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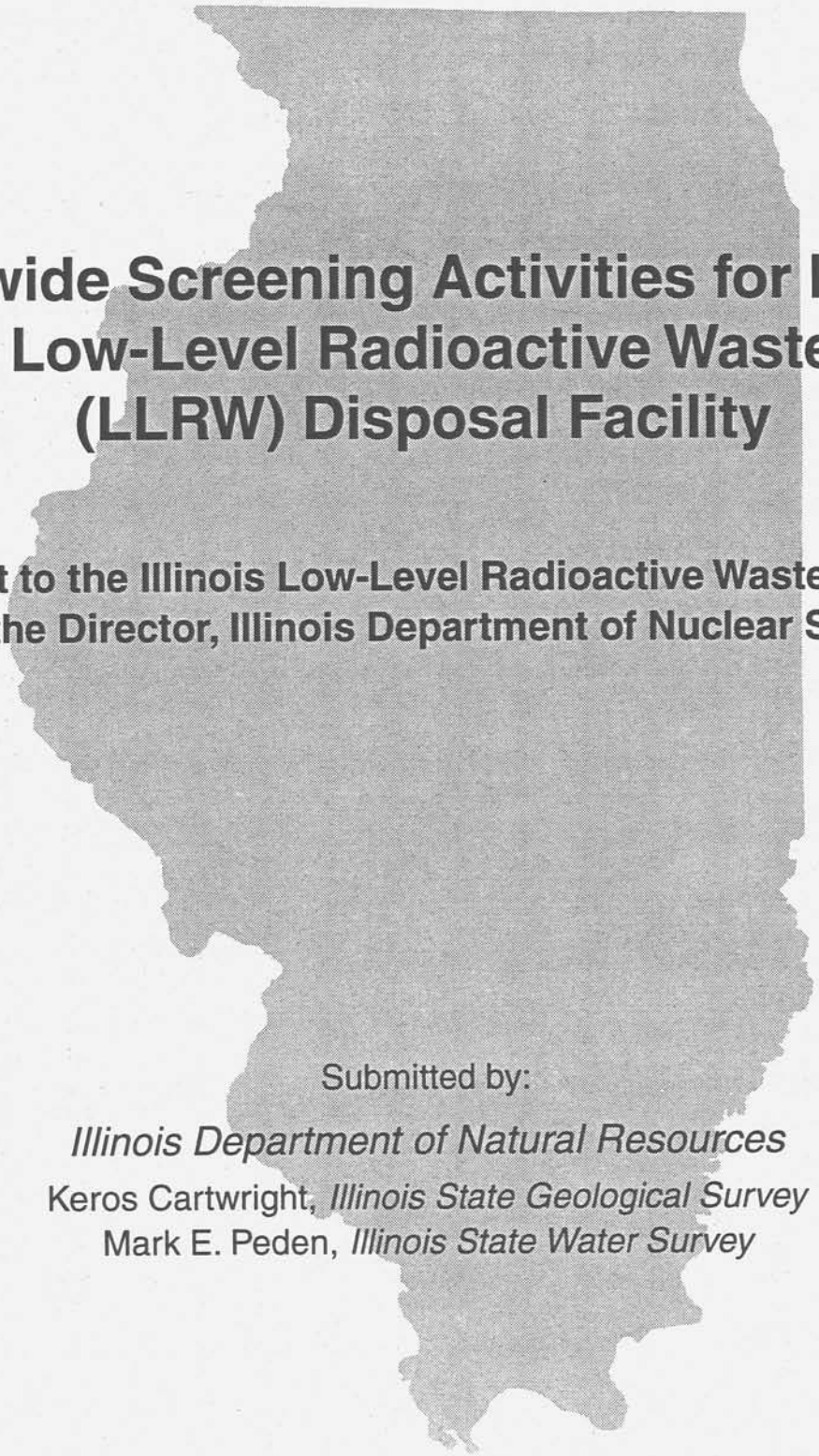

Statewide Screening Activities for Illinois' Low-Level Radioactive Waste (LLRW) Disposal Facility

Final Report to the Illinois Low-Level Radioactive Waste Task Group and the Director, Illinois Department of Nuclear Safety

Submitted by:

Illinois Department of Natural Resources

Keros Cartwright, *Illinois State Geological Survey*

Mark E. Peden, *Illinois State Water Survey*

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INTRODUCTION

Public Acts 87-1267 and 88-458, which amended the Illinois Low-Level Radioactive Waste Management Act, were signed into law by Governor Jim Edgar on March 3, 1993, and August 20, 1993, respectively. These Acts created a Low-Level Radioactive Waste Task Group charged with developing "proposed criteria for selection of a site for a facility for the disposal of low-level radioactive waste away from the point of generation." The Illinois State Geological Survey (ISGS) and Illinois State Water Survey (ISWS), Divisions of the Illinois Department of Natural Resources, were named in the Act as the parties responsible for screening the state to "identify at least ten locations, each of at least 640 acres, that appear likely to meet the criteria" adopted by the Task Group. The Scientific Surveys were also charged with evaluating "any location of at least 640 acres that is volunteered by a landowner or unit of local government to determine whether the volunteered location appears likely to meet the criteria." Volunteer sites were to be in addition to the ten or more locations identified by the Scientific Surveys.

Task Group members were appointed by Governor Edgar in December 1993, and first met in January 1994. Staff members from the Scientific Surveys attended this and all subsequent Task Group meetings until the siting criteria were adopted on December 19, 1996. Scientific Survey staff provided testimony related to hydrologic and geologic issues discussed by the Task Group during these meetings. Five public meetings and two public hearings were held during the course of the criteria development. Scientific Survey staff presented exhibits that described their role in the siting process at each of these public forums.

While the Task Group developed draft criteria, the Scientific Surveys prepared an implementation plan based on the draft criteria document. This implementation plan, presented to the Task Group on May 2,1996, described the screening and selection approach the Scientific Surveys would use to identify ten or more locations that appeared likely to meet the Task Group's criteria. The implementation plan was presented as a dynamic document, subject to modifications pending the final wording of the Task Group criteria upon adoption.

The screening process began on a statewide scale with the focus on smaller areas to come later. The process was designed to examine all land in the state using all appropriate information available at the time of the screening effort to identify at least ten locations that appeared likely to meet the Task Group criteria. The screening plan used the Geographic Information System (GIS) developed by the Scientific Surveys during the past 13 years. The Scientific Surveys maintain extensive statewide databases of natural resources information that were essential to the screening process. The GIS was ideally suited for integrating both existing and selected new data sets that were available at various map scales.

The implementation plan summarized each draft criterion and discussed which database(s) would be used to address it. Some criteria would necessitate updating existing databases before their use in the screening process. Some criteria would require the development of new GIS databases. Database development work by the Scientific Surveys began prior to publication of the draft criteria document and was ongoing throughout the Task Group's deliberations in an effort to provide the most current map data possible. It was recognized by the Task Group that not all the criteria could be fully addressed by the Scientific Surveys.

The discussions of individual criteria contained in the implementation plan also described the phase of the screening process at which each criterion would be addressed. For instance, databases that were developed statewide at a scale of 1:500,000 or smaller would be used during the preliminary statewide screening phase to eliminate large tracts of land from further consideration by the Scientific Surveys. Examples include maps showing seismic risk potential and groundwater resources. Databases that were most relevant at the locational stage of the screening process would be applied after the preliminary screening was completed. Examples of these types of databases include the locations of private water wells, known occurrences of threatened and endangered species, and the locations of mines, quarries, and gravel pits.

The Scientific Surveys' implementation plan provided a process and a time line whereby ten or more locations would be identified at the conclusion of their screening program. This process involved the preparation of new, more detailed maps at a scale of 1:100,000 for areas not eliminated by the initial statewide screening and limited field reconnaissance to verify the geologic and hydrologic data known for a specific area. Field reconnaissance would have included activities such as well location verification, seismic refraction profiling, aerial photography reviews, outcrop studies, and other investigations to verify information contained in the GIS map coverages and U.S. Geological Survey topographic maps. These activities would not have included procedures such as drilling, well construction, water well pump tests, or water or sediment testing.

The Scientific Surveys' role under the 1993 revisions to the Low-Level Radioactive Management Act included the evaluation of sites volunteered by a landowner or a unit of local government to determine whether the sites appear likely to meet the Task Group's siting criteria. Volunteered sites were accepted for consideration beginning on December 19, 1996, and ending 60 days after publication of the criteria. Rules for the volunteer site process were adopted January 8, 1996, and made available to the Scientific Surveys for their use in the volunteer site evaluation process. During the 60 days following the adoption and publication of the Task Group criteria, two sites were volunteered by private landowners, one in Wayne County near the town of Jeffersonville (Geff) and a second in McLean County near the village of Ellsworth. The McLean County site was withdrawn from further consideration on June 11, 1997 at the request of the landowner. The Scientific Surveys' evaluation of both sites is contained in the body of this report, because the evaluation of the McLean County site was already completed at the time the site was withdrawn.

During the Spring 1997 session of the Illinois General Assembly, legislation was introduced that would modify the siting process and alter the role of the Scientific Surveys. This legislation was passed by the Illinois House and Senate and signed into law by the Governor on June 26, 1997 as Public Act 90-29. The amendment to the 1993 Low-Level Radioactive Waste Management Act stated, "By September 30,1997, the Scientific Surveys shall (i) complete a statewide screening of the State using available information and the Scientific Surveys' geography-based information system to produce individual and composite maps showing the application of individual criteria; (ii) complete the evaluation of all land volunteered before the effective date of this Amendatory Act of 1997 to determine whether any of the volunteered land appears likely to satisfy the criteria; (iii) document the results of the screening and volunteer site evaluations in a written report and submit the report to the chairman of the Task Group and to the Director; and (iv) transmit to the Task Group and to the Department, in a form specified by the Task Group and the Department, all information and

documents assembled by the Scientific Surveys in performing the obligations of the Scientific Surveys under this Act."

This Amendatory Act significantly altered the Scientific Surveys' work plan by moving the time line for their final report from March 1998 to September 30, 1997. The wording of the amendment also eliminated the requirement for the Scientific Surveys to identify ten or more locations likely to meet the criteria. Under the revised law, the Scientific Surveys are to produce statewide maps showing the application of individual criteria as well as a composite map. Field reconnaissance activities were eliminated from the Scientific Surveys' work plan, as were the tasks related to locational screening. The resulting work product consists of maps and GIS databases that may provide useful information in the future for site selection, characterization, and licensing. This report fulfills the requirements of the amended act and documents the results of the statewide screening and volunteer site evaluations.

PROJECT QUALITY ASSURANCE

Development of the Quality Assurance Plan

The principal purpose for developing a Quality Assurance (QA) Plan was to assign clear responsibilities for project personnel and to provide written technical and QA procedures to support, guide, and document the quality of the work performed. This section describes the QA plan developed by the Scientific Surveys and documents the procedures used to ensure compliance with the QA plan The Illinois Low-Level Radioactive Waste Disposal Facility Screening Project Quality Assurance Plan was developed by the Scientific Surveys. The QA plan sets forth the policy and requirements for the Illinois State Geological Survey and Illinois State Water Survey to follow during the course of the project.

The QA plan was written to address all project activities and to ensure that the appropriate level of QA was planned and implemented. The QA plan applied to all project participants and copies of the QA plan were issued to all project staff members for use as a reference for effective management and as a basis for overview of the QA objectives.

A QA manager was appointed at each Survey and was responsible for developing and maintaining the QA plan. The QA plan was implemented principally through clear assignment of responsibilities and written technical and QA procedures. The QA plan defined responsibilities and requirements to ensure that procedures were established to guide project tasks including documentation, data acquisition, field activities and sampling, technical reviews, computer software, and data management.

The effectiveness of the QA plan was verified through periodic internal technical reviews conducted by project management staff. The internal reviews were carried out to verify conformance to established requirements detailed in the QA plan. During the internal reviews, field instruments, databases, data security, data completeness, and GIS coverage development protocols were reviewed. Corrective actions were implemented to resolve any deficiencies noted during the review process.

Technical Procedures

The nature of the LLRW project demanded that the highest possible quality be attained when staff generated GIS data sets for the statewide screening. A series of technical procedures was developed to address this need. These procedures required documentation of GIS processing and ensured consistent handling of the GIS data sets. An additional technical procedure addressed the use of a global positioning system (GPS) to collect location data in the field.

The purpose of the technical procedures was to establish the requirements for technical tasks associated with the project. Technical procedures were written to ensure that the collection and mapping of data were planned, executed, documented, and evaluated. Part of the QA plan established the responsibilities and requirements for technical activities to verify conformance to specified requirements and to demonstrate that activities and equipment will perform their intended function.

To prepare for the statewide screening, staff members at the Scientific Surveys focused on preparing GIS databases for the screening process, writing technical procedures for several GIS related tasks, and compiling documentation (metadata) for many data sets.

Database preparation involved extensive review of existing databases via a detailed quality assurance component. Maps were plotted from the GIS coverages and compared to original source maps and features were corrected to line-width accuracy. A coverage consists of two components, a graphic component that contains the points, lines, or polygons that comprise the map and a set of tables that contains the attributes of each graphic element. Coverage tracking sheets were created to document steps completed in the QA review process. Pertinent information was recorded including root mean square (RMS) errors when new digitizing was performed, topology processing information, and information about who performed the QA checking and when it was completed. Several new coverages were created for the screening process using the QA guidelines. Metadata files were created using Arc/Info's DOCUMENT feature for both existing and new coverages. Arc/Info is a GIS software supplied by the Environmental Systems Research Institute (ESRI) of Redlands, CA

The technical procedures were written to establish consistency in data processing because several staff members were involved with creating and checking the database and coverages. These procedures were developed to provide a "how to" guide and to establish standards necessary for many of the processes that are specific to the GIS software used at the Scientific Surveys. Some of the procedures developed include those for well data entry, coverage digitizing, coverage processing, metadata documentation, raster/vector coverage conversion, and GPS operation. These procedures were developed to ensure that appropriate and consistent steps were followed and to ensure consistency and maintain high standards for processing GIS data.

All technical procedures were written in the same format to ensure consistency between the Scientific Surveys. This format included: area covered or the scope of the procedure; author names; issue date; revision number, and signatures of the author(s), LLRW Project Director, and LLRW QA Manager. The Project Director and QA Manager were responsible for maintaining complete copies of all current technical procedures. The QA Manager was responsible for maintaining an archive of all procedures. It was required that technical procedures include specifications for key equipment such as digitizers, global positioning systems, plotters, and software (name and release number). The QA plan required that references to other technical documents be included where appropriate.

Well Data Entry

The ISGS has a large repository for hundreds of thousands of pieces of information pertaining to the geology of Illinois. These include logs of water well borings, oil and gas wells, as well as engineering borings, geologic field notes, and a large variety of geologic test borings. Prior to the LLRW project, digital data for wells and boring were incomplete and in need of update and verification for use in location screening. The digital well database consists of two large files. A "header" file contains general information about the well, i.e., property owner, location, driller, date drilled, and type of well. This header database is related to a "units" file by a unique well identification number. The units file contains a listing of the geologic descriptions of the materials encountered while drilling the well. A major effort was initiated to enter well logs that had not been automated and

to verify previously automated well records. The well database technical procedure consists of three internal documents: Well Database Guidelines for Data Handling, Well Data Entry System Field Explanations and Descriptions, and a list of accepted well status codes and abbreviations.

The ISWS is the repository for over 1.5 million documents pertaining to Illinois' groundwater resources. These documents include water well construction reports, community and noncommunity resource reports, water quality analyses, engineering reports, well and aquifer test analyses, miscellaneous hydrologic field notes, and a vast array of historical information on private and public groundwater supplies in Illinois. Information pertaining to water wells is available from two distinct databases. The Private Well database includes general information for over 200,000 wells and includes such items as the property owner, location, driller, type of well, water level, and pumping rate. The Public Industrial Commercial Survey (PICS) database includes similar detailed well information for all community water supply and large industrial (well pumpage greater than 70 gallons per minute) facilities in Illinois. Three other databases (Water Quality, Aquifer Properties, and Water Level) house additional water resource information collected and maintained by the ISWS. A major effort was undertaken to complete the computerization of groundwater resource information that had not been automated prior to the start of this project.

Map Digitizing

Map digitizing that included both manual digitizing and scanning techniques was used to create new map coverages as well as update and correct existing coverages. Many variables needed to be addressed to accurately develop each map in digital form, mostly due to the large variety of maps available. Several characteristics of the hard copy map affected settings and tolerances acceptable in the digital version. These included, but are not limited to, original map scale, medium on which the map was printed, physical condition of the map, and the amount of care taken in making the map.

The map digitizing technical procedure provides the steps needed to create coverages, including acceptable values for tolerance settings and RMS values (amount of error between original and new coordinate locations calculated by the transformation process). Steps taken to ensure an accurate and consistent product included a check of the digitizing board for proper operation, listing RMS tolerances acceptable for various scale maps, listing of acceptable editing tolerances (also based on scale), and detailed instructions for consistent digitizing. Additional steps included use of maps on a stable base (mylar), use of original work maps (which were often drawn at a larger scale than the final published version), and checking digital products carefully to ensure the work is within line-width accuracy.

RasterA/ector Conversion

Raster to vector conversion of scanned images was another method of coverage automation used for this project. Maps were scanned to create an image file that was processed using available software routines in Arc/Info. This technical procedure specified the steps for digitizing the map, rectifying the images to real world coordinates, importing the rectified image, processing and "cleaning up" the grid, and converting the grids to coverages. Once the coverage was created, a number of methods were used to edit the coverage and assign attributes. These methods were

specified in the Coverage Processing and Quality Assurance Review technical procedures. Quality assurance tracking sheets similar to the ones developed for manual digitizing were created to record pertinent information.

Coverage Processing and Quality Assurance Review

This technical procedure described the method used for checking the digital map file accuracy, coverage processing and editing techniques, and project QA (a multi-step operation). A QA tracking sheet was developed to record all information pertaining to the coverage automation procedure. This included RMS values incurred during digitizing, tolerances used for processing the coverage, source map used for digitizing, source and location of tic marks used for registration, and a record of the people who checked the coverage. After the coverage was digitized and checked for line-width accuracy, the line work and coverage attributes were checked by at least two other project personnel to complete the review process. This technical procedure also covered basic coverage processing steps including locating and correcting errors (e.g., polygons that lacked closure), building coverage topology, and assigning map attributes.

Metadata Documentation

Critical to any GIS data set is information about the data from which it was created. The documentation technical procedure specified the technique used to generate metadata for the digital map files used in the screening process. The Arc/Info DOCUMENT command was used to create the on-line metadata. These documentation files include information about the GIS data such as (1) data description (2) intended use, (3) contact individuals, (4) completeness report, (5) technical data parameters, (6) lineage and source documents, (7) record and attribute definitions and descriptions, and (8) other pertinent information.

System Security

The project files developed in support of the LLRW project are controlled by the QA managers at the Scientific Surveys. Documents on file include:

1. QA documents
2. QA checklists of GIS coverages

3. Maps used for QA review of digitizing and editing efforts
4. QA maps for the grid format databases

All GIS coverages, grids, and other documents were stored on disk drives that are part of the Unix workstation networks at each of the Scientific Surveys. Disk space was identified, reserved, and used as project GIS archives at each Survey. The system administrators and the project GIS database administrators were the only persons with write access to the archive directories.

Unix workstations were used for most GIS database operations, including data compilation, editing, analysis, and map production. Personal computers were used to access and view the GIS

databases. Solaris 2.5.1 was the operating system used on the Unix workstations. System backup was performed at regular intervals using magnetic tape systems (8 millimeter and 4 millimeter). Full system backups were performed weekly on all workstations. At the ISWS, a four-tape system was used with a full backup saved every week. At the beginning of a new month, the tapes were rotated and copied over. One tape was stored off site. At the ISGS, all new or revised files were backed up daily with full system backups once every three months. New tapes were used and stored on-site in a fireproof vault. Copies of the full system backup tapes were stored off-site.

The Oracle database management software is used at the ISGS to manage the well database. From the beginning of this project until July 1, 1997, the Oracle software was installed and run on a Digital VAX 3200 workstation. After July 1, 1997, the Oracle software was installed on a Sun UltraSparcstation. All data entry, review, and updates of well information were performed on personal computers via a network connection to these database servers.

Hardware and Software Descriptions

The following hardware was used for this project.

Workstations: SUN SPARCstation 1+, IPX, LX, 2, 5,10, and 20, SUN Ultra 1 Digital Equipment Company VAX 3200

Printers and Plotters: HP 750C Inkjet Plotter, Calcomp Plotter 1044, Calcomp 9500 Series Electrostatic Plotter, Apple LaserWriter Pro, TI Power Pro, Tektronix Phaser U, QMS PostScript Laser, Hewlett-Packard LaserJet, Hewlett-Packard XL300 inkjet printer

Digitizing Boards: Altek AC31, Calcomp, and GTCO

Personal Computers: Dell, Gateway, and Comtrade PCs with 486 and Pentium Processors; Apple Macintosh II, IIsi, and Quadra computers

The following software was used for this project.

Workstation:

Operating Systems. Sun OS 4.1.3, Sun Solaris 2.4,2.5, and 2.51, VMS 5.4.2

GIS. ESRI Arc/Info 7.0, 7.03, and 7.11, ESRI ArcView 2.0, and 3.0

Graphic File Processing. ESRI ArcPress 11.0, Larson Software Technology

Database Software. Oracle 7

Personal Computers:

Operating Systems. Windows 3.11, Windows 95, Windows NT, and Macintosh OS 7.1

GIS. Arc View for Windows versions 2 and 3

Desktop. MS Office 5.0, MS Office 95, and MS Office 97

GEOGRAPHIC INFORMATION SYSTEM (GIS) OVERVIEW

A Geographic Information System (GIS) is an integrated system of computer hardware, software, geographic data, and personnel organized to efficiently capture, store, update, manipulate, analyze, and display all types of geographically referenced (geo-referenced) information.

A GIS uses geographically referenced information that consists of raster (grid cells or pixels) or vector (x,y coordinates) digital data based on a specific map projection or coordinate system. An example of raster data is a satellite image for which information is assigned to each grid cell; for example, color values that indicate vegetation type. Vector data are comprised of points, lines, and polygons. For example, a road map has several roads (lines), road intersections (points), and areas bounded by roads (polygons). These are topological features, and the spatial relationship between them is termed topology. These features can be assigned attributes such as road name, road surface type, and unique identification number. Roads and vegetation are just two of the possible themes (or layers) that can be used with GIS software. Other common themes are streams, railroads, municipalities, nature preserves, well locations, and survey control points. The information contained in a theme can be any type of geo-referenced data. Themes used in the Low-Level Radioactive Waste (LLRW) screening process fall primarily into the broad categories of natural resources and infrastructure.

Information in tabular databases is also an important part of a GIS. Relational database software (such as Oracle or dBase) is used to maintain information about map features that are represented in vector or raster format (e.g., sample location numbers, street addresses, thickness measurements for a particular rock unit, or water-depth measurements). Although a tabular database can be used independently of the graphic information (points, lines, polygons, or grids), GIS integrates attribute data with map features to allow both mapping and spatial analysis.

GIS technology provides software that integrates or overlays different types of spatial data. Most types of natural resource and infrastructure data are spatial rather than temporal. The LLRW screening effort is an ideal application of GIS technology. The advantage of using digital, geo-referenced data over traditional paper maps is that numerous computational algorithms are available for analysis of the relationships between various geographic features. The simplest and most common of these techniques are the map overlay and buffer operations. The map overlay feature allows digital map layers to be stacked one on top of another, which facilitates answering spatial queries. The buffer operation typically answers a question regarding the proximity of such features; e.g., to prepare a map of all lands within 1,000 feet of a sensitive stream habitat. The GIS analysis and processing for this project uses combined map overlay and buffer techniques.

Using GIS Technology to Apply Task Group Screening Criteria

The statewide screening process prescribed by the Task Group Site Selection Criteria document deems that natural features such as flood zones, wetlands, mined areas, and public lands are inappropriate locations for a LLRW disposal facility. To address these criteria, standard GIS overlay and buffer techniques were applied to available digital data of appropriate scale, resolution,

and areal extent to produce screening maps and one composite map of these criteria. Several supplemental maps have also been developed. Several issues were considered in generating the maps: (1) use of data appropriate to the criterion, (2) selection of data suitable for statewide representation, (3) data scale and resolution, (4) availability of data documentation, (5) map projection and other technical parameters, and (6) production of final map products. These issues are discussed below, beginning with a description of the map products.

Map Products

Eighteen screening maps and eight supplemental maps were prepared. The screening maps depict the application of each criterion on a statewide basis. The supplemental maps show locations where additional data exist, but are not of the appropriate scale or resolution for inclusion in the screening maps. The supplemental data are useful for indicating areas with additional features that may require consideration for a specific site. All the maps are statewide in areal extent with a scale of 1:500,000. As such, they are too large to be included in this report. Instead, page size versions at a scale of 1:2,750,000 are included for reporting purposes only and do not replace the large format screening maps (which are on file with the LLRW Task Group and the Illinois Department of Nuclear Safety). Each map figure accompanies the discussion of how the criterion was (or was not) applied at the statewide level.

Data Quality and Documentation

The value of GIS products or results are entirely dependent on data quality. Therefore, GIS database maintenance and updates are vital. Much of the geo-referenced data relate to features that can change (such as parcel boundaries and suburban streets), so regular database maintenance is required to keep it current. Other data pertain to more static features (such as a bedrock map of the state), but require updates as new information becomes available. To ensure accurate results during the screening process, considerable time and effort were expended developing, updating, and reviewing the pertinent GIS databases. Each data set used to produce the screening maps underwent digitizing, processing, and quality review as outlined in the Scientific Surveys' technical procedures. Generally, the process was as follows: new data were automated through digitizing or scanning processes. Automated data, both new and existing, were plotted and overlain on a light table with original paper-copy source maps. Stable-base source maps (matte film, known commonly as Mylar) were used if available. Locations of features (points, lines, and polygons) were verified between the digital data plots and the source maps. Digital features within one line-width or point-width of source features were deemed acceptable. Necessary corrections were made, and the tabular data (attributes) associated with each feature were checked and corrected if needed. This process was repeated for each data set as necessary until all features and associated records were acceptable. Some GIS data sets were created strictly through GIS processing and thus do not have corresponding paper-copy source maps. In this case, the processing was verified by Scientific Survey staff. All screening maps were subsequently reviewed by project personnel with technical expertise in various fields. Completed data were stored on the Scientific Surveys' computer systems with controlled access to ensure data integrity, and each data set was thoroughly documented in a metadata file.

Some data shown on the supplemental maps did not undergo equally rigorous review. However, most of these data were intended for use in regional and locational screening stages. They

may be considered reasonably accurate in terms of a general distribution and description of small features, but they require field verification of exact location and areal extent.

Data Scale, Resolution, and Accuracy

Data used in the screening maps have a variety of source scales, generally ranging from 1:250,000 to 1:500,000, but include 1:24,000 (e.g., wetlands) and 1:7,500,000 (e.g., seismic risk). Scale is sometimes expressed using dimensions such as "one inch = one mile." Sometimes it is expressed as a number (or ratio), such as "1:500,000," which is read, "one to five hundred thousand" and is equal to the ratio "one over five hundred thousand." It is translated as "one distance unit on the map equals 500,000 of the same distance units on the earth's surface"; for example, "one inch on the map equals 500,000 inches (about eight miles) on the ground." The advantage of a dimensionless ratio scale is that it allows the map user to measure distances on the map in any units desired; e.g., centimeters, inches, meters, miles, etc. Dimensionless scales also allow for easy comparison of different maps at different scales. The denominator of the scale ratio determines the size at which a feature will appear on a map. On a 1:500,000 scale map, a square mile appears about one-eighth of an inch on a side. On a 1:24,000 scale map, the same square mile appears to be about 2.6 inches on a side. Consequently, to show large areas (such as an entire state) on a single map, a relatively smaller scale (such as 1:500,000) must be used. Many features are shown, but they are all shown at a very small scale and with little detail. Conversely, to show small areas (such as a single township), a relatively larger scale (such as 1:24,000) can be used. Not as many features can be shown, but they are larger and have more detail. (Note that the bigger the denominator the smaller the scale, and vice versa.)

The scale of a map has significant impact on the resolution of the data that can be depicted. On a paper map, resolution is a measure of the smallest distance between two points on the map that can be distinguished as separate. In other words, how close together can two points on a map be placed? As the points are moved together, they begin to appear as a single point. The threshold at which the two points begin to appear as one is the resolution of the map. Features smaller than the resolution of the map cannot be accurately represented because they cannot be seen. Map resolution has a significant impact on data accuracy. Raw data mapped on a base map at a scale of 1:500,000 is only as accurate as the resolution of the base map. A pencil mark at a scale of 1:500,000 represents a swath of land about 300 feet wide. Obviously, only very large, generalized features can be mapped at such a scale.

The issues of scale, resolution, and accuracy had an important effect on the screening maps described in this report. Most data used were mapped at scales of 1:500,000 or 1:250,000. This means that the interior of large areas shown on the maps can be considered to be very accurate, but the exact boundaries of these areas are only known within distances of several hundred feet. Screening maps in this report are intended to indicate large tracts of land in Illinois where data exist to demonstrate potential nonconformity to the site selection criteria. Specific boundary lines between areas likely or unlikely to meet the criteria are not, and cannot be, properly determined by using these maps. Determination of the suitability of specific sites for the location of a LLRW disposal facility can only be accomplished through site-specific studies.

Data scale, resolution, and availability determine which data are suitable for use at a statewide scale and which data are not. As a result, there is not a screening map for every criterion. In some cases the data do not exist (or cannot be well portrayed) in digital format. In other cases, applicable GIS data exist but are not of the appropriate resolution or scale. Such data in the possession of the Scientific Surveys are shown on supplemental maps that show point locations where additional features exist. However, in most cases the areal extent of individual features is not known and may vary from a fraction of an acre to several square miles. The data lack the accuracy and resolution required for inclusion in the screening maps, but they are useful for indicating areas with additional features that may require consideration for a specific site. These data will require field verification.

Map Projection and Base Map Information

A map projection is a specific set of mathematical parameters that define how a three-dimensional curved surface (the earth) is portrayed on a two-dimensional flat surface (the map). All map projections result in some distortion because it is impossible to flatten a curved surface onto a flat surface without making adjustments. The four primary factors that are affected by projection are direction, distance, area, and shape. A projection is chosen to best preserve certain factors, always at the expense of the other factors.

The GIS databases used in this project were developed using a Lambert Conformal Conic projection that has been traditionally used by the Scientific Surveys for GIS data. This projection generally minimizes distortion in all four factors (direction, distance, area, and shape).

The projection parameters are:

1st standard parallel	33° 00'00"
2nd standard parallel	45° 00' 00"
Central meridian	-89° 00' 00"
Latitude of projection origin	33° 00' 00"
False easting	914,400.00 meters
False northing	0.0 meters

These parameters are based on the following geodetic model:

Horizontal datum:	North American Datum, 1927
Ellipsoid:	Clarke, 1866
Semi-major axis:	6378206.4 meters
Flattening ratio:	1/294.98

The planar distance units are Lambert feet.

Some types of data required for the screening process were received in different map coordinate systems and were re-projected to the Lambert Conformal Conic projection system after undergoing quality assurance review.

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Swann, D.H., P.B. DuMontelle, R.F. Mast, and L.H. Van Dyke. 1970. *ILLMAP-A Computer-Based Mapping System for Illinois,* Illinois State Geological Survey Circular 451, Champaign, IL, 24 pp.

APPLICATION OF SITE SELECTION CRITERIA

The Task Group developed 25 criteria to be used both in the initial statewide screening process and in final site selection to ensure the safe disposal of low-level radioactive waste. Each criterion statement included a detailed narrative discussion that explained the intent of the criterion and provided guidance to the Scientific Surveys and the IDNS contractor responsible for site characterization and licensing. Criteria discussions and accompanying maps contained in this chapter are based on the guidance provided by the Task Group in its site selection criteria report published in December 1996. Maps are presented for criteria for which statewide data are available. *These maps are presented for illustration purposes only and are not to be used for screening purposes*. Large format, 1:500,000 scale maps, which more accurately represent the features shown on 8½- x 11-inch maps, are on file with the Task Group and the Illinois Department of Nuclear Safety (IDNS). In cases where statewide maps are not shown for a specific criterion, the accompanying discussion indicates what data are available and at what scale they can be applied at a later stage in the site selection process.

The discussion included with each criterion description has been paraphrased from the Task Group document "Site Selection Criteria for a Low-Level Radioactive Waste Disposal Facility." For a complete discussion of the Task Group criteria, refer to the Task Group's site selection criteria report.

Hydrology and Geology

Criterion 1

The hydrogeologic conditions of the site must inhibit groundwater flow to the extent that groundwater resources are protected.

Discussion. This criterion emphasizes that the hydrogeologic characteristics of a site must protect groundwater. Thus, this criterion favors the selection of a site that has geologic materials and hydrogeologic properties that will minimize groundwater flow, thereby minimizing the potential migration of any radionuclides that may be released from the disposal facility. A site will be considered to satisfy or not to satisfy Criterion 1 based on an evaluation of its hydrogeologic properties acting together as a system and, therefore, the criterion wording specifically avoids listing arbitrary cutoff values of site variables such as depth-to-aquifer and hydraulic conductivity of geologic materials.

The Task Group acknowledged, however, that the Scientific Surveys must use certain mappable threshold values, particularly depth-to-aquifer materials, in their statewide screening process. In this manner, resources can be directed toward investigating areas more likely to satisfy Criterion 1 by eliminating broad areas unlikely to meet the criterion statement. The Task Group provided the following threshold values as guidance to the Scientific Surveys.

Major aquifers that are within 300 feet of land surface should not underlie a location.
Mapped aquifer materials that are within 50 feet of land surface should not underlie a location.

Geologic materials at each location must be dominantly composed of fine-grained materials to ensure that the bulk hydraulic conductivities of the geologic materials are liable to be low enough to favor low groundwater velocities, long travel times, and small volumetric fluxes.

Scientific Surveys' Approach. A number of geologic map databases were combined to satisfy the Task Group's first two recommended threshold values. A list of those map databases appears below. No specific map exists that addresses the Task Group's third recommendation; however, a general assumption can be made that if a location does not fall within areas described by the first two recommendations, then it will likely fall into areas described by the third recommendation.

List of Geologic and Aquifer Map Databases Used to Create Map for Criterion 1

Major Bedrock Aquifers within 300 Feet of Land Surface
Major Sand and Gravel Aquifers within 300 Feet of Land Surface
Unconsolidated Permeable Materials within SO Feet of Land Surface, including the following geologic units:

- Cahokia alluvium
- Parkland sand
- Equality Formation, Dolton Member
- Henry Formation
- Sand and gravel within Wedron Formation: within 6 meters (19.7 feet) of land surface
- Sand and gravel within Winnebago Formation: within 6 meters (19.7 feet) of land surface
- Pearl Formation (includes Hagarstown Member)
- Sand and gravel within Glasford Formation: within 15 meters (49.3 feet) of land surface
- Mounds gravel and related units
- Cretaceous sediments, silts, sands, etc.
- Pennsylvanian rocks, mainly sandstones
- Mississippian rocks, mainly limestones, some sandstones
- Silurian and some Devonian rocks, mainly dolomite
- Ordovician and Cambrian rocks, mainly dolomite, some sandstone

Additional significant regional "Minor Aquifers" (within 300 feet depth potentially containing potable water):

Pleistocene Aquifers

a. ISGS/ISWS Cooperative Groundwater Report 8, figure 12, Mahomet sand and all other aquifers in area bounded by Decatur on the west, Champaign-Urbana on the north, Mattoon on the south, and the Illinois/Indiana state line on the east.
b. ISGS/ISWS Cooperative Groundwater Report 17, figure 23, Glasford and Upper Banner formations in southwest McLean and southeast Tazewell Counties.
c. ISGS/ISWS Cooperative Groundwater Report 18, figure 22, sand and gravel in the Mahomet bedrock valley in the Danville area.

Galena-Platteville and Mississippian Limestones

The accompanying map (Figure 1) clearly shows major portions of northern and western Illinois are underlain by aquifer materials within 300 feet of land surface. This is also true of extreme southern Illinois and, to a lesser degree, east-central Illinois. New maps were created to depict the "minor" Galena-Platteville and Mississippian limestone aquifers. Areas of the Galena-Platteville within 300 feet of land surface were determined by subtracting a map of the elevation of the top surface of the Galena from the statewide land-surface elevation to obtain those areas within 300 feet of land surface. Areas of the Mississippian limestone within 300 feet of land surface were created by subtracting the thickness of the Pennsylvanian system from the bedrock topography to get a map of the top of the Mississippian system. The Mississippian surface was then subtracted from the land surface to identify areas within 300 feet of the land surface. Those areas were then edited to show only the areas with limestone (areas of shale and siltstone were deleted).

In addition, where detailed regional aquifer studies have been conducted, the results of these studies have been incorporated into the screening maps as regionally significant "minor aquifers." However, such studies do not cover the entire state. Thus, the aquifer map does not show, and no maps are available that show, on a statewide basis, the locations of all regionally significant "minor aquifers". The presence of aquifers will need to be evaluated for a specific site.

Figure 1. Groundwater Resources

The shaded areas on this map show major bedrock aquifers within 300 feet of the land surface, major sand and gravel aquifers, unconsolidated permeable materials within 50 feet of the land surface, and significant regional minor aquifers where such aquifers are mapped.

Although the major sand and gravel aquifers map suggests it includes aquifers to any depth, in reality the top of all such aquifers probably lies within 300 feet of ground surface and, therefore, this map can be used to satisfy the guidance provided by the Task Group.

The Task Group guidance regarding the predominant presence of fine-grained materials cannot be applied at any scale with current Illinois geographic information system data. Detailed large scale geologic mapping required for such an analysis does not exist, except for significant regional minor aquifers mapped in some areas. Review of geological records for the presence of fine-grained materials should be conducted during the site selection process using data from water well, oil well, and construction boring records maintained at the Scientific Surveys.

Sources

Berg, R.C., and J.P. Kempton. 1988. Stack-unit Map of Geologic Materials in Illinois to a Depth of 15 Meters, Illinois State Geological Survey, Circular 542, Plates 1-4, scale 1:250,000.

Berg, R.C., H.A. Wehrmann, and J.M. Shafer. 1989. *Geological and Hydrotogical Factors for Siting Hazardous or Low-Level Radioactive Waste Disposal Facilities.* Illinois State Geological Survey, Circular 546, 61 p.

Herzog, B.L, S.D. Wilson, D.R. Larson, E.C. Smith, T.H. Larson, and M.L. Greenslate. 1995. *Hydrogeology and Groundwater Availability in Southwest McLean and Southeast Tazewell Counties: Part 1: Aquifier Characterization,* Illinois State Geological Survey and Illinois State Water Survey, Cooperative Groundwater Report 17, figure 23, approximate scale 1:200,640.

Illinois State Geological Survey. 1994. Major Bedrock Aquifers within 300 Feet of Ground Surface, ISGS digital data set aqmb300, ed. 2.0, scale 1:500,000.

Illinois State Geological Survey. 1994. Major Sand and Gravel Aquifers, ISGS digital data set aqmsg, ed. 2.0, scale 1:500,000.

Illinois State Geological Survey. 1995. Stack-unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters, ISGS digital data set stack-st, ed. 2.0, scale 1:250,000.

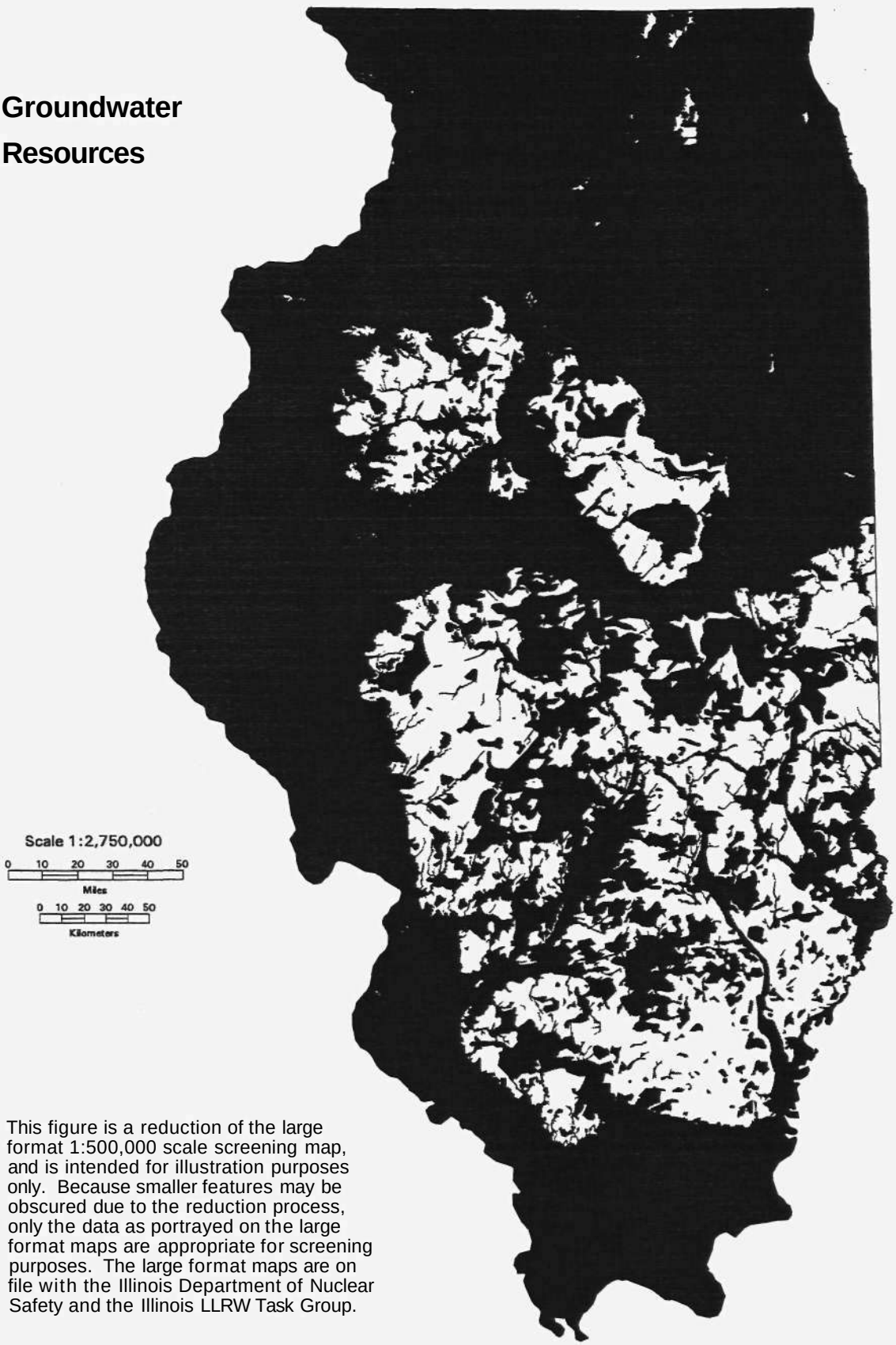
Illinois State Geological Survey. 1997. Galena-Trenton Minor Aquifer within 300 Feet of Ground Surface, ISGS digital data set gal300, ed. 1.1, source scales vary from 1:250,000 to 1:500,000.

Illinois State Geological Survey. 1997. Mississippian Carbonates within 300 Feet of Ground Surface, ISGS digital data set miss300, ed. 1.1, source scales vary from 1:250,000 to 1:3,000,000.

Kempton, J P., W.J. Morse, and A.P. vlsocky. 1982. Hydrogeologic Evaluation of Sand and Gravel Aquifers for Municipal Groundwater Supplies in East-Central Illinois, Illinois State Geological Survey and Illinois State Water Survey, Cooperative Groundwater Report 8, figure 12, approximate scale 1:559,308.

Larson, D.R., J.P. Kempton, and S. Meyer. 1997. *Geologic, Geophysical, and Hydrologic Investigations for a Supplemental Municipal Groundwater Supply, Danville, Illinois,* Illinois State Geological Survey and Illinois State Water Survey, Cooperative Groundwater Report 18, figure 22, approximate scale 1:226,764.

Groundwater Resources



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Criterion 2

Hydrologic conditions at the site must protect public, private, and semiprivate wells and must not be hydrologically affected by the operation of a major well.

Discussion. Although Criterion 2 may be considered redundant with respect to Criterion 1, this criterion was written explicitly to protect existing off-site water supply wells, and shallow private wells completed in glacial till units. To satisfy this criterion, the contractor must demonstrate that the overall geologic conditions at a site, including surficial till units, are likely to protect all existing potable groundwater resources, including groundwater produced from noncommunity, semiprivate, and private wells within 200 feet of the boundary of the site. Further, the Task Group recommended that the boundary of a site not lie within 1,000 feet of a community water supply well. Finally, the contractor must demonstrate that the site will not be affected by operation of an existing well or wells such that a potential release could be induced to migrate off the site to affect a groundwater resource, and that there is a low potential for development of such a well.

Scientific Surveys' Approach. The Scientific Surveys maintain a number of data sets that can be used to address this criterioa Principal to this are the data sets of well locations derived from well records on file at the two Scientific Surveys. Such wells include community wells (both publicly and privately owned), industrial and commercial wells, and private domestic wells.

The number of private well records contained in the ISWS Private Well database exceeds 225,000 wells. The Private Well database was initiated in 1987 and contains well records dating back into the early part of this century. Most of these records were originally created by drillers as they constructed wells for rural homeowners. Hundreds of records were also created from private well inventories conducted by ISWS personnel in the 1920s, 1930s, and 1960s. Locations of many of the domestic wells are often reported only to the nearest 1/4-section (sometimes only to the nearest section). With such a general description, several wells may be plotted at the same location, and apparent well locations may be hundreds to more than a thousand feet from their actual location. In addition, field studies have shown that: 1) private well locations described by drillers' records can be erroneous (for example, records can be sent in with the incorrect township or range, thus providing a well location that is six miles or more from the actual location), and 2) many more wells exist than records indicate (in some instances, the Scientific Surveys may have records for only 50 percent of the wells existing in a region). For these reasons, studies conducted by the Scientific Surveys in a particular region often include well location reconnaissance and verification. For statewide screening purposes, however, such an undertaking would take years, perhaps decades. Therefore, the Scientific Surveys believe that use of private well locational data at the statewide scale is not appropriate and a statewide private well GIS coverage was not created.

The Public, Industrial, and Commercial Survey Wells (PICS) database, maintained by the ISWS, contains descriptive information on all known public, industrial, and commercial wells. The locations for the community wells listed in the PICS database are generally much more accurate than locations for the domestic wells listed in the Private Wells database. Records of community wells listed in the PICS database originate from drillers or the Illinois Environmental Protection Agency and have been verified by ISWS staff. The database contains records for 3,379 active community wells within Illinois. The locations of these community water supply wells, buffered with a 1,000-foot

radius circle as the recommended setback distance by the Task Group, are shown on the accompanying map (Figure 2).

There are 3,372 community wells shown on this map (locations for seven new community wells need to be verified). Included are 1,923 bedrock wells and 1,421 sand and gravel wells supplying water to approximately 1,274 water systems that include communities, mobile home parks, subdivisions, etc. Twenty-six additional wells are classified as producing water from both sand and gravel and bedrock, and another nine wells have no aquifer association. Sand and gravel well depths range from 13 to 438 feet below land surface and bedrock well depths range from 32 to 2,821 feet. Pumping capacities range from 3 to 7,100 gallons per minute for the sand and gravel wells (the latter being a horizontal collector well along the Illinois River) and from 3 to 3,300 gallons per minute for the bedrock wells.

The locations of these community wells, in combination with the aquifer map prepared for Criterion 1, delineate very well the areas to avoid during the site selection process based on the presence of known groundwater resources. This map does not show the area of influence created by the operation of any particular community well, an area that can often exceed 1,000 feet. Further, as. previously stated, this map also does not show the locations of private domestic, commercial, industrial, and irrigation wells. Information on the location of such wells is maintained by the Scientific Surveys and can be more appropriately applied as specific sites are evaluated.

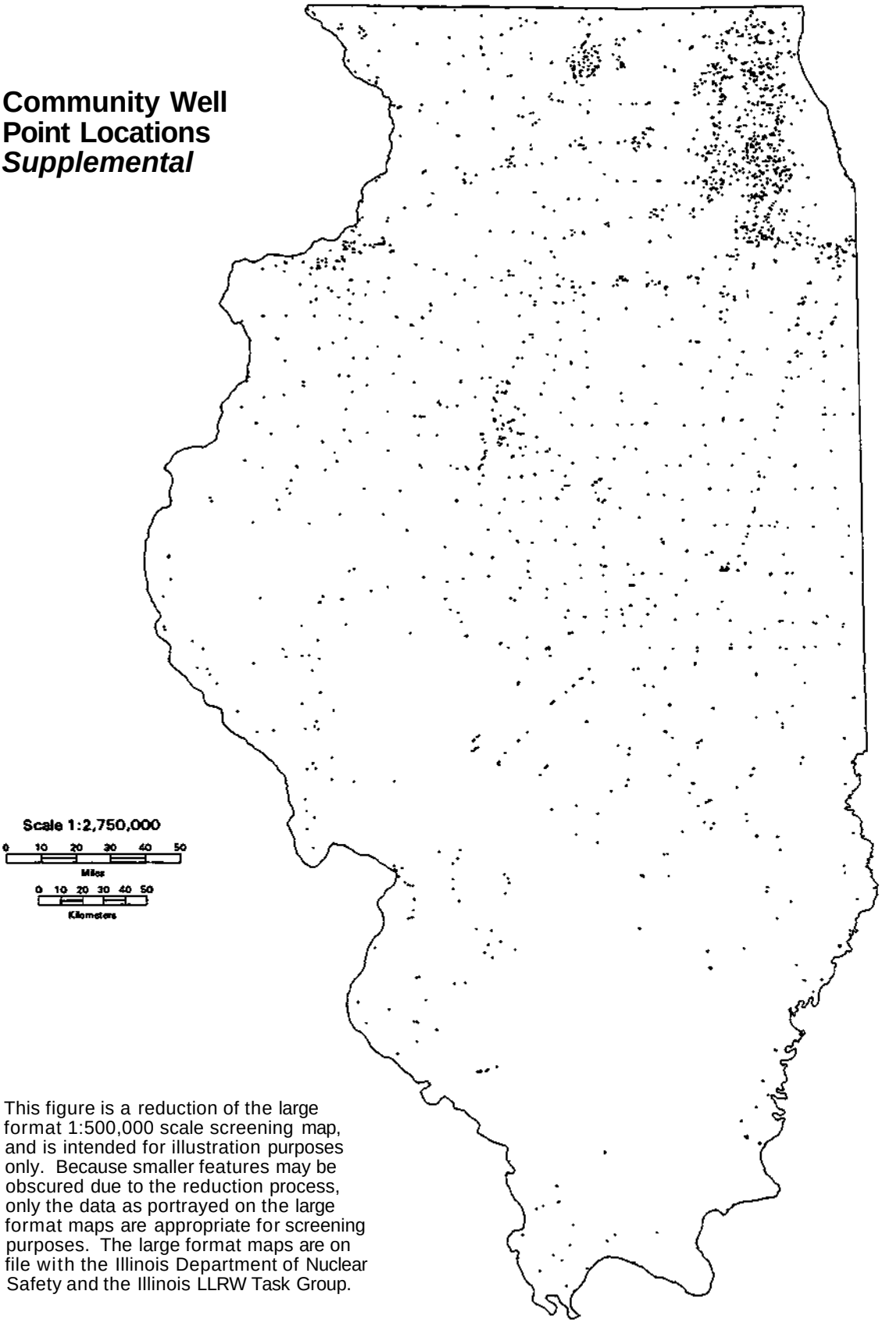
Figure 2. Community Well-Point Locations (Supplemental)

The points on this map show the locations of community wells listed as of August 1997 in the Illinois State Water Survey's Public, Industrial, and Commercial Survey (PICS) Database. The map incorporates a 1,000-foot setback or buffer zone around each well, as directed by the Task Group.

Source

Public, Industrial, and Commercial Survey Database, Illinois Water Use Inventory, Illinois State Water Survey. 1997.

Community Well Point Locations *Supplemental*



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Criterion 3

The site must not be located in a watershed upstream from an in-channel reservoir for a public water supply if that reservoir has a normal pool storage capacity of less than 15,000 acre-feet or a total upstream drainage contributing area of less than 75 square miles.

Discussion. The intent of this criterion, as explained in the guidance statement contained in the Task Group Site Selection Criteria Report, is to minimize public concerns about the location of the disposal facility upstream from a small reservoir used for a public water supply. Reservoir and watershed size limitations identified in the criterion statement were defined to separate small public water supplies from larger supply systems.

Scientific Surveys' Approach. The ISWS maintains the PWS-ALL-AREA database, which includes information about all public water supplies that extract their water from surface sources, such as streams, lakes, and reservoirs. Contained in the database is information on the storage capacity of public water supply reservoirs and the delineated boundaries of the upstream drainage contributing areas (or watersheds) of these reservoirs. The PWS-ALL-AREA database was originally based on data from Singh et al. (1988) and Singh and Durgunoglu (1990). Database updates are performed periodically, with the latest update conducted in 1996 as part of the statewide screening process presented in this report.

Watershed boundary delineations in the PWS-ALL-AREA database were originally extracted from the U.S. Geological Survey (USGS) Drainage Area Basins database, which was created and digitized for the entire state in 1990-1991 as a joint project between the USGS Illinois District Office and the Scientific Surveys. Approximately 80 percent of the total coverage comes from the USGS Water Resources Division Drainage Area Basin files, delineated on 1:24,000 scale topographic maps, and furnished to the Scientific Surveys in digital form. The Scientific Surveys digitized the remaining watershed boundaries, and all boundaries were then appended into a single statewide coverage.

The PWS-ALL-AREA database contains a separate boundary coverage created by the ISWS for watersheds of public water supply reservoirs. Additional boundaries were delineated and digitized for watersheds not included in the statewide coverage. Another separate watershed boundary coverage was extracted from the PWS-ALL-AREA database for only those reservoirs meeting the Criterion 3 storage capacity and watershed size specifications.

The accompanying map (Figure 3) shows the upstream drainage contributing areas for the public water supply reservoirs specified in the criterion statement. This map fully satisfies the requirements of Criterion 3.

Figure 3. Public Water Supply Watersheds

The shaded areas on this map show the upstream drainage contributing areas for the public water supply reservoirs specified in the criterion statement.

Identification of reservoirs meeting the criterion's specifications and delineations of contributing areas were obtained from the PWS-ALL-AREA database maintained at the Illinois State Water Survey.

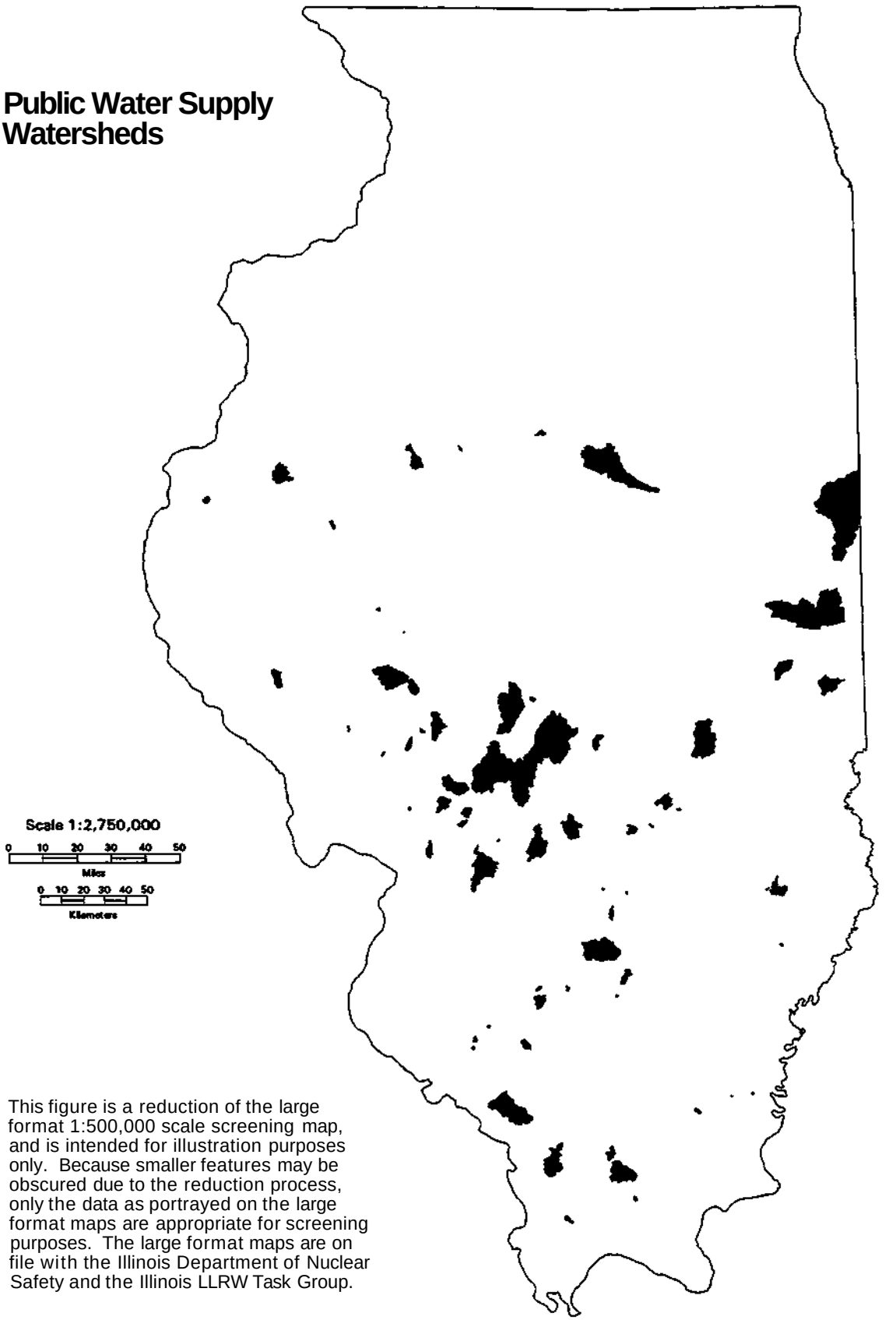
Sources

Singh, K.P., S. McConkey-Broeren, R.B. King, and M.L. Pubentz. 1988. *Future Water Demands of Public Water Supply Systems in Illinois,* Illinois State Water Survey Contract Report 442, Champaign, IL.

Singh, K.P., and A. Durgunoglu. 1990. *An Improved Methodology for Estimating Future Reservoir Storage Capacities: Application to Surface Water Supply Reservoirs in Illinois* (Second Edition), Illinois State Water Survey Contract Report 493, Champaign, IL.

U.S. Geological Survey (USGS) Drainage Area Basins database, delineated and digitized by the USGS using 1:24,000 scale topographic maps.

Public Water Supply Watersheds



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Criterion 4

The geologic materials beneath the site must exhibit a sufficiently high degree of lateral continuity to permit reliable geological mapping and hydrogeological modeling.

Discussion. A site underlain by geologic materials that have a high degree of lateral continuity can be more readily investigated and characterized to permit reliable modeling of groundwater flow and environmental monitoring than can a geologically complex site. The objective of this criterion is to require that each proposed site be underlain by geologic materials that are relatively predictable and uniform so as to strengthen confidence in groundwater modeling and the prediction of effects on groundwater.

The Task Group acknowledged that the requirement of a high degree of lateral continuity is difficult to specify in quantitative terms. A site is more likely to be acceptable if its underlying stratigraphic units are of sufficient thickness and areal extent such that data collected during detailed site characterization would permit investigators to map the units reliably. Additionally, a site having significant geologic anomalies, such as major faults, that may provide hard to predict pathways for groundwater flow must be avoided.

Scientific Surveys' Approach. Most geologic discontinuities have not been nor can be mapped on a statewide basis. This map (Figure 4) shows the regional extent of mapped faults in Illinois and is used at this scale to identify areas where bedrock discontinuities caused by faulting are known to exist. The source of this map is the publication *Structural Features in Illinois* (Nelson, 1995).

Features shown on the map are limited to well documented, significant faults, faulted flexures, and grabens in Illinois. The map should be used at a scale of 1:500,000 or smaller for regional analysis, for display purposes, and for showing geologic information related to faults, flexures, and grabens.

The Task Group recognized that discontinuities, such as joints and sand lenses, are present in many of the near-surface glacial till deposits in the state. Other geologic discontinuities exist that are not shown on Figure 4. These include lithologic contacts, unconformities, sandstone channels in adjoining sedimentary rocks, clay dikes, fades changes, sand and gravel units within glacial till, fractures, and open conduits (e.g., karst features - sinkholes and caves). Except for karst features, these discontinuities are not mapped on a statewide basis. Many of these features have been documented in detailed studies of well records, coal mines, and other site-specific studies. Detailed, site-specific investigations are required to identify most of these features in the field. Specific sites should be evaluated for faults and other types of discontinuities.

Figure 4. Major Faults

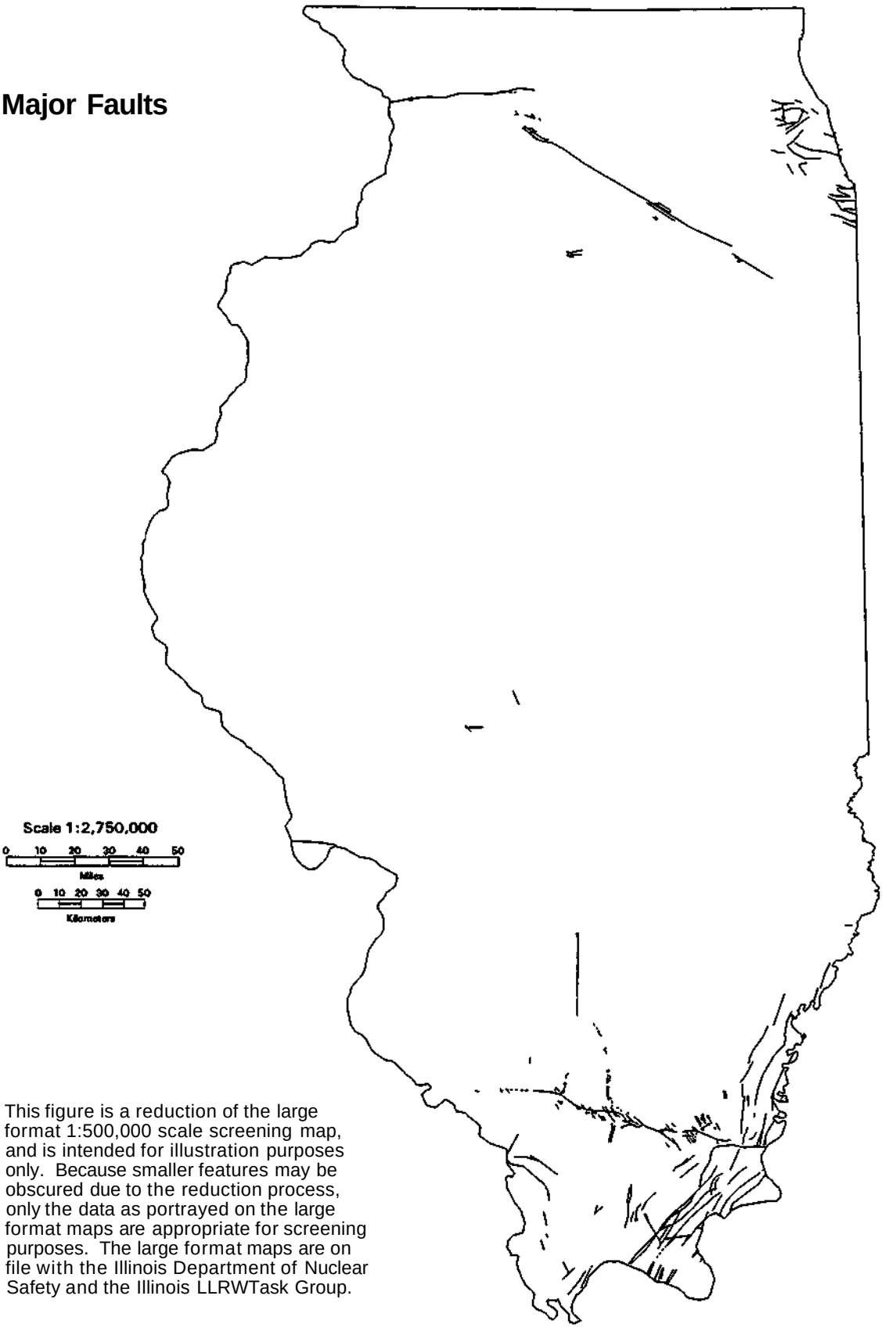
There is no GIS coverage specific to this criterion. However, the lines on this map show the regional extent of well documented, significant faults, faulted flexures, and grabens in Illinois, and are shown at this scale to identify areas where bedrock discontinuities exist.

Sources

Illinois State Geological Survey. 1995. Structural Features in Illinois: Faults, ISGS digital data set structfaults, ed. 1.0, scale 1:500,000, based on:

Nelson, W.J. 1995. *Structural Features in Illinois,* Illinois State Geological Survey Bulletin 100, Champaign, IL, Plate 1, scale 1:500,000.

Major Faults



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Criterion 5

The site must not be in a karstic area.

Discussion. Karst is a type of topography formed on water-soluble rock, such as some limestones or gypsum; however, not all limestones exhibit karstic formation. Dissolution of the rock typically results in sinkholes, caves, or underground drainage that may contribute to subsidence and provide preferential pathways for groundwater flow. Exclusion of karstic areas will contribute to selection of a stable site for which defensible modeling of groundwater flow paths can be developed. Areas exhibiting any karstic feature, such as sinkholes, caves, or underground drainages, must be avoided. At a minimum, the Scientific Surveys must exclude from consideration locations containing mapped karstic areas.

Scientific Surveys' Approach. Landforms that typify karstic terrain include closed depressions (sinkholes), caves, large and/or numerous springs, and fluted rock outcrops (Ford and Williams, 1989). Figure 5, the karst map of Illinois (Weibel and Panno, 1997), shows the distribution of areas that contain one or more sinkholes throughout the state. Karstic areas depicted on the map were digitized from U.S. Geological Survey (USGS) 1:100,000 topographic or planimetric maps upon which the features were compiled. The extent of sinkhole features was mapped from landforms observed on stereo-paired U.S. Department of Agriculture aerial photographs (approximate scale 1:20,000) and USGS 7.5-minute (1:24,000) topographic maps, and sinkholes identified on Soil Conservation Service county soil survey maps.

Sinkholes are the primary manifestation on the land surface of karstic bedrock because they usually are large, visible features. For this reason, the karst map shows areas that contain topographic depressions that are considered to have formed by karstification of the underlying bedrock. Each of these areas, referred to as "sinkhole areas" on the map by Weibel and Panno (1997), contains at least one sinkhole depression. Some of the larger areas shown on the map contain hundreds to thousands of sinkholes. The other common landforms of karstic terrain, caves and springs, are very small features and are not suitable for use in the statewide screening process.

Sinkhole areas depicted on the map were not exhaustively field checked to determine if karstification was the origin of each depression. Some of the mapped areas thus may contain depressions that have another origin other than karst. There may also be some sinkhole depressions in areas outside the mapped sinkhole areas. In addition, karstic areas that lack obvious karst-indicating landforms, particularly sinkholes, may occur in places outside of the areas shown on the map. This map provides a basis for land-use planning and decision making, and it should be used at scales of 1:100,000 or smaller.

Source

Ford, D. C, and P. W. Williams. 1989. *Karst Geomorphology and Hydrology:* Unwin Hyman Ltd., London, 601 p.

Figure 5. Karst Areas

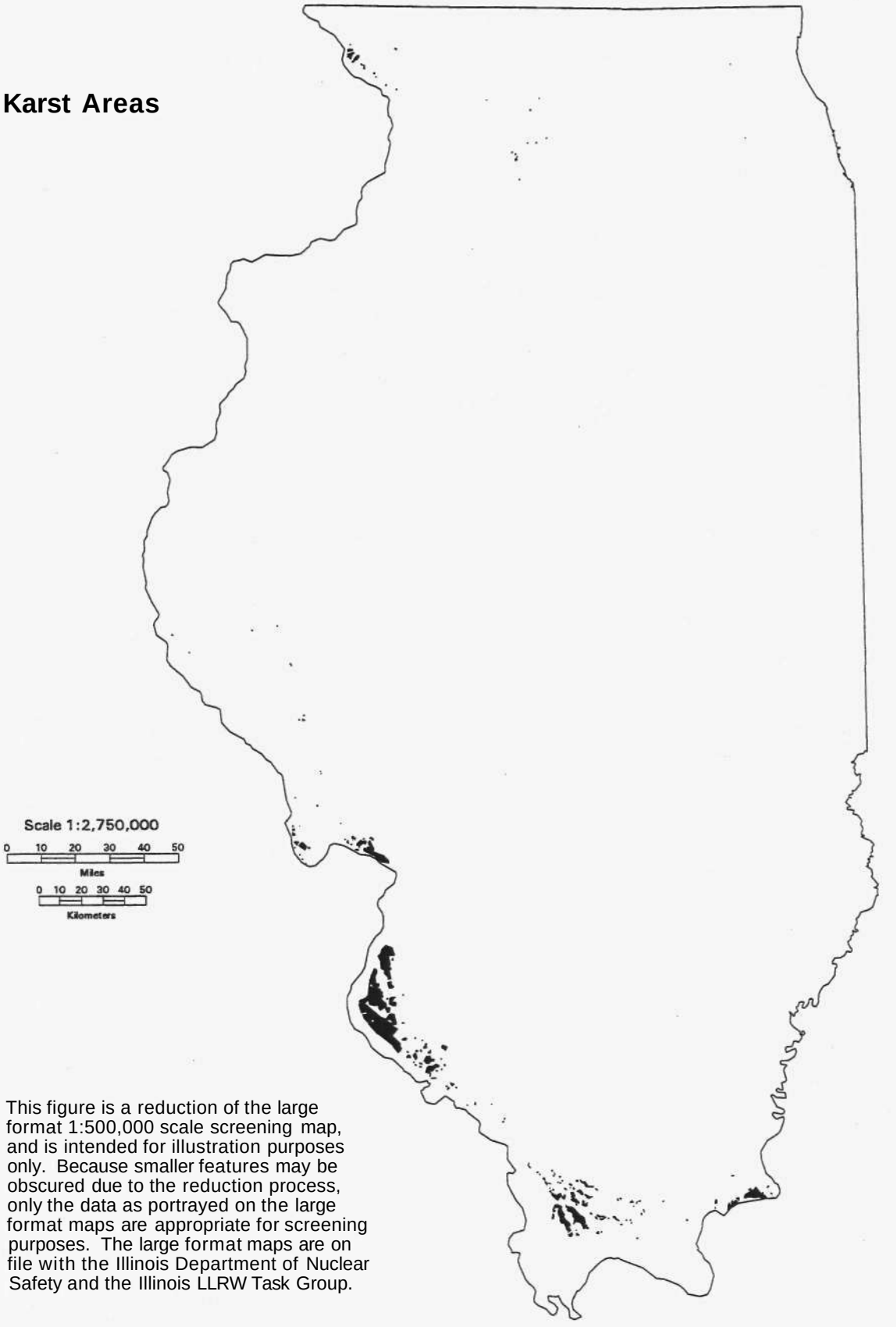
The shaded areas on this map show the regional extent of karst areas mapped in Illinois. During the site selection process, field reconnaissance and review should be conducted to further identify areas with obvious karst features.

Sources

Weibel, C.P., and S.V. Panno. 1997. *Karst Areas of Illinois.* ISGS digital data set karst. ed. 2.0, scale 1:100,000.

Weibel, C.P., and S.V. Panno. 1997. *Karst Terrains and Carbonate Bedrock in Illinois.* Illinois State Geological Survey Illinois Map 8, scale 1:100,000, Champaign, IL

Karst Areas



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Criterion 6

The site must be located so as not to be adversely affected by earthquakes or ground motions that are likely to occur during the period of most significant radiological risk.

Discussion. The potential for seismic activity to adversely affect an LLRW disposal facility is a legitimate public concern in Illinois. The Task Group recognized that seismic activity severe enough to cause instability of the robust structures that are required for LLRW disposal is extremely unlikely ever to occur anywhere in Illinois. Nevertheless, seismic conditions must be considered so that areas likely to experience excessive ground motions are eliminated from consideration.

The severity of an earthquake is denned by the magnitude of force generated by the earthquake that causes shaking, or ground motion. It is most important to consider horizontal forces because they are most likely to cause damage. Most structures are less vulnerable to vertical forces. The peak, or most severe, horizontal acceleration is the standard engineering parameter used to assess the effect of an earthquake on structures. Horizontal acceleration is the percentage of the mass of the structure (%g) expressed as force during its acceleration from motionless to its maximum horizontal velocity due to an earthquake. Small earthquakes are much more common than are large ones, so engineering design for lower levels of acceleration is based on more experience than is engineering design for higher levels of acceleration. All well-designed buildings can survive a 0.2g peak horizontal ground motion (acceleration) without fundamental structural damage. In the case of disposal facility structures, there should be a low probability of cracking. In compact soil or rock, the probability of permanent strain of geologic foundation materials due to 0.2g peak acceleration is extremely small.

Figure 6 (Figure 1 in the Task Group's report) is based on the map "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years" found in USGS Open-File Report 96-532 entitled *National Seismic-Hazard Maps: Documentation June 1996* (A. Frankel et al., 1996). It is the result of a synthesis of contemporary knowledge about the occurrence of earthquakes in the region that includes Illinois during a period of several thousand years. The synthesis makes use of a computer model that integrates the patterns of earthquake occurrence with regard to: (1) geographical space, (2) time or recurrence interval of each source contributing the risk, and (3) magnitude of the earthquake. This analysis allows the prediction of the likelihood on a yearly basis that an earthquake of specific severity will occur. Figure 1 in the Task Group report was developed for an annual probability of exceedance of 0.04 percent, which is a 1 in 2,500 chance that the peak acceleration of 0.2g will be exceeded in any given year for 50 years. The low peak horizontal acceleration of 0.2g and the low risk of exceedance constitute very conservative screening guidance. Areas that exceed 0.2g must be eliminated from consideration by the Scientific Surveys.

Scientific Surveys' Approach. To meet this criterion, the Illinois State Geological Survey contacted the authors of USGS Open-File report 96-532 and obtained the digital data file of the map. The USGS map shows areas of peak acceleration with a 2 percent probability of exceedance in 50 years. The map in Figure 6 shows the area shaded in gray where the probabilistic peak horizontal acceleration is greater than or equal to 0.2g as a result of seismic activity with a 2 percent probability exceedance in 50 years. The source map was created by the USGS to show probabilistic earthquake acceleration for the United States and Puerto Rico. Data resolution is 0.1 degree of latitude or longitude. In Illinois, this translates to approximately 10,800 meters north-south and 7,200 to 9,000

meters east-west. The data were originally portrayed at a scale of 1:7,500,000. The USGS should be contacted for specific information on the derivation and contouring of data points.

The degree to which the known seismic record represents an adequate sample of seismicity for the purpose of projection of future earthquake activity has considerable uncertainty. New maps, models, and data will need to be assessed as they become available.

Figure 6. Seismic Risk

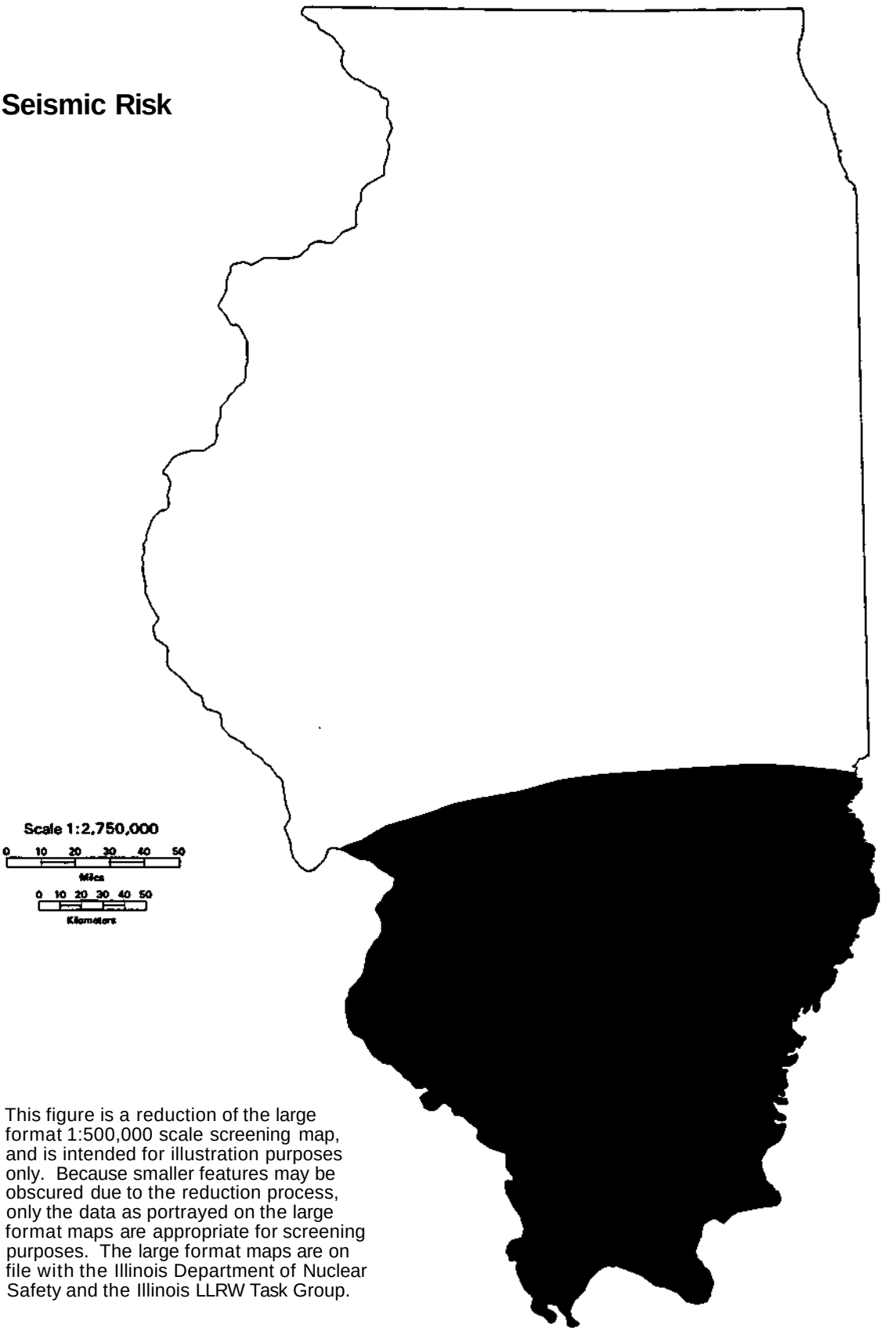
The shaded area on this map shows the region of peak acceleration greater than or equal to 0.2 g with a 2 percent probability of exceedance in 50 years.

Sources

Frankel, A., C. Mueller, T. Bamhard, D. Perkins, E. V. Leyendecker, N. Dickman, S. Hanson, and M. Hopper. 1996. *National Seismic Hazard Maps: Peak Acceleration (percentage) with 2 Percent Probability of Exceedance in 50 Years,* United States Geological Survey, USGS Open-File Report 96-532, map 3, scale 1:7,500,000, Denver, CO. Also available on the internet at: (http://gldage.cr.usgs.gov/eq /).

Illinois State Geological Survey. 1997. Horizontal Acceleration With A 90 Percent Probability Of Not Being Exceeded In 250 Years In Illinois, ISGS digital data set il250, scale 1:7,500,000, based on Frankel etal., 1996.

Seismic Risk



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Criterion 7

The site must not exhibit evidence of, or potential for, significant mass wasting phenomena, including landsliding, slope failure, or surface subsidence.

Discussion. Exclusion of areas known to be subject to significant mass wasting will contribute to selection of a stable site. Mass wasting could potentially damage a disposal facility by undermining if the materials directly adjacent to or beneath it are subject to movement. Furthermore, the surface and near-surface hydrology of a site could be altered if mass wasting processes were to: (1) generate preferential pathways for shallow subsurface flow, (2) create seepage zones at land surface where none previously existed, or (3) contribute to increased surface erosion and gullying near the facility. Significant mass wasting is defined as a mass wasting process that, if continued throughout the period of most significant radiological risk, could threaten the stability of the site.

The tendency for mass wasting to occur at a site is largely dependent upon the geotechnical properties of the near-surface geologic materials, the local slope angle, and the geomorphic history of the site. Significant mass wasting hazards in Illinois include: (1) slumping and landsliding along streams due to locally steep slopes and unstable sediments, (2) surface collapse and subsidence associated with subsurface development of underground mine workings, and (3) surface collapse and subsidence associated with subsurface development of karstic features.

Scientific Surveys' Approach. The Scientific Surveys placed three GIS databases on one map in applying this criterion. This map (Figure 7) shows areas where: (1) landsliding has been reported, (2) areas of underground mine cavities, and (3) areas having slopes greater than 5 percent. Additional point locations of landslides not included on this map should be used for more detailed local screening.

Landslides were compiled from published and available data (unpublished reports) from several sources including a map that represents the first statewide inventory of landslides in Illinois at a 1:500,000 scale (Killey et al., 1985). Other sources include a report (and associated maps) on landslides along the Ohio and Mississippi Rivers (Su and Stohr, 1992) from Olmsted, Illinois on the Ohio River to Alton, Illinois, on the Mississippi River. Both reports were augmented by voluntary reports from the Illinois Department of Transportation, universities, and government agencies. The landslides occured along streams and with few exceptions are limited to a few tens of feet from the edge of the slope.

Data on underground mines were extracted from the coal mine data in the ISGS Coal GIS database. Areas delineate the approximate outer boundary of individual mines (if known) or general mined areas. Interior mine boundaries such as pillars or small blocks of unmined coal, are commonly not depicted. Mine outlines have been compiled from a variety of sources. Outlines of areas mined before 1987 are commonly from source maps at scales of 1:62,500 or smaller. Outlines of areas mined since 1987 are commonly digitized at scales ranging from 1:4,800 to 1:12,000. Not included in this coverage are mines whose extent is not known or which comprise only a few acres. Figure 7 depicts selected areas where there are several overlapping mines. Attributes in the digital data indicate mine identification number, mine type, mining method, and mine status. Additional information is available from the ISGS.

Areas of land surface with slopes greater than 5 percent were developed from a statewide grid of elevation data compiled by the ISGS from USGS topographic data at a scale of 1:250,000.

Outlines of extensive landslides and the boundaries of underground mine workings may be incomplete. Symbols indicating points where landslides have occurred are shown in Figure 8. Such locations should be considered during the site selection process. The extent of mined out areas are delineated to the extent known as of 1996.

Ground surface subsidence and collapse associated with subsurface development of karst are also addressed by Criterion S, which excludes karstic areas.

Sources

Killey, M.M., J.K. Hines, and P.B. DuMontelle. 1985. *Landslide Inventory of Illinois,* Illinois State Geological Survey, Ciruclar 534,27 pp.

Su, W. J., and C. J. Stohr. 1992. *Landslides in the New Madrid Seismic Zone: Landslide Inventory and Risk Assessment in Illinois along the Ohio and Mississippi Rivers from Olmsted to Chester*. Final Technical Report to the U.S. Geological Survey, Illinois State Geological Survey, Champaign, IL, 147 pp.

Figure 7. Steep Slopes, Landslides, and Underground Mine Cavities

The shaded areas on this map show locations where mass wasting has occurred, areas of underground mine cavities, and areas with steep slopes greater than 5 percent. Most of the mines shown are coal mines. Many underground mines and landslides are not included on this map because the associated data exist as points in the ISGS GIS database, and are not appropriate for use at this scale. ISGS point data, and data obtained from the Illinois Department of Natural Resources, Office of Mines and Minerals will be available to the contractor during the site selection process.

Sources

Illinois State Geological Survey. 1997. *Areas Mined for Coal in Illinois - Part 1,* ISGS digital data set coalmines_py, scale 1:100,000.

Illinois State Geological Survey. 1997. *Areas Mined for Coal in Illinois - Part 2,* ISGS digital data set coalmines_py2,1:100,000 scale.

Illinois State Geological Survey. 1996. *ISGS Coal Database,* scale varies.

Illinois State Geological Survey. 1996. *Non-coal Underground Mines of Illinois,* ISGS digital data set ncmin_py, 1:24,000 scale.

Illinois State Geological Survey. 1996. *ISGS Coal Section Non-Coal Mines Database,* scale varies.

Illinois State Geological Survey. 1996. *Generalized Slopes in Illinois,* ISGS digital data set slopes, 1:250,000 scale.

Illinois State Geological Survey. 1995. *Landslide Inventory of Illinois* - Polygons, ISGS digital data set Indsld85-py, 1:500,000 scale.

Killey, M.M., J.K. Hines, and P.B. DuMorrtelle. 1985. *Landslide Inventory of Illinois,* Illinois State Geological Survey Circular 534, Plate 1,1:500,000 scale, Champaign, IL.

Steep Slopes, Landslides, and Underground Mine Cavities

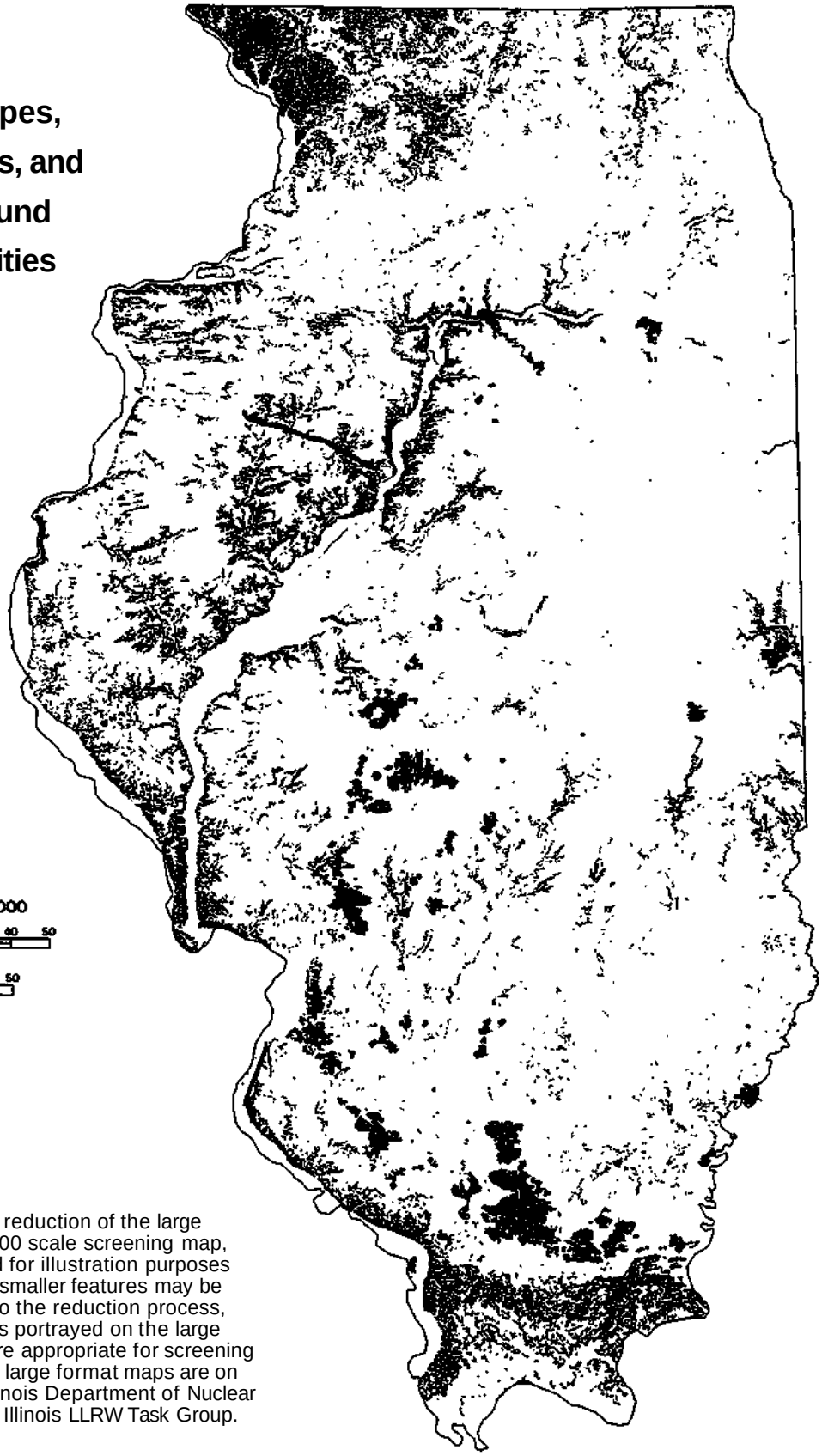

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Figure 8. Landslides - Point Locations (Supplemental)

This map shows point locations of reported landslides the areal extent of which are unknown. Many of the points shown are not accounted for on the screening maps. The map indicates locations that may require verification of the presence and status of additional landslides, or potential for mass wasting, during the site selection process.

Sources

Illinois State Geological Survey. 1997. *Landslide Inventory of Illinois - Points,* ISGS digital data set Indsld85-pt, scale 1:500,000.

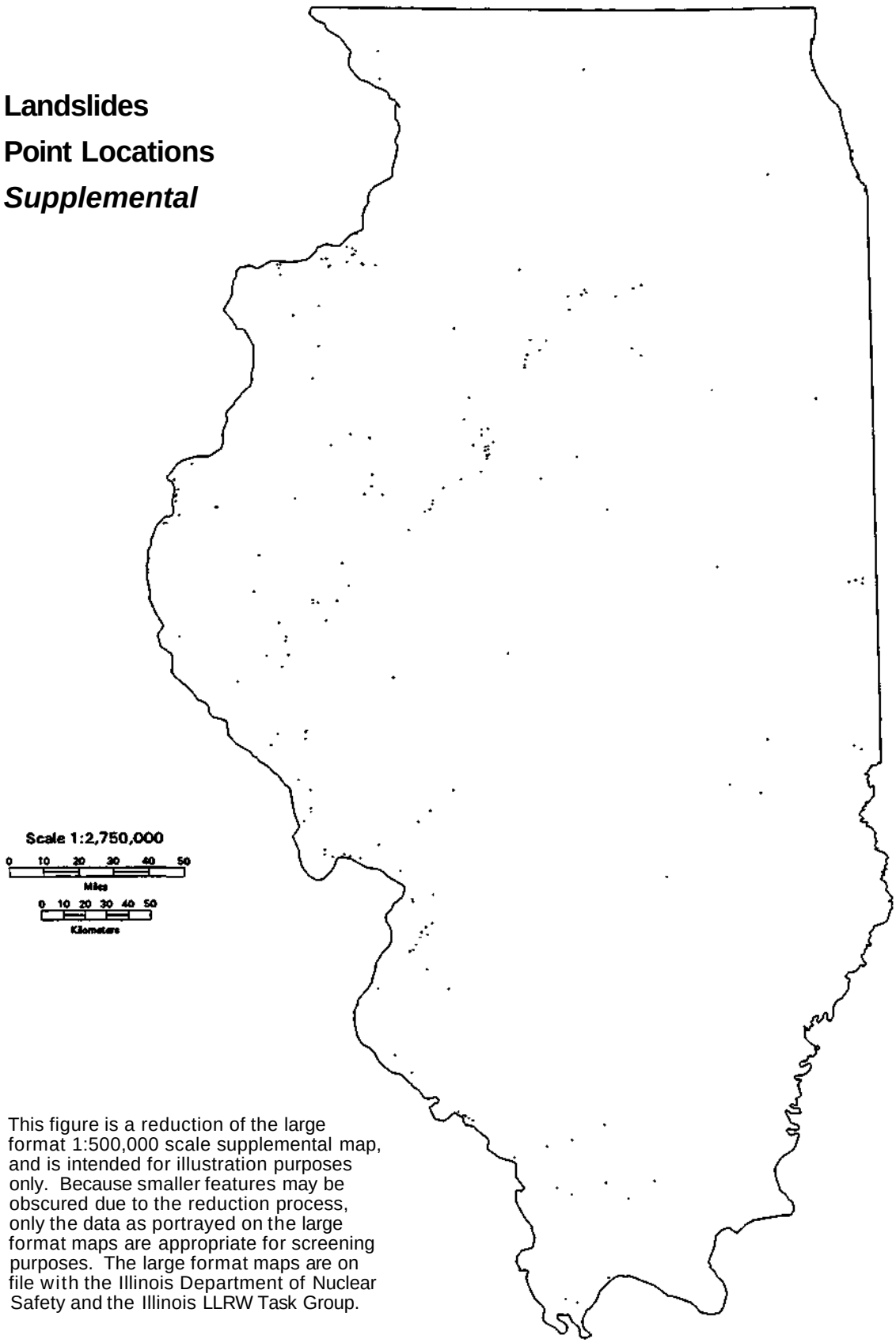
Illinois State Geological Survey, 1997, Landslide Inventory of Illinois - Points (1995), ISGS digital data set Indsld95-pt, scale 1:24,000.

Killey, M.M., J.K. Hines, and P.B. DuMontelle. 1985. *Landslide Inventory of Illinois,* Illinois State Geological Survey Circular 534, Plate 1,1:500,000 scale, Champaign, IL.

Landslides

Point Locations

Supplemental



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Criterion 8

The site must not have the potential to be undermined significantly by stream incision, bank erosion, or undercutting.

Discussion. A meandering stream could undermine the disposal facility by downcutting of the stream channel or undercutting of the stream bank. A proposed site must not be located so that the lateral migration of a stream or vertical downcutting of a stream channel in the vicinity of a site represents a significant hazard. A significant hazard is defined as that posed by a stream channel that exhibits such a high rate of either lateral migration or vertical downcutting that the stability of the disposal site could be threatened if these rates were to be maintained during the period of most significant radiological risk.

Stream channels are generally capable of eroding geologic materials along the banks of a channel and within the channel bed. Lateral migration of a stream channel can cause bank erosion. A channel bed can be eroded, resulting in downcutting of the channel, or be subject to aggradation, which is the deposition of quantities of sediments on the channel bed sufficient to alter the channel. Aggradation can result in subsequent erosion and further modification of the channel form.

Other criteria provide protection against certain fluvial processes. Criterion 9 excludes sites with natural stream channels or man-made channels that are persistent and that cannot be permanently eliminated by site engineering. Criterion 10 excludes land located within the 500-year floodplains of stream channels, which will provide an additional distance between the present location of a surface channel and the disposal facility. Criterion 8 excludes sites adjacent to a stream channel that exhibits such a high rate of lateral migration or vertical downcutting that the stability of the disposal site could be threatened if these rates were to be maintained during the period of most significant radiological risk.

Scientific Surveys' Approach. No statewide map or GIS coverage is available to address this criterion, and it has not been addressed at the statewide screening level. This is consistent with the guidance on this criterion that was provided by the Task Group. For this criterion, the Task Group recognized that the potential for a significant stream-related hazard (i.e., undercutting or erosion of banks, migration of stream channel) depends on a number of factors, including channel size, channel location within the drainage network, geologic materials within and adjacent to the channel, and historical channel behavior. Recognizing these factors, the Task Group recommended that this criterion be applied on a site-by-site basis.

The Task Group also recognized that this criterion could not be specified in terms of setbacks (i.e., a specified distance) from surface channels. They recommended that screening for this hazard rely on existing aerial photographs and other historical records to determine trends in stream channel behavior. The Task Group indicated that field work might be useful to establish the stability of channels in the vicinity of each proposed site. To ascertain and evaluate the issues of stream bank erosion and lateral migration, the Scientific Surveys recommend that this criterion be applied on a site-specific basis as part of the investigation of potential sites.

Criterion 9

The site must not contain perennial streams, lakes, or ponds or extensive artificial drainage systems that strongly control site hydrology.

Discussion. The intent of this criterion, as explained in the guidance statement contained in the Task Group Site Selection Criteria Report, is to exclude sites that have groundwater discharge to land surface. The presence of perennial streams, lakes, or ponds indicates that a release of groundwater sustains these water bodies during dry periods. Extensive artificial drainage systems, including drainage tiles, are also usually pathways for the release of shallow groundwater to land surface. As indicated by the Task Group, the presence of drainage tiles should not automatically exclude a site from consideration.

Scientific Surveys' Approach. The only data applicable to this criterion that are available for use in statewide screening are those dealing with the location of perennial streams. The common designation of perennial streams in Illinois is taken from the USGS 1:24,000 scale topographic maps in which streams are designated as either perennial or intermittent. In general, those streams that have flow for 50 percent of the time or more are classified as being perennial; those that have flow less than 50 percent of the time are classified as intermittent. This designation is not exact and for most cases is believed to come from local accounts and field reconnaissance conducted during the original topographic mapping from the late 1800s and early 1900s. Designation of perennial streams may Vary somewhat between topographic maps, but it is generally consistent with the 50 percent flow definition. However, provisional map editions developed since 1980 may not differentiate perennial from intermittent streams.

The delineation of perennial streams used for statewide screening is that given as a stream attribute in the USGS 1:100,000 scale Digital Line Graph (DLG) file created in 1980-1986. Designation of perennial streams in the DLG file is identical to that given on USGS 1:24,000 scale topographic maps. For some locations, the perennial stream designation is taken from provisional map editions in which all streams included at the 1:100,000 scale are considered to be perennial. Visual inspection and comparison with 1:24,000 maps indicates that many first- and second-order streams are not included in the 1:100,000 DLG coverage.

The estimated error in horizontal position based on USGS National Map Accuracy Standards is 167 feet, and is identical to that for the 1:100,000 analog maps. Edge mapping and generation of a polygon coverage for lakes and large rivers are incomplete. The DLG file will be updated by the USGS. The level of completeness of the coverage varies from one quadrangle to another due to the variation in the original DLG data.

The accompanying map (Figure 9) does not fully satisfy the requirements of Criterion 9 because only the location of perennial streams is indicated. Guidance from the Task Group indicates that the presence of man-made surface water bodies and artificial drainage systems will not automatically exclude a site from consideration, and site-specific data will be needed to demonstrate compliance with the intent of the criterion.

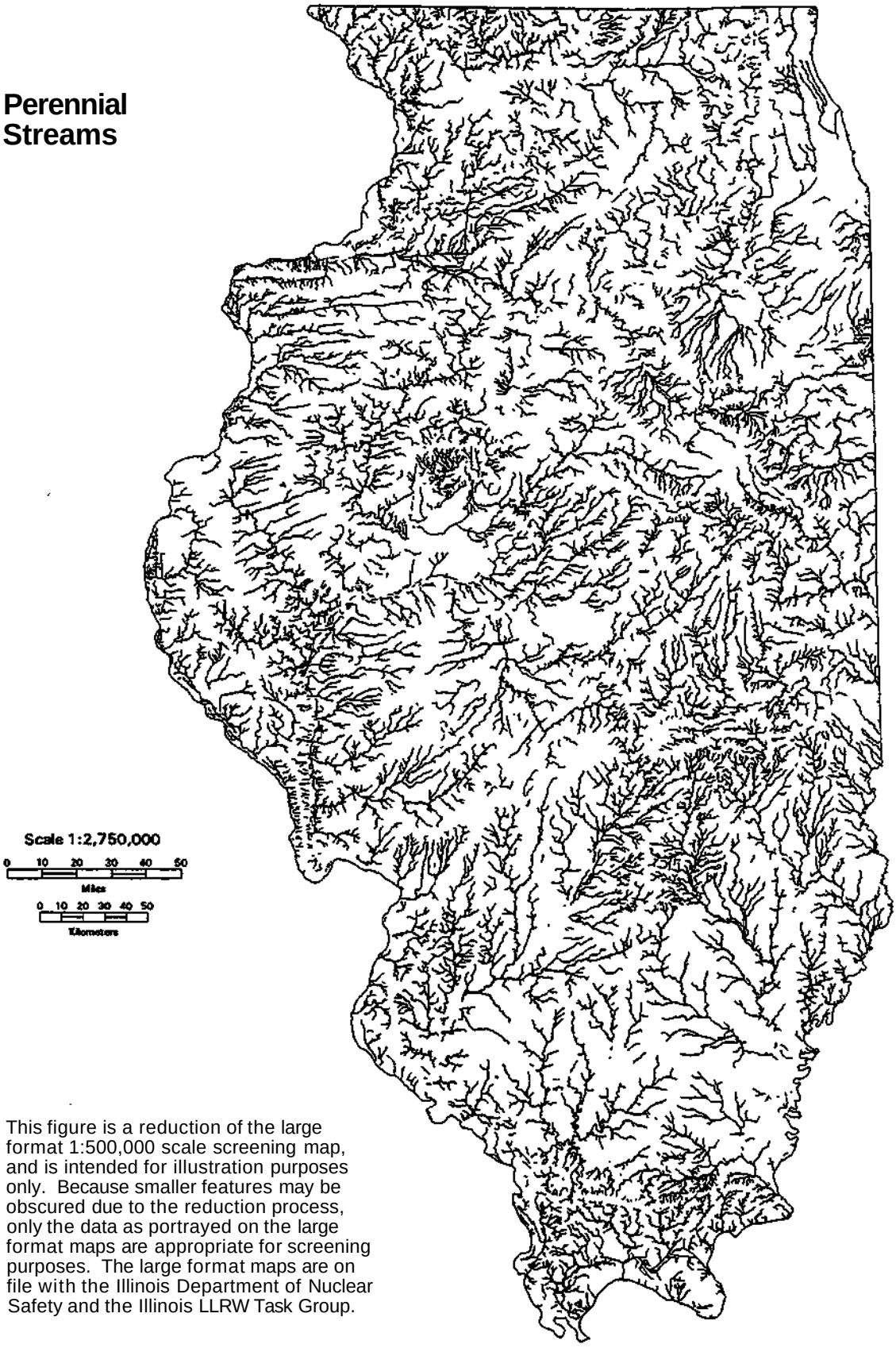
Figure 9. Perennial Streams

The lines on this map show the locations of perennial streams in Illinois as designated by the USGS using 1:100,000 scale topographic maps. This map does not include other elements from Criterion 9 that may exclude a site from consideration, such as perennial lakes and ponds, or areas having extensive artificial drainage systems.

Source

U.S. Geological Survey, 1:100,000 scale Digital Line Graph (DLG) database.

Perennial Streams



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Criterion 10

The site must not contain any areas within a 500-year floodplain.

Discussion. As directed by the Task Group guidelines, the Scientific Surveys used 500-year floodplain maps, if available, and otherwise relied on 100-year floodplain maps to identify most of the flood prone areas of the state.

Scientific Surveys' Approach. The Federal Emergency Management Agency (FEMA) issues two type of maps, Flood Insurance Rate Maps (FIRMs) and Flood Hazard Boundary Maps (FHBMs), which delineate flood zone areas for all counties and most incorporated communities throughout the state. The ISWS digitized the FIRMs and FHBMs for unincorporated areas in all counties in 1987-1997 from paper maps (panels) issued by FEMA. Panels are mapped at scales from 1:6,000 to 1:24,000. Each county has its own digital coverage and includes floodplain mapping from roughly 10 to 20 panels. Digitized flood zone areas are updated and added to the appropriate county coverage as FEMA issues new and/or revised FIRMs and FHBMs. The dBase file "FLOODPLA.DBF' was also created during the digitizing process and contains documentation on individual panels from throughout the state. Most FIRMs for incorporated communities in the state are not digitized and have not been included in the statewide screening. Panels for incorporated communities are voluminous and are available for use in any screening of potential sites near incorporated areas.

The location of floodplains on FIRM and FHBM panels is not of the same accuracy as features shown on USGS topographic mapping of the same scale (1:24,000). Floodplain features on the FEMA panels are occasionally mapped as much as 300 to 400 feet away from their correct location.

The accompanying map (Figure 10) presents the floodplain areas for unincorporated areas in Illinois as issued by the FEMA. This is not a comprehensive map of the floodplain areas that would be eliminated by Criterion 10, and specifically does not include floodplain areas for most incorporated communities or most smaller to moderate-sized rural streams. In addition, most of the floodplains designated by FEMA for unincorporated areas and shown on this map are 100-year floodplains and do not match the more restrictive 500-year criterion. Additional examination of the presence of floodplains should be conducted for a potential facility site using detailed hydrologic and hydraulic methods.

Supplemental Floodplain Mapping. There are many small to moderate-sized streams in rural areas for which FEMA studies do not provide any floodplain designation. It is roughly estimated that more than 70 percent of the stream miles in rural portions of the state have no designated floodplains. As part of the statewide screening activities, supplemental floodplain coverages were developed for moderate-sized streams in unincorporated areas for which no previous floodplain designation existed.

The depth of flooding associated with the 100-year flood is computed using the USGS Depth and Frequency Method, presented in Prugh (1976). Lardner and Terstriep (1982) examined the accuracy of this method and then developed a set of adjustments to eliminate bias in the estimation

of flood depths for certain stream types. The flood depth as calculated using the Depth and Frequency Method is added to the elevation of the stream channel bed to develop the elevation of the 100-year flood and USGS 1:24,000 scale topographic maps are then used to delineate the extent of the area flooded at that elevation. Where available, more detailed topographic information is used instead of USGS topographic maps. Use of the adjusted equations presented in Lardner and Terstriep is the standard nondetailed method for estimating flood depths in Illinois, and it is the method used in FIRM development for rural areas.

Previous applications of the Depth and Frequency Method have identified specific stream types where the equations and their adjustments may not be appropriate. The method works well in areas where the stream has a well-defined channel and valley. But flood depths may be overestimated in locations where there is no defined valley and the overbank area near the stream has a flat or gentle slope. Areas of flat or gentle slope produce additional problems in the application of the method, in that the topographic maps in flat areas generally do not display elevations with the resolution needed to accurately map the flood extent.

Certain regions, such as east-central Illinois, have particularly flat topography and poorly defined drainage. Floodplain coverages used in statewide screening, both from FEMA studies and the supplemental floodplain mapping, will generally define few floodplains in these regions because of the lack of accurate topographic information and other difficulties in applying nondetailed approximation methods such as the Depth and Frequency Method.

Sources

Lardner, J.P., and M.L. Terstriep. 1982. *Evaluation of the USGS Depth and Frequency Method of Flood Elevation Determination*. Illinois State Water Survey Contract Report 285, Champaign, IL.

Prugh, B.J. 1976. *Depth and Frequency of Floods in Illinois*. U.S. Department of the Interior, U.S. Geological Survey.

Figure 10. Flood Zone Areas

The shaded areas on this map show the combined 100-year and 500-year (where available) floodplains for unincorporated areas in Illinois as designated by the Federal Emergency Management Agency (FEMA) for the National Flood Insurance Program.

This is not a comprehensive map of the floodplain areas that would be eliminated by Criterion 10, and specifically does not include floodplain areas for incorporated areas or most small rural streams. In addition, most of the floodplains designated by FEMA for unincorporated areas and shown on this map are 100-year floodplains and do not match the more restrictive 500-year criterion.

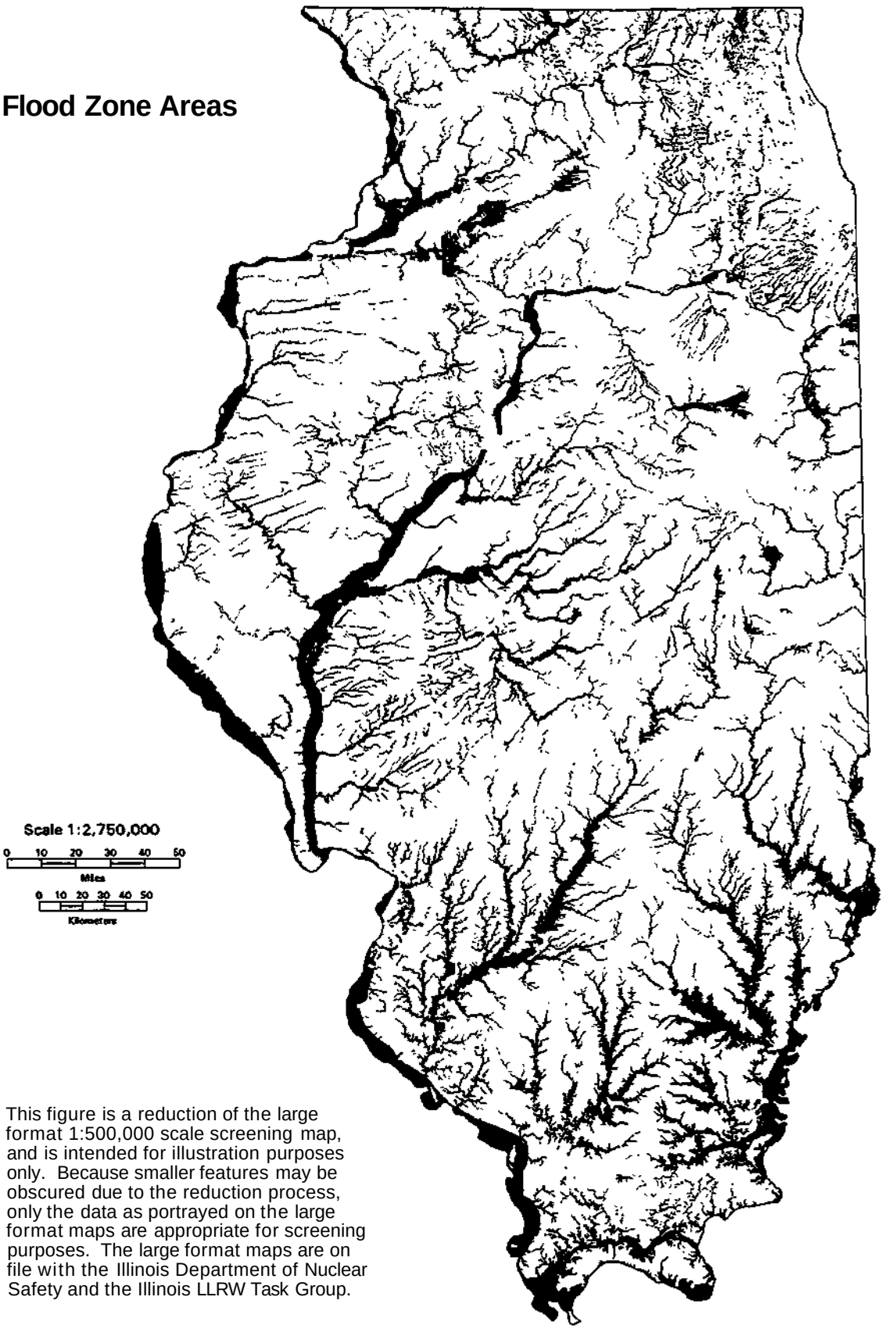
Sources

FEMA Flood Insurance Rate Maps (FIRMs) for Unincorporated Areas of 85 Counties.

FEMA Flood Hazard Boundary Maps (FHBMs) for Unincorporated Areas of 17 Counties.

The digital database was created by the Illinois State Water Survey from the FIRM and FHBM maps.

Flood Zone Areas



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Criterion 11

The site must not contain lands that meet the criteria of the classification codes of the National Wetlands Inventory for Illinois; however, a site containing certain man-made wetlands, such as farm ponds and sewage lagoons, should not be automatically excluded from further consideration.

Discussion. This criterion is intended to prevent negative impacts on important natural wetland areas. Several classes of man-made wetlands within the National Wetlands Inventory (NWI) will not automatically exclude a site from consideration. Table 1 lists classification codes in the NWI that will not result in exclusion of a site, as taken from the Task Group guidance statement.

Table 1. Wetlands Not Excluded by Criterion 11

Description	*System*	*Class*	*Water Regime*	*Modifier*
Palustrine aquatic bed with all water regimes possible that have been excavated or impounded.	p[a]	AB[b]	All[c]	x[d] or h[e]
Palustrine open water systems with all water regimes possible that have been excavated or impounded.	p[a]	OW[f]	All[c]	x[d] or h[e]
Palustrine unconsolidated bottom with all water regimes possible that have been excavated or impounded.	p[a]	UB[g]	All[c]	x[d] or h[e]
Palustrine unconsolidated shore with all water regimes possible that have been excavated or impounded.	p	US[h]	All[c]	x[d] or h[e]
Palustrine emergent wetlands that are flooded, seasonally flooded; all are farmed or partially drained.	p	EM[1]	A[j], B[k], C[1]	f[n] and/or d[n]

Source: Suloway and Hubbell, 1994.

a. P = palustrine
b. AB = aquatic bed
c. All = flooded/seasonally flooded
d. x = excavated (lies in a basin or channel excavated by humans)
e. h = diked or impounded (barrier obstructs inflow or outflow)
f. OW = open water
g. TJB = unconsolidated bottom
h. US = unconsolidated shore
i. EM = emergent
j. A = flooded
k. B = lake
1. C=seasonally flooded
m. f = farmed (altered for production of crops but hydrophytes, or water-adapted plants, could reestablish)
n. d = partially drained (artificially drained but can still support hydrophytes)

Wetland locations in Illinois and wetland attributes were inventoried in the 1980s as part of the NWI by the U.S. Fish and Wildlife Service (1987). Wetland locations were delineated on 1:24,000 scale maps using the USGS 1:24,000 topographic maps as base maps. Wetland locations and

attributes were primarily interpreted from aerial photography from 1981 to 1987. The NWI data are as current as the photography used to delineate the wetlands.

Scientific Surveys' Approach. The digital database of the NWI for Illinois was developed by the Illinois Natural History Survey (INHS) and documented in Suloway and Hubbell (1994). A wetland coverage was developed by the INHS for each county of the state with wetland areas being represented by polygon, line, and point coverages. Polygons were developed for locations as small as 0.1 acres, with point coverages for smaller areas. Riverine wetlands were represented with line and polygon coverages. The accuracy of the wetland locations is equivalent to that of the 1:24,000 analog maps. Use of the data is appropriate for locational and regional screening and analyses, but these data are not accurate enough to be used as an engineering base.

The accompanying map (Figure 11) shows the wetland areas in the NWI for Illinois that meet the criterion. The map does not show man-made wetlands, which are specifically not considered as indicated in the Task Group guidelines. Wetland areas meeting the NWI specifications will need to be evaluated for a specific site.

Figure 11. Wetland Areas

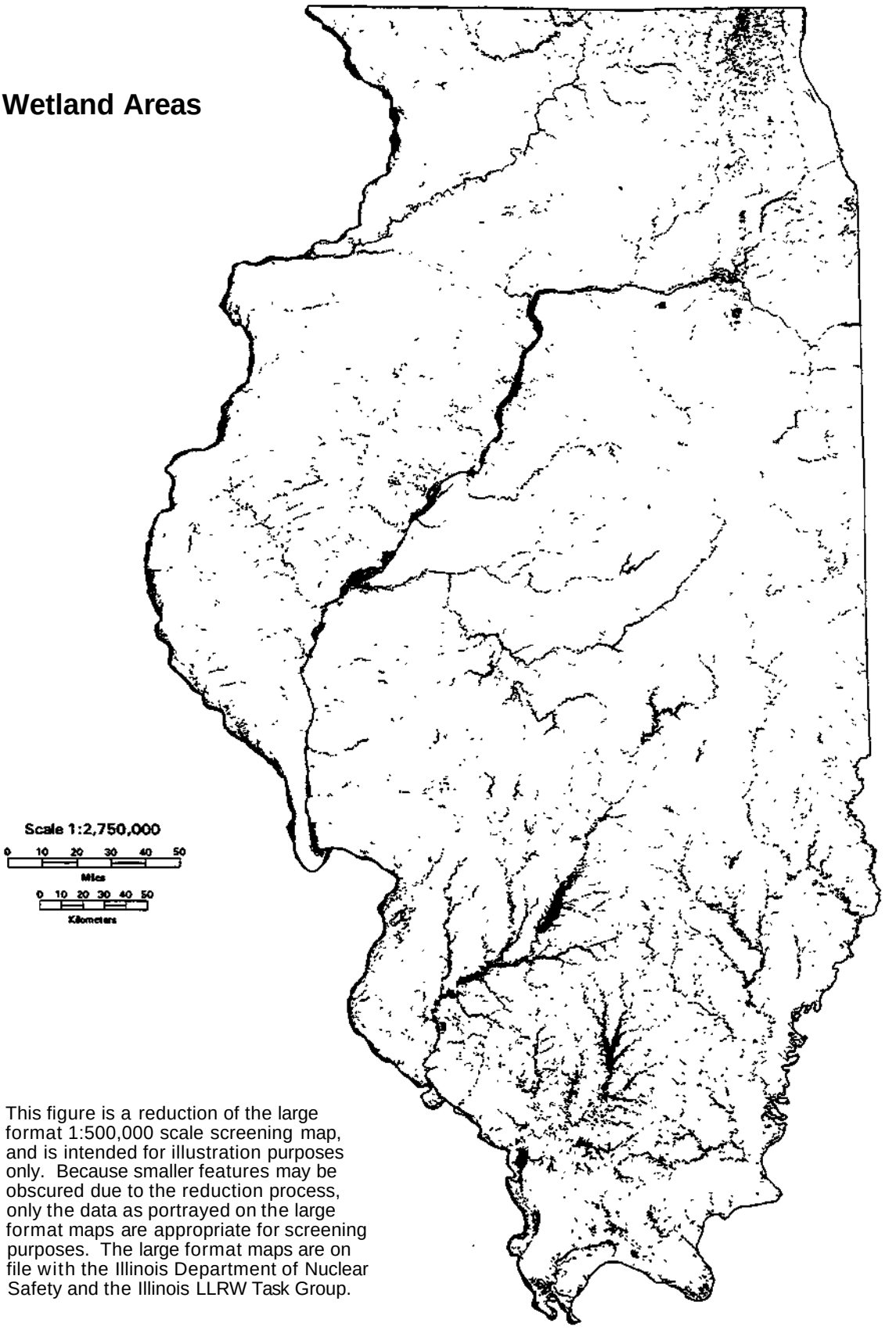
The shaded areas on this map show the wetland areas in the National Wetlands Inventory for Illinois with the exception of man-made wetlands that are not to be considered, as specified in the Task Group guidelines. The presence of wetland areas meeting these specifications need to be field evaluated for a specific site.

Sources

Suloway, L, and M. Hubbell, 1994, *Wetland Resources of Illinois, An Analysis and Atlas,* Special Publication 15, Illinois Natural History Survey, Champaign, IL

U.S. Fish and Wildlife Service, 1987, National Wetlands Inventory, U.S. Department of Interior, Washington, D.C.

Wetland Areas



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Criterion 12

The site must not be located within a groundwater management zone.

Discussion. Groundwater management zones have been established by the Illinois Environmental Protection Agency to identify regions in the state that have experienced contamination and are designated for mitigation activities. The Task Group criterion states that all such areas be excluded from consideration for a disposal facility to ensure that the contamination present in no way impairs the ability to monitor a potential low-level radioactive waste site.

Scientific Surveys' Approach. The IEPA Bureaus of Land and Water maintain the statewide inventory of groundwater management zones. The Bureau of Water, Division of Public Water Supplies provided an ARC/INFO GIS point coverage often groundwater management zones under its jurisdiction. The GIS coverage was developed by digitizing groundwater management zones located on 7.5-minute USGS quadrangle maps. The center of each groundwater management zone was used to develop the point coverage. This coverage was imported into the Scientific Surveys' GIS. The IEPA Bureau of Land, Division of Remediation Management also maintains an inventory of groundwater management zones in conjunction with the federal Resource Conservation and Recovery Act (RCRA). Groundwater management zones within the Bureau of Land are separated into RCRA facilities and all other statewide facilities. Currently, 16 RCRA facilities have delineated groundwater management zones either in place or anticipated to be approved in the near future. Seven additional facilities statewide have groundwater management zones approved. The data received from the IEPA Bureau of Land were in tabular form with insufficient location information to develop an accurate GIS coverage.

Groundwater management zone data need to be considered for a specific site. The Scientific Surveys can provide both tabular and digital GIS data for this use.

Land Use

Criterion 13

The site must not contain pre-existing contamination that has not been or cannot be remediated.

Discussion. This criterion was written so neither chemical nor radiological contaminants are present on a proposed site in quantities that might hamper the ability to monitor site conditions. The disposal facility could be located on a site where limited contamination once existed, or may exist, if the contamination has been, or could be, remediated. For any such proposed site, the Task Group must be provided with proposed or implemented remediation plans to ensure that the contamination will in no way complicate the siting of a disposal facility.

Scientific Surveys' Approach. Four databases were used to make the map shown in Figure 12: two types of Comprehensive Environmental Response, Compensation, & Liability Act (CERCLA) data and Leaking Underground Storage Tank (LUST) data obtained from the ISGS, and LUST data generated by the ISWS.

The CERCLA database pertains to abandoned or unregulated sites that have been reported to the U.S. Environmental Protection Agency (USEPA) as potentially hazardous sites that might pose a threat to public health or the environment. Furthermore, this database incorporates the old "emergency and remedial response information system" (ERRIS) and "project tracking system" (PTS) into one automated system. Inclusion in this database does not necessarily mean that a site has been found to be a threat or that it will be cleaned up through USEPA's Superfund Program. Point locations for the Illinois CERCLA sites have been generated by the Illinois Department of Natural Resources GIS. A comparison between the previous CERCLA coverage and the most recent CERCLA coverage shows that many sites in the old coverage did not appear in the new coverage because they are no longer active or have been remediated. Because the Scientific Suveys have no way of knowing which of the remaining sites have been remediated and because these sites may have pre-existing contamination, they were included in the map.

Several coverages were developed from the LUST data. Leaking underground storage tanks for petroleum products pose a risk to the environment. The IEPA and Camp Dresser and McKee, Inc. (CDM) worked to identify those leaking tanks that pose the greatest immediate potential for environmental contamination. The ISGS assisted in this effort by determining the geologic setting of leaking tanks and ranking those geologic settings according to contamination potential. This process resulted in a vulnerability map of contamination potential. The ISGS provided data to be used in the LUST ranking model developed by CDM to prioritize the IEPA's incident reports of leaking petroleum underground storage tanks. The original contamination potential map was digitized at a scale of 1:250,000. Tank locations were digitized at 1:24,000, a much larger scale than the vulnerability map. This may introduce some error in the location of point data (tank locations) with respect to the polygon data.

The ISWS obtained from the IEPA Bureau of Land a dBase file that listed the locations of leaking underground storage tanks and then split the data into smaller county files. Each file contained a field for address and zip code along with any other identifying attributes. An address matching process used ArcView software to map LUST locations from address information. Successful address matching requires correct addresses and zip codes. Some problems encountered in address matching included incorrect zip codes, lack of N., S., W., or E. direction identifier for streets, other errors in the original database, and limitations in the address matching software. Of the 13,410 LUST locations received, 54 percent were successfully entered into the ISWS GIS coverage and are included on the map shown in Figure 12. The remaining locations are available as a tabular listing.

Figure 12. Pre-existing Contamination - Point Locations (Supplemental)

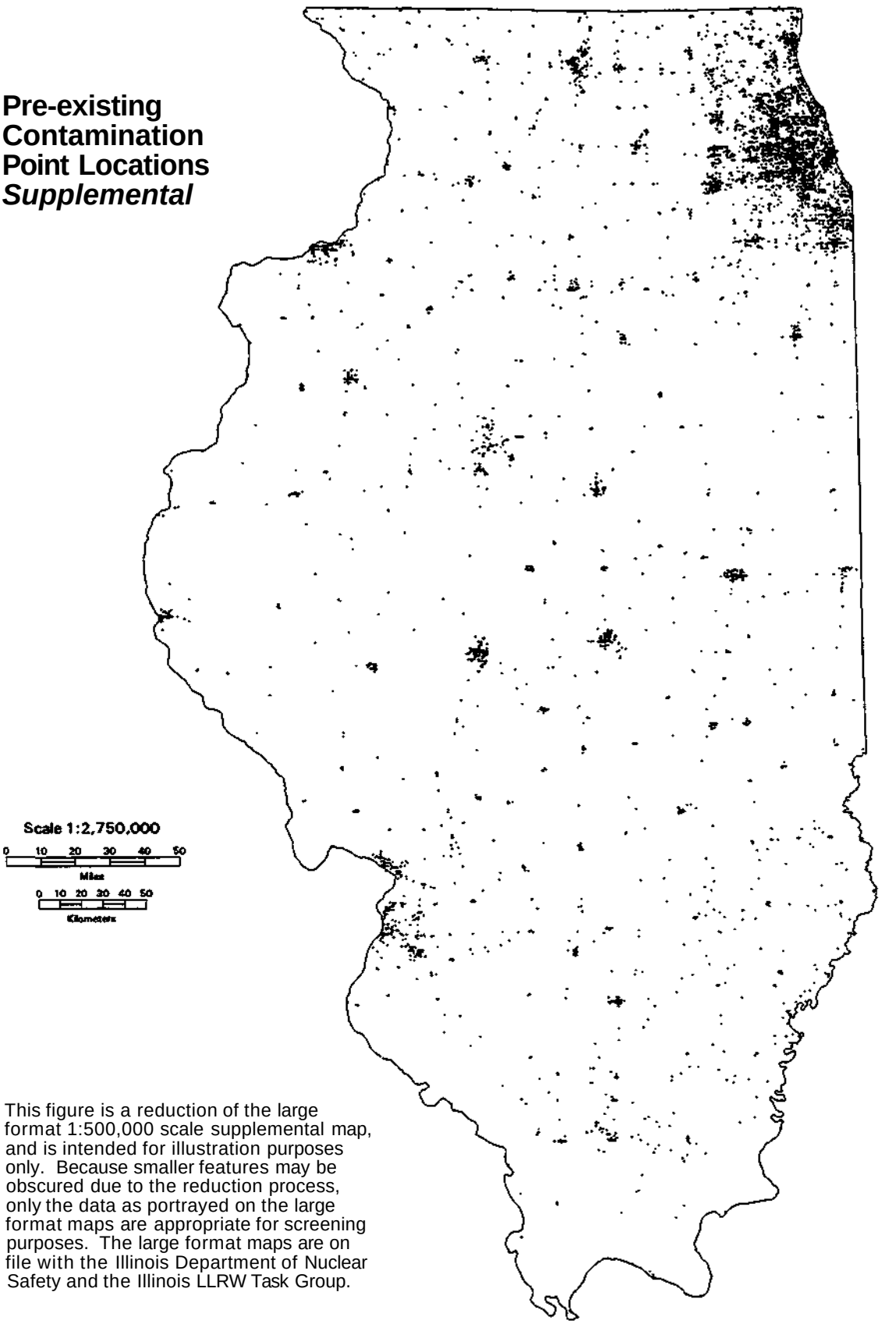
The points on this map show locations of leaking underground storage tanks and sites identified under the federal Comprehensive Environmental Response, Compensation, and Liability Act.

Sources

Mehnert, E., M.J. Mushrush, and L.G. Peny. 1991. *Statewide Inventory of Land-Based Disposal Sites: FY88 Update.* Illinois State Geological Survey, Champaign, IL.

Smith, L.R., and S.L Denhart. 1990. *Documentation and Final Report for the Evaluation of Geologic Factors for Underground Storage Tank Risk Assessment,* IEPA Region 1. Illinois State Geological Survey, Champaign, IL.

Pre-existing Contamination Point Locations *Supplemental*



This figure is a reduction of the large format 1:500,000 scale supplemental map, and is intended for illustration purposes only. Because smaller features may be obscured due to the reduction process, only the data as portrayed on the large format maps are appropriate for screening purposes. The large format maps are on file with the Illinois Department of Nuclear Safety and the Illinois LLRW Task Group.

Criterion 14

The site must not be intersected by a highway that is part of the National System of Interstate and Defense Highways or by an operational railroad track.

Discussion. Railways and roadways are map features that, used at a scale of 1:500,000, are linear in nature, and therefore have no area. As such, they do not by themselves delineate specific areas of the state that may or may not be appropriate for the disposal of LLRW materials. Instead, they act as potential boundaries when considered in conjunction with other mapped features, such as aquifers or mined-out lands. For example, where a highway crosses an area that may otherwise have promising potential for a disposal facility, the highway will serve to divide the area into two or more smaller areas, which then must be considered individually for suitability. If the resulting smaller areas are less than 640 acres in size, the presence of the highway may have the effect of eliminating an area from further consideration. Conversely, if the resultant areas maintain sufficient areal extent, the presence of the highway may not have significant impact on the suitability of a specific site.

Given these considerations, the most appropriate use of highway and railroad data at the statewide screening stage is to simply portray the linear features on the composite screening map. This allows for a depiction of the spatial relationship between these potentially limiting features and other areal screening features without specifically excluding otherwise potentially suitable areas. In this way, the presence of highways and railroads can be used to assist in the determination of areas that appear appropriate for larger scale, regionally focused, future screening activities. The specific impact of the proximity of highways and railroads to potential sites cannot be assessed until site-specific studies are conducted.

The operational status of highways and railways is very dynamic. New highways and railways are continually under construction, and underused railways are often inactivated. Thus, at the time when further screening activities are conducted, the data shown here will undoubtedly require review and updating.

Scientific Surveys' Approach. Features shown on this map (Figure 13) are highways of the National System of Interstate and Defense Highways and known active railways in Illinois, updated to 1996. Data originally derived from USGS Digital Line Graph (DLG) files have subsequently been updated with information from the Illinois Department of Transportation. Highways shown are believed to be fully representative of the requirements of the criterion.

The railway data have been generalized in two ways: (1) In areas where there is a large density of railways, yards, and spur lines (e.g., Chicago and East St. Louis), spur lines and yards are not generally shown (Figure 13). The data for these areas are too dense for proper display at the scale used for the initial screening maps and would only serve to obscure other underlying screening data. (2) Throughout the state many small spur lines connect to industrial, agricultural, and local use sidings, features not generally shown because their existence and status are difficult to ascertain. The specific impact of such features cannot be determined until site-specific studies are conducted.

Figure 13. Interstates and Railroads

The lines on this map show roads of the National System of Interstate and Defense Highways and operational railroads.

Sources

Illinois Department of Transportation. 1994. Illinois Railroad Map, scale 1:500,000.

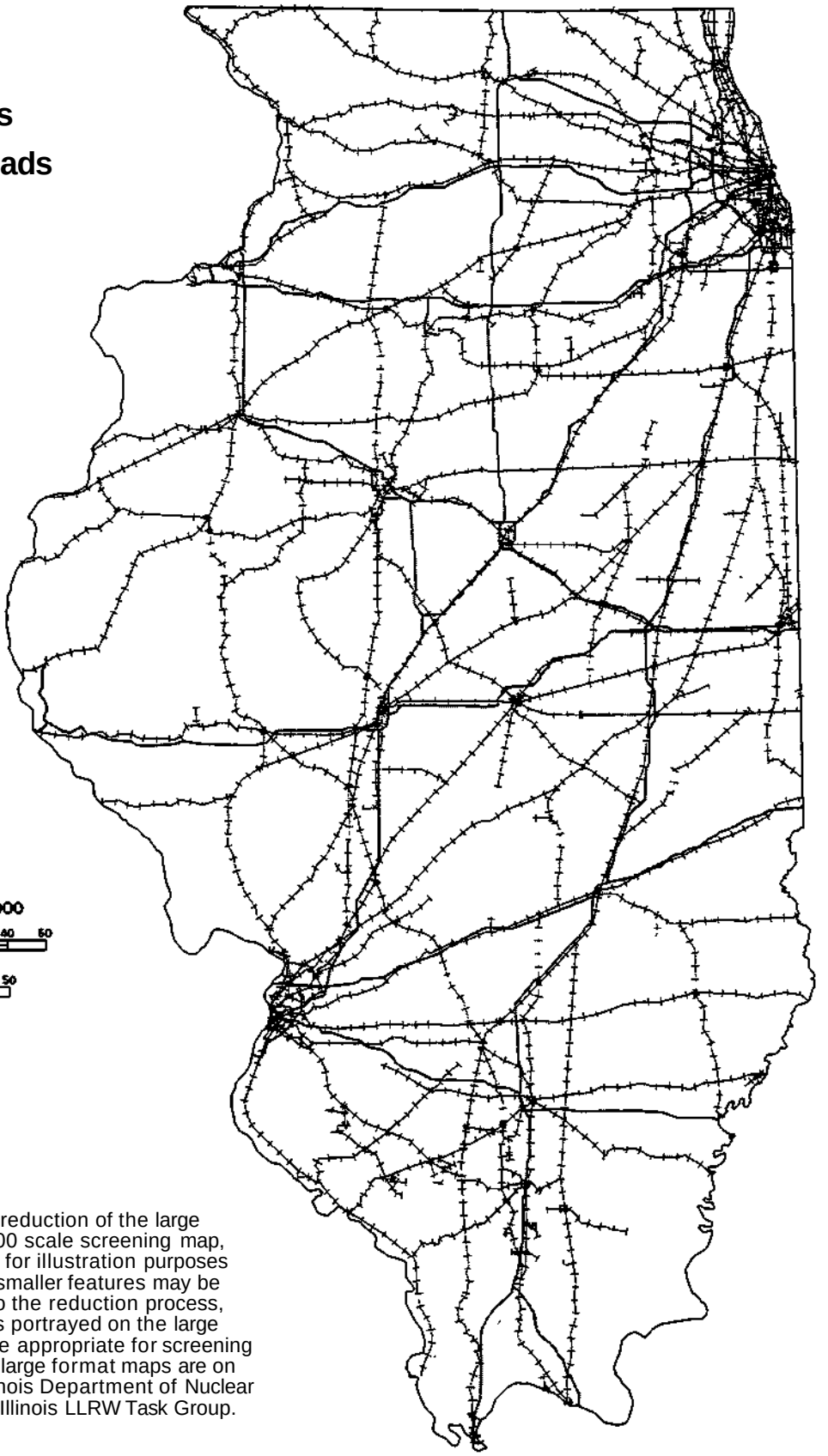
Illinois State Geological Survey. 1993. Interstates in Illinois, ISGS digital data set interstates, scale 1:100,000.

Illinois State Geological Survey. 1993. Generalized Railroads in Illinois, ISGS digital data set genrails, scale 1:100,000.

U. S. Geological Survey. 1980-1986. Digital Line Graph (DLG) files, transportation layer, scale 1:100,000.

U. S. Geological Survey. Various dates, Topographic Quadrangles, scale 1:24,000.

Interstates and Railroads



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Natural Resources

Criterion 15

The site must not be located in an area where it would be impacted by an operational mine, quarry, gravel pit, or petroleum production reservoir.

Discussion. Mineral resources in Illinois include coal, oil, gas, zinc, limestone, dolomite, sand, and gravel. These resources are distributed throughout the state. An operational mine, quarry, gravel pit, or petroleum production reservoir could be the source of blast vibrations, slope instability, or subsidence. In the case of petroleum reservoirs, extraction or secondary recovery methods could alter groundwater flow patterns and make groundwater flow modeling or environmental monitoring of the site more difficult.

The Radioactive Waste Storage Act, 420 ILCS35/6, requires that the land on which the disposal facility is sited be held by the state in fee simple absolute. Thus, the state will own and control the mineral rights beneath the property and will exercise the same control over the mineral rights as over the surface rights. It can be reasonably expected that the state will prevent development of the mineral rights that it owns if development would impair the performance of the facility. Even though the on-site mineral rights are protected, extraction of minerals on the lands adjacent to the property controlled by the state could cause blast vibrations, slope instability, or subsidence, or could alter groundwater flow patterns. Thus, a proposed site must not be altered as the result of nearby mining or petroleum extraction activities.

Scientific Surveys' Approach. Several coverages were compiled and updated to create a map showing operational coal mines, polygon data of non-coal underground mines, oil and gas fields, and gas storage fields in Illinois.

The coverage of operational coal mines was assembled to provide a current, statewide coverage showing surface/underground coal mines for use with the ISGS coal industry map (1996). The same information has been incorporated into the Scientific Surveys' response to Criteria 7 and 16. The map (Figure 14) indicates areas mined for coal in Illinois as of 1996 based on information extracted from detailed coal mine data stored in the ISGS Coal GIS database. Lines delineate the approximate outer boundary of individual mines (if known) or general mined areas. Areas have been compiled from a variety of sources. Areas mined before 1987 are commonly from source maps at scales of 1:62,500 or smaller. Areas mined since 1987 are commonly digitized at scales ranging from 1:4,800 to 1:12,000. Due to the wide range of source map scales, these data are suitable for regional applications only at the 1:100,000 scale or smaller. The map depicts selected areas where there are several overlapping mines. Attributes in the digital data indicate mine identification number, mine type, mining method, and status.

Other types of mines are not included on this map because they exist only as point locations in the ISGS GIS database. ISGS point data, shown in Figure 15, and data obtained from the Illinois Department of Natural Resources, Office of Mines and Minerals should be applied during the site selection process. The absence of pit mining operations can be verified during field reconnaissance.

Polygon data showing the mined extent of non-coal underground mines were assembled as a subset of all underground mines in Illinois to identify areas that may be subject to mine subsidence. These data were extracted from the ISGS Coal database and have a nominal scale of 1:24,000. Areas approximate the boundaries of individual mines (if known) or general mined areas. Because there is no legal filing requirement for non-coal mines in Illinois, only those mines are shown for which areas are known. Mine index numbers are related to tabular information on mines, but these data are not actively maintained by the ISGS.

The oil and gas fields coverage was digitized from the original ISGS 1:500,000 scale source map of oil and gas fields in Illinois (1983). Areas show the approximate limits of individual oil and gas fields.

The coverage showing the distribution of underground gas storage fields was extracted from the ISGS well database. Points from which these data were derived are from locations of wells as recorded on permits issued by the Illinois Department of Natural Resources, Office of Mines and Minerals. Well points were buffered 1/4 mile to define the field area. Both gas injection well points and gas storage well points were used and may include observation wells used to monitor conditions at gas storage fields.

The map (Figure 14) shows the locations of operational coal mines, the mined extent of non-coal underground mines, oil and gas fields, and gas storage fields.

This map does not represent a complete collection of the location of mine entrances (shafts and slopes) and other openings. It is estimated that less than 20 percent of the non-coal, underground mines in Illinois are represented. Interior mine boundaries, such as pillars or small blocks of unmined coal, are not depicted in Figure 14. Mines whose extent is not known or which cover only a few acres are included in Figure I5. Attributes in this coverage are accurate with respect to the source data. Not all the attribute data available for these coal mine locations are included in this coverage. The data library from which this coverage was extracted was updated with available information in 1996. The timeliness of the update source documents is largely dependent on the mining companies that provide the requisite documentation. Horizontal positional accuracy is verified by visual comparison of source and paper copy plots. The source materials used are commonly paper copies (ozalid or hand traces) or microfilm prints of original mine maps supplied by mining companies or other parties. ISGS staff have not verified the accuracy or validity of the original source material. Some original maps are not drawn on a cartographic base. Due to the physical and cartographic quality of the source materials used, horizontal positions may be in error by 500 feet or more. For applications requiring precise horizontal accuracy, the original source maps should be consulted.

Well locations and types used to create the map from which the oil and gas fields coverage was digitized have not been field verified. Unreported oil, gas, injection, or disposal wells may exist. The areal extent of an oil and gas field is primarily controlled by site geology, so the limits of a given field are only approximate. Thus the horizontal accuracy of the fields is unknown, but can be considered to be generally representative at small scales (1:500,000 and less).

Gas storage fields in Figure 14 may be based in part on observation wells used to monitor conditions at gas storage fields. Well locations and types have not been field verified. Unreported gas storage or injection wells may exist. The areal extent of a gas storage field is primarily controlled by site geology, so field limits generated by buffering well points can only roughly approximate gas storage field boundaries. Thus the horizontal accuracy of these boundaries is unknown, but can be considered to be generally representative at small scales (1:100,000 and less).

Figure 14. Operational Mines and Oil and Gas Fields

The shaded areas on this map show operational mines and oil and gas fields. Most of the mines shown are coal mines. The majority of non-coal mine types are not included on this map because the associated data exist as points in the ISGS GIS database, and are not appropriate for use at this scale. ISGS point data, and data obtained from the Illinois Department of Natural Resources, Office of Mines and Minerals, will be available during the site selection process. Some abandoned oil and gas fields are included on this map.

Sources

Illinois State Geological Survey. 1997. Areas Mined for Coal in Illinois - Part 1, ISGS digital data set coalmines_py, scale 1:100,000.

Illinois State Geological Survey. 1997. Areas Mined for Coal in Illinois - Part 2, ISGS digital data set coalmines_py2,1:100,000 scale.

Illinois State Geological Survey. 1997. Gas Storage Fields in Illinois, ISGS digital data set gstgwells, scale 1:500,000.

Illinois State Geological Survey. 1996. ISGS Wells and Borings Database, scale varies.

Illinois State Geological Survey. 1996. ISGS Coal Database, scale varies.

Illinois State Geological Survey. 1996. ISGS Coal Database, scale varies.

Illinois State Geological Survey. 1996. Non-coal Underground Mines of Illinois, ISGS digital data set ncmin_py, 1:24,000 scale.

Illinois State Geological Survey. 1996. ISGS Coal Section Non-Coal Mines Database, scale varies.

Illinois State Geological Survey. 1984. Oil fields in Illinois, ISGS digital data set oil fields, scale 1:500,000.

Illinois State Geological Survey. 1983. Oil and Gas Fields in Illinois, ISGS Miscellaneous Map, scale 1 inch = 6 miles.

Operational Mines and Oil and Gas Fields

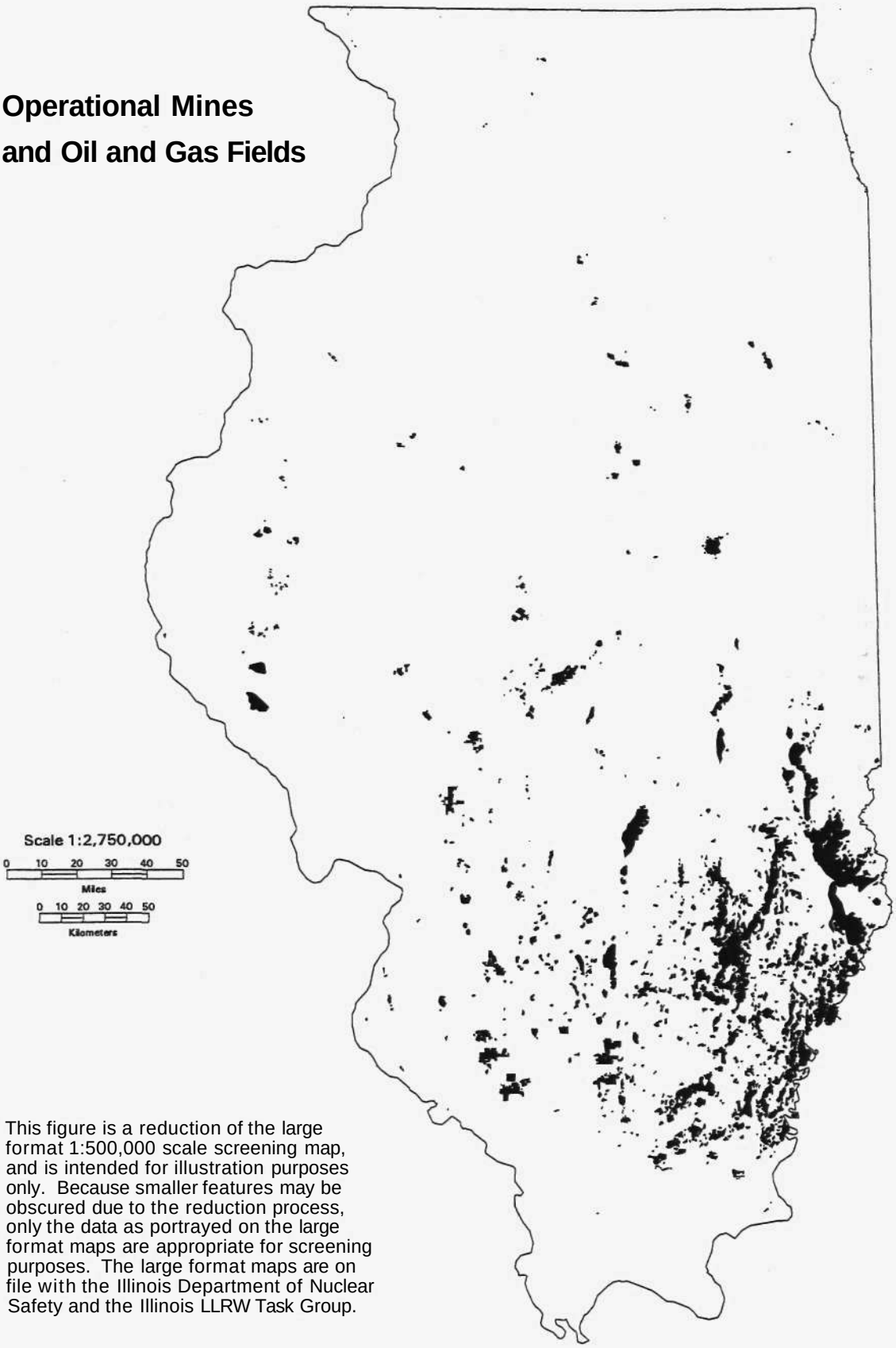

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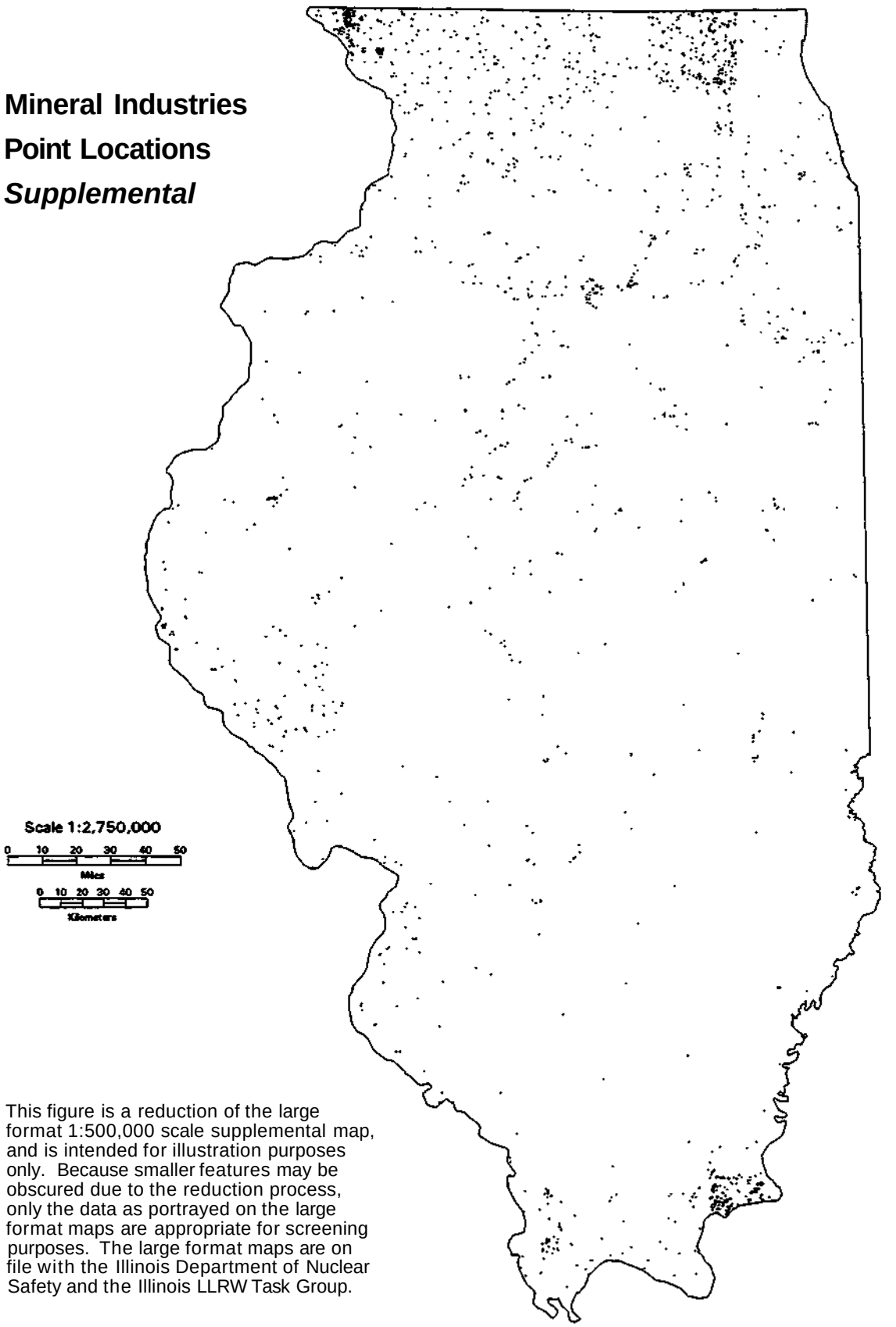
Figure 15. Mineral Industries - Point Locations (Supplemental)

This map shows point locations of active and inactive mineral industries where the areal extent may be unknown. Most of the points shown are not accounted for on the screening maps. The map indicates areas that may require verification of the presence and status of additional non-coal mines during the site selection process.

Source

Illinois State Geological Survey. 1992. Mineral Industries in Illinois, ISGS digital data set min_old, 1:500,000 scale.

Mineral Industries
Point Locations
Supplemental



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Criterion 16

The site must not be underlain by mine cavities or located on surface-mined lands.

Discussion. Some areas of Illinois have been affected by the surface or underground extraction of coal and other minerals. Mine workings are prone to subsidence or settlement in the future, which could result in instability of a site. To eliminate the possibility of subsidence or settlement, areas where mine workings are known to be present must be avoided. At a minimum, the Scientific Surveys must exclude from consideration areas mapped as containing surface or underground mines, including both reclaimed and unreclaimed surface mines.

Scientific Surveys' Approach. Two coverages were compiled and updated to create a map (Figure 16) showing active and inactive coal mines, reclaimed and unreclaimed surface mines, and active and inactive non-coal underground mines in Illinois. Other mine types were not included on this map because they are in the ISGS GIS database only as point locations and are not appropriate for use at this scale. ISGS point data and data obtained from the Illinois Department of Natural Resources, Office of Mines and Minerals should be applied in more detailed screening. The absence of pit mining operations can be verified by field reconnaissance.

The coverage of active and inactive coal mines in Figure 16 was assembled to provide a current, statewide coverage showing surface/underground coal mines for use with the ISGS Coal Industry Map (1996). The same information has been incorporated into the Scientific Surveys' response to Criteria 7 and 15. Areas mined for coal in Illinois are known as of 1996. This information was extracted from detailed coal mine data stored in the ISGS Coal GIS database. The areas show approximate limits of individual mines (if known) or general mined areas. Mine areas have been compiled from a variety of sources. Areas mined before 1987 are commonly from source maps at scales of 1:62,500 or smaller. Areas mined since 1987 are commonly digitized at scales ranging from 1:4,800 to 1:12,000. Due to the wide range of source map scales, these data are suitable for regional applications only at the 1:100,000 scale or smaller. The map (Figure 16) depicts selected areas where there are several overlapping mines. Attributes in the digital data indicate mine identification number, mine type, mining method, and status.

Polygon data showing the mined extent of active and inactive non-coal underground mines were assembled as a subset of all underground mines in Illinois to identify areas that may be subject to mine subsidence. These data were extracted from the ISGS Coal database and have a nominal scale of 1:24,000. Areas show the approximate limits of individual mines (if known) or general mined areas. Because there is no legal filing requirement for non-coal mines in Illinois, only those mines for which records exist in the database as polygon data are shown. Mine index numbers can be related to tabular information or mines, but these data are not actively maintained by the ISGS.

The map (Figure 16) shows the locations of active and inactive coal mines, reclaimed and unreclaimed surface mines, and polygon data showing the mined extent of active and inactive non-coal underground mines.

This map does not represent a complete collection of the location of mine entrances (shafts and slopes) and other openings. It is estimated that less than 20 percent of the non-coal underground

mines in Illinois are represented. Interior mine boundaries, such as pillars or small blocks of unmined coal, are not depicted. Mines whose extent is not known or which cover only a few acres are not included but are shown in Figure 17 as a supplemental point coverage. Attributes in this coverage are accurate with respect to the source data. Not all the attribute data available for these coal mine locations are included in this coverage. The data from which this coverage was extracted was updated with available information in 1996. The timeliness of the update is largely dependent on the mining companies that provide the requisite documentation. Horizontal positional accuracy is verified by visual comparison of source and paper copy plots. The source materials used are commonly paper copies (ozalid or hand traces) or microfilm prints of original mine maps supplied by mining companies or other parties. ISGS staff have not verified the accuracy or validity of the original source material. Some original maps are not drawn on a cartographic base. Due to the physical and cartographic quality of the source materials used, horizontal positions may be in error by 500 feet or more. For applications requiring precise horizontal accuracy, the original source maps should be consulted.

Figure 16. Mine Cavities and Surface - Mined Lands

The shaded areas on this map show surface and underground coal mines, both active and inactive. Most of the mines shown are coal mines. The majority of non-coal mine types are not included on this map because the associated data exist as point data in the ISGS GIS database that are not appropriate for use at this scale. ISGS point data, and data obtained from the Illinois Department of Natural Resources, Office of Mines and Minerals, will be available to the contractor during the site selection process.

Sources

Illinois State Geological Survey. 1997. Areas Mined for Coal in Illinois - Part 1, ISGS digital data set coalmines_py, 1:100,000 scale.

Illinois State Geological Survey. 1997. Areas Mined for Coal in Illinois - Part 2, ISGS digital data set coalmines_py2,1:100,000 scale.

Illinois State Geological Survey. 1996. ISGS Coal Database, scale varies.

Illinois State Geological Survey. 1996. Non-coal Underground Mines of Illinois, ISGS digital data set ncmin_py, 1:24,000 scale.

Illinois State Geological Survey. 1996. ISGS Coal Section Non-Coal Mines Database, scale varies.

Mine Cavities and Surface-Mined Lands

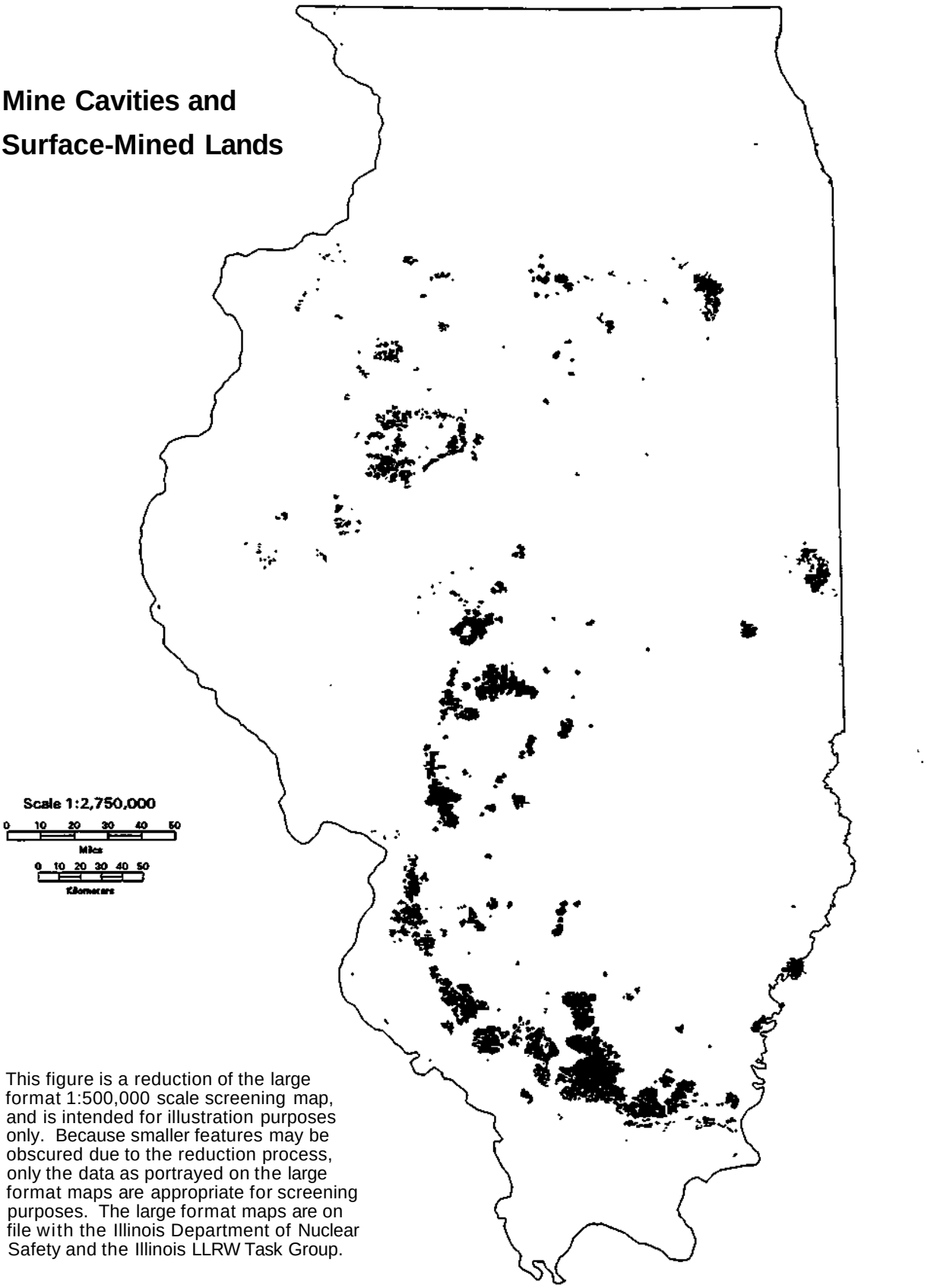

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Figure 17. Coal Mines - Point Locations (Supplemental)

This map shows point locations of surface and underground coal mines, both active and inactive, where the areal extent may be unknown. Many of the points shown are not accounted for on the screening maps. The map indicates areas that may require verification of the presence and status of additional coal mines during the site selection process.

Sources

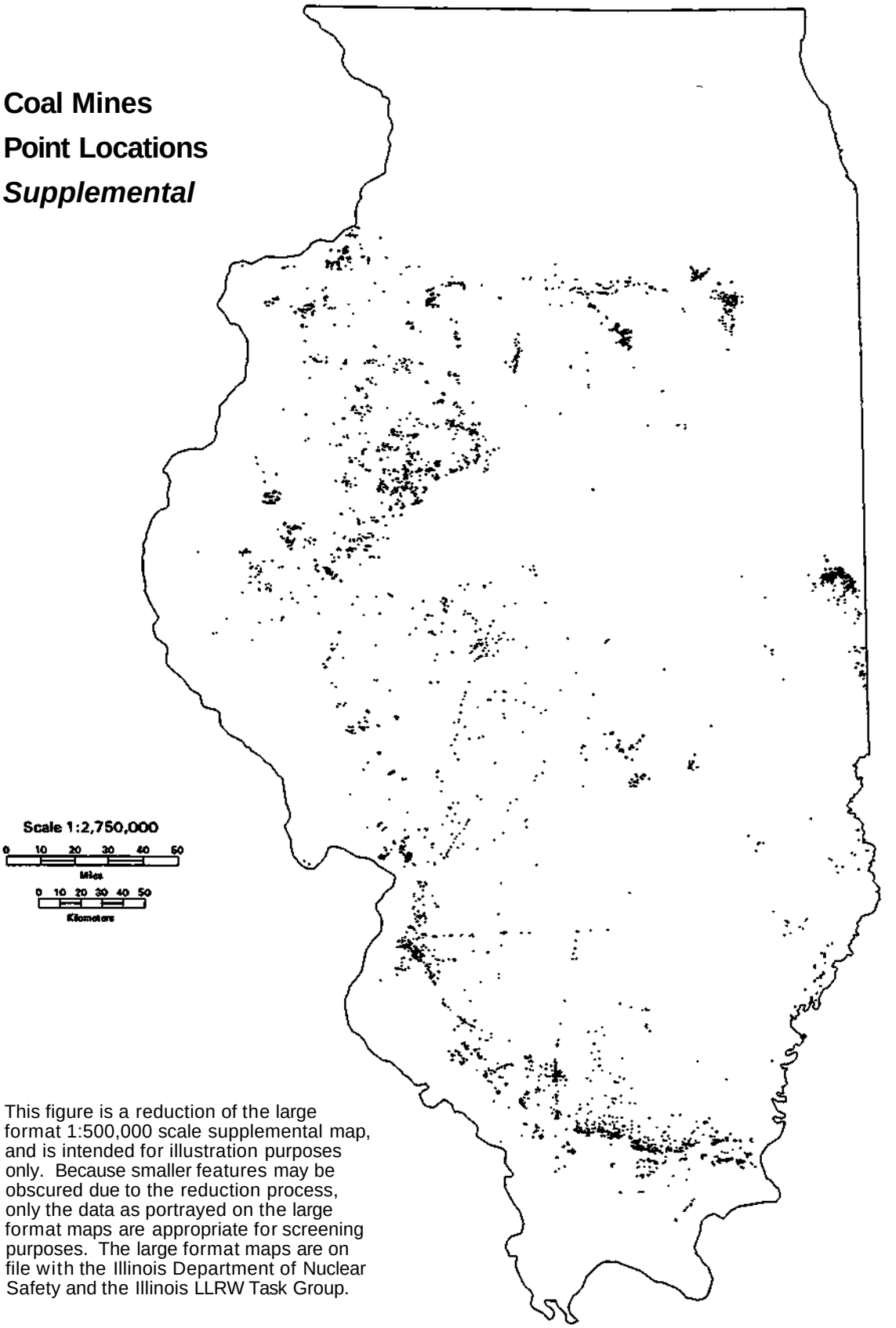
Illinois State Geological Survey. 1997. Locations of Active and Abandoned Coal Mines in Illinois (1996), ISGS digital data set newclpts, scale 1:100,000.

Illinois State Geological Survey. 1996. ISGS Coal Database, scale varies.

Coal Mines

Point Locations

Supplemental



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Ecological and Recreational Areas

Criterion 17

The site must not be located on or be within 1,000 feet of lands that are owned or leased by an agency of the state or federal government and that are managed for recreational or conservation purposes.

Discussion. The intent of this criterion is to protect lands managed by state and federal governments that are used for recreation and conservation purposes. The requirement for a 1,000-foot setback is intended to prevent both direct and indirect impacts on these lands. Examples of areas included under this criterion are state parks and conservation areas, national forests, and state and federal wildlife refuges.

Scientific Surveys' Approach. Data used to develop the GIS coverage were acquired by the Illinois Natural History Survey which produced coverages from maps provided by the Illinois Department of Natural Resources, the U.S. Fish and Wildlife Service, county plat books, U.S. Census Bureau Topologically Integrated Geographic Encoding and Reference (TIGER) files, and 1:24,000 scale USGS quadrangle maps. Map boundaries shown in Figure 18 are approximate. The map does not indicate ownership. Data were assembled from various sources into individual coverages using lists of state conservation areas, state and national forest areas, state and national fish and wildlife areas, and state parks contained in the Illinois Department of Conservation Land and Water Report #30 (1994). These coverages were then combined into a single grid coverage. Digitized boundaries have not been field verified. Boundaries from county plat books were digitized from electronic 1:100,000 coverages that contain roads, section lines, etc. A buffer of 1,000 feet was added to each parcel to delineate areas that did not meet the Task Group criterion. Precise boundary locations will need to be verified for a specific site.

Figure 18. State and Federal Recreational and Conservation Lands

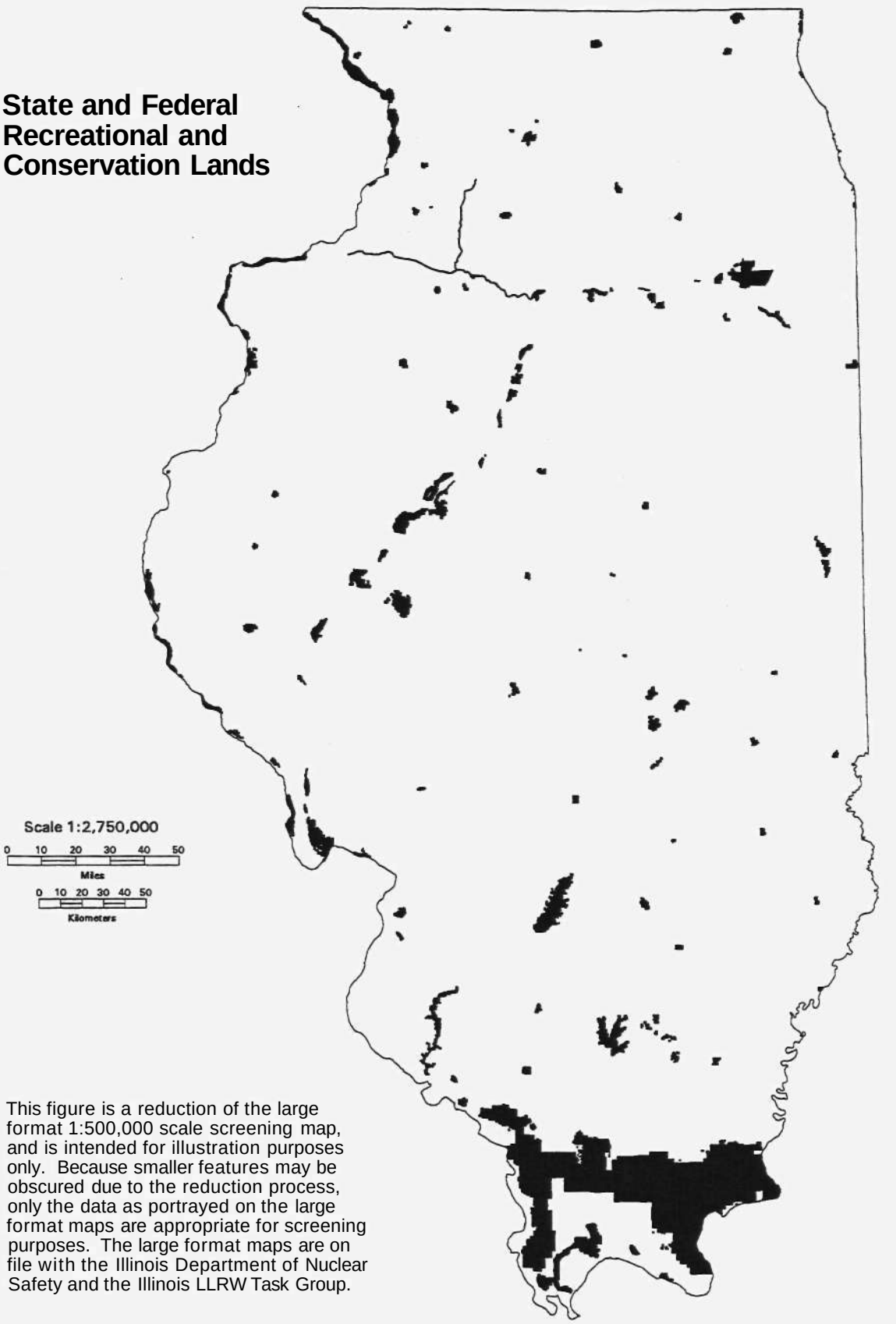
The shaded areas on this map show lands owned or leased by the state and federal government and managed for recreational and conservation purposes. These areas were delineated and digitized by the Illinois Natural History Survey using USGS 7.5 Minute Quadrangle Maps, USGS TIGER files, county plat books, and maps provided by the U.S. Fish and Wildlife Service.

Sources

Illinois Department of Natural Resources CD ROM. 1996. Volume II.

Illinois Department of Conservation. 1994. *Land and Water Report No. 30,* Springfield, IL

State and Federal Recreational and Conservation Lands



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Criterion 18

The site must not be located on or be within 1,000 feet of lands that are managed for recreational or conservation purposes and that are owned or leased by a local unit of government or a not-for-profit corporation as of the date of adoption of the criteria.

Discussion. This criterion is similar in its intent to Criterion 17, but focuses attention on county, municipal, and not-for-profit recreational and conservation lands rather than state and federal properties. Examples provided by the Task Group include municipal parks, forest preserves, and lands owned and operated by not-for-profit organizations. This criterion also requires a 1,000-foot setback around designated lands to prevent both direct and indirect impacts.

Scientific Surveys' Approach. The original GIS coverage that addresses this criterion was created in 1983 by Environmental Systems Research Institute, Inc. (ESRI). Data on private and not-for-profit recreational and conservation lands were selected from the original coverages to form the new coverage. Individual overlays were prepared for all data using existing collateral data that were available at widely differing scales and projections. Data from each overlay were then transferred and consolidated into a single coverage at map scale of 1:500,000.

The resultant map (Figure 19) shows recreational and conservation lands with a 1,000-foot buffer. Locations of state and federal recreational and conservation areas were deleted from the final coverage since they are included on the map described for Criterion 17. A supplemental point coverage (Figure 20) provides additional locations of recreational and conservation lands which will need to be considered in the evaluation of a specific site.

Sources

Ackerman, K. 1977. *Inventory of Public Recreation Lands in Illinois*, Illinois Department of Transportation, Bureau of Location and Environment, Springfield, IL.

Figure 19. Local and Not-For-Profit Recreational Lands

This map shows the locations of non-state and non-federal recreation and conservation lands with a 1,000 foot buffer around the property boundaries. Properties shown include municipal, county, and private facilities such as forest preserves, parks, conservation areas, sportsmen's clubs, and game refuges.

Local and Not-For-Profit Recreational Lands

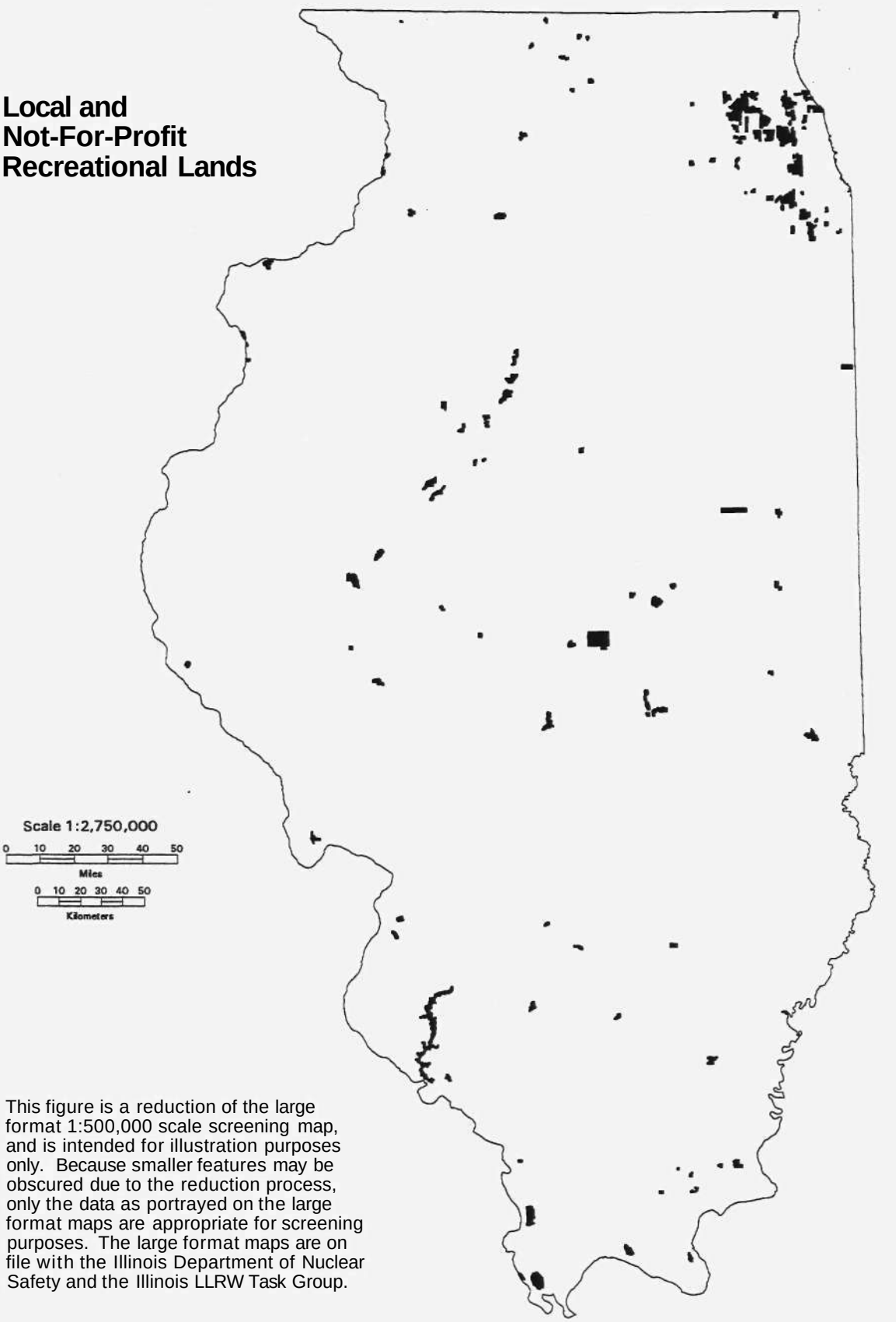

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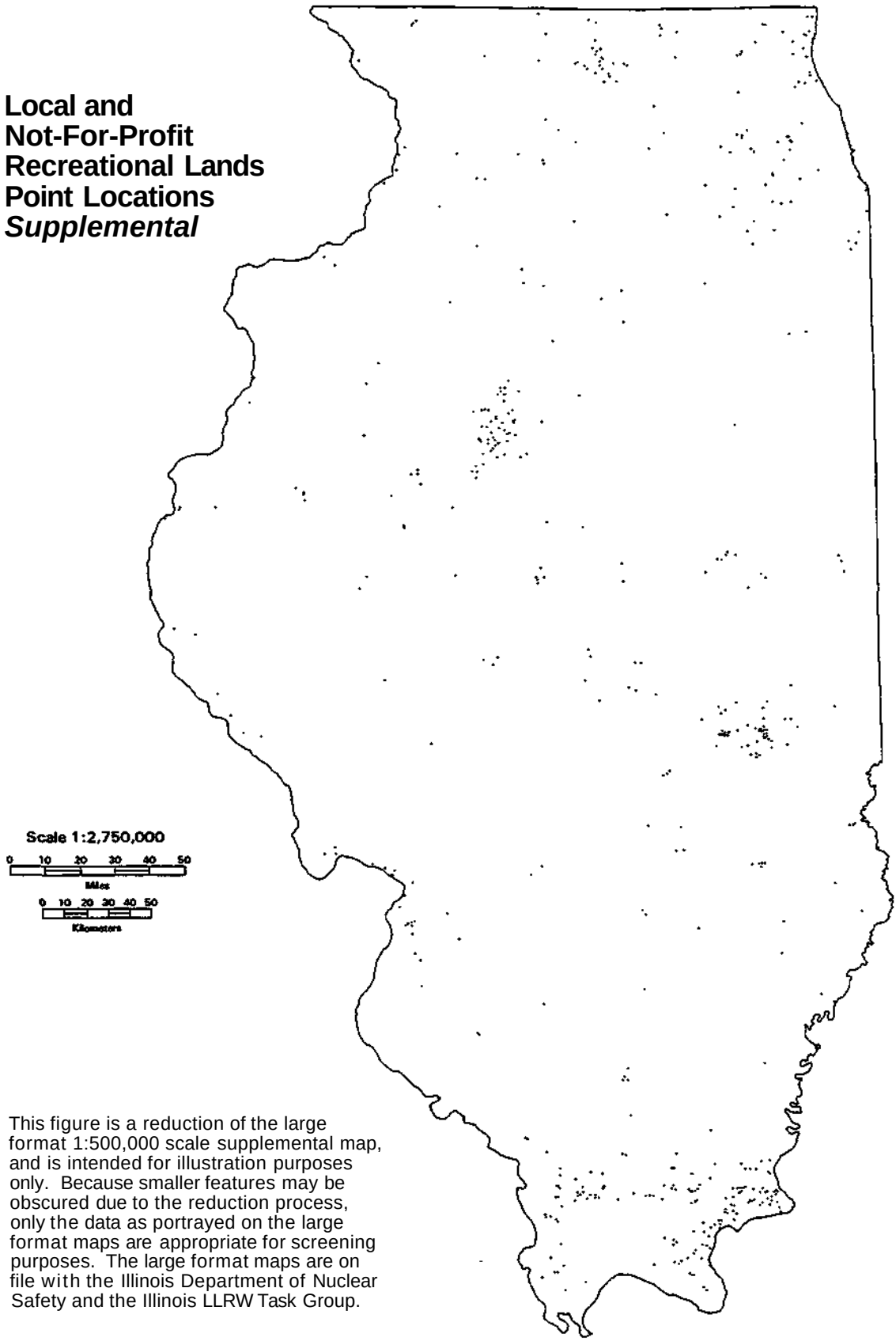
Figure 20. Local and Not-For-Profit Recreational Lands - Point Locations (Supplemental)

This map shows point locations of non-state and non-federal recreation and conservation lands where the areal extent of the property boundaries is not known. Properties included in this point coverage include municipal, county, and private facilities such as forest preserves, parks, conservation areas, sportsmen's clubs, and game refuges.

Local and Not-For-Profit Recreational Lands Point Locations *Supplemental*



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Criterion 19

The site must not be located so as to cause an adverse impact on a dedicated nature preserve, a registered natural area, or lands listed on the Illinois Natural Areas Inventory.

Discussion. The Task Group defined natural areas as lands registered in conjunction with the Illinois Natural Areas Preservation Act (INAPA) and lands listed in the Illinois Natural Areas Inventory. Nature preserves include lands that have been legally protected under the provisions of the INAPA. The intent of this criterion is to prevent an adverse impact on natural areas through alterations of the physical or biological attributes of air, land, or water. Examples of adverse impacts provided by the Task Group included alterations of existing topography, changes in drainage patterns, and creation of barriers to wildlife movement.

Scientific Surveys' Approach. The accompanying map (Figure 21) shows the locations of nature preserves identified in *A Directory of Illinois Nature Preserves* (1995) and natural areas identified in the *Illinois Natural Areas Inventory* (1996). These areas were digitized by the Illinois Natural History Survey. The boundaries shown are those available at the release date of each database.

The natural areas data set contains information on the extent of the natural areas in Illinois, digitized from USGS 7.5-minute quadrangles or from aerial photographs at a scale of 1:8,000. Boundaries are approximate. The map does not indicate ownership or legal boundaries. Areas included in this data set are those which are in the Illinois Natural Areas Inventory as of October 1995. There is a supplemental point coverage shown in Figure 22 for those natural areas which were not mapped as of October 1995. This map is included as supplemental information to be used during site selection. Attribute information is based upon data obtained from the Illinois Department of Natural Resources, Division of Natural Heritage and The Nature Conservancy biological and conservation data systems.

Digitized boundaries have not been verified against the original source. This quality assurance review is scheduled to be completed by staff of the Illinois Department of Natural Resources, Division of Natural Heritage by the end of 1997. Areas that were digitized from aerial photos were not rectified to any base.

The nature preserves data set contains information on the nature preserves of Illinois, digitized from USGS 7.5-minute quadrangles. A nature preserve is an area of land or water in public or private ownership that is formally dedicated pursuant to the terms of the law, to be maintained in its natural condition. Boundaries are approximate and do in some instances portray legal property boundaries.

Data were digitized by the Illinois Natural History Survey from USGS 7.5-minute quadrangle paper maps. National Map Accuracy Standards suggest an accuracy of 40 feet. Property boundaries were approximated. Attribute information is based upon data provided by the Illinois Nature Preserves Commission. All the data are topologically complete polygons. Preserves shown in Figure 22 are those dedicated prior to October 1995. These data are appropriate for use in locational screening but require field verification of precise boundaries.

Source

University of Illinois at Urbana-Champaign, Department of Landscape Architecture and the Natural Land Institute. 1978. *Illinois Natural Areas Inventory,* Technical Report (with county maps delineating natural areas) Illinois Department of Conservation.

Figure 21. Natural Areas and Nature Preserves

The shaded areas on this map show nature preserves identified by McFall and Kames and natural areas identified in the Illinois Natural Areas Inventory (1996). These areas were digitized by the Illinois Natural History Survey. The boundaries shown are those available at the release date of each database. New boundaries mapped since the last release may be evaluated for a specific site.

Sources

Illinois Natural Areas Inventory (INAI). 1996. Illinois Department of Natural Resources, Illinois Natural History Survey, Champaign, IL.

McFall, D., and J. Kames (eds.). 1995. *A Directory of Illinois Nature Preserves.* Illinois Department of Natural Resources, Division of Natural Heritage, Springfield, IL.

Natural Areas and Nature Preserves

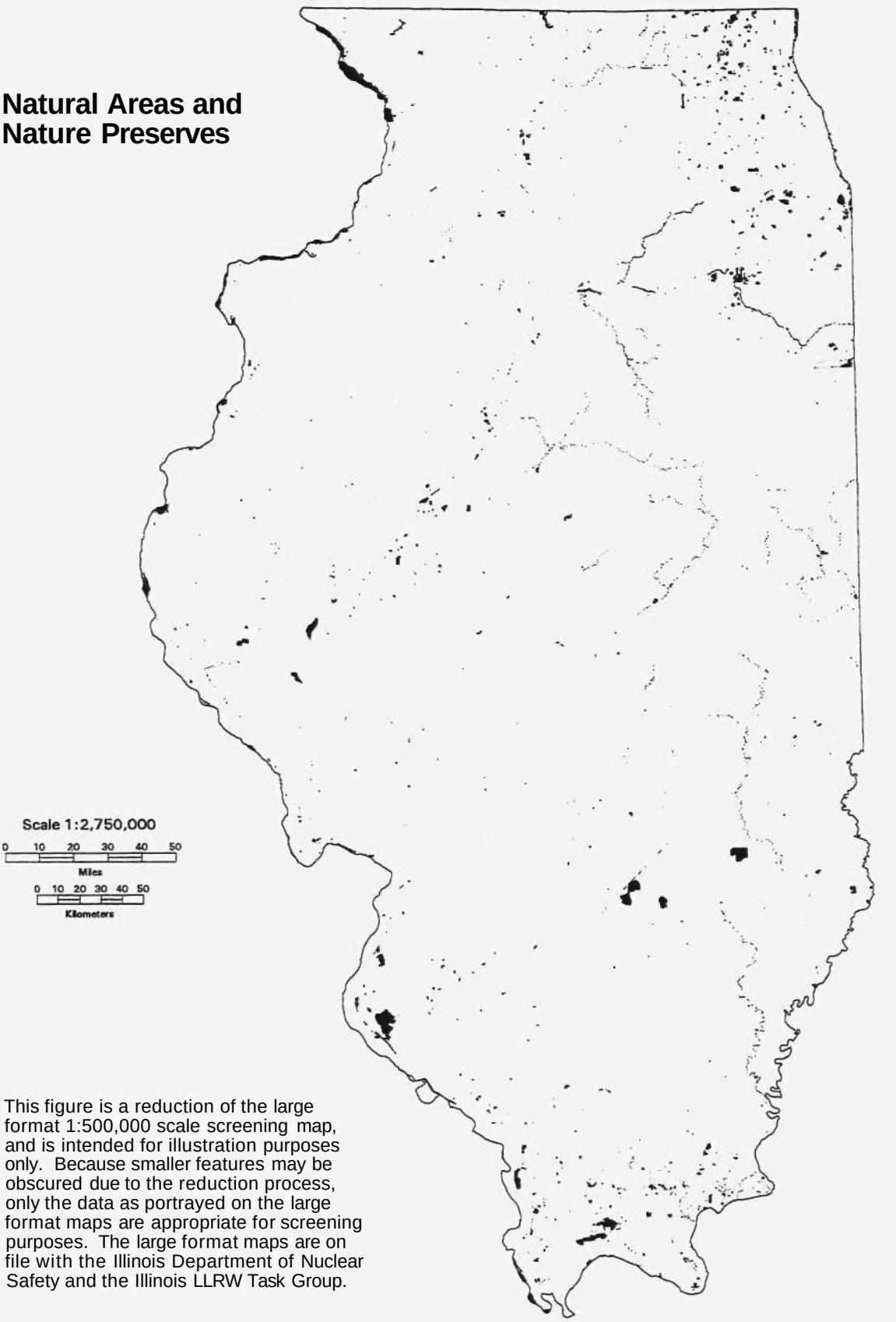

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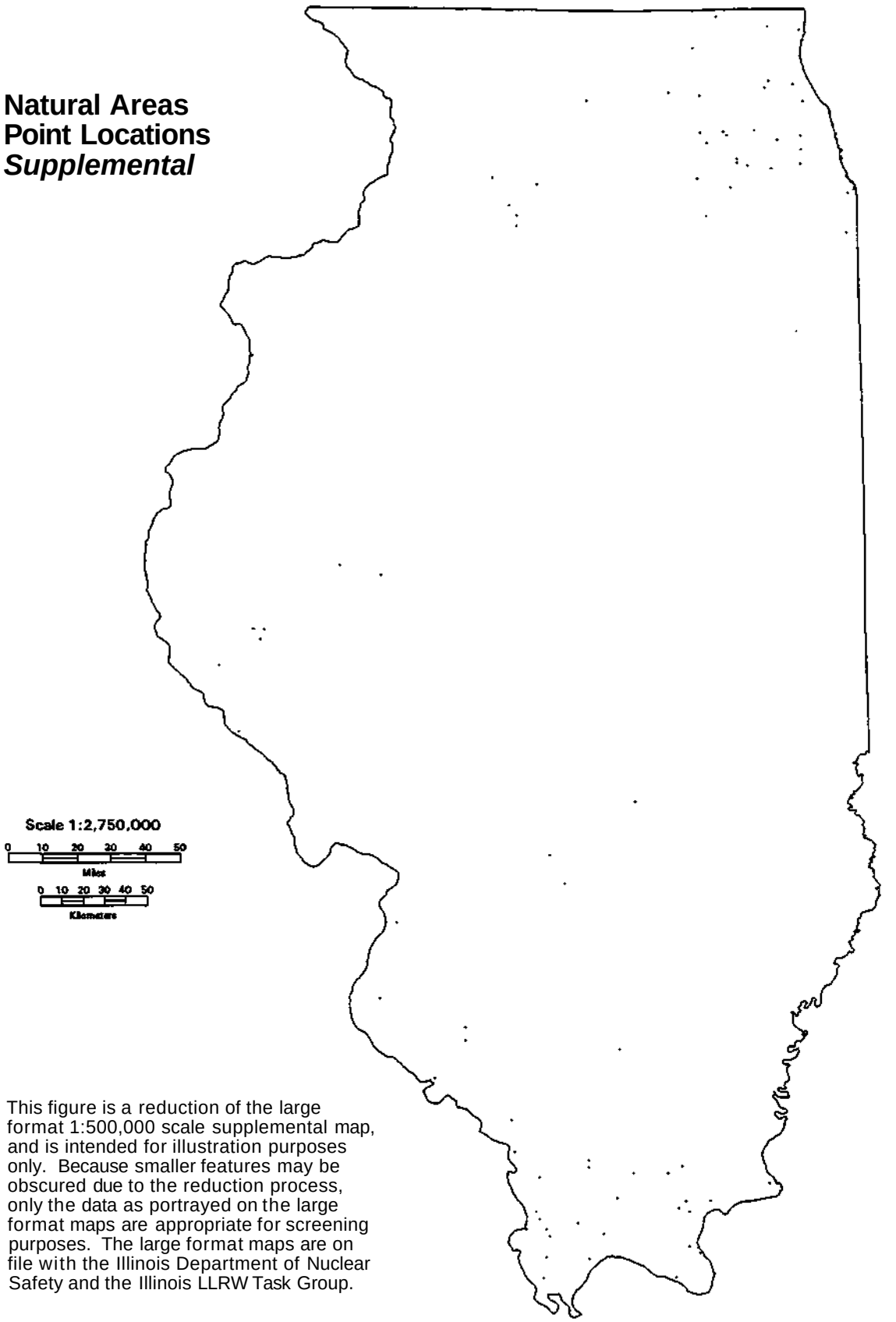
Figure 22. Natural Areas - Point Locations (Supplemental)

The points on this map represent the locations of natural areas identified in the Illinois Natural Areas Inventory (1996). The areal extent of these natural areas had not been mapped as of October 1995.

Source

Illinois Natural Areas Inventory (INAI). 1996. Illinois Department of Natural Resources, Illinois Natural History Survey, Champaign, IL

Natural Areas Point Locations *Supplemental*



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Criterion 20

The site must not be located so as to cause an adverse impact to the habitat for documented occurrences of state or federal endangered or threatened species.

Discussion. The Task Group criterion on endangered and threatened species addresses the need to avoid endangering the habitat for documented occurrences of listed plant or animal species. In Illinois, the Illinois Endangered Species Protection Board and the U.S. Fish and Wildlife Service designated such species. The Illinois Department of Natural Resources, Division of Natural Heritage maintains a database of species and their locations within the state.

Scientific Surveys' Approach. Data on the locations of threatened and endangered species are generally not made public because of concerns over potential negative impacts on habitat or species viability. The Scientific Surveys' implementation plan indicated that statewide screening for threatened and endangered species would not be conducted. Review by the Division of Natural Heritage would not be initiated until the locational screening phase. Recent changes to the Illinois Low-Level Radioactive Waste Management Act no longer require the Scientific Surveys to identify ten or more locations, so the evaluation for compliance with this criterion is deferred until a specific site is identified.

Criterion 21

The site must not contain any forest land that is part of a large forest ecosystem.

Discussion. The Task Group recognized the importance of large forest ecosystems in maintaining the biodiversity required for ecological stability. The intent of this criterion is to avoid these lands during the process of selecting a site for a LLRW disposal facility.

The Task Group cited the report *Large Forest Ecosystems of Illinois* by Randall W. Collins and John E. Buhnerkempe (1991) as the reference document to be used by the Scientific Surveys to identity areas that qualified for large forest ecosystem status. Each qualifying area was required to be at least ½ mile wide and at least 500 acres in size.

Collins and Buhnerkempe described the process that was followed to identify 40 tracts that met their criteria for a large forest ecosystem. USGS 7.5-minute topographical quadrangle maps were examined for areas that appeared to be large enough to qualify for large forest ecosystem status, photocopied, and the acreage was measured using a planimeter to determine if the area was at least 500 acres. The areas were then reviewed by examining county soil survey maps to determine the quality of the tracts (amount of disturbance in the area). Disturbances included roads that did not have canopy closure above them, power line right-of-ways, evidence of clear cutting, pine plantation stands, subdivisions, or any other type of man-made disruption.

The tracts were then compared to 9- x 9-inch contact prints from the 1988 National Aerial Photography Program for the final evaluation in the study. Final area calculations and perimeter outlines were determined, boundaries were placed on the photocopied maps, and transparencies outlining the boundaries were overlaid on the contact prints.

Scientific Surveys' Approach. The ISWS transposed the boundaries from the photocopied maps onto USGS 7.5-minute quadrangle maps and digitized them for inclusion in a GIS coverage. Boundaries were then plotted and checked for accuracy. The accompanying map (Figure 23) represents the digitized version of the tracts identified in the Collins and Buhnerkempe report.

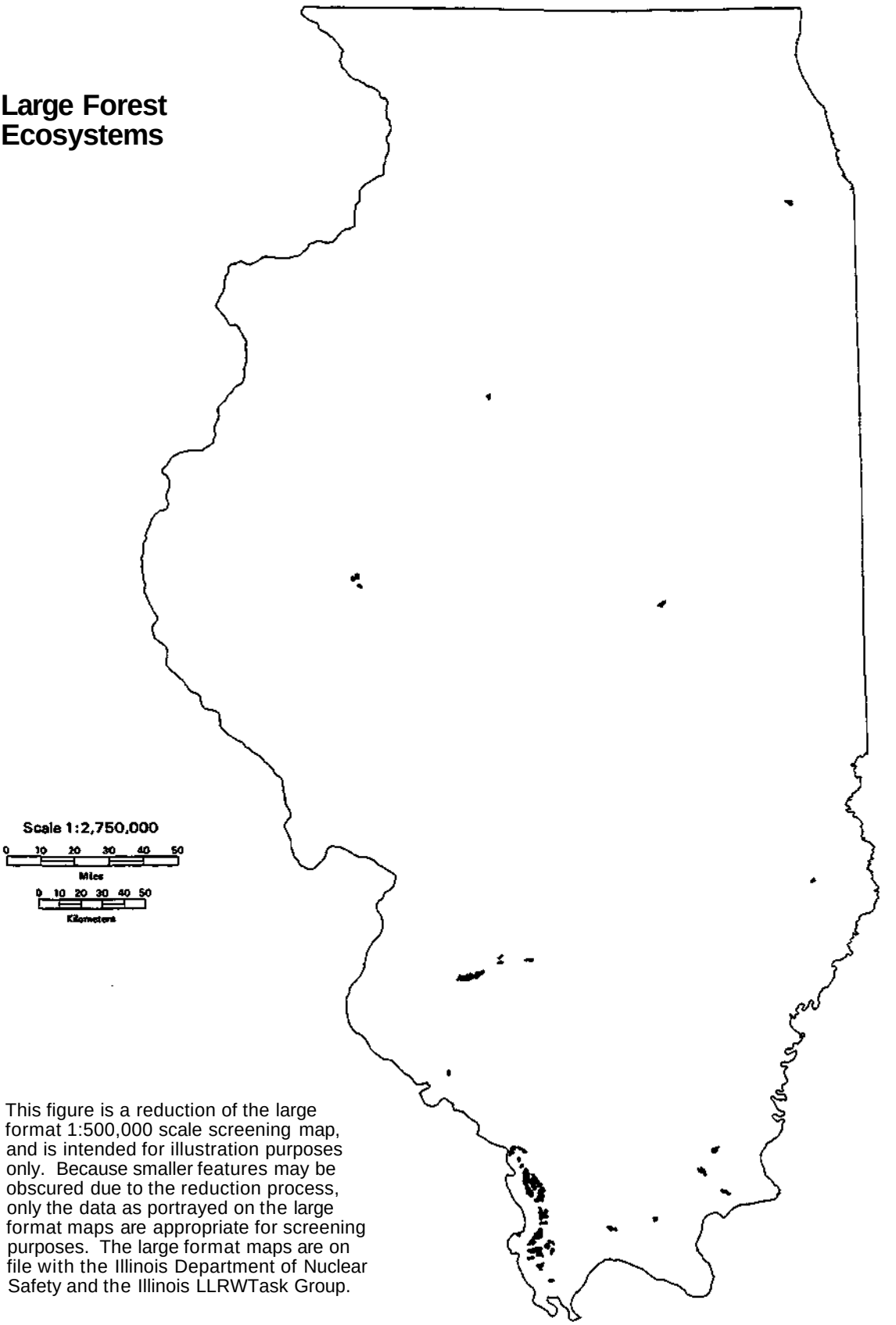
Figure 23. Large Forest Ecosystems

The shaded areas on this map show large forest ecosystem tracts as identified by Collins and Buhnerkempe (1991). In this study USGS 7.5 minute quadrangle maps were analyzed for areas that appeared to be large enough to qualify for large forest ecosystem status. Once an area was identified, it was delineated and verified using county soil survey maps and aerial photographs. The Illinois State Water Survey transposed the boundaries from photocopied maps provided by the Natural Heritage Division and digitizied them to create a GIS coverage.

Source

Collins, R. W., and J. E. Buhnerkempe. 1991. *Large Forest Ecosystems of Illinois.* Illinois Department of Conservation, Natural Heritage Division, Springfield, IL.

Large Forest Ecosystems



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Criterion 22

The boundaries of the site must be at least 1,000 feet from sensitive stream habitats.

Discussion. The Task Group defined a sensitive stream habitat as a stream segment that meets at least one of the following designations:

1. Class A, B, and C habitat as designated by IEPA or Illinois Department of Natural Resources using the procedures specified by Hite and Bertrand (1988) for the Biological Stream Classification (BSC) stream quality index, and
2. Biologically significant streams as designated by Page et al. (1992).

Scientific Surveys' Approach. Separate stream segment coverages for the above classification systems were developed by the Illinois Natural History Survey using the USGS 1:100,000 scale Digital Line Graph of water features as a base. Streams within the BSC classification meeting the specifications of the criterion, specifically those with a habitat classification of A, B, or C, were identified and the location and attributes of these streams were placed in a separate coverage called "bsc-crit." A 1,000-foot buffer was added to all stream segments in the bsc-crit coverage and the biologically significant streams coverage "sig-streams," and placed into coverages "bsc-1000" and "sig-1000," respectively. Quality control reviews of both buffered coverages were conducted, and no errors or inconsistencies were found.

This map (Figure 24) identifies stream segments in Illinois meeting the Task Group definition and fully meets the requirements of Criterion 22.

Figure 24. Sensitive Stream Habitats

The lines on this map show sensitive stream habitats that meet at least one of the following designations:

Class A, B, and C habitat as designated by the Illinois Environmental Protection Agency or the Illinois Department of Natural Resources using the procedures specified by Hite and Bertrand (1988) for Biological Stream Classification (BSC) stream quality index or biologically significant stream as designated by Page and others (1992).

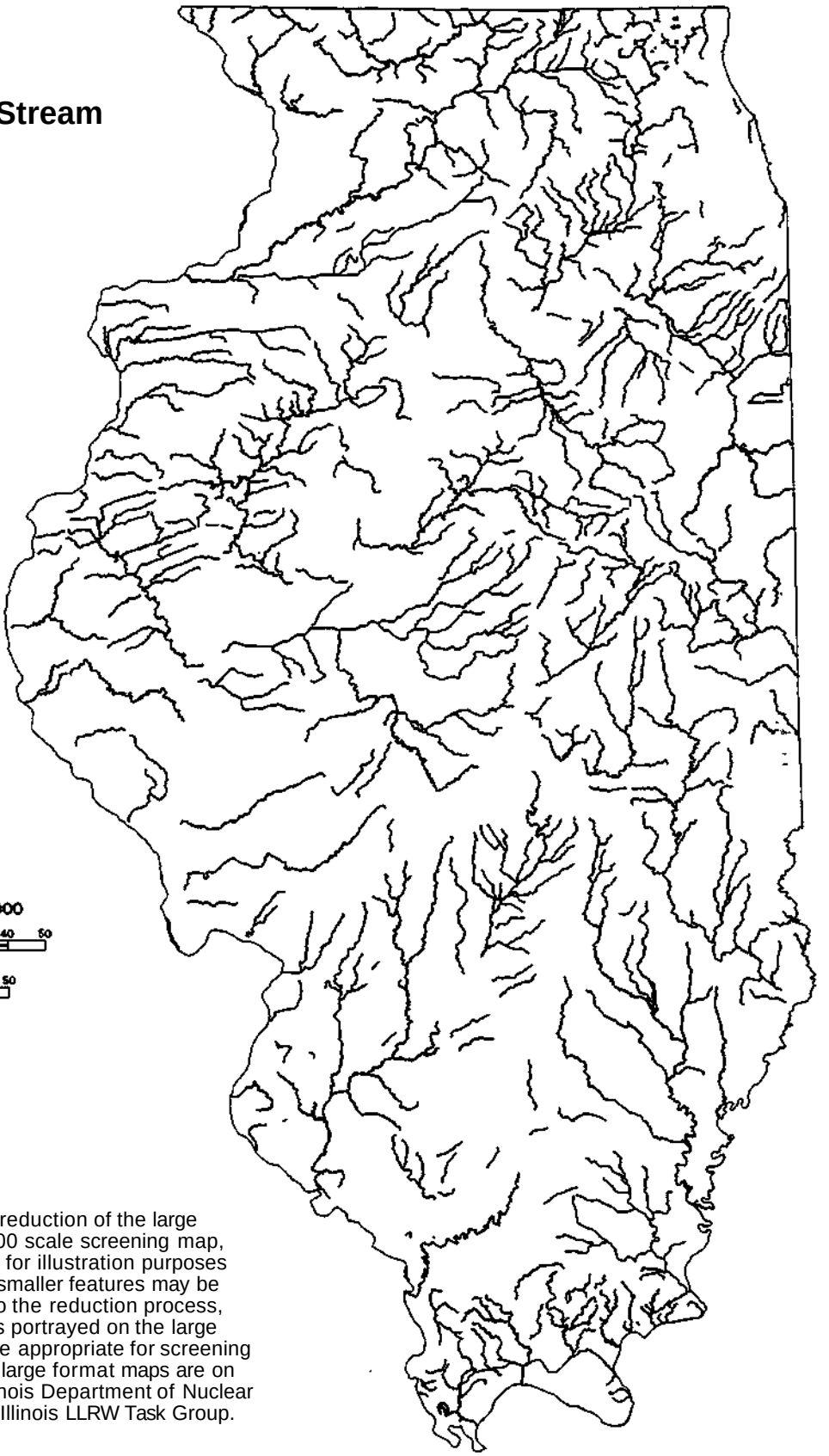
Sources

Stream segment coverages were developed by the Illinois Natural History Survey using the USGS 1:100,000 Digital Line Graph database.

Hite, R.L, and B.A. Bertrand. 1988. *Biological Steam Characterization (BSC): A Biological Assessment of Illinois Stream Quality,* Special Report 13 of the Illinois State Water Plan Task Force, Illinois Department of Conservation, Springfield, IL.

Page, L.M., K. S. Cummings, C. A. Mayer, S. L Post, and M. E. Retzer. 1992. *Biologically Significant Illinois Streams: An Evaluation of the Streams of Illinois Based on Aquatic Biodiversity,* Illinois Natural History Survey, Center for Biodiversity, Technical Report 1992(1), Champaign, IL.

Sensitive Stream Habitats



This figure is a reduction of the large format 1:500,000 scale screening map, and is intended for illustration purposes only. Because smaller features may be obscured due to the reduction process, only the data as portrayed on the large format maps are appropriate for screening purposes. The large format maps are on file with the Illinois Department of Nuclear Safety and the Illinois LLRW Task Group.

Criterion 23

The boundaries of the site must be at least 1,000 feet from a lake of 20 acres or more in surface area that provides substantial public access and benefits to citizens of Illinois.

Discussion. As stated in the Task Group guidelines, this setback is provided as additional assurance that a potential release of radionuclides from a disposal facility will not reach an accessible environment that is used by the public. This criterion is not intended to be applied to farm ponds, borrow pits, or other lakes that do not provide free access to a substantial number of persons.

Digital coverages of the location and areal extent of Illinois lakes are provided in the USEPA 1:100,000 scale Stream Reach File, Version 3 Database (RF3). There is little information on the amount of public access provided to individual Illinois lakes. In order to screen the state using the available data on lakes, it was necessary to assume that most lakes having a size of 20 acres or more would provide substantial public access.

Scientific Surveys' Approach. The RF3 Stream Reach File is a 1:100,000 hydrology coverage developed nationwide by the USEPA The RF3 database was created using the USGS 1:100,000 scale Digital Line Graph database of water features as a base coverage. The ISWS conducted a quality control analysis of the RF3 coverage for Illinois streams; any inconsistencies in the coverage were corrected. The surface areas of all lakes were computed. Lakes with areas greater than 20 acres were selected and put into a separate coverage called "lksgt20." A 1,000 foot buffer was added to the outside boundary of the lakes to produce the "lksgt20_buf' coverage used in screening.

The accompanying map (Figure 25) shows the locations of lakes in Illinois of 20 acres or more in surface area as delineated in the RF3 1:100,000 scale coverage. This is not a comprehensive map of all lakes in Illinois meeting Criterion 23. Some lakes on this map may not provide substantial public access to the citizens of Illinois. Additional review should be conducted for specific sites.

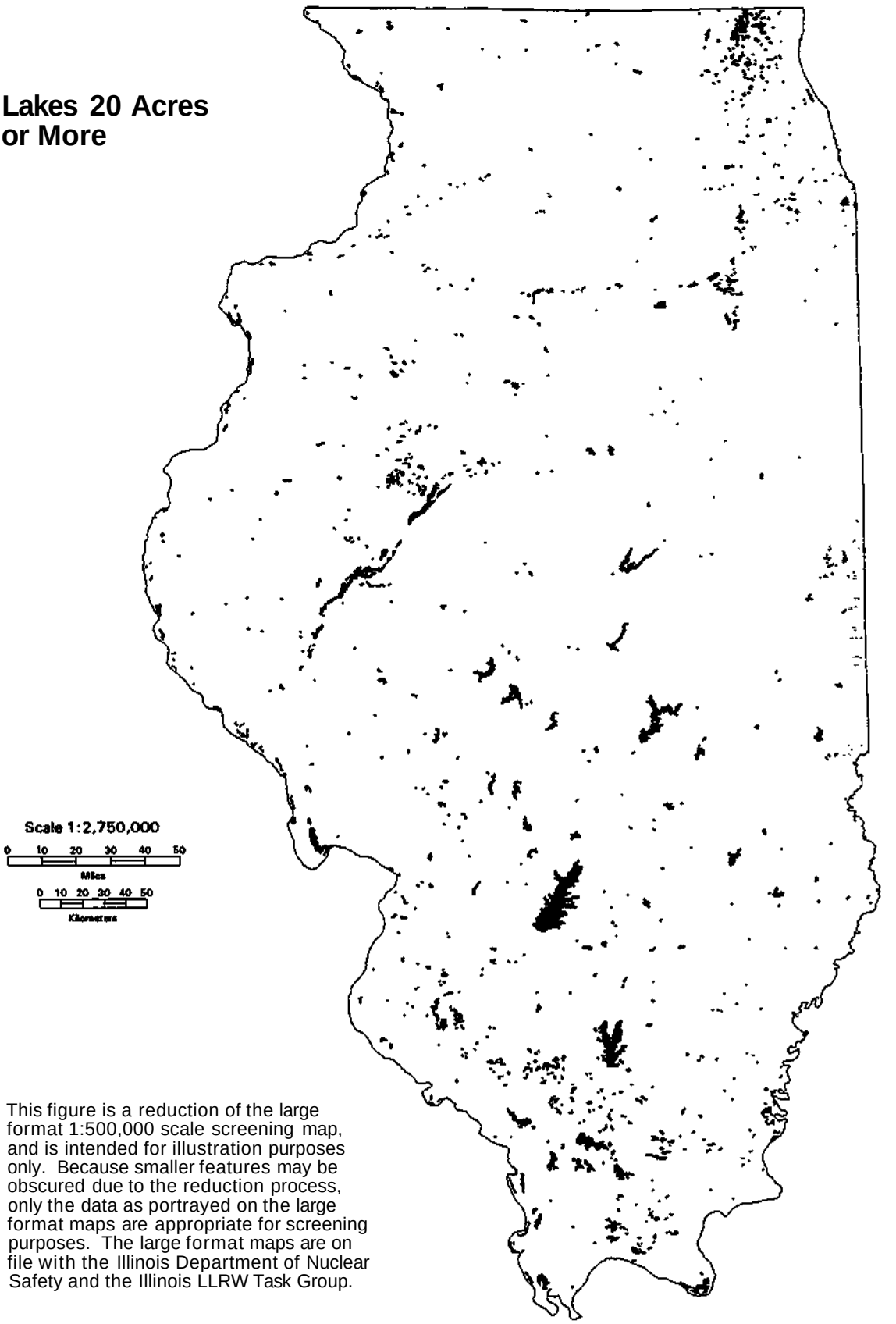
Figure 25. Lakes 20 Acres or More

The shaded areas on this map show the locations of lakes in Illinois of 20 acres or more in surface area, as delineated in the U.S. Environmental Protection Agency 1:100,000 scale Stream Reach File, Version 3 Database. This is not a comprehensive map of all lakes in Illinois meeting this criterion. Additional review may be required for specific site.

Source

USEPA. 1:100,000 Stream Reach File, Version 3 Database.

Lakes 20 Acres or More



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Cultural and Paleontological Resources

Criterion 24

The site must not be located so as to cause an adverse impact on historic properties or on paleontological and archaeological resources.

Discussion. The Task Group criterion on protection of historic properties and paleontological and archaeological resources is consistent with state and federal laws. The Illinois Historic Preservation Agency and the National Advisory Council on Historic Preservation determine whether an adverse impact on a historic property is likely and whether an exception may be granted for appropriate mitigation measures.

Scientific Surveys' Approach. The locations of properties in Illinois are available in digital format. The Scientific Surveys were to include this assessment during the locational phase of the screening process, but changes to the Illinois Low-Level Radioactive Waste Management Act have eliminated the requirement for the Scientific Surveys to identify ten or more locations. This assessment, along with an assessment of paleontological and archaeological resources will need to be conducted for a specific site. An inventory of paleontological resources in the state is maintained by the Illinois State Museum.

Criterion 25

The site must not be located so as to cause an adverse impact on human skeletal remains that are interred in a cemetery owned, operated, controlled, or managed by a cemetery authority as defined in the Cemetery Care Act, 760 ILCS 100/1, or to human skeletal remains that are interred in unregistered cemeteries or graves and thus protected by the Illinois Human Skeletal Remains Protection Act, 20 ILCS 3440 0.01.

Discussion. Legislation protects the graves of early Illinoisans from desecration and ensures that all human remains are accorded respect. Burial grounds must be avoided during the process of siting a LLRW disposal facility.

The Comptroller for the State of Illinois maintains a listing of registered cemeteries. Many cemeteries are located on USGS topographic maps, and their locations are available in digital format. Identification of unregistered graves is more problematic. Although the locations of some graves may be documented by historic atlases and plat maps, many graves are discovered and documented only through systematic historic resource assessments conducted in accordance with the provisions of the Illinois State Agency Historic Resources Preservation Act, 16 U.S.C. § 470.

Scientific Surveys' Approach. The ISWS used the USGS Geographic Names Information System (GNIS) database of cemeteries as a starting point. Additional cemeteries (3,392) were located in Illinois on USGS 7.5-minute quadrangle maps and their locations were digitized. A total of 7,101 cemeteries were located from these two sources. The digitizing process was determined to be

accurate to within 20 feet. Check plots were performed and compared to the original paper map for each quadrangle.

A Cemetery Licensee Report, a list of private cemeteries in perpetual care, was obtained in paper form from the State Comptroller's, Cemetery and Burial Trust Office. A text file was created by scanning the document. Using a computer program, a comparison was made with the coverage developed by the ISWS. If the cemetery was in the Licensee Report, a "yes" was entered in the licensee report field. Of the 890 cemeteries listed in the Licensee Report, 619 were in the coverage that the ISWS developed using the GNIS database and USGS quadrangle maps.

The database is current up to the most recent USGS quadrangle maps available. It accurately represents the data on the source maps. The coverage includes all of the state and can be used during screening. All cemeteries are digitized as point coverages regardless of their size. Field verification of cemetery boundaries will be required for evaluation of a specific site. The statewide cemeteries map is shown in Figure 26.

Figure 26. Cemeteries - Point Locations (Supplemental)

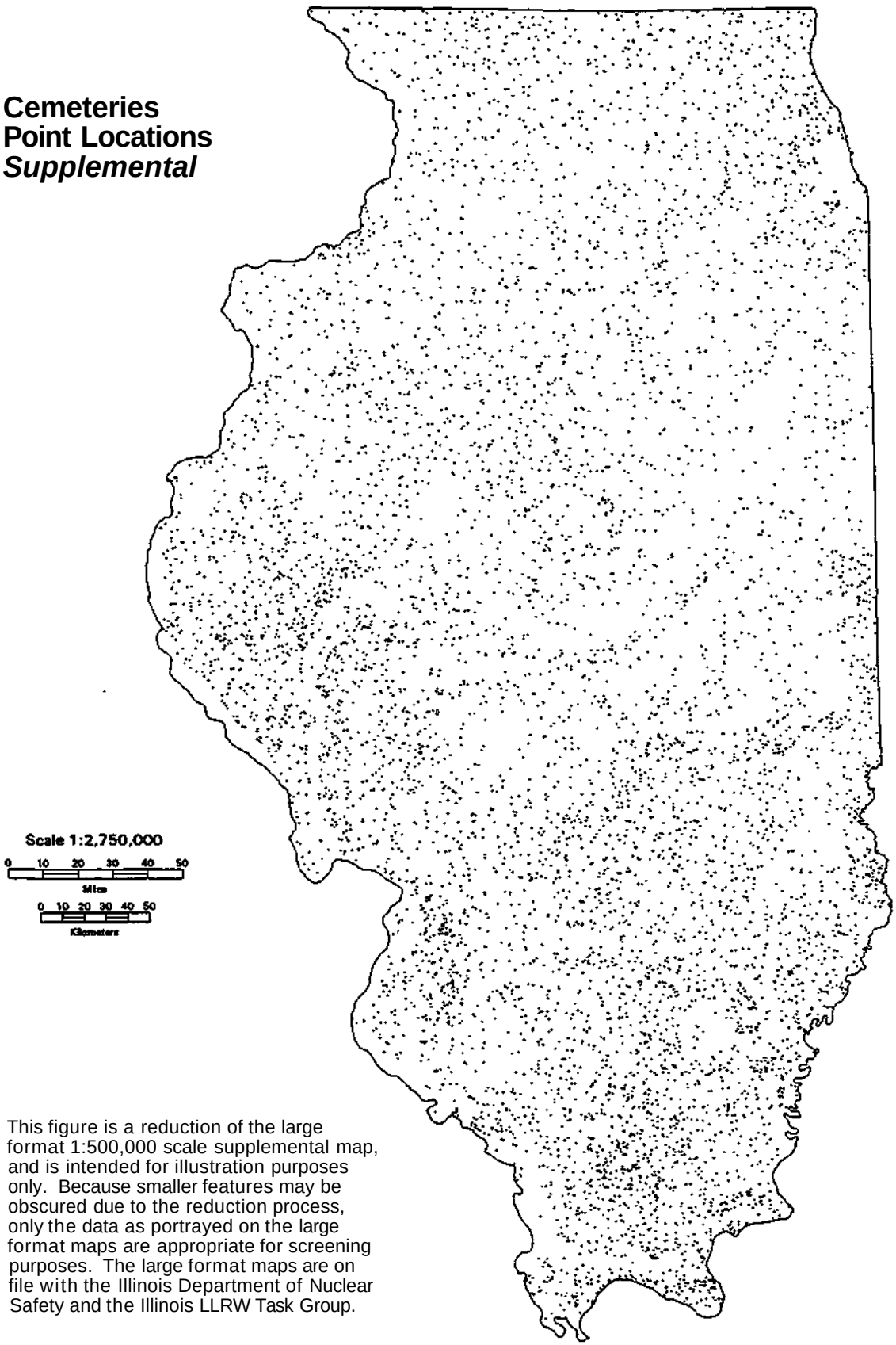
The points on this map show locations of cemeteries. The U.S. Geological Survey Geographic Names Information System (GNIS) database of cemeteries and U.S. Geological Survey 7.5-minute quadrangle maps were used to develop this point coverage.

Sources

U.S. Geological Survey, Phase I tape for Illinois for the National Geographic Names Database, National Cartographic Information Center, Reston, VA.

U.S. Geological Survey, Topographic Quadrangle Series: Scale 1:24,000.

Cemeteries
Point Locations
Supplemental



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COMPOSITE SCREENING MAP

The composite screening map (Figure 27) was assembled by overlaying the data shown on the individual statewide screening maps onto a single map template. Like the individual screening maps, the composite map is divided into two classes: gray and white.

Any area of the state that appears gray on any one of the individual screening maps will also appear gray (or black) on the composite map. In other words, the composite map includes all the gray areas on the individual screening maps. The statewide coverages used for the composite include the maps shown for Criteria 1,3,4,5,6,7,9,10,11,14,15,16,17,18,19, 21, 22, and 23. The supplemental point coverages were not used in developing the composite map.

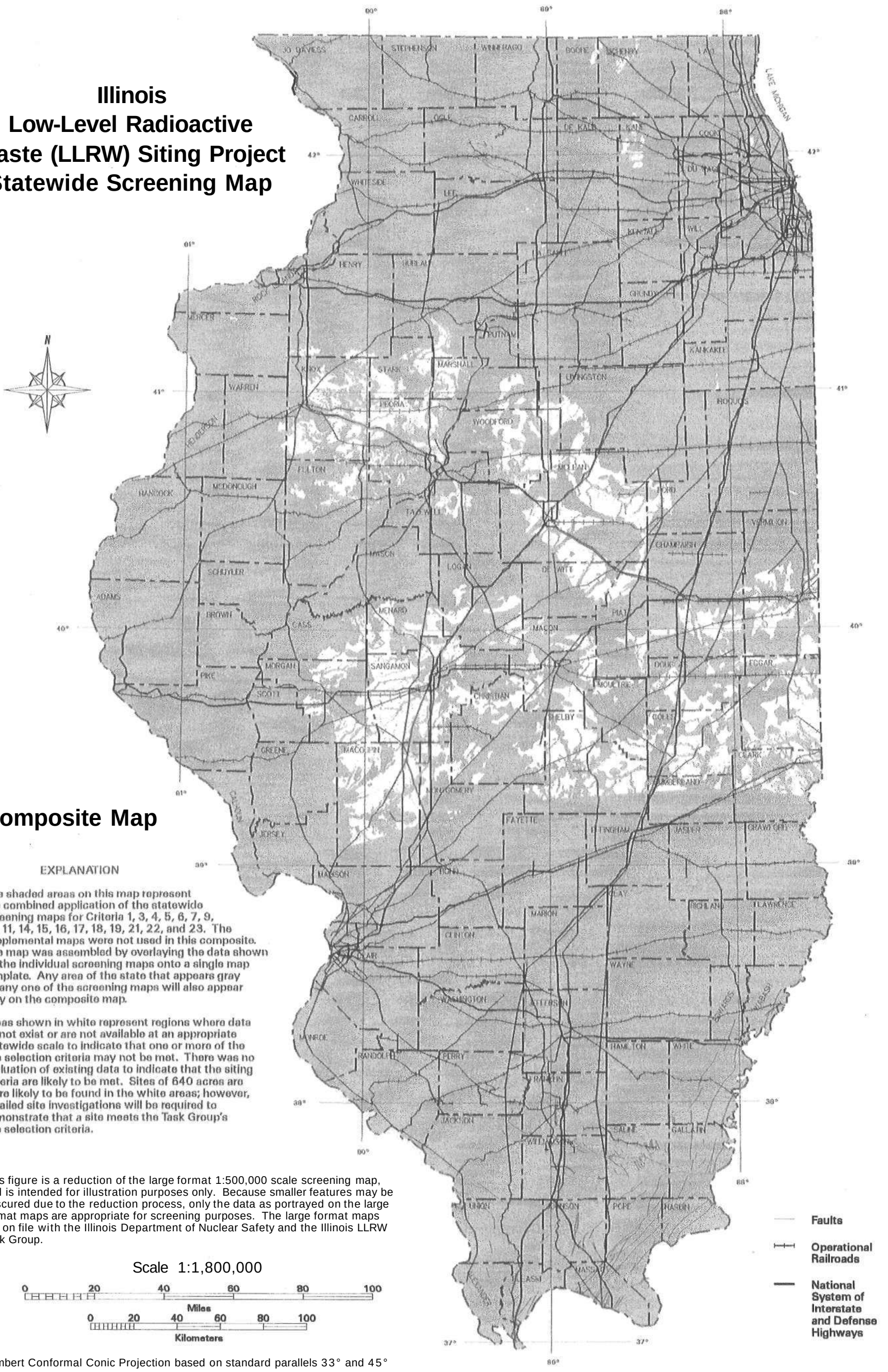
Areas shown in white represent regions where data do not exist or are not available on an appropriate statewide scale to indicate that one or more of the Task Group's criteria may not be met. There was no evaluation of existing data to indicate that the siting criteria are likely to be met. Because of the scale of maps used in the screening and the relative accuracy of some of the coverages, it is possible that a site of 640 acres could be found in the gray areas. Sites of 640 acres are more likely to be found in the white areas; however, detailed site investigations will be required to demonstrate that a site meets the Task Group's siting criteria.

Figure 27. Composite Map

The shaded areas on this map represent the combined application of the statewide screening maps shown for Criteria 1, 3,4, 5,6,7,9,10,11,14,15,16.17,18,19,21,22, and 23.

Illinois
Low-Level Radioactive Waste (LLRW) Siting Project
Statewide Screening Map

Composite Map



EXPLANATION

The shaded areas on this map represent the combined application of the statewide screening maps for Criteria 1, 3, 4, 5, 6, 7, 9, 10, 11, 14, 15, 16, 17, 18, 19, 21, 22, and 23. The supplemental maps were not used in this composite. The map was assembled by overlaying the data shown on the individual screening maps onto a single map template. Any area of the state that appears gray on any one of the screening maps will also appear gray on the composite map.

Areas shown in white represent regions where data do not exist or are not available at an appropriate statewide scale to indicate that one or more of the site selection criteria may not be met. There was no evaluation of existing data to indicate that the siting criteria are likely to be met. Sites of 640 acres are more likely to be found in the white areas; however, detailed site investigations will be required to demonstrate that a site meets the Task Group's site selection criteria.

This figure is a reduction of the large format 1:500,000 scale screening map, and is intended for illustration purposes only. Because smaller features may be obscured due to the reduction process, only the data as portrayed on the large format maps are appropriate for screening purposes. The large format maps are on file with the Illinois Department of Nuclear Safety and the Illinois LLRW Task Group.

Scale 1:1,800,000

0 20 40 60 80 100
Miles
0 20 40 60 80 100
Kilometers

Lambert Conformal Conic Projection based on standard parallels 33° and 45°

Faults

Operational Railroads

National System of Interstate and Defense Highways

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VOLUNTEER SITE EVALUATIONS

Prior to the enactment of Public Act 90-29 Section 10.2(e) of the Illinois Low-Level Radioactive Waste Management Act required that preference be given to volunteered locations when the contractor submits potential sites for consideration by the Task Group. Volunteered sites could be offered by a landowner or unit of local government, providing the minimum size requirement of 640 acres is met. Formal rules for volunteering sites were adopted on January 8, 1996. Those rules also set forth the time frame for consideration of volunteered sites.

The Management Act assigned the Scientific Surveys responsibility for evaluating volunteered sites to determine whether the sites appeared likely to meet the Task Group's siting criteria. The rules for volunteering sites provided two opportunities for landowners and units of local government to have property considered. The initial time period began upon the adoption of the Task Group criteria and ended 60 days later. The second time period was to begin after the Scientific Surveys identified ten or more locations deemed likely to meet the Task Group's criteria. This volunteer period would have continued until three months after the contractor begins to evaluate locations for site selection.

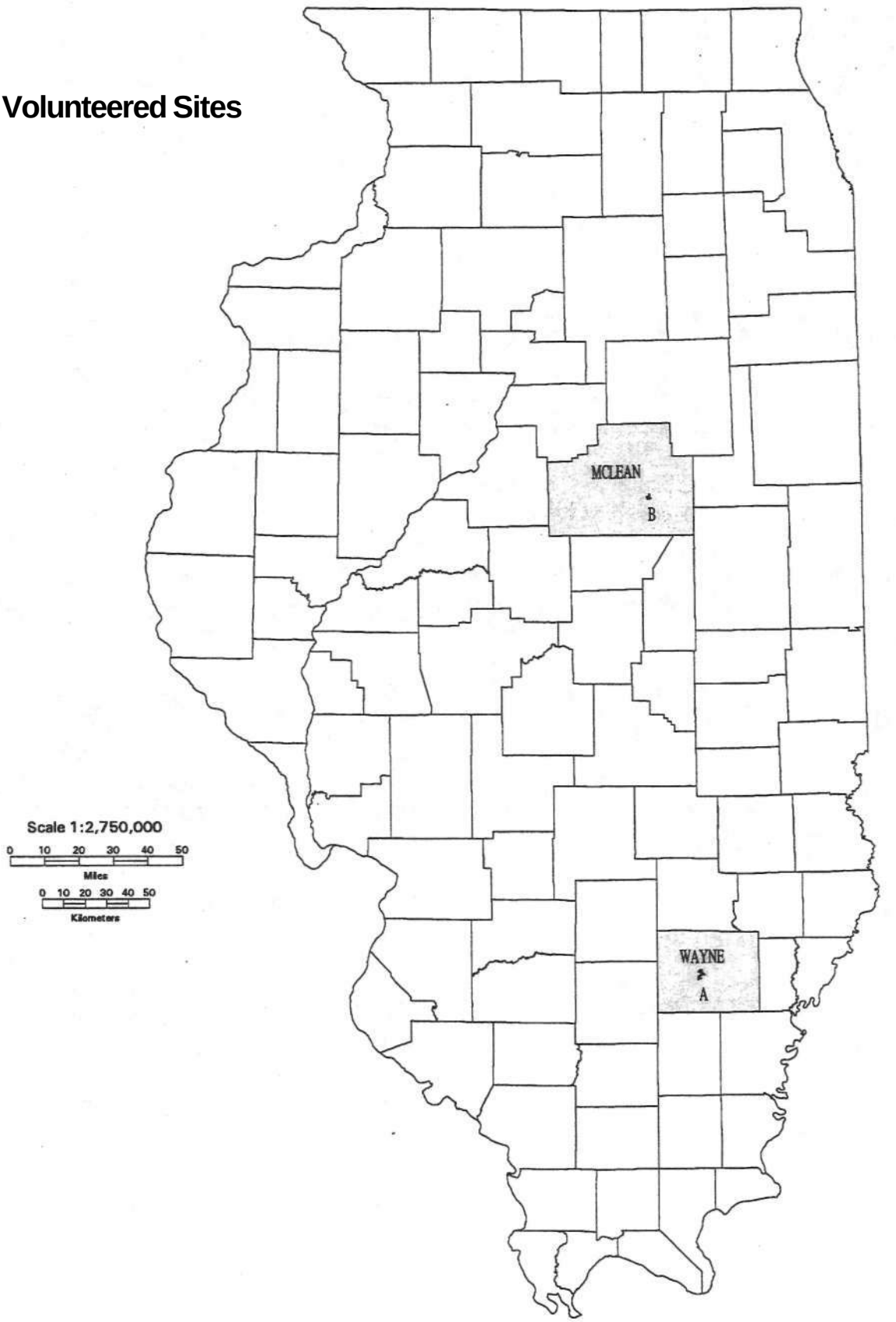
Amendments to the Management Act approved by Governor Edgar in June 1997 modified the site selection procedures to provide for an all-volunteer process. Under the new law, the only locations evaluated by the contractor will be those volunteered jointly by landowners and specified units of local government. The revised Management Act also stated that lands volunteered before the effective date of the new law would be evaluated by the Scientific Surveys.

During the 60-day period after adoption of the Task Group criteria, two sites were volunteered by private landowners (Figure 28). The sites were submitted for consideration to the Illinois Department of Nuclear Safety in accordance with the rules for volunteer locations. The first site is in Wayne County near the town of Jeffersonville (Geff). The second property is in McLean County near the village of Ellsworth. The Scientific Surveys' evaluation of these two sites was completed and reported to the Task Group members at their June 30,1997 meeting in Oak Brook, Illinois. A summary of the Scientific Surveys' findings was transmitted to the Director of the Department of Nuclear Safety and is included in this report. Based on the Scientific Surveys' evaluation, neither of the volunteer sites appeared likely to meet all of the criteria adopted by the Task Group.

Figure 28. Volunteered Sites

This map shows the locations of the two volunteer sites. Site A is located in Wayne County near the town of Jeffersonville (Geff). Site B is located in McLean County adjacent to the village of Ellsworth. Site B was withdrawn from consideration by the landowner in June 1997.

Volunteered Sites



Wayne County - Site A

The Wayne County site was volunteered on December 19, 1996 by multiple owners of a 1,734-acre parcel of land in Lamard and Berry Townships. The property consists of one contiguous parcel of 1,669 acres and a smaller parcel of 65 acres south of the contiguous unit. The closest town is Jeffersonville (Geff), northeast of the site. Portions of this site had been evaluated during 1988-1990 as part of the previous low-level radioactive waste siting process. As part of the evaluation process, staff members from the Scientific Surveys reviewed data contained in the Geff Alternative Site report (1992) and compared the boundaries of the volunteered site to the previously evaluated site. The central portion of the volunteered site is the same as the previous site, but land had been added to the western and southern boundaries. The northeast portion of the previous site was not included in the volunteered site. These differences in site configuration were considered when data from the Geff Alternative Site report were evaluated. In addition to the Geff Site report, Scientific Survey staff reviewed USGS 1:24,000 scale topographic maps, county plat book information, aerial photography, and well records to develop the property evaluation.

Table 2 summarizes the Scientific Surveys' assessment of the Wayne County volunteer site. Based on the examination of pertinent records in the Scientific Surveys' files and the information contained in the GIS databases, the site did not appear likely to meet all of the Task Group's criteria. The site is wholly contained in the seismic risk area identified by the Task Group in Criterion 6 as an exclusionary factor. Well records indicate the presence of a regionally significant minor sandstone aquifer between 20-160 feet below the land surface that provides a source for public and private water supplies in the area. The site also contains numerous active and inactive oil production wells. The impact of these wells on groundwater flow patterns in the region was not determined during this evaluation.

Some portions of the site may be susceptible to mass wasting from stream erosion, but excluding these areas would still provide a site of 640 acres or more. The potential for headward stream migration is greatest along the first-order tributaries of Walton Creek, but eliminating this area of the site would still provide adequate acreage to meet the requirement for minimum size. The floodplain of Wash Branch and its tributaries eliminates a small area on the northwestern boundary of the site, but not enough to impact the minimum size guideline.

Finally, approximately 25 man-made ponds are present on the site with estimated areas of between 0.02 and 1.25 acres and depths ranging from less than one foot to fifteen feet. These ponds have been constructed within the past 50 years and could be eliminated through site engineering.

Figures 29-32 show the application of GIS coverages that were used in developing the site assessment. Many of these maps were assembled from databases developed from maps at a scale of 1:500,000 and are depicted in these figures at a scale of 1:74,000 for illustration purposes only. Boundary locations are not accurate at the scale presented. These maps should not be used for any other type of regional assessment or evaluation.

Figure 29 shows the location of the volunteered site in relation to the town of Geff and also shows that the site is wholly contained in the seismic risk area that has been identified by the Task

Group. Figure 30 shows the Wash Branch creek and its tributary streams that have been identified in the National Wetlands Inventory database. Figure 31 shows the mapped extent of oil and gas reservoirs that underlie much of the volunteered site. Figure 32 illustrates the GIS database information on aquifer materials within 50 feet of land surface. This database was developed at a 1:500,000 scale and is representative of groundwater resources in the area. It should be noted that the sandstone aquifer identified during the Geff site investigation is not shown on the GIS coverage. This is an indication of the limitation of the Criterion 1 map. Site specific studies would be required to accurately characterize the precise boundaries of various aquifers.

Source

Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and HI. 1992. Battelle Memorial Institute and Hanson Engineers, Inc., Springfield, IL.

Table 2. Statewide Screening of Volunteered Sites - Site A

Date: June 18. 1997

Site: Volunteer "A" Wayne County

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
1. The hydrogeologic conditions of the site must inhibit groundwater flow to the extent that groundwater resources are protected, (p. 84)		√		Moderate yield regional aquifer present within 20-160 feet of land surface. At least 25 water wells and cisterns have been documented on the site.[2]
2. Hydrologic conditions at the site must protect public, private, and semiprivate wells and must not be hydrologically affected by the operation of a major well. (p. 88)		√		Numerous private wells finished in a regionally significant minor aquifer.

[1]Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.
[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
3. The site must not be located in a watershed upstream from an in-channel reservoir for a public water supply if that reservoir has a normal pool storage capacity of less than 15,000 acre-feet or a total upstream drainage contributing area of less than 75 square miles. (p. 90)	√			The site is not located in a watershed designated by the Task Group criterion.
4. The geologic materials beneath the site must exhibit a sufficiently high degree of lateral continuity to permit reliable geological mapping and hydrogeological modeling. (p. 91)	√			Site is underlain by a relatively uniform sequence of Quarternary glacial and nonglacial sediments.[2]
5. The site must not be in a karstic area. (p. 93)	√			The site is not in a karstic area.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
6. The site must be located so as not to be adversely affected by earthquakes or ground motions that are likely to occur during the period of most significant radiological risk. (p. 94)		√		Site is entirely contained within the greater than 0.2g seismic area shown in Figure 6.
7. The site must not exhibit evidence of, or potential for, significant mass wasting phenomena, including landsliding, slope failure, or surface subsidence. (p. 98)	√			Some parts of the site, including small areas near the western and southern boundaries and the northwest corner, may be susceptible to mass wasting from stream erosion.[2] Excluding these areas would still provide at least 640 acres that appear to meet the criterion.
8. The site must not have the potential to be undermined significantly by stream incision, bank erosion, or undercutting, (p. 99)	√			Greatest potential for headward stream migration appears to be along first-order tributaries of Walton Creek where historical record suggests a migration rate of less than one foot per year.[2]

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

[2] Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
9. The site must not contain perennial streams, lakes, or ponds or extensive artificial drainage systems that strongly control site hydrology. (p. 100)	√			Approximately 25 man-made ponds are present on the site with areas between 0.02 and 1.25 acres and depths ranging from less than one foot to fifteen feet.[2] They have been constructed within the past 50 years and could be eliminated through site engineering. Other surface water features include unnamed intermittent tributaries to Wash Branch and Walton Creek.
10. The site must not contain any areas within a 500-year floodplain. (p. 101)	√			The floodplain of Wash Branch and it tributaries eliminates an area on the northwestern fringe of the site and the floodplain of Walton Creek and its tributaries eliminates an area on the southeastern portion of the site. Excluding these areas would still provide at least 640 acres that appear likely to meet the criterion.
11. The site must not contain lands that meet the criteria of the classification codes of the National Wetlands Inventory for Illinois; however, a site containing certain man-made wetlands, such as farm ponds and sewage lagoons, should not be automatically excluded from further consideration. (p. 103)	√			Wetland areas along the Wash Branch and one of its tributaries eliminate approximately 60 acres on the northwestern edge of the site. Remaining acreage appears likely to meet the criterion.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
12. The site must not be located within a groundwater management zone (p. 105)	√			The site is not in an identified groundwater management zone.
13. The site must not contain preexisting contamination that has not been or cannot be remediated. (p. 105)			√	Verification of the absence of contaminant sources (e.g., leaking underground storage tanks, spilled pesticides, etc.) would be required to ensure that this criterion is met.
14. The site must not be intersected by a highway that is part of the National System of Interstate and Defense Highways or by an operational railroad track. (P. 106)	√			The site contains no interstate highways or operational railroad tracks.
15. The site must not be located in an area where it would be impacted by an operational mine, quarry, gravel pit, or petroleum production reservoir. (P. 106)			√	Site contains numerous active and inactive oil production wells. Impact of off-site oil wells on groundwater flow patterns needs to be assessed to determine if criterion is met.

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[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
16. The site must not be underlain by mine cavities or located on surface-mined lands, (p. 107)	√			No known mining activities on the site.
17. The site must not be located on or be within 1,000 feet of lands that are owned or leased by an agency of the state or federal government and that are managed for recreational or conservation purposes. (p. 108)	√			The site boundaries are not within 1,000 feet of state or federal recreation or conservation lands.
18. The site must not be located on or be within 1,000 feet of lands that are managed for recreational or conservation purposes and that are owned or leased by a local unit of government or a not-for-profit corporation as of the date of adoption of the criteria. (p. 108)	√			The site is not within 1,000 feet of municipal or not-for-profit recreation or conservation lands.

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[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
19. The site must not be located so as to cause an adverse impact on a dedicated nature preserve, a registered natural area, or lands listed on the Illinois Natural Areas Inventory. (p. 109)	√			The site is not adjacent to and does not contain any registered natural areas.
20. The site must not be located so as to cause an adverse impact to the habitat for documented occurrences of state or federal endangered or threatened species. (p. 110)			√	Requires a detailed biological investigation to verify the absence of endangered or threatened species.
21. The site must not contain any forest land that is part of a large forest ecosystem, (p. I11)	√			The site is not part of a forest ecosystem as defined by the Task Group.
22. The boundaries of the site must be at least 1,000 feet from sensitive stream habitats, (p. 112)	√			Wash Branch and Walton Creek are not classified as biologically significant or designated as a class A, B, or C stream.

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[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
23. The boundaries of the site must be at least 1,000 feet from a lake of 20 acres or more in surface area that provides substantial public access and benefits to citizens of Illinois. (p. 113)	√			The site is more than 1,000 feet from a public access lake of 20 or more acres.
24. The site must not be located so as to cause an adverse impact on historic properties or on paleontological and archaeological resources. (p. 114)			√	No assessment of historic properties or paleontological resources has been conducted.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
25. The site must not be located so as to cause an adverse impact on human skeletal remains that are interred in a cemetery owned, operated, controlled, or managed by a cemetery authority as defined in the Cemetery Care Act, 760 ILCS 100/1, or to human skeletal remains that are interred in unregistered cemeteries or graves and thus protected by the Illinois Human Skeletal Remains Protection Act, 20 ILCS 3440 0.01. (p. 115)	√			No registered cemeteries are present on the property.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

[2]Alternative Site Investigation Studies; Geff Alternative Site, Wayne County, Illinois, Vols. II and III; Battelle Memorial Institute and Hanson Engineers, Inc., 1992.

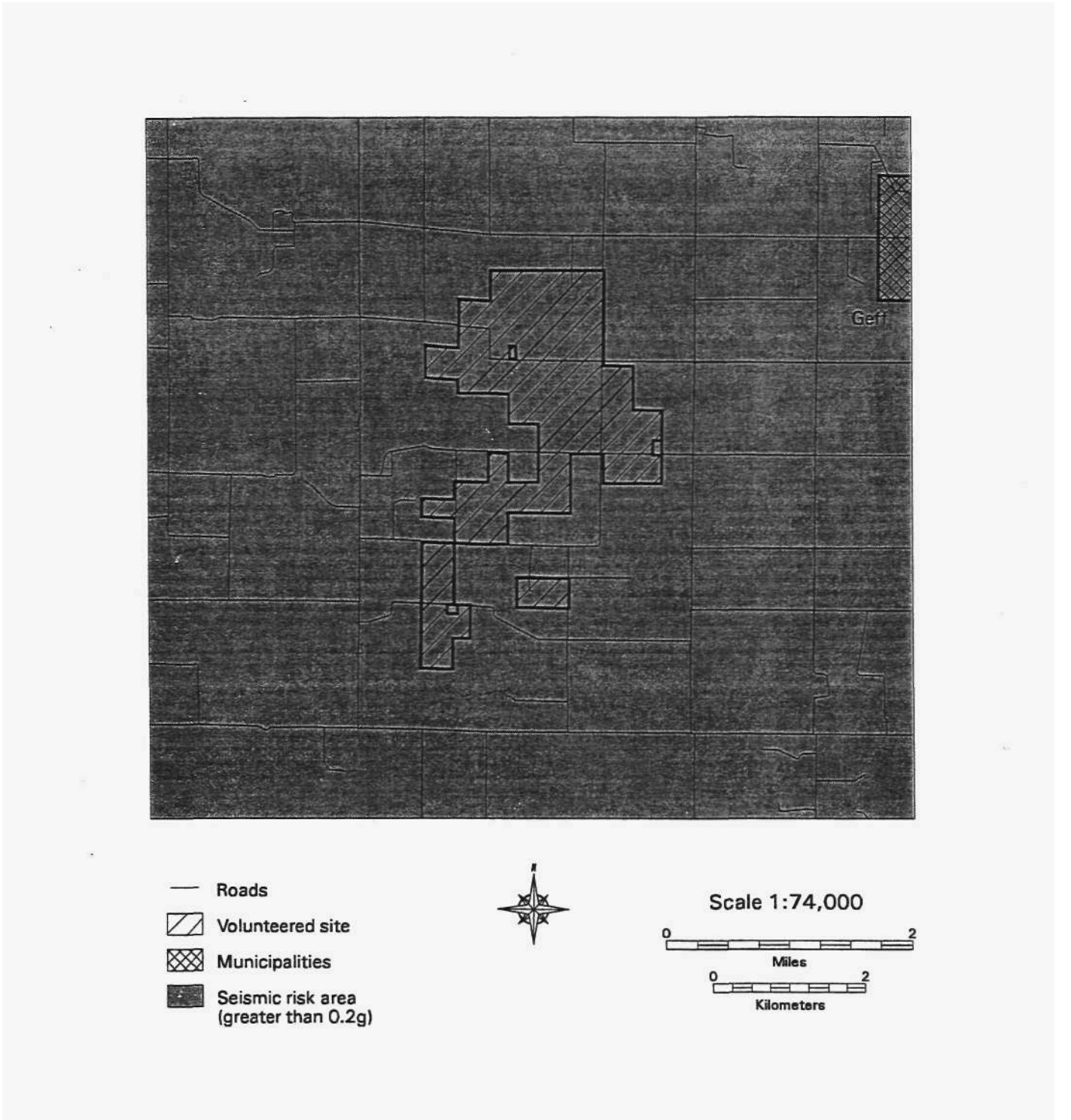

Figure 29. Seismic Risk Area - Volunteer Site A

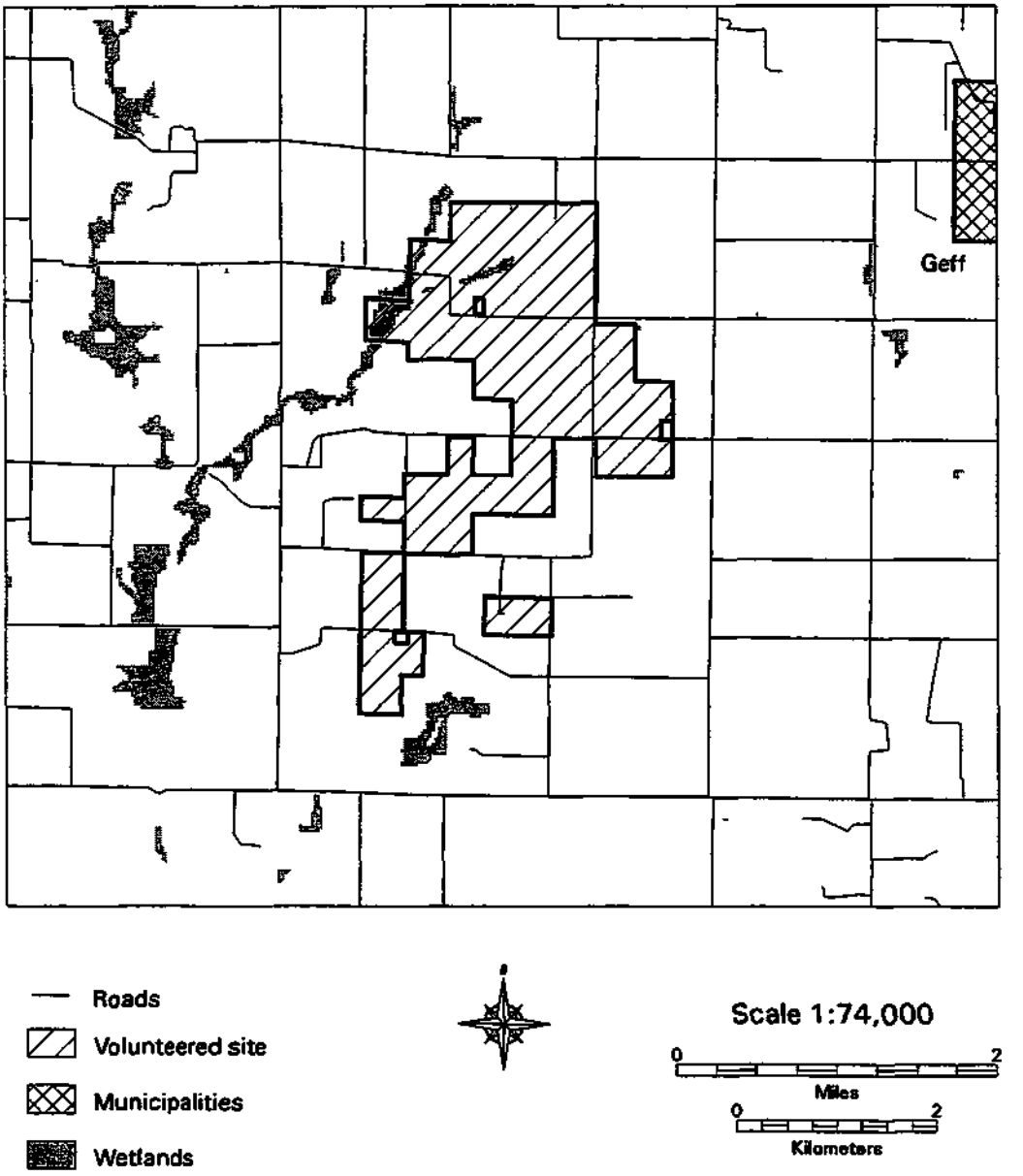

Figure 30. Wetland Areas - Volunteer Site A

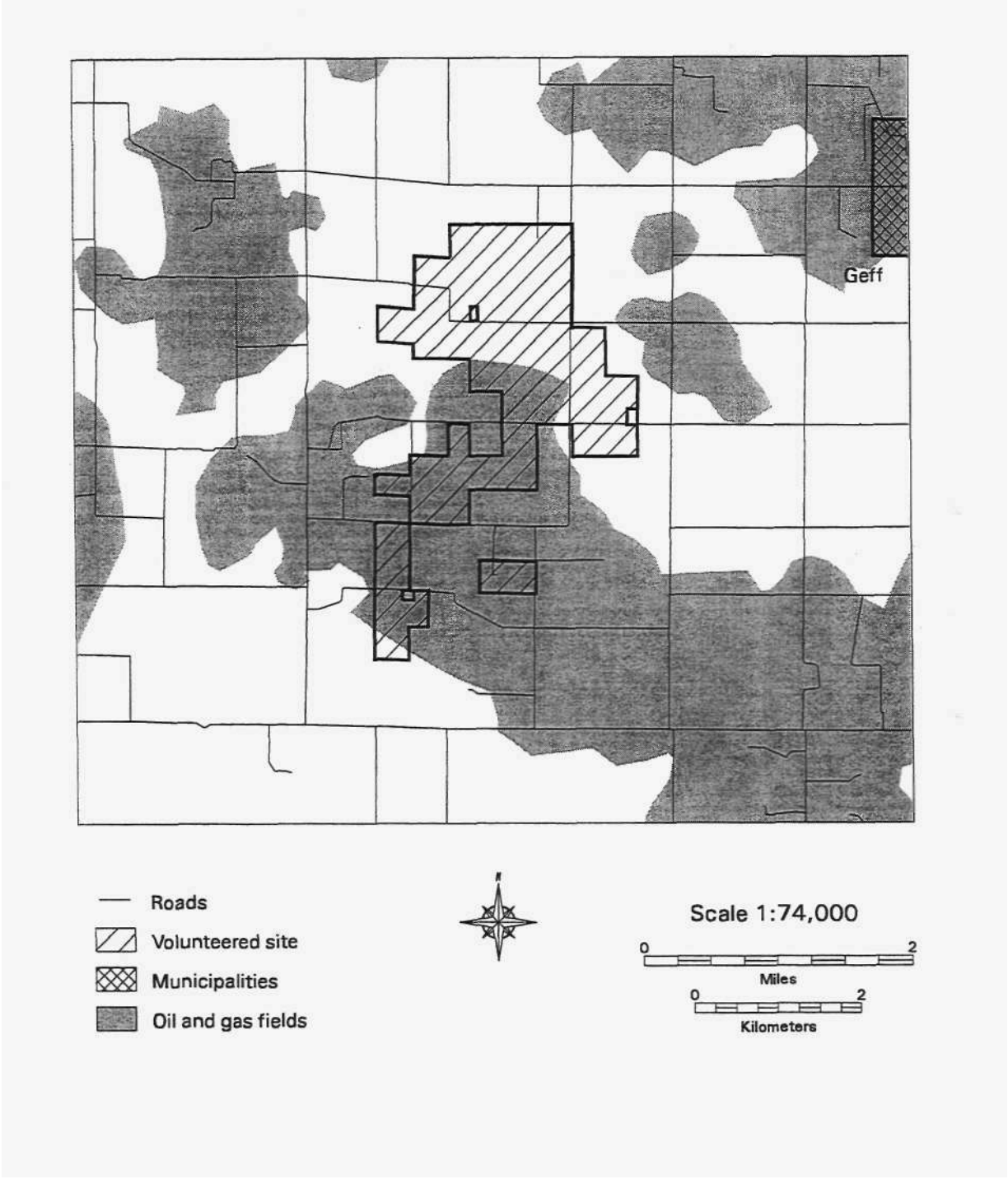

Figure 31. Oil and Gas Fields - Volunteer Site A

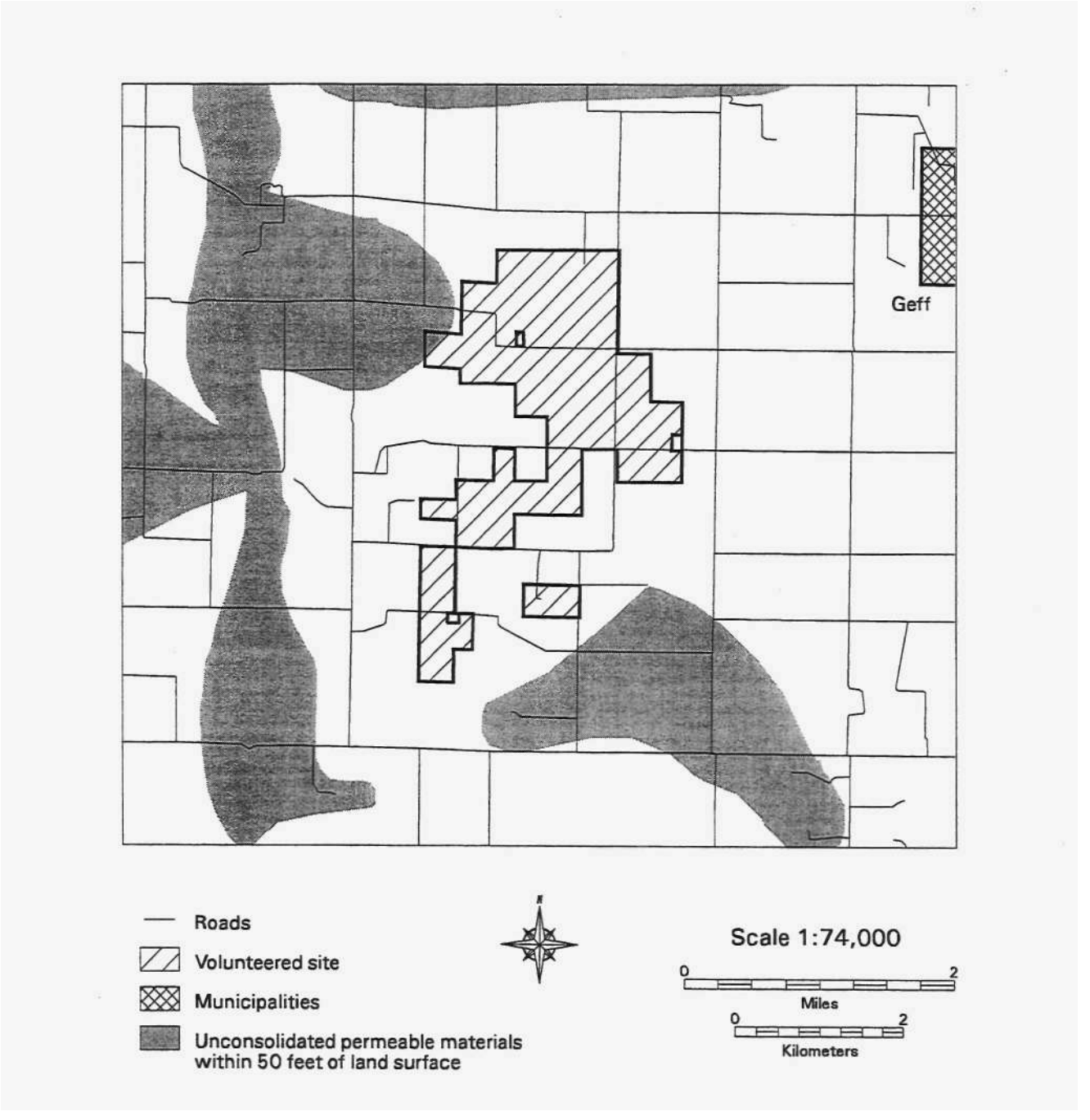

Figure 32. Aquifer Materials - Volunteer Site A

McLean County - Site B

The McLean County site was volunteered on February 13,1997 by multiple owners of an 840-acre parcel of land contiguous with and east of the village of Ellsworth in Dawson Township. The property consists of one homestead on the southwesten corner of the parcel with the remainder of the land used for farming. As part of the evaluation process, staff members from the Scientific Surveys conducted a site visit to the property on March 26, 1997. Prior to the visit, historical aerial photographs of the property were reviewed and water well records were examined for the volunteered site and surrounding sections.

During the visit, Scientific Survey staff met with two of the owners and the tenant farmer who resides on the property. The tenant and owners provided valuable information on local drainage patterns, presence of water wells, and a history of the property. A tour of the property included the perimeter boundaries as well as all interior roadways that provide farming access. At the completion of the visit, Survey staff combined all of the information that was available on the property to develop a preliminary site assessment.

After completion of the Scientific Surveys' evaluation of the property, but prior to its release, the owners withdrew the site from further consideratioa The Scientific Surveys' site report is included here for information purposes only.

Table 3 summarizes the Scientific Surveys' assessment of the McLean County volunteer site. Based on the on-site visit, examination of pertinent records in the Scientific Surveys' files, and the data contained in the GIS databases, the site did not appear likely to meet all of the Task Group's criteria. The northern portion of the site is transected by the headwaters of the Sangamon River and active railroad tracks, both factors that would eliminate that part of the property as a potential site. The approximately 680 acres south of the railroad tracks would still be large enough to meet the minimum 640-acre size requirement, but water well records for the area revealed the presence of a regional sand and gravel aquifer within 300 feet of the land surface.

Records were found for over 50 public and private wells within the 16 sections immediately adjacent to the site. Of these wells, over 70 percent were completed within 200 feet of land surface; 98 percent were completed within 300 feet of land surface. Fifty-three percent were completed between 100 and 200 feet. This information suggests that a regional sand and gravel aquifer exists within 300 feet of land surface beneath the area, and in fact, exists within 200 feet of land surface beneath most of the area.

Figures 33-36 show the application of GIS coverages that were used in developing the site assessment. Many of these maps were assembled from databases developed from maps at a scale of 1:500,000 and are depicted in these figures at a scale of 1:74,000 for illustration purposes only. Boundary locations are not accurate at the scale presented. These maps should not be used for any other type of regional assessment or evaluation.

Figure 33 shows the location of the volunteered site in relation to the village of Ellsworth and also shows the railroad tracks that transect the northern part of the site. Also shown in Figure 33 are

the presence of major sand and gravel aquifers and coarse-grained materials within SO feet of the land surface. The aquifer information was obtained from a 1:500,000 statewide coverage and represents a regional characterization of groundwater resources. Examination of water well records in the Illinois State Water Survey files, however, supports the presence of a regional aquifer.

Figure 34 illustrates the application of Criterion 3, which relates to the proximity to a watershed that feeds into small water supply reservoirs. The watershed area shown feeds into the Lake Bloomington water supply reservoir but is not within the outline of the site boundaries.

Figure 35 shows the area surrounding Moraine View State Park with a 1,000 foot buffer, as required by the Task Group in Criterion 17. The gray shaded area also includes Dawson Lake, with a 1,000 foot buffer as required in Criterion 23. The volunteer site boundaries are outside of this buffered area, consistent with the Task Group guidance to the Scientific Surveys.

Figure 36 illustrates the application of Criterion 22, which concerns the proximity to sensitive stream habitats. The headwaters of the Sangamon River, which transect the northern part of the volunteer site, are classified as a biologically significant stream due to the presence of high mussel diversity, the state threatened mussel species *Lasmigona compressa* (creek heelsplitter), and the state endangered mussel species *Alasmidonta viridis* (slippershell) (Page et al., 1992). The Task Group has directed that biologically significant streams and sensitive stream habitats be avoided during the site selection process and that a 1,000 foot buffer be used to protect these habitats. Figure 36 shows the extent of the sensitive stream designation with the 1,000 foot buffer. This portion of the volunteer site would not meet the Task Group criterion.

Source

Page, L.M., K.S. Cummings, C.A. Mayer, S.L. Post, and M.E. Retzer. 1992. *Biologically Significant Illinois Streams: An Evaluation of the Streams of Illinois Based on Aquatic Biodiversity*, Illinois Natural History Survey, Center for Biodiversity Technical Report 1992 (1), Champaign, IL.

Table 3. Statewide Screening of Volunteered Sites - Site B

Date: June 18. 1997

Site: Volunteer "B" McLean County

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
1. The hydrogeologic conditions of the site must inhibit groundwater flow to the extent that groundwater resources are protected. (p. 84)		√		An examination of water well records on and near the site revealed the presence of a regional aquifer within 300 feet of land surface.
2. Hydrologic conditions at the site must protect public, private and semiprivate wells and must not be hydrologically affected by the operation of a major well. (p. 88)		√		Records were found for over SO public and private wells within the 16 sections immediately adjacent to the site. Over 70 percent of the wells were completed within 200 feet of land surface and 98 percent were completed within 300 feet of land surface. Fifty-three percent of the wells were completed between 100 and 200 feet. This information suggests that a regional sand and gravel aquifer exists within 300 feet of land surface and exists within 200 feet of land surface beneath most of the area.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, EL.

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
3. The site must not be located in a watershed upstream from an in-channel reservoir for a public water supply if that reservoir has a normal pool storage capacity of less than 15,000 acre-feet or a total upstream drainage contributing area of less than 75 square miles, (p. 90)	√			The site is not within the designated boundaries of the watershed for Lake Bloomington.
4. The geologic materials beneath the site must exhibit a sufficiently high degree of lateral continuity to permit reliable geological mapping and hydrogeological modeling, (p. 91)			√	No borings were made nor other on-site testing carried out.
5. The site must not be in a karstic area. (p. 93)	√			The site is not in a karstic area.
6. The site must be located so as not to be adversely affected by earthquakes or ground motions that are likely to occur during the period of most significant radiological risk. (p. 94)	√			The site is outside of the seismic risk area identified by the Task Group.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, EL

Criterion Statement'	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
7. The site must not exhibit evidence of, or potential for, significant mass wasting phenomena, including landsliding, slope failure, or surface subsidence. (p. 98)	√			No visible evidence of mass wasting potential was noticed during a March 26, 1997 visit to the site.
8. The site must not have the potential to be undermined significantly by stream incision, bank erosion, or undercutting. (p. 99)	√			The March 26, 1997 site visit did not yield any evidence of stream incision or undercutting, nor did a review of historical aerial photographs.
9. The site must not contain perennial streams, lakes, or ponds or extensive artificial drainage systems that strongly control site hydrology. (p. 100)	√			The Sangamon River transects the northern part of the property and is a major component of the local hydrology and drainage pattern. There are approximately 680 acres south of the railroad tracks that do not contain perennial water bodies. Further investigations would be necessary to evaluate to what extent the sub-surface tile drains control the movement of water within and external to the site.
10. The site must not contain any areas within a 500-year floodplain. (p. 101)	√			The Sangamon River floodplain transects the northern part of the property. The 680 acres south of the railroad tracks are not in a designated floodplain even though ponding on the site is common after heavy rains.

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Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
11. The site must not contain lands that meet the criteria of the classification codes of the National Wetlands Inventory for Illinois; however, a site containing certain man-made wetlands, such as farm ponds and sewage lagoons, should not be automatically excluded from further consideration. (p. 103)	√			The Sangamon River in the northern part of the property is classified as a riverine wetland in the National Wetlands Inventory of Illinois but the area south of the railroad tracks appears to meet the criterion. Additional field work would be required to fully verify the absence of wetland areas.
12. The site must not be located within a groundwater management (p. 105)	√			The site is not in an identified groundwater management zone.
13. The site must not contain preexisting contamination that has not been or cannot be remediated. (p. 105)	√			Verification of the absence of contaminant sources (e.g., leaking underground storage tanks, spilled pesticides, etc.) would be required to ensure that this criterion is met.
14. The site must not be intersected by a highway that is part of the National System of Interstate and Defense Highways or by an operational railroad track, (p. 106)	√			Criterion is not met for the land north of the railroad tracks but is met for the 680 acres south of the tracks.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19, 1996, Springfield, IL.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
15. The site must not be located in an area where it would be impacted by an operational mine, quarry, gravel pit, or petroleum production reservoir. (p. 106)	√			There are no known mines, quarries, gravel pits, or oil and gas extraction activities on or near the site.
16. The site must not be underlain by mine cavities or located on surface-mined lands. (p. 107)	√			There are no mines on the site.
17. The site must not be located on or be within 1,000 feet of lands that are owned or leased by an agency of the state or federal government and that are managed for recreational or conservation purposes. (p. 108)	√			The site is more than 1,000 feet from Moraine View State Park boundary.
18. The site must not be located on or be within 1,000 feet of lands that are managed for recreational or conservation purposes and that are owned or leased by a local unit of government or a not-for-profit corporation as of the date of adoption of the criteria, (p. 108)	√			The village of Ellsworth municipal park is within 1,000 feet of the boundary of the site. The small area excluded by this criterion is in the northwest portion of the site that abuts the village limit. The nonexcluded area is greater than 640 acres.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
19. The site must not be located so as to cause an adverse impact on a dedicated nature preserve, a registered natural area, or lands listed on the Illinois Natural Areas Inventory. (p. 109)	√			The site is not adjacent to and does not contain any registered natural areas.
20. The site must not be located so as to cause an adverse impact to the habitat for documented occurrences of state or federal endangered or threatened species, (p. 110)			√	Requires a detailed biological investigation to verify the absence of endangered or threatened species.
21. The site must not contain any forest land that is part of a large forest ecosystem, (p. I11)	√			The site is not part of a forest ecosystem as defined by the Task Group.
22. The boundaries of the site must be at least 1,000 feet from sensitive stream habitats, (p. 112)	√			The Sangamon River is classified as a sensitive stream habitat in the reach that transects the northern part of the property. The 1,000 feet buffer includes most of the area north of the railroad tracks. The 680 acres south of the tracks appears to meet the criterion.

[1]Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

Criterion Statement[1]	*Appears likely to meet criterion*	*Does not appear likely to meet criterion*	*Insufficient data/not evaluated*	*Comments*
23. The boundaries of the site must be at least 1,000 feet from a lake of 20 acres or more in surface area that provides substantial public access and benefits to citizens of Illinois. (p. 113)	√			The site is more than 1,000 feet from the boundary of Dawson Lake.
24. The site must not be located so as to cause an adverse impact on historic properties or on paleontological and archaeological resources. (p. 114)			√	The site visit on March 26, 1997 did not reveal the presence of historic properties. No assessment of paleontological resources has been conducted.
25. The site must not be located so as to cause an adverse impact on human skeletal remains that are interred in a cemetery owned, operated, controlled, or managed by a cemetery authority as defined in the Cemetery Care Act, 760 ILCS 100/1, or to human skeletal remains that are interred in unregistered cemeteries or graves and thus protected by the Illinois Human Skeletal Remains Protection Act, 20 ILCS 3440 0.01. (P. 115)	√			No registered cemeteries are present on the property.

[1] Site-Selection Criteria for a Low-Level Radioactive Waste Disposal Facility, Illinois Low-Level Radioactive Waste Task Group, December 19,1996, Springfield, IL.

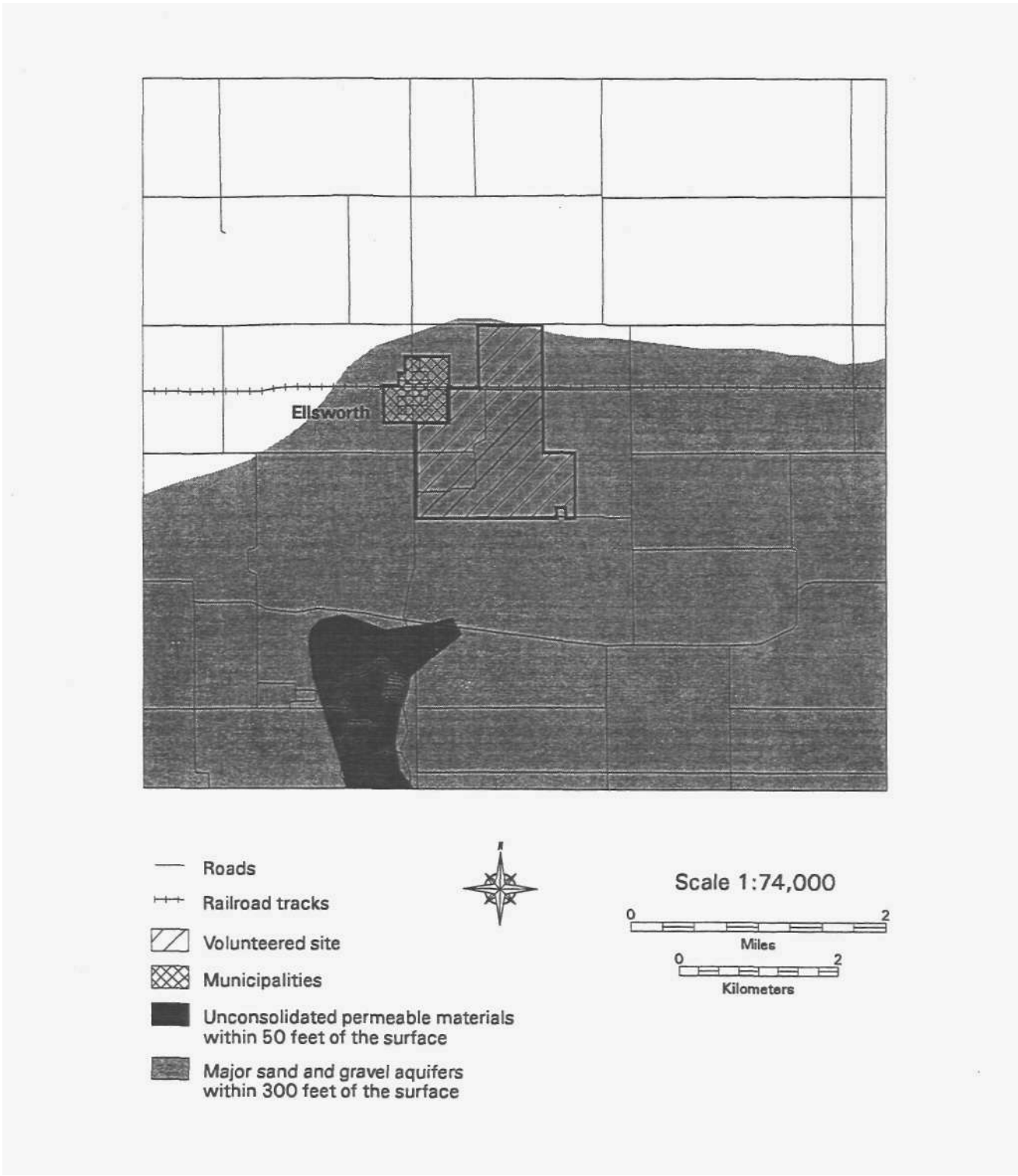


Figure 33. Groundwater Resources - Volunteer Site B

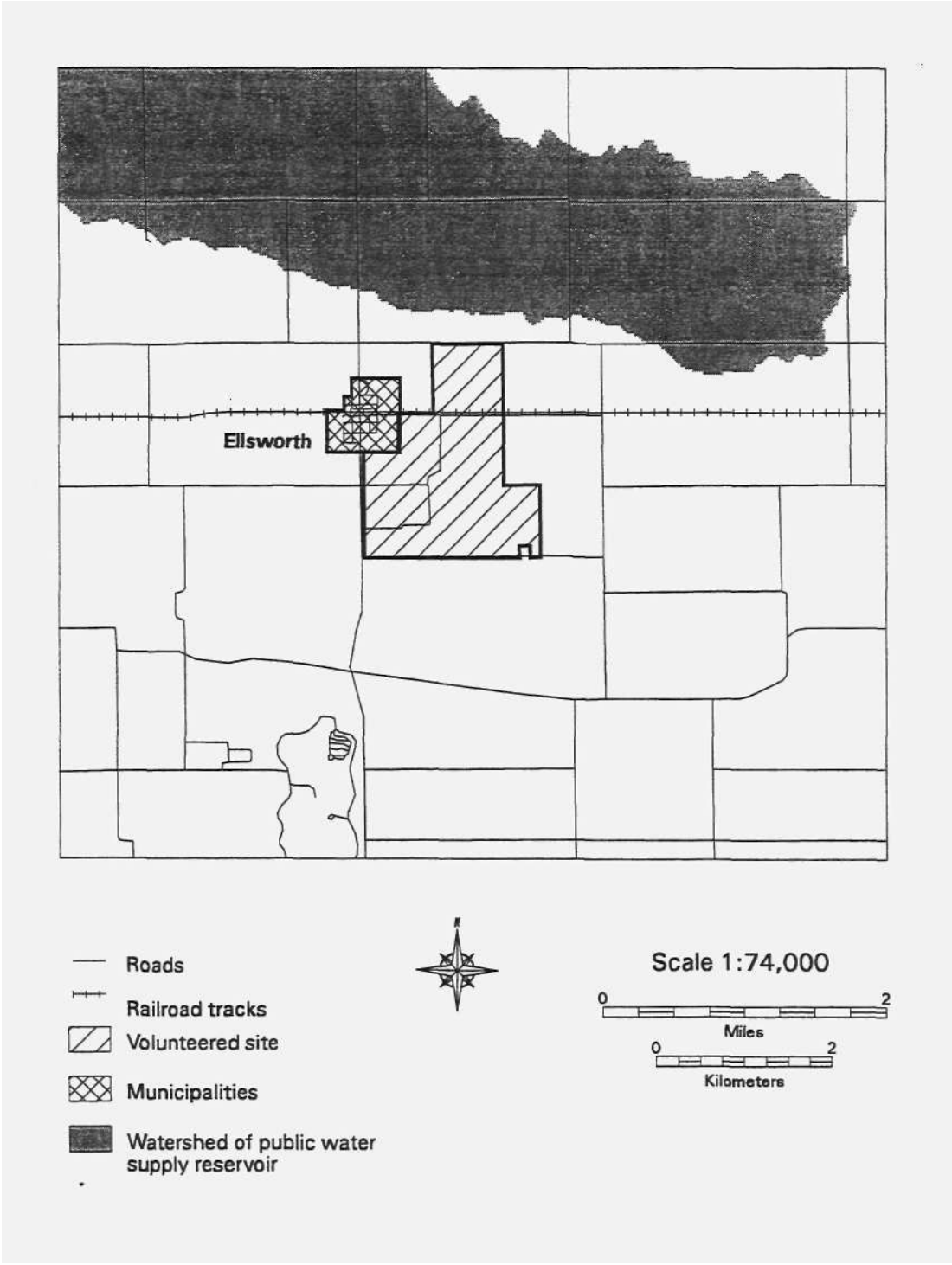


Figure 34. Water Supply Reservoir Watershed - Volunteer Site B

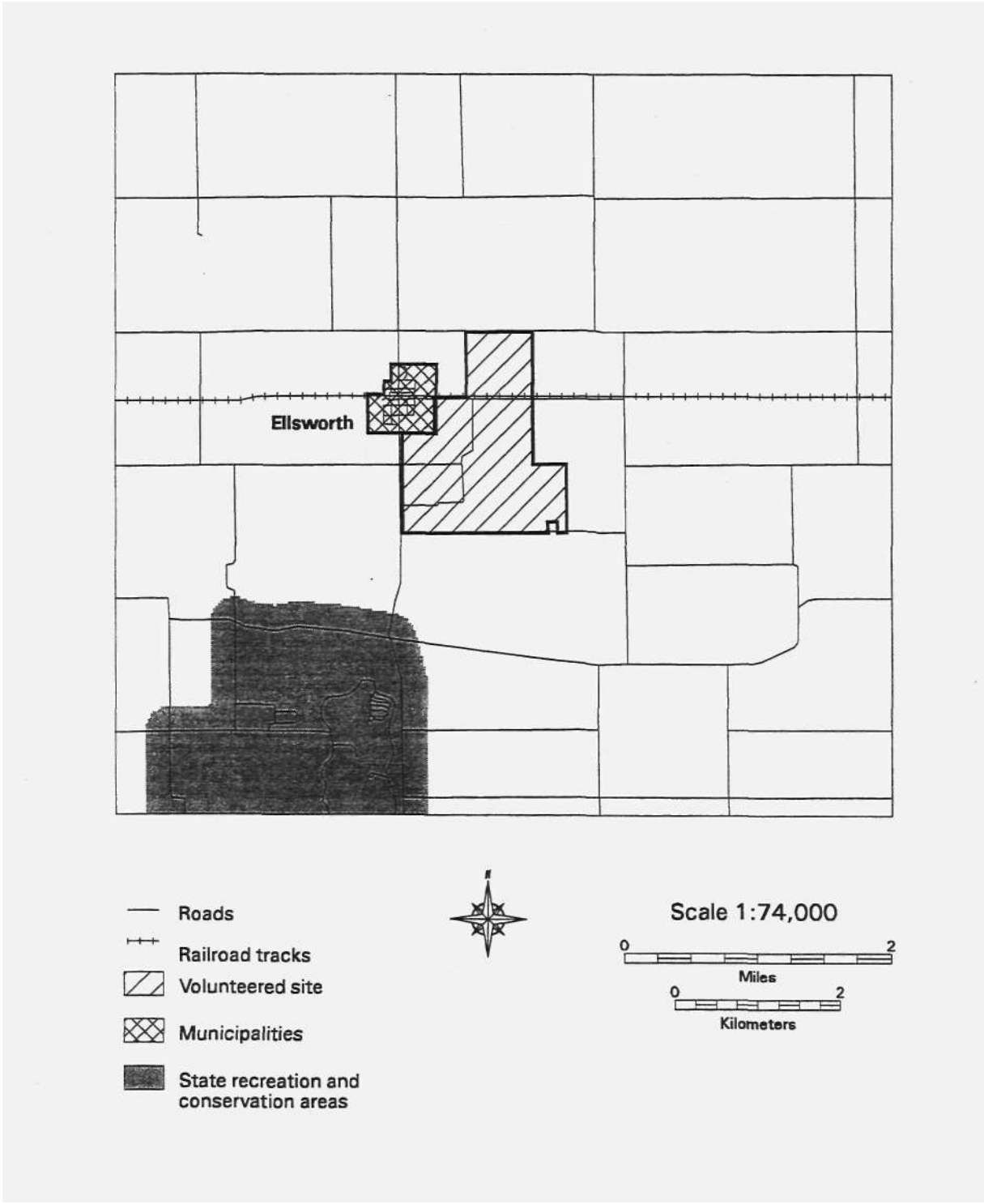


Figure 35. State Recreation Area - Volunteer Site B

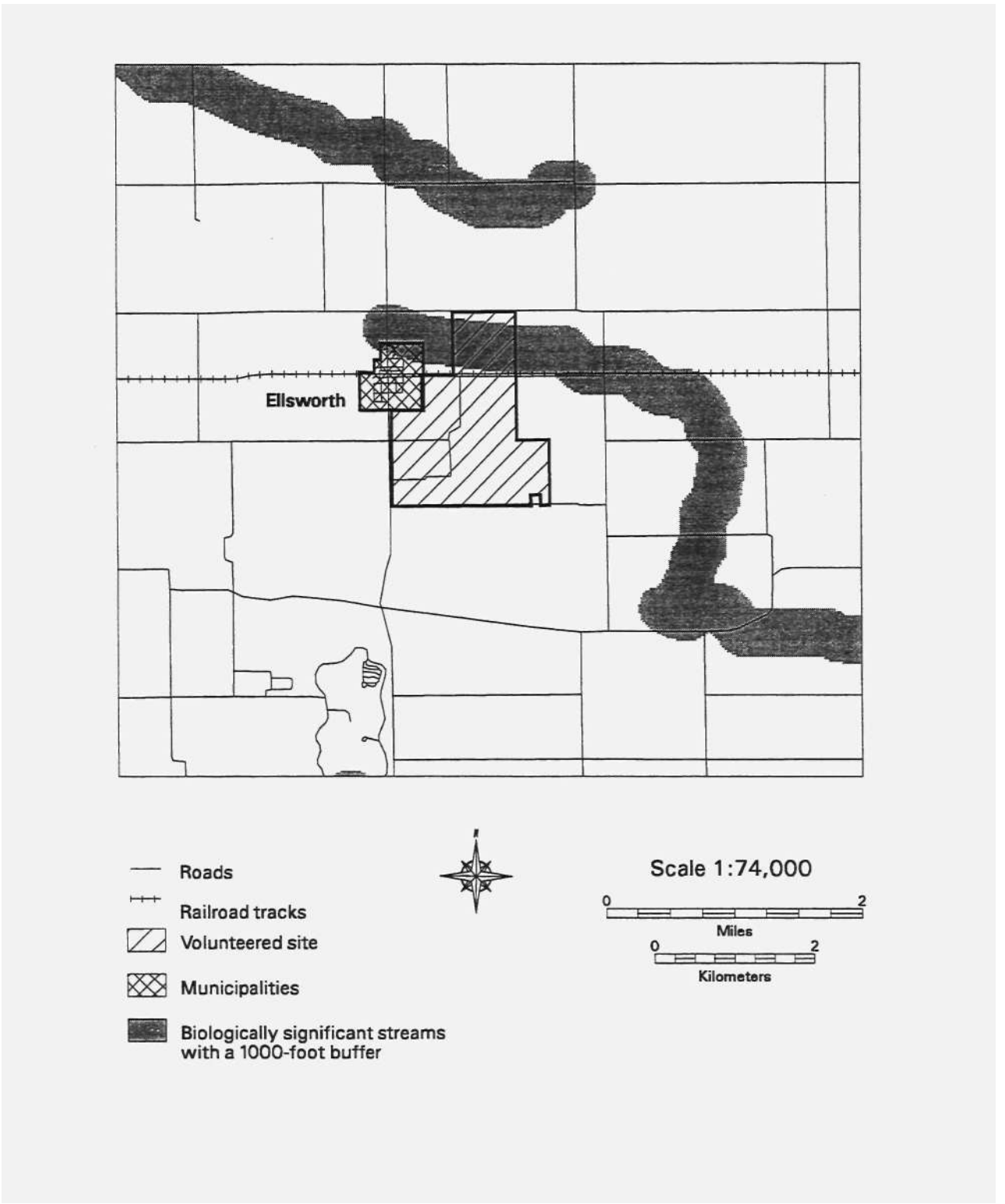
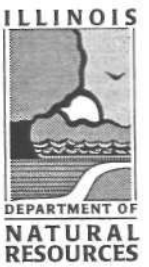


Figure 36. Biologically Significant Streams - Volunteer Site B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