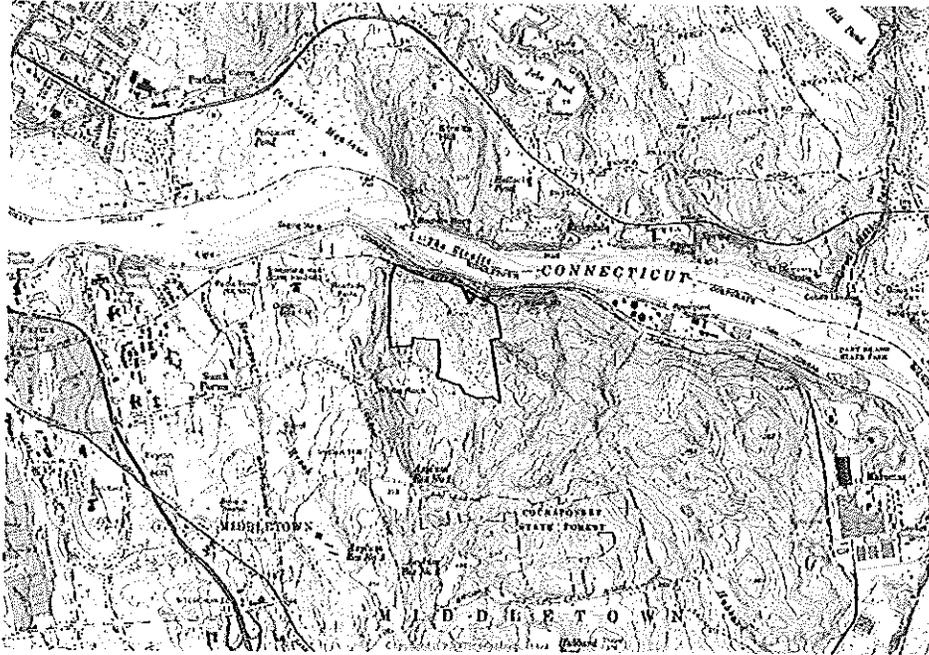


# **Kleen Energy Systems Project Middletown, Connecticut**



## **For a Certificate of Environmental Compatibility and Public Need for an Electric Generating Facility and Switchyard in Middletown**

**Volume I  
March 2002**

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*Customer-Focused Solutions*

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Appendix H	EMF Project Report
Appendix I	Project Schedule
Appendix J	Storm Water Report

## Volume II

### Drawings

## ACRONYMS

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<u>Acronym</u>	<u>Full Name</u>
7FA	General Electric 7FA Combustion Turbine
7Q10	Low Flow Conditions
A	Ampere
ACC	Air Cooled Condenser
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
ASC	Actual Stack Concentration
ATR	Automatic Traffic Recorder
BACT	Best Available Control Technology
BMP	Best Management Practices
CBOT	Chicago Board of Trade
CEMS	Continuous Emissions Monitoring System
CH <sub>2</sub> O	Formaldehyde
CL&P	Connecticut Light and Power
CO	Carbon Monoxide
Conn. Gen. Stat.	Connecticut General Statutes
C <sub>p</sub>	Maximum Plume Contrast
CSC	Connecticut Siting Council
CT	Combustion Turbine
CT	Connecticut
CT DEP	Connecticut Department of Environmental Protection
CAAQS	Connecticut Ambient Air Quality Standards
CTDEPT	Connecticut Department of Environmental Protection
CTDOT	Connecticut Department of Transportation
dBA	Decibel, A weighted scale
DC	Direct Currents
Delta E	Plume perceptibility
DEP	Department of Environmental Protection
DLN	Dry Low Nitrogen Dioxide
DOT	Department of Transportation
EHC	Hydraulic Oil

EMF	Electric and Magnetic Fields
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
FAA	Federal Aviation Association
FP	Flood Plain
FPS	Feet per Second
GE	General Electric
gpm	Gallons per minute
H <sub>2</sub> SO <sub>4</sub>	Sulfuric Acid
HAP	Hazardous Air Pollutant
Hp	horsepower
HRSG	Heat Recovery Steam Generators
Hz	Hertz
I-3	Special Industrial
ISO-NE	Independent Systems Operator -- New England
IWWC	Inland Wetland and Watercourse Commission
kA	Kiloampere
kV	Kilovolt
kV/m	Kilovolt per meter
LAER	Lowest Achievable Emission Rate
ln. ft.	Linear Feet
LOS	Level of Service
LTR	Shared Left, through, and Right turning Lane
Mainline	Duke/Algonquin Mainline
MASC	Maximum Allowable Stack Concentration
mG	Miligauss
MGD	Million Gallons per day
MIWW	Middletown Inland Wetland and Watercourses Commission
mph	Miles per hour
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MULT	Meteorological Plume Dispersion Program
MW	Megawatt
N <sub>2</sub>	Nitrogen

NAAQS	National Ambient Air Quality Standards
NEC	National Electric Code
NEMA	National Electric Manufacturing Association
NESCAUM	Northeast State for Coordination Air Use Management
NFPA	National Fire Protection Association
NH <sub>3</sub>	Ammonia
No Build	2005 Future Operations Conditions without the Proposed Project
No.	Number
NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Nitrogen Oxides
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NSR	New Source Review
O <sub>2</sub>	Oxygen
O <sub>3</sub>	Ozone
P&W	Pratt and Whitney
PAGE	Meteorological Graphical PostProcessing Program
Pb	Lead
pH	Acid/Base Scale
Plan	City of Middletown's Plan of Development
PM	Particulate Matter
PM <sub>10</sub>	Particulate Matter less than 10 microns
PREP	Meteorological PreProcessing Program
ppm	Part Per Million
PSD	Prevention of Significant Deterioration
R45	Residentially Zoned Land
RCRA	Resource Conservation and Recovery Act (1976)
RCSA	Regulations of Connecticut State Agencies
SACTI	Seasonal and Annual Cooling Tower Impact Cooling Tower Model
SCR	Selective Catalytic Reduction
Sec.	Seconds
SO <sub>2</sub>	Sulfur Dioxide
SO <sub>x</sub>	Sulfur Oxides
SPCC	Spill Prevention Control and Counter Measures Plan

sq. ft.	Square Feet
TABLE	Meteorological program to produce tabular summaries of modeling results
The Area	Middletown, Connecticut Area
The City	The City of Middletown, Connecticut
TPY	Tons Per Year
U.S.	United States of America
U.S. ACOE	United States Army Corps of Engineers
US DOT	United States Department of Transportation
US OSHA	United States Occupational Safety and Health Administration
USDA	United States Department of Agriculture
USEPA	United States Protection Agency
USFW	United States Fish and Wildlife Service
USGS	United States Geological Society
V	Volts
V/m	volts per meter
VOC	Volatile Organic Compounds
Zoning Code	City of Middletown Zoning Code

## **EXECUTIVE SUMMARY**

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Kleen Energy Systems, LLC (hereinafter "Kleen Energy" or the "Applicant") is proposing to build a new 520 megawatt (MW, nominal capacity) combined cycle generating facility and switchyard in Middletown, Connecticut ("the Project" or "the facility"). The Project will be fueled primarily with natural gas, but will also be able to burn low sulfur distillate No. 2 fuel oil as a backup fuel. The Project will be among the cleanest in the world, meeting the emission limits for the cleanest projects in Connecticut.

The Project has a 345 kV electric transmission line abutting the site and a high pressure interstate gas transmission line approximately 1 mile away. The transmission line is bi-directional with load that can be served by the Project in both directions. Armetta and Associates, one of the Project proponents, also controls property north of the Project site with frontage on the Connecticut River in its tidal reach, which provides the opportunity for the Project to employ an evaporative cooling tower and benefit from the increased efficiencies inherent in this cooling technology. This water resource is expected to be developed by a separate entity with participation by the City of Middletown.

The Project will be located in an existing Special Industrial Zone (I-3) on River Road at the site of the old Feldspar Corporation mine. This will locate the Project nearly ¼ mile from the nearest residential receptor. Locating the Project on a previously mined area, that is a fairly steep hillside, presents some civil engineering challenges, however the proximity of gas and electric infrastructure and a usable source of freshwater more than compensates for the difficult topography. The solution to the engineering challenge also brings with it benefits. Fitting the Project into the hillside results in the Project having very low visibility from most directions.

The Project represents a unique opportunity to reclaim an abandoned mine that has very few alternative uses. Any project that would use the mined area would be faced with the same substantial civil works and would quickly conclude that other land areas that did not require this effort would be better alternatives. It is the unique proximity of an adequate gas supply, electric transmission and an abundant water source that makes this location an excellent site for a generation project. Only a project with a substantial capital investment, like a generation project, could support the investment needed to reclaim the abandoned mine site.

Reclaiming the abandoned mine site has other benefits, particularly the opportunity to stabilize the site so that it does not continue to be a source of other environmental damage, especially erosion and sedimentation into the Connecticut River. Reconfiguring the site will allow for the creation of a comprehensive stormwater management plan that will control the quality of site runoff, as well as provide improved aquatic habitat.

The Kleen Energy Project will provide a new highly reliable and efficient source of electricity to Connecticut, while also enhancing competition by bringing a new entrant into the supplier mix. It will result in a substantial investment in Middletown and the attendant increase in tax revenue. It will displace existing more polluting generation resulting in improvements in regional air quality. The Project is a unique opportunity to benefit Connecticut statewide, the Middletown region, and the environment.

## **1.0 FILING REQUIREMENTS**

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### **1.1 Quantity, Form and Filing Requirements**

Except as allowed elsewhere, Kleen Energy hereby furnishes to the Connecticut Siting Council (Council) an original and 20 copies of these application documents.

This application is presented based on the Council's January 19, 2000 guide to assist applicants in filing a certificate for an electric generating facility. Kleen Energy is including with this application a copy of this guideline showing section references for the items required in the sections titled "Contents of Application."

Kleen Energy has filed a single application seeking certificates for both the electric generating and switchyard facilities since the switchyard is an integral component of the electric generating facility project and in order to avoid undue repetition of information. A separate petition for declaratory ruling will be filed requesting a finding that no certificate is required for the electric transmission line interconnection since it does not have a substantial adverse environmental effect.

Kleen Energy has consulted Connecticut General Statutes §§ 16-50g through 16-50aa and Sections 16-50j-1 through 16-50j-4 of the Regulations of Connecticut State Agencies and believes this application meets the requirements of those sections.

The applicant requests administrative notice of the following Council docket records, generic hearings or statements prepared by the Council as a result of generic hearings, and other pertinent documents:

- The Council's Findings of Fact, Opinion and Decision and Order for the following dockets:
  - Docket 187 (PDC - El Paso Milford);
  - Docket 189 (Lake Road - Killingly);
  - Docket 190 (PDC - El Paso Meriden);
  - Docket 191 (AES Southington);
  - Docket 192 (Towantic Energy - Oxford);
  - Docket 193 (New Milford Energy);
  - Docket 377 (UI Bridgeport Harbor); and
  - Docket 451 (PPL Wallingford Energy).
  - Connecticut Siting Council Electric and Magnetic Field Best Management Practices, February 11, 1993.
  - Connecticut Siting Council Review of the Connecticut Electric Utilities' Twenty-Year Forecasts of Loads and Resources, November, 2001.

- NEPOOL Forecast Report of Capacity, Loads and Transmission 2001-2010, April 1, 2001.
- Connecticut Guidelines for Soil Erosion and Sediment Control.
- Connecticut 1998 Report on Task Force Activities to Evaluate Health Effects from Electric and Magnetic Fields (January 1998).
- Life Cycle Cost Studies for Overhead and Underground Transmission Lines (March 1996 and May 2001).

At least 60 days prior to the filing of any application with the Council, pursuant to Conn. Gen. Stat. § 16-50l(e), Kleen Energy began consultations with the City of Middletown, the host municipality, and the Town of Portland, which has a boundary within 2,500 feet of the proposed facility. Such consultation processes included meetings and providing the chief executive officer technical reports concerning the public need, the site selection process and the environmental effects of the proposed facility. These meetings are listed in Appendix A. The municipalities have the right to issue recommendations to the Applicant. Within 15 days after this application is submitted to the Council, Kleen Energy will provide a Bulk Filing containing all materials provided to the municipalities and all recommendations received from the municipalities.

### **1.2 Application Filing Fees**

The filing fee for this application is determined by the schedule set forth in Reg. Conn. State Agencies § 16-50v-1a. Based upon this schedule, a check accompanies the application in the amount of \$25,000 payable to the Council. Kleen Energy understands that additional assessments may be made for expenses in excess of the filing fee, and that fees in excess of the Council's actual costs will be refunded to Kleen Energy.

### **1.3 Proof of Service**

This application was served on the following:

- The chief elected officials, the planning and zoning commissions, the conservation commissions and the inland wetlands commissions of the City of Middletown and the Town of Portland.
- The regional planning agency, which encompasses the City of Middletown and the Town of Portland.
- The Connecticut Attorney General.
- Each member of the Connecticut General Assembly in whose district the facility is to be located or is within 2,500 feet of the facility.
- Any federal agency which has jurisdiction over any matter that would be affected by the proposed facility.

- The Connecticut departments of environmental protection, public health, public utility control, economic and community development and transportation; the council on environmental quality; and the office of policy and management.

Names of specific agencies and officials are listed in Attachment #1 to the application cover letter.

#### **1.4 Public Notice**

Notice of the application was published at least twice prior to the filing of the application in a newspaper having general circulation in the City of Middletown and the Town of Portland. The notice includes the name of the Applicant, the date of filing and a summary of the application. The notice was published in not less than ten point type. An Affidavit of Publication will be provided in a Bulk Filing.

#### **1.5 Notice to Abutting Landowners**

Notice of the application has been sent by certified or registered mail to each person appearing of record as an owner of property which abuts the proposed site of the facility. Such notice has been sent at the same time that notice of the application is given to the general public. An Affidavit of Notice will be provided in a Bulk Filing.

Names and mailing addresses of abutting property owners are listed in Attachment #2 to the application cover letter.

#### **1.6 Notice To Community Organizations**

The Applicant has made reasonable efforts to provide notice of the application to the following:

- Affected community groups including land trusts, environmental groups, trail organizations, historic preservation groups and river protection organizations within the watershed affected by the proposed facility that have been identified by the City of Middletown or that have registered with the Council to be provided notice; and
- Any affected water company that would provide water to, or be within the watershed affected by, the proposed facility.

Names of specific organizations are listed in Attachment #3 to the application cover letter.

#### **1.7 Purpose of the Application**

Kleen Energy is applying to the Council for the issuance of a Certificate of Environmental Compatibility and Public Need with respect to constructing a new 520 megawatt (nominal) combined cycle, natural gas fired combustion turbine electric generating facility and switchyard in Middletown.

## **1.8 Statutory Authority for the Application**

Kleen Energy is applying to the Connecticut Siting Council pursuant to Sections 16-50k(a) and 16-501(a) of the General Statutes of Connecticut.

## **1.9 Legal Name and Address of Applicant**

The Applicant is Kleen Energy Systems, LLC, ("Kleen Energy") a Connecticut limited liability corporation. Kleen Energy is a subsidiary of Armetta & Associates. Kleen Energy was formed to construct and operate the proposed Kleen Energy Electric Generation Project in Middletown. The address of the Applicant is 90 Industrial Park Road, Middletown, Connecticut 06457.

## **1.10 Applicant's Contacts**

Correspondence and other communication with regard to the application are to be addressed to, and notices, orders and other paper may be served upon the following:

Mr. William C. Corvo  
President  
Kleen Energy Systems, LLC  
90 Industrial Park Road  
Middletown, Connecticut 06457  
Telephone: (860) 632-1044

Lawrence J. Golden, Esq.  
Pullman & Comley, LLC  
90 State House Square  
Hartford, Connecticut 06103  
Telephone: (860) 424-4346

## **2.0 DOCUMENT OVERVIEW**

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### **2.1 Introduction**

Kleen Energy Systems, LLC (herein after “Kleen Energy” or “ the Applicant”)is proposing to site and construct two (2) new combined cycle, natural gas fired combustion turbines (CT) and switchyard in the Maromas section of the City of Middletown, Connecticut. For purposes of this document, the proposed Project is herein referred to as the “Kleen Energy Generating Facility”, “proposed facility”, “proposed Project”, “the Project” or “the plant”. The Project location is shown with respect to the State of Connecticut in Figure 2.1-1. Kleen Energy will construct and operate the electric generating facility.

#### ***2.1.1 Organization of the Document***

This Document consists of two volumes. Volume I is organized as follows:

The Executive Summary which contains a summary of the proposed Project, purpose, and environmental impacts.

Section 1.0 is the Filing Requirements for this document.

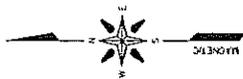
Section 2.0 is the Document Overview which contains the description of the document format and a summary of the permits and approvals required.

Section 3.0 is the Public Benefits which explains the benefits the Project will bring to the State of Connecticut and to the competitive electricity markets.

Section 4.0 is the Project Description and Site Selection which contains a description of the proposed Project, physical characteristics of the Project and surroundings, Project construction and Project operation, and discusses the site selection process, including why the site is appropriate for the location of an electric generating facility.

Section 5.0 is the Environmental Setting, Impact Assessment, and Mitigation Measures that provides a discussion of specific environmental study areas (e.g. Air Quality, Water Resources, Noise, Cultural Resources, etc.). Each environmental resource area is addressed with a discussion of existing conditions, an evaluation of potential impacts, and proposed mitigation measures.

Volume II is a compilation of engineering drawings and architectural renderings for the Project and presents additional detail.



MASSACHUSETTS

RHODE ISLAND

CONNECTICUT

NEW YORK



PROJECT SITE

SOUND

ISLAND

LONG

**TRC**  
Booth Mills, South  
Foot of John Street  
Lowell, MA 01852  
(978) 970-5600

KLEEN ENERGY SYSTEMS, LLC  
MIDDLETOWN, CONNECTICUT

FIGURE 2.1-1  
REGIONAL LOCATION MAP

Date: 1/02

PROJ. NO. 33876

## 2.2 Permits and Approvals

Table 2.2-1 below outlines the permits and approvals required for the construction and operation of the proposed Project.

<b>Table 2.2-1 Kleen Energy Systems Project Permits and Approvals</b>		
<b>General Topic</b>	<b>Required Permits</b>	<b>Review Agency</b>
Air Permits	Construct and Operate	CT DEP BAM EPA
Water Resources	Location Review Conn. Gen. Stat § 16-50x(d)	City of Middletown Inland Wetland and Watercourses Commission
	CWA Section 401 Water Quality Certification	CT DEP
	Section 404 Dredge and Fill Review	U.S. Army Corps of Engineers
	Water Connection Permit	City of Middletown
Water Discharges	Stormwater General Permits for Construction and Industrial Activities	CT DEP
Water Discharges	State Permit for Wastewater Discharge to Sanitary Sewer (POTW)	CT DEP
	Sewer Connection Permit	City of Middletown
Stack Height Approval	Notice of Proposed Construction	FAA
	Notice of Actual Construction	
Bulk Storage	SPCC Plan	EPA
	Risk Management Plan	EPA
Noise	Connecticut Standards	CT DEP/City of Middletown
Zoning	Location Approval Conn. Gen. Stat. § 16-50x(d)	City of Middletown Planning and Zoning Commission
Site Approval	Certificate of Environmental Compatibility and Public Need (for an Electrical Generating Facility and Switchyard) Petition for Declaratory Ruling (for Transmission Line)	CT Siting Council

## **3.0 PROJECT NEED AND PUBLIC BENEFITS**

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### **3.1 Public Benefits of the Project.**

The statutes governing the Siting Council review require that the Council find that there is a "public benefit" for the Project. A "public benefit" exists if the Project "is necessary for the reliability of the electric power supply of the state or for a competitive market for electricity." Conn. Gen. Stat. § 16-50p(c)(1). The public benefit of the proposed Project, in addition to increased electric service reliability, include reductions in state-wide air pollutant emission levels, reductions in fossil fuel use, and increased potential for realizing the economic benefits of electric deregulation through diversification of power plant ownership.

The Project furthers the public policies of the State of Connecticut regarding electric competition, reliability and displacement of older, more polluting generation. As stated in Conn. Gen. Stat. § 16-244: state regulations should encourage and allow for a sufficient number of in-state generating facilities to ensure an adequate and reliable power supply and to ensure the development of a truly competitive generation market; competitive market forces can result in a reduction in electric rates in Connecticut; reliable and affordable electricity is the key to the continuing economic growth of Connecticut and the general welfare of its citizens.

The Project also advances state energy policies set forth in Conn. Gen. Stat. § 16a-35k. These include consuming energy efficiently; diversifying the state's fuel mix; and utilizing energy sources less vulnerable to interruption due to circumstances beyond the state's control.

This Project will provide clean energy from natural gas utilizing efficient combined cycle technology. For reliability purposes it will be able to utilize low sulfur distillate oil, should natural gas supplies not be readily available. Oil use however is projected to occur for a limited number of days per year, most likely in winter, and overall operation on oil would occur under 10% of the time. All generation would be within permitted emission limitations for new sources as regulated by the Connecticut DEP.

The Project owners believe that due to efficiencies they will be able to effectively compete in the marketplace, providing electricity at a cost below that of their competitors. Specifically, the proposed facility uses about one-third less fuel per unit of output than the average fossil power plants now operating in the region. Further, the facility will be as efficient or nearly as efficient as any similarly sized and type of power plant proposed in the region. This plant, like all merchant plants, will be assigned operating time by ISO-NE based for the most part on the relative position of its daily bid price. Because this plant will have lower operating costs than most current plants, it can be expected that its competitive bids will help drive down the cost of energy for all consumers.

The Project is also well positioned to enhance system reliability by providing electricity to areas of Connecticut which lack generation. Locally, the Project may be configured to help relieve transmission constraints in the Middletown area, better assuring the reliable distribution of power to that region. The Connecticut Light & Power Company (CL&P) has announced plans to construct a transmission line from Middletown to Norwalk to help relieve serious transmission

constraints in the southwestern portion of the state. The addition of the proposed plant, especially in conjunction with the above-described proposed transmission line, could further help meet this need. CL&P has also proposed placement of a new autotransformer at Middletown which could potentially broaden the reliability benefits of the proposed Project.

The location and design of the proposed plant switchyard provide flexibility regarding interconnection to the grid. Specifically, as proposed, the plant will tie into CL&P's 345 kV line designated as number "353". However, the Project owners have allowed in the switchyard design for the ability to also connect to the 115 kV lines near the plant site if it is determined that such additional interconnection is beneficial to grid operations. This flexibility is provided by building an extra (third) bay into the switchyard. This provides sufficient space to locate CL&P's proposed autotransformer if desired.

The Siting Council issued a "Review of the Connecticut Electric Utilities 2001 Twenty-Year Forecasts of Loads and Resources" in November, 2001. The Siting Council made the following findings which support this application:

- "Reliability has become a key issue to facility operation due to the age of many Connecticut generating plants." In this regard, "57 percent of the state's electric capacity is 20 years old or older."
- "Connecticut currently has 46 oil-fired electric generating facilities, some of which can also burn natural gas, contributing a total of 2,706 MW, approximately 45 percent of the state's current capacity.... Approximately 60 percent of the United States' oil is imported, making it potentially vulnerable to market manipulation by foreign nations."
- "Natural gas is expected to be the fuel of choice to be used for electric generation to meet sulfur dioxide standards and other limitations set by the [Clean Air Act]. Natural gas electric generating facilities are currently preferred primarily because of the available technology, high efficiency, cleaner emissions, and the relatively low capital cost per kwh produced. In addition, reserves from Canada have increased supply in New England by more than 50 percent through new pipelines...."
- "Generally, it is prudent to locate generation assets near load centers because of efficiency of transmission."

The Project will assist in meeting Connecticut's capacity needs. Peak demand in Connecticut and New England is much higher than recently projected. For example, the peak demand in Connecticut in the summer of 2001 was 6,799 MW, which was 13.6% above the 2000 peak of 5,900 MW and 7.2% above the previous peak of 6,345 MW (1999). By contrast, in the 2001 Loads and Resources Forecast, it was projected that peak loads in Connecticut would grow at an annual average rate of 1.3% from 2000-2020 and that the 2001 peak would be 6,255 MW. The 2001 peak of 6,799 MW actually exceeded the projected 2010 peak of 6,715 MW (contained in the 2001 forecasts filed with the Siting Council). Similarly, the 2001 peak in New England was 25,158 MW. The 2001 "NEPOOL Forecast of Capacity, Energy, Loads and Transmission 2001-2010" predicted a peak load in 2001 of 23,650 MW.

As the Siting Council noted in its 2001 Load Forecast Report, Connecticut's projected reserve margins are "speculative and subject to a number of variables, conditions and expectations that can quickly change." In addition to much higher than forecast peak demand, capacity resource projections may also fall short. The 2001 Forecast Report assumed the addition of the 512 MW Towantic Energy (Oxford) plant. However, construction of that plant has now been delayed and its future is uncertain.

Natural gas supplies are expected to be more than adequate to supply the Project as the primary fuel source. As reported in the 2001 Load Forecast, new gas supplies and pipeline additions provide for the potential of approximately 12,000 new MW of combined cycle natural gas facilities in New England. Since the 2001 Report was issued in November, FERC has approved several new projects, including Tennessee Gas Pipeline's "Dracut Expansion," Algonquin Gas Pipeline's "HubLine," Maritimes & Northeast Pipeline's "Phase III Expansion," Iroquois Gas Transmission's "Eastchester Expansion" and Duke Energy/KeySpan's "Islander East" (preliminary approval). New projects have also been announced. In February, 2002, the Maritimes & Northeast Pipeline's "Phase IV Expansion" was filed with FERC, which would allow Maritimes to nearly double its capacity to transport gas from offshore Nova Scotia.

In addition, there is reliable delivery capability to the Project. The Project will be supplied by a lateral that runs from the Duke/Algonquin mainline in Glastonbury, approximately 8 miles away. The lateral has sufficient capacity to provide gas to the Project without additional offsite compression. The lateral taps into two pipelines at the mainline, providing supply redundancy. Further, the Duke/Algonquin mainline has the advantage that it is supplied both from the north by the Sable Island gas fields and from the south by the Gulf Coast gas fields. This is very different from the traditional view that the Northeast was "at the end of the pipe" and that energy was supplied from resources to the south and west.

New clean, efficient electric energy from the Project is projected to displace older, more polluting power plants, through market forces, providing important economic and environmental benefits for Connecticut. Specifically, it is expected that the proposed plant will significantly reduce the need to operate certain units of the adjacent NRG Middletown Generating Station, which units are now dispatched at certain times to maintain local reliability. The proposed plant, with its state-of-the-art emission controls, primary fueling on natural gas, and high fuel use efficiency (from 26% to 38% less fuel needed by kilowatt hour produced than the four units at the NRG Middletown Generating Station) will reduce regional air emissions at all times including during critical air quality periods. Reductions will occur as the Project offsets the use of less efficient, high pollutant emitting older plants.

The continued operation of all older plants is uncertain due to the cost and difficulty of bringing those plants into compliance with existing and anticipated environmental standards coupled with the competitive pressures introduced as new, more efficient plants enter the marketplace. The uncertain continued operation of older plants, the need to improve air quality, and the potential for load growth beyond what is forecasted all factor into the level of benefit of the proposed plant. It should be noted that not all of the new plants recently added or planned to be added in Connecticut are situated to exclusively deliver power to Connecticut. The proposed plant will

feed into a 345 kV line that is so situated that it is expected that the plant's power output will physically flow to serve Connecticut load.<sup>1</sup> In addition, from a contractual basis, the Project owners are committed to initially offering a portion of plant output for sale to Connecticut power providers. Such sales can occur either as power off take contracts or on an equity participation basis.

Moreover, additional entrants into the energy marketplace will help to disperse market power, an important benefit as more power plants in Connecticut come under common ownership. Market power has been shown to occur in the deregulated wholesale electric marketplace when too few parties own or otherwise control the majority of power plants. The majority of Connecticut's generating capability is in a few hands. The proposed ownership structure of the proposed Project brings a new market entrant to the Connecticut deregulated generation marketplace. This helps to reduce the market power of entities currently owning and/or operating Connecticut power plants. This broadening of market participants in turn will result in a more competitive lower priced electric market, less prone to market manipulation, to the benefit of all consumers.

The Project is well sited and is adjacent to needed infrastructure. Only limited construction activities are required beyond the Project's boundaries to interconnect the facility to its fuel input and power output paths. Its location will allow it to meet regional needs, providing electricity systems benefits throughout Connecticut.

Other public benefits that the Project include are restoration of a heavily disturbed site and installation of stormwater management systems to alleviate serious erosion problems which now impact nearby roads and the Connecticut River. Also, the Project owners have voluntarily proposed to set aside a significant portion of the Project site as a not-to-be developed reserve to enhance regional conservation and wildlife management efforts. Project owners are committed to initially offering a portion of plant output for sale to Connecticut power providers. Such sales can occur either as power off take contracts or on an equity participation basis.

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<sup>1</sup> The Project owners have applied to ISO-NE for a transmission interconnection study that will include an analysis to verify how power flows from this Project through the transmission grid. The results of this study are expected to be available late this year. The study is required as part of the New England Power Pool requirements for interconnecting a new power plant to the grid.

## **4.0 PROJECT DESCRIPTION AND SITE SELECTION**

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### **4.1 Project Description**

#### ***4.1.1 Type, Size and Proposed Use of Project***

The Project is a 520 MW (nominal) natural gas-fired combined-cycle electric generating facility. It will supply electricity to the regional grid as an exempt wholesale generator as defined by federal regulations. The Project will participate in the new wholesale electricity market, selling at market-determined prices, thereby providing competitively-priced electrical energy to Connecticut consumers. The Project will be a merchant facility developed, constructed, and operated using private funding sources and placing no risk on Connecticut electricity consumers.

The Project will include two nominal 172 MW General Electric (GE) 7FA combustion turbines (CTs) (Appendix B) and associated heat recovery steam generators (HRSGs). The CTs will be equipped with dry low nitrogen oxide (NO<sub>x</sub>) combustors and have a combined nominal generating capacity of 344 MW (net). The HRSGs will be connected to a steam turbine generator, which will extract energy from the steam generated by the CT exhaust heat in the HRSGs and provide the rest of the 520 MW (nominal) electric capacity. Supplemental duct firing in the HRSG will also be used to increase power output when it is economically viable. The configuration of two gas turbines and one steam turbine is commonly referred to as a "2 on 1" combined-cycle configuration. By utilizing the otherwise wasted heat from the CTs, the combined-cycle facility will be more efficient than simple-cycle CTs and existing steam-cycle power plants. The facility will be fired primarily with natural gas, with low sulfur distillate No. 2 fuel oil used as a backup.

The majority of the power generation equipment will be housed within a building containing the gas turbines and their associated subsystems and equipment, the steam turbine and its associated systems, and a control complex which includes the control room, water sampling lab, electrical switchgear and electrical distribution systems. There will be a separate water treatment building and gas compressor building. The plant will use an evaporative cooling tower to provide condenser cooling to condense the steam turbine exhaust so that it may be recycled back to the HRSGs. The cooling tower is expected to be supplied with water from wells adjacent to the tidal reach of the Connecticut River.

#### ***4.1.2 Project Switchyard***

Each generating unit will have a generation stepup transformer that will convert electricity generated at 18 kV in the generators to the transmission line voltage of 345 kV. The transmission line will connect through a new switchyard that will be built on a flat terrace north of the generation building. The terrace will be excavated at an area previously subject to intense quarrying.

The switchyard arrangement is based on a 345 kV "breaker and one half" configuration. This arrangement provides for three connections to the power plant, and three connections for outgoing transmission lines. The three connections to the power plant are for each of the three

generator step-up transformers. Two outgoing transmission connections would loop the existing transmission line into the switchyard and would be the primary connections to the transmission system. The third outgoing connection would provide for a future 345 kV transmission line to a new substation by CL&P which could be used to provide an autotransformer connection between the 345 kV and 115 kV transmission systems.

## **4.2 Site Selection**

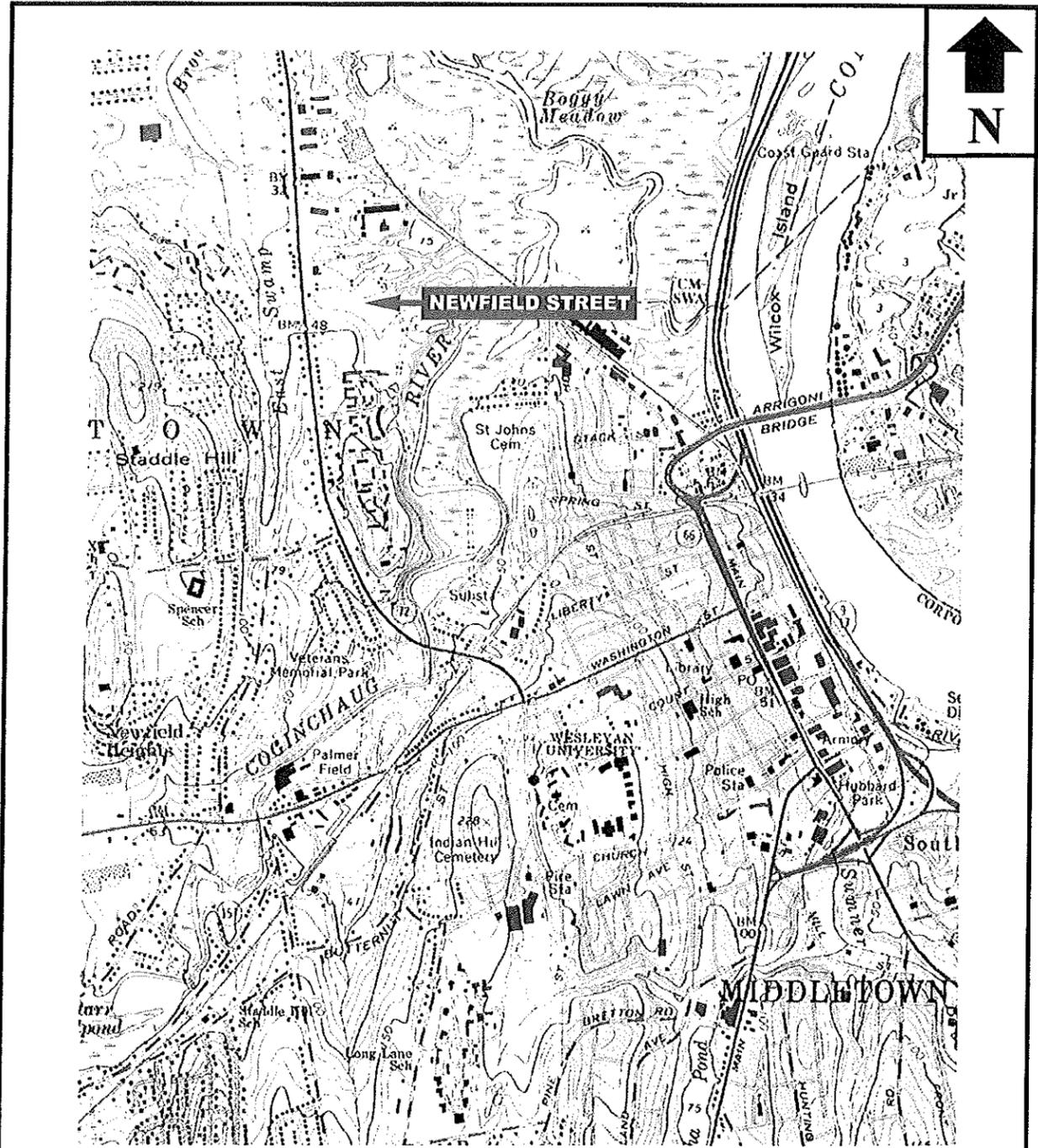
### **4.2.1 Background**

The founder of Kleen Energy Systems, LLC, Mr. Phillip Armetta, has an established track record developing energy projects. He is the leading private developer of waste-to-energy plants in Connecticut. He became interested in pursuing the development of a gas fired combined cycle plant as the electric industry restructuring matured in Connecticut.

### **4.2.2 Newfield Street Site**

Among Mr. Armetta's holdings was an approximately 150 acre site that was formerly a brick yard on Newfield Street in Middletown, Connecticut (Figure 4.2-1). In 1999, Mr. Armetta began consulting with the City of Middletown, Planning and Zoning Department regarding the potential development of the Newfield Street site. After review, it became apparent that it has several challenges or drawbacks. First, the Newfield Street site is zoned Newfield Street Planned Retail Business Commercial Zone (NPC). This zone does not allow for electric generating facilities and switchyards. Thus, a variance or zoning change would be required from the City of Middletown Planning and Zoning Department. Additionally, the site is surrounded by residential uses to the west (R-1 and R-15), to the north and east by the Mattabassett River (Sebethe), and to the south by a multiple family zone (M). Figure 4.2-2 is a portion of the City of Middletown zoning map containing the Newfield Street site. St. Johns Cemetery is located approximately 0.37 miles (1,950 feet) southeast of the site. The Veteran's Memorial Park is located approximately 0.90 miles (4,750 feet) southwest and the Spencer School is approximately 0.8 miles (4,200 feet) southwest of the site. The existing topography of the site would not shield the Project from viewsheds to the north, south, east or west. An electric generation facility located on the Newfield Street site would be visible from residential neighborhoods in all directions and other sensitive receptors in the area.

After re-evaluating the Newfield Street site, Mr. Armetta was advised by the head of the Planning and Zoning department, Mr. William Warner, that there might be a better site for the development of such a proposal in the Middletown area. Thus, Mr. Armetta was introduced to the River Road site.



BASE MAP IS A PORTION OF THE FOLLOWING 7.5' USGS TOPOGRAPHIC QUADRANGLE:  
 MIDDLETOWN, CT, 1965, PHOTOINSPECTED 1992



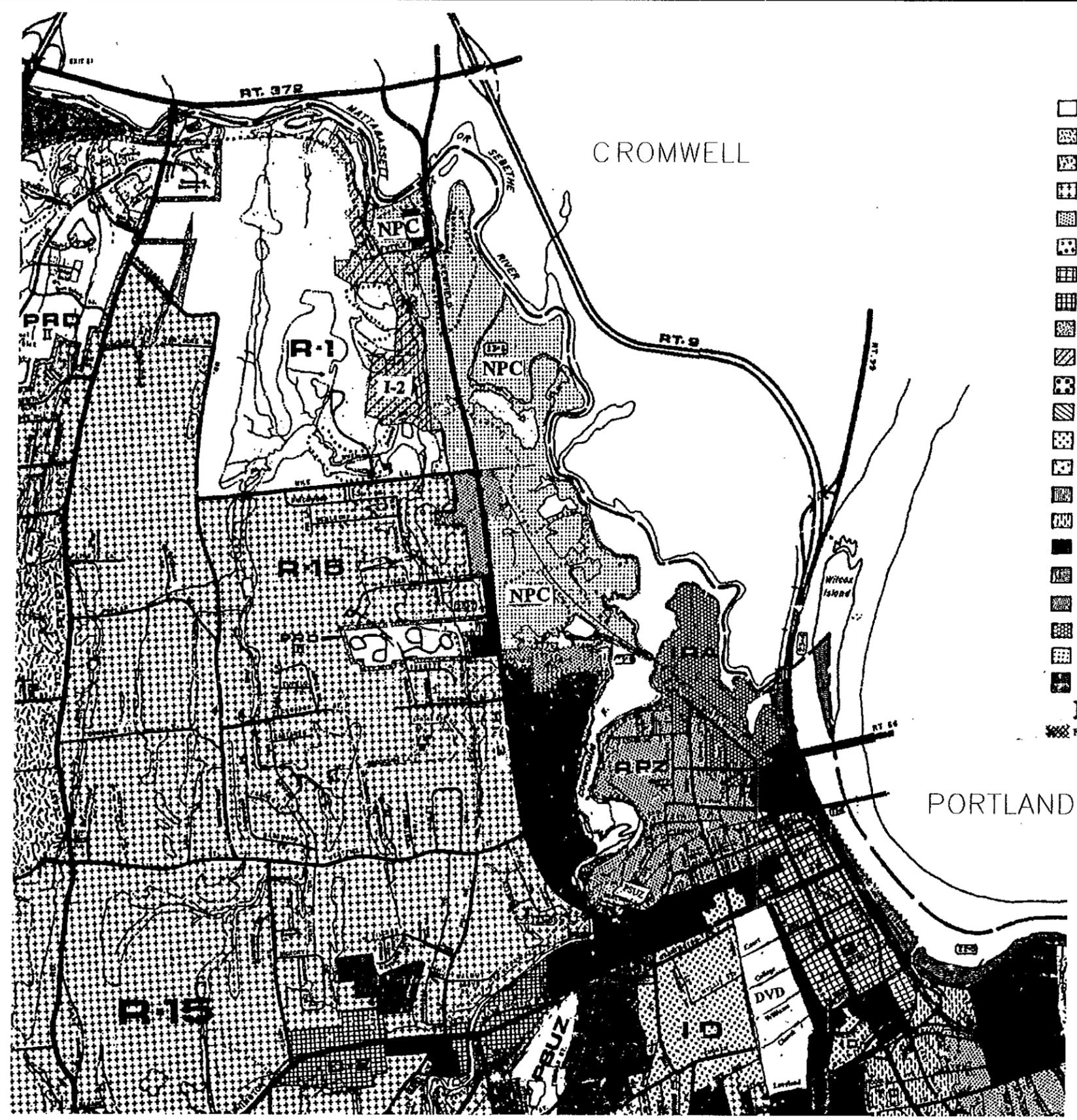
<b>TRC</b>	Boott Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600
	KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT
<b>FIGURE 4.2-1 NEWFIELD STREET LOCATION</b>	
Date: 1/02	Project No. 33876

33876/NEW FIELD ST ALT/TOPO



**ZONES**

- R-1
- ▨ R-45
- ▩ R-30
- ▧ R-15
- ▦ RPZ RESIDENTIAL PRE-ZONING
- ▥ R-60
- ▤ B-1 CENTRAL BUSINESS
- ▣ B-2 GENERAL BUSINESS
- ▢ I-1 SERVICE INDUSTRIAL
- ▧ I-2 RESTRICTED INDUSTRIAL
- ▦ I-3 SPECIAL INDUSTRIAL
- ▥ IOP INTERSTATE OFFICE PARK
- ▤ ID INSTITUTIONAL DEVELOPMENT
- ▣ IT INTERSTATE TRADE
- ▢ PL PARK LAND
- ▧ TD TRANSITIONAL DEVELOPMENT
- ▦ MX MIXED USE
- ▥ M MULTIPLE FAMILY
- ▤ RF RIVERFRONT RECREATION
- ▣ IRA INDUSTRIAL REDEVELOPMENT AREA
- ▢ I-4 LIMITED INDUSTRIAL
- ▧ IM INTERSTATE MIXED
- ▦ PSUZ PUBLIC SER. UTILITY
- ▥ NEIGHBORHOOD/RURAL COMM. DEVELOPMENT



Source:  
Zoning Map of Middletown, Connecticut Planning  
and Zoning Commission, January 1988

33876 NEW FIELD STREET ZONE

<b>TRC</b>	Boott Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600
KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT	
<b>FIGURE 4.2-2</b> Newfield Street Zoning Map	
Date: 3/02	Project No. 33876

#### 4.2.3 Evaluation of the River Road Site

Upon evaluation of the River Road Site two things became apparent. First, in many ways it is nearly ideal for the development of a natural gas fired combined cycle generation plant. Second, it is, topographically a very difficult site to develop.

A major concern with siting new generation plants is the need for reasonable proximity to a high voltage electric transmission network. A similar concern is proximity to a fuel supply. The River Road site has both. A CL&P 345 kV transmission line (designated the "353 line") runs between the Scovill Rock Substation and the Manchester Substation, and is immediately adjacent to the site on the east side. Interconnection at high voltages (e.g., 345 kV) is generally easier than at lower transmission voltages (e.g., 115 kV) as the higher voltage lines tend to be larger and newer. Therefore, the addition of a new generation plant is a smaller incremental change in the line's loading. The addition is also less likely to overload other nearby (electrical) system components and thus avoid costly, and often contentious, system upgrades. Therefore, the location adjacent to the 353 line is highly favorable.

Approximately 1.1 miles east of the River Road Site a gas transmission lateral pipeline has been installed beneath the Connecticut River to connect the NRG Middletown Generating Station to the Duke/Algonquin Mainline, 8.4 miles to the north in Glastonbury, CT. This lateral has a diameter of 20 inches and is large enough to provide an adequate supply of gas to the proposed Project as well as serve the existing generation facility for which it was originally installed. The Mainline consists of two independent gas transmission pipes. This adds a level of redundancy and therefore, reliability, not available at sites more distant from the Mainline. Again, the fuel supply circumstances of the site are highly favorable compared to other sites developed for generation uses in New England.

Adjacent land controlled by the Project proponents borders on the Connecticut River. In this reach the Connecticut River is tidally influenced, but is fresh water (salt water does not intrude up the River this far when the tide comes in). The Connecticut River is the largest river in New England; therefore, comparatively large volumes of fresh water can be obtained from the River without impacting natural resources. This allows the proposed Project to utilize wet evaporative cooling which further enhances its efficiency. This not only has financial benefits to the developer by making more electricity per unit of fuel burned, but allows the facility to burn less fuel, and therefore release less air pollution to serve the same load. The availability of fresh water in such quantity without adverse effects is extremely rare in New England and unique in Connecticut. Of the new generation stations licensed or built in New England in recent years, none is on a site that approaches the ease of availability of fresh water for cooling offered by the River Road site.

The River Road site is zoned I-3. This reflects the community's collective thinking that the site is appropriate for industrial uses, such as power generation. The NRG Middletown Generating Station is located nearby, as is the Pratt & Whitney manufacturing plant. The Project site consists of approximately 137 acres. Of the 137 acres, there is an approximate 30 acres of land that is highly disturbed by previous mining activity. This highly disturbed portion of the site was selected for the placement of the Project. The placement of the Project on this portion of the site provides for resolving an erosion and sedimentation problem from the existing disturbed areas,

and positively utilizes the natural topography of the site and surrounding area. The placement also preserves less disturbed areas of the site which offer better wildlife habitat than the proposed Project area. The choice of using the most disturbed area is consistent with recommendations received from local environmental organizations.

Generally, industrial development on land previously committed to uses resulting in a high level of disturbance, like mining, is looked on more favorably than, for example, converting existing agricultural or forested land to industrial use. The use of this portion of the property achieves the goal of using existing previously disturbed land and preserves the areas of greater environmental value.

The portion of the site selected for Project use is located furthest from the residentially zoned areas along Bow Lane and River Road. The Project site is also located closest to the existing industrial uses: NRG Middletown Generating Station and Pratt & Whitney. By maximizing the distance between the Project and the residential areas, noise from the Project will potentially impact the least number of residents. In addition to the distance between the Project and sensitive receptors, the natural topography in this area may provide an acoustic block to these receptors.

From a visibility standpoint, the natural terrain aids in shielding the Project from viewsheds to the south, east and west. The existing deciduous tree line also creates a vegetative barrier around the Project site to the north, south, east and west.

The Project location on the eastern portion of the 137 acre parcel minimizes the length of the electric and gas interconnects across the site reducing ground disturbance and visual impacts.

The remaining 107 acres not included in the 30 acres of highly disturbed area consists of moderately forested land, water filled quarries, and a residentially zoned area. From a land use perspective the Project site and location of the development footprint within the site appears highly favorable. The location of the Project on the 137 acre parcel enhances the existing disturbed areas and positively utilizes the natural topography of the site and surrounding area to reduce potential visual and acoustical impacts.

#### ***4.2.4 Site Selection Conclusion***

After consideration of these factors, Mr. Armetta entered into negotiations and acquired the River Road site, believing that the topographic issues could be resolved at a cost that would be more than compensated by the site's location and the benefits that result from the location. This has now been verified through preliminary engineering studies. As discussed above, from a variety of perspectives the site is ideally suited for a gas-fired electric generation project. While the topography is challenging, and will require creativity and additional funding to make it useable, in every other key category that would be analyzed in a site selection study, the River Road site scores very high and would be equal or superior than most of the other power project sites recently permitted in Connecticut.

### 4.3 Cooling Method Alternatives

The Project's objective is to choose an efficient cooling system that is conservative in the quantity of water used and wastewater generated, while maximizing the fuel efficiency and net power generation of the facility. The Project proposes to use conventional mechanical draft (wet) cooling towers. Alternative cooling technologies that were considered include dry cooling towers and once-through cooling. These are each described in more detail below. Additionally, alternative water sources were also considered. These include gray water from the Mattabassett and water from the Middletown well field located approximately 1.4 miles west of the Project site (Figure 4.3-1).

#### 4.3.1 Evaporative Cooling

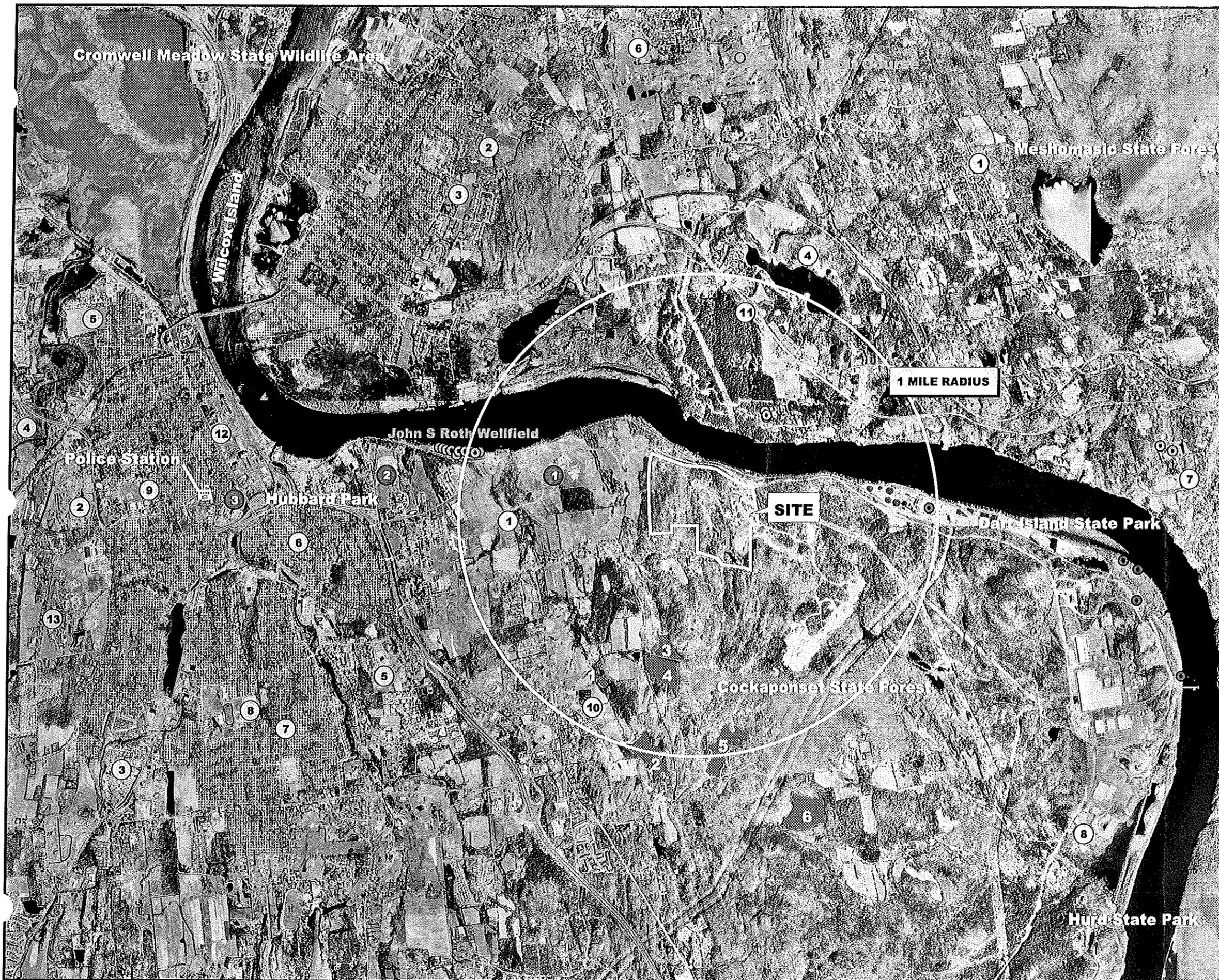
The Project's proposed cooling system uses evaporative cooling implemented with a counter flow induced mechanical draft cooling tower. In this system heat is removed from the condenser by circulating water through the condenser and then to the cooling tower. There the water is cooled by flowing large quantities of ambient air over the water allowing for both the transfer of heat in the water to the cooler ambient air and also for evaporation of the water which absorbs the bulk of the heat. The ability to use the high cooling capacity of the evaporation of water allows for evaporative cooling towers to be much more efficient and compact than similarly sized dry cooling systems.

The Project is sensitive to visibility concerns that evaporative cooling towers have raised on other projects. Therefore, the Project is the first in Connecticut to propose the use of a plume abatement system. Plume abatement is achieved by reheating the air exhausting from the cooling tower. This is accomplished by placing a heat exchanger above the wet section of the tower. The heat exchanger is supplied with water coming from the condenser, which after passing through the heat exchanger is distributed to the wet sections of the tower. Up to 20-25% of the heat from the condenser may be rejected to reheating the air passing through the cooling tower when plume abatement is in use. The plume abatement system will be able to be turned on and off as needed. When the system is active, the cooling tower functions as a hybrid wet and dry cooling tower.

#### 4.3.2 Dry Cooling

Air-cooled condensers (ACC) use ambient air to cool and condense the steam from the turbine exhaust without use of water or other intermediary heat transfer medium. Steam from the steam turbine exhaust is conveyed to a series of tubes (heat exchangers) over which air is passed to reduce the temperature. Cooling is provided by the large volumes of air moving past the coils like a giant car radiator/fan assembly. The airflow is forced across the coils by an array of large fans mounted below the heat transfer coils.

The steam turbine back pressure, which is critical to steam cycle efficiency, is set by the temperature of the ambient air and the "approach" temperature in a dry cooled cycle. The approach temperature is the difference between the ambient air temperature and the temperature



- Recreation Area
- ① Hospital
  1. Riverview Hospital for Children and Youth
  2. Connecticut Valley Hospital
  3. Middlesex Hospital
- ① Schools, Camps, and Day Care
  1. Noyes School Camp
  2. Portland High School
  3. Valley View School
  4. Camp Sprague
  5. Bielefield School
  6. Hubbard School
  7. Farm Hill School
  8. Woodrow Wilson High School
  9. Wesleyan University
  10. Middlesex Community Technical College
  11. Little Acorn Day Center
  12. High School
  13. Long Lane School
- ▨ Connecticut Valley Hospital Reservoirs 1-6
- ▨ Urban Areas
- ▨ Forests and Parks
- Community Water System Well
- Non-Community Water System Well
- ① Cemetery
  1. Connecticut Valley Hospital Cemetery
  2. Indian Hill Cemetery
  3. Pine Grove Cemetery
  4. Veterans Memorial Park
  5. St. John's Cemetery
  6. Portland Burying Ground
  7. Union Hill Cemetery
  8. Maromas Cemetary



2000 0 2000 Feet

Source: 1995 digital ortho quarter quad obtained from Map and Geographic Information Center, University of Connecticut (MAGIC). GIS spatial data layers obtained from MAGIC, and USGS topographic quadrangle information.

**TRC** Boott Mills South  
Foot of John Street  
Lowell, MA 01852  
978-970-5600

**KLEEN ENERGY SYSTEMS, LLC**  
MIDDLETOWN, CONNECTICUT

**FIGURE 4.3-1**  
**Local Resources**

of the saturated steam exiting the steam turbine. The approach temperature is determined by the surface area, or size, of the ACC apparatus. An approach temperature of zero (where the steam is cooled to the air temperature) would result in an infinitely large (and infinitely expensive) cooling surface in the ACC. Clearly, practical considerations, such as economics and available land area, play a key role in determining the size of the ACC surface area, the approach temperature (and ST back pressure), and the equipment cost. The steam is condensed in the finned tube sections and the condensate is collected in headers along the sides of the A-frame in which the coils are mounted. The headers route the condensate to a storage tank from which it is retained to the steam cycle. Because air is a less effective cooling medium than water, dry cooling towers would occupy up to three to four times the land area of wet cooling towers and stand nearly twice as tall for the same load. The entire coil/fan assembly must be located well above ground level to allow ample air to enter from the sides of the unit. The capital cost of an air cooled condenser is 3 to 4 times the cost of a wet tower.

#### ***4.3.3 Once-Through Cooling***

In a once-through cooling system water from a large water body (ocean, lake, large river) is passed directly through the steam turbine condenser. Environmental impacts notwithstanding, it is the preferred method of power plant cooling and is found at many older generating stations. A plant with a steam cycle the size of the Kleen Energy Systems Project would be expected to circulate on the order of 140 to 220 mgd. The Connecticut River would be physically capable of supplying this flow. However, a technical challenge to the use of once through cooling for the Project would be the energy needed to pump this volume of water from the river (sea level) up to the power block sited at elevation 340 feet. Further, once-through cooling systems have come under extreme pressure because of environmental impacts associated with them. The rejection of large quantities of heat directly to a water body can have serious environmental impacts by raising the temperature and having more direct impacts from heated water at the point of discharge. Aquatic organisms that are entrained (drawn into the system) or that are impinged on screens protecting such a system experience a high level of mortality. Recent EPA rulemaking governing the permitting of cooling water intake systems appear to render once-through cooling from the Connecticut River as impossible to permit (66 FR 65256).

In light of the importance placed on the Connecticut River and its ecosystem, and the technical and regulatory issues associated with once-through cooling systems, it was deemed to be not a feasible approach for providing cooling for the Project.

#### ***4.3.4 Alternate Cooling Methods Comparison***

The Kleen Energy Project, as proposed with evaporative wet cooling towers, provides the most efficient, economic, and environmentally sound approach for power production among the approaches and systems considered.

The use of dry cooling would have significant technical feasibility, economic efficiency and fuel use implications on the Project. The piping between the steam turbine and the ACC is very large. Therefore it is necessary that the steam turbine and the ACC be in close proximity. Combining this requirement with the large size of the ACC (up to four times the size of the

proposed cooling tower) and the site's difficult topography reveal that the entire project concept would need to be reconsidered. It is likely that the Project footprint would have to be moved to some of the less disturbed area of the 137 acre parcel in order to be able to create enough contiguous flat area for the ACC and the power block.

Evaporative cooling systems are quieter, smaller, less expensive and more efficient than a comparable ACC. Evaporative cooling towers have two kinds of impacts that are avoided through use of an ACC. First, evaporative cooling towers use a substantial volume of water. Very often this leads to concerns that under dry conditions, the water withdrawal to supply the tower will be significant enough to impact the ecosystems of the water source. This is generally the issue that forces the decision to use an ACC. At the Project site this is simply not the case. The Connecticut River is the largest river in New England, with a drainage area of over 10,000 square miles. This alone would mean that the Project's water use would not have a detectable impact on flow in the river even at its lowest flow conditions. On top of this, the river is tidally influenced in the reach where the Project site is located, so a withdrawal at this point would never impact the flow patterns or water levels that define the river ecosystem in this area. The water withdrawal that will supply the Project's water will utilize infiltration well technology so as to avoid any intake associated impacts and the need to perform construction in the river. In conclusion, the Project's use of water in evaporative cooling towers is extremely benign at this site, and hence, the leading advantage an ACC has, is without import in this instance.

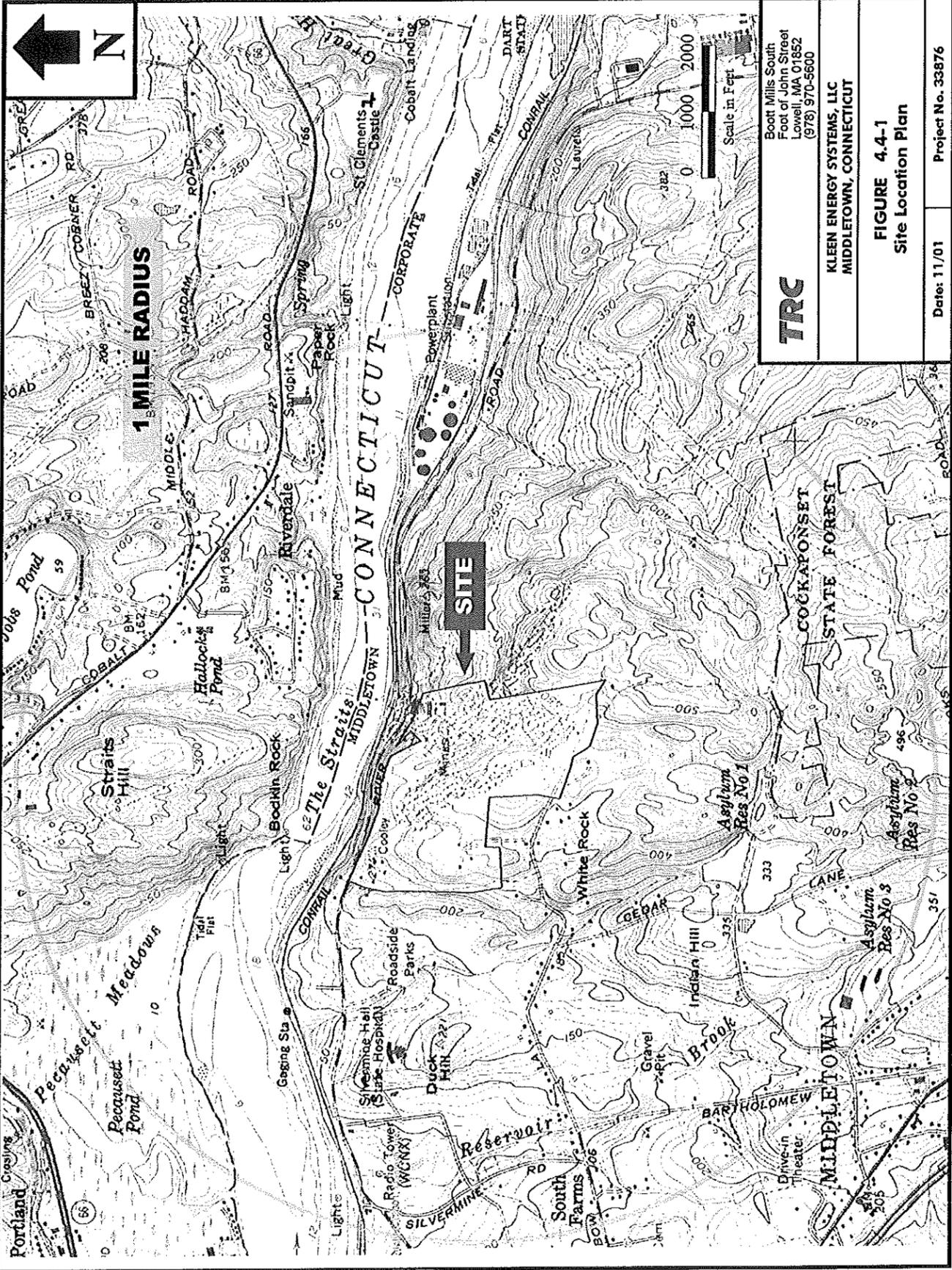
The second impact that evaporative towers have that an ACC does not concern plumes. There are three types of plume impacts- ground level fogging, ground level icing and plume visibility. The Project's cooling tower is predicted to have very limited ground level fogging and icing impacts. Because the cooling tower is located in a remote location with a substantial buffer to the site boundary, these impacts will generally occur either on the Project site or in adjacent wooded areas. The Project has addressed visibility issues by proposing plume abatement technologies. This should eliminate visible plumes in all but extreme conditions. Plumes are predicted to become visible when humidity is high and temperatures drop below 20° F.

#### **4.4 Physical Characteristics of the Project and Surroundings**

##### **4.4.1 Site and Area Description**

###### **4.4.4.1 Site Location**

The Project site is zoned in a Special Industrial (I-3) Area. The site consists of approximately 137 acres, bounded to the south by Bow Lane, to the east by land owned by CL&P, to the west by largely vacant land owned by the State of Connecticut, zoned for residential use (R-45) and to the north by River Road, a rail line, property owned by Armetta and Associates and the Connecticut River. The Project site lies entirely within the limits of the City of Middletown. The facility site location details are shown on Figure 4.4-1 and in Volume II, Drawings C2 and C5.



River Road runs north of the Project site and to the east to the existing NRG Middletown Generating Station. There the road is gated and generally closed. Beyond the gate is the Pratt & Whitney (P&W) jet engine manufacturing plant which is a secure installation. The gate on River Road can be opened to provide emergency access either to, or through, the P&W site. Hence, the only traffic using River Road by the site is associated with the NRG Station.

The Project site is highly disturbed and has been intensively used as a quarry for many decades. The Project has a goal of focusing its development on as much of the severely disturbed areas of the site as possible, thereby limiting the Project's impacts to less disturbed areas that provide higher quality natural habitat. The site is steeply sloped, reaching its highest elevations at its southern boundary and sloping to the north down to River Road and the Connecticut River.

#### 4.4.4.2 Site History

The Kleen Energy Project is located in the Maromas section of Middletown, Connecticut. The City of Middletown is ideally located in the center of Connecticut (Figure 2.1-1). Middletown has an area of approximately 42 square miles of rural, suburban and urban land. The City's population is approximately 45,000 persons. Rt. 9 runs along the eastern side of the City and provides a direct link to Interstate 91 north of the City and Interstate 95 approximately 20 miles south of the City in Old Saybrook. The City is within one hour of three of Connecticut's airports. The Bradley International Airport located in Hartford is approximately 27 miles north of the City. Tweed New Haven is located 36 miles southwest and the Groton-New London airport is located off Interstate 95 approximately 45 miles southeast of Middletown.

The Maromas section is located in the southeastern portion of Middletown along the Connecticut River. The historic downtown area and business district of Middletown is approximately 3 miles west of Maromas on the Connecticut River. Maromas is bordered to the north by the Connecticut River and the Town of Portland, to the east by the Connecticut River and East Hampton, and to the south by the Town of Haddam. The Maromas section of Middletown is accessible via the Eastern Drive/Bow Lane and Silver Street exits off of Route 9. The Maromas area of Middletown is primarily zoned Special Industrial. Current residents include Pratt & Whitney, the NRG Middletown Generating Station, Connecticut Light & Power (CL&P), and Connecticut State Property and Facilities.

Historically, the exact boundaries of the Maromas area are not clearly defined. There were originally eleven owners in the Maromas area. The original eleven proprietors owned approximately eight square miles. The setting of Maromas as of 1937 has been described as, "Except at one or two places, the river is bordered by grassy meadows; west of these are the slopes with precipitous sides; then a level stretch of land on which are the best farms in Maromas. Back of this is a large area of hills, valleys and ridges, with glacial rocks jutting from steep hillsides" (Works Progress Administration, Middletown, Connecticut, 1937).

In 1959 and 1960 Feldspar Corporation, a wholly owned subsidiary of Pacific Tin Consolidated Corporation of New York, started purchasing land in the Maromas section of Middletown for the purpose of mining feldspar. Prior to Feldspar Corporation gaining control of this area, land records indicate that the area was previously mined for pegmatite, a coarse grained granite. The

property purchased by Feldspar Corporation, located along River Road, the proposed Project Site, was mined between 1959 and the early 1990s.

Feldspar, a very common mineral found in the earth's crust, is the German word for "field mineral." Feldspars, a family of silicate minerals, occur in igneous rock. Feldspar is nonmetallic and ranges in color from white to dark gray. It is comprised of silica and oxygen, as well as calcium, sodium, and potassium. Calcium, sodium, and potassium occur in varying amounts depending on the rock. These three elements determine how feldspar is formed.

It was reported that Feldspar Corporation produced feldspar in two grades at the River Road site. Ceramic feldspar grade was produced and sent to New Jersey and glass grade ceramic was sent to the glass industry in and out of Connecticut (Middletown Press, August 29, 1985).

Overall, the Project site was extensively mined for approximately 100 years for pegmatite and feldspar. In 1999 Armetta and Associates purchased the River Road site property.

#### *4.4.4.3 Environmental Setting*

The Project site lies on the eastern side of Middletown, near the Connecticut River. Middletown is in Middlesex County and is about 4.5 miles south on Route 9 from the intersection of I-91 and Route 9. The Project site is about 3 miles due east of the Middletown business district and about 2.6 miles from the intersection of Route 9 and Silver Street, which would be expected to be the principal access route to the site.

The Project site is at the western end of a larger I-3 Special Industrial Zone that includes the existing NRG Middletown Generating Station, and the Pratt & Whitney aircraft engine manufacturing plant. The Project is being located on the eastern side of the site which has the combined benefits of maximizing reuse of previously disturbed areas and providing a buffer left in a natural state between the Project and existing or potential residences. A CL&P 345-kV transmission line abuts the site at the eastern edge and a high pressure gas transmission line is about 1 mile further east at the NRG Middletown Generating Station.

#### *4.4.2 Primary Project Components: Layout and Appearance*

The Project design and layout were carefully planned to minimize its impact to the surrounding community and the environment. The Project will consist of the power generation building, containing the administration areas, control room, gas turbines, steam turbine, water sampling lab, and electrical switchgear; two HRSGs with exhaust stacks; an evaporative cooling tower; ammonia storage; water treatment buildings and tanks; a back up fuel oil storage tank; a stormwater management system; access roadways; a security fence around the facility; interconnections to the electric transmission system and water and wastewater systems; and a gas metering station with gas infrastructure internal to the site, to be supplied by a lateral off of an existing interstate natural gas pipeline.

The most prominent structures associated with the Project are the generation building at approximately 95 feet high and the exhaust stacks at 215 feet high. The cooling tower is

proposed to be located at the rear (southern portion) of the site. The generation building and ancillary power block facilities are located to the north on a terrace. The switchyard will be located further to the north on a terrace about 100 feet lower than the power block. Because of the steep slopes in the area, the view of the Project should be very limited from most directions. The only area from which the Project is expected to be particularly noticeable will be from the top of the Connecticut River gorge along the northern riverbank (Town of Portland).

#### **4.4.3 Project Components and Process Description**

The facility will be comprised of the following five main areas: main power generation area, water treatment systems, wastewater collection systems, electrical switchyard and staff facilities. A listing of each proposed area, with the main structures that will be constructed for those areas and a brief description of their function is provided below.

- Main Power Generation
  - Steam turbine and CT building enclosures – house the power generation equipment and provide sound attenuation
  - Gas metering area – receiving point for pipeline natural gas flow
  - HRSGs – boilers that create steam from the CT exhaust and also house the air pollution control equipment
  - Evaporative Cooling Tower – provides condenser cooling of the steam turbine exhaust
  - Electrical/battery room building – houses Project electrical control systems and emergency backup power
  - CEMS buildings – houses exhaust gas analyzers to continuously monitor air emissions
- Tanks and Water Treatment Systems
  - Water treatment building – houses control systems for water purification system
  - Demineralized water system and chemical feed areas – water treatment systems necessary to produce highly purified feedwater for the HRSGs; antiscalant and biocide storage and injection for the cooling tower
  - Water storage tanks – storage for filtered water and demineralized water
  - Ammonia unloading and storage area – tanks and unloading area for aqueous ammonia used for air pollution control
  - Oil storage
- Wastewater Systems
  - Secondary containment sumps (indoors) – contains liquids within material storage areas
  - Building and area sumps – collects washwater for treatment
  - Neutralization tank – adjusts pH to within acceptable range

- Oil/water separator – removes oil from wastewater prior to discharge
- Connection to River Road force main - for sanitary and contaminated wastewater discharge
- Discharge of clean cooling tower and boiler blowdown wastewater
- Electrical Switchyard
  - Transformers – steps up voltage from turbine generators to 345 kV
  - Switchyard electrical control house – controls switchyard equipment that controls flow of electricity from and to the Project
- Staff Facilities
  - Warehouse/maintenance building – spare parts storage and machine shop
  - Administration/control room building – staff offices and plant control systems
  - Gate house – provides 24 hour per day manned control over access to the plant facilities

The heart of the combined cycle generation process are the Project's two CTs and one steam turbine. Each turbine is attached to a generator and step-up transformer. The CTs are fueled primarily by natural gas. Air is drawn into the unit, compressed, and fed to the combustion chamber, and then mixed with pipeline quality natural gas and combusted. The combustion chambers feature dry low NO<sub>x</sub> (DLN) combustors to reduce formation of nitrogen oxides. The expanded exhaust gas then passes through a 3-stage turbine, which powers both the compressor and the attached generator.

Waste heat from each CT is routed to a HRSG. The HRSG has multiple pressure zones to maximize the recovery of waste heat to generate steam. While in the HRSG, the exhaust gas passes through an oxidation catalyst and through the selective catalytic reduction (SCR) system to reduce air emissions. Exhaust gases are then vented to the atmosphere through stacks which will be 215 feet tall.

Steam generated in the HRSG is routed to the steam turbine to generate additional electricity. At the outlet of the steam turbine, the remaining low-pressure steam is routed through a condenser, where it is cooled and condensed to be recycled within the closed loop steam cycle. The condenser is cooled with water circulating through the cooling tower where the waste heat is rejected to air passing through the cooling tower through the cooling of evaporation and latent heat transfer. The cooling tower employs a counter-flow induced mechanical draft, which is state of the art technology for cooling towers. The cooling tower will be comprised of 12 cells, constructed of wood or fiberglass. Each cell of the cooling tower contains its own individual fan. The tower will be erected over a cold water basin. Water flowing through the tower will pass over a PVC plastic fill to maximize the contact of the water to the flowing air stream. The tower will also include a dry section for plume abatement. Plume abatement will be employed to reduce the amount of visible plume seen from the cooling tower. Drift from the cooling tower

will be 0.0005% of the circulating flow. Noise from the cooling tower will be mitigated as required to meet applicable Connecticut noise regulations.

#### Air Emission Control

The Project will be one of the most efficient and cleanest combined-cycle power plants in the world. The facility will be designed to meet lowest achievable emission rate (LAER) and best available control technology (BACT) standards, as applicable, for emissions control. Emissions of sulfur dioxide (SO<sub>2</sub>) will be limited by using natural gas as the primary fuel. Emissions of particulate matter (PM), carbon monoxide (CO), and volatile organic compounds (VOC) will be limited through use of sophisticated combustion controls. An oxidation catalyst to further control CO, and possibly some VOC, will be installed.

The 7FA achieves superior NO<sub>x</sub> emission levels as a result of its DLN sequential combustion system working in conjunction with SCR, a post combustion flue gas control. SCR is a commercially available, proven technology to remove NO<sub>x</sub> from the exhaust gases in the HRSGs. The SCR process involves injecting ammonia into the flue gas stream and then passing the flue gas stream through a catalyst bed that converts NO<sub>x</sub> to benign nitrogen (N<sub>2</sub>) and oxygen (O<sub>2</sub>) gases.

#### System Availability

The GE 7FA combustion turbine is based on GE's latest, proven technology. Availability of combined cycle generating plants has been higher than other technologies used in the past. Earlier combined cycle plants built in the 1980's tended to have availabilities of about 80-85%, comparable to the better conventional steam-electric units. As the technology has been refined and a larger experience base developed 7FA based combined cycle units regularly report availabilities exceeding 90% including forced and scheduled maintenance outages.

A study of 75 unit-years of MS7001F/FA gas turbine experience as reported through the User's group and customer surveys for the period of 1990 through 1997, indicated median reliability levels of 98.4% and median availability levels of 94.5%. Plant reliability considers only forced outages whereas Plant availability includes both forced outages and scheduled maintenance outages.

The Capacity Factor of a combined cycle power plant is dependent upon the power market conditions. Capacity factor is an expression of how much of the time the plant is expected to be dispatched by the local Independent System Operator (ISO). It is anticipated that the Kleen Energy Systems Project will operate with a capacity factor of approximately 80%.

The anticipated service life of the Kleen Energy Systems plant is expected to be 25 to 30 years.

#### 4.4.4 Water

##### 4.4.4.1 Water Source

The Project will make use of an evaporative cooling tower. Evaporative cooling towers have many advantages over alternative cooling systems including reduced noise, smaller footprint and increased efficiency particularly in hot weather. Evaporative cooling towers have two impacts that often result in the use of other cooling techniques. First, in cold humid weather they can result in substantial visible plumes of water vapor. The Project has addressed this concern by being the first plant in Connecticut to propose the use of active plume abatement (plume reheat) to enable the plant to keep the extent of visible plume under control. Second, evaporative cooling towers require a significant volume of water that can be hard to locate with acceptable environmental impacts. In this case, an available supply of water is assured from the tidal reaches of the Connecticut River. It is expected that water for the Project will be supplied through a separate entity including Armetta and Associates and the City of Middletown. Regardless of business structure, the source of water supply will be the Connecticut River.

The Project will require a maximum daily water supply of 4.5 million gallons per day (mgd) with a daily average of about 2.8 mgd. This compares with a low flow (7Q10) condition in the River of about 1,900 mgd. Therefore, the Project's use of water would have no discernable impact on the River. Water would be withdrawn through an infiltration well system so there would be no intake construction in the river and no intake effects on aquatic organisms. In the event of water system failure, the Project would have several hours of reserve water for normal operations available in the raw water storage tank and the cooling tower basin.

##### 4.4.4.2 Alternative Water Sources – Gray Water

Use of wastewater treatment plant effluent is usually pursued to avoid having a new water withdrawal. Because the water is already being withdrawn for human use, much of the controversy involved in creating a new withdrawal can be avoided. As the use of freshwater by the Project can be virtually impact free, this benefit is lost in the Project's case. Nonetheless, the Project team has evaluated potential gray water options.

The closest available source of gray water with sufficient capacity to supply the Project even at the lower end of its range of inflows would be the Mattabassett District Commission treatment plant located in Cromwell, Connecticut. Use of this water source would require the installation of a pipeline over 5 miles in length. The treatment plant discharges to the Connecticut River. As the process of using water for evaporative cooling does not add any pollutants to the water, the pollutant load in the River would probably remain unchanged through the use of this gray water. The concentration of pollutants in the evaporative cooling process might lead to some additional pollutant removal assuming the Project discharge was through a treatment plant.

After due consideration, it was determined that the additional infrastructure of the pipeline and the disruption inherent in its installation could not be justified by the limited potential for reducing pollutant loading to the River. As the Mattabassett plant discharges to the River, whether the water was taken at Mattabassett, or removed from the River 5 miles downstream

through infiltration wells would have virtually identical effects, which as previously stated are expected to be undetectable.

#### *4.4.4.3 Wastewater*

The Project will have a process wastewater discharge of about 0.5-0.75 mgd. This water will be primarily from the cooling tower and contains the constituents in the water feeding the cooling tower (from the River) concentrated by the evaporation of water in the cooling tower. This water could be discharged back to the River. There would be no new pollutant loading in the River as the discharge would contain materials taken from the River. However, to ensure even greater protection, the Project is proposing that this water be discharged into the municipal sewer system.

The Project will use very little water for domestic and sanitary purposes. Sanitary wastewater will be discharged to the municipal sewer.

#### *4.4.5 Utility Interconnections*

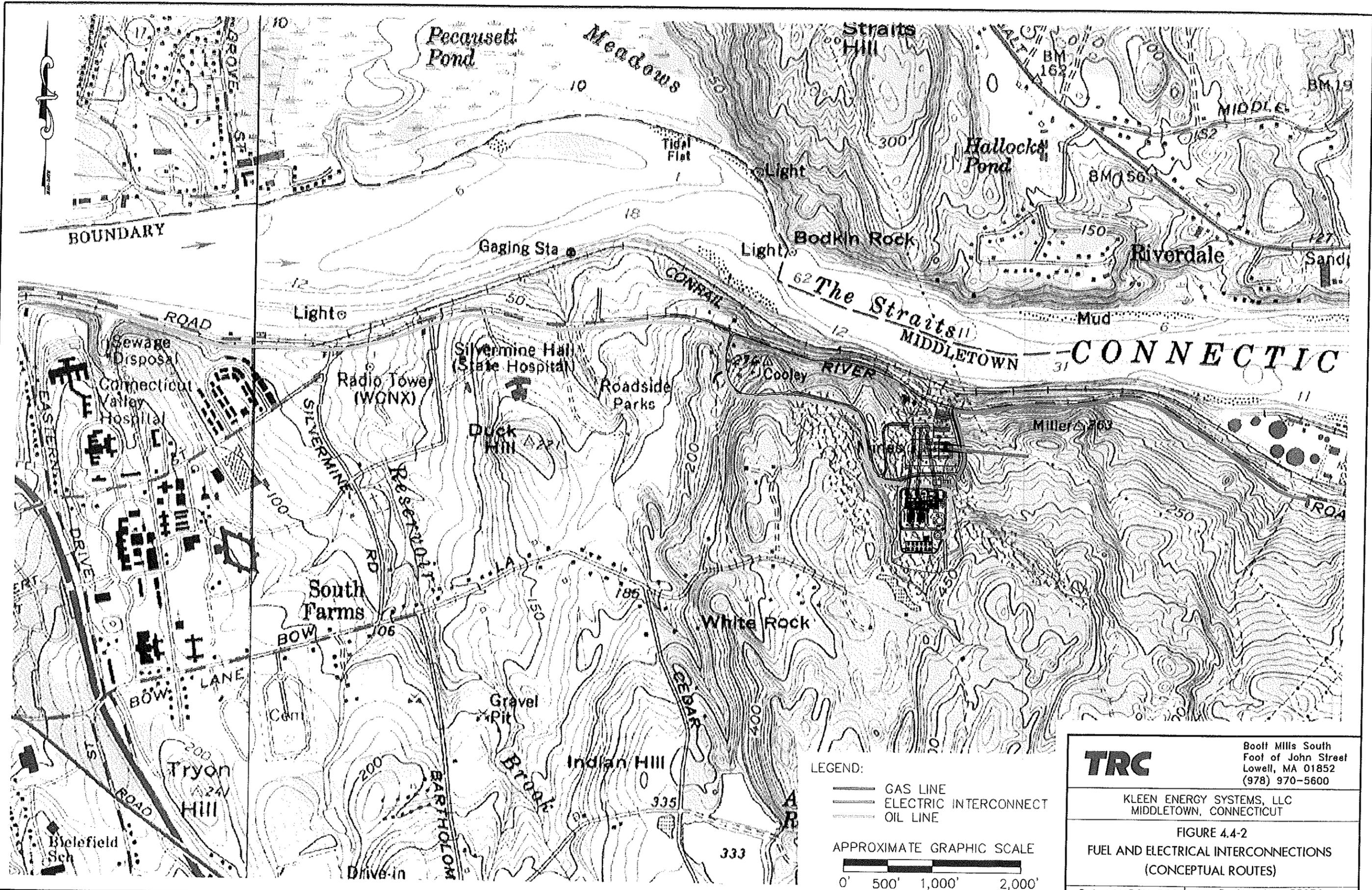
Two utility interconnection corridors are planned. The first will follow the access road to the facility from River Road. Utilities along this corridor are expected to include potable water, sanitary sewer, telecommunications, and distribution level electricity. The second will run along the eastern edge of the site and will include high pressure gas, raw water, sanitary sewer, and an oil pipeline to be used when replenishing the backup oil supply (Figure 4.4-2).

##### *4.4.5.1 Electrical Interconnections*

The electrical interconnection for the Project is based on having the capability of exporting a nominal 540 MW on a continuous basis. Investigations at the site, and discussions between the development team and Northeast Utilities indicate that the best option for this connection is to tap the existing CL&P line that runs from the Scovill Rock substation to the Manchester substation. The tap would be made just southeast of structure 12100, which is a river crossing structure located just east of the Project switchyard location. The tap would loop (sectionalize) the line and bring two new lines into the Project switchyard.

The line is expected to have sufficient capacity for the Project requirements. Informal discussions with Northeast Utilities indicate that the connection of the Project into the 345 kV system should not present any load flow, fault duty, or stability problems. This will be confirmed by interconnection and load flow studies which will be required by the independent system operator (ISO-NE) and the utility.

The line is bi-directional meaning that load can be served from both ends. Therefore, since the line will be looped into the Kleen Energy switchyard, in the event that either line running from Kleen Energy fails or must be taken out of service for maintenance, the other side of the line should remain in service, allowing Kleen Energy to continue generating and supplying load. This is unlike many interconnections that use a tap line, and a single contingency event can force the units off-line.



LEGEND:

- GAS LINE
- ELECTRIC INTERCONNECT
- OIL LINE

APPROXIMATE GRAPHIC SCALE

**TRC**

Boott Mills South  
Foot of John Street  
Lowell, MA 01852  
(978) 970-5600

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KLEEN ENERGY SYSTEMS, LLC  
MIDDLETOWN, CONNECTICUT

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FIGURE 4.4-2  
FUEL AND ELECTRICAL INTERCONNECTIONS  
(CONCEPTUAL ROUTES)

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Date: MARCH 2002      Project No. 33876

#### 4.4.5.2 Switchyard Arrangement and Features

The Project switchyard arrangement is based on a 345 kV breaker and one half configuration. This arrangement provides for three (3) connections to the power plant, and three connections for outgoing transmission lines. The three connections to the power plant are for each of the three (3) generator step-up transformers. As described above, two outgoing transmission connections would be the primary connections to the transmission system. The third outgoing connection would provide for a future 345 kV transmission line to a new substation by Northeast Utilities which could be used to provide an autotransformer connection between the 345 kV and 115 kV transmission systems. This configuration is shown in Volume II Drawing C3 and C4.

The switchyard is designed for a nominal 2000 amperes (A) continuous current and 40 (kiloamperes) kA interrupting capacity.

The takeoff structures at the step-up transformers, and the take-off structures in the switchyard will be the tallest electrical structures on site. The height of each of the structures will be approximately 65 feet above grade to the static wire attachment. An additional approximately 15 foot pipe will extend above this attachment as part of the lightning protection system. The structures are anticipated to be tapered tubular galvanized steel construction.

#### 4.4.5.3 Power Plant Electrical Configuration

The power plant is configured as shown on the One Line Diagram in Volume II Drawing C4. Each of the combustion turbine generators connects to isolated phase bus duct, and each has a generator circuit breaker. The isolated phase bus duct from the generator circuit breaker continues to the generator step-up transformer, and is tapped to connect to a unit auxiliary transformer. The steam turbine generator connects directly to a generator step-up transformer via isolated phase bus duct.

Each of the two unit auxiliary transformers is sized to carry continuously the entire station auxiliary load.

Each of the unit auxiliary transformers supplies a 4.16 kV switchgear bus. The 4.16 kV buses can be connected through a normally open tie circuit breaker. 480 Volt (V) load centers are fed from each of the 4.16 kV buses. Ties are provided between the 480V load centers where redundancy of supply can enhance the operation of the power plant. 480V motor control centers are supplied from the 480V load centers.

The combustion turbine generator static start systems, and generator excitation systems are supplied from the 4.16 kV buses. Motors 250 horsepower (hp) and larger are also supplied from the 4.16 kV switchgear. Motors from 100 hp to 249 hp are supplied from the 480 V load center switchgear. Motors from ½ hp to 99 hp are supplied from the 480 V motor control centers.

#### 4.4.5.4 *Natural Gas Interconnect*

The Project will be supplied with natural gas by a new dedicated supply line to be run along River Road from the Duke/Algonquin metering station directly across the street from the existing NRG Middletown Generating Station. This line will run approximately 1 mile along River Road to the Project Utility Easement. The line will extend up the Project site past the switchyard to a gas compression building. In the gas compression building, gas will be compressed to the appropriate pressure to supply the combustion turbines. A line will connect the gas compression building to the turbine building. In the event compression is not needed, the compressor building may be omitted and the pipe coming up the utility corridor will go directly to the turbine building (Figure 4.4-2).

The Duke Algonquin metering station is supplied by a lateral that runs from the Duke Algonquin mainline in Glastonbury, Connecticut. The mainline consists of two pipes - a 24-inch and 30-inch pipelines. The lateral interconnects to both lines through a tap valve system and runs 8.4 miles south to the metering station at the NRG Middletown Generating Station site, crossing under the Connecticut River (installed by directional drill). Most of the lateral follows existing CL&P transmission line right-of-ways. The lateral is a 20-inch diameter pipeline and has sufficient capacity to support the service provided to NRG and the proposed use by Kleen Energy without any additional offsite compression. The lateral was installed in the late 1990s to support air pollution control efforts at the NRG station.

Because the relatively short lateral connects to the Duke/Algonquin mainline the gas supply should be especially reliable. There is a very small exposure to situations where a single contingency could result in interruption of the gas supply. Enhancements being undertaken now in Massachusetts and northern New England will further enhance the supply of gas from the Maritime provinces. With these enhancements in place, Kleen Energy will be in the enviable position of being served from either the north or the south with only 8.4 miles of pipeline to a redundant system. In the event of a curtailment of natural gas supply, the Project will be able to quickly change to its backup fuel supply.

#### 4.4.5.5 *Fuel Oil Supply*

The Project will have a 950,000 gallon fuel oil tank on site. This will support the Project at full load operation for about 1.5 days. In order to avoid the traffic concerns and facilities needed to support the plant through truck deliveries, the Project proposes to connect the facility to existing oil pipeline networks in the area. The Buckeye pipeline system has an existing pipeline that runs up the east side of the Connecticut River and connects into a tank farm of over 18 million gallons capacity in Portland just north of the Arrigoni Bridge. An existing pipeline from the tank farm crosses the Connecticut River and runs south as far as the Middletown Wastewater Treatment Works, about 2.5 miles west of the Project site. This pipeline is currently unused. The Project is arranging to obtain storage at the tank farm and the rights to use the pipeline, and to have the pipeline extended to refill its on-site day tank. The pipeline will be extended from the Treatment Works on River Road to the Project site on River Road. It will then interconnect with a Project pipeline that will run up the Project Utility easement along the east side of the Project and connect with the day tank.

#### **4.4.6 Instrumentation and Controls**

A sophisticated control system will be used to monitor and control the various plant processes. A central control room will be staffed at all times with operators maintaining full plant control. The control system will be programmed to automatically control and/or monitor plant functions and notify the operators of abnormal conditions. A continuous emissions monitoring system (CEMS) will be used to monitor exhaust stack emissions. Local control systems will be provided for equipment that is operated manually (Figure 4.4-2).

#### **4.4.7 Solid and Hazardous Waste Generation and Disposal**

The Project will generate relatively little solid waste, as well as small amounts of wastes that are classified as hazardous and subject to the Resource Conservation and Recovery Act of 1976 (RCRA).

Solid waste will be generated during Project operations. Office and other facility wastes will be recycled to the extent feasible. A private contractor will dispose of non-recyclable materials. Normal project maintenance will generate small quantities of solid waste on a periodic basis. Depleted SCR and oxidation catalysts will be sent for reprocessing to the original manufacturer or to a licensed facility for recovery or disposal.

The Project will implement a pollution prevention and solid waste management program and evaluate recycling opportunities. Recycling will be encouraged and supported through the on-site placement of appropriate containers. Solid waste and debris that cannot be recycled, reused or salvaged, will be stored in on-site dumpsters or similar containers for off-site disposal.

Based on experience at facilities presently being constructed and operated, about 5 to 10 cubic yards of waste will be generated weekly during operation. Approximately 50 to 100 cubic yards will be generated weekly during construction. This is equivalent to approximately 400 cubic yards of solid waste per month for the short-term construction period, some of which will be recycled.

Potentially hazardous wastes will be separated from normal waste through segregation of storage areas and proper labeling of containers. All hazardous waste will be removed from the site by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities. During Project construction and pre-operational cleaning, some solvents and flushing materials may be used. Section 5.12, Chemical Storage and Handling, of this application outlines the materials that will be stored on-site.

#### **4.4.8 Chemical and Petroleum Storage and Handling**

During the construction phase of the Project there will be potential requirements for on-site storage of various hazardous materials, waste lube oils, and other lubricants, in addition to the bulk storage of chemicals. During operations, a similar need will exist to store limited amounts of hazardous materials.

#### **4.4.9 Protection Systems**

The Project will be designed, constructed and operated to ensure maximum safety for employees and the surrounding community. Design, construction and operation of equipment for the proposed Project will be in accordance with applicable federal, state, and local regulations, and will comply with the latest regulations and standards of applicable governmental agencies and engineering associations. These organizations include the National Electrical Manufacturing Association (NEMA), Department of Transportation (DOT), the American Society of Mechanical Engineers (AMSE), the American National Standards Institute (ANSI), and the National Fire Protection Association (NFPA).

#### **4.5 Project Construction**

Construction at the Project site is expected to commence in 2003, with peak construction occurring in 2004. The peak construction work force on-site is estimated to be about 400 to 430 workers per day. The construction schedule is 24 months.

The construction sequence proceeds in a series of overlapping phases. It begins with site preparation. This will include installation of sedimentation and erosion control facilities, clearing, grubbing, and grading of the site and access road. Site preparation also includes excavation of the stormwater detention and infiltration basins, and formation of drainage swales. These tasks will be conducted early in the construction schedule. The offsite laydown areas along the access road will also be cleared and prepared.

As site preparation progresses, the delivery and installation of temporary buildings to house offices and worker lockers occurs. An on-site area will be set aside for temporary laydown and storage of facility materials and equipment. A gravel or crushed stone parking area will be constructed to serve workers and park construction vehicles when not in use. Temporary electric and phone utilities will be installed.

The next major step in the construction sequence will be excavation and compaction for foundations for the plant buildings, and excavation for and placement/backfilling of underground pipes and conduits. Excavated materials will be stored on-site and reused as fill and topsoil material in final grading to the extent possible.

Immediately following excavation, the building foundations will be formed, rebar and conduit will be installed, and concrete will be placed. At this juncture, approximately six months of the construction period will have elapsed. During this period, an intense level of site activity is anticipated. Since this could occur during summer months, dust from construction activities will be controlled by measures such as wetting of exposed soils on a regular basis and stabilizing storage piles by wetting and/or seeding. These measures will be implemented as standard practice for the construction effort.

Following site preparation and installation of foundations, erection of structural steel will begin. Concurrently, major equipment – the CTs, steam turbine, generators and HRSGs – will be

delivered, assembled and set in place. Field-erected tanks, vessels, and cooling towers will be constructed. Then the labor-intensive process of installing a complex array of interconnecting piping, electrical and instrument wiring and ductwork will begin. This is when the peak labor force will be required.

As the erection of building walls, finish work and final connections of piping and wiring is nearing completion, the process of checking the electrical and control systems, starting up major equipment, cleaning pipelines, and testing all systems will begin.

The culmination of Project construction will be the firing and initial synchronization of the CTs and generators, followed by the production of steam, free blow of steam lines, and initial synchronization of the steam turbine. Simultaneously, the water circulation pumps to the cooling towers will be tested. Finally, integrated combined-cycle operation will commence, and enter a rigorous test and shakedown period. The Project will then enter commercial service.

#### **4.6 Project Operation**

The Project will be designed to operate continuously (24 hours per day, 7 days per week) to provide baseload power. The operational labor force will consist of approximately 25 to 30 full-time employees, with about half working the normal day shift. The remaining employees will perform shift work to maintain 24 hour operation.

Plant workers will be trained and qualified in accordance with industry standards and state requirements. Project personnel will be trained in the areas of environmental compliance, safety and emergency response. The Project will also train local fire and police in the layout and operation of the plant, including safety systems, to facilitate local emergency response.

## 5.0 ENVIRONMENTAL SETTING, POTENTIAL IMPACTS AND MITIGATION MEASURES

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This section describes the environmental context, both natural and man-made, in which the proposed Project is located. For each environmental consideration, probable environmental impacts are assessed.

### 5.1 Land Use and Zoning

This section describes the existing land uses and zoning of the proposed Project site and surrounding areas. Potential land use impacts relating to the operation of the proposed Project are also discussed in this section. Information was obtained from the City of Middletown Zoning Code and map, site field surveys, and existing published sources. The existing conditions are defined for the proposed Project site and immediate surrounding areas, as well as for land within a one-mile radius of the site. The area evaluated was one mile or less due to the limited zone of potential impact associated with the proposed Project.

#### 5.1.1 Land Use

##### A. Existing Land Use

###### Proposed Site and Contiguous Areas:

The proposed Kleen Energy Project site is located in the Maromas section of the City of Middletown, Connecticut. The Project site is located in an I-3, Special Industrial District. The proposed Project location is entirely within the Armetta and Associates property, and is located in the northeast portion. This property has long been subject to industrial use. Prior to Armetta and Associates purchasing the property, it was owned by Feldspar Corporation, who extensively mined the Project site for feldspar from the 1950s or before through the early 1990s.

Most of the Project site where the facilities will be located has been disturbed and is underlain by rock and remnants of extensive mining. Portions of the Project site are barren, overgrown with secondary revegetation typical of previously disturbed areas, or forested.

The property contiguous to the Project area on three sides is owned by Armetta and Associates. To the north of the proposed Project site is River Road. North of River Road is Armetta and Associates property and a rail line which bisects Armetta and Associates property, beyond which lies the Connecticut River. Three residences are on River Road northwest of the site. To the west of the area to be developed is a substantial area of vacant land owned by Armetta and Associates. The far western edge of the Armetta and Associates property abuts residentially zoned land (R45) that is largely vacant. This zone boundary is over 2500 feet from the Project area. Land east of the Project site is owned by CL&P, and includes an overhead 345 kV transmission line. The southern side of the site is bordered by Bow Lane, and a woods road that extends from the end of Bow Lane.

The Project site is within the Connecticut River Watershed. It is however outside of the public water supply watershed area. The Project will not negatively impact the Connecticut River Watershed or any public water supply watershed areas.

Area within One-mile Radius:

The land uses within one mile of the site are primarily state land or undeveloped vacant land with limited residential uses (Figure 4.3-1).

Land uses to the north of the site within one-mile radius consist of the Connecticut River, vacant land (owned by Armetta and Associates) and a rail line in the City of Middletown. Across the Connecticut River in the Town of Portland land uses within the one-mile radius include, undeveloped vacant land zoned Flood Plain (FP), with some commercial and residential areas (RR and R15). The Connecticut River represents the municipal boundary between the City of Middletown and the Town of Portland. Land north and northwest of the River is vacant land zoned Flood Plain. This vacant land includes marshland and a 300-foot ridge, along the top of which runs a utility right-of-way. North and northeast of the River, the land use is primarily residential and commercial. Businesses line Portland-Cobalt Road, with residential communities mainly located on side streets. Some of the businesses along Portland-Cobalt Road include Portland Power Equipment, Little Acorn Day Care Center, Woodings Farm and Greenhouses, Mo's Restaurant, Riverdale Motel, and Axelrod Tire and Service. North of Portland-Cobalt Road is Jobs Pond, which is lined with residences, and Middle Haddam Road, a residential street. The main residential community south of Portland-Cobalt Road is off of Payne Boulevard. This neighborhood resides atop a 150-foot bluff above the Connecticut River.

Land east of the Armetta and Associates property is owned by CL&P, and is undeveloped with the exception of a few utility right-of-ways. Further east is the industrial site of the NRG Middletown Generating Station, which is located between the rail line and the Connecticut River.

Land to the south of the Armetta and Associates property is mainly undeveloped state land with limited residential uses. Much of the state land belongs to the Connecticut Valley Hospital, which is managed by the State of Connecticut Department of Mental Health and Addiction Services. The majority of this hospital land is undeveloped, and includes three reservoirs utilized by the Hospital. Cockaponset State Forest is also located within a mile to the south. Residences are limited along Cedar Lane, Reservoir Road and Bow Lane southwest of the proposed site.

Land within ¼ mile to the west of the Project location is owned by Armetta and Associates. The land beyond is mainly undeveloped state land with limited residential and commercial uses. Approximately ¾ mile west of the proposed site is the Riverview Hospital for Children and Youth. Within the one-mile radius to the west is the WMRD radio station and tower. South of the radio station along Silvermine Road is the Connecticut Valley Hospital cemetery. Bow Lane, which runs east-west and dead ends approximately ¼ mile southwest from the Project site, supports limited residential uses west of the site.

**B. Land Use Impacts, Consistency with Local Land Use Plans**

Proposed Site and Contiguous Areas:

The proposed use will be compatible with the previous industrial land use of the site. The proposed Project site will be developed with two new CT generators operating in combined cycle mode to produce electricity. Overhead 345 kV transmission facilities already exist east of the Project site. The proposed facility will alter the existing land use of the proposed site from "abandoned" to "active" industrial use, and is consistent with the historic land use of the property. As the proposed Project site was historically used for industrial purposes, approximately 100 years of feldspar mining, the proposed Project will be consistent with the historical use of the property as well as the zoning, I-3 Special Industrial.

Area within One-mile Radius:

The land use patterns in the one-mile proposed Project study area will not be adversely affected by the development of the proposed facility. Much of the developed land within the one-mile study area is state and industrial/commercial uses. The majority of residential uses to the southwest and northeast within a mile from the site are well buffered from the proposed Project site by intervening wooded terrain. As the proposed Project site was historically used for industrial purposes, the construction and operation of the proposed facility will not greatly impact the residences along the river bluff in Portland. As such, no adverse impacts to the existing land use patterns within the proposed Project area will result from construction and operation of the Kleen Energy Project.

Consistency with Plan of Development

The City of Middletown's Plan of Development (Plan) is currently being revised. The revised Plan under consideration and current planning mapping calls for the area to be used for industrial development. The Project is consistent with this goal. Earlier plans, while recognizing that the area was (then) being mined, suggested that after reclamation the area could be used for residential use. However, in light of the condition of the site after mining was completed and the site abandoned, residential use would not be feasible. Residential use could never support the cost of the civil works needed for the site to be graded such that it could be prudently and safely used for residential purposes.

**C. Conclusions**

The Kleen Energy Electrical Generating Project site is proposed to be located along the eastern edge of the Armetta and Associates Property. As a result, the Armetta and Associates property acts as a buffer zone for the Project and helps to minimize impacts to surrounding land uses. The use of the 137 acre parcel for electric generation purposes is consistent with historic land use.

## 5.1.2 Zoning

### A. Overview

The City of Middletown Zoning Code ("Zoning Code") and Zoning map regulates land uses in the municipality where the Project site is located. In addition to land use controls, the Zoning Code also sets minimum lot size; building areas, heights and setbacks; parking requirements and sign restrictions.

Kleen Energy is undertaking this proposed Project to provide reliable, economic energy to the New England grid to meet the public need for additional clean, efficient energy generation. In conjunction with this undertaking, Kleen Energy has determined that the proposed Project is consistent with the City of Middletown's Zoning Code. Moreover, the Middletown Planning and Zoning Commission has approved the location of the Project pursuant to Conn Gen Stat §16-50x(d).

### B. City Zoning Code

The Project site, wholly within the City of Middletown, is located within an I-3, Special Industrial Area (see Figure 5.1-1). Under the Zoning Code, lots in I-3 Districts are required to be a minimum of 217,800 square feet (5.0 acres) and are restricted to agriculture, laboratories, manufacturing, printing and related trades, and public utilities buildings and structures and its accessory uses. With special exception the following uses may also be allowed in an I-3 District: junkyards and buildings material salvage yards, natural resource extraction, bus stop passenger shelters, adaptive historic preservation use harmonious with the physical characteristics and originally designed use of the structure, child care facilities, and solid waste facilities. The proposed Project location conforms to the existing I-3 zoning.

#### Section 15, Performance Standards:

Section 15 of the City of Middletown Zoning Code states:

No land or structures in any zone shall be used or occupied in any manner so as to create any dangerous, injurious, noxious, or otherwise objectionable fire, explosive, or other hazard; noise or vibration, smoke, dust, odor or other form of air pollution, heat, cold, dampness, electrical or other substance, condition or element; in such a manner or in such quantities and of such characteristics and duration as to be, or likely to be, injurious to public welfare, to the health of human, plant or animal life or to property in the adjoining premises or surrounding area (referred to herein as "dangerous or objectionable elements") provided that any use permitted or not prohibited by this Code may be established and maintained provided it conforms to the provisions of this section.



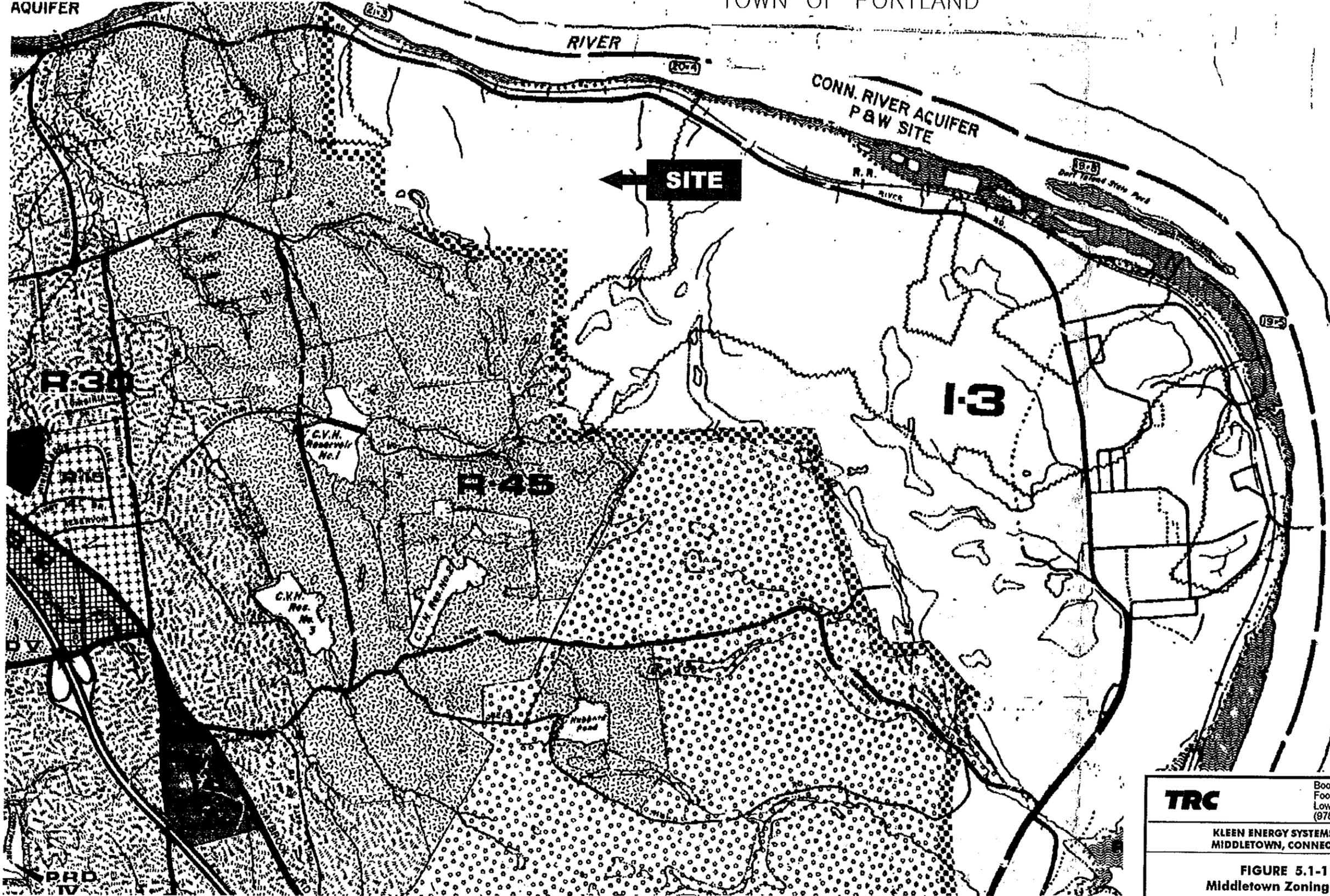
AQUIFER

TOWN OF PORTLAND

RIVER

CONN. RIVER AQUIFER  
P&W SITE

← SITE



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Boott Mills South  
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Lowell, MA 01852  
(978) 970-5600

KLEEN ENERGY SYSTEMS, LLC  
MIDDLETOWN, CONNECTICUT

**FIGURE 5.1-1**  
Middletown Zoning Map

Date: 11/01

Project No. 33876

33876.ZONE

The construction and operation of the Project will be regulated by the Connecticut Siting Council and the Connecticut Department of Environmental Protection. Notwithstanding, the Project will be in compliance with the City of Middletown performance standards. The Project will not be injurious to or threaten the public welfare, the health of human, plant or animal life, or property in the adjoining premises or surrounding area.

Section 37, I-3 Special Industrial Zone:

Under Section 37 of the Zoning Code, the following standards and dimensional regulations apply to a project to be sited in an I-3, Special Industrial District. The Project as proposed complies with virtually all of these regulations.

**Minimum Lot Area:** The minimum lot area within the I-3 Special Industrial District is 217,800 square feet or 5.0 acres (43,560 square feet = 1 acre).

The proposed Project complies with this requirement because the facility will be located on an approximately 137 acre parcel.

**Minimum Front Yard Setback:** There is no minimum front yard requirement in the I-3 district.

**Minimum Rear Yard Setback:** In the I-3 Special Industrial District there is no rear yard requirement.

**Minimum Side Yard Setback:** In the Special Industrial District, there is a minimum requirement of 20 feet on the side yard.

The proposed Project complies with this requirement because the facility structures will have setbacks more than 150 feet on all sides of the developed area.

**Maximum Lot Coverage (inclusive of accessory buildings):** Each main building or structure erected, together with its accessory buildings or structures, shall not cover more than thirty (30) percent of the net lot area. (Zoning Code 37.04)

The proposed Project complies with this requirement because the facility and all accessory buildings will cover less than 7 acres, less than 5 % of the total 137 acre Project site.

**Maximum Height:** In the I-3 Special Industrial District, the maximum height shall not exceed one hundred and fifty (150) feet, except as provided in Section 13.02 (Height Modifications). Zoning Code Section 13.02.04 discusses structures to which height limitations do not apply. Included in this section are flues.

The proposed facility will have stacks that exceed the 150 feet requirement. The Project stack will be 215 feet above grade. The stack will be within the exception set out in section 13.02.04. The other main buildings associated with the Project will have heights less than 150 feet above grade.

**Off-Street Parking and Off-Street Loading Requirements:** The City of Middletown Zoning Code requires off-street parking and off-street loading in I-3 Districts. I-3 off-street parking and off-street loading requirements are outlined in Section 40 of the Zoning Code.

The proposed facility will comply with all off-street parking and off-street loading requirements with the exception of Section 40.04, Quantity of parking spaces. The zoning code requires one (1) parking space for each two (2) employees plus additional parking for customers. It also states that no use in this category shall have less than three (3) spaces or less than one (1) space for every 500 sq. ft of gross building area. If the Project were to have to comply with this requirement over 160 parking spaces would be required. The Project proposes a total of 24 spaces. Twenty four spaces allow one parking space per employee at peak shift (16 employees) and 8 spaces for guests.

Section 48, Sign Regulations:

The City of Middletown has established signage regulations and standards. Section 48 of the Zoning Code outlines these requirements.

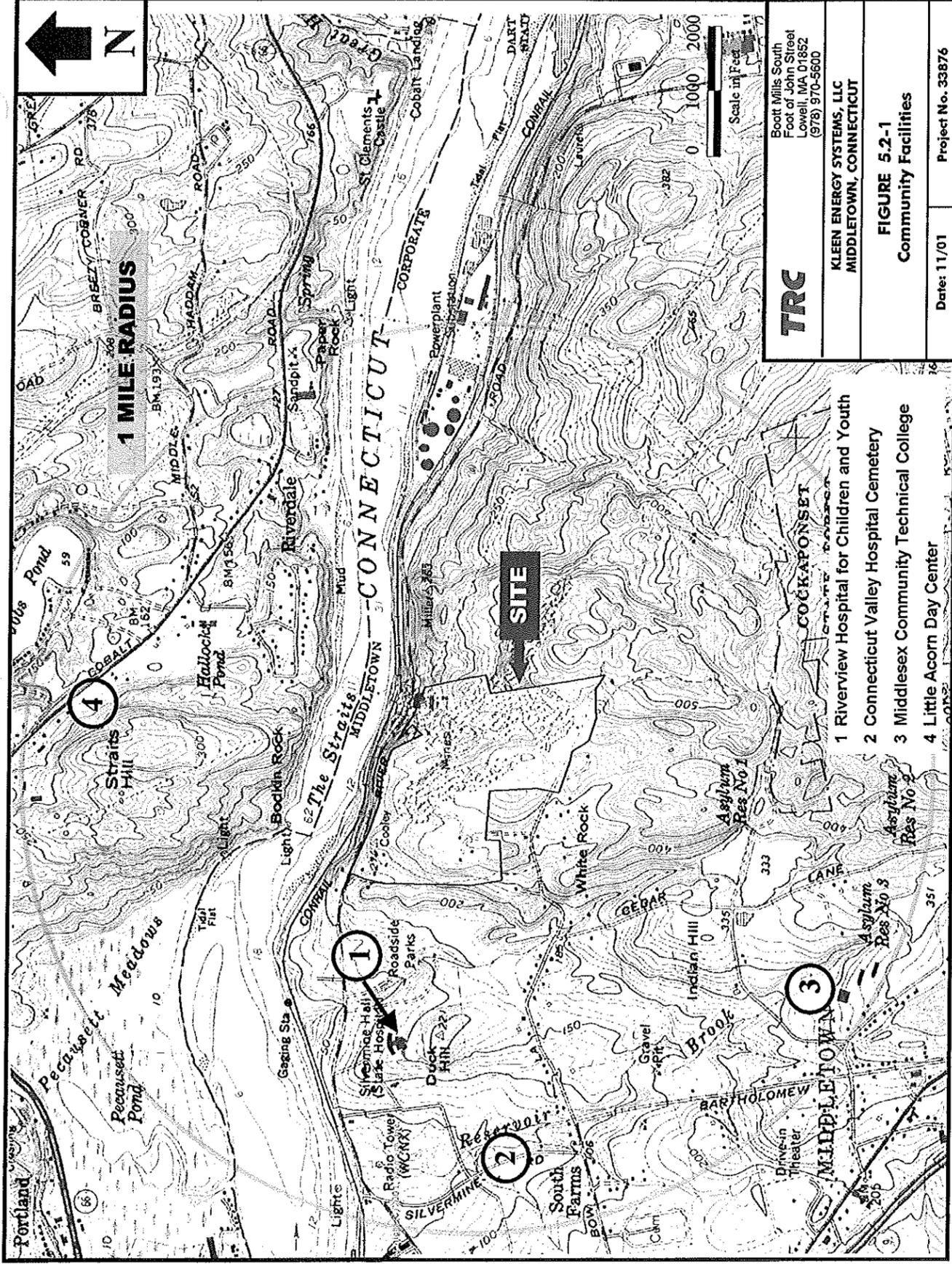
The Project will comply with all signage regulations and standards specified in Section 48 of the City of Middletown, Zoning Code.

**E. Conclusion**

The proposed Project has been designed with careful consideration of local ordinances. As a result, the Project as proposed, and to the extent feasible, is in substantial compliance with the City of Middletown Zoning Code. As noted above, this Project is also consistent with surrounding land use and the location of the Project has been approved by the Middletown Planning and Zoning Commission. Additionally, the Project is consistent with plans for future development of this area as it is zoned special industrial (I-3) and does not encroach on any areas of recreational value. The construction and operation of the Project will be regulated by the Connecticut Siting Council and Connecticut Department of Environmental Protection.

**5.2 Community Facilities and Recreational Resources**

An inventory of community facilities (schools, hospitals, government offices, religious facilities, etc.) has been taken within a one-mile radius of the Project site to assess the potential impacts, if any, of the proposed Project on these facilities. Four community facilities are located within a one-mile radius of the site (Figure 5.2-1).



### 5.2.1 Community Facilities and Recreational Facilities Inventory

Community and recreational facilities within a one mile radius of the proposed site are presented below:

- **Riverview Hospital for Children and Youth.** The Riverview Hospital for Children and Youth is a State of Connecticut facility, and is located on River Road approximately ¼ mile west of the proposed site in Middletown.
- **Connecticut Valley Hospital Cemetery.** The Connecticut Valley Hospital Cemetery is part of a State of Connecticut mental health and addiction facility, and is located just under one mile to the west of the proposed site on Silvermine Road in Middletown.
- **Middlesex Community Technical College.** The Middlesex Community Technical College is located on Training Hill Road just beyond the one mile radius southwest of the proposed site in Middletown.
- **Little Acorn Day Care Center.** The Little Acorn Day Care Center is located approximately ¼ mile north of the proposed site on Portland-Cobalt Road in Portland.

### 5.2.2 Project Impacts on Community Facilities

The Kleen Energy Generating Facility is physically separated from the identified community facilities by Armetta and Associates property, intervening industrial and commercial land use development, and the Connecticut River. Because of this physical separation, the proposed facility will have no direct impact on identified community facilities located within the one-mile study area. The proposed facility construction and long term operation will also not result in any induced growth in demand on the community facilities.

With respect to indirect impacts on community facilities, the proposed facility's maximum modeled air quality concentrations will be below the U.S. EPA National Ambient Air Quality Standards (NAAQS). The cumulative modeled concentrations representing the generating facility's concentrations added to existing background air quality will also be below the NAAQS. As indicated in Section 5.10 of this document, no adverse impacts on community facilities are expected due to air quality considerations. The noise analysis in Section 5.4 indicates that compliance will be achieved with both Connecticut Department of Environmental Protection and the City of Middletown noise standards. As indicated in Section 5.3, no adverse visual impacts on community facilities will occur.

The proposed facility will not have a significant impact on public safety services such as police and fire services. The proposed facility will not result in an increased need for police services, as it does not result in the addition of substantial population to the area and will not require access to a police station. The proposed Project will coordinate directly with the City of Middletown Fire Department regarding emergency response capabilities. In addition, the proposed facility will have fire protection capabilities incorporated in the proposed Project design.

Existing solid waste services in the Project area will also not be adversely impacted by operation of the proposed facility, as solid waste generated at the proposed Project site while in operation is expected to be very limited. Approximately 25-30 employees will be permanently stationed at the proposed facility, and very little solid waste will be generated. A licensed contractor will handle the transport, storage, treatment and disposal of solid wastes associated with the operation of the facility. All solid waste generated will be disposed of at an approved facility. Oily wastes collected in the proposed facility's oil/water separator will be contained and hauled off-site for disposal by a licensed contractor. Therefore, the proposed facility will not place any significant burdens on either publicly or privately operated solid waste collection and disposal systems.

### **5.2.3 Conclusion**

The Kleen Energy Generating Facility will have no direct or indirect impact on the identified community facilities. The proposed Project would not place any significant additional demands on community facilities or City services.

## **5.3 Visual Resources**

Design and placement of the Project has included significant consideration of visual impact both to important aesthetic resources and to the community. The most prominent structures associated with the Project are the generation building at about 95 feet high, and the exhaust stacks, which will be 215 feet high. The setting of the Project site, within the 137 acre Armetta and Associates property and the existing industrial uses to the northeast (NRG Middletown Generating Station, Pratt and Whitney, and CL&P), nearby vertical elements (transmission lines), and a certain amount of terrain and vegetation screening surrounding the Project site, will limit the visual impact on the community. Coloration techniques will be incorporated into the design of the Project to screen/mitigate views of any potentially visible structures from these residences. More specifically, a neutral color scheme will be used for the Project. Visual impact mitigation will also include shielded lights and a planting program.

The following section characterizes the visual quality of surrounding communities, identifying specific visual resources within a 1-mile study area of the proposed Project site, and evaluates the potential visual impact of the proposed Facility on these resources. The potential visual impacts were assessed based on field visits to the Project site and study area in November and December 2001, February 2002, and review of aerial photographs of the Project area. In addition, analyses are provided for stack plume visibility during cold weather.

### **5.3.1 Existing Environmental Setting**

The proposed Project site is located in the northeast corner of the Armetta and Associates property in the Maromas section of the City of Middletown, Connecticut. The Project site is bound to the north by River Road and the Connecticut River. East of the property is undeveloped CL&P land with an overhead 345 kV transmission line and right-of-way. The Armetta and Associates property is bordered to the south and west by undeveloped state land, with Bow Lane along the southwest border. The Armetta and Associates property has been historically an industrial use, and surrounding areas include State facilities and vacant land. The

nearest residential community begins about 600 feet south of the proposed site, with additional communities beginning about  $\frac{1}{3}$  mile to the northeast and about  $\frac{1}{4}$  mile to the southwest.

The proposed site is an old feldspar mine that was operated by Feldspar Corporation for over 44 years and was actively mined for a period of over 100 years. The terrain varies due to the extensive mining that occurred, and is underlain by rocks and mining tailings. Dirt roads which supported the mining operations wind throughout the site. Portions of the Project site are barren or overgrown with secondary revegetation typical of previously disturbed areas, while others are forested (Figures 5.3-1 and 5.3-2). Another residual of the mining operations are several quarry pits, some that make up wet pockets on the Project site.

The elevation of the site varies from approximately 100 to 500 feet above mean sea level (MSL), with quarry pockets dipping down to about 200 feet above MSL. The elevation of the surrounding area is greatly varied, with tidal flats and marshes along the River to the northwest and east, and 300-foot bluffs rising from the River north of the proposed site. Change in topography, as well as tall stands of deciduous and evergreen trees within the residential communities to the northeast and southwest of the proposed Project site, limit the views of the proposed site from these locations.

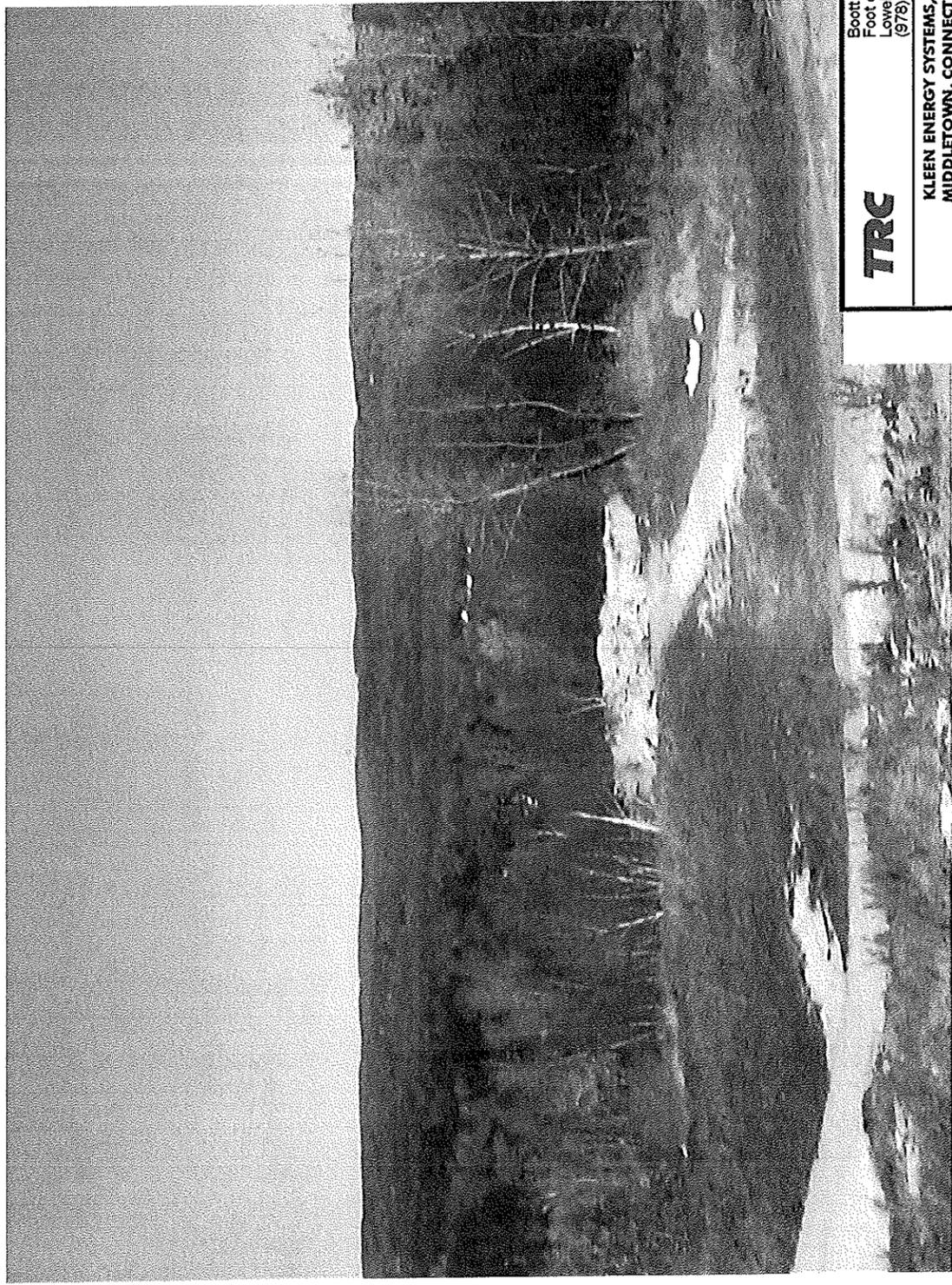
### *5.3.2 Visual Characteristics of the Project*

The most prominent structures associated with the Project are the exhaust stacks, generation building, and HRSGs. The tallest structures will be the facility exhaust stacks. Stack height is determined based on air quality and will be 215 feet. Each stack will be approximately 20 feet in diameter. The tallest structures on the site other than the exhaust stacks will be the generation building at approximately 95 feet. Ancillary facilities, such as miscellaneous storage tanks, will be smaller and less prominent than the main structures. A neutral color scheme will be used to screen the facility from potential viewsheds.

### *5.3.3 Siting and Layout*

The site was chosen in part for its excellent ability to screen visual impacts from the community. Visibility is projected to be very limited for views from the south, east and west. The Project will be visible as a feature on the hillside from a limited area to the north. Figure 5.3-3 identifies the limited areas where the stacks of the Project will be above the existing horizon. Residences and other sensitive receptors will be screened by existing vegetation, mitigating the Project's visual impact.

The layout of the Project also limits its visibility. As the Project is laid out, the switchyard sits at an elevation of 240 feet above MSL. The power block is approximately 340 feet above MSL. The existing topography on the west edge of the site is a ridge rising to about 425 feet MSL. To the south and to the east the hill that dominates the Project site continues to rise to over 500 feet MSL.



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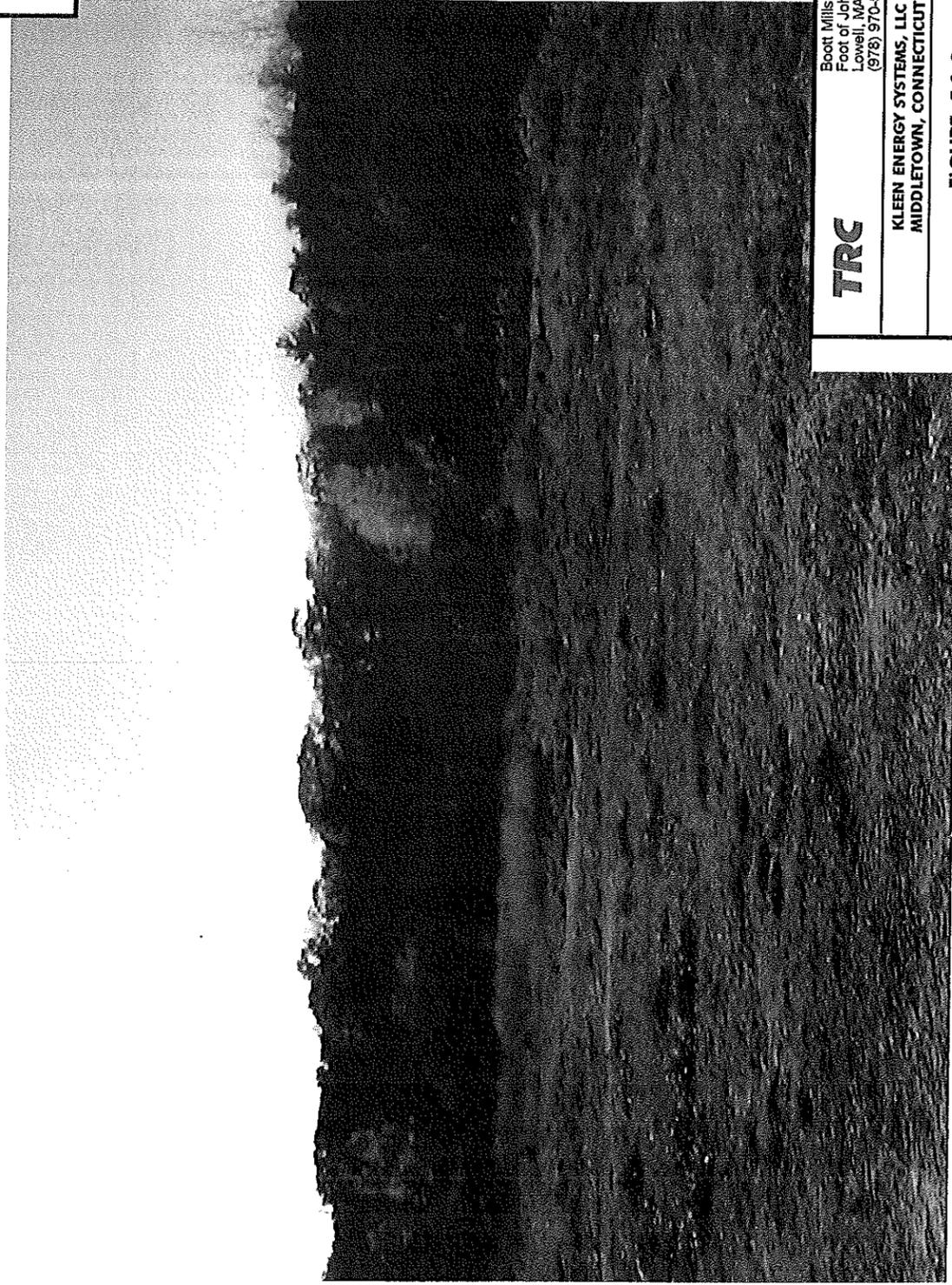
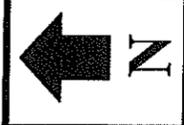
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**FIGURE 5.3-1**

**Project Site Looking Northeast**

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**FIGURE 5.3-2**  
**Project Site Looking West**

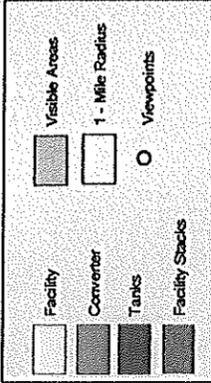
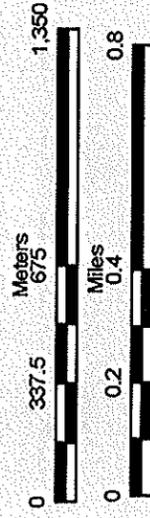
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**KLEEN ENERGY SYSTEMS PROJECT**  
 Visibility Analysis of Elevation Heights With Vegetation

PROJECTION UTM  
 DATUM NAD 83 ZONE 18 N



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Figure 5.3-3  
 Kleen Energy Systems, LLC  
 Viewshed Analysis  
 Middletown, Connecticut

Produced by TRC Advanced Mapping Support Staff

#### *5.3.4 Visual Resource Identification*

A Project site file search at the Connecticut Office of Parks Recreation and Historic Preservation (OPRHP) was undertaken to find records of sites listed or evaluated as eligible for the National Register of Historic Places (NRHP). As presented in Section 5.6, the file search concluded that there are no properties listed on the NRHP located within a one-mile radius of the Project area.

No State-designated recreation areas exist within the 1-mile study area, but there is a State forest located approximately ¾ mile to the south.

#### *5.3.5 Potential Visual Impacts on the Project Area*

In order to assess the potential visual impacts associated with locating the Project at this site, a viewshed analysis was conducted for the study area. Computerized methods were used to identify areas from which the stack or other elements of the facility would break the horizon. This was done, by creating a digital elevation model of the area from United States Geological Survey (USGS) terrain data. To account for vegetation, the approximate extent of forested areas was identified from a 1 meter Multi Spectral orthorectified aerial photograph (Fall 2000). Vegetation was assigned a conservative height (20 feet) based on local assessment, and combined with the digital elevation model to create a model that accounted for both terrain and vegetation. Vegetation areas were identified using the ENUI 3.5 two dimensional scatter plot algorithm processing software. All other visibility modeling was performed using ARC/INFO® GIS software. Using the visibility function within the computer model, the areas from which the top of the stacks (215 feet above a base elevation of 340 feet MSL) could potentially be seen were identified.

Figure 5.3-3 shows the results of this analysis. As can be seen from that figure, locations where the stacks enter the horizon are quite limited. Terrain has a pronounced effect in the south, southeast, and southwest of the study area. Terrain also accounts for some of the obstruction of view to the northwest and northeast of the Project.

The proposed Project design will be compatible with nearby uses and developments, thereby minimizing visual impacts for the local community. Potential visual impacts of the proposed facility have been assessed for the surrounding communities near the one mile study area in the City of Middletown and the Town of Portland. Figure 5.3-4 shows locations of photographs taken for visual analysis. Three figures display views of the site from residential communities.

### 5.3.6 Selection and Description of Viewsheds

The proposed Project design will be compatible with nearby uses and developments, thereby minimizing visual impacts for the local community. Potential visual impacts of the proposed facility have been assessed for the surrounding communities in the one mile study area in the City of Middletown and the Town of Portland. Figure 5.3-4 shows locations of photographs taken for visual analysis.

#### Northern Quadrant

The northern quadrant largely encompasses the Town of Portland with the exception of River Road and the property owned by Armetta and Associates located between River Road and the Connecticut River. The midline of the Connecticut River is the border between the City of Middletown and the Town of Portland. This area of Portland is characterized by marshlands and woodlands to the northwest of the Project site, and residential and commercial uses along Portland-Cobalt Road to the northeast of the Project site.

The elevation of land in Portland within a mile of the site to the northeast ranges from about 50 feet to 150 feet above MSL. The marshlands and woodlands to the northwest range in elevation from approximately 5 to 350 feet above MSL. Just beyond the one-mile radius of the proposed Project site, to the northwest, is a small residential community. These residences lie north of the Portland Boat Works along the riverbank in the development bound by Riverside Street, Riverview Street, Grove Street, and Portland-Cobalt Road. Residences located along the southern portion of Riverview Street and Grove Street are at approximately 20 feet above MSL, and may have limited views of the stacks at the proposed site. Figure 5.3-5 was taken just west of the Portland Boat works. Figure 5.3-6 is the computer simulation with the Project superimposed. Visible in Figure 5.3-6 is a potential view of the Project stacks during winter conditions, without leaf-cover.

Just north of Portland-Cobalt Road, outside of the one-mile radius is a small residential community along Grandview Terrace. Residences located along Grandview Terrace are at about 10 feet above MSL and may have limited views of the stacks at the proposed site. Figures 5.3-7 and 5.3-8, show the potential view areas both without the Project and with the Project, respectively.

Northeast of the Project site is another residential community. This residential community consists of residents along Wellwyn Drive, Payne Boulevard, and Lyman Road. The closest residences are along Wellwyn Drive on the river bluff north of the site at 150 feet in elevation. Existing vegetation presently obscures residential view of much of the site. The existing view from Wellwyn Drive is of the Connecticut River, transmission lines and right-of-way, and the existing NRG Middletown Generating Station to the southeast. Figure 5.3-9 is a view from Wellwyn Drive. Figure 5.3-10 is a photosimulation of the Project. As depicted in the photosimulation, residences along Wellwyn Drive will potentially have views of the Project across the river depending on the density of vegetation on the northern shore of the River.



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**FIGURE 5.3-05**

**WEST OF PORTLAND BOAT WORKS**

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FIGURE 5.3-06

WEST OF PORTLAND BOAT WORKS

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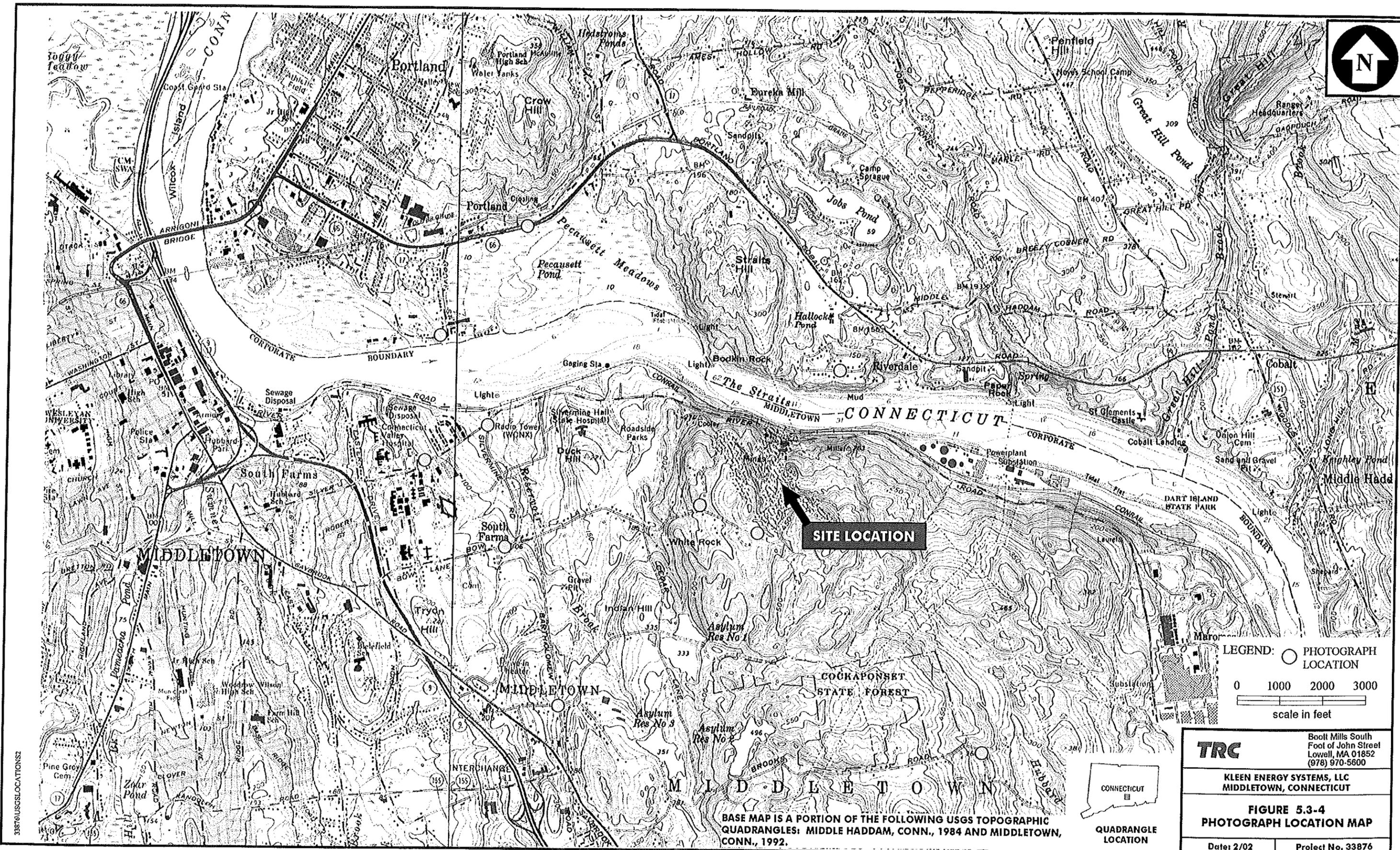
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FIGURE 5.3-07

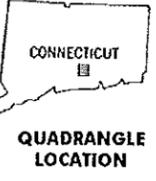
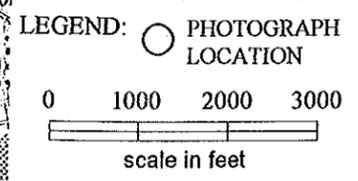
GRANDVIEW TERRACE

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**SITE LOCATION**



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**FIGURE 5.3-4  
PHOTOGRAPH LOCATION MAP**

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BASE MAP IS A PORTION OF THE FOLLOWING USGS TOPOGRAPHIC QUADRANGLES: MIDDLE HADDAM, CONN., 1984 AND MIDDLETOWN, CONN., 1992.

33876USGSLOCATIONS2



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**FIGURE 5.3-08**

**GRANDVIEW TERRACE**

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<b>FIGURE 5.3-09</b>	
<b>EASTERN SECTION OF WELLWYN DRIVE</b>	
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**FIGURE 5.3-10**  
**EASTERN SECTION OF WELLWYN DRIVE**

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**FIGURE 5.3-11**

**OPEN SPACE ON BOW LANE**

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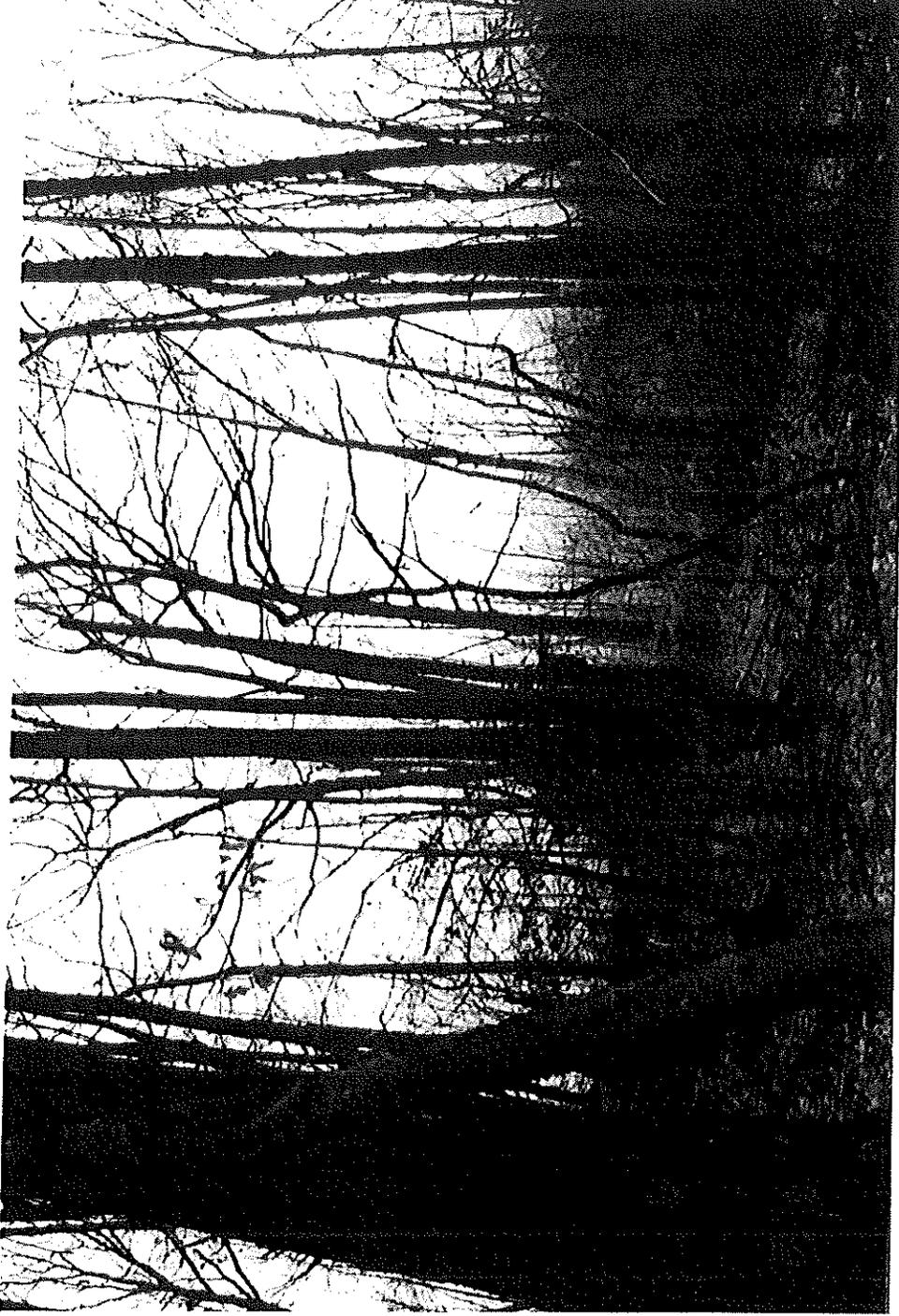
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**FIGURE 5.3-12**

**OPEN SPACE ON BOW LANE**

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**FIGURE 5.3-13**  
**977 BOW LANE**

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**(With Project)**

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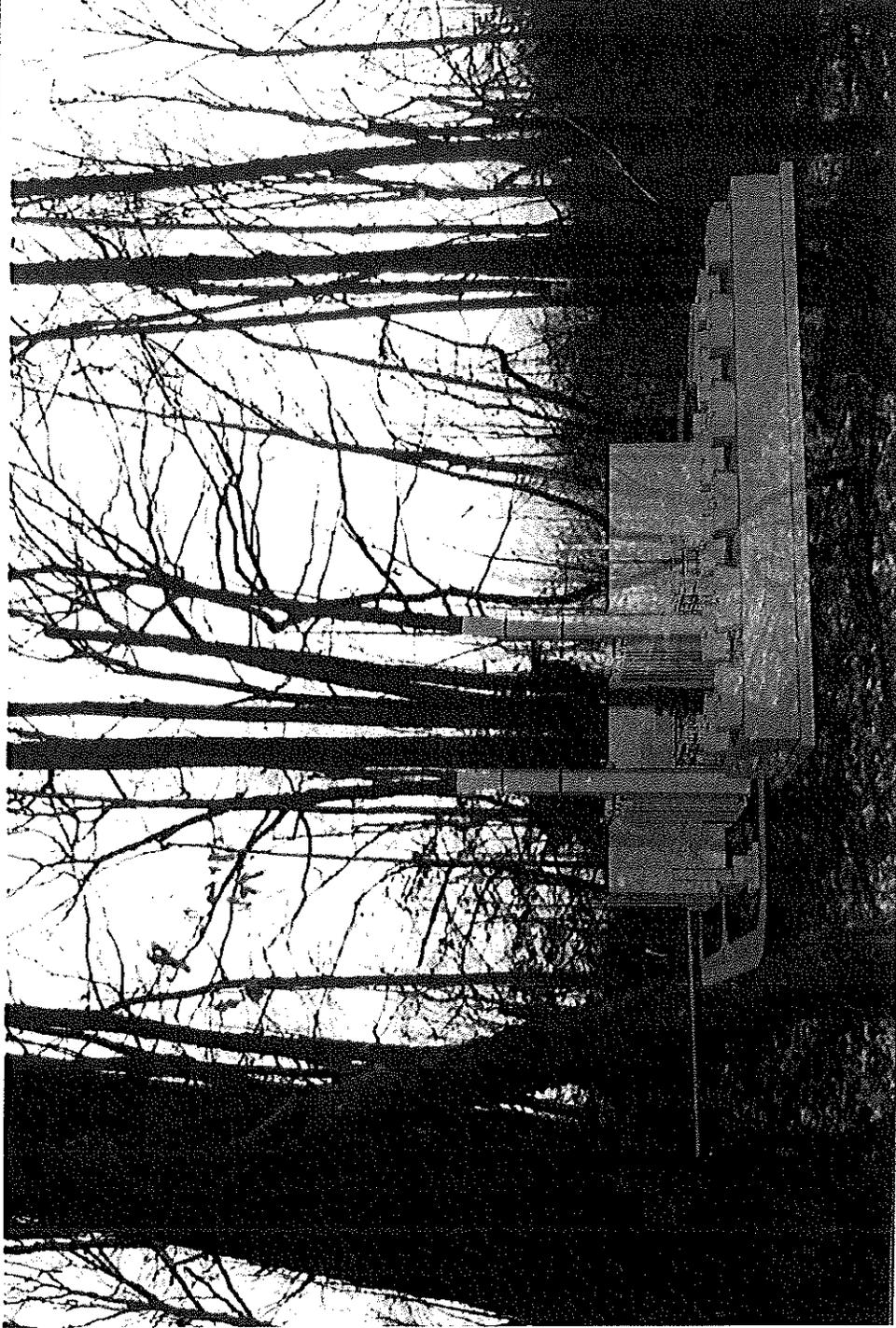
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**FIGURE 5.3-14  
977 BOW LANE**

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**(With Project, Plant Ghosted)**

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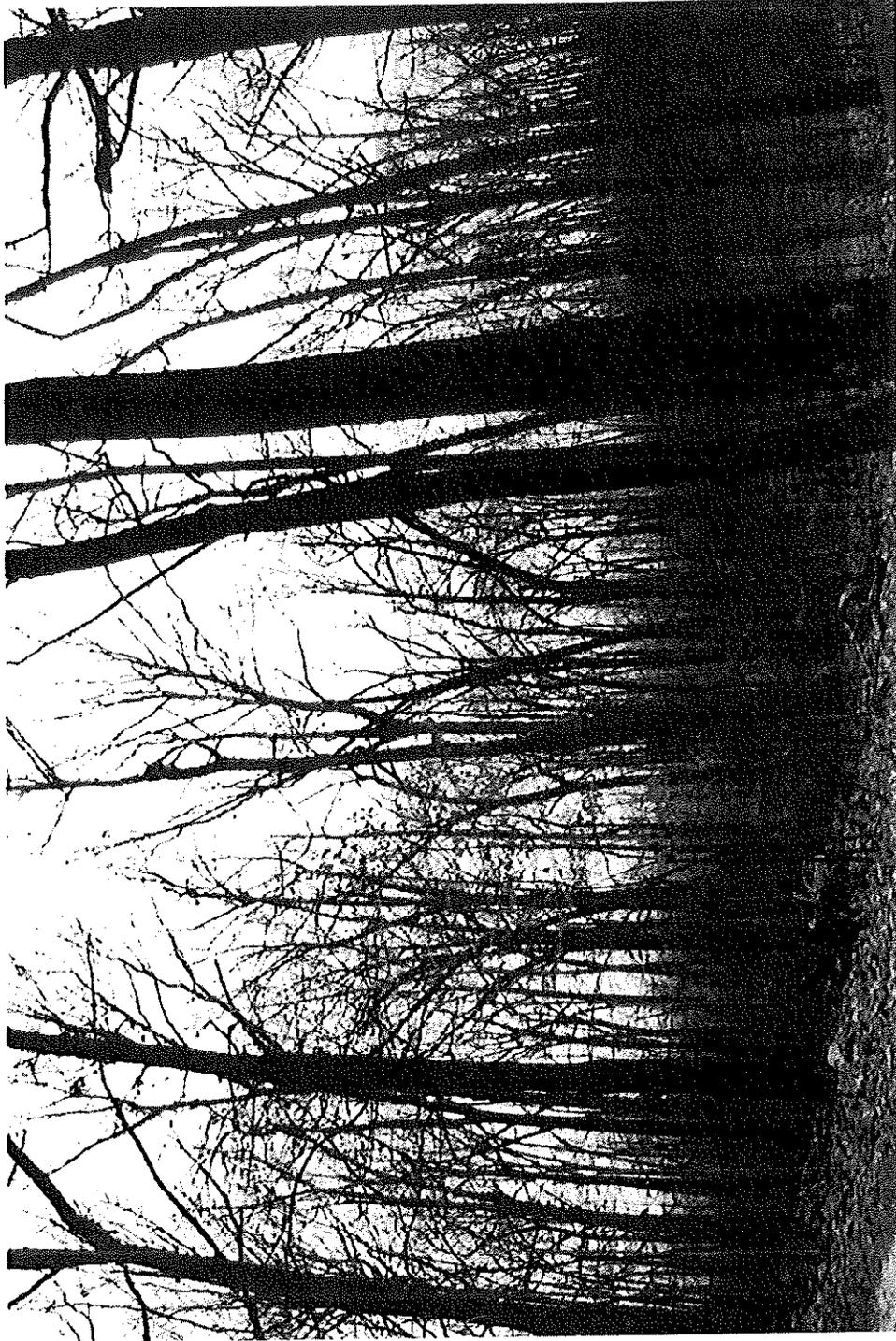
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**FIGURE 5.3-14b  
977 BOW LANE**

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**FIGURE 5.3-15  
896 BOW LANE**

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<b>FIGURE 5.3-16</b> <b>896 BOW LANE</b>	
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**FIGURE 5.3-17**  
**BROOKS ROAD**

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**(With Project)**



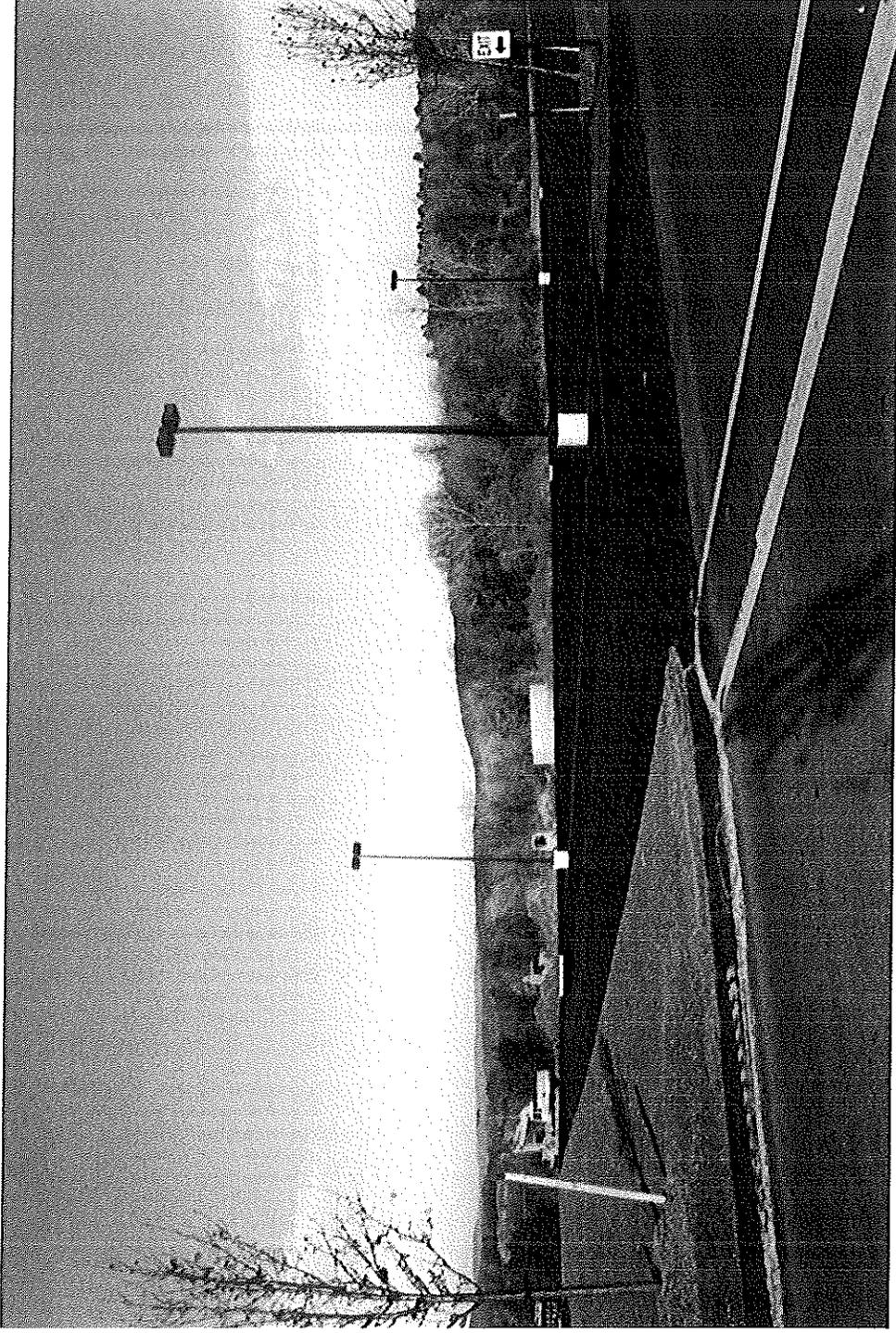
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**FIGURE 5.3-18  
BROOKS ROAD**

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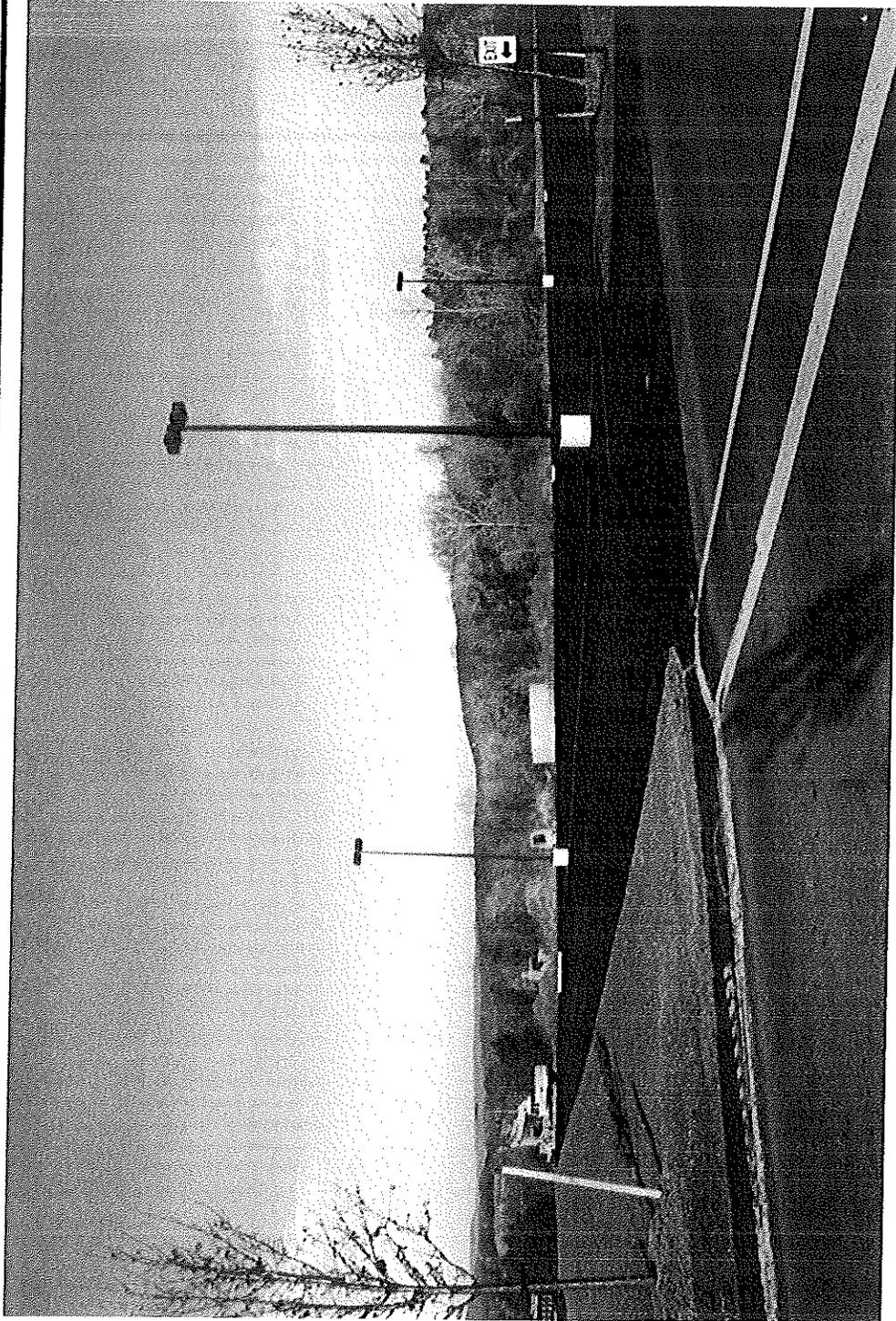
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FIGURE 5.3-19

MIDDLESEX COMMUNITY COLLEGE

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**FIGURE 5.3-20**

**MIDDLESEX COMMUNITY COLLEGE**

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### Eastern Quadrant

East of the Project site is land zoned I-3 (Special Industrial). This area is occupied by the existing NRG Middletown Generating Station approximately 1.1 miles east of the Project site, CL&P property and vacant land owned by the State of Connecticut.

The East Hampton town line is located approximately 2 miles to the east of the site. Similar to the Town of Portland, the border of Middletown and East Hampton is at the midline of the Connecticut River.

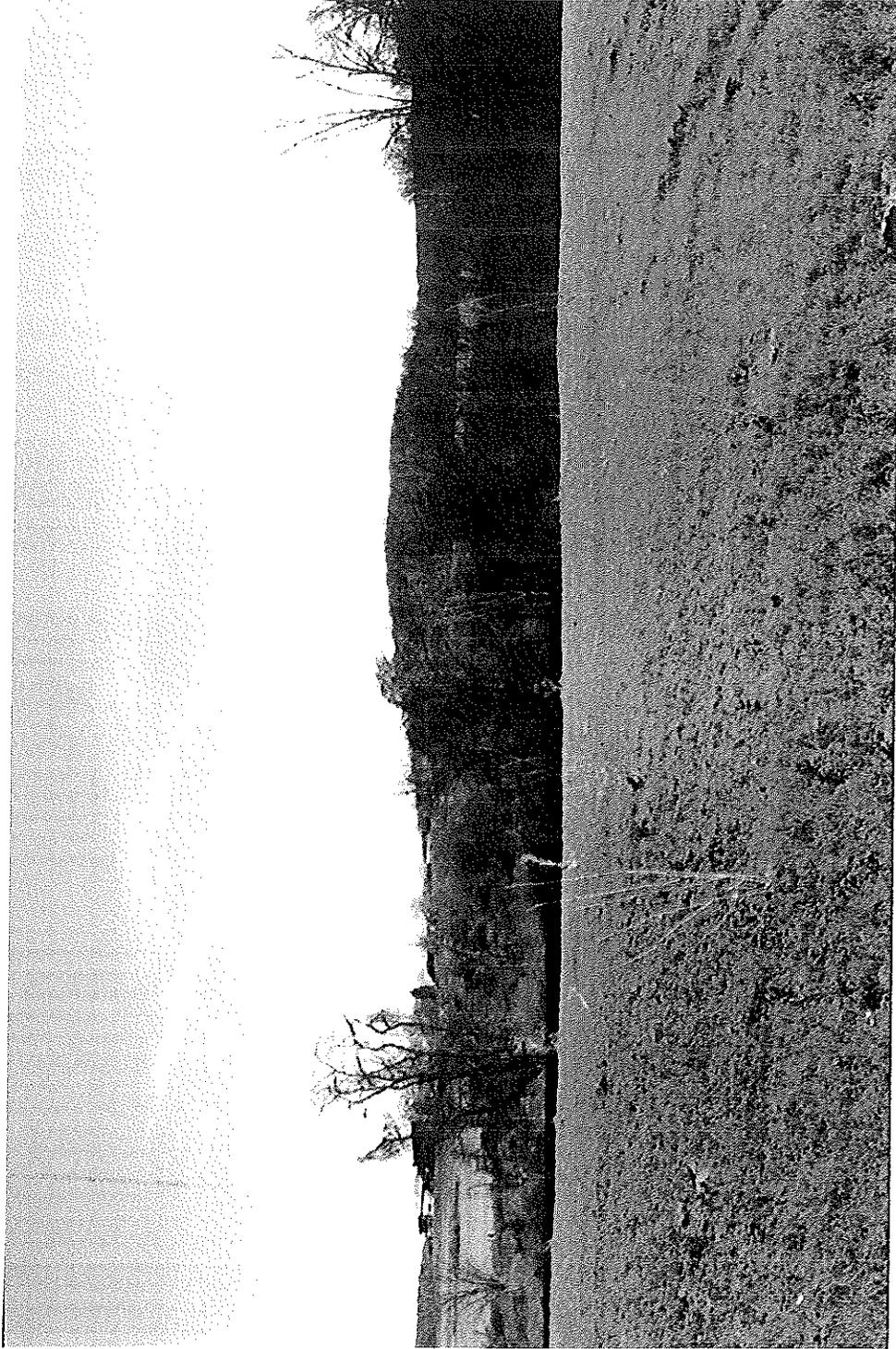
No photographs were taken from this quadrant as the Project will fit in with the existing special industrial zone (I-3) and access to the Project area is restricted. Access is restricted due to several reasons. River Road ends at the NRG Middletown Generating Station and, after the September 11, 2001 terrorist attacks, guards are stationed along River Road restricting entrance to the NRG Middletown Generating Station area.

### Western Quadrant

Directly to the west of the Project site is additional land owned by Armetta and Associates and two residences along River Road. Further west are the Connecticut Valley Hospital facilities, which are run by the State of Connecticut Department of Mental Health and Addiction Services. Hospital facilities consist of administration and residential buildings, a hospital cemetery, and the Hospital's power plant with a 175 foot high stack. The base elevation of the stack is 150 feet AMSL, total stack height is 325 feet AMSL. Figure 5.3-21 is a photograph taken across the street from the existing Hospital Power Plant. Figure 5.3-22 is a photosimulation of the Project from this view. As shown in Figure 5.3-22 only a small portion of the Project stacks are visible. An existing radio tower is located approximately 0.8 miles west of the Project site. A photograph was taken just west of the radio tower, Figure 5.3-23, intersection of River Road and Silvermine Road. The radio tower is located on the left side of the photograph. Figure 5.3-24 is the same view with the Project. Route 9 is approximately 1.5 miles from the Project site and downtown Middletown is approximately 3 miles west.

#### **5.3.7 Visual Renderings Procedure**

All photographs were taken using a Nikon N70 35-mm camera with a standard 50-mm lens. For each of the selected viewpoint locations, a computer simulation assessment was undertaken using 3D Studio Viz<sup>®</sup>. The modeling exercise allows for the computer to render a plant image. The image is then oriented, scaled and placed within the photograph. The modeled simulation of the Project with its 215-foot stacks was inserted into each photograph as an overlay. Then line of sight analysis was performed to account for intervening topography and vegetation. The change in view for each identified vantage point, with the Project in place, is shown in Figures 5.3-5 through 5.3-24, which show both "without project" and "with project" views. Through a systematic comparison of these two views, the extent of change in that view as a result of the Project can be assessed.



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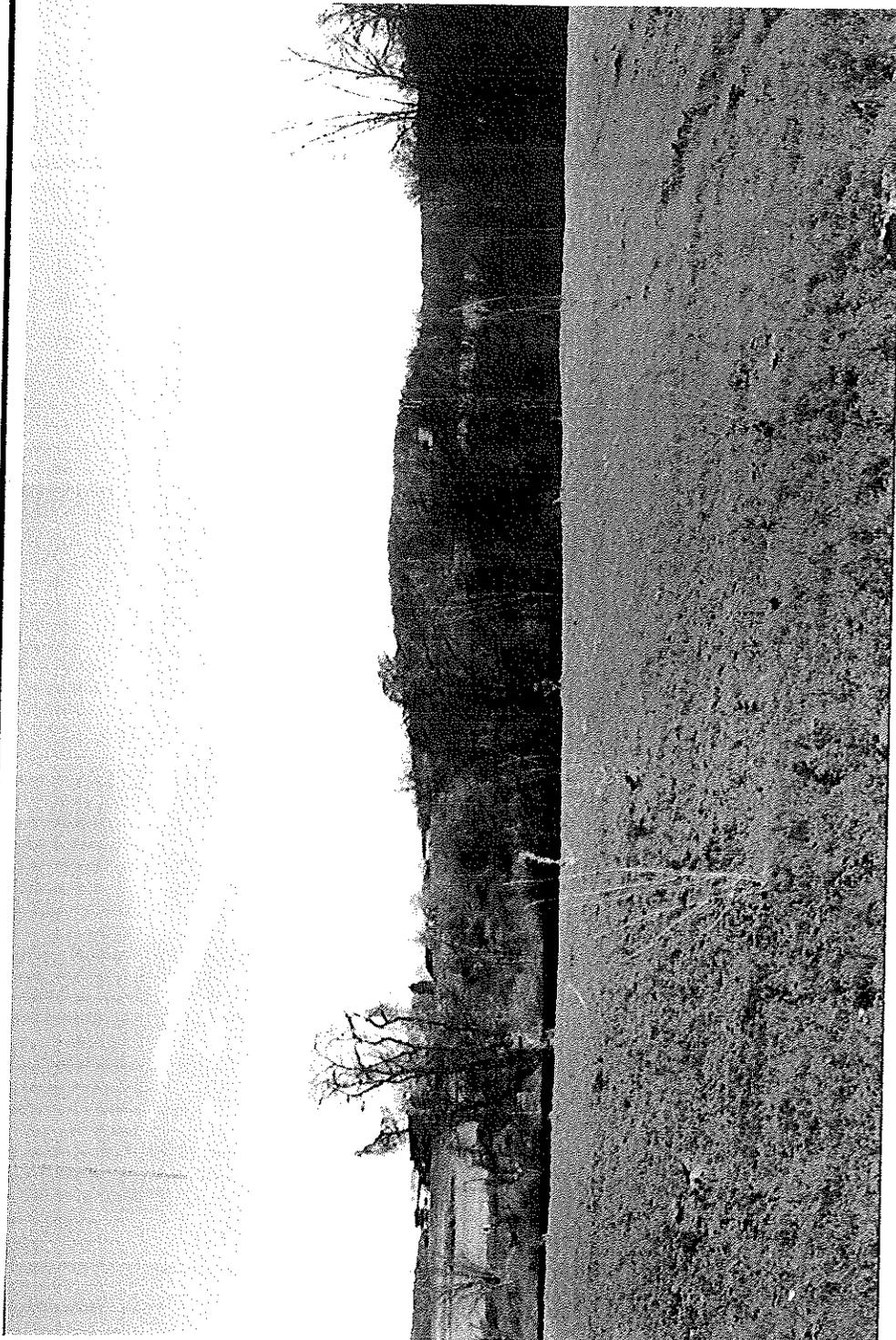
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**FIGURE 5.3-21**

**INTERSECTION OF SILVERMINE  
ROAD & RIVER ROAD**

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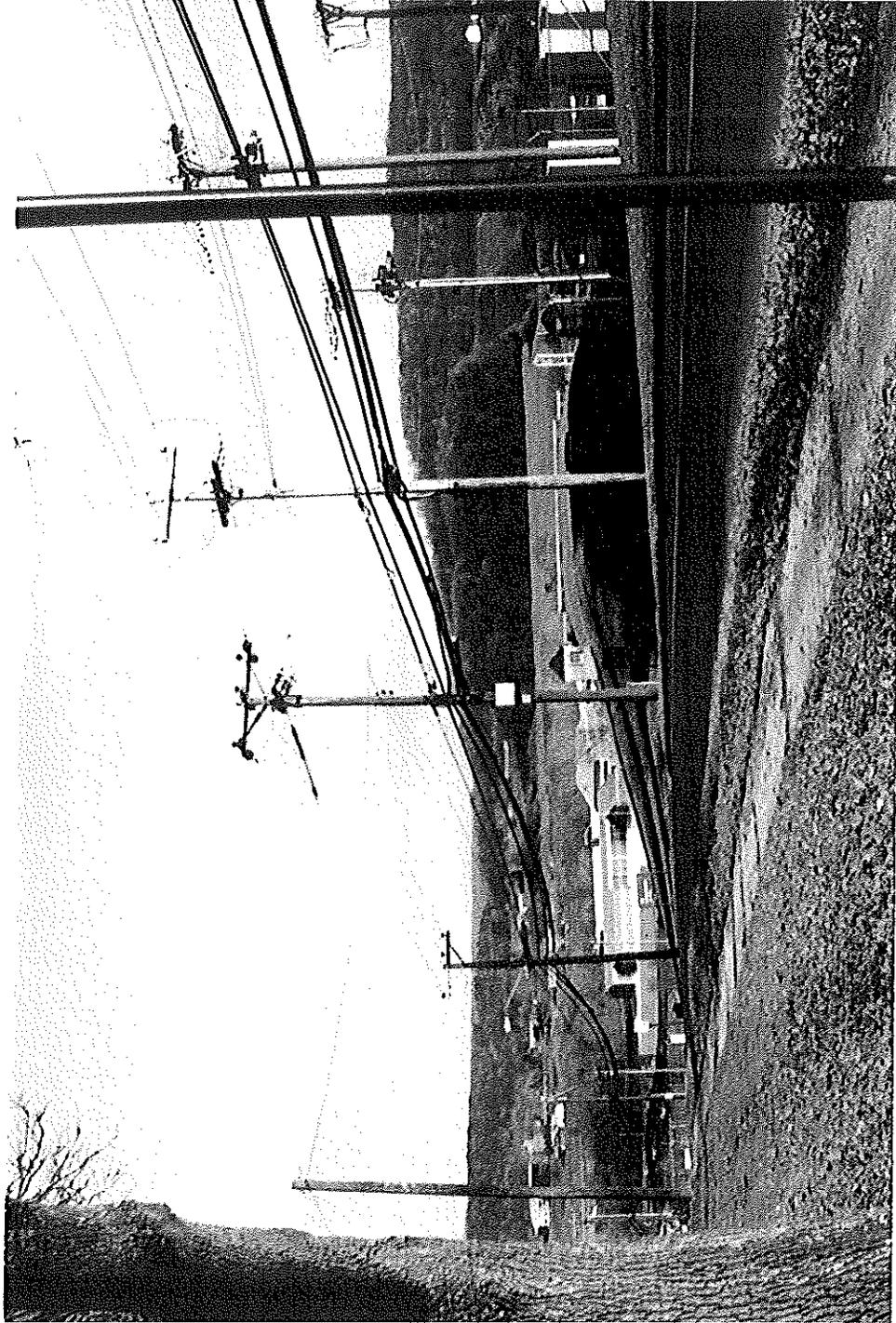
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**FIGURE 5.3-22**  
**INTERSECTION OF SILVERMINE  
ROAD & RIVER ROAD**

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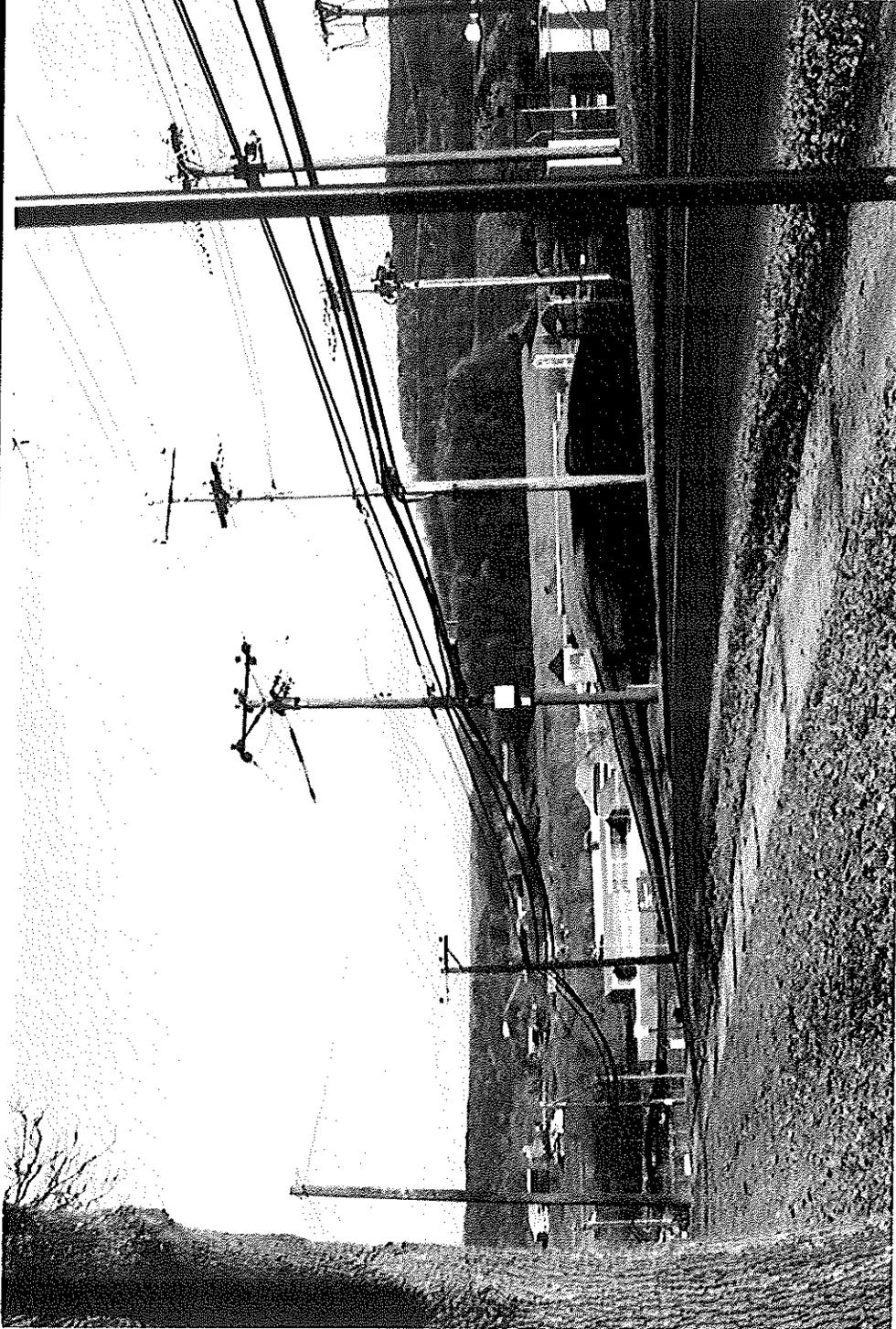
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FIGURE 5.3-23

STATE OF CONNECTICUT DEPARTMENT OF  
MENAHL HEALTH & ADDICTION SERVICES  
POWER PLANT

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**FIGURE 5.3-24**

**STATE OF CONNECTICUT DEPARTMENT OF  
MENAHL HEALTH & ADDICTION SERVICES  
POWER PLANT**

**Date: 2/02**

**Project No. 33876**

### ***5.3.8 Screening and Landscaping***

Screening is an integral part of visual mitigation for the Project. An approximately 500 foot wide forested area is being left undisturbed along the entire western portion of the site, except for the site entrance on River Road. An approximately 400 foot wide forested area is also being left undisturbed along the entire southern portion of the site. Landscaping will occur along the entire length of the site access road, around the Power Block and Switchyard, and around the parking areas (Drawing C5 in Volume II).

### ***5.3.9 Lighting Plan***

Lighting for the Project will be designed to have a minimal impact on the surrounding community while providing for safe operations. The Project has committed to designing the exterior lighting to be consistent with the recommendations of the International Dark Sky Association, an organization led by astronomers which is dedicated to eliminating glare and wasted outdoor lighting. All pole-mounted lighting will be no higher than 20 feet tall. All lighting will be shielded so as to provide downward directivity and avoid nighttime glare.

The amount of interior light from the powerhouse that will be visible externally will be minimized through the use of shades, blinds, louvers, film or similar materials. Interior lighting is not anticipated to add appreciably to any potential off-site lighting impacts.

The FAA is in the process of reviewing the Project's stacks as potentials for hazard to air navigation and will make a finding of significance. If lighting is required by the FAA for the two stacks, the lighting of the stacks will be in accordance with FAA regulations (Appendix C).

### ***5.3.10 Cooling Tower Plume Analysis***

#### **Introduction**

Condenser cooling for the Project will be supported by a 12-cell hybrid (mitigated wet evaporative) cooling tower. The primary concern with installation of a full wet evaporative tower is the potential effects of fogging and icing on local roadways, and on the switchyard and transmission lines and towers. Additional consideration is given to the frequency and extent of visible plumes from the tower. The installation of a hybrid, mitigated tower results in significantly improved control over the effects of the cooling tower plume on the local community. In particular, potential adverse plume effects caused by fogging and/or icing may be significantly reduced or eliminated by the use of a hybrid tower.

In order to address these concerns a cooling tower analysis was performed using the Electric Power Research Institute (EPRI) Seasonal and Annual Cooling Tower Impact (SACTI) cooling tower model. The SACTI model was developed especially for modeling cooling towers associated with electric generation facilities. The model is the most widely used and validated cooling tower plume model available for modeling power plant cooling tower plumes. This

section briefly discusses the structure of the SACTI model, the modeling methodology employed, and the summary of potential impacts.

### *5.3.11 Modeling Analysis Procedures*

#### *SACTI Model Description*

The SACTI cooling tower model calculates the seasonal and annual impacts of cooling tower vapor plumes. Various environmental impacts simulated in the SACTI model include:

- Plume-induced fogging and icing (during freezing conditions) downwind of the cooling tower.
- Frequencies of plume length, height and radius.
- Hours of plume shadowing (the amount and duration of plume shadows at a given location).
- Deposition of liquid water (drift), and minerals dissolved in the cooling tower plume drift (water droplets entrained in the plume during plume exhaust). Mineral deposition is primarily from the concentration of calcium and magnesium carbonates in the circulating water.

The impacts of primary concern to the Project and surrounding area included hours of ground fog and rime ice formation and the visible plume length and frequencies of occurrence. As such, the model output results were further processed to provide graphical presentations of these potential impacts to provide a visual representation of the modeling results.

The SACTI model is a multiple-source model that calculates cooling tower plume impacts from any number of identical natural draft, linear mechanical draft, or circular mechanical draft cooling towers. The SACTI model was designed to provide statistical summaries of potential cooling tower impacts. The model developers validated the model with field and laboratory data in situations where good quality data existed.

The seasonal/annual modeling methodology employed by the SACTI model is a parameterization scheme that reduces the available hourly meteorological data to approximately 35 categories of unique meteorological conditions (from a cooling tower plume dispersion perspective). Potential fogging and icing cases are reduced to 10 categories. Each category is modeled separately and the modeling results of the category are assumed to apply for all occurrences of the category for the period for which modeling is performed. The number of specific categories for a given situation is dependent upon the cooling tower geometry, tower emission parameters, and the meteorological conditions experienced at the site. The categorization scheme used in the SACTI model allows a user to analyze multiple years of meteorological data without the need to model every hour of every year to determine plume impacts. The representative scenarios are assumed to apply for multiple hours, thereby keeping the resulting data sets manageable.

The SACTI model is composed of four separate programs: a meteorological preprocessing program (PREP); a plume dispersion program (MULT); and a program to produce tabular

summaries of the modeling results (TABLES). The model also includes a graphical postprocessor program (PAGE) that was not used in this analysis.

PREP screens a sequential hourly meteorological data file for validity and generates a set of meteorological scenarios that produce significant plume dispersion effects. The hourly meteorological records are then tagged with the corresponding category and direction index, and a preprocessed meteorological file is created for the plume calculation program – MULT.

The MULT program computes the expected plume dispersion for each meteorological scenario developed by PREP. An internal format summary file of all plume conditions is created and passed to the TABLES module. The printed output from the MULT program contains a listing of the plume dispersion and fogging impacts for each meteorological scenario (category) simulated.

The TABLES program combines the output of the PREP and MULT programs and produces a set of tabular frequency of occurrence listings of the various environmental effects produced by the cooling tower plume. The environmental effects computed by the TABLES program are the average of the individual impacts of each scenario modeled, weighted by the number of occurrences of that scenario in the input PREP data file.

Graphical post-processing in this analysis was performed using a separate graphics package. In this analysis, the contour figures were developed using the Golden Software, Inc, Surfer<sup>™</sup> graphics processor. A base map was obtained from scanned USGS topographic quadrangles, available on the internet from Topozone ([www.topozone.com](http://www.topozone.com)). The image was scaled accordingly for merging with overlays of the cooling tower tabular results.

### Ground Fog Formation

Cooling tower “fogging” occurs when the condensed water vapor plume comes in contact with the ground near the tower for short time periods. Although this potential impact is referred to as fogging, it is not the type of area-wide atmospheric fogging that is generally thought of when the term “fog” is used. Cooling tower plume touchdown or fogging is usually a temporary event of only a few hours duration. The SACTI model is used to calculate the average number of hours of potential ground fog expected to occur around the proposed tower. The worst-case location is identified as that area which will experience the greatest number of potential fog events.

### Rime Ice Formation

The model also calculates occurrence of rime ice formation. Super-cooled cloud water droplets that freeze on contact with a sub-freezing surface cause rime ice. Rime ice is not to be confused with glaze ice that may occur by the deposition of liquid drift droplets. The model does not account for glaze ice, however, modern towers with high efficiency drift eliminators typically reduce glaze ice formation to only an on-site operational concern (e.g., slippery walkways, stairs, or ladders around the facility.) The Kleen Energy tower proposes to have a high efficiency drift eliminator that will reduce the amount of drift to 0.0005 percent of the circulating water. This results in an estimated 0.6 gallons per minute (gpm) of liquid drift at full load. During winter

operation when the tower will be operated at part load the drift will also be minimized, such that glaze icing will rarely occur, and only immediately adjacent to the downwind side of the tower(s). Furthermore, operation of the dry section to mitigate any potential condensed plume impacts also will serve to evaporate any drift formed, and minimize or eliminate glaze ice formation.

### 5.3.12 Plume Visibility and Plume Shadowing

Plume visibility may be of concern as related to the visual aesthetics of the proposed Kleen Energy Project. Plume shadowing is generally a concern only when considering its effect on agriculture, which due to the attenuation of sunlight by the plume's shadow may reduce crop yield.

#### Model Input Parameters

TRC used one year of hourly meteorological data (1974) recorded at Bradley Field, Windsor Locks Airport. These data are considered to be the most representative meteorological data to assess the potential proposed cooling tower impacts for the Kleen Energy Project. Data was obtained from the National Climatic Data Center in CD144 format, which contained meteorological parameters (wind speed and direction, temperature, dew point, and atmospheric stability parameters) suitable for use with SACTI.

The PREP and MULT programs were executed for each case described above. The tower design parameters were provided for full design operation of the tower. However, during periods when the ambient conditions are significantly cooler than the design conditions, the tower will be operated at a lower load. This lower load case is simulated in SACTI by reducing the total heat rejection rate while maintaining airflow through the tower. In this case, one or more fans are turned off, and the cells are operated in a convection mode. Table 5.3-1 lists the specific cooling tower dimensional parameters input into MULT for the full tower operation, which will be the worst-case.

<b>Table 5.3-1 Kleen Energy Project - Proposed Cooling Tower Operating Parameters</b>	
<b>Parameters (both locations)</b>	
Proposed Tower Loading Case:	Full
Number of Cells (configuration):	12 (2 x 6)
Tower Height (meters):	18.3 (60 ft)
Tower Length (meters):	90.5 (297 ft)
Tower Width (meters):	32.9 (108 ft)
Cell Diameter (meters):	10.0 (32.8 ft)
Tower Eff. Diameter (meters):	34.6 (113.6 ft)
Tower Heat Duty (MW):	366 (1,250 MMBtu/hr)
Tower Air Flow (total) (MMACFM):	1.2

<b>Table 5.3-1 Kleen Energy Project - Proposed Cooling Tower Operating Parameters</b>	
<b>Parameters (both locations)</b>	
Circulating Water (gpm):	98,000
Cycles of concentration:	5
Drift (@0.0005%) (gpm)	0.4
Makeup TSS/TDS (as CaCO <sub>3</sub> )	~500 ppm
Circulating water TSS/TDS (as CaCO <sub>3</sub> )	~2,500 ppm
Site Latitude (degrees):	41.5527 N
Site Longitude (degrees):	72.5974 W

### 5.3.13 Model Output

The SACTI model computed the expected frequency of occurrence of ground-level plume fogging, icing, plume length, shadowing, and mineral deposition. In the case of plume fogging, icing and shadowing, the SACTI model provides results tabulated as total hours for the period analyzed. Plume lengths are provided in percent of total plumes. Since SACTI is a statistical model, it assumes that a plume will occur for every hour within the meteorological record, and where frequencies are provided, the hours of occurrence per year may be estimated by multiplying the frequency by 8,760 hours in a year.

Plume length frequency is a cumulative frequency distribution, where the percentages are tallied from the greatest distance working inward towards the cooling tower, for each wind direction examined. In this way, the percentages may be interpreted to be probability distributions of plume lengths. The 1% distance represents the 99<sup>th</sup> percentile for the extent of the cooling tower plume at that distance. This means that 99% of all plumes formed have a length less than the 1 percentile distance.

Plume shadowing is tabulated by the number of hours a plume shadow will occur on the ground for the entire period analyzed. Plume shadow events only occur during the daylight hours, and take into account the solar elevation angle, the height of the plume and the plume angle relative to the horizontal. Inclement weather conditions during the day when there may be no shadow formed are not considered, but may be subsequently discounted by further examination of the meteorological data. Plume shadowing was used as a method to calculate occurrence and length of visible plumes, since the plumes sufficiently dense to cause a shadow are tabulated for daylight hours only.

In the case of mineral deposition, the values provided are maximum deposition rates (i.e., mass/area/time). The units provided by SACTI for deposition are kilograms/square kilometer/month. These are often converted to more meaningful (or easier to visualize) units of grams/square meter/day. With the extremely efficient drift eliminator proposed for the cooling tower, mineral deposition will be negligible and was not analyzed further.

### Methodology for Estimating Ground-Level Impacts

The MULT model assumes that fogging and icing potentially occur during pre-defined meteorological scenarios. Fogging is computed to occur for a given scenario when the plume is modeled to be in physical contact with the ground. The area covered by the plume is then taken to be the area of fogging. Likewise, ground-level icing is computed by assuming icing occurs during the plume fogging scenarios for which the air temperature is less than freezing.

As previously discussed, the analysis for the Kleen Energy Project examined the potential for cooling tower plumes to produce impacts of fogging and icing on the adjacent roadways. Additionally, the extent of elevated visible plumes from the proposed Kleen Energy Project was determined.

### Summary of Cooling Tower Impacts

The cooling tower impact types examined were:

- Plume ground fog and ground rime ice formation resulting from the plume impinging on adjacent roadways.
- Length of elevated visible plumes as a frequency of total plume formation.
- Impacts of ground fog or icing on the adjacent switchyard.

### Ground Fog Formation

The analysis calculated a maximum of 16 hours of ground fog 150 meters (500 feet) south of the cooling tower for the one year of data assessed. The only directions indicated to have a potential fog was due south, due north and southeast of the project. A maximum of 3 hours of ground fog occurred to the north, while 2 hours occurred to the southeast. The location of the maximum number of hours in these directions was 150 meters (500 feet) from the project. A maximum of 8 hours of ground fog extended 600 meters to the north of the facility. No public roadways are impacted by any ground fog conditions. The extent of potential ground fog conditions is illustrated on Figure 5.3-25. As shown on this figure, the contours do not extend to any public roads or areas.

### Ground-Level Rime Icing

The model indicates that there will be a maximum of one hour of rime ice formation to the southeast per year. This will likely occur on the Kleen Energy project site, and not impact any public roadways or public access areas. Figure 5.3-26 illustrates the potential location for rime ice formation.

### Elevated Visible Plumes

The extent of visible plumes is shown on Figure 5.3-27 as the expected hours per year. There is a maximum of 700 hours a year of visible plume dense enough to cause a plume shadow immediately east of the project, while the 100 hour contour extends nearly circular around the

Figure 5.3-25  
 Annual Hours of Ground Fog Formation  
 (Contours in 2 hour/year intervals)

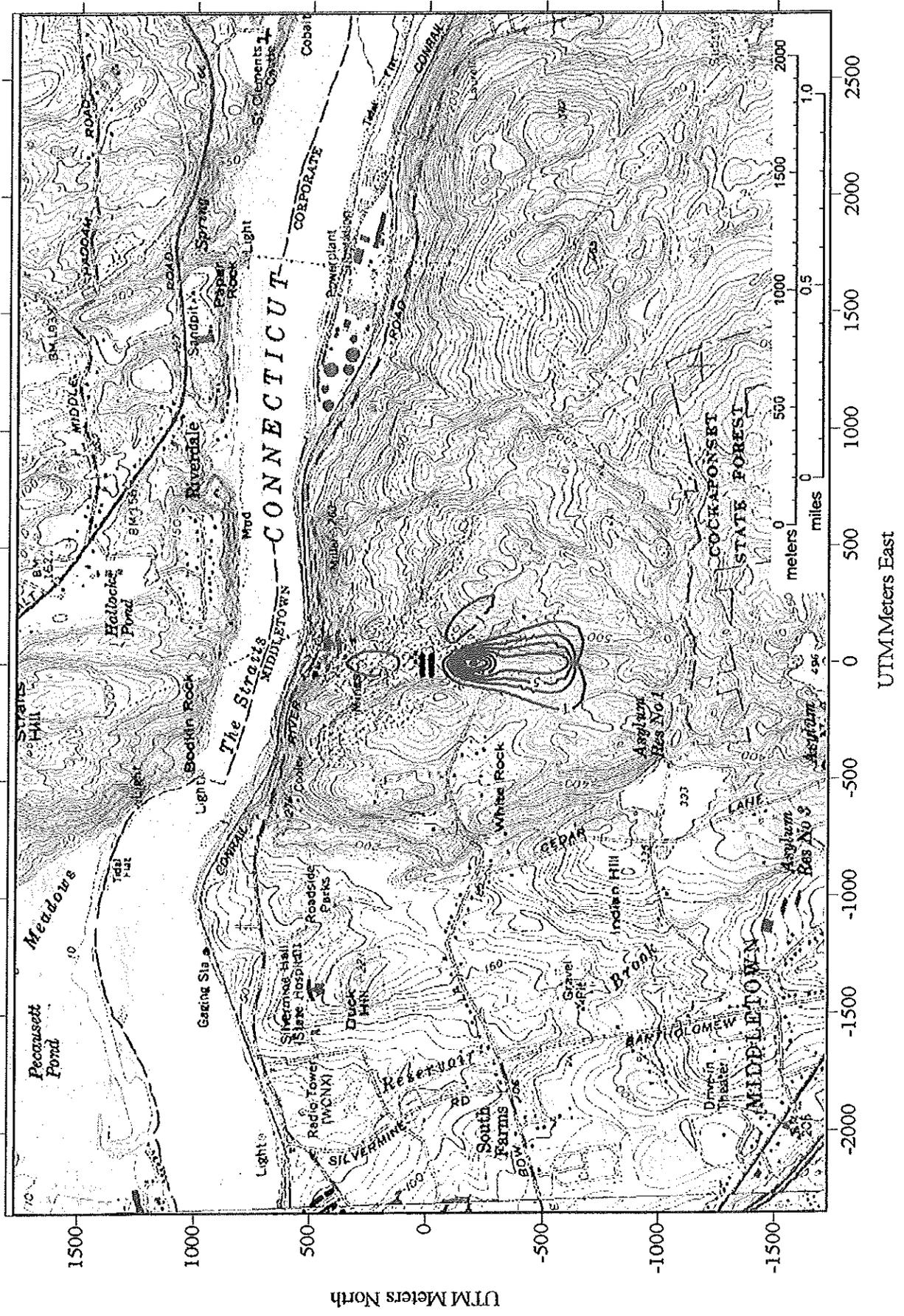
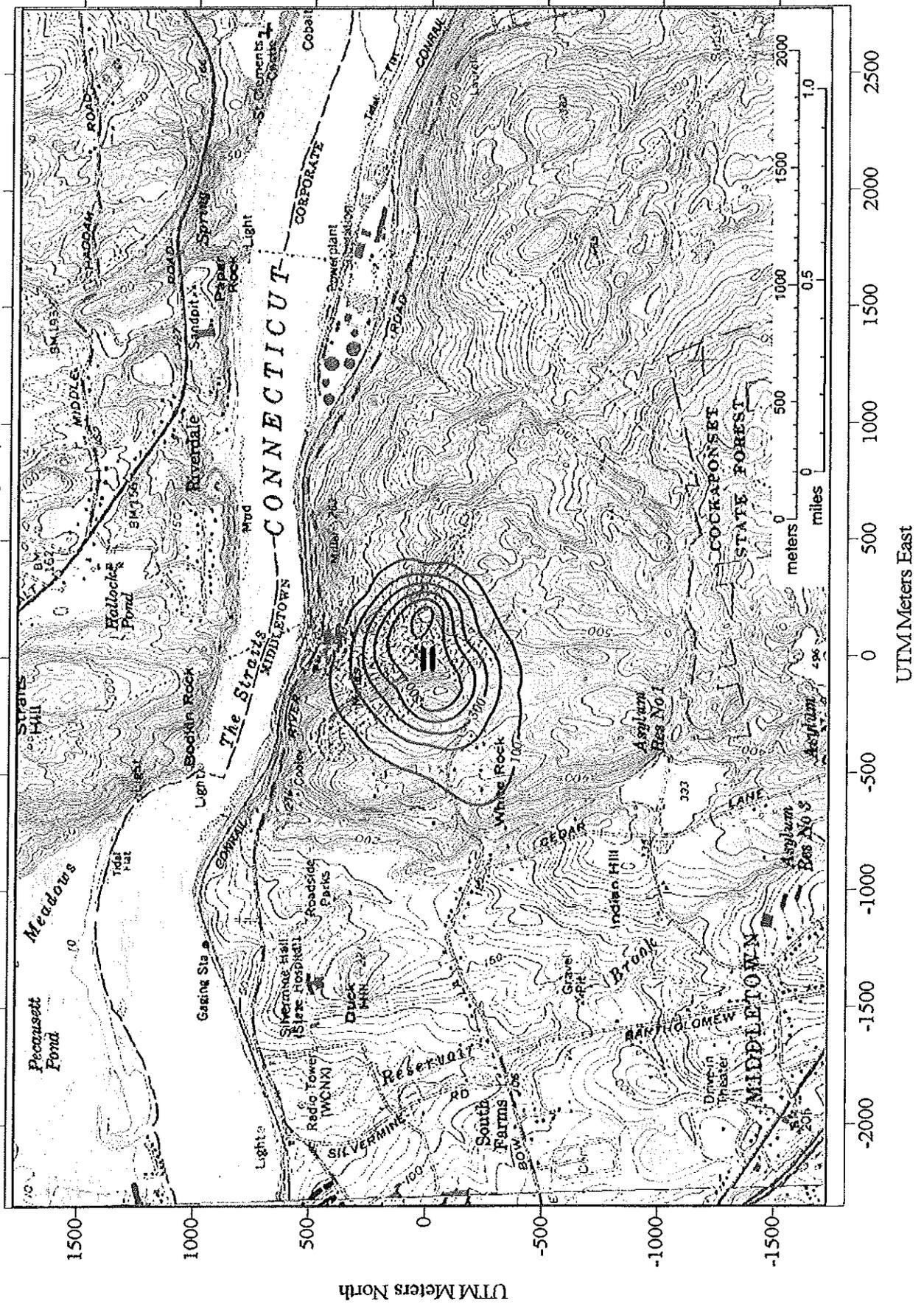




Figure 5.3-27  
 Annual Frequency of Visible Plumes  
 (Contours in 100 visible plume hours/year)



facility at a distance of 500 to 600 meters. These plumes are elevated, typically being within a few hundred feet above the ground. Most of these plumes will also extend only a few hundred feet from the tower. The majority of the elevated visible plumes will occur during the colder months. The model does not incorporate plume mitigation that is planned for the tower. As such, this analysis over estimates the quantity and length of elevated plumes expected from the project. With plume mitigation employed, elevated plumes are expected to be minimally visually intrusive.

#### **5.3.14. Conclusion**

The proposed Project will not adversely affect the existing visual character of the communities surrounding the proposed development site. The proposed site was previously used for industrial purposes as a feldspar mine, and the land immediately east is used for utility purposes with overhead transmission towers and lines in a utility right-of-way. Additionally, the site is situated within a location that offers existing screening that conceals the site from residences to the southwest, while limited views of the proposed facility's stacks would be afforded from some areas to the north and northeast. The proposed facility will ultimately be incorporated into a previous industrial setting, with additional industrial facilities further east, and consequently, will not result in a significant alteration of existing viewsheds in the proposed Project area. Architectural renderings and simulations are located in Volume II, Drawings A5, A6 and A7.

### **5.4 Noise**

#### **5.4.1 Introduction**

A noise assessment study has been performed for the Project. The assessment consisted of two parts: an ambient noise monitoring program in the vicinity of the proposed Project, and a noise modeling study. The background ambient noise monitoring program was conducted on October 31, 2001 in order to establish current noise levels in the area. The noise modeling study was performed by modeling a combination of vendor supplied and derived noise data for the major noise producing equipment, and by determining projected noise levels in the surrounding community.

The proposed Project is located in a bowl shaped depression in the side of the hill rising from the Connecticut River. This depression is a result of original natural contour, past mining activities, and excavation that will be needed to restore the mined area into a useable site. This depression will help to shield any Project noise to the south, east and west. Sensitive sources to the north, residences in Portland, while not benefiting from the noise blocking effects of interceding landforms, nonetheless will benefit from the width of the Connecticut River – the distance from the core of the Project to the residences in Portland exceeds 2500 feet.

Both the State of Connecticut and City of Middletown noise standards are applicable to the proposed Project. The Project is designed to achieve compliance with these standards.

## 5.4.2 General Information on Noise

Noise is defined as unwanted sound resulting from vibrations in the air. Excessive noise can cause annoyance and adverse health effects. Annoyance can include sleep disturbance and speech interference. It can also distract attention and make activities more difficult to perform (EPA, 1978).

The range of pressures that cause the vibrations that create noise is large. Noise is therefore measured on a logarithmic scale, expressed in decibels (dB). Noise is typically measured on the A-weighted scale (dBA). The A-weighting scale was developed and has been shown to provide a good correlation with the human response to sound and is the most widely used descriptor for community noise assessments. (Harris, 1991).

Common descriptors of noise include the  $L_{eq}$ ,  $L_{90}$  and  $L_{10}$ . These descriptors are defined below.

*L<sub>eq</sub>* The equivalent noise level over a specified period of time (e.g., 1-hour). It is a single value of sound that includes all of the varying sound energy in a given time duration.

*Statistical Sound Levels* The A-weighted  $L_{90}$  and  $L_{10}$  sound levels: the  $L_{90}$  is the sound level exceeded 90 percent of the time and is often considered the background or residual noise level; the  $L_{10}$  is the sound level exceeded 10 percent of the time and is a measurement of intrusive sounds, such as aircraft overflight.

## 5.4.3 Applicable Standards/Guidelines

### 5.4.3.1 Noise Standards

The State of Connecticut has a detailed noise standard that is applicable to the proposed Project. The standard limits noise, as measured at certain Noise Zones, that is emitted from a source in another Noise Zone. These Zones include the following:

- Class A - Generally residential, hotels, hospitals and other sensitive areas.
- Class B - Commercial areas.
- Class C - Industrial uses.

The proposed Project is an industrial use in an industrially zoned area, Class C, under the noise standard. The nearest noise sensitive areas are Class A, lands of residential use on Bow Lane and various plots bordering the proposed Project site's property line. As such, the applicable portion of the noise standard concerns the noise level from a source, located in a Class C area, as measured at a Class A area. Summarized below are the noise limits for this scenario.

### Class C source emitting to a Class A receiver

<u>Daytime</u>	<u>Nighttime</u>
61 dBA	51 dBA

Nighttime is defined in the standard as the hours between 10 p.m. and 7 a.m. A second limit is applicable to the proposed Project site's property line where it borders lands zoned for industrial use. Facility noise at these locations would be limited to 70 dBA at any hour of the day.

The allowable level is reduced by 5 dBA if the proposed source emits prominent discrete tones.

Should an area be found to have high existing ambient levels (i.e., higher than the allowable standard), then the allowable project noise limit is set to 5 dBA above the measured ambient levels (ambient noise monitoring, to be discussed later in this report, revealed that existing levels are below the allowable standard).

The City of Middletown Code of Ordinances includes a Noise Control Ordinance that defines nighttime as sundown to 7 a.m. and establishes dBA limits identical to the State of Connecticut's limits.

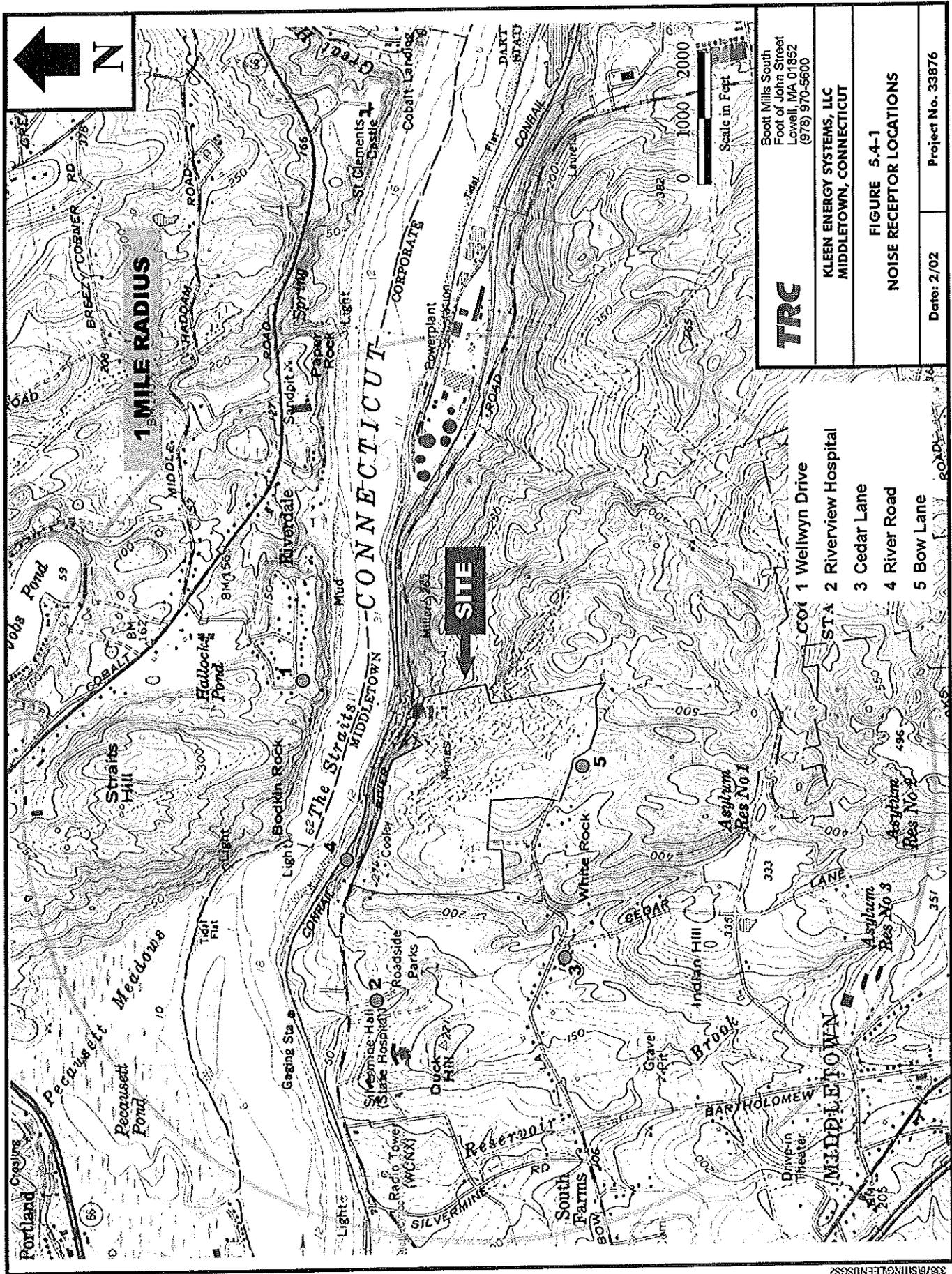
#### 5.4.3.2 USEPA Noise Guideline

The United States Environmental Protection Agency (USEPA) has issued a set of recommended noise levels. The USEPA recommended levels were identified as sufficient to protect public health and welfare from the effects of environmental noise (USEPA, 1978). It is important to note that these levels were developed without concern for technical or economic feasibility. They also contain a margin of safety to insure their protective value.

The USEPA has identified an outdoor  $L_{dn}$  sound level of 55 dBA, (the  $L_{dn}$  is defined as the day-night noise level. It is the A-weighted sound level over a 24-hour period with an additional 10 dB added to sounds which occur between 10 p.m. and 7 a.m.) which equates to a continuous level of 48 dBA, for "residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use" as sufficient to protect against interference and annoyance (USEPA, 1978). This recommended level was designed to prevent speech and sleep interference. This recommended level was evaluated in the analysis in order to determine potential noise impacts.

#### 5.4.4 Noise Monitoring Program

The area in the vicinity of the proposed Project site consists of a combination of residential and industrial uses. The lands of residential use nearest the generating equipment are located on Bow Lane, directly south and southwest of the proposed Project. A topographic map of the area is presented as Figure 5.4-1.



<b>TRC</b>	
Booth Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600	
KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT	
FIGURE 5.4-1 NOISE RECEPTOR LOCATIONS	
Date: 2/02	Project No. 33876

- 1 Wellwyn Drive
- 2 Riverview Hospital
- 3 Cedar Lane
- 4 River Road
- 5 Bow Lane

#### 5.4.4.1 Noise Monitoring Methodology

An ambient noise monitoring program was conducted during the late night (very early morning) and daytime of October 31, 2001 at a total of five locations. The program consisted of short-term (20 minutes at each location) monitoring, including octave band sound level measurements, at all five locations. A RION NA-27 precision integrating Type 1 sound level meter with precision integrating octave band analyzer was utilized for this program.

The meter meets ANSI S1.4-1983 requirements for precision Type 1 sound level meters. The meter was calibrated before and after each survey period using a Bruel & Kjaer Model 4231 sound level calibrator. The microphone was fitted with a windscreen to reduce wind generated noise and mounted at a height of approximately five feet above the ground. The meter was configured to measure the  $L_{eq}$ ,  $L_{90}$ , and  $L_{10}$  one-third octave band levels.

In addition to noise level measurements, the contributing noise sources were identified and recorded, along with the prevailing meteorological conditions. Wind speed and direction and sky conditions were observed and recorded at each location.

A total of five monitoring locations were chosen to represent the study area. The monitoring location descriptions are presented below and depicted on the area map (Figure 5.4-1).

- Wellwyn Drive (across the Connecticut River, in Portland)
- Riverview Hospital
- Cedar Lane
- River Road
- Bow Lane

#### 5.4.5 Existing Noise Levels

Meteorological conditions during the monitoring periods consisted of mostly clear skies with light south winds less than 5 miles per hour during the night, and cloudy skies with light winds less than 5 miles per hour during the day. Temperatures ranged from between approximately 30°F at night to 50°F during the day.

Contributing noise sources in the area were not significant, but included motor vehicle traffic from Route 9, the existing NRG Middletown Generating Station and/or Pratt and Whitney Aircraft Plant to the east along the Connecticut River, the Connecticut Valley Hospital power plant to the west, and occasional natural sounds of birds and dogs.

A summary of the overall A-weighted measured data are provided in Table 5.4-1 below.

**Table 5.4-1 Measured Ambient Noise Levels**

Location	Measured Noise Levels (dBA)					
	Daytime			Nighttime		
	L <sub>90</sub>	L <sub>10</sub>	L <sub>eq</sub>	L <sub>90</sub>	L <sub>10</sub>	L <sub>eq</sub>
Wellwyn Drive	38	47	51	27	33	31
Riverview Hospital	39	48	46	35	39	37
Cedar Lane	36	44	46	33	36	35
River Road	35	46	49	27	34	38
Bow Lane	35	43	42	26	32	33

Measured noise levels were found to be lower during the nighttime hours at all locations, which is typical for this type of setting.

#### 5.4.6 Noise Modeling

##### 5.4.6.1 Methodology

The NOISECALC model was used to predict noise levels expected from operation of the proposed Project. The model was developed for predicting noise levels from power plants. The proposed Project will consist of two General Electric Frame 7FA gas-fired CTs and HRSG, a steam turbine, and associated equipment including various pumps and ammonia blowers, coolers, air compressors and transformers. The CTs, some pumps and the air compressors will be enclosed within a single turbine building.

NOISECALC requires inputs of receptor and source coordinates and octave band source noise levels. Estimated noise level data for the CTs (inlet, casing and exhaust) and HRSGs were obtained from GE. Detailed noise data for most of the ancillary sources were not available since final specifications and design for these components have not yet been developed. For these sources, octave band spectra were developed following accepted industry procedures found in Edison Electric Institute's "Electric Power Plant Environmental Noise Guide". Estimated performance data for the equipment (MVA, horsepower ratings) were some of the parameters considered in developing the noise data.

NOISECALC accepts a variety of attenuation factors under varying meteorological conditions. The model was configured to accept hemispherical spreading and atmospheric absorption for this analysis. Standard conditions of 59<sup>0</sup> F and 70 percent relative humidity, and no wind were assumed. Existing topographical features were considered in the modeling but no attenuation due to ground cover was considered. Omitting ground cover attenuation compensates for downwind conditions, which maintains a conservative factor in the modeling.

Modeling receptors were chosen in the same locations as where background monitoring was performed.

### 5.4.7 Noise Control Measures

The noise modeling revealed that extensive noise control measures will be required in order to achieve compliance with the Connecticut standard and to minimize potential noise impacts at the bordering residential areas. These measures included the following:

- An acoustically treated turbine building;
- Mitigated cooling tower;
- Mitigated HRSG casings;
- High performance exhaust stack silencers; and
- Enclosures for the boiler feedwater pumps, cooling tower circulation pumps, and the gas compressor.

### 5.4.8 Modeled Facility Noise Levels

The noise modeling results, with the aforementioned noise control measures incorporated, for the residential locations are provided in Table 5.4-2 below along with the existing measured ambient noise levels. Also provided in this table are the cumulative ambient levels with the Project in operation and the USEPA recommended noise level.

<b>Location</b>	<b>Average Existing Late Night L90</b>	<b>Calculated Facility Level</b>	<b>Applicable Standard</b>	<b>Cumulative Future Late Night Ambient</b>	<b>USEPA Recommended Level*</b>
Wellwyn Drive	26	48	51	48	48
Riverview Hospital	35	28	51	36	48
Cedar Lane	33	30	51	35	48
River Road	27	35	51	36	48
Bow Lane	26	48	51	48	48

\* Continuous level over a 24-hour period.

A review of the data in Table 5.4-2 reveals that noise levels from Project operation are expected to be in compliance with the State of Connecticut and Middletown standards at these residential areas. Further, the cumulative noise level (background plus Project) would be at or below the USEPA recommended level at all locations.

Additional receptor locations were placed along the Project property line in order to determine compliance with the industrial property line standards. Table 5.4-3 presents modeled Project noise levels at the Project property line locations. These locations are depicted in Figure 5.4-2.

<b>Table 5.4-3 Calculated Property Line Noise Levels (dBA)</b>		
<b>Property Line Receptor</b>	<b>Standard</b>	<b>Projected dBA</b>
Property line receptor 1*	51	35
Property line receptor 2	70	54
Property line receptor 3	70	54
Property line receptor 4*	51	50
Property line receptor 5*	51	50
Property line receptor 6	70	48
Property line receptor 7	70	57
Property line receptor 8	70	66
Property line receptor 9	70	66
Property line receptor 10	70	49
Property line receptor 11	70	49
Property line receptor 12	70	51

\* These property line locations border residentially zoned property.

A review of the data in Table 5.4-3 reveals that noise levels from Project operation are expected to be in compliance with the Connecticut and Middletown standards at all Project property line locations, including those bordering residential zones.

The modeling analysis was conservative in nature and the calculated noise levels presented herein are anticipated to be the “worst case” levels. Lower noise levels than presented in this analysis may be expected during various meteorological conditions such as when the facility is downwind of a given location and during conditions of negative temperature gradient (e.g., cooler temperatures with height). A negative temperature gradient occurs during sunny days with light winds.

#### **5.4.9 Discrete Tone Noises**

Several sources at the facility have the potential to generate discrete tone noises as defined in the Connecticut standard. These sources can generate a specific “pitch” of sound which can be audible above the remaining broadband sound generated by the source. If a source generates a discrete tone noise as defined in the Connecticut standard, the allowable overall level of noise is reduced by 5 dBA.



It was not possible to model the potential for discrete tone noise, since this would require 1/3 octave band data, which were not available (and typically are not available) from any of the equipment vendors. Therefore, the facility design will include a specification to all equipment vendors and construction contractors that, in addition to discrete tone noises meeting the noise levels which were incorporated into this analysis, these discrete tone noises must be controlled, either through physical controls on the source, or through the use of the previously listed acoustical enclosures.

#### **5.4.10 Conclusion**

An ambient noise monitoring program was conducted in order to establish the existing noise levels in the area. The results of this program revealed that existing levels are below the standard. The noise environment in the area is affected by traffic noise (Route 9) and several industrial sources (the nearby NRG Middletown Generating Station and Pratt and Whitney Aircraft Plant).

The State of Connecticut and City of Middletown have standards that limit noise from this type of facility. Specifically, noise generated by the Project may not exceed 51 dBA at night at any residential area and 70 dBA during any hour of the day at any industrial area.

Computer noise modeling of the proposed Project was conducted in order to determine if the Project could be designed to comply with the state standard and minimize potential noise impacts to the surrounding residential areas. The modeling revealed that extensive noise control measures would be required.

The modeling results revealed that the proposed facility, with the noise control measures incorporated, will be in compliance with the Connecticut and Middletown standards. Further, the modeled noise levels were shown to be at or below the USEPA recommended noise level at all residential locations.

### **5.5 Traffic Analysis**

#### **5.5.1 Existing Roadway Geometry**

Field observations to determine the existing baseline traffic conditions in the vicinity of the proposed Project were conducted. An analysis has been performed of the traffic to be generated during both the construction and operation of the proposed facility to verify that the Project will not have a significant impact on the traffic operating conditions of the adjacent roadway network.

The following are brief descriptions of the roadways in the vicinity of the proposed Kleen Energy Generating Facility in Middletown, Connecticut:

- **Silver Street.** Silver Street is a two-lane roadway that runs in an east to west direction in the City of Middletown. No shoulders are provided on either side of the roadway. A sidewalk is

provided on the northern side of the street. Silver Street is under local jurisdiction and has a posted speed limit of 25 mph.

- **Eastern Drive.** Eastern Drive connects Bow Lane to the south (directly opposite the northbound Route 9 Off-ramp) with River Road to the north. Eastern Drive is a one lane per direction roadway traveling in a north/south direction and does not provide shoulders or sidewalks on either side of the roadway. Eastern Drive has a posted speed limit of 25 mph and is under local jurisdiction.
- **Route 9.** In the vicinity of the site, Route 9 is a two lane per direction roadway traveling in a north/south direction. Route 9 has a posted speed limit in the vicinity of the site of 45 mph. Route 9 is under the jurisdiction of the Connecticut Department of Transportation (CTDOT).
- **Silvermine Road.** Silvermine Road is an unpaved one lane per direction roadway traveling in a north/south direction from Bow Lane in the south to Silver Street in the north. Silvermine Road has a posted speed limit of 20 mph and is under local jurisdiction.
- **River Road.** River Road is a one lane per direction roadway traveling in an east/west direction. River Road has a posted speed limit of 25 to 30 mph. River Road is under local jurisdiction.

The following is a brief description of each of the intersections in the vicinity of the proposed Kleen Energy Generating Facility:

- Silver Street and Route 9 Southbound Off-Ramp: This unsignalized intersection is a three-legged intersection with Silver Street forming the eastbound and westbound approaches consisting of a through lane in each direction. The Route 9 Southbound Off-Ramp consists of a shared left/right lane and operates under STOP control.
- Eastern Drive and Route 9 Northbound On-Ramp: This unsignalized intersection is a three-legged intersection with Eastern Drive forming the northbound approach consisting of a shared left/through lane and the southbound approach consisting of a shared right/through lane. The Route 9 Northbound On-Ramp provides one receiving lane.
- Silver Street and Eastern Drive: This unsignalized intersection is a four-legged intersection with Silver Street forming the eastbound and westbound approaches and Eastern Drive forming the northbound and southbound approaches under STOP control, with all approaches consisting of a shared left/through/right lane.
- Bow Lane and Eastern Drive / Route 9 Northbound Off-Ramp: This unsignalized intersection is a four-legged all way STOP controlled intersection with Bow Lane forming the eastbound and westbound approaches, Eastern Drive forming the southbound approach, and the Route 9 Northbound Off-Ramp forming the northbound approach. The Bow lane eastbound approach consists of a shared left/through lane and the westbound approach consists of a shared through/right lane. The southbound Eastern Drive approach consists of a

shared left/right lane and the northbound Route 9 Off-Ramp approach consists of a shared left/through/right lane.

- River Road and Silver Street / Silvermine Road: This unsignalized intersection is a four-legged unsignalized intersection with River Road forming the westbound approach, Silver Street forming the eastbound approach and Silvermine Road forming the northbound approach under STOP control. All approaches consist of a shared left/through/right lane. The southbound approach consists of a receiving lane (enter only) for the Rushford Center (1250 Silver Street).

### *5.5.2 Site Access*

Access to the site is to be provided via a access road to be located along River Road to the east of Silver Street. The access road will provide one entering lane and one exiting lane. The Kleen Energy Systems access road approach to River Road will be under STOP control.

Vehicles arriving to the site will most likely travel along Route 9 to Silver Street (in the southbound direction) and to Eastern Drive at Bow Lane in the northbound direction.

### *5.5.3 Traffic Counts and Field Observations*

After a thorough review of the arrival and departure distributions for the proposed Project, the following study locations were determined to be the key locations. Manual turning movement traffic counts were conducted at these key locations:

1. Silver Street and Southbound Route 9 Off-ramp
2. Silver Street and Eastern Drive
3. Eastern Drive and Northbound Route 9 On-ramp
4. Eastern Drive/Northbound Route 9 Off-ramp and Bow Lane
5. Silvermine Road and Silver Street/River Road

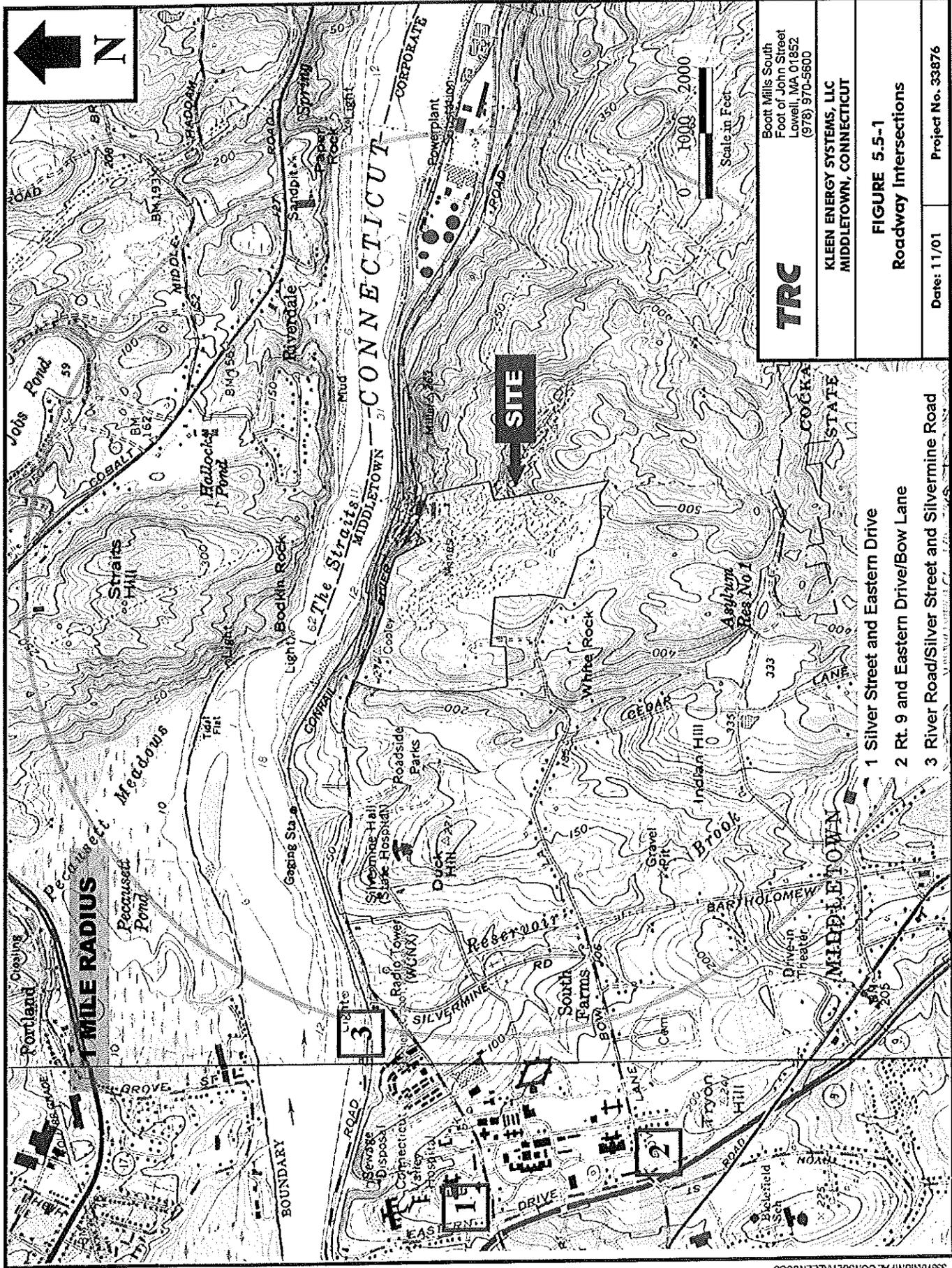
Figure 5.5-1 identifies the location of each of the roadways identified above.

Manual turning movement traffic counts were conducted on Wednesday, November 7, 2001 from 2:30 PM to 6:30 PM and Thursday, November 8, 2001 from 6:30 AM to 9:30 AM at the above-mentioned locations. Automatic Traffic Recorder (ATR) counts were also performed to supplement the manual traffic counts.

Based upon the performed traffic counts, the representative Peak Highway Hours were determined to be as follows:

Peak AM Highway Hour: 7:30 to 8:30 AM

Peak PM Highway Hour: 2:45 to 3:45 PM



<b>TRC</b>	Boott Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600
KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT	
<b>FIGURE 5.5-1</b> Roadway Intersections	
Date: 11/01	Project No. 33876

- 1 Silver Street and Eastern Drive
- 2 Rt. 9 and Eastern Drive/Bow Lane
- 3 River Road/Silver Street and Silvermine Road

The early Peak PM Highway Hour is a result of the adjacent Hospital traffic. During these hours, the existing traffic along the roadways adjacent to the site is generally the highest of the day, and thus represents Design Hour conditions. The 2001 Existing Peak AM Hour and Peak PM Hour Traffic Volumes were balanced, where appropriate, to insure uniformity. The 2001 Existing Traffic Volumes are illustrated graphically on Figure 5.5-2. Additional traffic volumes, obtained from the Connecticut Department of Transportation are contained in Appendix D.

#### 5.5.4 Existing Levels of Service

Capacity analyses were performed at the five (5) study locations in Middletown, Connecticut. Capacity analysis is a method by which traffic volumes are compared to the calculated roadway and intersection capacities to evaluate future traffic conditions. The methodology used is described in the 2000 Highway Capacity Manual published by the Highway Research Board. In general, the terminology "Level of Service" is used to provide a qualitative evaluation based upon certain quantitative calculations related to empirical values. Levels of Service are defined in general delay ratings. Delay is utilized as a measure of driver discomfort, frustration, efficiency, etc. In general, Level of Service "A" represents the best traffic operating condition.

Table 5.5-1 summarizes existing Levels of Service at the study intersections in the vicinity of the site. Capitalized Levels of Service indicate signalized intersections, while lower case Levels of Service indicate unsignalized intersections. As illustrated in Table 5.5-1, under the existing operating conditions, all the intersections will operate at an acceptable overall Level of Service "D" or better. During the AM and PM Highway Hours, all intersections are currently operating with minimal delays. The intersections in the study area currently operate safely and efficiently. Therefore, no improvements are currently required at any location.

<b>Table 5.5-1 2001 Existing Levels of Service</b>					
<b>Level Of Service Summary – 2001 Existing Conditions</b>					
<b>Approach <sup>(1)</sup></b>		<b>Peak AM Hour</b>		<b>Peak PM Hour</b>	
		<b>LOS <sup>(2)</sup></b>	<b>Delay (sec.) <sup>(3)</sup></b>	<b>LOS</b>	<b>Delay (sec.)</b>
Silver St & Route 9 Southbound Off-ramp	Southbound LR	c	19.4	b	13.8
Eastern Dr. & Route 9 Northbound On-ramp	Northbound LT	a	7.5	a	8.1
Silver Street & Eastern Drive	Eastbound LTR	a	7.5	a	8.4
	Westbound LTR	a	8.5	a	7.8
	Northbound LTR	d	34.8	d	33.1
	Southbound LTR	b	10.7	c	18.8

Table 5.5-1 (Cont.) 2001 Existing Levels of Service					
Level Of Service Summary – 2001 Existing Conditions					
Approach <sup>(1)</sup>		Peak AM Hour		Peak PM Hour	
		LOS <sup>(2)</sup>	Delay (sec.) <sup>(3)</sup>	LOS	Delay (sec.)
Bow Lane & Eastern Dr./Route 9 Northbound Off-ramp	Eastbound LTR	a	9.55	a	8.49
	Westbound LTR	a	8.65	a	8.17
	Northbound LTR	b	13.37	a	8.52
Border (need double line)	Southbound LTR	a	8.31	a	8.04
	OVERALL	b	11.71	a	8.28
River Road & Silver Street/Silvermine Road	Eastbound LTR	a	7.3	a	7.5
	Westbound LTR	a	7.4	a	7.3
	Northbound LTR	a	9.7	a	9.7

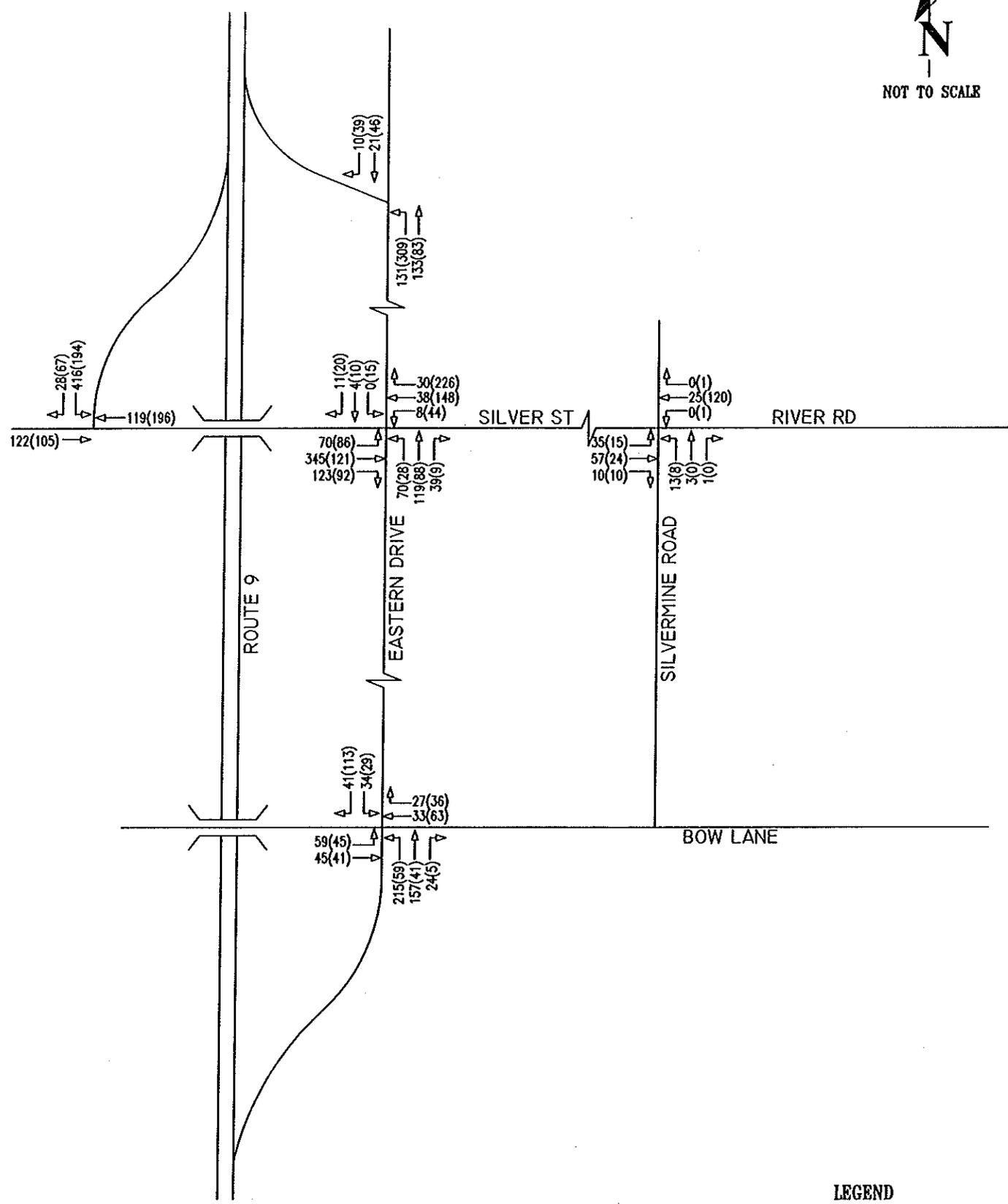
NOTES:

- (1) L-Left, T-Through, R-Right, LTR-Shared Left, Through, Right, etc.
- (2) Unsignalized intersections LOS denoted by lower case letters. Signalized intersection LOS denoted by upper case letters. LOS= Level of Service.
- (3) sec. = seconds

As indicated in Table 5.5-1, Eastern Drive and Route 9 Southbound off-ramp and Eastern Drive and Route 9 Northbound on-ramp are the only two intersections that do not have a shared left, through, and right turning lane. Eastern Drive and Route 9 Southbound off-ramp has a shared left and right turning lane. Eastern Drive and Route 9 Northbound on-ramp has a shared left and through lane.

**5.5.5 Projected Traffic volumes in 2005 without the Project**

A compounded growth rate of 2.0% per year for four years was applied to the existing traffic volumes to account for future background growth, including any potential adjacent developments. These volumes are shown on Figure 5.5-3.



**LEGEND**

00 - PEAK AM HOUR  
 (00) - PEAK PM HOUR

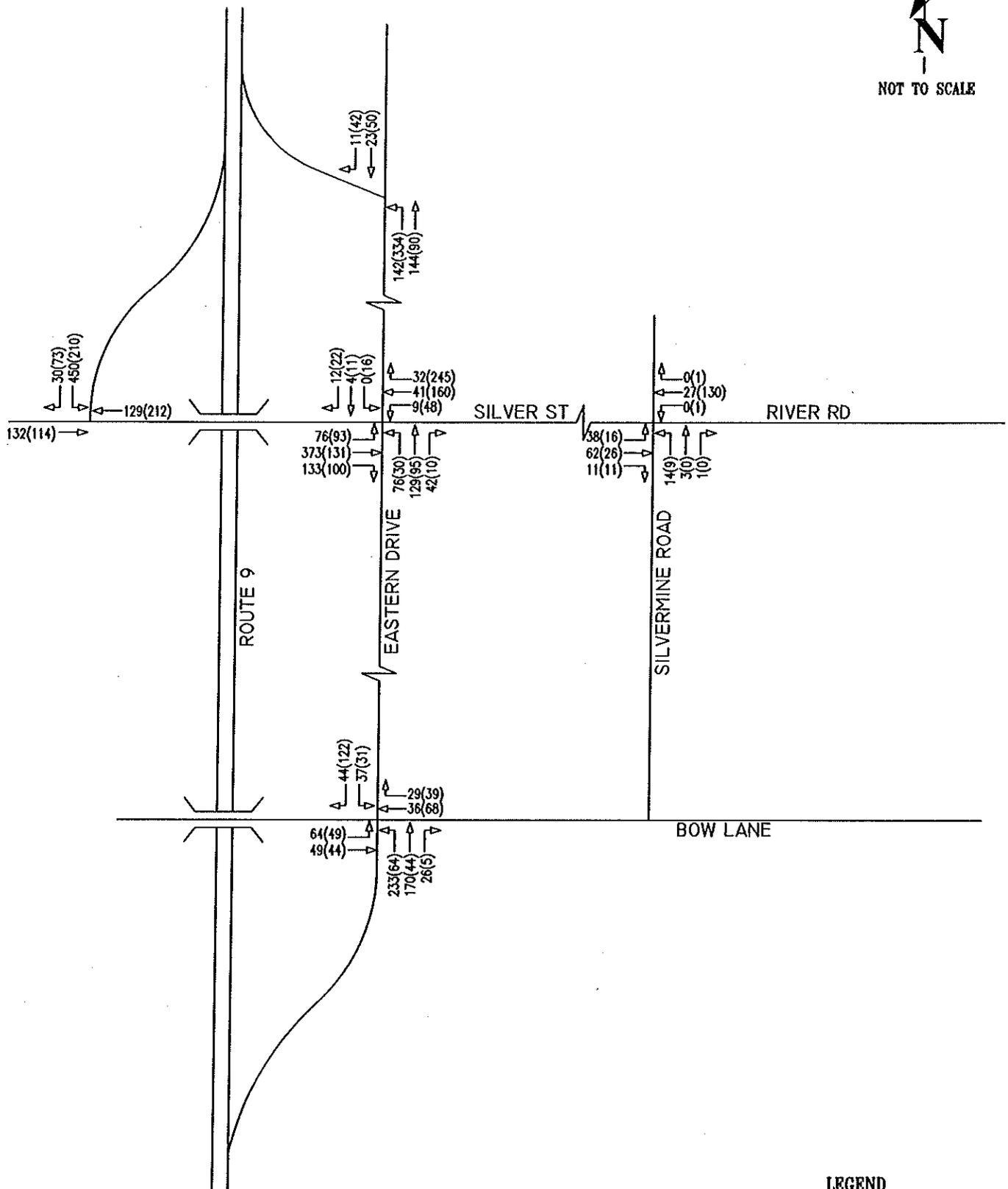
**TRC Raymond Keyes Associates**  
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**2001 EXISTING TRAFFIC VOLUMES**  
 MIDDLETOWN, CT

DATE: 03/15/02  
 JOB NO. 33876  
 FIGURE NO.5.5-2



NOT TO SCALE



**LEGEND**

00 - PEAK AM HOUR  
 (00) - PEAK PM HOUR

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2005 NO-BUILD TRAFFIC VOLUMES  
 MIDDLETOWN, CT

DATE: 03/15/02  
 JOB NO. 33876  
 FIGURE NO.5.5-3

### 5.5.6 Projected Generated Traffic and Distribution

The ability of any roadway network to accommodate anticipated traffic volumes is measured by comparing the Peak Hour traffic volumes to roadway capacities. Thus, it is essential to determine the hourly traffic volumes to be generated by the proposed Project and add those volumes to the No-Build Traffic Volumes for each Peak Hour. Trips to be generated by the facility were determined based upon employee information provided by Kleen Energy. On weekdays, 15-19 employees will operate the plant during the day shift with 2-3 employees working the other shifts. The estimated trip generation for the proposed facility for each of the Peak Hours is outlined in Table 5.5-2 below.

	<b>Operational Peak Hour Trip Generation</b>			
	<b>Peak Am Hour</b>		<b>Peak Pm Hour</b>	
	<b>Enter</b>	<b>Exit</b>	<b>Enter</b>	<b>Exit</b>
Employee Trips	19	2	3	17

As illustrated in the above table, the facility will not generate a significant number of vehicular trips during operation. It should be noted that the above trips generation is conservative as facilities of this nature generate their traffic outside of the peak roadway hours.

The arrival/departure patterns for traffic to be generated by the facility were developed based upon a review of existing traffic patterns in this vicinity as well as the adjacent roadway network and the U.S. Census Journey-to-Work data. Accordingly, the estimated arrival/departure distribution patterns are illustrated on Figures 5.5-4 and 5.5-5.

### 5.5.7 2005 Projected Traffic Volumes with Project in Service

The Project-generated traffic volumes were assigned to the roadway network in accordance with the arrival/departure distributions, resulting in the site-generated traffic volumes illustrated on Figure 5.5-6. The site-generated traffic volumes were then combined with the 2005 Projected Traffic Volumes (2% compounded growth rate per year above existing volumes), resulting in the 2005 Traffic Volumes with the Project in operation. These are illustrated on Figure 5.5-7. To be conservative, the site-generated traffic volumes were added to the peak roadway hour traffic volumes, even though they would actually occur when the adjacent roadway contains less traffic.

### 5.5.8 2005 Projected Operating Conditions with Project in Operation

Capacity analyses were conducted for the 2005 Future Operating Conditions without (No-Build) and with (Build) the proposed Project for the Peak AM Hour and Peak PM Hour for the studied intersections in the vicinity of the site. The results of the capacity analyses are summarized in Tables 5.5-3 and 5.5-4 below.

**Table 5.5-3 Morning Peak Capacity Analysis – 2005  
Level Of Service Summary  
2005 Peak Am Hour Operating Conditions**

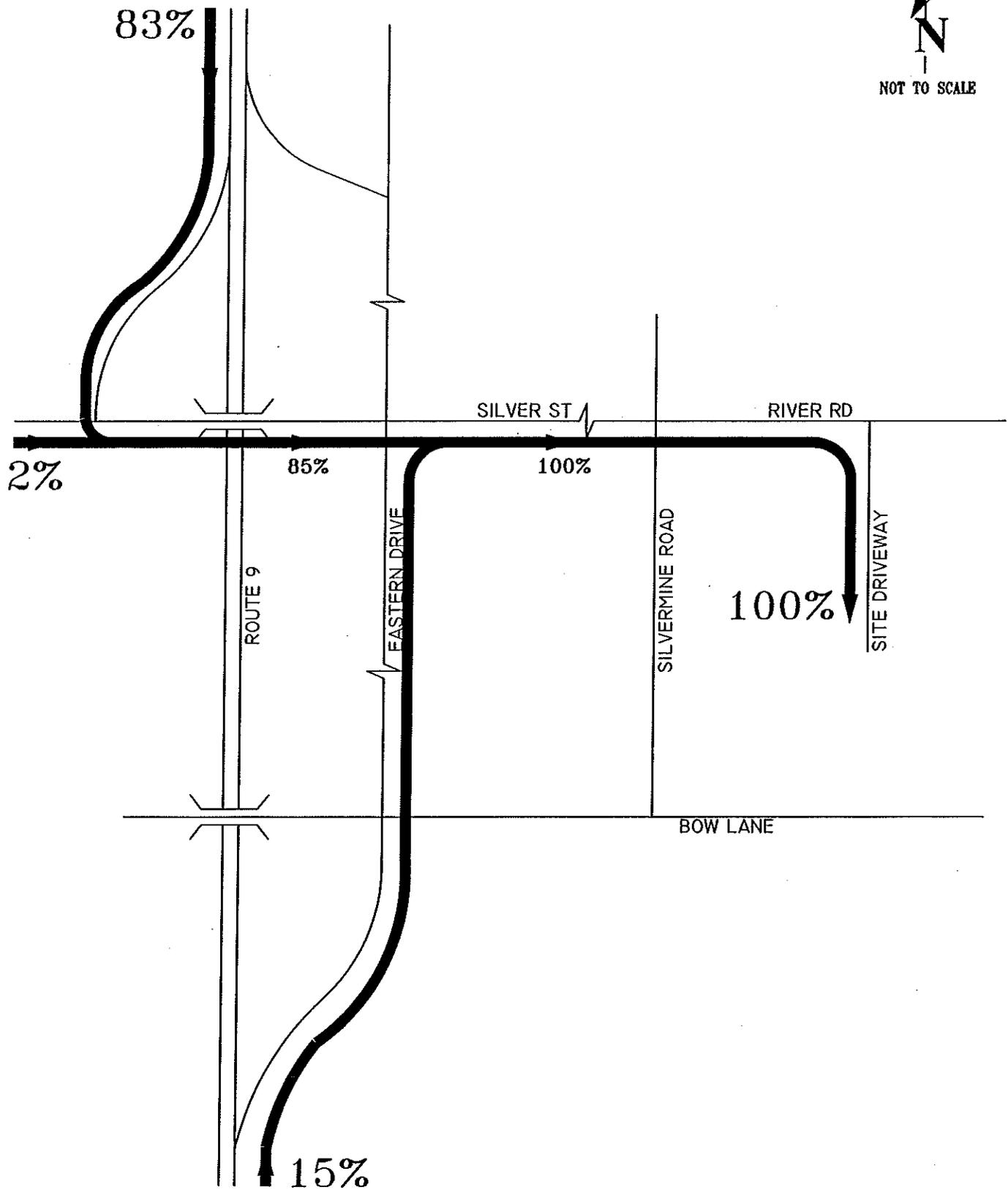
Approach <sup>(1)</sup>		No-Build		Build (Peak Construction)	
		LOS <sup>(2)</sup>	Delay (sec.) <sup>(3)</sup>	LOS	Delay (sec.) <sup>(3)</sup>
Silver St at Route 9 Southbound Off-ramp	Southbound LR	c	23.5	c	24.8
Eastern Dr. at Route 9 Northbound On-ramp	Northbound LT	a	7.5	a	7.5
Silver Street at Eastern Drive	Eastbound LTR	a	7.5	a	7.5
	Westbound LTR	a	8.6	a	8.6
	Northbound LTR	f	51.7	f	56.1
	Southbound LTR	b	10.9	b	11.0
Bow Lane at Eastern Dr./Rt. 9 Northbound Off-ramp	Eastbound LTR	a	9.88	a	9.90
	Westbound LTR	a	8.90	a	8.91
	Northbound LTR	b	14.96	c	15.07
	Southbound LTR	a	8.54	a	8.54
	OVERALL	b	12.80	b	12.88
River Road at Silver St./Silvermine Rd.	Eastbound LTR	a	7.3	a	7.3
	Westbound LTR	a	7.4	a	7.4
	Northbound LTR	a	9.8	a	9.9
River Road at Site Access Road	Westbound LT	-	-	a	7.4
	Northbound LR	-	-	a	9.1

NOTES:

- (1) L-Left, T-Through, R-Right, LTR-Shared Left, Through, Right, etc.
- (2) Unsignalized intersection LOS denoted by lower case letters. Signalized intersection LOS denoted by upper case letters. LOS = Level of Service.
- (3) sec. = seconds.



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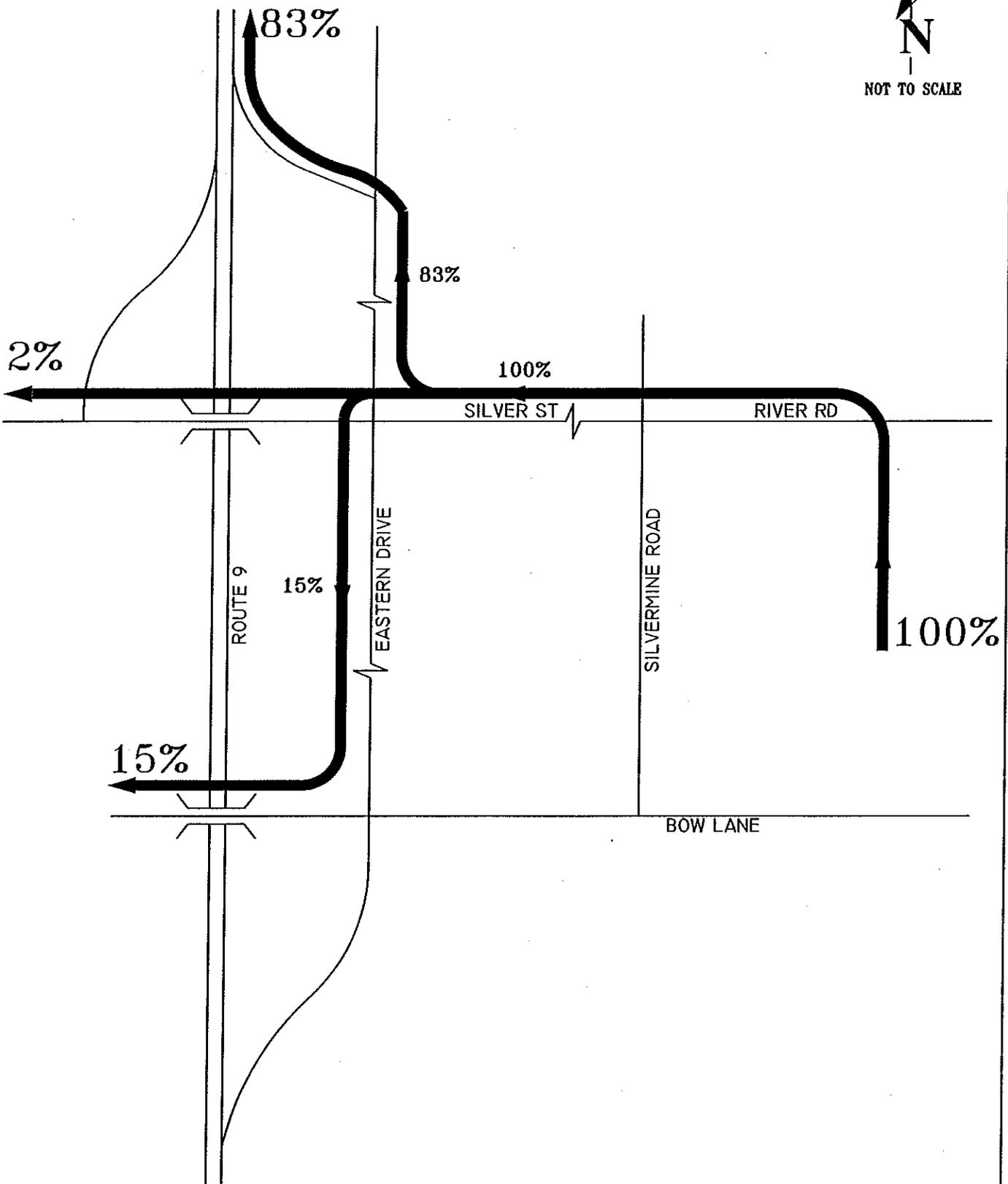
DATE: 03/15/02

JOB NO. 33876

FIGURE NO.5.5-4



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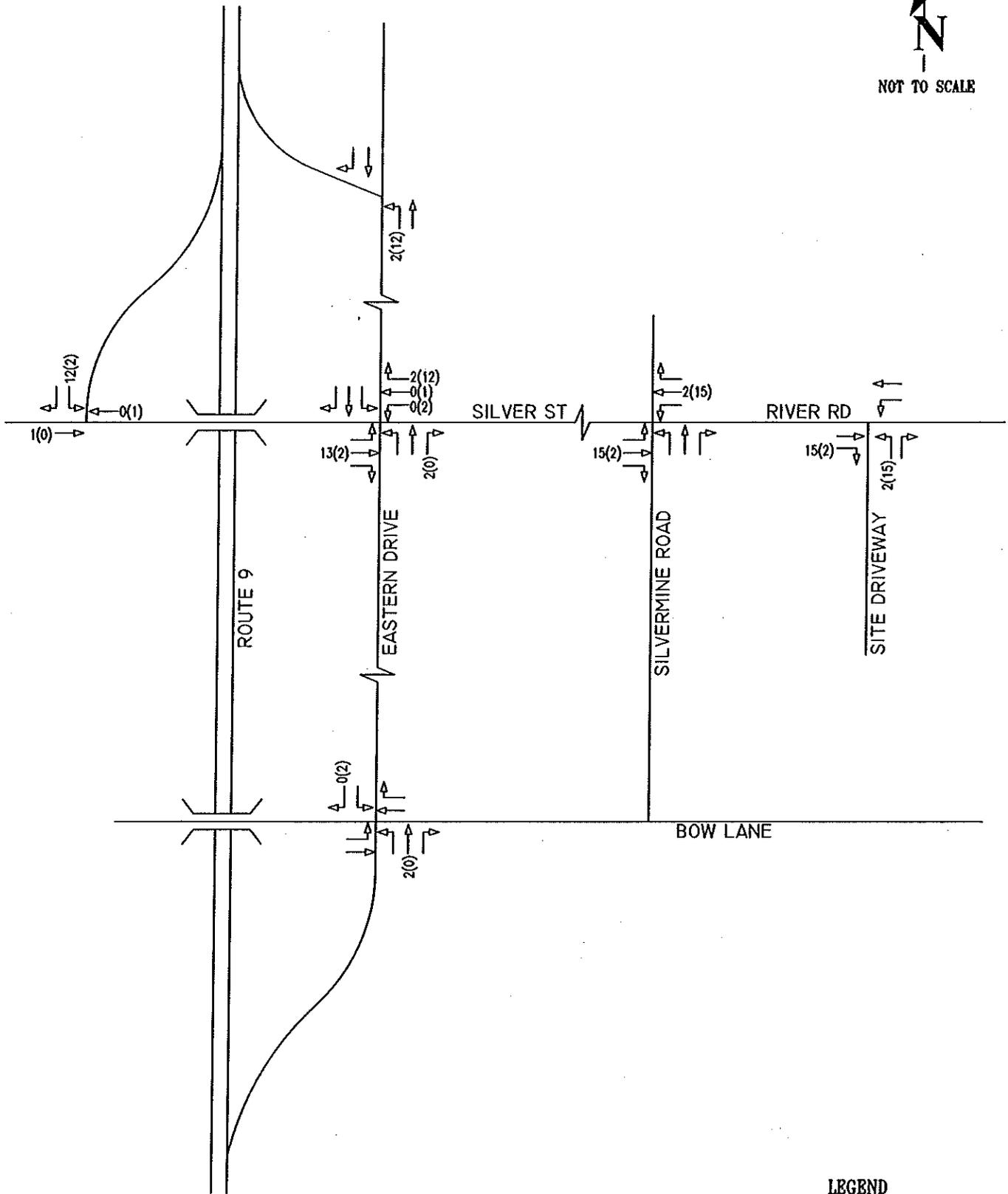
DATE: 03/15/02

JOB NO. 33876

FIGURE NO.5.5-5



NOT TO SCALE



**LEGEND**

00 - PEAK AM HOUR  
(00) - PEAK PM HOUR

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2005 SITE GENERATED  
TRAFFIC VOLUMES  
MIDDLETOWN, CT

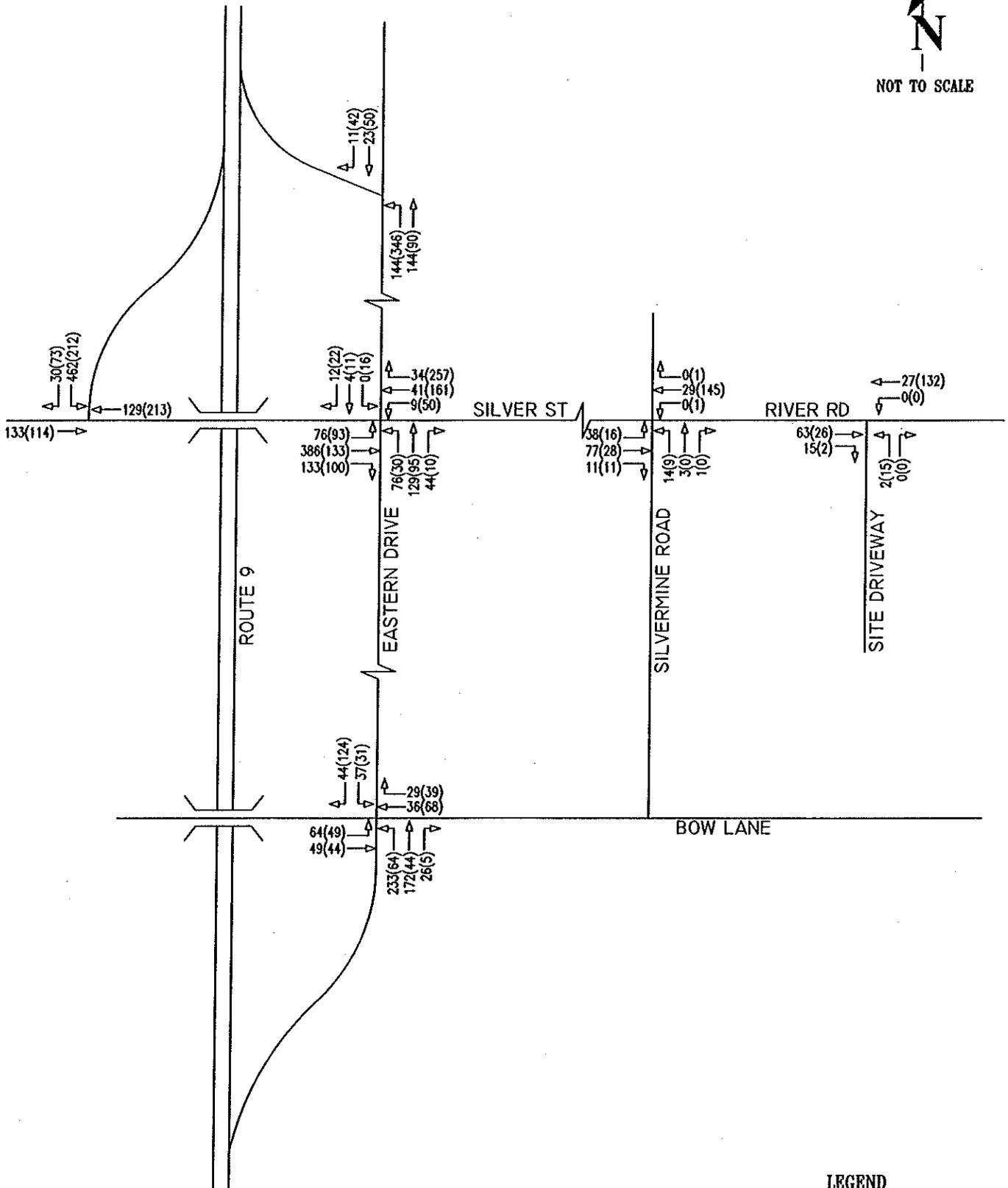
DATE: 03/15/02

JOB NO. 33876

FIGURE NO.5.5-6



NOT TO SCALE



LEGEND

00 - PEAK AM HOUR  
(00) - PEAK PM HOUR

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2005 BUILD TRAFFIC VOLUMES

MIDDLETOWN, CT

DATE: 03/15/02

JOB NO. 33876

FIGURE NO.5.5-7

**Table 5.5-4 Afternoon Peak Capacity Analysis – 2005  
Level Of Service Summary  
2005 Peak Pm Hour Operating Conditions**

Approach <sup>(1)</sup>		No-Build		Build (Peak Construction)	
		LOS <sup>(2)</sup>	Delay (sec.) <sup>(3)</sup>	LOS	Delay (sec.) <sup>(3)</sup>
Silver St at Route 9 Southbound Off-ramp	Southbound LR	b	14.9	b	14.9
Eastern Dr. at Route 9 Northbound On-ramp	Northbound LT	a	8.2	a	8.2
Silver Street at Eastern Drive	Eastbound LTR	a	8.6	a	8.6
	Westbound LTR	a	7.9	a	7.9
	Northbound LTR	e	44.7	e	47.7
	Southbound LTR	c	22.0	c	22.8
Bow Lane at Eastern Dr./Rt. 9 Northbound Off-ramp	Eastbound LTR	a	8.65	a	8.65
	Westbound LTR	a	8.32	a	8.33
	Northbound LTR	a	8.69	a	8.69
	Southbound LTR	a	8.22	a	8.23
	OVERALL	a	8.44	a	8.45
River Road at Silver Street/Silvermine Road	Eastbound LTR	a	7.5	a	7.6
	Westbound LTR	a	7.3	a	7.3
	Northbound LTR	a	9.8	a	9.9
River Road at Site Access Road	Westbound LT	-	-	a	7.3
	Northbound LR	-	-	a	9.5

NOTES:

- (1) L-Left, T-Through, R-Right, LTR-Shared Left, Through, Right, etc.
- (2) Unsignalized intersection LOS denoted by lower case letters. Signalized intersection LOS denoted by upper case letters. LOS = Level of Service.
- (3) sec. = seconds.

As illustrated above in Tables 5.5-3 and 5.5-4, the proposed Project will not have a significant impact on the study intersections during the Peak AM and Peak PM Roadway Hours. All intersections will continue to operate at the same overall intersection Level of Service even after the facility is constructed. The unsignalized Eastern Drive northbound movement at Silver Street may experience some delay during the Peak AM Hour. As modeled, the condition without the Project for this intersection will experience a delay of 51.7 seconds. As modeled with the Project, the delay is predicated to be 56.1 seconds. Therefore, no improvements are recommended at any of the locations as a result of the Project.

**5.5.9 Construction Impacts**

The peak construction period is anticipated to occur in the Year 2004. Construction-related traffic was therefore estimated for that period. Construction is anticipated to be completed within a 24-month timeframe and during much of that period, traffic volumes will be significantly less during most of the construction period than during the peak period. The Peak Construction period, however, is considered in order to evaluate a “worst case” construction impact scenario. Table 5.5-5 contains a summary of the average number of construction workers on the site per day projected by month.

<b>Month</b>	<b>Day Shift Enter</b>	<b>Night Shift Enter</b>
1	17	0
2	38	0
3	49	12
4	78	15
5	75	15
6	90	19
7	119	15
8	187	16
9	220	10
10	246	2
11	321	2
12	350	2
13	354	9
14	404	9
15	400	14
16	400	16
17	389	26
18	373	26
19	324	26
20	267	26
21	188	16
22	122	16
23	76	9
24	52	6

During construction, there will be two categories of Project-related vehicular trips: work trips and equipment/supply delivery. The first category, worker trips, consists of the traffic associated with construction employees traveling to and from the Project site. The maximum number of construction workers employed at any one time is expected to be approximately 416, as illustrated above in Table 5.5-5 during Month 16. This level is expected to be reached slightly past midway through the construction schedule and will occur for a few months, while piping and electrical work continues after the combustion turbine and steam turbine generators have been installed. Before and after this peak, fewer construction workers will be required at the facility and vehicle trips will be correspondingly less.

To account for the additional traffic due to the construction work force, a conservative worker occupancy rate of 1.1 persons per vehicle was assumed. Considering a Peak AM Hour construction work force of 404 employees (see Table 5.5-5, Month 14), and conservatively assuming 50 percent arrive during the Peak Roadway Hour, a total of 182 vehicles would arrive during the Peak AM Hour. With a Peak PM employee count of 416 (total of both shifts – see Table 5.5-5, Month 16), utilizing the above methodology of 50 percent departing during the peak Roadway Hour, 182 would depart during the Peak PM Hour. This is a conservative assumption because the construction workers generally will not arrive/depart during the peak roadway hours. In addition to the arrival of the construction workers, truck trips arriving and departing during each peak roadway hour also were added to be conservative. Project-generated traffic volumes during the 2004 peak construction period are presented in Table 5.5-6.

It is expected that the majority of construction activity will occur during the daytime hours. Construction of the facility will be from 7:00 AM to 12:30 AM. It is possible that extensions of this basic workday or moderate amounts of additional evening work might occasionally occur. Such activity, however, would require only a small number of workers. Although some construction activity, such as the pouring of concrete for the building foundations, will require a prolonged workday, these activities will occur prior to the majority of the peak construction activity and will not involve significant traffic. Therefore, traffic from the construction workers will not have an impact upon the peak roadway hours of 7:30 to 8:30 AM and 2:45 to 3:45 PM, but will occur when there is less traffic on the adjacent roadways.

The second type of traffic associated with construction of the facility involves trips by trucks delivering construction materials, equipment and supplies. These vehicles include pick-up trucks, dump-trucks, concrete trucks, flatbed trucks, and tractor trailers.

Truck arrival time during civil construction of the facility would be between 6:00 AM and 6:00 PM. It is estimated that between 12 and 16 trucks per day will be required for deliveries to the site during the peak truck delivery period, which will be over a three-month period and will not coincide with a significant number of construction workers, conservatively assuming half will enter/exit the site during Peak Roadway Hours.

It should be noted that the majority of trucks will arrive during non-peak periods when traffic on the adjacent roadways is lower, not during the peak roadway hours or during the peak construction employee hours. Therefore, the trucks will not have a significant impact on traffic operating conditions in the area and no improvements are required at any of the locations.

Table 5.5-6 summarizes a conservative estimated Peak Hour number of construction worker and truck trips projected during the 2004 peak construction period.

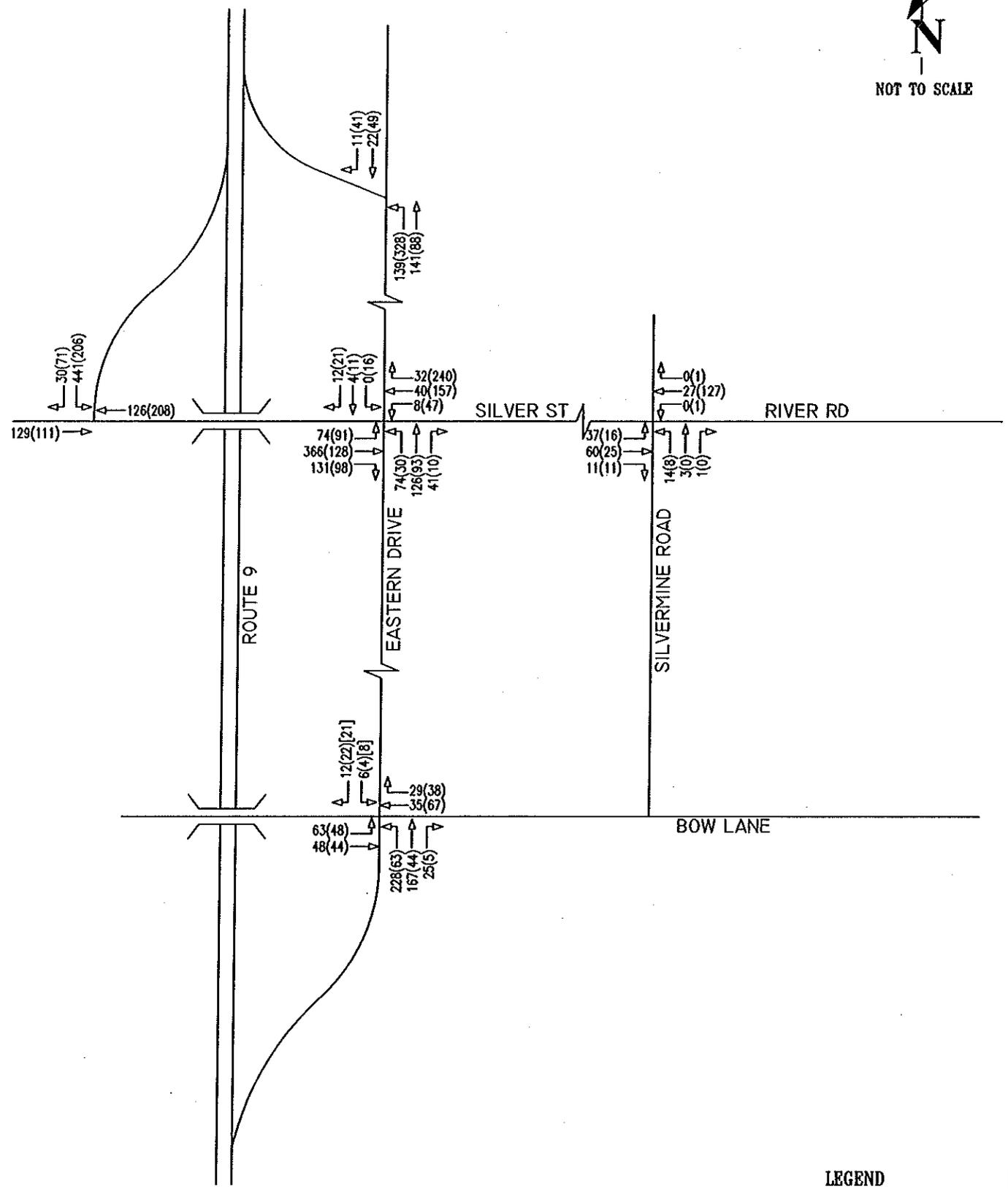
Vehicle Type	Peak AM Vehicles		Peak PM Vehicles	
	Enter	Exit	Enter	Exit
Construction Workers	184	4	7	182
Trucks	4	4	3	3
<b>TOTAL</b>	<b>188</b>	<b>8</b>	<b>10</b>	<b>185</b>

The projected trip generation construction worker and truck traffic volumes were assigned to the roadway network in accordance with the arrival/departure distributions, illustrated in Figures 5.5-4 and 5.5-5, resulting in the construction trip generated traffic volumes outlined in Figure 5.5-9. (It should be noted that in the possible rare occasion during construction that a truck may be over 13'8", the maximum bridge height for the Walnut Street bridge over Route 9, the truck would be required to use an alternative route exiting Route 9 southbound at Main Street). The Construction Generated Volumes were then combined with the 2004 Projected Traffic Volumes (2% compounded growth rate per year above existing volumes) (illustrated in Figure 5.5-8) to form the 2004 Peak Construction Traffic Volumes (see Figure 5.5-10).

Capacity analyses were conducted for the peak construction conditions for the study intersections in the vicinity of the site. The results of the capacity analyses are summarized in the following Tables 5.5-7 and 5.5-8.



NOT TO SCALE



LEGEND

00 - PEAK AM HOUR  
 (00) - PEAK PM HOUR

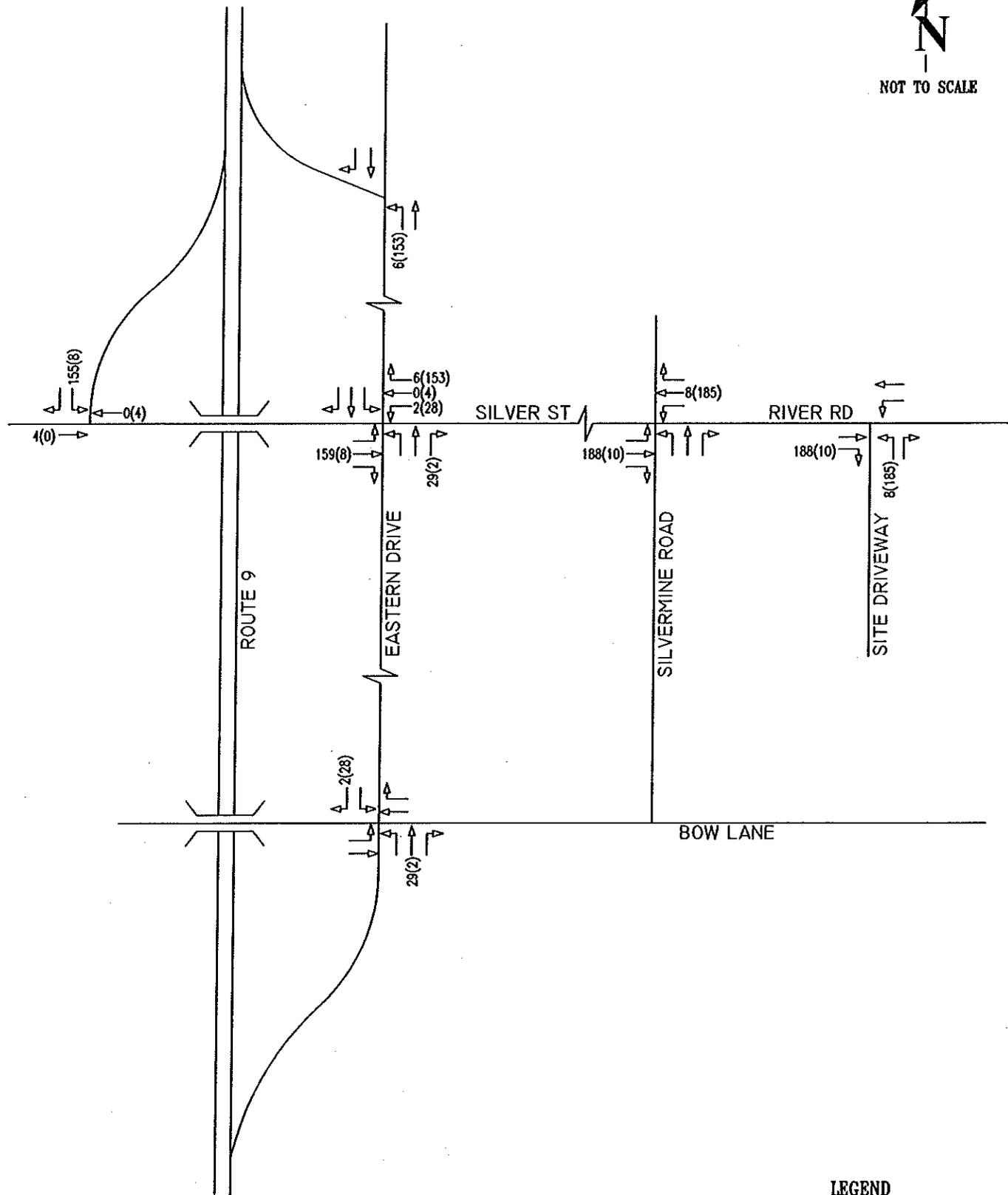
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2004 NO-BUILD TRAFFIC VOLUMES  
 MIDDLETOWN, CT

DATE: 03/15/02  
 JOB NO. 33876  
 FIGURE NO.5.5-8



NOT TO SCALE



**LEGEND**

- 00 - PEAK AM HOUR
- (00) - PEAK PM HOUR

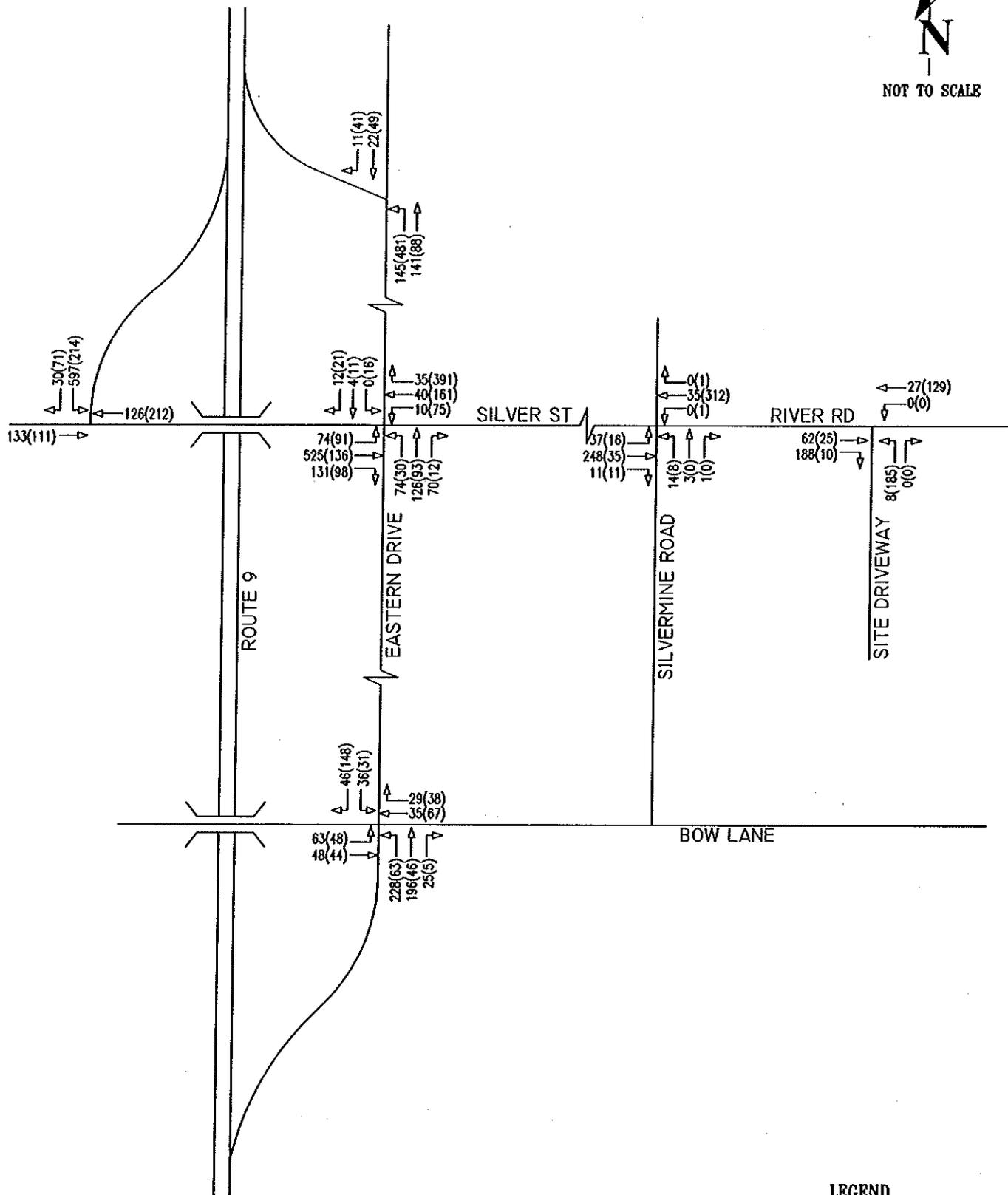
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**2004 SITE GENERATED TRAFFIC VOLUMES**  
 MIDDLETOWN, CT

DATE: 03/15/02  
 JOB NO. 33876  
 FIGURE NO.5.5-9



NOT TO SCALE



LEGEND

00 - PEAK AM HOUR  
(00) - PEAK PM HOUR

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2004 BUILD TRAFFIC VOLUMES

MIDDLETOWN, CT

DATE: 03/15/02

JOB NO. 33876

FIGURE NO.5.5-10

**Table 5.5-7 Morning Peak Capacity Analysis at Peak of Construction  
Level Of Service Summary – 2004 Peak Am Hour  
Peak Construction Conditions**

Approach <sup>(1)</sup>		No-Build		Build (Peak Construction)	
		LOS <sup>(2)</sup>	Delay (sec.) <sup>(3)</sup>	LOS	Delay (sec.) <sup>(3)</sup>
Silver St. at Route 9 Southbound Off- ramp	Southbound LR	c	22.3	f	52.8
Eastern Dr. at Route 9 Northbound On- ramp	Northbound LT	a	7.5	a	7.5
Silver Street at Eastern Drive	Eastbound LTR	a	7.5	a	7.5
	Westbound LTR	a	8.6	a	9.2
	Northbound LTR	e	45.2	f	130.6
	Southbound LTR	b	10.8	b	11.8
Bow Lane at Eastern Dr./Rt. 9 Northbound Off- ramp	Eastbound LTR	a	9.81	a	9.95
	Westbound LTR	a	8.83	a	8.95
	Northbound LTR	b	14.53	c	15.83
	Southbound LTR	a	8.48	a	8.56
	OVERALL	b	12.50	b	13.44
River Road at Silver Street/Silvermine Road	Eastbound LTR	a	7.3	a	7.4
	Westbound LTR	a	7.4	a	7.8
	Northbound LTR	a	9.8	b	11.4
River Road at Site Access Road	Westbound LT	-	-	a	7.8
	Northbound LR	-	-	a	9.6

NOTES:

- (1) L-Left, T-Through, R-Right, LTR-Shared Left, Through, Right, etc.
- (2) Unsignalized intersection LOS denoted by lower case letters. Signalized intersection LOS denoted by upper case letters. LOS = Level of Service.
- (3) sec. = seconds.

**Table 5.5-8 Afternoon Peak Capacity Analysis at Peak of Construction  
Level Of Service Summary – 2004 Peak Pm Hour  
Peak Construction Conditions**

Approach <sup>(1)</sup>		No-Build		Build (Peak Construction)	
		LOS <sup>(2)</sup>	Delay (sec.) <sup>(3)</sup>	LOS	Delay (sec.) <sup>(3)</sup>
Silver St. at Route 9 Southbound Off-ramp	Southbound LR	b	14.6	b	14.9
Eastern Dr. at Route 9 Northbound On-ramp	Northbound LT	a	8.2	a	8.7
Silver Street at Eastern Drive	Eastbound LTR	a	8.5	a	9.2
	Westbound LTR	a	7.8	a	7.9
	Northbound LTR	e	41.1	f	101.7
	Southbound LTR	c	21.3	e	36.6
Bow Lane at Eastern Dr./Rt. 9 Northbound Off-ramp	Eastbound LTR	a	8.62	a	8.73
	Westbound LTR	a	8.29	a	8.40
	Northbound LTR	a	8.66	a	8.75
	Southbound LTR	a	8.19	a	8.41
	OVERALL	a	8.41	a	8.55
River Road at Silver Street/Silvermine Road	Eastbound LTR	a	7.5	a	8.0
	Westbound LTR	a	7.3	a	7.3
	Northbound LTR	a	9.7	b	11.3
River Road at Site Access Road	Westbound LT	-	-	a	7.3
	Northbound LR	-	-	b	10.9

NOTES:

- (1) L-Left, T-Through, R-Right, LTR-Shared Left, Through, Right, etc.
- (2) Unsignalized intersection LOS denoted by lower case letters. Signalized intersection LOS denoted by upper case letters. LOS = Level of Service.
- (3) sec. = seconds.

As can be seen in Tables 5.5-8 and 5.5-9, during the Peak AM and PM Roadway Hours during construction, delays will be experienced at the Silver Street & Eastern Drive northbound movement during the Peak AM and PM Hours, and the Silver Street & Route 9 southbound Off-ramp during the Peak AM Hour. However, it should be noted that this is a temporary condition

and that analyses contained in this Study are very conservative, assuming a "worst case" scenario. In reality, the construction traffic will not occur during the Peak Roadway Hours. Traffic signal warrants would not be met. If delays become excessive during the peak construction period, traffic control officers can be provided. The remaining intersections will continue to operate at good Levels of Service. Therefore, as any delays would only be temporary, no improvements are recommended at these locations.

#### **5.5.10 Summary**

Traffic associated with the Project will not have a significant effect upon traffic operating conditions in the area. During and after construction of the Project, traffic on the adjacent roadway network will continue to flow in a safe and efficient manner. Additionally, a fuel spill risk assessment for access routes to the Project site is not required because both natural gas and fuel oil will be transported to the Project site via pipelines.

### **5.6 Historic, Cultural, and Archaeological Resources**

This section identifies whether known archaeological or historical resources are present on either the generating facility development site or contiguous areas. The potential impacts of the proposed facility on identified resources are also assessed.

A file review at the Connecticut Historical Preservation Office was performed in November 2001. No cultural, historical or archaeological resources were listed as being on the proposed Project site. The file review was performed for a one-mile radius. Within the one-mile radius, two find sites (113-015 and 113-003) were identified in the Town of Portland. The Town of Portland is located north of the Project site across the Connecticut River. However, no data was in the file with regard to the two find sites. Because the proposed Project is located across the Connecticut River from the recorded sites, no impacts are expected.

The Project site was mined for feldspar from the mid-1950s to the early 1990s. Due to the extensively mined nature of the site and a site walkover conducted by the Project archeologist, no archaeological resources are anticipated to be located on the site. Appendix E, Connecticut Historical Commission Correspondence, contains a summary of the archeological walkover conducted by the field archeologist.

### **5.7 Geological Conditions**

This section summarizes the soil and geology of the Project site, as documented in existing literature and site observation.

#### **5.7.1 Existing Topographic Settings**

The site is located on the south side of River Road in Middletown, Connecticut. Connecticut is broken into 4 geological regions: the Central Valley, the Coastal Lowland, the Western Highland and the Eastern Highland. The proposed site is located within the Central Valley region of

Connecticut. The Central Valley region exists within the area that the Connecticut River Valley passes through Connecticut.

Based on topographical maps, the elevation at the site ranges from approximately 100 feet to 400 feet above sea level. The change in elevation is variable on the site, with some areas having steep grades of over 35% slope.

Due to the range in elevation and slopes on site, leveling of the property will be part of the building plan. Additionally, as is discussed further in section 5.7.1.2, bedrock is exposed or near to ground surface over much of the site, so blasting will be necessary for site development. A blasting plan will be prepared as described below.

At a preliminary site walk, the site shows signs of rainwater erosion. Some elementary runoff control was evident on the site, including straw-bale barriers and run-off corridors, especially around the roadways and other areas where the surface vegetation was not present.

#### *5.7.1.1 Soil Analysis*

The site was previously used as a bedrock quarry, and much of the original soil on site was removed as overburden. Hence, the United States Department of Agriculture (USDA) soil survey for Middlesex County has no useful data on the soils located at the site. However, soils on the areas surrounding the site are relatively uniform and are probably representative of the soils that were on the site prior to removal to accommodate the mining operation. The USDA soil survey provides information about the soils surrounding the project site.

The soils surrounding the site are classified as "Hollis-Chatfield Rock Outcrop" Complex and "Charlton-Chatfield" Complex.

The Charlton series consists of very deep, loamy soils, usually well drained, formed in till. While the depth to bedrock is commonly more than 6 feet, rock fragments make up 50% of the soil below 40 inches. The permeability of this soil is moderate to moderately rapid while surface runoff ranges from medium to rapid.

The Chatfield series consists of moderately deep soils, usually well drained to excessively well-drained, formed in glacial till. Bedrock is typically between 20 to 40 inches below the soil surface. The permeability of this soil is moderate to moderately rapid while surface runoff ranges from medium to very rapid.

The Hollis series consists of shallow soils, usually well drained to excessively well drained, formed in a thin mantle of till derived mainly from gneiss, schist, and granite. Bedrock is typically only 10 to 20 inches below the soil surface. The permeability of this soil is moderate to moderately rapid while surface runoff ranges from negligible to very high, depending on soil slope.

### 5.7.1.2 *Bedrock Geology*

According to the Connecticut Geological and Natural History Survey, 1985, the bedrock at the project site is part of the Collins Hill Formation. This formation is rust-weathered, medium- to coarse-grained, poorly layered schist with a gray color. Schist is a crystalline, metamorphic rock with a closely foliated structure. (Rodger, 1985)

The depth to bedrock is variable within this region due to factors such as high relief of bedrock surfaces and postglacial erosion. (USGS, 1992) Soil characteristics of this area indicated that bedrock is found anywhere from 10 to 20 inches. Based on a preliminary site walk and site history, the bedrock appears very close, if not at, ground level in areas that are less disturbed. Bedrock is extensively exposed in the existing quarry pits.

### 5.7.2 *Hydrogeology*

The natural soil at this site was stripped away when the site was used as a quarry. Very little overburden exists on the site, and the depth of the remaining overburden is inconsistent. The site does not appear to have any significant overburden aquifer. The bedrock, as mentioned previously, is a crystalline, metamorphic rock. The metamorphic rock may act as a bedrock aquifer, but no historical data or physical data was found to verify this.

The nearest major water source to the site is the Connecticut River. Based on the topography of the site, surface water or groundwater is assumed to flow in a northern direction towards the Connecticut River.

The site does have some areas containing pooled water, such as in the major quarry. However, based on erosion control measures visible on site, the pooling water is largely a result of surface water run-off, rather than groundwater.

The Connecticut Water Resource Bulletin (1975) does not have data for the potential site in regards to aquifers. The majority of the test wells used in the Connecticut Water Resource Bulletin were in the sandstone bedrock region of Middletown, while the project site is located in a region with metamorphic bedrock.

### 5.7.3 *Seismic Conditions*

Middletown, Connecticut is located away from the edge of a tectonic plate. Earthquakes at plate boundaries are more frequent and more intense than earthquakes in the middle of a tectonic plate. However, moderate energy earthquakes are possible in mid-plate regions such as where the proposed site is located.

The site location is located next to the Eastern Border Fault. The stretching of bedrock during the Mesozoic Era formed this fault. (Little, 1996) Geologists believe earthquakes occurred along this fault helping to form the geology of New England, but no major earthquakes have occurred along this fault in recent history. (NEIC)

According to the National Earthquake Information Center, the following earthquakes occurred within a 15-mile radius of the site in the past 30 years. The date, magnitude, and distance from the Project site is shown in table 5.7-1.

<b>Date</b>	<b>Magnitude (Richter)</b>	<b>Distance from Site (miles)</b>
4/24/1976	2.20	10.6
6/17/1982	2.20	10.6
6/17/1982	2.20	10.6
6/17/1982	3.00	13.7
6/17/1982	2.40	11.2
9/11/1987	2.40	9.9
2/03/2001	1.80	11.8

For the facility area, the National Seismic Hazard Mapping Project of the United States Geological Survey has estimated a 2 percent probability of exceedance every 50 years of a peak ground acceleration at 0.14 g, and a 0.2 second spectral acceleration at 0.28g (g equals force relative to gravity) (USGS, 2001). Peak acceleration is a measure of the maximum force experienced by a small mass located at the surface of the earth during an earthquake. Spectral acceleration is an approximate measure of the force experienced by a building during an earthquake.

The structures proposed to support this facility will be designed in full accordance with the State of Connecticut seismic building codes.

#### **5.7.4 Proposed Blasting Plan**

Because of the site's prior use for mining, extensive work will be required to prepare level areas where the major project components will be located. Particularly in the lower areas of the site, extensive rock removal will be necessary. The only feasible approach to this work will be blasting. To ensure that necessary blasting operations will not have undue adverse effects, a blasting plan will be prepared prior to the beginning of blasting operations. The plan will be prepared by the blasting contractor and will be subject to the approval of the general contractor. At a minimum it will address the following issues.

- Coordination with local public safety officials including notification of blasting events and defining appropriate warning measures
- Charge sizes and limits
- Times of day when blasting operations will occur

- Evaluation of the potential for offsite impacts and the need for mitigation including use of blasting mats and monitoring seismographs
- Evaluation of the need for and implementation, as needed, for pre and post blasting surveys of nearby structures

Because the Project site is relatively remote, the likelihood of off-site damage is low. The blasting plan will be designed to ensure safe operations and further reduce the potential for damage.

## **5.8 Wetlands and Watercourses**

This section describes wetland and watercourse resources located on the site and an assessment of their functional value, the effect of the proposed Project layout, and proposed mitigation for the Project. The Middletown Inland Wetland and Watercourse Commission (MIWW) has approved the location of the Project pursuant to Conn Gen Stat § 16-50x(d).

### ***5.8.1 Inland Resource Delineations***

The USGS Middletown Quadrangle (1986) and the City's Inland Wetlands mapping (Nov. 1996) were reviewed and used as a basis for locating areas that exhibit characteristics of inland wetland and watercourse resources. Drawing C13 in Volume II depicts existing open water, siltation basins, channel and swales, and culvert locations. Also labeled on C13 are Areas 1-9, indicating the areas that have characteristics of MIWW wetlands and watercourses. The water-filled quarries and excavated depressions were delineated during field surveys using the MIWW definitions and "Notes on Criteria Used for Identifying Wet Soils in Connecticut and Rhode Island." A review of the Middletown Inland Wetlands mapping indicates that in 1996 there were two relatively deep quarries (Areas 1 and 1A) and one shallow stream (watercourse) flowing on the west-middle portion of the site. Another shallow stream (Area 2) (watercourse) traverses along the west boundary far from the proposed Project. In addition, a "canal," or what we would characterize as a drainage ditch, was mapped in 1996. It can be surmised that this channel was excavated and lengthened through the middle of the site to collect and convey surface and ground water seep. Subsequent to the construction of the channel, site drainage has eroded sub-channels and small depressions, some of which formed what we characterize as monotypic low quality wetland plant communities typical of disturbed sites.

Based on a review of the mapping noted above and several field surveys, TRC has determined that the wetland plant communities observed on the site developed after the cessation of mining activities within quarry pits, drainage swales, and depressions. Specifically, given the presence of shallow bedrock, apparent diversions of surface or sheet flow during mining operations have contributed to saturated soil conditions. It is estimated that wet areas on site have, over approximately 6 years, developed a predominance of hydrophytic vegetation as a result of their tolerance to adverse soil conditions and frequent saturation (see Section 5.8.3). The central orientation of the watercourse channel within extensively altered mining areas and steep grades, and its connection to the deep quarry pits, sediment capture, and wet depressions, have resulted

in a cascading water regime that now functions to control storm flow velocity and trap sediment from water leaving the site. A detailed functional assessment of these areas follows.

### **5.8.2 *Wetland and Watercourse Functional Assessment Summary***

A functional assessment of wetlands and watercourses in the proposed Project area was performed by TRC based on qualitative wetland functional value definitions provided in the Connecticut Bulletin Number 9 entitled "Method for the Evaluation of Inland Wetlands in Connecticut" (Ammann, Franzen, & Johnson, 1986). The functional assessment conducted for on-site wetlands and watercourses identifies the principal functions exhibited by each resource as well as any characteristics observed or inferred that are in transition or evolution as a result of the cessation of mining activity and site runoff. Wetland functional values can be determined in the field by the observation of various physical site conditions, hydrology, soils, vegetation and vegetation associations, mapping resources, and the application of wetland science and professional judgment. The wetland functional values assessment was conducted for the purpose of describing existing site characteristics, to compare project alternatives, avoid and minimize Project impacts, determine the significance of impacts, compare the potential impacts against project benefits, and to design and monitor compensatory wetland mitigation. Table 5.8-1 summarizes the type and condition of resources located on the site, their functional value, proposed impacts to these areas, and proposed mitigation. The following sections describe in detail the characteristics and functional attributes of the wetlands and watercourses found on the site.

### **5.8.3 *Wetland/Watercourse Descriptions and Functional Attributes***

Overall, the wetland functional assessment confirmed the site "hydrologic concept" expressed in foregoing sections. That is, the wetlands and watercourses evaluated have resulted from mining activities and the construction of a central channel to convey surface and ground water seep. As such, this drainage complex controls surface flow on the site fairly well. In general, the wetland plant communities that have developed during recent years function to trap sediment and filter drainage.

The TRC field assessment yielded a total of nine resource areas that exhibit watercourse and wetland characteristics or definitions enumerated in MIWW regulations, Section 2.42 or 2.44 respectively. The following describes in detail wetland characteristics of each resource on the site.

#### **5.8.3.1 *Areas 1 and 1A (Watercourse – Open Water/Wetland Scrub-shrub Fringe)***

Areas 1 and 1A are situated at the highest point along the presumed site hydraulic gradient and are well out of the proposed construction layout. These watercourse ponds have developed within quarry basins and are comprised primarily of open water with an extremely narrow scrub-shrub fringe along the outer margin of the basin and adjoining flat areas. A narrow channel leads out of the basin within which flow is diverted over a series of waterfalls and discharges downslope, forming an intermittent stream.

**Table 5.8-1 Summary of Regulated Areas, Impacts, and Mitigation**

Regulated Area	Type of Resource	Size of Resource	Primary Function(s)/Value (low, med., high)	Project Impact Area	Proposed Mitigation
Areas 1 and 1A- Watercourse	Deep quarry – man-made	1.25 acres and 0.38 acres (54,695 sq. ft. and 16,703 sq. ft.)	Water, nutrient retention; wildlife/ medium	0	None necessary.
Area 2 – Watercourse	Intermittent stream – altered	700 linear feet	Drainage; wildlife/ med.; low	400 linear feet	Restore and enhance to accommodate more flow; improve water quality with improved stream substrate.
Area 3 – Wetland/ Watercourse	Emergent wetland & intermittent watercourse formed in excavated depression.	0.36 acres (15,535 sq. ft.)	Water detention; sediment trap; wildlife/ med.; low	Excavation 0.36 acres (15,535 sq. ft.)	Restore and enhance to accommodate more flow; improve water quality through detention and improve wildlife use by constructing “wet pond” and bordering wetland habitat. 0.25 acres of wetland; 0.25 wet pond
Area 4 – Watercourse	Perennial stream	650 linear feet	Drainage attenuation and conveyance; sediment trap; wildlife use/ med.; low	Re-channel 80 linear feet	Restore channel with existing stone and vegetation
Area 5 – Wetland	Emergent isolated wetland formed in constructed wetland.	0.18 acre (7,839 sq. ft.)	Sediment trap/high	Fill 0.18 acre (7,839 sq. ft.)	Recreate at ratio of at least 1:1.2; improve water quality and wildlife use.
Area 6 – Watercourse/ Wetland	Emergent wetland with stream inlet and outlet formed in deep quarry.	0.44 acres (18,838 sq. ft.)	Drainage attenuation and conveyance; sediment trap; wildlife use/med.; med.; low	Fill 0.15 acres (6,545 sq. ft.)	Recreate adjacent to existing quarry 1:1.5; improve water quality and wildlife use.

**Table 5.8-1 Summary of Regulated Areas, Impacts, and Mitigation**

Regulated Area	Type of Resource	Size of Resource	Primary Function(s)/Value (low, med., high)	Project Impact Area	Proposed Mitigation
Area 7 - Watercourse/ Wetland	Forested wetland formed in excavated depression.	0.12 acre (5,279 sq. ft.) 625 linear feet stream	Drainage attenuation and conveyance; sediment trap; wildlife use.	Re-channel (currently piped) 300 linear feet of stream and 0.06 acre bordering wetland	Recreate 350 feet of stream channel with stone and restore 0.06 acre (3,000 sq. ft.) wetland vegetation for water quality enhancement.
Area 8 - Wetland	Emergent isolated wetland formed in quarry	0.27 acres (1,785 sq. ft.)	Drainage detention and sediment trap; wildlife/med.; medium.	Fill 0.12 acres (5,227 sq. ft.)	Recreate adjacent to existing quarry 1:1.5; improve secondary water quality function with using primary detention basin and constructing as "wet pond."
Area 9 - Watercourse/ Wetland	Scrub-shrub wetland formed from excavation or erosion situated between access roads.	0.02 acres (871 sq. ft.)	Drainage attenuation and conveyance; sediment trap/low	0	None necessary.
	Total Wetland Acres (emergent) Total Watercourse (stream length)	3.02 acres 1,975 ln.ft.	Total Wetland (emergent) Total Watercourse (stream length)	0.85 780 ln.ft.	Total Wetland/ Watercourse Replacement/Restoration 1.37 acres Total Stream Watercourse Restoration 780 ln. feet

Dominant plant species observed within the fringe community include *Vaccinium corymbosum* (highbush blueberry) and *Clethra alnifolia* (sweet pepperbush) with an admixture of *Myrica pennsylvanica* (bayberry) and *Kalmia latifolia* (mountain laurel). Scattered throughout the shrub fringe are *Acer rubrum* (red maple) and *Betula lenta* (sweet birch) stems.

Soils along the edge of the basin were comprised of tailings remaining from former quarry operations. There is very little, and in many areas, no organic matter present in bordering areas. Soils within the scrub-shrub fringe could not be effectively described due to an inability to penetrate further than 3 inches into the bedrock substrate.

The water columns in the quarry basins were observed to be nearly clear throughout. Surface runoff and groundwater seep appear to be the source of water for the quarry. Water depths within the basin are unknown. At the time of the initial field investigation, small fish were observed along the margins of the basin pools where water depths averaged 2 feet.

#### 5.8.3.2 Area 2 (Intermittent Watercourse)

This intermittent channel is dominated with young hardwood trees. Dominant plant species observed within the tree stratum include *Betula lenta* (sweet birch), *Acer rubrum* (red maple), and *Betula populifolia* (gray birch). The dominant shrub species observed include *Vaccinium corymbosum* (highbush blueberry). Within the understory, which was poorly developed, scattered patches of *Pilea pumila* (clearweed), *Polystichum acrostichoides* (Christmas fern) and *Polytrichum commune* (moss) dominated with only rare instances of *Onoclea sensibilis* (sensitive fern), *Smilacina racemosa* (false solomons seal), *Parthenocissus quinquefolia* (Virginia creeper), and *Clethra alnifolia* (sweet pepperbush) seedlings). Much of the forest floor is covered by leaf litter.

The plant community observed adjacent to the channel is also characterized as forested. Dominant plant species observed within the tree stratum adjacent plain included *Acer rubrum* (red maple), *Betula lenta* (sweet birch) with scattered *Ostrya virginiana* (American hophornbeam), *Betula populifolia* (gray birch) and *Populus deltoides* (cottonwood). All of these tree species exhibited shallow rooting systems, which in turn contribute to a mild hummock-hollow microtopography. Within the shrub layer, *Lindera benzoin* (spicebush) dominated, while *Pilea pumila* (clearweed) dominated the herbaceous layer, excluding nearly all other species with the exception of scattered *Osmunda cinnamomea* (cinnamon fern).

The channel substrate consists of medium sand with occasional cobbles. Soils within the level land adjacent to the channel are not poorly drained (hydric). The channel itself is more or less rectangular with a bed comprised of a mixture of sand, cobbles, and boulders. Channel width averages approximately three feet.

Upper reaches of the channel convey water out of Area 1, situated between two significant bedrock outcroppings. Water derived from Area 1 is diverted over a series of small rock waterfalls and discharges downslope. Standing water was observed within portions of the channel at a mean depth of four inches, no doubt a result of recent rainfall. Within down-stream portions of the channel, the bed angle lessens and the channel becomes wider with an associated

depositional plain. Specifically, channel width increased to five feet, with significant lateral accretion deposits and severe erosion scouring in apparent mine tailings deposited in the area. Where scouring was exceptionally deep, root systems of adjacent tree species are exposed. Standing water was not observed within this portion of the channel. The channel discharges or seeps into Area 3.

#### 5.8.3.3 Area 3 (Emergent Wetland/Pond)

Area 3 consists of an emergent wetland associated with the intermittent watercourse. This wetland is partly impounded by an adjacent roadway in addition to the steep surrounding topography. *Phragmites australis* (giant reed) dominate the wetland plant community. In addition to this species, *Pilea pumila* (clearweed) was observed in open spaces within the reed stand. Along the edge of the wetland, *Betula lenta* (sweet birch), *Acer rubrum* (red maple), *Hamamelis virginiana* (witch hazel), *Equisetum sp.* (horsetail), and *Aralia nudicaulus* (sarsaparilla) were observed. Along the edge of the wetland at the existing dirt access road, *Salix bebbiana* (Bebb willow), *Osmunda cinnamomea* (cinnamon fern), *Equisetum sp.* (horsetail), and *Polytrichum commune* (moss) have pioneered along a road drainage ditch.

In general, patches of organic matter are present within the surface of this wet area. These soils appear to be mine tailings deposited at various times during mine grading operations. Due to their position in the landscape, that is, down-gradient of an intermittent stream and in an excavated depression, the soils have become obviously saturated. They can be characterized as poorly drained.

Standing water was observed within this wetland in places at a depth of approximately 1 inch. The contribution of groundwater seep is evidenced by the presence of an iron precipitate. This precipitate was observed throughout the wetland and not just in the watercourse bed. Groundwater flow is discharged from the wetland into a narrow channel, which passes over the dirt access road and into Area 4.

#### 5.8.3.4 Area 4 (Perennial Watercourse)

Area 4 consists of an intermittent watercourse channel that drains into resource Area 6.

Plant species observed along the channel included young *Celastrus orbiculatus* (bittersweet), *Acer rubrum* (red maple), *Populus deltoides* (cottonwood), with occasional *Betula alba* (European white birch). A large *Tsuga canadensis* (hemlock) was observed within this community. *Polytrichum* (moss) mats were observed on some of the rocks within the channel.

Mean channel width was approximately three feet and the channel substrate is comprised of cobbles and boulders. Water depths averaged three inches for both pools and riffles within the channel. Water within the channel was observed to be turbid with a suspended solids load derived from the dirt roadway. These solids apparently settled out fairly quickly. Discharge water was observed to be clear after approximately 75 feet. The iron precipitate was observed in the channel bed after the 75-foot mark.

#### 5.8.3.5 Area 5 (Isolated Emergent Wetland)

This is a small and isolated emergent wetland that has developed within a quarry basin, or detention basin, apart from the system that has been described thus far. Significant disturbance has occurred along the edges of the wetland as evidenced by the deposition of quarry tailings and a retentive berm constructed of boulders.

Dominant plant species observed within this wetland include *Juncus canadensis* (Canada rush) and *Scirpus cyperinus* (woolgrass). In addition to these species there was an admixture of *Carex lurida* (shallow sedge), *Eleocharis obtusa* (blunt spikerush), and *Typha latifolia* (broad leaf cattail). Scattered shrubs included *Cephalanthus occidentalis* (button bush) and *Salix bebbiana* (bebb willow). The substrate of the pool was covered by a thin layer of a periphyton/algal mat.

Soils within the wetland were extremely shallow, situated on bedrock and are characterized as poorly drained. At the time of the field surveys, no standing water was observed in the wetland, although soils were saturated to the surface. Silt marks on vegetation within the basin indicate that water levels fluctuate as much as 1.5 feet. Given no evidence of groundwater seep, this detention basin wetland is derived from surface hydrology.

#### 5.8.3.6 Area 6 (Emergent Wetland)

Area 6 is associated with the intermittent watercourse that drains much of the surrounding area and is situated within the largest quarry pit observed on this portion of the site. This is also the largest wetland observed.

The dominant plant species within this wetland is *Phragmites australis* (giant reed), which has formed a monotypic stand. Species occurring at lower frequencies included *Populus deltoides* (cottonwood) and *Betula lenta* (sweet birch). These hardwoods were growing at the very edge of the wetland. The dominant species observed includes scattered *Alnus rugosa* (speckled alder) and a vine called *Celastrus orbiculatus* (bittersweet).

Soils within Area 6 were observed saturated to the surface and have characteristics of somewhat poorly drained soils laying on bedrock at approximately 19 inches below the surface. Groundwater input is present, as evidenced by the presence of the iron precipitate and actual flow from the intermittent watercourse that cascades down a 30-foot waterfall at the east end of the wetland. At this point, water discharges from the wetland and flows to a excavated channel from the intermittent watercourse converge. This flow discharges into Area 7. Channel width reaches approximately 5 feet in width. Channel substrate was comprised of equal mixture of sand, gravel and cobbles, and graduates to boulders on the slope situated between Area 6 and Area 7. Iron precipitate was also observed within the watercourse channel.

#### 5.8.3.7 Area 7 (Emergent Wetland)

Area 7 consists of an intermittent watercourse channel and a small associated forested wetland. Channel width is approximately three feet and the depth of water within the channel is approximately four inches. Flow was observed to be moderate, approximately 1.0 feet per

second (fps). The channel substrate is comprised of mixture of sand, cobbles, and boulders. Within the wetland, the main watercourse divides into a series of smaller "braided" channels.

The dominant plant species observed alongside the watercourse channel include *Alnus rugosa* (speckled alder). Within the wetland the dominant plant species include *Salix nigra* (black willow) with scattered *Ostrya virginiana* (American hophornbeam) and *Populus deltoides* (cottonwood). Within the herbaceous layer, *Pilea pumila* (clearweed) and *Impatiens capensis* (spotted touch-me-not) dominate, with only a small patch of *Phragmites australis* (giant reed).

Soils within this wetland were observed saturated and they have characteristics of poorly drained soils.

The watercourse passes through the wetland and terminates at the point of tangency along the dirt access road. At this point, based on field observations, flow enters a 32 inch (inner diameter) concrete pipe, which shunts flow beneath the road and parallel for approximately 100 feet. Channel flow resumes for only 20 feet before it is directed into another 32 inch corrugated metal pipe. This pipe passes perpendicularly beneath the dirt road and discharges flow onto the adjacent hillside where it once again becomes channelized. Flow then passes into another 32 inch pipe, is directed beneath River Road, and then discharges into the Connecticut River.

#### 5.8.3.8 Area 8 (Emergent Wetland)

Wetland 8 is a small, isolated scrub-shrub wetland identified alongside the dirt access road within the construction laydown area. Dominant plant species observed within the wetland include *Alnus rugosa* (speckled alder), *Salix bebbiana* (bebb willow), and *Scirpus cyperinus* (woolgrass). Within this plant community, the speckled alders formed a fairly dense stand of interlocking individuals. To the north of this shrub-dominated community is a monotypic stand of *Phragmites australis* (giant reed), with an admixture of *Carex lurida* (shallow sedge) and scattered *Alnus rugosa* (speckled alder).

Bedrock was observed at 12 inches in this wetland. Soils within the wetland have characteristics of poorly drained soils. This wetland is essentially an isolated pool. It appears to receive primarily surface water and is generally in an elevated position within the landscape relative to the other wetlands identified on the site. Although there is a v-shaped ditch situated at the northern border of the wetland, there was no evidence of significant flow out of the channel; there was no evidence by scour marks or deposited material. Drainage diversions located in the surrounding around appear to have been excavated during mining operations at various times, and subsequently abandoned.

#### 5.8.3.9 Area 9 (Emergent Wetland)

Area 9 is a very small emergent scrub-shrub wetland and is the most downgradient wetland identified on the site. It is bisected by the perennial watercourse described as Area 7 above. The wetland itself is situated in a depression between two access roads.

Dominant plant species observed within the wetland include *Lindera benzoin* (spicebush), *Pilea pumila* (clearweed), *Alnus rugosa* (speckled alder), and *Dryopteris cristata* (crested fern).

Bedrock was observed at 16 inches, rendering the soils as poorly drained. This wetland appears to be driven primarily by groundwater discharge. Specifically, the wetland occurs on a fairly steep slope and soils were saturated throughout. Water depths within the watercourse channel at the time of the site visit were on the order of 2-3 inches. Watercourse width within the wetland is two feet.

#### **5.8.4 Wetland Functional Values and Impact Assessment**

##### **5.8.4.1 Functions and Value Assessment Methodology**

The functions and values of wetlands and watercourse resources on the site were assessed based on the definitions enumerated in the DEP Bulletin Number 9 entitled "Method for the Evaluation of Inland Wetlands in Connecticut: A Watershed Approach" (Ammann et al., 1986). Applicable functional attributes considered in evaluating the wetlands and watercourses on site are summarized as follows:

- (1) Ecological Integrity – Evaluates the overall health and function of the wetland ecosystem.
- (2) Wildlife Habitat – Evaluates the suitability of the wetland as habitat for species generally associated with wetlands and wetland edges. No single species or group of species is emphasized.
- (3) Finfish Habitat – Evaluates the suitability of watercourses associated with the wetland for either warm-water or coldwater fish. No single species or group of species is emphasized.
- (4) Educational Potential – Evaluates the suitability of the wetland as a site for an "outdoor classroom."
- (5) Visual /Aesthetic Quality – Evaluates the visual and aesthetic values of the wetland.
- (6) Water Based Recreation – Evaluates the suitability of the wetland and associated watercourses for non-powered boating, fishing, and other similar recreational activities.
- (7) Flood Control – Evaluates the effectiveness of the wetland in reducing watercourse flooding.
- (8) Groundwater Use Potential – Evaluates the potential use of the underlying aquifer as a drinking water supply.
- (9) Nutrient Retention and Sediment Trapping – Evaluates the effectiveness of the wetland as a trap for sediment and nutrients in runoff water from surrounding upland.

- (10) Noteworthiness – Evaluates the wetland for certain special values such as critical habitat for endangered species, etc.

#### *5.8.4.2 Wetland Functional Assessment*

With the exception of Areas 5 and 8 (isolated wetlands) all resource areas are linked by a perennial watercourse channel. Due to the disturbed origin and nature of the wetlands and watercourses identified on the site, the functional significance of any one area is considered very low. Consequently, the following sections discuss the functional values associated with the watercourse and associated wetlands as a wetland/watercourse complex. The isolated wetlands identified as Areas 5 and 8 will be described separately. Drawing C14 (Volume II) depicts the existing topography and regulated areas on the site with the proposed Kleen Energy Generating Facility overlay. Table 5.8-1 lists and summarizes the wetland and watercourses located on the site, their type, and relative size, and primary functional value, as well as the affected area (fill or alteration) resulting from the proposed layout of the Kleen Energy Project. In addition, Table 5.8-1 lists the proposed compensation area for areas affected by the Project.

#### *5.8.4.3 Watercourse/Wetlands Areas 1-4, 6, 7, and 9*

This wetland and drainage complex inherently provides two principal functional values: nutrient retention and sediment trapping. A minor functional value, wildlife habitat, has developed in this complex as a result of the cessation of mining activities and the presence of a varied water regime. Other functions are either non-existent or considered so low in significance, they are not evaluated.

##### *Nutrient Retention and Sediment Trapping:*

The conditions or qualifiers that indicate the wetland/watercourse complex onsite has the potential for nutrient retention and sediment trapping include:

- There are potential sources of excess sediment in the sub-watersheds surrounding the wetland/watercourse complex;
- Rock-lined channels, depressions that have formed into wetlands trap sediments;
- Organic/sediment deposits have formed within the quarry bottoms;
- Vegetation has formed in depressions which may utilize excess nutrient and attenuate flows through the wetlands;

##### *Wildlife Habitat:*

The following conditions and qualifiers apply to this attribute on site:

- Wetlands and channels are contiguous;

- Wildlife may use this wetland/channel complex for overland access and cover to other wetlands and upland;
- Plant/animal indicator species are present, that is, some of the wetlands have habitat characteristics for amphibian populations and cover for bird activity.

#### *5.8.4.4 Potential Impact on Functional Attributes of Areas 1-4, 6, 7 and 9*

The central wetland/watercourse complex eventually drains to the Connecticut River via a surface and groundwater discharge. Although the wetlands associated with the watercourse are small relative to the overall drainage watershed, the headwater location makes flow attenuation and sediment trapping the primary functional attribute on this site. Based upon landscape position and previous disturbance, any fill-related impacts to onsite wetlands and watercourses could change the capacity for nutrient retention and sediment trapping on the site. Other minor functions exhibited by the wetlands associated with the watercourse and the isolated wetlands, namely wildlife habitat, would also be lost or compromised by filling or excavation. However, given the existing disturbed nature of the wetlands and surrounding landscape, this function presumably occurs at a very low level. As demonstrated in the Mitigation Plan enumerated in Section 5.8.5, these functional attributes not only can be maintained, they can be enhanced.

#### *5.8.4.5 Isolated Wetlands (Areas 5 and 8)*

The isolated wetlands provide two functional values with the primary function identified as nutrient retention and sediment trapping. The secondary functional value identified is wildlife habitat (namely amphibian habitat).

#### *5.8.4.6 Nutrient and Sediment Trapping*

The conditions or qualifiers that exist for this function in these two isolated wetlands include:

- There are potential sources of excess sediment that may drain to these areas;
- There are saturated soils in these areas that are vegetated and provide nutrient retention and water flow attenuation.

#### *5.8.4.7 Wildlife Habitat*

The following conditions or qualifiers apply to these two isolated wetlands:

- These wetlands provide conditions suitable for amphibian populations and potential avian cover.

#### *5.8.4.8 Potential Impact of Functional Attributes of Areas 5 and 8*

Given their isolated location within a heavily disturbed sub-watershed, these wetlands may provide some trapping of sediments and the retention and transformation of nutrients. However, due to their isolation from the central watercourse that leads to the Connecticut River, their importance is considered low for this function. Their significance in terms of wildlife potential, such as vernal pool habitat is higher. If these areas are filled, amphibians utilizing these isolated wetlands would be displaced. However, most of the proposed Project site occurs in areas that have been disturbed during the quarry and mining operation. Given that this site has a long history of deforestation and other disturbances, the impacts to amphibians are expected to be temporary or minor in terms of population density. Indeed, a majority of the wetland complex will remain undeveloped or in certain cases will be enhanced. Specifically, as indicated in the proposed mitigation plan (see Section 5.8.5), impacts to amphibian and reptile species will be compensated through the construction of both wetland and open water habitat on the site. The consequence of this is that amphibian species are expected to utilize these created habitats and continue to have access to a significant amount of available adjacent habitat on the site. Based upon the history of disturbance and the resilience of species present on this site, amphibian patterns of movement will return and exceed the pre-disturbance state following the construction of the Kleen Energy Generating Facility.

#### *5.8.5 Wetland Mitigation Plan*

##### *5.8.5.1 Sediment and Erosion Control Measures*

Wetlands and watercourses located outside of the layout of the Project will be protected from indirect impacts from erosion and siltation through the implementation of Best Management Practices (BMP's) prepared as part of Kleen Energy Systems Erosion/Sediment Control Plan. The proposed BMP's will minimize erosion, the migration of sediments, and adverse impacts to the wetland/watercourse on the site. These BMP's will include the use of detention ponds, grassed swales with temporary sediment traps, and haybale and/or silt fence barriers to minimize erosion and sedimentation outside the limits of construction, and stabilized construction roadways. Both construction and operational stormwater will be controlled according to existing sub-drainage areas on the site to maintain or even reduce peak stormwater flows. The proposed sedimentation basins have been sized to correspond with their respective sub-watershed area (Drawing C21, Volume II, depicts the overall Erosion and Sediment Control Plan for the proposed Project) to capture peak flows, and secondary "wet ponds" and wetland areas will be created to provide additional storm flow attenuation, sediment trapping, and enhance wetland and wildlife habitat.

Design measures taken to provide effective sediment and erosion control within the areas during construction include the concept of a series of appropriately sized catch basins and rock-lined and grass-lined swales/ditches that direct stormwater runoff to the detention ponds and wet ponds; silt barriers around stockpile areas; a site roadway system that will decrease road grades and employ a series of catch basins that will discharge to appropriately engineered detention basins and secondary wet ponds; and, during facility operation, a landscape plan that will include re-seeding all disturbed areas on the site and plantings in wetland areas.

The facility site stormwater control plan directs site runoff to nine detention basins, which have been designed to address state and local stormwater management guidelines (Appendix J). The stormwater runoff design maintains the existing drainage patterns present at the site. Sheet flow will be directed to constructed rock or grass swales, which will then be discharged to the proposed sedimentation basins.

Sediment and erosion controls will be installed in those areas where the placement of additional topsoil and the removal of vegetation are proposed. Geotextile fabric and haybales will be used to prevent erosion. This combination will effectively minimize sediment transport into onsite wetlands/watercourses and the Connecticut River. Temporary sediment and erosion control structures will be left in place until all exposed soil has successfully re-vegetated.

#### *5.8.5.2 Proposed Wetland Restoration and Compensation*

As previously described, the wetlands and watercourses observed on the site presumably developed into the wetland/watercourse complex observed today after the cessation of mining activities on the site. The existing wetland complex on the site is functioning as a means of controlling the velocity and the sediment load of water leaving the site in addition to providing low quality aquatic wildlife habitat.

The primary goals of the wetland compensation/mitigation plan herein is to minimize the filling of the wetland drainage complex on the site and expand those wetland functions found and within the existing wetlands/watercourses. Overall, this mitigation strategy will improve water quality discharging the site to the Connecticut River. A secondary goal is to increase the wildlife habitat potential on the site by introducing additional native wetland plant species in increased species richness (i.e. species structure and diversity). Specifically, the target plant species will consist of primarily aquatic and palustrine emergent wetland species. This can be achieved within both the restored and created wetlands proposed as mitigation. Kleen Energy Systems proposes to restore and create 1.37 acres wetlands and 780 feet of stream on the site, a net increase of 0.52 acres wetlands and 50 linear feet of stream habitat.

A detailed wetland restoration and compensation plan was submitted to the City of Middletown Inland Wetland and Watercourse Commission. The plan set up a framework in which to achieve the two goals outlined above, minimize filling of wetland areas and increase wildlife. Post construction monitoring included monitoring reports, photographic stations, and sampling. The restoration and compensation plan has been approved by the MIWW.

## **5.9 Ecology and Wildlife**

### *5.9.1 Background*

Field surveys were conducted to characterize and evaluate existing terrestrial, wetlands, and watercourse habitats on the 137 acre Project site. As is typical, emphasis was placed in delineating and characterizing potential wetland and watercourse habitats due to their regulatory

importance. Overall ecological and wildlife characteristics are summarized in the following sections.

The Project site is situated along the west side of River Road in Middletown adjacent to and up-gradient of the Connecticut River. The existing topography and much of the surrounding area ranges from moderately steep (10-30% slope gradient) to steep (20-60 % slope gradient). Approximately 27% of the site (40 acres) exhibits direct disturbance resulting from over 100 years of mining operations, with portions of the landscape consisting solely of quarry spoils (primarily feldspar tailings and micaceous deposits). The undisturbed portions of the site include early-mid phase successional plant communities, including terrestrial, forest stands, old-field, quarry-bottom with saturated sediments, and intermittent and perennial watercourses. In addition to these vegetation cover types, open water habitat is present on the site in the form of rain filled quarries positioned at the central and upper portion of the site, not far from Bow Lane.

#### 5.9.1.1 Existing Vegetative Communities

In general, wildlife species respond to the presence and/or transitions in vegetative communities. On the Project site it is readily apparent that vegetative communities on site have adapted to disturbance as evidenced by early to mid-successional plant communities. The plant communities observed on the site have previously been extensively altered and some remain in a disturbed condition devoid of vegetation or natural plant community structure. Two dominant terrestrial plant communities were observed and characterized on the Kleen Energy parcel, including *mesic Quercus* (oak) – *Betula* (birch) forested stands, and early-phase old field. There are also two sub-dominant communities on the parcel, including *Alnus rugosa* (speckled alder) stands and a plant community (Chasmophytic) adapted to rock-face and fissure environments, such as quarry walls, characteristically found in vegetation patches. These vascular species are commonly associated with non-vascular species including lichens. Descriptions of the dominant habit types on the site are as follows.

##### *Mesic Quercus* (oak) – *Betula* (birch) Northern Hardwood Forested Stand:

This particular stand type is the dominant vegetative cover type on the site and is typically observed on northeasterly facing ridges and slopes where the slope gradient exceeds 20%. Tree species noted within this stand type include the co-dominants *Quercus rubra* (northern red oak) and *Betula lenta* (sweet birch), with scattered *Acer rubrum* (red maple), *Betula allegheniensis* (yellow birch), *Betula pendula* (European white birch), *Acer saccharum* (sugar maple), and *Tsuga canadensis* (eastern hemlock). Within the shrub stratum, *Kalmia latifolia* (mountain laurel) is dominant with scattered occurrences of *Hamamelis virginiana* (witch hazel). The herbaceous layer is poorly developed and only includes *Aralia nudicaulis* (sarsaparilla), *Equisetum* sp. (horsetail), *Polystichum acrostichoides* (Christmas fern), and occasional patches of *Polytrichum commune* (haircap moss).

Within disturbed portions of this stand type, ruderal species tolerant of increased irradiance (light) levels and the microclimate unique to gaps (treefalls) were observed. Specifically, within the tree stratum, *Populus deltoides* (cottonwood) and *Betula populifolia* (gray birch) become more significant components. Within the shrub stratum *Rubus odoratus* (purple flowering

raspberry) forms dense thickets, with occasional *Berberis thunbergii* (Japanese berberry) and *Myrica pennsylvanica* (bayberry).

#### 5.9.1.2 Early-Phase Old Field

Small patches of early-phase old-field were observed in various portions of the site in areas cleared during the mining operation. Dominant species include the grass *Schizachyrium scoparium* (little bluestem) and other forbs including *Centaurea maculosa* (spotted knapweed), *Dauca carota* (Queen Anne's Lace), and *Saponaria officinalis* (bouncing bet). Dominant vines include *Parthenocissus quinquefolia* (Virginia creeper) and *Lonicera japonica* (Japanese honeysuckle). In addition to these species, occasional *Lonicera tatarica* (honeysuckle) and *Juniperus virginiana* (eastern red cedar) scattered throughout this low-standing plant dominated community.

#### 5.9.1.3 Shrub Community – Speckled Alder

A dense monotypic stand of *Alnus rugosa* (speckled alder) was observed occurring in non-hydric soils adjacent to an access road. Although typically associated with wetlands, speckled alder can form dense stands in the absence of hydric soils. This species will often do well in sandy and nutrient poor soils with little to no organic matter and achieves this by means of mycorrhizal associations. Mycorrhizae (“fungus roots”) function to simply increase the absorptive surface area of the plants roots which allows the species to maximize nutrients occurring at low levels. This is a symbiotic relationship, whereby the plant obtains nutrients accumulated from the soil by the fungus, and the fungus obtains organic nutrients synthesized by the plant.

#### 5.9.1.4 Wetland and Watercourse Vegetation

Wetland plant communities observed on the site have characteristics of one of two community types: palustrine emergent and palustrine scrub-shrub. Dominant plant species observed within palustrine emergent communities included *Phragmites australis* (giant reed), *Carex lurida* (lurid sedge), *Scirpus cyperinus* (wool grass), and *Juncus effusus* (soft rush). Dominant species observed in scrub shrub communities include *Salix bebbiana* (bebb willow), *Alnus rugosa* (speckled alder), with occasional *Cephalanthus occidentalis* (buttonbush). These species are also species adapted to disturbance, as well as saturated soil conditions.

As described in more detail above, the watercourse channel, has been characterizes as having been created during mining operations to control and convey storm and base flow, traverses the middle of the site and includes the following dominant tree species: *Betula lenta* (sweet birch), *Acer rubrum* (red maple), and, *Betula populifolia* (gray birch) saplings. The dominant shrub species observed in this community is *Vaccinium corymbosum* (highbush blueberry). Within the understory, which is poorly developed, scattered patches of *Pilea pumila* (clearweed), *Polystichum acrostichoides* (Christmas fern) and *Polytrichum commune* (moss) dominate, with only rare instances of *Onoclea sensibilis* (sensitive fern), *Smilacina racemosa* (false solomons seal), *Parthenocissus quinquefolia* (Virginia creeper), and *Clethra alnifolia* (sweet pepperbush) seedlings.

### 5.9.2 *Expected Wildlife Species*

With respect to potential wildlife, most of the species that may be encountered on the site are likely habitat generalists, and as such, will utilize a broad range of available habitats and food sources, including such transition habitats as wetlands and early successional fields. Additional bird species are likely to be present during spring and fall migrations. Although no rare species were observed during site visits, nor are they expected, the CT Department of Environmental Protection (CTDEP) and the U.S. Fish and Wildlife Service (USFW) will be contacted to review their records for any known occurrences of rare, threatened and endangered species.

The proximity of the Project Site to the Connecticut River affords the possibility that the forested stands discussed above may be used by migrating songbirds (e.g., warblers), during periods of Spring and Fall migration in association with flyway corridor and riverine habitat along the River.

As detailed in Section 5.8 Wetlands and Watercourses above, the field surveys revealed a total of nine resource areas ranging in size from 0.02 to 1.4 acres that have characteristics of open water habitat, vegetated wetlands, intermittent and perennial watercourses, or some combination thereof. The wetland plant communities observed on the site presumably developed after the cessation of mining activities that resulted in quarry pits, drainage channels, and depressions left during stages of mining operations. The presence of bedrock, steep side walls, groundwater, and diverted surface water has contributed to saturated soil conditions where, over time, have developed a predominance of wetland (hydrophytic) vegetation. Given the orientation of the watercourse channel, and the location of the quarry pits, the wetland complex on the site functions primarily as a means of controlling the velocity and the sediment load of water leaving the site, with little wildlife significance.

The permanent water present on the site is likely to provide limited habitat for aquatic species such as turtles and amphibian species. During the site visit, *Rana clamitans* (green frogs) were observed along the edges of the open water habitat present at the headwaters of the wetland/watercourse system and the permanent sections of the watercourse. The intermittently standing water present in some of the wetlands and the watercourse channel is anticipated to provide only limited habitat for certain herptiles. It is plausible that some ponded areas on site could function as vernal pool habitat for species such as *Rana sylvatica* (wood frog) and *Pseudacris c. crucifer* (spring peepers).

The absence of natural undisturbed soils on the site render ground-burrowing mammal species (e.g. moles, groundhogs, and shrews) that are typically associated with the surface soil horizon unlikely to persist on this site. Deer, rabbits, and field mice may roam the site since there is extensive forested land adjacent to the parcel that affords more suitable habitat for these species.

Appendix F contains all written correspondence with the Connecticut Department of Environmental Protection, Environmental & Geographic Information Center with regard to the Connecticut Natural Diversity Database review.

### 5.9.3 *Project Effects on Wildlife*

#### 5.9.3.1 *Terrestrial Species*

Wildlife inhabiting areas of old field and forested areas within the construction footprint may be affected by the Project. However, most of the Project site occurs in areas that have been previously cleared during the mining operations and large forested sections of the 137-acre site and adjacent properties are undeveloped. Moreover, previously cleared areas that have remained undisturbed since the cessation of mining operations are reverting back to old-field and early successional forest. Consequently, species that utilize these types of habitats will continue to have access to a significant amount of available habitat on the site and within adjacent areas.

Given that this site has a long history of deforestation and other disturbances, the impacts to wildlife resulting from re-development of the site are expected to be insignificant. Based upon the history of disturbance and the resilience of species present on this site, wildlife patterns of movement will return to a pre-disturbance state following the construction of the proposed electric generating facility.

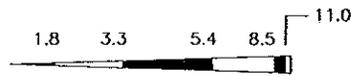
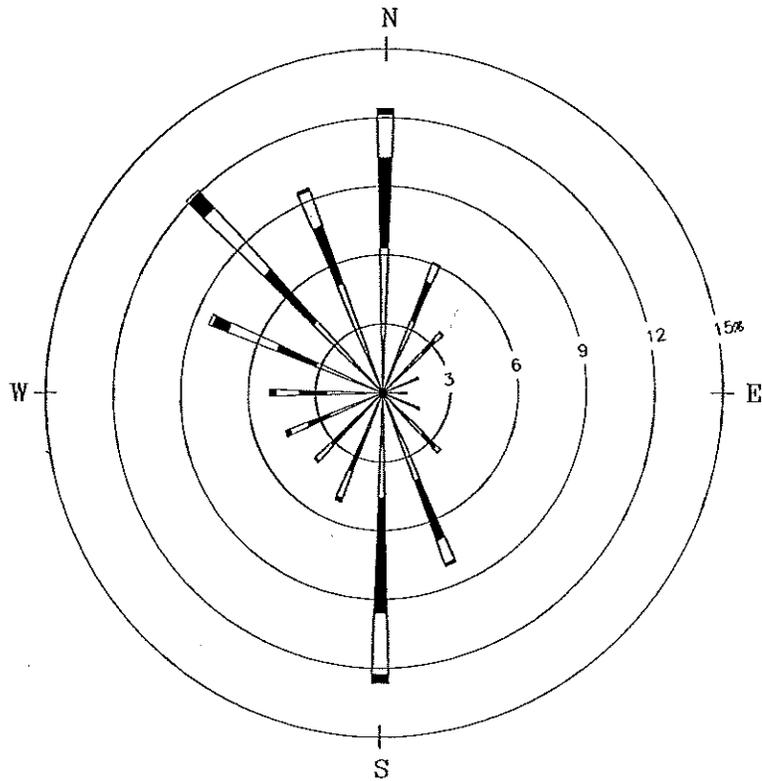
#### 5.9.3.2 *Wetland and Aquatic Species*

Impacts to amphibian and reptile habitat and some species will be compensated for through the construction of both wetland and open water habitat on the site as detailed in the restoration and compensation plan.

## 5.10 *Air Quality*

### 5.10.1 *General Climate*

Middletown, Connecticut lies in the northern temperate continental climate zone. This zone is characterized by prevailing winds with directions from the west and large-scale, migratory storm systems, resulting in virtually all wind directions being observed at some time during each year. The most representative, full-time weather observing station for the Middletown area is the National Weather Service office at Bradley International Airport in Windsor Locks, Connecticut, about 27 miles north of the project site. Bradley Airport and the proposed Project site are both located within the Connecticut River Valley. The normal annual precipitation at Bradley is 44.14 inches and the annual mean temperature is 49.8 degrees Fahrenheit. July is the hottest month, with normal daily maximum temperatures of 85.0 degrees, and January is the coldest month, with normal daily minimum temperatures of 15.8 degrees. Figure 5.10-1 shows the frequency distribution of wind directions and speeds measured at Bradley Airport. The valley's general north to south orientation is reflected in the wind patterns shown in Figure 5.10-1.



WIND SPEED CLASS BOUNDARIES  
(METERS/SECOND)

NOTES:  
 DIAGRAM OF THE FREQUENCY OF OCCURRENCE OF EACH WIND DIRECTION.  
 WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING.  
 EXAMPLE - WIND IS BLOWING FROM THE NORTH 12.4 PERCENT OF THE TIME.

## WINDROSE

STATION NO: 14740  
 WINDSOR LOCKS, CT  
 PERIOD: 1970-1974

Figure 5.10-1

BEE-LINE  
 SOFTWARE

### 5.10.2 Air Quality Regulations and Standards

Air emissions from the proposed Project are comprehensively regulated in accordance with the federal Clean Air Act and State law administered by DEP. The proposed Project must obtain construction and operating permits from DEP for its air emissions. As part of the permitting process, DEP must determine that the proposed Project meets all applicable regulatory standards. These standards include both technology-based standards and emissions limitations designed to assure that the proposed Facility will not interfere with the maintenance or attainment of State and federal ambient air quality standards. The following sections of this report summarize the key air quality requirements that apply to the proposed Project.

#### 5.10.2.1 Ambient Air Quality Standards

DEP and EPA have promulgated ambient air quality standards to protect the public health and welfare. The Connecticut and National Ambient Air Quality Standards (CAAQS/NAAQS) include Primary Standards, which are set at levels to protect human health, including the health of sensitive subpopulations, such as children or those with chronic respiratory problems. These regulations also contain Secondary Standards set at levels to protect public "welfare," including economic interests, visibility, vegetation, animal species, and other non-health related concerns. The NAAQS pertain to six "criteria" air pollutants: Particulate matter with a nominal aerodynamic diameter of less than or equal to 10 micrometers (PM<sub>10</sub>); sulfur dioxide (SO<sub>2</sub>); nitrogen dioxide (NO<sub>2</sub>); carbon monoxide (CO); ozone (O<sub>3</sub>); and lead (Pb). In addition, Connecticut has adopted standards for ambient dioxin and hydrocarbon concentrations. The CAAQS/NAAQS have been set for various concentration averaging periods.

DEP monitors ambient air quality at several sites throughout the State. In order to establish the existing or "background" pollutant concentrations, DEP's Ambient Impact Analysis Guideline (DEP, 1989) recommends that the average concentrations for the nearest three monitoring stations for the most recent three years be used. The most recent air quality monitoring data available are for the monitoring years 1998 through 2000. The background concentrations applicable to the City of Middletown and central Connecticut for the pollutants that will be emitted by the proposed Facility are:

- PM<sub>10</sub> Annual Average = 6.9 µg/m<sup>3</sup>
- PM<sub>10</sub>, 24-Hour Second High = 39.7 µg/m<sup>3</sup>
- Sulfur Dioxide, Annual Average = 15.7 µg/m<sup>3</sup>
- Sulfur Dioxide, 24-Hour Second High = 64.5 µg/m<sup>3</sup>
- Sulfur Dioxide, 3-Hour Second High = 107 µg/m<sup>3</sup>
- Nitrogen Dioxide, Annual Average = 38.3 µg/m<sup>3</sup>

Connecticut does not monitor carbon monoxide in most areas of the State because the levels are quite low. For dispersion modeling purposes, DEP recommends setting the background concentration for carbon monoxide equal to one-half of the ambient standard.

Under the Clean Air Act, major sources of air pollution in areas that comply with the ambient standards must undergo a "Prevention of Significant Deterioration" (PSD) review. The PSD regulations are designed to assure that there is no significant deterioration of air quality in areas meeting federal standards. These regulations establish increments, which set the maximum allowable increases in air pollutant concentrations permitted for all new sources. A summary of the air quality standards appears in Table 5.10-1.

Pollutant	Averaging Period	NAAQS		CAAQS		Class II PSD Increment <sup>(4)</sup>
		Primary	Secondary	Primary	Secondary	
PM <sub>10</sub>	Annual <sup>(1)</sup>	50	50	50	50	17
	24-Hour <sup>(2)</sup>	150	150	150	150	30
Sulfur Dioxide	Annual <sup>(3)</sup>	80	--	80	--	20
	24-Hour <sup>(4)</sup>	365	--	365	--	91
	3-Hour <sup>(4)</sup>	--	1300	--	1300	512
Nitrogen Dioxide	Annual <sup>(3)</sup>	100	100	100	100	25
Carbon Monoxide	8-Hour <sup>(4)</sup>	10,000	10,000	10,000	10,000	--
	1-Hour <sup>(4)</sup>	40,000	40,000	40,000	40,000	--
Ozone	1-Hour <sup>(2)</sup>	235	235	235	235	--
Lead	3-Month <sup>(3)</sup>	1.5	1.5	1.5	1.5	--
Dioxins	Annual <sup>(3)</sup>	--	--	0.000001	0.000001	--
Hydrocarbons	3-Hour (6-9 AM)	--	--	160	160	--

(1) Not to be exceeded by the arithmetic average of the annual arithmetic averages for three successive years.

(2) Not to be exceeded more than an average of once per year over three years.

(3) Not to be exceeded.

(4) Not to be exceeded more than once per year.

Air quality in central Connecticut meets all the air quality standards presented in Table 5.10-1, except the short-term ozone standard, which is exceeded on several days a year during the summer months throughout Connecticut and in much of the northeastern United States. Thus, the area is in "attainment" for all pollutants except ozone.

Connecticut is considered an ozone "non-attainment" area, as is most of the northeast. Ozone is created in the atmosphere when nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) react in the presence of sunlight. Ozone is a regional problem. Most of the NO<sub>x</sub> and VOCs that cause Connecticut to be an ozone non-attainment area are emitted upwind in areas like metropolitan New York.

### 5.10.2.2 Permit and Technology Requirements

The Regulations of Connecticut State Agencies (RCSA), Section 22a-174-3(b), set forth permit requirements for new sources of air pollution. These requirements are known as the new source review (NSR) regulations. For each individual air pollutant for which the stationary source has potential emissions equal to or greater than five (5) tons per year (TPY), the owner or operator must include an analysis of the Best Available Control Technology (BACT). BACT analyses allow consideration of energy, environmental, and economic impacts in determining the appropriate control technology. In the Middletown, Connecticut area (the Area), if the source has potential emissions of NO<sub>x</sub> or VOCs (precursors to ozone, for which the Area is non-attainment), in excess of 50 TPY, the source is considered a major stationary source, and an analysis of the Lowest Achievable Emission Rate (LAER) is required instead of BACT for ozone precursors. LAER considers only the technical feasibility of applying the control in determining the appropriate control technology.

Under the NSR regulations, the proposed facility will be subject to BACT for sulfur oxides (SO<sub>x</sub>), PM<sub>10</sub>, NO<sub>x</sub>, CO, VOCs, ammonia (NH<sub>3</sub>), formaldehyde (CH<sub>2</sub>O) and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). DEP requires that all BACT analyses adhere to the Northeast States for Coordinated Air Use Management (NESCAUM) guidelines. Per the NESCAUM guidelines, the BACT analysis is required to utilize a "top-down" approach whereby the applicant first identifies the most stringent control available for a similar or identical source or source category. Working from this "top" case, the applicant then must justify that the proposed emission levels represent BACT when energy, environmental and economic impacts are considered. As each level of control is evaluated, if it can be shown that this level of control is technically or economically inappropriate for the source in question, then the next most stringent level of control should be evaluated.

At a minimum, BACT can be no less stringent than any applicable federal New Source Performance Standard (NSPS). EPA has established NSPS for various categories of new sources, including gas turbines, see Subpart GG "Standards of Performance for Stationary Gas Turbines," 40 FR Part 60. Subpart GG sets emission standards for SO<sub>2</sub> and NO<sub>x</sub>. The NSPS limit for SO<sub>2</sub> is 150 ppmvd @ 15% O<sub>2</sub> or 0.8 weight percent sulfur in the fuel, while the limit for NO<sub>x</sub> is at least 75 ppmvd @ 15% O<sub>2</sub>. The emissions from the proposed Facility will be far less than the NSPS limits.

Under the PSD regulations, new major sources of attainment pollutants, and major modifications to existing major sources of attainment pollutants are subject to PSD review. The major stationary source threshold is 100 TPY for PM<sub>10</sub>, SO<sub>2</sub> and CO, and 50 TPY for NO<sub>x</sub>. The major modification thresholds are 15, 40, 25, 25 and 100 TPY for PM<sub>10</sub>, SO<sub>x</sub>, NO<sub>x</sub>, VOCs and CO, respectively. The proposed Project is subject to PSD review for PM<sub>10</sub>, SO<sub>x</sub> and NO<sub>x</sub>. This review requires various analyses including the impact of the new source in relationship to surrounding sources and existing background levels of attainment pollutants, and analyses of impacts to visibility, soils and vegetation.

The proposed Project will be subject to non-attainment review for NO<sub>x</sub> since potential emissions of this pollutant will be more than 50 TPY. Accordingly, the proposed Project will be required

to include the Lowest Achievable Emission Rate (LAER) in the design of its equipment. Also, NO<sub>x</sub> emission offsets for the proposed Project must be obtained in a ratio of at least 1.2 to 1.0. Since potential VOCs emissions will be less than 50 TPY, these non-attainment pollutant requirements will not apply to VOCs.

The proposed Project will also be subject to the requirements of the federal Acid Rain Program as a "New Affected Unit." As such, the proposed Project must complete and submit an Acid Rain permit application, including a compliance plan before commencing operation. Under the Acid Rain Program, owners and operators of Affected Units must obtain enough SO<sub>2</sub> allowances equal to the total annual emissions of SO<sub>2</sub>. Allowances are traded on the Chicago Board of Trade (CBOT). The Acid Rain Program also requires compliance verification using stack emissions testing or a Continuous Emissions Monitoring System (CEMS) for specified pollutants.

Finally, the NSR regulations require a review of compliance with Connecticut's Hazardous Air Pollutant (HAP) regulations. In accordance with this section of the State regulations, any source that is required to apply for and obtain a permit to construct and/or operate may not emit any State-regulated HAP in excess of the Maximum Allowable Stack Concentration (MASC). MASCs are calculated using conservative dispersion modeling equations.

### ***5.10.3 Impacts and Mitigation***

The design of the proposed Project incorporates several features to minimize air pollution. The proposed plant will use clean burning natural gas as its primary fuel source with low sulfur distillate oil as a secondary fuel, thus minimizing PM<sub>10</sub>, SO<sub>x</sub> and NO<sub>x</sub> emissions. The plant will utilize highly efficient state-of-the-art combined-cycle turbine systems that include GE 7FA combustion turbines, heat recovery steam generators (HRSGs) and steam turbines. These combined-cycle systems are nearly twice as efficient as existing fossil fuel fired steam boiler power plants. The turbines will incorporate dry low NO<sub>x</sub> and water injection NO<sub>x</sub> controls, which when used in conjunction with selective catalytic reduction (SCR), will attain a NO<sub>x</sub> emission rate of 2.0 parts per million (ppm) when burning natural gas and 5.9 ppm when burning distillate oil. The plant design will limit NO<sub>x</sub> emissions to the LAER level. In addition, the proposed Project will utilize an oxidation catalyst to minimize CO emissions, thus meeting BACT requirements. The BACT standards will also be met as required for all the other criteria pollutants.

### ***5.10.4 Facility Air Emissions and Control***

Table 5.10-2 shows the estimated maximum potential emissions of PM<sub>10</sub>, SO<sub>x</sub>, NO<sub>x</sub>, CO and VOCs from the proposed Project. The calculated potential emissions assume 8,760 hours of operation per year, including 720 hours of distillate fuel oil operation. These maximum emissions represent worst-case operating parameters. Actual emissions are expected to be less than these amounts. Because the potential emissions of PM<sub>10</sub>, SO<sub>2</sub>, and NO<sub>x</sub> will be greater than 100 TPY, the Project is subject to PSD review. The Project is also subject to non-attainment review for NO<sub>x</sub> since potential emissions will be greater than 50 TPY.

<b>Table 5.10-2 Potential Emissions of the Proposed Project</b>	
<b>Pollutant</b>	<b>Maximum Potential Emissions (Tons/year)</b>
PM <sub>10</sub>	288
SO <sub>2</sub>	117
NO <sub>x</sub>	224
CO	70
VOCs	22

#### 5.10.4.1 *Criteria Pollutants*

##### 5.10.4.1.1 Sulfur Oxides (SO<sub>x</sub>)

Sulfur present in the fuel is converted to SO<sub>x</sub> during the combustion process. The best mitigation for this pollutant is through the use of clean fuels such as natural gas. The proposed Project will utilize clean burning natural gas which has a minimal sulfur content as the primary fuel, and distillate fuel oil with a sulfur content of 0.05 percent or less (by weight) for a maximum of 720 hours per year.

##### 5.10.4.1.2 Nitrogen Oxides (NO<sub>x</sub>)

The proposed Project will utilize state-of-the-art GE 7FA turbines with dry low NO<sub>x</sub> burners to minimize NO<sub>x</sub> emissions when burning natural gas and water injection while burning distillate oil. The proposed Project will also install SCR, the most stringent feasible NO<sub>x</sub> control technology currently available. This control technique treats the exhaust gases through the injection of ammonia, and then passes the exhaust through a bed of catalytic material. The catalyst promotes the conversion of the NO<sub>x</sub> formed during the combustion process to nitrogen and water vapor. The proposed Project has been designed to achieve NO<sub>x</sub> emission limits of 2.0 and 5.9 ppmvd @ 15% O<sub>2</sub> on natural gas and distillate oil, respectively. These emission rates meet LAER for combined-cycle turbines.

No other technically feasible control technology can achieve lower NO<sub>x</sub> emission rates when applied to combined-cycle turbines.

##### 5.10.4.2 *Carbon Monoxide (CO)*

Carbon monoxide is a product of incomplete combustion that is present in the turbine exhaust during the firing of the natural gas fuel. The proposed Project will go beyond the use of good combustion techniques and will use catalytic oxidizers to minimize CO emissions. This is the most stringent available add-on technology for the control of CO emissions.

### 5.10.4.3 Particulate Matter and Volatile Organic Compounds

Particulate matter emissions originate from trace quantities of non-combustibles in the fuel, and from ammonium salts formed as byproducts of the SCR use together with the oxidation catalyst. Using clean burning natural gas as the primary fuel and low sulfur distillate fuel as the secondary fuel will minimize particulate matter emissions. In addition, good combustion practices will limit both PM<sub>10</sub> and VOCs emissions. The oxidation catalyst will help reduce VOCs emissions further.

### 5.10.5 Non-Criteria Pollutant Compliance

Table 5.10-3 illustrates that the maximum potential emissions from the proposed Project sources will comply with the HAP emission limits of Section 22a-174-29 of the State regulations.

Table 5.10-3 MASC Calculations						
Pollutants	CAS Number	Hazard Limiting Value (ug/m <sup>3</sup> )	Maximum Emission Rate (lb/hr)	Maximum Allowable Stack Conc. (MASC) (ug/m <sup>3</sup> )	Actual Stack Conc. (ASC)	Pass/Fail
<b>Turbine</b>						
1,3 Butadiene	106-99-0	22000	3.21E-02	2,639,518	9.26	Pass
Acetaldehyde	75-07-0	3600	7.28E-02	431,921	21.0	Pass
Acrolein	107-02-8	5	1.16E-02	600	3.36	Pass
Ammonia	7664-41-7	360	2.89E+01	43,192	8,350	Pass
Arsenic	7440-38-2	0.05	3.89E-06	6.00	1.12E-03	Pass
Beryllium	7440-41-7	0.01	6.21E-04	1.20	0.179	Pass
Benzene	71-43-2	150	1.10E-01	17,997	31.8	Pass
Cadmium	7440-43-9	0.4	9.62E-03	48.0	2.78	Pass
Chromium	7440-47-3	2.5	2.20E-02	300	6.37	Pass
Ethylbenzene	100-41-4	8700	5.82E-02	1,043,809	16.8	Pass
Formaldehyde	50-00-0	12	6.55E-01	1,440	189	Pass
Lead	7439-92-1	3	2.80E-02	360	8.10	Pass
Manganese	7489-96-5	20	1.58E-00	2,400	457	Pass
Mercury	7439-97-6	1	2.40E-03	120	0.695	Pass
Naphthalene	91-20-3	1000	7.01E-02	119,978	20.3	Pass
Nickel	7440-02-0	5	9.22E-03	600	2.66	Pass
PAH (excluding Naphthalene)	NA	0.1	1.00E-02	12.0	2.89	Pass
Propylene Oxide	75-76-9	1000	5.28E-02	119,978	15.2	Pass

**Table 5.10-3 MASC Calculations**

<b>Pollutants</b>	<b>CAS Number</b>	<b>Hazard Limiting Value (ug/m<sup>3</sup>)</b>	<b>Maximum Emission Rate (lb/hr)</b>	<b>Maximum Allowable Stack Conc. (MASC) (ug/m<sup>3</sup>)</b>	<b>Actual Stack Conc. (ASC)</b>	<b>Pass/Fail</b>
Selenium	7782-49-2	4	5.01E-02	480	14.5	Pass
Sulfuric Acid	7664-93-9	20	8.30E+00	2,400	2,398	Pass
Toluene	108-88-3	7500	2.37E-01	899,836	68.3	Pass
Xylenes	1330-20-7	8680	1.16E-01	1,041,410	33.6	Pass
<b>Emergency Generator</b>						
1,3 Butadiene	106-99-0	22000	1.20E+00	469,939	26,698	Pass
Acetaldehyde	75-07-0	3600	3.89E-04	457,367	9.75	Pass
Acrolein	107-02-8	5	1.22E-04	635	3.05	Pass
Benzene	71-43-2	150	1.20E-02	19,057	300	Pass
Beryllium	7440-41-7	0.01	1.06E-06	1.27	0.0267	Pass
Formaldehyde	50-00-0	12	1.22E-03	1,525	30.5	Pass
Mercury	7439-97-6	1	4.65E-06	127	0.117	Pass
Naphthalene	91-20-3	1000	2.01E-03	127,046	50	Pass
PAH (benzene soluble)	NA	0.1	6.60E-05	12.7	1.66	Pass
PAH (coal tar pitch)	NA	1	1.25E-02	127	31.3	Pass
Naphthalene	91-20-3	1000	2.01E-03	127,046	50.3	Pass
Sulfuric Acid	7664-93-9	20	1.60E-0	2,541	400	Pass
Toluene	108-88-3	7500	4.34E-03	952,847	109	Pass
Xylenes	1330-20-7	8680	2.98E-03	1,102,762	74.7	Pass
<b>Firewater Pump</b>						
1,3 Butadiene	106-99-0	22000	7.39E-05	21,597,728	14.0	Pass
Acetaldehyde	75-07-0	3600	1.45E-03	3,534,174	275	Pass
Acrolein	107-02-8	5	1.75E-04	4,909	33.2	Pass
Benzene	71-43-2	150	1.76E.03	147,257	335	Pass
Beryllium	7440-41-7	0.01	1.30E-07	1.36	3.27E-03	Pass
Formaldehyde	50-00-0	12	2.23E-03	11,781	424	Pass
Mercury	7439-97-6	1	5.70E-07	982	0.108	Pass
Naphthalene	91-20-3	1000	1.60E-04	981,715	30.5	Pass
PAH (benzene soluble)	NA	0.1	1.66E-04	98.2	31.5	Pass
PAH (coal tar pitch)	NA	1	2.73E-03	982	519	Pass

**Table 5.10-3 MASC Calculations**

Pollutants	CAS Number	Hazard Limiting Value (ug/m <sup>3</sup> )	Maximum Emission Rate (lb/hr)	Maximum Allowable Stack Conc. (MASC) (ug/m <sup>3</sup> )	Actual Stack Conc. (ASC)	Pass/Fail
Naphthalene	91-20-3	1000	1.60E-04	981,715	30.5	Pass
Sulfuric Acid	7664-93-9	20	1.96E-03	19,634	372	Pass
Toluene	108-88-3	7500	7.73E-04	7,362,862	147	Pass
Xylenes	1330-20-7	8680	5.39E-04	8,521,285	102	Pass
<b>Auxiliary Boiler</b>						
Arsenic	7440-38-2	0.05	1.40E-05	5.83	0.194	Pass
Barium	7440-39-3	10	3.09E-04	1,166	4.27	Pass
Benzene	71-43-2	150	1.47E-04	17,484	2.04	Pass
Beryllium	7440-41-7	0.01	8.42E-07	2.06	0.0211	Pass
Butane	106-97-8	38000	1.47E-01	7,841,049	2,692	Pass
Cadmium	7440-43-9	0.4	7.71E-05	82.5	1.93	Pass
Chromium	7440-47-3	2.5	9.82E-05	516	2.46	Pass
Cobalt	7440-48-4	2	5.89E-06	413	0.148	Pass
Copper	7440-50-8	2	5.96E-05	413	1.49	Pass
Formaldehyde	50-00-0	12	5.26E-03	2,476	132	Pass
Hexane	110-54-3	36000	1.26E-01	742,836	3,164	Pass
Lead	7439-92-1	3	3.51E-05	519	0.879	Pass
Manganese	7489-96-5	20	2.66E-05	4,127	0.668	Pass
Mercury	7439-97-6	1	1.82E-05	206	0.457	Pass
Naphthalene	91-20-3	1000	4.28E-05	206,343	1.07	Pass
Nickel	7440-02-0	5	1.47E-04	1,032	3.69	Pass
PAH (benzene soluble)	NA	0.1	6.73E-07	20.6	0.0169	Pass
PAH (coal tar pitch)	NA	1	1.92E-06	206	0.0482	Pass
Naphthalene	91-20-3	1000	4.28E-05	206,343	1.07	Pass
Pentane	109-66-0	7000	1.82E-01	1,444,404	4,571	Pass
Selenium	7782-49-2	4	1.68E-06	825	0.0422	Pass
Sulfuric Acid	7664-93-9	20	1.22E-002	4,127	305	Pass
Toluene	108-88-3	7500	2.38E-04	1,547,575	5.98	Pass
Vanadium	7440-62-2	1	1.61E-04	206	4.04	Pass

### *5.10.6 NO<sub>x</sub> Offsets Acquisition and DEP Approval*

New major sources of non-attainment pollutants must obtain offset emission reductions from other facilities within the same or higher classification of non-attainment area. Thus, the proposed Project must obtain NO<sub>x</sub> emission reductions to offset new emissions at a ratio of at least 1.2 to 1. At this ratio, the Project will be required to obtain 269 tons of offsets. Kleen Energy expects to obtain the required offsets from one or more facilities that have achieved or will achieve actual, creditable, contemporaneous, permanent and federally enforceable emission reductions by the over-control or shutdown of existing sources. The proposed emission offsets must achieve a net air quality benefit and be approved by DEP prior to issuance of any required air permits for the proposed Project.

### *5.10.7 Ambient Air Quality Impacts*

An assessment of compliance of the proposed Project with ambient air quality regulations (NAAQS, CAAQS, and PSD increments) was performed in accordance with DEP's Ambient Impact Analysis Guideline. The guideline specifies a two-stage air quality dispersion modeling process: screening modeling to determine the "worst-case load conditions" and domain of possible impacts, and refined modeling to assess compliance. The screening modeling and refined modeling are discussed below.

Screening modeling is conducted to identify the operating scenarios for the proposed Project that cause the highest model-predicted concentrations, i.e., the worst-case operating scenario, and the aerial extent of the region to be modeled. The screening concentration predictions themselves are not used to assess compliance. Table 5.10-4 presents the operating conditions and emission rates modeled for the Project. Various load conditions, ambient temperatures and operating scenarios were modeled. Through screening modeling, firing at 100 percent load for SO<sub>2</sub>, NO<sub>2</sub>, PM<sub>10</sub> and CO was identified as the key plant operating scenario to be carried forward to refined modeling. The screening modeling results were also used to determine the spacing for the refined modeling receptor array, as specified in DEP's modeling guidance.

For each of the four worst-case operating scenarios, an array of 579 receptors was modeled for all directions from the plant boundary to a distance of 29 kilometers. Both EPA's ISCST3 model (applicable to receptor locations at elevations at or below the stack top elevation) and DEP's PTMTPA-CONN model (applicable to receptors above the stack top elevation) were used. The ISCST3 model was run using five years of hour by hour meteorological data from the Bradley Airport National Weather Service office. PTMTPA-CONN was run using the set of meteorological data shown in Table 5.10-5, in accordance with DEP guidance. Table 5.10-6 presents the modeled concentrations, background concentrations and total concentrations, as well as the applicable regulatory standards for each pollutant. Each total concentration is the sum of the model-predicted concentration plus the background concentration. Note that in all cases, the total concentrations are well below the ambient air standards and the maximum-modeled concentrations are below the allowed PSD increments. Thus, the proposed Project will comply with state and federal ambient air quality standards.

**Table 5.10-4 ISCST3 Worst-Case Load Screening Modeling Source Parameter Data  
Middletown, CT  
(Stack Nos. 1-2)**

Operating Scenarios			Emission Rate* (g/s)				Exhaust Gas Exit	
Fuel	Load (%)	Ambient Temp. (degF)	Pollutant				Temp. (K)	Velocity (m/s)
			SO <sub>2</sub>	NO <sub>2</sub>	PM <sub>10</sub>	CO		
Oil	100	32	13.0	5.81	15.0	0.870	384	22.1
	100	59	12.6	5.62	14.7	0.830	384	21.4
	100	95	11.7	5.23	14.0	0.760	386	20.2
	75	32	10.7	4.75	13.1	0.680	384	17.4
	75	59	10.1	4.52	12.6	0.640	385	16.7
	75	95	9.20	4.10	11.9	0.600	386	15.8
	50	32	7.93	3.53	10.8	0.610	381	15.3
	50	59	7.50	3.34	10.5	0.610	381	15.2
	50	95	6.88	3.06	9.96	0.570	382	14.6
	100	-10	13.8	6.15	15.7	0.920	383	23.5
	75	-10	11.3	5.02	13.6	0.720	384	18.4
	50	-10	8.45	3.76	11.3	0.620	382	15.5
	Natural Gas	100	32	0.510	1.70	2.69	0.390	345
100		59	0.490	1.63	2.67	0.370	347	18.5
100		95	0.450	1.51	2.64	0.340	351	17.5
100		95	0.460	1.96	2.85	0.540	349	17.5
75		32	0.420	1.40	2.62	0.310	335	14.9
75		59	0.400	1.33	2.60	0.290	338	14.3
75		95	0.360	1.20	2.56	0.270	344	13.8
50		32	0.320	1.06	2.53	0.270	336	13.0
50		59	0.300	1.00	2.52	0.270	341	13.1
50		95	0.280	0.920	2.50	0.250	347	12.8
100		-10	0.540	1.81	2.72	0.410	345	20.2
75		-10	0.450	1.50	2.64	0.320	335	15.5
50		-10	0.340	1.14	2.55	0.270	336	13.1
100		95	0.470	2.44	2.84	0.630	347	17.7

Stack Height\*\*: 65.5 m (215 ft)  
Stack Diameter\*\*: 5.64m (18.5 ft)  
Stack Base Elevation\*\*: 104m (340 ft)  
Turbine Stack No. 1 Location 700,341 E, 4602,696 N  
Turbine Stack No. 2 Location 700375 E, 4602697 N

\*Per Unit

\*\*Both Turbines Have Identical Stack Parameters and Building Dimensions

<b>Stability Class</b>	<b>Wind Speed Used for Stability Class (m/sec)</b>	<b>Mixing Height Used for Stability Class (meters)</b>
A	2.5	1,800
B	2.5, 4	1,200
C	2.5, 4, 6, 8, 10	1,200
D	2.5, 4, 4, 8, 10	950
E	2.5, 4	700
F	2.5, 4	700

<b>Dispersion Model</b>	<b>SO<sub>2</sub></b>			<b>NO<sub>2</sub></b>	<b>PM<sub>10</sub></b>		<b>CO</b>	
	<b>3-Hour</b>	<b>24-Hour</b>	<b>Annual*</b>	<b>Annual*</b>	<b>24-Hour</b>	<b>Annual*</b>	<b>1-Hour</b>	<b>8-Hour</b>
ISCST3	62.5	13.1	1.90	4.82	19.4	2.88	1,267	312
PTMPTA-CONN	169	22.0	5.05	2.40	25.7	4.81	78.9	55.2
Maximum	169	22.0	5.05	4.82	25.7	4.81	1,267	312
PSD Increment	512	91.0	20.0	25.0	30.0	17.0	N/A	N/A
Background	107	64.5	15.7	38.3	39.7	16.9	10,981	5,471
Total (Maximum+Background)	276	86.5	20.8	43.1	65.4	21.7	12,248	5,783
CAAQS/NAAQs	1,300	365	80.0	100	150	50.0	40,000	10,000

\*Maximum Impacts  
N/A = Not Applicable

### **5.10.8 Plume Visibility Analyses**

#### **5.10.8.1 PSD Class I Areas**

The PSD regulations require a visibility analysis to protect visual impacts in all Class I areas such as national parks and wilderness areas for all sources that are found near Class I areas. The Workbook for a Plume Visual Impact Screening and Analysis (Revised) (EPA, 1992) recommends two levels of screening analysis, to assess the possible effects of PM<sub>10</sub> and NO<sub>x</sub> emissions from the proposed Project. The plume visual impacts screening model (VISCREEN) (Version 1.01 dated 88341) was used to perform the analysis. The VISCREEN model calculates maximum plume contrast (Cp) and plume perceptibility (Delta-E) against the bright sky and dark terrain objects, respectively. These visual effects result from light absorption by NO<sub>x</sub> (a reddish-brown gas) and light scattering by primary particulate matter. VISCREEN also calculates visibility impairment that is an estimate of contrast reduction resulting from primary particulate matter (general visual range reduction).

The visibility analysis was performed, using maximum facility PM<sub>10</sub> and NO<sub>x</sub> emissions. The facility is approximately 180 kilometers (km) south of Lye Brook in southern Vermont (the closest Class I PSD area in the northeastern part of the U.S.). EPA's recommended worst-case model options were used in VISCREEN to determine if emissions from the facility would adversely affect visual range or perception to the Lye Brook area.

The modeling results show that emissions are well below the level-I visibility screening threshold values. Therefore, no further visibility analysis is required as the state-of-the-art combined-cycle power plant will have no adverse visual impacts at the Lye Brook Class I area.

#### *5.10.8.2 Combustion Turbine Condensed Water Vapor Plumes*

Condensed water vapor plumes from the GE 7FA combined-cycle turbines were evaluated. The turbines were subjected to modeling to determine the duration and extent of plume visibility.

A byproduct of the combined-cycle turbine combustion process is water vapor, which is exhausted to the atmosphere through the stacks. The additional amounts of water used for NO<sub>x</sub> control and controlling the turbine air intake temperature are also discharged out the stacks. As the exhaust enters the atmosphere, it cools, and depending on the ambient air temperature and moisture content, the water vapor in the exhaust can condense to form a visible plume.

Since the exhaust gas may contain a higher concentration of water vapor than the ambient air, an analysis was performed to determine if the exhaust plume would be visible under normal atmospheric conditions. To perform this plume visibility analysis, the exhaust conditions of the combustion gas turbines were assessed using a plume visibility model (VISPLUME) developed by TRC. TRC's plume visibility model processes the output results from the ISCST3 model.

The analysis examined the water vapor emissions during natural gas firing (with and without steam injection for power augmentation) and oil firing. The two cases that represent the greatest amount of water vapor emissions are: 1) oil firing when water injection is required for NO<sub>x</sub> suppression, and 2) steam injection for power augmentation. These cases typically occur during different seasons. Oil firing could occur if natural gas were not readily available, typically during the winter. Power augmentation may occur during the summer months when the power output from the turbine is normally lower than during the colder months, and additional power output is required.

The analysis was performed for two combustion turbines emitting through two separate stacks. The analysis examined 8,759 hourly observations (one year) of meteorological conditions at Bradley Airport in Windsor Locks, CT, which included a total of 4,403 daylight hours, 730 twilight hours (one hour before sunrise and one hour after sunset) and 3,626 nighttime hours. For 1,567 hours (17.9% of the total), visibility was obstructed by naturally occurring weather conditions, such as fog (1,120 hours), rain (250 hours), or snow (197 hours).

For natural-gas firing (see Table 5.10-7), the plume visibility analysis showed that a steam plume would be visible for a total of 2,987 hours, of which 2,346 hours (26.9% of the year) occurred during conditions when visibility was not naturally obstructed by fog, rain, or snow. It should be noted that 2,214 of these hours (74% of all visible plumes) occurred in the cold season from December to March, and only six hours of visible plumes occurred in June through August.

The VISPLUME model separates clear-air situations (without fog, rain, snow, or 100% humidity) into those hours where the temperature is above or below the freezing point (32°F). For gas-firing, the steam plume is visible over 99% of the time in clear conditions below 32°F, but only 11.6% of the time in clear conditions above 32°F. This analysis shows that most of the visible steam plumes occur in cold weather, and are unlikely in warm weather. Note that "clear air" in this analysis does not necessarily mean clear skies, but only the absence of precipitation or fog.

Because the plant has the potential to need to run on its backup fuel, low sulfur distillate oil, at any time, it is necessary to model the entire year to fairly model the potential for stack plume visibility, even though the Project's total operating hours on oil will be limited to 720 hours/per year. It is important to realize that the visibility of stack plumes does not change significantly between natural gas and oil, and actually is reduced slightly on oil because of higher exhaust temperatures. Therefore, the impacts from stack plume are best judged based on the gas-fired modeling alone, as this is both the preferred case (no natural gas curtailment) as well as the case with the most hours of this relatively minimal impact.

For oil firing (see Table 5.10-8), the plume visibility analysis showed that a steam plume would be visible for a total of 2,331 hours, of which 1,832 hours (20.9% of the year) occurred during conditions when visibility was not naturally obstructed by fog, rain, or snow. It should be noted that 1,865 of these hours (80% of all visible plumes) occurred in the cold season from December to March, and only three hours of visible plumes occurred in June through August.

For oil-firing, the steam plume is visible about 91.5% of the time in clear conditions below 32°F, but only 4.5% of the time in clear conditions above 32°F. This analysis shows that most of the visible steam plumes occur in cold weather, and are unlikely in warm weather. Visible steam plumes are less frequent for oil-firing than for gas-firing, due to the higher water-vapor content of the combustion products from gas firing.

### ***5.10.9 Impacts to Soils and Vegetation***

The pollutants of primary concern for impacts on vegetation and soils are SO<sub>2</sub>, ozone and NO<sub>2</sub>. As discussed above, the air quality impacts of the proposed Project have been compared to the PSD increments and the CAAQS/NAAQS, the latter of which were established to protect public health and welfare, including vegetation and soils. Thus, compliance with these standards will ensure adequate protection for vegetation and soils. The proposed Project will not adversely impact surrounding soils and vegetation.

**Table 5.10-7 Gas Firing: Annual Hours of Visible Plume Formation by Month**

Month	Clear Air		Observed Fog	100% Humidity, No Fog	Rain, No Fog	Snow, No Fog	Total Hours
	T > 32°F	T < 32°F					
January	90	358	55	61	8	45	617
February	47	394	25	1	2	74	543
March	53	203	101	11	15	32	415
April	45	22	53	11	5	4	140
May	34	1	19	3	2	0	59
June	2	0	0	3	0	0	5
July	0	0	0	0	0	0	0
August	0	0	0	1	0	0	1
September	20	5	4	4	0	0	33
October	116	62	19	4	2	0	203
November	70	208	37	5	6	6	332
December	152	366	76	4	16	25	639
Total Hours Visible	629	1,619	389	108	56	186	2,987
Total Hours at Conditions	5,423	1,633	1,120	136	250	197	8,759
% of Visible Plumes	11.60	99.14	34.73	79.41	22.40	94.42	34.10

**Table 5.10-8 Oil Firing: Annual Hours of Visible Plume Formation by Month**

Month	Clear Air		Observed Fog	100% Humidity, No Fog	Rain, No Fog	Snow, No Fog	Total Hours
	T > 32°F	T < 32°F					
January	54	348	54	59	7	45	567
February	16	356	24	1	1	71	469
March	5	167	89	11	10	29	311
April	12	21	38	9	2	4	86
May	14	1	0	3	0	0	18
June	0	0	0	3	0	0	3
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	13	5	1	3	0	0	22
October	45	57	2	1	0	0	105
November	25	190	9	1	3	4	232
December	59	349	75	4	10	21	518
Total Hours Visible	243	1,494	292	95	33	174	2,331
Total Hours at Conditions	5,423	1,633	1,120	136	250	197	8,759
% of Visible Plumes	4.48	91.49	26.07	69.85	13.20	88.32	26.61

### ***5.10.10 Solid Waste Generation and Disposal***

The Project will implement a program to minimize solid waste and encourage recycling. Programs tailored towards solid waste minimization during construction may include such elements as:

- The directing of clearing and grubbing wastes to local composting facilities where available.
- Segregation of waste materials into stockpiles of metal and scrap wood made available for salvage on a regular basis.
- Utilizing excess excavation materials in the final grading plan to eliminate disposal, thus creating a balanced cut and fill for the Project.
- Minimization of spill impacts when transferring fluids or refueling vehicles through careful transfer processes and containment structures to mitigate the amount of solid waste generated in spill cleanups.

Recycling will be encouraged and supported through placement of appropriate containers, labeled for the wastes designated for recycling, in and around the construction offices, warehouses, craft change houses, lunch rooms, and other areas of the Project to facilitate the recycling program.

Solid waste and debris that cannot be recycled, reused or salvaged, will be stored in on-site dumpsters or similar containers for disposal. Programs will be developed to ensure potentially hazardous wastes are separated from normal waste including segregation of storage areas and proper labeling of containers. All waste will be removed from the site by licensed contractors in accordance with applicable regulatory requirements and disposed of at either local or regional approved facilities.

During Project construction and pre-operational cleaning, some solvents and flushing materials will be used. These materials will be provided by the construction contractor, and will be removed by the contractor for appropriate off-site disposal.

Solid waste will be generated during Project operations. Office and other facility wastes will be recycled. Non-recyclable materials will be disposed of by a private contractor. Normal Project maintenance will generate very small quantities of solid waste on a periodic basis. Depleted SCR and CO catalysts will be sent for reprocessing to the original manufacturer.

### **5.11 Hazardous Waste Generation and Disposal**

The Project will be a generator of hazardous waste, but not a hazardous waste treatment, storage and disposal facility and thus will not require a RCRA permit. To fall below the RCRA threshold, the Project will not exceed the quantities and/or timeframes allowed for satellite accumulation or temporary accumulation of hazardous waste. In addition, the Project will fulfill

certain statutory and regulatory requirements as part of its hazardous waste management protocol, as outlined below.

- The Project will acquire a unique hazardous waste generator identification number issued by the USEPA.
- The Project will ensure that hazardous waste transporters servicing the Project have their own USEPA identification number prior to releasing hazardous wastes.
- Personnel will follow accurate record-keeping requirements as to the quantity and nature of hazardous wastes generated on-site, with Material Safety Data Sheets (MSDS).
- All hazardous waste will be transported under a cradle-to-grave system of manifests.
- Hazardous waste management includes careful labeling, placarding, and placement of containers to be readily identifiable.
- Appropriate containers will be used, along with secondary containment measures where applicable.

## **5.12 Chemical Storage and Handling**

### **5.12.1 Chemical Storage Requirements**

A regulated facility storing chemicals must maintain a spill prevention report for preventing and responding to spills, releases, and accidents at the facility. The Project will use the following required practices and technology or, if requested and approved during detailed design, equivalent technology.

- Aboveground tank design in compliance with applicable regulations and industry standards.
- Transfer protocols including continuous visual monitoring of transfers, with immediate steps to address any leaks; leak inspections both before and after chemical transfer has been initiated; a requirement that brakes, chock blocks and caution signs must be in place during transfer; a requirement to control and keep incompatible and ignitable substances at a distance; and flexible connections such as hoses.
- Five-year structural inspections – for aboveground tanks with a capacity of 10,000 gallons or more; and for all piping systems, a complete inspection of structural soundness and the absence of external or internal corrosion that may result in a release before the next inspection and re-certification.
- Annual comprehensive inspection – for aboveground tanks and their interconnecting piping systems, a comprehensive inspection that includes testing of cathodic corrosion protection systems, thorough visual inspections of all facilities (including secondary containment) for wear and tear, and inspection of emergency response equipment.

- Monthly leak detection inspection – testing of cathodic corrosion protection systems and release detection tests, similar to the protocol for underground tanks.
- Daily visual inspection – visual inspection of aboveground storage tank systems for spills and leaks each operating day. In addition, the operator will check to ensure that drain valves are closed if not in use and there are no unpermitted discharges of contaminated water or hazardous substances.

### ***5.12.2 Petroleum Storage Requirements***

The Project will have the capability of burning low sulfur distillate oil as backup fuel to ensure a reliable electricity supply. The Project will store about 950,000 gallons of distillate oil on site. This tank will be protected by a secondary containment capable of containing 110% of the capacity of the tank and will have an impermeable floor. The tank is expected to be supplied by an underground pipeline running to one of several sources of bulk oil. The pipeline will be designed and constructed in compliance with all applicable regulations and standards.

Other fuel oil storage at the Project site will be small aboveground tanks associated with emergency diesel equipment: a backup diesel fire pump (to be operated in case power from the grid to the firewater pumping system is not available during a firefighting event) and an emergency diesel generator (which is designed to operate only in order to ensure safe shutdown of the plant in case power from the grid is not available; and during testing). Petroleum fuel oil storage will include secondary containment in the form of 110% containment for both the emergency diesel generator and the fire pump storage tanks.

- Tanks will be made of steel and, if sited on-ground, underlain by impermeable barriers, with a leak monitoring system and cathodic protection for the bottom of the tank or equivalent.
- Exterior surfaces of all new aboveground storage tanks will be protected by appropriate protective coatings.
- All new oil underground piping systems must be made of steel or iron that is cathodically protected, fiberglass reinforced plastic or equivalent.

### ***5.12.3 Project's Spill Prevention and Control Design***

Consistent with the state regulations described above, as well as with federal regulations under the Oil Pollution Act of 1990, the Project will implement a spill prevention, control, and countermeasures (SPCC) plan, which will consist of the following design and operational components, describing each in greater detail. The SPCC Plan for the Project cannot be finalized until facility design is completed.

***Outdoor Chemical Storage Tanks.*** Spill prevention and control measures will include containment around the ammonia, acid and caustic tanks. The dikes will be sized to contain

110% of the volume of the tank. A normally closed and locked drain valve will prevent rainwater from being released without proper observation and testing, as necessary.

**Boiler Chemicals.** Curbed enclosures will be provided for boiler feedwater treatment chemicals and water pretreatment chemicals which will be stored in their delivery containers.

**Cooling Tower Water Treatment Chemicals.** Various chemicals needed to control the cooling tower water chemistry (including descaling agents and biocides like sodium hypochlorite) will be stored in curbed enclosures near the cooling water circulation pumps.

**Oil Reserves.** Curbs will also be provided around the STG lube and hydraulic (EHC) oil mechanical package reservoirs to provide secondary containment.

**Oil-Filled Transformers.** Each oil-filled transformer will be located over a concrete sump. The sump will be filled with crushed stone so that in the event of a failure, oil released will be collected in the interstitial spaces in the crushed stone. Each sump will have a monitor to check the level of liquid in the containment. Rain water that accumulates in the sump will be periodically pumped out and trucked off site with sufficient frequency so as not to compromise the sump's function and the sump will be sized to contain the total oil volume of the transformer(s) plus 10 minutes of fire deluge system operation.

**Liquid Fuels/Chemicals.** Spill containment control measures will also include containment around liquid fuel tanks, fuel/oil transfer equipment, and chemical unloading areas.

#### 5.12.4 Project Chemical and Petroleum Storage Requirements

Project operation will require limited amounts of diesel fuel (for the emergency generators), lubricating oils and certain other industrial chemicals, which will be stored in specially designed, covered containment areas. The Project will also require chemicals for boiler feedwater treatment and SCR. A summary typical of chemical usage, quantity, and storage method is provided in Tables 5.12-1.

Area	Chemical		Purpose	Storage State	Amount (gallons)
HRSG	Trisodium Phosphate (TSP)	Na <sub>3</sub> PO <sub>4</sub>	Antiscalent	Dry powder or liquid solution	100-400(i)
HRSG	Hydrazine	H <sub>2</sub> NNH <sub>2</sub>	Oxygen scavenger	Liquid Solution	100-400(i)
HRSG	Amine	Proprietary Blend	Elevate pH	35-99% solution	100-400(i)
Water Treatment	Sulfuric Acid	H <sub>2</sub> SO <sub>4</sub>	Ion exchange resin regeneration	93% solution	6,000
Water Treatment	Sodium Hydroxide	NaOH	Ion exchange resin regeneration	50% solution	6,000

Table 5.12-1 Chemical Storage					
Area	Chemical		Purpose	Storage State	Amount (gallons)
SCR	Aqueous Ammonia	NH <sub>4</sub> OH	NO <sub>x</sub> reduction	19% solution	20-30,000
CTG	Detergent	Proprietary Blend	Compressor Wash	Liquid concrete	
Cooling Tower	Sodium hypochlorite	NaOCl	Oxidizing biocide	12-15% solution	10,000
Cooling Tower	Sulfuric Acid	H <sub>2</sub> SO <sub>4</sub>	Reduce pH	93% solution	Incl. above
Cooling Tower	Corrosion Inhibitor	Proprietary Blend	Corrosion reduction	Liquid	100-400 <sub>(1)</sub>
Cooling Tower	Dispersant	Proprietary Blend	Dispersion	Liquid	100-400 <sub>(1)</sub>

Note:

(1)-Storage in a tote container

All chemical storage areas on site will be situated indoors with appropriate containment. Containment will be accomplished through the installation of curbs and drains. Following observation of any spilled material, off-site disposal to an appropriate location will be implemented.

Aqueous ammonia, for use in the Project's SCR system, will be stored on-site in 20,000 gallon tanks located within a storage building and designed with measures to ensure that the risk of spills is minimized. Transfer of ammonia from delivery vehicles will occur within a concrete containment area. Any spillage in the unloading area will run into a local sump and from there to the ammonia tank containment area inside the ammonia storage building. In the unlikely event of a significant release of ammonia solution from the tanks, spilled liquid would be retained within the concrete containment area. Spilled ammonia solution will be pumped into a truck as quickly as possible to avoid the release of ammonia vapor. An emergency response plan, including employee training programs, will be in place prior to delivery of ammonia.

### 5.12.5 On-Site Storage Tanks

The Project will require numerous on-site storage tanks. The Project will have two types of storage tanks, field erected storage tanks and shop fabricated storage tanks. All field erected storage tanks will be constructed and operated in compliance with all federal and state regulations. All shop fabricated storage tanks will be furnished complete.

#### 5.12.5.1 Field Erected Storage Tanks

The field erected tanks and containment wall shall be designed, constructed, and erected in accordance with AWWA Standard D100 or API Standard 650 as applicable, the requirements of the specifications and codes referenced therein, AISC, ASTM, NEC, and other such regular

published and accepted codes except where modified or supplemented by these specifications; in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards"; and in accordance with local codes. In addition, the containment shall be designed, constructed, and erected in accordance with the requirements of NFPA 30.

Each water tank may be designed and constructed in accordance with the requirements of AWWA Standard D100.

#### 5.12.5.2 Shop Fabricated Storage Tanks

Steel tanks shall be designed and constructed in accordance with the applicable code or standard required for each tank.

ASME code stamping shall be applied as indicated. Data reports shall be developed and shall be maintained by the Contractor for all ASME or equivalent code stamped tanks. ASME code stamped tanks shall be registered with the National Board of Boiler and Pressure Vessel Inspectors.

The major on-site storage tanks for the Project are as follows:

Type of Tank	Number of Tanks	Field Erected or Shop Fabricated	Capacity (gallons)
Raw Water Storage Tank	1	Field Erected	1,600,000
Demineralized Water Storage Tank	1	Field Erected	150,000
Fuel Oil Storage Tank	1	Field Erected	950,000
Ammonia Tank	1	Field Erected	20,000
Turbine Lube Oil Storage Tank	1	Shop Fabricated	
Closed Cooling Water Head Tank	1	Shop Fabricated	
Flash Tank	1	Shop Fabricated	

### 5.13 Safety and Security

Construction and operation of the Project will be designed and managed to ensure maximum safety for employees and the surrounding community. All design, construction and operation activities and equipment for the proposed Project will be in accordance with good engineering practice and Federal, state, and local regulations, and will comply with the latest editions of the regulations of all applicable governmental agencies and engineering associations. These organizations include the United States Occupational Safety and Health Administration (OSHA), National Electrical Manufacturing Association (NEMA), United States Department of Transportation (USDOT), the American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), and the National Fire Protection Association (NFPA).

The Project is located in a remote area which eliminates any need for complex public warning or evacuation plans. The Project's combined cycle technology is intrinsically very safe and it

would be extremely rare for an incident to have any impacts off site. There is no potential for a release of dangerous materials that might require large evacuation zones and commensurate evacuation plans to ensure that large numbers of affected people would be able to leave the zone in a timely fashion. If in an extreme situation, local public safety officials determined that evacuation was necessary within ½ mile of the power block, less than 10 dwellings would be affected.

### ***5.13.1 Construction Safety***

During the construction phase, all contractors would be required to have programs in place to ensure compliance with all applicable federal and state safety and health standards. Provisions would be included in all construction contracts for auditing and for penalties or termination, to enforce environmental, safety and health performance obligations. Chemicals and other related substances used in construction would be managed in accordance with all relevant regulations. Chemical cleaning agents would be contained after use and hauled off-site by a licensed contractor for environmentally safe disposal or reuse.

All on-site contractors would be required to have safety meetings on a weekly basis and would be monitored by the site's Safety Manager. The site Safety Manager would also perform periodic safety inspections to assure that all work is being performed in accordance with state, local, and federal requirements. The contractor would have the overall responsibility to observe, monitor, audit, and direct, when necessary, the safety program for all vendors and contractors performing work on site.

During construction and operation of the facility, the facility will be staffed with a security guard 24 hours a day, 7 days a week, 365 days a year.

### ***5.13.2 Operations Safety***

Safety and emergency systems will be included in the design of the Project to ensure safe and reliable facility operation. The Project design will include, at a minimum, the following features:

- All storage areas will be provided with properly designed containment basins or dikes;
- Equipment and building layout will provide safe access to and from the facility, and will allow adequate access for fire fighting vehicles and equipment;
- Emergency lighting, with backup power supply;
- Safe, automatic shutdown systems with backup power supply for the turbines, fuel supply and chemical systems;
- Fire-retardant building materials; and
- A self-sufficient fire protection system.

Project operation will be carefully controlled and continuously monitored. The plant control system will integrate with the combustion turbine, steam turbine, generator, HRSG, continuous emissions monitoring system (CEMS), water treatment and electrical systems. An efficient,

functional maintenance program will be implemented to ensure safe and reliable Project operation. The maintenance program will include provisions for regular visual inspections, preventative maintenance checks, and continuous documentation of operating and maintenance parameters.

An additional benefit to the use of combined cycle technology is that unlike some other generating technologies, the generation systems can be shutdown very quickly if necessary. While a more gradual ramp down is desirable it is possible to bring the generating units off line very quickly, with no protection systems required to be available to prevent threats to the public.

#### *5.13.2.1 Medical Facilities*

First aid kits, eyewash stations, and drench showers will be provided at designated Project locations. This will facilitate rapid medical response in an emergency situation.

#### *5.13.2.2 Fire Protection*

The Project fire protection system will be designed per National Fire Protection Association recommendations. A complete on-site fire protection system will be installed for emergency use. NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Converter Stations* is a recommended practice that has become the standard for power plant design. Insurers will require that the Project complies with NFPA 850. Fire prevention and protection for the facility, including all drawings, calculations, and related system details, will be reviewed and must receive approval from the local Fire Marshall and the Project's insurance representative.

Each combustion turbine is equipped with an independent gas-based (carbon dioxide or similar) automatic fire extinguishing system. This system is designed to quickly and effectively address fires occurring within the turbine enclosure.

Automatic and manual fire protection systems employing detection and extinguishing equipment will be provided at all locations having potential fire hazards due to the presence of combustible materials or where major property damage could result. Yard hydrants, interior fire hose stations, and portable extinguishers will provide additional incipient fire extinguishing capability and overall protection throughout the plant site. The fire protection water supply will be from the raw water storage tank via a centrifugal electric driven fire pump. A second fire pump will be diesel driven and also draw water from the fire/service water tank. The tank will be designed with a standpipe to reserve water for fire protection water supply in accordance with NFPA 13 standards. The main underground fire header will serve strategically placed yard hydrants and supply water to fire sprinkler/spray systems for plant equipment and structures. Each fire pump will supply maximum water demand for any automatic sprinkler system plus water for fire hydrants and hose stations.

A jockey pump will maintain water pressure in the fire water distribution headers. During fire conditions, the primary (electric driven) fire pump will start automatically when pressure in the firewater distribution header drops below the predetermined set point. If the system header

pressure drops below the second set point, or in the event of an electric power failure, the back-up full-flow diesel driven fire water pump will start. Once started, the diesel pump will continue to run until stopped manually. Discharge from the pump will be connected to the underground yard loop. The fire pumps will be installed in accordance with NFPA 20.

The water supply for the permanent fire protection installation will be based on the largest fixed suppression system demand plus 500 gpm for hose stream demand for a 2-hour duration, required by NFPA 850.

The Project is located approximately 2 miles from the Randolph Road Fire Station and 2.5 miles from the Fire Station on Main Street. The Project will work with local and regional emergency service providers to ensure contingency plans are in place to respond to any emergency situation.

#### *5.13.2.3 Emergency Operations and Shutdown*

The Project has been designed and equipped to address reasonably foreseeable contingencies. The Project's systems will be closely monitored and will be controlled by an advanced Digital Control System (DCS). In the event of a malfunction, the DCS would isolate and shutdown independent systems as feasible. In the event that equipment failure is more serious, than noted above, an advantage of combustion turbine based combined cycle technology is that the entire unit can be tripped off line and shutdown with no risk of a larger failure putting the facility, or the public at risk.

#### *5.13.3 Site Access*

The Project has been designed to incorporate a guardhouse at the entrance to the facility. The facility will be surrounded by an 8 foot high chain link fence. In addition to the manned guardhouse, access to the facility will be required via an access card system.

#### *5.13.4 Employee Training*

Procedures and personnel training will be required for all activities inherently dangerous, such as working in confined spaces, handling of toxic chemicals, exposure to dangerous noise levels, live electrical work, and spill or releases of oil and hazardous materials. All personnel will be appropriately trained to properly manage any new chemicals, such as aqueous ammonia.

Every employee will continue to be trained in cardiopulmonary resuscitation and basic first aid. The facility will contain the appropriate emergency response equipment, including first aid kit, eyewash station, and drench station. All personnel will be appropriately trained in use of this equipment. Employees will be fully trained in fire prevention and small fire extinguisher techniques.

#### *5.13.5 City of Middletown Safety Services*

The proposed Project would not have a significant impact on public safety services such as police and fire services. The proposed facility would not result in an increased need for police

services nor would it impede access to the police station. The proposed project would coordinate directly with the South Fire District regarding emergency response capabilities. In addition, the proposed facility would have comprehensive fire protection capabilities incorporated in the proposed project design and operation.

#### **5.14 Construction Impacts**

It is anticipated that construction of the proposed project would take approximately twenty four months to complete. During this period numerous types of construction activity would occur at the project site. These activities are summarized below.

##### ***5.14.1 Preconstruction Site Preparation***

Pre-installation site preparation would start with surface soil excavation and blasting. This would be followed by installation of the equipment foundations for the CTs. Installation of the equipment foundations would require excavation. Excavated material is anticipated to remain on the 137 acre parcel. Soil erosion and sediment controls would be installed to reduce the potential for erosion and soil loss. If soils were removed from the site, it would be transported for use as clean fill in accordance with applicable rules and regulations.

Site preparation would require heavy equipment for grading and excavation. This would include backhoes, front end loaders, dump trucks, and concrete trucks. During this period, there would be an estimated 150 workers at the site.

##### **Unit Assembly and Site Finish**

Much of the proposed facility (which includes the CT units, ammonia tank, control systems, electric transformer, switchgear, etc.) is delivered in a modular form ready for placement on reinforced concrete foundations. An on-site crane is required to lift the components from the transport vehicles for placement on the individual equipment pads. Transport would likely be by truck; however, the feasibility and benefits of barge transport on the River of large components may be examined.

While the major units of the proposed facility are delivered in modular form, other elements of the facility would be transported to the site in component parts for final on-site fabrication and assembly. This would include the demineralized water tank, the SCR system, and the exhaust stack. Further component commodities integrating the various aforementioned components including fuel piping and instrument air piping, aqueous ammonia piping, fire protection piping, water piping, and electrical conduits and raceways would be transported to site and there fabricated. On-site fabrication would generally require arc-welding, solvent welding, screwing and bolting of pieces.

Once installed, mechanical components would be tested in accordance with American Society of Mechanical Engineers (ASME) B 31.1. Electrical components and systems would be tested in accordance with the latest revision of the National Electric Code (NEC).

Final site installation activities would include a paved perimeter drive providing access to equipment, an 8-foot-high protective chain link fence, site lighting, and some landscaping. Total time for unit installation is approximately twenty-four months. During the peak phase, about 400-430 employees would be at the site. Equipment would include cranes, air compressors, backhoes, bulldozers, and hand held equipment.

### Utility Connections

The proposed facility requires connections to fuel oil (No. 2 low sulfur), electrical transmission grid and water. A 345 kV overhead electric tap line would connect the existing transmission line to the switchyard.

Utility connections would be constructed concurrently with the construction of the generating units.

For additional information, Appendix G contains the Project construction plan.

## **5.15 Electric and Magnetic Field**

### ***5.15.1 Characteristics and Sources of Power Frequency Electric and Magnetic Fields***

Electric and magnetic fields are associated with the transport and use of electricity. These fields oscillate at the power frequency of 60 cycles per second, or 60 hertz (Hz). Some of the sources of these fields are transmission and distribution lines. There are many other sources of these fields including household appliances, power tools, office machines, building wiring, and any other type of electrical equipment. Currents flowing on water pipes or grounding systems are also sources of magnetic fields.

The voltage on the conductors of transmission lines and other electrical equipment produces an electric field. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter kV/m (a kilovolt per meter is equal to 1000 V/m). Electric fields are easily blocked by most objects including fences, shrubbery, and buildings. This prevents outside sources, such as power lines, from contributing significantly to electric field exposure indoors.

The current flowing on the conductors of transmission lines or other electrical equipment produces a magnetic field. Unlike the electric field, the magnetic field is not readily blocked by most materials and so outdoor sources like power lines may be potential contributors to indoor exposures.

### ***5.15.2 Other Types and Sources of Fields***

The term "EMF" refers primarily to electric and magnetic fields at power frequencies (60-Hz in North America). However, "EMF" has been widely used in the media to refer to electric and magnetic fields from much higher frequencies, such as the radio frequencies. Fields at higher frequencies have vastly different physical characteristics from 60 Hz fields, and therefore have

different electrical as well as biological characteristics. Because of these differences, calling 60 Hz fields and higher frequency fields by the same term, EMF, causes confusion.

Above frequencies of 1000 Hz, to 300 billion Hz of the electromagnetic spectrum is defined as the radio frequency range. Radio frequency sources include radio, television, microwave, and cellular telephone antennas, as well as radars, security alarms, and garage door openers. These devices operate at frequencies that are thousands or millions of times higher than 60 Hz. For example, FM radio operates at 88-108 million cycles per second or Hz; one million Hz is more often referred to as megahertz (MHz). VHF television (channels two through 13) operates at 54 to 216 MHz. The fields produced by these sources have very different physical characteristics from power frequency fields. The 60-Hz fields do not interact with conducting objects or living organisms in the same way as do fields at other frequencies.

There are also naturally occurring and man-made sources of electric and magnetic fields whose frequencies are lower than power frequencies. These are often referred to as static or direct current (dc) fields. These fields have a frequency at or close to zero hertz. DC electric fields can be experienced in thunderstorms and indoors as static 'cling' on dry days. DC magnetic fields are produced by iron-containing deposits deep within the Earth and by magnets on refrigerator doors, both of which cause compass needles to align in a north-south direction.

#### *5.15.2.1 Typical Levels of Magnetic Fields in the Environment*

The strength of 60-Hz magnetic fields is commonly expressed as magnetic flux density in units called milligauss (mG). The strength of the magnetic field at any point depends on characteristics of the source, including the amount of current flow through the source, and distance from the source. Electric and magnetic fields by convention are measured and calculated at a height of 1 meter (40 inches) above the ground. Both electric and magnetic fields diminish in intensity with increasing distance from the source. Surveys show that in most homes, background magnetic field levels average about 1 mG, even when not near a particular source, such as an appliance, but there is considerable variation from one house to another. Figure 5.15-1 shows the levels of magnetic fields measured within homes, near appliances, and within the rights-of-way of distribution lines, subtransmission lines, and transmission lines (Savitz et al, 1989). The strongest sources of 60-Hz magnetic fields that we encounter are electrical appliances; fields near appliances vary over a much wider range, from a fraction of a milligauss to a thousand milligauss or more.

#### *5.15.3 Typical Daily Exposure to Magnetic Fields*

Because electric and magnetic fields decrease in strength as the distance from the source increases, the actual exposures that people receive depends on both, sources of these fields and an individual's daily activities. The contribution of any source to a person's total daily exposure depends not only on current flow, but how close the person is to the source, and the amount of time spent as well. The EMF *RAPID* program reported the results of a population survey of 24-hour exposures (Zaffanella and Kalton, 1998). More than one thousand people wore meters that took measurements every 10 seconds, so an average exposure included time at home, at work or

Ambient Background

Within Homes

Away from appliances

Next to appliances

Electric blankets

Distribution/ Subtransmission lines

Edge of right-of-way

Within right-of-way

High voltage transmission lines

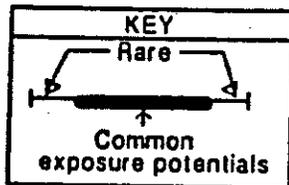
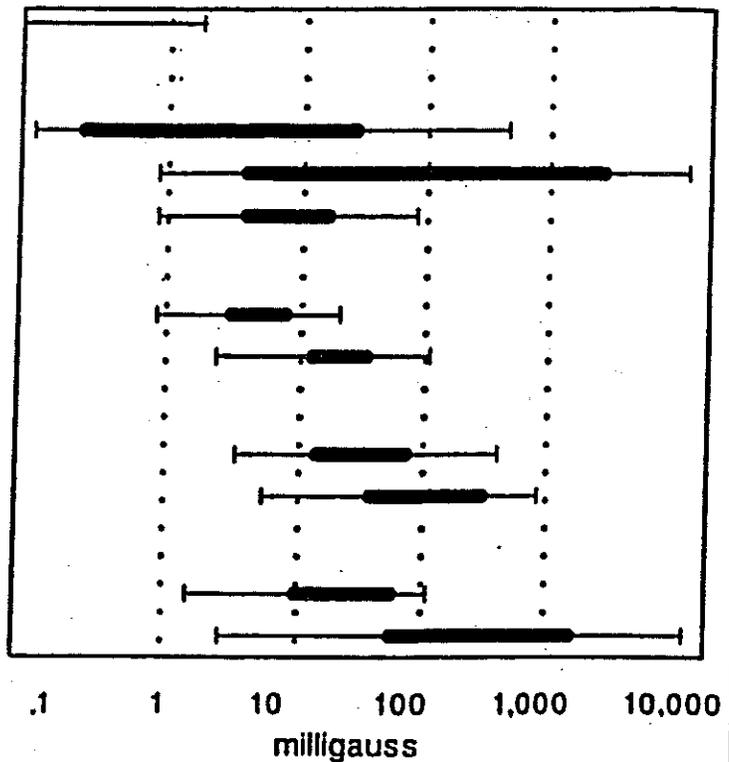
Edge of right-of-way

Within right-of-way

Occupational environments

Office

Specialized, high exposure



Kleen Energy Systems  
Middletown, Connecticut

Figure 5.15-1  
Magnetic Field Strengths

Date: 2/02

Project No. 33876

school, and travel. The average exposure over a 24-hour period for 853 people for whom complete data were obtained is 1.26 mG. In this randomly selected population, 14.7% of those surveyed had a 24-hour average exposure greater than 2 mG, and 5.9% had a 24-hour average more than 3 mG.

#### *5.15.4 Electric and Magnetic Field Study*

Pursuant to the Connecticut 1998 Report on Task Force Activities to Evaluate Health Effects from Electric and Magnetic Fields, January 1998, a study was performed on the Project area to identify existing electric and magnetic field sources, existing electric and magnetic field levels and the impacts of the Project. Appendix H contains a copy of the EMF Project Report.

##### *5.15.4.1 Electric and Magnetic Field Introduction*

As a part of this application, a preliminary assessment of the electromagnetic field (EMF) impact on the Connecticut Light & Power (CL&P) Company's transmission line 353 was completed. As part of the assessment, existing electric field measurements were taken at a representative location and the addition of the proposed 520MW (nominal) electric generating facility by Kleen Energy Systems, LLC was calculated.

The Kleen Energy Project will connect to CL&P's 345 kV transmission facilities existing in the adjacent transmission line corridor occupied by Line 353, which extends between CL&P's Scovill Rock and Manchester 345 kV Substations. Tower 12100 is adjacent to the Project site and supports a long span of the Connecticut River. It is expected that the line will be looped into the Kleen Energy switchyard between structures 12100 and 12099 which is the next structure to the southeast. The corridor of the looped transmission line is expected to generally follow the existing line's right-of-way. Because of the proximity of the line to the Project switchyard very little new area (all on CL&P land or the Project site) will be affected by the Project interconnect.

##### *5.15.4.2 Electric and Magnetic Field Analysis*

On February 27, 2002, magnetic field measurements were taken at the following locations with a Deksil Fieldstar 1000 recording gaussmeter:

- Measurement A – Lateral measurement mid-span between tower 12100 & structure 12099 (west to east).
- Measurement B - Lateral measurement at structure 12099 (east to west).
- Measurement C – Lateral measurement mid-span between structure 12099 & structure 12098 (west to east).

Similarly, on February 27, 2002, spot Electric field measurements were conducted across the right-of-way at roughly midspan between tower 12100 and structure 12099 with an Electric Fields Measurement EFM 160-3-60, Electric Field sensor, and a Fluke voltmeter. Spot measurements found Electric Field Strengths of 1.9 to 2.1 kV per meter directly underneath the

outer phase conductors, 1 kV per meter beneath the center phase conductor and 0.8 kV per meter at approximately 75 feet from the center line of the structures.

#### *5.15.4.3 Electric and Magnetic Field Applicability*

Despite the absence of any determination that health risks derive from exposures to magnetic fields, guidance has been developed by some states regarding magnetic field strengths permitted at the edge of transmission right-of-ways. The State of New York limits the design of new transmission lines to no more than 200 mG at the edge of right-of-way. Similarly, the state of Florida has a standard of 150 mG. The state of Massachusetts accepted a benchmark level of 85 mG at the edge of right-of-way. In all cases, the magnetic field impacts resulting from the proposed Kleen Energy Project appear to be within these standards.

#### *5.15.4.4 Electric and Magnetic Field Conclusion*

The principal potential sources of magnetic fields associated with the addition of the Kleen Energy Project are the generator exit lines and CL&P Line 353. Based upon the preceding preliminary review, the operation of the proposed Kleen Energy Project does not appear to cause magnetic field strengths on the transmission lines to exceed generally accepted standards for edge of right-of way levels

### **5.16 Project Schedule**

The permitting process for the Project is expected to take approximately 18 months. Processes began in September 2001. Project construction is anticipated to start in May 2003 and last 24 months. The total Project timeline is approximately 3 ½ to 4 years before the Project will reach commercial operation. Appendix I contains a detailed Project Schedule.

The Project is expected to cost approximately \$200 million. Compared to other similar projects, there are many differences. The site acquisition cost was very low because of the highly disturbed history of the site and problems associated with the site including an erosion and sediment control problem. Some expenses that might be expected to contribute to the capital costs, such as water supply infrastructure, are converted to operating costs because of the adopted structure of creating a separate entity to supply water to the Project as well as other opportunities.

**APPENDIX A**

**MUNICIPAL CONSULTATION AND MEETINGS**

**Kleen Energy Systems, LLC Municipal Consultation and Meetings**

<b>City or Town</b>		<b>Date</b>
<b>City of Middletown</b>		
	Technical reports delivered to the Mayor	January 11, 2002
	Public hearing held by the Middletown Common Council	March 4, 2002
<b>Portland</b>		
	Technical reports delivered to the First Selectman	January 11, 2002
	Meeting scheduled with the Board of Selectmen	March 13, 2002

## **APPENDIX B**

# **GENERAL ELECTRIC 7FA BROCHURE**



*GE Power Systems*

HEAVY-DUTY  
& AERODERIVATIVE  
PRODUCTS



# GAS TURBINES

*Long-Term Value  
for Power Producers,  
Cogenerators & Industry*

# Innovations in Gas Turbine Technology.

Since the early 1900s, GE has set the pace in the power generation industry with innovative technology, products, and services. During the past 50 years, a key element in advancing the capabilities of power generation has been the development of gas turbines. The strong synergy between GE's Aircraft Engine division and Power Systems has enabled a highly

successful transfer of technology and components, from aircraft engines to power generation applications, speeding the evolution of both industrial and utility gas turbines.

As a result, GE now offers the widest range of gas turbines available, from aeroderivatives to heavy-duty systems, ranging from 2 - 480 MW. Within the product line are machines for every utility, IPP and industrial application, from pure power generation to cogeneration and district heating. A variety of units, adaptable to mechanical drive, are available as well.

Each new GE gas turbine is the product of thousands of unit-years of predecessor unit operation. The accumulated knowledge is continually applied to advance gas turbine technology, and to



*Systems has dramatically improved gas turbine performance by adapting new materials and cooling technology.*

achieve superior performance in each new generation of machine. Engineering feedback from a fleet of more than 6,000 machines encompassing over 200 million fired hours of operating experience has been translated into unparalleled levels of reliability.

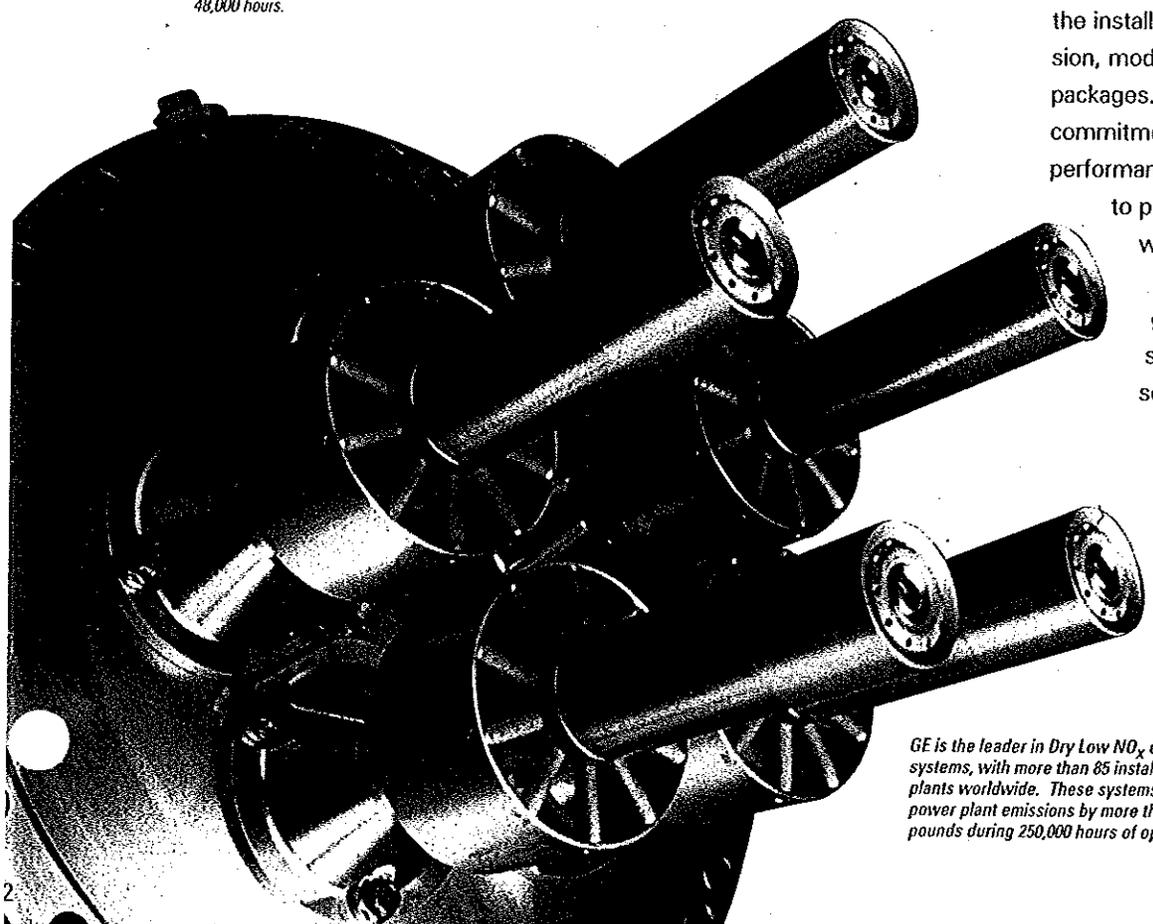
Through an engineering philosophy based on evolution of design, much of GE's rapidly advancing technology is readily adaptable to the installed fleet through conversion, modification, or upgrade packages. It's all part of GE's commitment to make proven, high performance machines even better;

to provide gas turbine users with the most reliable and competitively advantageous equipment, systems, and support services possible.

*GE is the leader in Dry Low NO<sub>x</sub> emissions systems, with more than 85 installed at power plants worldwide. These systems have reduced power plant emissions by more than 100 million pounds during 250,000 hours of operation.*



*Systems has adapted to earlier gas turbine models to provide increased firing temperature, output and efficiency - with concurrent improvements in maintenance. For example, new thermal barrier coatings applied to MS5002 components can extend their maintenance cycles from 24,000 to 48,000 hours.*



# The Next Step is H.

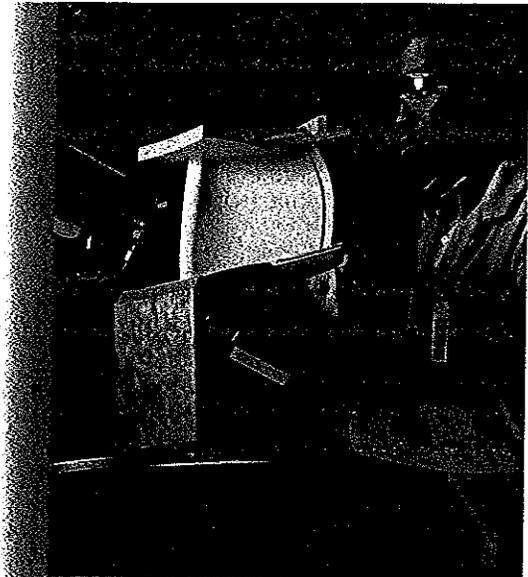
Industry deregulation is driving demand for highly efficient, low cost per kW-hour power plants. GE's H technology answers this need by integrating the gas turbine, steam turbine and heat recovery steam generator into a seamless combined cycle system, where each component's performance is optimized.

GE's H technology gas turbines for advanced combined cycle power plants were introduced to provide power generators with the most competitive cost of electricity. H combined cycle systems are based on a unique technology platform in which the steam plant reheat process and gas turbine bucket and nozzle cooling are accomplished

by the same integrated heat transfer system. This enables higher firing temperature operation – and dramatic improvements in efficiency.

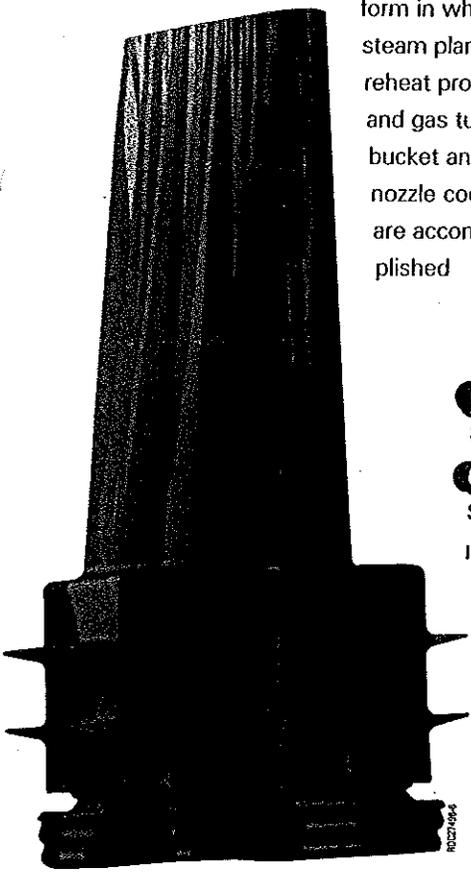
H machines are incorporated into a new line of combined cycle systems for 50 and 60 Hz power generation that operate at firing temperatures in the 2600°F (1430°C) class with net thermal efficiencies of 60%. Despite higher firing temperature, combustion temperature is retained at levels that minimize emission production.

Through the highest efficiency, lowest NO<sub>x</sub> emissions and lowest cost of producing electricity available in the industry, H advanced technology can reduce power plant operating costs by at least 10% compared to current plants. The efficient operation of H systems leads to substantial fuel cost



*Thermal Barrier Coatings (TBCs) from aircraft engines are applied to H gas turbine nozzles, buckets and shrouds. In addition to extending parts lives, the application of TBCs to hot gas path components reduces cooling flow requirements, thereby improving efficiency.*

savings – while their low cost power makes them highly dispatchable in competitive grid schemes. The bottom line is improved return on investment. For example, in a typical 480 MW combined cycle plant, the period for recovering an initial investment can be shortened by nearly 20%.

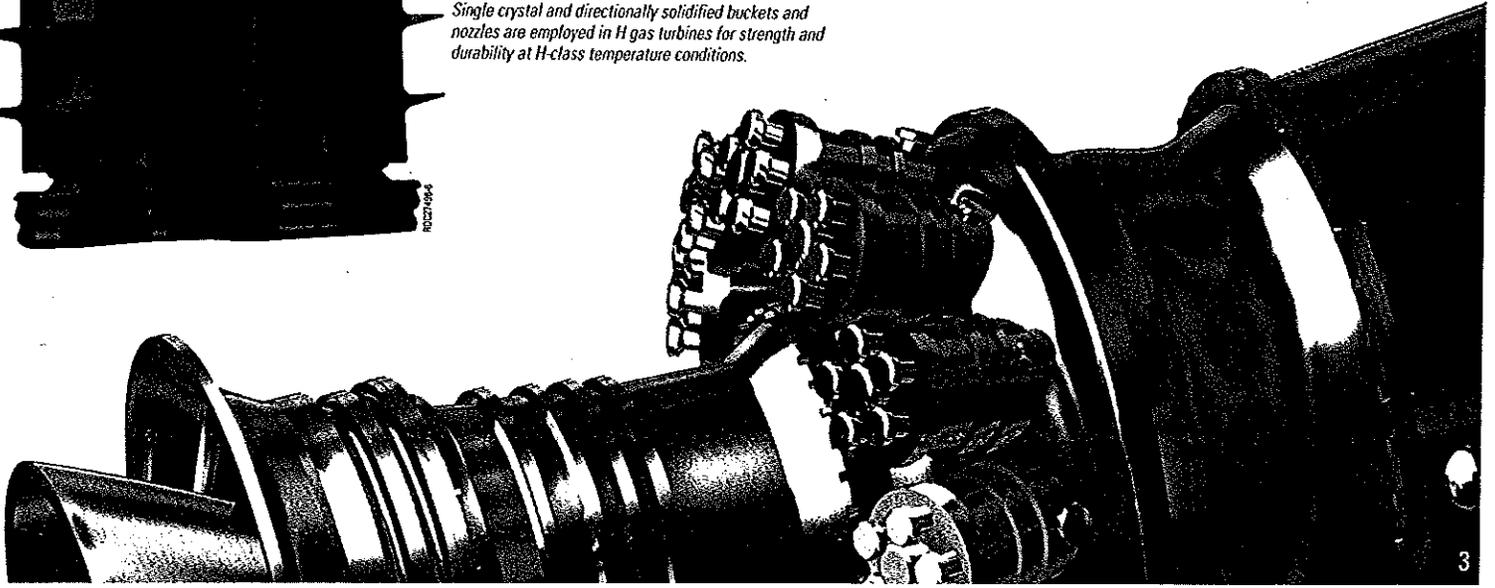


### MS9001H / MS7001H Combined Cycle Performance

	Net Plant Output (MW)	Heat Rate (Btu/kWh)	Heat Rate (kJ/kWh)	Net Plant Efficiency (%)	GE Number	Steam Cycle
<b>50 Hz</b>						
S109H (single-shaft)	480	5,690	6,000	60.0%	1 x MS9001H	reheat
<b>60 Hz</b>						
S107H (single-shaft)	400	5,690	6,000	60.0%	1 x MS7001H	reheat

ISO base rating (LHV), natural gas fuel.

*Single crystal and directionally solidified buckets and nozzles are employed in H gas turbines for strength and durability at H-class temperature conditions.*



# 7FA and 9FA. The Industry Standards for Large Power

With over 140 units ordered or in operation and more than 1 million fired hours, GE's F-class gas turbines represent the world's largest, most experienced fleet of advanced machines. Designed for maximum reliability and efficiency with low maintenance, they are favored by both power generators and industrial cogenerators requiring large blocks of power.

This program facilitated the application of technologies such as advanced bucket cooling techniques, compressor aerodynamic design and new alloys to F gas turbines, enabling them to attain higher firing temperatures than previous generation machines.

All GE gas turbines offer flexibility in cycle configuration, fuel selection, and site adaptation. Today, the

7FA and 9FA provide a wide range of choices to meet any project need. Rated at 171.7 MW in simple cycle, the 7FA can produce 262.6 MW in combined cycle. The 9FA is a 1.2 aerodynamic scale of the 7FA, rated at 255.6 MW in simple cycle and 390.8 MW in combined cycle. In addition, F gas turbines can be designed to operate on low-heating-value fuels, which results in significant fuel savings over previous power plant designs, and also makes them ideally suited to IGCC applications.



Using advanced bucket cooling techniques, materials and coatings, current model F technology gas turbines operate at temperatures in the 2400°F (1315°C) class.

## MS9001FA / MS7001FA - Simple Cycle Performance

	50 Hz	60 Hz
Output (MW)	255.6	171.7
Heat Rate (Btu/kWh)	9,250	9,470
	9,757	9,930
Pressure Ratio	15.4:1	15.5:1
Mass Flow (lb/sec)	1,375	952
	624	432
Turbine Speed (rpm)	3,000	3,600
Exhaust Temperature (°F)	1,129	1,116
Exhaust Temperature (°C)	609	602
Model Designation	PG9351FA	PG7241FA

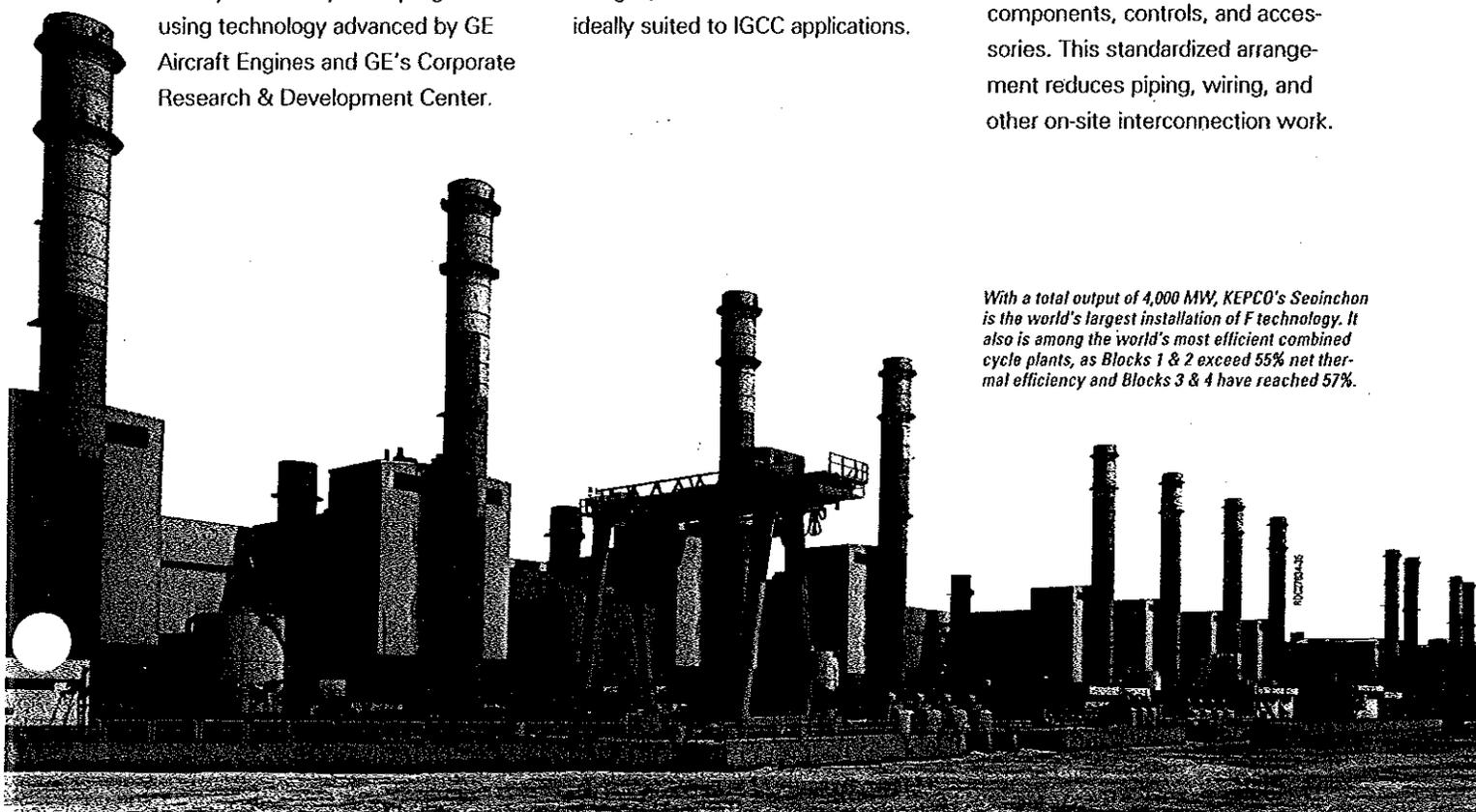
ISO base rating (LHV), natural gas, standard inlet and exhaust pressure drops.

GE's F-class gas turbines, introduced in 1986, were the result of a multi-year development program using technology advanced by GE Aircraft Engines and GE's Corporate Research & Development Center.

Both gas turbines have an 18-stage compressor and a 3-stage turbine. They feature cold-end drive and axial exhaust which is beneficial for combined cycle arrangement where net efficiencies over 56% can be achieved.

With reduced cycle time for installation and start-up, F-based power systems can be brought on-line fast. Building on its Frame 6, 7 and 9 installation experience, GE developed a packaging concept featuring consolidated skid-mounted components, controls, and accessories. This standardized arrangement reduces piping, wiring, and other on-site interconnection work.

With a total output of 4,000 MW, KEPCO's Seoinchon is the world's largest installation of F technology. It also is among the world's most efficient combined cycle plants, as Blocks 1 & 2 exceed 55% net thermal efficiency and Blocks 3 & 4 have reached 57%.

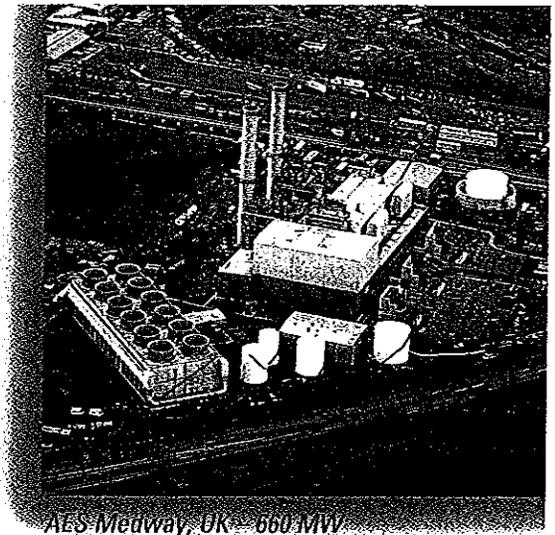


# eneration.

While helping to meet global demand for large blocks of new power capacity, F technology units have proven to be excellent performers for all applications and types of duty. For example, one of

F technology also has displayed outstanding environmental characteristics. Because of the higher specific output of these machines, less NO<sub>x</sub> and CO are emitted per unit of power produced for the same exhaust concentrations. F systems have succeeded in meeting or exceeding the site requirements of every project in which they have been applied, accumulating over 900,000 operating hours on DLN (Dry Low NO<sub>x</sub>). Several plants operate at single digit NO<sub>x</sub>.

For example, four GE 7FA gas turbines at FP&L's Martin Station,



AES Medway, UK - 660 MW

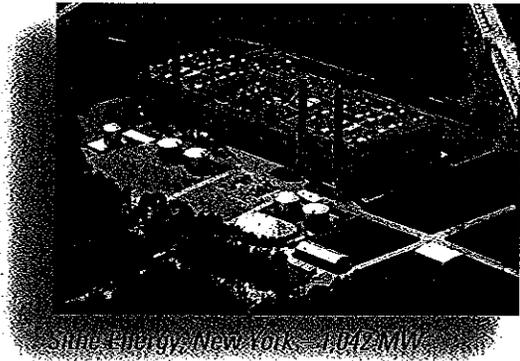
cycle plant where eight STAG 107F combined cycle systems (Blocks 1 & 2) have compiled nearly 200,000 hours of commercial service. Four more STAG 207FA systems, now installed at Seoinchon Blocks 3 & 4, bring the total plant output to 4,000 MW, making Seoinchon the world's largest combined cycle facility.

Other landmark F technology, combined cycle installations include Tokyo Electric Power Company's 2,800 MW Yokohama plant and CAPCO's 2,400 MW Black Point



South Bangkok, Thailand - 600 MW

facility in Hong Kong. These also rank among the world's largest and most efficient combined cycle plants.



Sithe Energy, New York - 1042 MW

### MS9001FA / MS7001FA Combined Cycle Performance

	Net Plant Output (MW)	Heat Rate (Btu/kWh)	Heat Rate (kJ/kWh)	Net Plant Efficiency	GT Number & Type
<b>50 Hz</b>					
S109FA	390.8	6,070	6,350	56.7%	1 x MS9001FA
S209FA	786.9	5,980	6,305	57.1%	2 x MS9001FA
<b>60 Hz</b>					
S107FA	262.6	6,090	6,425	56.0%	1 x MS7001FA
S207FA	529.9	6,040	6,375	56.5%	2 x MS7001FA

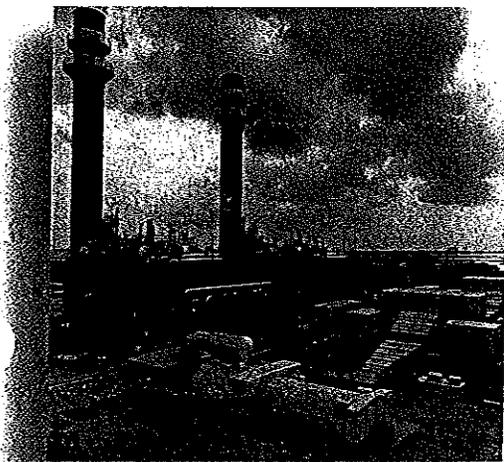
All models with 3 pressure reheat steam cycle, ISO base rating (LHV), natural gas fuel.

the four 7FA gas turbines installed at Sithe Energy's Independence Station in New York recorded 100% availability and reliability over a 108-day stretch of continuous operation in late 1995 and early 1996. In 1997, a FP&L (Florida Power & Light) 7FA ran continuously for 230 days.

equipped with advanced DLN systems, were the first advanced technology gas turbines to achieve NO<sub>x</sub> emissions levels below 25 ppm in commercial service, and typically run at 15-18 ppm NO<sub>x</sub> at base load.

The first F technology unit installed was a 7F in a repowering application at Virginia Power's Chesterfield Station. This fleet leader has now accumulated over 40,000 fired hours and 500 starts.

The largest installation of F technology gas turbines is at Korea Electric Power's Seoinchon combined



Martin Station, Florida - 950 MW

# 6FA. High Performance in a Mid-Size Package.

In a performance class all its own, the highly efficient 6FA gas turbine is a mid-size version of the well-proven 7FA and 9FA. Designed for either 50 or 60 Hz applications, the gear-driven 6FA answers the need for mid-size power blocks

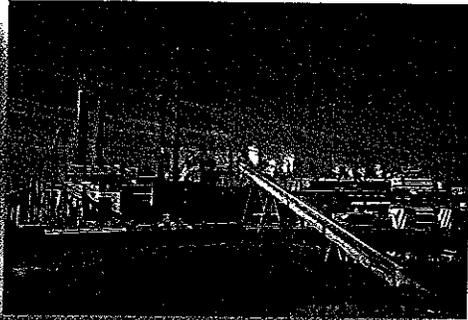
This high-speed gas turbine produces 70 MW of simple cycle power at 34% efficiency and 108 MW of combined cycle power at 53% net efficiency. The 6FA provides major fuel savings in base-load combined cycle operation over earlier mid-range machines and is adaptable to either single-shaft or multi-shaft configurations. In IGCC operation, gross plant efficiencies can reach up to 46%.

A 2/3 scale of the 7FA, the 6FA is a classic example of the GE philosophy of evolutionary design improvement. The compressor, for example, is an 18-stage axial

Simple Cycle Power (MW)	70
Combined Cycle Power (MW)	108
Efficiency (%)	34
Heat Rate (Btu/kWh)	9,300
(kJ/kWh)	21,320
Pressure Ratio	25.1
Mass Flow (lb/sec)	437
(kg/sec)	198
Turbine Speed (rpm)	5,254
Exhaust Temperature (°F)	1,107
(°C)	597
Model Designation	PG6101FA

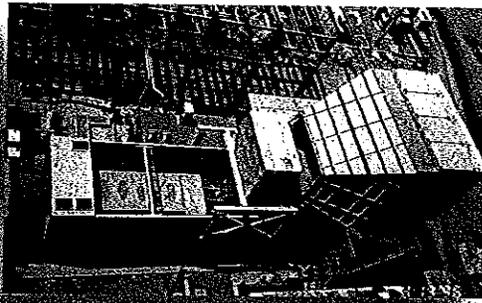
ISO base rating (LHV), natural gas fuel, standard inlet and exhaust pressure drops.

design, aerodynamically scaled from the 7FA. It has can-annular combustors of the same size and configuration as the 9FA, however the number of combustion chambers is decreased from 18 to 6. Cold-end drive allows exhaust gases to be directed axially into the HRSG.

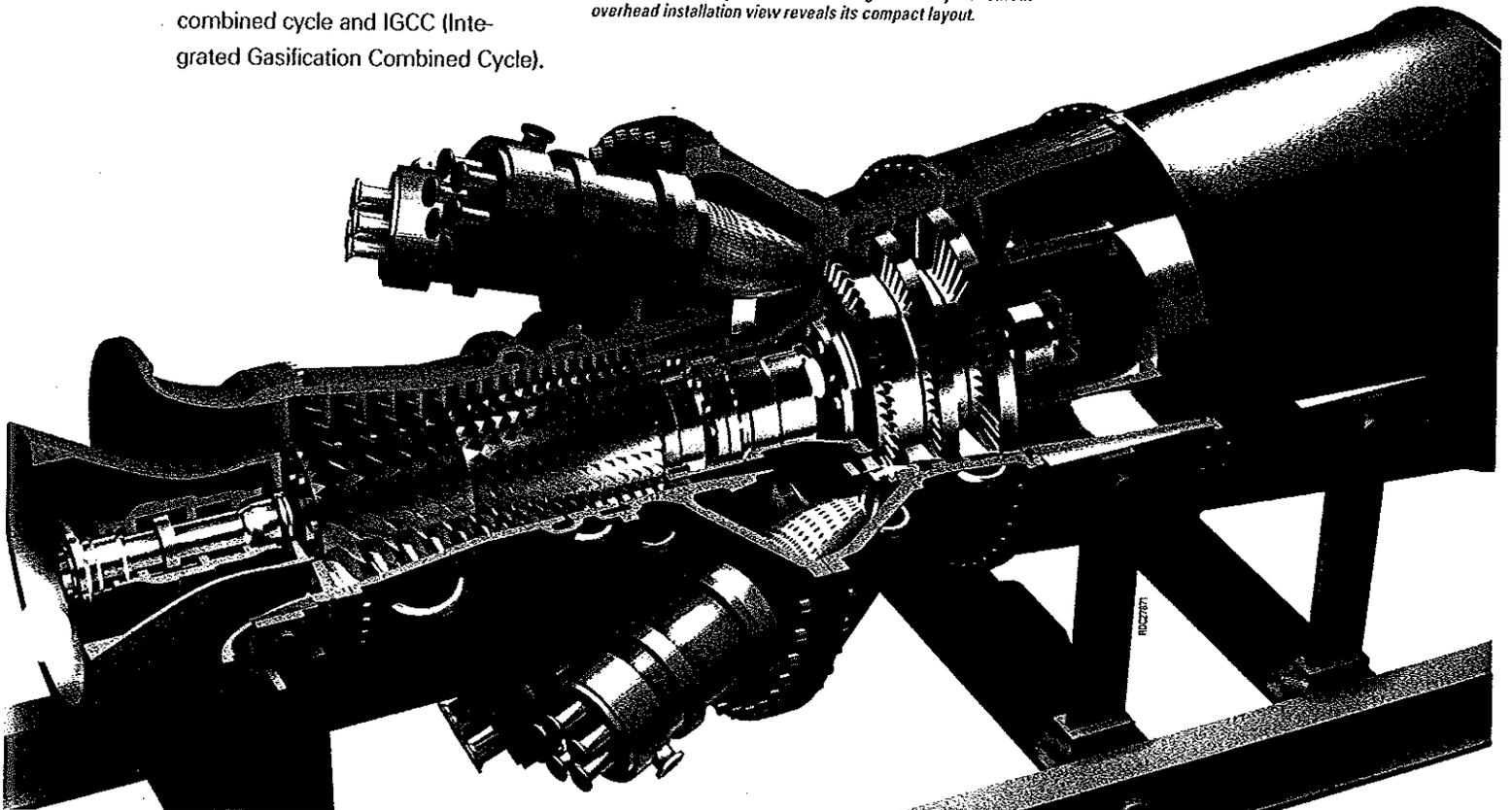


The 6FA gas turbine is chosen for applications. The Kirkkemi paper mill chose a 6FA system to fulfill their needs for low cost electricity, and large amounts of steam and hot water.

with high performance in combined heat and power applications. Its output range, high exhaust energy, full packaging and robust design make the 6FA ideally suited for a wide variety of applications, ranging from cogeneration and district heating to pure power generation in combined cycle and IGCC (Integrated Gasification Combined Cycle).

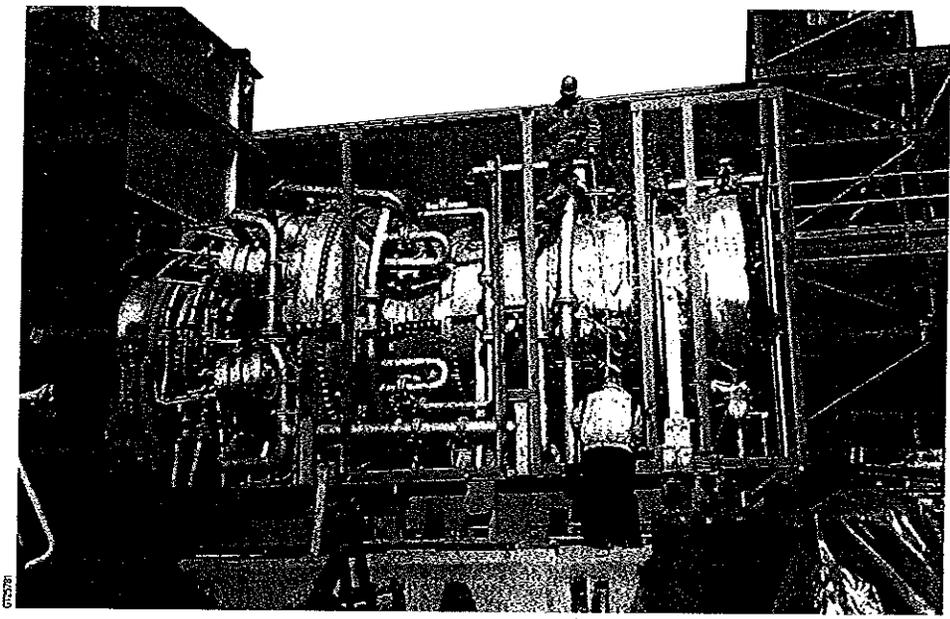


The 6FA gas turbine is chosen for applications. The Kirkkemi paper mill chose a 6FA system to fulfill their needs for low cost electricity, and large amounts of steam and hot water. An overhead installation view reveals its compact layout.



Like other F technology units, the fuel-flexible 6FA provides the ability to burn a wide spectrum of fossil fuels, including gasified coal. Fuels can be switched after start-up without sacrificing performance. A Dry Low NO<sub>x</sub> combustion system is available, which can achieve NO<sub>x</sub> emissions under 15 ppm when burning natural gas.

6FA application flexibility is evidenced through installations on-line and coming on-line. The first two 6FAs to enter service were installed at Sierra Pacific Power Company's Piñon Pine IGCC plant in Nevada, and Kingston CoGen Limited Partnership's cogeneration plant in Ontario. Two other cogeneration units for paper mills are



A 6FA module shown during commissioning at Kingston CoGen Limited Partnership's cogeneration plant in Canada shows its slab-mounted design. All other 6FA accessories are on separate skids for easy installation and maintainability.

installed at Metsa-Serla in Kirkniemi, Finland and at Boffalora, Italy. Boffalora is a single-shaft combined cycle configuration.

A 6FA installation is also under-way at the Fife Environmental

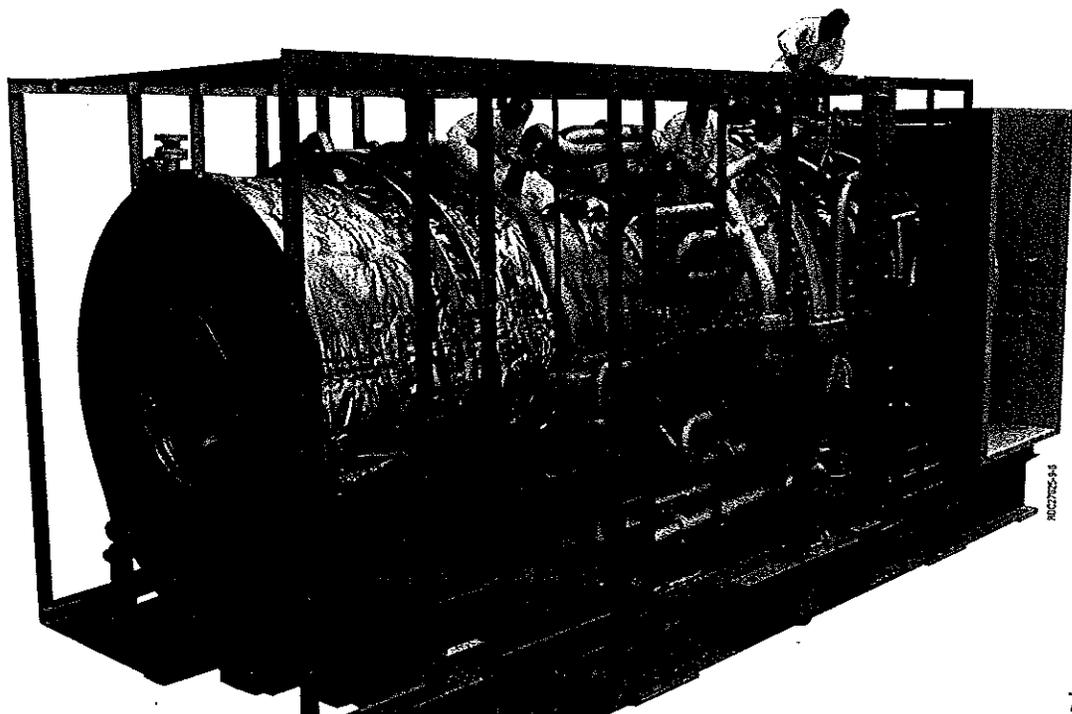
Energy Park in Scotland, which will be the UK's first IGCC facility. Simple cycle 6FA gas turbines are being supplied for the Neste Oy power plant in Porvoo, Finland and the Usti power plant in the Czech Republic. Another single-shaft 6FA for a 110 MW combined cycle plant in Cologne, Germany will supply power and steam at a district heating application.

**MS6001FA**  
**Combined Cycle Performance**

	Unit MW	Heat rate (kJ/kWh)	Efficiency (%)	Number Units
<b>50 Hz</b>				
S106FA	107.1	6,420	67.75	1 x MS6001FA
S206FA	218.7	6,305	66.50	2 x MS6001FA
<b>60 Hz</b>				
S106FA	107.1	6,440	67.95	1 x MS6001FA
S206FA	217.0	6,355	67.05	2 x MS6001FA

All models with 3 pressure reheat steam cycle, ISO base rating (LHV), natural gas fuel.

The 6FA is packaged for quick and cost-effective installation.



# 9E. The Fuel-Flexible 50Hz Performer.

The MS9001E gas turbine is GE's 50 Hz workhorse, proven in over 3 million hours of utility and industrial service; many in arduous climates ranging from desert heat to tropical humidity to arctic cold. Originally introduced at 105 MW in 1978, numerous component improvements have been incorporated into the unit, so that the latest model now boasts an output of 123 MW and is capable of achieving over 52% efficiency in combined cycle.

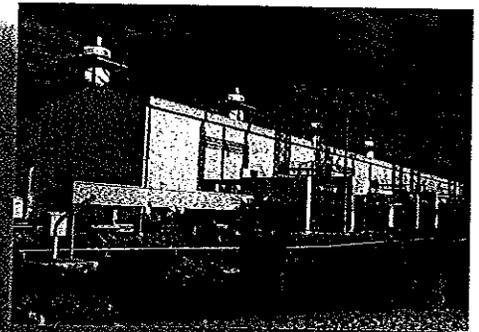
## MS9001E - Simple Cycle Performance

Model Designation	PG9171E
Exhaust Temperature (°C)	594
Exhaust (°F)	1101
Efficiency (%)	50.00

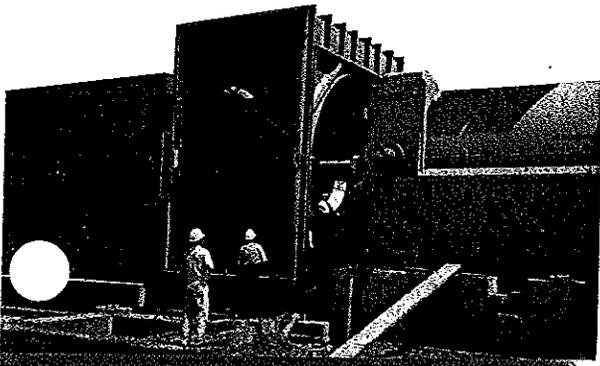
ISO base rating (LHV), natural gas fuel, standard inlet and exhaust pressure drops.

With its state-of-the-art fuel handling capabilities, the 9E accommodates a wide range of fuels including natural gas, light and heavy distillate oil, naphtha, crude oil and residual oil. It is also able to utilize a variety of syngases produced from oil or coal without turbine modification. This flexibility, along with its extensive experience and reliability record, make the 9E well suited for IGCC projects.

Whether for simple cycle or combined cycle application, base load or peaking duty, 9E packages are comprehensively engineered with integrated systems that include controls, auxiliaries, ducts and silencing. They are designed for reliable operation and minimal maintenance at a competitively low installed cost.



Delivering 440 MW of reliable peaking power for Port Dickson Power, one of Malaysia's first IPPs.



Efficiently operating on low-BTU value gas, such as that being supplied to the 584 MW Uch combined cycle IPP plant in Pakistan, shown here during construction.

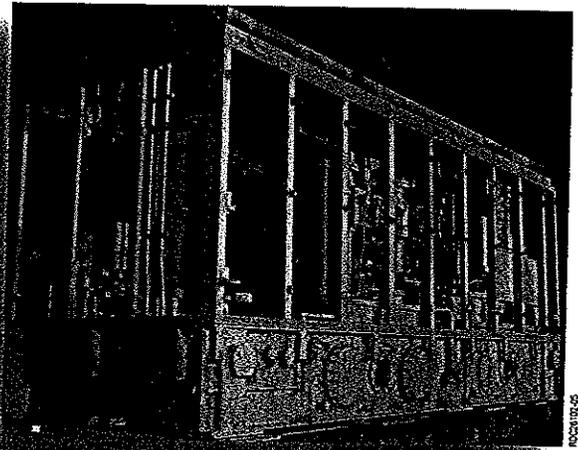
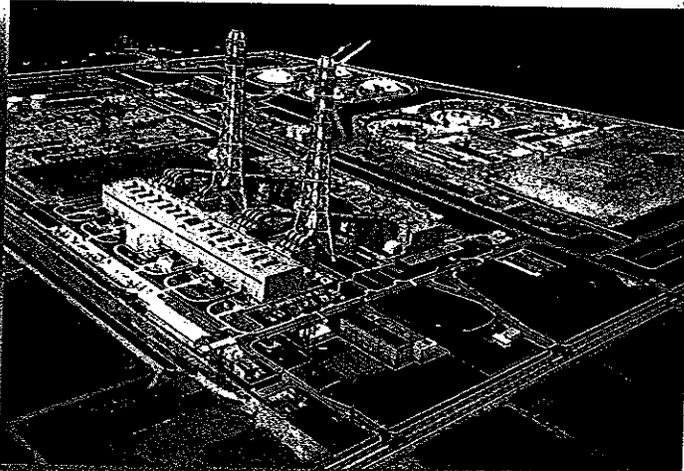
## MS9001E Combined Cycle Performance

### 50 Hz

S109E	180	6,571	6,935	52.0%	1 x MS9001E
S209E	383.7	6,480	6,840	52.7%	2 x MS9001E

All models with 3 pressure non-reheat steam cycle, ISO base rating (LHV), natural gas fuel.

Tokyo Electric Power's 2,000 MW Futtsu combined cycle plant's 14 MS9001E gas turbines have accumulated over 675,000 fired hours and 16,700 starts, posting reliability over 99%.



and start-up. The 9E's split-base packaging brings standardization to its modularized accessory systems, contributing to its low installed cost.



# 7EA. Simplicity and Versatility Set a Standard.

The 7EA is a time-tested, performance-proven, heavy-duty gas turbine, designed for 60 Hz applications. With over 600 units in service, Frame 7 models have accumulated more than 15 million hours of service. Today, the 7E/EA fleet is acknowledged as the industry standard for reliability and availability.

## MS7001EA – Simple Cycle Performance

		60 Hz
Output	(MW)	85.4
Heat Rate	(Btu/kWh)	10,420
	(kJ/kWh)	10,999
Pressure Ratio		12.6:1
Mass Flow	(lb/sec)	643
	(kg/sec)	292
Turbine Speed (rpm)		3,600
Exhaust Temperature	(°F)	998
	(°C)	536
Model Designation		PG7121EA

## MS7001EA – Mechanical Drive

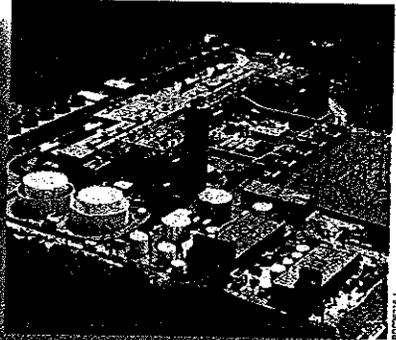
Output	(hp)	109,376
Heat Rate	(Btu/kWh)	7,781
	(kJ/kWh)	11,920
Pressure Ratio		11.8:1
Mass Flow	(lb/sec)	614
	(kg/sec)	278
Turbine Speed (rpm)		3,460
Exhaust Temperature	(°F)	1,016
	(°C)	546
Model Designation		M7111EA

ISO base rating (LHV), natural gas fuel, standard inlet and exhaust pressure drops.

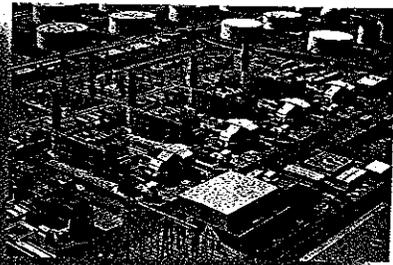
With strong efficiency in simple and combined cycle applications, this 85 MW machine is used in a wide variety of power generation, industrial and cogeneration applications. It is uncomplicated and versatile; its medium-size design lends itself to flexibility in plant layout and fast, low-cost additions of increments of power.

With state-of-the-art fuel handling equipment, advanced bucket cooling, thermal barrier coatings and a multiple fuel combustion system, the 7EA can accommodate the full range of fuels. It is designed for dual fuel operation, able to switch from one fuel to another while the turbine is running under load or during shutdown. 7E/EA units have accumulated over 4 million hours of operation using crude and residual oils.

In addition to power generation, the 7EA can serve in selective mechanical drive applications. The high reliability demonstrated by the 7EA in power generation



... cycle plant in Rhode Island, now under GE O&M contract, employs two 250 MW STAG 207EA systems. The total plant has sustained a reliability level over 99% since 1994.



... designed for low installed cost. Its dispatch ease and loading flexibility make it ideal for applications such as peak and emergency stand-by.

applications, combined with economies of scale in unit power, fuel efficiency and space utilization, provide a strong incentive for its use in large capacity projects.

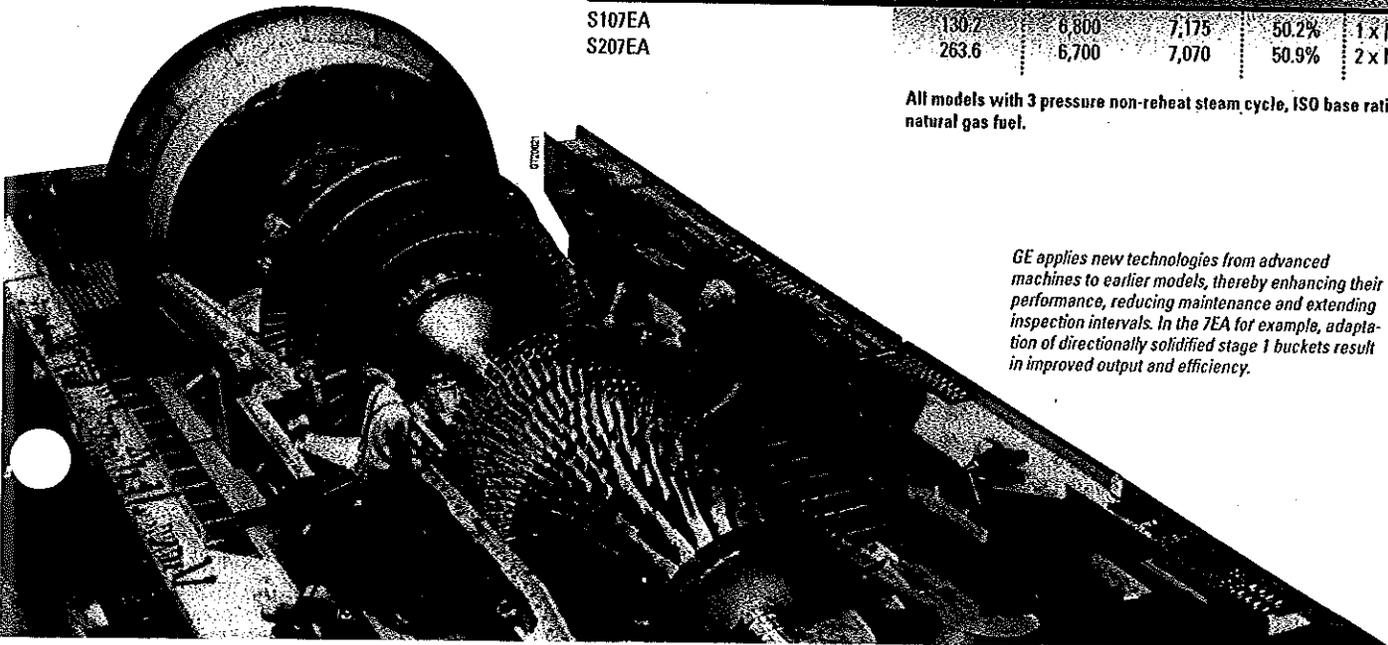
## MS7001EA Combined Cycle Performance

### 60 Hz

	Output (MW)	Heat Rate (Btu/kWh)	Heat Rate (kJ/kWh)	Efficiency	Number of Units
S107EA	130.7	6,800	7,175	50.2%	1 x MS7001EA
S207EA	263.6	6,700	7,070	50.9%	2 x MS7001EA

All models with 3 pressure non-reheat steam cycle, ISO base rating (LHV), natural gas fuel.

GE applies new technologies from advanced machines to earlier models, thereby enhancing their performance, reducing maintenance and extending inspection intervals. In the 7EA for example, adaptation of directionally solidified stage 1 buckets result in improved output and efficiency.



# 6B. Reliable and Rugged 50/60 Hz Power.

The MS6001B is a performance-proven 40 MW-class gas turbine, designed for reliable 50/60 Hz power generation and 50,000 hp-class mechanical drive service. With availability well documented at 96.9% and reliability at 98.9%, it's the popular choice for efficient, low installed cost power generation or prime movers in mid-range service.

The 6B evolved from the MS5001 and MS7001, two of the most versatile and widely used gas turbines ever manufactured. It can be installed fast, for quick,

Like all GE heavy-duty gas turbines, the 6B has earned a solid reputation for high reliability and environmental compatibility. It can accommodate a wide range of fuels, and is adaptable to IGCC.

The 6B, like the 7EA, is increasingly used by process industries. With its excellent fuel efficiency, low cost per horsepower and high horsepower per square foot of footprint area, the MS6001B is an excellent fit for selective mechanical drive applications.

## MS6001B – Simple Cycle Performance

Footprint Area (sqm)	18.5
Exhaust Temperature (°F)	890
Exhaust Temperature (°C)	532
Model Designation	PG6561B

## MS6001B – Mechanical Drive

Footprint Area (sqm)	18.5
Turbine Speed (rpm)	3600
Exhaust Temperature (°F)	1017
Exhaust Temperature (°C)	557
Model Designation	M6511B

ISO base rating (LHV), natural gas fuel, standard inlet and exhaust pressure drops.

## MS6001B Combined Cycle Performance

### 50 Hz

S106B  
S206B  
S406B

### 60 Hz

S106B  
S206B  
S406B

Model	Capacity (MW)	Efficiency (%)	Configuration
S106B	59.8	48.7%	1 x MS6001B
S206B	121.4	49.4%	2 x MS6001B
S406B	243.9	49.7%	4 x MS6001B

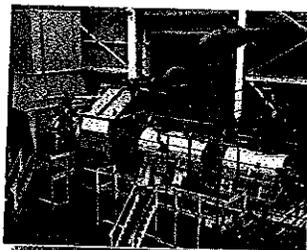
All models with 3 pressure non-reheat steam cycle, ISO base rating (LHV), natural gas fuel.

near-term capacity. With a fleet that has logged over 8 million hours of service, the 6B is recognized as rugged and reliable, able to handle the multiple start-ups required for peak load service.

In combined cycle operation, the 6B is a solid performer, producing 60 MW at nearly 50% efficiency. It is also a flexible choice for cogeneration applications, capable of producing a thermal output ranging from 20 to 400 million Btu/hr.

*Cogen Technologies, this 165 MW plant in Bayonne, NJ, employs a 1x306B 2 pressure non-reheat system which provides steam for oil handling and power to Jersey Central Power & Light.*

*Low investment cost, unattended remote control operation, dispatch ease and loading flexibility of the packaged MS6001B make it ideal for peak load use, emergency stand-by, cogeneration and industrial self-generation.*



*The MS6001B's demonstrated level of high reliability is broadening its acceptance for mechanical drive applications in LNG plants and for refrigeration compressor drives.*



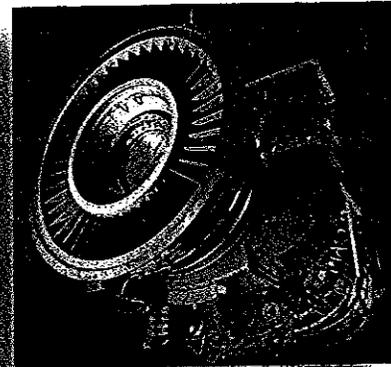
# Small Heavy-Duty and Aero-derivative Machines – Gas 1

GE's acquisition of Stewart & Stevenson's Gas Turbine Division (now called S&S Energy Products) and its affiliation with Nuovo Pignone have extended the traditional GE heavy-duty gas turbine product lines with a wide range of turbomachinery products to serve power generation, industrial cogeneration and mechanical drive applications worldwide.

Nuovo Pignone's gas turbine products include a range of small heavy-duty industrial machines with outputs ranging from 2 to 30 MW, as well as GE aero-derivative

machines. S&S Energy Products enables GE to offer a broader portfolio of small packaged power plants. The broad and integrated product lines provide a single source turbomachinery capability that is unique in the industry.

GE's aero-derivative gas turbines are excellent power producers for a variety of mechanical drive, electric generator drive and cogeneration applications. They are well suited for simple cycle power generation and cyclic applications such as peaking power, which parallels aircraft engine use.



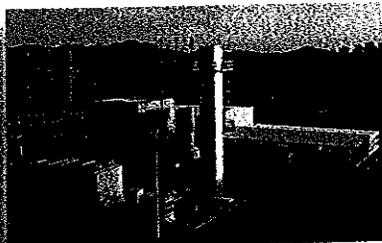
For emergency power applications, the powerful LM6000 is one of the most fuel efficient simple cycle gas turbines in the world.

With start times around one minute, these units are often used for emergency power applications.

	ISO Rating (MW)	Heat Rate (Btu/kWh)	Heat Rate (kJ/kWh)	Pressure Ratio	Exhaust Flow (lb/sec)	Exhaust Temp (°C)	Exhaust Stack Temp (°F)	Exhaust Temp (°C)
<b>Generator Drive</b>								
<b>Heavy-Duty</b>								
PGT2	2.0	13,650	13,400	17.7:1	23.3	101	22,500	978
PGT5 (single-shaft)	5.2	12,772	12,422	19.1:1	34.5	236	18,140	977
PGT10	10.22	10,932	11,534	14.1:1	92.8	421	7,900	902
PGT10B (single-shaft)	11.27	10,670	11,250	15.6:1	100.7	457	11,000	903
MS5001	26.3	11,990	12,650	10.5:1	273.6	124.1	5,094	909
<b>Aero-derivatives</b>								
PGT16 (LM1600)	13.76	9,763	10,298	20.1:1	104.5	47.4	7,900	919
PGT25 (LM2500)	22.45	9,389	9,904	17.9:1	151.9	68.9	6,500	976
PGT25+ (LM2500+)	27.5	8,861	9,347	20.7:1	179.2	81.25	6,100	925
LM6000	43.0	8,212	8,663	27.6:1	277.0	125.6	3,600	845

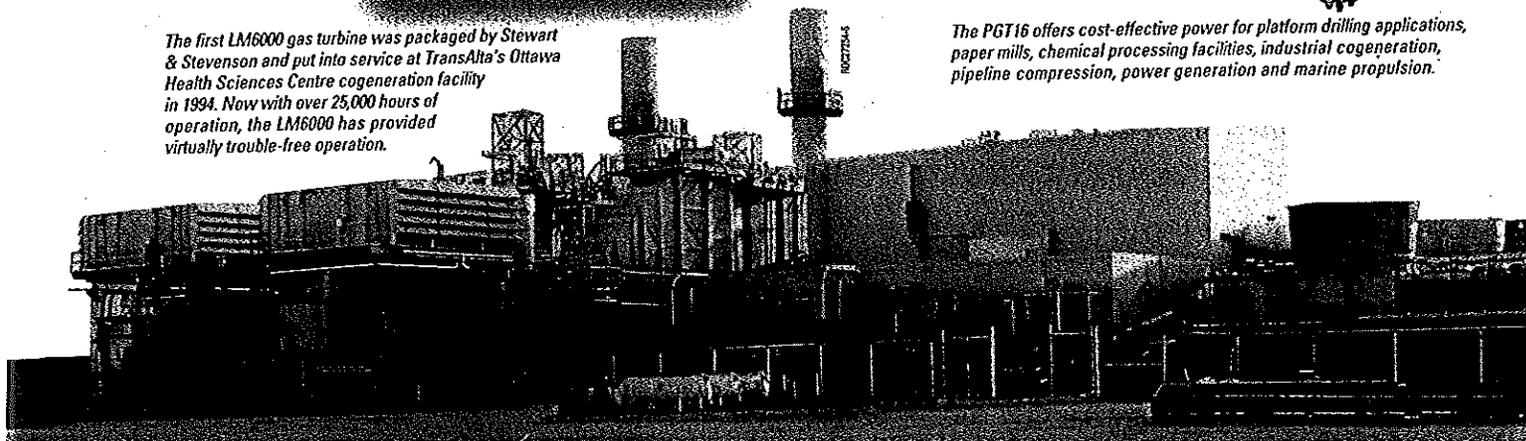
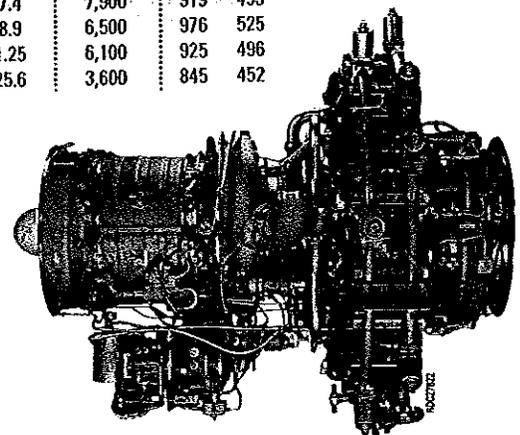
ISO base rating (LHV), natural gas fuel, zero inlet and exhaust pressure drops.

The Pavana Power Plant in the Honduras exhibits the highly compact, packaged arrangement of a single LM6000 aero-derivative gas turbine generator, available through S&S Energy Products.



The first LM6000 gas turbine was packaged by Stewart & Stevenson and put into service at TransAlta's Ottawa Health Sciences Centre cogeneration facility in 1994. Now with over 25,000 hours of operation, the LM6000 has provided virtually trouble-free operation.

The PGT16 offers cost-effective power for platform drilling applications, paper mills, chemical processing facilities, industrial cogeneration, pipeline compression, power generation and marine propulsion.



# Turbines for Every Application.

The gas turbine product line includes:

**PGT2.** The 2 MW PGT2 was developed specifically for cogeneration application in medium to small plants, such as paper mills and cement, ceramic, textile and food industries.

**PGT5.** The 5 MW PGT5 is widely used in the pipeline industry and is now available for power generation. More than 200 units have been sold since the PGT5 was developed in the early 1970s.



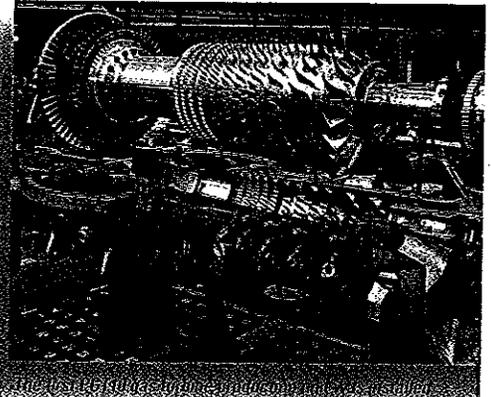
Technicians inspect the PGT2 with GE's patented Dry Low Emissions combustion system at Nuovo Pignone's Florence, Italy manufacturing facility.

**PGT10B.** The PGT10 was recently uprated to slightly over 11 MW and is now designated as the PGT10B. Since the PGT10 was introduced in 1988, more than 80 units have been sold for mechanical drive and power generation applications.

**MS3002,** is a versatile two-shaft machine noted for its highly reliable, low cost mechanical drive operation. Over 900 are in service, many employed in pipeline, process plant and offshore applications.

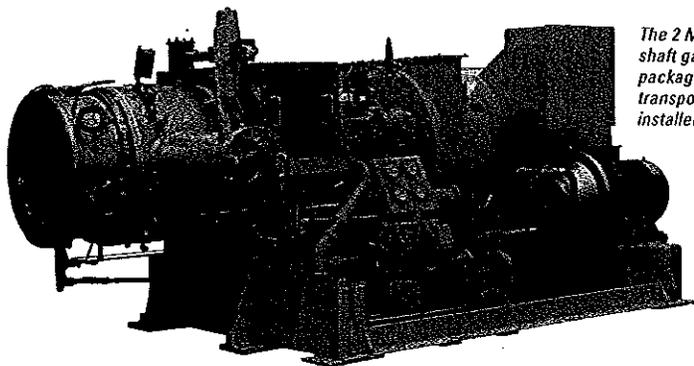
**MS5001** single-shaft turbine is a compact heavy-duty prime mover typically applied in industrial cogeneration and district heating systems. With 75 million operating hours experience, the 2,000 unit MS5001 is the world's most tested machine.

**MS5002** is a two-shaft heavy-duty gas turbine designed for high operating efficiency over a wide load and speed range. The MS5002 is most commonly used in large pipeline projects and in natural gas reinjection and liquefaction plants.

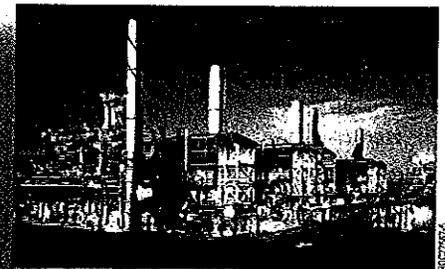


in a refinery cogeneration plant in Japan in 1989.

**Aeroderivative Gas Turbines** derived from GE's aircraft engine technology are high performance power makers, noted for their compact design and ease of operation and maintenance. Each machine, from the LM1600 and LM2500 to the LM6000, is a high power-to-weight ratio gas turbine closely derived from the company's highly reliable aircraft engines.



The 2 MW PGT2 single shaft gas turbine generator package can be easily transported and quickly installed.



Novuo Pignone centrifugal compressors driven by GE MS5002C two-shaft gas turbines.

## Mechanical Drive

### Heavy-Duty

	1980 ISO Base Rating (LHV)			1980 ISO Base Rating (HHV)			1980 ISO Base Rating (HHV)			1980 ISO Base Rating (HHV)		
	Power (MW)	Power (HP)	Power (kW)	Power (MW)	Power (HP)	Power (kW)	Power (MW)	Power (HP)	Power (kW)	Power (MW)	Power (HP)	Power (kW)
PGT2	2.0	2700	1470	2.0	2700	1470	2.0	2700	1470	2.0	2700	1470
PGT5 (two-shaft)	5.0	6750	3675	5.0	6750	3675	5.0	6750	3675	5.0	6750	3675
PGT10	10.0	13,500	7350	10.0	13,500	7350	10.0	13,500	7350	10.0	13,500	7350
PGT10B (two-shaft)	11.0	14,850	8085	11.0	14,850	8085	11.0	14,850	8085	11.0	14,850	8085
MS3002	11.29	15,140	8190	11.29	15,140	8190	11.29	15,140	8190	11.29	15,140	8190
MS3002R	10.83	14,520	7890	10.83	14,520	7890	10.83	14,520	7890	10.83	14,520	7890
MS5002C	26.34	35,000	18,700	26.34	35,000	18,700	26.34	35,000	18,700	26.34	35,000	18,700
MS5002R	26.55	35,600	19,000	26.55	35,600	19,000	26.55	35,600	19,000	26.55	35,600	19,000
MS5002D	32.07	43,000	23,000	32.07	43,000	23,000	32.07	43,000	23,000	32.07	43,000	23,000

### Aeroderivatives

PGT16 (LM1600)	14.26	19,120	7,020	9,420	9,935	20.1:1	47.4	104.5	7,900	493	919
PGT25 (LM2500)	23.27	31,200	6,760	9,070	9,565	17.9:1	68.9	151.9	6,500	525	977
PGT25+ (LM2500+)	29.98	40,200	6,315	8,470	8,935	20.7:1	81.3	179.2	6,100	496	925
LM6000	44.62	59,835	5,974	8,013	8,452	29.4:1	127.0	280.0	3,600	450	842

ISO base rating (LHV), natural gas fuel, zero inlet and exhaust pressure drops.

# GE Offers All the Options to Meet Project Needs.

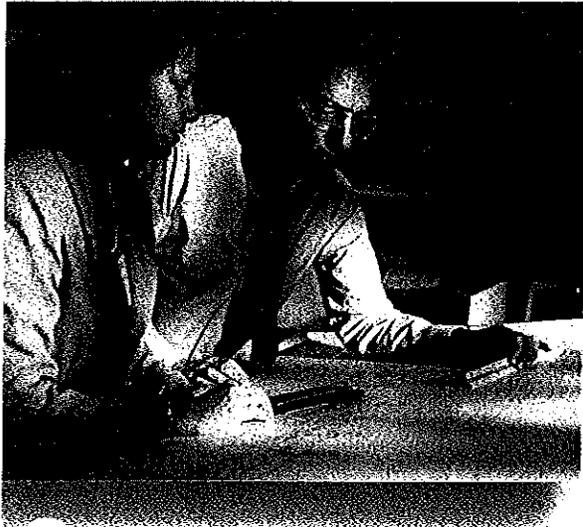
Global competition and increasingly complex market conditions are dramatically changing the power generation industry. Owners of generation facilities are more frequently looking to suppliers to take greater responsibility—and share risk—in bringing their plants

optimizing the performance of installed systems while minimizing operating costs over their entire lifetime is also of paramount importance. It requires an expansive scope of services and maintenance programs that few OEM providers have the resources to offer.

which add value to projects while facilitating their closure. Services range from pre-project activity—such as proposal feasibility studies and site and grid analysis—to subsequent activities which can include debt financing, equity participation, export credit agency guarantees, contract negotiation, power purchase agreements, fuel sourcing and local manufacturing arrangements.

## Project Implementation

A wide range of high quality power generation equipment is available to you through GE and its business affiliates. Recognizing that each project has its own special set of challenges and needs, GE's scope of supply can be as limited or as extensive as is needed.



on-line. Suppliers, like GE, can perform comprehensive, value-added services that plants historically performed themselves.

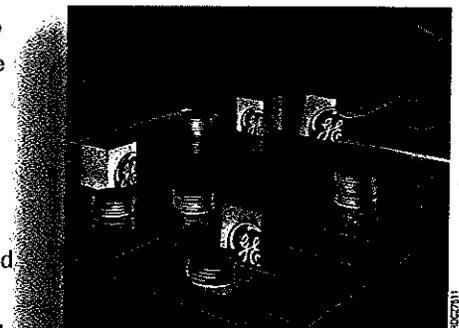
Unquestionably, quality equipment and systems—such as GE's gas turbine-based power plants—are an integral part of the equation for success. However,

GE continues to grow in this area. In the past year alone, GE has invested nearly a quarter of a billion dollars in programs, joint ventures and acquisitions to broaden its service offerings around the world.

In addition, GE recognizes that customers have many needs beyond equipment supply and maintenance. GE has facilitated the successful completion of numerous power projects throughout the world and, through an understanding of expanded customer needs, continues to tailor its resources to readily and comprehensively serve the needs of the industry.

## Project Development and Financing

GE works with an accomplished group of consortium partners and can support project development on a world-wide basis. This encompasses non-technical services

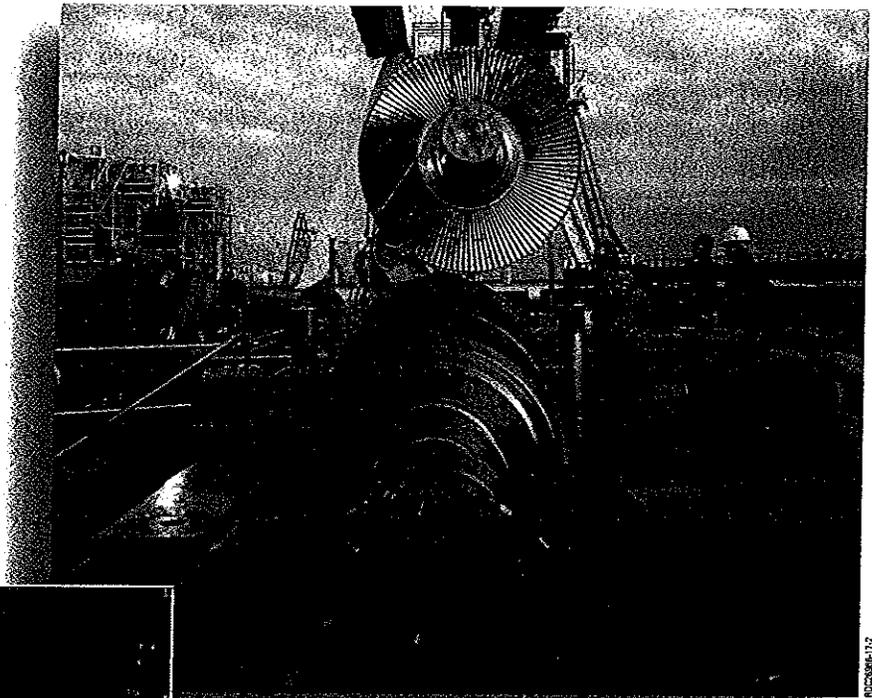


GE's engineered equipment packages and reference plants are designed with specific project requirements in mind; taking into account key factors such as plant location, fuel availability, environmental guidelines, commercialization scheduling and budget.

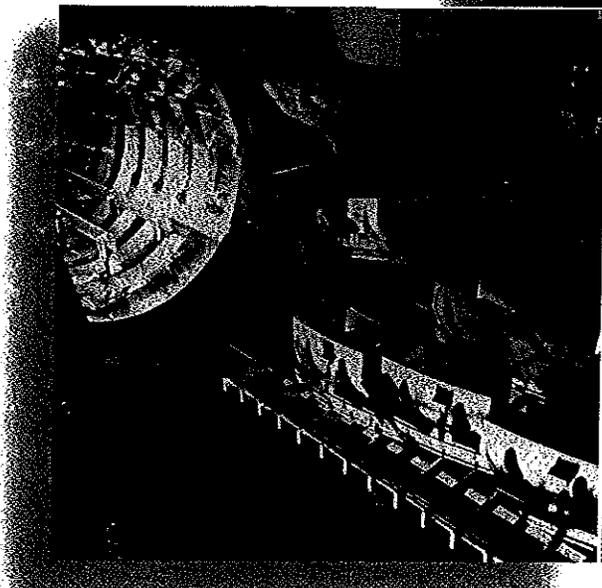
Beyond equipment only, GE can assume total turnkey responsibility; from feasibility studies to site analysis, all the way through to civil



work, installation and start-up. As the single point of contact, GE works with a global and regional network of partners to cover all aspects of project supply, including provision of labor, material procurement, schedule logistics and personnel training. This approach results in a power plant that is quickly built and ready for many years of low cost, reliable service.



PHOTOGRAPH BY



PHOTOGRAPH BY

### Operation and Maintenance

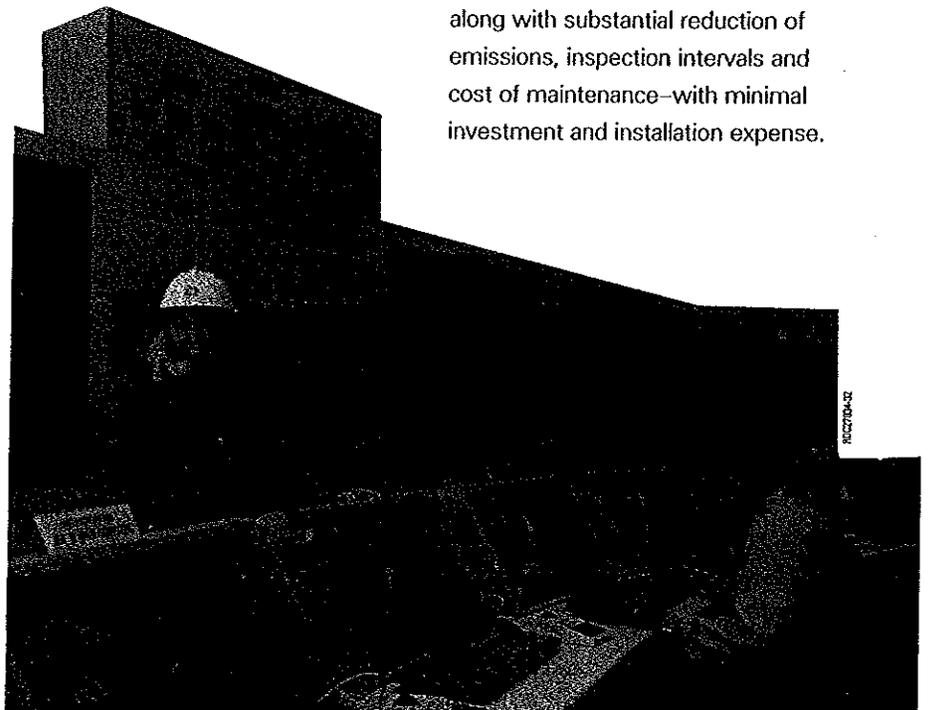
In today's fiercely competitive market, even the smallest difference in plant performance can make a significant impact on a project's success. Beyond its extensive offerings of traditional extended scope and on-site maintenance services, GE is also the world's largest third-party O&M provider. With extensive experience operating and maintaining facilities around the globe, GE has achieved exceptional reliability and availability at plants under O&M contract.

Utilizing an unequaled experience base, GE can plan and execute operations, schedule maintenance and manage spare parts—all to minimize operating costs—while keeping power and income flowing. In addition, highly trained personnel can be provided to operate any plant.

### Upgrades and Uprates

GE turbines are designed for the long-term. As GE equipment engineers develop new technology for advanced machine designs, they continually apply those improvements across the operating fleet of mature units.

Resulting uprate and upgrade programs enable power producers to retain competitive performance levels through gains in power output, efficiency and reliability—along with substantial reduction of emissions, inspection intervals and cost of maintenance—with minimal investment and installation expense.



PHOTOGRAPH BY

# GE. Power for a Changing World.

Producing and supplying electrical power has never been more challenging.

Around the globe, power markets are undergoing radical change. This change is driven by privatization, deregulation, competition and a new breed of power generation owners and investors with a bottom line focus on cost-per kilowatt hour.

In this arena, who you buy equipment and services from is more important than ever.

Today, you need a supplier who delivers added-value from initial purchase to equipment retirement. The focus is on life cycle value that delivers bottom line advantages day-in, day-out.

You need a supplier who invests in continual technology advancement. One with a proven track record of adapting improvements to its installed fleet; advances that increase performance, lower O&M costs and extend equipment life.

You need a supplier who provides flexible, innovative solutions. These should include on-time, quality installation, maintenance,

repairs, and customized long-term service agreements that can cover total plant operation and maintenance, plus financing and leasing options ranging from parts to the entire power plant.

In short, you need the unique power of GE; the power of experience drawn from 125 years and more than 11,000 turbine-generators operating in 184 countries around the globe. And you need the power of GE support—the industry's most extensive global sales and service network, bringing GE power to your doorstep—wherever you are, worldwide.

In this changing industry environment, bottom line performance, lowest life cycle cost, and continual improvement are essential. With GE, you team up with a supplier who understands your operating challenge and will be there to help you succeed today and into the future.

This is the unique power only GE can offer you.



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GE Power Systems  
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Europe/Middle East/Africa/CIS  
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Asia  
GE Power Systems  
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32 Hysan Avenue  
Causeway Bay, Hong Kong

**GE Power Systems**

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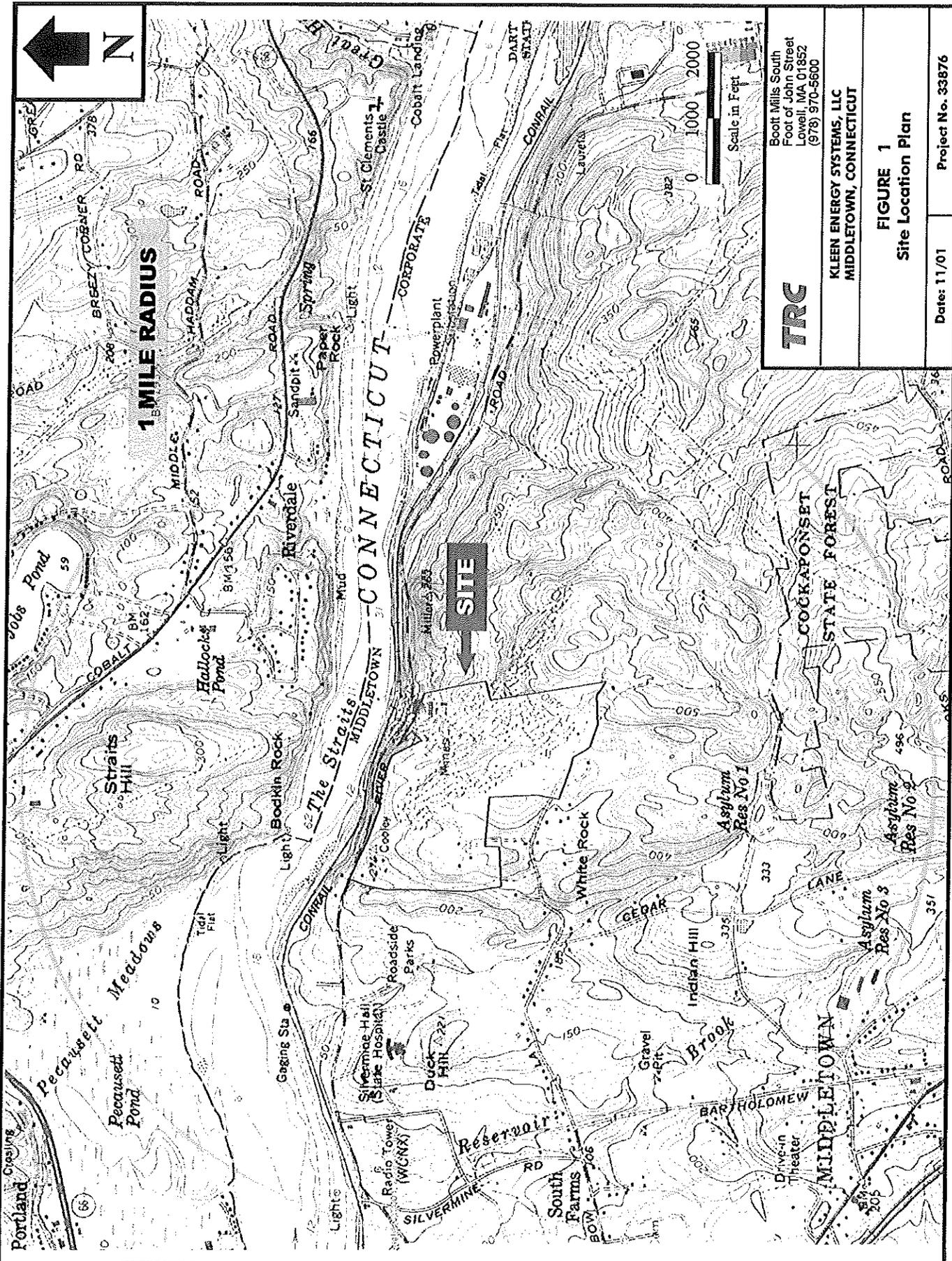
## **APPENDIX C**

# **FAA CORRESPONDENCE AND LIGHTING REQUIREMENTS**





1 MILE RADIUS



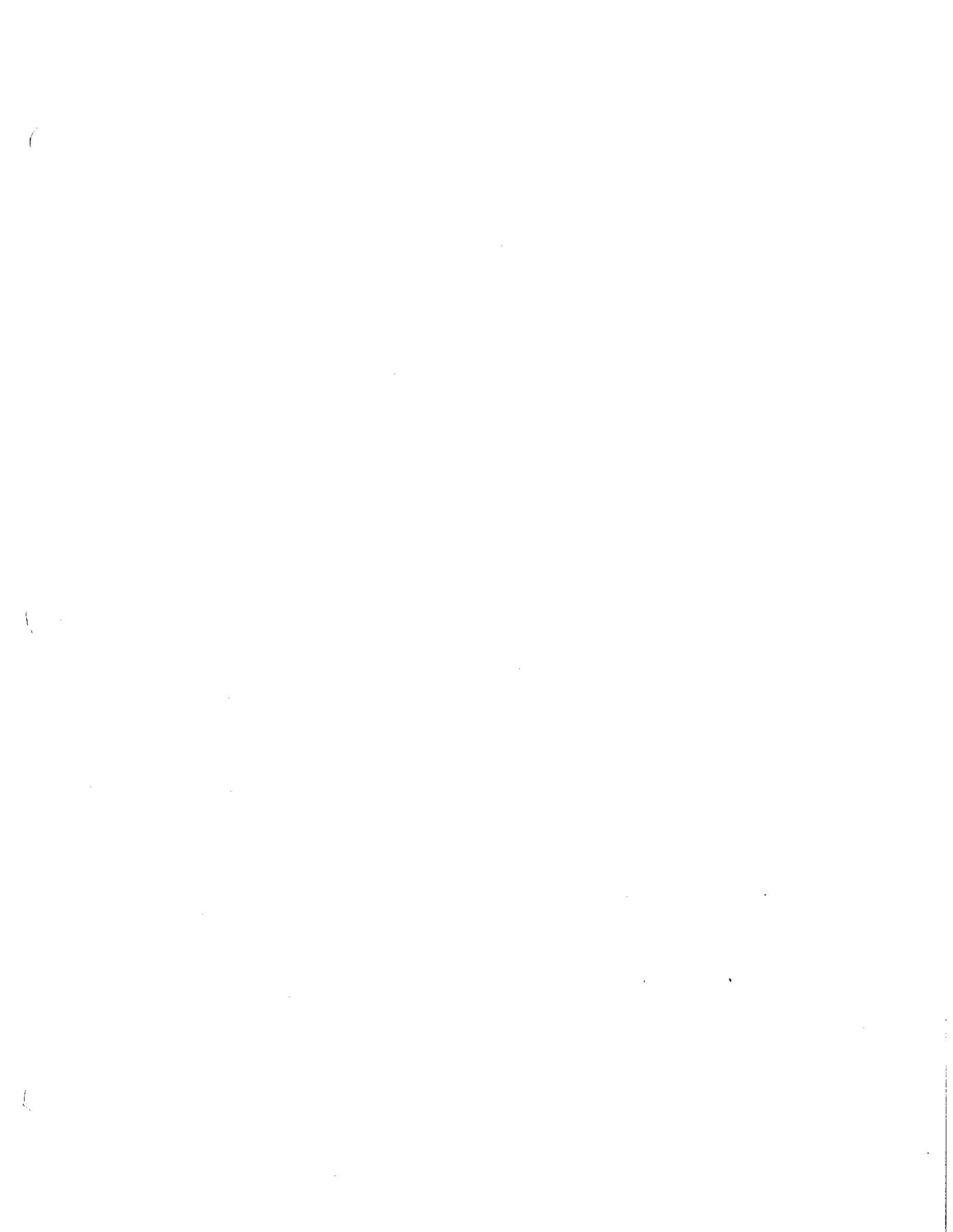
TRC  
Boott Mills South  
Foot of John Street  
Lowell, MA 01852  
(978) 970-5600

KLEEN ENERGY SYSTEMS, LLC  
MIDDLETOWN, CONNECTICUT

FIGURE 1  
Site Location Plan

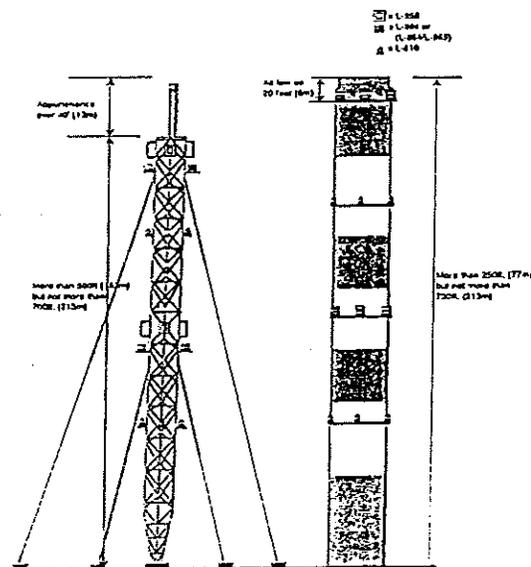
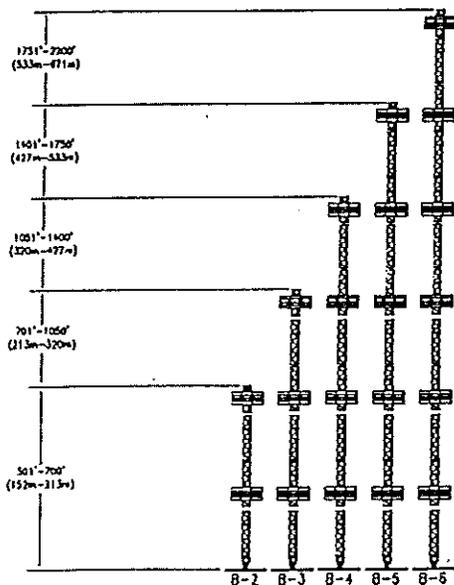
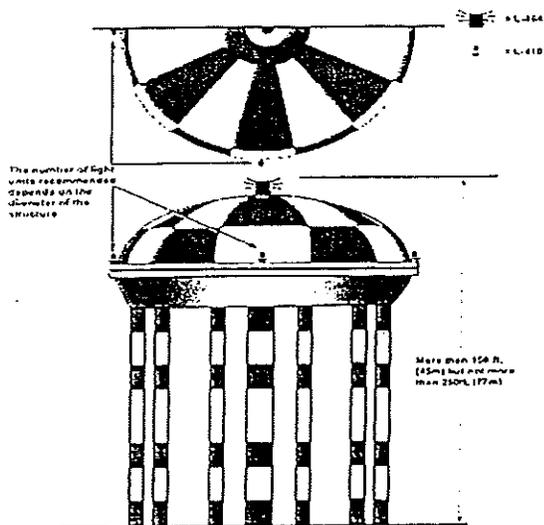
Date: 11/01

Project No. 33876





## Obstruction Marking and Lighting





U.S. Department  
Of Transportation  
Federal Aviation  
Administration

# ADVISORY CIRCULAR

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Subject: CHANGE I TO OBSTRUCTION  
MARKING AND LIGHTING

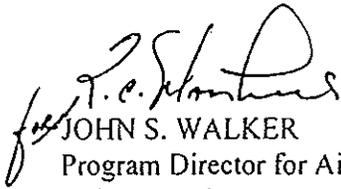
Date: 4/15/00  
Initiated by: ATA-400

AC No: 70/7460-1K  
Change: 1

- 
1. PURPOSE. This change amends the Federal Aviation Administration's (FAA) standards for marking and lighting structures to promote aviation safety. The Change Number and date of the change material are located at the top of the page.
  2. EFFECTIVE DATE. This change is effective August 1, 2000.
  3. EXPLANATION OF CHANGES.
    - a. Table of Contents. Change pages i through iii.
    - b. Change pages 19 through 32 beginning at Chapter 7. High Intensity Flashing White Obstruction Light Systems to read 21 through 34.
    - c. Page 1. Paragraph 1. Reporting Requirements. Owner changed to read sponsor.
    - d. Page 1. Paragraph 5. Modifications and Deviations. Owner changed to read sponsor.
    - e. Page 1. Paragraph 5.b.3. Voluntary Marking and/or Lighting. Owner/s changed to read sponsor.
    - f. Page 2. Paragraph d. Chapter 6 changed to read Chapter 12, Table 4.
    - g. Page 2. Paragraph d. Owners/proponents changed to read sponsors.
    - h. Page 2. Paragraph 6. Additional Notification. Proponents changed to read sponsors.
    - i. Page 2. Paragraph 7. Metric Units. Proponents changed to read sponsors.
    - j. Page 3. Paragraph 23. Light Failure Notification. Proponents changed to read sponsors.
    - k. Page 4. Paragraph 24. Notification of Restoration. Owner changed to read sponsor.
    - l. Page 7. Note. Change proponents to read sponsors.

m. Page 11. Paragraph 49. Distraction. Owner changed to read sponsor

n. Replace Pages A1-1 through A1-19. New illustrations. In addition, mid-level lighting on structures beginning at 250 feet above ground level (AGL) has been corrected to reflect lighting beginning at 350 feet AGL.



JOHN S. WALKER

Program Director for Air Traffic  
Airspace Management

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PAGE CONTROL CHART

AC 70/7460-1K, CHG. 1

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Remove Pages	Dated	Insert Pages	Dated
i through iii	3/1/00	i through iii	8/1/00
1 through 4	3/1/00	1 through 4	8/1/00
7	3/1/00	7	8/1/00
11	3/1/00	11	8/1/00
A1-1 through A1-19	3/1/00	A1-1 through A1-19	8/1/00

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## CHAPTER 1. ADMINISTRATIVE AND GENERAL PROCEDURES

### 1. REPORTING REQUIREMENTS

A sponsor proposing any type of construction or alteration of a structure that may affect the National Airspace System (NAS) is required under the provisions of 14 Code of Federal Regulations (14 CFR part 77) to notify the FAA by completing the Notice of Proposed Construction or Alteration form (FAA Form 7460-1). The form should be sent to the FAA Regional Air Traffic Division office having jurisdiction over the area where the planned construction or alteration would be located. Copies of FAA Form 7460-1 may be obtained from any FAA Regional Air Traffic Division office, Airports District Office or FAA Website at [www.faa.gov/ats/ata/ata400](http://www.faa.gov/ats/ata/ata400).

### 2. PRECONSTRUCTION NOTICE

The notice must be submitted:

a. At least 30 days prior to the date of proposed construction or alteration is to begin.

b. On or before the date an application for a construction permit is filed with the Federal Communications Commission (FCC). (The FCC advises its applicants to file with the FAA well in advance of the 30-day period in order to expedite FCC processing.)

### 3. FAA ACKNOWLEDGEMENT

The FAA will acknowledge, in writing, receipt of each FAA Form 7460-1 notice received.

### 4. SUPPLEMENTAL NOTICE REQUIREMENT

a. If required, the FAA will include a FAA Form 7460-2, Notice of Actual Construction or Alteration, with a determination.

b. FAA Form 7460-2 Part 1 is to be completed and sent to the FAA at least 48 hours prior to starting the actual construction or alteration of a structure. Additionally, Part 2 shall be submitted no later than 5 days after the structure has reached its greatest height. The form should be sent to the Regional Air Traffic Division office having jurisdiction over the area where the construction or alteration would be located.

c. In addition, supplemental notice shall be submitted upon abandonment of construction.

d. Letters are acceptable in cases where the construction/alteration is temporary or a proposal is abandoned. This notification process is designed to

permit the FAA the necessary time to change affected procedures and/or minimum flight altitudes, and to otherwise alert airmen of the structure's presence.

*Note-*  
*NOTIFICATION AS REQUIRED IN THE DETERMINATION IS CRITICAL TO AVIATION SAFETY.*

### 5. MODIFICATIONS AND DEVIATIONS

a. Requests for modification or deviation from the standards outlined in this AC must be submitted to the FAA Regional Air Traffic Division office serving the area where the structure would be located. The sponsor is responsible for adhering to approved marking and/or lighting limitations, and/or recommendations given, and should notify the FAA and FCC (for those structures regulated by the FCC) prior to removal of marking and/or lighting. A request received after a determination is issued may require a new study and could result in a new determination.

b. *Modifications.* Modifications will be based on whether or not they impact aviation safety. Examples of modifications that may be considered:

1. *Marking and/or Lighting Only a Portion of an Object.* The object may be so located with respect to other objects or terrain that only a portion of it needs to be marked or lighted.

2. *No Marking and/or Lighting.* The object may be so located with respect to other objects or terrain, removed from the general flow of air traffic, or may be so conspicuous by its shape, size, or color that marking or lighting would serve no useful purpose.

3. *Voluntary Marking and/or Lighting.* The object may be so located with respect to other objects or terrain that the sponsor feels increased conspicuity would better serve aviation safety. Sponsors who desire to voluntarily mark and/or light their structure should request the proper marking and/or lighting from the FAA to ensure no aviation safety issues are impacted.

4. *Marking or Lighting an Object in Accordance with the Standards for an Object of Greater Height or Size.* The object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure the safety to air navigation.

c. *Deviations.* The FAA regional office conducts an aeronautical study of the proposed deviation(s)

and forwards its recommendation to FAA headquarters in Washington, DC, for final approval. Examples of deviations that may be considered:

1. Colors of objects.
2. Dimensions of color bands or rectangles.
3. Colors/types of lights.
4. Basic signals and intensity of lighting.
5. Night/day lighting combinations.
6. Flash rate.

d. The FAA strongly recommends that sponsors become familiar with the different types of lighting systems and to specifically request the type of lighting system desired when submitting FAA Form 7460-1. (This request should be noted in "item 2.D" of the FAA form.) Information on these systems can be found in Chapter of this AC. While will make every effort to accommodate the first sponsors should also request information from system manufacturers. In order to determine system best meets their needs based on proposed installation, and maintenance costs.

**6. ADDITIONAL NOTIFICATION**

Sponsors are reminded that any change to the submitted information on which the FAA has based its determination, including modification, deviation

or optional upgrade to white lighting on structures which are regulated by the FCC, must also be filed with the FCC prior to making the change for proper authorization and annotations of obstruction marking and lighting. These structures will be subject to inspection and enforcement of marking and lighting requirements by the FCC. FCC Forms and Bulletins can be obtained from the FCC's National Call Center at 1-888-CALL-FCC (1-888-225-5322). Upon completion of the actual change, notify the Aeronautical Charting office at:

NOAA/NOS  
 Aeronautical Charting Division  
 Station 5601, N/ACC113  
 1305 East-West Highway  
 Silver Spring, MD 20910-3233

**7. METRIC UNITS**

To promote an orderly transition to metric units, sponsors should include both English and metric (SI units) dimensions. The metric conversions may not be exact equivalents, and until there is an official changeover to the metric system, the English dimensions will govern.

## CHAPTER 2. GENERAL

### 20. STRUCTURES TO BE MARKED AND LIGHTED

Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61m) above ground level (AGL) or exceeds any obstruction standard contained in 14 CFR part 77, should normally be marked and/or lighted. However, an FAA aeronautical study may reveal that the absence of marking and/or lighting will not impair aviation safety. Conversely, the object may present such an extraordinary hazard potential that higher standards may be recommended for increased conspicuity to ensure safety to air navigation. Normally outside commercial lighting is not considered sufficient reason to omit recommended marking and/or lighting. Recommendations on marking and/or lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design. The FAA may also recommend marking and/or lighting a structure that does not exceed 200 (61m) feet AGL or 14 CFR part 77 standards because of its particular location.

### 21. GUYED STRUCTURES

The guys of a 2,000-foot (610m) skeletal tower are anchored from 1,600 feet (488m) to 2,000 feet (610m) from the base of the structure. This places a portion of the guys 1,500 feet (458m) from the tower at a height of between 125 feet (38m) to 500 feet (153m) AGL. 14 CFR part 91, section 119, requires pilots, when operating over other than congested areas, to remain at least 500 feet (153m) from man-made structures. Therefore, the tower must be cleared by 2,000 feet (610m) horizontally to avoid all guy wires. Properly maintained marking and lighting are important for increased conspicuity since the guys of a structure are difficult to see until aircraft are dangerously close.

### 22. MARKING AND LIGHTING EQUIPMENT

Considerable effort and research have been expended in determining the minimum marking and lighting systems or quality of materials that will produce an acceptable level of safety to air navigation. The FAA will recommend the use of only those marking and lighting systems that meet established technical standards. While additional lights may be desirable

to identify an obstruction to air navigation and may, on occasion be recommended, the FAA will recommend minimum standards in the interest of safety, economy, and related concerns. Therefore, to provide an adequate level of safety, obstruction lighting systems should be installed, operated, and maintained in accordance with the recommended standards herein.

### 23. LIGHT FAILURE NOTIFICATION

a. Sponsors should keep in mind that conspicuity is achieved only when all recommended lights are working. Partial equipment outages decrease the margin of safety. Any outage should be corrected as soon as possible. Failure of a steady burning side or intermediate light should be corrected as soon as possible, but notification is not required.

b. Any failure or malfunction that lasts more than thirty (30) minutes and affects a top light or flashing obstruction light, regardless of its position, should be reported immediately to the nearest flight service station (FSS) so a Notice to Airmen (NOTAM) can be issued. Toll-free numbers for FSS are listed in most telephone books or on the FAA's Website at [www.faa.gov/ats/ata/ata400](http://www.faa.gov/ats/ata/ata400). This report should contain the following information:

1. Name of persons or organizations reporting light failures including any title, address, and telephone number.
2. The type of structure.
3. Location of structure (including latitude and longitude, if known, prominent structures, landmarks, etc.).
4. Height of structure above ground level (AGL)/above mean sea level (AMSL), if known.
5. A return to service date.
6. FCC Antenna Registration Number (for structures that are regulated by the FCC).

*Note-*

1. When the primary lamp in a double obstruction light fails, and the secondary lamp comes on, no report is required. However, when one of the lamps in an incandescent L-364 flashing red beacon fails, it should be reported.

2. After 15 days, the NOTAM is automatically deleted from the system. The sponsor is requested to call the nearest FSS to extend the outage date. In addition, the sponsor is required to report a return to service date.

#### 24. NOTIFICATION OF RESTORATION

As soon as normal operation is restored, notify the same AFSS/FSS that received the notification of failure. The FCC advises that noncompliance with notification procedures could subject its sponsor to penalties or monetary forfeitures.

#### 25. FCC REQUIREMENT

FCC licensees are required to file an environmental assessment with the Commission when seeking authorization for the use of the high intensity flashing white lighting system on structures located in residential neighborhoods, as defined by the applicable zoning law.

## CHAPTER 3. MARKING GUIDELINES

### 30. PURPOSE

This chapter provides recommended guidelines to make certain structures conspicuous to pilots during daylight hours. One way of achieving this conspicuity is by painting and/or marking these structures. Recommendations on marking structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 31. PAINT COLORS

Alternate sections of aviation orange and white paint should be used as they provide maximum visibility of an obstruction by contrast in colors.

### 32. PAINT STANDARDS

The following standards should be followed. To be effective, the paint used should meet specific color requirements when freshly applied to a structure. Since, all outdoor paints deteriorate with time and it is not practical to give a maintenance schedule for all climates, surfaces should be repainted when the color changes noticeably or its effectiveness is reduced by scaling, oxidation, chipping, or layers of contamination.

a. *Materials and Application.* Quality paint and materials should be selected to provide extra years of service. The paint should be compatible with the surfaces to be painted, including any previous coatings, and suitable for the environmental conditions. Surface preparation and paint application should be in accordance with manufacturer's recommendations.

*Note-*

*In-Service Aviation Orange Color Tolerance Charts are available from private suppliers for determining when repainting is required. The color should be sampled on the upper half of the structure, since weathering is greater there.*

b. *Surfaces Not Requiring Paint.* Ladders, decks, and walkways of steel towers and similar structures need not be painted if a smooth surface presents a potential hazard to maintenance personnel. Paint may also be omitted from precision or critical surfaces if it would have an adverse effect on the transmission or radiation characteristics of a signal. However, the overall marking effect of the structure should not be reduced.

c. *Skeletal Structures.* Complete all marking/painting prior to or immediately upon

completion of construction. This applies to catenary support structures, radio and television towers, and similar skeletal structures. To be effective, paint should be applied to all inner and outer surfaces of the framework.

### 33. PAINT PATTERNS

Paint patterns of various types are used to mark structures. The pattern to be used is determined by the size and shape of the structure. The following patterns are recommended.

a. *Solid Pattern.* Obstacles should be colored aviation orange if the structure has both horizontal and vertical dimensions not exceeding 10.5 feet (3.2m).

b. *Checkerboard Pattern.* Alternating rectangles of aviation orange and white are normally displayed on the following structures:

1. Water, gas, and grain storage tanks.
2. Buildings, as required.

3. Large structures exceeding 10.5 feet (3.2m) across having a horizontal dimension that is equal to or greater than the vertical dimension.

c. *Size of Patterns.* Sides of the checkerboard pattern should measure not less than 5 feet (1.5m) or more than 20 feet (6m) and should be as nearly square as possible. However, if it is impractical because of the size or shape of a structure, the patterns may have sides less than 5 feet (1.5m). When possible, corner surfaces should be colored orange.

d. *Alternate Bands.* Alternate bands of aviation orange and white are normally displayed on the following structures:

1. Communication towers and catenary support structures.

2. Poles.

3. Smokestacks.

4. Skeletal framework of storage tanks and similar structures.

5. Structures which appear narrow from a side view, that are 10.5 feet (3.2m) or more across and the horizontal dimension is less than the vertical dimension.

6. Wind turbine generator support structures including the nacelle or generator housing.

7. Coaxial cable, conduits, and other cables attached to the face of a tower.

e. *Color Band Characteristics.* Bands for structures of any height should be:

1. Equal in width, provided each band is not less than 1½ feet (0.5m) or more than 100 feet (31m) wide.

2. Perpendicular to the vertical axis with the bands at the top and bottom ends colored orange.

3. An odd number of bands on the structure.

4. Approximately one-seventh the height if the structure is 700 feet (214m) AGL or less. For each additional 200 feet (61m) or fraction thereof, add one (1) additional orange and one (1) additional white band.

5. Equal and in proportion to the structure's height AGL.

Structure Height to Bandwidth Ratio

Example: If a Structure is:		
Greater Than	But Not More Than	Band Width
10.5 feet (3.2m)	700 feet (214m)	1/7 of height
701 feet (214m)	900 feet (275m)	1/9 of height
901 feet (275m)	1,100 feet (336m)	1/11 of height
1,100 feet (336m)	1,300 feet (397m)	1/13 of height

TBL 1

f. *Structures With a Cover or Roof.* If the structure has a cover or roof, the highest orange band should be continued to cover the entire top of the structure.

g. *Skeletal Structures Atop Buildings.* If a flagpole, skeletal structure, or similar object is erected on top of a building, the combined height of the object and building will determine whether marking is recommended; however, only the height of the object under study determines the width of the color bands.

h. *Partial Marking.* If marking is recommended for only a portion of a structure because of shielding by other objects or terrain, the width of the bands should be determined by the overall height of the

structure. A minimum of three bands should be displayed on the upper portion of the structure.

i. *Teardrop Pattern.* Spherical water storage tanks with a single circular standpipe support may be marked in a teardrop-striped pattern. The tank should show alternate stripes of aviation orange and white. The stripes should extend from the top center of the tank to its supporting standpipe. The width of the stripes should be equal, and the width of each stripe at the greatest girth of the tank should not be less than 5 feet (1.5m) nor more than 15 feet (4.6m).

j. *Community Names.* If it is desirable to paint the name of the community on the side of a tank, the stripe pattern may be broken to serve this purpose. This open area should have a maximum height of 3 feet (0.9m).

k. *Exceptions.* Structural designs not conducive to standard markings may be marked as follows:

1. If it is not practical to color the roof of a structure in a checkerboard pattern, it may be colored solid orange.

2. If a spherical structure is not suitable for an exact checkerboard pattern, the shape of the rectangles may be modified to fit the shape of the surface.

3. Storage tanks not suitable for a checkerboard pattern may be colored by alternating bands of aviation orange and white or a limited checkerboard pattern applied to the upper one-third of the structure.

4. The skeletal framework of certain water, gas, and grain storage tanks may be excluded from the checkerboard pattern.

34. MARKERS

Markers are used to highlight structures when it is impractical to make them conspicuous by painting. Markers may also be used in addition to aviation orange and white paint when additional conspicuity is necessary for aviation safety. They should be displayed in conspicuous positions on or adjacent to the structures so as to retain the general definition of the structure. They should be recognizable in clear air from a distance of at least 4,000 feet (1219m) and in all directions from which aircraft are likely to approach. Markers should be distinctively shaped, i.e., spherical or cylindrical, so they are not mistaken for items that are used to convey other information. They should be replaced when faded or otherwise deteriorated.

a. *Spherical Markers.* Spherical markers are used to identify overhead wires. Markers may be of another shape, i.e., cylindrical, provided the projected area of such markers will not be less than that presented by a spherical marker.

#### 1. *Size and Color.*

The diameter of the markers used on extensive catenary wires across canyons, lakes, rivers, etc., should be not less than 36 inches (91cm). Smaller 20-inch (51cm) spheres are permitted on less extensive power lines or on power lines below 50 feet (15m) above the ground and within 1,500 feet (458m) of an airport runway end. Each marker should be a solid color such as aviation orange, white, or yellow.

#### 2. *Installations.*

(a) *Spacing.* Markers should be spaced equally along the wire at intervals of approximately 200 feet (61m) or a fraction thereof. Intervals between markers should be less in critical areas near runway ends (i.e., 30 to 50 feet (10m to 15m)). They should be displayed on the highest wire or by another means at the same height as the highest wire. Where there is more than one wire at the highest point, the markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard. This method allows the weight and wind loading factors to be distributed.

(b) *Pattern.* An alternating color scheme provides the most conspicuity against all backgrounds. Mark overhead wires by alternating solid colored markers of aviation orange, white, and yellow. Normally, an orange sphere is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (61m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

b. *Flag Markers.* Flags are used to mark certain structures or objects when it is technically impractical to use spherical markers or painting. Some examples are temporary construction equipment, cranes, derricks, oil and other drilling rigs. Catenaries should use spherical markers.

1. *Minimum Size.* Each side of the flag marker should be at least 2 feet (0.6m) in length.

2. *Color Patterns.* Flags should be colored as follows:

(a) *Solid.* Aviation orange.

(b) *Orange and White.* Arrange two triangular sections, one aviation orange and the other white to form a rectangle.

(c) *Checkerboard.* Flags 3 feet (0.9m) or larger should be a checkerboard pattern of aviation orange and white squares, each 1 foot (0.3m) plus or minus 10 percent.

3. *Shape.* Flags should be rectangular in shape and have stiffeners to keep them from drooping in calm wind.

4. *Display.* Flag markers should be displayed around, on top, or along the highest edge of the obstruction. When flags are used to mark extensive or closely grouped obstructions, they should be displayed approximately 50 feet (15m) apart. The flag stakes should be of such strength and height that they will support the flags above all surrounding ground, structures, and/or objects of natural growth.

#### 35. UNUSUAL COMPLEXITIES

The FAA may also recommend appropriate marking in an area where obstructions are so grouped as to present a common obstruction to air navigation.

#### 36. OMISSION OR ALTERNATIVES TO MARKING

There are two alternatives to marking. Either alternative requires FAA review and concurrence.

a. *High Intensity Flashing White Lighting Systems.* The high intensity lighting systems are more effective than aviation orange and white paint and therefore can be recommended instead of marking. This is particularly true under certain ambient light conditions involving the position of the sun relative to the direction of flight. When high intensity lighting systems are operated during daytime and twilight, other methods of marking may be omitted. When operated 24 hours a day, other methods of marking and lighting may be omitted.

b. *Medium Intensity Flashing White Lighting Systems.* When medium intensity lighting systems are operated during daytime and twilight on structures 500 feet (153m) AGL or less, other methods of marking may be omitted. When operated 24 hours a day on structures 500 feet (153m) AGL or less, other methods of marking and lighting may be omitted.

*Note-*  
SPONSORS MUST ENSURE THAT ALTERNATIVES TO MARKING ARE COORDINATED WITH THE FCC FOR STRUCTURES UNDER ITS JURISDICTION PRIOR TO MAKING THE CHANGE.

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## CHAPTER 4. LIGHTING GUIDELINE

## 40. PURPOSE

This chapter describes the various obstruction lighting systems used to identify structures that an aeronautical study has determined will require added conspicuity. The lighting standards in this circular are the minimum necessary for aviation safety. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

## 41. STANDARDS

The standards outlined in this AC are based on the use of light units that meet specified intensities, beam patterns, color, and flash rates as specified in AC 150/5345-43.

These standards may be obtained from:

Department of Transportation  
TASC  
Subsequent Distribution Office, SVC-121.23  
Ardmore East Business Center  
3341 Q 75th Avenue  
Landover, MD 20785

## 42. LIGHTING SYSTEMS

Obstruction lighting may be displayed on structures as follows:

a. *Aviation Red Obstruction Lights.* Use flashing beacons and/or steady burning lights during nighttime.

b. *Medium Intensity Flashing White Obstruction Lights.* Medium intensity flashing white obstruction lights may be used during daytime and twilight with automatically selected reduced intensity for nighttime operation. When this system is used on structures 500 feet (153m) AGL or less in height, other methods of marking and lighting the structure may be omitted. Aviation orange and white paint is always required for daytime marking on structures exceeding 500 feet (153m) AGL. This system is not normally recommended on structures 200 feet (61m) AGL or less.

c. *High Intensity Flashing White Obstruction Lights.* Use high intensity flashing white obstruction lights during daytime with automatically selected reduced intensities for twilight and nighttime operations. When this system is used, other methods of marking and lighting the structure may be omitted.

This system should not be recommended on structures 500 feet (153m) AGL or less, unless an FAA aeronautical study shows otherwise.

*Note-*

*All flashing lights on a structure should flash simultaneously except for catenary support structures, which have a distinct sequence flashing between levels.*

d. *Dual Lighting.* This system consists of red lights for nighttime and high or medium intensity flashing white lights for daytime and twilight. When a dual lighting system incorporates medium flashing intensity lights on structures 500 feet (153m) or less, or high intensity flashing white lights on structures of any height, other methods of marking the structure may be omitted.

e. *Obstruction Lights During Construction.* As the height of the structure exceeds each level at which permanent obstruction lights would be recommended, two or more lights of the type specified in the determination should be installed at that level. Temporary high or medium intensity flashing white lights, as recommended in the determination, should be operated 24 hours a day until all permanent lights are in operation. In either case, two or more lights should be installed on the uppermost part of the structure any time it exceeds the height of the temporary construction equipment. They may be turned off for periods when they would interfere with construction personnel. If practical, permanent obstruction lights should be installed and operated at each level as construction progresses. The lights should be positioned to ensure that a pilot has an unobstructed view of at least one light at each level.

f. *Obstruction Lights in Urban Areas.* When a structure is located in an urban area where there are numerous other white lights (e.g., streetlights, etc.) red obstruction lights with painting or a medium intensity dual system is recommended. Medium intensity lighting is not normally recommended on structures less than 200 feet (61m).

g. *Temporary Construction Equipment Lighting.* Since there is such a variance in construction cranes, derricks, oil and other drilling rigs, each case should be considered individually. Lights should be installed according to the standards given in Chapters 5, 6, 7, or 8, as they would apply to permanent structures.

### 43. CATENARY LIGHTING

Lighted markers are available for increased night conspicuity of high-voltage (69KV or greater) transmission line catenary wires. These markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, etc. The lighted markers should be manufacturer certified as recognizable from a minimum distance of 4,000 feet (1219m) under nighttime conditions, minimum visual flight rules (VFR) conditions or having a minimum intensity of at least 32.5 candela. The lighting unit should emit a steady burning red light. They should be used on the highest energized line. If the lighted markers are installed on a line other than the highest catenary, then markers specified in paragraph 34 should be used in addition to the lighted markers. (The maximum distance between the line energizing the lighted markers and the highest catenary above the lighted marker should be no more than 20 feet (6m).) Markers should be distinctively shaped, i.e., spherical, cylindrical, so they are not mistaken for items that are used to convey other information. They should be visible in all directions from which aircraft are likely to approach. The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights. Where a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide a full coverage.

### 44. INSPECTION, REPAIR AND MAINTENANCE

To ensure the proper candela output for fixtures with incandescent lamps; the voltage provided to the lamp filament should not vary more than plus or minus 3 percent of the rated voltage of the lamp. The input voltage should be measured at the lamp socket with the lamp operating during the hours of normal operation. (For strobes, the input voltage of the power supplies should be within 10 percent of rated voltage.) Lamps should be replaced after being operated for not more than 75 percent of their rated life or immediately upon failure. Flashtubes in a light unit should be replaced immediately upon failure, when the peak effective intensity falls below specification limits or when the fixture begins skipping flashes, or at the manufacturer's recommended intervals. Due to the effects of harsh environments, beacon lenses should be visually inspected for ultraviolet damage, cracks, crazing, dirt

build up, etc., to insure that the certified light output has not deteriorated. (See paragraph 23, for reporting requirements in case of failure.)

### 45. NONSTANDARD LIGHTS

Moored balloons, chimneys, church steeples, and similar obstructions may be floodlighted by fixed search light projectors installed at three or more equidistant points around the base of each obstruction. The searchlight projectors should provide an average illumination of at least 15 foot-candles over the top one-third of the obstruction.

### 46. PLACEMENT FACTORS

The height of the structure AGL determines the number of light levels. The light levels may be adjusted slightly, but not to exceed 10 feet (3m), when necessary to accommodate guy wires and personnel who replace or repair light fixtures. Except for catenary support structures, the following factors should be considered when determining the placement of obstruction lights on a structure.

a. *Red Obstruction Lighting Systems.* The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

b. *Medium Intensity Flashing White Obstruction Lighting Systems.* The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

c. *High Intensity Flashing White Obstruction Lighting Systems.* The overall height of the main structure including all appurtenances such as rods, antennas, obstruction lights, etc., determines the number of light levels.

d. *Dual Obstruction Lighting Systems.* The overall height of the structure including all appurtenances such as rods, antennas, obstruction lights, etc., is used to determine the number of light levels for a medium intensity white obstruction light/red obstruction dual lighting system. The overall height of the structure including all appurtenances is used to determine the number of light levels for a high intensity white obstruction light/red obstruction dual lighting system.

e. *Adjacent Structures.* The elevation of the tops of adjacent buildings in congested areas may be used as the equivalent of ground level to determine the proper number of light levels required.

f. *Shielded Lights.* If an adjacent object shields any light, horizontal placement of the lights should be adjusted or additional lights should be mounted on that object to retain or contribute to the definition of the obstruction.

#### 47. MONITORING OBSTRUCTION LIGHTS

Obstruction lighting systems should be closely monitored by visual or automatic means. It is extremely important to visually inspect obstruction lighting in all operating intensities at least once every 24 hours on systems without automatic monitoring. In the event a structure is not readily accessible for visual observation, a properly maintained automatic monitor should be used. This monitor should be designed to register the malfunction of any light on the obstruction regardless of its position or color. When using remote monitoring devices, the communication status and operational status of the system should be confirmed at least once every 24 hours. The monitor (aural or visual) should be located in an area generally occupied by responsible personnel. In some cases, this may require a remote monitor in an attended location. For each structure, a log should be maintained in which daily operations status of the lighting system is recorded. Beacon

lenses should be replaced if serious cracks, crazing, dirt build up, etc., has occurred.

#### 48. ICE SHIELDS

Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulations from damaging the light units.

#### 49. DISTRACTION

a. Where obstruction lights may distract operators of vessels in the proximity of a navigable waterway, the sponsor must coordinate with the Commandant, U.S. Coast Guard, to avoid interference with marine navigation.

b. The address for marine information and coordination is:

Chief, Aids to Navigation Division (OPN) U.S. Coast Guard Headquarters 2100 2nd Street, SW., Rm. 3610 Washington, DC 20593-0001 Telephone: (202) 267-0980
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## CHAPTER 5. RED OBSTRUCTION LIGHT SYSTEM

## 50. PURPOSE

Red Obstruction lights are used to increase conspicuity during nighttime. Daytime and twilight marking is required. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

## 51. STANDARDS

The red obstruction lighting system is composed of flashing omnidirectional beacons (L-864) and/or steady burning (L-810) lights. When one or more levels is comprised of flashing beacon lighting, the lights should flash simultaneously.

a. *Single Obstruction Light.* A single (L-810) light may be used when more than one obstruction light is required either vertically or horizontally or where maintenance can be accomplished within a reasonable time.

1. *Top Level.* A single light may be used to identify low structures such as airport ILS buildings and long horizontal structures such as perimeter fences and building roof outlines.

2. *Intermediate Level.* Single lights may be used on skeletal and solid structures when more than one level of lights is installed and there are two or more single lights per level.

b. *Double Obstruction Light.* A double (L-810) light should be installed when used as a top light, at each end of a row of single obstruction lights, and in areas or locations where the failure of a single unit could cause an obstruction to be totally unlighted.

1. *Top Level.* Structures 150 feet (46m) AGL or less should have one or more double lights installed at the highest point and operating simultaneously.

2. *Intermediate Level.* Double lights should be installed at intermediate levels when a malfunction of a single light could create an unsafe condition and in remote areas where maintenance cannot be performed within a reasonable time. Both units may operate simultaneously, or a transfer relay may be used to switch to a spare unit should the active system fail.

3. *Lowest Level.* The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by an FAA aeronautical study, the lowest level of lights may be eliminated.

## 52. CONTROL DEVICE

Red obstruction lights should be operated by a satisfactory control device (e.g., photo cell, timer, etc.) adjusted so the lights will be turned on when the northern sky illuminance reaching a vertical surface falls below a level of 60 foot-candles (645.8 lux) but before reaching a level of 35 foot-candles (367.7 lux). The control device should turn the lights off when the northern sky illuminance rises to a level of not more than 60 foot-candles (645.8 lux). The lights may also remain on continuously. The sensing device should, if practical, face the northern sky in the Northern Hemisphere. (See AC 150/5345-43.)

## 53. POLES, TOWERS, AND SIMILAR SKELETAL STRUCTURES

The following standards apply to radio and television towers, supporting structures for overhead transmission lines, and similar structures.

a. *Top Mounted Obstruction Light.*

1. *Structures 150 Feet (46m) AGL or Less.* Two or more steady burning (L-810) lights should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

2. *Structures Exceeding 150 Feet (46m) AGL.* At least one red flashing (L-864) beacon should be installed in a manner to ensure an unobstructed view of one or more lights by a pilot.

3. *Appurtenances 40 Feet (12m) or Less.* If a rod, antenna, or other appurtenance 40 feet (12m) or less in height is incapable of supporting a red flashing beacon, then it may be placed at the base of the appurtenance. If the mounting location does not allow unobstructed viewing of the beacon by a pilot, then additional beacons should be added.

4. *Appurtenances Exceeding 40 Feet (12m).* If a rod, antenna, or other appurtenance exceeding 40 feet (12m) in height is incapable of supporting a red flashing beacon, a supporting mast with one or more beacons should be installed adjacent to the appurtenance. Adjacent installations should not exceed the height of the appurtenance and be within 40 feet (12m) of the tip to allow the pilot an unobstructed view of at least one beacon.

b. *Mounting Intermediate Levels.* The number of light levels is determined by the height of the structure, including all appurtenances, and is detailed in Appendix 1. The number of lights on each level is

determined by the shape and height of the structure. These lights should be mounted so as to ensure an unobstructed view of at least one light by a pilot.

**1. Steady Burning Lights (L-810).**

(a) *Structures 350 Feet (107m) AGL or Less.* Two or more steady burning (L-810) lights should be installed on diagonally or diametrically opposite positions.

(b) *Structures Exceeding 350 Feet (107m) AGL.* Install steady burning (L-810) lights on each outside corner of each level.

**2. Flashing Beacons (L-864).**

(a) *Structures 350 Feet (107m) AGL or Less.* These structures do not require flashing (L-864) beacons at intermediate levels.

(b) *Structure Exceeding 350 Feet (107m) AGL.* At intermediate levels, two beacons (L-864) should be mounted outside at diagonally opposite positions of intermediate levels.

**54. CHIMNEYS, FLARE STACKS, AND SIMILAR SOLID STRUCTURES**

**a. Number of Light Units.**

1. The number of units recommended depends on the diameter of the structure at the top. The number of lights recommended below are the minimum.

2. When the structure diameter is:

(a) *20 Feet (6m) or Less.* Three light units per level.

(b) *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.

(c) *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m).* Six light units per level.

(d) *Exceeding 200 Feet (61m).* Eight light units per level.

**b. Top Mounted Obstruction Lights.**

1. *Structures 150 Feet (46m) AGL or Less.* L-810 lights should be installed horizontally at regular intervals at or near the top.

2. *Structures Exceeding 150 Feet (46m) AGL.* At least three L-864 beacons should be installed.

3. *Chimneys, Cooling Towers, and Flare Stacks.* Lights may be displayed as low as 20 feet (6m) below the top to avoid the obscuring effect of deposits and heat generally emitted by this type of structure. It is important that these lights be readily accessible for cleaning and lamp replacement. It is understood that

with flare stacks, as well as any other structures associated with the petrol-chemical industry, normal lighting requirements may not be necessary. This could be due to the location of the flare stack/structure within a large well-lighted petrol-chemical plant or the fact that the flare, or working lights surrounding the flare stack/structure, is as conspicuous as obstruction lights.

c. *Mounting Intermediate Levels.* The number of light levels is determined by the height of the structure including all appurtenances. For cooling towers 600 feet (183m) or less, intermediate light levels are not necessary. Structures exceeding 600 feet (183m) AGL should have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

1. *Steady Burning (L-810) Lights.* The recommended number of light levels may be obtained from Appendix 1. At least three lights should be installed on each level.

2. *Flashing (L-864) Beacons.* The recommended number of beacon levels may be obtained from Appendix 1. At least three lights should be installed on each level.

(a) *Structures 350 Feet (107m) AGL or Less.* These structures do not need intermediate levels of flashing beacons.

(b) *Structures Exceeding 350 Feet (107m) AGL.* At least three flashing (L-864) beacons should be installed on each level in a manner to allow an unobstructed view of at least one beacon.

**55. WIND TURBINE STRUCTURES**

Wind turbine structures should be lighted by mounting two flashing red beacons (L-864) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction.

**56. GROUP OF OBSTRUCTIONS**

When individual objects, except wind turbines, within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent, the outer structure should be lighted in accordance with the standards for individual obstructions of a

corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. In addition, at least one flashing beacon should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group.

#### 57. ALTERNATE METHOD OF DISPLAYING OBSTRUCTION LIGHTS

When recommended in an FAA aeronautical study, lights may be placed on poles equal to the height of the obstruction and installed on or adjacent to the structure instead of installing lights on the obstruction.

#### 58. PROMINENT BUILDINGS, BRIDGES, AND SIMILAR EXTENSIVE OBSTRUCTIONS

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. If the structure is a bridge and is over navigable water, the sponsor must obtain prior approval of the lighting installation from the Commander of the District Office of the United States Coast Guard to avoid interference with marine navigation. Steady burning lights should be displayed to indicate the extent of the obstruction as follows:

a. *Structures 150 Feet (46m) or Less in Any Horizontal Direction.* If the structure/bridge/extensive obstruction is 150 feet (46m) or less horizontally, at least one steady burning light (L-810) should be displayed on the highest point at each end of the major axis of the obstruction. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

b. *Structures Exceeding 150 Feet (46m) in at Least One Horizontal Direction.* If the structure/bridge/extensive obstruction exceeds 150 feet (46m) horizontally, display at least one steady burning light for each 150 feet (46m), or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals not to exceed 150 feet (46m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

c. *Structures Exceeding 150 Feet (46m) AGL.* Steady burning red obstruction lights should be installed on the highest point at each end. At intermediate levels, steady burning red lights should be displayed for each 150 feet (46m) or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground level as the shape and type of obstruction will permit. One such light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

d. *Exceptions.* Flashing red beacons (L-864) may be used instead of steady burning obstruction lights if early or special warning is necessary. These beacons should be displayed on the highest points of an extensive obstruction at intervals not exceeding 3,000 feet (915m). At least three beacons should be displayed on one side of the extensive obstruction to indicate a line of lights.

e. *Ice Shields.* Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulations from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

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## CHAPTER 6. MEDIUM INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

### 60. PURPOSE

Medium intensity flashing white (L-865) obstruction lights may provide conspicuity both day and night. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 61. STANDARDS

The medium intensity flashing white light system is normally composed of flashing omnidirectional lights. Medium intensity flashing white obstruction lights may be used during daytime and twilight with automatically selected reduced intensity for nighttime operation. When this system is used on structures 500 feet (153m) AGL or less in height, other methods of marking and lighting the structure may be omitted. Aviation orange and white paint is always required for daytime marking on structures exceeding 500 feet (153m) AGL. This system is not normally recommended on structures 200 feet (61m) AGL or less.

The use of a 24-hour medium intensity flashing white light system in urban/populated areas is not normally recommended due to their tendency to merge with background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations, i.e., med-evac, and police helicopters to see these structures. The use of this type of system in urban and rural areas often results in complaints. In addition, this system is not recommended on structures within 3 nautical miles of an airport.

### 62. RADIO AND TELEVISION TOWERS AND SIMILAR SKELETAL STRUCTURES

a. *Mounting Lights.* The number of levels recommended depends on the height of the structure, including antennas and similar appurtenances.

1. *Top Levels.* One or more lights should be installed at the highest point to provide 360-degree coverage ensuring an unobstructed view.

2. *Appurtenances 40 feet (12m) or less.* If a rod, antenna, or other appurtenance 40 feet (12m) or less in height is incapable of supporting the medium intensity flashing white light, then it may be placed at the base of the appurtenance. If the mounting location does not allow unobstructed viewing of the medium intensity flashing white light by a pilot, then additional lights should be added.

3. *Appurtenances Exceeding 40 feet (12m).* If a rod, antenna, or other appurtenance exceeds 40 feet (12m) above the tip of the main structure, a medium intensity flashing white light should be placed within 40 feet (12m) from the top of the appurtenance. If the appurtenance (such as a whip antenna) is incapable of supporting the light, one or more lights should be mounted on a pole adjacent to the appurtenance. Adjacent installations should not exceed the height of the appurtenance and be within 40 feet (12m) of the tip to allow the pilot an unobstructed view of at least one light.

b. *Intermediate Levels.* At intermediate levels, two beacons (L-865) should be mounted outside at diagonally or diametrically opposite positions of intermediate levels. The lowest light level should not be less than 200 feet (61m) AGL.

c. *Lowest Levels.* The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by an FAA aeronautical study, the lowest level of lights may be eliminated.

d. *Structures 500 Feet (153m) AGL or Less.* When white lights are used during nighttime and twilight only, marking is required for daytime. When operated 24 hours a day, other methods of marking and lighting are not required.

e. *Structures Exceeding 500 Feet (153m) AGL.* The lights should be used during nighttime and twilight and may be used 24 hours a day. Marking is always required for daytime.

f. *Ice Shields.* Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulations from damaging the light units. The light should be mounted in a manner to ensure an unobstructed view of at least one light by a pilot approaching from any direction.

### 63. CONTROL DEVICE

The light intensity is controlled by a device that changes the intensity when the ambient light changes. The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Twilight-to-Night.* This should not occur before the illumination drops below five foot-candles (53.8

lux) but should occur before it drops below two foot-candles (21.5 lux).

b. *Night-to-Day*. The intensity changes listed in subparagraph 63a above should be reversed when changing from the night to day mode.

#### 64. CHIMNEYS, FLARE STACKS, AND SIMILAR SOLID STRUCTURES

a. *Number of Light Units*. The number of units recommended depends on the diameter of the structure at the top. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6m) below the top to minimize deposit build-up due to emissions. The number of lights recommended are the minimum. When the structure diameter is:

1. *20 Feet (6m) or Less*. Three light units per level.
2. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m)*. Four light units per level.
3. *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m)*. Six light units per level.
4. *Exceeding 200 Feet (61m)*. Eight light units per level.

#### 65. WIND TURBINE STRUCTURES

Wind turbine structures should be lighted by mounting two flashing white beacons (L-865) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction. Intermediate light levels and other marking may be omitted on these structures.

#### 66. GROUP OF OBSTRUCTIONS

When individual objects within a group of obstructions are not the same height and are spaced a maximum of 150 feet (46m) apart, the prominent objects within the group should be lighted in accordance with the standards for individual obstructions of a corresponding height. If the outer structure is shorter than the prominent, the outer structure should be lighted in accordance with the standards for individual obstructions of a corresponding height. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. In addition, at least one medium intensity flashing white light should be installed at the top of a prominent center obstruction or on a special tower located near the center of the group.

#### 67. SPECIAL CASES

Where lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators, or pilots on an approach to an airport. In these cases, shielding may be necessary. This shielding should not derogate the intended purpose of the lighting system.

#### 68. PROMINENT BUILDINGS AND SIMILAR EXTENSIVE OBSTRUCTIONS

When objects within a group of obstructions are approximately the same overall height above the surface and are located a maximum of 150 feet (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of prominent obstructions. Light units should be placed to ensure that the light is visible to a pilot approaching from any direction. Lights should be displayed to indicate the extent of the obstruction as follows:

a. *Structures 150 Feet (46m) or Less in Any Horizontal Direction*. If the structure/extensive obstruction is 150 feet (46m) or less horizontally, at least one light should be displayed on the highest point at each end of the major axis of the obstruction. If this is impractical because of the overall shape, display a double obstruction light in the center of the highest point.

b. *Structures Exceeding 150 Feet (46m) in at Least One Horizontal Direction*. If the structure/extensive obstruction exceeds 150 feet (46m) horizontally, display at least one light for each 150 feet (46m) or fraction thereof, of the overall length of the major axis. At least one of these lights should be displayed on the highest point at each end of the obstruction. Additional lights should be displayed at approximately equal intervals not to exceed 150 feet (46m) on the highest points along the edge between the end lights. If an obstruction is located near a landing area and two or more edges are the same height, the edge nearest the landing area should be lighted.

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c. *Structures Exceeding 150 Feet (46m) AGL.* Lights should be installed on the highest point at each end. At intermediate levels, lights should be displayed for each 150 feet (46m), or fraction thereof. The vertical position of these lights should be equidistant between the top lights and the ground

level as the shape and type of obstruction will permit. One such light should be displayed at each outside corner on each level with the remaining lights evenly spaced between the corner lights.

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## CHAPTER 7. HIGH INTENSITY FLASHING WHITE OBSTRUCTION LIGHT SYSTEMS

### 70. PURPOSE

Lighting with high intensity (L-856) flashing white obstruction lights provides the highest degree of conspicuity both day and night. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 71. STANDARDS

Use high intensity flashing white obstruction lights during daytime with automatically selected reduced intensities for twilight and nighttime operations. When high intensity white lights are operated 24 hours a day, other methods of marking and lighting may be omitted. This system should not be recommended on structures 500 feet (153m) AGL or less unless an FAA aeronautical study shows otherwise.

### 72. CONTROL DEVICE

Light intensity is controlled by a device that changes the intensity when the ambient light changes. The use of a 24-hour high intensity flashing white light system in urban/populated areas is not normally recommended due to their tendency to merge with background lighting in these areas at night. This makes it extremely difficult for some types of aviation operations, i.e., med-evac, and police helicopters to see these structures. The use of this type of system in urban and rural areas often results in complaints.

The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Day-to-Twilight.* This should not occur before the illumination drops to 60 foot-candles (645.8 lux), but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

b. *Twilight-to-Night.* This should not occur before the illumination drops below five foot-candles (53.8 lux), but should occur before it drops below two foot-candles (21.5 lux).

c. *Night-to-Day.* The intensity changes listed in subparagraph 72 a and b above should be reversed when changing from the night to day mode.

### 73. UNITS PER LEVEL

One or more light units is needed to obtain the desired horizontal coverage. The number of light units recommended per level (except for the supporting structures of catenary wires and buildings) depends upon the average outside diameter of the specific structure, and the horizontal beam width of the light fixture. The light units should be installed in a manner to ensure an unobstructed view of the system by a pilot approaching from any direction. The number of lights recommended are the minimum. When the structure diameter is:

- a. *20 Feet (6m) or Less.* Three light units per level.
- b. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.
- c. *Exceeding 100 Feet (31m).* Six light units per level.

### 74. INSTALLATION GUIDANCE

Manufacturing specifications provide for the effective peak intensity of the light beam to be adjustable from zero to 8 degrees above the horizon. Normal installation should place the top light at zero degrees to the horizontal and all other light units installed in accordance with Table 2:

Light Unit Elevation Above the Horizontal

Height of Light Unit Above Terrain	Degrees of Elevation Above the Horizontal
Exceeding 500 feet AGL	0
401 feet to 500 feet AGL	1
301 feet to 400 feet AGL	2
300 feet AGL or less	3

TBL 2

a. *Vertical Aiming.* Where terrain, nearby residential areas, or other situations dictate, the light beam may be further elevated above the horizontal. The main beam of light at the lowest level should not strike the ground closer than 3 statute miles (5km) from the structure. If additional adjustments are necessary, the lights may be individually adjusted upward, in 1-degree increments, starting at the bottom. Excessive elevation may reduce its conspicuity by raising the beam above a collision course flight path.

b. *Special Cases.* Where lighting systems are installed on structures located near highways, waterways, airport approach areas, etc., caution should be exercised to ensure that the lights do not distract or otherwise cause a hazard to motorists, vessel operators.

or pilots on an approach to an airport. In these cases, shielding or an adjustment to the vertical or horizontal light aiming may be necessary. This adjustment should not derogate the intended purpose of the lighting system. Such adjustments may require review action as described in Chapter 1, paragraph 5.

*c. Relocation or Omission of Light Units.* Light units should not be installed in such a manner that the light pattern/output is disrupted by the structure.

1. *Lowest Level.* The lowest level of light units may be installed at a higher elevation than normal on a structure if the surrounding terrain, trees, or adjacent building(s) would obscure the lights. In certain instances, as determined by an FAA aeronautical study, the lowest level of lights may be eliminated.

2. *Two Adjacent Structures.* Where two structures are situated within 500 feet (153m) of each other and the light units are installed at the same levels, the sides of the structures facing each other need not be lighted. However, all lights on both structures must flash simultaneously, except for adjacent catenary support structures. Adjust vertical placement of the lights to either or both structures' intermediate levels to place the lights on the same horizontal plane. Where one structure is higher than the other, complete level(s) of lights should be installed on that part of the higher structure that extends above the top of the lower structure. If the structures are of such heights that the levels of lights cannot be placed in identical horizontal planes, then the light units should be placed such that the center of the horizontal beam patterns do not face toward the adjacent structure. For example, structures situated north and south of each other should have the light units on both structures installed on a northwest/southeast and northeast/southwest orientation.

3. *Three or More Adjacent Structures.* The treatment of a cluster of structures as an individual or a complex of structures will be determined by the FAA as the result of an aeronautical study, taking into consideration the location, heights, and spacing with other structures.

#### 75. ANTENNA OR SIMILAR APPURTENANCE LIGHT

When a structure lighted by a high intensity flashing light system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white light (L-865) should be placed within 40 feet (12m) from the tip of the

appurtenance. This light should operate 24 hours a day and flash simultaneously with the rest of the lighting system.

#### 76. CHIMNEYS, FLARE STACKS, AND SIMILAR SOLID STRUCTURES

The number of light levels depends on the height of the structure excluding appurtenances. Three or more lights should be installed on each level in such a manner to ensure an unobstructed view by the pilot. Normally, the top level is on the highest point of a structure. However, the top level of chimney lights may be installed as low as 20 feet (6m) below the top to minimize deposit build-up due to emissions.

#### 77. RADIO AND TELEVISION TOWERS AND SIMILAR SKELETAL STRUCTURES

*a. Mounting Lights.* The number of levels recommended depends on the height of the structure, excluding antennas and similar appurtenances. At least three lights should be installed on each level and mounted to ensure that the effective intensity of the full horizontal beam coverage is not impaired by the structural members.

*b. Top Level.* One level of lights should be installed at the highest point of the structure. If the highest point is a rod or antenna incapable of supporting a lighting system, then the top level of lights should be installed at the highest portion of the main skeletal structure. When guy wires come together at the top, it may be necessary to install this level of lights as low as 10 feet (3m) below the top. If the rod or antenna exceeds 40 feet (12m) above the main structure, a medium intensity flashing white light (L-865) should be mounted on the highest point. If the appurtenance (such as a whip antenna) is incapable of supporting a medium intensity light, one or more lights should be installed on a pole adjacent to the appurtenance. Adjacent installation should not exceed the height of the appurtenance and be within 40 feet (12m) of the top to allow an unobstructed view of at least one light.

*c. Ice Shields.* Where icing is likely to occur, metal grates or similar protective ice shields should be installed directly over each light unit to prevent falling ice or accumulations from damaging the light units.

#### 78. HYPERBOLIC COOLING TOWERS

Light units should be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

*a. Number of Light Units.* The number of units recommended depends on the diameter of the structure

at the top. The number of lights recommended in the following table are the minimum. When the structure diameter is:

1. *20 Feet (6m) or Less.* Three light units per level.

2. *Exceeding 20 Feet (6m) But Not More Than 100 Feet (31m).* Four light units per level.

3. *Exceeding 100 Feet (31m) But Not More Than 200 Feet (61m).* Six light units per level.

4. *Exceeding 200 Feet (61m).* Eight light units per level.

b. *Structures Exceeding 600 Feet (183m) AGL.* Structures exceeding 600 feet (183m) AGL should have a second level of light units installed approximately at the midpoint of the structure and in a vertical line with the top level of lights.

#### 79. PROMINENT BUILDINGS AND SIMILAR EXTENSIVE OBSTRUCTIONS

When objects within a group of obstructions are approximately the same overall height above the surface and are located not more than 150 feet (46m) apart, the group of obstructions may be considered an extensive obstruction. Install light units on the same horizontal plane at the highest portion or edge of prominent obstructions. Light units should be placed

to ensure that the light is visible to a pilot approaching from any direction. These lights may require shielding, such as louvers, to ensure minimum adverse impact on local communities. Extreme caution in the use of high intensity flashing white lights should be exercised.

a. *If the Obstruction is 200 feet (61m) or Less in Either Horizontal Dimension,* install three or more light units at the highest portion of the structure in a manner to ensure that at least one light is visible to a pilot approaching from any direction. Units may be mounted on a single pedestal at or near the center of the obstruction. If light units are placed more than 10 feet (3m) from the center point of the structure, use a minimum of four units.

b. *If the Obstruction Exceeds 200 Feet (61m) in One Horizontal Dimension,* but is 200 feet (61m) or less in the other, two light units should be placed on each of the shorter sides. These light units may either be installed adjacent to each other at the midpoint of the edge of the obstruction or at (near) each corner with the light unit aimed to provide 180 degrees of coverage at each edge. One or more light units should be installed along the overall length of the major axis. These lights should be installed at approximately equal intervals not to exceed a distance of 100 feet (31m) from the corners or from each other.

c. *If the Obstruction Exceeds 200 Feet (61m) in Both Horizontal Dimensions,* light units should be equally spaced along the overall perimeter of the obstruction at intervals of 100 feet (31m) or fraction thereof.

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## CHAPTER 8. DUAL LIGHTING WITH RED/MEDIUM INTENSITY FLASHING WHITE SYSTEMS

### 80. PURPOSE

This dual lighting system includes red lights (L-864) for nighttime and medium intensity flashing white lights (L-865) for daytime and twilight use. This lighting system may be used in lieu of operating a medium intensity flashing white lighting system at night. There may be some populated areas where the use of medium intensity at night may cause significant environmental concerns. The use of the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 81. INSTALLATION

The light units should be installed as specified in the appropriate portions of Chapters 4, 5, and 6. The number of light levels needed may be obtained from Appendix 1.

### 82. OPERATION

Lighting systems should be operated as specified in Chapter 3. Both systems should not be operated at the same time; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of one of two lamps in the uppermost red-beacon (L-864 incandescent unit) or outage of any uppermost red light shall cause the white obstruction light system to operate in its specified "night" step intensity.

### 83. CONTROL DEVICE

The light system is controlled by a device that changes the system when the ambient light changes. The system should automatically change steps when

the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Twilight-to-Night*. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

b. *Night-to-Day*. The intensity changes listed in subparagraph 83 a above should be reversed when changing from the night to day mode.

### 84. ANTENNA OR SIMILAR APPURTENANCE LIGHT

When a structure utilizing this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white (L-865) and a red flashing beacon (L-864) should be placed within 40 feet (12m) from the tip of the appurtenance. The white light should operate during daytime and twilight and the red light during nighttime. These lights should flash simultaneously with the rest of the lighting system.

### 85. WIND TURBINE STRUCTURES

Wind turbine structures should be lighted by mounting two flashing dual beacons (L-864/L-865) on top of the generator housing. Both beacons should flash simultaneously. Lighting fixtures are to be mounted at a horizontal separation to ensure an unobstructed view of at least one fixture by a pilot approaching from any direction. Intermediate light levels and other marking may be omitted on these structures.

### 86. OMISSION OF MARKING

When medium intensity white lights are operated on structures 500 feet (153m) AGL or less during daytime and twilight, other methods of marking may be omitted.

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## CHAPTER 9. DUAL LIGHTING WITH RED/HIGH INTENSITY FLASHING WHITE SYSTEMS

### 90. PURPOSE

This dual lighting system includes red lights (L-864) for nighttime and high intensity flashing white lights (L-856) for daytime and twilight use. This lighting system may be used in lieu of operating a flashing white lighting system at night. There may be some populated areas where the use of high intensity lights at night may cause significant environmental concerns and complaints. The use of the dual lighting system should reduce/mitigate those concerns. Recommendations on lighting structures can vary depending on terrain features, weather patterns, geographic location, and in the case of wind turbines, number of structures and overall layout of design.

### 91. INSTALLATION

The light units should be installed as specified in the appropriate portions of Chapters 4, 5, and 7. The number of light levels needed may be obtained from Appendix 1.

### 92. OPERATION

Lighting systems should be operated as specified in Chapters 4, 5, and 7. Both systems should not be operated at the same time; however, there should be no more than a 2-second delay when changing from one system to the other. Outage of one of two lamps in the uppermost red beacon (L-864 incandescent unit) or outage of any uppermost red light shall cause the white obstruction light system to operate in its specified "night" step intensity.

### 93. CONTROL DEVICE

The light intensity is controlled by a device that changes the intensity when the ambient light changes.

The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Day-to-Twilight.* This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The illuminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

b. *Twilight-to-Night.* This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

c. *Night-to-Day.* The intensity changes listed in subparagraph 93 a and b above should be reversed when changing from the night to day mode.

### 94. ANTENNA OR SIMILAR APPURTENANCE LIGHT

When a structure utilizing this dual lighting system is topped with an antenna or similar appurtenance exceeding 40 feet (12m) in height, a medium intensity flashing white light (L-865) and a red flashing beacon (L-864) should be placed within 40 feet (12m) from the tip of the appurtenance. The white light should operate during daytime and twilight and the red light during nighttime.

### 95. OMISSION OF MARKING

When high intensity white lights are operated during daytime and twilight, other methods of marking may be omitted.

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## CHAPTER 10. MARKING AND LIGHTING OF CATENARY AND CATENARY SUPPORT STRUCTURES

### 100. PURPOSE

This chapter provides guidelines for marking and lighting catenary and catenary support structures. The recommended marking and lighting of these structures is intended to provide day and night conspicuity and to assist pilots in identifying and avoiding catenary wires and associated support structures.

### 101. CATENARY MARKING STANDARDS

Lighted markers are available for increased night conspicuity of high-voltage (69KV or greater) transmission line catenary wires. These markers should be used on transmission line catenary wires near airports, heliports, across rivers, canyons, lakes, etc. The lighted markers should be manufacturer certified as recognizable from a minimum distance of 4,000 feet (1219m) under nighttime conditions, minimum VFR conditions or having a minimum intensity of at least 32.5 candela. The lighting unit should emit a steady burning red light. They should be used on the highest energized line. If the lighted markers are installed on a line other than the highest catenary, then markers specified in paragraph 34 should be used in addition to the lighted markers. (The maximum distance between the line energizing the lighted markers and the highest catenary above the lighted marker should be no more than 20 feet (6m).) Markers should be distinctively shaped, i.e., spherical, cylindrical, so they are not mistaken for items that are used to convey other information. They should be visible in all directions from which aircraft are likely to approach. The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights. Where a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide a full coverage.

a. *Size and Color.* The diameter of the markers used on extensive catenary wires across canyons, lakes, rivers, etc., should be not less than 36 inches (91cm). Smaller 20-inch (51cm) markers are permitted on less extensive power lines or on power lines below 50 feet (15m) above the ground and within 1,500 feet (458m) of an airport runway end. Each marker should be a solid color such as aviation orange, white, or yellow.

b. *Installation.*

1. *Spacing.* Lighted markers should be spaced equally along the wire at intervals of approximately

200 feet (61m) or a fraction thereof. Intervals between markers should be less in critical areas near runway ends, i.e., 30 to 50 feet (10m to 15m). If the markers are installed on a line other than the highest catenary, then markers specified in paragraph 34 should be used in addition to the lighted markers. The maximum distance between the line energizing the lighted markers and the highest catenary above the markers can be no more than 20 feet (6m). The lighted markers may be installed alternately along each wire if the distance between adjacent markers meets the spacing standard. This method allows the weight and wind loading factors to be distributed.

2. *Pattern.* An alternating color scheme provides the most conspicuity against all backgrounds. Mark overhead wires by alternating solid colored markers of aviation orange, white, and yellow. Normally, an orange marker is placed at each end of a line and the spacing is adjusted (not to exceed 200 feet (61m)) to accommodate the rest of the markers. When less than four markers are used, they should all be aviation orange.

### 102. CATENARY LIGHTING STANDARDS

When using medium intensity flashing white (L-866), high intensity flashing white (L-857), dual medium intensity (L-866/L-885) or dual high intensity (L-857/885) lighting systems, operated 24 hours a day, other marking of the support structure is not necessary.

a. *Levels.* A system of three levels of sequentially flashing light units should be installed on each supporting structure or adjacent terrain. Install one level at the top of the structure, one at the height of the lowest point in the catenary and one level approximately midway between the other two light levels. The middle level should normally be at least 50 feet (15m) from the other two levels. The middle light unit may be deleted when the distance between the top and the bottom light levels is less than 100 feet (30m).

1. *Top Levels.* One or more lights should be installed at the top of the structure to provide 360-degree coverage ensuring an unobstructed view. If the installation presents a potential danger to maintenance personnel, or when necessary for lightning protection, the top level of lights may be mounted as low as 20 feet (6m) below the highest point of the structure.

2. *Horizontal Coverage.* The light units at the middle level and bottom level should be installed so as to provide a minimum of 180-degree coverage centered perpendicular to the flyway. Where a

catenary crossing is situated near a bend in a river, canyon, etc., or is not perpendicular to the flyway, the horizontal beam should be directed to provide the most effective light coverage to warn pilots approaching from either direction of the catenary wires.

3. *Variation.* The vertical and horizontal arrangements of the lights may be subject to the structural limits of the towers and/or adjacent terrain. A tolerance of 20 percent from uniform spacing of the bottom and middle light is allowed. If the base of the supporting structure(s) is higher than the lowest point in the catenary, such as a canyon crossing, one or more lights should be installed on the adjacent terrain at the level of the lowest point in the span. These lights should be installed on the structure or terrain at the height of the lowest point in the catenary.

b. *Flash Sequence.* The flash sequence should be middle, top, and bottom with all lights on the same level flashing simultaneously. The time delay between flashes of levels is designed to present a unique system display. The time delay between the start of each level of flash duration is outlined in FAA AC 150/5345-43, Specification for Obstruction Lighting Equipment.

c. *Synchronization.* Although desirable, the corresponding light levels on associated supporting towers of a catenary crossing need not flash simultaneously.

d. *Structures 500 feet (153m) AGL or Less.* When medium intensity white lights (L-866) are operated 24 hours a day, or when a dual red/medium intensity system (L-866 daytime & twilight/L-885 nighttime) is used, marking can be omitted. When using a medium intensity white light (L-866) or a flashing red light (L-885) during twilight or nighttime only, painting should be used for daytime marking.

e. *Structures Exceeding 500 Feet (153m) AGL.* When high intensity white lights (L-857) are operated 24 hours a day, or when a dual red/high intensity system (L-857 daytime and twilight/L-885 nighttime) is used, marking can be omitted. This system should not be recommended on structures 500 feet (153m) or less unless an FAA aeronautical study shows otherwise. When a flashing red obstruction light (L-885), a medium intensity (L-866) flashing white lighting system or a high intensity white lighting system (L-857) is used for nighttime and twilight only, painting should be used for daytime marking.

### 103. CONTROL DEVICE

The light intensity is controlled by a device (photocell) that changes the intensity when the ambient light changes. The lighting system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:

a. *Day-to-Twilight (L-857 System).* This should not occur before the illumination drops to 60 foot-candles (645.8 lux), but should occur before it drops below 35 foot-candles (376.7 lux). The illuminant-sensing device should, if practical, face the northern sky in the Northern Hemisphere.

b. *Twilight-to-Night (L-857 System).* This should not occur before the illumination drops below 5 foot-candles (53.8 lux), but should occur before it drops below 2 foot-candles (21.5 lux).

c. *Night-to-Day.* The intensity changes listed in subparagraph 103 a. and b. above should be reversed when changing from the night to day mode.

d. *Day-to-Night (L-866 or L-885/L-866).* This should not occur before the illumination drops below 5 foot-candles (563.8 lux) but should occur before it drops below 2 foot-candles (21.5 lux).

e. *Night-to-Day.* The intensity changes listed in subparagraph d. above should be reversed when changing from the night to day mode.

f. *Red Obstruction (L-885).* The red lights should not turn on until the illumination drops below 60 foot-candles (645.8 lux) but should occur before reaching a level of 35 foot-candles (367.7 lux). Lights should not turn off before the illuminance rises above 35 foot-candles (367.7 lux), but should occur before reaching 60 foot-candles (645.8 lux).

### 104. AREA SURROUNDING CATENARY SUPPORT STRUCTURES

The area in the immediate vicinity of the supporting structure's base should be clear of all items and/or objects of natural growth that could interfere with the line-of-sight between a pilot and the structure's lights.

### 105. THREE OR MORE CATENARY SUPPORT STRUCTURES

Where a catenary wire crossing requires three or more supporting structures, the inner structures should be equipped with enough light units per level to provide a full 360-degree coverage.

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 CHAPTER 11. MARKING AND LIGHTING MOORED BALLOONS AND KITES

## 110. PURPOSE

The purpose of marking and lighting moored balloons, kites, and their cables or mooring lines is to indicate the presence and general definition of these objects to pilots when converging from any normal angle of approach.

## 111. STANDARDS

These marking and lighting standards pertain to all moored balloons and kites that require marking and lighting under 14 CFR, part 101.

## 112. MARKING

Flag markers should be used on mooring lines to warn pilots of their presence during daylight hours.

a. *Display.* Markers should be displayed at no more than 50-foot (15m) intervals and should be visible for at least 1 statute mile.

b. *Shape.* Markers should be rectangular in shape and not less than 2 feet (0.6m) on a side. Stiffeners should be used in the borders so as to expose a large area, prevent drooping in calm wind, or wrapping around the cable.

c. *Color Patterns.* One of the following color patterns should be used:

1. *Solid Color.* Aviation orange.

2. *Orange and White.* Two triangular sections, one of aviation orange and the other white, combined to form a rectangle.

## 113. PURPOSE

Flashing obstruction lights should be used on moored balloons or kites and their mooring lines to warn pilots of their presence during the hours between sunset and sunrise and during periods of reduced visibility. These lights may be operated 24 hours a day.

a. *Systems.* Flashing red (L-864) or white beacons (L-865) may be used to light moored balloons or kites. High intensity lights (L-856) are not recommended.

b. *Display.* Flashing lights should be displayed on the top, nose section, tail section, and on the tether cable approximately 15 feet (4.6m) below the craft so as to define the extremes of size and shape. Additional lights should be equally spaced along the cable's overall length for each 350 feet (107m) or fraction thereof.

c. *Exceptions.* When the requirements of this paragraph cannot be met, floodlighting may be used.

## 114. OPERATIONAL CHARACTERISTICS

The light intensity is controlled by a device that changes the intensity when the ambient light changes. The system should automatically turn the lights on and change intensities as ambient light condition change. The reverse order should apply in changing from nighttime to daytime operation. The lights should flash simultaneously.

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## CHAPTER 12. MARKING AND LIGHTING EQUIPMENT AND INFORMATION

### 120. PURPOSE

This chapter lists documents relating to obstruction marking and lighting systems and where they may be obtained.

### 121. PAINT STANDARD

Paint and aviation colors/gloss, referred to in this publication should conform to Federal Standard FED-STD-595. Approved colors shall be formulated without the use of Lead, Zinc Chromate or other heavy metals to match International Orange, White and Yellow. All coatings shall be manufactured and labeled to meet Federal Environmental Protection Act Volatile Organic Compound(s) guidelines, including the National Volatile Organic Compound Emission Standards for architectural coatings.

a. **Exterior Acrylic Waterborne Paint.** Coating should be a ready mixed, 100% acrylic, exterior latex formulated for application directly to galvanized surfaces. Ferrous iron and steel or non-galvanized surfaces shall be primed with a manufacturer recommended primer compatible with the finish coat.

b. **Exterior Solventborne Alkyd Based Paint.** Coating should be ready mixed, alkyd-based, exterior enamel for application directly to non-galvanized surfaces such as ferrous iron and steel. Galvanized surfaces shall be primed with a manufacturer primer compatible with the finish coat.

Paint Standards Color Table

COLOR	NUMBER
Orange	12197
White	17875
Yellow	13538

TBL 3

#### Note-

1. Federal specification T1-P-59, aviation surface paint, ready mixed international orange.
2. Federal specification T1-102, aviation surface paint, oil titanium zinc.
3. Federal specification T1-102, aviation surface paint, oil, exterior, ready mixed, white and light tints.

### 122. AVAILABILITY OF SPECIFICATIONS

Federal specifications describing the technical characteristics of various paints and their application techniques may be obtained from:

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GSA- Specification Branch  
 470 L'Enfant Plaza  
 Suite 8214  
 Washington, DC 20407  
 Telephone: (202) 619-8925

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### 123. LIGHTS AND ASSOCIATED EQUIPMENT

The lighting equipment referred to in this publication should conform to the latest edition of one of the following specifications, as applicable:

#### a. *Obstruction Lighting Equipment.*

1. AC 150/5345-43, FAA Specification for Obstruction Lighting Equipment.
2. Military Specifications MIL-L-6273, Light, Navigational, Beacon, Obstacle or Code, Type G-1.
3. Military Specifications MIL-L-7830, Light Assembly, Markers, Aircraft Obstruction.

**b. Certified Equipment.**

1. AC 150/5345-53, Airport Lighting Certification Program, lists the manufacturers that have demonstrated compliance with the specification requirements of AC 150/5345-43.

2. Other manufacturers' equipment may be used provided that equipment meets the specification requirements of AC 150/5345-43.

**c. Airport Lighting Installation and Maintenance.**

1. AC 150/5340-21, Airport Miscellaneous Lighting Visual Aids, provides guidance for the installation, maintenance, testing, and inspection of obstruction lighting for airport visual aids such as airport beacons, wind cones, etc.

2. AC 150/5340-26, Maintenance of Airport Visual Aid Facilities, provides guidance on the maintenance of airport visual aid facilities.

**d. Vehicles.**

1. AC 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport, contains provisions for marking vehicles principally used on airports.

2. FAA Facilities. Obstruction marking for FAA facilities shall conform to FAA Drawing Number D-5480, referenced in FAA Standard FAA-STD-003, Paint Systems for Structures.

**124. AVAILABILITY**

The standards and specifications listed above may be obtained free of charge from the below-indicated office:

**a. Military Specifications:**

Standardization Document Order Desk 700 Robbins Avenue Building #4, Section D Philadelphia, PA 19111-5094
--

**b. FAA Specifications:**

Manager, ASD-110 Department of Transportation Document Control Center Martin Marietta/Air Traffic Systems 475 School St., SW. Washington, DC 20024 Telephone: (202) 646-2047 FAA Contractors Only
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**c. FAA Advisory Circulars:**

Department of Transportation TASC Subsequent Distribution Office, SVC-121.23 Ardmore East Business Center 3341 Q 75th Avenue Landover, MD 20785 Telephone: (301) 322-4961
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**APPENDIX 1: Specifications for Obstruction Lighting Equipment Classification**
**APPENDIX**

Type	Description
L-810	Steady-burning Red Obstruction Light
L-856	High Intensity Flashing White Obstruction Light (40 FPM)
L-857	High Intensity Flashing White Obstruction Light (60 FPM)
L-864	Flashing Red Obstruction Light (20-40 FPM)
L-865	Medium Intensity Flashing White Obstruction Light (40-FPM)
L-866	Medium Intensity Flashing White Obstruction Light (60-FPM)
L-864/L-865	Dual: Flashing Red Obstruction Light (20-40 FPM) and Medium Intensity Flashing White Obstruction Light (40 FPM)
L-885	Red Catenary 60 FPM
FPM = Flashes Per Minute	

TBL 4

PAINTING AND/OR DUAL LIGHTING OF CHIMNEYS, POLES, TOWERS, AND SIMILAR STRUCTURES

- ☐ = L-856
- ▢ = L-864 or (L-864/L-865)
- ⬢ = L-810

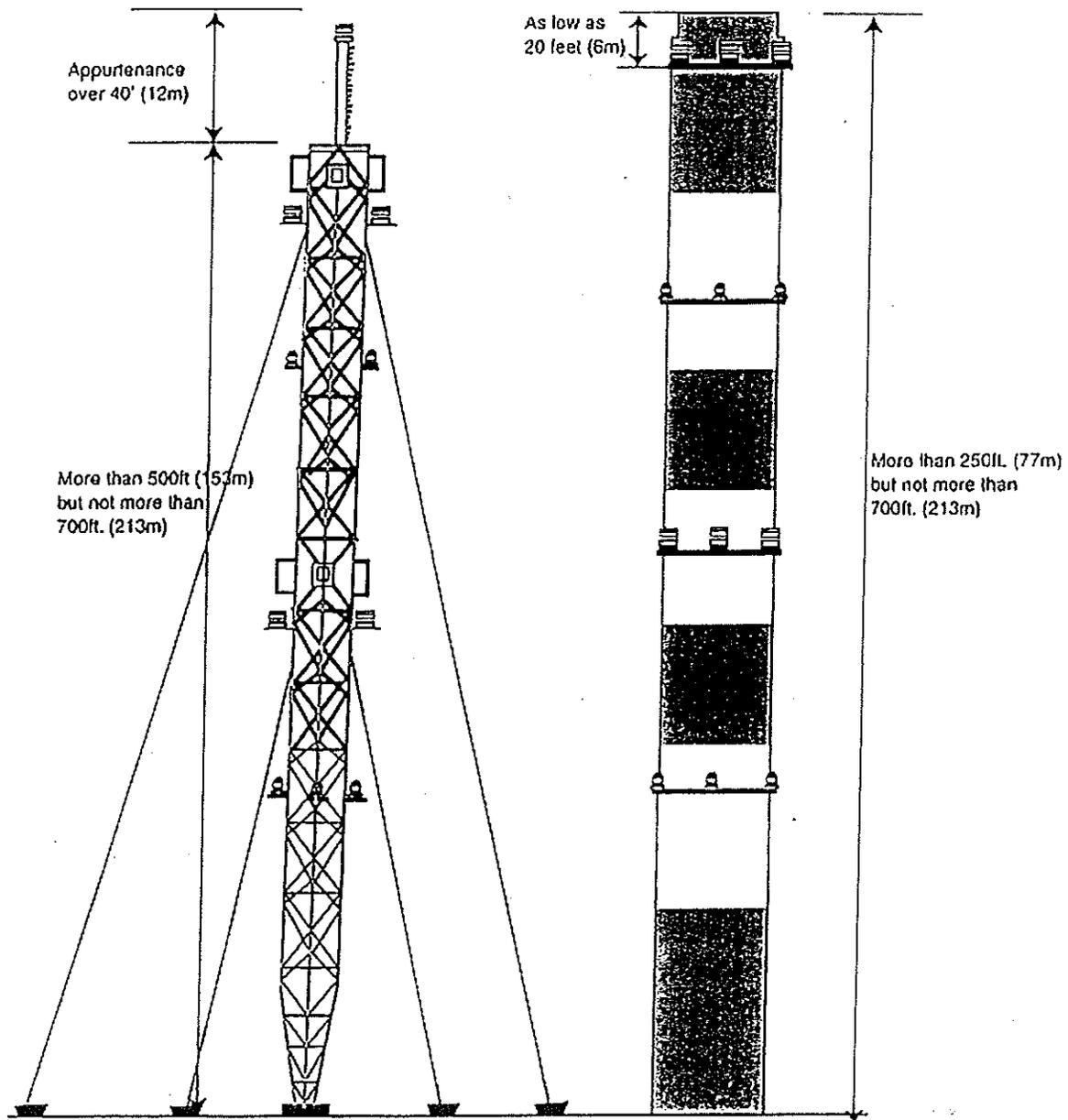
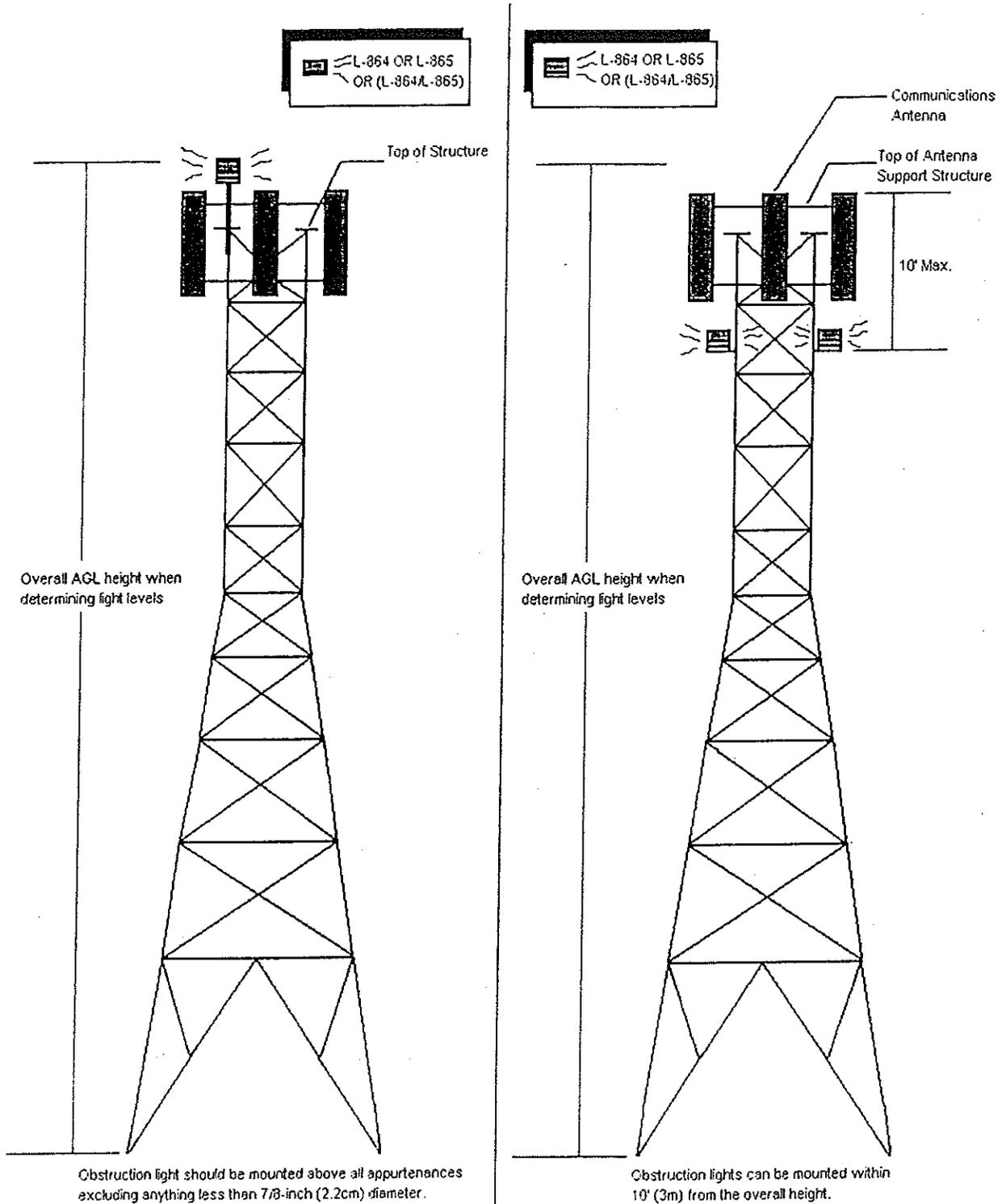


FIG 1

### LIGHTING FOR TOP OF STRUCTURES



Intermediate lighting not shown. Overall AGL height if more than 200' (61m), but not more than 500' (153m).

FIG 2

PAINING AND LIGHTING OF WATER TOWERS, STORAGE TANKS, AND SIMILAR STRUCTURES

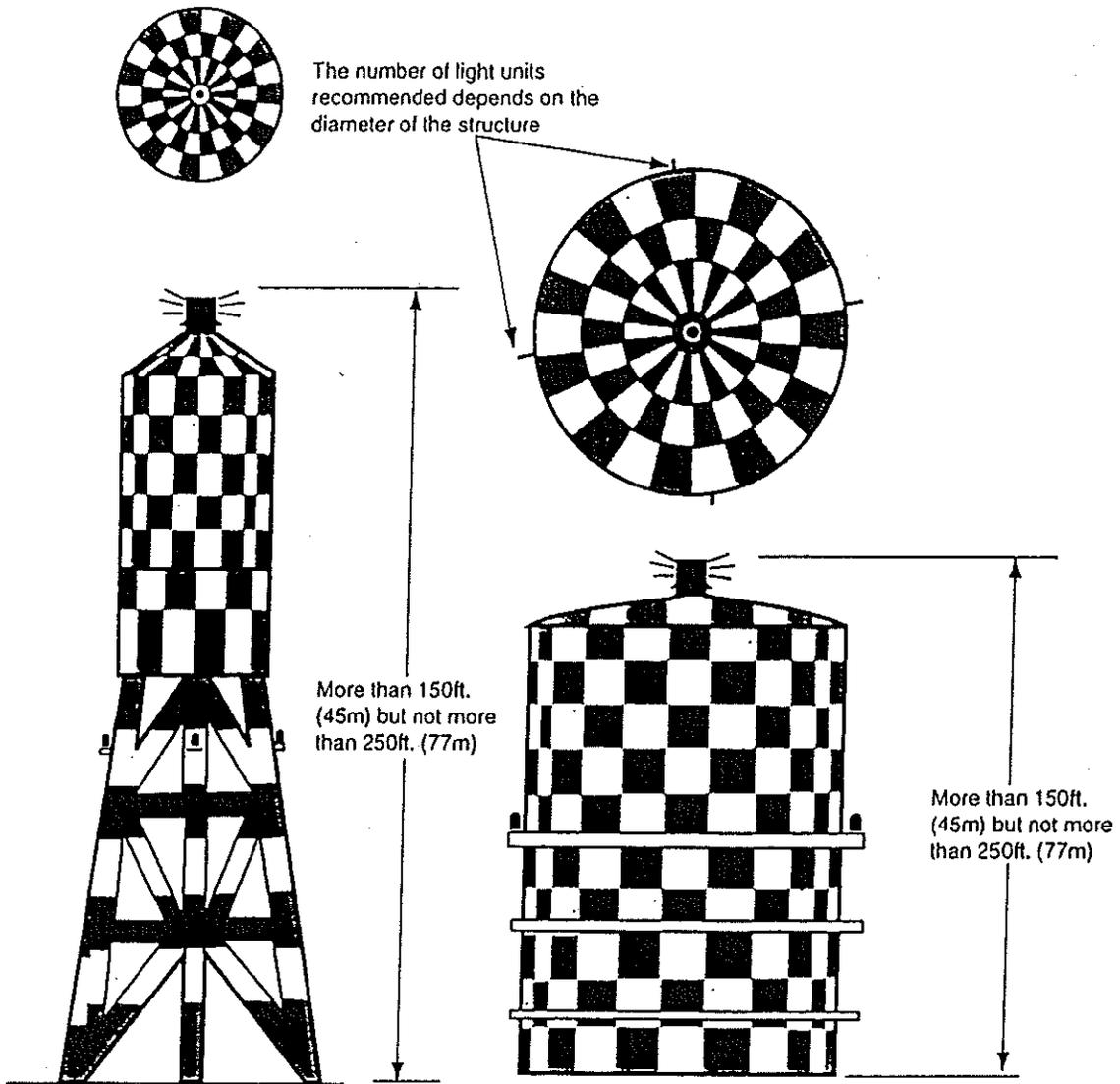


FIG 3

PAINING AND LIGHTING OF WATER TOWERS ANDE SIMILAR STRUCTURES

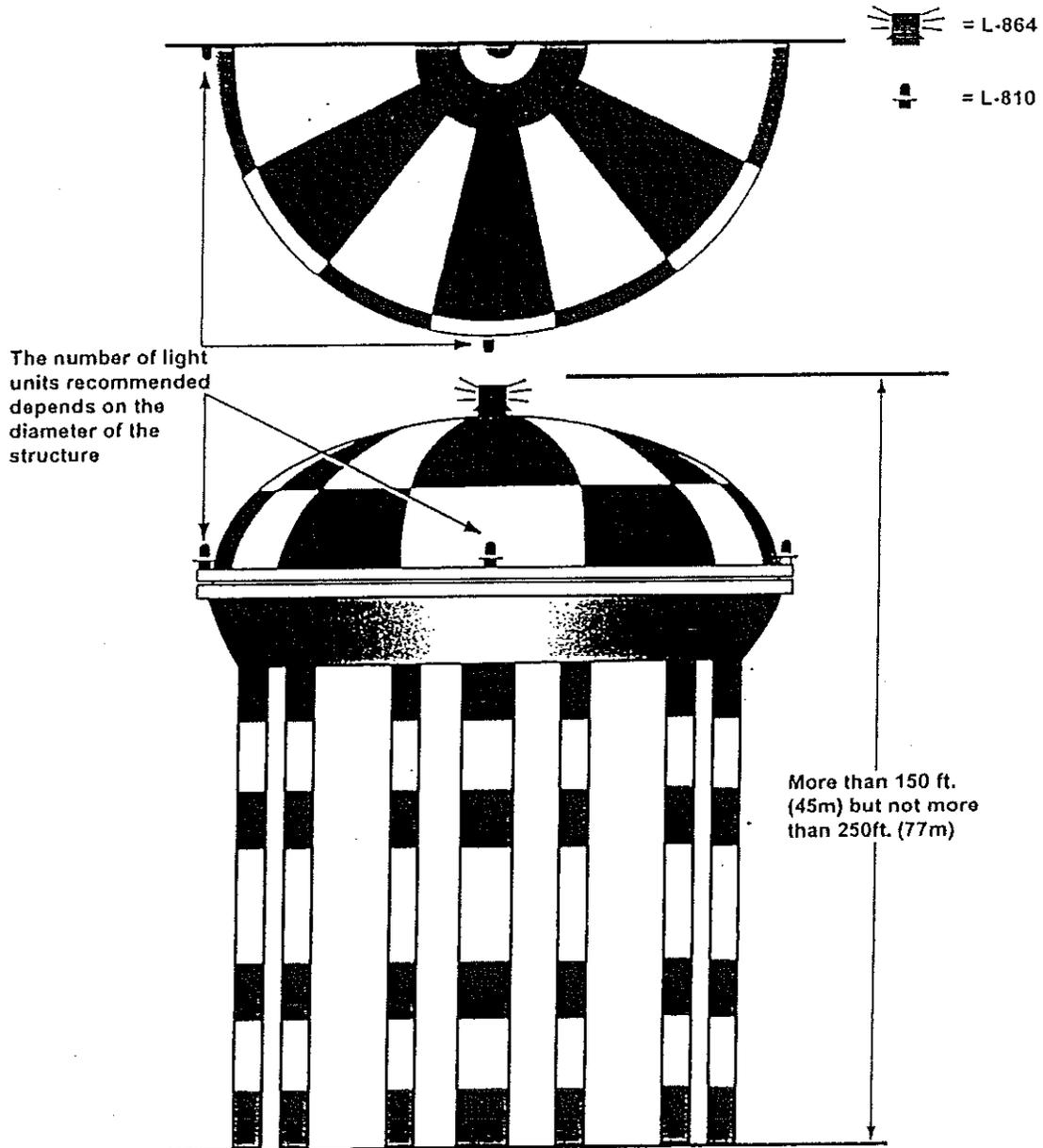


FIG 4

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PAINING OF SINGLE PEDESTAL WATER TOWER BY TEARDROP PATTERN

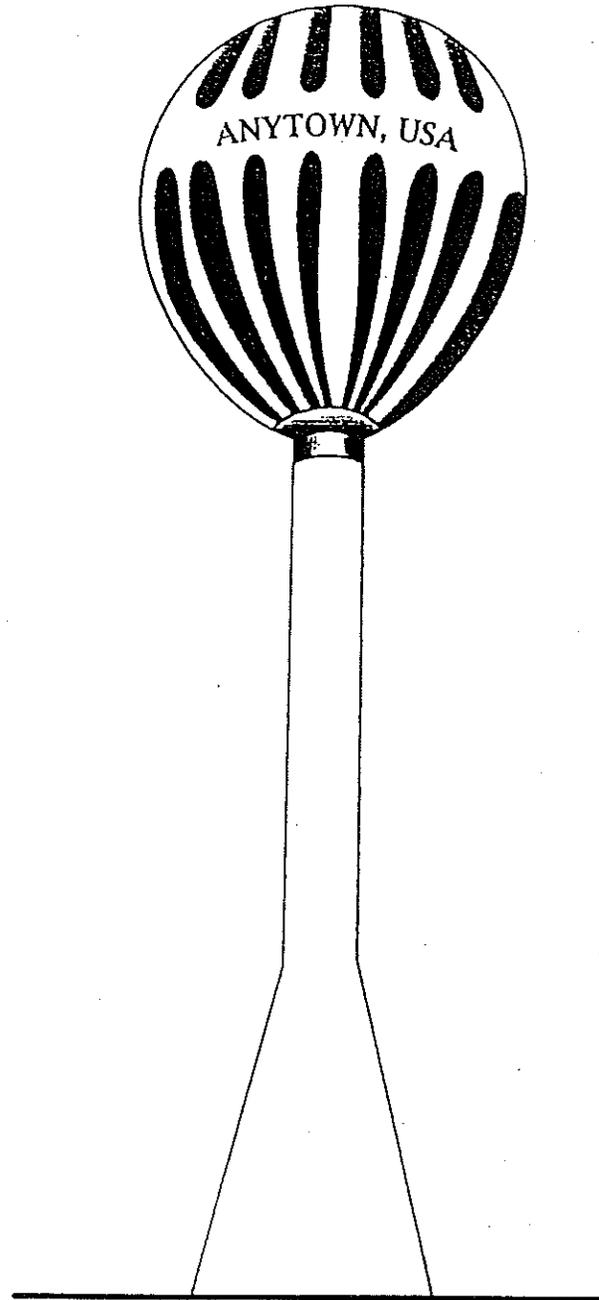
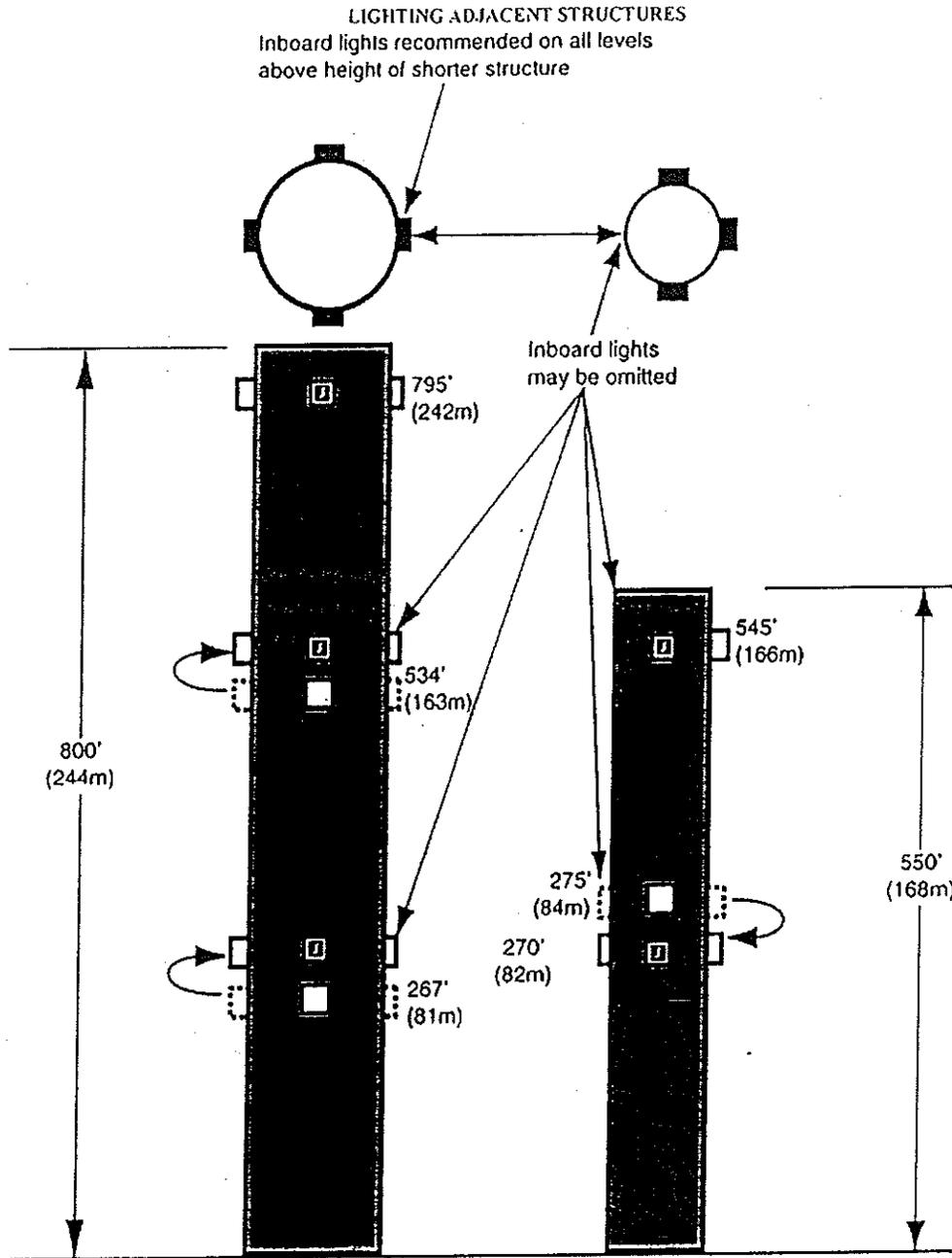


FIG 5



Minor adjustments in vertical placement may be made to place lights on same horizontal plane. Lights on both structures be synchronized

FIG 6

Lighting Adjacent Structure

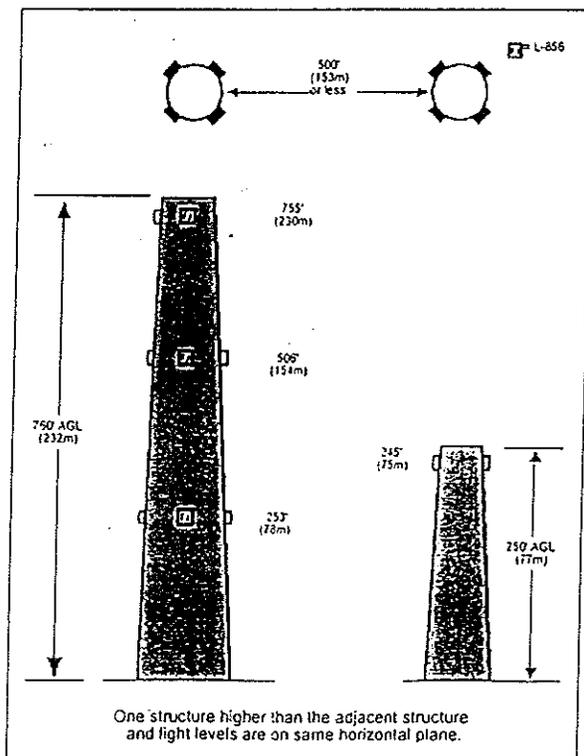
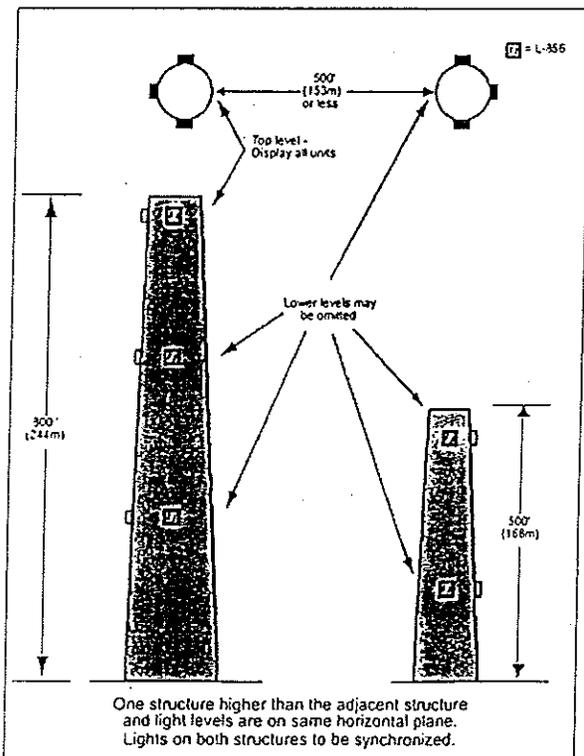
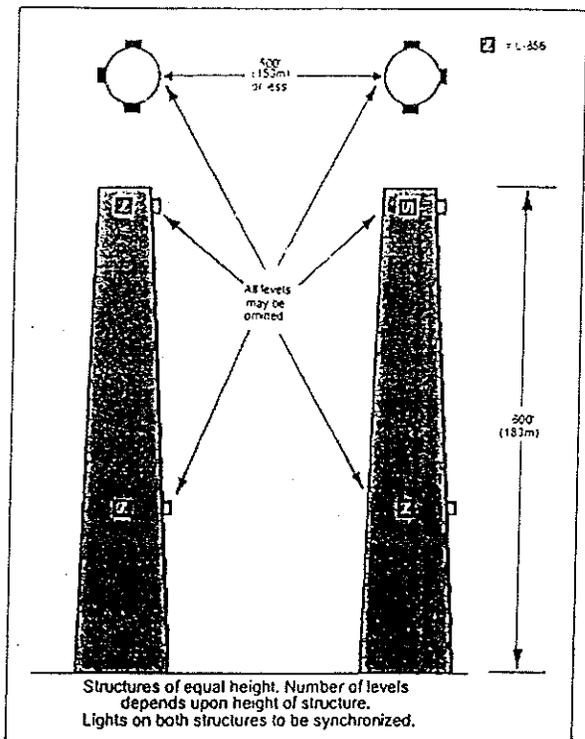
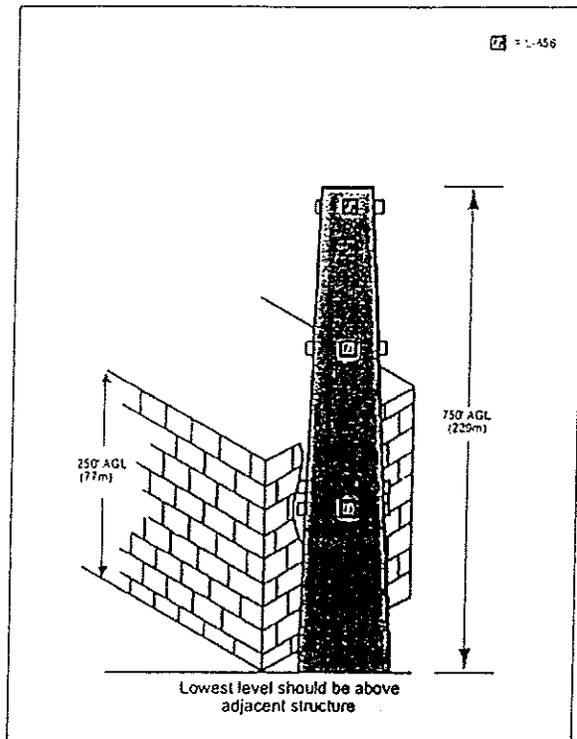


FIG 7

### Lighting Adjacent Structure

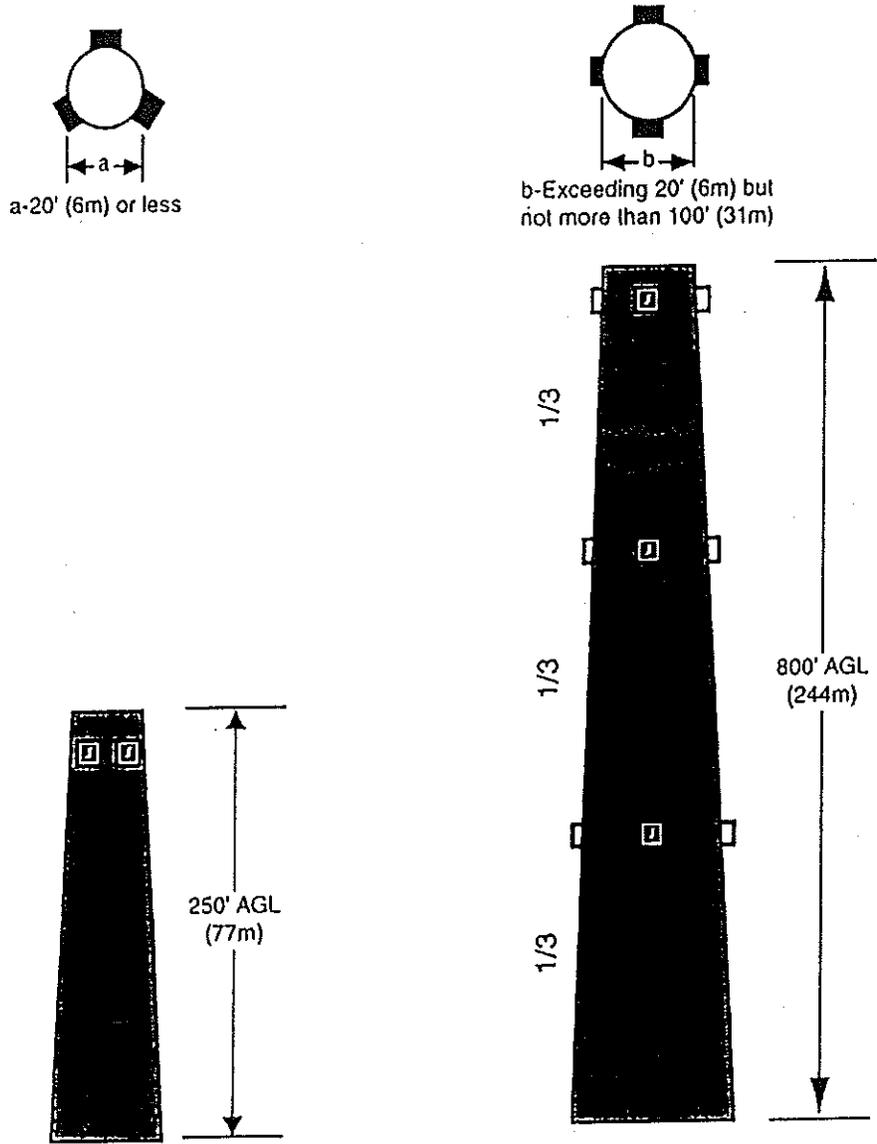


FIG 8

### HYPERBOLIC COOLING TOWER

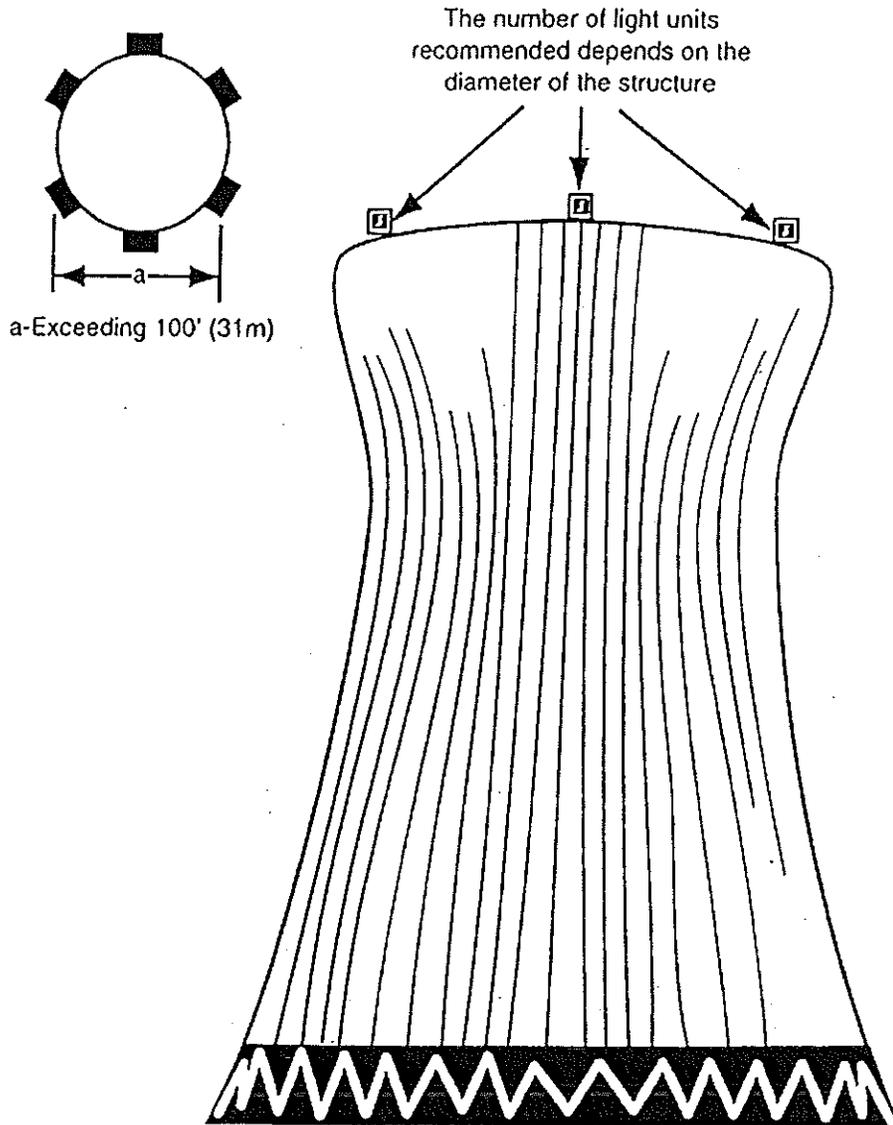


FIG 9

BRIDGE LIGHTING

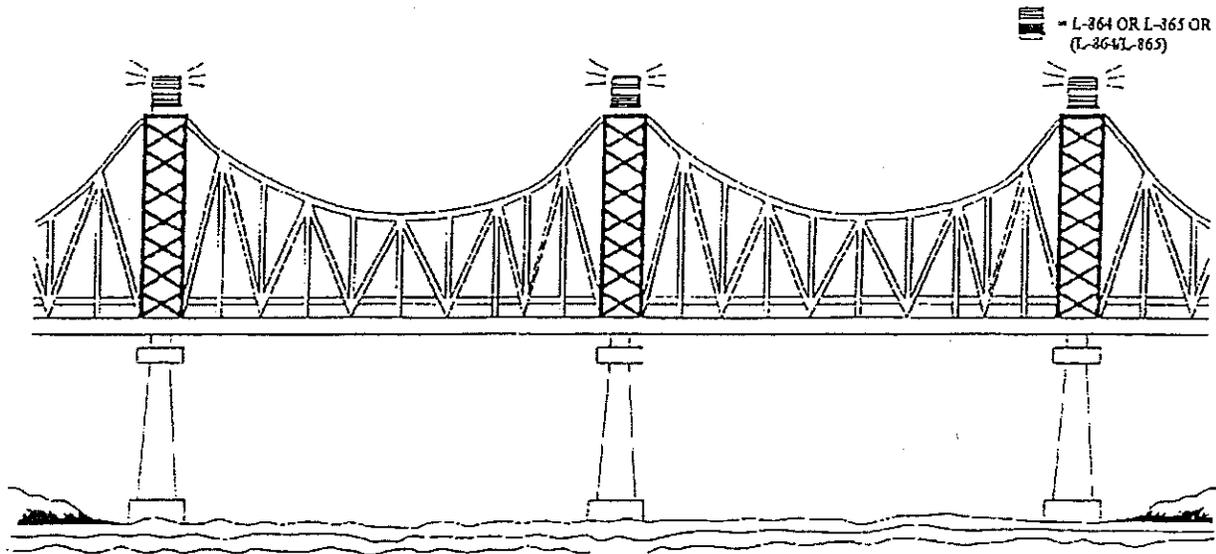
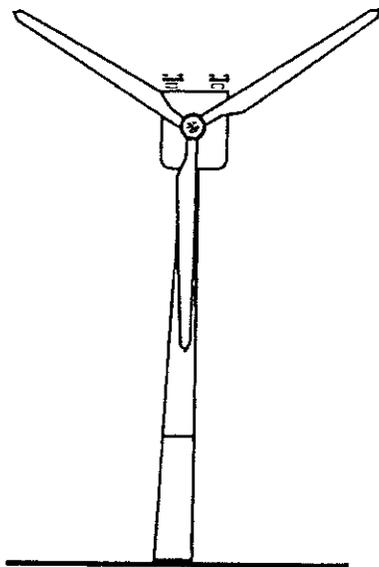
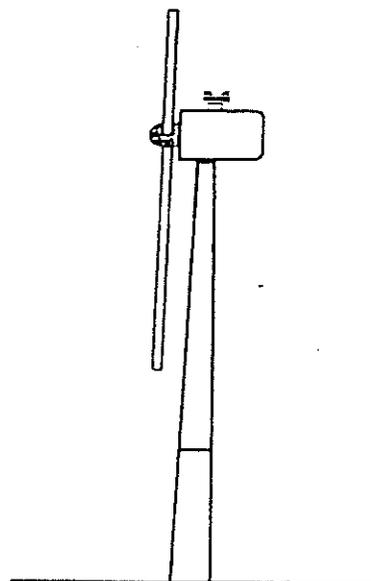


FIG 10

TYPICAL LIGHTING OF A STAND ALONE WIND TURBINE



Front View



Side View

FIG 11

WIND TURBINE GENERATOR

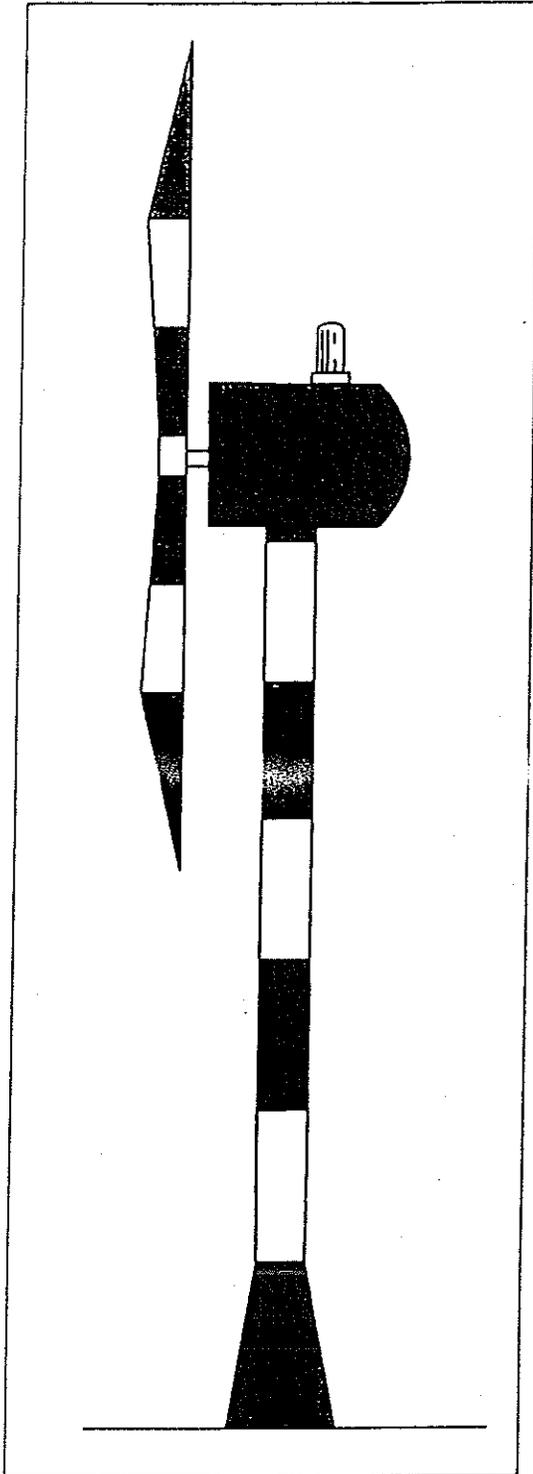
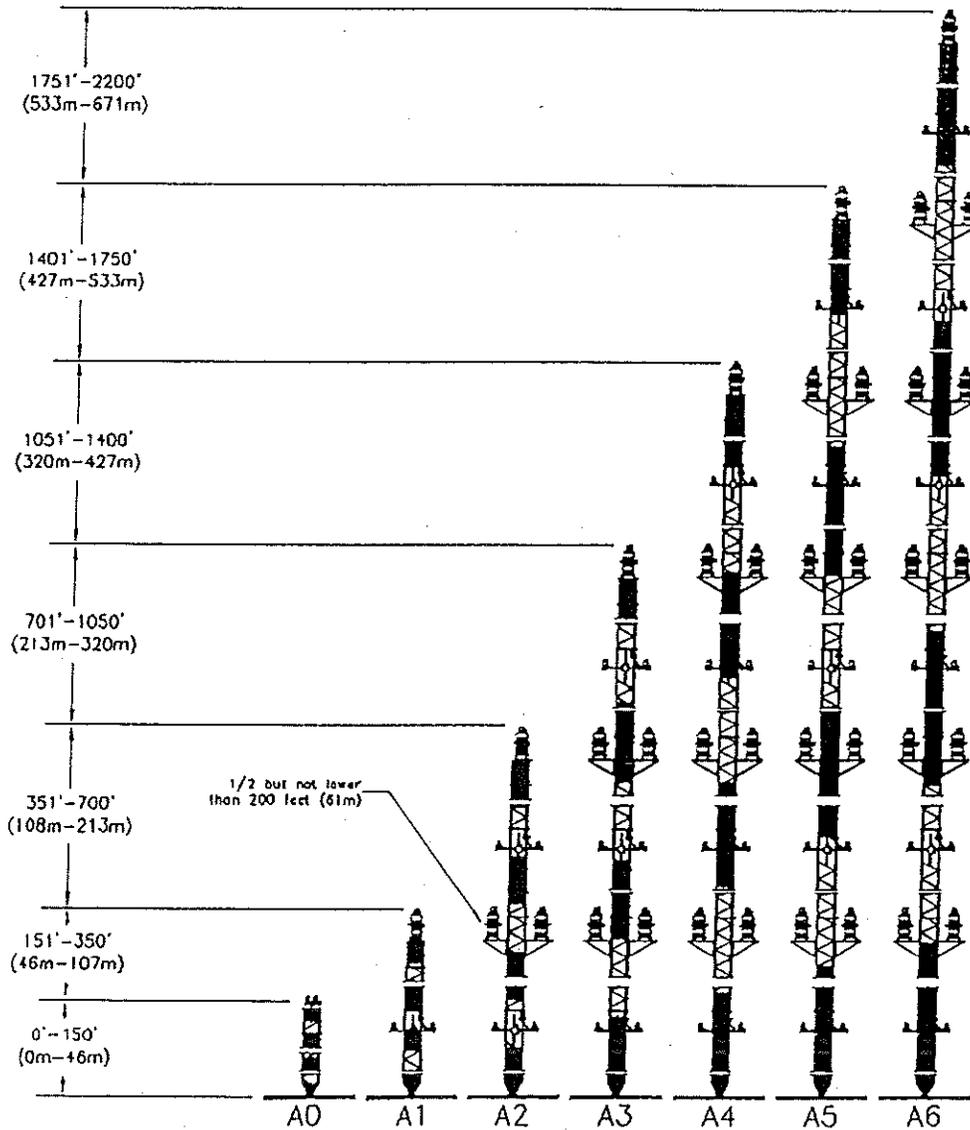


FIG 12

# RED OBSTRUCTION LIGHTING STANDARDS (FAA Style A)

Day Protection = Aviation Orange/White Paint  
Night Protection = 2,000cd Red Beacon and sidelights



- L-864 Flashing Beacon

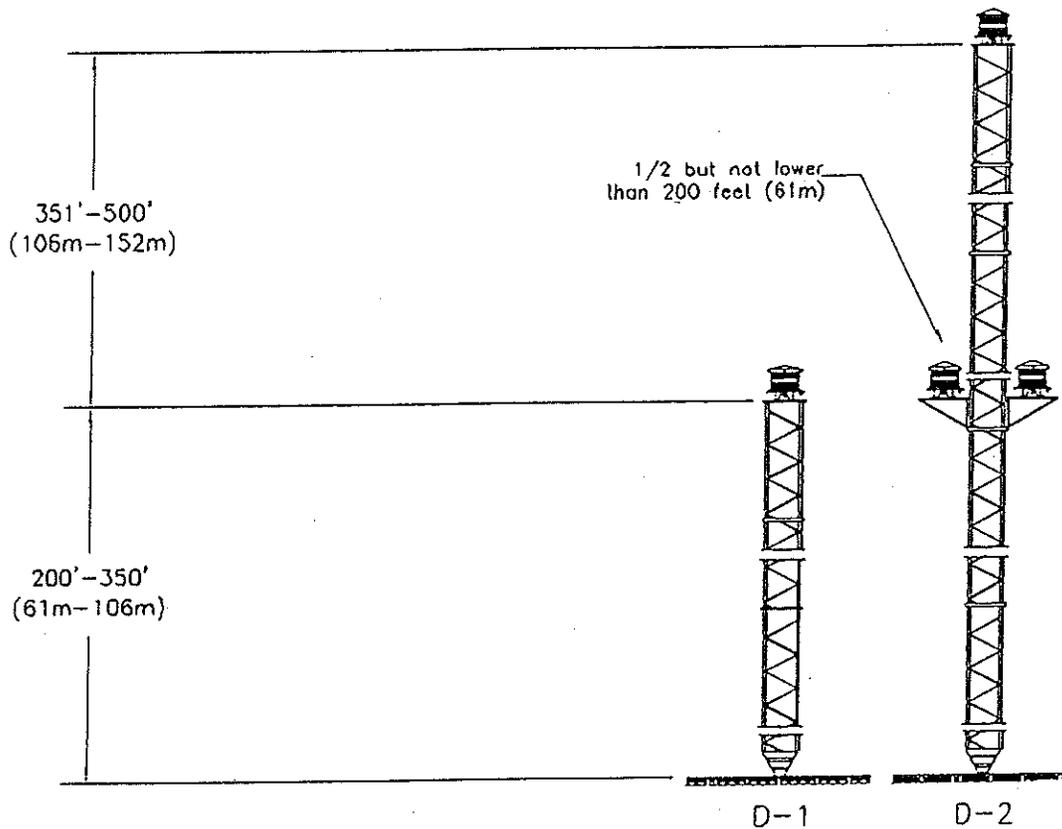


- L-810 Obstruction Light

FIG 13

# MEDIUM INTENSITY WHITE OBSTRUCTION LIGHTING STANDARDS (FAA Style D)

Day/Twilight Protection = 20,000cd White Strobe  
Night Protection = 2,000cd White Strobe  
Painting of tower is typically not required.

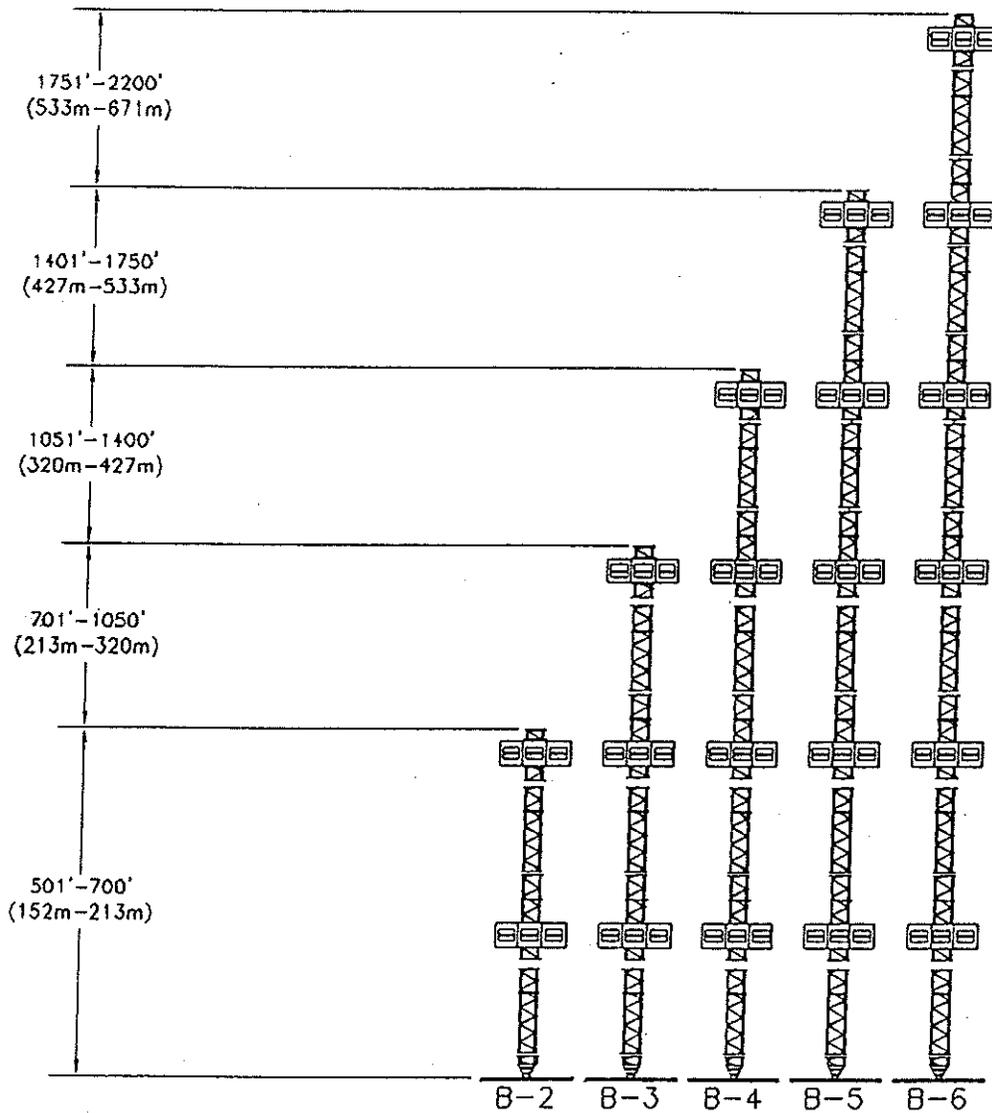


- L-865 Flashing White Strobe

FIG 14

# HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style B)

Day Protection = 200,000cd White Strobe  
Twilight Protection = 20,000cd White Strobe  
Night Protection = 2,000cd White Strobe

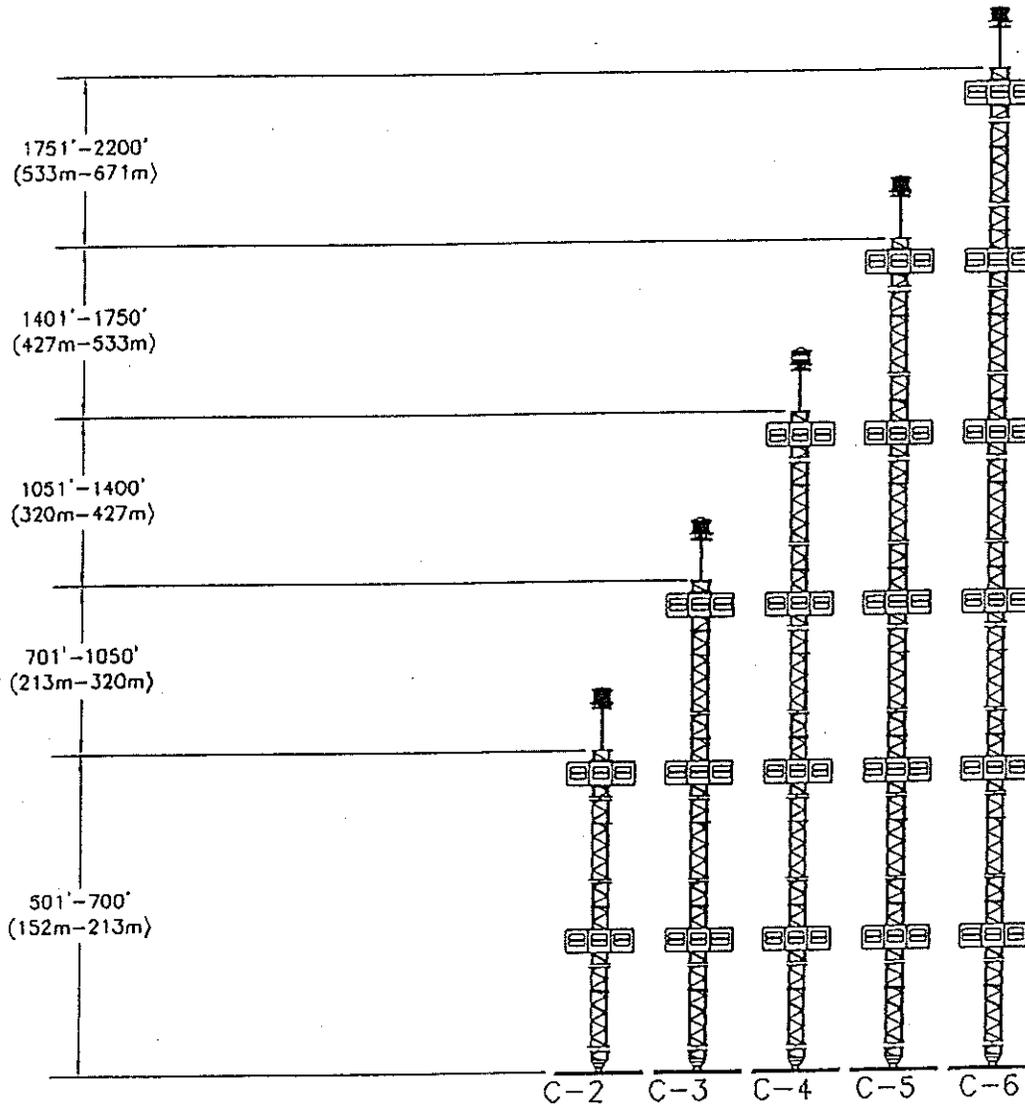


 - L-856 High Intensity Strobe  
(3 Flashheads required per level for 360° coverage)

FIG 15

# HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style C)

Day Protection = 200,000cd White Strobe  
Twilight Protection = 20,000cd White Strobe  
Night Protection = 2,000cd White Strobe



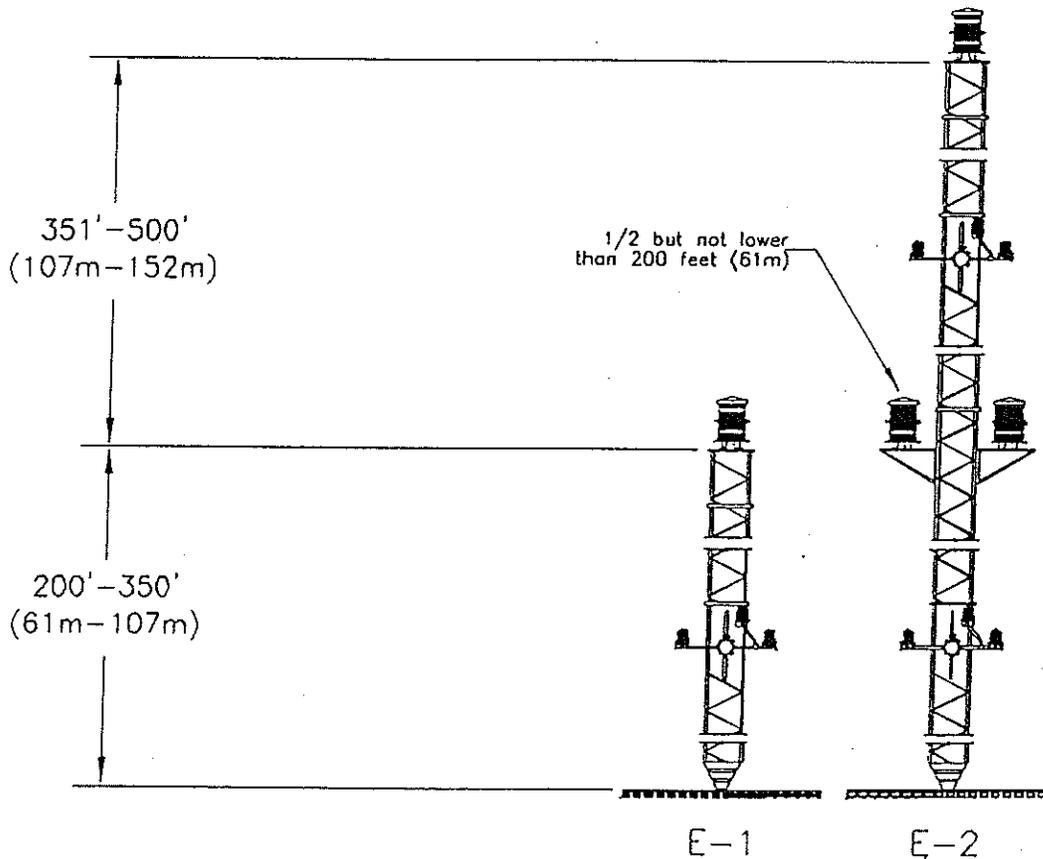
 - L-856 High Intensity Strobe  
(3 flashheads required per level for 360° coverage)

 - L-855 Medium Intensity Strobe  
required for obstructions of 40 feet or greater.

FIG 16

# MEDIUM INTENSITY DUAL OBSTRUCTION LIGHTING STANDARDS (FAA Style E)

Day/Twilight Protection = 20,000cd White Strobe  
Night Protection = 2,000cd Red Strobe and sidelights  
*Painting of tower is typically not required.*

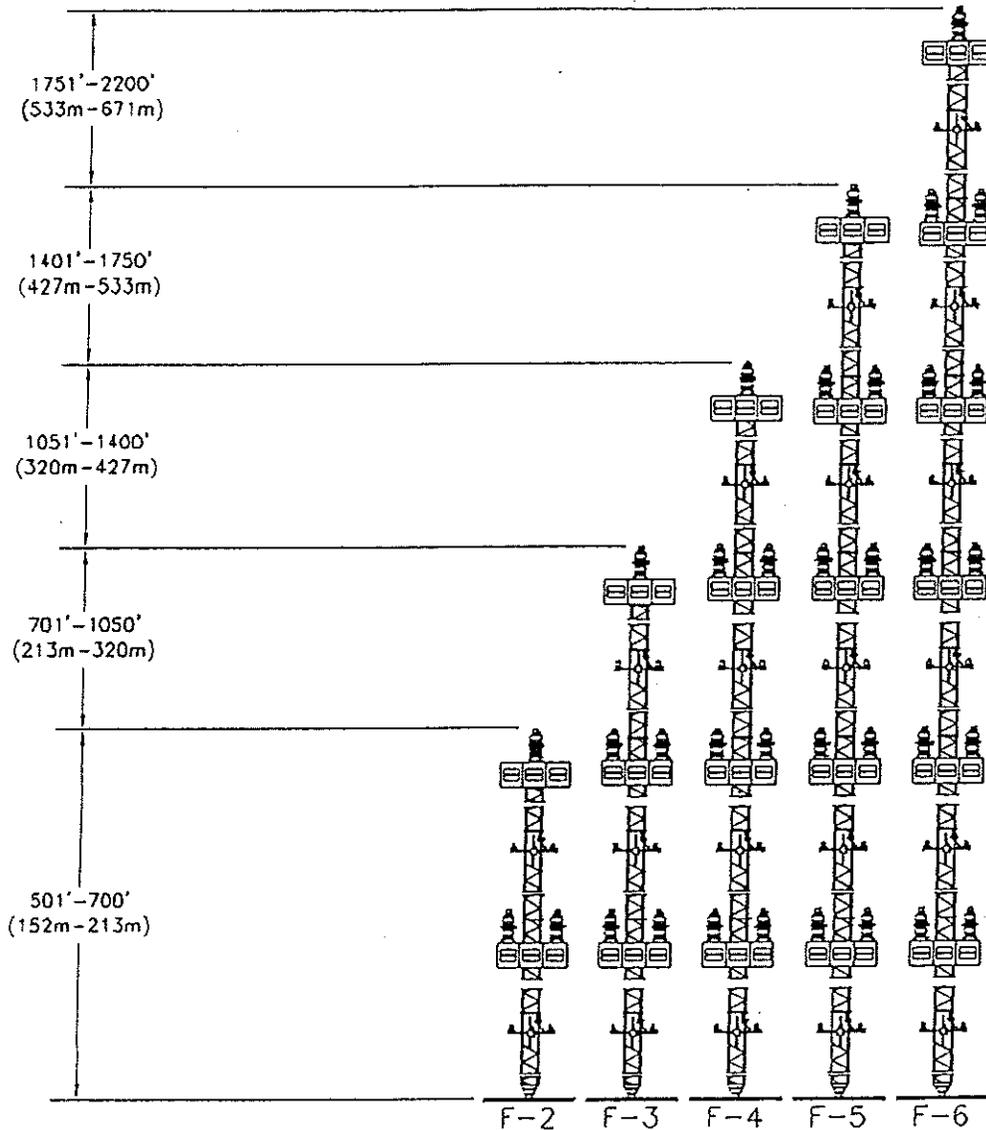


-  - L-864/L-865 Flashing Dual (White/Red) Strobe
-  - L-810 Obstruction Light

FIG 17

# DUAL HIGH INTENSITY OBSTRUCTION LIGHTING STANDARDS (FAA Style F)

Day Protection = 200,000cd White Strobe  
 Twilight Protection = 20,000cd White Strobe  
 Night Protection = 2,000cd Red Beacon and sidelights



-  - L-854 Flashing Beacon
-  - L-810 Obstruction Light
-  - L-856 High Intensity Strobe  
(3 Flashheads required per level for 360° coverage)

FIG 18

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## APPENDIX 2. Miscellaneous

**1. RATIONALE FOR OBSTRUCTION LIGHT INTENSITIES.**

Sections 91.117, 91.119 and 91.155 of the FAR Part 91, General Operating and Flight Rules, prescribe aircraft speed restrictions, minimum safe altitudes, and basic visual flight rules (VFR) weather minimums for

governing the operation of aircraft, including helicopters, within the United States.

**2. DISTANCE VERSUS INTENSITIES.**

TBL 5 depicts the distance the various intensities can be seen under 1 and 3 statute miles meteorological visibilities:

Distance/Intensity Table

Time Period	Meteorological Visibility Statute Miles	Distance Statute Miles	Intensity Candelas
Night		2.9 (4.7km)	1,500 (+/- 25%)
	3 (4.8km)	3.1 (4.9km)	2,000 (+/- 25%)
		1.4 (2.2km)	32
Day		1.5 (2.4km)	200,000
	1 (1.6km)	1.4 (2.2km)	100,000
		1.0 (1.6km)	20,000 (+/- 25%)
Day		3.0 (4.8km)	200,000
	3 (4.8km)	2.7 (4.3km)	100,000
		1.8 (2.9km)	20,000 (+/- 25%)
Twilight	1 (1.6km)	1.0 (1.6km) to 1.5 (2.4km)	20,000 (+/- 25%)?
Twilight	3 (4.8km)	1.8 (2.9km) to 4.2 (6.7km)	20,000 (+/- 25%)?

*Note-*

1. DISTANCE CALCULATED FOR NORTH SKY ILLUMINANCE.

TBL 5

**3. CONCLUSION.**

Pilots of aircraft travelling at 165 knots (190 mph/306kph) or less should be able to see obstruction lights in sufficient time to avoid the structure by at least 2,000 feet (610m) horizontally under all conditions of operation, provided the pilot is operating in accordance with FAR Part 91. Pilots operating between 165 knots (190 mph/303 km/h) and 250 knots (288 mph/463 kph) should be able to see the obstruction lights unless the weather deteriorates to 3 statute miles (4.8 kilometers) visibility at night, during which time period 2,000 candelas would be required to see the lights at 1.2 statute miles (1.9km). A higher intensity, with 3 statute miles (4.8 kilometers) visibility at night, could generate a residential annoyance factor. In addition, aircraft in these speed ranges can normally be expected to operate under instrument flight rules (IFR) at night when the visibility is 1 statute mile (1.6 kilometers).

**4. DEFINITIONS.**

a. Flight Visibility. The average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

Reference-  
AIRMAN'S INFORMATION MANUAL  
PILOT/CONTROLLER GLOSSARY.

b. Meteorological Visibility. A term that denotes the greatest distance, expressed in statute miles, that selected objects (visibility markers) or lights of moderate intensity (25 candelas) can be seen and identified under specified conditions of observation.

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5. LIGHTING SYSTEM CONFIGURATION.

- a. *Configuration A.* Red lighting system.
- b. *Configuration B.* High Intensity White Obstruction Lights (including appurtenance lighting).
- c. *Configuration C.* Dual Lighting System - High Intensity White & Red (including appurtenance lighting).
- d. *Configuration D.* Medium Intensity White Lights (including appurtenance lighting).
- e. *Configuration E.* Dual Lighting Systems - Medium Intensity White & Red (including appurtenance lighting).

*Example-*

*"CONFIGURATION B 3" DENOTES A HIGH INTENSITY LIGHTING SYSTEM WITH THREE LEVELS OF LIGHT.*

**APPENDIX D**

**TRAFFIC VOLUMES OBTAINED FROM THE  
CONNECTICUT DEPARTMENT OF  
TRANSPORTATION**

STA TYPE:7

0827049N1997  
STA NO 082 7049

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE 9 DIRECTION N  
LOC N.B. OFF RAMP TO BOW LANE

DAY SUN MON TUES WED THUR FRI SAT  
DATE 0 0 0 604 605 0 0

TYPE

HOUR 1997 ADT = 1600 ACF = NA

BEG \*\*\*\*\*

BEG	SUN	MON	TUES	WED	THUR	FRI	SAT
12A	0	0	0	0	13	0	0
1A	0	0	0	0	3	0	0
2A	0	0	0	0	5	0	0
3A	0	0	0	0	7	0	0
4A	0	0	0	0	11	0	0
5A	0	0	0	0	21	0	0
6A	0	0	0	0	149	0	0
7A	0	0	0	249	0	0	0
8A	0	0	0	239	0	0	0
9A	0	0	0	137	0	0	0
10A	0	0	0	92	0	0	0
11A	0	0	0	67	0	0	0
12P	0	0	0	84	0	0	0
1P	0	0	0	62	0	0	0
2P	0	0	0	122	0	0	0
3P	0	0	0	102	0	0	0
4P	0	0	0	109	0	0	0
5P	0	0	0	97	0	0	0
6P	0	0	0	68	0	0	0
7P	0	0	0	43	0	0	0
8P	0	0	0	52	0	0	0
9P	0	0	0	30	0	0	0
10P	0	0	0	28	0	0	0
11P	0	0	0	25	0	0	0
TOT	0	0	0	1606	209	0	0

RECORDER 104

24 HR = 1815

G - 4

STA TYPE:7

082705081997  
STA NO 082 7050

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN		ROUTE 9		DIRECTION S			
LOC S.B. OFF RAMP TO SILVER STREET							
DAY	SUN	MON	TUES	WED	THUR	FRI	SAT
DATE	0	0	0	0	605	606	0
TYPE							
HOUR	1997 ADT = 3700			ACF = NA			
BEG	*****						
12A	0	0	0	0	0	38	0
1A	0	0	0	0	0	23	0
2A	0	0	0	0	0	26	0
3A	0	0	0	0	0	29	0
4A	0	0	0	0	0	33	0
5A	0	0	0	0	132	0	0
6A	0	0	0	0	438*	0	0
7A	0	0	0	0	362	0	0
8A	0	0	0	0	380	0	0
9A	0	0	0	0	206	0	0
10A	0	0	0	0	177	0	0
11A	0	0	0	0	174	0	0
12P	0	0	0	0	200	0	0
1P	0	0	0	0	222	0	0
2P	0	0	0	0	303	0	0
3P	0	0	0	0	319	0	0
4P	0	0	0	0	257	0	0
5P	0	0	0	0	222	0	0
6P	0	0	0	0	144	0	0
7P	0	0	0	0	124	0	0
8P	0	0	0	0	95	0	0
9P	0	0	0	0	81	0	0
10P	0	0	0	0	77	0	0
11P	0	0	0	0	102	0	0
TOT	0	0	0	0	4015	149	0
RECORDER	132		24 HR.		4164		G - 4

STA TYPE:7 0827049N1994  
 STA NO 082 7049

STATE OF CONNECTICUT  
 DEPARTMENT OF TRANSPORTATION  
 BUREAU OF POLICY AND PLANNING  
 PLANNING INVENTORY AND DATA  
 TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE 9 DIRECTION N  
 LOC N.B. OFF RAMP TO BOW LANE

DAY	SUN	MON	TUES	WED	THUR	FRI	SAT
DATE	0	0	0	1109	1110	0	0

HOUR 1994 ADT = 1700 ACF = NA  
 BEG \*\*\*\*\*

12A	0	0	0	0	32	0	0
1A	0	0	0	0	2	0	0
2A	0	0	0	0	3	0	0
3A	0	0	0	0	6	0	0
4A	0	0	0	0	11	0	0
5A	0	0	0	0	19	0	0
6A	0	0	0	0	127	0	0
7A	0	0	0	0	228	0	0
8A	0	0	0	265*	0	0	0
9A	0	0	0	124	0	0	0
10A	0	0	0	102	0	0	0
11A	0	0	0	101	0	0	0
12P	0	0	0	82	0	0	0
1P	0	0	0	104	0	0	0
2P	0	0	0	110	0	0	0
3P	0	0	0	137	0	0	0
4P	0	0	0	90	0	0	0
5P	0	0	0	93	0	0	0
6P	0	0	0	60	0	0	0
7P	0	0	0	47	0	0	0
8P	0	0	0	24	0	0	0
9P	0	0	0	10	0	0	0
10P	0	0	0	24	0	0	0
11P	0	0	0	22	0	0	0
TOT	0	0	0	1395	428	0	0
RECORDER 028				24 HR =	1823		G - 4

STA TYPE:7

0827050S1994  
STA NO 082 7050

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE 9 DIRECTION S  
LOC S.B. OFF RAMP TO SILVER STREET

DAY SUN MON TUES WED THUR FRI SAT  
DATE 0 1114 1115 0 0 0 0

TYPE

HOURLY

1994 ADT = 3600 ACF = NA

BEG

\*\*\*\*\*

12A	0	0	16	0	0	0	0
1A	0	0	12	0	0	0	0
2A	0	0	2	0	0	0	0
3A	0	0	6	0	0	0	0
4A	0	0	28	0	0	0	0
5A	0	0	50	0	0	0	0
6A	0	0	372	0	0	0	0
7A	0	0	341	0	0	0	0
8A	0	400*	0	0	0	0	0
9A	0	216	0	0	0	0	0
10A	0	182	0	0	0	0	0
11A	0	158	0	0	0	0	0
12P	0	214	0	0	0	0	0
1P	0	212	0	0	0	0	0
2P	0	299	0	0	0	0	0
3P	0	305	0	0	0	0	0
4P	0	240	0	0	0	0	0
5P	0	194	0	0	0	0	0
6P	0	138	0	0	0	0	0
7P	0	96	0	0	0	0	0
8P	0	74	0	0	0	0	0
9P	0	76	0	0	0	0	0
10P	0	79	0	0	0	0	0
11P	0	99	0	0	0	0	0
TOT	0	2982	827	0	0	0	0
RECORDER	105		24 HR	=	3809		G - 4

STA TYPE:7

0827049N1993  
STA NO 082 7049

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE 9 DIRECTION N  
LOC N.B. OFF RAMP TO BOW LANE

DAY SUN MON TUES WED THUR FRI SAT  
DATE 0 0 615 616 0 0 0

TYPE

HOURLY

1993 ADT = 1600 ACF = NA

BEG

\*\*\*\*\*

BEG	SUN	MON	TUES	WED	THUR	FRI	SAT
12A	0	0	0	18	0	0	0
1A	0	0	0	4	0	0	0
2A	0	0	0	1	0	0	0
3A	0	0	0	4	0	0	0
4A	0	0	0	5	0	0	0
5A	0	0	0	19	0	0	0
6A	0	0	0	134	0	0	0
7A	0	0	215*	200	0	0	0
8A	0	0	212	200	0	0	0
9A	0	0	118	200	0	0	0
10A	0	0	101	200	0	0	0
11A	0	0	80	200	0	0	0
12P	0	0	103	200	0	0	0
1P	0	0	86	0	0	0	0
2P	0	0	120	0	0	0	0
3P	0	0	136	0	0	0	0
4P	0	0	86	0	0	0	0
5P	0	0	78	0	0	0	0
6P	0	0	72	0	0	0	0
7P	0	0	44	0	0	0	0
8P	0	0	32	0	0	0	0
9P	0	0	21	0	0	0	0
10P	0	0	47	0	0	0	0
11P	0	0	24	0	0	0	0
TOT	0	0	1575	385	0	0	0
RECORDER			24 HR (=	1760		G - 4	

STA TYPE:7

0827050S1993  
STA NO 082 7050

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN		ROUTE 9		DIRECTION S			
LOC S.B. OFF RAMP TO SILVER STREET							
DAY	SUN	MON	TUES	WED	THUR	FRI	SAT
DATE	0	0	615	616	0	0	0
TYPE							
HOUR			1993 ADT = 3600		ACF = NA		
BEG			*****				
12A	0	0	0	20	0	0	0
1A	0	0	0	16	0	0	0
2A	0	0	0	8	0	0	0
3A	0	0	0	8	0	0	0
4A	0	0	0	30	0	0	0
5A	0	0	0	71	0	0	0
6A	0	0	0	455*	0	0	0
7A	0	0	333	0	0	0	0
8A	0	0	371	0	0	0	0
9A	0	0	217	0	0	0	0
10A	0	0	165	0	0	0	0
11A	0	0	163	0	0	0	0
12P	0	0	228	0	0	0	0
1P	0	0	250	0	0	0	0
2P	0	0	300	0	0	0	0
3P	0	0	295	0	0	0	0
4P	0	0	217	0	0	0	0
5P	0	0	174	0	0	0	0
6P	0	0	122	0	0	0	0
7P	0	0	146	0	0	0	0
8P	0	0	86	0	0	0	0
9P	0	0	74	0	0	0	0
10P	0	0	99	0	0	0	0
11P	0	0	114	0	0	0	0
TOT	0	0	3354	608	0	0	0
RECORDER			24 HR = 3962		G - 4		

STA TYPE:7

0827051N1993  
STA NO 082 7051

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE 9 DIRECTION N  
LOC N.B. ON RAMP FROM EASTERN DRIVE

DAY SUN MON TUES WED THUR FRI SAT  
DATE 0 0 615 616 0 0 0

TYPE  
HOUR 1993 ADT = 2700 ACF = NA  
BEG \*\*\*\*\*

BEG	SUN	MON	TUES	WED	THUR	FRI	SAT
12A	0	0	0	125	0	0	0
1A	0	0	0	4	0	0	0
2A	0	0	0	14	0	0	0
3A	0	0	0	5	0	0	0
4A	0	0	0	7	0	0	0
5A	0	0	0	28	0	0	0
6A	0	0	0	105	0	0	0
7A	0	0	0	278	0	0	0
8A	0	0	150	0	0	0	0
9A	0	0	112	0	0	0	0
10A	0	0	112	0	0	0	0
11A	0	0	161	0	0	0	0
12P	0	0	167	0	0	0	0
1P	0	0	110	0	0	0	0
2P	0	0	168	0	0	0	0
3P	0	0	507*	0	0	0	0
4P	0	0	316	0	0	0	0
5P	0	0	188	0	0	0	0
6P	0	0	96	0	0	0	0
7P	0	0	88	0	0	0	0
8P	0	0	45	0	0	0	0
9P	0	0	65	0	0	0	0
10P	0	0	40	0	0	0	0
11P	0	0	85	0	0	0	0
TOT	0	0	2410	566	0	0	0
RECORDER			24 HR	976		G - 4	



STA TYPE:0

0820252B1995  
STA NO 082 0252

STATE OF CONNECTICUT  
DEPARTMENT OF TRANSPORTATION  
BUREAU OF POLICY AND PLANNING  
PLANNING INVENTORY AND DATA  
TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN ROUTE DIRECTION B  
LOC RIVER ROAD # 1 - EAST OF EASTERN DRIVE

DAY SUN MON TUES WED THUR FRI SAT  
DATE 0 0 0 0 907 908 0

TYPE  
HOUR 1995 ADT = 200 ACF = NA

BEG	SUN	MON	TUES	WED	THUR	FRI	SAT
12A	0	0	0	0	0	2	0
1A	0	0	0	0	0	1	0
2A	0	0	0	0	0	0	0
3A	0	0	0	0	0	0	0
4A	0	0	0	0	0	0	0
5A	0	0	0	0	0	0	0
6A	0	0	0	0	0	6	0
7A	0	0	0	0	0	3	0
8A	0	0	0	0	11	0	0
9A	0	0	0	0	13	0	0
10A	0	0	0	0	16	0	0
11A	0	0	0	0	14	0	0
12P	0	0	0	0	16	0	0
1P	0	0	0	0	20*	0	0
2P	0	0	0	0	7	0	0
3P	0	0	0	0	13	0	0
4P	0	0	0	0	17	0	0
5P	0	0	0	0	17	0	0
6P	0	0	0	0	12	0	0
7P	0	0	0	0	10	0	0
8P	0	0	0	0	7	0	0
9P	0	0	0	0	8	0	0
10P	0	0	0	0	6	0	0
11P	0	0	0	0	2	0	0
TOT	0	0	0	0	189	12	0
RECORDER 075			24 HR		201	G - 4	

STA TYPE:0 0820261B1995  
 STA NO 082 0261

STATE OF CONNECTICUT  
 DEPARTMENT OF TRANSPORTATION  
 BUREAU OF POLICY AND PLANNING  
 PLANNING INVENTORY AND DATA  
 TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN	ROUTE	DIRECTION B					
LOC SILVER STREET - EAST OF	EAST MAIN STREET						
DAY	SUN	MON	TUES	WED	THUR	FRI	SAT
DATE	0	0	0	0	907	908	0
TYPE							
HOUR	1995 ADT = 4600						ACF = NA
BEG	*****						
12A	0	0	0	0	0	36	0
1A	0	0	0	0	0	27	0
2A	0	0	0	0	0	18	0
3A	0	0	0	0	0	5	0
4A	0	0	0	0	0	17	0
5A	0	0	0	0	0	29	0
6A	0	0	0	0	0	110	0
7A	0	0	0	0	244	0	0
8A	0	0	0	0	284	0	0
9A	0	0	0	0	336	0	0
10A	0	0	0	0	355	0	0
11A	0	0	0	0	385	0	0
12P	0	0	0	0	415	0	0
1P	0	0	0	0	330	0	0
2P	0	0	0	0	336	0	0
3P	0	0	0	0	408	0	0
4P	0	0	0	0	461*	0	0
5P	0	0	0	0	367	0	0
6P	0	0	0	0	254	0	0
7P	0	0	0	0	196	0	0
8P	0	0	0	0	142	0	0
9P	0	0	0	0	107	0	0
10P	0	0	0	0	71	0	0
11P	0	0	0	0	66	0	0
TOT	0	0	0	0	4757	242	0
RECORDER 067	24 HR = 4999						G - 4

STA TYPE:0 0820251B1994  
 STA NO 082 0251

STATE OF CONNECTICUT  
 DEPARTMENT OF TRANSPORTATION  
 BUREAU OF POLICY AND PLANNING  
 PLANNING INVENTORY AND DATA  
 TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN	ROUTE							DIRECTION B
LOC RIVER ROAD # 1 - EAST OF HARBOR DRIVE								
DAY	SUN	MON	TUES	WED	THUR	FRI	SAT	
DATE	0	0	0	0	804	805	0	
TYPE								
HOUR	1994 ADT = 1500							ACF = NA
BEG	*****							
12A	0	0	0	0	0	13	0	
1A	0	0	0	0	0	9	0	
2A	0	0	0	0	0	5	0	
3A	0	0	0	0	0	3	0	
4A	0	0	0	0	0	14	0	
5A	0	0	0	0	0	19	0	
6A	0	0	0	0	0	81	0	
7A	0	0	0	0	0	77	0	
8A	0	0	0	0	0	70	0	
9A	0	0	0	0	0	88	0	
10A	0	0	0	0	0	104	0	
11A	0	0	0	0	0	107	0	
12P	0	0	0	0	0	109	0	
1P	0	0	0	0	100	0	0	
2P	0	0	0	0	108	0	0	
3P	0	0	0	0	148*	0	0	
4P	0	0	0	0	143	0	0	
5P	0	0	0	0	120	0	0	
6P	0	0	0	0	71	0	0	
7P	0	0	0	0	90	0	0	
8P	0	0	0	0	52	0	0	
9P	0	0	0	0	37	0	0	
10P	0	0	0	0	40	0	0	
11P	0	0	0	0	22	0	0	
TOT	0	0	0	0	931	699	0	
RECORDER	24 HR = 530							G - 4

STA TYPE:0 0820264B1994  
 STA NO 082 0264

STATE OF CONNECTICUT  
 DEPARTMENT OF TRANSPORTATION  
 BUREAU OF POLICY AND PLANNING  
 PLANNING INVENTORY AND DATA  
 TRAFFIC RECORDER DATA

TOWN OF MIDDLETOWN	ROUTE	DIRECTION B					
LOC SILVER STREET - S.W. OF RIVER STREET # 1							
DAY	SUN	MON	TUES	WED	THUR	FRI	SAT
DATE	0	0	0	1019	1020	0	0
TYPE							
HOUR			1994 ADT = 1600		ACF = NA		
BEG	*****						
12A	0	0	0	0	5	0	0
1A	0	0	0	0	1	0	0
2A	0	0	0	0	2	0	0
3A	0	0	0	0	1	0	0
4A	0	0	0	0	26	0	0
5A	0	0	0	0	44	0	0
6A	0	0	0	0	309*	0	0
7A	0	0	0	0	196	0	0
8A	0	0	0	0	0	0	0
9A	0	0	0	0	0	0	0
10A	0	0	0	0	0	0	0
11A	0	0	0	0	0	0	0
12P	0	0	0	0	0	0	0
1P	0	0	0	0	0	0	0
2P	0	0	0	0	0	0	0
3P	0	0	0	0	0	0	0
4P	0	0	0	0	0	0	0
5P	0	0	0	0	0	0	0
6P	0	0	0	0	0	0	0
7P	0	0	0	0	0	0	0
8P	0	0	0	0	0	0	0
9P	0	0	0	0	0	0	0
10P	0	0	0	0	0	0	0
11P	0	0	0	0	0	0	0
TOT	0	0	0	1132	584	0	0
RECORDER 025			24 HR		1716	G - 4	

**APPENDIX E**

**CONNECTICUT HISTORICAL COMMISSION  
CORRESPONDENCE**



Customer-Focused Solutions

January 14, 2002

Mr. David Poirier  
Archaeologist  
State of Connecticut Historical Commission  
59 South Prospect Street  
Hartford, CT 06106

**Subject: Phase IA Cultural Resource Survey  
Proposed Kleen Energy Generating Facility, Middletown Connecticut**

Dear Mr. Poirier:

TRC Environmental Corporation conducted a Phase IA cultural resource survey for the proposed 520 MW (nominal) natural gas-fired combined-cycle Kleen Energy Generating Facility in Middletown, Connecticut. The Project site is located in the southeastern, Maromas section of Middletown, near the Connecticut River. Middletown is in Middlesex County and is about 4.5 miles south on Route 9 from the intersection of I-91 and Route 9. The Project site is about 3 miles due east of the Middletown business district and about 2.6 miles from the intersection of Route 9 and Silver Street, which would be expected to be the principal access route to the site (Figure 1). The survey was performed on January 8, 2002. The Project site is approximately 137 acres. Approximately 48 acres of the Project site would be used for the construction of the power block, the substation, the roadway network, and the laydown and parking areas required for construction of the Project.

In 1959 and 1960 Feldspar Corporation, a wholly owned subsidiary of Pacific Tin Consolidated Corp of New York purchased the project site for the purpose of mining feldspar. Prior to Feldspar Corporation gaining control of this area, land records indicate that the area was also mined for pegmatite, a coarse grained granite. Although the Feldspar Corporation mined the area where the proposed Project is to be located between 1959 and the early 1990s, portions of the project site were mined for pegmatite beginning nearly 100 years ago. The proposed Project site has been disturbed by the mining activities that have taken place. No original habitable land surfaces remain. In some areas as much as 50 meters of soil and rock have been removed.

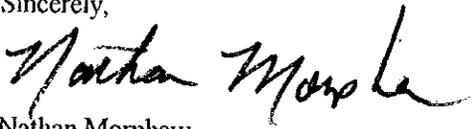
The most prominent structures associated with the proposed Project are the generation building at about 95 feet high; and the two exhaust stacks, expected to be about 215 feet high. The cooling tower is proposed to be located at the rear (southern portion) of the site. The generation building and ancillary power block facilities would be located to the north on a terrace that will also contain the cooling towers. The switchyard would be located further to the north on a terrace about 100 feet lower than the power block. Because of the steep slopes in the area, the view of the Project should be very limited from most directions. The only area from which the plant would be particularly noticeable would be from the top of the Connecticut River gorge along the northern riverbank (Town of Portland). This vantage point also affords a view of the existing NRG Middletown Generating Station Facility- ½ mile east of the Project site (Figure 1).

There are two extant structures located in the Project site, the feldspar processing building and an equipment storage building. Both structures were constructed in the 1960's and are ineligible for listing in the National Register of Historic Places (NRHP).

Because of the extensive previous disturbances, construction of the proposed Project would have no impact on archaeological resources. No further cultural resource investigations are recommended.

Should you have any questions please contact me directly at (860) 298-6260.

Sincerely,

A handwritten signature in black ink that reads "Nathan Mophew". The signature is written in a cursive style with a large, sweeping initial "N".

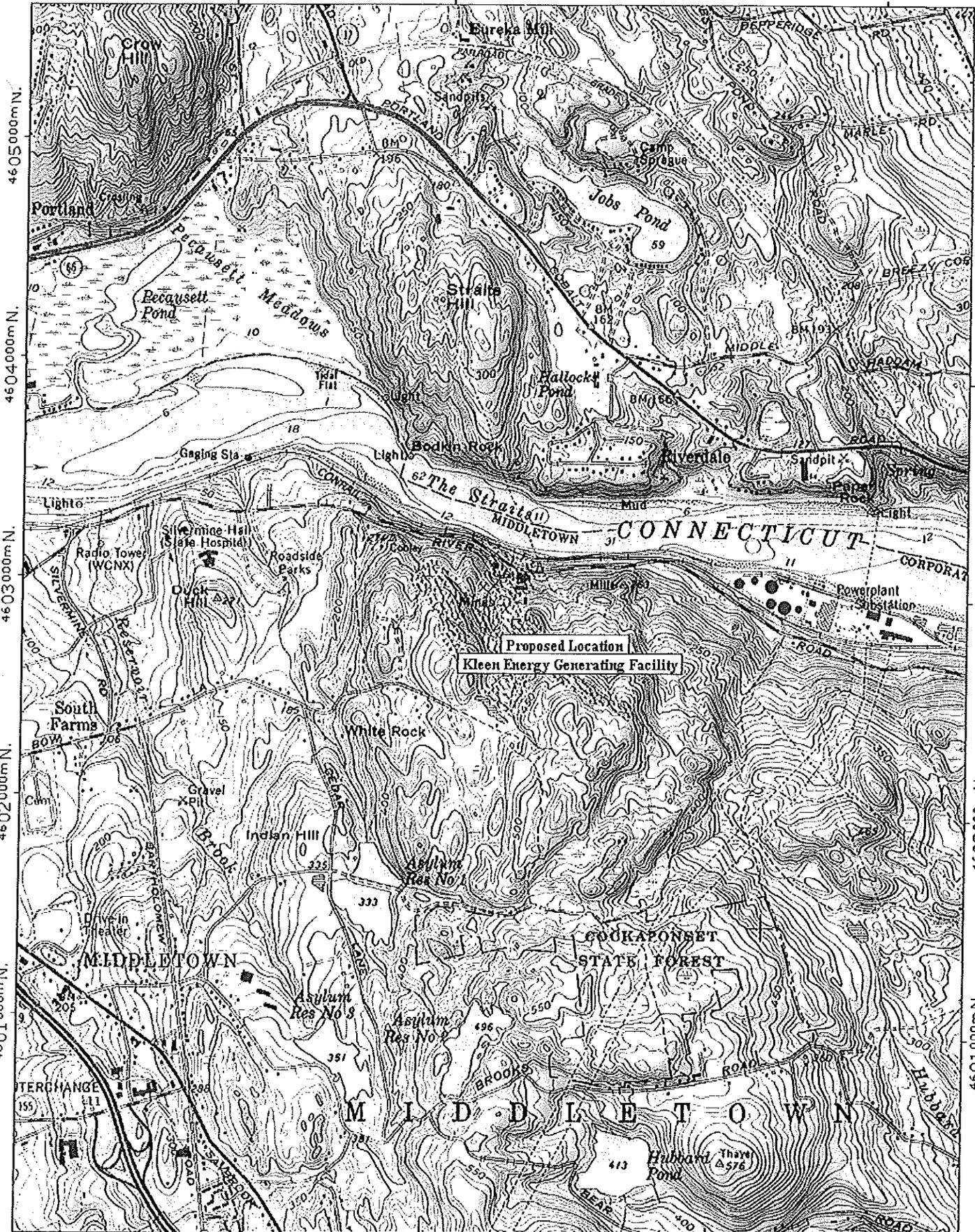
Nathan Mophew  
Archaeologist

cc. Nicholas Bellantoni  
Richard Audette  
William Corvo  
Mark Slade  
Tricia Claussen

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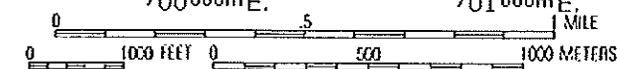
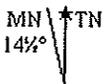
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**APPENDIX F**

**CONNECTICUT NATURAL DIVERSITY  
DATABASE CORRESPONDENCE**



## Connecticut Natural Diversity Data Base Review Request Form

Please complete this form *only* if you have conducted a review which determined that your activity is located in an area of concern.

Name: Mark Slade

Affiliation: TRC Companies Inc

Mailing Address: Boott Mills South, Foot of John Street

City/Town: Lowell

State: MA

Zip Code: 01852-

Business Phone: 978-656-3689

ext.

Fax: 978-453-1995

Contact Person: Mark Slade

Title: Project Manager

Project or Site Name: River Road, Middletown, CT

*Project Location*

Town: Middletown

USGS Quad: Middle Haddam

*Brief Description of Proposed Activities:*

Kleen Energy Systems, LLC is proposing to build a new 520 megawatt combined cycle generating station on a 137 acre parcel of land in Middletown, Connecticut.

Have you conducted a "State and Federal Listed Species and Natural Communities Map" review?

Yes  No Date of Map: 07/27/2000

Has a field survey been previously conducted to determine the presence of any endangered, threatened or special concern species?  Yes  No

If yes, provide the following information and submit a copy of the field survey with this form.

Biologists Name: Jeffrey Park

Address: Boott Mills South, Foot of John Street, Lowell, MA 01852

If the project will require a permit, list type of permit, agency and date or proposed date of application:

See Attachment 1 for a list of permits and approvals that will be required for the construction and operation of the Project.

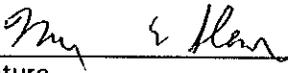
*(See reverse side - you must sign the certification on the reverse side of this form)*

The Connecticut Natural Diversity Data Base (CT NDDB) information will be used for:

- permit application  
 environmental assessment (give reasons for assessment):

- other (specify):  
Connecticut Siting Council

"I certify that the information supplied on this form is complete and accurate, and that any material supplied by the CT NDDB will not be published without prior permission."



Signature

01/09/2002

Date

I requests must include a USGS topographic map with the project boundary clearly delineated.

Return completed form to:

NATURAL DIVERSITY DATA BASE/DATA REQUEST  
ENVIRONMENTAL & GEOGRAPHIC INFORMATION CENTER  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
79 ELM STREET, STORE LEVEL  
HARTFORD, CT 06106-5127

\* You must submit a copy of this completed form with your registration or permit application.

**Attachment 1  
Kleen Energy Systems Project Permits and Approvals**

<b>General Topic</b>	<b>Required Permits</b>	<b>Review Agency</b>
Air Permits	Construct and Operate	CT DEP BAM EPA
Water Resources	Location Approval Conn. Gen. Stat § 16-50x (d)	City of Middletown Inland Wetland and Watercourse Commission
	CWA Section 401 Water Quality Certification	CT DEP
	Section 404 Review	U.S. Army Corps of Engineers
	Water Connection Permit	City of Middletown
Water Discharges	Stormwater General Permits for Construction and Industrial Activities	CT DEP
	State Permit for Wastewater Discharge to Sanitary Sewer (POTW) and / or Surface Water	CT DEP
	Sewer Connection Permit	City of Middletown
Stack Height Approval	Notice of Proposed Construction  Notice of Actual Construction	FAA
Bulk Storage	SPCC Plan	EPA
	Risk Management Plan	EPA
Noise	Siting Council Approval	CT Siting Council
Zoning	Location Approval Conn. Gen. Stat § 16-50x (d)	City of Middletown
Site Approval	Certificate of Environmental Compatibility and Public Need (for an Electrical Generating Facility) and Petition for Declaratory Ruling (for Transmission Line and Substation)	CT Siting Council

## Ecology and Wildlife Field Report

### *Background and Field Survey*

Field surveys were conducted to characterize and evaluate existing terrestrial, wetlands, and watercourse habitats on the 137 acre Project site. As is typical, emphasis was placed in delineating and characterizing potential wetland and watercourse habitats due to their regulatory importance. Overall ecological and wildlife characteristics are summarized in the following sections.

The Project site is situated along the west side of River Road in Middletown adjacent to and up-gradient of the Connecticut River. The existing topography and much of the surrounding area ranges from moderately steep (10-30% slope gradient) to steep (20-60 % slope gradient). Approximately 27% of the site (40 acres) exhibits direct disturbance resulting from over 100 years of mining operations, with portions of the landscape consisting solely of quarry spoils (primarily feldspar tailings and micaceous deposits). The undisturbed portions of the site include early-mid phase successional plant communities, including terrestrial, forest stands, old-field, quarry-bottom with saturated sediments, and intermittent and perennial watercourses. In addition to these vegetation cover types, open water habitat is present on the site in the form of rain filled quarries positioned at the central and upper portion of the site, not far from Bow Lane.

### *Existing Vegetative Communities*

In general, wildlife species respond to the presence and or transitions in vegetative communities. On the Project site it is readily apparent that vegetative communities on site have adapted to disturbance as evidenced by early to mid-successional plant communities. The plant communities observed on the site have previously been extensively altered and some remain in a disturbed condition devoid of vegetation or natural plant community structure. Two dominant terrestrial plant communities were observed and characterized on the Project parcel, including *mesic Quercus* (oak) –*Betula* (birch) forested stands, and early-phase old field. There are also two sub-dominant communities on the parcel, including *Alnus rugosa* (speckled alder) stands and a plant community (Chasmophytic) adapted to rock-face and fissure environments, such as quarry walls, characteristically found in vegetation patches. These vascular species are commonly associated with non-vascular species including lichens. Descriptions of the dominant habit types on the site are as follows.

#### *Mesic Quercus* (oak) –*Betula* (birch) Northern Hardwood Forested Stand:

This particular stand type is the dominant vegetative cover type on the site and is typically observed on northeasterly facing ridges and slopes where the slope gradient exceeds 20%. Tree species noted within this stand type include the co-dominants *Quercus rubra* (northern red oak) and *Betula lenta* (sweet birch), with scattered *Acer rubrum* (red maple), *Betula allegheniensis* (yellow birch), *Betula pendula* (European white birch), *Acer saccharum* (sugar maple), and *Tsuga canadensis* (eastern hemlock).

Within the shrub stratum, *Kalmia latifolia* (mountain laurel) is dominant with scattered occurrences of *Hamamelis virginiana* (witch hazel). The herbaceous layer is poorly developed and only includes *Aralia nudicaulus* (sarsaparilla), *Equisetum* sp. (horsetail), *Polystichum acrostichoides* (Christmas fern), and occasional patches of *Polytrichum commune* (haircap moss).

Within disturbed portions of this stand type, ruderal species tolerant of increased irradiance (light) levels and the microclimate unique to gaps (treefalls) were observed. Specifically, within the tree stratum, *Populus deltoides* (cottonwood) and *Betula populifolia* (gray birch) become more significant components. Within the shrub stratum *Rubus odoratus* (purple flowering raspberry) forms dense thickets, with occasional *Berberis thunbergii* (Japanese berberry) and *Myrica pennsylvanica* (bayberry).

#### *Early-Phase Old Field*

Small patches of early-phase old-field were observed in various portions of the site in areas cleared during the mining operation. Dominant species include the grass *Schizachyrium scoparium* (little bluestem) and other forbs including *Centaurea maculosa* (spotted knapweed), *Dauca carota* (Queen Anne's Lace), and *Saponaria officinalis* (bouncing bet). Dominant vines include *Parthenocissus quinquefolia* (Virginia creeper) and *Lonicera japonica* (Japanese honeysuckle). In addition to these species, occasional *Lonicera tatarica* (honeysuckle) and *Juniperus virginiana* (eastern red cedar) are scattered throughout this low-standing plant dominated community.

#### *Shrub Community - Speckled Alder*

A dense monotypic stand of *Alnus rugosa* (speckled alder) was observed occurring in non-hydric soils adjacent to an access road. Although typically associated with wetlands, speckled alder can form dense stands in the absence of hydric soils. This species will often do well in sandy and nutrient poor soils with little to no organic matter and achieves this by means of mycorrhizal associations. Mycorrhizae ("fungus roots") function to simply increase the absorptive surface area of the plants roots which allows the species to maximize nutrients occurring at low levels. This is a symbiotic relationship, whereby the plant obtains nutrients accumulated from the soil by the fungus, and the fungus obtains organic nutrients synthesized by the plant.

#### *Wetland and Watercourse Vegetation*

Wetland plant communities observed on the site have characteristics of one of two community types: palustrine emergent and palustrine scrub-shrub. Dominant plant species observed within palustrine emergent communities included *Phragmites australis* (giant reed), *Carex lurida* (lurid sedge), *Scirpus cyperinus* (wool grass), and *Juncus effusus* (soft rush). Dominant species observed in scrub shrub communities include *Salix bebbiana* (bebb willow), *Alnus rugosa* (speckled alder), with occasional *Cephalanthus occidentalis* (buttonbush). These species are also species adapted to disturbance, as well as saturated soil conditions.

The watercourse channel, which we characterize as having been created during mining operations to control and convey storm and base flow, traverses the middle of the site and includes the following dominant tree species: *Betula lenta* (sweet birch), *Acer rubrum* (red maple), and, *Betula populifolia* (gray birch) saplings. The dominant shrub species observed in this community is *Vaccinium corymbosum* (highbush blueberry). Within the understory, which is poorly developed, scattered patches of *Pilea pumila* (clearweed), *Polystichum acrostichoides* (Christmas fern) and *Polytrichum commune* (moss) dominate, with only rare instances of *Onoclea sensibilis* (sensitive fern), *Smilacina racemosa* (false solomons seal), *Parthenocissus quinquefolia* (Virginia creeper), and *Clethra alnifolia* (sweet pepperbush) seedlings.

### *Expected Wildlife Species*

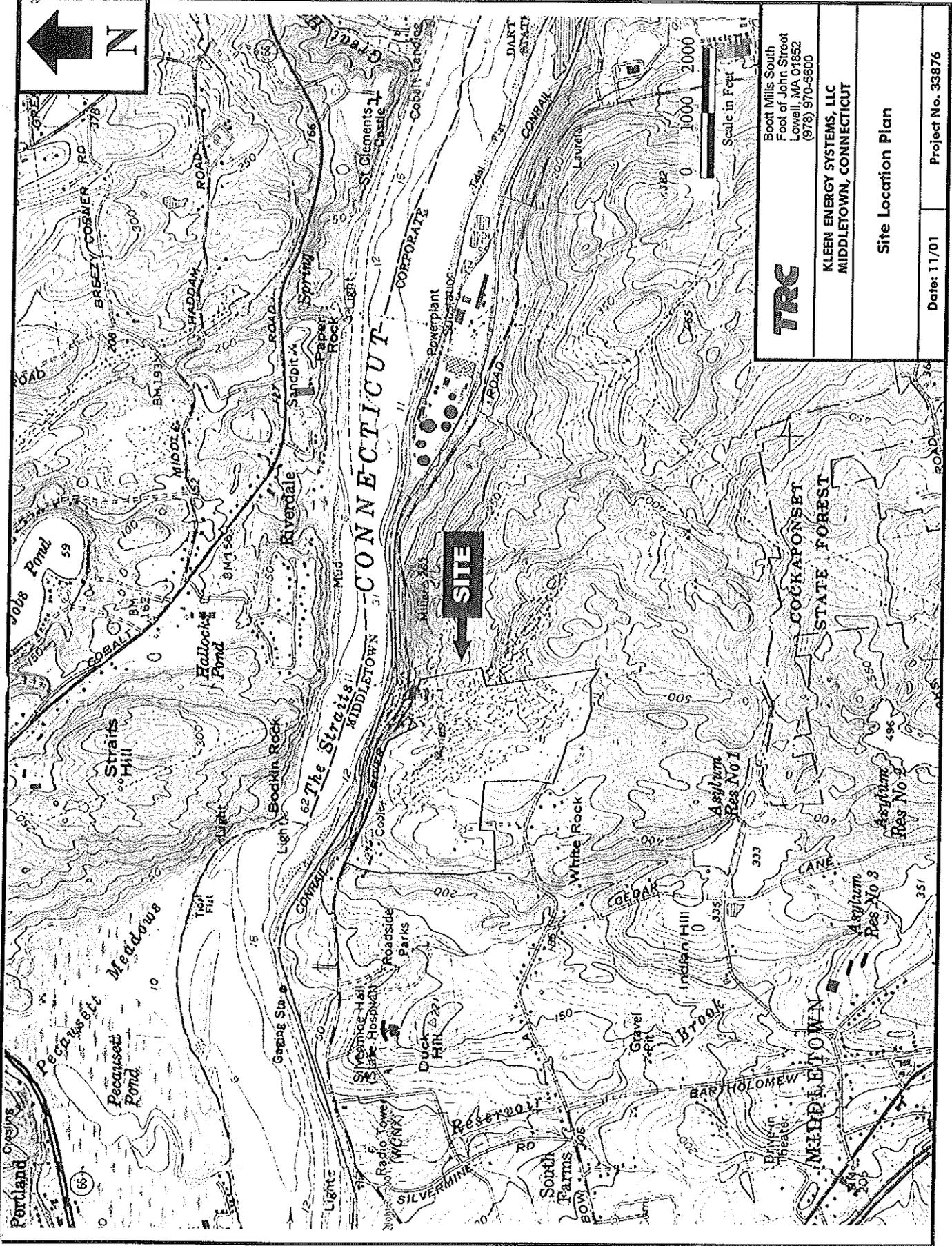
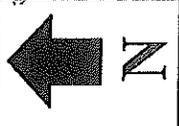
With respect to potential wildlife, most of the species that may be encountered on the site are likely habitat generalists, and as such, will utilize a broad range of available habitats and food sources, including such transition habitats as wetlands and early successional fields. Additional bird species are likely to be present during spring and fall migrations. No rare species were observed during site visits.

The proximity of the Project Site to the Connecticut River affords the possibility that the forested stands discussed above may be used by migrating songbirds (e.g., warblers), during periods of Spring and Fall migration in association with flyway corridor and riverine habitat along the River.

The field surveys revealed a total of nine resource areas ranging in size from 0.02 to 1.4 acres that have characteristics of open water habitat, vegetated wetlands, intermittent and perennial watercourses, or some combination thereof. The wetland plant communities observed on the site presumably developed after the cessation of mining activities that resulted in quarry pits, drainage channels, and depressions left during stages of mining operations. The presence of bedrock, steep side walls, groundwater, and diverted surface water has contributed to saturated soil conditions where, over time, have developed a predominance of wetland (hydrophytic) vegetation. Given the orientation of the watercourse channel, and the location of the quarry pits, the wetland complex on the site functions primarily as a means of controlling the velocity and the sediment load of water leaving the site, with little wildlife significance.

The permanent water present on the site is likely to provide limited habitat for aquatic species such as turtles and amphibian species. During the site visit, *Rana clamitans* (green frogs) were observed along the edges of the open water habitat present at the headwaters of the wetland/watercourse system and the permanent sections of the watercourse. The intermittently standing water present in some of the wetlands and the watercourse channel is anticipated to provide only limited habitat for certain herptiles. It is plausible that some ponded areas on site could function as vernal pool habitat for species such as *Rana sylvatica* (wood frog) and *Pseudacris c. crucifer* (spring peepers).

The absence of natural undisturbed soils on the site render ground-burrowing mammal species (e.g. moles, groundhogs, and shrews) that are typically associated with the surface soil horizon unlikely to persist on this site. Deer, rabbits, and field mice may roam the site since there is extensive adjacent forested land adjacent to the parcel that affords more suitable habitat for these species.



<b>TRC</b>	Booth Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600
	KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT
Site Location Plan	
Date: 11/01	Project No. 33876

**APPENDIX G**  
**CONSTRUCTION PLAN**

## **Kleen Energy Systems, LLC Construction Plan**

### **1.0 Purpose of Report**

This Construction Plan serves as a guide to facilitate the proposed new construction of the Kleen Energy Systems, LLC Combined Cycle Power Plant in Middletown, Connecticut. The plan identifies key project issues, considers mitigation measures, and will serve as an overall plan for the new construction of a 520 MW Combined Cycle Power Plant at the site of the former feldspar mine and rock quarry which was owned by Feldspar Corporation. Key elements of this plan include:

- Project Schedule
- Construction Start-Up
- Construction Management- Special Provisions
  
- Construction Safety Management Control
- Quality Assurance/Material Testing
- Public Relations

The construction planning effort for any project begins with the development of a Construction Plan. It is essential to the success of any project that the key project issues be identified and resolved in order to avoid their impacting the project at a future date. Prior to the start of construction, this report will be used for the development of a Project Quality Control Plan for the construction of the project.

## 2.0 Project Description

The major components in this combined cycle power plant are two (2) General Electric 7FA Combustion Turbine Generators. Each Combustion Turbine Generator is equipped with a heat recovery steam generator equipped with a selective catalytic reduction zone. The steam produced in the heat recovery steam generator is piped to a single steam turbine generator to increase the thermal efficiency. Heat rejection will be through a wet cell cooling tower. The proposed plant will fire natural gas as the primary fuel with #2 fuel oil as a backup fuel. A 950,000 gallon storage tank will be provided for #2 fuel oil on the site of this power plant.

The electrical output from the power plant will deliver 520 MW of new electrical generation to the grid to meet increasing regional power needs. The new equipment will be installed on a site owned by Armetta & Associates, LLC that was formerly owned by Feldspar Corporation in the Maromas section of Middletown, Connecticut.

The utilization of this abandon mine and quarry greatly reduces the impact on the environment and community due to the proximity to a nearby existing electrical transmission line and gas transmission pipeline.

The project will redevelop this environmentally damaged parcel of land resulting in a benefit to the community. Approximately 38 acres of the 137-acre site will be used for the construction of the power plant and electrical switchyard. An additional 10 acres of the site will be impacted for the creation of a construction equipment laydown area, construction offices and worker parking. A new site access road will be constructed from River Road to access the power plant, electrical switchyard, and the construction laydown areas. Of the 137-acre site, approximately 50 acres will not be impacted by the development and will remain open space.

### 3.0 Construction Start-up Issues

It is generally agreed in construction that an efficient, well organized construction plan can go a long way towards ensuring a successful project. A well-organized and prepared Construction Plan identifies key project issues and identifies an organization structure that can implement the plan in a cost effective manner with minimum impact on the environment and the local community.

#### 3.1 Organization - Program Management

Program Management is the management of an entire project that will result in the construction of the facility. Design Engineering firm, PB Power, environmental firm, TRC Environmental, architectural firm, Hibbard & Rosa Architects, and law firm, Pullman & Comley, in conjunction with Kleen Energy Systems, LLC has been selected to design and permit the project. Each of the involved parties brings experienced personnel to the project team that will be responsible for its successful completion. Each firm has extensive experience in their respective areas of expertise. Ultimately, Kleen Energy Systems, LLC will be responsible for the construction of the new project and connection into the existing power grid.

#### 3.2 Project Permitting

Prior to the start of construction the project must obtain local, state, and federal permits to construct the facility. The facility will be designed and permitted in accordance with all applicable local, state and federal regulations. The permitting process in Connecticut is governed by the requirements of the Connecticut Siting Council and the Connecticut Department of Environmental Protection. The local permitting of the project within the City of Middletown is also governed by the Siting Council regulations.

#### 3.3 Engineering and Design

Upon the successful conclusion of the permitting phase the project will move into detailed engineering and design. During the engineering and design phase, the project scope will be detailed on plans with specifications to ensure that it complies with all of the requirements of the applicable permits as well as with local and state building codes, industry codes, and good engineering practices.

#### 3.4 Equipment Procurement

Well before construction on the project site commences, the major power generation and electrical distribution equipment must be specified and procured. Many of the pieces of equipment that comprise the power plant require more than one year of lead time for engineering, fabrication, testing, and delivery. The lead time for this equipment must be factored into both the engineering and construction schedules to ensure an efficient construction process.

#### 3.5 Contractor Mobilization

The planning for mobilization will be done well before the construction phase of the project commences. Contractor mobilization consists of preplanning activities necessary to ensure the efficient prosecution of the construction tasks. Mobilization consists of developing the construction plan, construction schedule, contracting with vendors and subcontractors, hiring the workforce, developing a quality assurance plan, and staging the construction site.

It is estimated that between 50 (earliest construction phase) and 400 (peak construction phase) craft workers coming from 10 or more trades will be involved in this project with approximately 416 craft workers at the peak level of construction. The project must also plan for the delivery and storage of the equipment. Due to the large numbers of construction workers and equipment delivery, the construction plan will include site access controls to minimize the traffic impact on the community. Construction offices will be established on-site. Worker parking, equipment storage, and lay down areas will also be located on-site.

### 3.6 Temporary Construction Offices - On-Site

Limited temporary office space will be made available on-site. These offices will house the construction management/supervisory personnel that will be involved in the project. This office space will be made available through the use of temporary construction trailers. In addition to office space, construction trailers will provide space for meeting rooms, equipment storage, and sanitary facilities.

### 3.7 Construction Workers On-Site Parking

Construction worker parking will be located in a designated area(s) on the project site. The parking areas for the construction workers will be adjacent to the primary site access road. The construction parking area will have a crushed stone base.

### 3.8 Material & Equipment On-Site Storage Area

During the construction of this facility there will be a need for material & equipment storage in an area close to the actual construction site. A temporary construction laydown area located adjacent to the access road will be built with a crushed stone base. Trailers will be provided in this area for covered storage of components when required. All deliveries to the site will be via the road network using trucks.

### 3.9 Site Access

As shown on the site plan, the entrance to the site will be from River Road. This entrance will be used for construction and for the subsequent operation of the plant. There will be no secondary access to the site. There will be no means of access to the site from Bow Lane.

### 3.10 Site Security

As an operating power facility the power plant site and electrical switchyard will be completely fenced in and secured. During construction, the construction site, equipment laydown area, and construction offices will be secured by a construction fence. Site security will consist of security guards and/or O&G Industries personnel at gate locations. All gates will be monitored or locked to limit access to approved personnel and vehicles only. The construction fencing also will be maintained throughout the construction phase of the project until the permanent site fence is in place.

#### 4.0 Construction Issues

Each project has its own special conditions that need to be addressed to facilitate the safe and smooth completion of the project. This section identifies specific concerns and discusses their proposed resolution.

##### 4.1 Soil Erosion & Sediment Control

The project intends to construct portions of the sedimentation ponds, retention basins, and the proposed site drainage system early in the construction phase. These facilities will be used during the construction phase to control erosion and to remove sedimentation from storm water prior to discharge.

Design measures taken to provide effective sediment and erosion control within the areas during construction include the concept of a series of appropriately sized catch basins and rock-lined and grass-lined swales/ditches that direct stormwater runoff to the detention ponds and wet ponds; silt barriers around stockpile areas; a site roadway system that will decrease road grades and employ a series of catch basins that will discharge to appropriately engineered detention basins and secondary wet ponds.

A comprehensive storm water management plan, as approved by the City of Middletown Inland Wetlands and Watercourses Commission, will be put into place prior to the start of construction.

##### 4.2 Noise Control

The project is concerned with noise from three perspectives; worker safety, construction noise impact on community, and operational noise impact on the community.

Noise control related to worker safety on a construction site consists of monitoring noise levels to assess the need for personal hearing protective equipment (ear plugs, etc.) to be worn by the workers in the vicinity of the construction equipment. The permissible noise exposures are established by OSHA and range from 85 to 115 sound level dBA slow response depending on length of exposure and 140 dBA peak sound pressure level for an impact or impulsive noise level. The project safety plan will detail the measures to be taken to ensure worker safety during construction. When noise levels exceed 85 dBA, workers will be required to use personal hearing protection. Administrative controls will be put into place to ensure that workers are protected. Construction equipment noise levels will be controlled so as not to exceed allowable industry standards.

The project will develop a noise control program to monitor and control the construction noise impact on the surrounding community. The City of Middletown's zoning regulations restrict the noise level on a construction site. The project will comply with the standards set forth in the regulations. The project's noise control program will establish administrative and engineering controls to monitor and control the noise that will be generated by construction operations and develop special conditions that will be implemented at the start of the project and maintained throughout the construction of the project. The General Contractor will arrange for third party monitoring services to ensure the project meets the noise limits required by the federal, state, and local regulations. Regular noise monitoring will occur within the vicinity of the equipment, around the work site and along the property lines. All high noise producing work activities will be monitored at startup. Any activity causing sound levels to exceed acceptable limits will be shut down until the work can be completed within acceptable limits.

The noise levels generated from the facility during operation are modeled as part of the permitting process. Requirements for noise attenuation to meet the local, state, and federal noise regulations are factored into the design of the facility. This includes provisions for sound attenuation and configuring the site layout to minimize noise generation. The operating facility will be in compliance with Connecticut State Noise Codes, and the Middletown Noise Ordinance.

#### 4.3 Dust Control

To minimize the impact on the community and adjacent neighborhoods, the project will develop procedures for the use of calcium chloride and water for dust control. The project will establish a wheel wash station to preclude vehicles from leaving the site contaminated with excavation materials that would impact local roads. These measures will be implemented at the start of the project and be maintained throughout the construction of the project. A water truck will be stationed on the site for watering during construction activities.

Site specific issues regarding the need for daily watering of site routes to prevent dust, the use calcium chloride, and additional measures deemed necessary will be incorporated as part of the dust control program.

#### 4.4 Construction Lighting

Temporary lighting will be provided by various means to support construction. A temporary lighting plan will be developed to control the levels of light trespass from the temporary lighting consistent with the City of Middletown zoning regulations. Light trespass is not considered a major problem due to the remote location of the site.

#### 4.5 Roadway Work

Current on-site roadway access to the plant site is not sufficient to support the construction of the power plant. The construction of the site access road will be an early construction activity to allow for safe and efficient access to the site from River Road. The site access road will be constructed to the City of Middletown Public Works Department standards. The early construction of the access road will ensure that all construction worker and equipment deliveries to the site are from River Road.

#### 4.6 Equipment Delivery & Installation

The new generation equipment consists of numerous large individual pieces of equipment that will require special permitting for transportation. These deliveries will be coordinated with City Officials and Departments for transportation to the site. The status of the major equipment shipment will be closely monitored and coordinated with each supplier. Once equipment leaves the factory, it will be closely tracked to the site. The construction schedule will be planned such that when the major equipment is delivered to the site it can be lifted from its trailer and placed directly onto the equipment foundation. Smaller equipment, commodities, and consumable parts will be delivered to the equipment laydown area where they will be staged on-site until needed for assembly.

#### 4.7 Building, Architectural Work, & Enclosures

The power plant will include a Power House Building, Maintenance Building, Gas Compressor Building and numerous out buildings. The proposed new buildings will be designed to incorporate the architectural features developed by the project architect working together with Kleen Energy Systems, LLC, Government Officials and City Departments. The buildings and other plant equipment will be sited to comply with local zoning regulations and to minimize visual impact on the adjacent community. Building structures will also be used to provide noise attenuation around noisy equipment to meet the zoning requirements for noise.

#### 4.8 Site Landscaping and Development

As part of the proposed site plan, a concentrated effort will be made to improve the overall appearance of the existing abandon quarry and mine. Site development will include grading, landscaping and planting to enhance the existing environmental condition that the site is currently in and to blend the plant into the natural setting of the Maromas site. Project created wetland areas will be created in a natural setting to benefit wildlife in the area and site stabilization.

## 5.0 Project Schedule

The successful delivery of the project equipment and components will depend, to a large degree, on the quality of the construction planning provided at the beginning of the project and the diligent monitoring of the construction plan during construction.

The project will develop an overall project schedule, which is usually referred to as the Master Schedule.

The Master Schedule will be used to coordinate the numerous subcontractors, equipment procurement, design, fabrication, delivery, and startup tasks. The Master Schedule will show projected milestones and critical dates for the project and will provide the appropriate level of detail to manage the project.

### 5.1 Procurement Control

The timely procurement and delivery of the necessary equipment and materials is critical to the project schedule. It is essential to identify delivery items that have a long lead time or other critical pieces of equipment that could hold up other components in order to safeguard the desired completion date. Some long-lead items identified for this project include:

- Combustion Turbine Generator Packages
- Steam Turbine Generator Package
- Heat Recovery Steam Generator Units
- High Voltage Transformers and Switchgear
- Mechanical Draft Cooling Tower
- Transmission Line Cable

### 5.3 Working Hours

Prerequisite to the development of a resource loaded construction schedule is establishment of the project working hours. We are cognizant of the local residential neighborhood adjacent to the site and the need to protect local residents from construction activity that might disrupt them or disturb their routine.

The project may utilize a two shift operation during critical portions of the construction phase. Work hours for the first shift would be from 6:30 AM to 3:00 PM daily. When a second shift is required the work hours would be 4:00 PM to 12:30 AM. The project will make every effort to limit construction work that generates an objectionable noise level to between the hours of 8:00 AM to 6:00 PM, Monday through Saturday. The project does not anticipate working past 6:00 PM most workdays except during the final stages of installation, startup, or situations where a task has been started that must be completed.

To the maximum extent feasible, activities planned to occur after 6:00 PM will be limited to installation of electric components and wiring, instrumentation, interconnection, and other activities that are inherently quiet. In addition, no work that could disrupt the local residents will be permitted on holidays and Sundays to minimize the impact on their normal routines. Some exceptions that will require special cases would include the delivery of the large equipment and materials that may not be allowed on the roadways during the normal work hours. These activities will be coordinated with City Officials.

#### 5.4 Staffing Levels

As with any construction project, there will be mobilization, ramp up, peak, ramp down and demobilization during the construction. It is estimated that between 50 (earliest construction phase) and 400 (peak construction phase) craft workers will be on-site at any one time with a peak work force of approximately 416 craft workers on site after the delivery of the major components and their installation.

#### 5.5 Construction Equipment

This project will involve numerous construction trades and various types of construction equipment. Some of the specific pieces of equipment that will be required are:

- Backhoe
- Bar Bender
- Bulldozers
- Chain Saw
- Cherry Picker
- Compressors
- Concrete Trucks
- Cranes
- Crushers
- Excavators
- Front End Loaders
- Heavy Equipment Movers
- Paver
- Rock Drills
- Welding Machines

## 6.0 Construction Safety

Kleen Energy Systems, LLC has a strong commitment to safety and risk control programs and fully supports federal, state, and local regulations relating to job site safety. The safety of workers and the public during construction is a primary concern for everyone involved in the project. The safety program prescribes the elements relevant to controlling the loss of lives, health, equipment, and materials. A Safety and Risk Control program will be created to stimulate awareness of potential accidents and losses during construction, startup, and operation of this combined cycle power plant. The safety and risk control program will be designed to promote safety and to minimize and control the hazards and risks associated with construction.

A proactive approach to the program will ensure the active participation and cooperation of the project's managers, supervisors, and line employees to achieve the following objectives:

- Planning all work to minimize the potential for personal injury, property damage, and loss of productive time;
- Complying with federal, state and local laws, ordinances and regulations, and industry standards;
- Maintaining a system of prompt detection and correction of unsafe practices and conditions;
- Establishing and conducting educational programs to stimulate and maintain the interest and cooperation of all employees through safety meetings and safety training programs;
- Insistence on the use of personal protective equipment and mechanical guards; and
- Notifying and investigating, in a timely manner, all accidents or claims to determine the causes and taking necessary corrective actions.

### 6.1 Health & Safety Plan

A project Health & Safety Plan will be developed prior to the start of any site work. This plan will note the required OSHA regulations and other safety measures that will be followed during the construction. In addition, it will provide the details for the training that will be required for all workers involved on this project. This plan will be kept on-site at all times during construction and operation.

### 6.2 Public Safety

As part of the project's regular progress meetings, a specific review of any public safety concerns will be addressed and the construction management team will identify any future work that could have an interface with the public.

## 7.0 Quality Assurance/Materials Testing

The primary objective of the Quality Assurance Program will be to verify that materials and products incorporated into the work are manufactured, procured, installed, tested, and, modified as necessary to conform to contract documents and applicable codes, standards, procedures and processes. Inspections and testing will be conducted by a third party agency.

The project team will select a competent and experienced QA engineer to be responsible for supervising and coordinating the QA program. Sampling and testing activities will be conducted in accordance with acceptable frequencies and approved procedures. In addition, results of testing and quality assurance inspections will be interpreted and recommendations will be made regarding remedial actions required to correct unacceptable portions of the work.

## 8.0 Public Relations

Another key aspect of our approach is to be proactive in our community outreach program. Our proactive approach identifies the concerns of community groups and develops measures to mitigate or minimize their impact during construction.

We believe it makes good business sense to consider the impact of the project on the local community and taking reasonable steps to mitigate or minimize potential nuisance, noise, and irritants. Numerous meetings have been held with the City Officials and Departments and the project has received extensive community input.

Consideration for the welfare of the local community will help prevent incidents and disputes that can affect the progress of the work. Where the local community can see that their comfort, safety, and convenience are important and given due consideration, they will have a far greater comfort level with the project.

To prevent local business and community concerns arising from the project, the project team will work closely with the local business community and general public to review and keep them informed of all critical construction activities.

**APPENDIX H**  
**EMF PROJECT REPORT**

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**KLEEN ENERGY SYSTEMS, LLC  
ELECTRIC GENERATING PROJECT  
PRELIMINARY EMF ANALYSIS**

**EXECUTIVE SUMMARY:**

This report summarizes the results of a preliminary assessment of the electromagnetic field (EMF) impact on Connecticut Light & Power (CL&P) Company's transmission line 353 associated with the addition of a proposed 520MW (nominal) electric generating facility by Kleen Energy Systems, LLC in the City of Middletown, Connecticut. Lateral measurements and calculations were performed at a representative location in the area of the proposed interconnection.

Magnetic field strengths at the edge of the transmission right-of-way, as measured under existing conditions and as calculated with the future addition of the Kleen Energy Project, will be less than the strictest state standards. The maximum possible impacts of the addition are assumed to be experienced on the 345 kV line with no assumption that load would split and run north, in part or south, in part, of the interconnection. The estimated magnetic field intensity at the edge of right-of-way are projected to be less than the standards set forth by the states of Florida and New York, 150 mG and 200 mG respectively; nor do the field strengths appear to exceed the 85 mG level used as a benchmark by the state of Massachusetts.

Based upon this cursory assessment, the proposed Kleen Energy Project appears to create edge of right-of-way magnetic fields that are less than any established magnetic field standards pertaining to transmission lines.

**BACKGROUND:**

E/PRO has been engaged to assess baseline magnetic field strengths and estimate anticipated changes to magnetic field strengths resulting from the addition of the Kleen Energy Project. The proposed facility is to be located in the City of Middletown, Connecticut, south of River Road along the Connecticut River, and west of the NRG Middletown Generating Facility, formerly owned by CL&P as indicated in Appendix A.

The Kleen Energy Project will connect to CL&P's 345 kV transmission facilities existing in the adjacent transmission line corridor occupied by Line 353 which extends between CL&P's Scovill Rock and Manchester 345 kV Substations. The generator output leader is expected to run overhead from the facility, across an unoccupied area, to the transmission line corridor and will interconnect with line 353 at a point most likely between structure 12099 and tower 12100. The transmission line corridor is presently

occupied by a single 345 kV Line employing H-frame or flat construction similar to that shown in Appendix B except that the line in this particular segment is a single 2156 ACSR, not bundled, conductor. The line is situated on steeply sloping terrain that slopes downward from south to north and west to east. Clearances between the conductors and ground are greater on the east and south side of the line due to this topography. Photographs of Line 353 are provided in Appendix E.

The intensity of magnetic fields is a function of current flow, distance between conductors, phasing of adjacent lines and distance from conductors. Appendix B illustrates the typical transmission line geometry between conductors, structures and ground level. (Note: Conductor height is estimated to be 50 feet at midspan.)

**BASELINE MAGNETIC FIELD MEASUREMENTS:**

On February 27, 2002, during the 60 minute period ending 12:00 hours, magnetic field measurements were taken at the following locations with a Dexsil Fieldstar 1000 recording gaussmeter:

- Measurement A - Lateral measurement mid-span between tower 12100 & structure 12099 (west to east).
- Measurement B - Lateral measurement at structure 12099 (east to west).
- Measurement C - Lateral measurement mid-span between structure 12099 & structure 12098 (west to east).

Based upon typical CL&P 345 kV transmission lines in the area, the transmission right-of-way is presumed to be 150 feet wide with the center line of the 345 kV transmission line located 75 feet from the edge of right-of-way. The measured magnetic field intensities are illustrated on the following charts in Appendix C and ranged as follows:

	<u>Westerly edge of right-of-way</u> (mG)	<u>Peak value in right-of-way</u> (mG)	<u>Easterly side right-of-way**</u> (mG)
At the Midspan (Chart C1)	18.0	38.8	15.8 @ (73')
At the Structure (Chart C2)	26.0	46.1	13.0 @ (75')
At the Midspan (Chart C3)	21.9	56.3	21.5 @ (59')

\*\* Note: Due to physical constraints, measurements were limited to distances less than the full right-of-way. The easterly distance from the center phase of Line 353 is indicated in the parentheses.

### **BASELINE ELECTRIC FIELD MEASUREMENTS:**

Similarly, on February 27, 2002, spot Electric field measurements were conducted across the right-of-way at roughly midspan between tower 12100 and structure 12099 with an Electric Fields Measurement EFM 160-3-60, Electric Field sensor, and a Fluke voltmeter. Spot measurements found Electric Field Strengths of 1.9 to 2.1 kV per meter directly underneath the outer phase conductors, 1 kV per meter beneath the center phase conductor and 0.8 kV per meter at approximately 75 feet from the center line of the structures.

### **ELECTRIC AND MAGNETIC FIELD CALCULATIONS:**

Electric & Magnetic field calculations were developed through application of the "ENVIRO" computer program developed by the Electric Power Research Institute (EPRI). Initial calculations were bench marked against actual measurements by performing a series of calculations based upon assumed transmission line operating conditions at the time measurements were taken. These calculations are based upon a level right-of-way and do not reflect the actual topography of the right-of-way. The assumed power flow and voltage level in the line at the time of measurements is 345 MVA at 362 kV.

In examining the preliminary magnetic field impacts of the Kleen Energy Systems, Inc. Middletown Project, assumptions were made relative to line loading and operating voltage. These assumptions should be reviewed when detailed interconnection studies are completed. In the interim, it is assumed that Line 353 is impacted by the full output of the proposed power plant (520 MVA) and that no division of generator output takes place at the interconnection.

An additional calculation at 750 MVA was also conducted to gauge the impact of running the line at 1200 amperes which approximates the upper load capability of Line 353. The lateral profiles presented in Appendix D illustrate the estimated magnetic field intensity that would likely result from operation under the assumptions outlined above. Similarly, Appendix D contains a lateral profile for an Electric Field which illustrates the typical Electric Field for Line 353 operating at 362 kV.

Under these assumptions, the magnetic field intensity at the 520 MVA load level ranges from 26.3 mG at the edge of right-of-way to a maximum of 56.4 mG within the right-of-way. At midspan, the magnetic field intensity ranges from 32.2 mG at the edge of right-of-way to a maximum of 87.9 mG within the right-of-way.

The Electric Field ranges from 0.7 kV/m to 2.1 kV/m across the right-of-way with the maximum electric field strengths existing directly underneath the outer phase conductors.

### **COMPARISON TO PROMULGATED STANDARDS:**

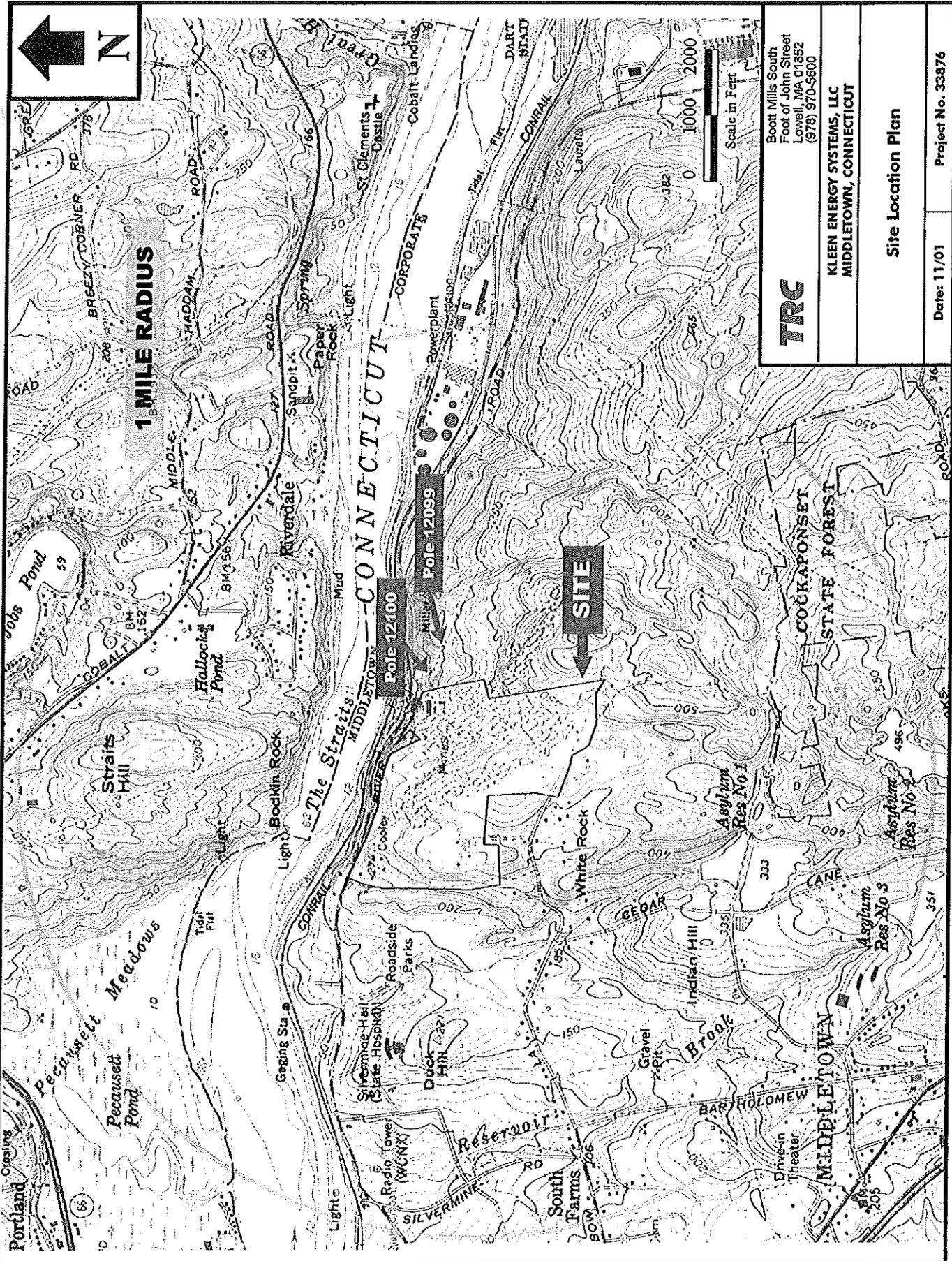
Despite the absence of any determination that health risks derive from exposures to magnetic fields, regulations have been developed by some states regarding magnetic field strengths permitted at the edge of transmission right-of-ways. For example, in the State of New York, regulations limit the design of new transmission lines to no more than 200 mG at the edge of right-of-way. Similarly, the state of Florida has a standard of 150 mG. Recent siting decisions in the state of Massachusetts have applied a benchmark level of 85 mG at the edge of right-of-way. In all cases, the magnetic field impacts resulting from the proposed Kleen Energy Project should be within these standards.

### **CONCLUSIONS:**

The principal potential sources of magnetic fields associated with the addition of the Kleen Energy Project are the generator exit lines and CL&P line 353. Based upon the preceding preliminary review, the operation of the proposed Kleen Energy Project does not appear to cause magnetic field strengths on the transmission lines to exceed generally accepted standards for edge of right-of way levels.



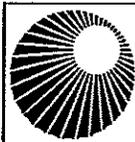
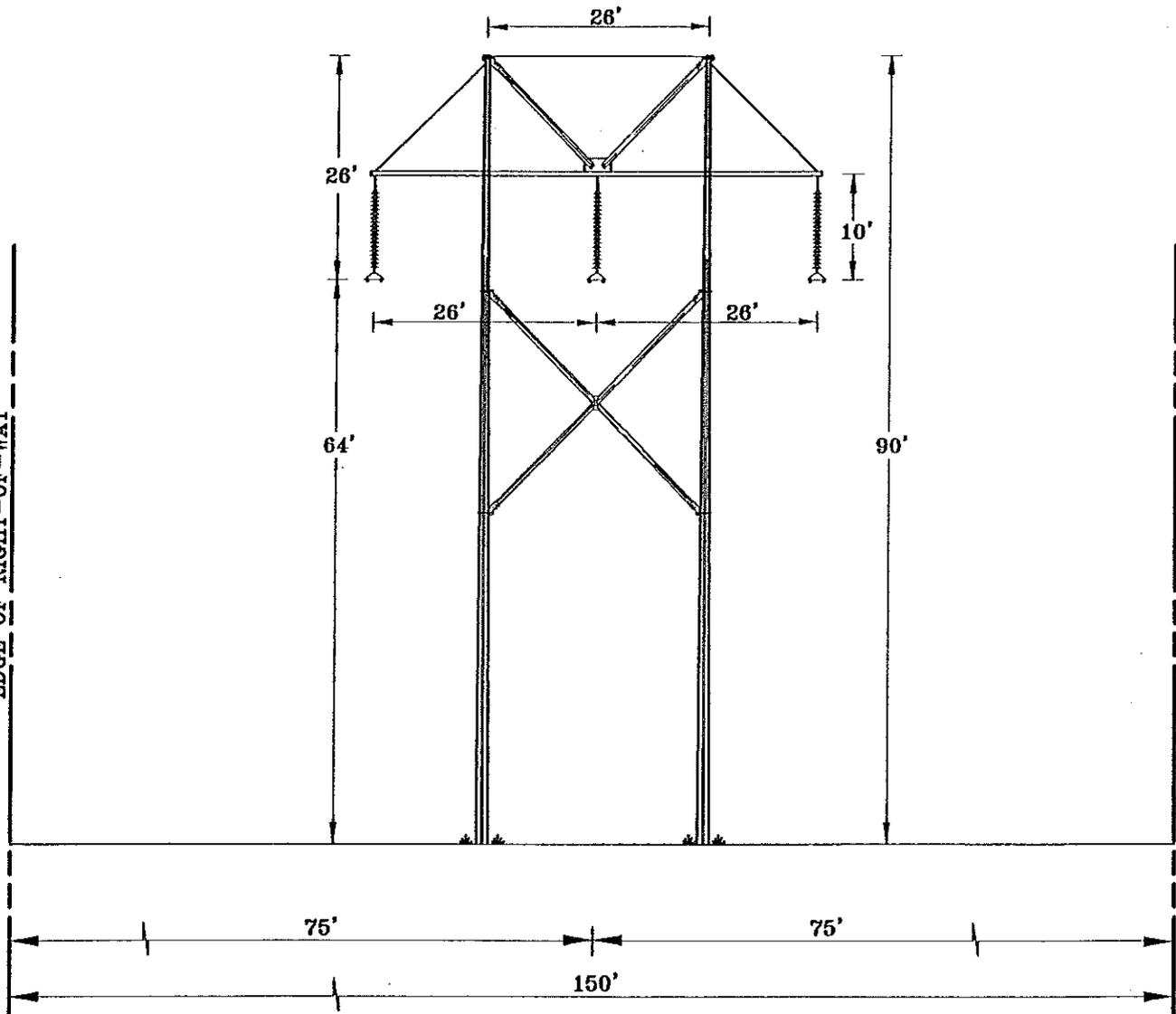
1 MILE RADIUS



<b>TRC</b>	
Boott Mills South Foot of John Street Lowell, MA 01852 (978) 970-5600	
KLEEN ENERGY SYSTEMS, LLC MIDDLETOWN, CONNECTICUT	
Site Location Plan	
Date: 11/01	Project No. 33876

EDGE OF RIGHT-OF-WAY

EDGE OF RIGHT-OF-WAY



**NORTHEAST UTILITIES SERVICE CO.**

FOR  
**THE CONNECTICUT LIGHT AND POWER CO.**

TITLE  
**MIDDLETOWN - NORWALK  
345-kV H-FRAME WOOD POLE (TYPICAL)**

BY	DAP	CHKD	APP	APP
DATE	6/01/2001	DATE	DATE	DATE
SCALE	1" = 20'	MICROFILM DATE	DWG. NO.	<b>FIGURE 21</b>
P.A. #			MISC./DETAILS/DETAILS/SECTION_21	

**PRELIMINARY**

Chart C1 - Measurement A Kleen Energy Systems

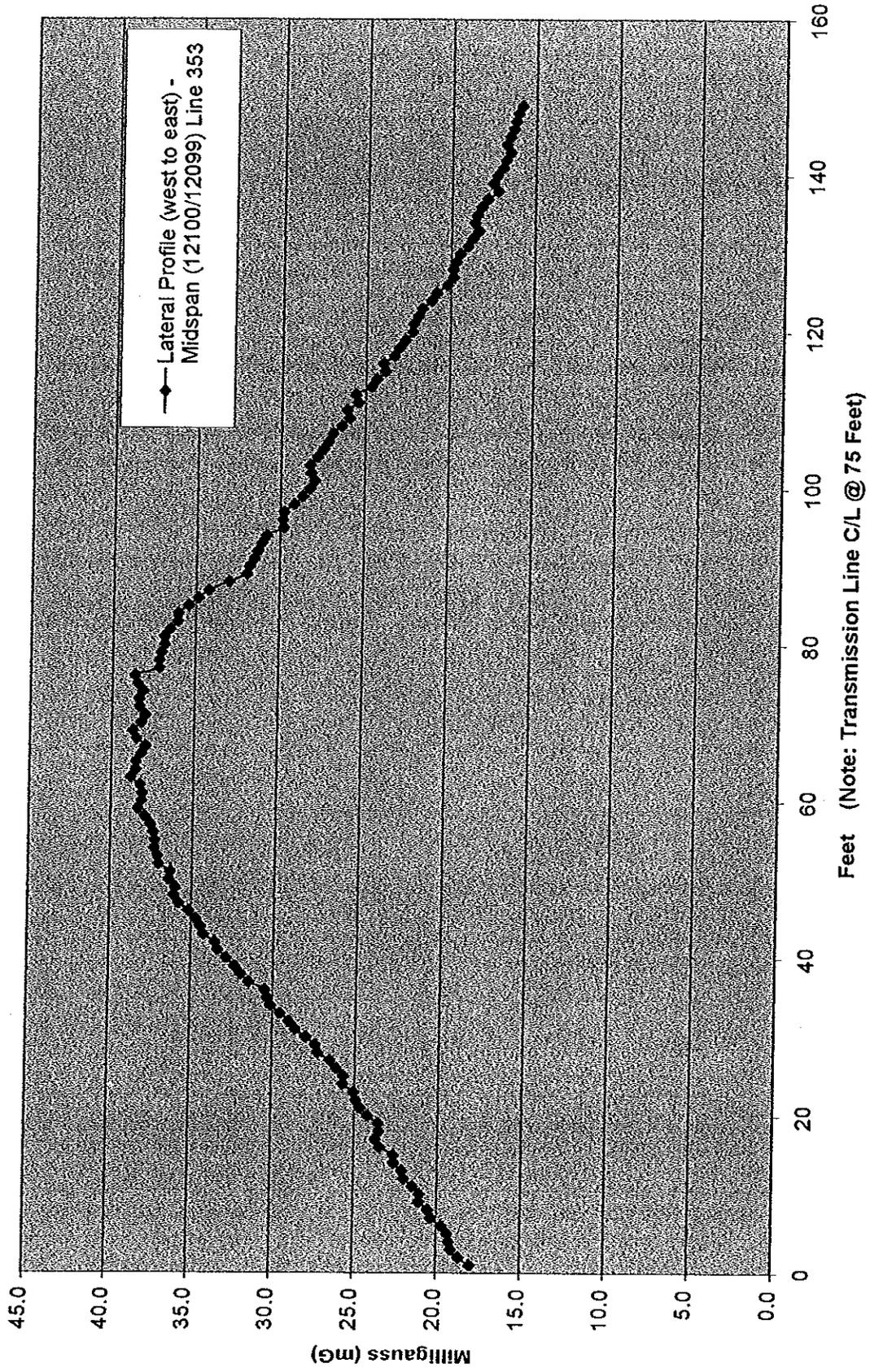


Chart C2 - Measurement B Kleen Energy Systems, LLC

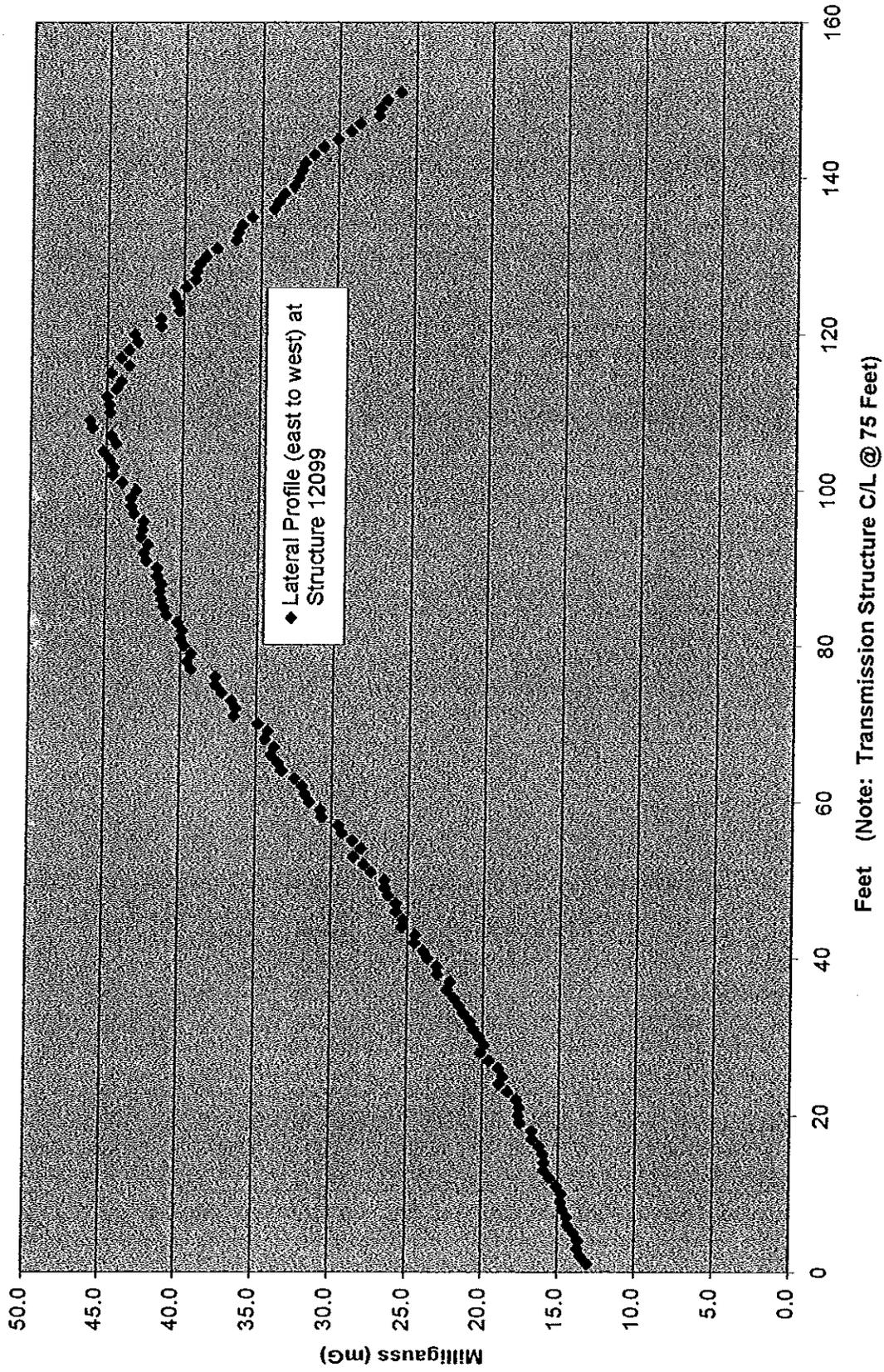


Chart C3 - Measurement C - Kleen Energy Systems, LLC

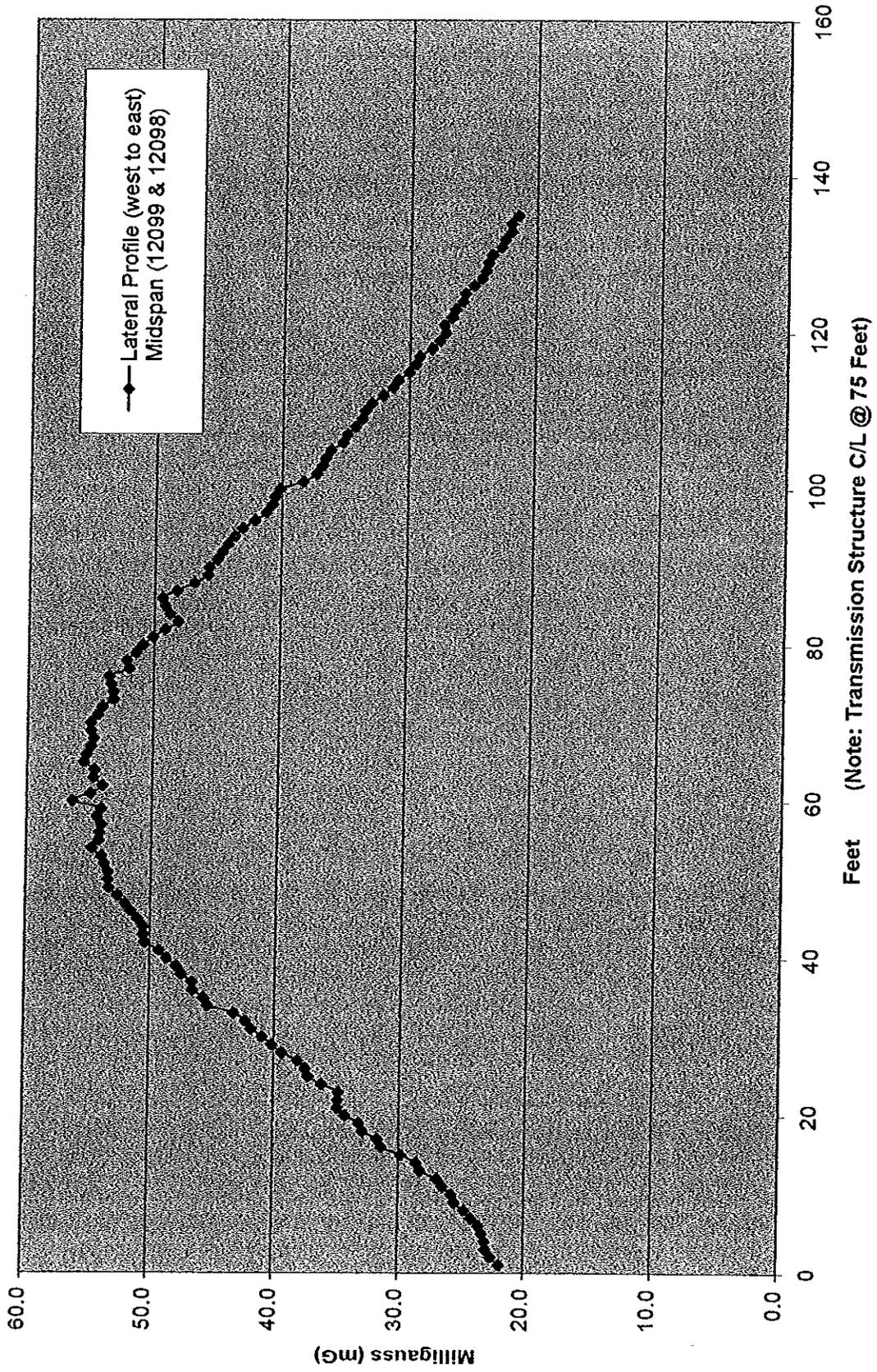


Chart D1  
Kleen Energy Systems - Calculated Magnetic Fields at Structure 12099 - Line 353

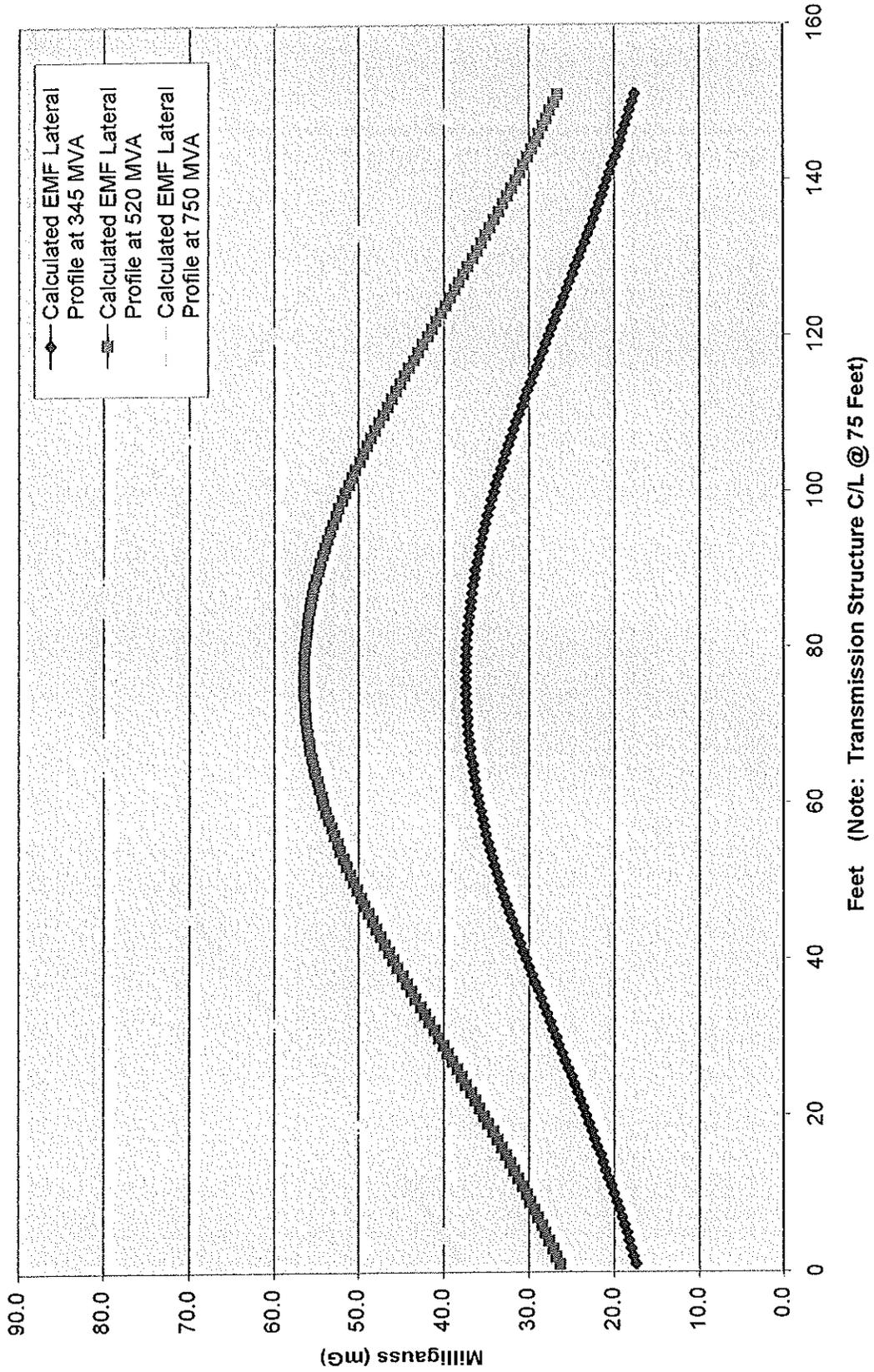


Chart D2  
Kleen Energy Systems - Calculated Magnetic Fields at Midspan (Tower 12100 & Structure  
12099) Line 353

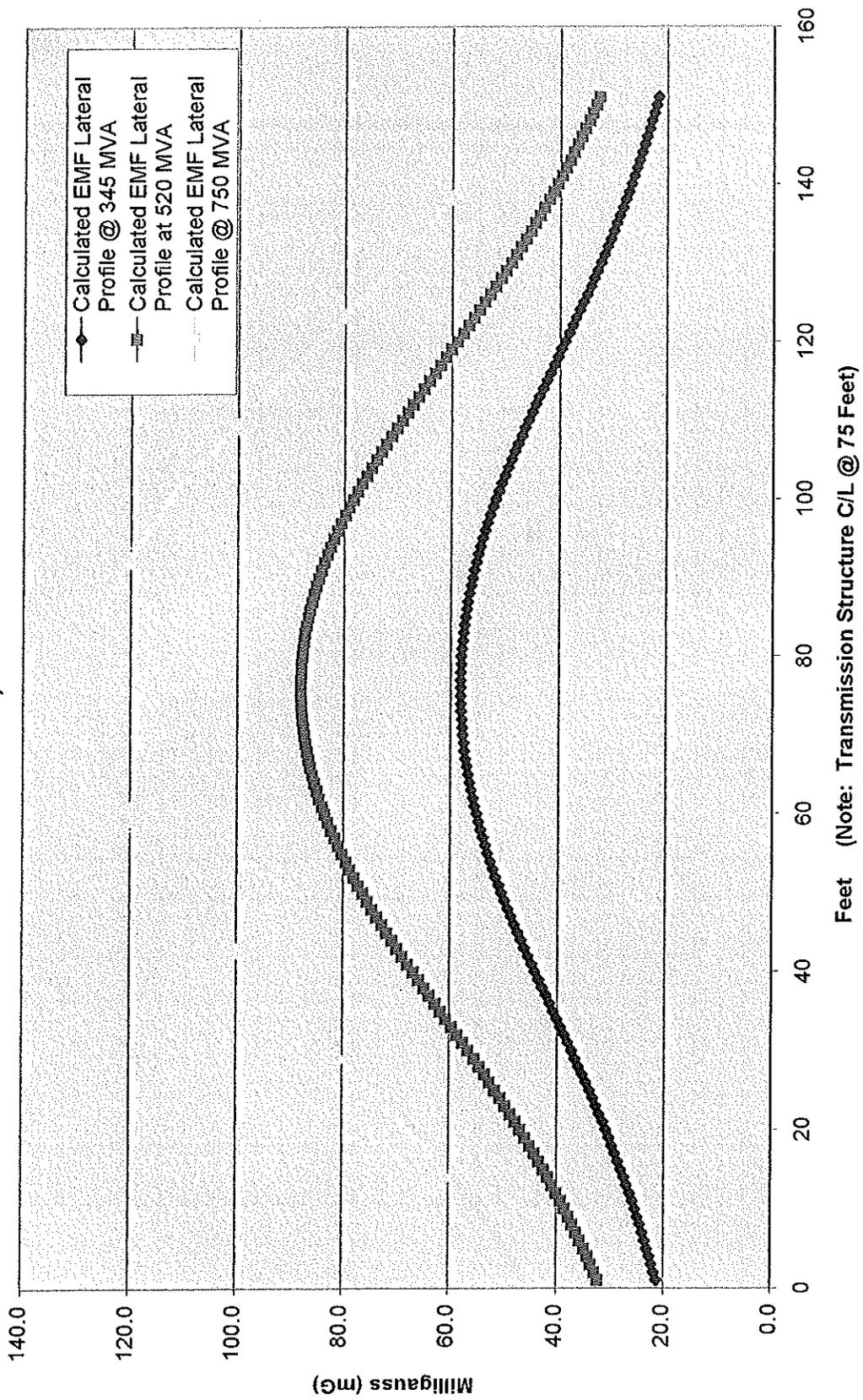
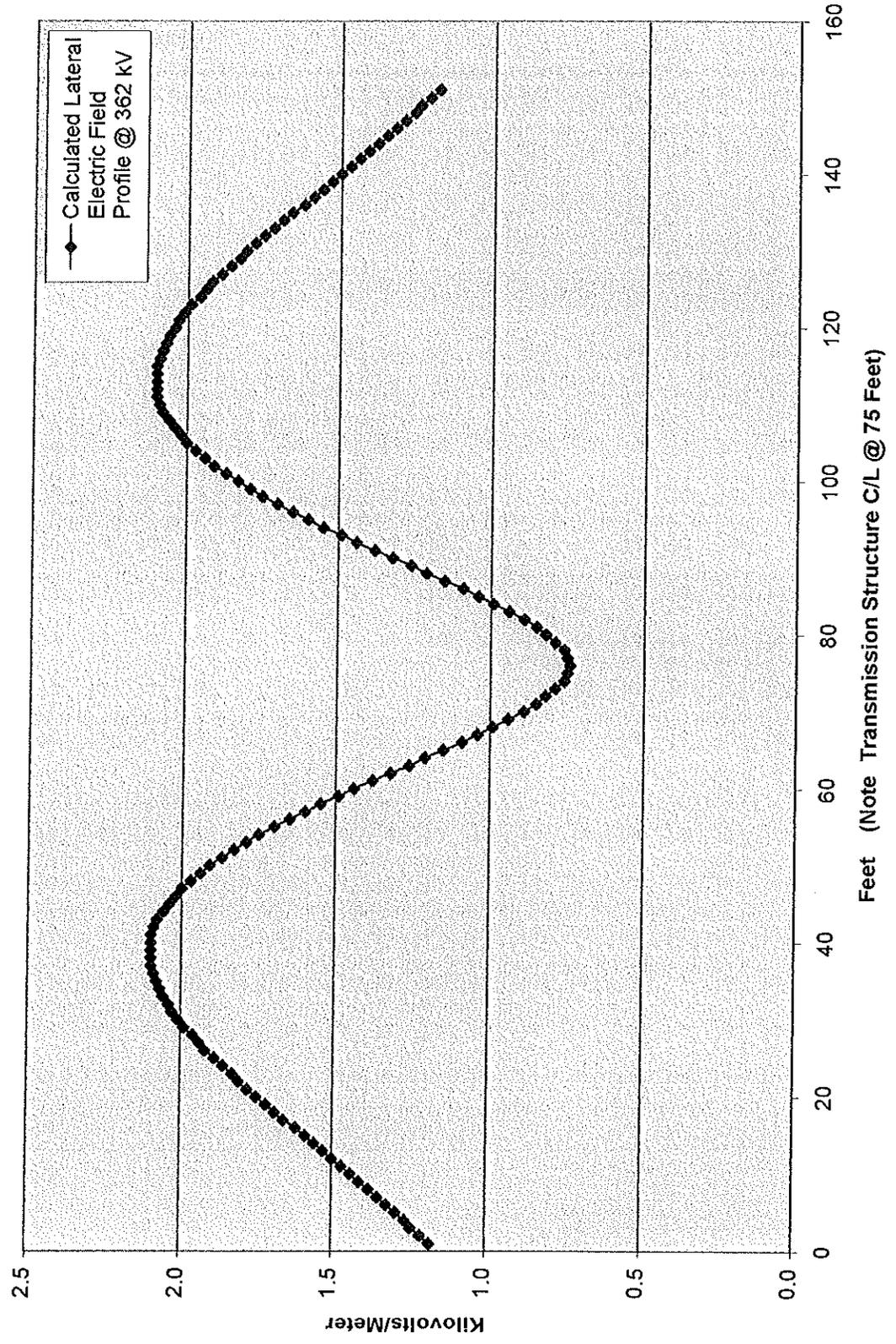
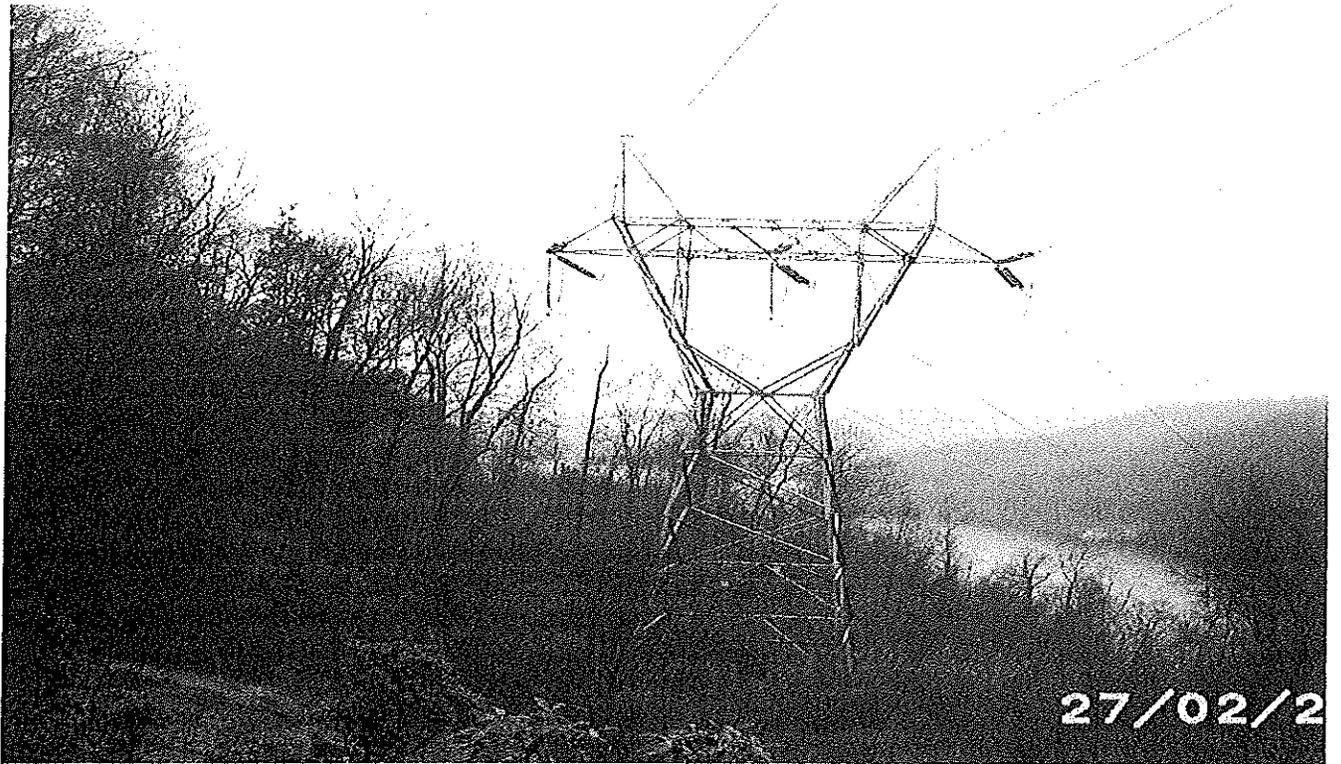


Chart D3  
Kleen Energy Systems - Calculated Electric Fields at Midspan - Line 353





Tower 12100 – Line 353 Looking Southeast from River Road



Tower 12100 – Line 353 Looking Northwest across the Connecticut River



Tower 12100 – Line 353 Looking Northwest towards tower



Structure 12099 – Line 353 Looking southeast from tower 12100



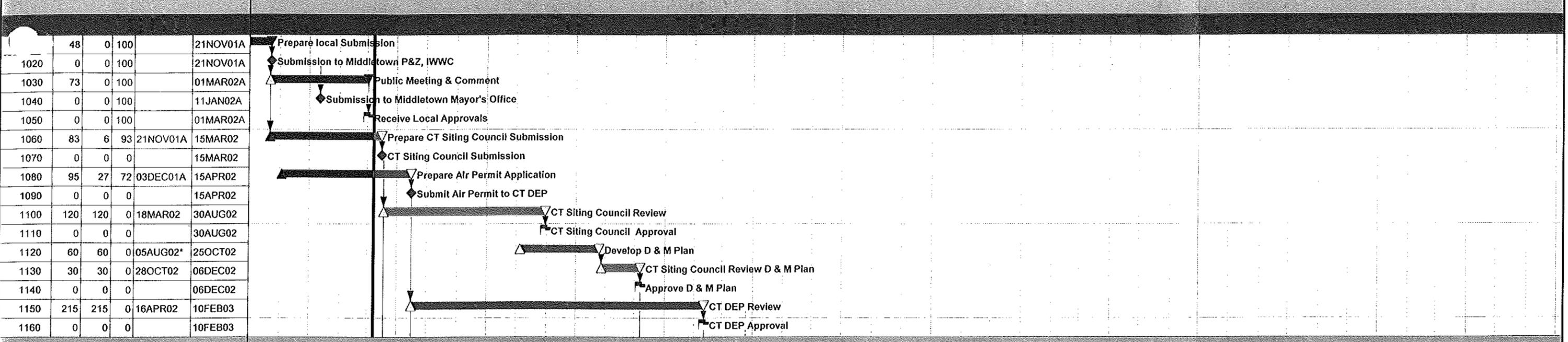
Structure 12099 – Line 353 Looking East at Structure 12099



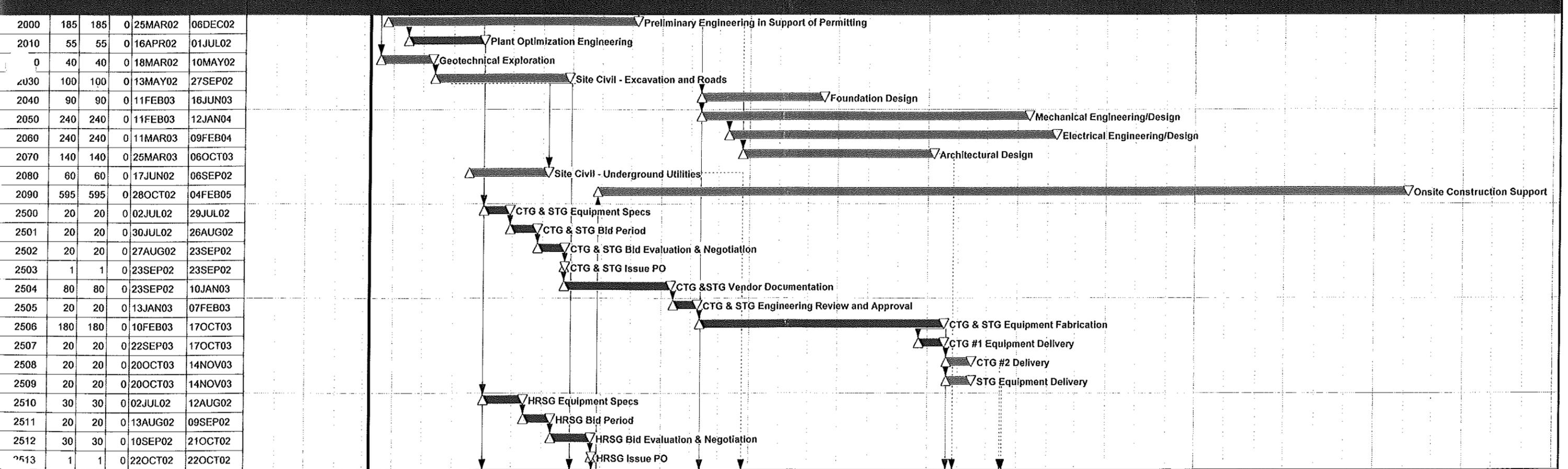
Structures 12099 & 12098 – Line 353 Looking South East from east side of  
Right-of-way

**APPENDIX I**  
**PROJECT SCHEDULE**

**PERMITTING**



**ENGINEERING & PROCUREMENT**



17SEP01 Early Bar  
 08FEB05 Progress Bar  
 08MAR02 Critical Activity  
 12MAR02 15:29

MODT  
 Kleen Energy Systems  
 Kleen Energy Systems Project  
 Classic Schedule Layout

Sheet 1 of 3

Date	Revision	Checked	Approved
12MAR02	Siting Council Submission	CLM	RJL





**APPENDIX J**

**STORM WATER REPORT**

KLEEN ENERGY SYSTEMS PROJECT  
MIDDLETOWN, CONNECTICUT  
PRELIMINARY STORM  
WATER ANALYSIS  
TECHNICAL REPORT NO. 7

Submitted to:

Armetta and Associates, LLC  
90 Industrial Park Road  
Middletown, CT 06457

December 4, 2001

Submitted by:

PB Power, Inc.  
A Parsons Brinckerhoff Company



**Kleen Energy Systems Project  
Middletown, CT  
Preliminary Storm Water Report  
Technical Report No. 7**

PB has developed a preliminary design of the storm water facilities for the proposed Kleen Energy Project. The design is based on the City of Middletown Inland Wetlands and Watercourses Regulations, the City of Middletown Public Works Department Standards, Connecticut DEP, USEPA, Federal Highway Administration, and Connecticut DOT standards. The intent of this preliminary analysis is to confirm the viability of the concept design and to provide information to the Middletown Inland Wetlands and Watercourses and Planning and Zoning Commissions.

**INTRODUCTION**

Storm water will be managed in such a way as to minimize erosion of planted areas and capture petroleum products from paved surfaces prior to discharge to Sedimentation Areas. The purpose of the storm water design for this project is to minimize erosion and to provide an adequate level of water quality treatment for runoff during the operational phase. Modifications to the storm water analysis may be required to accommodate the construction effort.

**METHODOLOGY**

The methodology utilized to analyze the storm water at the site is described below. This method is typically used to characterize storm water runoff for sizing ponds and associated structures.

Drainage Areas were delineated based on the Site's topographic Features (Refer to Appendix C: Drainage Area Map). The Drainage Area Map provides the basis for the analysis of runoff characteristics. Runoff rates from the drainage areas contributing flow to the Wet Ponds/Sedimentation Areas were computed using the TR-55 program (Refer to Appendix A: Comprehensive Summary of TR-55 Tabular Hydrograph Method). The 50-year 24-hour storm event was used to determine the peak flow rates to each Wet Pond/Sedimentation Area.

The results of the TR-55 Program formed the basis to determine the size of each Wet Pond/Sedimentation Area and the size of the outlet structure (Appendix B: Summary of Hydraulic Structures). The Wet Ponds/Sedimentation Areas were sized based on Connecticut department of Environmental Protection (CTDEP) Standard of 134 cubic yards per acre providing flow to the pond area. The capacity of outlet structures for each Wet Pond/Sedimentation Area were sized using the contributing Total Peak Flows (Refer to Table 2 and to Appendix B).

There are two tables that summarize the site's existing and proposed hydrology including the Wet Pond/ Sedimentation Areas. The drainage areas summarized in Table 1 are shown on Drawing C37 in Appendix C.

**Table 1**  
**Summary of Project Runoff Hydrology**

<b>Drain Area No.</b>	<b>Size of Drain Area (acres)</b>	<b>Peak Flow Rate (Based on 50 Year Storm-24 hour Frequency (cfs))</b>	<b>Drainage Area Contribution to Wet Pond/Sedimentation Area</b>
1	31.62	112.46	SA# 1
2	2.82	14.7	SA# 2
3	16.563	29.4019	Road Culvert
4	2.62	13.5979	SA# 3
5	2.52	See DA No. 6	
6	10.94	44.1430	SA # 4
7	18.46	68.1092	WP# 5
8	.502	See DA No. 12	
8A	1.682	See DA No. 12	
9	2.0	See DA No. 13	
10	.9566	See DA No. 13	
11	12.83	See DA No. 13	
12	9.61	51.3	SA# 6
13	4.96	75.5804	SA# 7
14	.56	See DA No.13	
14A	2.8	See DA No.12	
15	7.0	37.9984	WP# 8
16	10.0	2.6225	WP# 9
17	1.2	See DA No. 1	
17A	.41	See DA No. 1	
18	1.61	See DA No. 1	

Table 2 provides a summary of the volumes, areas, and peak flows into the Sedimentation Ponds and Wet Ponds. The location of the Sedimentation Ponds and Wet Ponds are shown in Figure C37 in Appendix C.

**Table 2**  
**Summary of Wet Pond/Sedimentation Hydrology**

Wet Pond (WP/SA) Sedimentation Area	Volume of Sediment Capture (ft <sup>3</sup> )	Area of WP/SA (ft <sup>2</sup> )	Peak Flow Rate (cfs)	Size of Principal Spillway
1	10000	8000	112.4565	54" Riser 36" Outlet or 4ft by 7 ft rectangular weir
2	10200	8000	14.705	18" Riser 15" Outlet
3	9000	10000	29.4019	36" Riser 24" Outlet
4	9100	10000	44.1430	36" Riser 24" Outlet
5	9100	10000	239.2095	60" Circular Culvert
6	10000	10000	51.3034	30" Riser 24" Outlet
7	10000	10000	75.6539	42" Riser 30" Outlet
8	15000	12000	277.2079	60 " Circular Culvert
9	15000	12000	279.8304	4ft by 5ft Box Culvert

The storm water design for this project identified three major areas as requiring drainage controls:

1. Plant Power Block and area roadways
2. Access Roadway
3. Steep Terrain Areas

The drawings in Appendix C of this report include the site's existing and proposed drainage systems and drainage structure details.

**Plant Power Block**

The proposed drainage system for the Plant Power Block area is made up of three components. The first component, curbing of the extension of the plant roadway will direct flows to a closed drainage system that will be equipped with hooded catch basins and sump areas. Second, oil/water separators will be installed prior to discharge to Sedimentation Areas. The last component, sedimentation Areas (SA), will be installed to capture sediment during construction as well as during the operational phase. These areas have been sized to capture the required amount of sediment and also allow for the peak flows to be conveyed downstream.

**Roadways**

The storm water system for the access roadway will consist of a closed drainage system equipped with catch basins with hoods and sump areas. Where possible, the closed drainage system will discharge onto slopes for overland flow. The roadside channels will convey and discharge storm water to Sedimentation Areas.

### **Steep Terrain**

Interceptor channels will be installed across steep slopes to minimize erosion and where possible to divert flows into Sedimentation Areas. Storm water flows will be diverted upstream of work areas to separate overland and construction runoff. Appropriate vegetation will be established on disturbed areas that are not impervious.

The storm water systems for this project were designed to maintain water quality and to minimize erosion. Pre/Post Runoff Attenuation was not considered for this project since the existing area designated for the plant footprint and associated infrastructure is considered impervious due to the presence of underlying rock.

### **DESIGN CRITERIA**

Several design methodologies were used to determine the adequate size and type of hydraulic structures. These design methodologies are:

1. **CTDEP General Permit for the Discharge of Storm Water and Dewatering Waste Waters Associated with Construction Activities, Issuance Date: OCTOBER 1997.**
  - A. The proposed Sedimentation Areas are sized to capture a minimum of 134 cubic yards of sediment laden runoff storage per acre.
  - B. The proposed Sedimentation Areas are designed to remove 80% of Total Suspended Solids from the storm water discharges associated with post development runoff from the project.
2. **Connecticut DOT Hydraulic Standards**
  - A. The proposed closed drainage system that services the access roadways will be sized to convey the 10-year storm frequency in accordance with the CTDOT 2000 Drainage Manual.
  - B. The proposed hydraulic structures associated with the sedimentation areas are sized to convey flows, safely, from the 50-year storm frequency.
3. **USEPA Standards**

The plant area will be serviced by two (2) oil-water separators that will be placed off-line from the main closed drainage system. These oil-water separators are designed to capture oil laden runoff prior to discharge to the Sedimentation Areas. These separators are designed to meet the USEPA Spill Prevention and Countermeasure Control Plan regulations.
4. **Federal Highway Administration Standards**

HEC-5, entitled "Hydraulic Design Highway Culverts", September 1985 has been utilized to design the culverts associated with the project. Softdesk version 8.0 is the software that was used to calculate the results.
5. **USDA-NRCS (Formerly Soil Conservation Service) Runoff Methodology**

Runoff characteristics were modeled using Technical Release 55 prepared by the USDA Natural Resources Conservation Service (NRCS). TR-55 is the standard used today to determine runoff characteristics. The Tabular Method of TR-55 was used to determine the peak flow rates to each Wet Pond/Sedimentation Area.

**6. Scour Protection**

Scour Protection Measures have been incorporated into the design of the project. Appropriate lining material and outlet protection have been designed in accordance with CTDOT 2000 Drainage Manual.

**7. TRC Wetlands Report, November 2001**

The TRC Wetlands Report was utilized as criteria to size and place the Sedimentation Areas. The Wet Pond/Sedimentation Areas are designed to allow for wetland vegetation to grow and to provide habitat on the fringes of the pond areas. The primary purpose of the ponds/sedimentation areas is water quality but there are opportunities to provide wetland vegetation and habitat for wildlife.

**SUMMARY**

The preliminary storm water analysis has been developed to support the permitting process with the local Middletown Inland Wetlands and Watercourses and Planning and Zoning Commissions. Subsequent to further geotechnical evaluation and finalization of the site topography, the storm water analysis will be revised to support the final design of the project. The storm water analysis may also require revisions to support storm water management during construction. This cannot be done until the construction sequencing has been established. Two separate storm water management plans will be completed for the project, a construction plan and an operation plan.

**APPENDICES**

- Appendix A: Comprehensive Summary of TR-55 Tabular Hydrograph Method
- Appendix B: Summary of Hydraulic Structures
- Appendix C: C-36 Drawing---Existing Site Drainage System  
C-37 Drawing ---Proposed Site Drainage System  
C-48 Drawing ---- Drain Details  
C-49 Drawing----- Drain Details

# APPENDIX A

## Comprehensive Summary of TR-55 Tabular Hydrograph Method

### 1. Sediment Area (SA) #1

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.0494 mi<sup>2</sup>  
 Peak Time ..... 12.2000 hrs  
 Peak Flow ..... 112.4565 cfs

#### Composite Runoff Curve Number Calculator

Description	Area (mi <sup>2</sup> )	Curve Number
gravel road	0.0025	89
gravel road	0.0079	89
woods	0.0390	70
Total Area ----->	0.0494	74 <----- Weighted CN

#### Time of Concentration Calculation

##### 1. Sheet Flow

Description ..... gravel road  
 Manning's n ..... 0.0110  
 Flow Length ..... 300.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.1000 ft/ft  
 Computed Sheet flow time .....> 0.0252 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

##### 2. Shallow Concentrated Flow

Description .....  
 Surface ..... Paved  
 Flow Length ..... 50.0000 ft  
 Watercourse Slope ..... 0.1000 ft/ft  
 Velocity ..... 6.4283 fps  
 Computed Shallow flow time .....> 0.0022 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

##### 3. Channel Flow

Description .....  
 Flow Area ..... 2.5000 ft<sup>2</sup>  
 Wetted Perimeter ..... 50.8328 in  
 Flow Length ..... 1638.0000 ft  
 Channel Slope ..... 0.1000 ft/ft  
 Manning's n ..... 0.0250  
 Hydraulic radius ..... 7.0820 in  
 Velocity ..... 13.2250 fps  
 Computed Channel flow time .....> 0.0344 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

4. Sheet Flow

-----  
 Description ..... gravel road  
 Manning's n ..... 0.0110  
 Flow Length ..... 300.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.1000 ft/ft  
 Computed Sheet flow time .....> 0.0252 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
**Total Time of Concentration .....> 0.0870 hrs**  
 \*\*\*\*\*

2. Sediment Area (SA) # 2

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.0044 mi2  
 Peak Time ..... 12.2000 hrs  
 Peak Flow ..... 14.7015 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi2)	Curve Number
----- gravel road	----- 0.0044	----- 89

Total Area -----> 0.0044      89 <----- Weighted CN

Time of Concentration Calculation

1. Shallow Concentrated Flow

-----  
 Description .....  
 Surface ..... Paved  
 Flow Length ..... 218.0000 ft  
 Watercourse Slope .....0.1000 ft/ft  
 Velocity .....2.0328 fps  
 Computed Shallow flow time .....> 0.0298 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
**Total Time of Concentration .....> 0.0298 hrs**  
 \*\*\*\*\*

3. Sediment Area (SA) # 3

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
Rainfall..... 6.3 inches  
Total Drainage Basin Area ..... 0.01432 mi2  
Peak Time ..... 12.30 hrs  
Peak Flow ..... 29.4019 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi2)	Curve Number
Parking area	0.0046	89
Woods	0.0097	70
Total Area ----->	0.01432	76 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
Description ..... Parking Area  
Manning's n ..... 0.0110  
Flow Length ..... 300.0000 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.02000 ft/ft  
Computed Sheet flow time .....> 0.0479 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Shallow Concentrated Flow

-----  
Description ..... Woods  
Surface ..... Unpaved  
Flow Length ..... 1195.3842.9259 ft  
Watercourse Slope ..... 0.2000 ft/ft  
Velocity ..... 7.2156 fps  
Computed Shallow flow time .....> 0.0460 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

3. Sheet Flow

-----  
Description ..... Steep Grass Slope  
Manning's n ..... 0.24  
Flow Length ..... 157.0294 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.5000 ft/ft  
Computed Sheet flow time .....> 0.0927 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
Total Time of Concentration .....> 0.1866 hrs

\*\*\*\*\*

4. Sediment Area (SA) # 4

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
Rainfall..... 6.3 inches  
Total Drainage Basin Area ..... 0.0210 mi2  
Peak Time ..... 12.2000 hrs  
Peak Flow ..... 44.1430 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi2)	Curve Number
Parking area	0.0039	89
Woods	0.0171	70
Total Area ----->	0.0210	74 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
Description ..... Parking Area  
Manning's n ..... 0.0110  
Flow Length ..... 280.0000 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.02000 ft/ft  
Computed Sheet flow time .....> 0.0453 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Shallow Concentrated Flow

-----  
Description ..... Woods  
Surface ..... Unpaved  
Flow Length ..... 900.0000 ft  
Watercourse Slope ..... 0.2000 ft/ft  
Velocity ..... 7.2156 fps  
Computed Shallow flow time .....> 0.0346 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

4. Sheet Flow

-----  
Description ..... Steep Grass Slope  
Manning's n ..... 0.24  
Flow Length ..... 134.1641 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.5000 ft/ft  
Computed Sheet flow time .....> 0.0818 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
Total Time of Concentration .....> 0.1617 hrs  
\*\*\*\*\*

5. Wet Pond(WP) # 5

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.0319 mi<sup>2</sup>  
 Peak Time ..... 12.2000 hrs  
 Peak Flow ..... 68.1092 cfs  
 Additional Peak Flows from SA # 4, 6, 7.....155.5896 cfs  
 Total Peak Flow to WP# 5..... 223.6988 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi <sup>2</sup> )	Curve Number
Parking Area	0.0288	89
woods	0.0288	70
Total Area	-----> 0.0319	74 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

Description ..... gravel road  
 Manning's n ..... 0.0110  
 Flow Length ..... 300.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.1000 ft/ft  
 Computed Sheet flow time .....> 0.0252 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Shallow Concentrated Flow

Description ..... Woods  
 Surface ..... Unpaved  
 Flow Length ..... 1830.0000 ft  
 Watercourse Slope ..... 0.2000 ft/ft  
 Velocity ..... 7.2156 fps  
 Computed Shallow flow time .....> 0.0704 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

3. Channel Flow

Description ..... Channel Outlet from Wet Pond  
 Flow Area ..... 1.3333 ft<sup>2</sup>  
 Wetted Perimeter ..... 37.8885 in  
 Flow Length ..... 261.0000 ft  
 Channel Slope ..... 0.1000 ft/ft  
 Manning's n ..... 0.0250  
 Hydraulic radius ..... 5.0674 in  
 Velocity ..... 10.5799 fps  
 Computed Channel flow time .....> 0.0069 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
 Total Time of Concentration .....> 0.1025 hrs  
 \*\*\*\*\*

6. Sediment Area (SA) # 6

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
Rainfall..... 6.3 inches  
Total Drainage Basin Area ..... 0.0234 mi<sup>2</sup>  
Peak Time ..... 12.3000 hrs  
Peak Flow ..... 51.3034 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi <sup>2</sup> )	Curve Number
Parking Area	0.0044	91
Grass Slope	0.0026	74
woods	0.0120	70
Roads	0.0044	91
Total Area ----->	0.0234	78 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
Description ..... Parking Area  
Manning's n ..... 0.0110  
Flow Length ..... 270.0000 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.05000 ft/ft  
Computed Sheet flow time .....> 0.0305 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Shallow Concentrated Flow

-----  
Description ..... Woods  
Surface ..... Unpaved  
Flow Length ..... 1169.7305 ft  
Watercourse Slope ..... 0.2000 ft/ft  
Velocity ..... 7.2156 fps  
Computed Shallow flow time .....> 0.0450 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

4. Sheet Flow

-----  
Description ..... Grass Slope  
Manning's n ..... 0.24  
Flow Length ..... 262.3131 ft  
Two Yr, 24 hr Rainfall ..... 3.3000 in  
Land Slope ..... 0.5000 ft/ft  
Computed Sheet flow time .....> 0.1398 hrs  
NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
Total Time of Concentration .....> 0.2153 hrs  
\*\*\*\*\*

7. Sediment Area (SA) # 7

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.0332 mi<sup>2</sup>  
 Peak Time ..... 12.3000 hrs  
 Peak Flow ..... 75.6539 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi <sup>2</sup> )	Curve Number
Slope	0.0200	74
Buildings	0.0077	91
Road	0.0031	91
Road 2	0.0009	91
Woods	0.0015	70
Total Area ----->	0.0332	80 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
 Description ..... gravel road  
 Manning's n ..... 0.0110  
 Flow Length ..... 300.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.1000 ft/ft  
 Computed Sheet flow time .....> 0.0252 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Shallow Concentrated Flow

-----  
 Description ..... Buildings  
 Surface ..... Paved  
 Flow Length ..... 444.7476 ft  
 Watercourse Slope ..... 0.02000 ft/ft  
 Velocity ..... 2.8748 fps  
 Computed Shallow flow time .....> 0.0430 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

3. Sheet Flow

-----  
 Description ..... Grass Slope  
 Manning's n ..... 0.24  
 Flow Length ..... 102.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.5000 ft/ft  
 Computed Sheet flow time .....> 0.0947 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

4. Shallow Concentrated Flow

-----  
 Description ..... Woods  
 Surface ..... Unpaved  
 Flow Length ..... 1934.0567 ft

Watercourse Slope ..... 0.02000 ft/ft  
 Velocity ..... 7.2156 fps  
 Computed Shallow flow time .....> 0.0745 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
 Total Time of Concentration .....> 0.2374 hrs  
 \*\*\*\*\*

8. Wet Pond (WP) # 8

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.01092  
 Peak Time ..... 12.2000 hrs  
 Peak Flow ..... 37.9984 cfs  
 Additional Peak Flows from the outlet Structure at WP #5.....223.6988 cfs  
 Total Peak Flows to WP # 8 Outlet Structure.....261.6972 cfs

Composite Runoff Curve Number Calculator

Description	Area (mi2)	Curve Number
Station Area	.01092	91
Total Area	-----> 0.01092	91 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
 Description ..... Station Area  
 Manning's n ..... 0.0110  
 Flow Length ..... 270.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.0100 ft/ft  
 Computed Sheet flow time .....> 0.0581 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

3. Channel Flow

-----  
 Description ..... Channel  
 Flow Area ..... 2.5000 ft2  
 Wetted Perimeter ..... 50.8328 in  
 Flow Length ..... 472.0000 ft  
 Channel Slope ..... 0.01000 ft/ft  
 Manning's n ..... 0.0250  
 Hydraulic radius ..... 7.0820 in  
 Velocity ..... 4.1821 fps  
 Computed Channel flow time .....> 0.0314 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
 Total Time of Concentration .....> 0.0895 hrs  
 \*\*\*\*\*

9. Sediment Area (SA) # 9

Rainfall Distribution ..... Type III, 50-Year, 24-Hour Storm Event  
 Rainfall..... 6.3 inches  
 Total Drainage Basin Area ..... 0.0008 mi<sup>2</sup>  
 Peak Time ..... 12.2000 hrs  
 Peak Flow ..... 2.6225 cfs  
 Additional Peak Flows from the outlet structure at WP# 8.....261.6972 cfs  
 Total Peak Flows to Outlet Structure at WP # 9.....264.3197 cfs  
 Composite Runoff Curve Number Calculator

Description	Area (mi <sup>2</sup> )	Curve Number
Station	0.0008	91

Total Area -----> 0.0008      91 <----- Weighted CN

Time of Concentration Calculation

1. Sheet Flow

-----  
 Description ..... Station  
 Manning's n ..... 0.0110  
 Flow Length ..... 272.0000 ft  
 Two Yr, 24 hr Rainfall ..... 3.3000 in  
 Land Slope ..... 0.01000 ft/ft  
 Computed Sheet flow time .....> 0.0584 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

2. Channel Flow

-----  
 Description ..... Channel  
 Flow Area ..... 3.5556 ft<sup>2</sup>  
 Wetted Perimeter ..... 59.7771 in  
 Flow Length ..... 1044.0000 ft  
 Channel Slope ..... 0.01000 ft/ft  
 Manning's n ..... 0.0250  
 Hydraulic radius ..... 8.5653 in  
 Velocity ..... 4.7474 fps  
 Computed Channel flow time .....> 0.0611 hrs  
 NOTE: Time of Concentration rounded to 0.1000 hrs.

\*\*\*\*\*  
**Total Time of Concentration .....> 0.1195 hrs**  
 \*\*\*\*\*

# APPENDIX B

## Summary of Hydraulic Structures

### I. Sedimentation Area (SA) # 1

#### Riser Pipe and Outlet

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

Q = Flow rate expressed in Cubic Feet/Second (cfs)

A = Pipe Cross Sectional Area

G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)

K<sub>e</sub> = Entrance Loss Coefficient

K<sub>b</sub> = Pipe bend Loss Coefficient

K<sub>p</sub> = Pipe Friction Coefficient

L = Pipe Length

#### Data:

Base Flow rate .....	112.4565 cfs
Riser Elevation .....	156.0000 ft
Inlet Elevation .....	146.0000 ft
Outlet Elevation .....	136.2150 ft
Water Surface Elevation .....	159.0000 ft
Spillway Elevation .....	156.0000 ft
Pipe Length .....	57.8500 ft
Manning's n .....	0.0200
Entrance Coefficient .....	0.2000

#### Computed Results:

Riser Diameter .....	54.0000 in
Pipe Diameter .....	36.0000 in
Riser Flow rate .....	132.5850 cfs
Pipe Flow rate .....	129.6753 cfs
Flow Type .....	Weir
Orifice Flow .....	132.5850 cfs
Weir Flow .....	244.6181 cfs
Riser Head .....	3.0000 ft
Pipe Head .....	19.7850 ft

#### Weir Hydraulics

Equation Used:  $Q = 2/3 C*L \text{SQRT}((2G)*(H^{1.5}))$

Where:

Q = Flow Rate expressed in Cubic Feet/Second (cfs)

C = Weir Coefficient

L = Length of Weir

G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)

H = Weir Head

#### Given Input Data:

Weir Type .....	Rectangular
Solving for .....	Flowrate
Depth of Flow .....	36.0000 in
Coefficient .....	0.6500
Height .....	48.0000 in

**Computed Results:**

Flowrate ..... 126.4357 cfs  
Full Flow ..... 194.6604 cfs  
Velocity ..... 6.0207 fps  
Width ..... 84.0000 in  
Area ..... 28.0000 ft<sup>2</sup>  
Perimeter ..... 180.0000 in  
Wet Perimeter ..... 156.0000 in  
Wet Area ..... 21.0000 ft<sup>2</sup>  
Percent Full ..... 75.0000 %

**2. Sedimentation Area (SA) # 2**

**Riser Pipe and Outlet**

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

- Q = Flow rate expressed in Cubic Feet/Second (cfs)
- A = Pipe Cross Sectional Area
- G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)
- K<sub>e</sub> = Entrance Loss Coefficient
- K<sub>b</sub> = Pipe bend Loss Coefficient
- K<sub>p</sub> = Pipe Friction Coefficient
- L = Pipe Length

**Given Input Data:**

Base Flowrate ..... 14.7015 cfs  
Riser Elevation ..... 257.0000 ft  
Inlet Elevation ..... 249.0000 ft  
Outlet Elevation ..... 244.0000 ft  
Water Surface Elevation ..... 260.0000 ft  
Spillway Elevation ..... 257.0000 ft  
Pipe Length ..... 32.0000 ft  
Manning's n ..... 0.0200  
Entrance Coefficient ..... 0.2000

**Computed Results:**

Riser Diameter ..... 18.0000 in  
Pipe Diameter ..... 14.0000 in  
Riser Flowrate ..... 14.7317 cfs  
Pipe Flowrate ..... 17.4633 cfs  
Flow Type ..... Weir  
Orifice Flow ..... 14.7317 cfs  
Weir Flow ..... 81.5394 cfs  
Riser Head ..... 3.0000 ft  
Pipe Head ..... 13.0000 ft

### 3. Sedimentation Area (SA) # 3

#### Riser Pipe and Outlet

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

Q = Flow rate expressed in Cubic Feet/Second (cfs)

A = Pipe Cross Sectional Area

G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)

K<sub>e</sub> = Entrance Loss Coefficient

K<sub>b</sub> = Pipe bend Loss Coefficient

K<sub>p</sub> = Pipe Friction Coefficient

L = Pipe Length

#### Given Input Data:

Base Flowrate ..... 29.4019 cfs  
Riser Elevation ..... 327.0000 ft  
Inlet Elevation ..... 319.0000 ft  
Outlet Elevation ..... 312.2400 ft  
Water Surface Elevation ..... 330.0000 ft  
Spillway Elevation ..... 327.0000 ft  
Pipe Length ..... 67.6000 ft  
Manning's n ..... 0.0200  
Entrance Coefficient ..... 0.2000

#### Computed Results:

Riser Diameter ..... 30.0000 in  
Pipe Diameter ..... 24.0000 in  
Riser Flowrate ..... 33.1462 cfs  
Pipe Flowrate ..... 34.7656 cfs  
Flow Type ..... Weir  
Orifice Flow ..... 33.1462 cfs  
Weir Flow ..... 122.3090 cfs  
Riser Head ..... 3.0000 ft  
Pipe Head ..... 14.7600 ft

### 4. Sedimentation Area (SA) # 4

#### Riser Pipe and Outlet

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

Q = Flow rate expressed in Cubic Feet/Second (cfs)

A = Pipe Cross Sectional Area

G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)

K<sub>e</sub> = Entrance Loss Coefficient

K<sub>b</sub> = Pipe bend Loss Coefficient

K<sub>p</sub> = Pipe Friction Coefficient

L = Pipe Length

#### Given Input Data:

Base Flowrate ..... 44.1430 cfs  
Riser Elevation ..... 327.0000 ft  
Inlet Elevation ..... 319.0000 ft  
Outlet Elevation ..... 318.0000 ft  
Water Surface Elevation ..... 330.0000 ft  
Spillway Elevation ..... 327.0000 ft

Pipe Length ..... 40.3000 ft  
Manning's n ..... 0.0200  
Entrance Coefficient ..... 0.2000

**Computed Results:**

Riser Diameter ..... 33.0000 in  
Pipe Diameter ..... 24.0000 in  
Riser Flowrate ..... 49.5148 cfs  
Pipe Flowrate ..... 48.9285 cfs  
Flow Type ..... Weir  
Orifice Flow ..... 49.5148 cfs  
Weir Flow ..... 149.4888 cfs  
Riser Head ..... 3.0000 ft  
Pipe Head ..... 9.0000 ft

**5. Wet Pond (WP) # 5 Culvert Outlet Design**

Equation used: Input and Output variables based on the Federal Highway Administration (FHWA) Hydraulic Design Series #5 Publication entitled "Hydraulic Design of Highway Culverts"

**Entered Data:**

Shape ..... Circular  
Number of Barrels ..... 1  
Solving for ..... Headwater  
Chart Number ..... 1  
Scale Number ..... 1  
Chart Description ..... CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE  
Scale Description ..... SQUARE EDGE ENTRANCE WITH HEADWALL  
Flowrate ..... 239.2095 cfs  
Manning's n ..... 0.0130  
Roadway Elevation ..... 330.0000 ft  
Inlet Elevation ..... 319.0000 ft  
Outlet Elevation ..... 318.0000 ft  
Diameter ..... 60.0000 in  
Length ..... 40.3000 ft  
Entrance Loss ..... 0.0000  
Tailwater ..... 2.4592 ft

**Computed Results:**

Headwater ..... 328.1952ft From Inlet  
Slope ..... 0.0248 ft/ft  
Velocity ..... 21.6991 fps

**Notes:**

Inlet head > Outlet head.  
Computing Inlet Control headwater.  
Solving Inlet Equation 26 of HEC-5:  
 $HW_i/D = H_c/D + K*[Q/A*D^{0.5}]^M - 0.5S^2$ :

Solving Inlet Equation 28 of HEC-5:  
 $HW_i/D = c*[Q/A*D^{0.5}]^2 + Y - 0.5S^2$

Where:

$HW_i$  = Headwater Depth above inlet control section invert, (ft)  
D = Interior height of culvert barrel, (ft)

$H_c$  = Specific head at critical depth ( $d_c + V_c^2/2 * g$ ), (ft)  
Q = Discharge, ft<sup>3</sup>/s  
A = Full cross sectional area of culvert barrel, (ft<sup>2</sup>)  
S = Culvert barrel slope ft/ft  
K, M, c, Y = Constants from Table 9 of HEC-5

Headwater: 328.1952 ft

#### 6. Sedimentation Area (SA) # 6

##### Riser Pipe and Outlet

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

Q = Flow rate expressed in Cubic Feet/Second (cfs)  
A = Pipe Cross Sectional Area  
G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)  
 $K_e$  = Entrance Loss Coefficient  
 $K_b$  = Pipe bend Loss Coefficient  
 $K_p$  = Pipe Friction Coefficient  
L = Pipe Length

##### Given Input Data:

Base Flowrate ..... 51.3034 cfs  
Riser Elevation ..... 337.0000 ft  
Inlet Elevation ..... 332.0000 ft  
Outlet Elevation ..... 324.0000 ft  
Water Surface Elevation ..... 340.0000 ft  
Spillway Elevation ..... 337.0000 ft  
Pipe Length ..... 105.1100 ft  
Manning's n ..... 0.0200  
Entrance Coefficient ..... 0.2000

##### Computed Results:

Riser Diameter ..... 36.0000 in  
Pipe Diameter ..... 30.0000 in  
Riser Flowrate ..... 58.9267cfs  
Pipe Flowrate ..... 53.4272 cfs  
Flow Type ..... Weir  
Orifice Flow ..... 58.9267 cfs  
Weir Flow ..... 163.0787 cfs  
Riser Head ..... 3.0000 ft  
Pipe Head ..... 13.0000 ft

#### 7. Sedimentation Area (SA) # 7

##### Riser Pipe and Outlet

Equation Used:  $Q = A * \text{SQRT}((2GH)/(1+K_e+K_b+K_pL))$

Where:

Q = Flow rate expressed in Cubic Feet/Second (cfs)  
A = Pipe Cross Sectional Area  
G = Acceleration Due to Gravity (32.174 ft/sec<sup>2</sup>)  
 $K_e$  = Entrance Loss Coefficient  
 $K_b$  = Pipe bend Loss Coefficient  
 $K_p$  = Pipe Friction Coefficient  
L = Pipe Length

**Given Input Data:**

Base Flowrate ..... 75.6539 cfs  
Riser Elevation ..... 323.0000 ft  
Inlet Elevation ..... 315.0000 ft  
Outlet Elevation ..... 313.0000 ft  
Water Surface Elevation ..... 326.0000 ft  
Spillway Elevation ..... 323.0000 ft  
Pipe Length ..... 31.2850 ft  
Manning's n ..... 0.0200  
Entrance Coefficient ..... 0.2000

**Computed Results:**

Riser Diameter ..... 42.0000 in  
Pipe Diameter ..... 30.0000 in  
Riser Flowrate ..... 80.2057 cfs  
Pipe Flowrate ..... 77.6648 cfs  
Flow Type ..... Weir  
Orifice Flow ..... 80.2057 cfs  
Weir Flow ..... 190.2585 cfs  
Riser Head ..... 3.0000 ft  
Pipe Head ..... 10.0000 ft

**8. Wet Pond #8 Culvert Outlet Design**

**Entered Data:**

Shape ..... Circular  
Number of Barrels ..... 1  
Solving for ..... Headwater  
Chart Number ..... 1  
Scale Number ..... 1  
Chart Description ..... CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE  
Scale Description ..... SQUARE EDGE ENTRANCE WITH HEADWALL  
Flowrate ..... 277.2079 cfs  
Manning's n ..... 0.0130  
Roadway Elevation ..... 250.0000 ft  
Inlet Elevation ..... 230.0000 ft  
Outlet Elevation ..... 220.0000 ft  
Diameter ..... 60.0000 in  
Length ..... 112.0000 ft  
Entrance Loss ..... 0.0000  
Tailwater ..... 1.2373 ft

**Computed Results:**

Headwater ..... 241.0597 ft From Inlet  
Slope ..... 0.0893 ft/ft  
Velocity ..... 36.3138 fps

**NOTES:**

Inlet head > Outlet head.

Computing Inlet Control headwater.

Solving Inlet Equation 26 of HEC-5:

$$HW_i/D = H_o/D + K*[Q/A*D^{0.5}]^M - 0.5S^2:$$

Solving Inlet Equation 28 of HEC-5:

$$HW_i/D = c*[Q/A*D^{0.5}]^2 + Y - 0.5S^2$$

Where:

$HW_i$  = Headwater Depth above inlet control section invert, (ft)  
D = Interior height of culvert barrel, (ft)  
 $H_c$  = Specific head at critical depth ( $d_c + V_c^2/2 * g$ ), (ft)  
Q = Discharge,  $ft^3/s$   
A = Full cross sectional area of culvert barrel, ( $ft^2$ )  
S = Culvert barrel slope ft/ft  
K,M,c,Y = Constants from Table 9 of HEC-5  
Headwater: 240.1968 ft

### 9. Wet Pond # 9 Culvert Outlet Design

#### Entered Data:

Shape ..... Rectangular  
Number of Barrels ..... 1  
Solving for ..... Headwater  
Chart Number ..... 1  
Scale Number ..... 1  
Chart Description ..... CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE  
Scale Description ..... SQUARE EDGE ENTRANCE WITH HEADWALL  
Flowrate ..... 279.8304 cfs  
Manning's n ..... 0.0130  
Roadway Elevation ..... 130.0000 ft  
Inlet Elevation ..... 117.0000 ft  
Outlet Elevation ..... 94.0000 ft  
Height ..... 48.0000 in  
Width ..... 60.0000 in  
Length ..... 71.0000 ft  
Entrance Loss ..... 0.0000  
Tailwater ..... 4.0000 ft

#### Computed Results:

Headwater ..... 126.8236 ft From Inlet  
Slope ..... 0.3239 ft/ft  
Velocity ..... 53.2541 fps

#### NOTES:

Inlet head > Outlet head.

Computing Inlet Control headwater.

Solving Inlet Equation 26 of HEC-5:

$$HW_i/D = H_c/D + K * [Q/A * D^{0.5}]^M - 0.5S^2;$$

Solving Inlet Equation 28 of HEC-5:

$$HW_i/D = c * [Q/A * D^{0.5}]^2 + Y - 0.5S^2$$

Where:

$HW_i$  = Headwater Depth above inlet control section invert, (ft)  
D = Interior height of culvert barrel, (ft)  
 $H_c$  = Specific head at critical depth ( $d_c + V_c^2/2 * g$ ), (ft)  
Q = Discharge,  $ft^3/s$   
A = Full cross sectional area of culvert barrel, ( $ft^2$ )  
S = Culvert barrel slope ft/ft  
K,M,c,Y = Constants from Table 9 of HEC-5  
Headwater: 126.8236 ft

River Road/Entrance to Main Kleen Power Project Access Road Culvert Design

Entered Data:

Shape ..... Circular  
Number of Barrels ..... 1  
Solving for ..... Headwater  
Chart Number ..... 1  
Scale Number ..... 1  
Chart Description ..... CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE  
Scale Description ..... SQUARE EDGE ENTRANCE WITH HEADWALL  
Flowrate ..... 112.4565 cfs  
Manning's n ..... 0.0130  
Roadway Elevation ..... 110.0000 ft  
Inlet Elevation ..... 103.0000 ft  
Outlet Elevation ..... 98.6000 ft  
Diameter ..... 60.0000 in  
Length ..... 44.0000 ft  
Entrance Loss ..... 0.0000  
Tailwater ..... 2.0000 ft

Computed Results:

Headwater ..... 107.3699 ft From Inlet  
Slope ..... 0.1000 ft/ft  
Velocity ..... 29.3766 fps

NOTES:

Inlet head > Outlet head.

Computing Inlet Control headwater.

Solving Inlet Equation 26 of HEC-5:

$$HW_i/D = H_c/D + K*[Q/A*D^{0.5}]^M - 0.5S^2$$

Solving Inlet Equation 28 of HEC-5:

$$HW_i/D = c*[Q/A*D^{0.5}]^2 + Y - 0.5S^2$$

Where:

$HW_i$  = Headwater Depth above inlet control section invert, (ft)

D = Interior height of culvert barrel, (ft)

$H_c$  = Specific head at critical depth ( $d_c + V_c^2/2g$ ), (ft)

Q = Discharge, ft<sup>3</sup>/s

A = Full cross sectional area of culvert barrel, (ft<sup>2</sup>)

S = Culvert barrel slope ft/ft

K, M, c, Y = Constants from Table 9 of HEC-5

Headwater: 107.3699 ft

Access Road Culvert Design at Station 14+000

Entered Data:

Shape ..... Circular  
Number of Barrels ..... 1  
Solving for ..... Headwater  
Chart Number ..... 1  
Scale Number ..... 1  
Chart Description ..... CONCRETE PIPE CULVERT; NO BEVELED RING ENTRANCE  
Scale Description ..... SQUARE EDGE ENTRANCE WITH HEADWALL  
Flowrate ..... 54.0 cfs

Manning's n ..... 0.0130  
Roadway Elevation ..... 265.0000 ft  
Inlet Elevation ..... 245.0000 ft  
Outlet Elevation ..... 240.000 ft  
Diameter ..... 30.0000 in  
Length ..... 80.8031.0000 ft  
Entrance Loss ..... 0.0000  
Tailwater ..... 2.50000 ft

**Computed Results:**

Headwater ..... 251.4141 ft From Inlet  
Slope ..... 0.0619 ft/ft  
Velocity ..... 21.0942 fps

**NOTES:**

Inlet head > Outlet head.

Computing Inlet Control headwater.

Solving Inlet Equation 26 of HEC-5:

$$HW_i/D = H_c/D + K*[Q/A*D^{0.5}]^M - 0.5S^2$$

Solving Inlet Equation 28 of HEC-5:

$$HW_i/D = c*[Q/A*D^{0.5}]^2 + Y - 0.5S^2$$

Where:

$HW_i$  = Headwater Depth above inlet control section invert, (ft)

D = Interior height of culvert barrel, (ft)

$H_c$  = Specific head at critical depth ( $d_c + V_c^2/2*g$ ), (ft)

Q = Discharge, ft<sup>3</sup>/s

A = Full cross sectional area of culvert barrel, (ft<sup>2</sup>)

S = Culvert barrel slope ft/ft

K, M, c, Y = Constants from Table 9 of HEC-5

Headwater: 107.3699 ft

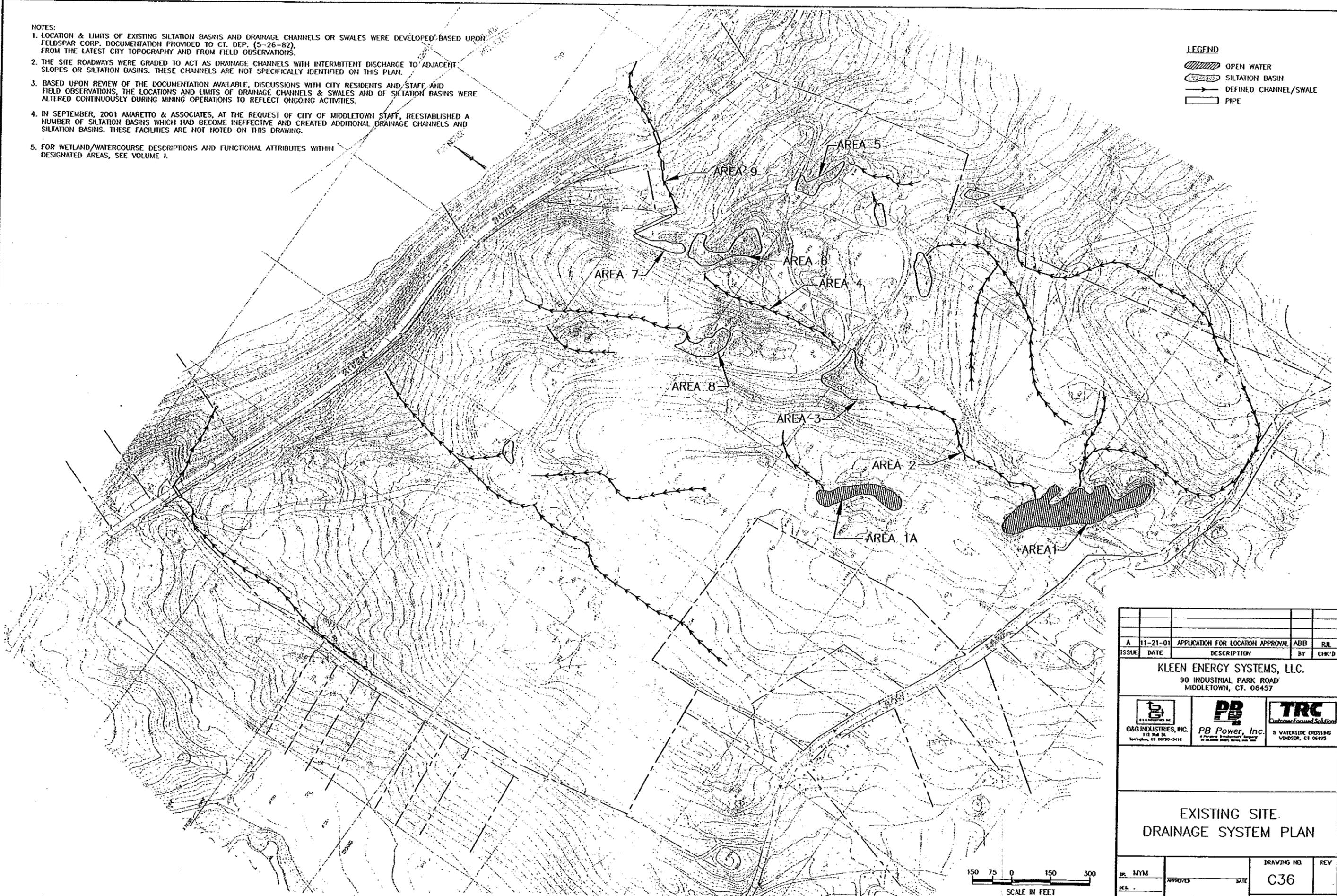
## APPENDIX C

NOTES:

1. LOCATION & LIMITS OF EXISTING SILTATION BASINS AND DRAINAGE CHANNELS OR SWALES WERE DEVELOPED BASED UPON FELDSPAR CORP. DOCUMENTATION PROVIDED TO CT. DEP. (5-26-82), FROM THE LATEST CITY TOPOGRAPHY AND FROM FIELD OBSERVATIONS.
2. THE SITE ROADWAYS WERE GRADED TO ACT AS DRAINAGE CHANNELS WITH INTERMITTENT DISCHARGE TO ADJACENT SLOPES OR SILTATION BASINS. THESE CHANNELS ARE NOT SPECIFICALLY IDENTIFIED ON THIS PLAN.
3. BASED UPON REVIEW OF THE DOCUMENTATION AVAILABLE, DISCUSSIONS WITH CITY RESIDENTS AND STAFF AND FIELD OBSERVATIONS, THE LOCATIONS AND LIMITS OF DRAINAGE CHANNELS & SWALES AND OF SILTATION BASINS WERE ALTERED CONTINUOUSLY DURING MINING OPERATIONS TO REFLECT ONGOING ACTIVITIES.
4. IN SEPTEMBER, 2001 AMARETTO & ASSOCIATES, AT THE REQUEST OF CITY OF MIDDLETOWN STAFF, REESTABLISHED A NUMBER OF SILTATION BASINS WHICH HAD BECOME INEFFECTIVE AND CREATED ADDITIONAL DRAINAGE CHANNELS AND SILTATION BASINS. THESE FACILITIES ARE NOT NOTED ON THIS DRAWING.
5. FOR WETLAND/WATERCOURSE DESCRIPTIONS AND FUNCTIONAL ATTRIBUTES WITHIN DESIGNATED AREAS, SEE VOLUME I.

**LEGEND**

-  OPEN WATER
-  SILTATION BASIN
-  DEFINED CHANNEL/SWALE
-  PIPE

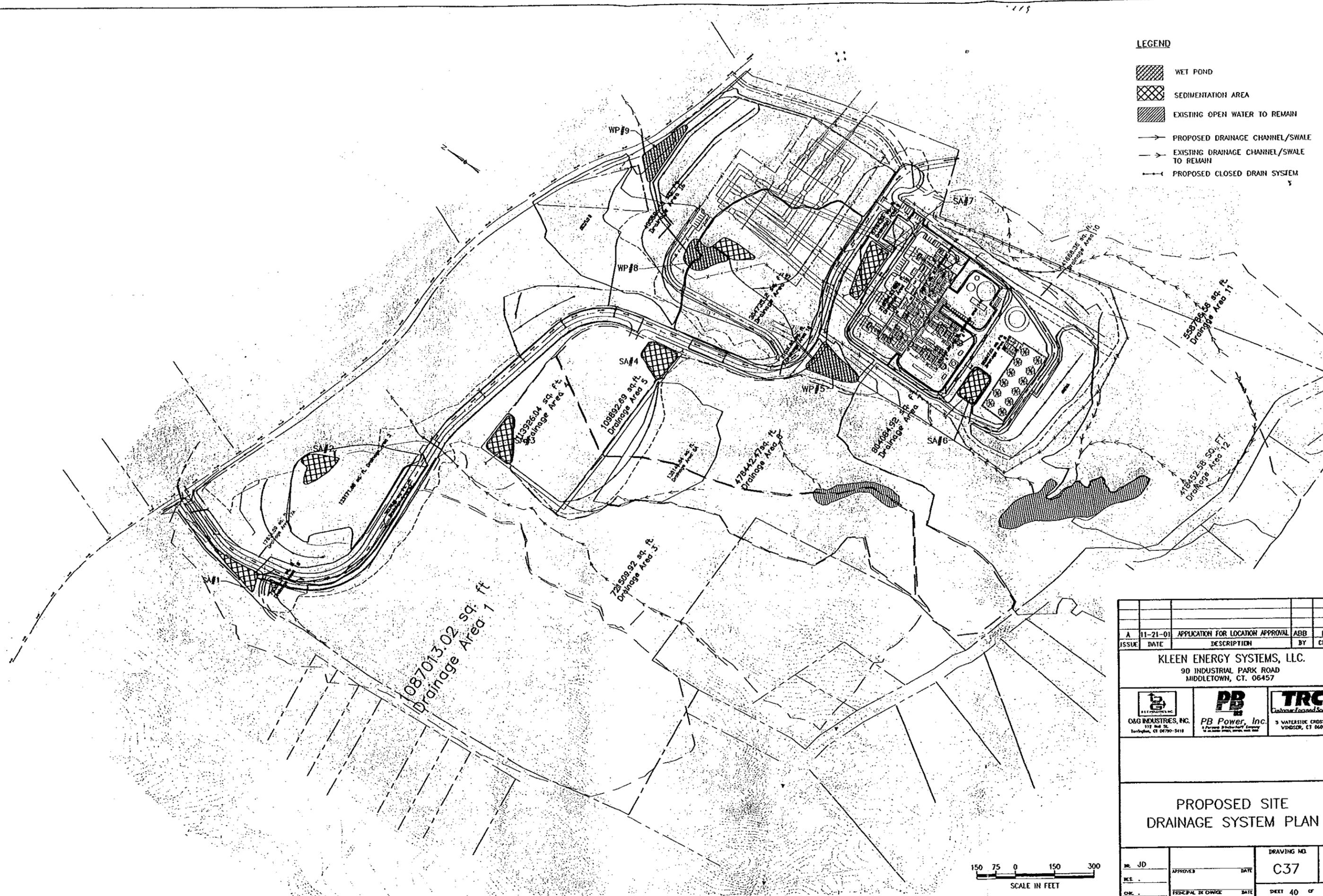


M:\26018A-MIDDLETOWN PROJECT\1 SITE PLAN FILING\C36.DWG 11/26/01 13:29

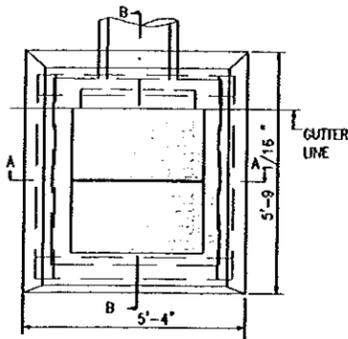
A	11-21-01	APPLICATION FOR LOCATION APPROVAL	ABB	R/L
ISSUE	DATE	DESCRIPTION	BY	CHK'D
<b>KLEEN ENERGY SYSTEMS, LLC.</b> 90 INDUSTRIAL PARK ROAD MIDDLETOWN, CT. 06457				
				
O&G INDUSTRIES, INC. 112 Rte 34 Torrington, CT 06790-5416	PB Power, Inc. A Professional Engineering Company 100 Main Street, Torrington, CT 06790	TRC Custom Formed Solutions 5 WATERSIDE CROSSING WINDSOR, CT 06455		
<b>EXISTING SITE DRAINAGE SYSTEM PLAN</b>				
DR. MYM	APPROVED	DATE	DRAWING NO.	REV
			C36	
CHK. . . . .	PRINCIPAL IN CHARGE	DATE	SHEET 39	OF 58

\\BOSC\CADD\26018A-MIDDLETOWN PROD\CIVIL\SITE PLAN FILING\C37A-DRAINAREAS.DWG 12/04/01 14:46

- LEGEND**
-  WET POND
  -  SEDIMENTATION AREA
  -  EXISTING OPEN WATER TO REMAIN
  -  PROPOSED DRAINAGE CHANNEL/SWALE
  -  EXISTING DRAINAGE CHANNEL/SWALE TO REMAIN
  -  PROPOSED CLOSED DRAIN SYSTEM

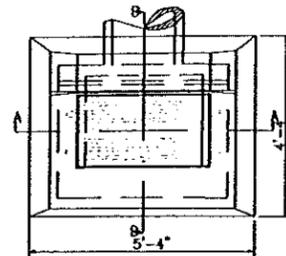


A	11-21-01	APPLICATION FOR LOCATION APPROVAL	ABB	R.L	
ISSUE	DATE	DESCRIPTION	BY	CHK'D	
<b>KLEEN ENERGY SYSTEMS, LLC.</b> 90 INDUSTRIAL PARK ROAD MIDDLETOWN, CT. 06457					
					
O&G INDUSTRIES, INC. 117 Main St. Middletown, CT 06457-3418	PB Power, Inc. 4 Farmington Street Farmington, CT 06030	TRC Customer Focused Solutions 3 WATERLICK CROSSING VANDERBILT, CT 06457			
<b>PROPOSED SITE DRAINAGE SYSTEM PLAN</b>					
DR. JD	APPROVED	DATE	DRAWING NO.	REV	
M.S.			C37		
CHK.	PREPARED BY	DATE	SHEET 40	OF 58	



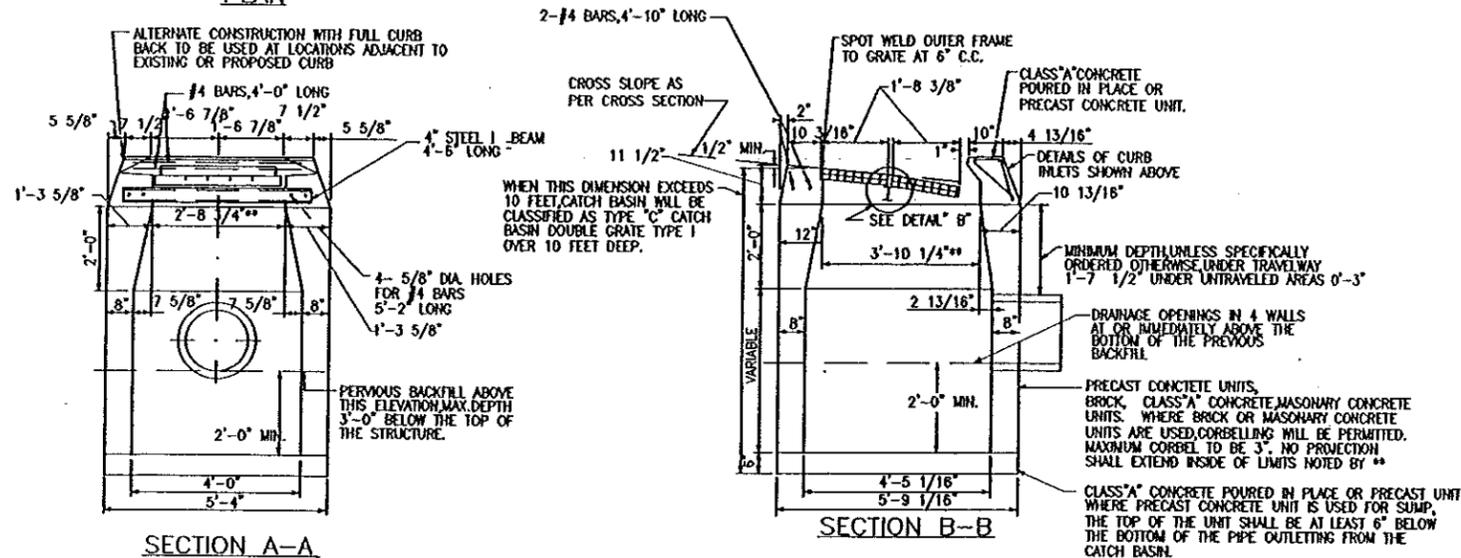
NOTE: WHEN CATCH BASIN IS SET IN CONCRETE PAVEMENT THE 1/2" SLOPE ON THE TOP SURFACE SHALL BE CHANGED TO MATCH ADJOINING PAVEMENT.

PLAN



NOTE: WHEN CATCH BASIN IS SET IN CONCRETE PAVEMENT THE 1/2" SLOPE ON THE TOP SURFACE SHALL BE CHANGED TO MATCH ADJOINING PAVEMENT.

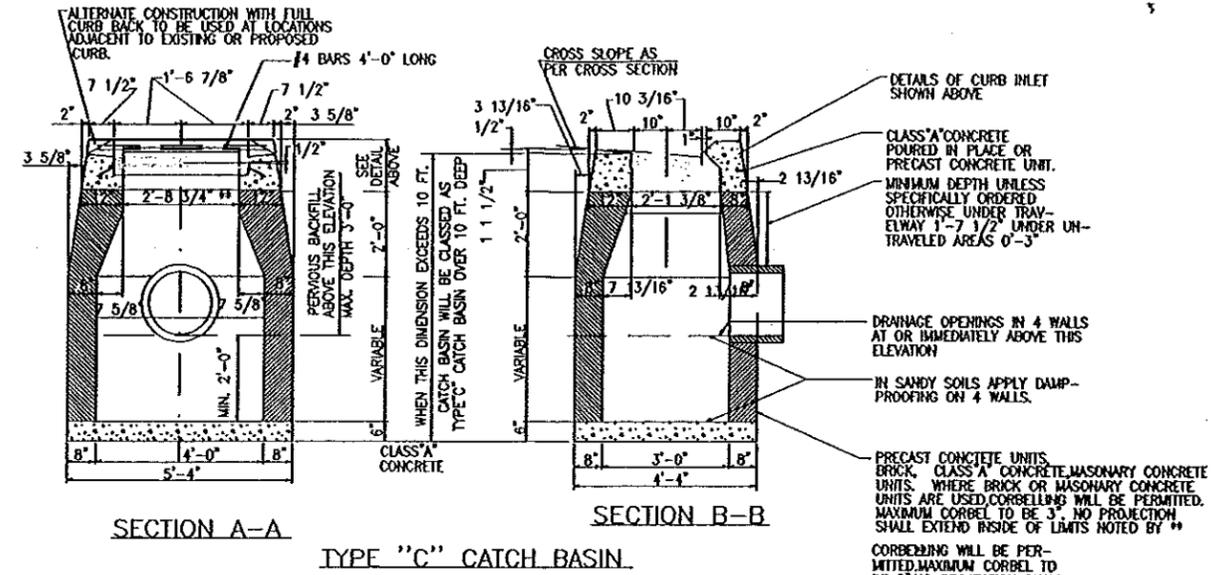
PLAN



SECTION A-A

SECTION B-B

TYPE "C" CATCH BASIN DOUBLE GRATE -- TYPE 1



SECTION A-A

SECTION B-B

TYPE "C" CATCH BASIN

DETAILS OF CURB INLET SHOWN ABOVE

CLASS "A" CONCRETE POURED IN PLACE OR PRECAST CONCRETE UNIT.

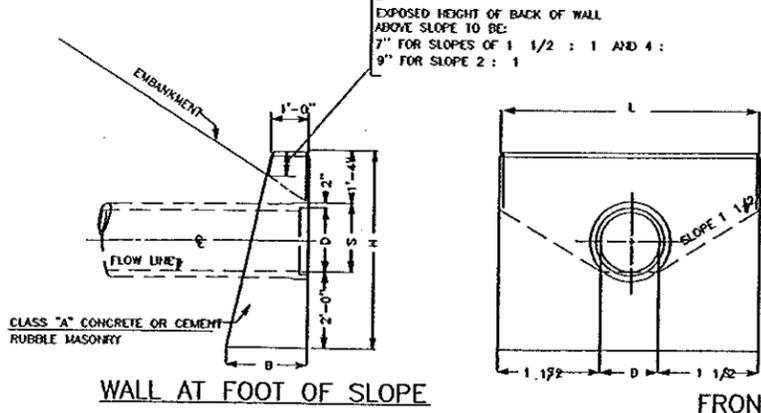
MINIMUM DEPTH UNLESS SPECIFICALLY ORDERED OTHERWISE UNDER TRAVELWAY 1'-7 1/2" UNDER UNTRAVELED AREAS 0'-3"

DRAINAGE OPENINGS IN 4 WALLS AT OR IMMEDIATELY ABOVE THIS ELEVATION

IN SANDY SOILS APPLY DAMPPROOFING ON 4 WALLS.

PRECAST CONCRETE UNITS, BRICK, CLASS "A" CONCRETE, MASONRY CONCRETE UNITS. WHERE BRICK OR MASONRY CONCRETE UNITS ARE USED CORBELLING WILL BE PERMITTED. MAXIMUM CORBEL TO BE 3". NO PROJECTION SHALL EXTEND INSIDE OF LIMITS NOTED BY \*\*

CORBELLING WILL BE PERMITTED. MAXIMUM CORBEL TO BE 3". NO PROJECTION SHALL EXTEND INSIDE OF LIMITS NOTED BY.



WALL AT FOOT OF SLOPE

FRONT ELEVATION

DIMENSIONS AND QUANTITIES FOR ONE ENDWALL BASED ON  $S = D + 2'$

D	S	H	L	BATTER	F	VOL.
INS.	FT.&INS.	FT.&INS.	FT.&INS.	INS./FT.	FT.&INS.	CU.YD.
12"	1'-2"	4'-6"	4'-6"	2 1/2"	1'-11 1/2"	1.10
15"	1'-5"	4'-9"	5'-6"	2 1/2"	1'-11 7/8"	1.45
18"	1'-8"	5'-0"	6'-6"	2 1/2"	2'-0 1/2"	1.83
24"	2'-2"	5'-6"	8'-6"	2 1/2"	2'-1 3/4"	2.72
30"	2'-8"	6'-0"	10'-6"	2 1/2"	2'-3"	3.79
36"	3'-2"	6'-6"	12'-6"	3"	2'-7 1/2"	5.45
42"	3'-8"	7'-0"	14'-6"	3"	2'-9"	6.40 *
48"	4'-2"	7'-6"	16'-6"	3"	2'-10 1/2"	8.00 *

\* VOLUME BASED ON "O" AND WALL THICKNESS AT Q OF PIPE HAS BEEN DEDUCTED

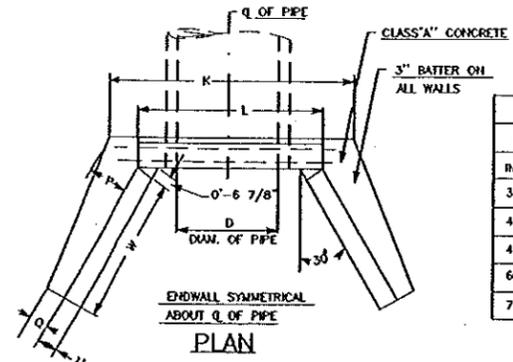
STANDARD ENDWALL

NOTE

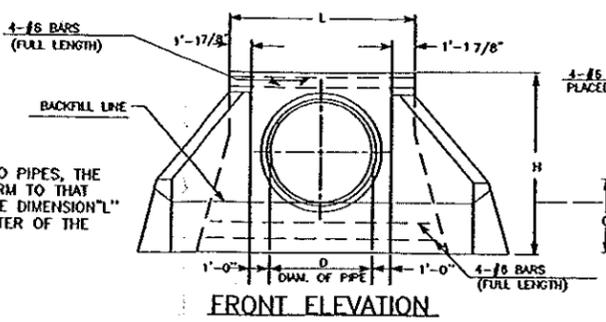
ALL CONSTRUCTION DIMENSIONS ARE NOMINAL.

WHEN ONE ENDWALL IS TO BE USED FOR TWO PIPES, THE DIMENSIONS OF THAT ENDWALL SHALL CONFORM TO THAT REQUIRED FOR THE LARGER PIPE, EXCEPT THE DIMENSION "L" SHALL BE INCREASED BY THE OUTSIDE DIAMETER OF THE SMALLER PIPE PLUS ONE FOOT.

THESE ENDWALLS WILL BE USED ONLY AT LOCATIONS WHERE THEY WILL NOT BE A HAZARD TO VEHICLES THAT RUN OFF THE ROAD. IN NO CASE WILL THE LOCATION OF THESE ENDWALLS BE LESS THAN 30' FROM THE EDGE OF THE TRAVELED WAY.



PLAN

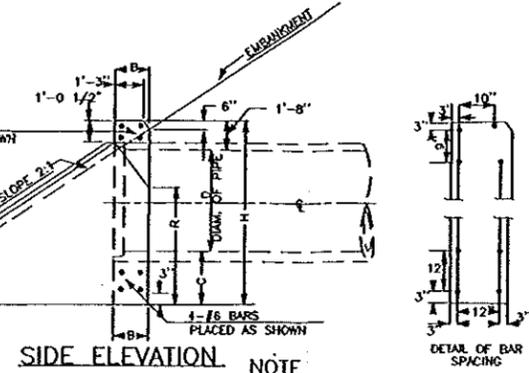


FRONT ELEVATION

DIMENSIONS AND QUANTITIES FOR ONE WING TYPE ENDWALL

D	B	C	G	H	K	L	P	Q	R	W	VOL.
INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	FT.&INS.	CU.YD.
36"	1'-6"	2'-0"	3'-3"	6'-8"	9'-1 1/2"	27'-3 3/4"	4'-4 1/2"	8'-9 3/8"	4'-4 7/8"	5 3/8"	48.87
42"	1'-6"	2'-0"	3'-3"	7'-2"	9'-10 1/2"	27'-9 3/8"	4'-6 3/8"	8'-9 3/8"	4'-10 1/2"	7 3/8"	47.67
48"	1'-7"	2'-6"	3'-9"	8'-2"	10'-10 1/2"	28'-3 3/8"	4'-9 3/8"	8'-11 1/8"	4'-9 3/8"	7'-9 1/2"	48.11
60"	1'-7"	2'-6"	3'-9"	9'-2"	12'-4 1/8"	32'-0 3/8"	5'-0 3/8"	8'-11 1/8"	4'-9 3/8"	10'-1 1/2"	42.4
72"	1'-7"	2'-6"	3'-9"	10'-2"	13'-10 3/8"	32'-3 3/8"	5'-3 3/8"	8'-11 1/8"	4'-9 3/8"	12'-5"	16.30

STANDARD WING TYPE ENDWALL REINFORCEMENT TO BE PLACED FOR 48" PIPE AND UP.



SIDE ELEVATION

NOTE

COST OF REINFORCING BARS TO BE INCLUDED IN THE CONTRACT UNIT PRICE FOR CLASS "A" CONCRETE.

ISSUE	DATE	DESCRIPTION	BY	CHK'D
A	11-21-01	APPLICATION FOR LOCATION APPROVAL	ABB	RJA

KLEEN ENERGY SYSTEMS, LLC.  
90 INDUSTRIAL PARK ROAD  
MIDDLETOWN, CT. 06457

O&G INDUSTRIES, INC.  
173 Main St.  
Farmington, CT 06030-5416

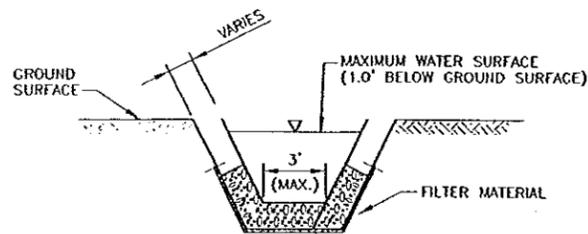
PB Power, Inc.  
Customer Focused Solutions

TRC  
Customer Focused Solutions  
5 WATERBURY CROSSING  
WATERBURY, CT 06705

DRAINAGE DETAILS

DR.	JD	APPROVED	DATE	DRAWING NO.	REV
RES.				C48	
CHK.		PRINCIPAL IN CHARGE	DATE	SHEET 51	OF 58

BOSCAWEN, 26018A-MIDDLETOWN, CT CIVIL SITE PLAN, 12/24/01 14:49

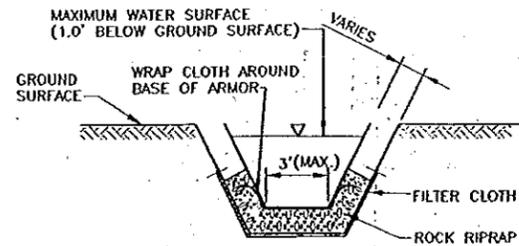


**NOTES:**

1. A FILTER MATERIAL EITHER GRANULAR OR SYNTHETIC FABRIC FILTERS MAY BE USED. THESE FILTERS SERVE AS TRANSITIONAL LAYER BETWEEN THE ROCK RIPRAP AND UNDERLYING SOIL.
2. IF GRANULAR FILL IS TO BE USED, THE MAXIMUM THICKNESS IS 12.0 INCHES AND THE MINIMUM THICKNESS IS 6.0 INCHES.
3. IF FILTER CLOTH (GEOTEXTILE) IS TO BE USED, THE FOLLOWING PROCEDURES ARE TO BE IMPLEMENTED:
  - A. A 6" GRAVEL BEDDING LAYER SHOULD BE PLACED BENEATH THE ROCK RIPRAP.
  - B. THE FILTER CLOTH SHOULD BE WRAPPED AROUND THE TOE MATERIAL.
  - C. ADEQUATE OVERLAPS MUST BE PROVIDED BETWEEN INDIVIDUAL FABRIC SHEETS.
  - D. SECURING PINS WITH WASHERS ARE RECOMMENDED AT 2 TO 5 FT INTERVALS ALONG THE MIDPOINT OF THE OVERLAPS.
  - E. ROCK RIPRAP PLACEMENT ON THE FILTER BEGINS AT THE TOE AND PRECEDES UP THE SLOPE.

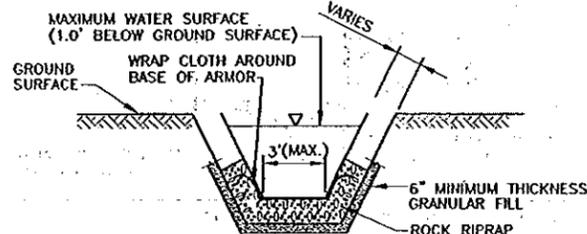
**TYPICAL ROCK RIPRAP INSTALLATION**

N.T.S.



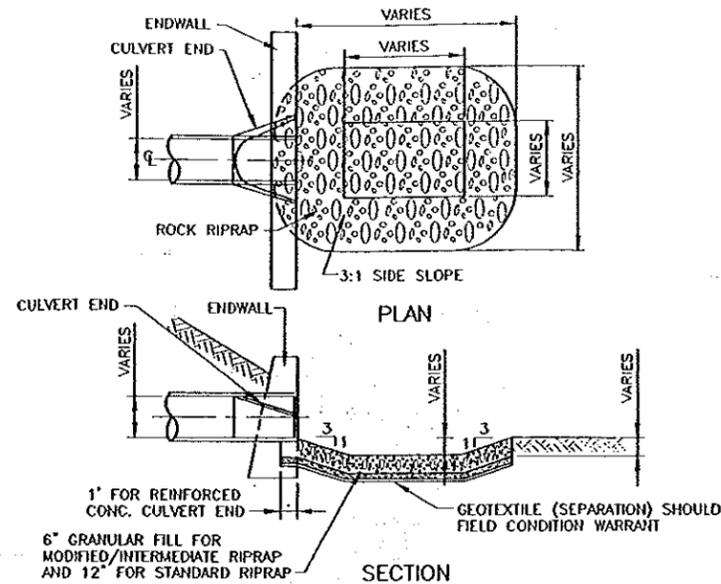
**TYPICAL FABRIC PLACEMENT**

N.T.S.



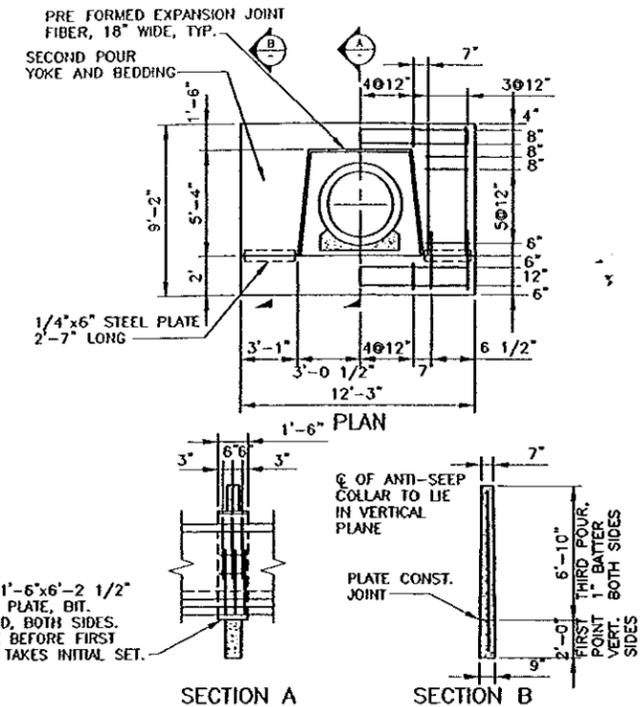
**TYPICAL GRANULAR FILL PLACEMENT**

N.T.S.



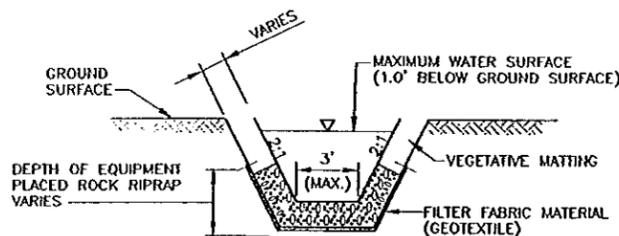
**TYPICAL OUTLET PROTECTION**

N.T.S.



**ANTI-SEEP COLLAR**

N.T.S.

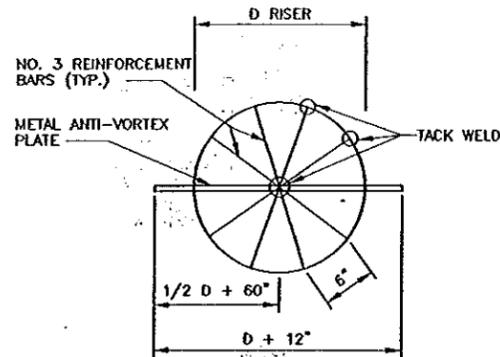


**NOTES:**

1. FOR ROADSIDE CHANNELS, THE MINIMUM FREE BOARD IS 1.0' FROM THE WATER SURFACE TO THE TOP OF THE CHANNEL BANK.
2. ALL CHANNELS ARE DESIGNED TO THE 25 YEAR STORM FREQUENCY.
3. ROCK RIPRAP SIZE WILL BE DETERMINED USING THE PERMISSIBLE SHEAR STRESS EQUATION AS DESCRIBED IN CONN. DOT 2000 DRAINAGE MANUAL, CHAPTER 7.0.
4. EROSION CONTROL MATTING MATERIAL WILL BE INSTALLED TO PROTECT THE SEED BED FROM LOSS OF SOIL AND PROMOTE THE ESTABLISHMENT OF PERENNIAL VEGETATIVE COVER. MATERIALS APPROVED FOR USE ARE:
  1. WOVEN PAPER NET
  2. JUTE NET
  3. SINGLE OR DOUBLE FIBERGLASS ROVING
  4. STRAW WITH NET
  5. CURLED WOOD NET

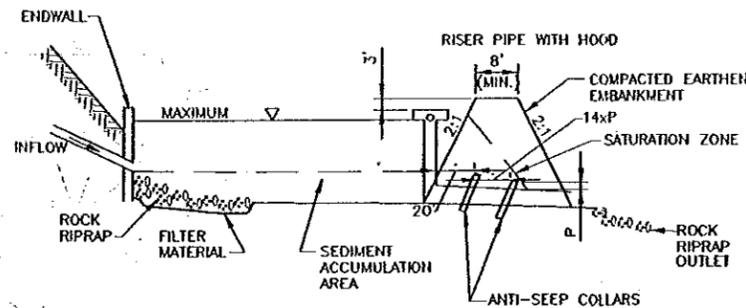
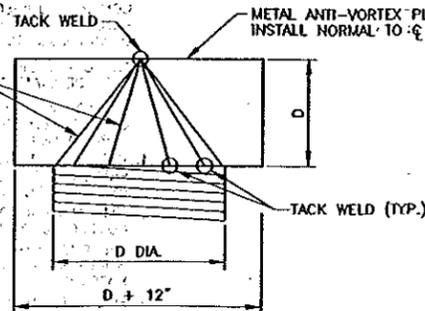
**TYPICAL CHANNEL**

N.T.S.



**ANTI-VORTEX PLATE AND TRASH RACK**

N.T.S.



**NOTES:**

1. PRINCIPAL SPILLWAY (RISER) SHALL CONSIST OF A SOLID (NON-PERFORATED), VERTICAL PIPE OR BOX OF CORRUGATED METAL OR REINFORCED CONCRETE JOINED BY A WATERTIGHT CONNECTION TO AN OUTLET PIPE EXTENDING THROUGH THE EMBANKMENT AND OUT LETTING BEYOND THE DOWNSTREAM TOE OF THE EMBANKMENT FILL.
2. THE CREST OF THE PRINCIPAL SPILLWAY SHALL BE A MINIMUM OF 3 FT BELOW THE TOP OF THE EMBANKMENT.
3. AN ANTI-VORTEX DEVICE AND TRASH RACK SHALL BE ATTACHED TO THE TOP OF THE PRINCIPAL SPILLWAY TO PREVENT FLOATING DEBRIS FROM BEING CARRIED OUT OF THE BASIN.
4. THE BASE OF THE PRINCIPAL SPILLWAY SHALL BE FIRMLY ANCHORED TO PREVENT ITS FLOATING. AS A MINIMUM, A FACTOR OF SAFETY q 1.25 SHALL BE USED (DOWNWARD FORCES - 1.25x UPWARD FORCES).
5. FILL MATERIAL SHALL BE PLACED AROUND THE PIPE IN 8" LAYERS AND COMPACTED BY HAND.
6. THE EMBANKMENT SHALL BE CLEAN MINERAL SOIL, FREE OF ROOTS, WOODY VEGETATION, OVERSIZED STONES, ROCKS OR OTHER DELETERIOUS MATERIAL.
7. FILL MATERIAL WILL BE PLACED IN 8" CONTINUOUS LAYERS OVER THE ENTIRE LENGTH OF THE FILL. COMPACTION SHALL BE OBTAINED BY ROUTING THE HAULING EQUIPMENT OVER THE FILL SO THAT THE ENTIRE SURFACE OF THE FILL IS TRAVERSED BY AT LEAST ON WHEEL OR TREAD TRACK OF THE EQUIPMENT, OR BY USING A COMPACTOR.
8. THE EARTHEN EMBANKMENT SHALL BE STABILIZED WITH TEMPORARY VEGETATION WITHIN 15 DAYS OF COMPLETION OF THE POND.

**TYPICAL POND/SEDIMENTATION AREA**

N.T.S.

KLEEN ENERGY SYSTEMS, LLC. 90 INDUSTRIAL PARK ROAD MIDDLETOWN, CT. 06457			
<b>POND &amp; CHANNEL DETAILS</b>			
DR. JD	APPROVED	DATE	REV C49
DES.	PRINCIPAL IN CHARGE	DATE	SHEET 52 OF 58