in upper Swamp Creek are hornyhead chub, northern redbelly dace, blacknose dace, longnose dace,

TABLE A

THE SENSITIVITIES OF SWAMP CREEK FISHES TO TURBIDITY AND SEDIMENTATION. RANKINGS BASED ON LIFE HISTORY DATA.

COMMON NAME	SCIENTIFIC NAME	SENSITIVITY*
Brook trout	Salvelinus fontinalis	S
Brown trout	Salmo trutta	S
Largescale stoneroller	Campostoma oligolepis	S
Blacknose dace	Rhinichthys atratulus	S
Longnose dace	Rhinichthys cataractae	S
Pearl dace	Semotilus margarita	I
Creek chub	Semotilus atromaculatus	NS
Hornyhead chub	Nocomis biguttatus	S
Fathead minnow	Pimephales promelas	NS
Bluntnose minnow	Pimephales notatus	NS
N. Redbelly dace	Phoxinus eos	S
Golden shiner	Notemigonus crysoleucas	NS
Brassy minnow	Hybognathus hankinsoni	NS
Common shiner	Notropis cornutus	I
Blackchin shiner	Notropis heterodon	I
Blacknose shiner	Notropis heterolepis	S
White sucker	Catostomus commersoni	NS
Shorthead redhorse	Moxostoma macrolepidotum	I
Northern hogsucker	Hypentilium nigricans	S
Central mudminnow	Umbra limi	NS
Northern pike	Esox lucius	I
Brook silverside	Labidesthes sicculus	I
Black bullhead	Ictalurus melas	NS
Yellow bullhead	Ictalurus natalis	NS
Tadpole madtom	Noturus gyrinus	NS
Yellow perch	Perca flavescens	I
Iowa darter	Etheostoma exile	I
Johnny darter	Etheostoma nigrum	NS
Rock bass	Ambloplites rupestris	I
Largemouth bass	Micropterus salmoides	I
Bluegill	Lepomis macrochirus	I
Pumpkinseed	Lepomis gibbosus	I
Black crappie	Poxomis nigromaculatus	I
Mottled sculpin	Cottus bairdi	I

* S = Sensitive, defined as highly susceptible; would be extirpated under continuous turbid conditions or if sedimentation were severe.
I = Intermediate; can withstand periodic high turbidities and some sedimentation.
NS = Not sensitive; unlikely to be affected adversely except in the most severely polluted conditions.

and brook trout. Even these species can withstand moderately turbid waters if turbidity is not severe or prolonged. They have this resistance because most streams become somewhat turbid at certain times--for example, following heavy thunderstorms or during spring snowmelt. Our greatest concern was that sedimentation caused by erosion would harm those fish and macroinvertebrate species that are dependent on and often restricted to the riffle areas of Swamp Creek. Blacknose dace, brook trout, and especially longnose dace are the best examples among the fish species. Good examples of macroinvertebrates that require such areas are the stonefly (Acroneuria abnormis), mayflies in the genus Paraleptophelbia, and caddisflies in the genus Glossosoma.

Q. What is a "riffle area"?

A. An area of swift, shallow, turbulent water flow over a relatively steep-gradient bed of gravel or boulder and bedrock substrate.

Q. What, then, is the potential for harm to these species found in upper Swamp Creek, particularly in the riffle areas you mentioned?

A. The potential is not appreciable. Selection of total-span bridge designs that will not involve construction activities in the creek, and adherence to Exxon's erosion-control plan, are sufficient measures to protect sensitive fish and macroinvertebrate species. Any effects that did occur would be localized and temporary.

Q. Could turbidity caused by construction activities adversely affect the sight-feeding fishes of Swamp Creek?

A. We considered that possibility but concluded that adverse impacts would be unlikely even if Exxon's erosion-control measures were not implemented. First, most of the fishes of Swamp Creek are not sight feeders. Second, the length of time that turbidity might reasonably be expected to occur in Swamp Creek would be short enough that negligible harm would occur to sight-feeding species.

Q. What about the possible impacts of erosion on brook trout?

A. We believe the potential for such impacts is negligible for the following reasons. First, the only potential construction-related sources of siltation in upper Swamp Creek would be to areas immediately downstream of the access road and rail spur crossings. Brook trout could avoid these areas during the short periods when such turbidity might exist as a result of construction activities. Second, the only known potential spawning site is located upstream of both the planned railroad spur and access road crossings. Construction activities would not cause any turbidity in this area. Finally, even if there were spawning sites downstream of these crossings, the likelihood that trout eggs would be smothered by sediment from erosion would be very low because of the erosion-control measures to be used by Exxon during and following construction activities.

Q. You earlier mentioned the possibility of impacts to macroinvertebrates caused by erosion and sedimentation. What are the risks of such impacts?

A. The concern here is that severe sedimentation could bury the organisms themselves or the gravel and rocks on which certain species depend. We concluded that no such impacts would occur in lower Swamp Creek because this portion of this stream is dominated by organisms that prefer and are adapted to fine-grained substrates. Should it occur, sedimentation would potentially have more of an impact in upper Swamp Creek because gravel/rock substrates and riffles are more common there. Again, however, the erosion-control methods described earlier make it very unlikely that severe erosion will occur. Moreover, any changes would be temporary and would be compensated for by the rapid reestablishment of the community via drifting organisms.

Q. Dr. Lauer, what about the impacts to other waterbodies that might result from the construction of mitigation or contingency facilities proposed in Exxon's Hydrologic Impact Contingency Plan?

A. A water discharge structure of the type depicted in EXHIBIT 305, along with a connecting pipeline to sources of water, will be installed at the shoreline of the Hoffman Spring/Creek system, Martin Spring/Creek 11-4 system, Upper Pickerel Creek, and Skunk Lake prior to dewatering activities; and, if necessary, on other creeks and lakes in the vicinity of the project as specified in the Contingency Plan.

The excavation and associated construction activities to install these facilities will result in the potential for increased turbidity and siltation in the waterbodies due to disturbance at the shoreline and erosion from excavated ground surfaces.

As with the construction activities I have previously described, however, numerous construction and erosion-control measures will be used as necessary to minimize turbidity and siltation. Construction measures may include installation of a temporary curtain wall along the shoreline between the water and the construction site, installation of concrete headwalls set back from the shoreline approximately 10 feet, with a floor in between made of rip-rap at a minimum thickness of 1 foot. Erosion-control measures to be used where feasible include silt fences and straw bales, soil mulching, and immediate revegetation.

The resultant turbidity and siltation will be temporary and limited to a localized area in each waterbody. It is unlikely that siltation will be severe enough to alter the benthic fauna beyond a very small area. In any case, most benthic species quickly reestablish themselves following such a temporary disturbance. Fish would likely move toward the area of disturbance to feed, if the disturbance were sufficient to suspend prey organisms. Thus, it is highly unlikely that construction of these mitigation/contingency water discharge structures would have any direct or substantial adverse impact on water quality, aquatic life, or recreational use of the respective waterbodies.

Q. Turning now to the potential impacts caused by the ground-water cone of depression, Dr. Lauer, how did EA go about evaluating these potential impacts?

A. Exxon requested that we assess how the net reduction in water levels would affect the water quality and aquatic life inhabiting lakes and streams in the area. We relied on the data received from Dr. Djafari and Exxon, together with waterbody-specific physical water quality and biological data, in determining the likelihood that the biota in area lakes and streams would be adversely affected by the net reductions. As part of that assessment, EA reviewed a considerable amount of the scientific literature dealing with impacts caused by reductions in stream flows and lake levels.

Our focus was on potential effects on water quality, fish, macroinvertebrates, and rooted aquatic plants. As discussed earlier in this testimony, our predictions focus on the potential impacts assuming Exxon takes the contingency measures set forth in its Contingency Plan.

Q. Dr. Lauer, with those introductory remarks in mind, I would like now to turn first to potential impacts to aquatic life in area lakes. What are the potential impacts with respect to Oak Lake?

A. Oak Lake is perched--that is, the bottom of the lake is above the ground water table, so the water level in the lake is not influenced by the ground water table. Therefore, impacts on Oak Lake from mine dewatering and depression of the ground water level are not expected.

Q. What are the potential impacts with respect to Deep Hole Lake?

A. Deep Hole Lake has a surface area of about 97 acres and a maximum depth of 10 feet. The surface elevation from April 1977 to November 1980 varied 2.1 feet (from elevation 1,605 to 1,607.1 feet above Mean Sea Level [MSL]). The highest ground water elevation was about 1,589, or 16 feet below the minimum recorded surface elevation. Seepage is outward (downward) from the lake toward the main piezometric surface.

Exxon's modeling indicates the decline in water level of Deep Hole Lake caused by mine dewatering to be 0.1 feet. This amount of reduction is small compared to the pre-construction water fluctuation of 2.1 feet. This, in conjunction with information from the literature on effects of water level fluctuations, is sufficient to conclude that no appreciable impacts would result, even without mitigation. However, the

Contingency Plan provides for replacement of water lost to increased seepage caused by mine dewatering in the range of 20-180 gpm to maintain a minimum surface water elevation of 1,605 feet MSL for December through March or of 1,605.25 feet MSL for April through November. Thus, I predict there will be no impacts to aquatic life because these are levels that the communities in the lake have already adapted to, and there will be no impacts to recreational use of the lake.

Q. What are the potential impacts to aquatic life in Little Sand Lake?

A. Little Sand Lake has a surface area of 248 acres and maximum depth of 21 feet. Water level fluctuations have been measured over a range of 2.14 feet (elevations 1,592.96-1,590.82 feet above MSL). As a result of mine dewatering, and without any mitigation, the water level is predicted to decline by 0.23 feet under average conditions and approximately 0.7 feet during dry climatic conditions. Based on a hipsographic curve prepared by Exxon, showing the relationship between surface water area and standing water volume to the full range of the depth of the lake, the decline under average conditions would cause a reduction in lake area of 2 percent and in volume of 4 percent, and under dry conditions a decline in area of 3 percent and in volume of 9 percent.

This already low potential for adverse impacts on aquatic life will be further minimized by the Contingency Plan which is designed to prevent declines related to dewatering activities below Elevation 1,591 feet MSL during July through March, and below Elevation 1,591.51 feet MSL during April through June. These elevations are well within the existing range of measured water level fluctuations for Little Sand Lake and will not result in substantial adverse effects on aquatic life or recreational use of the lake.

Q. What are the potential impacts to aquatic life in Skunk Lake?

A. Skunk Lake has a surface area of 6 acres and a maximum depth of about 6 feet. It contains no fish and poor macroinvertebrate fauna, probably because of winter kill conditions under the ice. Water surface elevation measurements range 1.78 feet (1,598.26-1,596.48 feet MSL). Ground water blended with treated mine water will be pumped into Skunk Lake to prevent decline of water due to mine activities below Elevation 1,597.01 feet MSL. This elevation is well within the previously observed range of water level fluctuations, so it is expected to prevent adverse effects of declining water level on aquatic life in the lake and associated wetlands.

Q. What are the potential effects with respect to Duck Lake?

A. Duck Lake has a surface area of 26 acres and a maximum depth of 10 feet. Measured water surface elevations fluctuate over a range of 2.02 feet (1,612.25-1,610.23 feet MSL). Duck Lake is predicted to undergo a decline in surface level of approximately 0.2 feet without mitigation during average climatic conditions and a total of approximately 2.0 feet without mitigation under dry conditions.

Contingency pumping of ground water to Duck Lake will be conducted as needed to prevent decline of the lake surface due to dewatering activities below Elevation 1,610.59 feet MSL. This maintenance of the surface water elevation well within the range of previously recorded elevations will prevent adverse effects on fish, other aquatic life, associated wetlands, and recreational use of Duck Lake. The primary reason is that the flora, fauna, and recreational uses of the lake have already adapted to lower water levels than will occur with the Contingency Plan in place.

Q. What are the potential impacts with respect to Rolling Stone Lake?

A. Rolling Stone Lake has a surface acreage of 672 acres and a maximum depth of 12 feet. Recorded surface water elevations fluctuate over a modest range of 0.89 feet (1,534.95-1,535.84 feet MSL). Rolling Stone Lake is one of several drainage lakes located around the outer periphery of the predicted ground water depression cone. Therefore, as Dr. Djafari has testified, the ground water depression cone would cause only negligible decreases in the amount of direct ground water discharge to this lake. Reduction of tributary flows to these lakes due to mine dewatering would have very little effect on water levels in the lake even without contingency flow augmentation. Implementation of the Contingency Plan for Creek 12-9, Upper Pickerel Creek, and Martin Spring/Creek 11-4 will further ensure maintenance of water levels so as to preclude adverse effects.

Q. Dr. Lauer, what sorts of declines in lake levels would have to take place before significant adverse impacts might begin to occur?

A. Water level reductions do not necessarily harm fish or other aquatic organisms. For example, many reservoirs experience fall/winter drawdowns of several to many feet each year with little or no apparent harm. When adverse impacts have occurred, they have been associated with water level reductions on the order of feet, not inches. This, of course, depends on the depth of the lake among other factors. The littoral zone, or zone of shallow water, is the area most commonly affected.

Because effects are most noticeable in shallow water areas, organisms or communities restricted to or dependent on these areas are affected more than are those found in open or deep water areas. For example, nest building species like bluegill and largemouth bass are usually the group of fishes most susceptible to lake level reductions. Similarly, rooted aquatic vegetation is susceptible because of its reliance on shallow water areas.

Q. How do those factors relate to the lakes you have discussed?

A. As I earlier indicated, Oak Lake, perched high (44 feet) above the ground water table and with underlying soils of very low permeability, is not expected to incur water level decline due to mine dewatering. Skunk Lake has no fish because of oxygen depletion in winter due to its shallow depth and muck bottom. Of the remaining three lakes closest to the mine, only Little Sand Lake has the susceptible nest building species (bluegill, pumpkinseed, black crappie, and largemouth bass) as well as northern pike, which spawns in marshes. These species appear to be limited by low pH and productivity. Moreover, the unmitigated declines in water levels due to dewatering activities would be very gradual, over a period of years, which would allow ample opportunity for these fish species, as well as benthic invertebrate species and aquatic plants, to adjust and not incur substantial adverse impacts.

Without the contingency water augmentation, Little Sand, Skunk, Duck, and Deep Hole lakes could gradually become somewhat smaller, proportional to the predicted water level declines. Some of the higher elevation wetlands around these lakes could dry out, but more new wetlands would develop as the water levels gradually receded to new stable average depths. Without contingency augmentation, the highest potential for adverse impact would be increased potential for winter kill in Duck Lake, which already has very low dissolved oxygen in winter due to its shallow depth and muck bottom. On Little Sand Lake, some boat docks might have to be extended at some of the dwellings located around the shore line of the lake. With contingency water augmentation, the potential for these adverse effects will be avoided.

Q. To summarize, Dr. Lauer, what will be the net impacts to aquatic life in the lakes you have discussed due to water level reductions?

A. The impacts will be negligible in each lake. This is because the mine-related changes in lake levels, especially with the Contingency Plan in place, will be quite small and well within the observed range of water level fluctuations prior to Project construction.

Q. Dr. Lauer, Exxon's Contingency Plan proposes that water supplements be added to Little Sand Lake, Duck Lake, Skunk Lake, and Deep Hole Lake as needed to offset lake seepage resulting from mine dewatering. What will be the nature and quality of these water supplements?

A. The water supplement to Skunk Lake will be a blend of treated mine/mill process water and ground water, in relative proportions needed to meet effluent limits established by the Department of Natural Resources to ensure that in-lake water quality complies with water quality standards. These limitations will also protect use of the lake water for animal drinking.

Supplemental water to Little Sand Lake, Duck Lake, and Deep Hole Lake will be from ground water sources. Ground water quality can be expected to vary somewhat from one location to another, as illustrated by the range of values set forth in Table B of my prefiled written testimony. The quality of all

TABLE B

WATER QUALITY CHARACTERISTICS

Parameter*	Ground-Water Quality Average (Range)	Water Quality Criteria	Avg. (Range) of Background Lake Water Conc. Deep Hole Lake	Little Sand Lake	Duck Lake
Iron	.35(<.01-1.25)		.13(.05-.42)	.04(<.01-16)	
Total phosphorus	.02(<.01-.05)		.03(<.01-12)	.02(<.01-.17)	<.03
Nitrates	.24(<.05-.59)		.05(<.01-.39)	.11(<.01-52)	<.24
Conductivity (umhos/cm)	191(122-285)		28(17-85)	27(11-59)	27
Total alkalinity	119(102-187)		5(<1-28)	2.6(<1-6)	< 3
Total hardness	123(87-152)		15(8-36)	11(4-24)	15
Total dissolved solids	156(105-219)		58(8-196)	36(2-173)	
pH (s.u.)	7.6(6.2-8.4)		6.1(5.4-6.6)	5.5(4.8-6.3)	5.0
Temperature (C)	12.8		(0-)	(0-)	(0-)
Dissolved oxygen		5.0	(1.3-14.8)	(2.5-15.5)	(0.5-13.9)
Arsenic	<.001	.29	<.001	<.001	
Cadmium	<.001	.0022	.0016	.0015	
Chromium+6 Total	<.001	.0082	<.01	<.01	
Chromium+3		.085	<.001	<.001	
Copper	<.003	.0143	.0025	.005	<.005
Lead	< .01	.0016	<.01	<.01	
Mercury	<.0001	.00015	<.0001	<.0001	<.0001
Nickel	< .01	.002	<.01	<.01	.019
Zinc	< .01	.0712	.011	.018	
Cyanide	<.001	.0104	<.001	<.001	
Silver	<.001	.00085			
Selenium	<.001	.077			

* All values are in parts per million (ppm) unless otherwise stated.

of these ground water supplements will comply with the DNR's effluent criteria.

Q. What changes in lake chemistry will result from such discharges?

A. Ground water to be used for contingency augmentation has higher hardness, alkalinity, total dissolved solids, nitrate, and pH than the water of Deep Hole, Little Sand, and Duck lakes. The temperature of the ground water is expected to remain around 45° F year-round, so it will be warmer than the lakes' waters during the winter months and cooler than the lakes' waters in the summer. The dissolved oxygen in the ground water is expected to be low, but after aeration prior to discharge is expected to be higher than the low end of the observed ranges in Deep Hole, Little Sand, and Duck lakes. Concentrations of metals in the ground water are generally as low or lower than in the waters of the three lakes as presented in Table B of my prefiled testimony.

Q. What will be the changes, if any, to the aquatic life in these lakes resulting from the use of such water supplements?

A. The lakes' water chemistry will reflect the proportional blending of ground water with lake water. All possible combinations of the ground water and lake water of the quality expected will comply with the governing water quality standards, or in the case of dissolved oxygen and pH, will come closer to compliance with water quality standards than the present condition in these lakes.

The hardness, alkalinity, total dissolved solids, and pH of the lakes' waters will be increased in proportion to the amount of supplemental ground water needed to offset lake seegage caused by mine dewatering. Total phosphorus and metals concentrations in the lakes will not change appreciably because concentrations of those parameters in the ground water are essentially the same as in the water of all three lakes. Any increase in the present pH of the lakes will improve the suitability of the lakes for most species now present and will favor support of additional species. An increase in hardness, alkalinity, total dissolved solids, and pH will also tend to <u>improve</u> the fish productivity of all three lakes. However, total phosphorus, the nutrient usually most limiting of primary productivity, will not be increased because the ground water contains similarly low concentrations as the lakes' waters. Thus the potential for a significant increase in productivity of the lakes will probably be constrained by continuing low total phosphorus concentrations.

Q. Dr. Lauer, I would like now to turn to potential impacts to springs, creeks, and streams resulting from the effects of the ground water cone of depression as mitigated by the measures set forth in Exxon's Contingency Plan. What is the potential for adverse impacts to aquatic life in streams in the vicinity of the proposed mine/mill site?

A. The Hoffman Spring/Creek system, Martin Spring/Creek 11-4 system, Upper Pickerel Creek, Creek 12-9, Swamp Creek upstream from the access road, Swamp Creek downstream from the access road, and Hemlock Creek each will receive supplemental water from ground water sources as needed to offset the effects of mine dewatering. In each case, the specified flow rate is considerably higher than the existing low flow estimates (i.e., Q7,2 and Q7,10 flows).

Low flow rates typically occur in these streams during mid- to late summer. Supplementation based on the DNR-recommended minimal stream flows by contingency augmentation considerably in excess of historical Q7,2 and Q7,10 values for each stream will eliminate all potential for adverse effects of flows lower than average to low flow conditions. The potential for adverse effects of net reductions of flows above these recommended minimal limits is negligible because the fish, invertebrates, and plant communities present in the stream have already demonstrated that they can prevail and/or soon recover from flow rates considerably lower than the recommended minimal flow rates for each stream.

Q. Dr. Lauer, your answers to my previous questions have focused on the net impacts to aquatic life in creeks and streams that might result pursuant to the implementation of Exxon's Hydrologic Impact Contingency Plan. Assume for a moment that Exxon did not implement such contingency measures. What sorts of declines in stream flows would have to take place before significant impacts to aquatic life in these creeks and streams began to occur?

A. The potential for flow reduction to adversely affect stream biota, particularly benthic invertebrates and fishes, depends on the type of stream (e.g., broad and shallow, narrow and deep, high gradient or low gradient, etc.), the sensitivity of organisms in it, and the magnitude of expected flow reduction.

With regard to stream type, we concluded that most of the streams in the project area were of the type not particularly sensitive to flow reductions because they were slow moving streams with muck and sand substrates. The only notable exception is Swamp Creek above Rice Lake, which flows swiftly and has a considerable number of riffles and rocky substrates. Thus, all other things being equal, the upper portion of Swamp Creek would be more sensitive because the riffles it possesses would be the kind of area that would be among the first areas affected by reductions in flow.

Because it is logical to assume that some species will be more susceptible to flow reductions than others, EA examined the fish and macroinvertebrate communities found in each of the six streams I have mentioned. Other scientists have found that fishes preferring riffle areas are more sensitive to reductions in flow than are fishes preferring calm waters. Species found in the six streams in the study area that prefer hard substrates and fast water are brook trout, hornyhead chub, blacknose dace, longnose dace, and pearl dace. The distribution of these five species is shown in Table C of my prefiled testimony. Of these, only longnose dace is restricted to riffles. In the study area, it is found only in Swamp Creek upstream of Rice Lake, where it is abundant in the riffle areas.

Blacknose dace, pearl dace, and hornyhead chub need gravel areas or riffles only during portions of their life. They are not restricted to riffles and therefore are not as sensitive as are longnose dace. Brook trout are often found in fast water areas but do not necessarily require riffles. For example, in

TABLE C

OCCURRENCE OF SELECTED STREAM FISHES IN THE STUDY AREA

Swamp Creek Upstream of Rice Lake	Hemlock Creek	Upper Pickerel Creek
Brook trout Hornyhead chub Blacknose dace Longnose dace Pearl dace	Brook trout Hornyhead chub Blacknose dace	Brook trout

Creek 12-9	Creek 11-4 Martin Spring	Hoffman Creek
Brook trout	Pearl dace	Blacknose dace Brook trout Pearl dace

northeastern Wisconsin, brook trout are found in lakes, and the best fishing for them often occurs in beaver ponds. Brook trout do, however, require areas of clean sand or gravel (usually where ground water discharge is evident) on which to spawn and incubate their eggs.

Based on the number of sensitive species it possesses, we concluded that the upper portion of Swamp Creek is the stream in the study area most susceptible to reduction in flow. Swamp Creek in its upper reaches also contains various macroinvertebrates (primarily stoneflies, caddisflies, and mayflies) that are sensitive to flow reduction. Hoffman Creek, because of its shallow nature and its use as a spawning area by brook trout, is also quite sensitive.

Despite the inherent sensitivity of certain fishes and macroinvertebrates, it should be pointed out that normal stresses found in stream environments, due to seasonal low flows and periodic droughts, have allowed stream fishes to develop a tolerance to a wide range of flow conditions. If they did not possess this basic tolerance, they would quickly be eliminated from most streams. Furthermore, aquatic organisms can often rebound quickly from even the worst conditions.

Q. As with the lakes, Dr. Lauer, Exxon has proposed adding ground water supplements to creeks and streams as necessary to offset water lost due to mine dewatering. Have you reviewed this proposal?

A. Yes, I have.

Q. Would the ground water supplements be compatible with the existing water in these creeks and streams?

A. Yes, quite compatible. The streams are fed for the most part by ground water, except after heavy rainfall and snowmelt when they also receive runoff of water from the land surface. When the stream flows come mostly by ground water, which is most of the time, the quality of the streams' waters and the augmented flow from ground water are nearly identical. Ground water augmentation would generally result in slightly lower total phosphorus and sulfate, and slightly higher water hardness, alkalinity, and total dissolved solids, particularly during periods when surface runoff of softer water dominates stream flows. Generally, flow augmentation would not appreciably change stream water quality. Exxon's plan to aerate the ground water supplement to 5-6 ppm of dissolved oxygen before discharge will avoid stressful low mixed concentrations during summer daytime hours, and will add oxygen above low ambient concentrations in some instances during summer nighttime hours. Addition of the ground-water supplements will tend to raise stream water temperatures somewhat during winter months and lower stream temperatures somewhat in summer months, commensurate with the effect of present ground water seepage to the streams.

Q. What are the potential impacts, if any, to aquatic life in these creeks and streams resulting from the proposed discharge of ground water supplements?

A. The potential effects are so small that they cannot be discerned appreciably beyond the area required for complete mixing.

Q. Dr. Lauer, have you assessed the potential impacts resulting from Exxon's proposed discharge of treated mine water into Swamp Creek?

A. Yes, I have.

Q. Where will that discharge occur, and what is the nature of the proposed effluent?

A. The proposed mine/mill complex will discharge treated mine water to Swamp Creek by way of a pipeline that will discharge at the location shown in EXHIBIT 101. The flow rate of this discharge is expected to average 1,300 gallons per minute (2.9 cfs) with a maximum of 2,000 gallons per minute (4.46 cfs). Most of this flow will consist of ground water seepage pumped to the surface to prevent flooding of the mine. The remainder will be process water. This water will be treated prior to discharge into Swamp Creek. Exxon designed the treatment process to ensure that the effluent limits for Swamp Creek which have been specified by the DNR will be met. These limits were developed using recognized procedures designed to protect the aquatic life that exists in the creek.

Q. How will the chemical quality of the proposed effluent compare with the effluent limits provided by the DNR?

A. The chemical quality of the proposed effluent complies with water quality criteria and daily maximum and 30-day average effluent concentration limits established by the DNR for each parameter, as shown in Table D of my prefiled written testimony.

Q. Do any of the parameters you have discussed warrant special consideration from the standpoint of potential impacts to

TABLE D
COMPARISON OF CHEMICAL PARAMETERS OBSERVED IN SWAMP CREEK WITH THOSE IN THE PROPOSED MINE/MILL EFFLUENT AND WITH EFFLUENT CRITERIA LIMITS DERIVED BY THE WDNR

	Column 1 Ranges of Concs. in Swamp Creek 1982-1984	Column 2 Proposed Mine/Mill Effluent Daily Avg.	Water Quality Criteria and Effluent Concentration Limits Daily Maximum	Monthly Average at Qe 1,300 gpm	 1,301-2,000 gpm
Water temperature	32-84.6 F	32-65 F	89 F	NV	NV
Dissolved oxygen ppm	1.1-12.2	5-6	≥5.0	NV	NV
pH (units)	6.2-7.9	7.5	6-9	NV	NV
BOD	<1-2.9	<20	NV	20 summer 40 winter	15 summer 30 winter
Hardness	92	400			
Sulfate	5.2	410			
Total dissolved Solids	88-198	700	1,210/ 1,000	NV	NV
Arsenic	.0017 (.0002-.002)	0.05	1.48	.626/.663	.508/.533
Barium	.012 (<.005-.02)	0.03	NV	10.8/11.4	8.8/9.2
Cadmium	.0002 (<.0001-.0015)	(0.0006)	0.073	.0045/.0048	.0037/.0039
Chromium+6	.0016	(0.012)	0.058	.051/.053	.042/.043
Chromium+3	.0015	(0.06)	11.0	.27/.28	.22/.23
Copper	.0041 (<.001-.0228)	(0.01)	0.025	.025/.025	.025/.025
Cynaide	<.01	(0.006)	0.093	.010/.011	.010/.011

NOTE: All values in parts per million (ppm) unless stated otherwise.
< means less than; means greater than; ≥ means equal to or greater than.
NV = no value.

Table D (Cont.)

	Column 1 Ranges of Concs. in Swamp Creek 1982-1984	Column 2 Proposed Mine/Mill Effluent Daily Avg.	Water Quality Criteria and Effluent Concentration Limits		
			Daily Maximum	Monthly Average at Qe< 1,300 gpm	Monthly Average at 1,301-2,000 gpm
Flouride	.02-.11	2.0	NV	14.6/15.5	11.9/12.4
Iron ppm	0.29 (<.0002-.68)	(0.4)	NV	1.8/1.9	1.5/1.6
Lead ppm	.0014 (<.001-.005)	(0.04)	0.6	.118/.125	.096/0.10
Mercury ppm	.0002 (<.0003-<.00025)	(.00017)	0.002	0.0002	0.0002
Selenium ppm	.0017 (<.0005-.005)	(0.06)	1.0	.165/.174	.134/.140
Silver ppm	.00025 (<.0001-.0011)	(0.003)	0.007	NV	NV
Zinc ppm	.0148 (.0007-.078)	(0.06)	0.44	.14/.14	.11/.12
Total Suspended Solids	1-10	(10.0)	30	20	20

aquatic life?

A. The temperature, dissolved oxygen, hardness, and metal constituents in the proposed discharge merit special consideration.

Q. What is of interest regarding the temperature of the effluent?

A. Because it is made up mostly of excess ground water and is transported to Swamp Creek by underground pipeline, the discharge will have a temperature that remains relatively constant--between 63 and 65°F during the summer and near 32°F in the winter, except during warmer periods of winter with no wind, when the discharge may approach 52°F.

Q. Will the temperature of the effluent vary from the existing temperatures of the water in Swamp Creek?

A. Yes, water temperatures recorded in Swamp Creek range from 32°F in winter to 84.6°F in summer.

Q. What are the potential impacts resulting from such variations?

A. Adverse effects due to temperature generally are a result of changes that fall into one of three categories: exceedance of lethal tolerance limits, changes in optimal temperatures, or cold shock. The Exxon discharge will not push ambient temperatures towards one extreme or the other. Instead, the discharge will cause the cold ambient water in the winter to warm slightly, by about 1-3°F, and cause the warm ambient water in the summer to cool slightly, again by about 1-3°F. Thus, exceedance of the upper or lower tolerance limits of aquatic organisms will not be a problem. Moreover, because the discharge will have temperatures which will be relatively constant and will not exceed seasonal extremes, optimal temperatures for such life functions as spawning and growth will not be altered appreciably.

Thermal shock resulting from a sudden cessation of effluent flow is the only adverse impact related to temperature that appears possible. Thermal shock should not be a problem during the warmer months, however, because the fish species in Swamp Creek are all either warm- or cool-water species whose preferred temperatures during the summer would exceed those found in the coolest portion of the discharge plume. These species would actively avoid that part of the plume in the summer and, therefore, would not be affected if water flow from the discharge were suddenly shut off. The size of the area that the fish are likely to actively avoid, and therefore be excluded from, might be 20 percent of the stream cross-section for a short distance downstream of the discharge under average flow conditions. This area will be small and its removal as habitat will not significantly affect the Swamp Creek fish community.

In the winter, however, it is likely, based on their preferred temperatures, that fish will be attracted to the warmer discharge plume, thereby creating the possibility of cold shock should the discharge suddenly be shut off. Cold shock is a term used to describe injury to fish resulting from a sudden and substantial reduction in water temperature that would be caused by shutdown of the discharge or movement of the fish themselves. The potential for this type of situation exists in thermal plumes where the fish are acclimated to the warmer temperature and there is a possibility that the discharge will be shut off.

Cold shock potential generally occurs during the colder months (November through April) when the largest temperature difference (delta-T) between the ambient water temperature and the plume temperature exists.

EXHIBIT 361 presents a nomograph developed by the United States Environmental Protection Agency to determine the maximum weekly average temperature (MWAT) of plumes that can safely exist for various ambient temperatures. This figure shows that fish in a plume at 77°F could experience a drop in temperature to 50°F without significant mortality. At the low extreme of the winter ambient temperature range, an ambient temperature of 32°F would correspond to a maximum weekly average plume temperature of 50°F; stated another way, the most sensitive of fish acclimated to a plume with a temperature of 50°F could experience a drop in temperature to 32°F without substantial mortality. Initial mixing of the discharge at 52°F would result in plume temperature mostly lower than 50°F. Moreover, the nomograph has a safety factor built into it so that the tolerance line should ensure that the mortality of any species is negligible.

The important point with regard to EXHIBIT 359 is that it predicts that even at an ambient temperature of 32°F, sudden temperature drops on the order of 18° F would have to occur in order for there to be significant potential for mortality of the most sensitive warm water fish. The maximum temperature drop that could occur in Swamp Creek during the winter resulting from a cessation of effluent would be 13-16°F. I therefore conclude that the risk of cold shock to fishes in the discharge plume is negligible.

Q. What is the importance of the dissolved oxygen levels in Swamp Creek?

A. Dissolved oxygen is necessary for survival of aquatic life. The minimal water quality standard set by the State is 5.0 mg/liter. Dissolved oxygen levels recorded in this lower segment of Swamp Creek range from 1.1 to 12.2 mg/liter. The lowest value has been reported during the winter, but values as low as 2.8 mg/liter during the day and 1.1 mg/liter at night have also been recorded during the summer. Nevertheless, diverse fish and macroinvertebrate communities are present in Swamp Creek.

Q. Will the proposed discharge of the effluent into Swamp Creek have an adverse impact on dissolved oxygen levels?

A. No. The water from the mine/mill complex will be aerated to effect a dissolved oxygen concentration of 5-6 mg/liter prior to discharge. This concentration will represent a positive <u>contribution</u> to dissolved oxygen levels in Swamp Creek at those times when the level is less than 5 mg/liter.

Q. What is the importance of the metallic constituents in the treated water discharge and Swamp Creek?

A. All of them occur naturally and many of them are essential micronutrients for aquatic life, terrestrial organisms, and humans. No such function has been discovered yet for mercury, cadmium, or silver. On the other hand, when present in excessive concentrations, these same metals become toxic and some are thought to be carcinogenic, i.e., mercury, cadmium, and arsenic.

Q. How do the concentrations of metallic constituents in the proposed discharge of treated water compare with daily maximum and monthly average effluent limits imposed by the DNR?

A. As you can see from EXHIBIT 359, concentrations in the proposed treated water discharge are generally from several-fold to as much as 100-fold <u>less</u> than the daily maximum effluent limitations and several to 50-fold <u>less</u> than the monthly average effluent limitations for discharge flow rates of between 1,300 gpm and 2,000 gpm. These limitations were established by the DNR to protect the designated best uses of Swamp Creek.

Q. Will the proposed treated water effluent with these metallic constituents cause substantial adverse effects to aquatic life in Swamp Creek or to public use of Swamp Creek?

A. No. The proposed discharge to Swamp Creek will be treated to comply with effluent limits and water quality criteria for each and all of these metallic constituents. The primary purpose of such criteria and effluent limitations is to ensure protection of aquatic life and other designated best uses.

Q. Dr. Lauer, in conclusion, in your professional judgment, and to a reasonable degree of scientific certainty, will the construction and operation of the Crandon Project cause any significant harm to area surface waterbodies or the biota therein?

A. No.

Q. And on what do you base that opinion?

A. The bases for that opinion are the results of the assessments we have performed of the potential for substantial adverse effects to waters in the vicinity of the project due either to construction activities or to operation of the mine/mill complex.

Assuming that the project is built in the manner proposed, including particularly diligent application of measures to prevent, control, and mitigate erosion and siltation, to mitigate any significant declines in lake levels or stream flows, and to treat the mine/mill process water before it is discharged to Swamp Creek, there will be no significant harm to lakes, creeks, or springs caused by the mining operation or to the biota therein. Construction and operations activities will fully comply with regulatory standards.

Q. Thank you, Dr. Lauer.

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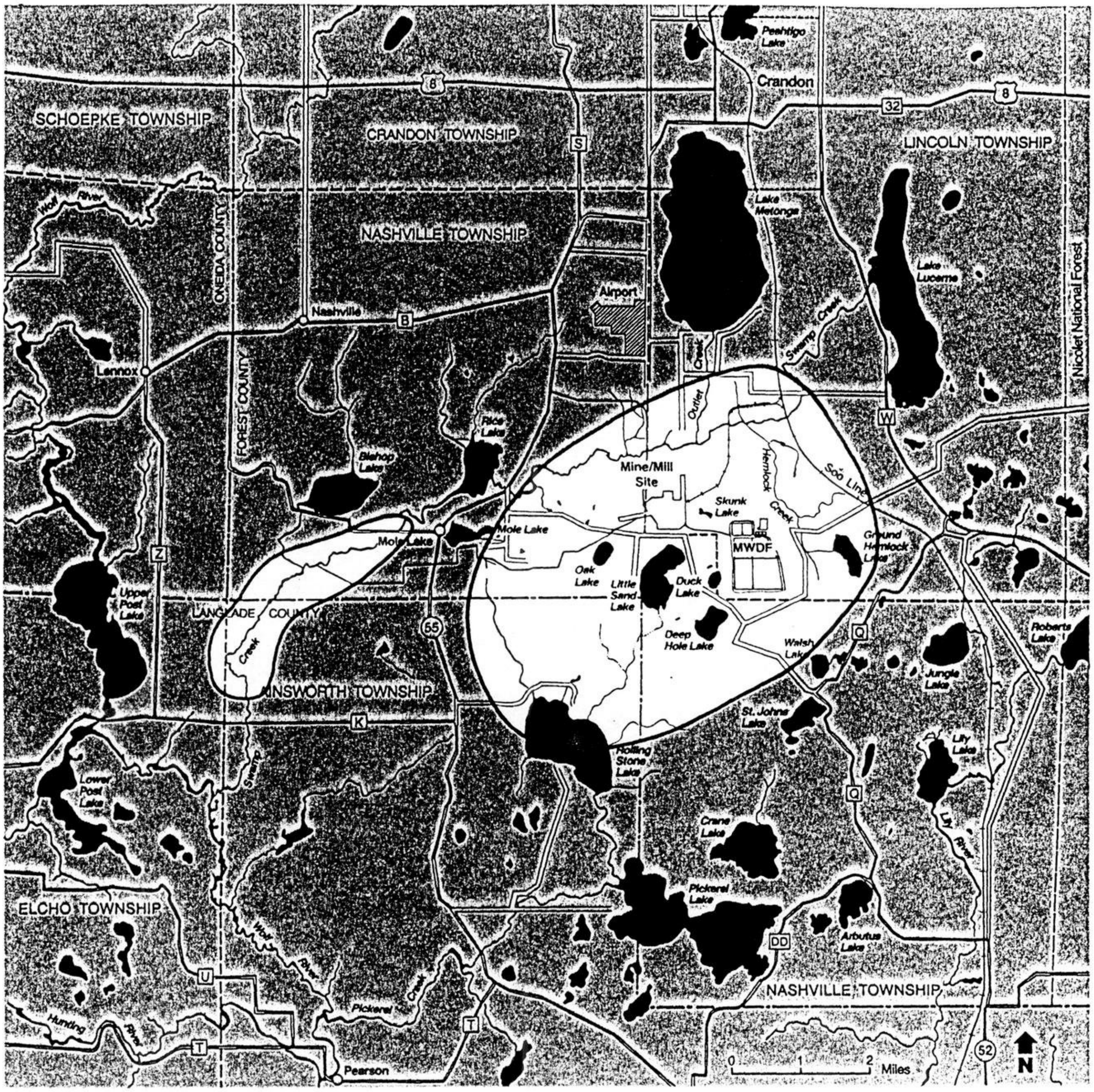
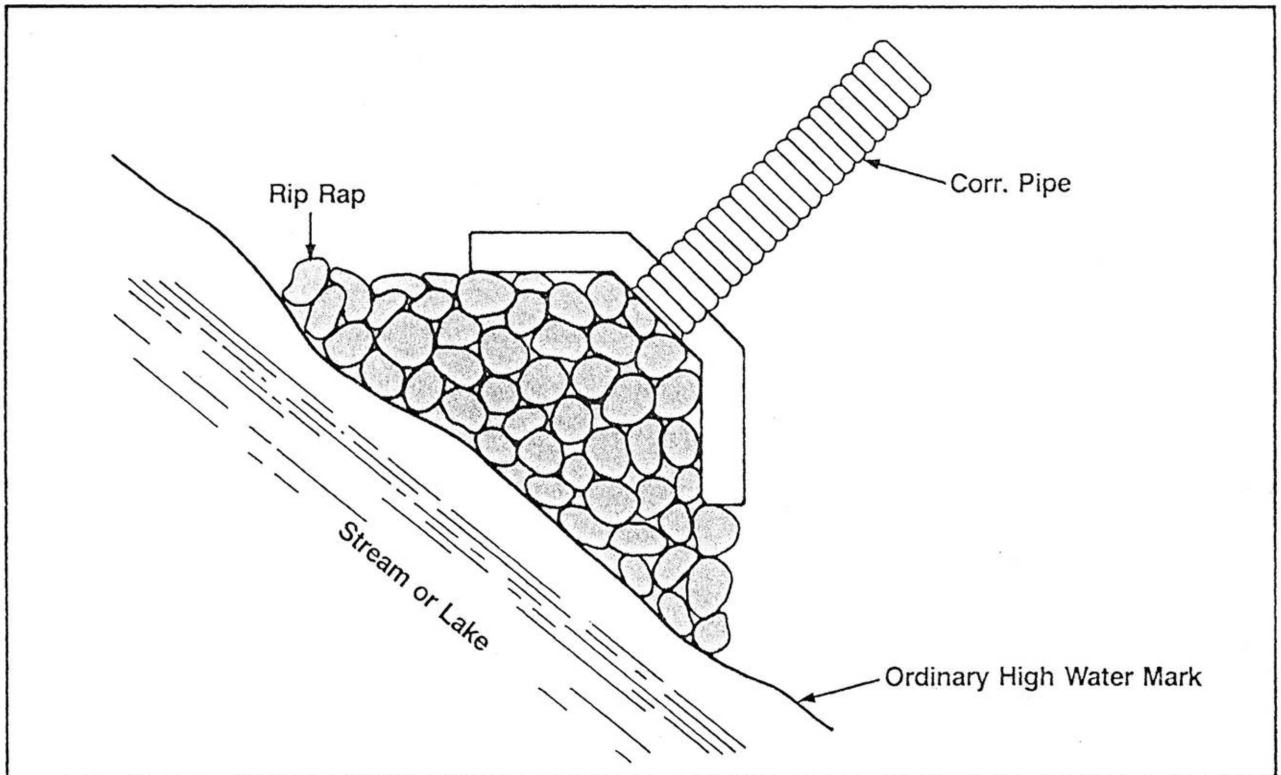
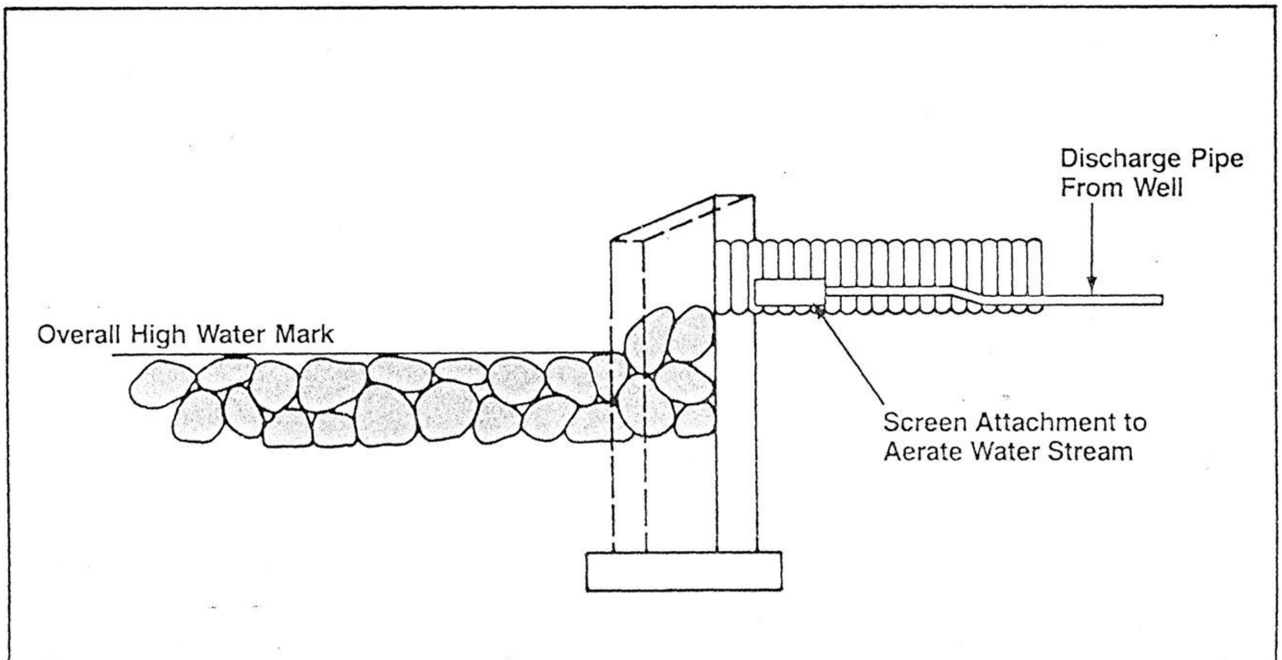
Study Areas-Surface Waters



Typical Discharge Structure

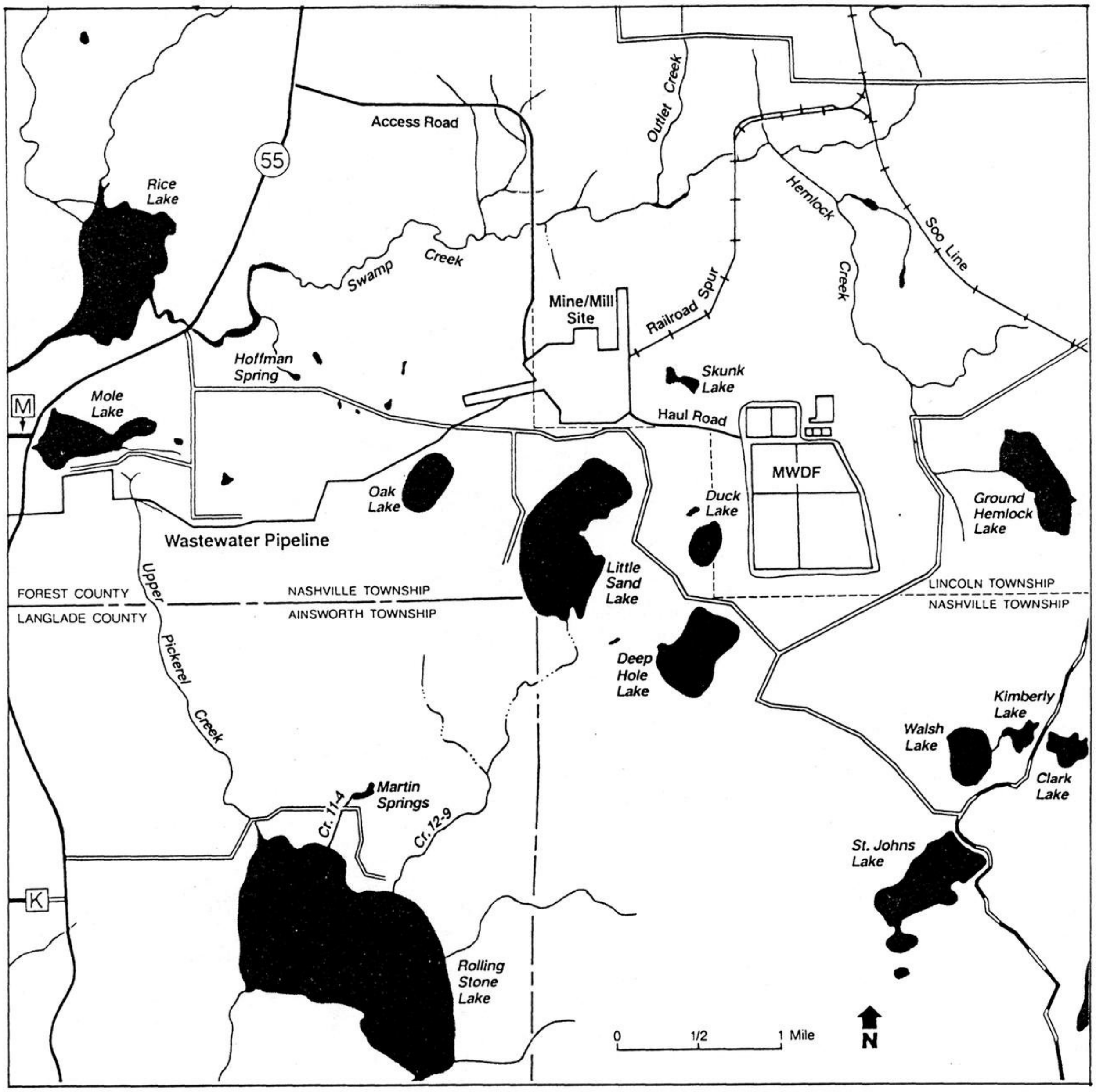


Typical Headwall Plan View



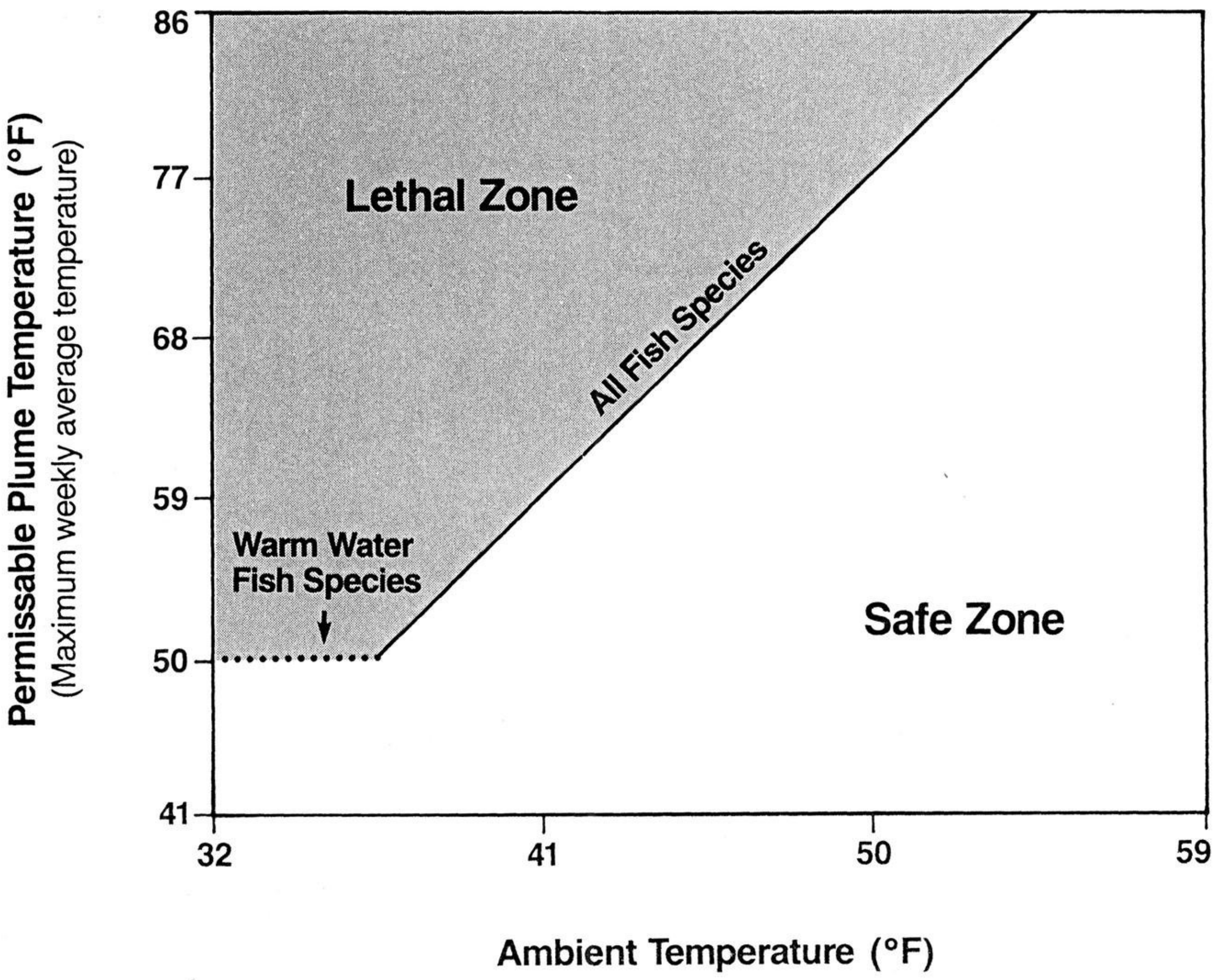
Typical Headwall Section

Project Area Map



Regional Base Map

Permissable Plume Temperatures



BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	))))	IH-86-18

TESTIMONY OF GARRETT G. HOLLANDS

PART II: WETLANDS IMPACTS

Q. Mr. Hollands, you previously testified about your evaluations of the wetlands areas in the vicinity of the Crandon Project mine and you gave us a baseline description of where those wetlands are located and the various functions they serve. What will be the scope of your testimony today?

A. I will discuss two subjects today. First, I will discuss the location and design of Crandon Project facilities as they bear on wetlands in the area. My colleagues and I at IEP, Inc. and Normandeau Associates were consulted by Exxon as it made many of these siting and design decisions. These decisions were made so as to avoid impacts to wetlands, or at least to minimize impacts where complete avoidance was not possible.

The second portion of my testimony will focus on the remaining potential for net impacts to wetlands in the area caused by the operation of Crandon Project facilities.

Q. What do you mean by the "net impacts" to wetlands?

A. Two sources of potential impacts to wetlands exist -- the filling of wetlands by the proposed facilities and the ground water cone of depression created by mine dewatering. The filling will be a permanent long-term impact, but this impact has been minimized as much as possible by facility alternatives analysis.

As you have heard from several other witnesses, the dewatering of the mine will lower ground water elevations in the immediate area and will create the potential for reducing the flows of area creeks and streams and lowering the levels of lakes in the immediate vicinity of the mine. This lowering of the ground water table would have a potential impact on some of the wetlands in the area. However, as you have also heard, Exxon has proposed various measures in its Hydrologic Impact Contingency Plan. These measures would ensure that the flows of creeks and streams would not decline below certain specified rates and that lakes would not decline below certain specified levels as a result of mine activities. When I speak of "net impacts" to wetlands, I mean impacts to wetlands that would result assuming that Exxon's various contingency measures were implemented.

Q. Mr. Hollands, before proceeding with your analysis, would you please briefly review the scope of your evaluation work with respect to area wetlands?

A. To summarize my earlier testimony, our work consisted essentially of four steps. First, through the use of aerial photography, review of existing data, and field work, we located and mapped all area wetlands including those that were less than 0.25 acres. This work, which defined the scope of our further evaluations, was in many respects the most important step. Accurate location is essential in avoiding and minimizing wetlands impacts.

Second, we developed 10 different models to evaluate the various functions that these wetlands serve, such as storm and floodwater storage, maintenance of lake and stream water quality, and ground water support. These models were derived from evaluation procedures we had previously used on other projects, and were modified to take account of regulatory standards here in Wisconsin. The models were developed in consultation with Exxon and the Department of Natural Resources.

Third, a team consisting of a botanist and a geologist (and other specialists, such as wildlife biologists and a hydrogeologist) made numerous field observations and collected a wide array of data, and they entered their findings for each wetland on a Wetland Inventory Form that had been prepared for that purpose. All wetlands 0.25 acres and larger -- a total of 158 wetlands -- were inventoried.

Finally, we evaluated all of the data we had collected and entered it into the 10 functional models. Our modeling results enabled us to rank the relative value of each of the wetlands in the area and to identify "above-average" and "below average" wetlands. This semi-quantitative approach, although a very valuable tool in analyzing these wetlands, was not the final word. We also made qualitative determinations respecting the functions and relative values of the wetlands in this area, basing those determinations on our field observations and on our professional judgment. All of these findings, the various quantitative rankings, and the qualitative assessments were then set forth in our reports to Exxon, <u>The Wetlands Assessment Report</u>, which appears in the record as EXHIBIT 183, and the <u>Supplemental Wetlands Assessment Report</u>, which appears in the record as EXHIBIT 185. These findings were also made available to the Department of Natural Resources to assist it in its own wetlands evaluations. These data enabled Exxon and the

Department to make design and sitings decisions based on a comprehensive understanding of the location of area wetlands and their relative function and potential impacts of the Crandon Project on those wetlands. As I indicated during my first testimony session, it is my professional opinion that the 158 wetlands in the vicinity of the proposed Crandon Project are among the most exhaustively mapped, inspected, and evaluated wetlands for a study area of this size.

Q. Mr. Hollands, what role did IEP, Inc. play in the sitings and design decisions with respect to Crandon Project facilities?

A. Neither IEP nor Normandeau Associates were directly involved in the actual siting and design decisions. Those decisions were made by Exxon in consultation with the DNR. Mr. Moe has already testified with respect to the factors that went into those decisions. Exxon, however, periodically requested our opinions in regard to various sitings and design alternatives and how those alternatives might affect wetland areas. We would review the data we had collected for the various wetland areas and on several occasions we actually went out and revisited the project site and further investigated other areas. In fact, the <u>Supplemental Wetland Assessment Report</u> was prepared in response to a need by Exxon to have a better understanding of the wetlands that lay to the west and north of the project site -- wetlands that could be impacted by alternative routes for the water discharge pipeline, the access road, and the railroad spur corridors. In our original work we investigated 127 wetlands, and we assessed 31 more in our supplemental work. For all of the various facilities that are part of this project we were asked to determine the possible impacts to wetland areas resulting from the different alternative routes, designs and locations.

Q. And did Exxon follow your advice?

A. Whenever Exxon asked us our opinion concerning various facility alternatives, it was evident to me that Exxon placed heavy weight upon our opinions concerning wetland impacts. I cannot recall any instance in which Exxon rejected our recommendations.

Q. Turning to the actual mine/mill site, Mr. Hollands, what are the potential impacts to wetlands resulting from the siting and design of the mine facilities?

A. In order to answer this question, I would like to reference this map (EXHIBIT 362) showing the location of the mine/mill site and the wetlands that surround that area. First, it is important to note that there are no wetlands that are being filled by the mine/mill site. Any potential impacts to the surrounding wetlands would result from changes in the characteristics of runoff from the existing land surface. The mine/mill site will remove the existing forested landscape and replace it with a variety of surfaces that will have increased coefficients of runoff. The mine/mill site will increase the amount of water and the rate at which this water flows from the site. This change in runoff could result in an impact to downstream wetlands. That could occur in a variety of ways. It could increase the amount of water that would reach these wetlands, causing them to be wetter than they are naturally. Moreover, this inflowing water could carry various sediments, particularly silt and clay size particles that could affect the water quality of the wetlands.

To prevent this from occurring, Exxon has designed detention basins that will ensure that there will not be an increased amount of flooding reaching these wetlands and also that silt and clay particles will settle out of the runoff waters. The sediment/erosion control plan which is designed for the site will prevent non-point source discharge of runoff waters from causing any harm to the adjacent wetlands. In working with Exxon we reviewed the runoff characteristics of the existing and proposed mine/mill site area and we reviewed the sediment/erosion control plans and the detention basin plans to ensure that these potentially adverse impacts to wetlands would not occur.

Q. In your opinion, will those plans be effective?

A. Yes.

Q. What about the siting and design of the access road?

A. EXHIBIT 362 shows the three primary access road corridor alternatives that we analyzed for Exxon. In reality, we analyzed a total of twelve possible routes. Following our initial Wetlands Assessment Report, we looked at a variety of routes that Exxon proposed for the access road. We also discovered that the study area we had initially inventoried was not large enough to give us a good understanding of the area around Swamp Creek, particularly north of Swamp Creek, and of the impacts of the various access road alternatives. Thus, we initiated the field work for the Supplemental Wetland Report by looking basically at what are called the "Z" wetlands -- those primarily associated with the Swamp Creek system. We went into the field and we walked the various routes that the access road could take.

We ultimately advised Exxon to choose route B-1 for a variety of reasons. First, it crosses wetlands at their narrowest points, crossing wetland W-1 perpendicular to the flow of Swamp Creek. It crosses wetlands Z-6, Z-7 and Z-9 in a similar manner, perpendicular to the flow of the various streams that pass down through these wetlands. This reduces the amount of wetland taking. Second, route B-1 passes between wetlands Z-1 and Z-2, rather than through those wetlands as one of the alternative routes would have done.

Alternative E would result in the loss of 1.2 acres of wetland area, versus the 2.6 acres lost by virtue of proposed route B-1. Route A-1 crosses an extensive area of Wetland W-2 and then follows the same corridor as route B-1 from the crossing at Swamp Creek to the mine/mill site. Alternative E is essentially an upgrading of Sand Lake Road which would require widening the road and impacting five wetlands in the process. Although access road alternative E would result in less wetland filling, it was deemed to be less viable than alternative route B-1 for other environmental reasons which Mr. Moe has already discussed. Alternative route B-1 does, in my opinion, result in minimal adverse impacts to wetlands.

Q. What about the railroad spur, Mr. Hollands?

A. EXHIBIT 363 shows the four railroad spur corridor alternative routes that we analyzed and the wetlands associated with these routes. As can be seen on the EXHIBIT, Routes A, B and D are all primarily associated with wetlands O-1 and T-4. There are some other smaller wetlands that are slightly affected. Alternative C crosses through a number of wetlands, particularly F-15, which is a unique wetland with a burr oak community, and it then continues eastward to cross the Hemlock Creek wetlands, passing just north of the Hemlock Creek spring area before it reaches the Soo Line.

We analyzed each one of these routes to determine the amount of wetland area that would be affected and the relative value of these wetland areas. Alternative Route D was the route that was finally chosen. It affects the smallest of wetland area -- only three acres, whereas routes A, B and C affected 6.2, 4.3 and 5.7 acres of wetlands, respectively. In addition, Route D crosses wetland T-4 at a very narrow point where the least amount of wetland associated with Swamp Creek is affected. The route also crosses two smaller Swamp Creek tributary streams with associated wetlands, but these are relatively small stream channels where little impact will occur.

Route A, on the other hand, would cross wetland O-4 at its outlet stream and would cross Swamp Creek three times. Alternative B would not only affect a portion of wetland O-1 but also would cross wetland T-4 associated with Swamp Creek in a manner which would be parallel to the stream and thus would result in a large crossing of wetlands associated with Swamp Creek.

Thus, based upon this analysis, it is my professional opinion that the corridor Route D would result in the least impact to wetlands.

Q. Turning to the slurry pipeline and haul road, is it your professional opinion that these facilities have been designed and located so as to minimize wetland impacts?

A. EXHIBIT 364 shows the four alternative routes that were considered and the relationship of these routes to various wetlands. All four of the routes result in some wetlands being taken. The primary wetland affected by the slurry pipeline and haul road is wetland F-11 which is an average value conifer swamp. The proposed route, Route 2, crosses F-11 at its narrowest part in an area where an access road for a bore hole has, in part, already altered the wetland. Route 2 also avoids impacting any of the small isolated wetlands that were not assessed because of their small sizes--wetlands that Routes 1 and 4 would impact. Thus, the impacts from Route 2 are limited to an impact to only one wetland at a location where it has already been altered by man.

Overall, there is very little difference in the total amount of wetland filling that would result from each of the four routes. Routes 1, 2, and 3 all result in about 1.3 acres of wetlands being filled and Route 4 results in the least amount of wetland being taken, which is about 0.9 acre. Route 4 crosses F-11 down in its lower portions where there is stream flow whereas Route 2 crosses at a portion at which there is no flow or very little stream flow. It has been my experience that crossing wetlands where there is a definite stream flow system is more difficult and has a higher impact upon the wetlands than an area that has little stream flow. The necessary culverts will be placed underneath Route 2 to ensure that there is a flow of water from one side of the wetland to the other, preventing any increase in water elevations on either side of the roadfill.

Thus, in my professional opinion, Exxon has chosen the route which has the least impact to wetlands of the four different routes. The width of the slurry pipeline corridor has been reduced so that the amount of wetlands taken is even less than we initially projected.

Q. Mr. Hollands, you have testified that there will be impacts to wetlands caused by the slurry pipeline, the haul road, the railroad spur and the access road. What will those impacts be?

A. Some wetland areas will be filled. We also analyzed the impact that this filling would have on the flood stage of Swamp Creek and found it to be so small as to not even be measurable. The proposed roadway surfaces were analyzed to determine whether increased runoff would adversely affect wetlands. We advised Exxon to design the roadway and railroad so as not to increase or reduce existing wetland watersheds and to use properly sized culverts to prevent flooding of wetlands. If proper engineering measures are used, it is my professional opinion that no significant hydrologic impacts to area wetlands should occur.

Q. What will be the impacts that result from the loss of wetlands that will be filled?

A. It is my professional opinion that these small amounts of wetlands that will be taken by these various corridors will be insignificant to the function of the wetlands within the study area and the region, the region being defined as the Wolf River watershed above Langlade. I use the term "insignificant" to mean that there will be no measurable decrease in the function of the remaining wetlands to provide for the ten functional values set forth in NR 132.

Q. What impacts to wetlands will occur as a result of the construction of the water discharge pipeline?

A. First of all, I would like to point out that my colleague, Dennis Magee, and I were asked by Exxon to walk the approximate route the water discharge pipeline would take from the mine/mill site to Swamp Creek and to choose along that corridor the route that would avoid the most wetlands. Also, we were asked to map and inventory the wetlands along the route in detail, to look at the sensitivity of these wetlands to the construction of a pipeline through them, and to consider how to mitigate possible impacts to wetlands. Both Mr. Magee and I have had considerable experience in working with pipelines and other utility crossings of wetlands. It has been our experience that with standard operating procedures, little long-term damage is done to a wetland by a buried pipeline.

We chose a route that avoided wetlands as much as possible. For those wetlands which were unavoidable and had to be crossed, the impacts will be short term because the pipeline will be buried. Following construction of the pipeline, the wetland area that is disturbed will be allowed to become revegetated as a wetland. We have advised Exxon to place organic soils at the land surface following construction of the pipeline. It has been our experience that, once these organic soils are placed, the area will become recolonized as a wetland within one growing season. Where the pipeline crosses through wooded communities, the wooded community will be changed to a herbaceous community. After a time woody species will invade the pipeline area and recolonize the disturbed area as a wooded swamp or a shrub swamp. We also advised Exxon to use standard construction procedures that will maximize sediment erosion control and reduce impacts to adjacent wetlands.

Q. Mr. Hollands, Exxon's Hydrologic Impact Contingency Plan provides for the construction of several pipelines and discharge structures. What wetlands impacts will occur as a result of the construction of these facilities?

A. The facilities have been designed so that they minimize disturbance to wetland areas. Where possible, pipelines have been located in existing corridors so that additional wetlands will not be disturbed. In addition, any pipelines that cross wetlands will only have a short-term impact similar to that of the water discharge pipeline that I discussed earlier because they will be buried.

Q. Turning to the Mine Waste Disposal Facility, what impacts will it have on wetlands?

A. The potential for impacts is twofold -- first, in the amount of wetlands to be filled, and second, in changes in runoff that could affect the water balance of downstream wetlands.

With respect to the amount of wetlands to be filled, I should note that it has been my experience in working on a variety of very large projects such as shopping malls, office parks, and so forth, that it is virtually impossible in glaciated areas of the United States such as Northern Wisconsin to find a site for a large project that does not result in the taking of some wetlands. That is certainly the case here. The MWDF in its current design will result in the loss of approximately 45 acres of wetlands. All of these are average to below average wetlands. None has a high value either as measured by the semi-quantitative method or as measured by the qualitative method.

With respect to impacts on downstream wetlands, we undertook extensive work that is set forth in our 1982 report entitled Hydrologic Balance for Selected Wetlands, Crandon Project. That report appears as EXHIBIT 184 in the record. Using these analyses, we worked with Exxon to design a surface for the MWDF that would, as closely as possible, recreate the existing watersheds for this area. The purpose was to maintain the same rates and quantities of surface water flow from the MWDF area as currently exist so that the water balance of downstream wetlands would not be significantly changed, thus avoiding the possibility of changes in the functions and vegetative communities of downstream wetlands. I conclude that, following construction and completion of the MWDF, there will be no measureable changes in the functions of the downstream wetlands.

I should also add that, in my professional opinion, the amount of wetlands that are being filled by the proposed MWDF -- 45 acres -- is relatively small in comparison to the large areas of remaining wetlands for the study area and for the region. I do not believe that this small loss of wetland area will result in any significant change in any of the functions of the remaining wetlands.

Q. What did Exxon consider in the way of alternatives to the location and design of the MWDF?

A. With respect to the location of the MWDF, there were a number of alternatives considered. For a variety of reasons, the choice eventually narrowed to area 40 versus area 41, as illustrated in EXHIBIT 368. As Mr. Moe has testified, area 41 was chosen over area 40 for several reasons other than wetlands impacts. But I do believe this was a sound choice from the standpoint of wetlands as well. Although area 40 would disturb approximately 20% less wetland area than area 41, the wetlands that occupy area 40 are more valuable qualitatively than the wetlands in area 41. This is because the wetlands of area 40 are directly upstream from Rolling Stone Lake and, as a result, perform a very valuable function in maintaining the quantity and quality of the water flowing into Rolling Stone Lake. In addition, the wetlands in area 40 provide a valuable hydrologic support function for a headwaters trout stream which flows into Rolling Stone Lake.

Moreover, the necessary corridor for the slurry pipeline and the haul road that would have to run from the mine/mill site to area 40 would disturb more wetlands than will a corridor running from the mine/mill site to area 41. In addition, there is a greater separation between the groundwater table and the land surface for area 41 than there is for area 40. Thus, any leachate that may enter the groundwater system would be more attenuated by the unsaturated zone of area 41 than would occur for area 40.

For these reasons, I believe that the location of the MWDF at area 41 was a sound choice from the standpoint of wetlands impacts and functions.

From the standpoint of design, we investigated a number of alternatives. Those alternative designs are set forth in Appendix 4.1A of Exxon's Environmental Impact Report, EXHIBIT 158 in the record. In each instance, the viable alternatives would have resulted either in the taking of greater amounts of wetlands or in the taking of above average wetlands. The design that was chosen, illustrated by EXHIBIT 366, results in the least overall impact to wetlands from the standpoint of quality versus quantity. As you can see, wetlands F-26 and F-62 are avoided by this design, and the amount of filling of F-25 and F-63 is minimized. This is important because these wetlands are maintained to produce an additional buffer between MWDF surface runoff and Deep Hole Lake.

Q. I would now like to turn to the potential impacts on wetlands resulting from the ground water cone of depression created by mine dewatering. Are you familiar with this general issue, Mr. Hollands?

A. Yes. From the very beginning of our involvement in the project this was a recognized concern and I was involved in numerous meetings of the various consultants working for Exxon to analyze this issue. I met a number of times with Thomas Prickett and representatives from D'Appolonia (now IT Corporation) and reviewed the various documents bearing on this issue that were generated, particularly Exxon's Hydrologic Impact Assessment Methodology and Results, which appears in Appendix 4.1A of the EIR and as EXHIBIT 334 in the record. I also worked on this issue with other members of the Exxon project team, particularly Dr. Joseph DeMarte and Carlton Schroeder. I discussed this issue in detail with Robert Read from the Wisconsin Department of Natural Resources and developed with Mr. Read and Exxon personnel a method to gather field data to examine the potential impacts of drawdown upon the Hoffman Spring area and the Swamp Creek wetlands.

Q. Are you also familiar with Exxon's proposed contingency measures set forth in its Hydrologic Impact Contingency Plan?

A. Yes.

Q. Taking into account the contingency measures that Exxon has proposed, what will be the impacts to area wetlands caused by mine dewatering?

A. Before discussing the potential impacts, I should review with you some of the terminology that I will use. We identified two distinct hydrogeological wetlands types in this area: perched wetlands and water table wetlands. Perched wetlands are those which lie above the ground water piezometric surface and generally occur on low permeability till deposits. Ground water discharge is not a significant portion of their water balances. There is a minor amount of leakage from these perched wetlands to the water table. I would like to refer you to EXHIBIT 367, which shows a schematic of a typical perched wetland. As you will note, the perched wetland occurs well above the regional piezometric surface on low permeability glacial till and its water balance is dominated by surface water and precipitation.

Water table wetlands are those where the piezometric surface is at or near the wetlands' surface. These wetlands are predominantly associated with permeable sand and gravel deposits. Ground water discharges into these wetlands and constitutes a major portion of their water balance. EXHIBIT 367 also shows a schematic of a typical water table wetland illustrating the relationship of the wetland to the piezometric surface and to stratified drift. These wetlands are typically discharge areas for the water table and ground water inflow is an important component of their water balances.

I will also make reference to lakeside wetlands. As the name suggests, these are wetlands located at the shoreline of lakes. The water balance and boundaries of these wetlands are dominated by the increases and declines in lake levels.

Q. With these definitions in mind, Mr. Hollands, what will be the impact of mine dewatering on area wetlands?

A. EXHIBIT 254 shows the locations of area lakes, streams, springs and wetlands. Let me first answer your question with respect to perched wetlands. These are the locations of the perched wetlands in the area (illustrating on map). Because ground water discharge is not a significant portion of the water balance of perched wetlands, the ground water cone of depression will not have a significant impact on perched wetlands. Moreover, because Oak Lake is perched, its level will not decline as a result of the cone of depression, and thus there will be no impact to the lakeside wetlands of Oak Lake.

Q. What about the impacts to other wetlands in the area?

A. Let me first discuss the lakeside wetlands. As you can see from EXHIBIT 254, there are substantial lakeside wetlands next to Duck, Little Sand, Deep Hole, and Skunk Lakes. They consist of a variety of vegetative communities reflective of the water balance of each lakeside site. For example, most of the wetlands associated with Duck Lake occur on a floating mat which rises and falls with lake level. The lake level of Deep Hole Lake is controlled by two beaver dams. The wetlands of this lake consist of marsh, shrub swamp and wooded swamp communities. The woody communities are drier communities than the marsh communities. The area distribution of these wetlands is directly related to lake levels determined by beaver dams. Under Exxon's Contingency Plan, water supplements will be pumped into these lakes as necessary to offset increased lake seepage caused by mine dewatering. Thus, the levels of these lakes will not be allowed to drop significantly and the water balance of the lakeside wetlands accordingly will not change. Thus, there will be no change in the functional values of these wetlands.

Q. Will the quality of the water supplements to be added to the lakes have any impact on the functional values of lakeside wetlands?

A. I have reviewed the anticipated changes in the chemistry of the lakes that would be receiving the ground water augmentation, and, in my professional opinion, the small change expected in the quality of these lake waters would result in no adverse impact to the lakeside wetlands.

Q. Assuming for a moment that Exxon did not take any contingency measures with respect to these lakes, how much of a decline in lake levels would have to occur before the functional value of lakeside wetlands began to change significantly?

A. Wetlands are extremely resilient, and it is very difficult to change the vegetative community of a wetland by lowering water levels. In theory, what one has to do in order to change the vegetative community is to lower the level of the ground water below the intense root zone of the wetland. With wooded swamps, for example, during the non-growing season the water level commonly is into or above the intense root zone. During the growing season, when evapotranspiration is at the maximum, the trees draw the water table down to a point where it is below the intense root zone. The literature shows that drawing the water table down below the intense root zone of a wooded swamp would not result in a change in the community as a result of dieback, but rather would increase the growth rate of the trees that occur there. When these trees are growing in wetland conditions with water up around their roots, they are essentially in a stressed condition. If you lower the water table below their root zone they are in less of a stress situation and their growth will increase.

In contrast, any significant decrease in the water table of a shallow marsh would cause the marsh to become much less wet and possibly change from a marsh to a shrub swamp or a wooded swamp.

The majority of these lakeside wetlands have thick organic soils within them. These soils range from sapric to fibric soils. It is very difficult to dry these soils out. By that I mean that, even though the water level of the lake may be drawn down, the fine-grained nature of these organic soils with very low permeabilities will retain any direct precipitation and runoff to maintain saturation of those soils. During the growing season, when maximum evapotranspiration occurs, the plants would draw the water table down below the intense root zone but during the non-growing season, it is very probable that direct precipitation and runoff would maintain saturation within the soils so that I would expect that in the woody communities, that is, the shrub swamp and the wooded swamp communities, there would be very little change in the nature of the vegetation. In the marshes and the aquatic beds associated with these lakes I would expect to see a change of the aquatic beds going to shallow marshes, and the marshes would tend to change into shrub swamp communities. I would expect none of the areas that are presently wetlands ever to become uplands.

Any change in the vegetative community would cause a very slight change in the functional values of these wetlands. That change could be an increase in value or it could be a decrease in value. It is hard to predict at this point without looking at a specific wetland and predicting a specific change in the amount of vegetative communities associated with the wetland. In any event, this would be a short-term impact because the ground water and the surface water levels would return to their baseline conditions after the conclusion of the project, and the wetlands would thereafter naturally revert back to their baseline conditions.

Q. Mr. Hollands, what about water table wetlands that are not immediately adjacent to lakes? What impacts to these wetlands can be expected?

A. Let me refer you here to EXHIBIT 254. If we may first examine the wetlands in the vicinity of Hoffman Spring, water reaches the Hoffman Spring wetland, Z-18, in two ways. First, the wetland appears to be a ground water discharge area -- the presence of the spring illustrates this. It is also an area where the existing piezometric surface is at the land surface. Water thus reaches this wetland by surface water flow through a system of wetlands. Flows come down from R-1, R-1A, and Z-20 and then passes from Z-20 down through an intermittent stream channel into Z-17. Z-17 appears to be a wetland which is dominated by surface water inflow. There is also a beaver population that maintains a dam that also regulates water levels. Water then passes down through and over an abandoned dam down to a lower portion of Z-17 which appears to be dominated by surface water flow as well. Water then passes through a culvert underneath the small woods road and into Z-18, which appears to be dominated by ground water flow from Hoffman Spring.

It is my belief that wetland Z-17 will not be adversely affected by the drawdown of the piezometric surface by the mine dewatering process. On the other hand, Z-18, the area that we believe is dominated by inflowing ground water, would be affected if there were no mitigation. Analyses of the impact of drawdown on water levels in this area were performed both by the Wisconsin Department of Natural Resources and by IEP. The conclusions were essentially the same--that there would be a drawdown of the piezometric surface below the spring level resulting in decreased spring flow into Z-18 and a lowering of the water balance for this wetland. This could adversely impact the water quality and quantity and the associated fisheries of Hoffman Spring and Creek.

However, Exxon's mitigation measures for Hoffman Spring and Hoffman Creek will assist in maintaining the water balance of associated wetlands. No change in the vegetative community of these wetlands is predicted, nor will there be a change in any of the other elements inventoried in the wetland assessment processes. Thus, it is my professional opinion that no significant change in the functional value of these wetlands will occur.

This is also true for water table wetlands associated with Swamp and Hemlock Creeks. Our field observations show that, along the steep hillside on the south side of Swamp Creek wetlands, there are a number of seeps which indicate that the piezometric surface is intersecting the land surface in this area and discharging ground water into the wetland. This is similar to what is found at Hoffman Creek but occurs on a lesser scale all along the steep hillside which is just to the south of wetland W-1, for example, on the south side of Swamp Creek. All of the work that has been done by others, such as D'Appolonia and the DNR, also illustrates that under existing conditions these are ground water discharge areas. The modeling done by D'Appolonia shows that these wetlands fall in that zone in which predicted drawdown will be less than one meter. Much of the wetland area will have a drawdown of less than a foot. These wetlands are coniferous wooded swamps and consist of species of trees that are capable of growing both in wetland conditions and in upland conditions. They also occur in an area where there are organic soils which are sapric in nature. Some of the wetland is subjected to overbank flooding from Swamp Creek on a yearly basis.

Because of the very fine grained nature and low permeabilities of the organic soils and the overbank flooding, it is my professional opinion that it would be very difficult, if not impossible, to dry these wetlands out due to the effect of a slight drawdown of the ground water table. If the drawdown of the ground water table underneath these wetlands does occur as predicted, the effect would be to stimulate the growth of the woody species that live in the wetland rather than to cause them to die back. If there is a slight change in the vegetative community, it will revert back to existing baseline conditions following completion of the project and reestablishment of the water table in these wetlands to baseline conditions. For these reasons, I do not predict a significant change in the vegetative communities of these wetlands that could result in any measurable functional changes for these wetlands.

Q. Mr. Hollands, after the Crandon Project is completed, will there be any long-term impacts to any of the wetlands in this area?

A. In my professional judgement, other than those wetlands which are filled, there will be no long-term impacts to wetlands or their functions as a result of this project. As I discussed earlier, the remaining wetlands contain vegetative communities that have adapted to a variety of climatic periods, both droughts and wet periods, and are areas that contain low permeability organic soils. I believe that it is going to be very difficult, if not impossible, to change the vegetative communities that occur within these wetlands and, thus, the functions of the wetlands. Wetlands are very resilient and it is very difficult to observe any measurable changes in the function of a wetland due to minor changes in water balance. Thus, in my professional opinion, there will not be any long-term impacts to wetlands other than those which are taken by filling.

Q. Before moving on to discussing your conclusions, Mr. Hollands, I would like to explore with you your assessment of the impact of the Crandon Project and its facilities on the various wetlands functions you discussed during your earlier testimony. Referring once again to EXHIBIT 250, which summarizes the functions that NR 132.06(4) requires to be considered, I would like briefly to examine each of these functions with you. Taking into account the wetlands that will necessarily be filled, the potential disturbances caused by construction, and the potential net impacts caused by mine dewatering, what is your professional opinion with respect to the impacts of the Crandon Project on the biological functions of area wetlands?

A. It is my professional opinion, based upon the work that we have done on this project, that the biological functions of the remaining wetlands, which is the vast majority of wetlands within the Crandon Project study area, will not be altered by the proposed project.

Q. What is your professional opinion with respect to Crandon Project impacts on the hydrologic support functions of these wetlands?

A. It is also my professional opinion that the remaining wetlands will not have their hydrologic support functions significantly altered. The only wetlands that have any potential for an alteration of their hydrological support function are those perched wetlands which are directly downstream from the MWDF such as wetlands F-60, F-61, and F-62. As I have stated earlier, our analyses of the hydrologic balance of these wetlands and the MWDF impact on those hydrologic balances do not show any significant changes in the hydrologic balance, and thus their hydrologic support function will not change.

For those water table wetlands, such as Swamp Creek wetlands W-1 and W-2 and for the Hoffman Spring area wetlands Z-18 and Z-19, augmenting the existing flows with pumped well water will maintain the hydrologic support function of those wetlands. The Contingency Plan will be important in maintaining the hydrologic support function of water table and lakeside wetlands.

Q. What is your professional opinion with respect to the impacts of the Crandon Project on the ground water function of these area wetlands?

A. The wetlands that are filled will cease to have either the same ground water recharge or the same ground water discharge functions as they previously had. Those wetlands which are not filled will continue to have similar ground water recharge and discharge functions as they had before. The drawdown of the piezometric surface because of mine dewatering will result in increasing the potential seepage rates from some of the perched and water table wetlands, but I do not believe that seepage is a significant component of the discharge portion of the water balances of these wetlands and I do not expect that there will be a significant change in the ground water recharge function of any of the perched water table wetlands. Those wetlands which are water table discharge wetlands will continue to serve that function. In summary, I do not foresee any significant changes, particularly with the Contingency Plan, in the recharge or discharge value of the site wetlands.

Q. And what is your professional opinion with respect to the impacts of the Crandon Project on the storm and flood water storage functions of these wetlands?

A. I do not foresee any negative impact to the storm and floodwater storage function of the wetlands other than those which are filled. Those wetlands that are filled will no longer have a natural valley flood storage function that they have under existing baseline conditions. On the other hand, the remaining wetlands will continue to have the same natural valley flood storage functions that they do at the present time. The topography will not be altered. The outlet characteristics of the remaining wetlands will not be altered and I do not foresee any decrease in their ability to mitigate storm and flood waters.

Q. What is your professional opinion regarding the shoreline protection function of these wetlands as it may be affected by the Crandon Project?

A. None of the wetlands that would be completely filled by the Crandon Project facilities have any shoreline protection function. At all of the stream crossings, bridges and culverts will be designed with various erosion protection measures such as rip-rap to prevent erosion. These engineering designs will replicate the function of the existing wetlands in preventing erosion. None of the proposed facilities is located on a lake shore, so there will be no impact to the shoreline protection function of any of the lakeside wetlands.

As I have testified earlier, I do not foresee any significant change in the vegetative communities of these lakeside wetlands and thus, I do not predict any change in the shoreline protection function.

Q. What is your professional opinion with respect to the potential impacts of the Crandon Project on the water quality maintenance function of area wetlands?

A. The wetlands which will be filled will have their water quality maintenance functions removed. For those wetlands that are not filled, as I have stated earlier, I do not foresee any significant changes in their hydrologic balances and thus, no significant change in the wetlands' vegetative communities. I do not foresee any significant change in the soil characteristics of these wetlands. As a result, I predict there will be no significant negative impact to the water quality maintenance function of the remaining area wetlands.

Q. How will the cultural and economic functions of these wetlands be changed?

A. Those wetlands that will be filled will lose their cultural and economic functions, but the remaining wetlands will continue to have the same cultural and economic functions as they have under baseline conditions. Again, the key to predicting either a positive or a negative change in the value of the wetland for cultural and economic functions is to predict a change in the vegetative communities. We are not predicting any changes to the vegetative communities of the remaining wetlands and, thus, we predict no changes to the cultural and economic functions.

Q. How will the recreational function of these wetlands change?

A. As I have said earlier, impacts will occur where wetlands are physically filled. The recreational function of the remaining wetlands will not change as long as the vegetative communities do not change. One exception would be Skunk Lake, where the drawdown predictions show that it would contain much less open water than it has now if there were no mitigation. Without mitigation, I would expect that the recreational value, particularly for waterfowl hunting at Skunk Lake, would decrease because of the decrease in open water habitat for waterfowl. On the other hand, the mitigation measures of pumping water into Skunk Lake would maintain the existing water levels and, thus, the existing recreational function of the Skunk Lake wetland.

Q. How will the aesthetics function of these wetlands be changed by the Crandon Project?

A. Other than those wetlands that are filled, I do not foresee any change to the aesthetics function of these wetlands because I do not foresee any changes to the vegetative communities in the wetlands.

Q. How will the educational function of these wetlands be changed?

A. I would predict that the only change in educational function would be where wetlands are physically filled. Other than that, I do not predict any change in the educational function of these wetlands.

Q. Mr. Hollands, in your professional opinion, how will the regional context function of these wetlands be changed as a result of the Crandon Project?

A. From a regional context function viewpoint, the wetlands that are proposed to be filled are predominantly wooded swamps, either coniferous or deciduous wooded swamps. This is the most common type of wetland found within the region -- that is, the watershed of the Wolf River above Langlade. The small amount of these common wetlands that will be filled will not result in a decrease in the regional context function of the remaining wetlands within the region.

Q. Looking for a moment at the types of wetlands that may be affected by the Crandon Project, are any of these wetlands scarce in the regional context?

A. As part of the Wetland Assessment Report, we analyzed the regional scarcity of the various wetland types found in the study area. The region that we looked at was the Wolf River watershed above Langlade, an area of approximately 300,000 acres. The type of wetland that was found to be the most scarce is aquatic bed or deep marsh. It was estimated that only approximately 785 acres of aquatic bed occur in the region. No area of aquatic bed or deep marsh will be filled by any of the Crandon Project facilities.

Shallow marsh was the second least abundant vegetative community found within the region. The proposed Crandon Project facilities will affect only 1.3 acres of marsh. I do not believe that the filling of 1.3 acres of marsh will result in a taking of a scarce wetland type, nor will it be significant in the regional context of marshes.

Other wetland vegetative types such as coniferous swamp, deciduous swamp, shrub swamp and bog are common in the region and cannot be considered to be scarce. The Crandon Project facilities will affect approximately 40 acres of coniferous swamp, 14 acres of deciduous swamp, 10 acres of shrub swamp and 7 acres of bog.

For these reasons, I do not believe that there will be any impact upon regional scarcity by the proposed project. There are no aquatic study areas, sanctuaries or refuges that occur in the Crandon Project area.

Q. Mr. Hollands, I would now like to conclude by posing to you a series of questions based on standards set forth in state and local laws and regulations. For each of these questions I will ask you to state your expert opinion to a reasonable degree of scientific certainty as to the appropriate answer and I will then ask you to explain the bases for your opinion. Mr. Hollands, in your opinion, has Exxon complied with all of the sitings principles and standards of NR 132.06(4) of the Wisconsin Administrative Code?

A. Yes.

Q. And what is the basis for your opinion?

A. NR 132 sets forth elaborate procedures requiring that an applicant map and locate wetlands, inventory those wetlands, assess each wetland for the functional values set forth in the regulation, and then design project facilities to avoid wetlands. Where avoidance cannot be accomplished, significant wetlands must be identified through an assessment process and impacts to any of the significant wetlands must be mitigated as much as possible. I believe that the wetland assessment procedures and the environmental impact analysis that we have been involved with does indeed meet the principles and standards set forth in NR 132.

Q. Will the siting and design of Crandon Project facilities minimize wetlands losses and result in the least overall adverse environmental impact to wetlands?

A. Yes.

Q. And what are the bases for your opinion?

A. First of all, the Crandon Project has avoided the physical filling or taking of wetlands to the maximum extent possible given the type of activity proposed. In those areas where wetlands must actually be filled, those wetlands being taken are generally of low or average value. Where a valuable wetland is being crossed, such as where the Swamp Creek wetland is crossed by the railroad and the access road, the crossings are being done in a manner by which the least amount of wetland is taken by crossing at the narrowest points. With these two general principles in mind, I believe that the Crandon Project facilities will minimize wetland losses and will result in the least amount of overall adverse impacts to wetlands in the Crandon Project area.

Q. Will the Crandon Project have a direct and substantial effect upon wetlands in the region?

A. No.

Q. And what are the bases for your opinion?

A. The only direct impact to wetlands will occur where wetlands are being filled. As I testified earlier, there will be approximately 80-81 acres filled by the proposed activities. I do not believe that, from the standpoint of either amount of wetlands or regional context, this will result in a substantial effect upon the wetlands of the region.

Q. Considering the role that wetlands can play in maintaining the quality of lakes and streams, will impacts to wetlands caused by the Crandon Project result in irreparable environmental damage to lake or stream bodies?

A. No.

Q. And what the bases for your opinion?

A. The small amount of wetlands that will be taken upstream of lakes and streams, particularly in the area of the MWDF, will not result in a lessening of the water quality or quantity in the downstream lakes and streams. The analysis that we did of the water balance of these wetlands shows that there will be no measurable change in the quantity of water reaching these lakes and, thus, I do not believe that there will be a quality change as a result of inflowing surface water.

As to drawdown effects to wetlands, the Contingency Plan that is being proposed by Exxon to maintain lake levels and stream flows will protect those waterbodies and adjacent and downstream wetlands.

I do not see any measurable changes in the functions of the wetlands remaining in the study area as to their ability to protect downstream waters. Nor do I foresee any detrimental impacts to the lakeside wetlands that are associated with the lakes of the study area. As a result, I do not foresee any irreparable environmental damage.

Q. Thank you, Mr. Hollands.

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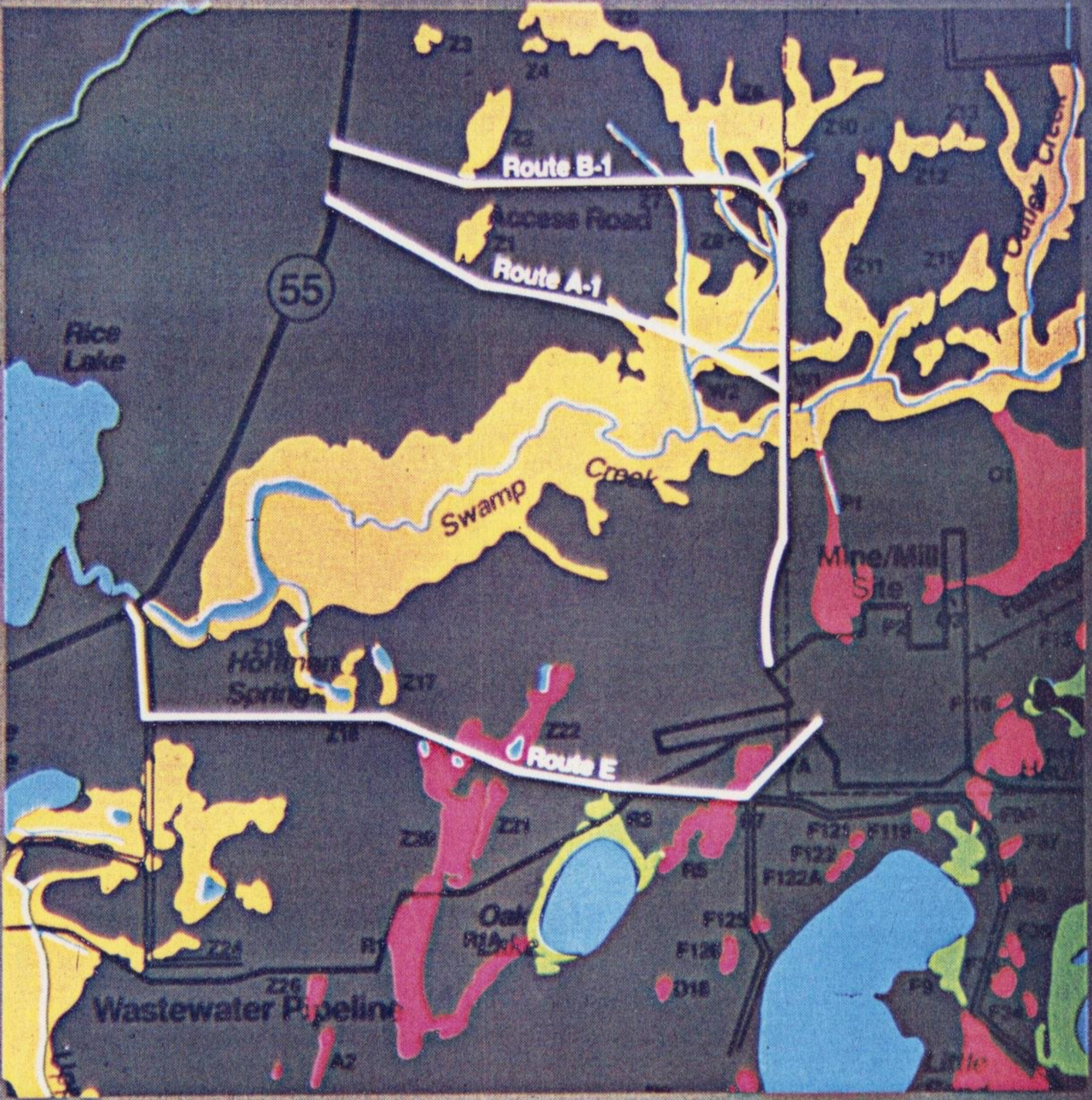
Access Road Alternatives
and Mill/Mine Site



Legend

- Lakeside Wetland
- Perched Wetland
- Water Table Wetland

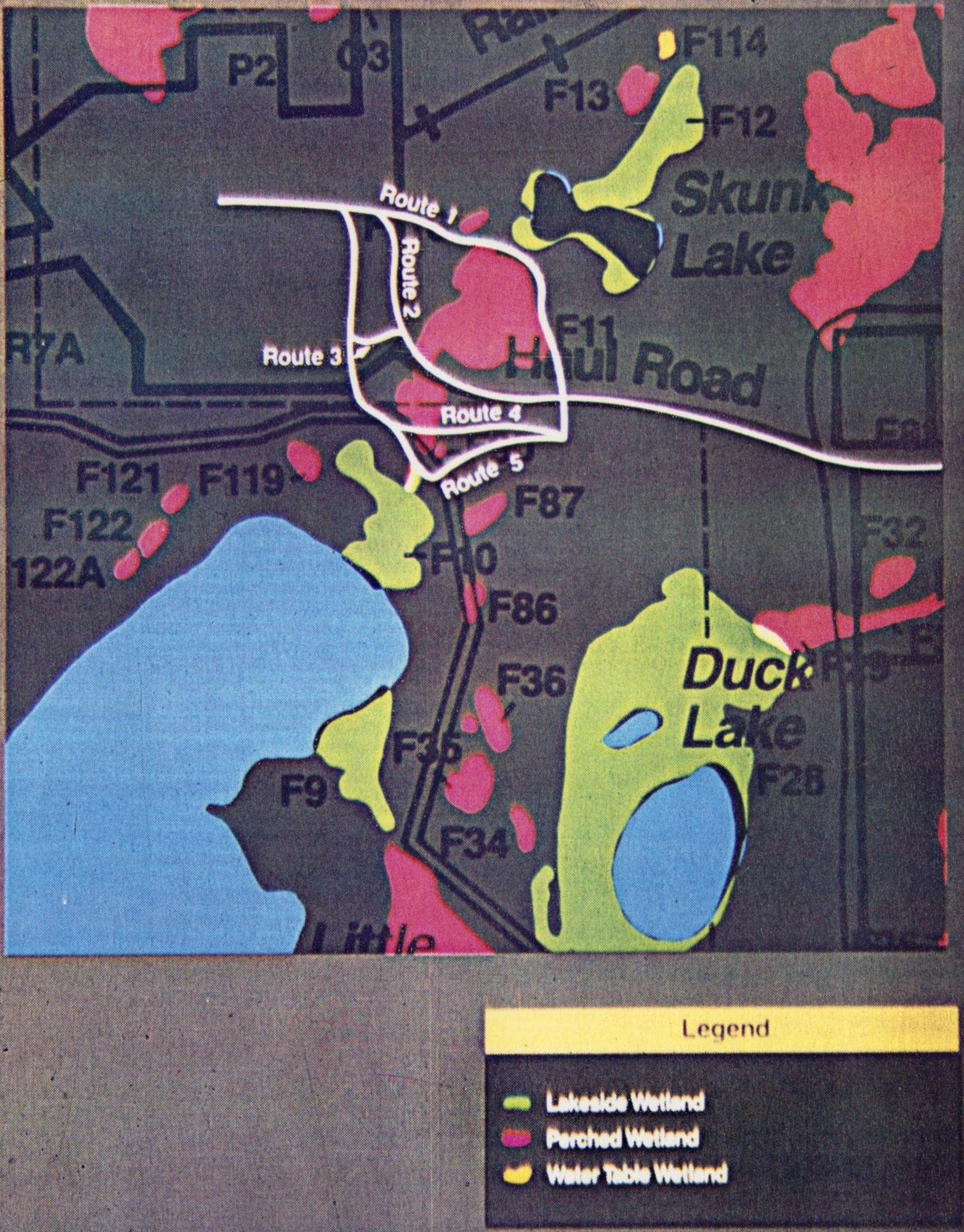
Railroad Spur Alternatives

Legend

- Lakeside Wetland
- Perched Wetland
- Water Table Wetland

Tailings Pipeline / Haul Road

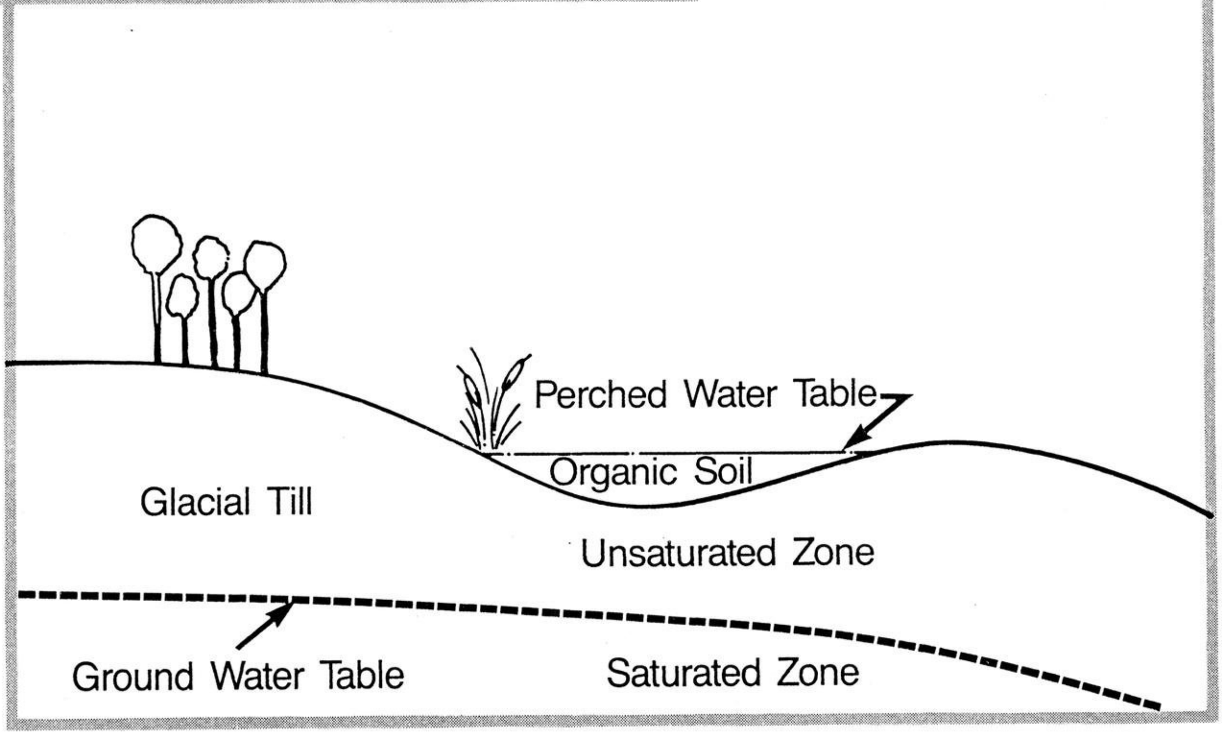
Alternatives



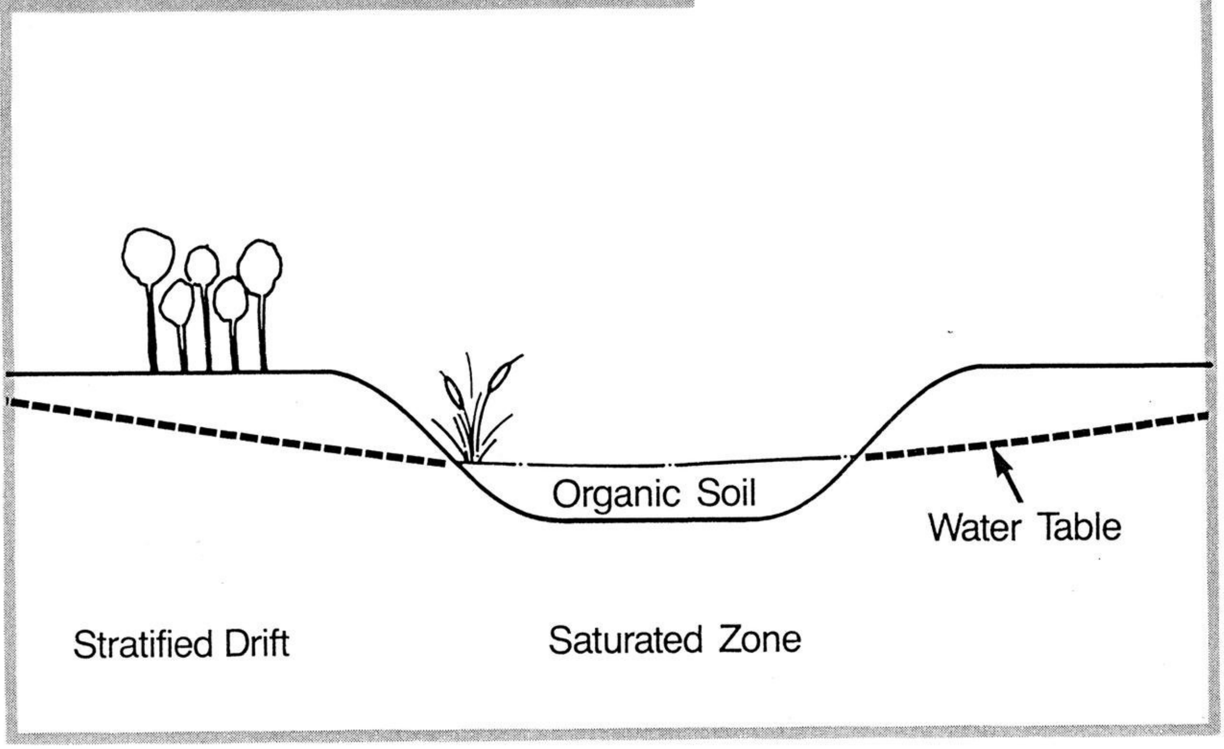
Sites 40 & 41
and Associated Wetlands

Typical Wetlands
Perched and Water Table

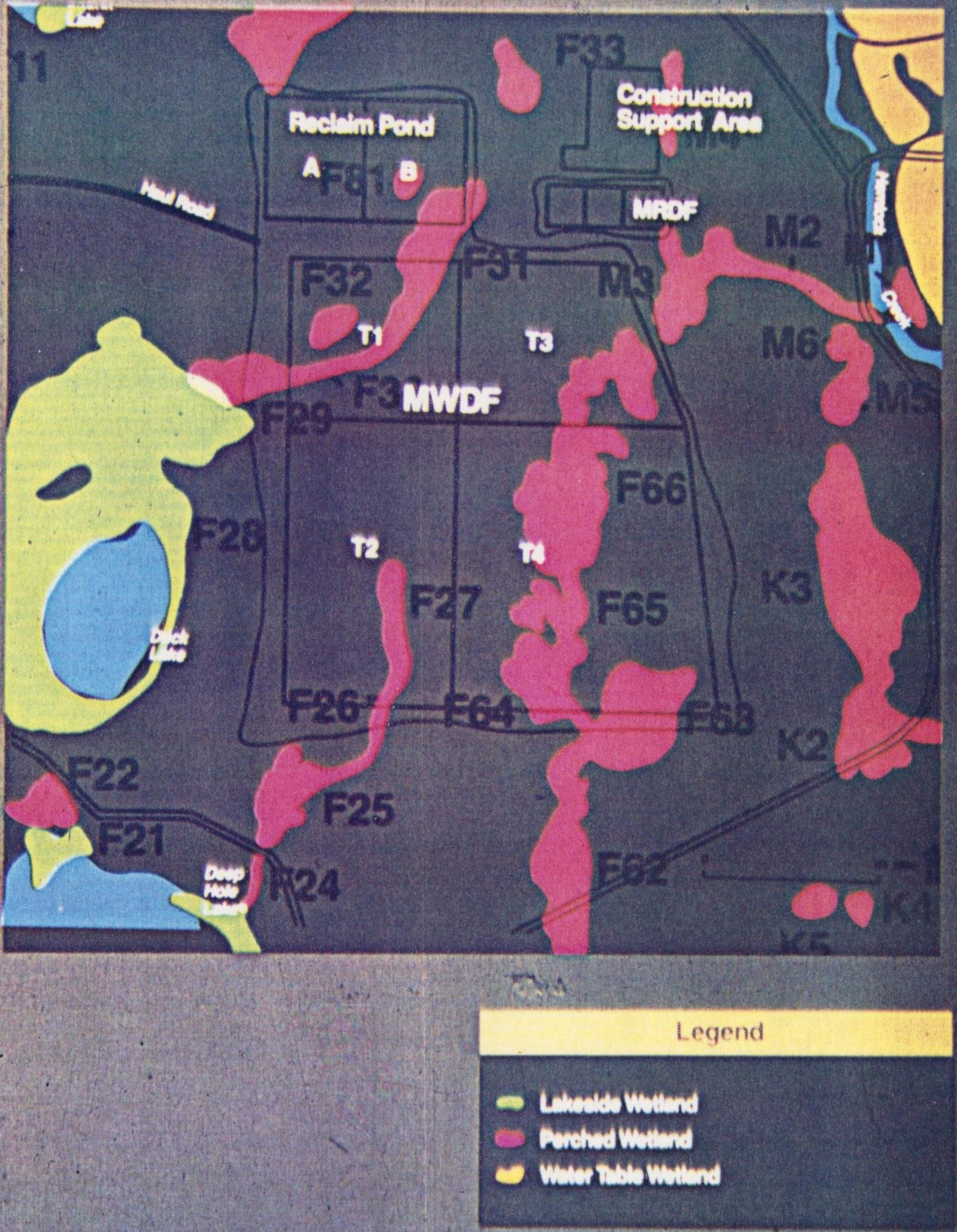
Perched Wetland



Water Table Wetland



MWDF Area Wetlands



Project Area Wetlands

Legend

- Lakeside Wetland
- Perched Wetland
- Water Table Wetland

Wetland Functions—NR 132

1. Biological Function
2. Hydrologic Support Function
3. Ground Water Function
4. Storm and Floodwater Storage Function
5. Shoreline Protection Function
6. Water Quality Maintenance Function
7. Cultural and Economic Function
8. Recreational Function
9. Aesthetics Function
10. Educational Function

BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	) IH-86-18

TESTIMONY OF DAVID R. SCHREIBER

AESTHETICS

Q. Please state your name, address and occupation.

A. I am David R. Schreiber. I am president of Schreiber/Anderson Associates, Landscape Architects, Urban Designer. My office address is 923 Williamson St., Madison, Wisconsin. I am a Landscape Architect.

Q. How long have you been involved with the Crandon Project?

A. My partner Tim Anderson and I have been involved with the project since 1981. Our work began as principals with the Sanborn Group, and has continued since 1983 as principals of our own firm, Schreiber/Anderson Associates.

Q. What aspects of the Crandon Project will you discuss in your testimony?

A. I will testify about the general aesthetic concerns we addressed in working on the site master plan, landscaping and landscaping restoration and the visual impact of the project facilities. I will base my testimony principally on the studies completed by me and Mr. Anderson.

Q. Please summarize the professional training and experience that qualify you to testify on this project's aesthetic and visual aspects.

A. EXHIBIT 373 is my resume. It describes my education and my experience as a landscape architect, which I define as a practitioner of the art and science of arranging natural and man-made objects in the environment to achieve a useful and enjoyable experience.

I am a graduate of the University of Wisconsin with a Bachelor of Science degree in landscape architecture. I have participated in professional development seminars and conferences related to reclamation of mining projects and in visual resource management.

I have worked fourteen years in private practice as a landscape architect, twelve of them as a principal in my own firm. In my twelve years as a firm principal, I have been responsible for more than four hundred site planning and design projects, some of which are detailed in EXHIBIT 373. Included have been master plans, feasibility studies and construction plans for a variety of recreation areas, industrial sites, housing projects, waterfront developments. Specialized work in visual assessment and landscape restoration has included work for both the Army Corps of Engineers and the USDA - Soil Conservation Service on major drainage channel and dike construction projects.

Q. Were there legal requirements that you were required to meet in planning the aesthetics of the Crandon Project site?

A. Yes. The State Administrative Code in NR 132.17(1) requires that site elements be placed where they are least observable from off the premises year-round, are visually compatible with the surrounding landscape, be painted and maintained to conform with the terrain and the vegetation, and that they be as visually inconspicuous as is practical. NR 182.08(2)(g), regulating the mine waste disposal facilities, requires that the impact of the disposal site's aesthetics be minimized. Local ordinances in the towns of Lincoln and Nashville also require the site to be as visually inconspicuous as possible. In addition, NR 132.18 and 182.07 require that any facilities located within 1000 feet of a state highway, a state park or certain designated scenic locations be made as aesthetically pleasing and inconspicuous as is feasible.

Q. Will any project facilities be located within 1000 feet of such locations?

A. Yes. The access road will connect with State Highway 55, and the discharge pipeline will cross Highway 55. Because the pipeline will be buried, it will not detract from the scenic qualities of the highway after construction is completed. The access road intersection will affect Highway 55's scenic qualities in the same way that any other intersection does.

Q. Do the project plans meet the legal requirements which you have outlined?

A. In my opinion all of the state and local aesthetic requirements have been met in the site planning.

Q. Did you consider site reclamation in your planning?

A. Yes. We had long term site reclamation benefits in mind from the very beginning. All of our site planning and aesthetic work was directed toward insuring that the site could be reclaimed and restored to a natural landscape after operations ended.

Q. Would you please describe in a general way how the legal requirements were met in your site master planning for the Crandon Project planning?

A. Yes. The major project facilities can be seen on EXHIBIT 374, an oblique aerial view. The headframe and the major buildings are concentrated in what I will refer to as the Mine/Mill site. Concentrating them minimizes disturbance of the existing forest landscape and maximizes the use of the disturbed lands. Clearing will be done in an irregular pattern to make the site perimeter appear more natural.

The access road corridor running toward Highway 55 on the left, and the railroad spur corridor, running across the top and off to the right, were located at the edges of the Mine/Mill site, located at the upper left.

Concentrating them minimizes disturbance of the existing forest landscape and maximizes the use of the disturbed lands. Clearing will be done in an irregular pattern to make the site perimeter appear more natural. The access road corridor running toward Highway 55 on the left, and the railroad spur corridor, running across the top and off to the right, were located at the edges of the Mine/Mill site to define its boundaries. The disposal facilities were designed to be as inconspicuous as possible.

In all construction areas, existing topographic and drainage features were preserved as much as possible and used to channel water run-off into retention areas. Throughout, clearing is called for only to the extent necessary to accomplish the required grading. We have retained as much existing vegetation as possible to screen the Project activities and to reduce the visual scale of the Project facilities. Where we have designed new landscaping, we have used it not only to enhance the aesthetics of the site but also to aid in restoring it to a natural landscape when mining operations end.

Q. What was the overall aesthetic goal of your landscape planning for the project site?

A. The aesthetic goal of our landscape plans was to provide for the restoration of disturbed areas of the project site to a landscape character compatible with the existing site character. Specific aesthetic landscaping objectives included:

1. Developing a landscape character compatible in line, form,

color and texture with the existing landscape;

2. Using indigenous plant species where possible to maintain continuity and the natural diversity that provides visual and seasonal interest on the perimeter;

3. Returning disturbed areas to indigenous vegetation as soon as possible following construction;

4. Preserving existing vegetation masses where possible in the construction process;

5. Establishing masses of indigenous vegetation both within and on the edges of the site in locations that will not be disturbed by final reclamation grading to serve as seed colonies when the mine closes; and

6. Using landscape massing techniques to create visual interest, break up the project operation areas and screen project facilities from view.

Q. Now I would like to discuss each of the plan areas individually in more detail. Would you please describe how you accomplished your aesthetic objectives in the landscaping of the Mine/Mill site?

A. EXHIBIT 277 is the landscape plan for the Mine/Mill site. Large masses of indigenous trees along the entrance road will screen operating facilities and provide a visual contrast with the site's industrial functions. The same masses, established early in the Project's life, will be maintained during final reclamation to serve as seed sources for native plant invasion and to create visual interest in the spaces left after facilities are removed.

The plan also includes a landscaped buffer zone along the entrance road to screen the project security fence and the concentrator service road.

Indigenous grasses and forbs are used throughout the Mine/Mill site to provide a wide range of seasonal flowering and visual interest.

Where project facilities come the closest to Sand Lake Road on the south, areas needed to achieve project grades but not necessary for facility operations will be allowed to return through succession to natural vegetation. This will increase the depth of natural screening along the road. Aesthetics were also considered in planning site maintenance. Landscaped areas adjoining public areas and major facilities will be maintained as lawns to give the project site a clean appearance. Areas around the operations zone and along the access road will be semi-maintained where indigenous grasses and forbs are used. That is, there will be only a yearly cutting or spraying to control woody tree and shrub growth. As a result, indigenous plants will be allowed to achieve their greatest visual interest. Areas planted to woodland will receive no maintenance and will be allowed to revegetate themselves through natural processes.

Q. How have design objectives been accomplished in the landscape plans for the access road, railway and utility corridors?

A. These corridors will be cleared to the minimum width necessary to construct the project facilities. When possible, existing vegetation masses will be left within the corridor right of way to help maintain a sense of enclosure for the roadway and to increase visual interest.

In upland areas, indigenous grasses and forbs will be used to restore the corridor ground layer. Indigenous trees and shrubs will also be added intermittently along the corridor edge to increase visual interest. Landscaping will emphasize the use of evergreen species to achieve year round interest. In lowland areas, wetland vegetation will be reestablished after construction. Indigenous wetland evergreens and shrubs will be emphasized to restore the wetlands' distinctive character.

Maintenance of the access corridors will include a yearly mowing or spraying with herbicides to control woody plant growth in drainageways and on facility embankments. Conducting maintenance operations in early fall will preserve the greatest seasonal and visual interest.

Q. How did you use landscaping to meet aesthetic objectives at the mine disposal facilities?

A. EXHIBIT 278 illustrates the landscape massing proposed for the Mine Waste Disposal Facility (MWDF). Landscaping at the Mine Refuse Disposal Facility (MRDF) will be similar. Aesthetic considerations include building and operating the MWDF in phases to minimize the disruption of the existing landscape. Disturbed portions of the site will also be reclaimed in phases as soon as disposal operations are completed in each of the four units. The perimeter embankments of the tailing ponds will be landscaped immediately after construction. Landscaping will include a ground layer of indigenous grasses and forbs with intermittent massing of indigenous trees and evergreens. The tree and evergreen plantings will be massed at the toe and lower half of the embankment to screen the facility.

On the cap of the tailings ponds after they are filled and in the refuse disposal, construction support and the borrow areas, indigenous trees and evergreens will be massed to create a broad pattern of forested and open spaces. The overall pattern emulates the character and scale of natural and agricultural openings in the region. Within the broad pattern will be smaller openings and plant massings designed to enhance the overall reforestation process by making maximum use of trees' ability to produce and deposit seeds in openings where they can germinate.

Ground layer landscaping throughout the MWDF will include indigenous grasses and forbs. We selected plants with a wide range of flowering seasons to assure the greatest visual variety throughout the growing season. Trees and evergreens used throughout the MWDF will be selected and placed to emulate as closely as possible the character and texture of the existing landscape.

Q. How will the landscaping plans you have shown us aid in the reclamation of the project facilities?

A. At the time of closing, landscaping in the access corridor will be thirty-five to forty years old. EXHIBIT 375 shows a section through the access corridor fifteen years into the Extended Care period. Pavement and rails will have been removed, leaving a corridor terrain that rolls gently with the site's existing topography. The tree masses left at the time of facility construction and the new landscaping will then be mature and will have been assimilated into the existing upland and lowland vegetation patterns. The corridor left at the time of final reclamation will have an irregular, meandering character. The new vegetation illustrated in EXHIBIT 375 will have begun to establish itself as a result of natural plant invasion and successional processes.

On the Mine/Mill site the new landscaping installed on the site perimeter and at the interior of the complex will be thirty-two to thirty-five years older at the time of final reclamation. It will resemble the surrounding forest in character, color, form and texture. EXHIBIT 376 is a section of the Mine/Mill site 15 years into the extended care period. All facilities will have been removed and the site regraded to resemble its original topography. This reclamation grading, together with the vegetation masses planted when the Mine/Mill site was constructed, create an irregular pattern of forest and open space, similar in character to the agricultural and forestry land uses found in the region. Large masses of vegetation will break up the open spaces and give them spatial character. New growth trees invading open spaces will resemble the second generation forest growth occurring after a forest clear cut.

Final landscape reclamation on the MWDF will occur as tailings ponds and other areas of the MWDF are developed and closed out. Reclamation of the landscape will occur in a manner similar to that described for the Mine-Mill site vegetation. Indigenous plant masses and ground cover will have been installed as shown in EXHIBIT 278 as areas of the site are closed out. These masses will mature to produce seeds and reinforce natural plant invasion and reforestation processes across the MWDF site.

Q. Did you make any studies to determine what residents and passers-by would see of the project from off Exxon's property?

A. Yes. We assessed the off-site visibility of the Mine Waste Disposal Facility embankments, the railroad siding located south of Keith Siding Road where the project rail corridor joins with the regional rail line, and the headframe located on the Mine/Mill site.

Q. How did you study off-site visibility?

A. The first step was to define representative viewpoints throughout the region from which the Crandon Project facilities might be visible to the general public. We then simulated the project facilities. For example, we tethered helium filled balloons to simulate the mine headframe and the MWDF embankments. Then we made photographs of the simulations from the selected viewpoints.

Q. How did you select the viewpoints for your study?

A. The objective of our study was to determine the locations from which project facilities might be visible to the general public. The viewpoints were either locations of intense land use activity, such as roads, homes or lake shores, locations with elevations similar to or higher than the project facilities, or locations on the edges of the project site where sizable openings in the foreground vegetation might afford a view of the Project.

The final selection of viewpoints was made in consultation with the DNR. Thirty-five viewpoints were selected, and are shown on EXHIBIT 377. Of the thirty-five, seven looked toward the MWDF, three toward the railroad siding and twenty-seven toward the headframe. At two of the viewpoints, the visibility of both the headframe and railroad siding were assessed. The photographs were made in the week of August 16, 1982, when leaves were on the trees. The locations of the headframe and the MWDF embankments were simulated by using helium-filled balloons triangularly tethered at the height then proposed for their construction. The location of the railroad siding was identified with white styrofoam boards located along its proposed alignment. For each photograph, we recorded the viewpoint location, its elevation, its distance from the simulated facility, the film used and field comments on the visibility of the simulation. Viewpoints from which the project facilities would be visible were documented on eight by ten inch black and white photographs on which a life-like image of the project facility was imposed. This image was then analyzed for its degree of visibility.

Q. What did you conclude about the visibility of the MWDF embankments?

A. We concluded that the mine disposal areas would not be visible from off the premises except possibly from the Sugarbush Hill lookout tower located 7.2 miles away. From the tower, the clearing for the MWDF may be visible in the distance.

The viewing points for the MWDF visibility study are shown on EXHIBIT 377. They are located on the southwest shore of Duck Lake, the southwest shore of Deep Hole Lake, the west shore of Little Sand Lake, Sand Lake Road, County highway Q and Deep

Hole Lake Road. Dense vegetation surrounding the MWDF and the viewpoints will screen the mine waste disposal facility from view at each of the viewpoints.

EXHIBIT 378 is a representative photograph, taken from viewpoint 30, showing how dense vegetation on the lakeshore hides the disposal facility. A similar condition exists from adjoining roadside viewpoints and no visual mitigation measures will be necessary.

Q. What did you conclude about the visibility of the railroad siding?

A. From our simulations and studies of the railroad siding viewpoints we concluded that the siding will not be visible from County Highway W because of intervening vegetation and land forms. However, about five hundred feet of the siding will be visible for approximately one-half mile along Keith Siding Road.

Q. Did you determine whether the headframe would be visible from off the premises?

A. Yes. The mine headframe will stand 160 feet high, and will therefore be the Project's most visible feature. We studied its visibility from a total of 27 viewpoints, located from one half mile to 7.2 miles away. The viewpoints are shown on EXHIBIT 377. We concluded that it would be visible from six viewpoints, those numbered 3, 11, 13, 14, 19 and 26.

Q. You testified earlier your photographs were taken in August, 1982. Then the headfframe was designated to be 254 feet high and approximately 200 feet north of its present location. How did you use those 1982 photographs to prepare your current assessment of the headframe's visibility?

A. If the balloon simulating the headframe was visible in a 1982 photo, we made a scaled simulation of the lower headframe using a scaled equation technique. That is, an object of known height and size, located at a known distance, can be used to establish the size of other objects at the same distance. EXHIBIT 379 illustrates our procedures. We knew the height of the top of the balloon, and the elevations of the foreground pond and of the headframe base. From that information, we could interpolate the top of the new headframe. Similarly using a regional base map of the project area we were able to locate the viewpoint and the current and 1982 headframe locations. Sight lines were then constructed between the viewpoint and the current and 1982 headframe location. The deviation between the two headframe locations was then scaled from the base map along a line to the site line to the 1982 headframe location and passing through the current headframe location. This distance was then interpolated on the viewpoint photograph as the new headframe location centerline. The photograph was then studied to determine if intervening topography or vegetation would mitigate the view to the headframe. In this case, it will not rise about the vegetation on the lakeshore opposite the viewer and therefore will not be visible from the lake, and is shown in the section drawing in EXHIBIT 379.

Q. Would you please discuss the visibility of the headframe from each of the six viewpoints?

A. Yes. EXHIBIT 380 is a view from viewpoint No. 3, the southwest shore of Little Sand Lake, 1.4 miles from the headframe, showing the balloon in the center of the photograph. This is the only lake south of the headframe from which it can be seen. The shoreline from which the view was taken is currently undeveloped and supports wetland vegetation. The view would be similar during winter months.

EXHIBIT 381 is a photo taken from viewpoint No. 11, a point along Highway 55, south of Sherman Corners, about 2.6 miles away from the headframe. The headframe can be seen in the center of the photo. It is barely visible because the distant tree line has an irregular top silhouette which tends to obscure the headframe. The view is also outside drivers' ordinary 65 degree cone of concentrated vision. While this view will be available to southbound motorists for about two-thirds of a mile along Highway 55, a concentrated effort would be required to detect the headframe. Because it is the mass of the background vegetation and not the foreground detail of leaves that obscures the view, I believe the headframe will also be inconspicuous during winter months.

EXHIBIT 382 is a view of the headframe from viewpoint No. 13, the public boat landing and swimming beach on Lake Metonga, in the Village of Crandon. This view is similar to that from the east shore of Lake Metonga, viewpoint No. 14. The boat launch is 5.3 miles from the head-frame. The winter view of the headframe will not be significantly different because of the viewing distance which makes the background vegetation appear as a mass.

EXHIBIT 383 is a view of the headframe from viewpoint No. 19, a point on Sand Lake Road one half mile away. This viewpoint is the closest point to the headframe from which the location balloon was visible.

Portions of Sand Lake Road are oriented directly toward the headframe for about one half mile. From this position the headframe may be viewed between the tree line edges of the road right-of-way. The screening impact of the foreground vegetation is lost and the headframe becomes visible over the background vegetation. The winter view from this position is not expected to be significantly different.

EXHIBIT 384 is a view of the headframe and project site from viewpoint No. 26, Sugarbush Hill Lookout Tower, 7.2 miles from the headframe. The headframe location balloon is barely visible in the center of the photo. From the tower a viewer has a panoramic view of the project region which appears completely wooded. The tower viewpoint is higher in elevation than the project site so it has been assumed that if the headframe can be seen, the project facilities and the clearing they create will also be visible in the distance. It is also possible the MWDF clearing will be visible. We do not expect the view to be significantly different in the winter.

Q. What are your conclusions about the Crandon Project's aesthetic and visual compatibility with the project site?

A. In my professional opinion, I have drawn the following conclusions:

1) The Mine/Mill facilities have been located, designed and landscaped to minimize disruption of the site's existing landscape character.

2) Landscaping of the project facilities following their construction will incorporate primarily indigenous plant materials compatible in form, color and texture with the existing landscape character, screen the facilities and initiate the site's long term reclamation.

3) The facilities will be as visually inconspicuous as feasible. The site's existing wooded character will substantially buffer the project facilities from view throughout the year. None of the Mine/Mill buildings except the headframe will be visible from off the premises, and the headframe will be visible only from a few points. The mine waste disposal facility will not be visible from adjoining lakes and roadways because it will be completely buffered by the existing forest cover. About five hundred feet of the railroad siding will be visible from a half mile length of Keith Siding Road.

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EXHIBIT 373

PROFESSIONAL RESUME

DAVID R. SCHREIBER
Landscape Architect, Principal

EDUCATION

Bachelor of Science - Landscape Architecture
University of Wisconsin - Madison 1972

Post-graduate studies in:

Recreation Facility Development
Project Management
Land Reclamation

REGISTRATION

Landscape Architect
0098643 (Minnesota) 1977

YEARS OF EXPERIENCE -- 14

ACADEMIC TRAINING

Training includes landscape design and construction, natural resource and ecological studies, horticulture, recreation facility development, landscape reclamation and project management.

TECHNICAL SKILLS

Skills include community land use planning, downtown revitalization, recreation facility planning and design, landscape design and construction, natural resource inventory and analysis, visual assessment techniques, model construction and technical report preparation.

PROFESSIONAL EXPERIENCE

Work experience included two years as a landscape architect with the firm of Hugh Dega and Associates, Madison, Wisconsin. Project work included master planning, site design and construction documents for a variety of park and housing site developments.

Worked six years as the principal and owner of David Schreiber and Associates, Madison, Wisconsin. Project work includes over forty park development projects in Wisconsin communities, site planning and landscape designs for numerous housing, commercial, institutional and industrial projects. Land reclamation work includes the planning and staging of Juneau County's sand and gravel removal along the Wisconsin River. Visual assessment work includes existing condition inventory and visual analysis of the proposed expansion of Consolidated Papers, Inc., Whiting Division, Whiting, Wisconsin, on adjoining residential neighborhoods.

In 1981 Mr. Schreiber merged his firm with Edwin A. Sanborn Associates to form The Sanborn Group, Inc. Project experience while a principal with the Sanborn Group, Inc. included the Green Bay Central Business District Revitalization, Green Bay, WI; Sheboygan Riverfront Revitalization, Sheboygan, WI; and, for Exxon Minerals Crandon Mine Project, the site Landscape Plan, restoring natural vegetation communities on the mining site, and along road and railroad corridors; a Visual Impact Assessment analyzing and simulating the impact of the proposed development on the natural forest environment; and the site Reclamation Plan detailing the restoration of the mine site to a natural environment following the conclusion of mine operations and the removal of all facilities.

As a principal with Schreiber/Anderson Associates Mr. Schreiber's work experience is highlighted by a site master plan and construction documents for the Good Samaritan Medical Center, Milwaukee, WI, and a Comprehensive Community Plan for the Village of Lake in the Hills, IL, which includes a detailed documentation and assessment of the community's natural resource base as an approach to directing future Village development. Visual assessment projects include a visual assessment resource evaluation and landscape development plan for the State Road Coulee drainage corridor, La Crosse, WI, a visual impact analysis, landscape and recreation potential plan for the Pine River Dike, Richland Center, WI, and currently, work on the visual character assessment and design recommendations for the City of Franklin Industrial Park.

PLANNING REPORTS AND ARTICLES

Kemper Center Historic Preservation and Site Development Study, Kenosha County Park Commission, 1979.

Sheehan Park Master Plan, City of Sun Prairie Park and Recreation Commission, 1980.

Graber Pond Conservation Area Master Plan, City of Middleton Park and Recreation Commission, 1981.

Water Based Recreation Feasibility Study, City of Stevens Point, WI, Department of Parks and Recreation (authored while a principal with the Sanborn Group, Inc., in association with Howard, Needles, Tammen, and Bergendorff), 1982.

Landscape Master Plan, part of the Crandon Project Mine/Mill Surface Facility, Site Master Plan; Exxon Minerals Company (authored while a principal with the Sanborn Group, Inc.), 1982, revised 1983.

Reclamation Plan, Crandon Project Mine/Mill Surface Facility, Exxon Minerals Company (authored while a principal with The Sanborn Group, Inc.), 1982.

Visual Impact Assessment, Crandon Project Mine/Mill Surface Facility, Exxon Minerals Company (authored while a principal with The Sanborn Group, Inc.,) 1983.

Visual Resource Evaluation and Landscape Development Plan, State Road Coulee Flood Control Project, LaCrosse, WI; Saint Paul Army Corps of Engineers, 1984.

Comprehensive Community Plan, Village of Lake in the Hills, IL; 1985.

Pine River Dike Landscape Development Plan, Pine River Watershed and Flood Prevention Project, Richland Center, WI; USDA - Soil Conservation Service; 1986

Wisconsin Waterfronts - A Development Frontier, article in the April 1983 issue of the Wisconsin Architect, co-authored with Mr. Tim Anderson.

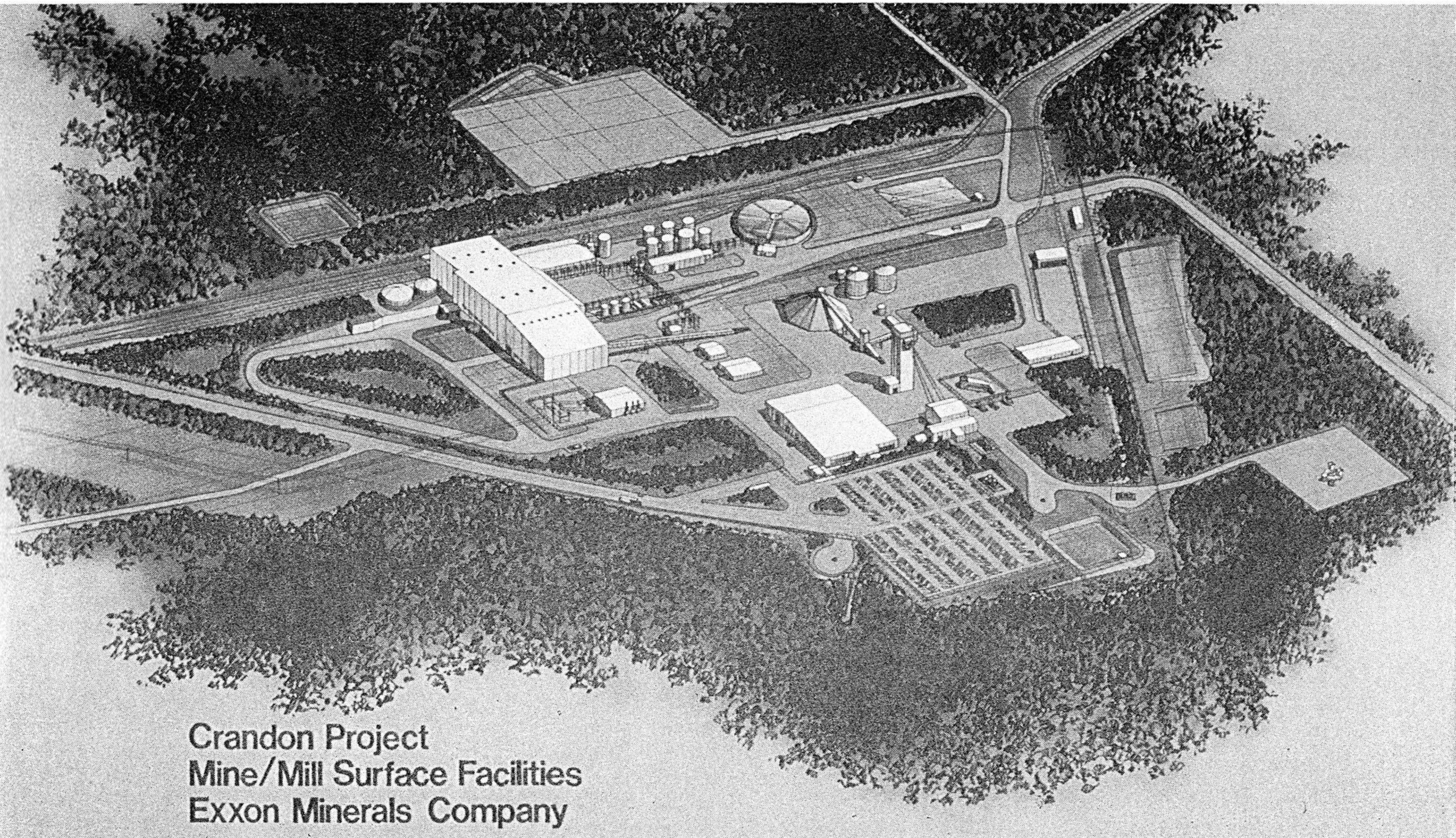
Off Main Street; once empty and unused, spaces off main streets are being transformed for new purposes resulting in exciting images for our urban centers.

PROFESSIONAL AFFILIATIONS

Member of the American Society of Landscape Architects

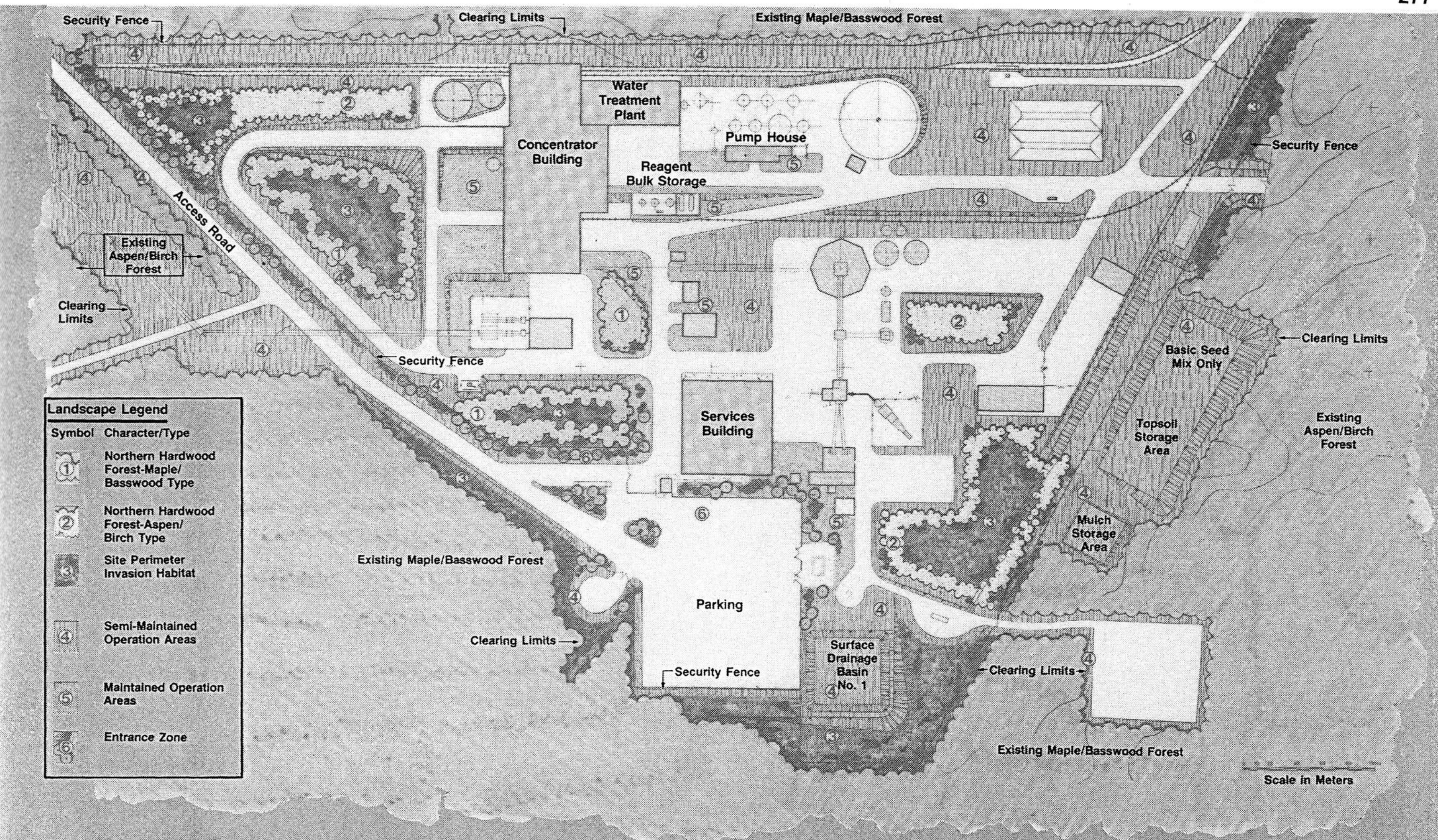
0790R

Aerial View of Mine

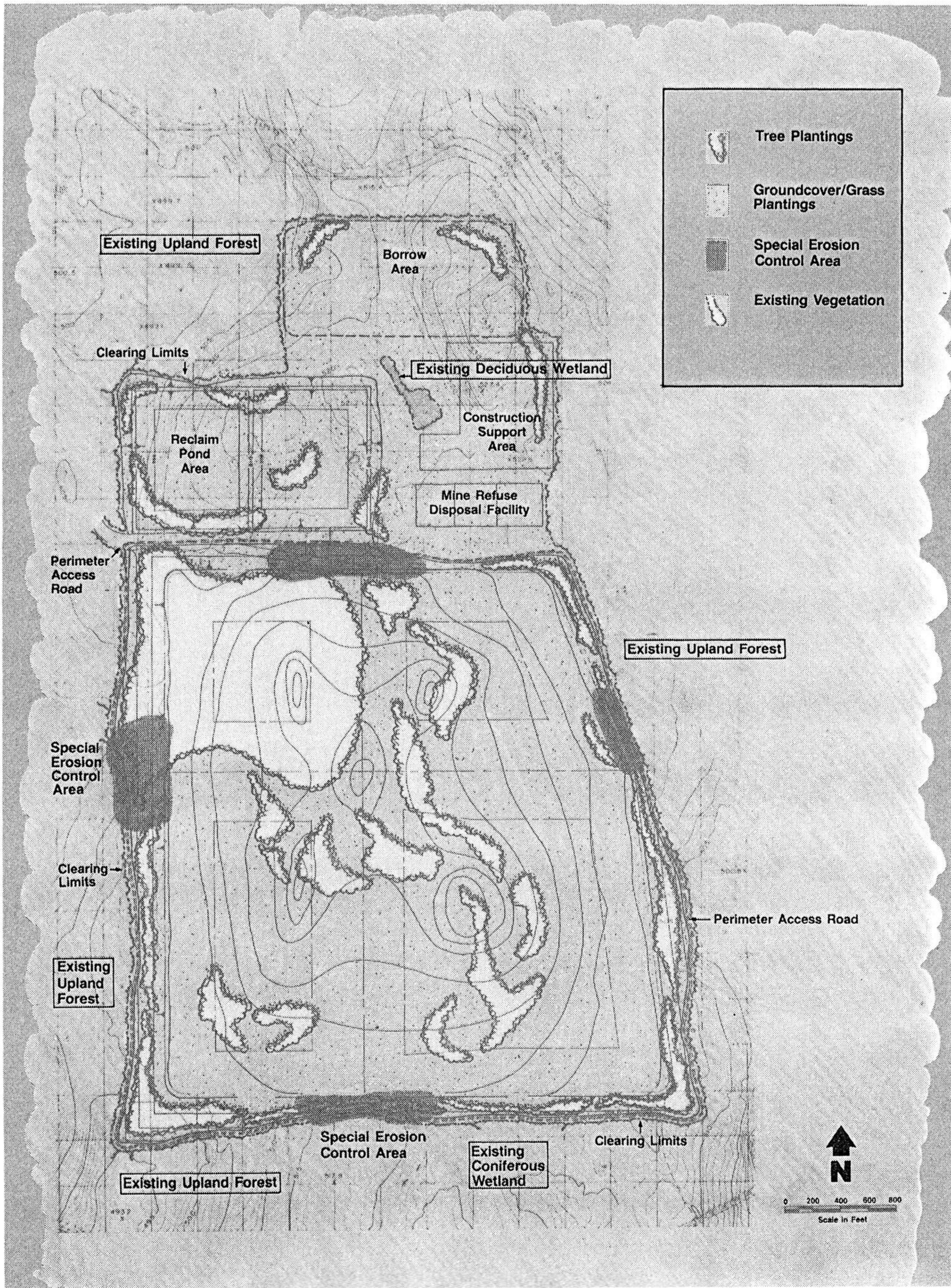


Crandon Project
Mine/Mill Surface Facilities
Exxon Minerals Company

Mine/Mill Site Landscape Plan

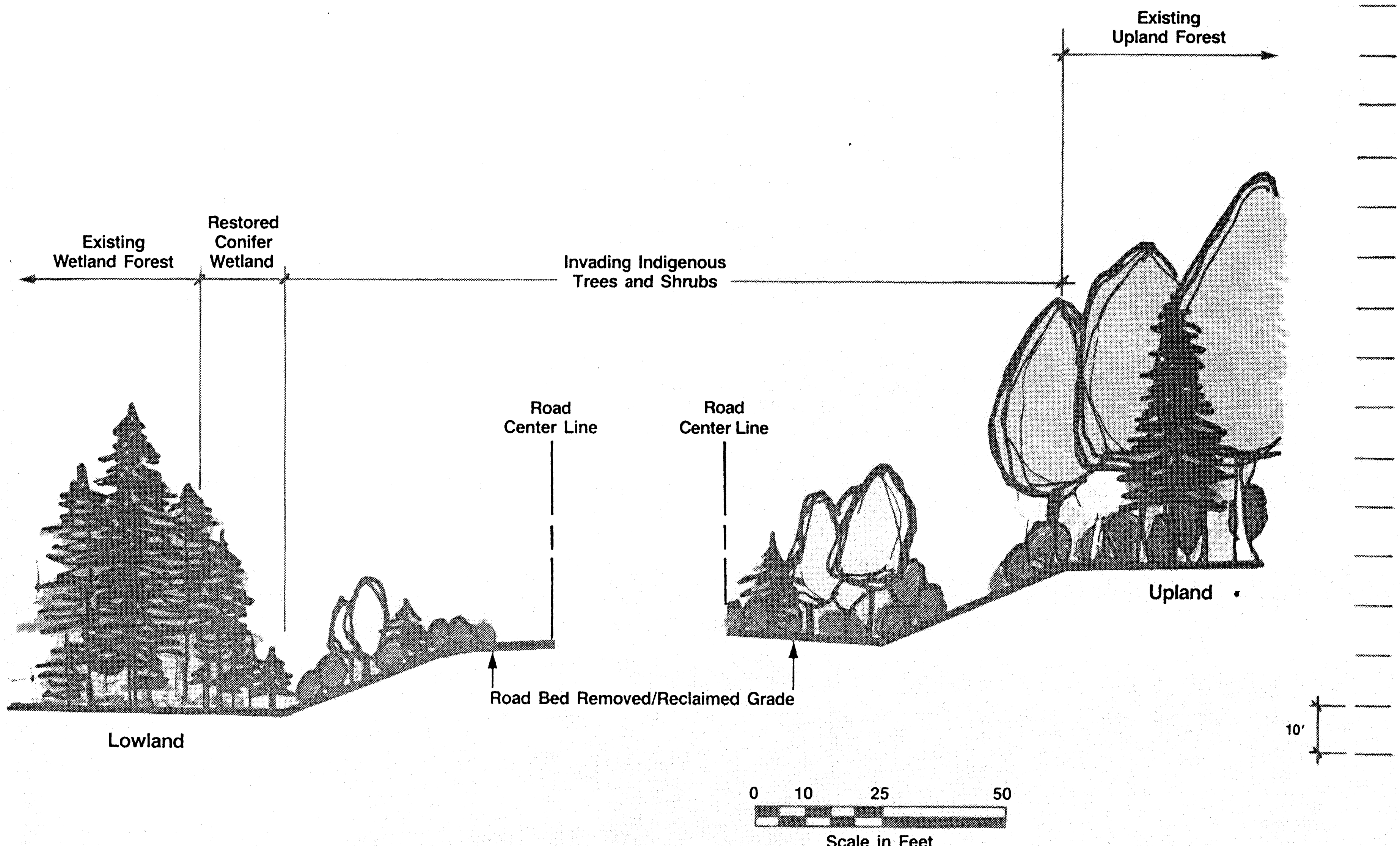


MWDF Area Reclamation Plan



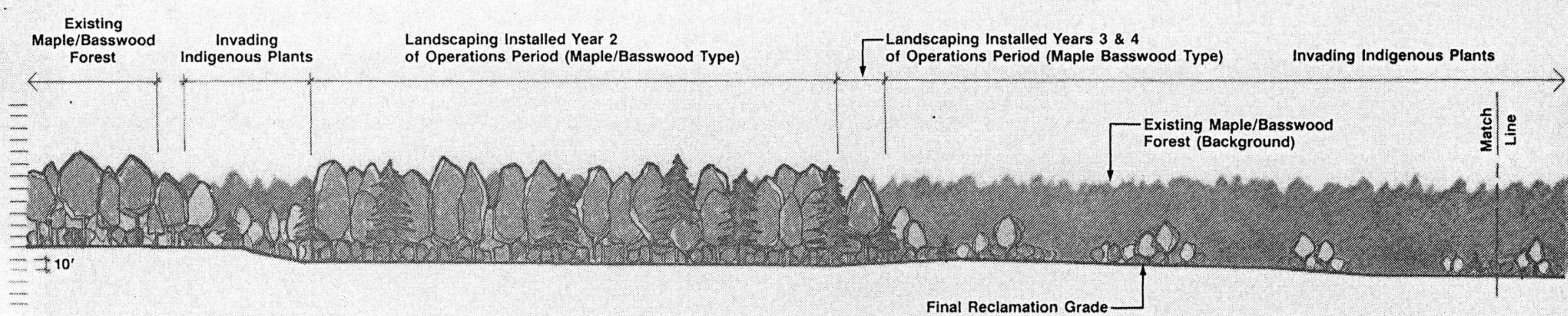
Access Corridor Sections

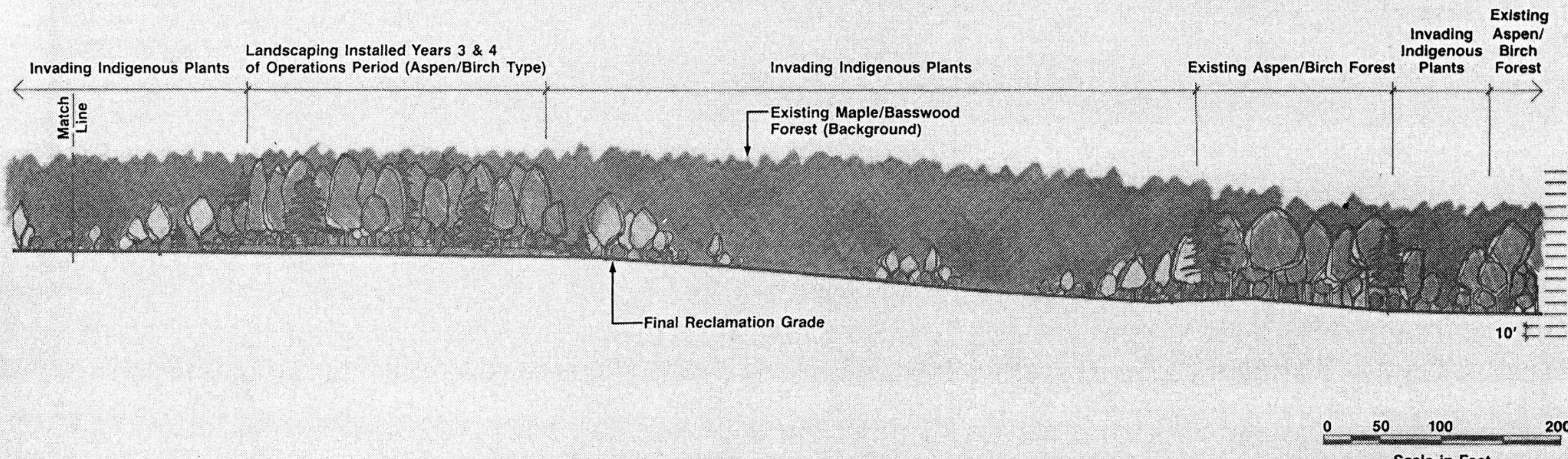
15 Years into Extended Care Period



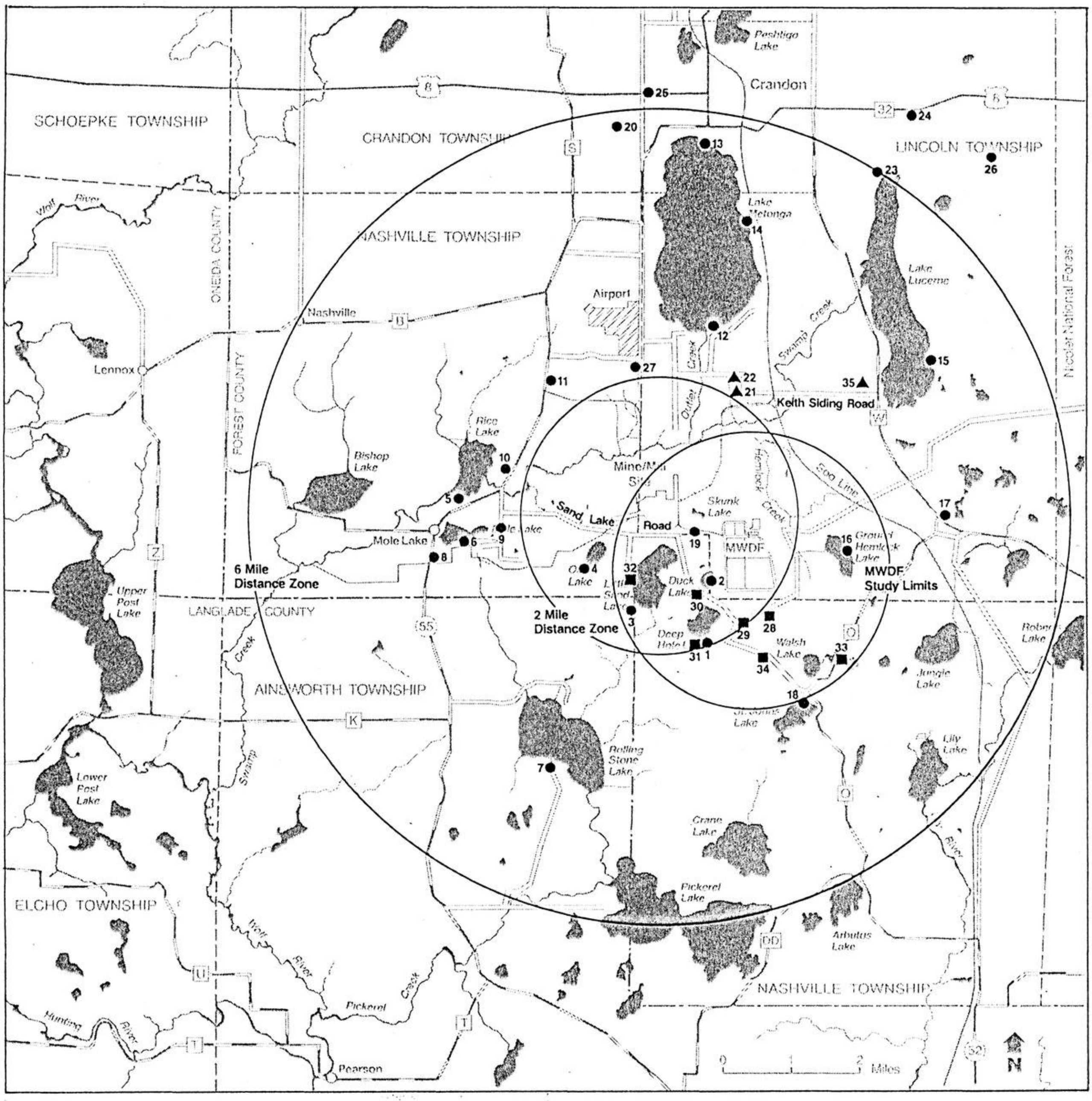
Mine/Mill Sections

15 Years into Extended Care Period





Viewpoint Locations

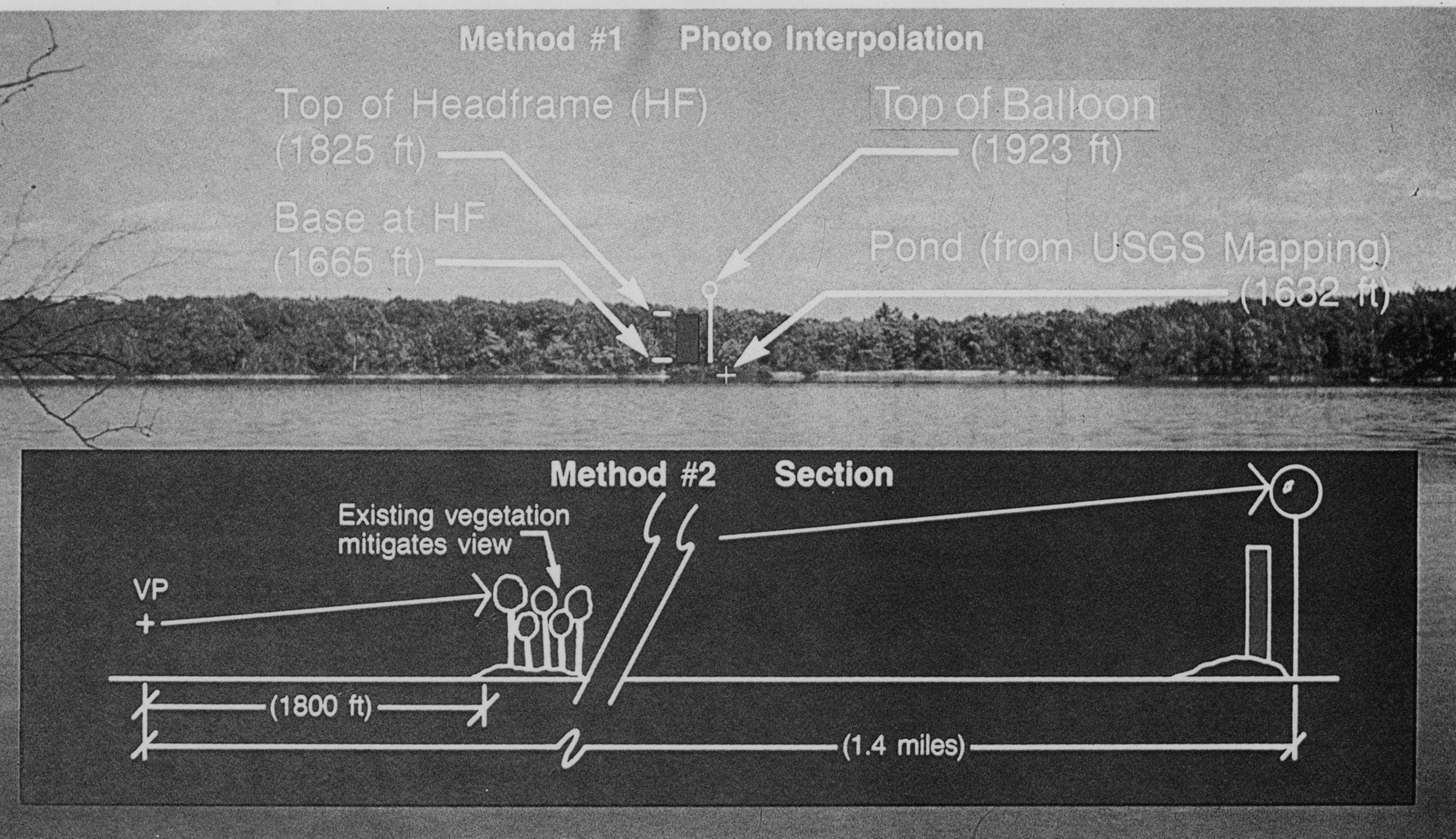


Legend

- ● Headframe viewpoints
- ■ MWDF viewpoints
- ▲ Siding viewpoints

Viewpoint 30

Visibility Determination



Viewpoint 3
Headframe Simulation

Viewpoint 11
Headframe Simulation

Viewpoint 13

Headframe Simulation

Viewpoint 19

Headframe Simulation

Viewpoint 26
Headframe Simulation

BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	))))	IH-86-18

TESTIMONY OF FRED M. KESSLER, Ph.D.

SOUND QUALITY

Q. What is your name, address, affiliation, and speciality?

A. My name is Dr. Frederick M. Kessler, 31 Shady Lane, Bound Brook, New Jersey. I am the President and Principal of FMK Technology, Inc. I am an acoustician and noise control engineer.

Q. Please outline your background and experience.

A. I have a Ph.D. in Electrical Engineering and have been a noise control engineer since 1959. Since 1971, I have been a consultant in this field and have specialized in community noise issues. I have consulted for the U.S. Environmental Protection Agency, Federal Highway Administration, and the U. S. Army Corps of Engineers, Construction Engineering

Research Laboratory. I have co-authored a book <u>Noise and Noise Control</u>, for which I wrote the chapters about community noise and noise impact assessment methods. More detail about my background can be found in my resume, which is EXHIBIT 388.

Q. What did you do on the Exxon Crandon Project?

A. I was the principal investigator for the sound quality section (labeled NOISE) of the Environmental Impact Report, EXHIBIT 158. In that connection, I developed and supervised the baseline measurement program, collected information about the construction and operation equipment noise sources, reviewed Exxon's modeling of the sound emissions and contour preparation, assessed the noise impact and reviewed the mitigative measures which Exxon was prepared to undertake should they be necessary.

Q. The Lincoln and Nashville town zoning ordinances require that mines limit noise and vibration levels during construction and operation to avoid creating a nuisance. From your studies, did you determine whether the Crandon project will create a noise nuisance?

A. Yes, I did. My assessment of the present and future sounds at a number of key locations indicates that the construction and operation will not create a noise nuisance. Occasionally, when it is particularly quiet, the construction and operation activities may be heard off-site, but the off-site sound levels will be low.

Q. So that we can understand your conclusions, would you give us some examples of the intensity of common sounds?

A. EXHIBIT 389 is a table of typical sounds found in everyday life. The center column contains a scale of the A-weighted sound levels and to the left of the scale are descriptions of typical sounds with which we may be familiar.

Q. You used a term, "A-weighted sound level." Would you please explain that?

A. The human ear is not perfect. For example, we do not hear low frequencies as well as high frequencies. Thus, a number of years ago, the A-weighting network was selected as a standard measure of the "noisiness" or "loudness" of sounds. Federal, state, and local agencies have adopted the A-weighting network as a measure of sounds for regulatory purposes and noise impact assessment.

The best way to explain is by demonstration. I have in my hand a calibrator which we use to insure that the sound measuring equipment is accurate. The calibrator generates a tone at a fixed level. I can adjust the frequency of the tone. Also in front of me is the sound level meter like the one we used to measure sound in the Project region.

I have turned on the calibrator. Can you all hear the tone? All right, I will place the calibrator on the microphone and you can see that the sound level meter reads 114 dB which is the level indicated on the calibrator. It does not sound loud but produces a high reading because the calibrator is very close to the microphone.

Now I am switching the calibrator to another frequency. Can you hear the tone? No? Well let me bring the calibrator closer to your ear. Can you hear the tone now? Yes. All right, let me place the calibrator on the microphone. As you can see, the sound level meter again reads 114 dB. Both tones produce the same sound pressure level but we hear the higher frequency sound much better than the low frequency sound.

Q. How did you come to the conclusion that this project would not create a noise nuisance?

A. We conducted a comprehensive study consisting of a number of important steps. These steps are:

a. We measured the sounds at representative locations. We call these pre-construction sounds the background ambient sound or baseline sounds.

b. We inventoried all the construction noise sources and the plant operation noise sources and determined when they would be operating and where they would be located on the site.

c. We used a computer model which incorporated noise sources and the ways in which they would be transmitted to the locations we used earlier as baseline sound level measurement locations.

d. The computer model enabled us to add the construction sound contribution to the baseline sound levels. The result was a prediction of future construction sound levels at the baseline measuring points. And we repeated this procedure for the operation sounds, as well.

e. We compared the future construction sound levels and the future operation sound levels with guidelines and standards of noise impact suggested by federal agencies such as the Environmental Protection Agency and the Department of Housing and Urban Development. We also compared the future sound levels with the present sound levels obtained from the measurement program.

f. We suggested mitigative measures for construction and operation phases. These mitigative measures take the form of administrative controls and engineering controls. Exxon plans to implement the mitigative program even though sound from the site will not be a nuisance.

Q. Let us start with your first step. What locations did you select to study the existing sound levels?

A. The ten measurement locations are shown on EXHIBIT 390. Each is representative of a "noise sensitive" area, meaning an area where people reside, worship, learn, or play. We selected the closest noise sensitive areas where the sound emitted from the site could affect people. Some of these locations are as much as three miles from the site, as can be seen from EXHIBIT 390, but each is the closest noise sensitive area to the site in their direction.

Location 5, although shown on EXHIBIT 390, is an isolated house located on Exxon property and used as an Exxon Field Office, and is therefore not a noise sensitive location.

Q. Describe the procedure you used to determine the baseline sound levels at the ten locations you used.

A. The environmental sounds were tape recorded using the system shown in EXHIBIT 391. The microphone was placed on a tripod at the measurement location and the sound level meter and recorder were about 100 feet from it. Sound levels were recorded for one-half hour periods during daytime and nighttime so that we evaluate the day-night average sound level.

Q. What is the day-night average sound level?

A. The U.S. Environmental Protection Agency, followed by other federal agencies, such as the Department of Housing and Urban Development, has adopted the day-night average sound level as the indication of environmental impact. The day-night average sound level is determined from the average A-weighted sound level measured during daytime and the average A-weighted sound level measured during nighttime, with the nighttime sound penalized by the addition of 10 dB.

This was done because nighttime sounds tend to annoy people more than daytime sounds of the same level

Q. What was the next step?

A. The tape recordings made in the field were analyzed using a computer controlled analyzer to determine the average sound levels for each measurement period. From these data we computed the day-night average sound level and, of course, included that 10 dB penalty for the nighttime sound.

Q. What were the results of your measurements?

A. We obtained a considerable amount of data from our measurements which are summarized in the body of the Environmental Impact Report, EXHIBIT 158, and detailed in its appendix. But, for this hearing, for clarity, we have limited our presentation of the baseline sound levels to day-night average sound levels at each measurement location for winter and summer periods. This information is seen in the first two columns of EXHIBIT 392. Note that although Location 5 is shown on EXHIBIT 392, it is not a noise sensitive location.

Q. Can you compare the numbers on EXHIBIT 392 to any standards for sound quality?

A. Yes, the U.S. Environmental Protection Agency and the Department of Housing and Urban Development have provided us with objective criteria for describing the sound quality of an area as seen in EXHIBIT 393. Noise is defined as unwanted sound. Many of us object to sounds which we do not generate. For example, our neighbor's lawn mower may be objectionable while our own equally noisy air conditioning compressor is not. Our young grandchild's violin playing is God-given music to us but is screechy noise to our neighbor.

To overcome the subjective assessment of noisiness, we utilize the guidelines and standards used by federal agencies. These guidelines result from numerous studies of noise annoyance and nuisance, and provide an objective measure for noise levels. I have also shown on EXHIBIT 392, the EPA Noise Exposure Class and the HUD acceptability grade for the noise sensitive areas represented by the baseline sound level measurement locations. As you can see, the baseline sound exposure at each location is rated "acceptable." On the EPA noise exposure scale, the baseline sound exposure is "minimal" at every location except Nos. 4 and 5 in summer. The slightly higher day/night average sound levels at those locations are explained by motorcycles and lawn mowers in use at Location 4 and by Exxon activities at Location 5.

Q. Please outline the steps you used to estimate the sound levels which will occur during construction.

A. Construction is conducted in phases. We obtained a list of the equipment expected to be used, and of the centers of construction activity. We learned from published data the maximum sound level emitted by each construction machine and the percentage of time that each machine typically operates at its noisiest.

Q. How did you estimate how noisy those machines would be at the distant noise sensitive locations?

A. Sound is reduced by distance and by such environmental factors as air, grass, brush, trees, hills and buildings. The computer model used some of these attenuation factors to estimate the sound at large distances from the site. For example, we did not consider the noise reduction from hills, buildings, grass or bushes, but we did use a reasonable noise reduction factor for air and trees. The computer model predicted the average sound level contributed by construction at each noise sensitive area. Contours of sound were also generated. The computer then added the construction sound to the baseline sound to estimate the future sound during construction. The model produced a "worst-case" estimate. That is, we assumed the construction sound emissions from each construction location on the site, e.g. waste disposal area, mine shaft, haul road, etc., would occur simultaneously even though that is unlikely to happen.

Q. What did you conclude about the sound levels at the ten baseline sound measurement sites during the construction period?

A. EXHIBIT 392 shows the day-night average sound levels at each baseline sound measurement location during construction. Also shown on the exhibit are the baseline sound levels. For example, construction will increase the sound levels at location No. 1 by four-tenths of a decibel in winter and by one-tenth of a decibel in summer when tree leaves absorb most of the construction sounds.

Q. Did you evaluate the sound quality at these locations for construction sound?

A. Yes. In the final two columns of EXHIBIT 392, I have added the EPA and HUD sound quality assessments for the noise levels expected during construction. As you can see, the sound remains in the acceptable range at each location. It remains minimal at each location except Nos. 4 and 5, where it remains moderate.

Q. Does that mean that no one will hear the sound from construction?

A. No. At some locations no construction sounds will be heard. At other locations, when the local nearby sounds are low, construction sound will be heard, although the sound will be of low level. Sometimes construction sounds may be heard when a particular wind pattern or a temperature inversion reduces the effect of distance on the construction sounds.

Q. On EXHIBIT 392, the greatest increase of sound during construction occurs at location 3 during the winter time when sounds increase by 5.1 dB. Is that a large increase?

A. No. Numerous experiments have shown that sound level changes of up to 5 dB are not noticed.

Q. Can you compare the average sound level at Location 3 with sound levels from sources with which we are familiar?

A. Yes, we can use EXHIBIT 389 to compare typical sound levels with the average sound levels at each location due to construction. For example, at Location 3 in winter <u>during construction</u>, the average daytime sound level will be about 45 dB. This is below the sound indoors at an average residence.

We can also compare the day-night average sound level, L_{dn}, at Location 3, during construction, with typical outdoor sound levels throughout the United States. The US EPA has provided the data in EXHIBIT 394 which shows the day-night average sound levels for typical outdoor locations in the US. Note that 45 dB is less than the typical sound levels for wooded residential areas and agricultural crop land. Even at Location 6, where the change during nighttime construction (if required) is 15.7 dB, the day-night average sound level during construction is comparable to a wooded residential area. EXHIBIT 394 can also be used to compare day-night average sound levels during operation of the proposed facility with typical outdoor environments.

Q. Did you use the same methods to estimate sound levels during mining operation?

A. Yes, we did. The mine operation noise sources were determined and located on a map of the site. Operation sound levels were determined for each major source of noise. Again, we assumed the worst-case in which all the mine operation noise sources were operating simultaneously.

Q. And what did you conclude?

A. EXHIBIT 395 shows the predicted day-night average sound levels at each baseline measurement location during winter and summer with the EPA noise exposure class and HUD acceptability class for each entry. The only change in the sound quality evaluation is at Location 5, which is not noise sensitive.

Q. Does Exxon plan to take any measures to minimize the sound emitted from its premises during construction or operation?

A. Yes. Exxon has developed a noise mitigation plan including both administrative and engineering noise controls. All engine powered equipment on site, during construction or operation, will have mufflers. The large exhaust blowers for the mine have been selected for their quiet operation. Ordinarily, no surface construction will be done at night. Other noise control measures are described in the Environmental Impact Report, EXHIBIT 158.

Q. Will any of the sounds emitted from the site constitute a hazard to the health of the receivers?

A. No. The sound emissions off-site will be quite low. Exposure to A-weighted sound levels exceeding 85 dB for eight hours per day for a working lifetime is required before hearing damage can result. As seen in the viewgraphs, sound levels reaching noise sensitive receptors will be well below 85 dB.

Q. Do the data and methods used in your study permit you to draw your conclusion to a reasonable degree of scientific certainty?

A. Yes. This was one of the most comprehensive environmental noise impact assessments I have ever participated in. Here we had comprehensive inventories of construction and operation equipment expected to be used, data that is usually not available at so early a planning stage. Also, Exxon Research and Engineering used their computer model to estimate the equi-A weighted sound level contours. This was done at the request of the community. Usually, we only compute the future environmental sound at the baseline sound level measurement locations which represent the critical noise sensitive areas near the site.

Q. What is a sound level contour?

A. The contour presentation is a graphic presentation of sound which can be used to picture the contribution of the source at many locations (both noise sensitive and pristine) off site. The day-night average sound levels at each baseline location during construction and operation can be inferred from the contour maps by adding the contribution shown by the contours at each location to the background ambient sound levels which were measured.

Q. The DNR uses the International Standards Organization (ISO) criteria to assess impact. In your professional opinion, are these criteria reasonable for this site and environs?

A. No. The ISO criteria are based on urban opinion, or data where ambient sound levels, in general, exceed the EPA long-term goal of 55 dB. It is interesting to note that the United States delegation to the ISO committee, which drew up these criteria, voted against their adoption.

I would suggest use of an EPA community reaction criteria which is based on day-night average sound levels. These EPA criteria are shown in EXHIBIT 396. Note the similarity in community reaction descriptors with those used by ISO. I would suggest use of EXHIBITS 393, 394 and 396 to assess noise impact since the sound quality near the proposed facility is representative of rural or wooded residential areas rather than urban neighborhoods. While the average sound levels change during construction or operation at the proposed facility, the sound quality represented by the day-night average sound level is still quite low indicating "No Overt Reaction."

0791R

EXHIBIT 388

FREDERICK M. KESSLER, Ph.D.

EXPERTISE:

Engineering Acoustics (Noise Control)
Mechanical/Electrical Engineering
Environmental Studies Management
Computer Systems and Software

EDUCATION:

Ph.D.E.E. Rutgers University, New Brunswick, New Jersey, 1971. Thesis: Application of Conjugate Gradient Optimization Methods to Acoustic Filter Synthesis.

M.S.E.E. Rutgers University, New Brunswick, New Jersey, 1967.

B.M.E. The City College of New York, New York, 1954.

Lafayette College, Easton, Pennsylvania, Electrical Engineering (1961 to 1964).

Massachusetts Institute of Technology, Cambridge Massachusetts, Noise Reduction (short course), 1961.

EXPERIENCE:

1983 - Present FMK Technology, Inc., Bound Brook, New Jersey

President. Practice of Engineering Acoustics and Noise Control Engineering. Consultant to the United Nations Industrial Development Organization, Vienna, Austria for project in India. Clients: Colgate Palmolive Company, Atlantic & Pacific Tea Company, Exxon Minerals, Company, Hydro Quebec, DELMARVA Power & Light Company, U. S. Army Construction Engineering Research Laboratory, New York City Bureau of Noise Abatement, U. S. Navy, Signal Rust and others.

1873 - 1983 Dames & Moore, Cranford, New Jersey

Managing Partner (1980 - 1983). Overall responsibility for noise control engineering, geotechnical, geohydrological, RCRA, and environmental studies for clients in government, mining, manufacturing,energy, and petrochemical industries. Responsible for the profitable operation of an office profit center with a gross income in the three to four million dollar range. Managed Engineering Acoustic and Noise Control practice serving clients such as General Electric Company, Leisure Technology, Exxon Research & Engineering, Boeing Computer Center and others. Managing Partner of White Plains and New York offices of firm.

Partner/Associate - Engineering Acoustics and Noise Control (1973 - 1980). Program Manager and Principal Investigator for numerous studies for private sector and government clients. Prepared more than 350 sound quality sections of Environmental Impact Studies. Served clients such as Baltimore Gas & Electric Company, Rochester Gas & Electric Company, U. S. Army Fort Carson, Fort Meade, Military Academy (West Point), Oregon Highway Department, New Jersey Department of Transportation. Completed community noise studies for the U. S. Army Construction Engineering Research Laboratory, U. S. Federal Highway Administration, and the U. S. Environmental Protection Agency's Office of Noise Abatement and Control. Participated in the preparation of the "Report to the President on Noise." Consultant to U. S. EPA Regions I, II, and III. Testified before the Federal Energy Commission, Federal Railroad Commission, New York State Public Service Commission, Montgomery County (MD) Appeals Board, New Jersey Attorney General Hearing Examiner, municipal and superior courts, and local township governments, planning boards, and boards of adjustments.

1973 - 1980 Stevens Institute of Technology, Hoboken, New Jersey.

Adjunct Professor, Mechanical Engineering Department, graduate courses in noise control engineering.

1971 - 1973 Lewis S. Goodfriend & Associates, Morristown, New Jersey.

Vice President and Manager of Engineering Acoustics. Contributed to the U. S. Environmental Protection Agency "Report to the President and Congress on Noise." Project management and preparation of report on "Construction Site and Equipment Noise in New York City," prepared for the New York City Bureau of Noise Abatement. Principal investigator of noise impact assessment for Sterling Power project application to the New York State Board on Generation Siting and Environment, for Rochester Gas & Electric Company.

1968 - 1971 Rutgers University, New Brunswick, New Jersey.

Member of the faculty of the Department of Electrical Engineering. Redesigned the Kantrowitz Heart-Assist Pump.

1961 - 1968 Ingersoll Rand Company, Princeton, New Jersey.

Senior Development Engineer in Research & Development Department. Leader of noise abatement programs for pneumatic and electric power tools which have been incorporated into tools which were manufactured and sold. Developed prototype quiet 900 cfm portable air compressor (first in the United States) and vibrationless pavement breaker. Invented mechanical impedance technique for stress measurement. Designed 5000 psig, 100 scfm vibrationless air compressor.

1959 - 1961 U. S. Navy David Taylor Model Basin, Washington, D.C.

Senior Project Manager, Submarine Section of Vibration and Structure-borne Noise Branch. Responsible for hull vibration tests at sea conducted on U. S. Naval submarines. Included are the theoretical calculation of hull natural frequencies and modes of vibration, preparation of transducer, amplifier, and recording equipment, and the supervision of engineers and technicians while at sea.

1956 - 1959 U. S. Naval Officer, LT.J.G.

U. S. Naval Shipyard, Brooklyn, New York (1958-1959). Engineering Duty Officer. Responsible for the orderly repair and overhaul of main propulsion system for the U.S.S. Lake Champlaign, and for the installation of boiler and distillation equipment on board U.S.S. Snyder. Qualified dry docking officer. U. S. Naval Ship Repair Facility, Yokosuka, Japan (1956-1958). Engineering Duty Officer. As Shop Superintendent, was responsible for procurement, maintenance, and repair of the Ship Repair Facility's plant account equipment. Also responsible for Safety and Transportation Departments.

1954 - 1955 Curtiss-Wright Corporation, Woodbridge, New Jersey.

Junior Test Engineer responsible for testing and trouble shooting J65 Gas Turbine Engine accessories.

PATENTS:

High Pressure Fluid Gun, Patent No. 3,207,442
A Stress Measuring Device, Patent No. 3,307,393
Muffler, Patent No. 3,323,615

PROFESSIONAL AFFILIATIONS:

Fellow of the Acoustical Society of America. Associate Editor, Journal of the Acoustical Society of America. Vice President for Technical Affairs of the Institute of Noise Control Engineering. Consulting Editor and former Chairman of the Editorial Board of the Noise Control Engineering Journal. Former Chairman of the Society of Automotive Engineers Committee on Construction Site Noise Measurement. Member of the Institute of Electric and Electronic Engineers. Sigma Xi. Former member of the Bridgewater Township, New Jersey Environmental Commission.

Selected for inclusion in the 6th Edition of "Who's Who in Engineering. Formerly included in Who's Who in Technology Today, Who's Who in Finance and Industry, Who's Who in the East, and American Men and Women of Science.

PUBLICATIONS:

Crocker, M., and Kessler, F. M., Noise and Noise Control, CRC Press, 1982, and over twenty technical publications.

PUBLICATIONS

Kessler, F.M., et al., "Highway Identification of Exhaust System Noise Problems," 106th Meeting of Acoustical Society of America, November 1983.

Crocker, M., and Kessler, F.M., "Noise and Noise Control," CRC Press, 1982.

Kessler, F.M., and Archambault, C., "Noise Control for Diesel Electric Generating Plant," InterNoise '82, San Francisco, California, May 1982.

"Cost Effectiveness of Construction Noise Abatement," Sound and Vibration, May 1981.

Kessler, F.M. and Schomer, P., "Pile Driver Noise Control," Proceedings of InterNoise '80, Miami, Florida, December 1980.

"Noise Control: Diesel Electric Generating Station," Proceedings of the First Haifa Symposium on Industrial and Applied Acoustics, Technion - Israel Institute of Technology, April 1980.

Kessler, F.M., and Alexander, M., "Sound Procedures for Measuring Highway Noise," FHWA-DP-45-1, May 1978.

Kessler, F.M., and Gray, L., "Pavement Breaker/Rock Drill Noise Control Methods," Proceedings of InterNoise '78, San Francisco, California, May 1978.

"Code of Standard Practices for the Enforcement of Noise Ordinances," Submitted to Office of Noise Abatement and Control Federal Environmental Protection Agency, 1978.

"Report of 1977 Symposium on Highway Construction Noise," FHWA-TS-77-211, 1977.

"Acoustic Impact Assessment Procedure Used in Industrial Plant Site Selection," Presented at the 4th World Congress of Architects and Engineers, Tel Aviv, Israel, December 1976.

Kessler, F.M., and Gottlieb, P., "Method to Convolve Sound-Level Distributions for Prediction of Community Sound Levels," J. Acoustical Society of America, Vol. 60, No. 5, November 1976.

Schomer, P.D., Kessler, F.M., et al., "Cost Effectiveness of Alternative Noise Reduction Methods for Construction of Family Housing," Interim Report N-3, U.S. Army Construction Engineering Research Laboratory, July 1976.

NOISEXPO '75 and NOISEXPO '74 Proceedings Book Review, J. Acoustical Society of America, Vol. 59, No. 5, May 1976.

"Acoustic Impact Assessment Used in Industrial Plant-Site Selection," Noise Control Engineering, Vol. 6, No. 1, January-February 1976.

"Assessment of Acoustic Impact of a Proposed Steam Generating Plant in New York State," Noise Control Engineering, Vol. 4, No. 1, January-February 1975.

SAE Draft Procedure Measures Construction Site Noise Levels," Proceedings on InterNoise '74, Washington, D.C., September 1974.

"Noise Data Recording and Computer-Controlled Analysis," Sound and Vibration, April 1973.

Goodfriend, L.S. and Kessler, F.M., "Industrial Noise Pollution," Presented at the First International Meeting of the Society of Engieering Science on Pollution: Engineering and Scientific Solution, Tel-Aviv, Israel, June 1972.

Kessler, F.M., Puri, N.N., and Sannuti, P., "A Modified Conjugate Gradient Algorithm Not Requiring the Adjoint Vector for Optimal Control Computation," Journal Dynamic Systems, Measurement and Control, March 1972.

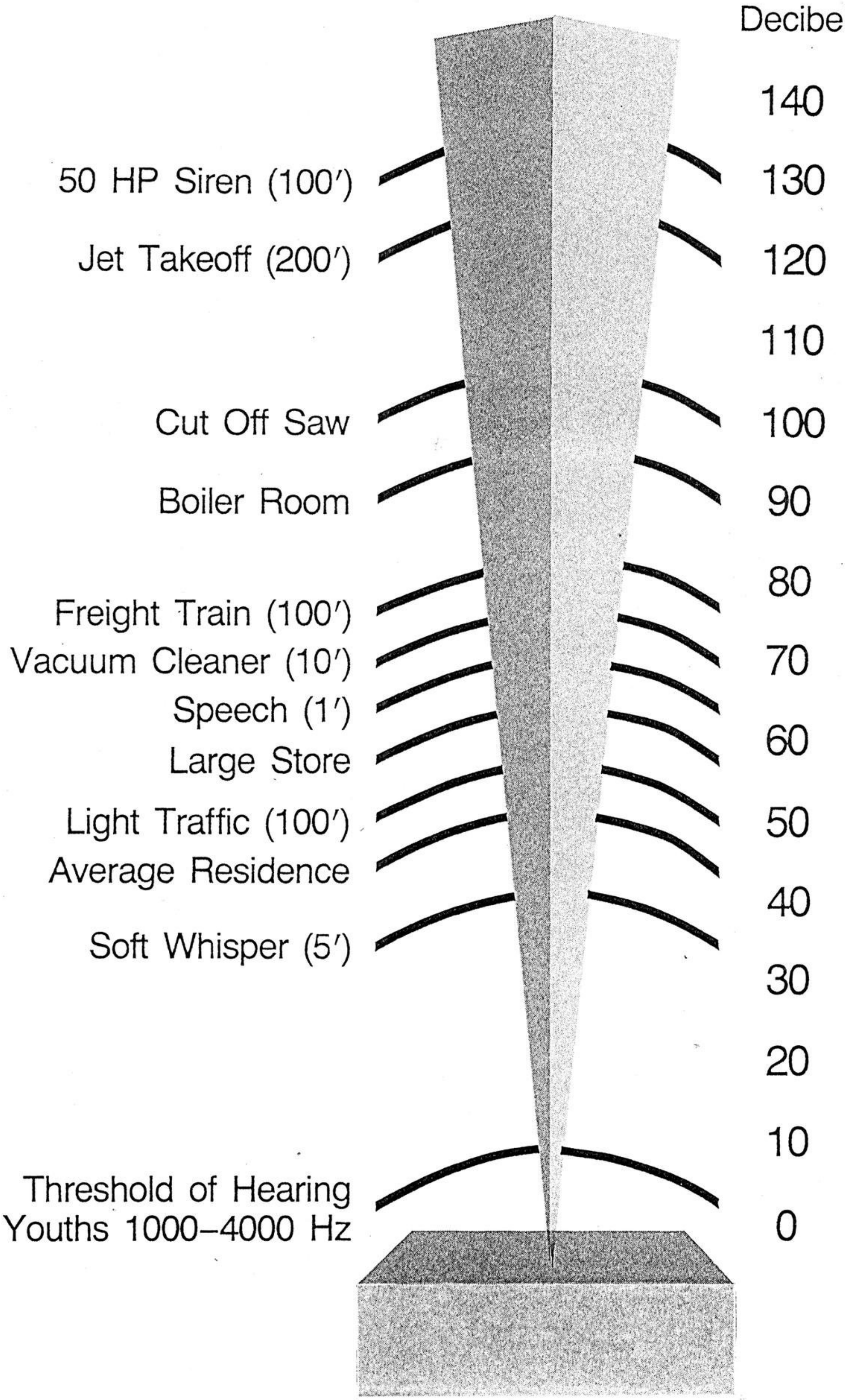
Contributor to Industrial Noise Section of U.S. Environmental Protection Agency, "Report to the President and Congress on Noise," GPO 5500-0040, February 1972.

"Acoustic Filter Synthesis," Presented at the 81st Meeting of the Acoustical Society of America, Paper No. T1, April 1971.

Kessler, F.M., and Puri, N.N., "Acoustic Filter Synthesis Using Conjugate Gradient Search Techniques," J. Acoustic Society of America, May 1971.

Sound Levels

Typical A-Weighted

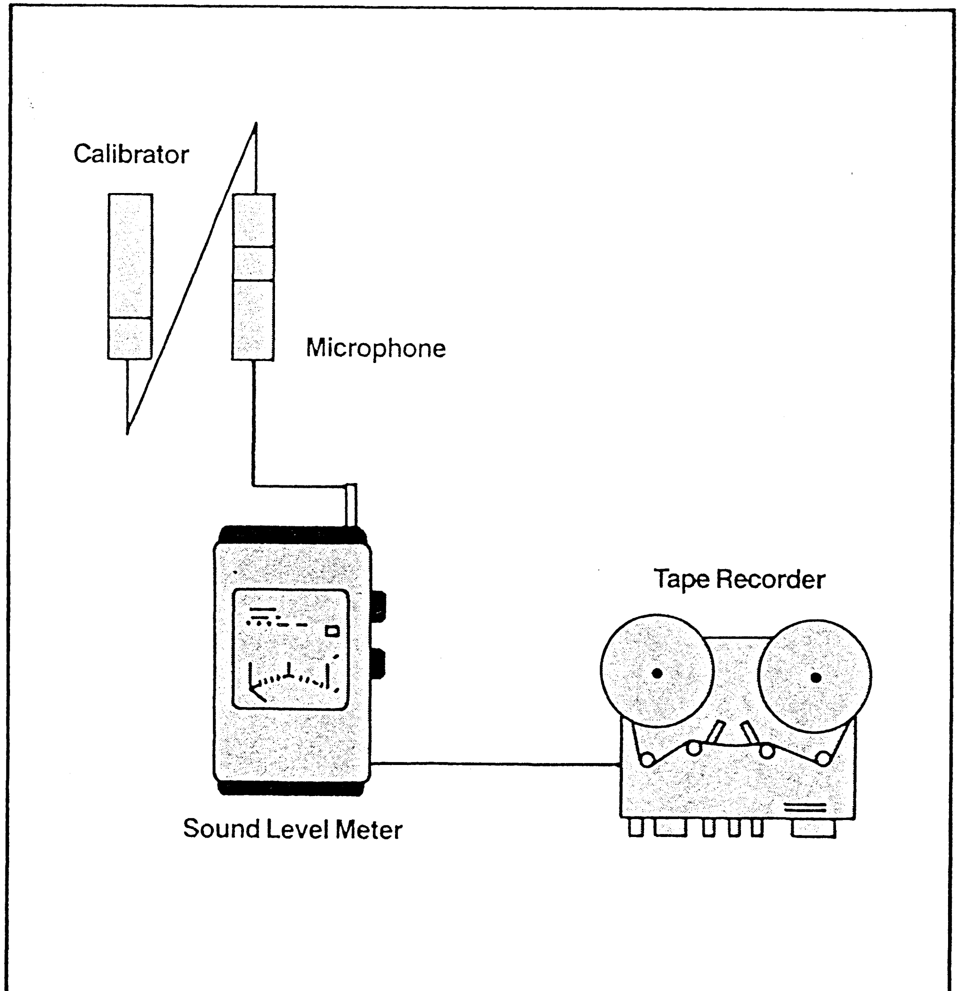


Sound Level Measurement
Locations

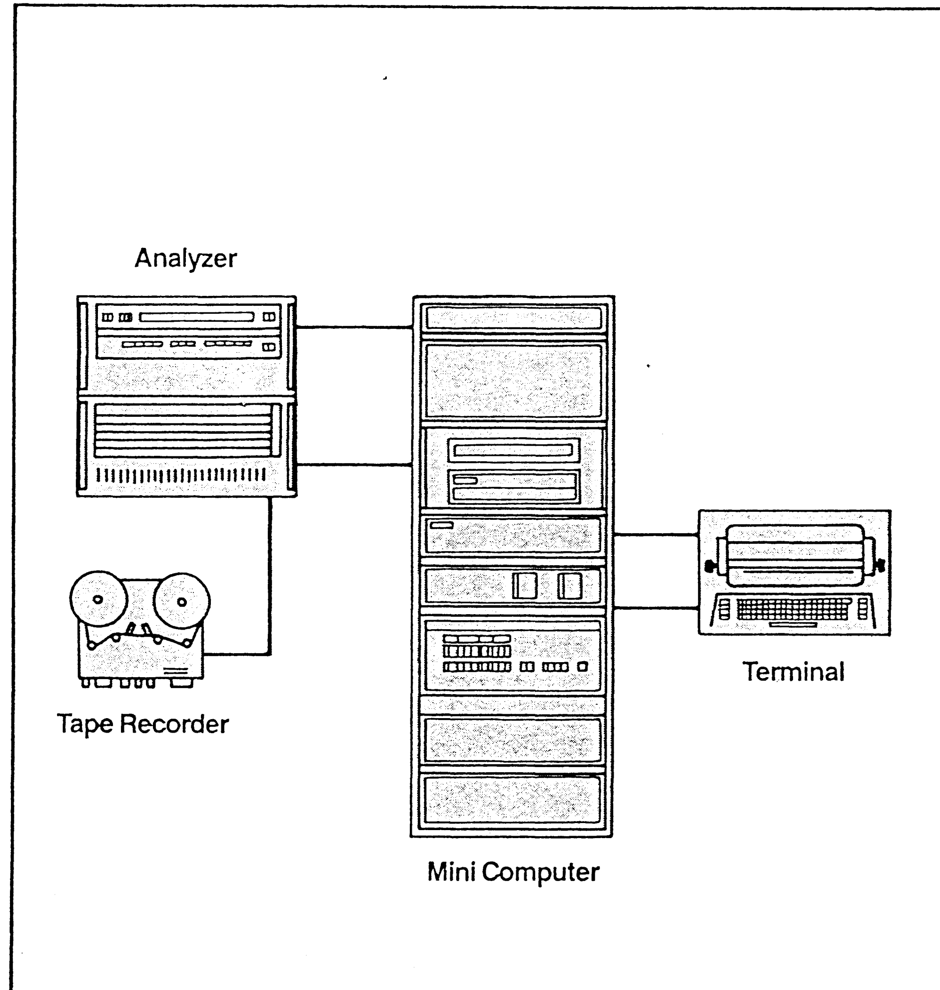
Legend

2 Measurement Locations

Sound Level Measurement Systems



Data Acquisition System



Computer Controlled Data Analysis System

Sound Levels/Day-Night Averages

Quality Assessment

Locations	Baseline L_{dn}	Baseline Sound Quality		Construction L_{dn}	Construction Sound Quality	
		EPA Noise Exposure	HUD Acceptability		EPA Noise Exposure	HUD Acceptability
WINTER						
1	41.9			42.3		
2	38.1			40.3		
3	38.0			43.1		
4	44.1			44.6		
5	45.2			53.2		
6	40.2			46.0		
7	48.8			49.0		
8	37.9			39.7		
9	37.1			43.7		
10	37.8			39.8		
SUMMER						
1	49.9			50.0		
2	46.5			46.9		
3	50.5			51.0		
4	62.3			62.3		
5	56.6			58.0		
6	44.9			47.8		
7	49.3			49.5		
8	46.2			46.5		
9	41.4			45.0		
10	38.4			40.2		

Minimal Exposure   Moderate Exposure   Acceptable

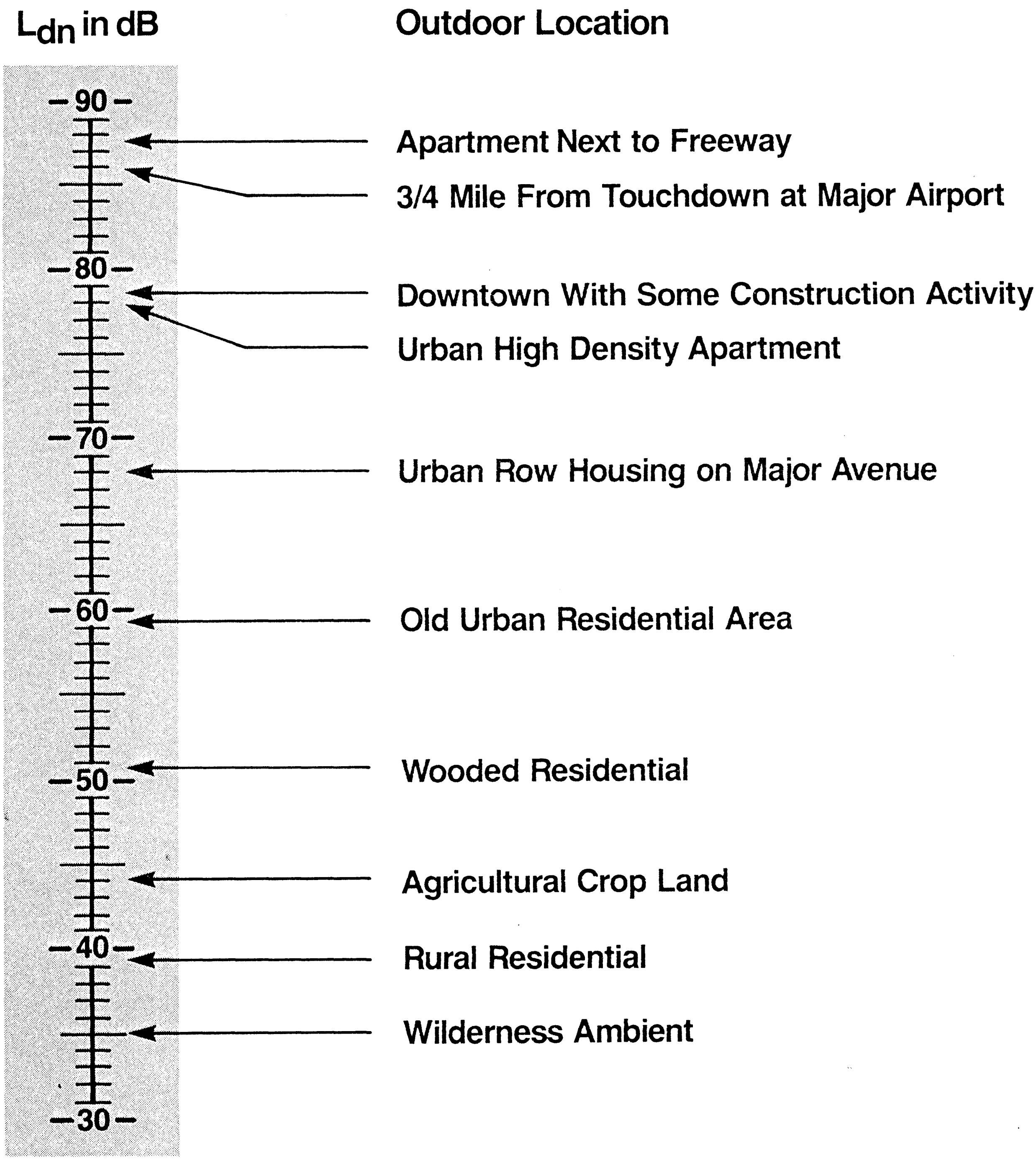
Noise Zone Classification

EPA Noise Exposure Class	L_{dn} = Day–Night Average Sound Level (dB)	HUD Noise Standards
Minimal Exposure	← Not Exceeding 55	Acceptable
Moderate Exposure	56 → 65	
Significant Exposure	66 → 70	Normally Unacceptable
	71 → 75	
Severe Exposure	76 → 80	Unacceptable
	81 → 85	
	86 ⟶	

HUD, DOT and EPA recognize L_{dn} = 55 dB as a long term goal for outdoors in residential areas

Outdoor Sound Level Examples

Day-Night Averages



Sound Levels/Day-Night Averages

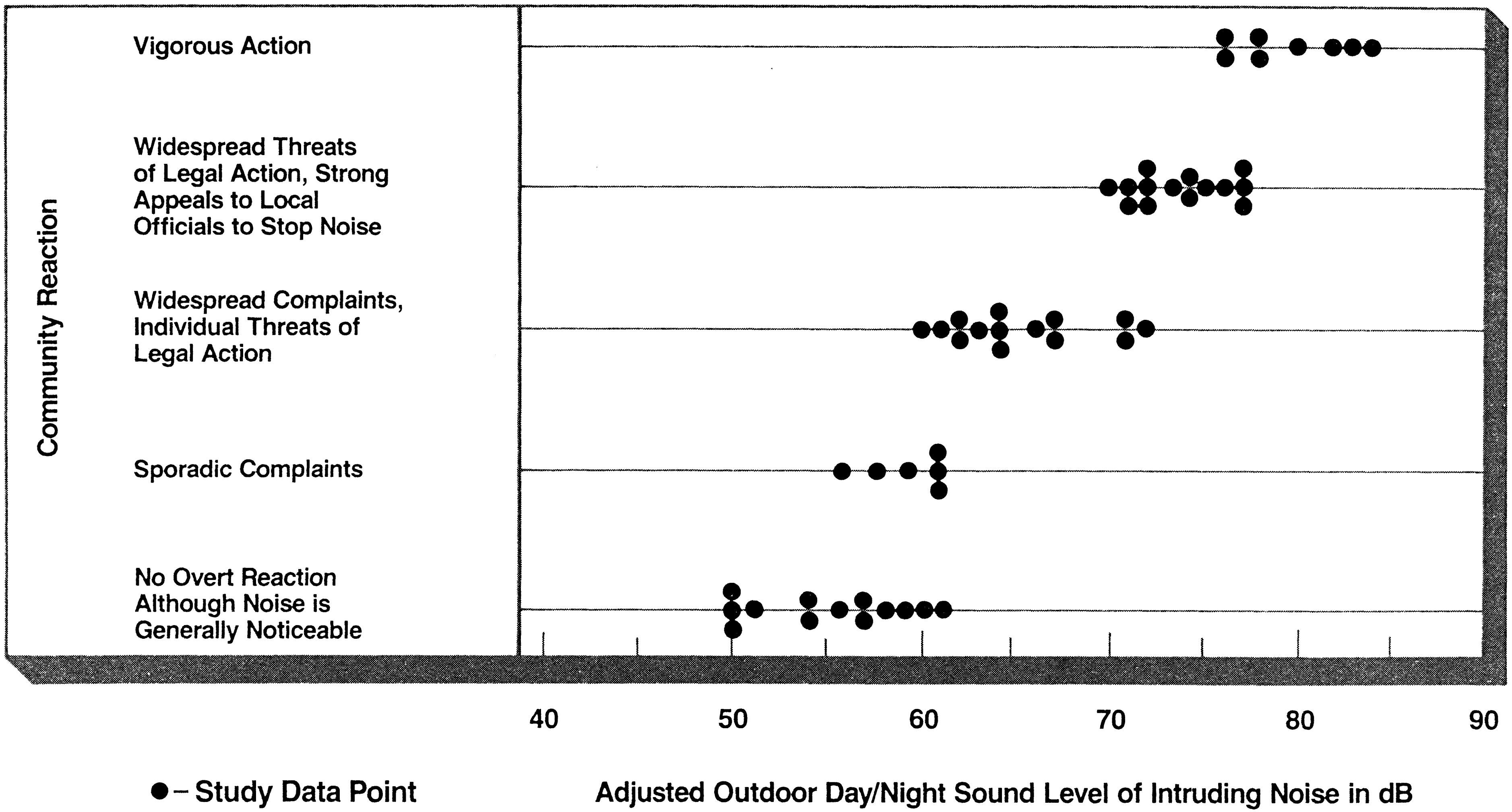
Quality Assessment

Locations	Baseline L_{dn}	Baseline Sound Quality		Operation L_{dn}	Operation Sound Quality	
		EPA Noise Exposure	HUD Acceptability		EPA Noise Exposure	HUD Acceptability
WINTER						
1	41.9			42.6		
2	38.1			42.0		
3	38.0			41.0		
4	44.1			44.7		
5	45.2			58.0		
6	40.2			49.7		
7	48.8			49.1		
8	37.9			40.8		
9	37.1			45.5		
10	37.8			40.5		
SUMMER						
1	49.9			50.1		
2	46.5			47.4		
3	50.5			50.8		
4	62.3			62.3		
5	56.6			60.2		
6	44.9			50.6		
7	49.3			49.6		
8	46.2			46.8		
9	41.4			46.4		
10	38.4			40.8		

Minimal Exposure — Moderate Exposure — Acceptable

Reactions to Noise

396



BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	))))	IH-86-18

TESTIMONY OF DR. RICHARD P. HERBST

MINING PERMIT: MONITORING PLAN

Q. Dr. Herbst, you testified earlier in this proceeding on the air permit, and at that time provided us with an extensive review of your education and experience. Rather than reviewing that information again in detail today, could you simply provide us with a curriculum vita?

A. Yes. That is attached as EXHIBIT 283 to my pre-filed written testimony.

Q. Dr. Herbst, what will be the scope of your testimony today?

A. Today I will review Exxon's Monitoring and Quality Assurance Plan, which includes programs for monitoring and evaluating potential effects from Project activities on air, ground and surface water, and aquatic and terrestrial ecosystems. The Plan also includes details on our pre-blasting survey.

Q. Were you involved in preparing the Monitoring Plan, Dr. Herbst?

A. Yes. Various Exxon personnel as well as outside consultants whom we retained worked on the Plan. I supervised their efforts and was responsible for preparing the Plan and completing the liaison with personnel from the Department of Natural Resources while the Plan was under review.

Q. Dr. Herbst, let me show you EXHIBIT 400. Is this the Monitoring and Quality Assurance Plan you have referred to?

A. Yes. That is the latest version of the Plan, which we submitted in April 1986 as part of the Mining Permit application. This version of the Plan is the product of intensive review within both the company and the Department of Natural Resources in an effort to provide the details of the monitoring programs to assure thorough environmental monitoring and protection with respect to all aspects of the Crandon Project.

Q. Dr. Herbst, what are the main objectives of the Monitoring Plan?

A. Over the course of this hearing, you have heard in very extensive detail about the various aspects of the Crandon Project and all of the various permits that will govern the operation of the Project. Our field and modelling studies have given us confidence that the Project will not lead to any major adverse effects on the environment, and that we can efficiently operate a large mine and at the same time protect the environment. The Monitoring Plan, in essence, is designed to ensure that we will continue to have current data on all aspects of the Project so that we can confirm our predictions, detect any problems at the earliest stage, if they should arise, and take appropriate measures in response.

Let me be more specific. The Monitoring Plan developed for the Crandon Project is responsive to NR 132.06(3)(d) and NR 182.08(2)(e)8, and includes programs for monitoring the ground water, surface water, aquatic ecology, air quality, and terrestrial ecology during the construction, operation and closure (reclamation) phases of the Project. The Plan will provide data for evaluation of Project activities at the mine, mill, reclaim ponds, mine refuse disposal facility (MRDF), mine waste disposal facility (MWDF), other associated activities, and their environs.

The focus and rationale of the Monitoring Plan are to provide information on the performance of the environmental protection designs and systems operations for the Project. Other elements of the Monitoring Plan are intended to confirm the modeling and predictions used in the design and planning of the Project, and to provide a source of information for contingency, mitigation, and reclamation planning. Further, because the mitigation planning incorporates techniques to prevent or eliminate various effects related to the Project, monitoring programs have been provided to obtain efficient, effective, and appropriate data.

Q. And Exxon's Monitoring Plan sets forth the company's commitments with respect to each of these various programs?

A. Yes. The Plan, submitted as EXHIBIT 400, is divided into various sections covering the major topics such as ground water, surface water, air quality and so forth.

Q. Dr. Herbst, will there be ongoing liaison with the Department with respect to the Monitoring Plan?

A. Yes. One of the objectives of our Plan is to keep the DNR advised on a regular basis about all of our monitoring programs. Modifications to the Monitoring Plan, if necessary, will be discussed with the DNR as required throughout implementation. In addition, we will discuss the monitoring programs with the Department prior to initiating them.

Q. Let me now review with you each of the programs in detail. Would you begin by explaining the blasting surveys?

A. As part of the mine permit requirements (NR 132.07(5)), Exxon will conduct a pre-blasting survey of all permanent structures within a 0.5 mile radius of the main shaft and exhaust raises. The survey area is shown on EXHIBIT 401. The half-mile point is where we predict the farthest measurable seismic effect resulting from blasting activities. The pre-blasting survey will be initiated before the construction phase activities, and the data will be provided to the DNR and other appropriate agencies prior to any site blasting. The survey will be conducted by state licensed professionals and will include property inspections (with the consent of the owners), and photographs.

Items to be inspected include (1) building foundations, (2) concrete slabs, (3) exterior and interior masonry, (4) building structural framing, (5) exterior and interior wall treatments, (6) ceiling and floor treatments, (7) doors and windows (framing and glass), (8) visible plumbing, (9) exterior utility services, (10) exterior structures (i.e., antennas, flag poles), and (11) miscellaneous items as required.

Copies of the pre-blasting survey inspection sheets, photographs and property condition report will be submitted to each property owner as well as the appropriate state agencies. File copies will be available at the mine/mill office.

Q. And what is the purpose of all of this survey work?

A. There are essentially two purposes. First, the survey will enable us to verify our predictions concerning the extent of the seismic effects resulting from blasting activities. Second, we will repair any damage caused by blasting activities. The survey will provide the data base necessary for us to evaluate any possible effects caused by blasting activities.

Q. What about Exxon's monitoring activities with respect to its air quality program?

A. The purpose of the air quality monitoring program is to evaluate Project emissions to ensure that state and federal standards are maintained by all facilities. This entails not only monitoring of air emission control equipment but also of the air quality throughout the mine/mill site and MWDF area. The air quality monitoring equipment will be located close to property boundary areas that represent potential access regions for the public.

Let me refer you to EXHIBIT 402, which shows the proposed sampling locations. One upwind ("U") and two downwind ("A" and "B") sampling locations will be established to monitor air quality for the prevailing summer and winter meteorological conditions. In addition, a third downwind sampling location ("C") for monitoring during the construction phase of the Project will be established at the property boundary by the railroad spur.

Q. Dr. Herbst, how will these sampling locations work?

A. A 30 foot meteorological tower will be located at the upwind monitoring station. Meteorological data will be collected during all phases of the Project. The parameters to be measured include wind speed and direction, precipitation and evaporation rates, temperature, and barometric pressure. All data collected will be provided to the DNR and will be compatible with the DNR reporting system.

In addition, total suspended particulates (TSP) will be monitored at all sampling locations.

Q. Let me stop you there for a moment, Dr. Herbst. What do you mean by "total suspended particulates?"

A. Total suspended particulates (TSP) is the technical term used for measuring and quantifying solid materials which are in the air. These solid materials can vary in particle size, but they are generally small enough to easily be transported by air movements. We commonly refer to these airborne particles as dust. They can be minerals such as soil, biological such as pollen, or chemicals such as lead. We measure these particles in the air by filtering a known quantity of air over a certain time period. Therefore, total suspended particulates is the total amount of solid material in the air at a given time.

Q. Thank you. How will Exxon monitor for TSP?

A. We will use samplers at each location that will enable us to distinguish between particles larger and smaller than 10 microns in diameter -- which is the defined particle size difference between "respirable" and "non-respirable" particles. The monitoring program will be operated under standard quality control operating procedures which will ensure that the data is accurate. Those procedures will be reviewed at great length prior to implementation of the program in our Plan.

Q. How frequently will Exxon monitor for total suspended particulates?

A. During the first two years of the construction phase, TSP monitoring will occur for 24 hours every day during active excavation, and during loading and dumping activities at the upwind and downwind sampler nearest the activities. As the earthwork decreases during periods when heavy equipment activity such as excavation is not occurring -- which will probably be by the end of the second year of construction activities -- the TSP monitoring will change to a "six day pattern" in coordination with the DNR statewide air quality sampling program.

Q. How will the "six day pattern" work?

A. Sampling will occur for 24 hours every sixth day after the second year of the construction phase and during all of the operation phase. When earthwork activities for construction of a tailings pond occur, the TSP sampling frequency will change to a three day sequence. This sampling pattern will also be used during reclamation activities at Tailing Pond T1. If an exceedance of the TSP standards occurs during the operation phase at any of the sampling stations, and if that exceedance is attributable to the Project, sampling will also revert to a 3-day sequence for one year at the location of the exceedance. This sampling sequence will be in coordination with the DNR statewide air quality sampling program. Data supplied will also be compatible with the DNR reporting system.

Q. How will you be able to determine what the particles are?

A. Particulate characterizations will be completed on 7 percent of the TSP filters collected from the samplers. The filters will be selected randomly to ensure a reliable and valid data set. Moreover, in the event that TSP quantities on any filter exceed the air quality standards, that filter will undergo particulate characterization.

The particulate characterizations will be analyzed quantitatively for general material types (i.e., biological, mineralogical). Size determinations for the particles will be semi-quantitative. In addition to particulate characterizations, one TSP filter from each sampling station will be analyzed annually for arsenic, cadmium, chromium, copper, lead, manganese, mercury, and zinc in conjunction with the soil, vegetation, and small mammal monitoring programs.

Q. Are there other components of Exxon's air quality monitoring program?

A. Yes. Asbestiform fiber monitoring and stack source testing will occur during the Project operation phase. Asbestiform fiber monitoring will occur daily for two weeks during October -- the driest autumn month -- of the fourth and fifth years of the operation phase. If asbestiform fibers are determined at a quantity which warrants further analysis, the sampling program will be continued into the sixth year of the operation phase.

Stack source sampling will be conducted at the east and west exhaust raises, as well as at other stacks for which the Air Permit requires such testing. This sampling will be designed to meet the requirements of the New Source Performance Standards (NSPS) for the metallic minerals processing industry.

Q. When will the air quality monitoring program begin?

A. The program will be initiated approximately six months prior to construction activities and will continue throughout operations. Detailed aspects of the air quality monitoring program, including monitoring station locations, will be discussed with the DNR before finalization and implementation. A quality assurance document compatible with the DNR Air Monitoring Section industrial certification requirements will be prepared prior to the start of the air quality monitoring program.

Q. Perhaps the program of most interest is ground water monitoring, since so many other Project activities are dependent on this one. Could you now please describe the details of that program?

A. The ground water monitoring program is designed to be responsive to a number of provisions of the Wisconsin Administrative Code which we discuss in the Plan. Its main objective, as stated in NR 182.075(1), "... is to provide a site specific ... minimizing (of) impacts on ground water quality, in order to assure that deviations from baseline ground water quality will be limited to deviations which will not violate the ground water quality standards ... or render ground water unfit for present or future use as determined by this section." In other words, the program will give us a data base to ensure compliance with ground water standards. The program involves two subprograms: Subprogram I will cover background (preconstruction) monitoring, and Subprogram II will cover construction, operation, and closure (reclamation) monitoring.

Subprogram I will be conducted a minimum of one year prior to construction of any of the facilities, and Subprogram II will commence with initial construction activities and is designed to continue throughout operation and reclamation (including closure and long-term care).

Q. How will "Subprogram I" work?

A. It is designed to provide us with background, or preconstruction, data on ground water. The program includes monitoring of the ground water table and quality for the site area generally and also at the MWDF compliance boundary in particular.

The spacial relationships of the mine, mill, MRDF, MWDF, reclaim pond, and surface water bodies are shown on EXHIBIT 403. Also shown on this exhibit are the ground water sampling locations for the general site area. The ground water table wells were selected based on the modeling predictions of ground water flow rates into the mine and the resulting drawdown in the water table. The ground water table elevations will be monitored from 45 wells (piezometers) surrounding the Project facilities.

Initially, 7 of the 45 wells will also be monitored for ground water quality. These wells are identified on EXHIBIT 403. The objective of the ground water quality measurements is to obtain a long-term record of the ground water quality related to Project activities. Subprogram I data will initiate the long-term record by providing the initial background measurements.

The ground water quality parameters measured will be "indicator parameters" which give a rapid and general quantification of the ground water quality. These parameters will be the "core" parameters which will be consistently monitored throughout the Project and represent the parameters meeting the requirements of state law. They include alkalinity, chemical oxygen demand, copper, hardness, iron, manganese, pH, sodium, specific conductance, sulfate, total dissolved solids, total organic carbon, water level, and zinc. If these "indicator parameters" are found to have a statistically significant difference among the wells sampled, further analyses for these and appropriate additional parameters will be considered to enhance the evaluation of the situation and the need for implementation of specific mitigative or protective measures.

Monitoring of these wells for ground water table elevations and quality will begin one year prior to the construction phase. Initial piezometer and ground water quality measurements will be obtained on a quarterly basis.

Q. You mentioned that there would be special preconstruction monitoring in connection with the Mine Waste Disposal Facility. What will that consist of?

A. The Subprogram I ground water monitoring program for the MWDF has been developed to include monitoring near the compliance boundary and at intermediate points between the facility and the compliance boundary. EXHIBIT 404 shows the locations of wells associated specifically with the MWDF ground water monitoring program. The collection of this information will give us a data base that will assist us in ensuring that the operation and filling of these tailing ponds will not cause ground water standards to be exceeded.

The compliance boundary wells will also function as background wells in Subprogram I. These wells (EX-14 AL, AU, BL, BU; G41-E19A; MW1-C, F, T; MW2-C, F, T; and MW3-C, F, T) are located near the compliance boundary of the MWDF. They as well as several others (EX-16 AL, AU, BL-background wells) are intended to provide reference ground water quality and water table data during MWDF construction, but prior to any tailings disposal.

Q. How frequently will Exxon sample the Subprogram I wells shown on EXHIBIT 403, and what will be the specific parameters that are measured?

A. The frequency and scope of sampling will vary from well to well. I have included in my pre-filed testimony a four-page table (Table 1) providing this data for each and every monitoring well. Specifically, that table provides data on the depth of the sampling to be conducted at each well, the frequency of the sampling, the duration of the sampling, and the various parameters that will be measured. As that table indicates, most samplings will be undertaken on a quarterly basis, although some wells will be sampled on a monthly basis. Most of the sampling will continue until the end of the proposed extended care period -- that is, for 66 years. As far as the scope of the measurements, some of the wells will be tested exclusively for ground water level. Many others will be

TABLE 1

Subprograms I and II - Ground water monitoring program for the Crandon Project indicating wells, screen depth intervals, lysimeters, other sampling points, parameters measured, and sampling frequency.

Sampling Location	Screen Depth Interval [a]	Sampling Frequency	Project Years	Parameters Measured
Monitoring Wells				
Ground Water Table and Quality				
CDM-16	485-484	Quarterly	1-66	1
DMA-12	482-480	Quarterly	1-66	2
DMA-18	473-472	Quarterly	1-66	1
DMA-19	480-479	Quarterly	1-66	2
DMA-20	470-469	Quarterly	1-66	1
DMA-31	479-478	Quarterly	1-66	1
DMA-48	464-463	Quarterly	1-66	1
DMB-4	480-477	Quarterly	1-66	1
DMB-11	478-475	Quarterly	1-66	1
DMB-13	475-472	Quarterly	1-66	1
DMB-15	478-475	Quarterly	1-66	1
DMB-21	463-460	Quarterly	1-66	1
DMB-23	449-446	Quarterly	1-66	1
DMI-2L	456-454	Quarterly	1-66	2
DMI-2U	481-480	Quarterly	1-66	2
DW-1A	485-481	Quarterly	1-66	2
DW-1U	474-473	Quarterly	1-66	2
DW-3L	466-465	Quarterly	1-66	1
EX-1AU	443-442	Quarterly	1-66	1
EX-4BL	492-488	Quarterly	1-66	1
EX-5CL	480-475	Quarterly	1-66	1
EX-8BL	462-461	Quarterly	1-66	1
EX-14AU	482-478	Quarterly	1-66	1
EX-15BL	485-480	Quarterly	1-66	2
EX-16AU	460-459	Quarterly	1-66	1
G40-L23	476-473	Quarterly	1-66	1
G40-P10A	477-474	Quarterly	1-66	1
G40-R23	474-471	Quarterly	1-66	1
G40-S17	451-448	Quarterly	1-66	1
G40-X1	470-467	Quarterly	1-66	1
G40-Y21	482-480	Quarterly	1-66	1

TABLE 1 (continued)

Sampling Location	Type [c]	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
G41-A23		479-477	Quarterly	1-66	1
G41-E22		449-446	Quarterly	1-66	1
G41-K13		439-436	Quarterly	1-66	1
TW-1		476-471	Quarterly	1-66	1
WP-1C[b]		d	Quarterly	1-66	1
WP-2C[b]		d	Quarterly	1-66	1
WP-3C[b]		d	Quarterly	1-66	1
WP-4C[b]		d	Quarterly	1-66	1
WP-4L		461-460	Quarterly	1-66	1
WP-4U		470-468	Quarterly	1-66	1
WP-5C[b]		d	Quarterly	1-66	1
WP-5L		463-462	Quarterly	1-66	1
WP-5U		471-470	Quarterly	1-66	1
WP-6C[b]		d	Quarterly	1-66	1
Reclaim Pond and Preproduction Ore Storage Pad					
RP1-D[b]	C	d	Quarterly	1-29	2
RP2-D[b]	C	d	Quarterly	1-29	2
EX-9AL	I	437-436	Quarterly	1-29	2
EX-9AU	I	447-446	Quarterly	1-29	2
EX-9BL	I	464-463	Quarterly	1-29	2
EX-9BU	I	486-480	Quarterly	1-29	2
PPO-1D[b] (Preproduction Ore Storage Pad)	P	d	Quarterly	1-29	2
MRDF					
RD1-D[b]	I	d	Quarterly	1-66	2
RD1-T[b]	I	d	Quarterly	1-66	2
RD2-D[b]	I	d	Quarterly	1-35	2
RD2-T[b]	I	d	Quarterly	1-35	2
Liner Lysimeters		Beneath Liner	Quarterly	1-66	2
MWDF[f]					
CW1-D[b]	P	d	Quarterly	4-66	2
CW1-T[b]	P	d	Quarterly	4-66	2
CW2-D[b]	P	d	Quarterly	4-66	2
CW2-T[b]	P	d	Quarterly	4-66	2
CW3-D[b]	P	d	Quarterly	4-66	2
CW3-T[b]	P	d	Quarterly	4-66	2
CW4-D[b]	P	d	Quarterly	4-66	2
CW4-T[b]	P	d	Quarterly	4-66	2
DMB-6	I	485-482	Quarterly	1-66	2
EX-9AL	I	437-436	Quarterly	1-32	2
EX-9AU	I	447-446	Quarterly	1-32	2
EX-9BL	I	464-463	Quarterly	1-32	2
EX-9BU	I	486-480	Quarterly	1-32	2

TABLE 1 (continued)

Sampling Location	Type[c]	Screen Depth Interval[a]	Sampling Frequency	Project Years	Parameters Measured
EX-10AU[g]	B	451–450	Monthly		2
EX-12AL	I	426–425	Quarterly	1–12	2
EX-12AU	I	444–443	Quarterly	1–12	2
EX-12BL	I	459–458	Quarterly	1–12	2
EX-12BU	I	482–477	Quarterly	1–12	2
EX-13BU[g]	I	462–461	Monthly		2
EX-14AL	B/C	432–431	Quarterly	1–66[e]	2
EX-14AU	B/C	452–451	Quarterly	1–66[e]	2
EX-14BL	B/C	465–464	Quarterly	1–66[e]	2
EX-14BU	B/C	482–478	Quarterly	1–66[e]	2
EX-16AL	B	450–449	Quarterly	1–66	2
EX-16AU	B	460–459	Quarterly	1–66	2
EX-16BL	B	476–471	Quarterly	1–66	2
G41-E17	I	436–433	Quarterly	1–66	2
G41-E19A	B/C	467–464	Quarterly	1–66	2
G41-H9	B	449–446	Quarterly	4–66	2
G41-H18B	I	468–465	Quarterly	22–66	2
G41-K13	I	439–436	Quarterly	1–11	2
IW1-D[b]	I	d	Quarterly	8–66	2
IW1-T[b]	I	d	Quarterly	8–66	2
IW2-D[b]	I	d	Quarterly	8–66	2
IW2-T[b]	I	d	Quarterly	8–66	2
IW3-D[b]	I	d	Quarterly	15–66	2
IW3-T[b]	I	d	Quarterly	15–66	2
IW4-D[b]	I	d	Quarterly	15–66	2
IW4-T[b]	I	d	Quarterly	15–66	2
IW5-D[b]	I	d	Quarterly	22–66	2
IW5-T[b]	I	d	Quarterly	22–66	2
IW6-D[b]	I	d	Quarterly	22–66	2
IW6-T[b]	I	d	Quarterly	22–66	2
IW7-D[b]	I	d	Quarterly	22–66	2
IW7-T[b]	I	d	Quarterly	22–66	2
MW1-C[b]	B/C	d	Quarterly	1–66[e]	2[e]
MW1-F[b]	B/C	d	Quarterly	1–66[e]	2[e]
MW1-T[b]	B/C	d	Quarterly	1–66[e]	2[e]
MW2-C[b]	B/C	d	Quarterly	1–66[e]	2[e]
MW2-F[b]	B/C	d	Quarterly	1–66[e]	2[e]
MW2-T[b]	B/C	d	Quarterly	1–66	2[e]
MW3-C[b]	B/C	d	Quarterly	1–66[e]	2
MW3-F[b]	B/C	d	Quarterly	1–66	2
MW3-T[b]	B/C	d	Quarterly	1–66	2

TABLE 1 (continued)

Sampling Location	Screen Depth Interval	Sampling Frequency	Project Years	Parameters Measured
Liner Lysimeters	Beneath Liner	Quarterly	4-66	2
Reclamation Cap Moisture Content	Above and Beneath Top Seal	Quarterly	10-66	4
Leachate	Underdrain	Quarterly; Annual	4-34	2;3
Mine Wells				
9 New Wells	Mine Shafts	Quarterly	30-66	2

a. Elevation in meters above mean sea level (MSL).
b. Proposed new well.
c. B = background; C = compliance; I = intermediate; B/C = background and/or compliance; P = performance
d. Screen depth interval for new wells will be determined from the hydrostratigraphy during installation.
e. Parameter lists 2 and 3 will be measured in the year following each tailing pond reclamation cap completion and the final year of closure.
f. Monthly during Subprogram I.
g. Well sampled only during Subprogram I.

1. Water level.
2. Alkalinity, chemical oxygen demand, copper, hardness, iron, manganese, pH, sodium, specific conductance, sulfate, total dissolved solids, total organic carbon, water level, zinc.
3. Arsenic, barium, cadmium, chloride, chromium, cyanide, fluoride, gross alpha radiation, gross beta radiation, lead, mercury, nitrate, radium-226, radium-228, selenium, silver, sulfide.
4. Moisture content.

tested for the "indicator parameters" that were discussed earlier. Still others will measure such parameters as arsenic, barium, cadmium, chloride, chromium, cyanide, fluoride, gross alpha radiation, gross beta radiation, lead, mercury, nitrate, radium-226, radium-228, selenium, silver, and sulfide. These are all of the parameters set forth in the federal and state primary and secondary drinking water standards, with the exception of the organic pesticides.

Q. Why isn't Exxon testing for organic pesticides?

A. Because we will not be using organic pesticides in the processes of this Project.

Q. Dr. Herbst, could you show us, with respect to one well, how the monitoring program will work?

A. Let me refer you to EXHIBIT 403, which shows the location of the general site area monitoring wells. Well DMA-19, as you can see from the map, is located just to the south and west of the mine/mill site and just to the northeast of Little Sand Lake. As indicated in Table 1 included in my written testimony, we will sample at this well on a quarterly basis.

We will do so for the proposed 66 years. And, each quarter, we will be testing for the "indicator parameters" that I have previously discussed -- that is, alkalinity, chemical oxygen demand, copper, hardness, iron, manganese, pH, sodium, specific conductance, sulfate, total dissolved solids, total organic carbon, water level, and zinc.

Table 1 contains similar information for each of the other wells that you have seen on EXHIBITS 403 and 404.

Q. What about "Subprogram II" -- the monitoring that will take place during the construction, operation, and reclamation of the Project?

A. Monitoring during the construction, operation and closure (reclamation) phases is collectively described as "operations monitoring." The operations ground water monitoring program also was designed to comply with various monitoring requirements set forth in the Wisconsin Administrative Code, and will utilize the sampling locations included in Subprogram I monitoring. The selected well locations will enable us to monitor for any impacts to ground water caused by the mine, the reclaim ponds, the preproduction ore storage pad, the tailing ponds, and the mine refuse disposal facility.

In addition, lysimeters will be used for monitoring the bottom liner of the individual tailing ponds and refuse disposal cells. A lysimeter is a particular kind of monitoring device that enables us to monitor ground water. The objective of the lysimeters is to give an indication of the effectiveness of the drainage layer and liner at the bottom of the tailing ponds and refuse disposal cells by monitoring the amount of water percolating through these barriers. Water quality of any seeping water can also be measured from the collection segments of the liner lysimeters.

Q. What specific measures will Exxon take to monitor the ground water table and quality during the Project's life?

A. The well locations utilized to measure the ground water piezometric surface will be the same as in Subprogram I. The ground water table measurements will also be utilized to provide data related to the Hydrologic Impact Contingency Plan. The data collected from the ground water table wells will be an integral part of the evaluation of the accuracy of the predicted changes to the ground water table and its possible associated effects to surface water. As Table 1 indicates, ground water quality measurements will also be obtained on a quarterly basis at a minimum.

Q. What about monitoring near the MWDF?

A. Well locations which will be utilized for Subprogram II monitoring of the MWDF are the same as for those presented in Subprogram I with the addition of sampling at intermediate wells constructed as the other tailing ponds are developed, and an additional background well, G41-H9, and the reduction in sampling wells EX-10 and EX-13 as construction of the tailing ponds proceeds, as shown on EXHIBIT 404. Ground water quality measurements from these wells will be obtained at least quarterly.

Q. What do you mean by "intermediate wells"?

A. Intermediate wells are located within the MWDF or between the MWDF and the compliance boundary -- the boundary 1200 feet from the MWDF at which Exxon's compliance with ground water standards will be determined. These wells will be monitored during operations to supplement the MWDF performance monitoring for Tailings Pond T1 (i.e., performance wells - CW series) and by the collection lysimeters beneath the pond bottom. If we look at EXHIBIT 404, the intermediate wells are generally identified by the letters IW. As you can see, they are located at the edge of the tailing pond embankments and are between the pond and compliance boundary.

Q. You earlier mentioned "compliance boundary wells." What are those?

A. Wells have been located to provide a relatively uniform distribution of sampling points along the compliance boundary and to ensure proper background measurements in the statistical analysis of the monitored ground water quality parameters. Additional wells (MW1-C, F, T; MW2-C, F, T; MW3-C, F, T) are planned to supplement those already in existence at or near the compliance boundary.

Q. Will you also be monitoring the performance of the liners and the seals on each tailings pond?

A. Yes. Lysimeters to determine seepage quantity will be installed during construction of the ponds beneath the liner within each pond. As you can see from EXHIBIT 405, liquids that may collect in these lysimeters will flow by gravity to collection points located either at the internal perimeter of the pond basin or at the outside toe of the pond embankment.

In addition to the well and lysimeter locations, samples for water quality measurements will be collected from the leachate -- the water being pumped from the underdrain system. Water quality parameters will be measured on at least a quarterly basis and have been selected utilizing the results of the waste characterization studies performed on the tailings.

A moisture content measuring system will be installed to monitor top seal performance. The specific type of moisture content measuring system proposed for installation in each pond will be determined at the time of reclamation to ensure the use of the latest technology. Table 1, which I discussed earlier, lists the parameters to be monitored for the MWDF lysimeters and wells.

Q. What are the monitoring measures for the reclaim pond, MRDF, and preproduction ore storage pad?

A. Let me refer to EXHIBIT 404. The reclaim pond operation phase ground water monitoring wells (RP1-D, RP2-D and EX-9AL, AU, BL, BU) will be sampled initially during pond construction. Similarly, one well will be constructed with development of the preproduction ore storage pad north of the mine/mill site to monitor ground water quality beneath this facility. In addition, three lysimeters, one beneath each refuse disposal cell, and two wells will be used to monitor the MRDF. Ground water measurements from these wells and the lysimeters will be obtained quarterly, as indicated in Table 1.

Q. Are there any special monitoring wells included in the Plan?

A. Yes. We have proposed nine additional wells for the closure phase to monitor mine reclamation. Three wells will be located within the reclaimed shafts or other boring locations (i.e., backfill delivery borehole) to sample mine water levels and quality. Six wells will also be located to allow measurements of the ground water in the glacial drift immediately above and adjacent to the reclaimed mine. These wells will be monitored on a quarterly schedule during the closure phase.

Q. Are there any particular sampling methods and standards that Exxon will be following in this monitoring program?

A. Yes. Methods of ground water sample collection, preservation, and analysis will be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater, published by the American Public Health Association. Sample comparisons for determination of any statistically significant differences among the wells (i.e., ground water quality and MWDF monitoring wells) will be completed using multiple analysis of variance tests. In the event of unnormalized data, the analysis of variance will utilize log-normal distribution for comparison testing.

All data will be provided to the DNR quarterly until the ground water table returns to its preconstruction levels and stabilizes after closure of the mine. After stabilization of the ground water table, the data will be submitted on a semi-annual or annual basis depending upon the parameter measured. An annual summary of the ground water monitoring program will also be provided to the DNR.

Q. The surface water program is obviously linked very closely with the ground water program. Would you now please describe that program?

A. The surface water monitoring program has been designed to measure the physical and chemical parameters necessary to evaluate the Project's impact on surface waters in the vicinity of the mining site and to confirm that the aquatic environment is not being adversely affected. Specifically, the program establishes monitoring related to the treated water discharge to Swamp Creek below Rice Lake; to mine dewatering activities and mitigation measures; to the MWDF; and to surface water drainage via the various retention structures of the surface facilities. The program incorporates monitoring the DNR will require as part of the WPDES Permit.

Q. What will be the scope of your surface water monitoring?

A. EXHIBIT 406 shows the location of water bodies that we will be monitoring. As you can see, these include Creek 11-4, Creek 12-9, Hemlock Creek, Hoffman Creek, Outlet Creek, Upper Pickerel Creek, Duck Lake, Deep Hole Lake, Hoffman Springs, Little Sand Lake, Martin Springs, Skunk Lake, Rice Lake, and Rolling Stone Lake. In addition, we will be sampling a number of locations along Swamp Creek, both above and below Rice Lake. I should also add that water monitoring at Rice Lake will be contingent upon access approval from the Mole Lake Chippewa Tribal Council.

Q. What parameters will Exxon be measuring, and how frequently will samples be collected?

A. This information is set forth in Table 2 of my prefiled testimony. That table shows, for each sampling location, the sampling frequency, the specific location at which the samples will be collected, and the various parameters that we will be measuring. For example, Table 2 indicates that, for Little Sand Lake, we will be sampling every month for dissolved oxygen levels, lake water level, and temperature. As Table 2 also indicates, every three months we will be performing additional chemical analyses for alkalinity, hardness, oil and grease, sulfate, total dissolved solids, and total suspended solids. We will also obtain field measurements for pH and specific conductance.

Let me add that, in connection with our surface water monitoring program, we will also be monitoring meteorological parameters (i.e., precipitation and evaporation). I have already discussed the collection of that data in connection with the air quality monitoring program.

Q. When will you begin monitoring?

A. The surface water monitoring program will be initiated approximately 12 months prior to the construction phase and will continue through operations. A modified program, which will reflect the then-current Project activities, will be conducted for the initial ten years of the closure phase.

TABLE 2

The surface water monitoring program for the Crandon Project indicating sampling locations, parameters measured, and sampling intervals.

Sampling Location	Sampling Frequency and Specific Locations	Parameters Measured
Swamp Creek Above Rice Lake	Annually, Monthly (at staff gages 2, 3 and 5A)	1, 5
Swamp Creek Below Rice Lake	Quarterly (at Location U)	1
	Monthly (at Locations A, and DS)	1
	Continuous (at Location A)	2
Swamp Creek (Sediment) Below Rice Lake	Annually (at Locations U, A and DS)	3
Creek 11-4	Monthly (at staff gage 30) Weekly (flow rate only)	5
Creek 12-9	Monthly (at staff gage 23) Weekly (flow rate only)	5
Hemlock Creek	Annually, Monthly (at staff gage 6)	1, 5
Hoffman Creek	Annually, Monthly (at staff gage E)	1, 5
Outlet Creek	Monthly (at staff gage 4)	5
Pickerel Creek	Monthly (at staff gage 19)	5
Duck Lake	Quarterly, Monthly (at lake gage 12)	4, 5
Deep Hole Lake	Quarterly, Monthly (at lake gage 13)	4, 5
Hoffman Springs	Quarterly, Monthly (at lake gage 31)	4, 5
Little Sand Lake	Quarterly, Monthly (at lake gage 7)	4, 5
Martin Springs	Monthly	5

TABLE 2 (Continued)

Sampling Location	Sampling Frequency and Specific Locations	Parameters Measured
Skunk Lake	Quarterly, Monthly (at lake gage 15)	4, 5
Rice Lake*	Quarterly, Monthly	4, 5
Rolling Stone Lake	Monthly (at lake gage 9)	5
Drainage Basins and Sedimentation Ponds	Weekly, when discharging	4

*Rice Lake monitoring will be contingent upon access approval from the Mole Lake Chippewa Tribal Council.

1. Chemical analysis for: aluminum, arsenic, biological oxygen demand (BOD), cadmium, chromium (+3 and +6), copper, cyanide, hardness, iron, lead, manganese, mercury, selenium, silver, sodium, sulfates, total alkalinity, total dissolved solids, total organic carbon, total sulfur, total suspended solids, and zinc. Field measurements for: dissolved oxygen, pH, specific conductance, stream discharge and velocity, temperature, and water levels.

2. Continuous monitoring for effluent dissolved oxygen, flow rate, pH, and specific conductance; daily composite sample for total dissolved solids and total suspended solids.

3. Chemical analysis for: aluminum, arsenic, cadmium, chromium (total), copper, iron, lead, manganese, mercury, selenium, silver, sulfate, sulfur (total), and zinc.

4. Chemical analysis for: alkalinity, hardness, oil and grease, sulfate, total dissolved solids, and total suspended solids. Field measurements for: pH, specific conductance, stream discharge and velocity, temperature, and water level.

5. Field measurements for dissolved oxygen, stream discharge and velocity, temperature, and water level.

Monitoring of Swamp Creek at the water treatment plant discharge location (locations U, A, and DS on Exhibit 406) will be conducted only during times of actual discharge.

Q. What specific monitoring measures will you undertake with respect to the water discharge to Swamp Creek?

A. Mr. Harris has already summarized that aspect of the monitoring program. To reiterate his summary, and referring here to Exhibit 406, initial monitoring will be continuous at sampling location A (i.e., within the discharge pipe) for the effluent dissolved oxygen, pH, flow rate, and specific conductance. Total dissolved solids and total suspended solids will be measured after collection of a daily composite sample from the discharge pipe. Duplicate sediment samples for chemical analysis will be collected annually in May at locations U, A, and DS in Swamp Creek.

Q. Dr. Herbst, what will Exxon do with all of these surface water data?

A. These data are essential to the implementation of the Contingency Plan and Hydrologic Impact Contingency Plan, which Mr. Schroeder has already discussed. The data from the surface water monitoring program will be provided to the DNR on a quarterly basis and summarized in our annual report. The special WPDES monitoring requirements and reporting schedules will be as specified in the permit.

Q. Dr. Herbst, may I turn now to the aquatic ecology program you mentioned at the beginning of your testimony. What does that program consist of?

A. The aquatic ecology monitoring program will combine biological sampling with the physical and chemical parameter measurements of the surface water monitoring program. Data from this program will also be used to evaluate effects which can be included in the analyses of the Hydrologic Impact Contingency Plan. The biological sampling will be conducted semi-annually (spring and late summer) in Swamp Creek above and below the wastewater treatment plant discharge structure, Swamp Creek above Rice Lake, and Hoffman Creek.

During the late summer, August or September, fish sampling will occur at location DS (see EXHIBIT 406) and will include three separate composite samples of two forage species, such as black bullhead and white sucker, and one predator species, such as yellow perch or northern pike. Each of the three composite samples will consist of a minimum of three fish of the same age class (e.g., 2-3 years) for the forage and predator species. If possible, the same species will be analyzed each year. The sample collections will be frozen and a whole fish analysis completed in the laboratory. The metals analyzed in the laboratory will be arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, selenium, silver, and zinc.

Sessile populations of fish food organisms (i.e., benthic macroinvertebrate populations) will also be sampled. Samples will be collected upstream (U), at the stream discharge location (A), and downstream (DS) (see EXHIBIT 406). Benthic macroinvertebrates will be collected during the early spring, before major snow melting, and late summer, during stream low flow rate/high temperature conditions. Four samples of actual substrates using appropriate bottom samplers will be collected from each location. Macroinvertebrates will be hand picked and composited by genus and/or species from each substrate sample in the lab.

Samples of the most common taxa from these collections will be segregated by size class into four groups. These four groups, which represent the feeding habits of "functional groupings" of the species, consist of sediment dependent, filter feeders, sediment associated, and predator.

The aquatic ecology monitoring program will be initiated with the early spring sampling, prior to construction activities, and will continue for the first three years of the operation phase. Monitoring of Swamp Creek at the water treatment plant discharge location (U, A, DS) (see EXHIBIT 406) will be conducted only during times of actual discharge. The sampling program will be repeated every five years after the third year of the operation phase until the water treatment plant discharge is discontinued during reclamation.

In addition, an acute bioassay study will be conducted annually and a chronic bioassay study will be performed once every five years on the water treatment plant discharge as part of the WPDES permit. A "bioassay study" is the use of specific aquatic test organisms to determine the effect on these organisms of different concentrations of substances in the water. The chronic bioassay studies will be performed just preceding and in conjunction with the WPDES reissuance. The bioassay studies will be initiated in the year of the construction phase when the actual discharge will occur.

Q. The last program you mentioned at the outset deals with the monitoring of the terrestrial ecology. What will that involve?

A. The main objective of the terrestrial ecology monitoring program is to enable an evaluation of any air emission or ground water table drawdown related effect on vegetation and animals. Similarly, any surface water discharge which may affect the terrestrial ecosystems will be monitored in this program. The program will be closely associated with the air quality monitoring program and the MWDF inspection program required by the Wisconsin Administrative Code, which includes, among other things, a three-shift-a-day inspection of the tailing ponds embankments.

The terrestrial ecology monitoring program will determine general conditions of the site area ecosystems, including wetlands, within a radius of approximately 3 miles of the mine/mill site -- an area that will include Rice Lake. EXHIBIT 407 shows the boundaries of this area. The monitoring will include color infrared (CIR) aerial photography at a scale of 1:7920 (i.e., approximately eight inches to the mile), which will be obtained at the same time as that of the inspection program which I mentioned above. If the MWDF construction and inspection program aerial photography schedule does not coincide with the timing requirements for the terrestrial ecology monitoring, separate flights will be utilized to obtain the information.

Q. Why will Exxon be using aerial photography in connection with this monitoring program?

A. The CIR aerial photography will be used to detect any vegetative stress or other changes exhibited in the terrestrial or wetland ecosystems. In the event any such stress or change is indicated, an evaluation of its particular cause and any resultant environmental consequence will be completed. Again, this evaluation would be designed to address the observed site-specific effects.

The terrestrial ecology monitoring program will be initiated with the aerial photography required by regulations prior to MWDF construction activities and will continue through operations and reclamation. Therefore, the aerial photography will be obtained the year prior to the start of the construction phase activities and will continue on a schedule of the year preceding and after completion of the development of each tailing pond. It will end with the completion of active reclamation activities.

All aerial photography will be obtained during July to coincide with sensitive growth phases of the potentially affected ecosystems. A copy of the CIR photos will be available to the DNR within 90 days of each flight. Any analysis of the photography will be provided to the DNR with the annual report for the mine permit. If stress conditions are detected, the DNR will be notified earlier than the annual report and discussion of further monitoring programs will be initiated.

Q. In addition to CIR photography, will Exxon be undertaking any additional work as part of the terrestrial ecology monitoring program?

A. Yes. An annual program of sampling soil, vegetation, and a common small mammal population will be conducted along a predominantly downwind direction line during the operation of Tailing Ponds T1 and T2. The downwind direction line will be sampled in August or September at the end of the growing season, and the sampling will be spaced to include at least 3 collection points along the line from the MWDF to the property fencing. Samples of soil, vegetation, and selected animal tissue and/or organs will be analyzed in the laboratory for arsenic, cadmium, chromium (total), copper, lead, manganese, mercury, selenium, silver, and zinc.

The DNR has also indicated that its regional monitoring programs for animal populations will continue and include the Project site area. Amphibians, birds and large mammal surveys will be included in the DNR programs. The data important to the Project site area will be forwarded by the DNR to Exxon for inclusion in the annual report where appropriate.

Q. Finally, Dr. Herbst, do these programs respond to the regulatory requirements and how will the data collected in these programs be checked to ensure their accuracy?

A. In my opinion, the proposed monitoring plan is responsive to the monitoring requirements set forth in NR 132.06 (3)(d), NR 132.11, NR 180.13, NR 182.075, NR 182.08(2)(e)8, and NR 182.13 as related to the construction, operation and closure (reclamation) phase activities of the Project. As I testified at the outset, the programs I have described are designed to detect unanticipated events early on so that we can take any necessary remedial action early enough to prevent environmental damage. The basic reporting structure for transferring the data and results of the monitoring programs will be the annual report required by NR 132, or as required by the various other permits. In the event that these monitoring programs require initiation of further studies, such data and information will be forwarded to the DNR.

Quality Assurance/Quality Control (QA/QC) procedures will be required for all programs of the Monitoring Plan. Exxon will require QA/QC submittals from all of its prospective contractors. Prior to initiating any monitoring program, specific QA/QC documents will be developed for the individual tasks and submitted to the DNR for approval. These QA/QC documents typically will include methodology for sample collection, transportation, and storage; techniques used for the sample analyses; data verification and evaluations to be performed; and presentation format for the information. Each approved QA/QC document will then contain the standard operating procedures for completing its particular monitoring program. The developed QA/QC documents will ensure reliable and valid data collection and evaluation from the monitoring programs.

Q. Thank you, Dr. Herbst.

0819R

EXHIBIT 283

Curriculum Vita

Richard P. Herbst

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The Woodlands, TX 77380

Phone: (713) 367-5039

Work Address: P. O. Box 400
Baytown, TX 77522

Phone: (713) 425-2358

Professional Experience: Exxon Minerals and Chemical Companies, 1979-Present. Senior Environmental Associate - Environmental & Regulatory Affairs.

Responsible for interfacing with domestic and international project staff for developing permitting strategy, schedules, and planning and implementing necessary environmental studies and quality reports. Participated in the development and completion of all major documents submitted in support of permit applications for the Crandon Project in Wisconsin. I was the principal author of state regulations dealing with hazardous wastes and mine waste disposal, ground water standards for disposal facilities, wetlands use and surface water discharges. Also responsible for coordinating permitting activities and negotiations with agencies as well as developing workable regulations with agencies. Staff of the Nuclear Regulatory Commission (NRC) cited the ground water monitoring and statistical analysis program I developed for a uranium tailings disposal facility as the model for the United States.

Manager, Environmental Sciences, ERT, 1975 - 1979. Responsible for managing five departments (Ecology, Industrial Hygiene and Safety, Chemistry Labs, Water Quality Engineers, and Water Treatment Design Engineers) conducting projects throughout the USA and internationally. Developed the business plan, staffing requirements and initiation of the Company's new venture into marine sciences and local project management for many activities of the energy companies. Also established the central support staff for hazardous waste disposal and mining projects in the southwest. Personally responsible for the total management for the client in permitting several offshore and onshore drilling rigs and production platforms, two "grassroots" refineries and coal and nuclear fueled power plants.

Developed quality assurance/control and environmental audit capabilities for internal and external corporate activities. This division conducted and completed studies on over 100 projects ranging from original design to trouble-shooting and all aspects, including the socioeconomics, of facility permitting. Personally responsible for the original development and implementation of water quality regulations for the Kingdom of Saudi Arabia and several aspects of the Massachusetts Energy Facility Siting Law. Several large studies were conducted under my direction for waste disposal, nuclear power plant siting, and permitting.

Associate Director, Environmental Research Division, CDM/Limnetics, Inc., 1972 - 1975 Organized, staffed and managed all aspects of the Company other than employee relations and finance. Was responsible for the completion of over 50 projects and directly managing the complete licensing of three nuclear power plants in the Midwest and the establishment of NRC required QA/QC programs. Also represented industrial clients in writing Wisconsin DNR environmental regulatory Codes 102-105 and the 1972 revisions to the Clean Water Act.

Professor, University of Wisconsin System. Was on the faculty and taught various courses at four different campuses of the University of Wisconsin. Was elected to the Faculty Senate and served on state of Wisconsin's panel for environmental policy reporting to Governor Lucey.

Teaching. Was an assistant instructor at the University of Wisconsin and University of Pittsburgh as well as Nicelot High School in Fox Point, Wisconsin.

Administrative Experience:

Management Training and Development Courses
- American Electronic Media Training
- Political Education Seminar
- The Fundamentals of Ground Water Quality Protection
- Groundwater Quality Protection
- Elements of Profitability Course - Exxon
- Exxon Corp. Conference on Assessment of Environment Impact
- Interpersonal Management Skills
- Business Writing
- Time Management
- Seminar on Data Base III and ECOTRAC software

Chairman, Town of Palmyra, Wisconsin. Was elected (twice) chairman of this southeastern Wisconsin town of over 2,000 people and was responsible for overall town government as well as cooperative government actions with the closely associated Village of Palmyra (joint Fire, Police, School governance) of over 4000 people and the county government of Jefferson, Wisconsin.

Community Services:

Chairman, Town of Palmyra,
Palmyra, Wisconsin

Environmental Policy Advisor
Gov. Lucey, State of Wisconsin

Board of Directors (President),
Blue Spring Lake Association.

Advisor to Wisconsin Organization of Lake Associations.

Advisor Wisconsin DNR on rehabilitation of inland lakes.

Horticultural Society of Wisconsin Presentation on Effects of Air Pollutants.

Publications. Have been the major author of over 30 publications from both the private and academic environments and contributing authorship on over 150 reports for domestic and international projects. Have presented several papers at technical seminars, professional meetings, and major universities throughout the United States. Am currently on the editorial board of a major professional technical journal, and in 1984 was elected Secretary of the International Society of Petroleum Industry Biologists.

Education:

B.S. 1964 University of Wisconsin-Milwaukee
M.S. 1966 University of Wisconsin-Milwaukee
Ph.D. 1969 University of Pittsburgh

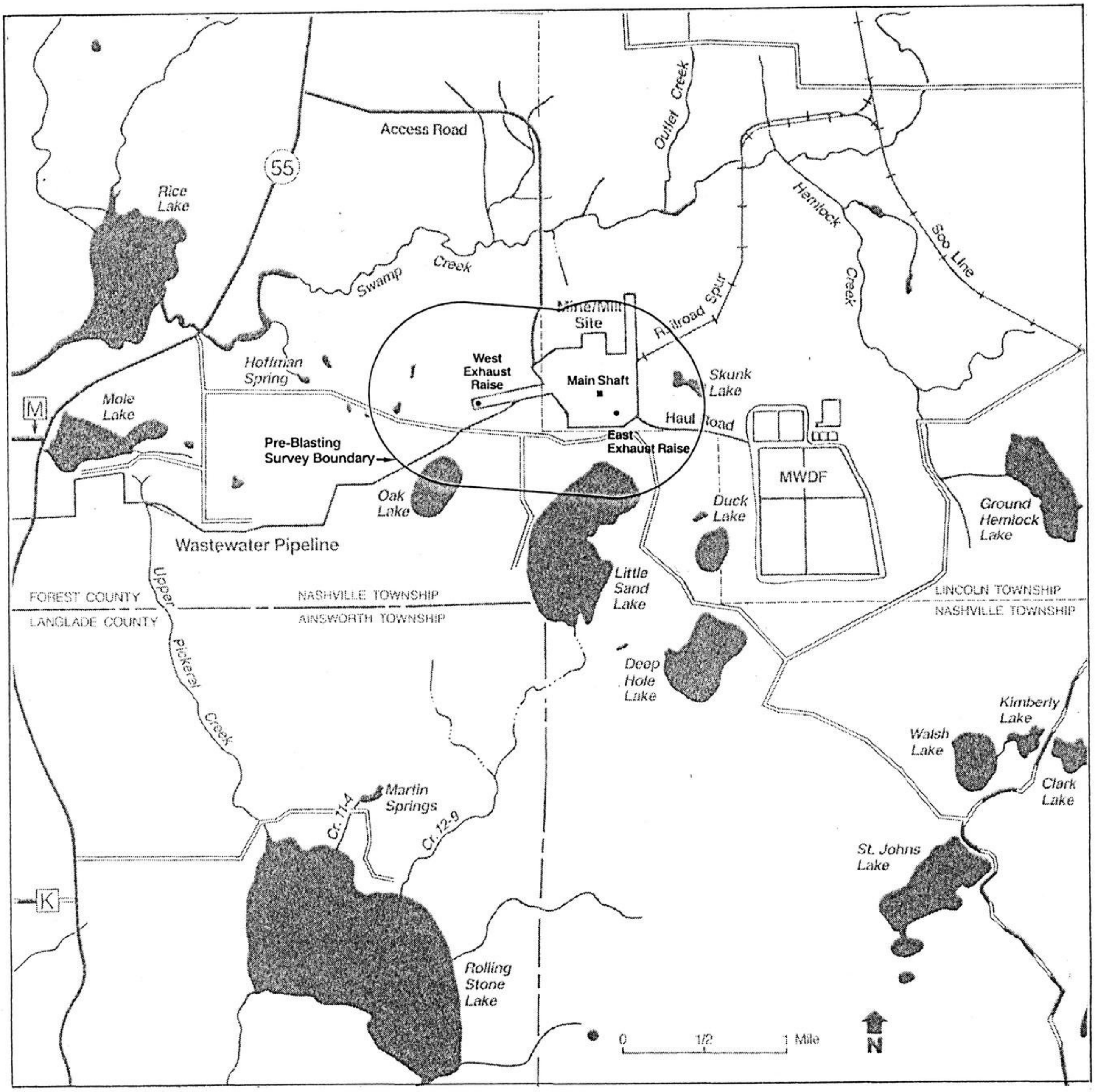
Currently enrolled in MBA program at the University of Houston, University Park.

Society Memberships:

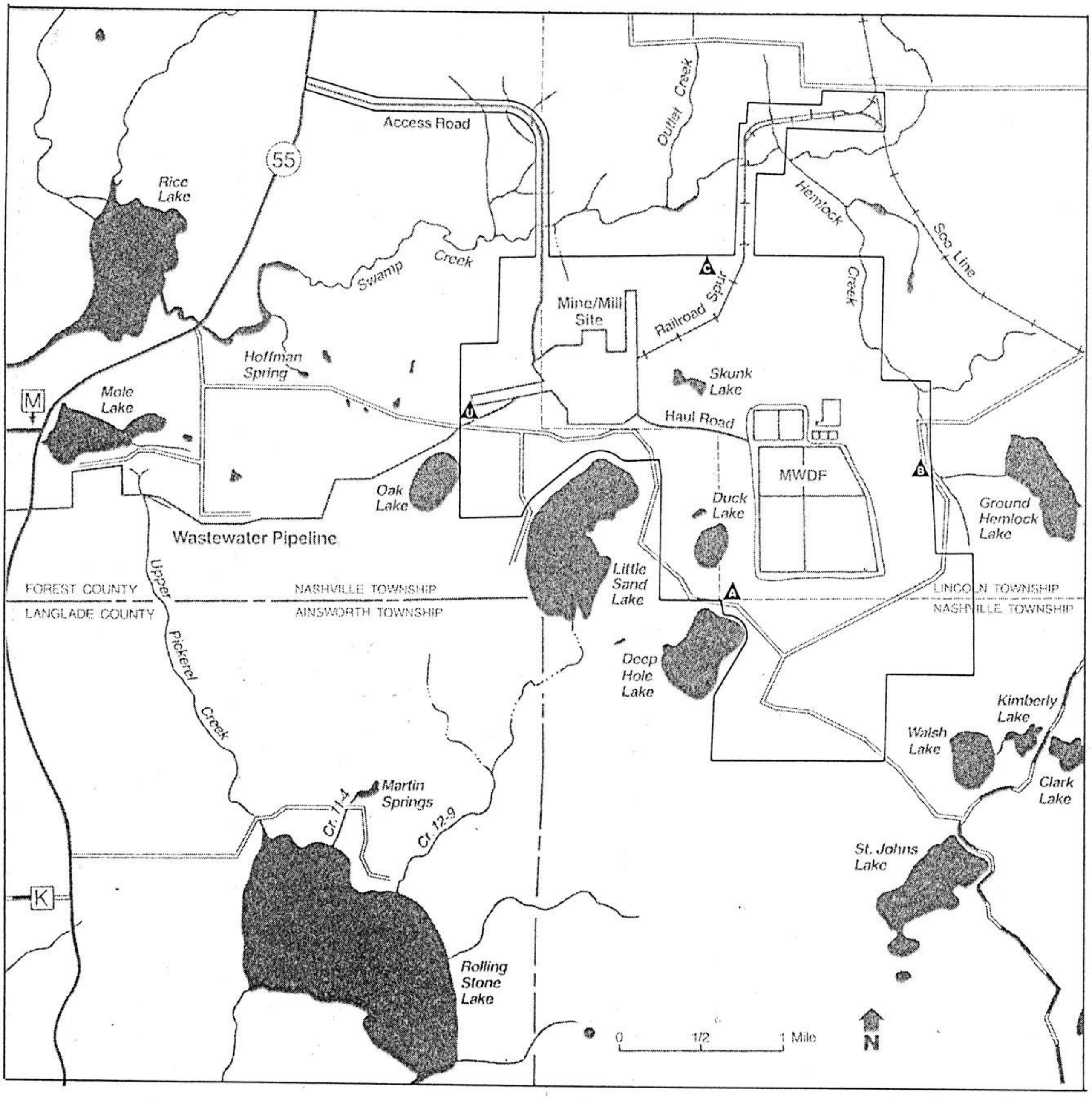
Air Pollution Control Association
American Association for the Advancement of Science
American Men and Women of Science - 1976-1986
American Society of Limnology and Oceanography
Associate Member of Sigma Xi
Ecological Society of America
Environmental Science and Technology
(American Chemical Society)
International Society of Petroleum Industry Biologists
Pollution Control Engineering
Solid and Hazardous Waste Disposal Engineering
Toastmasters International

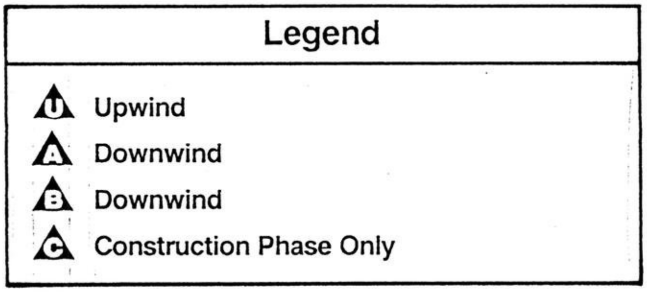
2402R

Pre-Blasting Survey Area



Air Quality
Sampling Locations



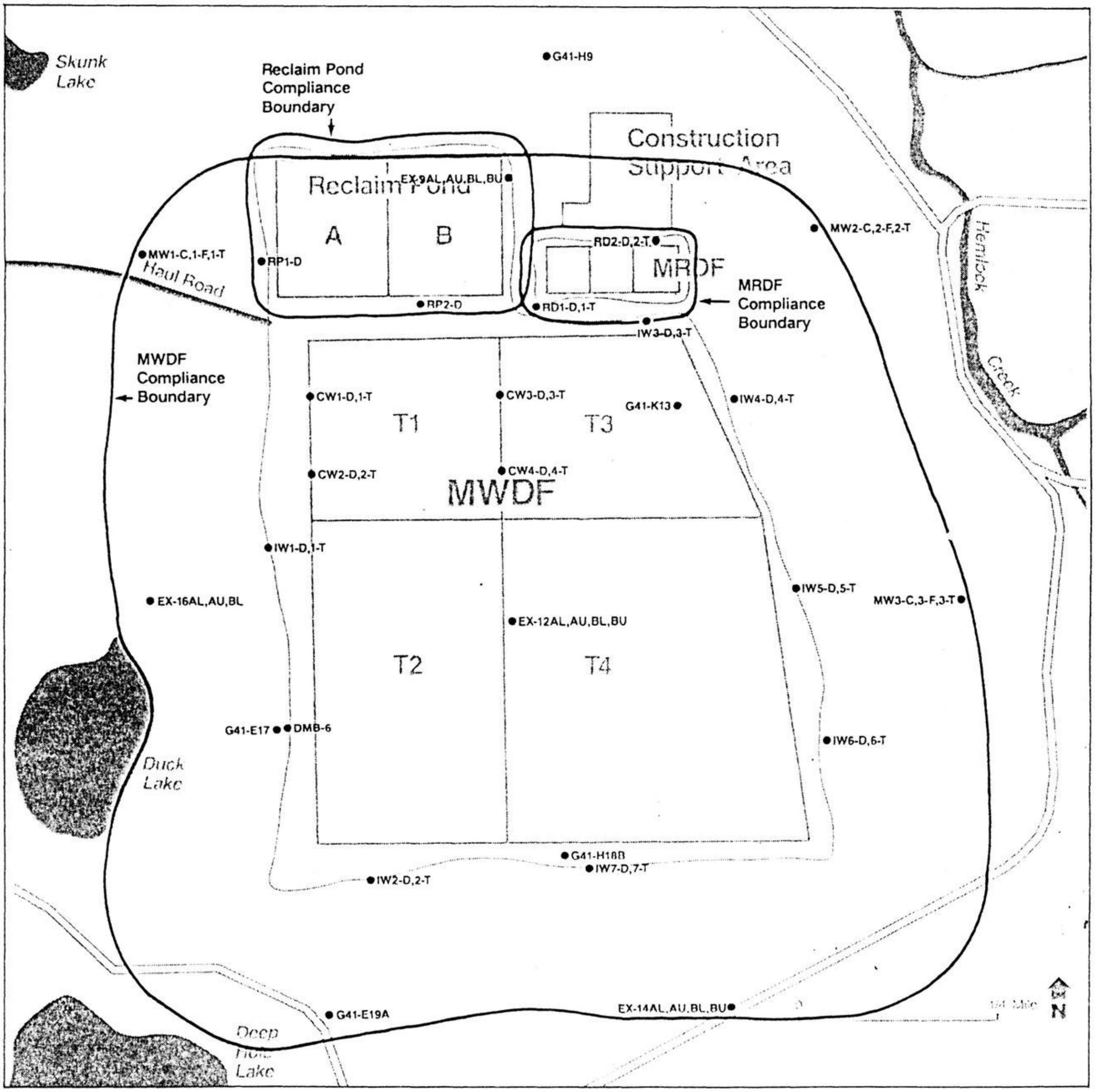


Monitoring Well Locations

Legend

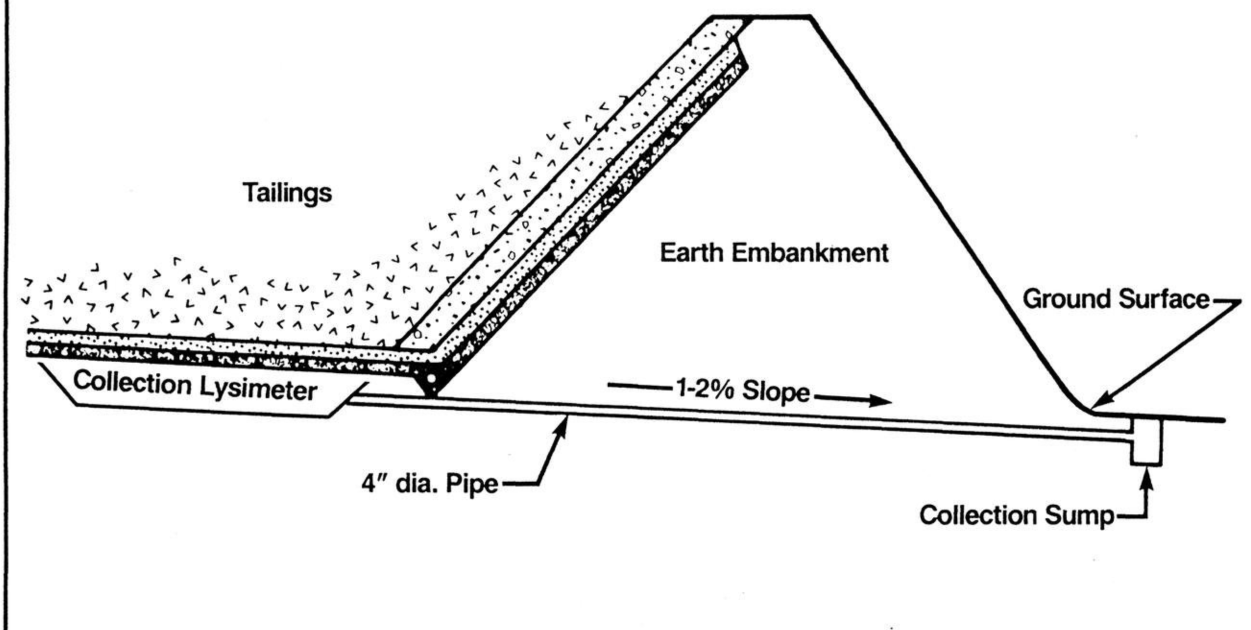
- ● Ground water table well location
- ■ Ground water table and quality well location

MWDF Well Locations

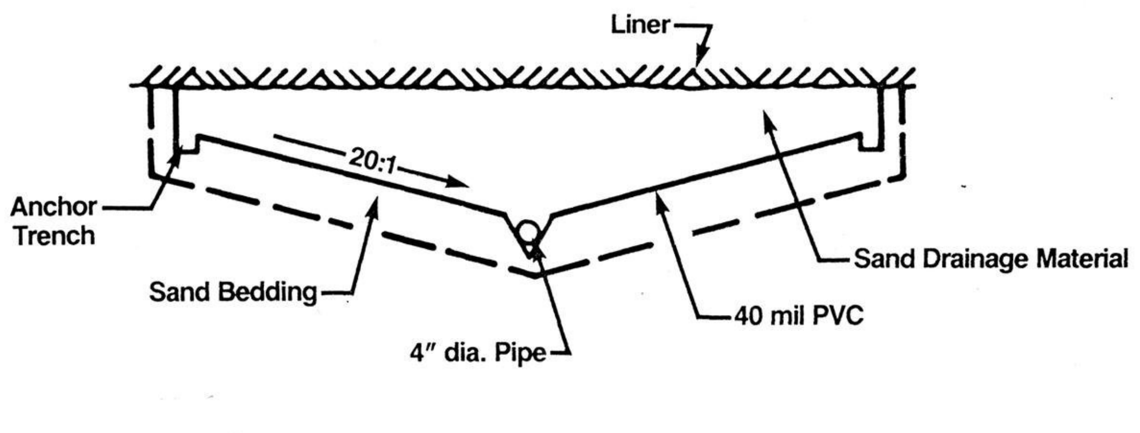


Legend
● IW = Intermediate well
● MW = Compliance boundary monitoring well
● CW = Crest well

Typical MWDF Lysimeter

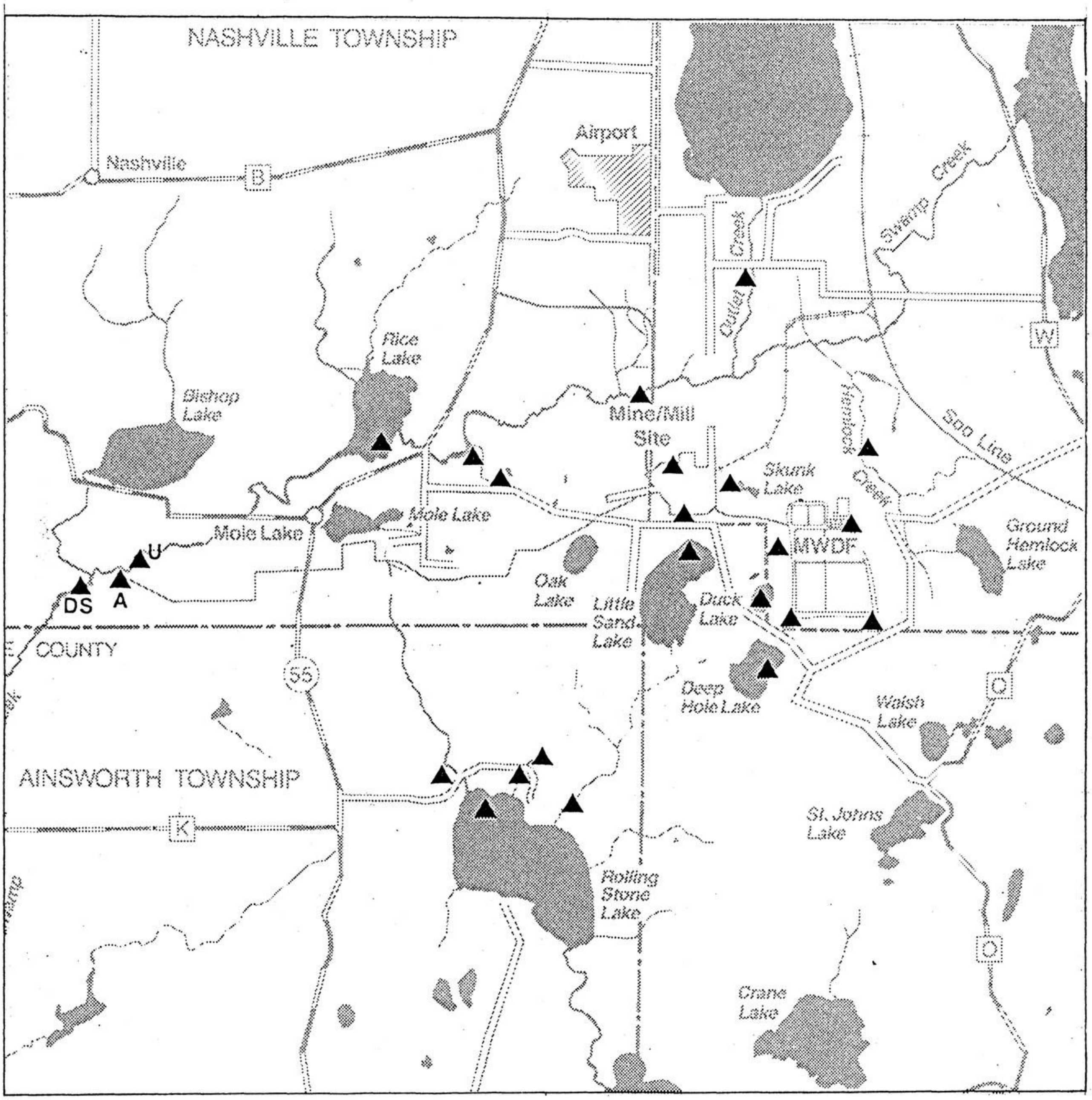


Gravity Drain Lysimeter, Pond T1



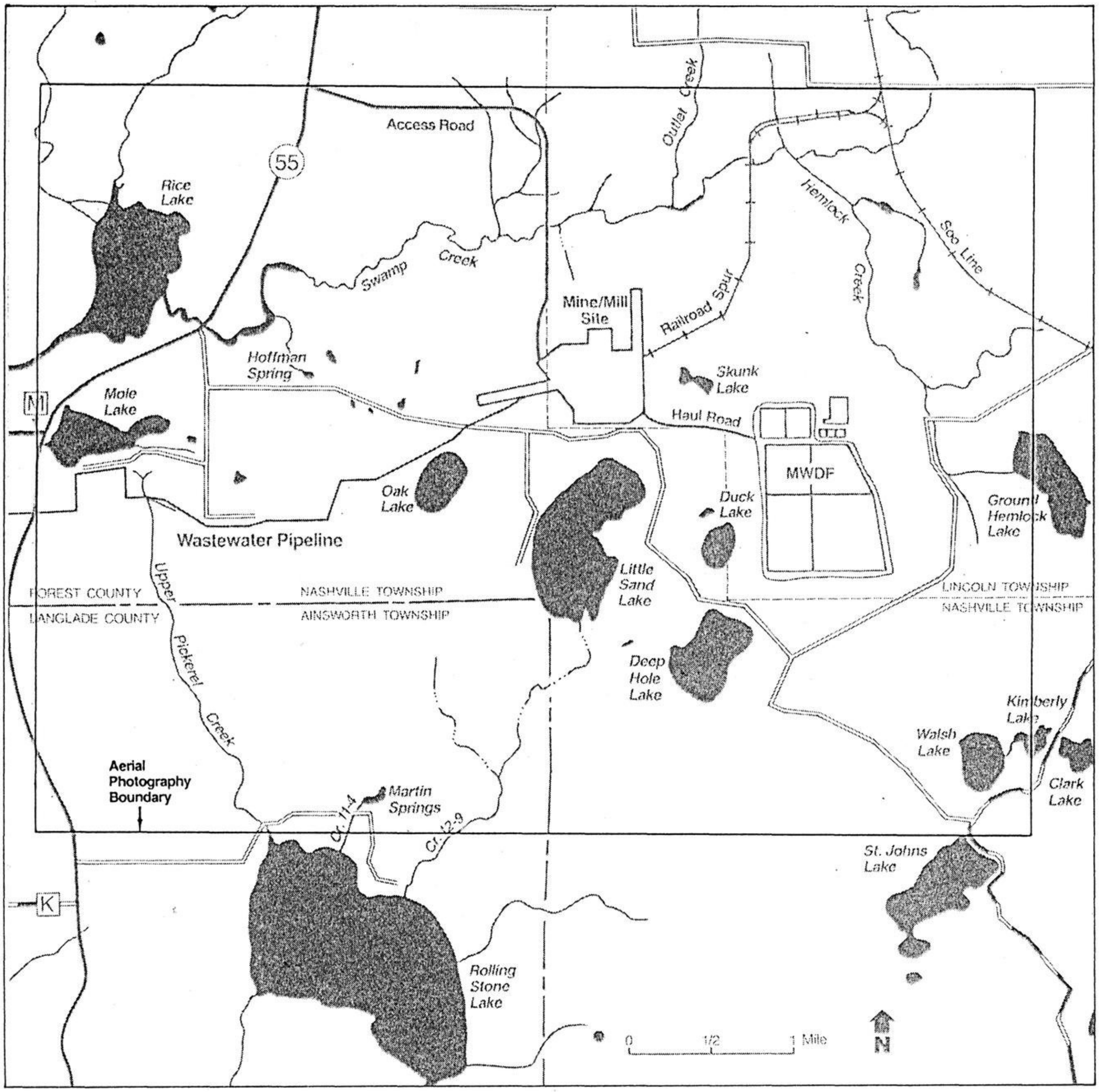
Collection Lysimeter Cross Section Detail

Surface Water
And Aquatic Ecology Monitoring Locations



Legend
▲ Monitoring Locations

Aerial Photography Boundary



BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	) IH-86-18

TESTIMONY OF RONALD T. LUKE

Q. Please state your full name, address, and occupation.

A. I am Ronald T. Luke, president of Research and Planning Consultants, Inc., also know as RPC, Inc., a socioeconomic consulting firm located at 500 Southwest Tower, Austin, Texas, 78701.

Q. Please summarize the professional training and experience that qualify you to testify on the socioeconomic impacts of the Crandon Project.

A. My background and publications are described in detail in my professional resume submitted as EXHIBIT 411. To summarize briefly, I hold a Bachelor of Arts in Social Studies degree from Harvard University, a Master of Public Policy degree from the John F. Kennedy School of Government at Harvard University, a Doctor of Jurisprudence degree from the University of Texas School of Law, and a Ph.D. degree in Public Policy from the John F. Kennedy School of Government at Harvard.

I have worked as a consultant in regional economic and demographic analysis and in health care planning since 1972. As part of my work, I have prepared population and economic analyses for regions, counties, cities, townships, and school districts in Texas, New Mexico, Louisiana, Arkansas, Colorado, Utah, and Maine, as well as Wisconsin. I have also managed and prepared major socioeconomic assessments since the mid-1970's.

Q. What is your individual and corporate experience in preparing socioeconomic impact assessments for other than the Crandon Project?

A. RPC has been in operation and active in performing major socioeconomic assessments since the mid-1970's. I joined RPC as Vice President-operations in 1976 and became President and principal owner in 1979. Since 1976, I have managed all RPC projects in these area .

From 1974 to 1978, RPC was retained by the Commissioner of the Texas General Land Office to develop the state's Coastal Zone

Management Program under the terms of the federal Coastal Zone Management Act. In this capacity, RPC conducted socioeconomic and physical baseline studies and assessments of the Texas coastal communities. Part of the effort was the development and testing of socioeconomic and ecological assessment routines for offshore energy development, port development, petrochemical development, and the associated residential and commercial development.

From 1980 to 1981, RPC was retained by a consortium of 17 natural gas pipeline companies as their socioeconomic consultant in their contest of the Louisiana First Use Tax. The issue in this case was whether offshore gas production in federal waters had imposed a socioeconomic burden on Louisiana which made it reasonable for the state to impose a tax on interstate commerce. To address this question, we had to look back in time to determine what conditions might have been without gas development in federal waters as well as to make projections concerning future conditions. The period of the analysis was from 1954 to 1979 and from 1980 to 2030. The amounts in issue under the tax were approximately $100 million per year.

We have undertaken the socioeconomic assessments for the Corps of Engineers (Trinity River Project), the Bureau of Reclamation (Seward Reservoir Project), Mesa County Colorado (Cumulative

Impact Assessment), Texas Eastern (New Mexico Gasification Project), and White River Shale (Oil Shale Project).

In the related waste management field, we have prepared land use impact assessments for both municipal and hazardous waste disposal facilities in Texas for Browning-Ferris Industries and for individual clients. We have also prepared an analysis of the impact of sanitary landfills on residential property values in Houston, Atlanta, Baltimore, and Minneapolis.

Q. What has been your involvement with the Crandon Project?

A. From 1979 to the present, RPC has been retained by Exxon Minerals Company (Exxon) as socioeconomic consultant for the Crandon Project to prepare a comprehensive assessment of the potential socioeconomic effects of the Crandon Project (the Project).

Q. Was the material that you are testifying to today prepared by you or under your direction and supervision?

A. Yes.

Q. When was the assessment prepared?

A. We prepared the assessment during the period 1980 to 1983.

Q. What Project description did you analyze?

A. We analyzed project descriptions which reflected Exxon's 1982 development plans, plus and minus ten percent.

Q. What were the reasons for the study?

A. There were several reasons for our study. First and most obvious, the study was done to identify the direction and magnitude of the Project's potential benefits and impacts. The second purpose was to satisfy state mining permit requirements. Wisconsin Statute 144.85(5)(a)1.e specifies that in considering any application for a metallic mining permit, the Wisconsin Department of Natural Resources must find that "the proposed mine will not result in a net substantial adverse economic impact in the area reasonably expected to be most impacted by the activity." Third, the study was done to fulfill requirements for the Environmental Impact Report, and provide the data necessary to develop a Draft Environmental Report. Fourth, it was designed to provide the information necessary to satisfy local zoning requirements. Finally, it was intended to provide a basis for planning by local study area jurisdictions.

SUMMARY OF KEY FINDINGS

Q. Please summarize the key findings and conclusions of your study. What did you conclude about the effect of the Project on population?

A. The Crandon Project will have only limited effects on local study area population levels. Population will increase by 8 to 11 percent during the peak year of construction, and 3 to 6 percent during operation.

Q. Will these population increases cause "boomtown" conditions in the local study area?

A. No. "Boomtown" conditions occur when growth is so rapid or sustained that it strains the ability of an area to cope. Examples of boomtown conditions are housing shortages, crowded schools, inadequate police and fire protection, and conflict between current and new residents. Boomtown conditions should not occur in any jurisdiction during any phase of the Project.

Q. What are the Project's economic effects?

A. Development of the Project will result in substantial economic benefits to local study area residents. The Project will increase local study area and overall state employment, personal income, per capita income, disposable per capita income and business activity levels. We do not expect substantial employment-related migration to the local study area. Further, existing industries should not be harmed by Project development.

Q. What specifically did you conclude about the Project's effects on jobs?

A. The Project will increase local study area employment by 8 to 11 percent during the peak year of construction, and 4 to 6 percent during operation. Many of these jobs can be filled by current residents of the local study area.

Q. How will it affect income?

A. The Project will increase local study area personal income by 8 to 11 percent during the peak year of construction, and 4 to 7 percent during operation. Per capita income will also increase, but not by as much as total income due to population changes associated with the Project.

Q. What about effects on housing and land use?

A. There will be no housing shortages in the local study area. The project will not lead to development of prime agricultural land or forestland. Overall land use patterns will not change.

Q. What did you conclude about transportation?

A. Traffic on local study area highways will increase, but not enough to require major highway expansions. Providers of rail and air services will benefit from the Project.

Q. What about effects on public facilities and services?

A. Project effects on public facilities and services will be modest and manageable. The local study area has a well-developed infrastructure. Few additional public facilities will be needed due to the Project, although population growth will lead to increased public expenditures and will accelerate the need for some capital improvements and additional public employees. There will be no problem in hiring more public employees. As I discussed earlier, boomtown conditions will not concur in any jurisdiction during any phase of the Project.

Q. What about the Project's fiscal effects?

A. The Crandon Project is projected to generate directly over $350 million (1982 constant dollars) in net proceeds and state income taxes. About $180 million of this will come from the net proceeds tax. Another $260 million in tax revenues will be generated indirectly. The net proceeds tax revenues available for mitigation should be several times greater than needed to eliminate and negative fiscal effects associated with the Project.

Q. What did you conclude about the sociocultural effects?

A. Our surveys showed that most seasonal and permanent residents of the local study area believe that the effects of the Project, on the whole, will be beneficial. The Project will not materially disrupt or alter the existing social structure of the local study area.

Q. What about the Project's effects on the Native American communities?

A. Project development will increase the employment opportunities for Native Americans and may make feasible the development of tribal enterprises.

Q. To summarize, how would you characterize the Project's effects?

A. The local study area has a relatively large population and well-developed infrastructure compared with a relatively small Project-related influx of population and demand on the infrastructure. We found that the Project will have positive economic and fiscal effects on the local study area, and that it will not cause shortages of housing or public facilities and services.

Q. What do you foresee happening after operations cease?

A. Without preplanning, post-mining conditions could revert to conditions similar to those projected without the Project.

Jobs would be lost and some out migration would occur. However, the scheduled closure of the Project is over thirty years away. Certainly, sufficient lead-time exists to avert any potential negative effects through proper planning, appropriate use of local impact funds, and active pursuit of alternate economic development plans.

The fact that the Project will eventually close when its mineral resources are exhausted does not make the mining project less desirable than a manufacturing project or other source of local economic growth. No mine, plant, or even government installation is guaranteed to continue forever. The eventual closure of the mine is not, <u>per se</u>, a negative impact of the Project. Closure is a planned part of the Project's operations which also must be planned for by the state and the local study area. In the meantime, the mine will have been in operation for a generation, and the local study area will have realized substantial economic benefits during that time.

Q. What if the mine had to shut down temporarily during its operation?

A. Layoffs and shutdowns are not unique to mining, but can occur in any business. If for some reason the mine had to close, production and income would be lost during that period. Keep in mind, though, that this mine will be built with the most current and lowest cost technology. If it were not designed to produce in the current metal price environment, it would not be built. Thus, it should be able to continue operating even under economic conditions which would cause other less efficient mines to shut down.

Q. Your findings and conclusions are based on your analysis of Exxon's 1982 development plans. What effect do the differences between that plan and the current project plan have on your findings and conclusions?

A. We have reviewed material prepared by Exxon and others, such as the Wisconsin Department of Revenue, which examines the current plan's impacts. The current plan entails reduced operations employment and investment levels, and the expected impacts are generally within or slightly lower than our projected ranges. It is therefore my opinion that our overall findings and conclusions are not materially affected by the current project plan.

NET EFFECTS: FINDINGS AND CONCLUSIONS

Q. I'd like to bring to your attention to the second purpose of the study, namely to determine whether the Project will have a "net substantial adverse economic impact in the area reasonably expected to be most impacted" by the Project. What have you determined to be the area reasonably expected to be most impacted by the Project?

A. EXHIBIT 412 shows the local study area for the Crandon Project. The local study area includes 40 towns and four incorporated areas encompassing most of Forest and Langlade counties, and about half of Oneida County. Besides the included towns and incorporated communities, we also analyzed the Project effects on school districts and county governments.

Q. How did you decide which towns and jurisdictions to include in the local study area?

A. In addition to the vicinities immediately adjacent to the mine/mill complex, the local study area includes communities where new residents are expected to locate in response to jobs directly or indirectly created by the Project. It also includes locations with existing industries which may compete with the Project for workers. The procedures by which we defined the local study area are fully described in our report <u>Definition of the Local Study Area, Socioeconomic Assessment, Crandon Project</u> (Research and Planning Consultants, 1980), which appears in the record as EXHIBIT 190.

Q. Why were some towns in the three counties excluded from the local study area?

A. We excluded the remaining towns in the three counties because they are not within a reasonable commuting distance from the Project site, because they lack land suitable for development, or because they are oriented to a trade center in the region other than Rhinelander.

Though the Crandon Project may have socioeconomic effects outside the local study area, most effects are likely to occur within its boundaries. Any socioeconomic effects which might occur outside the area are likely to be negligible. For informational purposes, however, we also examined potential Project effects on the state's economy, population, and tax revenues.

Q. How do you define economic impact for purposes of this statutory requirement?

A. The economic impact of the Project is that portion of its impact on business, households, and units of government which is measured in terms of business activity, labor markets, jobs, personal income, taxes, public expenditures, and public revenues. This definition of economic impact as a financial and fiscal test is consistent with the legislative history of the statute and makes possible a determination of whether or not the Project will result in a "net substantial adverse economic impact."

Q. Did you consider other impacts beside economic impacts in your study?

A. Yes. Although some impacts that we studied, such as the sociocultural impacts, do not factor into our determination of net economic impact, we nevertheless examined them in order to fulfill requirements for the Environmental Impact Report and for mitigation and planning purposes.

Q. How did you determine whether there is a net substantial adverse economic impact from the Project?

A. We developed a set of computer models. We also collected an enormous amount of data, conducted surveys in the local study area, and spent time there observing and talking to various people. The models and techniques that we used are described in our report Forecast of Future Conditions, Socioeconomic Assessment, Crandon Project (Research and Planning Consultants, 1983), EXHIBIT 191.

We ran our models first assuming that the Project is not built and then assuming three different scenarios of Project development. EXHIBIT 413 shows the types of assumptions underlying the scenarios.

We then compared each of the Project model runs with the projections assuming no Project. The differences between the runs with the Project and the run without the Project are the effects the Project would have on the local study area if it were developed.

In all cases, we found that there would be more business activity, more jobs, higher income levels, and no harm to existing industries. Some additional public expenditures would be required, and some jurisdictions would experience higher property tax mill rates if one did not consider net proceeds tax payments. However, the total amount of net proceeds taxes paid by the Project would be more than sufficient to make discretionary payments to these jurisdictions and eliminate the need for any Project-related increases in the property tax rate. Increases in per capita income would not be offset by increased taxes as a result of the Project.

These findings would not materially change under the current project plan.

Q. In light of these specific findings and all available data and analysis, what is your opinion as to whether the Project will have a net substantial adverse economic impact in the area reasonably expected to be most impacted by the Project?

A. It is my professional opinion that the proposed Crandon Project should have no net adverse economic impact in the local study area, which is that geographic area which I expect to be most impacted by the Project.

DETAILED FINDINGS AND CONCLUSIONS

DEMOGRAPHIC EFFECTS

Q. You told us earlier that the Project will have limited impacts on the population of the local study area. Would you give us more detail about that conclusion?

A. Certainly. Compared with the without-project population projections, total local study area population will be 8 to 11 percent higher during the peak year of construction, and 3 to 6 percent higher during operations. This represents an annual average growth rate of from 2.1 to 2.6 percent during construction and 0.1 to 0.2 percent during operation. The construction growth rate is higher than the annual rate of 1.3 percent experienced in the area in the 1970s, but is nowhere near the high rates of growth associated with boomtown developments. The rate during operation is actually less than the 0.3 percent annual rate of growth experienced in the area from 1950 to 1980.

Q. Where will the Project-related population live within the local study area?

A. The population will tend to be spread throughout the local study area, although naturally some jurisdictions will be affected more than others. After examining each jurisdiction's highest annual average rates of growth for one year and five years, we identified the towns of Lincoln and Nashville, four towns around Rhinelander--Cresent, Newbold, Pelican, and Pine Lake--and the City of Crandon as experiencing the greatest population impacts from the Project; these occur during the construction phase. Even though the cities of Rhinelander and Antigo receive substantial shares of the Project-related population, the absolute numbers of additional people are a small percentage of their base populations.

I repeat that none of the jurisdictions, even those most heavily impacted, receives percentage of absolute population increases due to the Project which would disrupt the orderly provision of housing and public services or would disrupt the social structure. Because the Project-related population will be dispersed over more than 40 jurisdictions, which dilutes its impact, and because the local study area has a well-developed infrastructure, the "boomtown" conditions sometimes associated with development in the western United States will not occur in the local study area.

Q. Why are the population impacts greater during construction than operation?

A. This is because of differences in the size and nature of the work forces. Although the influx of construction workers will be for the shorter period of construction, there will be more of them. The peak number of inmigrant construction workers is expected to range from 390 to 770, compared with 280 to 340 inmigrant operation workers. Also, more of the inmigrant construction workers will be single (or married without their families) than the operation workers.

Those construction workers who are single or who do not move their families in are expected to locate close to the Project site, especially in the towns of Lincoln and Nashville. As a result, during construction, Lincoln and Nashville are expected to have the highest five-year average annual growth rates of any local study area jurisdiction--more than 7 percent. In the peak year of construction, which is the year of peak impact, the Project-related populations in both towns result in most-likely population increases of approximately 42 to 43 percent. As I said, most of this population increase is generated by inmigrant construction workers.

After completion of Project construction, many construction workers and their families will leave the local study area, leading to a decrease in Project-related population in those jurisdictions where the construction workers had lived. One year after construction is finished, the Project-related population in Lincoln will decrease by 108 to 120 people, and in Nashville by between 125 and 140.

As operations continue, population impacts on all the jurisdictions will decline. For example, in a typical year of operation, the Project-related populations of Lincoln and Nashville in the most-likely case should be about 25 percent of their without-project populations--substantially lower than during the peak year of construction.

Q. How did you arrive at these conclusions?

A. As I discussed earlier, we built a system of computer models, as shown in EXHIBIT 414 in order to determine project impacts. The models, as shown in that we use to estimate population impacts are the demographic model, the labor market model, and the spatial allocation model.

The demographic model gives us projections of local study area population, the labor market model tells us how many people are going to move into or out of the area for job-related reasons, and the spatial allocation model distributes the local study area population to individual communities.

Q. How does the demographic model work?

A. The demographic model projects population using the cohort-survival technique. This is a standard projection technique which is based on simple arithmetic: the population in any year equals the population in the preceding year, plus the number of births, minus the number of deaths, plus the number of people who moved in, and minus the number who moved out.

The number of births in a given year minus the number of deaths produces what is referred to commonly as a population's "natural increase." We use the cohort-survival technique to project natural increase and net migration for those who have reached retirement age--those 65 and older.

With the cohort-survival technique, the population is divided into age/sex groups called cohorts. The population of a given cohort in a given year equals the number in the beginning, minus the deaths, plus the net migrants. Total population is the sum of all cohorts plus the number of births. The newborns form their own cohort for the next year. By dividing the population into cohorts and then projecting the number of births, deaths, and migrants for each cohort, we can account for differences in births, deaths, and migration which are age and sex related.

Q. How do you project migration for the working-age population?

A. Job-related reasons are a major factor in migration in working-age groups. We use the labor market model, illustrated in EXHIBIT 415 to account for this type of migration.

Q. How does the labor market model work?

A. As shown in EXHIBIT 415, the model first estimates the available labor pool in the local study area by applying cohort-specific labor force participation rates to the population projections for each cohort. It then combines this available labor pool with the projected employment from the economic model to get unemployment and a premigration unemployment rate. The model compares this rate with assigned minimum and maximum rates. If the premigration rate falls within the range, no migration occurs. If the rate is less than the minimum, inmigration occurs. The result of this matching procedure is a projection of the number of inmigrating workers.

The model then projects the changes in population associated with the inmigrating workers by considering worker characteristics like marital status and family size. The model tracks the workers by type as they move into the local study area. This means that we can apply different characteristics to the without-project, construction, operation, and secondary workers, and keep track of who gets what jobs. The result of all this is the number of job-related migrants.

The number of job-related migrants feeds back into the demographic model to give total population for the local study area. The spatial allocation model then distributes the population to individual communities in the local study area based on factors like housing and employment location, and driving time to the Project site.

Q. Did you run the models under both without-Project and with-Project conditions?

A. Yes. As I discussed earlier, we ran all models first assuming that the Project is not built and then for three Project scenarios. The differences between the runs with the Project and the without Project run are the population effects of the Project.

Q. Are the models and techniques that you just described a standard way of making population projections?

A. Yes. We used models and techniques which are state-of-the-art and considered to be a standard way of making comprehensive population projections.

Q. Did you use similar models and techniques when you made your projections for other areas, such as for employment and housing?

A. Yes. As I mentioned a few moments ago, we developed a system of computer models which we used to make projections and draw our findings and conclusions about the Project's effects. All of the models are comprehensive and state-of-the-art, and are based on reasonable assumptions concerning the future. Besides the models, we also looked at a broad collection of literature, conducted surveys in the local study area, and spent a great deal of time there observing and talking to people. The results of our modeling process and our professional interpretations are what we believe is a reasonable reflection of the future of the local study area and the probable effects of the Crandon Project.

ECONOMIC EFFECTS

Q. Let's go on to the Project's economic impacts. How many people will work at the Project?

A. Based on case studies of similar construction work forces, we conservatively estimate that about 10 percent of the construction work force will commute from outside the local study area. Excluding these commuters, we expect that direct construction employment would peak at between 870 and 1,070, and that the peak would occur during the last year of construction. Because there is a gradual build-up of operations employment during construction, the peak total work force would actually be somewhat higher since both construction and operations workers would be included. Thus, total employment will peak at between 1,400 to 1,700. Once the operation of the mine begins, the average direct employment would be from 700 to 860 jobs.

Q. Does this area have a high unemployment rate?

A. Yes, it does. The area's unemployment rate has traditionally been higher than the rest of the state and the nation.

Q. What effect does the Project have on local study area employment?

A. Including secondary jobs, the Project would increase local study area employment by 8 to 10 percent during the peak year of Project employment, and 4 to 6 percent during operation. The unemployment rates throughout the Project life would be approximately 1 percentage point lower than unemployment rates without the Project.

Q. Who are likely to get these jobs?

A. Between 25 to 50 percent of the construction jobs are projected to be filled by local residents. This is because of Exxon's stated hiring policy and the traditionally higher wages in construction. We anticipate that local residents will fill all or most of the jobs not requiring special skills. The rest will be filled with people with those special skills who either inmigrate or commute to the local study area. The actual percentage of construction jobs filled locally will depend on a number of factors, most of which are difficult to predict. Many of the secondary jobs created during the construction phase will probably be filled by local residents, or by family members of inmigrating workers. The relatively low unemployment rates during construction are likely to result in some migration into the local study area of people seeking employment. Some of these inmigrants may also take the secondary jobs.

In the operation stage, approximately 60 percent of the operation jobs could be filled by local residents. We assumed that the remaining 40 percent would be filled by inmigrants. These percentages are based on the assumptions that, given the relatively higher wages and Exxon's stated hiring policy, local residents will prefer the operation jobs, even to the point of switching from their current jobs, if necessary. However, we believe that a sufficiently large labor pool will be available during the operations period such that the increase in jobs will be reflected in a declining unemployment rate rather than in employment-related inmigration to the area.

Q. Will the Project generate other jobs besides those at the mine itself?

A. Yes. The spending by Exxon and the spending by persons employed at the mine will in turn generate other jobs, many of these in the consumer goods and services areas. The creation of jobs which those businesses provide is called the multiplier effect. We refer to the jobs created as secondary jobs. Almost none of these jobs require special skills and we would expect that most of them would be taken by local study area residents. If employment rates do fall to a sufficiently low level during the construction phase, there may be some inmigration of people to fill secondary jobs.

Q. Besides adding jobs and reducing unemployment, what other economic effects will the Project have?

A. Besides contributing jobs, the Project will add positively to total and per capita personal income in the local study area during both the construction and operation phase. The Project will increase personal income by 8 to 11 percent during the peak year of construction and between 4 to 7 percent during operation.

The increases in per capita personal income will not be quite as large as for total income of population changes associated with the Project. Nevertheless, per capital income should increase about 0.5 percent in the peak year of construction and up to 3 percent during operation.

Q. Will the Project have any negative effect on tourism in the area?

A. Over its life, the Project should have no significant negative impacts on tourism. RPC surveyed tourists, seasonal residents and permanent residents on how the Project would affect their recreational use of the local study area. Over 70 percent of tourists said the Project would have no effect on their vacation plans, with only 5.3 percent saying they would cease to visit the area because of the Project. The Project was viewed as a positive or neutral event by 70 to 80 percent of seasonal residents. Over 80 percent of permanent residents felt the Project would have a positive or neutral effect on outdoor recreation and on entertainment facilities.

During the construction phase temporary residents may rent seasonal residences and occupy hotel rooms. This might cause a few seasonal residents or potential tourists to spend the summer elsewhere. Such a diversion would only occur if tourist accommodations and seasonal residences were operating near capacity in the without project scenario. Given the abundance of accommodations in the area, this seems unlikely.

However, diversion of a few tourists during the construction period will not have negative economic effects. The economic effect of tourism is the money the tourist spends in the area on food, gas, entertainment, etc. Temporary residents are likely to spend money in much the same fashion as local study area tourists and seasonal residents. Thus any reduction in tourist spending in the local study area during the Project's construction phase should be more than offset by spending by temporary residents.

The Project should have no negative effect on tourism during its operations phase. Tourist-oriented businesses should experience no project-related problem in obtaining workers. The addition of project-related population and income may enable the area to support additional specialty shops, recreation and cultural events which would make the area more attractive to tourists and increase opportunities for tourist purchases.

During construction and operation the Project creates no widespread changes in area land use patterns, population density, traffic, noise, views, air quality, water quality or views which would affect use of the area by tourists or seasonal residents. Exxon has offered to purchase seasonal and permanent residences adjacent to the Project whose recreational use might be disturbed. With the proceeds from their sale, the owners of these residences should be able to replace them within the local study area.

Q. Overall, do you consider the economic effects of the Crandon Project to be positive?

A. Yes. The economic effects of the Crandon Project are individually and collectively positive. The Project will increase local study area employment and personal income, and reduce unemployment. It will help diversify the local economy by adding a new major industrial activity. It represents an expansion of the economic base and new economic opportunity for the local study area, yet it is not so large that the local study area becomes a one-project economy. These benefits should occur without harming existing industries or causing extensive employment-related migration.

HOUSING AND LAND USE EFFECTS

Q. How will the Crandon Project affect housing?

A. The Project-related employment creates additional demand for housing in two ways. First, the new jobs allow additional household formation in the local study area, and secondly, the jobs will attract new households to the area. Each new household, of course, requires a place to live.

Q. Will the additional households cause housing shortages?

A. No housing shortages will result from Project development. Over a third of the total housing stock in the local study area is seasonal and most of the recently-built seasonal housing is suitable for year-round occupancy. In addition, the area has a substantial stock of short-term housing in the form of hotels, motels, and resorts. Mobile homes are also widely used. Those construction workers who are only temporary residents of the area will find rental housing in the current rental stock, in seasonal homes and in motels.

The peak demand for new home construction is within the current capacities of local builders. The housing industry in the local study area is characterized by small builder/developers.

Subdivisions are generally less than 50 lots, and use wells and septic systems. The only improvements are paved roads and electrical connections. These rural subdivisions have a short lead time because they do not require central water and sewer systems or other infrastructure. Consequently, delays experienced elsewhere in developing buildable lots will not be a problem here. The area's homebuilding capacity is further increased by the location nearby of major providers of manufactured housing.

Q. What effect will the Project have on housing sale prices?

A. There will not be a shortage of buildable lots or housing. We therefore do not expect the Project to increase housing prices.

Q. What effect will the Project have on land use patterns?

A. The Project and related development do not use a significant amount of land relative to the available supply. Therefore, the overall patterns of land use will not change. Further, the Project will not result in the development of prime agricultural land or forest land.

Q. In summary, how would you characterize Project impacts on housing and land use?

A. The Project will not cause housing shortages in the local study area, and its impacts on land use are minimal.

TRANSPORTATION EFFECTS

Q. What effect will the Project have on traffic, especially near the Project?

A. The development of the Crandon Project will substantially increase current traffic levels along the roadways providing direct routes between the Project site and employee residential locations. These traffic levels, however, will not require the building of new highways or a major expansion of existing highways.

Q. When and where will the traffic increases occur?

A. Because the traffic increases are mostly associated with commuting workers, congestion will coincide with shift changes. The map, EXHIBIT 416, shows the major highway corridors and segments leading to the Project site. The major areas of congestion will be U.S. 8 and S.H. 55 through the City of Crandon, and the intersection of S.H. 55 and the Project Access Road.

The congestion in Crandon will occur principally because there is a discontinuous alignment of the through east-west and north-south highways (U.S. 8 and S.H. 55) in a downtown area. To avoid this section, traffic along Forest County Road S is likely to increase, leading to some congestion at its intersections with U.S. 8 and S.H. 55 and to a lesser degree along the stretch of road between the two intersections.

Q. Will truck traffic pose major problems in the area?

A. Truck traffic generated by the Project will not pose major problems in any roadway in the area. It may contribute to traffic congestion at the intersection of S.H. 55 and the Project Access Road, however, if truck deliveries happen to coincide with shift changes.

Q. How can the expected Project-related traffic be controlled?

A. The expected Project-related congestion can be controlled by simple improvements--warning signs and passing restrictions, turning lanes, traffic control devices, and illumination. The only road resurfacing which may be necessary will involve improving and strengthening Forest County Road S between U.S. 8 and S.H. 55. Again, no major highway modifications, such as extensive road-widening or construction of urban-area bypasses, will be needed due to the Project.

Q. What effect will the Project have on air traffic?

A. The Rhinelander/Oneida County Airport is presently served by commuter airlines affiliated with major air carriers. The Project should increase passenger traffic at the airport. Since the facility is currently under-utilized, the increase will not cause operational problems.

Q. What effect will the Project have on railways?

A. The Project's impact on the railways will be to increase the length of the average Soo Line train, but not the number of trains. The practical effect is that motorists will have to wait longer at crossings for trains to pass. Motorists' safety will not be affected, though, because of the 40 mph maximum rail-operating speed established for the line and the ongoing Wisconsin Department of Transportation programs to upgrade traffic control devices at major roadway-railway intersections.

PUBLIC FACILITIES AND SERVICES EFFECTS

Q. Let's go on to public facilities and services. People are usually most interested in the effects of development on schools, police and fire protection, and water and wastewater facilities. How will the Project affect the school districts?

A. Additional personnel, such as teachers, will be needed to handle increased school enrollment. However, all the school districts have adequate physical capacity to handle even the peak Project-related enrollment. Therefore, no additional school facilities must be built to handle the mine-related students. Of course, some districts might choose to replace existing schools with more modern buildings anyway. But any such replacement of buildings would not be due to the Project.

Q. How will the Project affect police and fire protection?

A. Even without the Project, a few jurisdictions are expected to hire several police officers and firefighters, and the towns of Newbold and Pelican are expected to start their own police departments. With three exceptions, though, the effect of the Project is merely to accelerate the hiring of personnel by 5 to 12 years.

The exceptions are the City of Rhinelander, Langlade County, and Forest County. As a result of the Project, the City of Rhinelander will temporarily need to hire a police officer and fire fighter to handle the increased population during construction, Langlade County will temporarily need another law enforcement officer for several years during construction and operation, and Forest County will need up to three more law enforcement officers during construction and two more during operation.

Q. Will any new centralized water or wastewater facilities be needed because of the Project?

A. No new centralized water or wastewater facilities will be necessary due to the Project _per se_. Although our with-Project projections indicate that the towns of Crescent, Pelican, and Pine Lake will reach population levels where central water and sewer service might be required, the same facilities will also be needed without the project. The effect of the Project is to cause the threshold for the services to be reached sooner.

I must emphasize that while the towns reach the population threshold both without and with the Project seemingly to warrant central sewer and water service, the nature of development in the towns makes this possibility extremely unlikely. And, if these facilities were constructed, they would be financed through user fees and other revenue sources, rather than by increasing the property taxes of residents.

Q. What new capital expenditures will be needed due to the Project?

A. The additional capital expansions required by project development are limited, for the most part, to small capital expenditures for general government and operations. Because of the well-developed infrastructure, no capital expenditures should be needed prior to Project construction.

Q. Overall, how would you characterize Project impacts on public facilities and services?

A. The local study area has a well-developed infrastructure with the capacity to absorb the Project-related population increases. Few additional public facilities will be needed due to the Project, although population growth will lead to increased public expenditures. In most cases, the Project's major effect will be to accelerate the need for some capital improvements and additional public employees compared to without-project conditions, rather than to require new, higher levels of services. There will be no problem in hiring more public employees. In summary, Project impacts on public facilities and services will be modest and manageable.

FISCAL EFFECTS

Q. What effect will the Project have on property tax rates?

A. When we did not consider net proceed tax payments and other non-property tax sources of revenue, we found that some jurisdictions will experience mill rate increases over rates without the Project during construction. This is due to delays in bringing properties of the Project and the homes of the new area residents onto the tax rolls and earlier needs for capital improvements. The most positive tax effects are in those jurisdictions with the Project-related facilities: the Towns of Lincoln and Nashville, Forest County, and the Crandon School District. Simulated tax rates for these jurisdictions show consistent decreases throughout the operation phase. Most of the other jurisdictions show no consistent patterns, although most will experience mill rate decreases at one time or other during operation.

As I mentioned, these conclusions are based on the assumption that all Project-related government costs will be paid from local property taxes. In reality, grants from the Mining Investment and Local Impact Fund (which are funded from net proceeds tax payments), user fees, and special assessments may also be used to cover Project-related costs.

Q. When you consider the net proceeds tax payments, will the mine generate sufficient revenues to eliminate the need for any Project-related increases in the property tax rate?

A. Yes. During construction, the jurisdictions in which the mine facilities are located will receive construction fee payments which will more than offset any Project-related cost increases. During operations, the facilities will increase the property tax base enough to cause a decrease in the rates. In addition, the two towns and Forest County will receive guaranteed annual payments from the net proceeds tax.

As for the other jurisdictions, the total net proceeds tax payments paid by the Project will be more than sufficient to make discretionary payments to these jurisdictions and eliminate the need for any Project-related increase in the property tax rates.

Q. Will there be a mismatch in the timing of Project-related government costs and Project net proceeds tax payments?

A. Yes. Even though some local study area governments will incur Project-related cost during construction which are not compensated for by Project-related increases in the tax base, the Project will not begin paying the net proceeds tax until after operations start. Consequently, the Mining Investment and Local Impact Fund may develop a cash flow shortage during construction, even though the net proceeds tax payments generated during the life of the Project will be more than sufficient to mitigate any fiscal impacts which may occur. Dr. Huddleston will testify in more detail about the Project's fiscal effects.

Q. In your determination of the Project's fiscal effects, what revenue sources did you consider?

A. We considered the net proceeds tax, state and federal income taxes, and other Project-related state tax payments. We also considered Project-related changes in local study area property tax payments and mill rates. We calculated the net proceeds tax, state and federal income taxes, and other state tax payments. We relied on Dr. Huddleston's calculations regarding property taxes and mill rates to arrive at our conclusions about fiscal effects on the local study area.

Q. Did you provide any information to Dr. Huddleston which he relied on in his calculations?

A. Yes. We provided Dr. Huddleston with projections of property values, local government spending, nontax revenues, population, and number of students for each jurisdiction.

Q. Let's talk in more detail about the revenue sources that you calculated, starting with the net proceeds tax. What is the net proceeds tax?

A. The net proceeds tax is a tax levied on the net proceeds of metals mining operations, net proceeds being gross revenue from operations minus allowable deductions. It is like a second state income tax. The net proceeds tax was levied by the Wisconsin Legislature to provide funds to municipalities and other jurisdictions for the costs associated with the social, educational, environmental, and economic impacts of metals mining.

Q. On what did you base your projections of the net proceeds tax payments?

A. For the purpose of our projections, the tax is calculated by applying the appropriate rate to net proceeds from operations, where net proceeds equals gross revenue minus allowable deductions. Gross revenue is the value of all minerals produced and was calculated by applying the Chase Econometrics July, 1982 Forecasts of Metals Prices to Exxon's 1982 estimates of annual mineral production. The deductions consist of charges and expenses allowed by Wis. Stat. 70.375 et seq. and were based on Project information from Exxon.

Q. What are the amounts of the net proceeds tax payments projected to be paid by the Crandon Project?

A. The estimated annual payments for the three Project scenarios average from $5 million to $13 million (in constant 1982 dollars).

Estimates of total payments range from $86 million to $278 million. In Scenario 2, the Project begins to pay net proceeds taxes in the third year of mining operation and total net proceeds tax payments are projected to approximate $183 million in constant 1982 dollars. Of this amount, 60 percent (or $110 million) will be available to mitigate mining-related impacts. The remaining 40 percent, or more if not needed for mitigative purposes, will be escrowed in the Badger Fund with the interest funding education and recreation programs.

Q. How do these payments compare with the expected Project effects on local study area property tax rates?

A. The total amount needed to maintain constant tax rates for those jurisdictions which are projected to have tax rate increases as a result of the Project is less than $12 million. As I discussed before, the total net proceeds tax payments which are estimated to be paid by Exxon and which are available to mitigate mining-related impacts are more than adequate to eliminate the need for any Project-related increases in the property tax rate.

Q. Your estimates of net proceeds tax payments are based on Exxon's 1982 development plans. Do you have an opinion regarding the adequacy of net proceeds tax payments under the current project plan?

A. We have reviewed the estimates done by the Wisconsin Department of Revenue. The DOR estimates assuming the baseline metals price forecast fall within our projected range. Therefore, our findings and conclusions regarding the adequacy of the net proceeds tax payments would not change under the current plan--payments would be adequate.

Q. Does the Project pay other taxes besides the net proceeds tax?

A. Yes, principally state and federal income taxes. State income taxes are forecast to average about $9 million per year, or $168 million over the life of the Project. Federal income taxes are forecast to average about $30 million per year. An additional $260 million in total state tax revenues will be generated indirectly due to direct and indirect Project employment and income. All of these amounts are in constant 1982 dollars.

SOCIOCULTURAL EFFECTS

Q. What are some of the techniques and methods that you used in the sociocultural analysis?

A. We examined available data on past trends in the local study area, conducted surveys of permanent residents, seasonal residents, and tourists, and spent time in the local study area observing and talking to people. We also considered the quantitative projections generated by other parts of the study.

Q. You mentioned that you conducted several surveys of local study area residents. Based on these surveys, what attitudes do residents have toward the area?

A. Our surveys of local study area residents indicate that residents feel that the area is a good place to live or visit. They are largely satisfied with the area and its public services, but believe that it provides insufficient shopping and employment opportunities. Most desire the economic growth that comes with development, but they also fear potential adverse environmental effects. They want development and growth which preserves the area's natural resources and physical environment.

Q. Please summarize the Project's sociocultural effects.

A. The Crandon Project's sociocultural effects are related to the population growth expected in the local study area due to the Project. This growth is modest, adding at most about 10 percent to the without-project population. Consequently, the sociocultural changes which we expect to occur due to the Project are also relatively modest.

We considered the Project's potential effects on the values, attitudes and perceptions of the local study area's residents and on the area's social organization.

Both seasonal and permanent residents of the local study area generally believe that the overall effects of the Project will be beneficial. This positive perception should prevail throughout the construction and operation phases, given the expected magnitude of the Project's population-related impacts.

The project will not change the rural nature of the local study area. The operations population will be more permanent and is likely to be older than the construction population, and will consist mostly of families rather than individual workers. Consequently, the operation inmigrants should be more active in the social life of the local communities than the construction workers.

Q. Do you foresee any sociocultural benefits from the Project?

A. Yes. The mine is expected to operate for a generation. During that time, the local study area will experience higher incomes, more employment opportunities and possibly better public facilities and services than without the Project. More young people may stay in the area, some of whom may be entrepreneurs who create jobs that stay on after the mine closes. The higher standard of living, the enhanced economic opportunity, and the potential for the area's young people to stay represent benefits to a generation which will remain with that generation even after operations cease and which will be felt even by succeeding generations.

NATIVE AMERICAN COMMUNITIES EFFECTS

Q. Please identify the Native American communities residing within the local study area.

A. EXHIBIT 417. The Mole Lake Sokaogon Chippewa and the Forest County Potawatomi communities hold small reservations in the local study area. The Mole Lake reservation is a single block of 2,000 acres in the Town of Nashville. In 1984, 343 out of 1,093 enrolled members lived on or near the reservation. The Forest County Potawatomi reservation consists of scattered holdings totaling 11,786 acres in Blackwell, Lincoln, and Wabeno towns. There were 466 out of 683 enrolled members living on or near the reservation in 1984.

Q. Please summarize the Project's effects on the Native American communities.

A. On balance, the Crandon Project's effects are potentially positive. Exxon has indicated that special attempts will be made to hire local residents including Native Americans. At present, both communities have personal and household incomes which are much lower, and unemployment rates which are substantially higher, than in the surrounding area. Most of the employed work in tribal government or tribally sponsored enterprises. Development of the Project will increase employment opportunities and may make feasible the development of tribal enterprises. Of course, the exact number of Project-related jobs filled by Native American depends on many factors including Native American interest in mining employment, the number of job openings, and competition in the labor force.

A major Project effect is the Mining Impact Fund's annual guaranteed payments of $100,000 (indexed for inflation) for each reservation. At present, both communities are largely dependent upon government support programs for funds. There is little private property to tax, so the only real internal source of revenue is money generated through various tribal enterprises. The Mining Impact Fund payments represent a major new source of revenue for the communities and are a means to provide infrastructure and to capitalize tribal enterprises.

Reverse migration to the reservation can be expected as off-reservation members return in hopes of finding better conditions and more jobs. This will increase the population living on the reservations. However, as I just mentioned, the communities will receive the annual guaranteed payments from the Mining Impact Fund. Long-range planning by Native American communities for the effective use of the payments, combined with the express desire of Exxon to hire local residents, should minimize the possibilities of Project-related negative effects.

Q. How did you arrive at these conclusions?

A. We used data from federal, state, local, and tribal records to identify past trends and major patterns of development in the communities. We also considered quantitative projections generated by other parts of the study. However, we were denied permission by the Native American Communities to survey members; this constitutes a limitation of our study.

GENERAL STATEWIDE ECONOMIC EFFECTS

Q. Will the Project have any statewise economic effects?

A. In addition to positive economic effects on the local study area, the Crandon Project will clearly benefit the state's economy. During Project construction:

1. For every construction worker at the Crandon site, 3.2 jobs will be created statewide.

2. For every dollar spent by Exxon Minerals Company, $2.50 in additional business volume will be created.

During Project operation:

1. Each operation job at the mine will generate 3.55 additional jobs.

2. Each dollar spent by Exxon will result in $1.70 in additional business volume.

Most business sectors in the Northwoods and throughout Wisconsin will benefit from purchases by Exxon, its employees and their families, and those employed in indirect jobs. These sectors include recreation and tourism, which would benefit from the increased year-round business generated by additional population.

NET ECONOMIC EFFECTS

Q. A major purpose of this hearing is to determine whether the Crandon Project will result in a "net substantial adverse economic impact in the area reasonably expected to be most impacted by the mining activity." Please summarize your study's findings.

A. The key findings of our study can be briefly summarized as follows:

1. Project effects on local study area population levels are limited. "Boomtown" conditions will not occur.

2. The Project will provide substantial economic benefits to the local study area and the state as a whole by increasing employment, income, and business activity.

3. Housing shortages will not occur.

4. The Project will have minimal impacts on land use patterns.

5. Major highway expansions will not be required.

6. Effects on public facilities and services will be modest and manageable.

7. Fiscal effects on local study area jurisdictions and the state as a whole will be positive. More than sufficient net proceeds tax revenues will be available for mitigation purposes.

8. There will be no significant disruption of social structure or change in residents' attitudes and perceptions.

9. Effects on Native Americans are potentially positive.

These findings would not materially change under the current project plan.

Q. In your professional judgment, will this Project provide a net economic benefit to the local study area?

A. Yes. We found that the local study area has a relatively large population and well-developed infrastructure compared with a relatively small Project-related influx of population and demand on the infrastructure. We also found that the Project will have positive economic and fiscal effects on the local study area. It will not cause shortages of housing or public facilities and services. Based on these findings and the data and analysis presented in our study and supporting documentation, it is my professional judgement that the Crandon Project will provide a net economic benefit to the local study area, which is that geographic area which we expect to be most affected by the proposed project.

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EXHIBIT 411

RESUME
RONALD T. LUKE

EDUCATION

Doctor of Philosophy in Public Policy, John F.Kennedy School of Government, Harvard University, 1975.

Doctor of Jurisprudence, The University of Texas School of Law, 1974.

Master of Public Policy, John F. Kennedy School of Government, Harvard University, 1972.

Bachelor of Arts in Social Studies, Harvard University, 1970.

PROFESSIONAL EXPERIENCE

Dr. Luke has worked as a consultant in regional economic and demographic analysis and in health care planning since 1972. He has prepared population and economic analyses for regions, counties, cities, townships, and school districts in states including Texas, Arkansas, Louisiana, Florida, California, Tennessee, Colorado, Wisconsin, and Maine. These forecasts have been used in environmental impact statements, housing bond feasibility studies, siting of waste disposal facilities, siting of health care facilities, siting of residential and commercial development, framing of state development policies, port planning, and designation of commercial zones for motor carriers.

His work in the field of water resources development includes supervising the preparation of socioeconomic assessments for the Corps of Engineers (Trinity River Project) and the Bureau of Reclamation (Seward Project). He has also participated in the development of water supply and wastewater treatment analyses, including computer-based financial models, for socioeconomic assessments and community development efforts in Texas, Wisconsin, Louisiana, New Mexico and Utah. He presently serves as a consultant to the Denver Water Board, assisting them in long-range planning of the region's water supply.

Dr. Luke has provided testimony before the legislatures of Wisconsin and Texas, state and federal courts, the Wisconsin Public Utility Commission, the Occupational Safety and Health Administration, the Texas Department of Health, the Texas Department of Water Resources, the Texas Railroad Commission and the health planning agencies of more than a dozen states.

He has also provided feasibility studies for rating of public bond issues which have been accepted by Standard & Poor's and by Moody's Investor Services. He has been accepted as an expert witness in demography; economics; socioeconomic impact analysis; trade area analysis; psychiatric, substance abuse and acute-care bed need; land use compatibility; fiscal analysis; and financial feasibility analysis.

Prior to joining RPC on a full-time basis, Dr. Luke was a consultant and Director of Administrative Services for the Gulf Coast Regional Mental Health and Mental Retardation Center. He was responsible for planning, financial management, and management information systems. He designed and helped implement a reorganization of the Center which was recognized in 1981 by the American Medical Association with a gold medal for reducing the rate of admissions to state hospitals to about one-third the state average. He has been a trustee and chairman of the budget and operations committee for the Austin/Travis County MHMR Center. Dr. Luke has also acted as a health planning consultant to several other Texas MHMR Centers and to the Texas Department of Mental Health and Mental Retardation.

Dr. Luke joined RPC as Vice President-Operations in 1976 and became President and principal owner of the firm in 1979. He is also president of Texas Field Service, a market research firm located in Highland Mall, Austin, Texas. Dr. Luke is the publisher of the Texas Natural Resources Reporter and the Texas Public Utility News. He has served as a guest lecturer on policy analysis at the University of Texas, Departments of Accounting and Economics; the Lyndon B. Johnson School of Public Affairs; and the University of Houston at Clear Lake City.

HONORS

Bachelor of Arts, Magna Cum Laude.

National Science Foundation Fellow, 1970 - 1972.

Phi Beta Kappa, Harvard University.

AFFILIATIONS

State Bar of Texas, Sections on Health Law, Public Law, and Natural Resources.

American Bar Association, Sections on Administrative, Public Utility, and Natural Resources Law.

National Health Lawyers Association.

National Association of Business Economists.

Texas Economic and Demographic Association.

Marketing Research Association.

PUBLICATIONS AND PROJECTS

Preparation of demographic and financial analysis for the Denver Water Department to support the system-wide planning effort, 1984-1985.

Preparation of Single-Family Mortgage Bond Feasibility Studies for Housing Finance Corporations in North Central Texas, the Panhandle, and Galveston, 1982.

Socioeconomic Assessment of a Proposed Coal Gasification Plant in Northwestern New Mexico, Texas Eastern Transmission Company and Utah International, Inc., 1981.

Socioeconomic Assessment of a Proposed Shale Oil Development in Northeastern Utah, White River Shale Oil Corporation, 1982.

Socioeconomic Assessment of Exxon's Proposed East Texas Synthetic Project, Profile of Current Conditions, Survey Research, Impact Assessment, Public Involvement Program, Monitoring System and Mitigation Planning, Exxon Company, U.S.A., Houston, 1981-1982.

Development of computer models to forecast population and employment distribution in Northwestern Colorado, Friendswood Development Company, 1982.

Analysis of socioeconomic impacts of siting a nuclear waste repository in Texas, Western Rural Development Center and Department of Energy, 1981.

Northwestern Colorado Energy Impact Assessment; Phase I Report, for Mesa County, colorado, August 1981.

"Improved Computer Assistance for Growth Management," The Western Planner, October 1981.

Socioeconomic Assessment of Exxon's Proposed Crandon Project, Study Plan, MEthodology Papers, Profile of Current Conditions, and Impact Assessment, Exxon Minerals Company, Rhinelander, Wisconsin, 1979-1985.

Texas Ports Study, six volumes, prepared for the General Land Office of Texas, with support from the U.S. Maritime administration and the Texas Coastal and Marine Council, Austin, 1979-1981.

PUBLICATIONS AND PROJECTS (continued)

"Managing Community Acceptance of Major Industrial Facilities," Coastal Zone Management Journal, February 1980.

Study of Potential Demand for Residential Mortgage Funds: City of Galveston, Galveston Housing Finance Corporation, February 1980.

Feasibility studies for development and redevelopment of commercial real estate projects in Galveston and Austin, Texas, various clients, 1975-1980.

Case studies of refinery and petrochemical facility siting on the Texas and Louisiana coasts, to Princeton University and the Department of Energy, 1979.

Environmental Impact Report: Quintana Marine Terminal, Brazos River Harbor Navigation District, Freeport, 1979.

Texas Coastal Management Program, various documents, including program descriptions, proposed regulations, legislation, analysis of onshore impacts of outer continental shelf oil and gas development, analysis of the coastal economy, and analysis of industrial facility siting procedures, General Land Office, Austin, 1976-1979.

Recommendations to the Legislature regarding services to the Visually Handicapped, Governor's Coordinating Office for the Visually Handicapped, Austin, 1976 and 1978.

"The Texas Department of Mental Health and Mental Retardation, A Political Perspective," Texas Council of Community MHMR Centers, Austin, November 1977.

Sources of innovation in State Government: Rehabilitating the Texas Mental Health System, doctoral dissertation, Harvard University, 1975, 3 vol., including case studies of the mental health systems of Colorado, California, and Wisconsin.

"The Budget - A State's Real Operating Plan," prepared for the Houston Appropriations Committee, Texas Legislature, 1974.

An Approach to Land Resource Management for Texas, 8 volumes, Governor's Division of Planning Coordination, Austin, 1973.

A Maine Manifest, Tower Publishing Company, Portland, 1972.

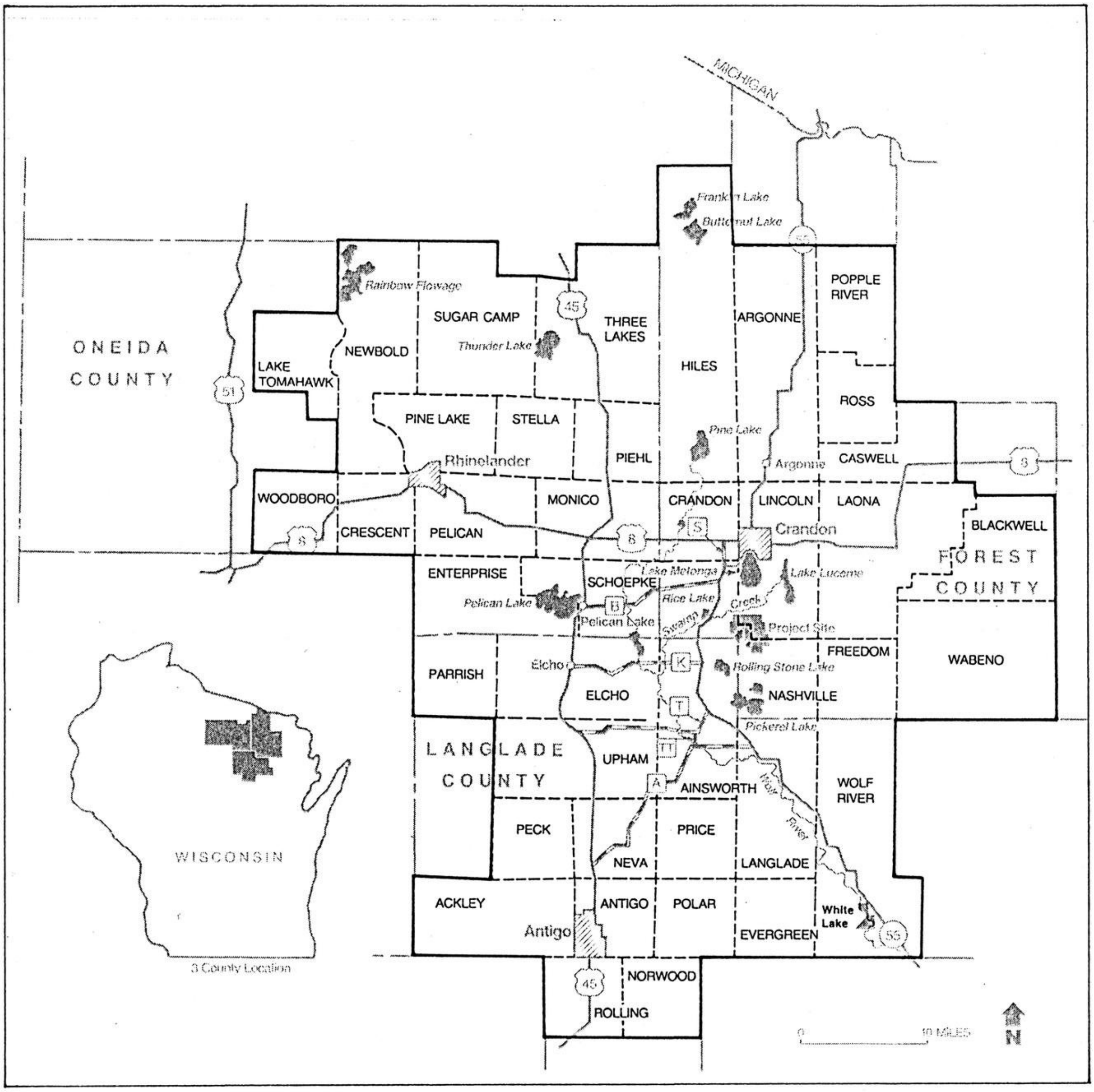
"A Non-industrial Future for the Maine Coast, Governor's Task Force on Industry on the Maine Coast, Augusta, 1972.

PUBLICATIONS AND PROJECTS (continued)

Perspective on Change: An Analysis of the Austin Capital Improvement Program, Texas Public Interest Research Group, Austin, 1972.

"An Analysis of the Costs and Benefits of Oil Refinery Development on the Maine Coast," Maine Times, Bath, 1971.

Local Study Area
Socioeconomic Assessment



Model Parameters

Demographic and Economic

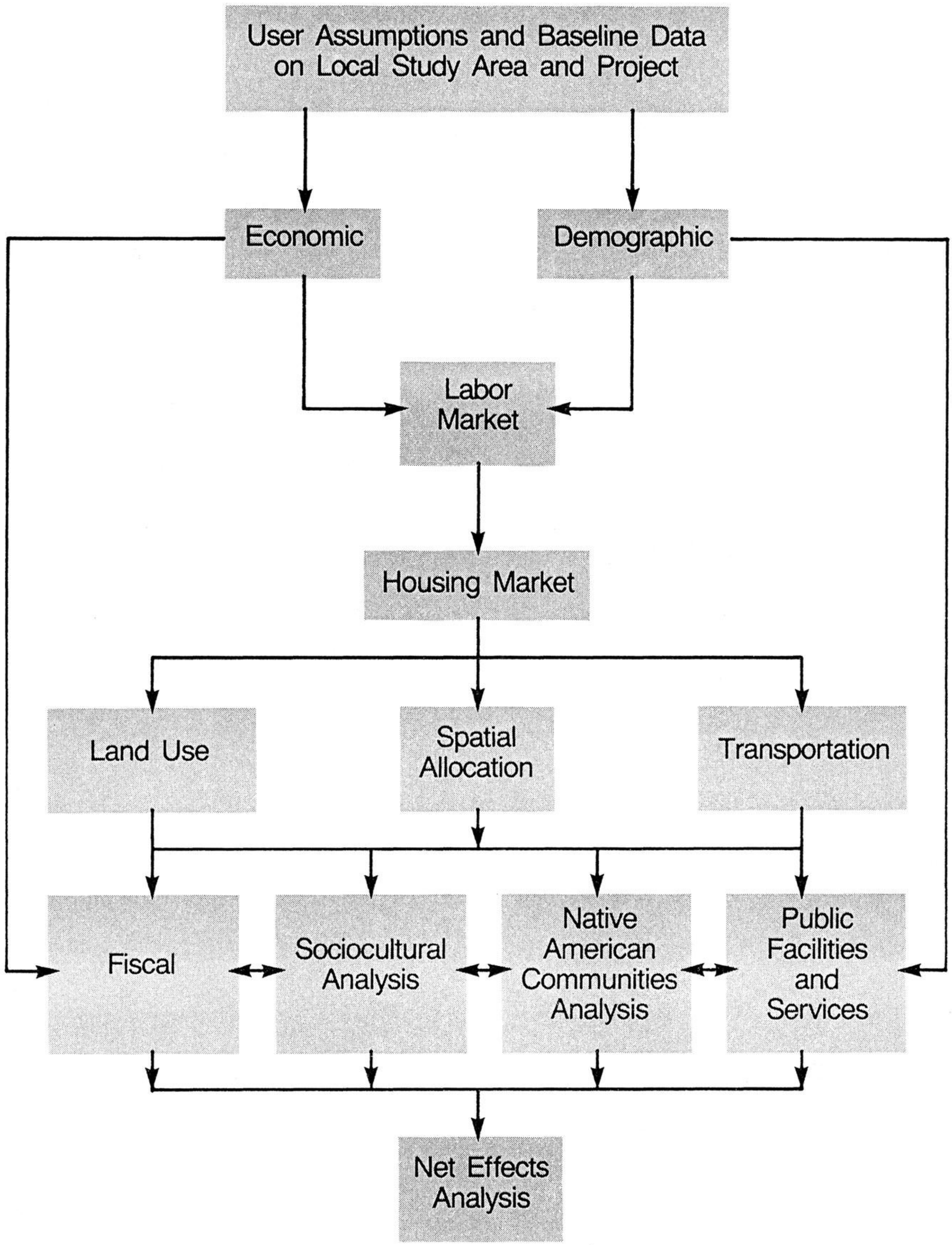
Demographic

1. Population characteristics of inmigrant workers

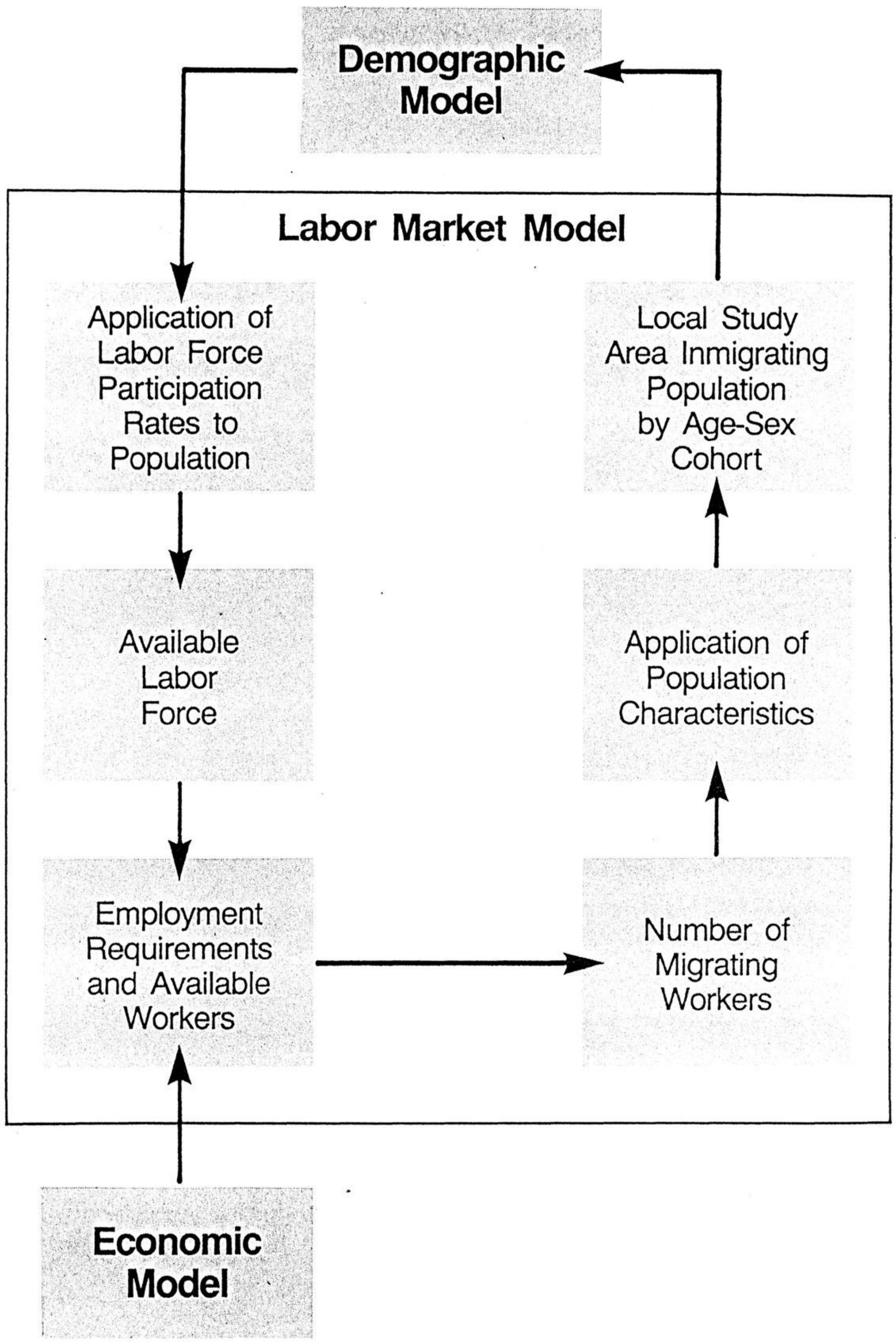
Economic

1. Life of mine
2. Number of construction workers in peak year of construction
3. Source of construction workers:
   Local
   Inmigrants
   Daily commuters
4. Number of operation workers in typical year of operation
5. Percent of locally hired operation workers
6. Project expenditures

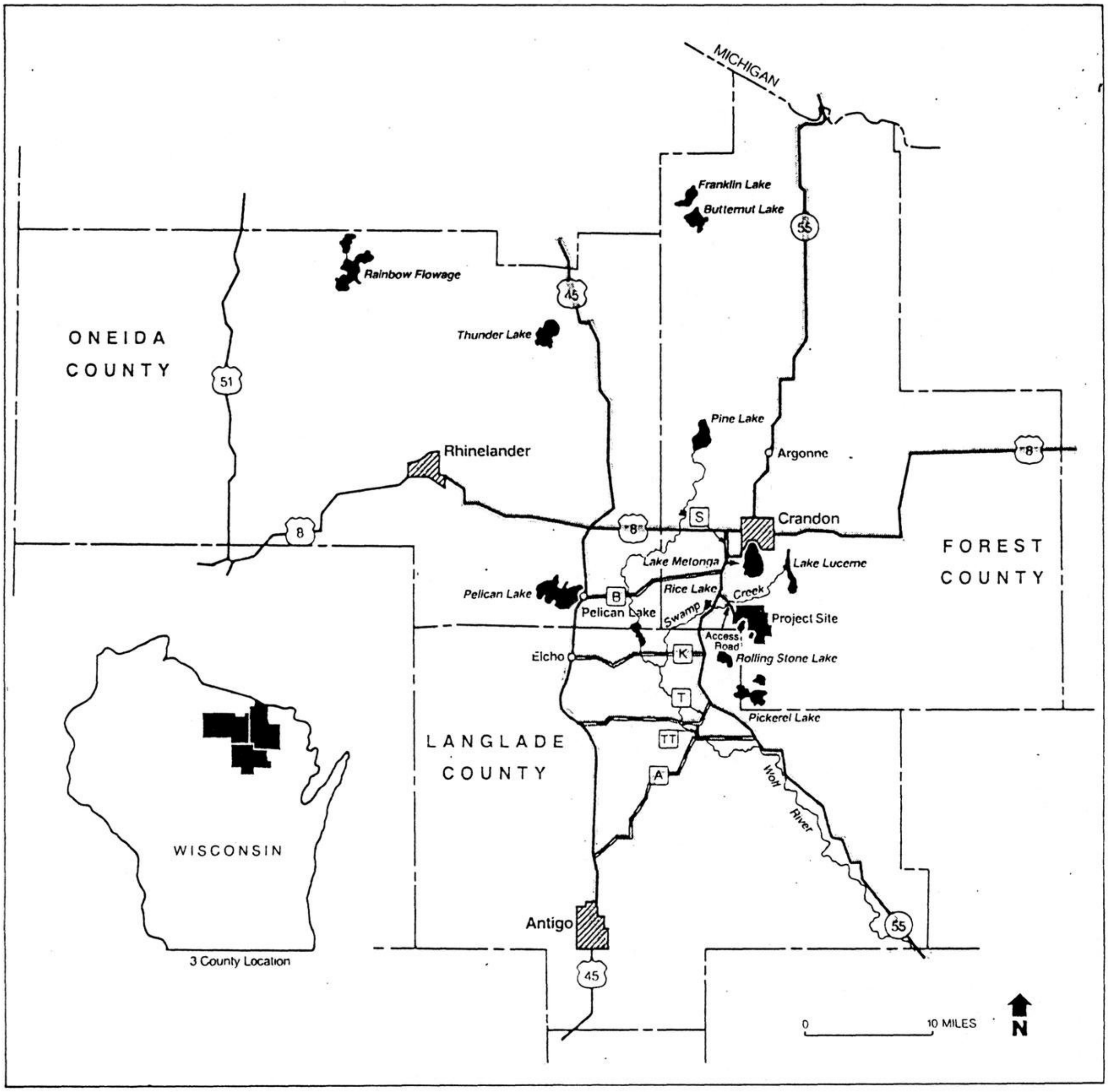
Project Model System
Interrelationship of Models and Analyses



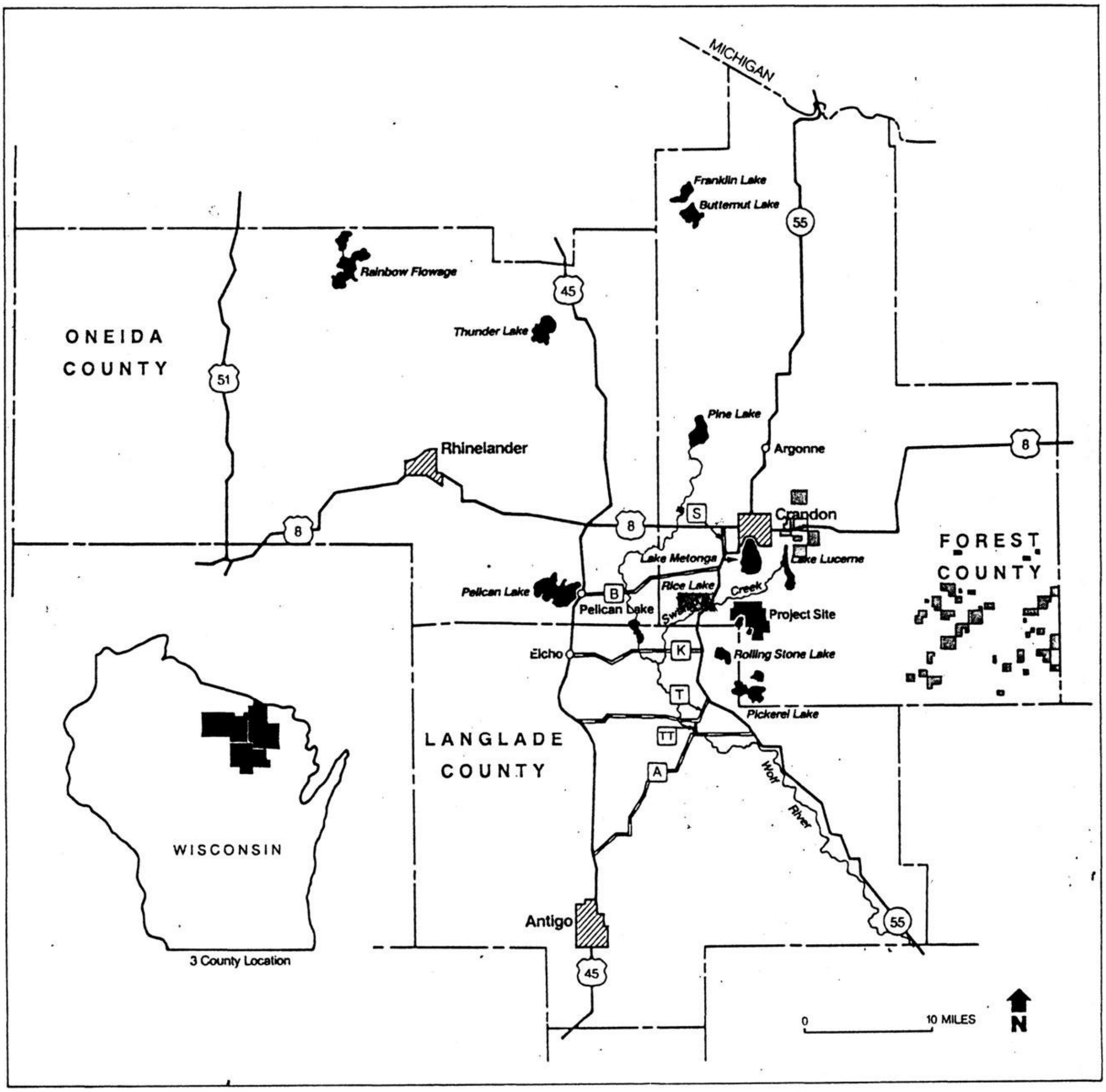
Labor Market Model



Highways
Corridors and Segments



Native American Lands



Legend

Mole Lake Chippewa tribal lands

Forest County Potawatomi tribal lands

BEFORE THE
STATE OF WISCONSIN
DIVISION OF HEARINGS AND APPEALS

Application of Exxon Corporation for Permits to Build and Operate an Underground Mining and Ore Concentrating Complex Located in Forest County, Wisconsin	) IH-86-18

TESTIMONY OF DR. JACK R. HUDDLESTON

LOCAL FISCAL IMPACTS

Q. What is your name and professional affiliation?

A. Dr. Jack Huddleston. I am Associate Professor of Urban and Regional Planning at the University of Wisconsin-Madison. Before that, I was the Chief of Local Fiscal Policy Analysis with the Wisconsin Department of Revenue and Chief Economist with the Wisconsin State Planning Office. EXHIBIT 420, my resume, describes my credentials in more detail.

Q. Would you please describe the analysis you made of the proposed Exxon Crandon project?

A. I and Professor Richard Stauber of the Department of Governmental Affairs in the University of Wisconsin-Extension estimated the impact of the project on property taxes of the various local governments likely to be affected by the project. We first estimated the tax rates for those governments if the mine were not built, the "without project" scenario. We then compared those rates to three "with project" scenarios. This was done for 44 cities, villages and towns, eight school districts and the counties of Forest, Langlade and Oneida.

Q. What jurisdictions' tax rates did you analyze?

A. The study area was the same as that identified by Research Planning Consultants, Inc. (RPC) in the Forecast of Future Conditions. Table 1 in my prefiled testimony identifies those governments for which tax rate impacts have been estimated.

Q. What did you conclude about property tax rates in the study area?

A. The mine will lower tax rates substantially throughout the Crandon school district, which includes the Towns of Lincoln and Nashville, where the mine is located and four other towns and cities such as the City of Crandon. Elsewhere in the study

TABLE 1

LOCAL GOVERNMENTS STUDIED

FOREST COUNTY	LANGLADE COUNTY	ONEIDA COUNTY
o Argonne	o Ackley	o Crescent
o Blackwell	o Ainsworth	o Enterprise
o Caswell	o Antigo (City)	o Lake Tomahawk
o Crandon (City)	o Antigo (Town)	o Monico
o Crandon (Town)	o Elcho	o Newbold
o Freedom	o Evergreen	o Pelican
o Hiles	o Langlade	o Piehl
o Laona	o Neva	o Pine Lake
o Lincoln	o Norwood	o Rhinelander
o Nashville	o Parrish	o Schoepke
o Popple River	o Peck	o Stella
o Ross	o Polar	o Sugar Camp
o Wabeno	o Price	o Three Lakes
	o Rolling	o Woodboro
	o Upham	
	o Wolf River	
	o White Lake	

SCHOOL DISTRICTS

o Antigo	o Elcho	o Rhinelander	o Wabeno
o Crandon	o Laona	o Three Lakes	o White Lake

area, the mine could cause some tax rates to increase and some to decrease. My analysis does not include the effect of mining impact fund payments to local governments. Governments receiving these funds should have lower tax rate impacts than I show. With these payments excluded, I estimate that it would require about $11,845,000 to keep tax rates from rising anywhere throughout the study area because of the mine. Dr. Luke has predicted that the mine will generate at least $182,000,000 in mining impact revenues. If these two estimates are correct, project-related tax rate increases could be avoided by the distribution of mining impact funds.

Q. What makes tax rates rise or fall?

A. Tax rates are a function of the value of the taxable property in a community, school district or county and the tax levy required to finance services of these local governments. Throughout the study area, taxable values will almost certainly increase either directly because of the mine or indirectly because of the people who move into the area because of the mine and the increased commercial activity that results.

The effect of the mine on the tax levy is more uncertain since it is determined by total local government spending minus state and federal aids and other local revenues. Government spending is likely to increase as a result of the mine and the increased population attracted by the mine. But state aids may either increase or decrease because of local changes that occur.

The actual impact on a government's tax rate is determined by the change that occurs in the tax levy (spending minus aids) and the growth that occurs in taxable values. If a government's levy increases at a faster rate than the increase in the property tax base, the government's tax rate will increase. On the other hand, if the value of taxable property increases faster than the government's levy, property tax rates will fall.

Q. How do you expect the mine to affect state aids?

A. The impact of the mine on state and federal aids is not something we can generalize about for all governments. Some communities in the study area do not receive state aids now, and therefore the mine will have no effect on those communities' aids payments. In some other communities the mine will cause state equalization aids to increase and in others to decrease. If the mine causes a community's state equalization aids to increase, the impact of increased local spending on the levy is softened--or reduced. If the mine causes state equalization aids to decrease, the levy to be financed by the property tax will increase by more than the increase in spending.

Q. You have been referring to governments' tax rates. How will the mine affect the property taxes paid by individual property owners?

A. The real estate owner pays property taxes to at least five different governments in Wisconsin. For example, the owner of a $50,000 property in the Town of Lincoln would have paid $656 in property taxes in 1981. As shown in EXHIBIT 421, this is determined by multiplying the full market or equalized value of the property by the tax rate of each of the governments, or by multiplying the gross tax rate for all governments by the equalized value. EXHIBIT 421 also illustrates the importance of school taxes in determining the overall taxes paid by individual property owners. In 1981 nearly two-thirds of property taxes paid by Lincoln property owners were used for school purposes.

The impact of the mine on individual property owners depends upon the combined change that occurs in the tax rates of the various governments. For example, if the mine causes the gross tax rate for all five governments to increase to 14 mills, the total taxes for an owner of a $50,000 property would increase to $700 -- or $50,000 times 14 mills. If the mine causes the gross tax rate to decrease to 12.5 mills, the tax bill for the $50,000 property would be $625. In most cases, the impact of the mine on school tax rates will be the largest determinant of overall tax rate changes.

Q. What is a mill?

A. A mill is one one-thousandth of a dollar, or one-tenth of a cent. Thus a tax rate of 14 mills requires the owner to pay 1.4 cents in tax on each dollar of the property's value. The same tax rate could be stated in other ways. It would be a 1.4 percent tax, for example. In Wisconsin, property tax rates are often described as dollars of taxes per $1,000 of property values, or, even more briefly, as dollars per thousand. In this example, the expression would be $14 per $1,000. Generally in my testimony and the exhibits to it, I will discuss tax rates as dollars per thousand. In the tables of my report, however, I have used decimals which express the rates in the fractions of dollars of tax on each dollar of property value.

Q. You mentioned two terms that seem to have special significance--equalized value and gross tax rate. What do they mean?

A. Equalized value is a measure of the full market value of a parcel of land and improvements that is determined by the Wisconsin Department of Revenue. This measure is used to ensure that similar properties are equally valued for taxation purposes throughout the state. Property values determined by local assessors, on the other hand, are called assessed values and may vary for similar properties across governments. All of my analysis was based upon equalized value.

The term gross tax rate simply refers to the total of the tax rates of all governments with jurisdiction over a particular piece of property. Taxpayers in most jurisdictions receive a property tax credit from the state that reduces the actual tax payment of individuals. This lower rate is sometimes referred to as the total effective tax rate or the net tax rate.

Q. You also mentioned earlier that state equalization aids are determined by a government's spending and tax base. Would you please go into greater detail about how these aids are determined?

A. State equalization aids are determined by a set of formulas that are fairly complex. Under each of the aid formulas the state guarantees a certain level of equalized property value per person to finance a government's spending. For example, in 1981 the state guaranteed $36,600 per person in taxable value for each town, village and city and county. If the taxable property in one of these jurisdictions totalled only $18,300 per person, or half of the state guaranteed amount, the state would pay one-half of that government's locally financed spending. If the government had three-fourths of the state guaranteed amount, or $27,450 per person, the state would pay one-fourth of locally financed spending.

In general, state equalization aid payments go down as equalized value per person increases toward the state guaranteed level. Aid payments go up as local government spending increases.

Two special features of state equalization aids should be discussed before leaving this topic.

(1) Governments that have equalized value per person in excess of the state guarantee do not receive state equalization aid.

(2) Towns, villages and cities have an economic development incentive built into the equalization aid formula in that manufacturing equalized value is not counted toward the state guarantee. Thus these governments can increase manufacturing value without losing state equalization aid. Mine property is considered manufacturing value under Wisconsin law.

Q. Would you please specifically explain the analysis that you conducted?

A. When I began my analysis in June 1983, RPC had identified 44 municipalities, eight school districts and three counties that were likely to be affected by the proposed mine. These were the governments listed in Table 1. RPC had estimated annual levels of thirteen important variables or parameters for the period 1980 to 2016 for four different scenarios. These scenarios, as described by Dr. Luke, were:

(1) Without project,

(2) With project: minimum impact,

(3) With project: most-likely impact, and

(4) With project: maximum impact.

The variables and parameters estimated by RPC are shown in Table 2 of my prefiled testimony.

In addition, Exxon supplied data on the probable taxable value of the mine for the years 1985 to 2013 for the three project scenarios, and the probable distribution of this equalized value between the Towns of Lincoln and Nashville. This

TABLE 2

INPUT DATA FOR THE FISCAL IMPACT ANALYSIS

Municipalities

- Population (RPC)
- Spending (RPC)
- Total Equalized Value (RPC)
- Manufacturing Value (RPC)
- Per Capita Non-Property Tax Revenue Multipliers (RPC)
- Mine Equalized Value (EMC)
- Distribution of Mine Value Between Lincoln and Nashville (EMC)
- Transportation Aids (DOT)
- State Tax Credits (DOR)
- Equalization Aid Formula (DOR)

School Districts

- Number of Pupils (RPC)
- Spending (RPC)
- Total Equalized Value (RPC)
- Per Pupil Non-Property Tax Revenue Multipliers (RPC)
- Mine Equalized Value (EMC)
- Equalization Aid Formula (DPI)

Counties

- Population (RPC)
- Spending (RPC)
- Total Equalized Value (RPC)
- Per Capita Non-Property Tax Revenue Multipliers (RPC)
- Mine Equalized Value (EMC)
- Transportation Aids (DOT)
- Equalization Aid Formula (DOR)

DATA CODES:

RPC: Estimated by Research and Planning Consultants, Inc.
EMC: Estimated by Exxon Minerals Company
DOT: Developed from Wisconsin Department of Transportation Data or Materials.
DOR: Developed from Wisconsin Department of Revenue Data or Materials.
DPI: Developed from Wisconsin Department of Public Instruction Data or Materials.

distribution was 90% Lincoln and 10% Nashville, and thus would lie totally (or 100%) within the boundaries of the Crandon School District and Forest County. The equalized value of the project under the three scenarios is shown in EXHIBIT 422.

Using both the RPC and EMC data and the state equalization formulas that existed in 1981, tax rates were simulated for each of the identified governments under the without project and the three with project scenarios for the years 1985 to 2015. These tax rates were then combined to reflect the gross tax rate or rates for the different tax administration districts in the study area and these were then adjusted for transportation aids and state tax credits to produce effective tax rates for individuals living in each of the tax rate areas. Then following the same approach taken by RPC in its analysis, tax rates for the three with project scenarios were compared to the tax rates for the without project scenario to identify the simulated impact of the mine.

I should point out that the Nicolet VTAE District was excluded from the fiscal impact analysis because of the relatively small impact of the mine on this jurisdiction's tax rate. The state forestry tax was also omitted since it has a statutorily set rate of 20 cents per $1,000 that would be unaffected by the mine.

Q. Why did your projections begin with the year 1985?

A. When the socioeconomic analysis was begun, mine construction was scheduled to begin in 1985 and the mine was expected to operate until the year 2012. Thus, 1985 would have been the first year in which the mine affected property tax rates. Current revised plans call for mine construction to begin in 1988 and mine operations to last until 2019.

Q. Does that mean your study and its conclusions are no longer reliable indicators of how the mine will affect local tax rates?

A. Certainly the revised plan for the project would have some effect on the analysis that I conducted, but I doubt these revisions would change its major conclusions in any significant way. The basic changes that have resulted due to the revised plan are: a reduction in the expected taxable value of the project; condensing of the construction phase from five to three years; and lengthening of the operations phase from 23 to 29 years. The revised plan also predicts fewer inmigrant construction workers and slightly lower peak operations employment. I believe that all of these changes will work toward dampening the fiscal impacts that I have estimated but will not alter the overall direction of the impacts.

Q. What assumptions did you make in projecting future property tax rates?

A. Assumptions always have to be made when one attempts to make predictions. Three of the most important one in my study were:

(1) Neither automatic nor discretionary payments from the Mining Impact Fund were considered as revenue for any of the local governments--including the Towns of Lincoln and Nashville and Forest County. If they had been considered, property tax increases would have been smaller and property tax decreases would have been larger.

(2) All increases in net local spending were assumed to be financed by the property tax, even though other methods of financing are often used by local governments. For example, governments may choose to use bonds so that future users of government services help to pay for them. Governments also may choose to finance services through fees paid by users rather than through general property taxes. Fees for garbage collection are a good example. A government using such revenue sources would thereby reduce the property tax rates that have been projected.

(3) Lastly, I assumed that governments have perfect knowledge of changes that will occur in next year's spending, and levy accordingly in the current year. Although such information is seldom known when the annual budget is being made, this assumption tends to make projected property tax rates higher than they otherwise might be, especially during construction years.

Q. How have you reported your conclusions about the effect of the project on study area property taxes?

A. My basic conclusions have been reported in Chapter 9 of the Forecast of Future Conditions Socioeconomic Assessment report that was earlier introduced by Dr. Luke.

Q. Did you arrive at any general conclusions?

A. Yes. Given the large number of tax rates generated in my analysis (over 18,000) it is perhaps best to discuss the conclusions based upon a comparison of the without project scenario to the most likely scenario.

Q. What did you conclude about the Town of Lincoln?

A. As shown in the far right hand portion of EXHIBIT 423, the tax rate for all purposes in the Town of Lincoln is estimated to be higher because of the mine during the first four years of construction. The mine could cause the total effective tax rate to rise as high as $11.30 per $1,000 of equalized value in the first year, an increase of $1.95 per $1,000 over the without project tax rate. For a $50,000 property this would mean a $97.50 increase in total taxes in the first year of construction. This increase per $1,000 falls to $1.04 in the second year, to 81 cents in the third year and to six cents in the fourth year.

The total tax rate for taxpayers in the Town of Lincoln decreases in comparison to the without project scenario for the remaining years of the project. The decrease in total tax rate averages $4.08 per thousand throughout the mine's operating years, with the greatest decrease being $4.34 per $1,000 in the second year of operation. For a $50,000 property this means an average property tax savings of about $204 per year through the operational life of the project.

The first three graphs in EXHIBIT 423 break down the total tax rate change into changes by each governmental unit. The project's greatest impact on tax rates will be those occurring in the Crandon School District. As shown in the first graph in EXHIBIT 423, the mine's property value will cut the Crandon schools' tax rate to less than half what it would be without the mine, even with increased enrollment. Since the school raises by far the largest portion of all local property taxes, this impact tends to dominate the changes that occur in the total effective tax rate for Lincoln Town taxpayers.

The second graph in EXHIBIT 423 shows the impact of the mine on the Forest County tax rate. It is expected to rise by 82 cents to $1.12 per $1,000 during the construction years, and to fall below the without scenario tax rate thereafter.

The third graph shows that the tax rate for Town of Lincoln purposes also increases by 23 cents to 92 cents per $1000 of value in the first three years of construction, and falls thereafter.

In summary, taxpayers in the Town of Lincoln may see their total tax bill rise during the first few years of mine construction and fall significantly during the operational phase of the project. But we should also recall here that my calculations ignore mining impact payments. The maximum amount that would be required to keep the Town of Lincoln tax rate from increasing because of the mine is $55,000 in the fourth year of construction. Annual, non-discretionary mining impact fund payments to the Town of Lincoln should be adequate to cover anticipated mining-related town expenditures. The maximum amount that would be required to keep Forest County's tax rate from increasing is $549,000, also in the fourth year of construction. The annual mining impact fund payment to Forest County of $300,000 would therefore reduce the anticipated mining-related levy increase by about 55 percent.

Q. What did you conclude about Nashville Town taxes?

A. As shown in the far right hand portion of EXHIBIT 424, the tax rate for all purposes in the Town of Nashville is estimated to be higher because of the mine over the first three years of construction. The mine could cause the total effective tax rate to rise as high as $11.25 per $1,000 in the first construction year, an increase of $1.56 per $1,000 of equalized value over the without project tax rate. For a $50,000 property this would mean a $78 increase in total taxes in the first year of construction. This increase would be smaller in the next two years, 69 cents and 53 cents per $1,000 respectively.

The total tax rate for taxpayers in the Town of Nashville is lower in comparison to the without project scenario for the remaining 27 years of the project. The decrease in total tax rate averages $4.18 per $1,000 lower for the operations period, reaching a maximum decrease of $4.59 in the 18th year of operations. For a $50,000 property this means an average property tax savings of about $209 per year through the operational life of the project.

Crandon School district and Forest County tax rates are the same for Nashville as for Lincoln. Nashville's own tax rate will be from 39 to 59 cents per $1,000 higher during the construction years, and lower during operating years. The maximum amount that would be required to keep the Town of Nashville tax rate from increasing due to the mine is $36,000 in the fourth year of construction. Like Lincoln, the annual non-discretionary mining impact fund payment to Nashville should be adequate to cover anticipated mining-related town expenditures.

Q. What did you conclude about property taxes in other jurisdictions in the local study area?

A. The remaining tax rate areas included in the fiscal impact analysis were places that do not include any portion of the mine site but which were expected to experience population changes due to the mine. Comparisons of with project tax rates to without project tax rates for these places are shown in Table 3 of my prefiled testimony. Due to the number of tax rate areas involved, I have shown only total effective tax rates for each area--that is, the rate experienced by taxpayers living in each of these areas.

Although tax rate impacts of the mine vary from place to place, three distinguishable patterns emerge. The two extreme patterns are "tax rate decrease" areas and "tax rate increase"

TABLE 3
AVERAGE ANNUAL TAX RATE CHANGES

TAX RATE INCREASE AREAS

	Construction Years		Operations Years	
Jurisdiction	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property
Ackley	$ 18.00	2.1	$ 3.50	0.4
Antigo (city)	$ 35.00	3.5	$ 19.00	2.1
Antigo (town)	$ 17.00	2.2	$ 6.00	0.8
Blackwell (Laona SD)	$ 47.00	19.2	$ 2.50	1.3
Crescent	$ 158.00	26.4	$ 5.50	0.9
Evergreen	$ 18.50	2.0	$ 1.00	0.1
Lake Tomahawk	$ 14.00	7.4	$ 2.50	1.3
Langlade (Antigo SD)	$ 18.00	2.2	$ 7.50	0.9
Langlade (White Lake SD)	$ 19.00	1.9	$ 1.50	0.2
Neva (Antingo SD)	$ 16.50	2.0	$ 5.50	0.7
Newbold	$ 16.50	2.9	$ 12.50	2.2
Norwood	$ 16.50	2.0	$ 4.50	0.6
Parrish	$ 23.50	4.8	$ 13.00	2.8
Peck (Antigo SD)	$ 16.00	1.9	$ 3.00	0.3
Pelican	$ 33.00	4.2	$ 14.00	1.9
Polar	$ 17.50	2.1	$ 5.00	0.7
Price	$ 15.50	1.9	$ 5.00	0.6
Rhinelander	$ 10.50	1.4	$ 4.50	0.6
Rolling	$ 15.00	1.8	$ 4.00	0.5
Stella	$ 18.50	3.4	$ 8.50	1.6
Upham (Antingo SD)	$ 19.50	2.3	$ 5.00	0.6
Whitelake	$ 14.00	2.9	$ 6.50	1.0
Woodboro	$ 16.00	2.8	$ 7.00	1.3

TABLE 3 (Contd.)
AVERAGE ANNUAL TAX RATE CHANGES

CONSTRUCTION INCREASE-OPERATIONS DECREASE AREAS

	Construction Years		Operations Years	
Jurisdiction	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property
Blackwell (Wabeno SD)	$ 64.50	80.0	-$ 4.00	- 6.2
Caswell	$ 49.50	5.9	-$ 4.50	- 0.6
Freedom	$ 64.00	9.5	-$ 13.50	- 2.5
Hiles (Three Lakes SD)	$ 75.00	20.8	-$ 20.50	- 7.1
Laona	$ 33.00	3.8	-$ 16.00	- 1.9
Monico	$ 38.50	9.1	-$ 1.00	- 0.4
Piehl	$ 34.00	9.5	-$ 2.50	- 0.8
Pine Lake	$ 163.50	24.4	-$ 9.00	- 1.1
Popple River	$ 42.50	7.3	-$ 15.00	- 2.8
Ross	$ 36.50	5.1	-$ 14.50	- 2.2
Sugar Camp	$ 34.00	7.6	-$ 5.50	- 1.6
Three Lakes	$ 35.00	7.2	-$ 8.00	- 2.1
Wabeno	$ 62.50	8.8	-$ 16.50	- 2.8
Wolf River (Wabeno SD)	$ 22.00	3.3	-$ 2.00	- 0.5
Wolf River (White Lake SD)	$ 22.00	3.3	-$ 2.00	- 0.5

TABLE 3 (Contd.)
AVERAGE ANNUAL TAX RATE CHANGES

TAX RATE DECREASE AREAS

	Construction Years		Operations Years	
Jurisdiction	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property	AV Annual Change on $50,000 Property
Ainsworth	-$ 56.00	- 11.1	-$ 57.50	- 15.9
Argonne	-$ 16.00	- 4.2	-$ 221.50	- 60.8
Crandon (city)	-$ 19.50	- 3.5	-$ 233.00	- 43.1
Crandon (town)	-$ 21.00	- 4.7	-$ 221.50	- 49.5
Elcho	-$ 50.50	- 8.5	-$ 58.50	- 13.0
Enterprise	-$ 62.50	- 13.0	-$ 65.50	- 19.1
Hiles (Crandon SD)	-$ 20.50	- 4.7	-$ 226.00	- 54.2
Neva (Elcho SD)	-$ 58.00	- 10.7	-$ 61.00	- 15.3
Peck (Elcho SD)	-$ 58.50	- 10.8	-$ 63.50	- 16.0
Schoepke	-$ 58.00	- 11.7	-$ 63.50	- 17.8
Upham (Elcho SD)	-$ 55.00	- 10.1	-$ 62.00	- 15.6

areas. In the decrease areas tax rates should be lower because of the mine over both the five years of construction and the subsequent 26 years of operation and closedown. The opposite is true of the tax rate increase areas. Between these groups is a group of tax jurisdictions that experience tax rate increases during mine construction, but tax rate decreases during the operations phase. I refer to these as "construction increase-operations decrease" areas.

Tax rates in the tax rate increase areas increase during both the construction and operations phases. The average increase for construction years is 52 cents per $1,000, or about $26 per year for a $50,000 property. Of all places in this group, only Crescent appears to have a significant absolute and percentage increase in its tax rate over construction years. For operations years the average tax rate increase would be only 11 cents per $1,000, or about $5.50 on a $50,000 property.

Although each place has its own unique tax rate impact pattern, all of the places shown in the second portion of Table 3 on average experience a tax rate increase during the mine construction period, followed by tax rate decreases during the operations years. The average increase during construction years for all places in this second group is $1.04 per $1,000, or $52 on a $50,000 property. The greatest impacts during construction years occur in Blackwell (Wabeno School District), Hiles (Three Lakes School District), and Pine Lake. Tax rates decrease on average during operations years by 18 cents per $1,000, or $9.00 per year on a $50,000 property.

It appears that taxpayers in 11 places (in addition to Lincoln and Nashville) will experience mostly lower tax rates because of the mine. The decrease over construction years ranges from about five to ten percent under the rates that were simulated for the without project scenario. During operations years these reductions become even greater, ranging from 13 to 60 percent. The average reduction in tax rates over operations years for these places is $2.42 per $1,000, or $121 less in taxes each year on a $50,000 property. Places experiencing the greatest tax rate decreases due to the mine are Argonne, Crandon City and Town, and Hiles (Crandon School District).

Q. Were the results from your fiscal impact analysis used for other purposes than estimating tax rate changes due to the project? If so, would you please describe that use?

A. I used the fiscal impact data to estimate the potential demands that might be placed each year against the Mining Impact Fund. To do this I calculated the amount of money that would be required to keep tax rates from increasing in any given year due to the project. My assumption was that municipalities, school districts and counties could apply for Mining Impact Funds in years in which they were negatively affected by the project. Once again I did not include the statutory payments to Lincoln, Nashville nor Forest County in this calculation.

Q. You mentioned earlier that certain aspects of the proposed project have been revised since the Forecast of Future Conditions was published. Have you considered what effect those changes will have on tax rates, and if so how the results of your earlier analysis would change?

A. I have simulated new tax rates for the Towns of Lincoln and Nashville, the Crandon School District and Forest County, but not the other jurisdictions. This is reported in EXHIBIT 182. The input data for this analysis was developed by Thomas L. Coefield Associates in November 1985, as described in Exhibit 166. In addition to the changes I noted earlier, the only other major change involved in the revised plan is the distribution of taxable project value between Lincoln and Nashville. The original estimate of a 90 percent share for the Town of Lincoln has been replaced by a share that ranges from 93 to 98 percent over the life of the project. Corresponding changes were made to Nashville's share of taxable project value.

In general, simulations based upon the revised project produce smaller tax rate increases during the construction period for taxpayers in both Lincoln and Nashville in comparison to the increases originally estimated. Tax rate decreases during the operations phase in both places are also diminished, going from \$4.09 to \$2.90 per thousand on average in Lincoln and from \$4.18 to \$3.19 per thousand on average in Nashville. These changes are consistent with my earlier suggestion that the project revisions will tend to dampen the fiscal impacts that were originally estimated, but should not change their general direction.

Q. Finally, what is your overall assessment of the economic impact of the proposed Crandon project?

A. The mine will affect the area's economy in many ways. Employment opportunities, unemployment rates and business activity are only a few of the most important examples. Those impacts were studied by Dr. Luke and others. My own segment of the economic analysis is much narrower. I studied only the impact of the mine on local government property tax rates--that is, the mine's fiscal effects on local governments.

As I summarized earlier, it is clear that tax rates will decrease significantly in all taxing jurisdictions directly benefitted by addition of the mining facility's property value. This clearly includes Lincoln and Nashville,and other communities that are served by the Crandon School District. Although spending will go up in these places, the tax base will grow even more as a result of the mine, resulting in decreases in tax rates throughout the area.

The spending-aids-tax base relationship in other affected areas is more difficult to generalize. Spending increases in all affected areas lead to tax rate increases in some areas and decreases in others. I did not observe any negative tax rate impacts that could not be mitigated either by the Mining Impact Fund or by traditional financial management practices.

I should perhaps make just a few brief comments on this last point as I conclude my remarks. You may recall that I used three key assumptions in conducting the fiscal impact analysis. Briefly, these were:

(1) Mining Impact Fund resources were not included in the fiscal impact estimates;

(2) all increases in spending were financed via the property tax; and

(3) local governments were able to fully anticipate future spending needs and to determine current year budgets accordingly.

All of these assumptions cause my study to overstate the impact of increased spending on local tax rates. In reality, tax rate increases could be made smaller by using Mining Impact Fund monies to finance local mine-related spending or by borrowing to defer the cost of early construction-related activity to years of more rapid tax base expansion.

But the more important point to be made is that ultimately, decisions on spending and taxing are made at the local level. My model has been restricted to simulating what local governments have done "on average" in the past. Local governments, with proper planning and community involvement, have the necessary tools to control much of their own fiscal future.

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EXHIBIT 420

June 1986

CURRICULUM VITA

JACK R. HUDDLESTON
Department of Urban and Regional Planning
University of Wisconsin
925 Bascom Mall
Madison, Wisconsin 53706

Telephone: 608 262-1004

EDUCATION

Ph.D., Oklahoma State University, Department of Economics, 1976.

<u>Dissertation</u>: "Factors Affecting the Variation in Cost Inflation Among Hospitals Which Expand Beds or Facilities: An Analysis of Hospital Regulation Policy."

<u>Fields of Specialization</u>: Economic theory; urban and regional economics; public finance; and manpower analysis.

M.S., Oklahoma State University, Department of Economics, 1973.

B.B.A., Wichita (Kansas) State University, Department of Business Administration, 1971.

POSITIONS HELD

1983 to present. Associate Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison, and Associate Professor, University of Wisconsin-Extension (25% appointment).

1977 to 1983. Assistant Professor, Department of Urban and Regional Planning, University of Wisconsin-Madison, and (1979 to 1983) Assistant Professor, University of Wisconsin-Extension (25% appointment).

1976 to 1977. Chief of Local Fiscal Policy Analysis, Wisconsin Department of Revenue.

1973 to 1976. Chief Economist, Wisconsin Office of State Planning and Energy.

PUBLICATIONS AND PRESENTED PAPERS

Articles, Book Chapters and Major Reports

Huddleston, Jack. "Intermetropolitan Financial Flows Under Tax Increment Financing," Policy Sciences, forthcoming.

Huddleston, Jack. "Distribution of Development Costs Under Tax Increment Financing," Journal of the American Planning Association, Vol. 52, No. 2, Spring 1986, pp. 194-198.

Huddleston, Jack. "Tax Increment Financing as a State Development Policy," Growth and Change, Vol. 15, No. 2, April 1984, pp. 11-17.

Huddleston, Jack. "A Comparison of State Tax Increment Financing Laws," in John Matzer (ed.), Capital Financing Strategies for Local Governments (Washington, D.C.: International City Management Association, 1983), pp. 129-137. First published in State Government, Vol. 55. No. 1, 1982, pp. 29-33 and reprinted in Assessment Digest, Vol. 5, No. 2, March/April 1983, pp. 18-22.

Huddleston, Jack and Matz, Deborah. "Emerging Issues in Intergovernmental Relations," Proceedings of the Seventy-Fifth Annual National Tax Association Conference on Taxation 1982, pp. 126-129.

Huddleston, Jack. "Local Financial Dimensions of Tax Increment Financing: A Cost-Revenue Analysis," Public Budgeting & Finance, Vol. 2, No. 1, Spring 1982, pp. 40-49.

Huddleston, Jack. "Tax Increment Financing in Wisconsin," Planning, Vol. 47, No. 11, November 1981, pp. 14-17.

Huddleston, Jack. "Variations in Development Subsidies Under Tax Increment Financing," Land Economics, Vol. 57, No. 3, August 1981, pp. 373-384.

Huddleston, Jack. "Analysis of Distressed Counties in Wisconsin," in Building on the Wisconsin Development Strategy (Madison, Wisconsin: Wisconsin Department of Development, 1981), pp. I-1 - V-27 (65 pages).

Huddleston, Jack and Krauskopf, Thomas. "Further Evidence Concerning Local Control of Land Use," Land Economics, Vol. 56, No. 4, November 1980, pp. 471-476.

Huddleston, Jack. "The Wisconsin of the 1980's: Demographic and Economic Outlook," Wisconsin Planning, Vol. 1, No. 1, Winter 1980, pp. 21-30.

Hartz, Debra and Huddleston, Jack. Tax Incremental Financing (Chicago, Illinois: Council of Planning Librarians, 1980, 14 pages.

Huddleston, Jack; Allen, Debra; Hartz, Thomas; McCormick, Lynn and Roden, Lisa. Tax Incremental Financing: A Handbook for Use in Wisconsin (Madison, Wisconsin: University of Wisconsin-Extension, 1980), 81 pages.

Other Publications

Huddleston, Jack. Tunisian Energy Demand Models: Use in Policy Analysis (Madison, Wisconsin: Resource Management Associates, Report RMA/GOT-TD-44, 1986).

Huddleston, Jack. Tunisian Energy Demand Models: Sectoral Integration and Forecasting (Madison Wisconsin: Resource Management Associates, Report RMA/GOT-TD-43, 1986).

Huddleston, Jack and Roberts, Allen. Retrospective Analysis of Hamman Biadha Renewable Energy Project (Madison, Wisconsin: Resource Management Associates, Report RMA/GOT-TD-39, 1986).

Huddleston, Jack and Fitzsimmons, Therese. Impact Study of the Clinicare Corporation's Eau Claire Academy (Madison, Wisconsin: Decision Research Associates, 1986).

Huddleston, Jack. "Management Impacts of Renewable Energy Resource Systems in Wisconsin," in A Framework for Energy Conservation and Renewable Energy Program Evaluation (Madison, Wisconsin: Energy Systems and Policy Research Program, University of Wisconsin, 1985) Appendix 2.

Huddleston, Jack. Assessing the Impact of Public Investment in Transportation on Wisconsin's Economy (Madison, Wisconsin: Transportation Policy Study Institute, 1985).

Prakash, Ved and Huddleston, Jack. Approaches to Financial Analyses and Investment Planning for Urban Development Projects (Nairobi, Kenya: United Nations Center for Human Settlements, 1984).

Huddleston, Jack. Fiscal Impacts of Greenfield Tax Incremental Financing District Number One on the Greenfield School District (Madison, Wisconsin: Department of Urban and Regional Planning, University of Wisconsin-Madison, 1982).

Huddleston, Jack. "Cost-Revenue Analysis on Wisconsin Tax Increment Financing," Occasional Paper Series in Urban and Regional Planning (Madison, Wisconsin: Department of Urban and Regional Planning, University of Wisconsin-Madison, 1982).

Huddleston, Jack. "The Size and Variation of Development Subsidies Under Wisconsin Tax Incremental Financing," Occasional Paper Series in Urban and Regional Planning (Madison, Wisconsin: Department of Urban and Regional Planning, University of Wisconsin-Madison, 1980).

Huddleston, Jack. "Impact of Tax Base Equalization on Local Development Planning," Occasional Paper Series in Urban and Regional Planning (Madison, Wisconsin: Department of Urban and Regional Planning, University of Wisconsin-Madison, 1979).

Erickson, Rodney and Huddleston, Jack. Small Community Growth (Madison, Wisconsin: Wisconsin State Planning Office, 1975).

Presented Papers

Prakash, Ved and Huddleston, Jack. "Urban Development Issues in Asia with Special Reference to Sri Lanka," presented at the International Conference on Asian Urbanization, Akron, Ohio, April 19-20, 1985.

Prakash, Ved and Huddleston, Jack. "Strategic Public Policy Issues for Financing Urban Development," presented at the United Nations Centre for Regional Development Workshop on Financing Local and Regional Development, Nagaya, Japan, December 1984.

Prakash, Ved and Huddleston, Jack. "Strategic Urban Development Issues in Asia with Special Reference to Sri Lanka," presented at the 13th Annual Conference on South Asia, Madison, Wisconsin, November 1984.

Tyson, Timothy and Huddleston, Jack. "An Evaluation of the Effects of Community Mental Health Boards as Gatekeepers for Medicaid Mental Health Services," presented at the 112th Annual Meeting of the American Public Health Association, Los Angeles, California, November 1984.

Huddleston, Jack. "Intrametropolitan Financial Flows Under Tax Increment Financing," presented at the 26th Annual Conference of the Association of Collegiate Schools of Planning, New York, New York, October 1984.

Huddleston, Jack; Pangotra, Prem and Penn, George. "Financial and Economic Dimensions of a Community Refuse-Derived-Fuel System," presented at the Nebraska National Colloquium on Community Energy Management as an Economic Development Strategy, Lincoln, Nebraska, October 1984.

Huddleston, Jack. "Predicting the Use of a Local Development Tool," presented at the 24th Annual Conference of the Association of Collegiate Schools of Planning, Chicago, Illinois, October 1982.

Huddleston, Jack and Matz, Deborah. "Emerging Issues in Intergovernmental Relations," presented at the 75th Annual Conference on Taxation, National Tax Association-Tax Institute of America, Cincinnati, Ohio, October 1982.

Huddleston, Jack and Tyson, Timothy. "An Index of Social Mortality," presented at the 109th Annual Meeting of the American Public Health Association, Los Angeles, California, November 1981.

Huddleston, Jack. "The Wisconsin of the 1980's: Demographic and Economic Outlook," presented at the Conference on Wisconsin Planning in the 1980's, Madison, Wisconsin, March 1980.

Huddleston, Jack. "Impact of State Intergovernmental Aid Policies on Local Development Planning," presented at the 11th Annual Meeting of the Mid-Continent Regional Science Association, Minneapolis, Minnesota, May 1979.

Tyson, Timothy and Huddleston, Jack. "An Analysis of the Effects of Long Term Care Reimbursement in State Medicaid Programs on Cost Inflation and the

Supply of Nursing Home Beds," presented at the 106th Annual Meeting of the American Public Health Association, Los Angeles, California, October 1978.

Huddleston, Jack. "The Relationship Between Expansion and Hospital Cost Inflation: An Examination of Hospital Regulation Policy," presented at the 46th Annual Meeting of the Southern Economic Association, Atlanta, Georgia, November 1976.

Huddleston, Jack and Tyson, Timothy. "Analysis of Hospital Expansion and Cost Inflation," presented at the 104th Annual Meeting of the American Public Health Association, Miami Beach, Florida, October 1976.

Tyson, Timothy and Huddleston, Jack. "Evaluating Physician Shortage Area Designations," presented at the 103rd Annual Meeting of the American Public Health Association, Chicago, Illinois, November 1975.

FUNDED RESEARCH

Resource Management Associates. Evaluation of renewable energy project; energy forecasting and policy analysis. December 1985 to June 1986.

Clinicare Corporation. "Impact Study of the Clinicare Corporation's Eau Claire Academy." November 1985 to February 1986.

Wisconsin Department of Transportation. "Economic Impacts of Wisconsin Transportation Investments." July 1984 to June 1985.

Wisconsin Division of State Energy. "Evaluation of Programs on Alternative Energy in the State of Wisconsin." June 1985.

Exxon Minerals Company. "Fiscal Impact Analysis of the Proposed Crandon Mine Operation." 1983 to present.

United Nations. "Mission to Sri Lanka to Evaluate the Use of Financial Analysis and Investment Planning." September to October 1983.

United Nations. "Manual Development for Investment Analysis and Financial Planning for Urban Development Projects in Developing Countries." January to December 1983.

School District of Greenfield, Wisconsin. "Fiscal Impact Analysis for the Proposed City Tax Increment Financing District." January to June 1982.

Department of Administration, City of Madison, Wisconsin. "Development of Expenditure and Revenue Forecasting Model." January to August 1981.

Wisconsin Department of Local Affairs and Development. "Analysis of Economic Distress in Wisconsin Counties." January to June 1980.

Wisconsin Department of Administration. "Analysis of a State Business Loan Program Proposal." June 1978.

TEACHING

URPL 721: Methods of Planning Analysis

A "core" (required) course that involves an introduction to statistical and analytical methods for planning and policy analysis. Methods covered include discriptive and multivariate inferential statistics, regression analysis, linear programming and simulation modelling.

URPL/ECON 734: Regional Economic Problem Analysis

A required course for students concentrating in economic/fiscal planning that involves a theoretical treatment of the processes behind regional economic problems and the conceptual and applied dimensions of selected regional economic analytical techniques. Techniques include export base analysis, input-output models, shift-share analysis and regional econometric models.

URPL 738: Regional Economic Development Policies and Planning

A sequel course to URPL/ECON 734 that develops a framework for conducting regional economic development planning and for evaluating regional development policies. Major federal, state and local development strategies are discussed and analyzed using traditional evaluation techniques.

URPL 950: Seminar in Planning: Urban and Regional Development and Finance

An advanced seminar for students concentrating in economic/fiscal planning. Topics typically include the application of multivariate forecasting techniques, cost-benefit analysis, fiscal impact analysis and computer simulation.

MEMBERSHIP IN NATIONAL ORGANIZATIONS

American Planning Association

Wisconsin Planning Association

National Tax Association

Southern Economics Association

SPECIAL HONORS AND AWARDS

Chair, Intergovernmental Relations Subcommittee, National Tax Association, 1981-1982.

Nomination, Distinguished Teaching Award, University of Wisconsin-Madison, 1981 and 1985.

National Defense Education Act Fellow, Oklahoma State University, 1971-1973.

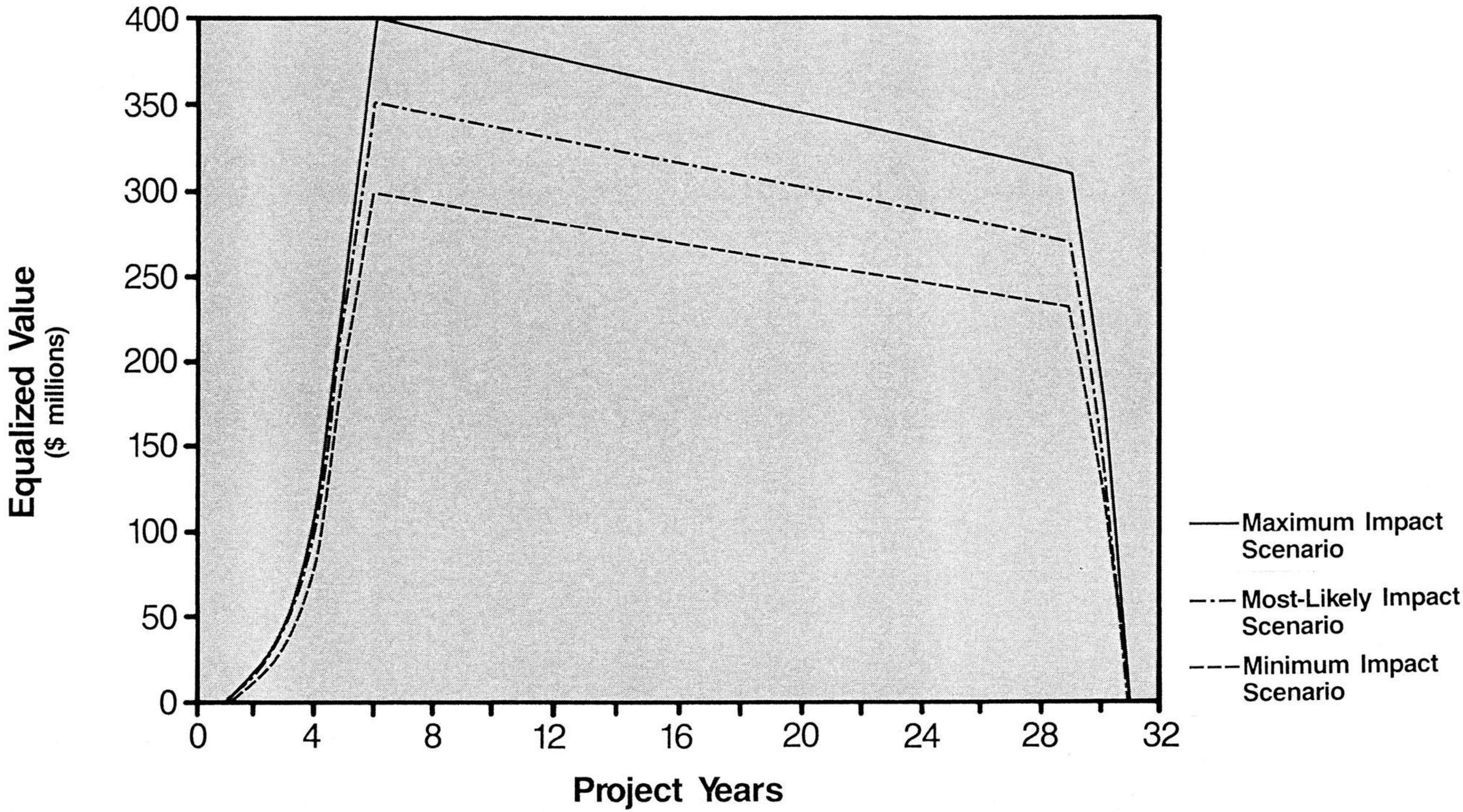
Member of the Board and Chair of the Planning Committee, WomanWork, Inc., a non-profit economic development group in Beloit, Wisconsin, April 1985 to present.

Gross Tax Rate

Town of Lincoln for $50,000 Property (1981)			
Jurisdiction	1981 Tax Rate (mills.)	Property Tax	% of Total
Town of Lincoln	.00094	$ 47	7
Crandon School District	.00803	401	61
Forest County	.00260	130	20
Nicolet VTAE District	.00136	68	10
State	.00020	10	2
Totals	.01313	$656	100

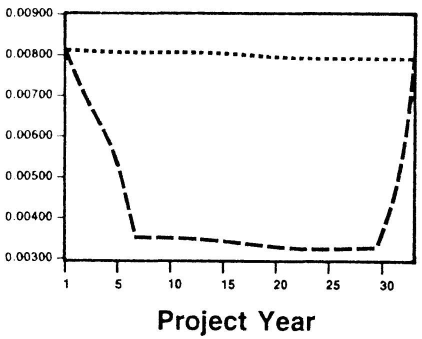
Equalized Value Estimates

Mine Complex

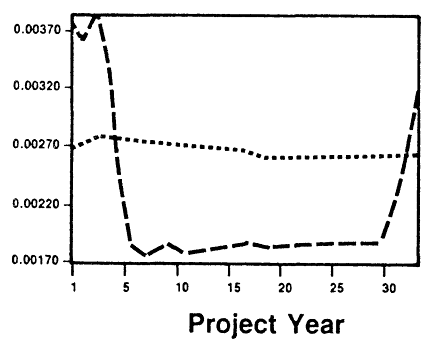


Town of Lincoln Tax Rates

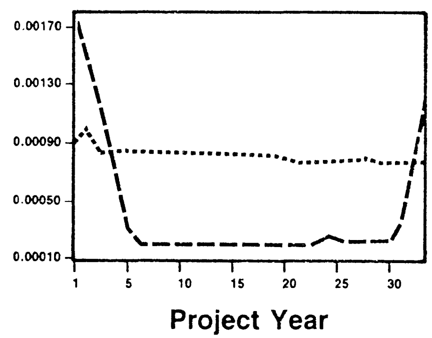
Crandon School District



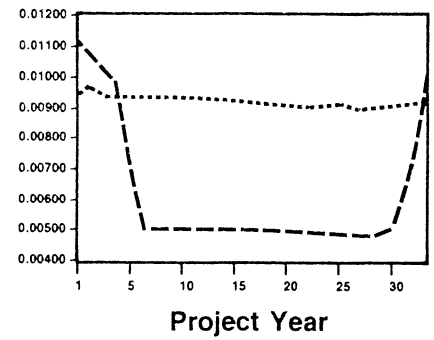
Forest County



Town of Lincoln

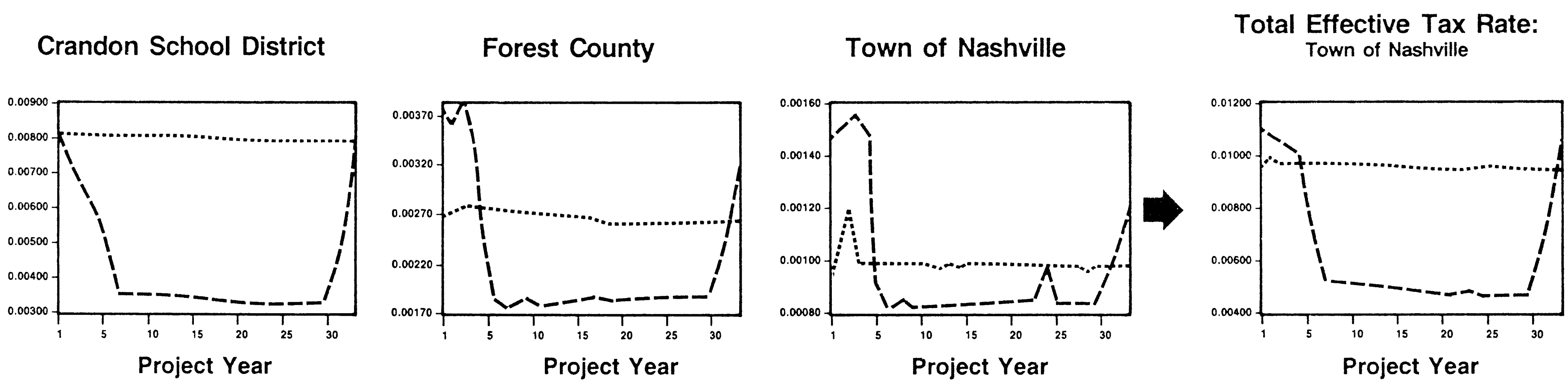


Total Effective Tax Rate:
Town of Lincoln



·········· Without Project ---- With Project

Town of Nashville Tax Rates



·········· Without Project ----- With Project

EXHIBITS NOT HEREIN REPRODUCED

Exxon has included in its three volumes of prepared direct testimony copies of all maps, diagrams, charts, tables, and resumes it intends to introduce as exhibits at the master hearing. The following items have not been reproduced herein but will be introduced as exhibits at the master hearing:

First, at page 11 of his prefiled testimony (Tab 12), Dr. Djafari refers to a "fence diagram" consisting of "nine cross-sectional diagrams" of the site geology and hydrology "which are tied together so that one may see how the geology of the site differs in the various locations." This diagram, which will be introduced as EXHIBIT 356 in the record, will be available for inspection upon request after September 30, 1986, at Exxon's Rhinelander office, 655 Washington Street, P. O. Box 813, Rhinelander, Wisconsin, 54501.

Second, the following permit and approval applications, local permits, Exxon reports and studies, and studies and reports by various consultants are not being reproduced herein. These items already have been submitted to the Department of Natural Resources, and Exxon believes that most already have been filed with the library repository system for the Crandon Project. Copies of each of these items are available for inspection upon request at Exxon's Rhinelander office at the address set forth above.

EXHIBIT NUMBER	DESCRIPTION
111	Mining Permit Application, Volume I dated January 1986 with May 1986 Addendum and Volume II dated December 1985 with May 1986 Addendum.
112	High Capacity Well Approval Application for the Mine Ground Water Inflow Control and Drainage Systems, Volume I dated December 1985 with May 1985 Addendum and Volume II dated May 1986.
113	High Capacity Well Approval Application for the Potable, Construction, and Contingency Supplement Water Wells and Transportation Systems, Volumes I and II dated December 1985 with May 1986 Addendum (Volume I)
114	Mine Waste Disposal Facility (MWDF) Feasibility Report dated December 1985

115 Mine Refuse Disposal Facility (MRDF) Feasibility Report, dated November 1985

116 Air Quality Permit Application, Notice of Intent (NOI), dated December 1985

117 Wisconsin Pollutant Discharge Elimination System (WPDES), Wastewater Discharge Permit Application, dated December 1985 with May 1986 Addendum

118 Water Treatment Facility Final Plans and Specifications, prepared by CH2M Hill, dated August, 1986

119 Facilities Plan for the Exxon Minerals Company Mine/Mill Complex Sanitary Wastewater, prepared by CH2M Hill, dated November 1985

120 Bridge over Swamp Creek for Access Road to Exxon Minerals Company, Crandon Project, and Appendix A - Hydraulic Analysis Input and Output, and Modeling Assumptions, dated April 1983

121 Bridge over Swamp Creek for Railroad Spur to Exxon Minerals Company, Crandon Project, dated April 1983

122 Culvert for a Swamp Creek Tributary Crossing at Station Reference 509.70 of a Railroad Spur to Exxon Minerals Company, Crandon Project, dated April 1983

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