STATE ENVIRONMENTAL QUALITY REVIEW ACT (SEQRA)
FINDINGS STATEMENT (6 NYCRR PART 617.9)
Kingston Business Park
Kingston Local Development Corporation, Project Sponsor

CITY OF KINGSTON PLANNING BOARD, Lead Agency

Adopted by the Lead Agency: February 8, 1996

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PART A

STATE ENVIRONMENTAL QUALITY REVIEW
FINDINGS STATEMENT

Pursuant to Article 8 (State Environmental Quality Review Act - SEQRA) of the Environmental Conservation Law and 6 NYCRR Part 617, the Common Council of the City of Kingston, as an involved agency, makes the following findings:

NAME OF ACTION: City of Kingston Business Park

NAME & ADDRESS OF APPLICANT: City of Kingston Local Development Corporation
c/o Kingston City Hall
One Garraghan Drive
Kingston, NY 12401

The Applicant is a local development corporation organized and existing pursuant to Sections 402 and 1411 of the Not-For-Profit Corporation Law, having been formed on May 26, 1994.

DESCRIPTION OF ACTION: See annexed findings.

LOCATION: The site of the proposed action consists of approximately 107 acres situate in the City of Kingston, County of Ulster and State of New York northerly of Delaware Avenue, easterly of Third and Fourth Avenues and westerly of Locust Street, and includes an easement or right of way for a proposed roadway leading to New York State Route 32 in the Town of Ulster. See City of Kingston Tax Map Section 48.084-1-5.

AGENCY JURISDICTION: The Common Council of the City of Kingston has jurisdiction over this proposed action for the reason the proposed development requires an amendment to the Zoning Map of the City of Kingston to change the classification of the 107.056 acre site from RRR Residential to M-1 Light Manufacturing pursuant to Article IX of the City of Kingston Zoning Code and Section 83 General City Law.

DATE FINAL GEIS FILED: January 26, 1996

FACTS AND CONCLUSIONS IN THE GEIS RELIED UPON TO SUPPORT THE DECISION: See annexed findings.

CERTIFICATION OF FINDINGS TO APPROVE

Having considered the Draft and Final GEIS, and having considered the annexed written facts and conclusions relied upon to meet the requirements of 6 NYCRR 617.9, this Statement of Findings certifies that:

1. The requirements of 6 NYCRR Part 617 have been met;

2. Consistent with the social, economic and other essential considerations from among the reasonable alternatives thereto, the action approved is one which minimizes or avoids adverse environmental effects to the maximum extent practicable; including the effects disclosed in the environmental impact statement; and

3. Consistent with social, economic and other essential considerations, to the maximum extent practicable, adverse environmental effects revealed in the environmental impact statement process will be minimized or avoided by incorporating as conditions to the decision those mitigative measures which were identified as practicable.

4. In accordance with the applicable provisions of Article 42 of the Executive Law and the applicable policies and purposes of the City of Kingston Local Waterfront Revitalization Program as contained in the City of Kingston Waterfront Consistency Review Law (Local Law #4 of 1992), this action is consistent, to the maximum extent practicable, with such policies, purposes and program.

5. Consistent with the applicable policies of Article 42 of the Executive Law, as implemented by 19 NYCRR 600.5 and the Local Waterfront Consistency Review Law, this action will adequately achieve a balance between the protection of the environment and the need to accommodate social and economic considerations.

COMMON COUNCIL OF THE CITY OF KINGSTON
(Name of Agency)

T.R. Gallo
(Signature of Responsible Official)

T.R. GALLO, Mayor
(Name of Responsible Official)

Mayor, City of Kingston
(Title of Responsible Official)

February 13, 1996

City of Kingston City Hall
One Garraghan Drive
Kingston, NY 12401

PART B

FINDINGS STATEMENT CITY OF KINGSTON BUSINESS PARK
FINDINGS OF FACT

I. DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the development of a business park to be located on a 107.056 acre site off Delaware Avenue in the City of Kingston, Ulster County, New York, which parcel of land is currently owned by Tilcon Materials, Inc. The Applicant intended to acquire title to the site and to construct thereon a business and commercial park that would ultimately accommodate three to five independent facilities totaling up to 500,000 square feet of building footprint and utilizing approximately 54 acres of the site.

The proposed development would take place in phases or stages, with only the first phase or stage currently being site specific.

A. Phase I: The first phase of the proposed business park consists of the development of approximately 142,200 square feet of building footprint to be developed for Huck, International, with provisions for future expansion and for an additional facility up to a total of 250,000 square feet. A site specific development plan for this phase has been submitted by the Applicant and includes:

(i) A buffer and non-disturbance area as shown on the site plan;

(ii) Water supply and sewage disposal for the development will be supplied by the existing City of Kingston community systems and regulated under the New York State Department of Health and Department of Environmental Conservation requirements;

(iii) Access to Phase I will be by way of a two lane roadway intersecting Delaware Avenue at a point approximately 200 feet westerly of Rosanna Street. This roadway will be constructed by the Applicant, dedicated and accepted by the City as a public street or highway; and

(iv) Electric power, telephone and other utilities are now available to the site and shall be extended to serve Phase I. These utilities shall be maintained by the utility companies.

B. Future Phases: As the site specific details of Phase I of the project are only known at this time, the GEIS is specific only as to such phase. Later phases of this multi-stage project are currently uncertain as to design, specific use, timing, layout and other factors. The environmental review of these possible subsequent phases has been addressed in the GEIS by considering the potential effects of a total build-out of the entire 107 acre site before approving any specific phase of the action.

The effects and impacts of future phases of the development, including cumulative effects on the environment and the existing natural resource base of the subsequent phases, are, of necessity, analyzed and evaluated in more general or conceptual terms, but at a level of detail sufficient to identify and formulate specific conditions and criteria under which both the first phase, as well as future phases, may be undertaken or approved. The GEIS and these findings (see Section XXVIII hereof) include procedures and criteria for:

(i) determining when no further SEQRA compliance will be required if a subsequent site specific phase is carried out in conformance with the conditions and thresholds established for such subsequent phases in the findings statement resulting from the Generic EIS;

(ii) providing for the preparation and filing of supplemental findings statements for impacts of subsequent phases that have been adequately addressed in the Generic EIS but not adequately addressed in the findings statement;

(iii) providing for supplements to reflect any significant environmental impacts, such as site specific impacts, which may not have been adequately addressed or analyzed in the Generic EIS [See 6 NYCRR Part 617.15 (b) and (c)];

(iv) establish baseline data for reference and to assist in determining the significance of any site specific impacts of subsequent phases, as well as to assist in scoping of any supplemental site specific EIS that may be required at the time of such review;

(v) limit the extent of future phased review by providing early guidance on significant determinations; and

(vi) provide environmental planning, particularly the considerations of mitigation and alternatives at a time when there is greater flexibility. Performance standards, conditions and impact thresholds shall be established, including maximum allowable densities; traffic and access road plans; archeological studies and measures; storm water management and pollution control plans; buffer zones, viewshed controls, and similar standards with site-specific project applications regarding future phases.

II. PROCEDURAL HISTORY OF ACTION

(i) On June 26, 1995, the Applicant applied to the City of Kingston Planning Board for Site Development Plan Approval of Phase I of the proposed Kingston Business Park, as well as "conceptual" review of the whole action including all subsequent phases. The action involves a series

of applications to several governmental agencies, as well as a number of stages that may be constructed over a number of years. This application included, among other things, a Full Environmental Assessment Form with Part I completed by the Project Sponsor and a Coastal Assessment Form required by the City of Kingston Waterfront Consistency Review Law (Local Law #4 of 1992).

(ii) On July 6, 1995, the Planning Board made its initial determinations and classification of the proposed action pursuant to 6 NYCRR Part 617.5 and caused the EAF with Part I completed by the Applicant and a copy of the Application for Site Development Plan Approval to be mailed or delivered to all involved agencies notifying them that a lead agency must be agreed upon within thirty (30) calendar days of the date of such mailing pursuant to 6 NYCRR Part 617.6 (b) and (c). The Planning Board also adopted a Resolution proposing that the site be rezoned from RRR Residential to M1 Light Manufacturing pursuant to Article IX, Section 123-61, B of the City of Kingston Zoning Code, which Resolution was forwarded to the City of Kingston Common Council and all other involved agencies.

(iii) The Planning Board received no objections to its serving as lead agency for this action, and all involved agencies have consented in writing to the Planning Board being established as lead agency in this action.

(iv) By Resolution dated July 13, 1995, the Planning Board confirmed its lead agency status and issued a Positive Declaration in this action and required the preparation of a Draft Generic Environmental Impact Statement (DGEIS); the Notice of Determination of Significance (Positive Declaration) having been filed pursuant to 6 NYCRR Part 617.10 (b) and published in the ENB on August 2, 1995.

(v) On July 13, 1995, the Planning Board and its consultants also provided the Applicant with a final written scope regarding issues to be addressed in the DGEIS.

(vi) On October 20, 1995, the Applicant submitted to the Planning Board an application to subdivide the 107.056 acre site into two parcels or lots, as well as a proposed DGEIS with several Appendices.

(vii) .On November 9, 1995, after reviewing the proposed DGEIS, the Planning Board determined that the DGEIS was complete and accepted the same with respect to its scope, content and adequacy and ordered its circulation as required by law.

(viii) On November 9, 1995, pursuant to the intent of SEQRA and the regulations promulgated thereunder that the environmental review process be integrated into existing agency review processes to the maximum degree feasible and occur at the same time as other agency reviews are being undertaken, the Planning Board and Common Council also scheduled a combined and coordinated public hearing on the DGEIS on the proposed rezoning of the site. The purpose of such combined and coordinated hearings were to consider and obtain public input and comment on the environmental effects of the entire business park, as well as the advisability of rezoning the site; approving a site development plan for Phase I and subdividing the site into two parcels or lots.

(ix) On November 14, 1995, a copy of the applications, the DGEIS and the completed Coastal Assessment Form (CAF) was referred to the City of Kingston Waterfront Advisory Committee pursuant to Section V, 3 of the Waterfront Consistency Review Law (Local Law #4 of 1992) and a copy of the application and DGEIS was also delivered to the City of Kingston Historic Landmark Preservation Commission for its review and

recommendations. The written recommendations of the Kingston Waterfront Advisory Committee were received by the lead agency on December 4, 1995. No comments or response was received from the Kingston Historic Landmark Preservation Commission.

(x) On November 13 and 14, 1995 a Notice of Completion of the DGEIS and Notice of Public Hearing and a copy of the DGEIS was filed with the Commissioner of Environmental Conservation and with all other involved agencies and the interested agencies in accordance with the provisions of Part 617.8 (b) and (c) and 617.10 (c) and (d). A copy of the DGEIS and the Notice of Hearing was also filed with the Kingston Area Public Library

(xi) On November 13, 1995 the Planning Board also referred a full statement of the proposed actions, including the DGEIS and Notice of Public Hearing to the Ulster County Planning Board. At the same time the Common Council of the City of Kingston also referred to the County Planning Board a complete text of the proposed Resolution amending the Zoning Map of the City of Kingston to rezone the premises from RRR to M1 Light Manufacturing. These referrals were voluntary and not mandated by Section 239-m of the General Municipal Law as the site of the proposed action is not within 500 feet of any of the features set forth in Section 239-m of the General Municipal Law.

(xii) Notices of Combined and Coordinated public hearings were published in the Kingston Daily Freeman on November 14th and 24th, 1995, in accordance with the applicable provisions of the General City Law, the Zoning Code of the City of Kingston and the SEQRA regulations. Notices of Public Hearing were also served on or mailed to all involved and interested agencies, including the Ulster County Planning Board and the Clerk of the Town of Ulster.

(xiii) The public hearing was held before the Planning Board and Laws and Rules Committee of the Common Council on November 30, 1995, at which time all persons attending who wished to be heard with respect to the proposed project were given an opportunity to be heard. A stenographic transcript of the public hearing was made and included in the record.

(xiv) The written comment period for the DGEIS terminated on December 18, 1995, pursuant to Part 617.8 (d) (3).

(xv) The City of Kingston Planning Department, the Ulster County Planning Board, Mark and Herman Knaust, and other nearby landowners, organizations and members of the public submitted comments to the Planning Board with respect to the DGEIS, which comments were both submitted in writing and at the November 30, 1995 public hearing. A copy of the stenographic transcript of the public hearing and copies of all of the written comments submitted to the Planning Board were delivered to the Applicant for the purpose of preparing draft responses and a FGEIS for the consideration of and review by the Planning Board.

(xvi) On December 22, 1995 KLDC formally applied to the City of Kingston Zoning Board of Appeals for a variance from Sections 3-21.6.1 and 3-21.7.10 of the off-street parking standards of the City of Kingston Zoning Code, and a public hearing on such variance was held before the Zoning Board of Appeals on January 31, 1996.

(xvii) The Applicant proceeded with the preparation of a proposed FGEIS for the consideration of and review by the Planning Board and on January 18, 1996, the Applicant filed the proposed draft FGEIS with the Planning Board.

(xviii) The members of the Planning Board and its staff carefully reviewed and thoroughly considered the proposed FGEIS and the

recommendations of the City of Kingston Planning Department with regard to the adequacy and completeness of the FGEIS.

(xix) On January 25, 1996, the Planning Board voted to issue the FGEIS, and caused the FGEIS, along with a Notice of Completion of FGEIS, to be filed and circulated in accordance with the SEQRA regulations.

(xx) Pursuant to Part 617.9 (a), more than ten (10) calendar days have passed since the filing of the FGEIS with the other involved and interested agencies and the lead agency is now authorized to make and file its Findings and decision in this action in accordance with Part 617.9 (c).

III. APPROVALS/FUNDING/DIRECT ACTION

The following state and local approvals are required for the development of the proposed Kingston Business Park:

a. CITY OF KINGSTON PLANNING BOARD: Lead Agency -- SEQRA Review; Site Development Plan Review and Approval pursuant to Article IV, Section 123-29 of the City of Kingston Zoning Code; consistency determination pursuant to Local Law #4 of 1992 - City of Kingston Waterfront Consistency Review Law; subdivision of the 107.056 acre site into two lots pursuant to the City of Kingston Subdivision Regulations.

b. CITY OF KINGSTON COMMON COUNCIL: Amendment to Zoning Map of the City of Kingston to change the zoning classification of the site from RR2 Residential to M1 Light Manufacturing pursuant to Article IX of the City of Kingston Zoning Code and Section 83 of the General City Law; acceptance of roads and other infrastructure as public street(s), etc.

c. ULSTER COUNTY HEALTH DEPARTMENT: Review and approval of water supply and sanitary sewer extensions -- Public Health Law and Ulster County Sanitary Code.

d. NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION: S.P.D.E.S. General Permit for storm water discharges from construction activities Permit Number GP-93-06 -- Article 17, title 7, 8 and Article 70 of the Environmental Conservation Law.

e. NEW YORK STATE DEPARTMENT OF TRANSPORTATION: Funding for a portion of the project pursuant to the Industrial Access Grant "IAP" Program.

f. CITY OF KINGSTON LOCAL DEVELOPMENT CORPORATION (Applicant): Acquisition of title to the 107 acre parcel and related easement, and development of project and site.

g. CITY OF KINGSTON ZONING BOARD OF APPEALS: Grant of Area Variances pursuant to Section 81-b of the General City Law and Article III of the Zoning Code of the City of Kingston regarding off-street parking and landscaping requirements.

IV. CONSIDERATIONS OF LEAD AGENCY IN MAKING ITS FINDINGS

The Planning Board has carefully and thoroughly reviewed the information contained in the FGEIS, including the DGEIS and its Appendices; any revisions thereto; the substantive comments received; the referenced documents and the lead agency's responses to all substantive comments, all of which constitute the FGEIS, and comments thereon, including but not limited to the following reports and investigations:

1. Report on Geotechnical Investigation Proposed High School, Kingston, New York - Joseph S. Ward & Associates, Consulting Engineers, 91 Roseland Avenue, Caldwell, NJ 07006, dated July 12, 1973, Project #A7306-12 - Appendix 2 to Appendix C7 of DGEIS.

2. Geotechnical Report - Kingston Business Park, Kingston, New York - Prepared by GeoDesign, Inc., P.C., 984 Southford Road, Middlebury, CT 06762, dated November, 1995, Appendix C7 of the DGEIS. This report includes soil tests and subsurface test borings into bedrock conducted in October of 1995 by SoilTesting, Inc. as subcontractor of GeoDesign, Inc., P.C.

3. Addendum to GeoTechnical Report Rock Probes - B-5/Station 12 + 00 Vicinity Kingston Business Park, Kingston, New York, as prepared by GeoDesign, Inc., P.C., under date of November 3, 1995 (Appendix B to Exhibit C to the FGEIS).

4. .Geologic and Water Quality Concerns Specific to the Knaust Mines and Underground Lake: Evaluation of Contaminant Potential Stemming from The Kingston Local Development Corporation's Proposed Kingston Business Park (Comments on November, 1995 Draft Generic Environmental Impact Statement) as submitted on December 15, 1995 by Paul A. Rubin, Hydrogeologist on behalf of Mark Knaust and Herman Karl Knaust. (Exhibit A to the FGEIS).

5. Letter from Charles Merguerian, Ph.D., Professor of Structural Geology, Duke Geological Laboratory, 16 Middle Lane, Westbury, NY 11590 to Mr. Theodore Van Rosenvinge, IV, P.E., GeoDesign, Inc., under date of December 27, 1995 regarding the issue of karst topography and development (Appendix C to Exhibit C to the FGEIS).

6. Letter report from GeoDesign, Inc., P.C., to Dennis Larios, P.E. of Brinnier & Larios, P.C., the applicant's engineers, dated January 2, 1996 regarding the geotechnical, subsurface/geological, and blasting aspects of the proposed development (Appendix C to Exhibit C to the FGEIS).

7. Letter report from GeoDesign, Inc., P.C., to Dennis Larios, P.E., dated January 9, 1996 regarding the results of a site visit to the Knaust mines by Dr. Charles Merguerian and Theodore Von Rosenvinge IV, P.E., together with Mr. Rubin and members of the Knaust family (Appendix D to Exhibit C of the FGEIS).

8. Modified Stormwater Management Report as prepared by Brinnier & Larios, P.C., under date of January 10, 1996 (Appendix A to Exhibit C - Exhibit F of the FGEIS).

9. Letter from John J. Privitera, Esq., of McNamee, Lochner, Titus & Williams, P.C., attorneys and counselors at law, 75 State Street, Albany, New York 12201-0459 under date of January 10, 1996 (Exhibit A to FGEIS).

STATE ENVIRONMENTAL QUALITY REVIEW ACT (SEQRA)
FINDINGS STATEMENT
OF CITY OF KINGSTON PLANNING BOARD

Addendum to Paragraph IV

CONSIDERATIONS OF LEAD AGENCY....Continued (Page 14)

14. Letter from Arthur N. Palmer, Director, Water Resources Program, State University of New York, Oneonta, New York under date of February 3, 1996 (received 2/7/96).

15. Letter from Scenic Hudson, Inc. to Mr. Steve Finkle under date of 2/7/96, copy annexed.

10. Written responses from Dennis Larios, P.E. to the comments received in the Paul A. Rubin Report, together with supporting documents, which responses are dated January 15, 1996 (Exhibit C to FGEIS).

11. Second letter from Paul A. Rubin, Hydrogeologist, to Suzanne Cahill, City Planner, under date of February 2, 1996 (copy annexed).

12. Further responses under date of February 6 and 7, 1996 from GeoDesign, Inc. and Charles Merguerian, Ph.D. to the Rubin letter of February 2, 1996 (copy annexed).

13. Letter from NYS Department of Environmental Conservation to John J. Privitera, Esq. under date of February 1, 1996 (copy annexed).

V. LAND USE AND REZONING

The lead agency is aware that any particular rezoning of a parcel of land and/or amendment to the Zoning Map must be in accordance with comprehensive and well considered planning for the general welfare and future development of the entire City of Kingston as mandated by Section 20 (25) of the General City Law. Zoning must address the multitude of problems that growth and development bring to a community, and to provide a means to achieve the community's goals and objectives for its growth.

Such a comprehensive plan is not necessarily a formal written document but is an underlying purpose to control land uses for the benefit of the whole community based upon consideration of the community's problems. Where a community, after a careful and deliberate review of the present and reasonably foreseeable needs of the community adopts a general development policy or planning process for the community as a whole and amends its zoning law in accordance with that plan or process, such rezoning is in the public interest. Zoning changes must be consonant with a total planning strategy which reflects the current needs of the community, which needs are constantly changing. The planning process is therefore

periodically updated and shaped to meet changing and unanticipated requirements. When a zoning map or regulations are amended, the test is whether such amendment accords with a well considered plan for the benefit of the public interest, which is done by examining all available and relevant evidence of the municipality's land use policies. If the original plan requires amendment because of the community's change and growth, and the amendment is calculated to benefit the community as a whole, it meets the statutory requirements.

Furthermore, not only must the City provide a properly balanced and well-ordered plan for the City itself, in enacting amendments to the Zoning Law consideration must also be given to any applicable regional needs and requirements.

The lead agency finds that the proposed zoning change and the development of the proposed Kingston Business Park is in accordance with comprehensive and well considered planning that is consistent with and carries out the objectives of a land use policy reflecting the land use problems and needs of the City of Kingston as well as regional needs for the following reasons:

A. Consistency with the Zoning Code of the City of Kingston: The most recent document intended to control land use for the benefit of the entire City of Kingston is Chapter 123 of the Code of the City of Kingston which embodies the zoning regulations for the City. Section 123-1 of Chapter 123 entitled "Purposes Enumerated" clearly states that the Comprehensive Zoning Plan for the City of Kingston is set forth in Chapter 123 and the constituent maps and is intended to protect and promote the public health, safety and welfare. (Section 123-1, PP. 12305-12306).

a. Purpose and Goals of M1 Light Manufacturing Zone: Chapter 123, Section 123-18 (P. 12350-12352) which sets forth the goals and regulations for the M-1 Light Manufacturing District provides in 123-18, A, that the purpose of this district is to provide areas for a wide range of industrial activity that conforms to a high level of performance standards that can be located in close proximity to residential, institutional and commercial areas without objectionable influence and that can serve as a buffer in some cases between more objectionable industrial activities and residential and/or certain commercial areas.

The goal of the M1 Light Manufacturing District is to provide an area devoted to smaller scale manufacturing "high technology" research and development, business services and warehousing, as well as for office space for specific or general business uses. All of these uses are "cleaner" than traditional heavy industry or manufacturing in terms of direct and indirect environmental effects and impacts on the surrounding neighborhood. These "high tech" light manufacturing and office developments are in the form of well designed industrial or business parks as herein proposed. Heavy industrial uses that involve manufacturing or extractive activities that by their very nature can cause environmental effects of noise, smoke, dust, vibration, heavy truck traffic and similar impacts, are confined to the M2 General Manufacturing District described in Section 123-19 and are not permitted in this proposed business park (PP. 39-41 of the DGEIS).

b. Continuing Review of Uses: All uses permitted in the M1 Light Manufacturing Zoning District require in each instance an independent and discretionary site development plan review and approval by the City of Kingston Planning Board (See Chapter 123, Section 123-29, PP. 12380-12388)

and Section 27-a. General City Law) before any building permit can be issued. Other governmental agencies such as the Ulster County Health Department and the New York State Department of Environmental Conservation may also have jurisdiction over any uses that may be proposed of especially in the areas of air and water quality, drainage and sewage capacity. This continuing jurisdiction of the Planning Board and other agencies over the development of the site will assure that all of the relevant conditions imposed in this action and future development will be complied with and that all such development will undergo an independent, case by case review and approval. Furthermore, many of the reasonably foreseeable cumulative impacts of future phases have been identified, analyzed and evaluated in the FGEIS; baseline data established and criteria and thresholds established under which future site-specific phases may be undertaken or approved.

c. Additional Development Standards: In order to supplement and enhance the performance standards inherent in the M-1 Light Manufacturing District, the Applicant has agreed to impose use and design criteria and standards on the development of the proposed business park which are more restrictive than those imposed by the land use regulations applicable to the Light Manufacturing Zoning District. These restrictions are annexed as Exhibit 3 to the FGEIS and include the imposition of buffer zones and vegetated strips, lot coverage limits, height restrictions, controls on the location and color of buildings, design approvals by the Applicant, and the elimination of certain uses otherwise permitted in the Light Manufacturing Zone but which could have a deleterious effect on other uses in the park or on adjoining residential districts.

These standards and criteria will apply to all development in the park and will mitigate adverse environmental effects and impacts of any uses to be established and structures to be erected on the site and minimize any potentially deleterious effect of the proposed zoning change on neighboring properties and residential districts. Such restrictions will supplement the performance standards inherent in the Light Manufacturing Zoning and assist in maintaining a high standard of development quality consistent with modern planning standards and the stated purpose and goals of the Light Manufacturing District (PP. 13, 15, 38 and 41 of the DGEIS).

These performance and development standards will be administered and enforced by the City of Kingston Local Development Corporation, a quasi-governmental agency that is performing essential governmental functions in exercising such powers. (Section 1411 (a) Not-For-Profit Corporation Law.)

Any variances from these standards or amendments thereto may only be granted or made by KLDC after the review and recommendations of the City of Kingston Planning Board and Planning Department. Amendments to or variances from certain basic environmental standards and protections such as permissible uses, height limits and buffer zone requirements which mitigate off-site impacts shall require the approval of the City of Kingston Planning Board and a separate environmental review (See FGEIS Pages 23-24 and Exhibit D, Section 9.04).

While the lead agency finds that the rezoning of the 107.056 acres site to M-1 Light Manufacturing is reasonable in relation to the neighboring uses, as well as part of a well-considered and comprehensive plan calculated to serve the general welfare of the community and therefore fully warranted without the imposition of these restrictions and standards,

The proposed Kingston Business Park is located in both the Kingston Ulster Economic Development Zone and the Kingston-Newburgh Enterprise Community, which were established to foster and enhance the economic needs and goals of the City of Kingston and the Town of Ulster/ City of Newburgh (Page 4 of the DGEIS). The proposed business park will do much to foster the creation and retention of jobs, enhance the property tax base, encourage investment by new industry and further the other goals and objectives of these regional programs (PP. 5 and 62-64 of the DGEIS).

Specific benefits to the City of Kingston include the retention of approximately 200 existing jobs at Huck International, as well as the creation of an opportunity for 600 additional jobs related to future phases of the park. The completed project could generate up to one-half million dollars in land rents; payrolls of thirteen million dollars and up to thirty-two million dollars in area expenditures. These potential economic and fiscal benefits will come at a time when such benefits are especially needed due to the closing of the IBM facility and satellite businesses in the Town of Ulster, the severe economic conditions in the area and the high unemployment rate for the City (PP. 2, 4, 5, 49 and 62-64 of the DGEIS).

C. Consistency with the County of Ulster Master Plan: In 1977 the County of Ulster adopted a Master Plan to help guide future development of land in the County, including the City of Kingston. Some of these goals as they relate to commercial development include the promotion of community viability and strengthening of the economic base. Such plan also encourages urban growth within the City and encourages major commercial and industrial uses where the infrastructure is available. These conditions are met by the proposed action (PP. 44-45 of the DGEIS). (See comments of Ulster County Planning Board, Exhibit A to FGEIS.)

D. Conformance of Project with Goals of The Kingston Local Development Corporation: The proposed development of the business park will contribute significantly to the goals of the Applicant which include the reduction of unemployment and promoting additional employment; the maintenance of job opportunities; the attraction of new business to the City of Kingston and the retention of existing businesses in the City of Kingston, including Huck, the proposed occupant of the Phase I of the park. The proposed business park should provide the necessary incentive to the future growth, development and re-development of the City of Kingston at a time when it is needed and will encourage private businesses to stay in the City while providing a more pleasant and efficient place to work.

E. Consistency of the Rezoning and Project with the City of Kingston Local Waterfront Revitalization Program: As discussed elsewhere in these Findings, the site of the park is situate in the City of Kingston Coastal Zone area as defined in the Local Waterfront Revitalization Program embodied in Article 42 of the Executive Law and the City of Kingston Waterfront Consistency Review Law (Local Law No. 4 of 1992). Of the various policies set forth in such law, most are not applicable as the site is situate 2,000 feet from the western shore of the Hudson River. However, as to the Local Waterfront Revitalization Program standards, conditions and policies that are applicable to this action, the proposed Kingston Business Park is consistent to the maximum extent practicable with the policies and purposes of such Waterfront Revitalization Program (See comments of Scenic Hudson, under date of December 1, 1995; comments of Ulster County Planning Board dated December 11, 1995 and comments of City of Kingston Urban Cultural Park Commission dated December 4, 1995, Exhibit A to FGEIS). A discussion of the effects of

this action on such policies and the basis for this consistency determination are set forth on Pages 41-44 and elsewhere in the DGEIS.

F. Availability of Funding for the Proposed Kingston Business Park: The City of Kingston has programs to assist new or expanding businesses to grow, as does the Ulster County Development Corporation (UCDC) and the Ulster County Industrial Development Agency (UCIDA). Significant funding from the federal and state government is or may be available to assist in the proper and sound development of the proposed business park, thereby assuring that it will be constructed, operated and maintained in accordance with sound planning, land use and business practices.

G. Impacts on Nearby Residential Zones and Uses: The site of the proposed business park and Light Manufacturing Zone is large in area (107 acres), heavily wooded and isolated topographically from the adjoining residential uses and districts to the west and south. The site of the proposed buildings and development is approximately 100 feet in elevation above the surrounding lands and development to the east and west. The lands to the east and north of the site are primarily vacant abandoned industrial sites formerly used for cement mining and brick manufacturing. The site itself was formerly used in part for cement manufacturing. Due primarily to such factors as the topographical isolation of the site from the surrounding uses; the densely wooded nature of the site; the elevations of the proposed building sites; the stable history of the surrounding uses and the lack of competition with the permitted uses for the proposed business park; the provision for buffer zones and retention of wooded areas/open space; the lack of visibility of the development and the restrictions on uses, the development of the Kingston Business Park in accordance with the proposed Site Development Plan and standards will not significantly impact

the surrounding land uses and zoning district and is compatible with such uses and zoning districts (PP. 4, 25, 28 and 37-49 of the DGEIS).

H. Infrastructure Capacity and Proposed Improvements: The 107 acre site is adjacent to Delaware Avenue which is a main City arterial street which can accommodate the prospective traffic at an acceptance level of service with certain improvements proposed by the Applicant such as turning lanes and signalization (PP. 11, 12, 15-16, 30-36, 68-71 of the DGEIS).

Water supply and sewage disposal to the site are available from the City's municipal systems adjoining the site and which are adequate in reserve capacity to meet the anticipated needs (PP. 16, 17 and 50-52 of the DGEIS).

Energy services such as electric power and natural gas are also readily available to serve the proposed development (PP. 53 and 54 of the DGEIS), as are fire, police and emergency protection (PP. 54-56 of the DGEIS).

Furthermore, there will be external mitigation in that Delaware Avenue will be widened, sight distances enhanced and sidewalks installed and maintained as a result of the proposed development.

I. Lack of Suitability of Site for Any Use Permitted in the RRR Residential District: Due to the physical features of the site such as topography, lack of infrastructure improvements and access roads, thin soils and similar problems, the cost of providing such needed infrastructure and the lack of need due to the saturation of the residential home market in this area, the site is not suitable for any of the uses permitted by right in the RRR One-Family Residence District. These uses include one family dwellings on individual lots, cemeteries, places of worship, hospitals and farms, and all of such uses are not feasible or

practicable for the development of the site (See City of Kingston Code, Section 123-7, PP. 12310-12311). (PP. 71 and 72 of the DGEIS).

J. Lack of Other Alternative Sites for the Proposed Development: Three other potential sites were identified, analyzed and evaluated by the lead agency and each was found to be unsuitable for the proposed business park (PP. 67 and 68 of the DGEIS). The re-development of the former industrial facilities in the proximity of mid-town Kingston was discussed in the FGEIS and found not to be feasible or practicable for the Applicant to pursue. (FGEIS Pages 63-68).

K. Unavoidable Adverse Impacts: The proposed development will cause a number of adverse short and long-term impacts on the site and on the adjoining neighborhood as are identified and evaluated on Pages 65 and 66 of the DGEIS. However, these adverse impacts can and have been mitigated to the maximum extent practicable and feasible consistent with social, economic and other essential considerations and are decisively overweighed by the benefits that will accrue to the City of Kingston and surrounding region by the development of the site.

L. Conditions of Rezoning: In order to insure that the site will be developed as a business park in conformance with the development plans which have been analyzed and evaluated by the involved agencies and in the FGEIS, and to further insure that the environmental and fiscal impacts, alternatives and mitigation measures that were identified and evaluated remain relevant as well as feasible to implement, any rezoning of the site to M-1 Light Manufacturing shall be conditioned upon the development of the site as a business park in accordance with the site specific development plans for Phase I as approved by the City of Kingston Planning Board, as well as the conceptual plans for future phases. Said site specific and

conceptual plans may, however, be modified, varied or amended from time to time provided all required governmental approvals are obtained and all such modifications, variances and amendments either are in conformance with the FGEIS or undergo an independent and separate environmental review before implementation.

VI. INJURY TO THE INTERESTS OF THE KNAUST FAMILY

As stated in the FGEIS, the Knaust family is concerned with geologic and water quality issues which are specific to the Knaust mine and the so-called lake located in the mine and relate to the potential economic harm and injury the proposed development may have on a possible future commercial use of this mine. The allegations and assumptions of harm are extremely speculative and conclusory and are unsupported by scientific authorities and data. Furthermore, any potential economic disadvantage to the Knaust family caused by speculative economic loss is not an environmental factor and not substantive (FGEIS Pages 29-33).

VII. POLLUTION OF SURFACE AND GROUNDWATER/ACQUIFER PROTECTION:

These issues have been adequately addressed in both the DGEIS and the FGEIS (See DGEIS Pages 26-27, Exhibits C 4 and 7). In response to the allegation of Mr. Rubin that the hydrologic setting of the site was a "maturely karstified carbonate acquifer", the Applicant and its engineering firm retained a professional geologist and conducted further testing and investigation of the site and the surrounding area including a personal inspection of the Knaust mine by the geologist and engineer. The results of these tests and investigations are contained in detail in the technical reports annexed to the FGEIS (See FGEIS Paragraph IV, A. Pages 34-54 and Exhibit C).

As a result of these tests and investigations, the basic premise of the Rubin Report as to the karst characteristics of the site were found to be erroneous and no evidence of any unusual hydrogeologic conditions or any hydraulic connections between the site and the flooded portion of the mine were found or substantiated.

The lead agency and the Applicant's professional advisors also identified, analyzed and evaluated potential sources of pollution and the possible adverse impacts of a change in the quantity and quality of stormwater runoff from the site, including the potential for flooding, erosion and water quality degradation in general and specific to the Knaust mine. The Applicant's engineers developed a Stormwater Management and Pollution Prevention/Erosion Control Plan that includes a variety of structural and non-structural measures including oil and grit separators, infiltration pits or trenches, flow attenuation, sediment traps, hay bales and silt fencing to control and mitigate the adverse impacts of stormwater runoff.

By the use of these measures which comply with the Stormwater Management Guidelines for New Development as promulgated by the NYS Department of Environmental Conservation, the runoff during and after development should not be substantially altered from the pre-development (existing) conditions, and the water quality both on-site and off-site (including the control of "first flush" pollutants and the Knaust "lake" and underground acquifers) are adequately protected from degradation by stormwater discharges that may reasonably be expected to affect such resources. A detailed discussion of this Plan and the controls to be implemented are contained in Exhibit F to the FGEIS and described in Pages 40-46.

As a condition to the grant of any approvals relating to this action, the Stormwater Management Plan shall be implemented pursuant to its terms and provisions and prior to the commencement of any construction activity, together with any additions, amendments or changes that may be required by the NYS Department of Environmental Conservation as a condition of compliance with a S.P.D.E.S. General Permit for stormwater discharge [6 NYCRR Part 617.3 (b)].

The lead agency recognizes that the NYS Department of Environmental Conservation also has jurisdiction over maintaining water quality and that any discharges authorized by the S.P.D.E.S. General Permit shall neither cause nor contribute to a violation of water quality standards as contained in Parts 700 through 705 of title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York including, but not limited to the following:

> 1. there shall be no increase in turbidity that will cause a substantial visible contrast to natural conditions;
>
> 2. there shall be no suspended, colloidal and settleable solids that will cause deposition or impair the waters for their best usage; and
>
> 3. there shall be no: residue from oil and floating substances, visible oil film, globules or grease.
>
> (NYS Department of Environmental Conservation S.P.D.E.S. General Permit, Part II, B).

By letter report dated February 2, 1996, Paul A. Rubin submitted additional comments to the lead agency concerning the responses to the FGEIS, a copy of which letter is annexed to these Findings. In such letter Mr. Rubin concludes that:

> 1. the lead agency has determined that the groundwater quality concerns are without foundation solely because the

issues raised related to the karst setting have been found to be unsubstantiated;

2. that stormwater is being discharged directly into the groundwater flow system without adequate concern, therefore placing the waters of the state in jeopardy; and

3. no consideration has been given by the lead agency to the groundwater resource.

Mr. Rubin also demands that karst specific hydrologic testing, including additional borings and tracer testing be done before the SEQRA process is completed.

On February 7, 1996 the lead agency received a rebuttal of the above report from the Applicant's geologist and engineer, which rebuttal is also annexed hereto and made a part hereof.

In regard to the issue of stormwater quality and quantity the lead agency has reviewed, analyzed and evaluated all of the conflicting professional and scientific opinions on the desirability of proceeding with this proposed business park. As the result of this review and analysis and based on the relevant data and information, the lead agency concludes that:

1. The FGEIS has identified as the relevant area of environmental concern the quality and quantity of the stormwater runoff from the areas of the site being developed, and the potential adverse effects this runoff may have on the quality of the existing water resources, including groundwater and the "lake" within the mine.

2. Contrary to the allegation of Mr. Rubin, a great deal of consideration has been given to this issue. Much of the FGEIS and the scientific/engineering work done concerning the proposed development is related to protecting the quality of the groundwater resource as demanded by the Knaust family and Mr. Rubin. A number of mitigative measures were designed and implemented for the sole purpose of limiting and controlling the discharge of pollutants from exposed areas of the site to the greatest degree attainable.

3. While the lead agency fully recognizes and has considered the karst issue raised by Mr. Rubin, the lead agency finds the

Rubin reports are largely conclusory, unsubstantiated, vague and speculative, especially in Mr. Rubin's determination that the flooded portion of the Knaust mine is hydrologically connected to the area of on-site stormwater discharge and that the water quality of such lake will be jeopardized by such discharge. These reports contain virtually no data or information supporting the conclusion that the surface water runoff from the impermeable areas of the site will enter the Knaust mine or that if it did, the runoff would impair or degrade such waters in contravention of current water quality standards.

4. As discussed in the FGEIS (Pages 40-46) the groundwater underlying the site and the Knaust "lake" are not being used as a source of potable water nor for any food processing or agricultural purposes. The Knaust family has not made any economic use of their 1.36 acres of the mine for over 30 years and the site does not lie within an area of any special environmental or ecological significance. As a result, the alleged possibility of a hydrologic connection and the possibility some stormwater discharged from the site may find its way into the mine is not a particularly important concern in relation to the overall action and its environmental effects. Any such possible impact is of limited duration and would affect a water body that is limited in area and restricted in use, and such impact can and will be adequately controlled as discussed below.

5. Of primary importance are the measures being implemented by the Applicant during and after construction of the proposed business park to control and mitigate the discharge of pollutants from the exposed areas of the site. The Stormwater Pollution Prevention Plans have identified the potential sources of pollution that may reasonably be expected to affect the quality of storm water discharges. It is noted that these potential pollutants do <u>not</u> include sewage or hazardous materials but are the normal and usual contaminants that accumulate on roadways, parking areas and roofs. The lead agency also notes that Delaware Avenue also runs over and adjacent to the Knaust mine and lake, and that the stormwater discharges from this roadway presumably enter the Knaust mine without any pre-treatment of contaminants. The Stormwater/ Pollution Prevention Control Plans contain a number of structural practices and other measures designed to control these stormwater discharges and to alleviate the adverse impact of such runoff, including any potential adverse impacts on the Knaust "lake". These measures comply with the design guidelines promulgated by NYS DEC and are deemed adequate to protect the Knaust "lake" from impairment due to stormwater discharges, notwithstanding a possible hydrologic connection to the on-site

discharge point. With proper and adequate pre-treatment of the stormwater from the disturbed and impermeable surfaces on the site prior to its final discharge to the ground, the existence of any possible subterranean connections with the flooded portion of the mine becomes much less relevant and the magnitude of any potential for degradation of the quality of the water in the mine is minimized and controlled to an acceptable level.

6. The aforesaid Stormwater Management/Pollution Protection Plans and the protection of water quality as the result of the development of this site are covered under DEC's S.P.D.E.S. Permit for stormwater discharges. Compliance with this permit is intended to assure that water quality standards are maintained. While the lead agency is not delegating its obligation and responsibility under SEQRA to identify, analyze and evaluate potential environmental impacts, it is recognized that DEC will further review and evaluate the Applicant's specific stormwater management plans prior to the commencement of any construction activity.

In conclusion, it is the function of the lead agency to identify and address such potential impacts as are reasonably anticipated or foreseeable and which are reasonably related to the proposed action, and not every conceivable environmental impact need be identified or addressed.

The level of detail with which each factor must be addressed will obviously vary with the circumstances and nature of this action. Applying a rule of reason and common sense, it is the determination of the lead agency that under the circumstances of this action all valid and reasonable concerns of the Knaust family have been adequately addressed in the FGEIS, and that all practicable mitigation measures are being implemented to ensure that any identified adverse environmental effects are being minimized or avoided to the maximum extent feasible. The lead agency does not concur with Mr. Rubin that further hydrologic studies such as those described in his letter are necessary or required, and that the expenditure of what could be hundreds of thousands of dollars is justified under the

circumstances of this action merely to prove the existence or non-existence of inter-connecting subsurface water channels.

VIII. STRUCTURAL STABILITY OF SITE AND SURROUNDING AREA/BLASTING ACTIVITY AND RELATED ISSUES

This area of environmental concern was also identified, analyzed and evaluated in the DGEIS (Pages 18-22, Exhibit C7). The analysis in the DGEIS was challenged by the Rubin Report, which challenge was again based on the erroneous assumption that the site and surrounding area was karstic in nature. The karst issue was adequately addressed by Dr. Merguerian and GeoDesign, Inc. in their reports (Exhibit C to the FGEIS) and the Applicant and its professional engineer have conducted a thorough investigation of the structural integrity of the surrounding bedrock, including but not limited to extensive test borings into bedrock, review of available maps and surveys and visual inspections of the mine (FGEIS Pages 41-44).

The Applicant's engineers also identified and proposed a number of feasible mitigation measures to protect the Knaust mine and nearby structures from vibration damage. These measures include limitations on the size and use of explosive charges and monitoring of test blasts (FGEIS Page 49, Exhibit E - Site work Specifications Pages 02200-5 to 02200-15).

Any approvals granted for this action shall comply with the City of Kingston Blasting Ordinance and shall contain a condition that a detailed blasting and monitoring plan implementing the aforesaid mitigation measures identified as feasible by the Applicant's engineers and consultants shall be reviewed and approved by the Engineering Department of the City of Kingston, as well as the Applicant's engineers before any blasting activity takes place. Notification to residents and landowners in the neighborhood shall also be given prior to any blasting activity.

IX. HAZARDOUS MATERIALS

The proposed Performance and Development Standards and existing strict governmental regulations, together with the requirement that all future phases will undergo an independent environmental review, will adequately protect against potential harm from this source.

Any approvals granted for this action shall contain a condition that the proposed Performance and Development Standards (Exhibit D to FGEIS) shall be formally adopted and implemented by the Applicant, KLDC, before any construction activity commences on the site.

X. ENDANGERED SPECIES

There is no evidence that any endangered species of plant or animal exist on the site or in the nearby mined areas. All competent reports and evidence, including a visual inspection of the mine on January 9, 1996 failed to show the presence of any endangered bats or other species. The construction and operation of the proposed business park will not threaten or harm any endangered or threatened species (DGEIS Page 29, FGEIS Pages 12-14 and 53).

XI. WETLANDS

The only potential wetland on the site is a small (0.25 of an acre) and isolated wet area at the extreme northwest corner which drains to the southwest. The wet area is wholly within the buffer zone and will not be disturbed by any construction activities. The Applicant's Stormwater Management Plan has directed any runoff from new impervious surfaces away from this area to further protect and preserve its quality while leaving the existing drainage from natural areas unaffected. It is therefore believed that no individual permit is required from the Army Corps of Engineers (FGEIS Pages 51-52, Map No. 4).

XII. AGRICULTURAL USE AND ZONING OF THE SITE

The site and adjoining Knaust property is zoned Residential and not Agricultural although farms and other agricultural uses are permitted subject to certain conditions and restrictions. Neither the site nor the Knaust lands are in any Agricultural district. No agricultural or other use has been made of the Knaust mine for at least thirty (30) years and the re-establishment of mushroom production in the Knaust mine is questionable and at best an expectancy of the Knaust family. The construction and operation of the proposed Kingston Business Park will not adversely impact any feasible economic use of such mine (FGEIS Section IV, Pages 34-68).

XIII. THE REZONING OF THE SITE FROM RRR RESIDENTIAL TO M-1 LIGHT MANUFACTURING WOULD BE ILLEGAL SPOT ZONING

The proposed rezoning of the 107.056 acre site to Light Manufacturing for the purpose of constructing the proposed Kingston Business Park in the form analyzed and evaluated in the GEIS and which would be subject to the conditions and mitigative measures set forth in the GEIS would appear to be for the benefit of the community as a whole and pursuant to a comprehensive plan for the general welfare of the community.

As discussed in detail in the FGEIS, due to changes in growth patterns, economic and financial conditions affecting the City of Kingston and the surrounding region and the absence of a suitable site for a manufacturing facility to locate or expand, when combined with the mitigation measures being implemented to protect the nearby residences and residential districts the proposed rezoning would not appear to constitute illegal spot zoning (See FGEIS Pages 56-57 and Paragraph V. of these Findings).

However, to insure that such rezoning of the site is for the sole and specific purpose of permitting the construction of this proposed development which has undergone exhaustive environmental review and analysis, any rezoning of the site shall be for the exclusive purpose of and conditioned upon the construction of this particular project in accordance with approved site development plans and other approvals of regulatory agencies (See Paragraph V, L. of these Findings).

XIV. THE DGEIS FAILS TO INVESTIGATE AND ANALYZE THE BROWNFIELDS REDEVELOPMENT OF THE OLDER INDUSTRIAL LANDS IN THE CITY OF KINGSTON.

Due to a number of factors, including the location, orientation, size and nature of the former industrial sites; the fact that most are currently in productive use; the lack of condemnation power in the Applicant and the uncertainty of obtaining adequate parcels for the project; the high and uncertain cost of acquiring land and demolishing the existing improvements; the potential risk to the Applicant for hazardous waste liability under federal and state statutes and other factors discussed in Pages 63-68 of the FGEIS, such an alternative site or type of action is not reasonable or feasible considering the objectives of the Project Sponsor.

In making its Findings regarding these technical issues, the lead agency notes that this action has undergone coordinated review with all other involved agencies, including the following:

1) The New York State Department of Environmental Conservation (DEC) whose primary jurisdictional involvement in this action concerns the quantity and quality of storm water discharges from construction activities (Permit No. GP-93-06) in accordance with Article 17, titles 7 and 8 and Article 70 of the Environmental Conservation Law.

DEC has specialized expertise in the potential effects of development on stormwater quantity and quality and acquifer protection, and under its permitting jurisdiction must approve the Applicant's Stormwater Management Plan which includes compliance with strict guidelines for controlling the quantity and quality of storm water runoff.

2) The Ulster County Health Department whose jurisdiction includes sewage disposal and water supply and the protection of the public health, safety and welfare.

3) While not an involved agency under SEQRA, the Army Corps of Engineers has been identified as an interested agency whose primary concern is the protection of the waters of the United States, including wetlands.

A copy of the Draft Generic EIS, as well as the notice of public hearing and comment period and a copy of the FGEIS were filed with each of the above agencies as required by the SEQRA regulations. To the date of these Findings no comments whatsoever were received by the lead agency from any of the above agencies, and it is assumed that such lack of response indicates that such agencies are in essential agreement with the identification, analysis and evaluation by the lead agency of all identified significant adverse environmental impacts including, but not limited to, stormwater control and management, acquifer and groundwater protection, wetland protection, safety of the public and nearby structures and related issues. A copy of a letter from NYS DEC t John J. Privitera, Esq. under date of February 1, 1996 was received by the lead agency, a copy of which letter is annexed to and made a part of these Findings.

XV. GEOLOGY, TOPOGRAPHY, SOILS

The lead agency has thoroughly considered the potential impacts of development on the geology, topography and soils of the site. Due to the extensive regrading required for the access road and to create suitable building sites, the lead agency issued a scope for the DGEIS (see Exhibit 6) that required extensive investigation be conducted in regard to these factors.

A. Geology:

The DGEIS summarized the geological character of the site (Pages 18-19) and specifically evaluated the possible impacts due to blasting based on detailed investigations by GeoDesign, Inc., a geotechnical engineering firm (see DGEIS, Appendix C-7). With regard to possible impacts on the mines on the easterly edge of the site, Geo Design stated (Appendix C-7, Page 6):

> "Thus, despite the close proximity of the mine to the proposed blasting (as compared to the proximity to off-site dwellings) the geometry of the new roadway excavation is favorable with respect to vibration impacts to the mine. Blasting can easily be accomplished in a manner which will impact using normal blast control techniques. The mines are outside of the zone of influence of the blasting required within the proposed building footprints."

In response to comments submitted on behalf of the Knaust family, owners of a small portion of the mines, the Applicant conducted additional geological investigations which confirmed the original conclusions. In response to the contention of Paul A. Rubin that the site is a "mature well-karstified carbonate acquifer" which would be adversely affected by site construction and drainage, Dr. Charles Merguerian, Ph.D., came to the conclusion that (see FGEIS, Exhibit C and letter dated December 27, 1995):

"The false impression that the region's geology is karstic cannot hold up on the face of geological fact. In my opinion, the Kingston area should not be terms a "maturely karstified carbonate acquifer" because of the absence of surface- and subsurface features diagnostically associated with such a classification."

The extensive response to the Knaust comments contained in the FGEIS (Pages 38-51 and Exhibit C) provide convincing evidence that the site does not contain karst topography and that blasting, drainage and site preparation will not have adverse impacts on the caves or lands adjacent to the site.

B. Topography:

The DGEIS analyzed site topography (Page 25) and determined that the most severe slopes, in excess of 20%, were primarily around the site's perimeter. The site plan proposed that a buffer area be established along the site boundary to preclude development in these steep areas so as to limit site clearance and minimize visual, site erosion and related impacts.

Following the public hearing and receipt of comments, the Applicant revised the site plan to substantially increase the size of the buffer so that the total area within the designated buffer represents 38% of the total site area (see FGEIS, Page 25; and Map No. 4). This revised buffer area includes virtually all of the steep areas on the site and, with the exception of the access road from Delaware Avenue, none of these areas are proposed to be disturbed.

The Performance and Development Standards specifically designate the buffer area and mandate that no change in the buffer area boundary can be made unless approved by the Kingston City Planning Board (see FGEIS, Exhibit D, Page 18). Consequently, impacts on steep slopes will be minimized by avoiding such areas to the maximum extent practicable.

C. Soils:

Soils on the site were analyzed in the DGEIS (Pages 22-24, Map No. 9 and Table No. 1) and revealed that virtually the entire upper portion of the site is within the Stockbridge-Farmington- rock outcrop group - and the steeper slopes around the perimeter are in the Farmington - rock outcrop complex. Potential for erosion during construction will be minimized by detailed erosion protection measures prepared for each site development plan (see FGEIS Page 9).

XVI. STORMWATER CONTROL AND MANAGEMENT

The Applicant prepared a Stormwater Management Report (see DGEIS, Appendix C-4) which provided that all stormwater would be disposed on- site with no increase in the rate of off-site discharge. First flush contaminants would be controlled by providing catch basin sumps and subsurface infiltration areas.

The FGEIS (see Exhibit F) contains a Modified Stormwater Management Report which refined the program for treatment of stormwater by directing runoff from building sites to water quality inlets for the treatment and removal of floatable products, including sand, silt, metals, hydrocarbons, etc. An on-site gorge will receive the pre-treated stormwater and will be partially filled with processed filtration material to further treat the stormwater prior to discharge into the ground.

The procedures set forth in the Modified Stormwater Management Report provide a technique that will adequately protect all on-site and off-site receptors of stormwater from adverse effects by treating the runoff and limiting discharge to pre-development rates. (See Section VII of these Findings for a more complete discussion.)

XVII. VISUAL AND AESTHETIC RESOURCES

In order to evaluate potential visual impacts of site development, the Applicant conducted a detailed visual simulation analysis of Phase 1 of the development (see DGEIS Pages 45-49 and Appendix C-6). The analysis utilized photographs from eight sensitive viewpoints to depict post-development views from the same locations. The photo simulation demonstrated that the view from the south would be completely screened by the on-site buffer area; the view from the west would be relatively open and views from the east (the Hudson River and both east and west shores) would be partially screened at distances of one-half to three miles. On-site landscaping, low profile buildings and use of muted earth tones in building facades would further mitigate potential impacts.

The Conceptual Development Plan for the entire site was modified in response to comments, several of which concerned the views from the west. The buffer area has been increased in width and the westernmost building has been reduced in size and moved 50 feet to the east to provide an undisturbed area between it and the edge of the plateau to screen the building (see FGEIS, Map No. 4). The phasing plan has been revised to remove the westernmost building from Phase 1 and replace it with the building immediately north of the proposed Huck building.

The Applicant has demonstrated that visual impacts will be limited to a significant degree by careful site planning techniques and has modified the location of the westernmost building to further mitigate potential visual impacts. Since the visual simulation did not address the impact of Phase 2 development, which has since been modified, the Planning Board has established policies to guide it during site plan review and to determine if additional visual analysis is required for subsequent building

construction (see FGEIS, Page 26). These policies will be applied to all proposed development subsequent to the Huck building.

XVIII. TRAFFIC RELATED ASPECTS

Traffic related aspects of project development were considered at length in the DGEIS (see Pages 30-36, 68-71 and Appendix C-1) including general traffic operation, site access, pedestrian traffic, emergency and construction access and alternates thereto.

The two intersections directly affected by the project (the site entrance and the Delaware Avenue-Murray Street intersection) will function at very satisfactory levels of service (A or B) upon full development of the site. Although surveys suggest that there will not be significant use of mass transit, the CitiBus route will be extended into the business park. To enhance pedestrian safety, particularly school children, a sidewalk and guard rail will be provided on Delaware Avenue and a school crossing guard stationed at the entrance road intersection. Emergency access will be provided via a breakaway gate from Ulster Avenue at the northerly end of the site (see FGEIS, Map No. 1).

In response to many comments, the location of the access road has been established 200 feet west of Rosanna Street to avoid problems associated with grades to the east during winter conditions (see FGEIS Page 18). To facilitate early access to the Huck site during construction of the main access road, the alternate construction road from Ulster Avenue will be utilized. Impacts on the surrounding neighborhood will be mitigated by limiting this road to use by cement trucks for 2-3 months under conditions which limit hours of use and require escort by a City vehicle (see FGEIS, Pages 18-20). During construction of the access road and the Huck building, an additional crossing guard will be posted at the intersection of Koenig

Boulevard and Murray Street to relieve any impacts from additional truck traffic.

XIX. UTILITIES AND COMMUNITY SERVICE

A. Utilities:

The site is served by the City's central water supply and sewage disposal systems. The lines in Delaware Avenue by which the business park will be served are of adequate size and the central water supply source and sewage treatment plant have adequate capacity to accommodate demands generated by the Kingston Business Park at total development of 500,000 square feet (see DGEIS, Pages 50-52 and Appendices C-2 and C-3).

B. Waste Disposal:

County-wide solid waste disposal facilities have adequate capacity to accommodate waste generated by the business park, which will be transported by private haulers (see DGEIS, Page 53). Central Hudson Gas & Electric Corporation facilities are of sufficient size and capacity to satisfy demand generated by the park (DGEIS, Pages 53-54).

C. Community Services:

There will be little impact on police, fire protection and emergency services from the business park. All buildings will be fully sprinklered. The only effect on police services will be short term traffic control, as required during the initial construction stages, which will not place any undue demands on the force (DGEIS Pages 54-55).

XX. HISTORICAL AND ARCHAEOLOGICAL RESOURCES

A complete survey of potential archaeological resources on the site was conducted by a professional archaeologist (see DGEIS, Page 60 and Appendix C-5). Field investigations were completed and data recovered for analysis. The Historic Preservation Coordinator of the New York State

Office of Parks, Recreation and Historic Preservation (NYS OPR&HP) concluded that, based on the End-of-Field letter submitted, "No further archaeological investigations are warranted and the project can proceed without any adverse effects on cultural resources.". (DGEIS, Appendix C-5, letter dated October 17, 1995).

There are no historic resources on the Kingston Business Park site, although there is one site listed on the National Register of Historic Places in proximity to the site. The possible visual and noise impacts of development of the business park on this and two other nearby structures which may be eligible for such listing was undertaken (see DGEIS, Pages 60-62 and Appendix C-6). The conclusion of the study was that possible visual and noise impacts on these structures were mitigated by distance, existing and proposed vegetation, grade differential and site planning.

XXI. DEMOGRAPHIC AND FISCAL IMPACTS

A. Demographic:

The Kingston Business Park will have the positive effect of retaining employment in the City and contributing to the reversal, or at least reduction, of the population decline in the City since 1960 (see DGEIS, Page 49).

B. Fiscal:

Upon full development, the Kingston Business Park will generate 600-800 workers with a total of $13,000,000 and indirect expenditures of $32,0000,000. Huck alone generates a payroll of over $6,000,000. At total buildout the project will generate $450-500,000 per year in payments in lieu of taxes (PILOT) and $200,000 in land rents to KLDC. The PILOT payments will not begin until the seventh year after completion; the one-third payment that year will be $150,000. The $20,000 per year for road

maintenance that the City will incur will be far outweighed by the PILOT payments, which increase to full value in year 10, and the positive fiscal benefits will be over $400,000 per year.

XXII. CHARACTER OF NEIGHBORHOOD

See Section V.

XXIII. AIR QUALITY

All of Ulster County is in "attainment" for all categories of air pollution. Measures to control dust during construction (see DGEIS Pages 56-58 and FGEIS, Exhibit E) will mitigate airborne silt and dust by watering, preserving vegetation, limiting areas of disturbance and controlling erosion. The satisfactory level of service operations of adjacent street intersections will avoid carbon monoxide concentrations due to traffic congestion. The Performance Standards will control uses which produce process emissions, all of which must also adhere to applicable state and federal standards.

XXIV. UNAVOIDABLE IMPACTS

Unavoidable construction-related, short term impacts include increased traffic due to workers and equipment, increased noise levels, fugitive dust and increased air emissions from construction equipment.

Unavoidable long-term impacts will also result from the construction of the park facilities. These include the conversion of undeveloped land into a business park, loss of woodlands, reduction of habitat for wildlife, increased traffic, commitment of water and sanitary sewer reserves.

XXV. ALTERNATIVES

The Applicant considered alternative site locations and access routes, alternate uses, reduced scale of development and the "no action"

alternative (DGEIS Pages 68-73, FGEIS, Pages 32-33 and 63-68). The analysis demonstrated that no other suitable site for the Kingston Business Park exists in the City. The most feasible access road alignment was selected; the alternate entrance location was selected, however, based on comments received at the public hearing (FGEIS Page 18), it was demonstrated that the site could not feasibly be developed for uses permitted under the current zoning designation, primarily due to the necessary cost of access and infrastructure improvements. Reduced scale of development would not alter the basic nature of the project and the no action alternate would deprive the City of the significant economic benefits due to the action.

XXVI. RESOURCE COMMITMENTS

The construction of the business park will result in irreversible and irretrievable commitments of land, energy, labor and economic resources.

XXVII. GROWTH-INDUCING ASPECTS

As Phase 1 of the proposed Kingston Business Park is primarily designed to accommodate Huck International which currently has its facility in the City of Kingston, this Phase will not result in any significant growth-inducing impacts. While the development of future phases will undergo a separate environmental review, due to the recent closing of numerous commercial and manufacturing facilities in the area there is currently a large labor pool as well as available housing to accommodate a new or expanded manufacturing facility. It is therefore anticipated that under current conditions the construction and operation of the park will not result in any significant growth-inducing impacts.

XXVIII. THRESHOLDS FOR FUTURE SEQR DETERMINATIONS

The DGEIS and FGEIS considered possible impacts from full development of the Kingston Business Park with a total floor area of 500,000 square

feet of floor area based on the Conceptual Site Development plan (see FGEIS, Map No. 1). A detailed site plan was also developed and evaluated for the Huck International building which, with expansion space, represents 75% of the 250,000 square foot first phase. The nature of potential effects on the environment considered in the EIS is such that in some cases the impact of total development has been evaluated in sufficient detail for the entire site to determine potential impacts at this time while in other cases the analysis has been based on assumptions about site development which may change during actual site development. In order to provide guidance for review of site plans and development subsequent to the Huck building, thresholds are established below to determine when future SEQR review will be required. These thresholds are in two categories:

A. Review of the following environmental factors under SEQR shall only be required when the basic development program is modified by increasing total floor area in the business park beyond 500,000 square feet or by allowing a use other than those set forth in Section 7 of the Performance and Development Standards. The analysis of these factors is based on the size and use of the facilities developed and is sufficiently detailed so that conclusions of the FGEIS will not be affected significantly by modifications of the Conceptual Development Plan during site specific development.

1. Traffic and transportation; however, a SEQR determination shall be required for any new or modified site access road.
2. Land Use, Zoning and Community Plans.
3. Demographic Characteristics.
4. Community Services and Utilities.
5. Cultural Resources.
6. Fiscal Impacts

B. Environmental review of the following factors under SEQR will be required prior to site plan approval to evaluate the effect(s), if any, due to site specific development plans that cause the following thresholds to be exceeded:

1. Geology, Topography and Soils

a. Proposed site disturbance will extend into the areas indicated as "areas of non-disturbance" on Map No. 4 in the FGEIS.

2. Water Resources

a. Projected stormwater discharge for a 25 year storm will exceed the existing discharge rate from the site based on detailed drainage analysis for a site specific plan.

3. Terrestrial and Aquatic Ecology

a. Site disturbance will extend into the areas indicated as "areas of non-disturbance" on Map No. 4 in the FGEIS.

b. Drainage flow into the small wet area at the northwest corner of the site will be increased or decreased due to site plan design.

4. Visual Resources

a. Site disturbance will extend into the areas indicated as "areas of non-disturbance" on Map No. 4 in the FGEIS.

b. Site plans for the Huck building are substantially modified.

c. Detailed site plans for additional buildings are proposed. (Note: The Planning Board will also be guided by the policies established in the FGEIS on Pages 26-27.)

5. Air Quality

a. Any significant increase in traffic generation is predicted based on a modification of permitted uses.

XXIX. CONSISTENCY DETERMINATION - LOCAL WATERFRONT REVITALIZATION PROGRAM (LWRP)

In accord with Local Law No. 4 of 1992, the proposed action has undergone a consistency review to determine whether it is consistent with the policies and standards set forth in the City's approved Local Waterfront Revitalization Program (LWRP).

A. As required in Part IV of Local Law No. 4 of 1992 a Coastal Assessment Form (CAF), the plans for the Kingston Business Park and the DGEIS were referred to the Kingston Urban Cultural Park Commission (the Committee) which is authorized to review and make recommendations regarding the consistency of proposed actions with the LWPR policy standards and conditions.

B. The Committee met and reviewed the CAF and the plans for the Kingston Business Park and in a letter dated December 4, 1996 (see FGEIS, Exhibit A) stated that "The Waterfront Consistency Review Board has found the application to be consistent with the policies set forth in the Local Waterfront Revitalization Program."

C. As required under Part IV, paragraph 7 of Local Law No. 4 of 1992, the Planning Board has evaluated the proposed action for consistency with the LWRP policy standards and conditions.

1. The action is consistent with the general policy (Policy 1) regarding revitalization of deteriorated and underutilized waterfront areas since the subject site is vacant and contains the abandoned remains of past mining activities. Other site specific policies (1.A-E) regarding such revitalization are not applicable since the Kingston Business Park does not include and is not within any of the sites mentioned.

2. Policies 2, 2A, B & C to retain and promote commercial and recreational water dependent uses are not applicable since the site is over 1,000 feet from the actual waterfront (Rondout Creek) and 2,000 feet from the Hudson River.

3. Policies regarding the strengthening of the economic base of smaller harbors (Policies 4, 4A, B & C) are not applicable since the site does not include any waterfront area.

4. The plan is consistent with Policy 5 regarding infrastructure in that streets and utilities serving the

site are well located and have ample capacity.

5. The policy to expedite local permit procedures (Policy 6) is supported by the Planning Board and has been utilized during the review of this project.

6. Policies 7, 7A & B are not applicable since the site does not contain identified significant coastal fish and wildlife habitats. Policy 8 regarding introduction of hazardous wastes and other pollutants will be achieved by the adoption of the Performance and Development Standards which preclude uses which generate hazardous waste and by the Stormwater Management Plan which will require removal of pollutants from stormwater run-off (see FGEIS, Exhibit F).

7. Policies 9, 10 and 10A regarding commercial and recreational fishing are not applicable since this site does not support such opportunities.

8. Policies 11, 12, 13, 13A, 14, 15, 16 and 17 regarding flooding and erosion hazards are not applicable since the site is hundreds of feet from the water's edge and does not contain the erosion protective structures (bulkheads, jetties, etc.) referred to in this policies.

9. As demonstrated throughout the DGEIS and FGEIS the proposed action will support Policy 18 to safeguard economic, social and environmental interests in the coastal area.

10. Policies regarding public access to the shoreline and water related recreation facilities (1, 1A & B, 1E, 2, 2B, 2C, 4, 4A, B & C, 5, 5A, 9, 19A & B, 20, 20A, 21, 21A & C and 22) are not applicable since the site is remote from such recreation opportunities.

11. Policies 23 and 23A regarding protection and restoration of historic and archaeological resources are supported by the extensive archaeological survey of the site and measures to mitigate impacts on historic sites set forth in the DGEIS and FGEIS.

12. Protection of scenic resources (Policies 25, 25A & B) are supported by the visual analysis which illustrates that the project's visual impact will be mitigated by site planning techniques, buffer areas, landscaping and building design techniques which are included on the site

plan and incorporated in the Performance and Development Standards.

13. Policies regarding major energy facilities (Policies 27 and 29) are not applicable since no such facility is proposed. The project is consistent with policies to prevent pollutants from entering the air or surface waters or groundwater due to design of on-site facilities and the requirements of other agencies for permits (Policies 30, 30A & B, 33, 37, 38 and 41).

PART C

CONCLUSIONS OF LEAD AGENCY

1. The lead agency has found the FGEIS to be an adequate examination of all important potential impacts which would result from affirmative action on the proposed Kingston Business Park, including the rezoning of the 107.056 acre site from RRR Residential to M-1 Light Manufacturing; the approval of the site plan for Phase I of the development; the approval of the proposed two lot subdivision; the grant of the area variances, and the concept of the business park. A broad review of land use, drainage, erosion control, stormwater management and control, traffic, road alignment and construction, public safety, structural safety, socio-economic, financial, visual and other considerations was undertaken and included in the DGEIS. Comments were received on that information and responses to those comments were included in the FGEIS, which responses this Board has carefully and thoroughly reviewed and determined to be adequate.

2. During this process the Planning Board has reviewed all of the written submissions, received oral comments at the November 30, 1995 public hearing and has carefully reviewed, analyzed and evaluated, with the assistance of the Board's staff, the various impacts of, alternatives to, and potential mitigative measures for this proposed action.

3. The Planning Board recognizes that qualified experts on any topic may differ in their conclusions and, in particular, may differ in the judgments employed during analysis. The Planning Board has carefully considered all of the relevant documentation on the various issues that have been submitted by other agencies, professionals and experts, neighboring landowners and the general public.

4. After careful consideration of all relevant documentation and comments, the Planning Board believes it has adequate information to evaluate all of the benefits and potential impacts of this proposed Business Park as a basis for considering the proposed rezoning of the site, the site specific development of Phase I and the conceptual development of future phases.

5. SEQRA was designed to foster a careful review by all interested parties of any potentially significant environmental impacts at a time when the discussions of such consequences has the most meaning. This review is conducted prior to any agency decisions regarding approvals or permits and when the proposed project is still in its conceptual and formative stages. This early environmental analyses of a proposal is particularly appropriate in this case where both a rezoning of land is required for project development and where the project itself is to be developed in a series of phases or stages over time.

6. The submission of conceptual plans for future phases of the proposed Business Park affords important opportunities to obtain information and keep shape the ultimate project which will continue to undergo independent environmental, as well as detailed technical and site plan review as subsequent phases or stages are proposed and submitted for approval. The generic environmental review of this action has afforded the

Planning Board and other involved agencies a clear understanding of the potential environmental impacts that might arise from the actual construction and operation of the proposed business park including the roadways and infrastructure improvements and buildings.

7. To the extent possible the Applicant presented detailed information regarding certain impacts, including traffic, access road configurations, visual and aesthetics, structural stability of the site and surrounding areas, surface and groundwater quality and quantity, which impacts can be reasonably anticipated and analyzed at an early stage of review. While some of the analyses of these impacts could only be performed in a conceptual manner to the extent they involve possible future phases of the Business Park, with the submission of a detailed site plan for any future phases the potential environmental effects of such phase(s) will undergo an independent review and determination.

8. In making these Findings and determinations, the Planning Board has relied upon the facts and conclusions in the FGEIS and the environmental record upon which it is based and, without intending to limit the foregoing, in particular, upon the environmental, social, economic and other factors hereinafter set forth, all of which form the basis of any action to approve the site development plan for Phase I and to grant subdivision approval. No such action will be taken until and unless the site is rezoned to M-1 Light Manufacturing by the Common Council and any requested variances are granted (or the site plan modified to conform to the standards of the City Zoning Law).

9. The DGEIS identified all relevant environmental effects of the proposed project that can be ascertained at this time and has adequately addressed a reasonable range of mitigation measures and

alternatives that are feasible. The DGEIS also addressed all relevant areas of environmental concern at a detail appropriate for the preliminary nature of the proposal and the early stage of review and the FGEIS contains a more complete and thorough discussion of such relevant issues and addresses those issues and questions raised by the comments. The DGEIS and FGEIS examine and discuss all relevant issues including surface and groundwater quantity and quality, public safety and structural safety at a level of detail which is reasonable and adequate under the circumstances, and none of the information contained in the comments relates to potential adverse environmental impacts which are new or have not been adequately addressed. As before stated, all future phases of the project will undergo an independent environmental review to identify and assess any significant environmental effects that may result from such particular use and circumstances.

10. All changes made by the Applicant to the Site Development Plans for the proposed Business Park in response to the comments to the Draft Generic Environmental Impact Statement, including the relocation of buildings, structures and roads, as well as changes to the Performance and Development Standards were and are for the purpose of eliminating or mitigating identified adverse environmental impacts and none of such changes will result in a significant adverse environmental effect.

11. No newly discovered information has arisen about significant adverse effects which was not previously addressed, nor have there been any changes in circumstances which may result in any significant adverse environmental effects.

The Planning Board shall defer making its final decision on whether or not to approve the site development plan for Phase I of the Kingston Business Park and to approve the proposed two lot subdivision until:

a. The Common Council of the City of Kingston has made and filed its own written SEQRA Findings pursuant to 6 NYCRR Part 617.9 (c) and has made its decision on whether to rezone the 107.056 acre site from RRR Residential to M-1 Light Manufacturing so as to permit the use of the site for the proposed business park; and

b. The Zoning Board of Appeals of the City of Kingston has also filed its own written SEQRA Findings and has made its decision on whether to grant the requested variances for the off-street parking requirements of the City of Kingston Zoning Ordinance.

Upon the completion of the above actions the Planning Board shall make any further or Supplemental Findings that may be appropriate or necessary and shall take final action in conformance therewith.

PART D

LIST OF SUBSTANTIVE CONDITIONS IMPOSED ON THIS ACTION TO ENSURE THAT THE REQUIREMENTS OF 6 NYCRR PART 617 HAVE BEEN SATISFIED [6 NYCRR PART 617.3 (b)]

1) A detailed blasting and monitoring plan implementing the mitigative measures set forth in the DGEIS and FGEIS and the exhibits thereto shall be prepared and reviewed and approved by both the Engineering Department of the City of Kingston and the Applicant's engineers or consultants before any blasting activity takes place on the site. Such plan shall include procedures to provide prior notice to residents and landowners in the neighborhood of the blasting schedules.

2) The Stormwater Management and Pollution/Erosion Control Plan contained in the DGEIS and FGEIS shall be implemented pursuant to its terms and provisions prior to the commencement of any site disturbance. The lead agency recognizes that such plan may be amended or supplemented by the applicable conditions of a S.P.D.E.S. General Permit for Stormwater Discharges from Construction Activities (Permit No. GP-93-06) that may be issued by the New York State DEC pursuant to Article 17, titles 7, 8 and Article 70 of the Environmental Conservation Law. Pursuant to Part III, B of the regulations, a copy of the final pollution prevention plan shall be submitted to the lead agency for its consideration.

3) The Performance and Development Standards contained in the FGEIS (Exhibit D) shall be adopted by the City of Kingston Local Development Corporation prior to the commencement of any construction activity on the site.

4) Any amendment of the Zoning Map of the City of Kingston to change the zoning classification of the site to M-1 Light Manufacturing shall be conditioned upon the development of the entire site as a business park in accordance with an approved site development plan or plans approved by the City of Kingston Planning Board.

New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, NY 12561-1696
(914) 256-3000 - Division of Regulatory Services

Michael D. Zagata
Commissioner

February 1, 1996

MR JOHN J PRIVITERA
MCNAMEE LOCHNER TITUS & WILLIAMS PC
75 STATE STREET
PO BOX 459
ALBANY NY 12201-0459

Re: Kingston Business Park

Dear Mr. Privitera:

Thank you for your January 12, 1996 letter regarding the proposed Kingston Business Park. Environmental issues, including those related to geology and water quality of the site and the Knaust property have been assessed as part of the environmental impact statement (EIS) process conducted pursuant to the State Environmental Quality Review Act (SEQR).

Your concerns are most appropriately addressed by the Lead Agency as a part of this EIS process. I understand that the Final Generic EIS presents further analyses of the geology and water quality issues for this project as a result of the issues raised on behalf of the Knausts. This document will be the environmental basis for any future decisions regarding the approval of the project.

Based upon review of the Draft Generic EIS, we determined that the NYS Department of Environmental Conservation does not have any direct permitting involvement. The protection of water quality as a result of site development is covered under DEC's SPDES General Permit for Stormwater Discharges (GP-93-06). Compliance with this permit is intended to assure that water quality standards are maintained. For the Kingston Business Park, the sponsor has indicated that specific plans will be provided to demonstrate that the terms and conditions of the permit are met. When more specific details regarding future tenants are available, DEC will be able to further assess other measures that may be required to assure water quality including the need for individual facility permits.

Again, thank you for your comments and if I can be of further assistance, please do not hesitate to contact me at (914) 256-3059 or Alec Ciesluk of my staff at (914) 256-3014.

Sincerely,

Margaret E. Duke

Margaret E. Duke
Regional Permit Administrator
Region 3

MED/AFC/ll

cc: S. Cahill, City of Kingston
S. Finkle, City of Kingston

Privitera.ltr

GEODESIGN
INCORPORATED
GEOTECHNICAL ENGINEERS AND ENVIRONMENTAL CONSULTANTS

d/b/a GeoDesign, Inc., P.C.

February 7, 1996
File No. 053-01

Dennis Larios, P.E.
Brinnier & Larios, P C.
67 Maiden Lane
P.O. Box 3720
Kingston, New York 12401
Fax (914) 338-7660

Re: Response to Knaust/Rubin Letter Dated 2/2/96

Dear Dennis:

In response to Mr. Finkle's request, this letter summarizes a review of the February 2, 1996 letter drafted by Mr. Rubin for the Knaust family titled "Groundwater Protection and Karst Hydrology Beneath the Proposed Kingston Business Park Site and Surrounding Area". The review was performed by the undersigned and Dr. Charles Merguerian. We understand that the letter was incomplete as it did not include the referenced attachments, some of which Mr. Finkle requested and faxed to us on 2/7/96. We understand that one of the missing attachments (#1) is yet to follow.

"Karst" Issue

Mr. Rubin bases his objections to the project on his central assumption that the subsurface is "karst". Dr. Merguerian's letter (attached) responds directly to this assumption, reiterating the scientific invalidity of the karst thesis.

Hydrogeology

Mr. Rubin states (page 2) "...it is first necessary to understand all the hydraulic relationships within the mine itself". He proceeds to describe selected water level data, and a site visit during a rainstorm. From this limited "data" broad and vague conclusions are put forth, unsupported by any calculations, figures or other demonstration of diligent scientific method or rationale. However, he expects the City of Kingston adhere to a standard which includes extensive field testing and exhaustive hydrogeologic studies to prove him wrong.

[illegible] • FACSIMILE [illegible]

Mr. Rubin cites the water levels in a man-made-cave as evidence of karst hydrology. Quite the contrary, if the site area was karst, one would expect water levels to rapidly seek the lower level of the nearby Hudson River and not be trapped in elevated pools in the mine. In fact as stated in our previous letter, the vastly differing water levels observed in the mine pools which are within close proximity to one another, demonstrate that the hydraulic character of limestone formation restricts water flow. Moreover, Mr. Rubin notes that the mine excavation was carried below sea level, hardly something which could be easily achieved with the type of geologic formation that Mr. Rubin has "discovered" at this locale.

Mr. Rubin references tours, tracer studies, retention of karst tracer study experts, resistivity surveys, deep rock core borings to groundwater, oversized large diameter (2 feet) rock core holes into voids to "permit hydrologic characterization and monitoring equipment" and to "provide physical access" (pages 6 and &7), as methods which should be used to characterize this site . Based on our experience with hydrogeologic studies including those performed for hazardous waste sites, to require the City to "delineate the site hydrogeology" (page 9) as Mr. Rubin suggests, would cost at least hundreds of thousands of dollars.

Such studies may be appropriate in the karstic areas of Oak Ridge, Tennessee Mr. Rubin liberally references where the Department of Energy has facilities with known waste disposal facilities and real contaminant transport and impact issues.

Putting things in perspective, the Kingston Industrial site is not in Tennessee, is not a waste disposal facility, and is not in a karstic setting. Moreover, the stormwater causing Mr. Rubin so much concern, will be pretreated.

Very Truly Yours,

GeoDesign, Inc.

Theodore von Rosenvinge, IV, P.E
Principal

attachment: Merguerian Report dated 2/6/96

cc: Dr. Charles Merguerian - Duke Geological Laboratory

M:\CL\053-01\MINELTR2.WP

DUKE GEOLOGICAL LABORATORY
16 Middle Lane
Westbury, NY 11590
(516) 334-7415

February 6, 1996

Mr. Ted von Rosenvinge IV, P.E.
GeoDesigns, Inc.
984 Southford Road
Middlebury, CT 06762

Dear Mr. von Rosenvinge:

Yesterday, I read Mr. Paul A. Rubin's February 02, 1996 letter to City Planner Sue Cahill. Similar to his previous lengthy letter to City Planner Cahill, dated 12/15/95, Mr. Rubin expresses his opposition to the Kingston Business Park on environmental grounds. He has dismissed the main points raised in my response to his initial December letter and maintains that the Kingston region is an active, maturely karstified carbonate aquifer. Again, I would like to state emphatically that, in my opinion, Mr. Rubin's central thesis is technically flawed in that much time has been spent overemphasizing minutia and expanding these observations to include regional terrain types.

I recognize, from reading Mr. Rubin's letter, that considerable time, money, and effort has been spent formulating an opposition position to the proposed Kingston Business Park development. Having already raised my prime objections to his characterizing the region as karstic in my 12/27/95 report, my overall response to this recent letter can best be summarized by the following statement: "Wishing something to be true does not constitute scientific evidence that it is so." In my twenty-five-years of professional experience on the regional geology and running field trips in southeastern New York, never once have I read of or heard the Kingston area characterized as karst.

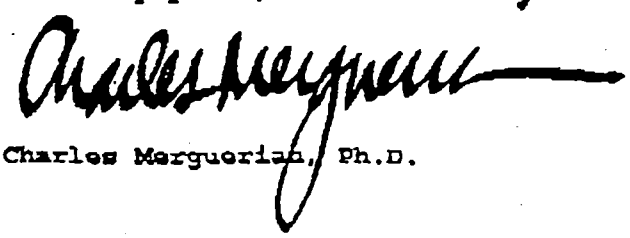
Mr. Rubin is attempting to convince the City Planning Board that the Kingston area is a karstic terrain despite the absence of characteristic landforms including disappearing streams, sinkholes, and subsurface interconnection of caves and caverns. I congratulate him on his ability to write lengthy letters with convincing technical jargon but he has failed to offer convincing geological evidence that the region is indeed a karst and not a localized area of highly fractured bedrock. In fact, during our early January site visit we observed that water levels were clearly different at various points in the Knaust mine, which together with the water levels observed at vastly different elevations on the ridge top by yourself, offers diagnostic evidence against interconnection of hydraulic channels in the region. Interconnection of subsurface water channels is a necessity for characterizing the integral geologic framework of a region as karst.

Mr. Rubin's central theme (that the region is a mature karst) is most seriously flawed on the basis of scale. This problem may stem from a perception that small-scale features near the proposed site (i.e. - a single surface opening, a spring, a disappearing stream, a possible cavern [based on boreholes but not proven], and a few possible sinkholes) identifies the region as karstic. Rather, these are limited outcrop-scale features that commonly develop around the world in temperate areas underlain by fractured carbonate rocks (limestone, dolostone, and in some areas, marble). The error in "fuzzy logic" is in making the intuitive leap that observed small-scale features proves the presence of an important regional landscape type, namely karst.

As I've already pointed out in my previous report, karstic regions cover hundreds of square kilometers and are not found limited to a single ridge. I'm surprised that Mr. Rubin chooses to ignore this problem in dimension as he has had experience in areas of known karst and has coauthored some hydrologic- and geologic reports on karst regions in Tennessee (Rubin, 1995, and Rubin and Lemiszki, 1992). The fact is, if the region were indeed karstic (an important point to prove as fears of groundwater contamination hinge on this perception), his landscape characterization has important regional implications that should extend the karst surface beyond Kingston throughout the Hudson Valley. Yet, with the exception of Mr. Rubin, no professional geologists (in over 150 years of study) have identified karst in the region. Interestingly, in the most recent and historically thorough geological review papers on the region [Marshak (1986, 1990) *as cited in Rubin et al., 1995*], absolutely no mention of the term "karst" exists.

Having spent considerable time in my professional career examining the rocks and reading the literature on this part of New York State, I find it interesting that the words karst and Kingston have never been mentioned together in the same sentence before this current transfer of letters. Naturally, I resist adopting such a terrain characterization based on Mr. Rubin's perception. To summarize my objections for the layperson, if one visualizes a karstic region as containing a subsurface structure analogous to a large wheel of swiss cheese (many large-scale interconnected voids and openings with some surface expression), Mr. Rubin would have us buy a small piece of swiss cheese with *only a hole or two* within it.

Sincerely yours,



Charles Merguerian, Ph.D.

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ONEONTA, NEW YORK 13820-4015

February 3, 1996

To whom it may concern:

I have been asked by Mr. Paul Rubin, of Accord, N.Y., to comment on the DEIS for the Kingston Business Park, Kingston, NY, in regard to the presence or absence of karst beneath the site. I have read the various conflicting arguments on both sides of the issue and hope to resolve some of the misunderstandings. I must mention, though reluctantly, that despite my preference for teaching at a small college, I am a well-known authority on karst. A recent evaluation of our program showed that I am one of the world's three most frequently cited authors in English-language books on karst (or which contain chapters on karst) in the past 10 years, and the most frequently cited on the topic of cave origin and morphology. An abbreviated resumé is appended.

Karst is one of the most widely misunderstood geologic phenomena, and it is no surprise that there are questions about its presence at the Kingston site. Although I am familiar with similar geologic settings throughout the Hudson Valley and elsewhere, I have not visited the exact site and so will limit my comments to resolving the conflict between the parties involved in the study.

1. Much of the controversy is semantic -- that is, it focuses on the definition and understanding of the term "mature karst." I agree with Dr. Merguerian that the site is is not a mature karst in the geomorphic sense, as illustrated in the diagrams by A. Lobeck and by the topographic map of the Manatí area of Puerto Rico. However, Mr. Rubin is concerned with *hydrologic* maturity, in which solution conduits have developed that are capable of transmitting turbulent groundwater flow and contaminants. The presence of these openings, rather than the nature of the topography, is the main issue.

2. Closed surface depressions (sinkholes) are sparse and usually small in limestone ridges of this kind, even in ridges that contain many well-developed solution conduits and caves. The Valley and Ridge province of the Appalachians contains hundreds of examples of similar limestone ridges with large traversable caves but limited surface expression. Their convex topography does not favor the convergent type of surface drainage necessary to produce large sinkholes. However, from personal experience in this province, ranging from the Hudson Valley to northeastern Alabama, *none* of them can definitively be said to lack karst drainage of some kind. According to Mr. Rubin there are several sinkholes on the ridge that do not appear on the topographic map. Again, this is typical, as a study of topographic maps of cavernous limestone ridges throughout the Appalachians will show (see Douglas, 1964, and Davies, 1958). The largest cave in southern New York, near Westbrookville, is in a ridge of nearly the same limestones as those of the Kingston site, but has no expression whatever on the topographic map.

3. The presence of subsurface voids in a great number of boreholes in the ridge (up to 8 ft in vertical extent) is a strong argument in favor of karst. Their apparent continuity in the downdip direction is consistent with the trend of the vast majority of dissolution conduits formed above the water table (Palmer, 1986). It is true that voids are occasionally encountered in non-soluble rock, but they are generally formed by gravity sliding or tectonic forces. They are much less frequent than those in karst and show virtually no solutional widening.

Standing water in the mine at different elevations is to be expected, because mines generally cut discordantly across natural hydraulic gradients and solution conduits. Rapid fluctuation of water levels in the mine following rainfall events indicates efficient connection with surface infiltration sources. Such field evidence supports the presence of subsurface drainage through solution conduits, and those who argue otherwise must bear the burden of proof.

4. The main issue is the potential dispersion of contaminants from the site into the groundwater system. I do not subscribe to the popular knee-jerk reaction against any kind of development on the grounds that it will "damage the environment." However, in this case the potential is real. Deformed limestone and dolomite of the kind at the site are notorious throughout the world for the dispersion of infiltrating water along many alternate flow routes -- not only along turbulent-flow solution conduits, but also along fissures widened only slightly by solution, tectonic forces, and gravity. The rather low water table below the site provides a thick unsaturated zone that enhances the lateral dispersion of water and contaminants. Dye tracing studies have shown that water infiltrating near the top of a mountain or ridge can disperse radially in virtually all directions (see examples in Bögli, 1980, and Ford and Williams, 1989). Subsurface conduits are fed by numerous widespread infeeders (Williams, 1983), and there is no reliable method of grouting them all.

5. If in fact there are sinkholes and solution caves in the ridge beneath the proposed site, they must indicate through-flowing turbulent groundwater that links the surface with springs at the base of the ridge. The presence of sinkholes requires underground conduits capable of transmitting turbulent flow able to transport sediment (Howard, 1963; White, 1988; Palmer, 1991). Subsurface conduits require continuity of flow from recharge areas to springs (generally at the local river level). Short segments of solution conduit cannot form in isolation, but must be part of this continuous system, as shown by field observations supported by geochemical modeling (Palmer, 1988, 1991; Dreybrodt, 1990). Therefore, if sinkholes, caves, and springs can be demonstrated to exist at the site, regardless of their size, the presence of solution conduits extending through the ridge between sinkholes and springs is assured.

6. There are some common misconceptions about karst that may give the false impression that it cannot be present in the Kingston area. Although surface karst features are enhanced by tropical climates, the development of lengthy subsurface conduits is in fact favored by cold temperatures, because the solubility of carbon dioxide and of carbonate rocks decreases with temperature. Although the dissolution *rate* increases with temperature, and the diminished solubility is offset to some extent by the greater carbon dioxide content of tropical soils, higher temperatures actually *increase* the time required to form solution conduits (Palmer, 1991). Some of the most extensive caves in the world are in alpine regions. The largest cave in Canada extends beneath the Columbia Ice Field and is still hydrologically active (Ford and Williams, 1989). All major limestone formations exposed in New York State contain numerous caves of Pleistocene age. Many have been partly blocked by glacial deposits, and their inputs have been deranged by glaciation, adding to the complexity of groundwater flow patterns.

7. I am familiar with Mr. Rubin's work in the Appalachians, most notably in New York State and at the Oak Ridge National Laboratory in Tennessee, and have no doubt that his observations of karst at the site are valid. The late Dr. James Quinlan, co-author of the ASTM guidelines on groundwater assessment in fractured rocks (ASTM, 1995), shared my confidence in Mr. Rubin (personal communication, 1994). Mr. Rubin has spent decades studying karst, and it is inconceivable that he should misinterpret the very features to which he has devoted most of his professional life. It is not appropriate to contradict him without first examining the evidence that he cites. I am aware of, and impressed by, the expertise of Dr. Merguerian in the field of structural geology and tectonics, and recognize the technical competence of the engineers who have studied the site. However, I am equally confident in Mr. Rubin's interpretation of subsurface solution conduits, and that he does not fall into the trap of imagining that karst is everywhere simply because that is what interests him. As a hydrologist, I would further contend that even if the ridge consisted simply of fractured, structurally

competent rock, that the dispersion of contaminants would be nearly as great a threat to nearby properties.

It is fruitless to argue about the topic simply on the basis of differing interpretations of "karst." The main point is this: can dispersion of contaminants take place beneath the site such as to affect nearby properties? **Two steps are necessary to resolve the issue: (1) on a field trip accompanied by all concerned, allow Mr. Rubin to point out the field evidence for sinkholes, sinking streams, caves, karst springs, and seepage into nearby mines; and (2) follow the ASTM guidelines for assessment of groundwater flow paths in carbonate rocks (ASTM, 1995) by dye tracing.** An independent hydrologist with extensive experience in dye tracing in karst is recommended (I obviously remove myself from consideration). A list of qualified personnel can be obtained from the Karst Waters Institute, P.O. Box 490, Charles Town (not Charleston), West Virginia 25414, phone 304-725-1211.

In an area with a geologic setting so susceptible to the dispersion of contaminants, these steps would be of mutual benefit to all parties by dealing with the problem now, rather than when it is too late. I have no personal, financial, or professional stake in the issue and am merely concerned that an appropriate site evaluation be made. I hope these comments are of value to everyone involved with the site and that they are not viewed as a deliberate obstruction of progress.

Yours truly,

Arthur N. Palmer

Arthur N. Palmer
Director, Water Resources Program

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Palmer, A.N. 1991, Origin and morphology of limestone caves: Geological Society of America Bulletin, vol. 103, p. 1-25.

White, W.B., 1988, Geomorphology and hydrology of karst terrains: New York, Oxford Univ. Press, 464 p.

Williams, P.W., 1983, The role of the subcutaneous zone in karst hydrology: Journal of Hydrology, vol. 61, p. 45-67.

ARTHUR N. PALMER
Abbreviated Resumé

ACADEMIC BACKGROUND

B.A., Williams College (Williamstown, Mass.) with honors in Geology, 1962.
M.A., Indiana University (Bloomington, Ind.), 1965; NDEA Title IV Fellowship; major in Hydrogeology.
Ph.D., Indiana University, 1969, NDEA Title IV Fellowship; major in Hydrogeology, minors in Geophysics and Geomorphology. Dissertation: "A Hydrologic Study of the Indiana Karst."

EMPLOYMENT

Technician in computer data processing, General Electric Corp., Pittsfield, Mass., summers of 1959-1962.
Teaching assistant in Geophysics, Geomorphology, and Glacial Geology, Indiana University, 1966-67.
State University of New York, College at Oneonta, N.Y., Earth Sciences Dept.:
Assistant Professor, 1967-72, Associate Professor, 1972-80, Professor, 1980-1994
Distinguished Teaching Professor, 1994-present
Adjunct Professor, Western Kentucky University, Department of Geography and Geology: instructor of Karst Geology summer field course, 1980-present.

TEACHING AREAS

Primary areas: Hydrology, Geochemistry, Karst Geology
Secondary areas: Geophysics, Field Geology, Computer Science.

PUBLICATIONS

Books and monographs

1972 (with F.-D. Miotke), Genetic relationship between caves and landforms in the Mammoth Cave National Park area: Geographic Institute, Technical University of Hannover (Germany), 69 p.
1981, Geology of Wind Cave, Wind Cave National Park, South Dakota: Hot Springs, S.D., Wind Cave National History Association, 44 p.
1981, A geologic guide to Mammoth Cave National Park: Teaneck, N.J., Zephyrus Press, 210 p.
1984, Jewel Cave -- a gift from the past: Hot Springs, S.D., Wind Cave Natural History Assoc., 41 p. Revised 1995 (57 p.).
1988, Wind Cave -- an ancient world beneath the hills: Hot Springs, S.D., Wind Cave / Jewel Cave Natural History Assoc., 49 p. Revised 1995 (65 p.).

Book chapters

1982, chapters on Carlsbad Caverns National Park and Mammoth Cave National Park, *in* Ann Harris and Esther Tuttle, eds., Geology of national parks, 3rd ed.: Dubuque, Iowa, Kendall-Hunt, p. 474-483 and 484-495. Revised in 4th edition (1990), p. 167-176, 145-158. Revised in 5th edition (in press).
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1986 (with J.F. Quinlan and R.O. Ewers), Hydrogeology of Turnhole Spring groundwater basin, Kentucky: Geological Society of America, Southeastern Section, Centennial Field Guide 6, p. 7-12.

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1989 (with M.V. Palmer), Paleokarst of the United States, *in* P. Bosák, ed., Paleokarst: Prague, Academia/ Elsevier, p. 337-363.

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1991 (with M.V. Palmer and D.G. Davis), Origin and geology of Lechuguilla Cave, *in* U. Widmer and M. Taylor, eds., Lechuguilla -- jewel of the underground: Basel, Switzerland, Speleo Projects, p. 22-31.

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Journal articles (excluding abstracts)

1965, The occurrence of groundwater in limestone: Compass, v. 42, p. 246-255.

1966, Hydrogeology of Indiana, *in* R.W. Frey and M.A. Lane, eds., A survey of Indiana geology: Bloomington, Ind., Indiana University, p. 75-81.

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1975 (with M.V. Palmer), Landscape development in the Mitchell Plain of southern Indiana: Zeitschrift für Geomorphologie, v. 19, no. 1, p. 1-39.

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1978, Geology of the Silvertip karst, Montana: Alpine Karst, v. 5, p. 31-39.

1983, Karst research in North America: Karstologia (France), v. 1, no. 1, p. 39-46.

1984, Recent trends in karst geomorphology: Journal of Geological Education, v. 32, p. 247-253.

1984, Objectives and current status of alpine and arctic karst research: Norsk Geografisk Tidsskrift (Norwegian Journal of Geography), v. 38, p. 145-150.

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1993 (with M.V. Palmer), Geologic leveling survey in Logsdon River, Mammoth Cave: Cave Research Foundation, 1992 Annual Report, p. 32-34.

1995 (with M.V. Palmer), reports on geologic research project at Mystery Cave, Forestville State Park, Fillmore County, Minnesota, for the Minnesota Department of Natural Resources; includes 120-page interpretive report (for use in presenting information to the public), a 145-page technical report, a 6-page management report, and 20 folio maps.

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AWARDS

Certificate of Merit from National Speleological Society for work in karst hydrology, 1970.

SUNY Chancellor's Award for Excellence in Teaching, 1979.

Honorary life membership in National Speleological Society, 1982.

SUNY Distinguished Teaching Professorship, 1994.

Kirk Bryan Award from Geological Society of America, for the paper "Origin and morphology of limestone caves," GSA Bulletin, v. 103 (1991), p. 1-25, 1994.

The E.B. Burwell Award for engineering geology was presented by the Geological Society of America in 1995 to "Groundwater geomorphology: the role of subsurface water in earth-surface processes and landforms," GSA Special Paper 252, edited by C. Higgins and D. Coates (1990), of which Chapter 8 was contributed by A.N. Palmer.

PART-TIME EMPLOYMENT (CONSULTING)

Geologic consultant for:

Time-Life Books, Planet Earth Series (1982).

National Park Service:

Interpretive programs, Mammoth Cave Natl. Park, Wind Cave National Park, Jewel Cave Natl. Monument, Carlsbad Caverns National Park (1974-present).

National Natural Landmark Program (1985); New River Gorge, West Virginia (1987).

Cincinnati Museum of Natural History (1987-1991).

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Stone Resource and Energy Corp., Worthington, Ohio: petrologic and geochemical analysis of a well core through the Knox unconformity in Coshocton County, Ohio (1987).

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International Exploration, Inc., Doylesville, Pa.: peer reviewer of Superfund site remediation proposals (1991).

Minnesota Department of Natural Resources: geologic mapping, geochemical and petrologic studies, and preparation of interpretive materials, Forestville State Park (1991-1995).

Delaware Engineering, Oneonta, NY: supervision of geophysical and hydrologic field work for siting of new village well in Walton, NY (1995).

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1977 (with M.V. Palmer and J.M. Queen), Geology and origin of the caves of Bermuda: Proceedings of 7th International Speleological Congress, Sheffield, U.K., p. 336-339.

1977 (with J.E. Mylroie), Karst geomorphology of the Cobleskill area, Schoharie County, New York: New York State Geological Association, guidebook to field excursions, 49th annual meeting, Oneonta, N.Y., 25 p.

1979 (with J.J. Cullen and J.E. Mylroie), Karst hydrogeology and geomorphology of eastern New York: National Speleological Society, annual convention guidebook, Pittsfield, Mass., 83 p.

1979, Stratigraphic variations in Mammoth Cave National Park: Cave Research Foundation, 1978 Annual Report, p. 23.

1981, Geology and origin of Wind Cave, South Dakota: Cave Research Foundation, 1980 Annual Report, p. 10-13.

1981 (with M.V. Palmer and R.L. Powell), Guide to the karst of south-central Indiana: 8th International Speleological Congress, Western Kentucky University, Bowling Green, Ky., 56 p.

1981 (with M.V. Palmer and W.B. White), Guide to the Historic Section of Mammoth Cave: 8th International Speleological Congress, Bowling Green, Ky., 59 p.

1981, Hydrochemical factors in the origin of limestone caves: Proceedings of 8th International Speleological Congress, Bowling Green, Ky., v. 1, p. 120-122.

1983, Gravity survey of sediment thickness in the main level of the Historic Route, Mammoth Cave: Cave Research Foundation, 1982 Annual Report, p. 21-23.

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909 County Rt. 2
Accord, New York 12404

February 2, 1996

Sue Cahill; City Planner
Kingston Planning Board
City of Kingston Planning Office
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Kingston, New York 12401

RE: **Groundwater Protection and Karst Hydrology Beneath the Proposed Kingston Business Park Site and Surrounding Area (Comments on the Jan. 25, 1996 Final Generic Environmental Impact Statement)**

Dear Ms. Cahill:

There is a pervasive theme throughout the Final Generic Environmental Impact Statement that the groundwater quality concerns of the Knaust family are without foundation because *"the issues raised related to hydrogeology in a karst setting are both irrelevant and erroneous"* and ***"absolutely no evidence of karst was found"*** (Larios, 1/15/96). Larios further states *"Mr. Rubin erroneously characterizes the site as karst"*. The applicant's geological experts indicate that the site is *"without a trace of karst" and that "the false impression that the region's geology is karstic can not hold up in the face of geological fact ... because of the absence of surface- and subsurface features diagnostically associated with such a classification"*. Unfortunately, a great deal of time, effort and money was spent in the FGEIS refuting my characterization of the geologic setting, rather than getting out in the field and investigating the site's hydrogeology. The hydrologic concerns raised in my December 15, 1995 letter are completely accurate, as is the need to conduct karst-specific hydrologic testing to protect underlying groundwater aquifers and the business interests of the Knaust family.

The applicant fails to characterize the groundwater resources and subsurface flow paths beneath and adjacent to the proposed site, yet plans to discharge stormwater directly to the underlying aquifer. Aquifers underlying the proposed industrial site are apparently of little concern as *"it is noted that groundwater was not detected in any of the borings taken during the geotechnical evaluation of the project, including the additional borings taken on October 25-27, 1995 ..."* (Larios, 1/15/96). The site has an active groundwater flow system, the applicant simply chose not to investigate it via standard engineering (i.e., ASTM D 5717-95) and hydrogeologic procedures. Nonetheless, the applicant intends to discharge stormwater directly to the groundwater flow system with no knowledge whatsoever as to where it might go or what it might contaminate. The waters of New York State are obviously in jeopardy.

The applicant has not adequately complied with the intent of the SEQR regulations and has not demonstrated *"that the action chosen is the one that minimizes or avoids environmental impacts to the maximum extent practicable"* (as per: 6 NYCRR 617; SEQRR, 1987). Incomplete and inadequately characterized site

hydrogeology make it impossible for involved agencies to reasonably prepare written SEQR findings statements as required after the FGEIS has been filed. Carbonate aquifers are extremely vulnerable to contaminant inputs. They are characterized by rapid subsurface flow and have virtually no ability to treat water-borne contaminants, instead they merely transmit contaminants, much as a sewer pipe would. Contaminants are then rapidly transported to surface streams. It is the cumulative contaminant additions from locations such as the proposed industrial park that result in surface water degradation from non-point pollution sources. As the FGEIS stands, its hydrogeologic characterization is non-existent and it would not be prudent to advance the application without proper hydrogeologic testing, evaluation, and stormwater impact consideration.

GEOLOGIC AND HYDROLOGIC CHARACTERIZATION REQUIRES DETAILED FIELD WORK

While it was a pleasure meeting structural geologist Dr. Merguerian on January 9, 1996, it was unfortunate that approximately four feet of snowpack present at the time of his visit precluded him from observing the many obvious karst features present throughout the proposed site area. Dr. Merguerian spent 75 minutes in a portion of the Kingston Mine during a period of low flow. He did not visit or step foot on the proposed industrial park site. He spent no time conducting the detailed type of examination of the geologic landform that one might consider routine for a structural geologist or for an assessment of potential environmental impacts. Dr. Merguerian was not in a position to evaluate the geologic nature of the landform based on a short-term examination of a man-made hole and a poor topographic map. Furthermore, Dr. Merguerian failed to acknowledge that evidence provided in the DEIS (e.g., borehole voids with gravel) and in my December 15, 1995 letter (e.g., enterable cave, sinkholes) documented the presence of karst. Nonetheless, Dr. Merguerian concluded that the landscape was *"without a trace of karst"* and that *"[t]he false impression that the regions geology is karstic can not hold up in the face of geological fact."* Much of the FGEIS then leans heavily of Dr. Merguerian's conclusion and no consideration is given to the groundwater resource.

My scientific analysis and characterization of the proposed industrial park site is based on years of karst research in physically similar karst terranes, familiarity with recent karst literature and karst engineering standards, repeated site visits, surveys, and measurements conducted over many days and during radically different surface and groundwater flow conditions. While more about the site's karst hydrology is learned with each visit, the physical manifestation of karst features would be difficult to miss in even one visit.

KARST CONCEPTS AND FEATURES PROXIMAL TO THE SITE AREA

Physical evidence present on and adjacent to the proposed site documents that 1) the site is underlain by karstified carbonate aquifers, and 2) that the standard engineering testing the Knaust's have requested [ASTM D 5717-95] should be conducted prior to formalizing findings statements.

Karst concepts and numerous karst features specific to the site area include:

1) Hydraulic relationships in the Kingston Mine. In order to understand the flow dynamics occurring throughout the Kingston Mine and in likely upgradient recharge areas (i.e., the industrial park), it is first necessary to understand all hydraulic relationships within the mine itself. At first glance, there appear to be numerous isolated and elevationally different pools, some small and some extensive. Many were not observed by consultants during their mine tour.

A six man survey team, headed by a practicing surveyor, conducted a detailed leveling survey of all pools (i.e., exposed flooded mine areas) throughout the mine. Several internal loops were utilized, all with excellent closure.

All pools fell cleanly into three hydraulically and elevationally distinct flooded mine sections. All elevations are tied to an arbitrary datum assigned an elevation of 100.00 feet. All pools along the western limb of the anticline were found to lie at 76.68 feet on the date of the survey, thus establishing their hydraulic connection beneath and around flooded portions of the roof and pillar mine. A canoe was taken into inaccessible portions of this lake, revealing air-filled mine portions extending beyond Allen's 1956 map and water-filled portions extending downdip to the west. As discussed in my December 15, 1995 letter, the flooded extent of the mine requires delineation. Smith and Randazzo (1993), for example, accomplished this with analyses of electrical resistivity, incorporating boreholes for cavity verification. Recent chemical testing of this water documents its pristine quality.

The second or central pool occurs closer to the hinge of the anticline than the western or eastern flooded mine segments. Its elevation was found to be 95.55 feet with respect to the arbitrary datum. While much of this flooded area is shallow, several deep areas were found via canoe. Now flooded heating ducts and electrical boxes reveal that this extensive area has filled to its present level in the last 30 years, since mushroom operations were temporarily terminated due to poor economic conditions. This level appears to be perched, filling slowly like a giant bathtub. It is hydraulically distinct from the eastern and western lakes.

The surface of all pools along the eastern limb of the anticline were at an elevation of 51.50 feet with respect to the arbitrary datum. Flashlights lowered into two deep, clear pools revealed an extensive flooded area extending down to at least 78 feet. The great depth here is related to the nearly vertically bedded (locally) rock unit and when tied to a bench mark may be found to extend to several feet below mean sea level.

Knowledge of the hydraulic relationships within the Kingston Mine now facilitate interpretation of groundwater response to storm events and sets the stage for tracer testing. Characterization of groundwater flow routes will entail delineation of at least two different recharge areas. [Drainage tributary to yet another discharge or resurgence area within the proposed business park is discussed below; # 4.] Attachment 3 examines lithologic, structural, and hydrologic parameters examined in a deformed area of the Valley and Ridge province in east Tennessee. The concepts discussed in this paper may be correlated with the structural controls present in this ridge. This should be useful in formulating a tracer test strategy to delineate groundwater flow routes.

2) Flooded portions of the Kingston Mine are not stagnant water bodies with *"[n]o evidence of groundwater flow .."* as suggested in the January 9, 1996 von Rosenvinge, IV, P.E. letter. Rather, they are integral components of two physically separate and apparently strike-parallel flow routes separated by an anticlinal feature. Both the eastern and western lakes respond dynamically to surficial storm and snowmelt events, thus establishing that they are both hydraulically connected to significant and different upgradient recharge areas.

Markedly different water levels have been observed in the eastern lake following precipitation and snowmelt events. For example, a 0.8 foot rise occurred in response to the January 19, 1996 precipitation and snowmelt

event. **Similarly, the western lake responds dynamically to storm events revealing both an influx and discharge of water at rates far greater than possible with laminar flow.** Rapid influx of large water quantities indicates turbulent flow through solution conduits (i.e., karst). Note the significant rise and fall in water level elevations associated with the storm and snowmelt peaks of January 19-20 and January 27-28, 1996 (Table 1). The large surface area of the western lake fluctuated within a 0.75 foot range above its cold-weather level of 1.52 feet.

A repeated rise and fall in water level of the magnitude observed requires a tremendous volume of influent recharge water. These water level rises do not reflect water volumes efficiently drained out of the western lake, only those temporarily stored in the lake. Thus, the total recharge incident to the western lake sums both the observed change in lake storage (i.e., change in lake level) plus an unknown amount of water efficiently transmitted through the flow system. It was during these two events that the snowpack on the ridge decreased from approximately 4 feet to 0 to 6 inches. Clearly, contrary to Dr. Merguerian's suggestion, melting snowpack and precipitation does not all run off the ridge top in surface streams. The groundwater was significantly recharged due to infiltration through the epikarst. The large surface area of this lake and significant water level fluctuations indicate recharge from a large area. It is likely that aquifer water is temporarily stored in these lakes above a certain threshold elevation, above which water influx exceeds the hydraulic efficiency of the discharge solution channel(s). Potential discharge areas for groundwater flowing through these lakes can be addressed at this time.

The rapid and dynamic response documented for the western lake (Table 1) accents the need to delineate subsurface flow paths and related environmental concerns prior to finalizing the environmental impact statement. This is a basic premise underlying the SEQR review process. Testing concepts specific to karst terranes are provided for in ASTM standard D-5717-95. The Knaust family has continued to request this action prior to project findings statements and approval.

TABLE 1
WATER LEVEL FLUCTUATIONS IN THE WESTERN KINGSTON MINE LAKE

Date	Time	Water Level Below Arbitrary Datum (ft)
12/24/95	12:00 noon	1.52
1/14/96	10:00 a.m.	1.52
1/19/96	5:00 p.m.	1.10
1/19/96	6:01 p.m.	1.03
1/20/96	9:00 a.m.	0.85
1/20/96	5:15 p.m.	0.90
1/21/96	7:35 a.m.	0.94
1/21/96	10:37 a.m.	0.95
1/27/96	2:10 p.m.	1.02
1/27/96	4:25 p.m.	0.97
1/27/96	5:15 p.m.	0.94
1/28/96	2:00 p.m.	0.77
1/29/96	4:00 p.m.	0.85

The anticlinal ridge extending through and beyond the Kingston Mine is of great significance structurally, hydrologically and environmentally. The hinge of this structure is readily traceable through the mine. It strikes northeast-southwest. Marshak (1990) depicts this structure in his

geologic map of the Hasbrouck Park area [Fig. 27]. Knowledge of the hydrologic relationships present in the mine permit us to assess the general area of recharge tributary to the mine's western lake. Allen (1956) depicts the elevation of this lake as 101.0 feet. Assuming that this is nearly correct, we can draw two lines on the U.S.G.S. 7.5 minute series Kingston East (Topographic) Quadrangle that will permit us to isolate the likely recharge area to the lake. The first line should trace the 100 foot contour interval. Any areas topographically lower than this line cannot provide recharge to the lake, otherwise they would lower the elevation of the lake. The second line that should now be drawn on the map is a straight line trending roughly S47°W originating close to the entrance area of the Kingston Mine, near where the hinge of the anticline passes. Everything southeast of the hinge axis can be excluded as potential recharge area. Similarly, all elevated areas greater than 100 feet in elevation, but physically separated from the western lake by an area of lower topography can be eliminated as likely recharge areas. The potential recharge area may further be reduced or isolated by eliminating the sediment deposits flanking and to the east of the limestone ridge (e.g., east of the planned stormwater disposal mine). Groundwater movement and lake recharge from this direction is unlikely because slow, laminar groundwater flow rates in sediments could not account for the significant and rapid water influx to mine lakes. This leaves a small portion of Hasbrouck Park as potential recharge area and an extensive area to the northwest. This northwestern area is riddled with well-drained sinkholes, has internal drainage and is the proposed site for the Kingston Industrial Park. The significant storm response documented in the western lake water levels requires a significant recharge area such as that on the ridge top. The need to conduct a tracer program is obvious.

3) A cave (the "Tilcon Spring Cave") is present within the proposed area of the industrial park. Dr. Merguerian (12/27/95) and karst hydrologists throughout the world cite caves as definitive evidence of karst. The cave has an entrance cross-sectional area of approximately 3.5 ft^2 and extends visually into the hillside for approximately 12 feet before disappearing around a bend. The cave was found blowing warm air on January 20, 1996 early in the morning when the outside air temperature was ~ 10° F. This indicates that the cave is air-filled for a considerable distance, enough that the cave air temperature has been warmed and maintained at a constant temperature by the earth. The cave must extend for a considerable distance underground.

4) A spring is present within the proposed industrial park area. As Dr. Merguerian notes, springs are one of the characteristic features of karst terranes. The Tilcon Spring issues from the cave discussed above. Discharge from the spring was carefully gaged on January 21 and January 27, 1996. It was found to be discharging approximately 400 gpm (0.9 cfs) and 1,000 gpm (2.2 cfs), respectively on these dates. The cross sectional area from a higher discharge associated with the January 19-20 storm peak was measured (a linear melted snow/no snow line provided physical evidence of stream depth). Since velocity was not measured, a reconstructed and conservative estimate of peak discharge is 6,500 gpm (14.5 cfs). Flow of this magnitude requires a sizable groundwater basin. Discharges of this magnitude are found in karstic conduit flow conditions. Dynamic short-term fluctuations in aquifer characteristics are well-documented in karst terranes and are not consistent with laminar groundwater flow conditions.

5) Non Darcian or turbulent flow may be observed issuing from the Tilcon Spring Cave. Larios (1/15/96) addresses my characterization of rapid karst-solution conduit flow beneath the proposed industrial site as being *"based on a misinterpretation of the geological setting"*. Many of the environmental and groundwater resource concerns are thus not addressed in the DEIS or FGEIS as Larios states: *"this issue relates to the 'rapid, non-Darcian flow' which may occur in a karst system. This is not a karst system. The fractured bedrock is therefore expected to exhibit slow, laminar flow characteristics..."*.

Turbulent flow is characteristic of rapid flow portions of carbonate aquifers. Water discharging from the Tilcon Spring Cave and its tributary carbonate aquifer was measured flowing at velocities of 1.0 m/s (3.3 ft/s) and 1.3 m/s (4.3 ft/s; 2.9 mph) on January 21 and January 27, 1996, respectively. The threshold between laminar and turbulent flow is on the order of 0.001 m/s. Thus, even though peak flow velocities were not measured, it can safely be stated that groundwater flow rates within the boundaries of the proposed industrial park were found to exceed the laminar/turbulent flow threshold by up to 1,300 times. As discussed in the December 15, 1995 letter, the risk of rapid, unfiltered contaminant transport is great.

6) Non Darcian or turbulent flow may be observed pouring into the southern end and addit of the mine (north of the Kingston Mine) targeted to receive stormwater runoff. During major snowmelt and runoff events, including those of January 19-20 and 27-28 large quantities of water discharged through several fractures in the walls of this mine. Significant infeeders from high up on the south end of this mine must drain solutional channels from the west, as little elevationally higher recharge area is present to the north and east. Once descending into the floor of the mine, this water may partially sink in quarry rubble, possibly following solutionally enlarged fractures and faults to the south, perhaps into the eastern Kingston Mine lake. Tracer testing is necessary.

Since the bulk of the upgradient areas capable of functioning as recharge areas are either on top of the ridge (proposed site of the industrial park) or high up along the flank of the ridge (including the mine to be used for stormwater discharge), there is a high probability that infiltration of any upgradient contaminants may flow to the Kingston Mine lakes and then to as yet undetermined locations. The discharge of one of the infeeders was estimated at 100 gallons per minute. Slow laminar flow does not exhibit concentrated turbulent flow of this nature. This condition occurs here because this groundwater flow in the epikarst occurs through solution channels in the limestone. This is the natural functioning of a karstified carbonate aquifer. As this flow may be likened to pipe flow conditions, it is obvious that any infiltrating contaminants (e.g., parking lot hydrocarbons), here or elsewhere in the carbonate aquifer may rapidly degrade the groundwater aquifer.

7) Borehole 5: A window into a portion of the karst aquifer north of the flooded portion of the Kingston Mine. The 8.4 foot cavity encountered in this borehole at a depth of 43.6 feet and in 8 other nearby borings represents one or more cave segments or a large room. The B-5 boring log revealed the presence of inwashed gravel that a sinking stream washed in through conduits to this cave segment. As discussed in my December 15, 1995 letter, these voids (the applicant's data) provide corroboration that a karst flow system is present. As discussed in Attachment 2, limestone ridges such as the one the industrial park is proposed on often contain portions of once larger cave systems.

An important concept brought out by Rubin et al. (1995) applies to the proposed site - that is, the ridge has survived many glaciations with karst development more and less active at various times. Parts of the conduit network in the ridge, while not receiving the same flows today that initially helped form them, still provide active infiltration pathways. Vadose percolation water follows fractures, bedding planes and faults through relict conduit segments superposed above other lower cave levels. All cave levels carried substantial groundwater flows at times and all still actively receive infiltrating percolation water descending through the epikarst. The conduits or room encountered in B-5 and adjacent borings may reflect relict cave segments, similar to Cherokee Caverns and Copper Ridge Cave (Rubin, 1995; Attachment 2-Fig. 1 label should be right-lateral shear fracture zone). All portions of the karst network are part of the continuum of groundwater flow in the carbonate aquifer, inclusive of slow-flow and rapid-flow components.

While erosion and glaciation have removed and truncated portions of these systems (as analogous to Copper Ridge Cave and Cherokee Caverns; Attachment 2) groundwater still infiltrates downward through the epikarst, into and through relict cave segments until coalescing with active karst flow paths. An example of such a relict cave segment is Salamander Cave, situated a short distance to the south.

A large cavity of this nature requires the influx of undersaturated water, the solution of bedrock, and its removal by turbulent groundwater. Tilcon Spring Cave provides an excellent example of these processes in action. The installation of an oversized borehole here, and perhaps some sediment removal, would make it possible to physically examine the inside of a portion of the site's carbonate aquifer system. It would then be possible to map conduit geometry and trend (see below).

As von Rosenvinge and La Fosse warn in their November 3, 1995 letter (following completion of a rock probing study that encountered significant cavities in 100 percent of all borings):

> *"Cavities are expected to be encountered in the deep excavations made for the roadway in this area. Although such cavities were not encountered in other test borings at the site, cavities may be encountered in other areas during excavation. The extent of the cavities could be mapped in advance of construction with an extensive program of additional probes."*

They further warn that special testing and grouting may be necessary to assure the structural stability of the access road and in other areas during excavation. Similarly, as indicated in the December 15, 1995 letter, this same concern should be carefully addressed when constructing foundation supports in karst terranes [Issue 18, p. 17]. It would appear that the authors of this letter recognized the site as a karst terrane on Nov. 3, 1995, yet on January 9, 1996 Principal engineer von Rosenvinge concluded: "**Absolutely no evidence for karst was found.**" [Emphasis not added].

Elective Drilling Designed To Further Assess Cave System

Borehole B-5 and nearby borings provide documentation of an underlying cave. While there is no question that a cave was penetrated by drilling here, it is possible to learn more about the hydrologic and geologic controls governing groundwater flow within this ridge by direct observation. In similar situations, karst hydrologists have drilled oversized boreholes through competent limestone into voids to permit access for hydrologic characterization and monitoring equipment. The

Kingston Local Development Corporation might consider drilling an oversized borehole 43.6 feet deep exactly at boring location B-5. An 18 to 24 inch diameter borehole would easily provide physical access to a portion of the underlying cave system. Similar installations are in use across the United States, permitting access for characterization of structural and hydraulic controls constraining groundwater flow in carbonate aquifers. An access point here would also be beneficial for evaluating subsurface engineering and foundation/structural integrity concerns specific to the planned access road. Should the entry conduit lead to cave segments sufficiently large and well decorated, cave commercialization could be considered.

8) Numerous sinkholes (i.e., dolines) are present within the proposed industrial park area. Merguerian (12/27/95) references the Glossary of Geology definition of karst as a type of topography *"that is characterized by closed depressions or sinkholes, caves, and underground drainage"*. Numerous broad closed depressions or sinkholes efficiently drain the proposed industrial park site underground through a carbonate aquifer. Note the need to conduct thorough field reconnaissance in karst terranes since sinkholes and other karst features routinely are not depicted on topographic maps (such as those presented in the FGEIS). Some of the ridge top sinkholes are compound sinkholes, all functioning as high permeability pathways that carry internal runoff collected by sinkholes into the subsurface. Usually a cover of soil, colluvium or other unconsolidated material forms the land surface. It is important to note that these sinkholes do not fill with soil. This is because material is regularly sapped downward into underlying solution conduits where it is transported away via turbulent flow. If the flow were not turbulent, the sinkholes would fill in a short period of time. They would also fill and overflow during storm and snowmelt events. Turbidity observed in the western lake coincident with both January storm and snowmelt events may stem from soils being flushed through the system.

High temperatures, heavy precipitation, and associated snowmelt in January 1996 provided an unusually excellent opportunity to witness the drainage patterns on the ridge top in action. In fact, extreme flooding throughout Ulster County at this time (perhaps the largest on record) resulted in loss of life and property stemming from this deadly combination (declared a major disaster by President Clinton). The heavy rains and rapid thinning of the ridge top snowpack (from ~ 4 ft. to 0-6 in.) created no intermittent stream channels draining off the ridge top, as was indicated by Dr. Merguerian who had not had the opportunity to investigate the geologic setting. Instead, all drainage and meltwater drained into closed depressions (i.e., sinkholes), entered the underlying carbonate aquifer and drained to as yet undetermined locations. It is quite likely that some of this recharge water flowed into and through the western lake in the Kingston Mine. **While only tracer testing will tell, the significant changes in water levels and storage in the Kingston Mine lakes (see Table 1), coupled with the limited area available to provide the necessary recharge water (discussed in 2 above) from the southwest (a portion of Hasbrouck Park), strongly suggests that Kingston Mine lake water originates from the sinkhole-rich industrial park site.** Not only is the quantity of recharge water incident to the Kingston Mine lakes significant, but also the arrival rate of the recharge water. The rate of influx is consistent with what would be expected of snowmelt rapidly infiltrating through nearby sinkhole drains, that is turbulent conduit flow - not the slow laminar flow typical of non-karstified aquifers.

Of the numerous sinkholes present on the ridge top, only one was observed temporarily ponding in response to the tremendous water infiltration. Here, water produced a small circular pond approximately 3 feet in depth.

By the next morning (Jan. 28, 1996) this water had infiltrated into the sinkhole drain and underlying carbonate aquifer. While one inefficient sinkhole drain temporarily retarded some of the meltwater from entering the subsurface, the ability of these sinkholes to rapidly transmit meltwater (or contaminants) into the carbonate aquifer is remarkable.

Site investigation is necessary in karst terranes, as important physical features are often not depicted on topographic maps of karst terrains - sinkholes, drainage pathways and other karst features are often missed altogether or incorrect. Field reconnaissance is necessary. Interpretation of stereo aerial photographs can also be used to assess karst landforms.

Stormwater Runoff Analysis Invalid

The assumptions and calculations used to evaluate and design the storm water management plan are not valid in a karst setting. The stormwater runoff analysis fails to account for the site's karst hydrology (i.e., internal drainage; infiltration) and must therefore be completely redone after the site hydrogeology has been delineated. Fluctuations in the western and eastern lake levels provide evidence for significant infiltration and have not been factored into the stormwater analysis. Since much of the ridge top (site of the proposed industrial park) drains internally, and will continue to do so unless completely sealed, and no such assumptions were factored into the analysis, it is necessary to completely redo the analysis. Furthermore, until such time as the model subbasins and their various sinkhole and epikarstic drains have been delineated by tracing, it is not possible to either correctly delineate pre- and post development drainage areas, or reliably conduct stormwater runoff analyses. Since topographic divides rarely coincide with subsurface divides in karst terranes (Quinlan, 1989), and since the geologic setting is dominated by sinkholes, the applicant cannot subdivide the proposed industrial park site into hydrologic segments (for stormwater analysis) without having first conducted the tracer tests necessary to delineate the subsurface flow paths. Moreover, the applicant had no basis for assessing runoff versus infiltration since the geologic setting was not recognized and analyzed as karstic. Since the environmental impact of contaminated stormwater on groundwater resources can not be evaluated, involved agencies are not in a position to fully evaluate the FGEIS. The entire stormwater analysis and design must therefore be completely redone.

9) A sinking stream, or the site of where a sinking stream is seasonally active, disappears within the proposed industrial park site. So great was the ridge top snowmelt that one pronounced intermittent stream discharged from a small wetland just north of the planned Huck International building site. It cut a two-foot wide melted snow channel, actively flowing into the nearest sinkhole where the stream disappeared into the underlying carbonate aquifer. Dr. Merguerian (12/27/95; p. 2) points out that *"underground drainage"* is characteristic of karst topography. A geologic tour (proposed below) would provide Dr. Merguerian and others with the opportunity to observe the numerous sinkholes on the ridge top, the substantial lack of surface ridge top runoff potential (as might attend *"a stream-dissected glaciated landscape without a trace of karst."*, and the lack of significant soil fill in the sinkholes.

Tracer testing is required to assess the impacts of stormwater infiltration on the underlying carbonate aquifer (i.e., from ridge top sinkholes). Since significantly more water is transmitted in the rapid-flow segments of karstified carbonate aquifers (e.g., via sinkhole drains), and because the slow-flow portions of carbonate aquifers

ultimately converge to the rapid-flow segments where the hydraulic head is lowest (Palmer, 1991), it becomes increasing important to determine the flow direction, destination, velocities, and water chemistry of groundwater in these aquifers. Unlike groundwater flow in porous or uniformly fractured media, preferential flow paths in carbonates cannot be predicted without detailed knowledge of solution conduit pathways (Palmer, 1991).

Tracer testing is more readily conducted during periods of high infiltration that during dry summer and fall months. The Kingston Local Development Corporation may wish to contract with an experienced karst tracing expert soon, in order to take advantage of wet spring flow conditions.

10) The ceiling of the Kingston Mine receives significant infiltration during storm and snowmelt events, so much so that a raincoat is needed. During January storm events, multiple ceiling infeeders were observed dripping and gushing water though solutionally enlarged joints. Several had discharges on the order of 25 to 50 gpm. Icicles, flowstone cascades, rimstone dams, cave pearls, dry rivulets and drip pock marks in the mine floor clearly tell of variable ceiling inputs along joint sets, even during times of little groundwater infiltration (such as when the applicant's consultants visited the mine). This represents groundwater percolation through the epikarst. Mine speleothems provide further evidence of active karst processes. Some of the most pronounced hydrologic action in karst systems occurs during and following storm events, responding much more dynamically than in fractured bedrock or porous media aquifers.

11) **Wetland.** The FGEIS does not address the small wetland situated approximately under the footprint of the planned Huck building.

ALTERNATE SITE OPTION

An abandoned unconsolidated material (soil) quarry immediately adjacent and east of the limestone ridge with the proposed industrial park site appears to present an excellent site for Huck International. With some easy bulldozing and landscaping work, a large and attractive site would provide wonderful expansion potential for Huck. Photogrammetric analysis of 1972 aerial photography indicates that at least 21 usable acres are present here. Since other potential business prospects for the proposed industrial park have not been identified as yet, the City of Kingston could consider evaluating other vacant land or abandoned buildings that could also stand revitalization. Meanwhile, this site off North Street could be tastefully reclaimed. Perhaps it is not necessary to promote business in one large location, especially one that is extremely environmentally sensitive. I urge you to further evaluate this potential alternate site.

OFFER TO CONDUCT A KARST HYDROLOGY TOUR OF THE PROPOSED SITE

Information shared in this letter report and my December 15, 1995 letter report thoroughly document the geologic setting as a karst terrane. It is maturely karstified in the sense that the limestone has well-developed sinkholes, solution conduits, caves and springs that function to rapidly transport groundwater. In order to familiarize Charles Merguerian, the lead agency, the Kingston Local Development Corporation, involved agencies, and hopefully an experienced KLDC karst hydrologist with the geology specific to the proposed industrial park and Kingston Mine, we offer to conduct a karst hydrology tour of the proposed site. The tour will be designed to corroborate what these letter

reports document. We believe that such a tour would be beneficial for all involved agencies prior to formalizing their SEQR findings statements.

As a result of insights gained on this tour, we are positive that all involved parties will come away with an appreciation of the presence and hydrologic dynamics associated with this karstified carbonate aquifer. With this new recognition of the geologic setting and the active karst flow processes occurring, we are confident that all parties will agree that the engineering test requirements set forth in ASTM D 5717-95 should be conducted prior to consideration and approval of an FGEIS. Only in this manner can the Knaust family's groundwater, environmental and economic concerns be evaluated.

Experience and Corroboration

I have guided similar geologic tours many times before. I am well versed in karst hydrology, having published numerous karst papers (Attachment 4), some with Dr. Arthur Palmer - a world recognized karst expert. Dr. Palmer has reviewed this letter, my December 15, 1995 letter, Dr. Merguerian's letter and viewed aerial photographs of the proposed site and provided corroboration (Attachment 1 with resume). I have also provided land use guidance to Towns and planners in karst terranes, developed and documented a conceptual model of carbonate and shallow storm flow systems comprising pathways of rapid contaminant transport for warfare chemicals in Oak Ridge, TN, taught karst hydrology and led all day field trips with professional geologists to areas where I am conducting karst research. Most recently, I led two field trips at a joint meeting of the New York State Geological Association and the American Association of Petroleum Geologists. The associated papers were:

> Rubin, P.A., Engel, T., and Nardacci, M., 1995, ***Geomorphology, paleoclimatology and land use considerations of a glaciated karst terrain, Albany County, New York***. Guidebook p. 81-107.
>
> Rubin, P.A., 1995, ***The geology of Clarksville Cave, Albany County, New York,*** Guidebook p. 251-273.

The geology and karst hydrology discussed on these field trips is analogous to that present in the proposed site area.

The proposed karst hydrology tour will provide a format for the 1) observation of area karst features, and 2) the open exchange of scientific information. By examining the nature of the geologic setting in the field, the proper environmental considerations can be advanced and hopefully litigation can be avoided.

We are confident that your review of this and the December 15, 1995 letter, perhaps aided by a karst hydrology tour, will accent the need to properly characterize the site's hydrogeology and thus, the need to protect New York State's and the Knaust's groundwater resources. Thank you for your cooperation.

Sincerely,

Paul A. Rubin
Hydrogeologist

cc: Mark Knaust
Herman Karl Knaust
City of Kingston Common Council
c/o T.R. Gallo, Mayor
Ulster County Health Department
NYS Department of Transportation
NYS Department of Environmental Conservation
Region 3 and Central offices
Environmental Protection Agency (Frank Brock)
U.S. Army Corps of Engineers
Congressman Maurice Hinchey
Ulster County Planning Board
Urban Cultural Parks Commission
Alderman Robert Senor
Scenic Hudson
Daily Freeman
The Times Herald Record

Attachments:

1) Arthur N. Palmer letter and resume

2) Rubin, P.A., 1995, ***The geology of Cherokee Caverns; Tennessee***. *In* Karst Geohazards (ed. by B. Beck), Proceedings of: The Fifth Multidisciplinary Conference on Sinkholes and the Engineering and Environmental Impacts of Karst; Sponsors include the National Ground Water Association and the American Society of Civil Engineers, Gatlinburg, TN, p. 541-547.

3) Rubin, P.A. and Lemiszki, P.J., 1992, ***Structural and stratigraphic controls on cave development in the Oak Ridge area, Tennessee.*** Tennessee Water Resources Symposium (5th, Nashville, TN., Oct. 1992), Proceedings. American Water Resources Association, Nashville, TN, p. 111-117.

4) Paul A. Rubin selected publications

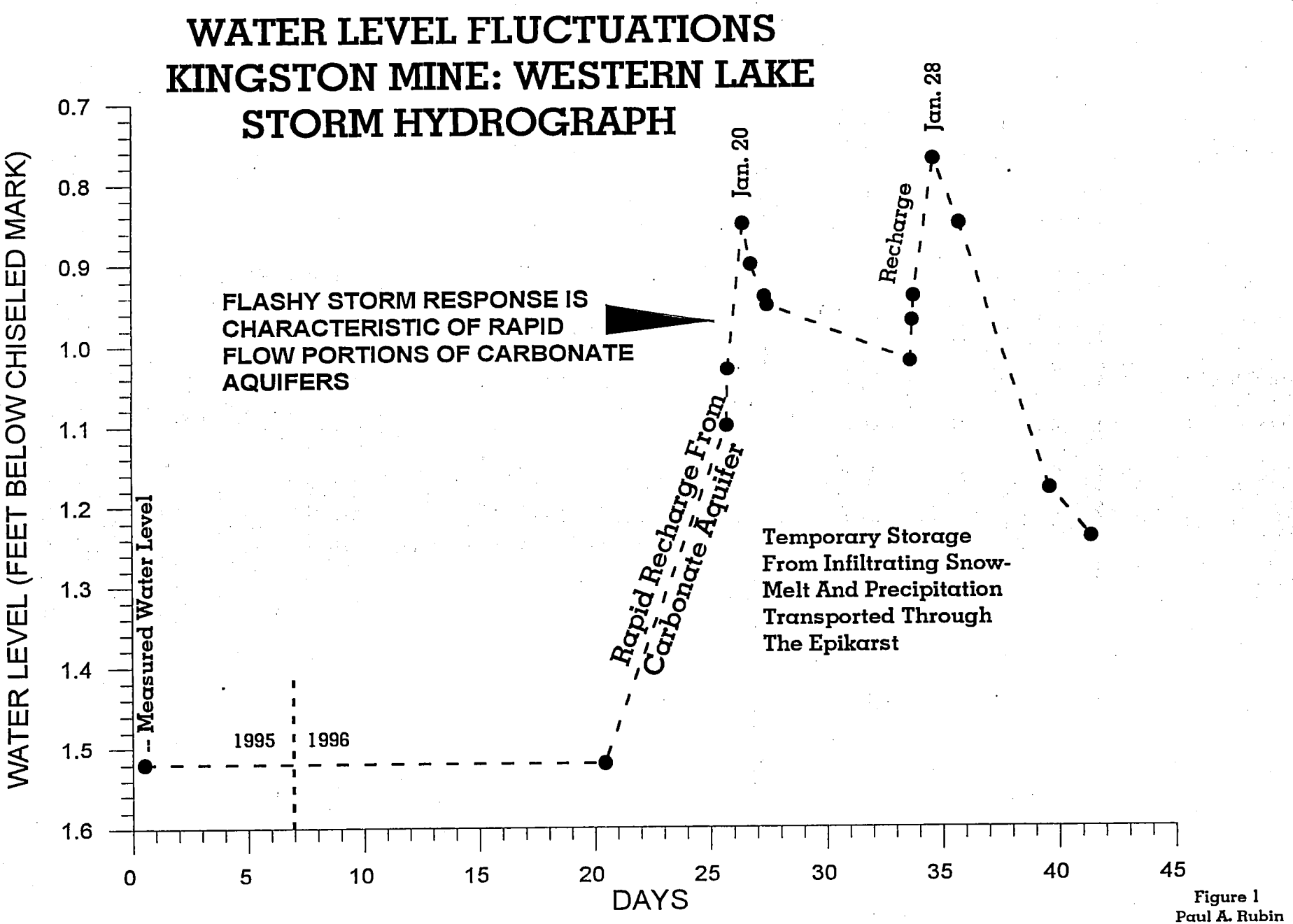
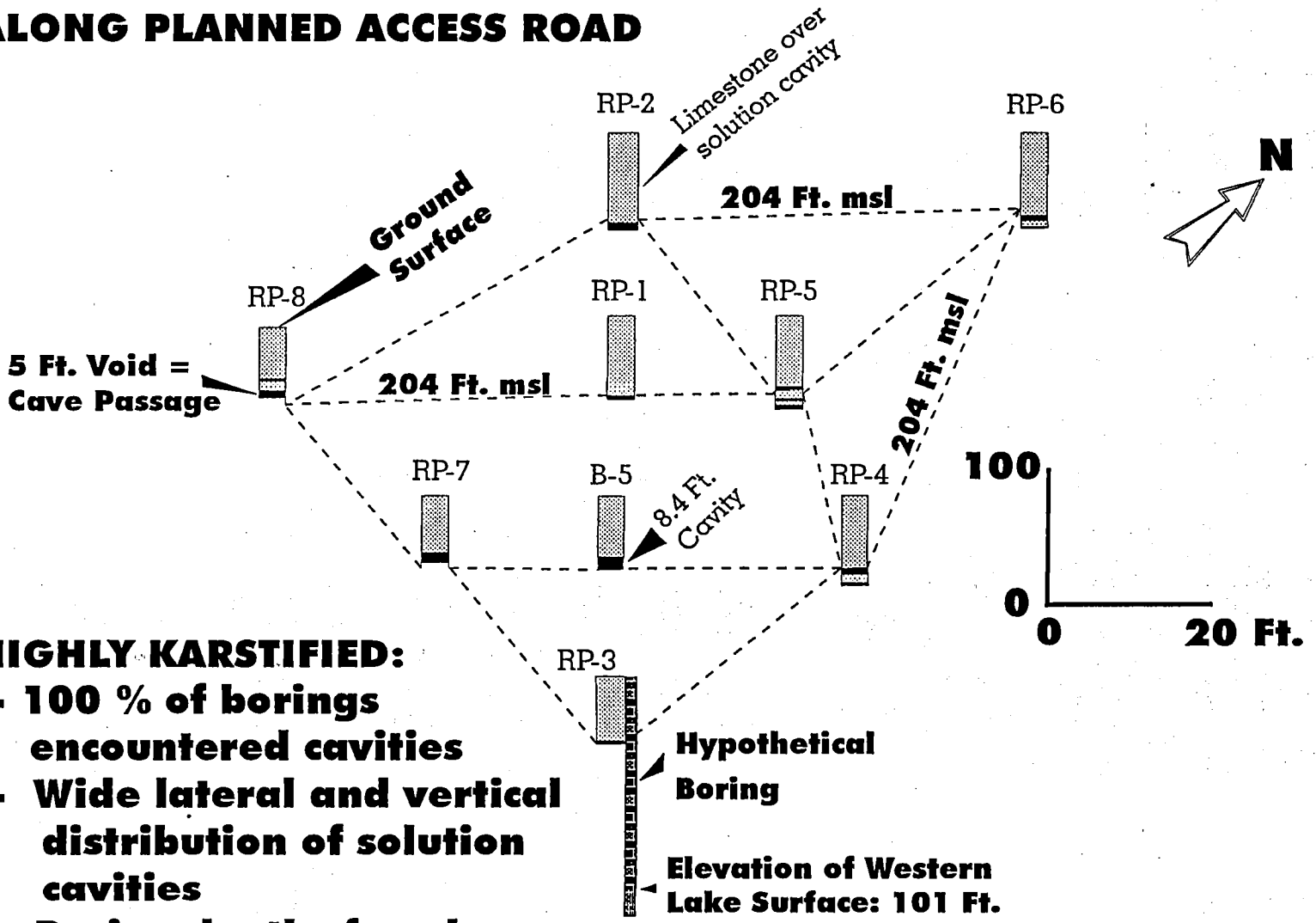


Figure 1
Paul A. Rubin

ROCK PROBE INVESTIGATION ALONG PLANNED ACCESS ROAD



HIGHLY KARSTIFIED:

- **100 % of borings encountered cavities**
- **Wide lateral and vertical distribution of solution cavities**
- **Boring depths far above active flow of Western Lake surface**

Figure 2
P. Rubin

FEBRUARY 4, 1996 ADDENDUM 1: ATTACH TO PAUL A. RUBIN LETTER OF FEBRUARY 2, 1996

RE: *Further Definition Of The Carbonate Aquifer Underlying The Proposed Kingston Business Park Site: Additional Geologic Facts*

ENTERABLE CAVES: DOORWAY INTO THE CARBONATE AQUIFER

Dr. Merguerian (12/27/95) has attempted to dispel the fact that the proposed business park site, and even the region, could be a karst terrain. Dr. Merguerian reports that sinkholes, caves, sinking streams and other karst features do not occur in the region. He states: *"[s]uch topographic features simply do not exist within or near the Kingston area."*. Dr. Merguerian, while retained by the applicant as an expert in karst hydrology, clearly has no experience in the regional karst hydrology. A massive limestone belt trends north-south through the region. Numerous sinkholes and caves (to 1.5 miles in length) have developed over hundreds of thousands of years. Dr. Merguerian, and engineers retained by the applicant, have put forth many strong statements attempting to dispel known *"geological facts"*. Their arguments form the basis for what they perceive as an unnecessary need to conduct standard hydrogeologic testing to assess potential adverse environmental impacts to New York State's groundwater resources. It is not possible to assess environmental impacts in the absence of scientific data. The proposed Kingston Business Park site overlies carbonate aquifers that require characterization prior to approval of an FGEIS.

Further hydrologic reconnaissance of the proposed site area (versus Dr. Merguerian's *"careful review of the literature"*) has documented important hydrologic, structural and geomorphic factors that influence groundwater flow in the karst aquifer system. Three physically enterable caves were located on February 4, 1996. Two caves, situated west of the Kingston Mine, and within the proposed site boundaries trend downdip. One exhibits the cross-sectional geometry of a vadose (air-filled) canyon. It has a maximum exposed ceiling height of ~ 10 feet, with a width varying between 2 and 5 feet. After some 25 feet, it is occluded with sediment fill. Nearby, another cave extends 20 or more feet downdip (14° NW). Like the first cave, the floor depth is difficult to determine due to the presence of sediment infill. A third dumbbell shaped solution conduit is also present, but it is now almost completely sediment filled. The large size of these caves required regular high discharge and high velocity flows, probably for tens of thousands of years in order to form. The obvious lack recharge area argues for an artificially enlarged watershed. The required drainage probably occurred from subglacial meltwater, at a time when a vast ice sheet pressed against the limestone ridge planned for development. These are relict or abandoned caves that no longer receive direct recharge into their entrance areas. Other caves formed or enlarged by invading subglacial meltwaters are documented by Rubin et al. (1995) and Rubin (1995). Further downdip, these caves may still receive percolation water that drains to points unknown. These caves are important because they provide evidence for structural control on groundwater flow in the ridge and provide evidence for a complex internal drainage pattern within the ridge. Paleoflow or relict conduits are probably superposed with active conduits.

The complex nature of the carbonate aquifer is further accented in another cave somewhat northeast of these relict caves and south of the proposed Huck building site. A stream actively flows through the cave, discharging to the southwest. This cave is readily enterable for about 50 feet before sediment partially occludes the passage. Examination of the sediment reveals the presence of quartz pebbles and cobbles atop finely laminated clays and silts. These pebbles and cobbles (like the gravel found in borehole B-5) do not occur naturally within the limestone bedrock. They document water and sediment throughput from one or more upgradient sources - most likely having been washed in through sinkhole drains. This is evidence of an actively functioning karst

system.

This cave is developed along a strike-oriented fracture trending N45°E. Water influx may occur both down dip and along a major thrust fault coincident with the entrance ceiling of the cave prior to following strike. The geometry of the cave is that of a vadose canyon. Undulatory ledges projecting outward into the passage may well reflect the repeated bedrock/void - bedrock/void sequence encountered in the B-5 area rock probe investigation (Fig. 2). The size of the cave documents that it has been active for a period of time in excess of 10,000 years. Its dimensions vary from 1 to 7 feet in width, with heights upward of 20 feet. A room approximately 17 feet long, 7 feet wide, and 20 feet high is used as a hibernaculum by bats. The size of the conduit suggests that the recharge area may be, or once was, reasonably large.

The elevation of the cave's invert requires survey, but is estimated at 150 feet msl. This has significant implications for drainage patterns present in the ridge and the recharge area of the Kingston Mine lakes. Since water recharging the western Kingston Mine lake ultimately does so close to 101 feet msl, it is possible that several distinct conduits actively operate at different elevations with different recharge areas. Attachment 2 documents a similar setting in Oak Ridge, Tennessee. Only a detailed tracer test program will be able to resolve the different flow paths. This should be conducted by an experienced tracer expert.

The location, elevation and trend of this cave may further truncate the small portion of Hasbrouck Park, discussed in the attached letter, that might conduct recharge water toward the Kingston Mine. The southwestern groundwater flow direction seen here may be indicative of the baselevel controlling groundwater flow.

ROCK PROBE INVESTIGATION

Figure 2 presents the results of the applicant's rock probe investigation. The remarkably high percentage (100 percent) of borings that encountered conduits attests to the highly karstified nature of the carbonate aquifer. The long period of time that this ridge has been exposed to erosion and infiltration has probably resulted in complex internal drainage patterns.

Figure 2 graphically depicts the relative elevations of the rock probe depths and the approximate elevation of the western lake in the Kingston Mine. Many more cavities or conduits (i.e., cave passages) may occur at greater depth. While groundwater elevations widely vary in the ridge, the applicant chose not to proceed to groundwater during any portion of the environmental assessment. The flashy response to storm water infiltration (as measured in the western lake) depicted in Figure 1 is characteristic of rapid flow portions of carbonate aquifers. The dynamic response observed over the surface of a large water body documents the presence of a large, well-drained, recharge area. As discussed in the attached letter, this recharge area almost certainly includes the proposed business park.

WETLANDS

As stated in the attached letter, the wetland near or under the planned footprint of the Huck building requires evaluation. It is depicted on the U.S.G.S. map. The lack of field studies upon which the FGEIS relies for its environmental assessment is further accented in the assessment of the small wetland situated near the site's northwestern border. This wet area is described as *"drain[ing] to the southwest off the site"* (FGEIS). Field reconnaissance reveals that this wetland is situated in an elongate and shallow sinkhole. It's drainage is internal through the epikarst, not via ".. *a stream-dissected*

glaciated landscape ***without a trace of karst.***" (Merguerian). January meltwaters caused the shallow closed depression here to temporarily pond. Evidence was found in the form of an elongate ice blanket (0.12 feet thick) situated 1.3 feet above the February 4, 1996 water level. The surface of the ice was readily distinguishable from ice-free areas. Observation of the snowpack beyond the ice margin revealed that no meltwater overflowed this sinkhole. Instead, much of the ponded water drained efficiently into the epikarst. Groundwater tracing should be used to delineate subsurface flowpaths.

Attachments:
2 figures

cc: John Privitera, Esq.

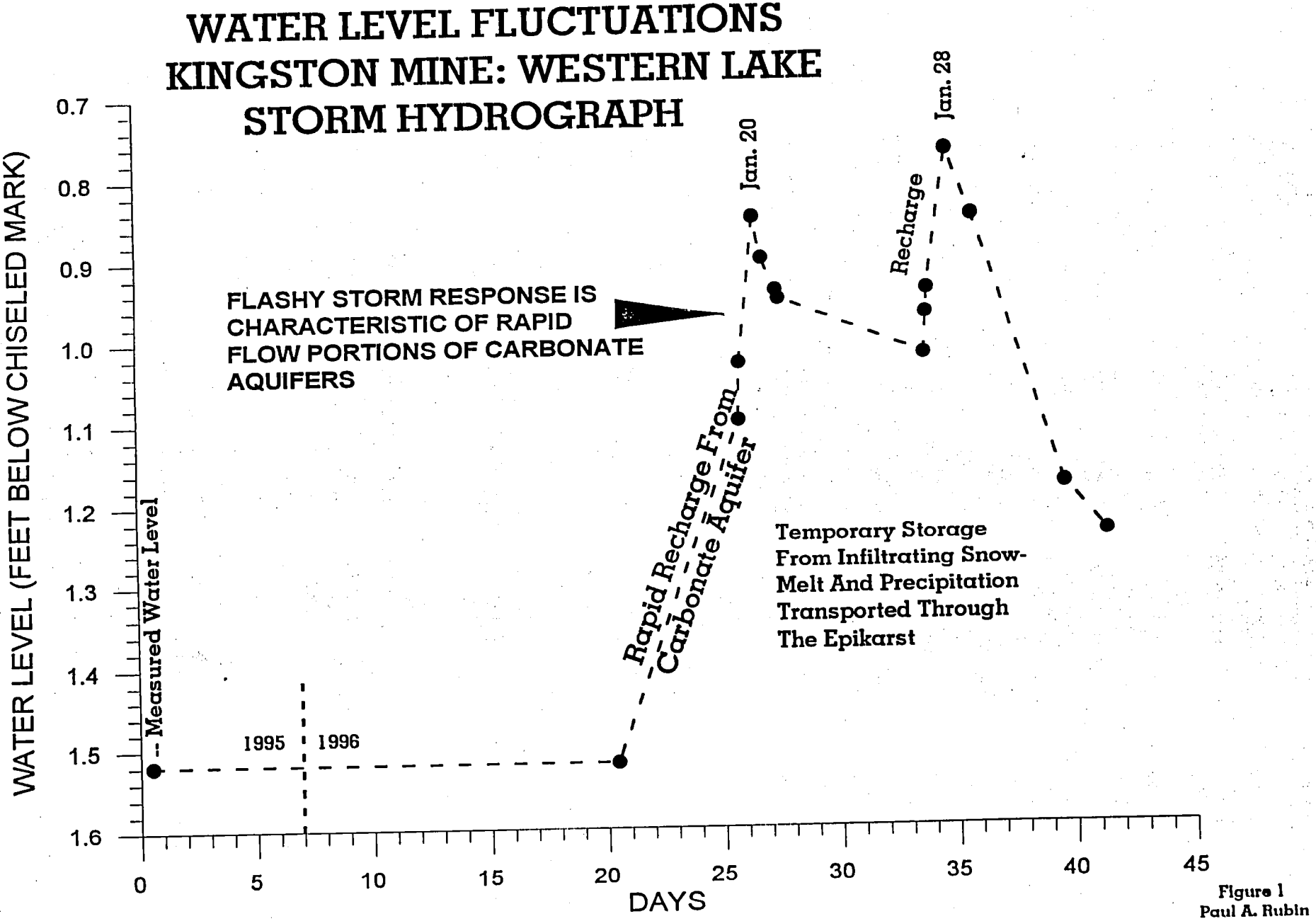
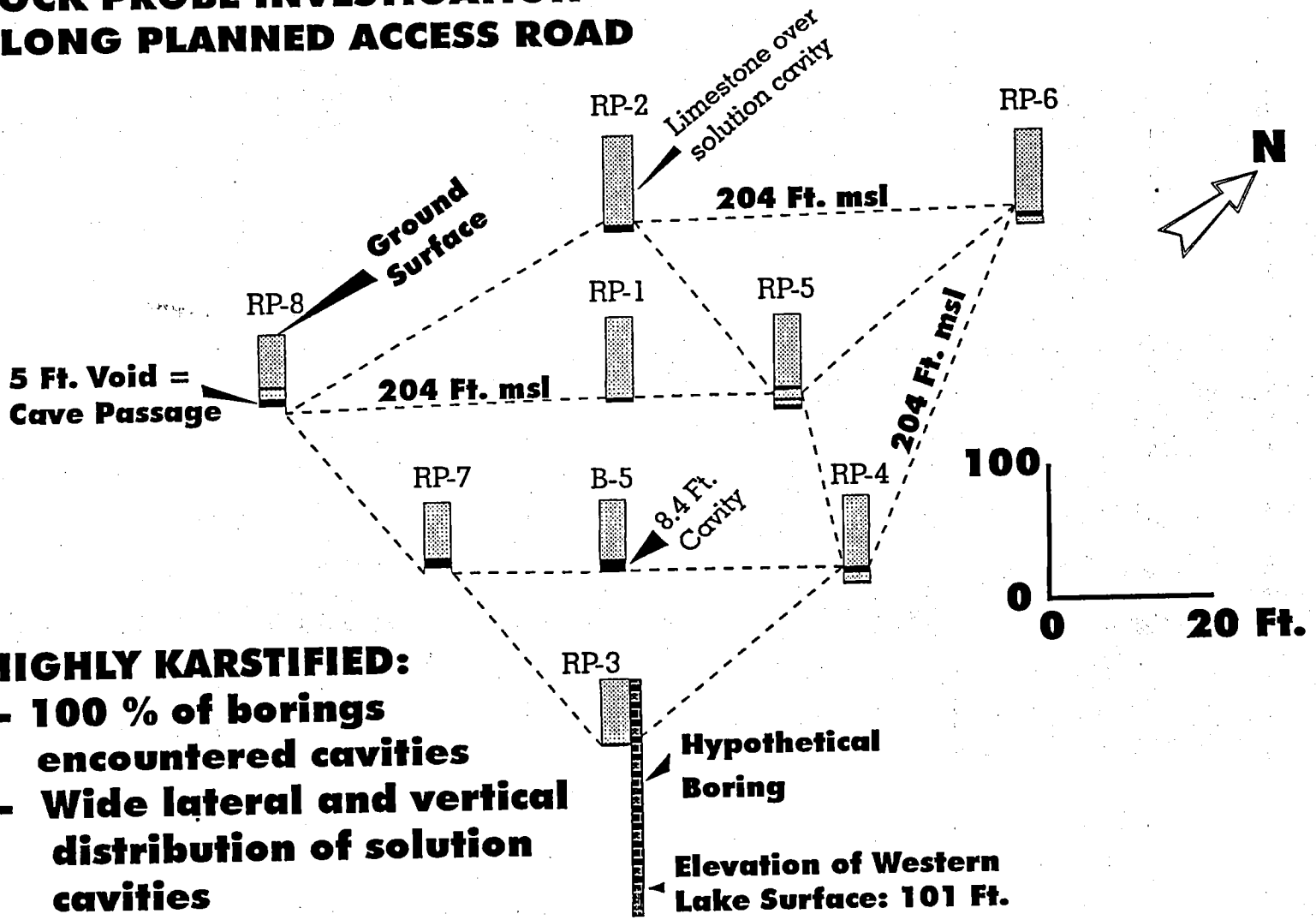


Figure 1
Paul A. Rubin

ROCK PROBE INVESTIGATION ALONG PLANNED ACCESS ROAD



HIGHLY KARSTIFIED:

- 100 % of borings encountered cavities
- Wide lateral and vertical distribution of solution cavities
- Boring depths far above active flow of Western Lake surface

Figure 2
P. Rubin

PROCEEDINGS OF THE FIFTH MULTIDISCIPLINARY CONFERENCE ON SINKHOLES
AND THE ENGINEERING AND ENVIRONMENTAL IMPACTS OF KARST
GATLINBURG/TENNESSEE/2-5 APRIL 1995

KARST GEOHAZARDS

ENGINEERING AND ENVIRONMENTAL PROBLEMS IN KARST TERRANE

Edited by

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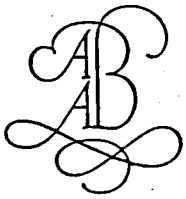

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Attachment 2

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The geology of Cherokee Caverns

PAUL A. RUBIN Accord, N.Y., USA

ABSTRACT

Cherokee Caverns is located in the northwestern part of the Valley and Ridge province in east Tennessee. Regional downcutting throughout the Pliocene has resulted in the preservation of relict cave segments within resistant carbonate ridges. This paper draws upon geologic, hydrologic, and survey work conducted in and around Cherokee Caverns, Copper Ridge Cave, and Eblen Cave. The relationship between conduit geometry and elevation and bedrock lithology has been used to interpret a portion of the geomorphic history of the Oak Ridge area. The resulting conceptual model of the geomorphic history and hydrologic evolution of karst systems in the Oak Ridge area provides information on the nature of karst systems that are still active in the area today. Since cave development and possible contaminant exit pathways in structurally deformed regions are often controlled by bedrock lithology and former or recent baselevels, concepts presented here may be applied to other studies (Rubin and Lemiszki, 1992; Rubin, Lemiszki, and Poling, 1992). The geometry and size of trunk passages in these caves document large paleoflow discharges (from an extensive catchment basin, active for tens of thousands of years), with active flow superposed into and through truncated conduit segments. Conduit geometries in Cherokee Caverns reveal very slow fluvial erosion alternating with periods of comparatively rapid erosional dissection. Relict phreatic conduits have superposed solutional features typical of floodwater origin under alternating vadose and phreatic flow conditions. This paper was prepared for inclusion in an educational guidebook specific to Cherokee Caverns.

INTRODUCTION

The rocks and sediments of Cherokee Caverns contain an exciting story about the geologic history of the region. The cavern was formed in a soluble rock unit called the Copper Ridge Dolomite during the Upper Cambrian time period (≈ 515 million years ago). Geologists can reconstruct a picture of what this area was like millions of years ago based on the size and shape of the cave's passage, the sediments filling the cave, and even the angle of the rock in which the cave is formed. A fascinating story is only now being unravelled.

ANCIENT MARINE LIFE, ROCK FORMATION, AND EROSION

We can look back in time and visualize the conditions and events that were necessary for the cave to form. During the Upper Cambrian, the sea level was rising and covered much of North America. The abundant marine life consisted mostly of trilobites and shellfish called brachiopods. Other species included snails, worms, sponges, and a few nautiloid cephalopods. Most life on earth during the Upper Cambrian was in the oceans, land plants and animals had not yet evolved. Through time, the buildup of dead marine life on the ocean floor ultimately compacted to form the Copper Ridge Dolomite. Although very few are preserved, we now know the fossils of the calcareous shelled organisms that make up this geologic formation lived in a warm, well-oxygenated sea less than 60 m (200 ft.) deep.

Through geologic time, more carbonates (limestones and dolomites), sandstones, and shales were deposited, filling up a slowly subsiding shallow marine basin. Ultimately, by the end of the Permian period (≈ 245 million years ago), some two miles of flat-lying sediments were built up over the Copper Ridge Dolomite. Soon thereafter, what we now know as the continents of North America and Africa collided, and caused the land to uplift far above the elevation of today's sea level. The collisional event, called the Alleghanian orogeny (≈ 240 million years ago), is indicated by the fact that the once horizontal rock layers are tilted and stacked on each other. By carefully looking at the rock walls of the cave, you can see that these beds are now inclined at approximately 14° to

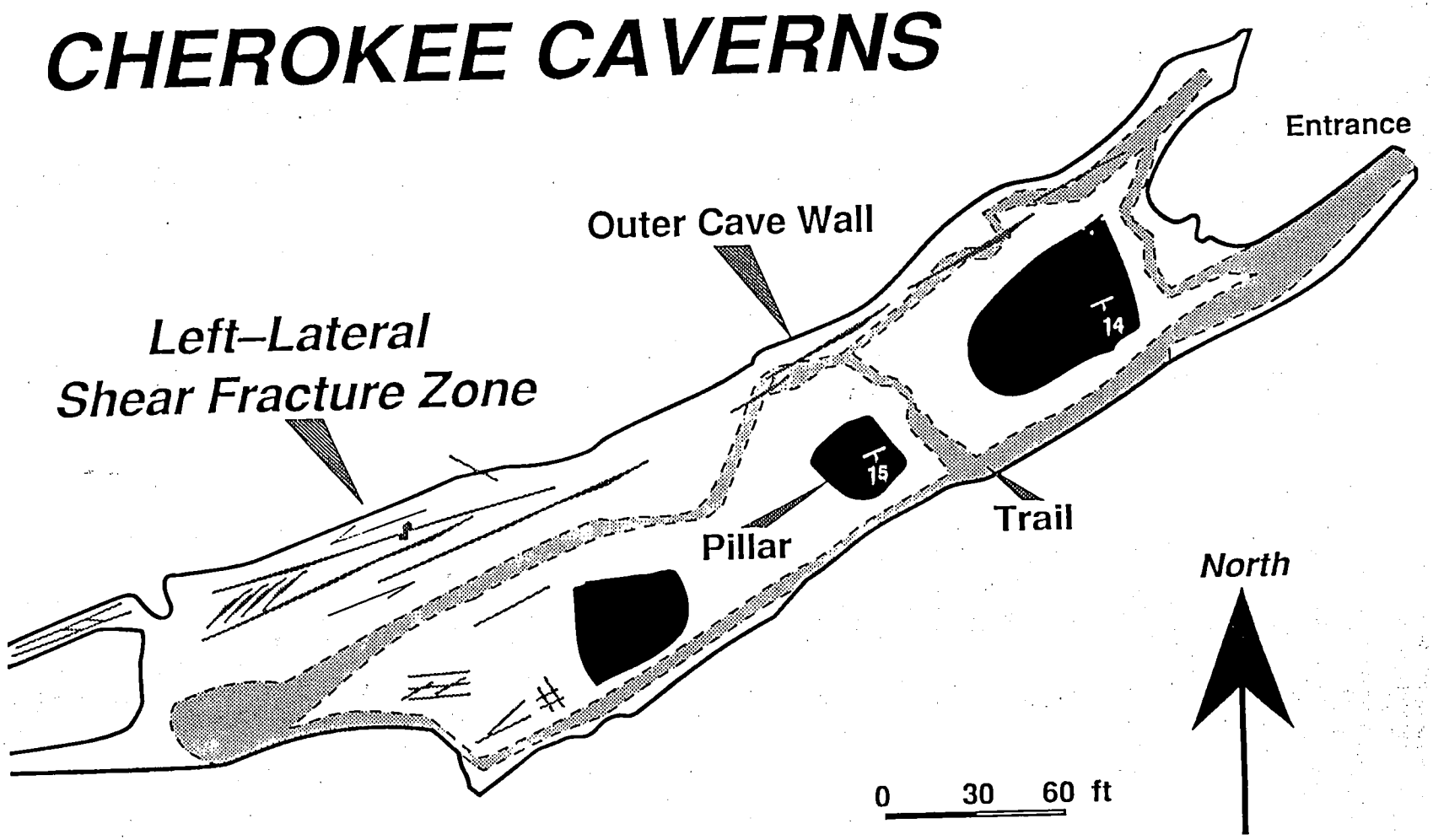


Figure 1 (Cartographer J. Thomason)

the southeast. Also the fractures and fault in the cave indicate that the rocks have been deformed (Fig. 1). As the land surface was uplifted and the sea began to recede, a very slow erosional process began that continues even today.

As rivers and streams downcut through the inclined rock layers, they eventually exposed the Copper Ridge Dolomite in which Cherokee Caverns now lies. It is difficult to date exactly when this occurred, but it most likely occurred between 2 and 5 million years ago. The 2 million year time frame is consistent with regional downcutting rates documented in other southeastern United States caves. Current investigations of the record of the ancient magnetic field present in sediments deposited in this and other Oak Ridge area caves are being conducted to more precisely date the events responsible for shaping the present-day landscape.

CHEROKEE CAVERNS

Cherokee Caverns is of particular scientific value because it preserves what may be the oldest remaining geologic record of the drainage patterns, river baselevels, and rates of regional erosion present millions of years ago in the Oak Ridge area. The way in which its rock layers are carved tell a story of the evolution of the landscape we see today. The surface topography and drainage routes present 2 million years ago were quite different. When Cherokee Caverns formed, water that flowed through it did so at the lowest topographic drainage level (i.e., baselevel or ancient water table) present at that time, much like the Clinch River is the lowest drainage level today. Such a reconstructed surface topography is depicted in Figure 2, where the tubular passage intersected by the conduit well represents Cherokee Caverns. The inclined passage descending down the slope or dip of the rock to the conduit represents a typical water infeeder to the cave system. An example of this is found in nearby Copper Ridge Cave that descends as a vadose (i.e., air-filled) canyon for a length of 243 m (798 ft.) until intersecting a relict phreatic conduit with passage dimensions up to 15 m (50 ft.) high and wide (Fig. 3).

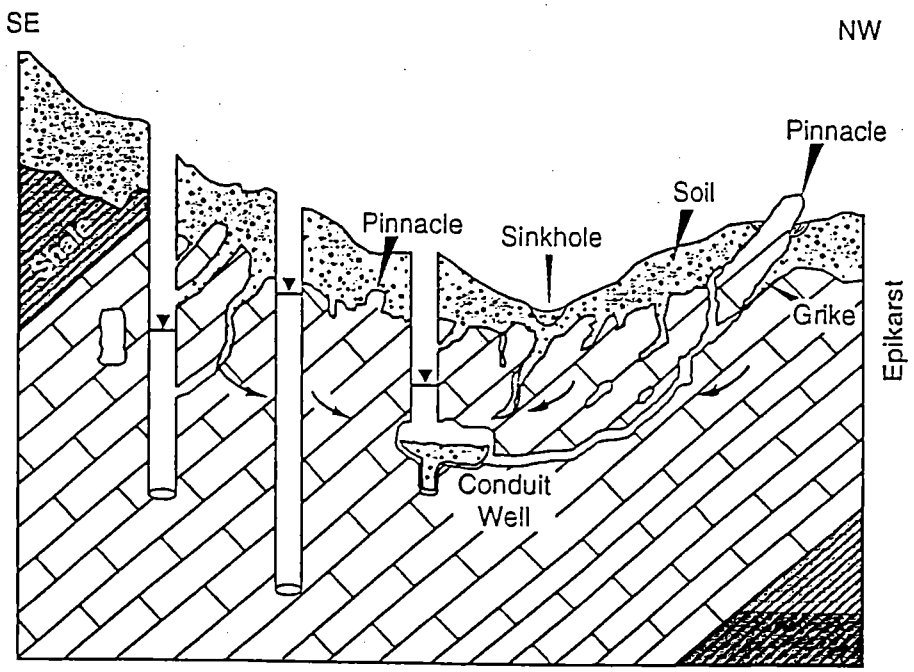


Fig. 2. Schematic showing a typical east Tennessee karst aquifer. Much of the area is covered by permeable soils and sinkholes through which water infiltrates downward until reaching fractured bedrock. Water in the uppermost bedrock (i.e., the epikarst) flows down the dip of the rock (e.g., northwestern infeeder to conduit) until reaching a drainage baselevel. Groundwater may also flow against the dip of the bedrock if a zone of low hydraulic head (i.e., a well-drained conduit) is present nearby, as depicted in the southeastern portion of the figure. Groundwater then follows the alignment or strike of the bedrock. The original land surface that drained water to Cherokee Caverns was elevated above the cave's baselevel conduit. Thus, we know that the high ridge that contains Cherokee Caverns must have once been considerably lower than the surrounding area. Less resistant geologic beds must have been eroded away from the Copper Ridge Dolomite.

COPPER RIDGE CAVE

BRUNTON AND TAPE SURVEY (TRN21)

Paul A. Rubin, Bruce Zerr, Gareth Davies

Low Flow Conditions 12/19/92

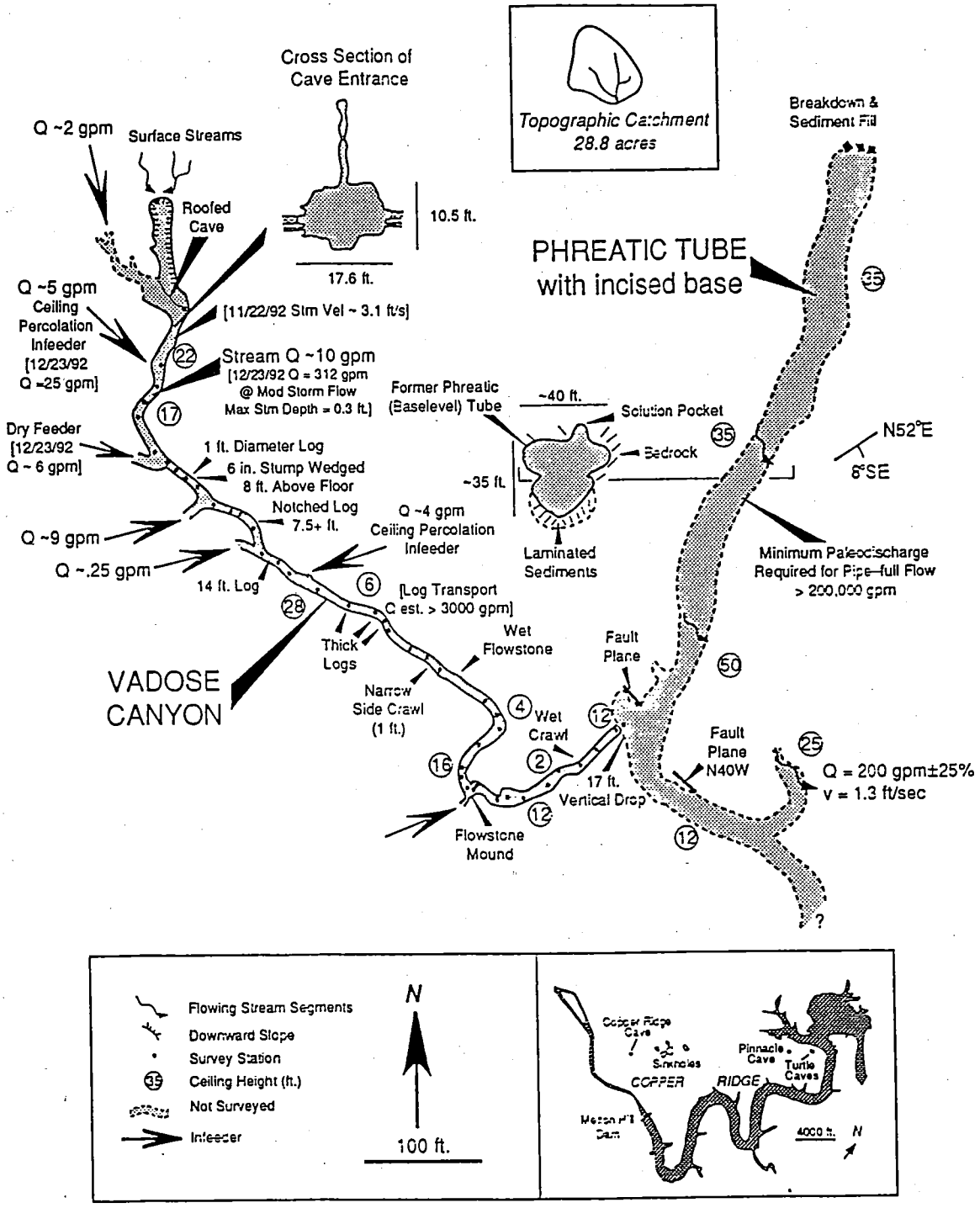


Figure 3

Although erosion and downcutting have left Cherokee Caverns as an abandoned segment of a river cave high up in a ridge, its physical setting was such that it once occupied a low valley. Runoff from high slopes northwest and southeast of the cave flowed downhill until sinking into sinkholes and fractures draining into Cherokee Caverns. Much of this recharge water originated far to the northeast, where it sank into the Copper Ridge Dolomite at higher elevations. Figure 2 shows schematically how once this water sank into the Copper Ridge Dolomite, its flow path was constrained to the southeast and northwest by impermeable rock units. It is possible that water shed off inclined geologic beds flanking the Cumberland Plateau may have contributed to the river that once flowed through Cherokee Caverns. As less resistant shales, siltstones, and limestones were deeply eroded, particularly northwest of Cherokee Caverns, the water once flowing through Cherokee Caverns found lower drainage outlets at nearby surface streams.

INTERPRETATION OF CAVE LEVELS

Cave levels, sizes, and shapes can be used to interpret much about the landscape at the time the cave formed (Fig. 4). Careful surveying has revealed that three former baselevels are faithfully recorded within the cave, at approximately 973, 945, and 937 feet above mean sea level (msl). These levels are recognized by their tubular (phreatic) cross sections, which form in water table passages grading very gently to distant, and mature, surface rivers. These passages form during time periods when stream erosion is relatively slow. The highest level is now about 73 m (240 ft.) above the bottom of the Clinch River. The size and tubular shape of the highest cave level provides evidence that water flowed at this elevation (973 ft. msl) for a minimum of ten thousand years. This level may represent the oldest recorded water table in the Oak Ridge area. The final chapter in the history of this stage of slow surface erosion is marked by finely layered sediments slowly filling the uppermost cave level virtually to the ceiling. The baselevel remained constant, until a relatively sudden drop in regional drainage level occurred. In response, groundwater flow in the cave rapidly excavated much of the sediment and downcut some 8.5 m (28 ft.) into the cave's floor before adjusting to a new stable baselevel (945 ft. msl). Evidence of this adjustment is seen in the form of the water-rounded solution hole above the Wishing Well, as well as in other solutionally enlarged fractures that connect the upper and middle cave levels. Many of these fractures are associated with a fault that is visible near the Wishing Well (Fig. 1). These holes probably represent some of the initial routes of water loss from the upper to middle cave level. These holes and other related wall and ceiling solution pockets were subsequently enlarged by the rise and fall of floodwaters, possibly aided by the mixing of chemically different water.

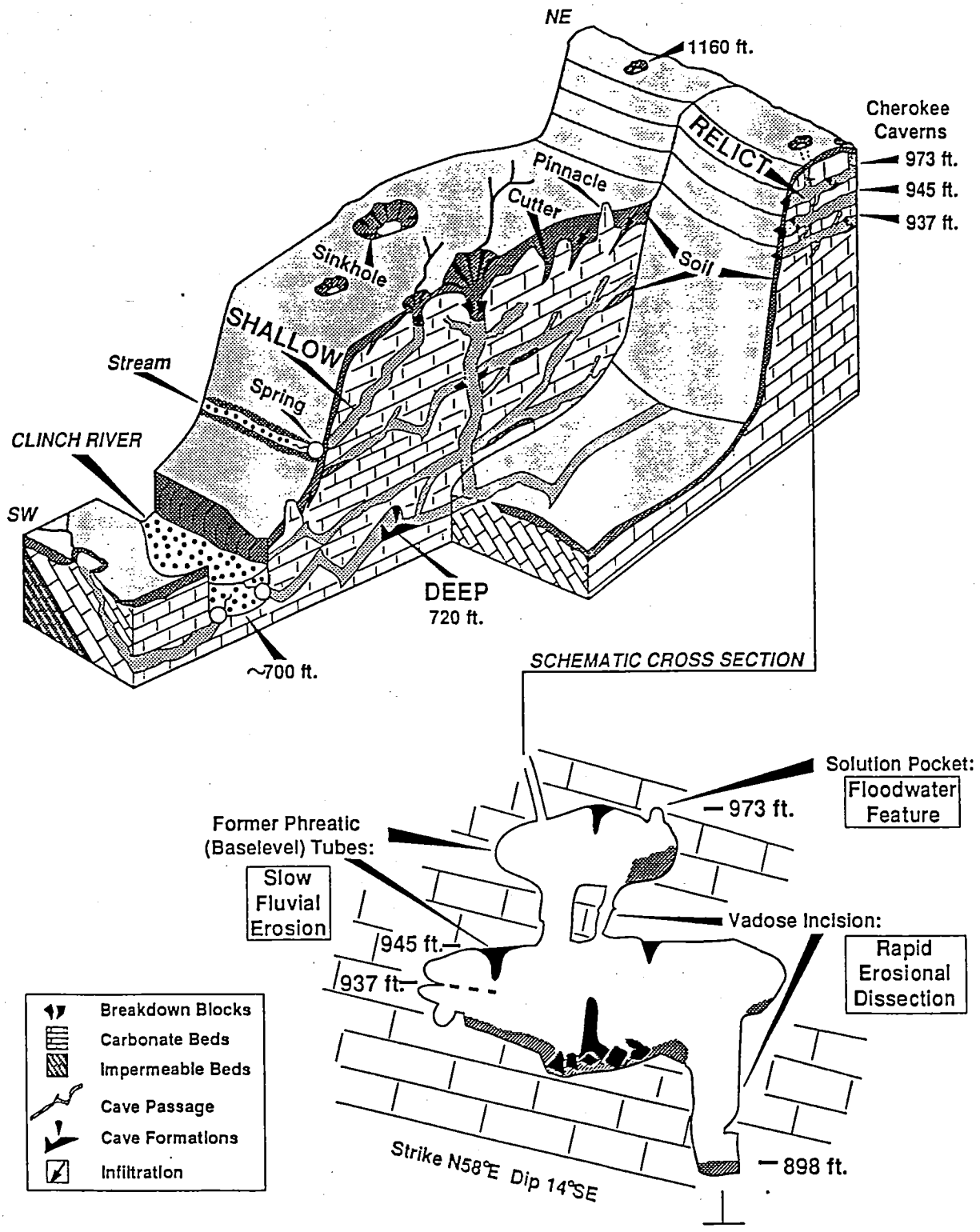
Once the baselevel dropped to 945 feet msl, more water than ever before reached Cherokee Caverns. As this water was captured by the cave, the cave passage reached widths of up to 33 m (110 ft.). Ceiling pockets tell us that the cave was sometimes filled with rapidly flowing aggressive water, while at other times only partly filled with a slow-flowing river. The relative size of this middle level tells us that the regional baselevel remained stable for a long period of time, certainly well in excess of 50,000 years, perhaps even hundreds of thousands of years. Then, the regional baselevel fell again, this time only about 2.4 m (8 ft.) to its lowest recorded baselevel (937 ft. msl). After the water table remained stable here for many thousands of years, another drop in regional baselevel occurred (to at least 898 ft. msl). It was probably at this time when the shales, siltstones, and limestones northwest of Cherokee Caverns were eroded lower than the more resistant Copper Ridge Dolomite. This erosion of the nearby land surface resulted in a lower flow path becoming available for the cave stream. This led to the abandonment of this cave by the original long continuous river that formed it.

Evidence of the water flow direction immediately preceding abandonment of the middle and lower level phreatic passages of the river cave is found northeast of the Wishing Well near two ceiling pendants (945.6 to 943.0 ft. msl). Here, floodwaters formed a small steeply descending passage that initially trends to the east. It's walls reveal evidence of rapid flow, apparently draining floodwaters back to the northeast, away from the expected water flow direction, down to a lower outlet. Excavation of clay in the base of this passage could lead to a northeast extension of Cherokee Caverns.

ARE THERE SECTIONS OF CHEROKEE CAVERNS AWAITING DISCOVERY?

Although the trail through the cave may make it appear that there is more than one major cave passage, Cherokee Caverns is really only one very small segment (≈ 230 m [750 ft.]) of a single river cave passage. Imagine the quantity of water required to fill Cherokee Caverns to the ceiling. Obviously, the cave had to have been much longer when it was active. What happened? How long was it? Where did it go? Is there still more to discover?

Cherokee Caverns appears short today owing to the effects of erosion through geologic time. As stream and river channels changed their courses through time, their downcutting cut off segments of the original river passage. The original river passage became truncated, often sealed by collapse against hillsides. As rivers and streams continued to downcut through the area, some sections of the original cave remained active, while others were totally abandoned. Other segments became plugged with mud. Look outward from the entrance of Cherokee Caverns and envision streams cutting down through the cave's roof, removing sections of the cave, and carving the valley below. Further to the southwest, the Clinch River meandered (six times) across what may have been the former route of Cherokee Caverns, further truncating the down-river portion of the original cave.



CONCEPTUAL MODEL OF THE GEOMORPHIC HISTORY AND HYDROLOGIC EVOLUTION OF KARST SYSTEMS IN THE OAK RIDGE AREA, TENNESSEE
(Source: Rubin and Lemiszki, March 1992)

Figure 4

The orientation of the rock layers, with impermeable shale units confining groundwater flow in dolomite and limestone units (Fig. 2), enables us to interpret that the original cave extended a considerable distance to both the northeast and southwest. Clues regarding its original route can be found on the surface today. The finger of geology points toward what may be another abandoned segment of the same cave some 23.8 km (14.8 mi.) to the southwest (Eblen Cave). The large tubular passage in Eblen Cave, at a lower elevation than Cherokee Caverns (≈ 820 feet msl), is consistent with the slope typically found along phreatic cave passages. In December of 1992, three cavers discovered another large segment of tubular cave passage between Cherokee Caverns and Eblen Cave, named Copper Ridge Cave (Fig. 3). The entrance to Copper Ridge Cave lies 16 km (10 mi.) southwest of Cherokee Caverns, is in direct alignment with these caves, and has passage dimensions upwards of 15 m (50 ft.) high and wide. Today, streams flow, sometimes perched on clay, within these isolated cave segments (e.g., Copper Ridge and Eblen caves) as they descend to the Clinch River. The presence of other, as yet undiscovered, intermediary segments is further suggested by sinkholes and sinking streams directly aligned with Cherokee Caverns. Along this alignment, ridge segments with elevations above 900 feet msl may preserve other pieces of the geologic puzzle.

Is it possible that the known passages in Cherokee Caverns may be extended further to the northeast? Surveying has shown that most of the large passage in Cherokee Caverns lies above 925 feet msl., reaching elevations up to 973 feet msl. Hydrologically, there is no doubt that Cherokee Caverns once received tremendous volumes of water. The original catchment basin tributary to the cave must have extended many miles to the northeast in order to provide a continuous supply of water capable of completely filling the river passage. However, a short distance beyond the known terminus of the cave, a tributary to the Beaver Creek has cut down to an elevation lower than the ceiling of Cherokee Caverns (to approximately 960 feet msl). It is likely that resultant passage collapse has completely blocked the northeastern end of Cherokee Caverns. However, several low level crawlways are found near the northeastern end of the cave. There is some potential that these crawlways could be dug open and extended, possibly bypassing or routing through the surface collapse area. It is also possible that probing in sinkholes northeast of this tributary will successfully open a route into yet another segment of the original Cherokee Caverns. There is little doubt that other pristine segments of the original river passage silently await the explorer.

ACKNOWLEDGMENTS

Heartfelt thanks are extended to the cavers who contributed to this study, spending hours surveying underground and on the surface: Gareth J. Davies, Scott Dixon, Peter J. Lemiszki, Dwayne Mize, Philip S. Neuhoff, and Bruce Zerr. Peter Lemiszki deserves a special note of thanks for expertly putting the concepts portrayed in the figures in black and white. Peter Lemiszki and Linda Armstrong provided valuable editorial suggestions. Jack Thomason provided the base map used to illustrate the cave's trail, pillars, and shear fracture zone. Victor Schmidt, formerly of the University of Pittsburgh's Rock Magnetism & Paleomagnetism laboratory contributed paleomagnetic dating and analysis of oriented sediment samples. Finally, the owners and managers of Cherokee Caverns are gratefully acknowledged for their encouragement and unrestricted access to the cave.

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STRUCTURAL AND STRATIGRAPHIC CONTROLS ON CAVE DEVELOPMENT IN THE OAK RIDGE AREA, TENNESSEE

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INTRODUCTION

The Oak Ridge Reservation (ORR) is located in the northwestern part of the Valley and Ridge province in east Tennessee. The Valley and Ridge province is the topographic expression of the southern Appalachian foreland fold–thrust belt, which formed during the late Paleozoic Alleghanian orogeny. In the Oak Ridge area, three major northwest verging thrust faults (Kingston, Whiteoak Mountain, and Copper Creek) imbricate and juxtapose carbonate and clastic stratigraphic units that range in age from the lower Cambrian to the lower Mississippian (Fig. 1). The carbonate stratigraphic units range in thickness from 1278 to 1748 m and include the Maynardville Limestone in the Conasauga Group (hereby included as part of the Knox Group), the Knox Group, and the Chickamauga Group. Stratigraphic relationships and repetition of units by thrust faulting has produced three northeast striking and southeast dipping carbonate bands bounded to the northwest and southeast by noncarbonate units (Fig. 1). Preliminary results indicate that within two of these carbonate bands, formations composed of mudstone and argillaceous limestone appear to further subdivide groundwater basins. Our efforts have focused on relating the stratigraphic and structural characteristics of these rock units with cave development in the region.

Understanding the relationship between conduit development and bedrock geology is important on the ORR because the presence of mature karst indicates the potential for rapid transport of contaminated groundwater from waste disposal sites. Various approaches are being used to examine this relationship. Because many wells have been drilled on the ORR, drilling logs are being used to infer the intensity of subsurface cavity and conduit development with respect to different stratigraphic units. Both recent and prebuilding construction topographic maps have been used to inventory surficial karst features above particular stratigraphic units. Once these karst features are identified, field work has involved describing known, as well as exploring for previously unrecognized surficial karst features. Finally, regional downcutting and karstification since the Pliocene has resulted in the preservation of sometimes large relict cave segments in resistant carbonate ridges of the Knox Group. For example, the strike oriented master conduit of Cherokee Caverns reaches approximately 45 m wide and and least 23 m high, and contains features that record very slow fluvial erosion alternating with periods of rapid erosional dissection. Since the formation of these caves is similar to others beneath the ORR, information from them can, by analogy, be used to infer the characteristics of presently active karst systems. Information of this type is needed for developing groundwater testing and monitoring strategies, and for characterizing and conceptualizing the base and storm flow response of the karst systems.

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*Managed by Martin Marietta Energy Systems, Inc., under contract DE–AC05–84OR21400 with the U.S. Department of Energy.

Attachment 3

STRATIGRAPHY AND KARST DEVELOPMENT

We are examining whether karst development in the Knox and Chickamauga Groups is affected by changes in: lithology (dolomite vs limestone), bed thickness, insoluble residue content, porosity, and grain size. The element of time, however, is so pronounced in the area that any potential discrepancy in erosional resistance between dolomite and limestone appears to be of little relevance. Although the major carbonate units are the focus of this study, it is important tc note that cavities have been documented in carbonate beds of the Rome Formation and Conasauga Group (Moore, 1988). In fact, although the Rome Formation is composed of predominantly clastic rocks, a thick dolomite sequence does occur which has been associated with the development of a sinkhole.

The Upper Cambrian to Lower Ordovician Knox Group is the thickest unit within each carbonate band (700 to 1000 m) and contains the greatest abundance of surficial karst features (sinkholes, springs, sinking streams, and caves) (Fig. 1). Locally, dissolution within the epikarst has produced enlarged fractures and enterable caves to depths of 15 m, which indicate the minimum vertical extent of infiltration in the quick–flow zone. The stratigraphic characteristics of the Knox Group remain the same within each thrust sheet, which indicates that stratigraphic controls on karst development will be similar within each carbonate band. The Knox Group consists of medium to massively bedded dolomite of various grain sizes, with lesser amounts of limestone, chert, and calcite cemented sandstone. Chert varies from thin, discontinuous lenses and pods that parallel bedding in dolomite, to individual beds ranging in thickness from 2 to 30 cm. It is unknown at this time whether some of the bedded cherts act as insoluble barriers capable of pearching groundwater, but the discontinuous lenses appear to have no effect on cave development. For example, in Cherokee Caverns large phreatic tubes developed in the Copper Ridge Dolomite, which contains numerous horizons of discontinuous chert lenses and pods (Fig. 1). Cave mapping indicates that the development of the passages was not affected by the presence of either the chert horizons, slight changes in dolomite grain size, or changes in dolomite bed thickness.

Subsurface information on cavity development in the Knox Group (and Maynardville Limestone) attests to the intensely karstified condition of this unit. The term cavity will be used to describe any subsurface void encountered during drilling, although most cavities are expected to be integrated with the overall conduit system. Some of these cavities contain sediments, indicating groundwater flow through conduits and their relative connectivity. For example, in the Whiteoak Mountain thrust sheet more than 50% of the wells drilled intersect cavities. This is an extraordinarily large percentage when compared to the predicted percentage of 0.04 for karst terranes (Quinlan and Ewers, 1985). In addition, Moore (1988) studied 21 Knox wells from throughout the ORR and found cavities in all of them that range in size from 0.03 to 8.5 m. Because of the difficulty in determining individual formations in the Knox Group based on well logs, however, the relative percentage of cavities in each formation is unknown. The maximum depth of conduit development will be controlled by factors such as: (1) the presence of underlying predominantly noncarbonate units of the Conasauga Group; (2) the maximum distance between recharge and discharge points; and (3) local and regional baselevels. Maximum cavity depths encountered during drilling are at least 30 m below the invert of the Clinch River.

The Middle and Upper Ordovician Chickamauga Group comprises the remaining portion of each carbonate band (Fig. 1). Although composed primarily of limestone, the stratigraphic characteristics of the Chickamauga Group vary within each thrust sheet, because of sedimentologic facies changes. Within the Chickamauga Group are a number of formations consisting of thick bedded mudstone, calcareous siltstone, and argillaceous limestone, which may not be cave formers and may separate cave systems in adjacent units. For example, at the base of the Chickamauga Group in the Kingston thrust sheet is the Pond Springs Formation (Fig. 1). The lower part of the

Pond Springs is approximately 50 m thick and consists of fine grained, thick bedded, micritic limestone. The upper part of the Pond Springs ranges from 50 to 100 m thick and is composed of mudstone with some micritic limestone and thin chert beds. Overlying primarily the lower part of the Pond Springs is a large, elongated sinkhole parallel to bedding strike that captures runoff from a large drainage area. The presence of the sinkhole proves the existence of subsurface conduits in the area, but the shape and position of the sinkhole appears to be influenced by the location of the mudstones in the upper Pond Springs.

The existence of an intensely karstified Chickamauga Group in the Kingston thrust sheet has been interpreted based on drilling and building foundation boring results at the K–25 site. Analysis of geologic logs from 74 carbonate wells in the area revealed that 34% of the wells intersected cavities. In addition, flowstone was found in two of the deep cavities indicating that they were formerly air–filled caves, which may still operate as exit pathways. The lack of detailed surface mapping and coring in the area, however, precluded an analysis of cavity development with respect to individual formations.

In the Chickamauga Group in the Whiteoak Mountain thrust sheet, the Rockdell, Benbolt, and Witten Formations are the purest and thickest limestone sequences (Fig. 1). The rest of the formations consist of mudstone, calcareous siltstone, argillaceous limestone,with minor amounts of micritic limestone and chert. A major potential barrier to downdip oriented conduit development is the Fleanor Shale, which is predominantly a 75 to 80 m thick mudstone and calcareous siltstone. Besides the presence of springs and a few sinkholes, however, data pertaining to the intensity of karst development in the Chickamauga Group are based on drilling results. Two across strike drilling transects at the X–10 site sampled every unit in the Chickamauga Group, but did not encounter any large conduits (Fig. 1; Lozier and Pearson, 1987). Although drilling results do not provide any information on large conduit locations, packer test results do provide information on the slow–flow zone. Groundwater in the slow–flow zone moves primarily in fractures, because of the low matrix porosity and permeability of the rock units. Core logs indicate that units comprised primarily of limestone are intensely weathered along bedding planes at all depths, but units composed of primarily mudstone appear more resistant to weathering. Highly weathered zones exhibit hydraulic conductivity values ranging from 10^{-5} to 10^{-6} cm/sec, whereas the weathering resistant zones exhibit hydraulic conductivities in the range of 10^{-8} cm/sec or lower (Lozier and Pearson, 1987).

The use of the aforementioned drilling results to interpret the intensity of karst development in the Chickamauga Group in this carbonate band is misleading, because drilling along strike towards the southwest intersected numerous cavities of various sizes. Investigations for the Clinch River Breeder Reactor site incorporated the acquisition of 24 coreholes over an area of approximately 0.16 km^2 (Fig. 1; Seay, 1973). The coreholes range in depth from 45 to 60 m and sampled the lower half of the Chickamauga Group. A total of 144 cavities were intersected in 22 of the 24 holes. Cavity heights ranged from 0.04 to 4.3 m, with 100 cavities smaller than 0.3 m, 30 cavities between 0.3 and 0.9 m, 10 cavities between 0.9 and 1.5 m, one 2.3 m cavity , and one 4.3 m cavity. In addition, during foundation construction a number of cavities were revealed with average diameters of 0.5 to 1 m. The largest cavities occur in the thick to massive limestone beds of the Rockdell Formation. A small scale tracer test conducted in an excavated cavity located in the Rockdell Formation indicates that the cavity is part of a conduit system with flow to the northeast parallel to bedding strike (Melroy, 1986). In addition, a surprising number of small cavities are present in the mudstone–rich Fleanor Shale (Fig. 1). The cavities are suspected to have formed in isolated, fractured limestone beds within the mudstone. These results (1) emphasize the variable results that can be obtained by drilling in a karst terrane, and (2) indicate that extensive cavity development may occur even in the very impure limestone units.

STRUCTURE AND KARST DEVELOPMENT

Map scale folds and thrust faults are responsible for the position and orientation of the carbonate bands across the ORR. One important aspect of the macroscopic thrust faulting is the change in stratigraphic characteristics of the Chickamauga Group in each carbonate band. A change in stratigraphy can lead to differences in karst development, and therefore the characterization of one carbonate band will not properly describe another. A second major influence folding and thrusting can have on cave trends is a result of local changes in the strike and dip of bedding (Palmer, 1991). In the K–25 area, complex bedding orientations are associated with the southwest hinge of the East Fork Ridge syncline and the development of the Whiteoak Mountain fault (Fig. 1). In general, both faulting and folding are responsible for a rotation in bedding orientation towards the northwest, which can affect the trend of vadose and phreatic cave components. Bedding orientations at depth are also expected to vary in this complex zone of deformation, although along strike away from K–25, bedding orientations maintain a fairly consistent northeast strike and southeast dip. In the Whiteoak Mountain thrust sheet carbonate band, the strike and dip of bedding is N50°E / 40°SE, and maintains a fairly constant orientation across the area. The consistency in bedding orientations in this carbonate band aids in the prediction of potential conduit pathways and discharge points. The less steep dip of bedding (10–15°SE) in the Copper Creek thrust sheet is responsible for the large width of the carbonate band. Bedding in this carbonate band maintains a fairly consistent northeast strike, but subtle changes in bedding dip towards the southeast may influence cave trends. For example within Cherokee Caverns, three superposed large phreatic passages are oriented parallel to the strike of bedding and appear unaffected by bedding dip (Fig. 1). On the other hand, Copper Ridge Cave is a large vadose passage that meanders in a downdip direction. Minor vadose infeeders in this cave also meander downdip with dip–parallel segments locally following a near vertical, northwest striking fracture set, and strike–parallel segments tending to follow bedding strike. Another important result of folding and thrusting is that dipping bedding exposes numerous bedding planes to weathering. Exposures in the Knox Group commonly contain weathered bedding planes that appear to be a primary source of surface water infiltration.

The fracture system in the area consists of both systematic and nonsystematic fracture sets comprised of extensional, hybrid, and shear fractures (Price and Cosgrove, 1990). The systematic fractures are considered to influence cave development because they are planar, have relatively long lengths, and maintain a fairly consistent orientation. The major systematic fracture sets are normal to bedding, strike northeast and dip moderately northwest, (referred to as strike–parallel) and strike northwest and dip steeply to the northeast or southwest (referred to as strike–perpendicular). The orientation of these two fracture sets suggests that they may serve to guide the initial development of both strike–parallel and downdip cave passages. For example, within Cherokee Caverns, a strike–parallel, left–lateral shear fracture zone can be traced for 200 to 300 m along the ceiling of the cave before being concealed by cave formations. The fracture zone consists of a set of fairly continuous shear fractures, with a local increase in minor fracturing associated with the shear fracture tips and stepover zones. Unfortunately, whether the position of the cave only aided recognition of the fracture zone or whether the increased fracture frequency associated with shear fracture development guided the initial trend of the cave cannot be determined. Solutional enlargement of fractures, however, is clearly evident in surface and cave exposures. Furthermore, faults observed in exposures of the Knox Group are often associated with a local increase in the frequency of fracturing, which appear to develop as preferred zones of dissolution.

In the Oak Ridge area, outcrop fracture spacing is partly a function of rock elastic moduli (Young's Modulus and Poisson's ratio) and the thickness of the fracturing unit. If either the thickness of the fracturing unit or value of the elastic moduli increases then the fracture spacing also increases.

The size of a fracturing unit is closely related to bed thickness in interbedded clastic rock types. In carbonates, bedded sequences of similar lithologies tend to deform as one thick unit, which will result in a wider fracture spacing, but also tends to produce very long fractures. Therefore the development of long fractures intersecting a number of bedding planes can enhance surface water infiltration and serve as avenues for solutional enlargement. Furthermore, cherts commonly have a very close fracture spacing, because they tend to be thin bedded and are more brittle then the surrounding carbonates. The highly fractured characteristic of the chert beds may cause them to be easily breached and prevent them from being insoluble barriers. In addition, the intense fracturing of the chert beds will increase their effective permeability and enhance infiltration, which may cause preferential solutional enlargement in the adjacent carbonates.

In summary, karst development in the Oak Ridge area is primarily within the Maynardville Limestone, Knox Group, and Chickamauga Group. Specific formations within the Chickamauga Group (e.g., Pond Springs and Fleanor Shale), however, appear to have fewer karst features and may act as insoluble barriers to conduit development. The combined effects of bedding dip, faults, and fractures in the carbonates act as important infiltration pathways and sites for initial cave development. Groundwater flow is constrained to the southeast and northwest by noncarbonate units, resulting in strike–parallel cave systems. Future studies of the karst systems in the Oak Ridge area will include: (1) definition of groundwater basins; (2) continuous monitoring of hydrographic and chemical response in conduit wells and springs; (3) tracer tests; (4) geophysical surveys; and (5) drilling of predicted subsurface conduits.

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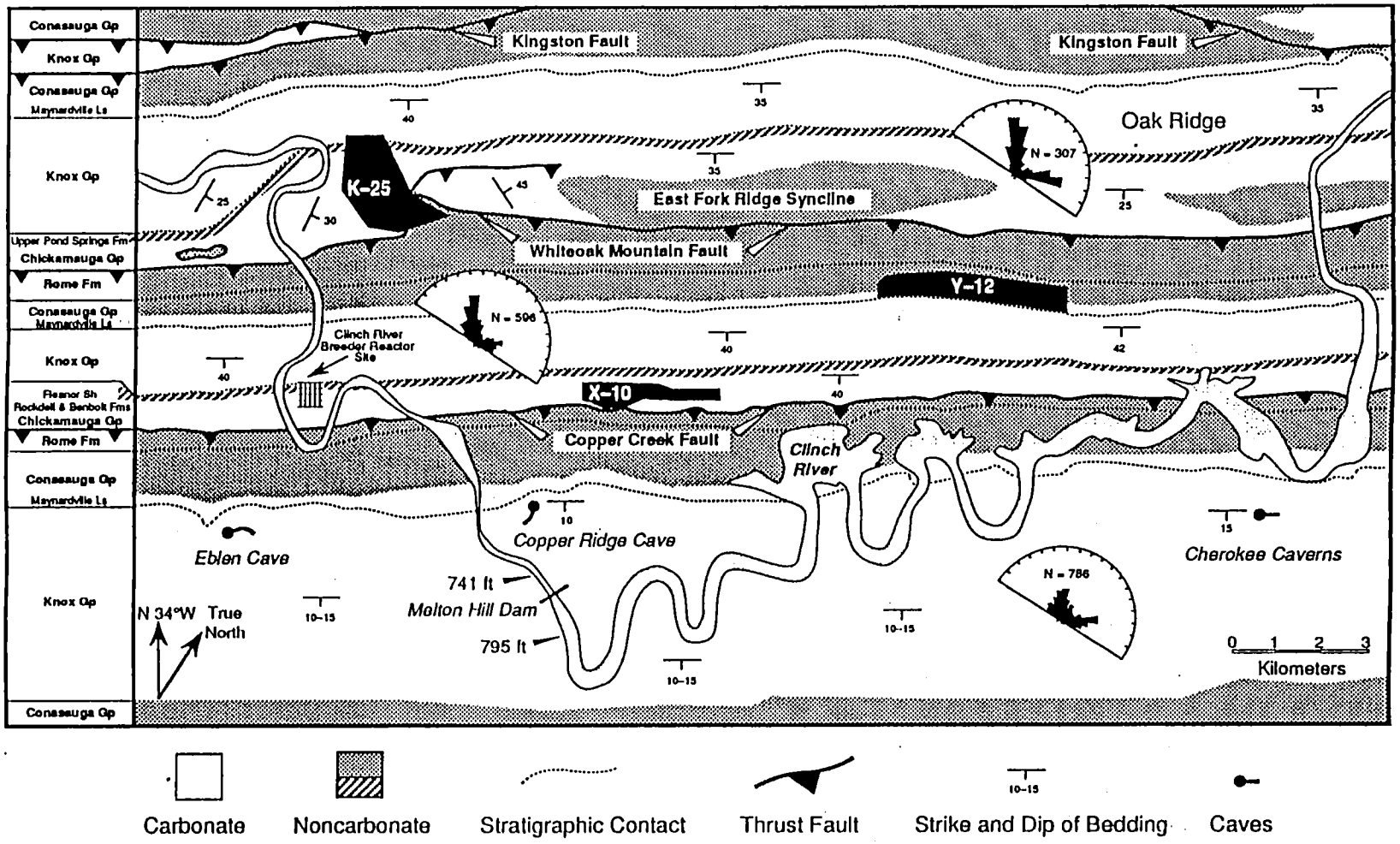

Figure 1 Generalized geologic map of the Oak Ridge area, with place names referred to in the text, and associated carbonate and noncarbonate groundwater flow systems. The Maynardville Limestone, Knox Group, and Chickamauga Group are the stratigraphic units comprising the carbonate bands in each thrust sheet. Individual formations discussed in the text are of smaller type size and listed adjacent to their approximate map position. Measured strikes of the systematic fracture sets in each thrust sheet are plotted on rose diagrams, and indicate that the dominant fracture sets strike to the northeast and to the northwest.

ATTACHMENT 4

SELECTED PUBLICATIONS FROM PROFESSIONAL AND PERSONAL RESEARCH

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