IGCC Development In Delaware

Coal Without Compromise

September 15, 2006

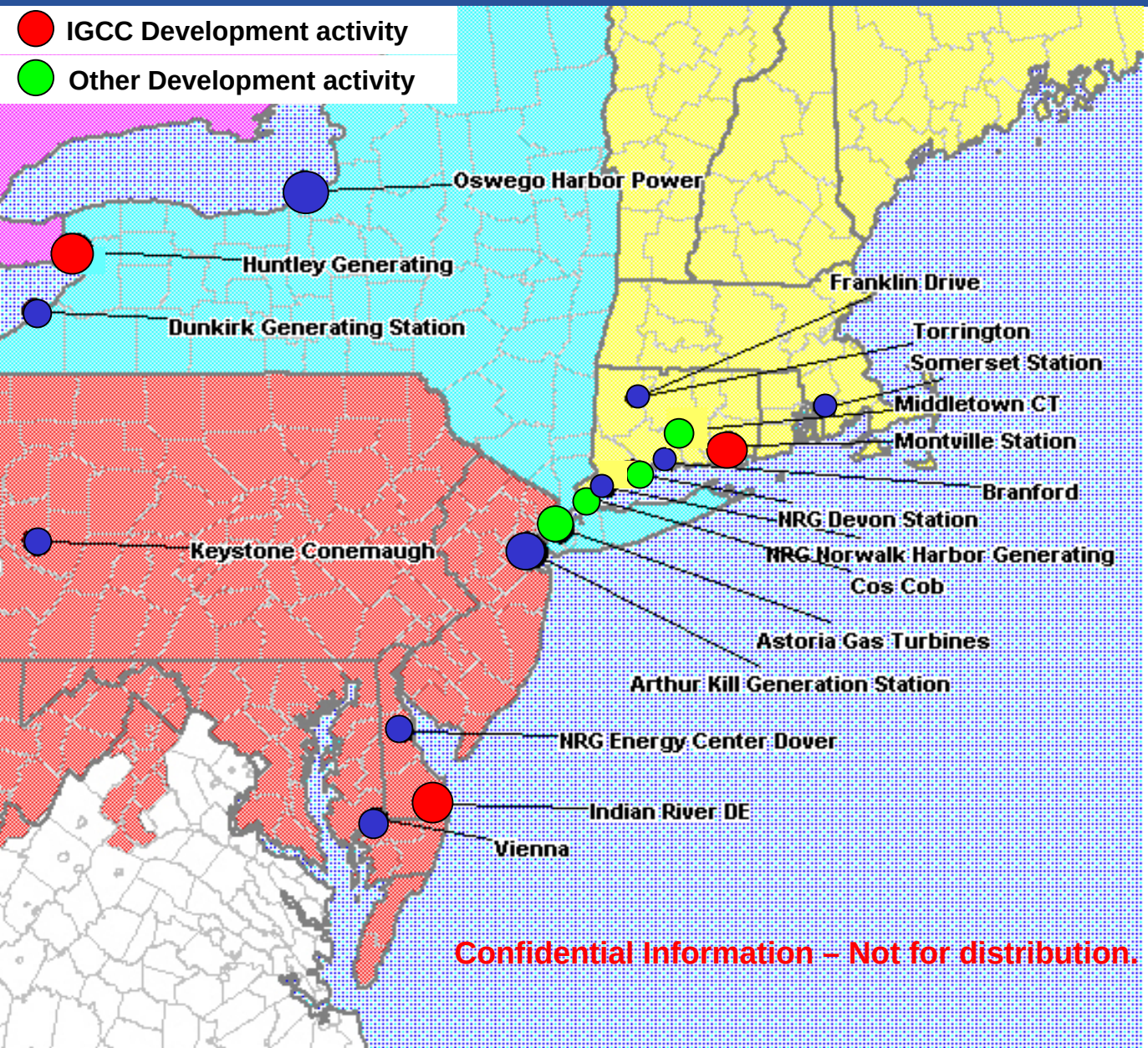
Table Of Contents

- **NRG's Northeast Development Plan**
- **IGCC In Delaware**
- **Why IGCC vs. Other Options**
- **Project Status**
  - **Permitting**
  - **Gasification technology selection**

NRG

- A wholesale power generation company with operations in the United States and internationally
  - Interests in 50 power projects with an aggregate net generation capacity of approximately 22,793 MW (7,976 MW coal-fired)
  - Approximately 7,900 MW of capacity is in the Northeast region
  - Approximately 1,200 MW located in PJM (900 MW coal-fired)

Northeast Development Plan



Northeast Existing Capacity	
	MW
PJM	
Indian River	737
Keystone & Con.	127
Vienna	170
NEPOOL	
Somerset	127
Middletown	770
Montville	497
Devon	124
Norwalk	342
CT Jets	104
New York	
Astoria	553
Arthur Kill	841
Huntley	552
Dunkirk	522
Oswego	1,634
TOTAL	7,099

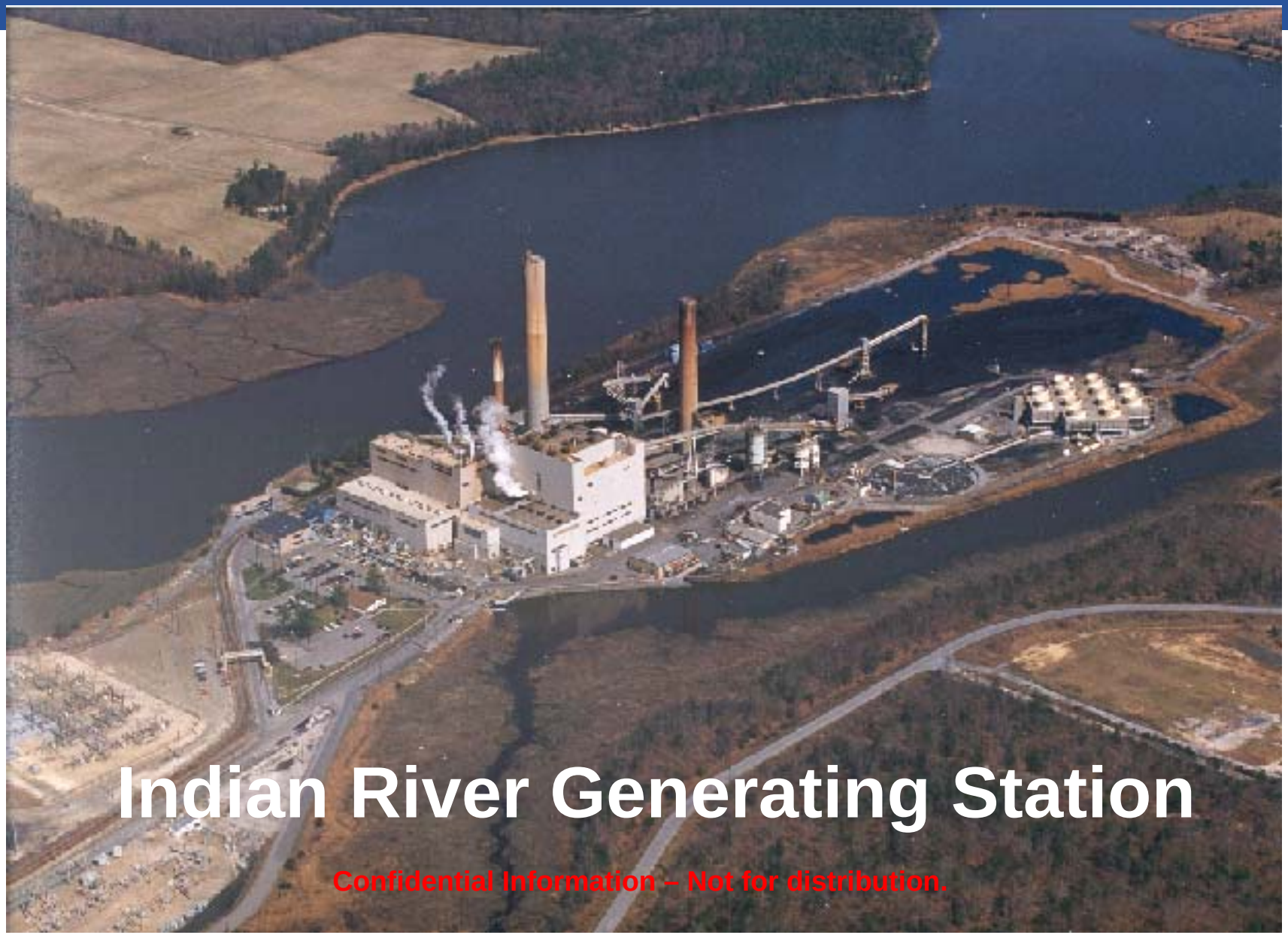
NRG's NE development plan expected to result in lower emission rates across all pollutants

Indian River

- 784 MW total capacity
- Four coal fired steam units
- One combustion turbine
- Two types of coal
- 170 employees
- Dispatched through PJM (transmission system operator)

NRG and Indian River

- NRG and Indian River are committed to:
  - Meeting environmental regulations
  - Providing electricity reliably
  - Being a low cost provider



Indian River Generating Station

Confidential Information – Not for distribution.

Repowering Delaware with NRG

Why Add Generation……..Why Delaware?

- **Reliability**
  - **Growth -** Delaware is seeing unprecedented population growth – 17.6% average with 38% growth in Sussex County.
  - **Demand -** (PJM) peak summer use is expected to grow at 1.6% as a whole, while Delaware @ 2% each year
  - **Demand -** Delmarva Power summer use is expected to grow from 4070 Mw to 4313 by 2010 and 4729 by 2015.
  - **Shortage -** Industry experts estimate shortfall in capacity beginning in 2008 in Delaware and across all of PJM, impacting Delaware's import capabilities
  - **Import/Export -** Delaware, a power importer, needs to add new generation in order to ensure an adequate power supply for the future
  - **New capacity Needs -** There are currently only 3 projects in the PJM queue for new capacity in Delaware for a total of 8MW

Repowering Delaware with NRG

Why Add Generation……Why Delaware?

- **Price Stability**
  - **Consumers -** Delmarva Power retail customer rates were increased by 59% effective 5/1/06
  - **Other Options -**Natural gas prices remain high and continue to drive electric wholesale costs
  - **Fuel Diversity -** Adequate supply and fuel diversity is key to stabilizing electricity prices

Repowering Delaware with NRG

Why Add Generation……..Why Delaware?

- **Environmental Impact**
  - **Clean Coal Generation –** Desire for new sources with low emissions.
  - **Clean Air Interstate Rule (CAIR) –** It contains an annual SO2 cap-and-trade program, as well as an annual and Ozone Season NOx cap-and-trade program, dependent on a state's contribution to downwind PM and Ozone concentrations.
  - **Clean Air Mercury Rule (CAMR) –** It is a mercury cap-and-trade program affecting new and existing coal fired units greater than 25 MW. Phase I starts in 2010 and has a national cap of 38 TPY; Phase II starts in 2018 and has a national cap of 15 TPY.
  - **Delaware -** DNREC is currently in the process of developing new multi-pollutant regulations for reducing emissions from Delaware power plants

Repowering Delaware with NRG

Indian River Plan – New and existing investment

- New Generation IGCC Technology
  - Construction of a new, base-load, clean coal facility.
  - New plant will assist the state in becoming less reliant on natural gas, contribute much needed base-load generation to stabilize electricity prices and will reducing overall emission rates per kwh of output.
- Existing Plant Emissions Reduction Technology
  - Installation of emissions controls on existing generating units
  - SO2 Controls
  - NOx Controls
  - HG Reduction

Existing Plant Emissions Reductions

SO2 Controls

Unit	Description	In-Service
Unit #1	In-Duct Injection	2009
Unit #2	In-Duct Injection	2009
Unit #3	In-Duct Injection	2009
Unit #4	Wet Scrubber	2012

NOx Controls

Unit	Description	In-Service
Unit #1	Low NOx Burners Selective Non-Catalytic Reduction (SNCR)	2009
Unit #2	Low NOx Burners Selective Non-Catalytic Reduction (SNCR)	2009
Unit #3	Low NOx Burners Selective Non-Catalytic Reduction (SNCR)	2009
Unit #4	Low NOx Burners Selective Catalytic Reduction (SCR)	2011

Existing Plant Emissions Reductions

Hg Controls

Unit	In-Service	Description
Unit #1	2009/2011	Activated Carbon Injection/Fabric Filter
Unit #2	2009/2011	Activated Carbon Injection/Fabric Filter
Unit #3	2009/2011	Activated Carbon Injection/Fabric Filter
Unit #4	2012/2011	Wet Scrubber/SCR

Impact on Delaware

- **Reliability**
  - Retention of existing units provides for continued reliable electricity supply
  - Installation of IGCC increases the local generating capacity by 630MW and allows for added load growth

Impact on Delaware

- **Price Stability**
  - Redevelopment plan is based on continued use of lower cost coal as the primary fuel source
  - Allows for continued fuel diversity within Delaware and avoids over reliance on natural gas
  - Long – term Power Purchase Agreement (PPA) contracts result in much desired rate stability for Delaware consumers

Impact on Delaware

- **Environmentally Responsible**
  - IGCC emissions are comparable to a natural gas combined cycle power plant
  - IGCC is able to capture CO2
  - Emissions on existing units are significantly reduced
  - Overall emissions rates significantly reduced for the entire site and exceed CAIR and CAMR requirements and are needed to meet Delaware's eventual regulations

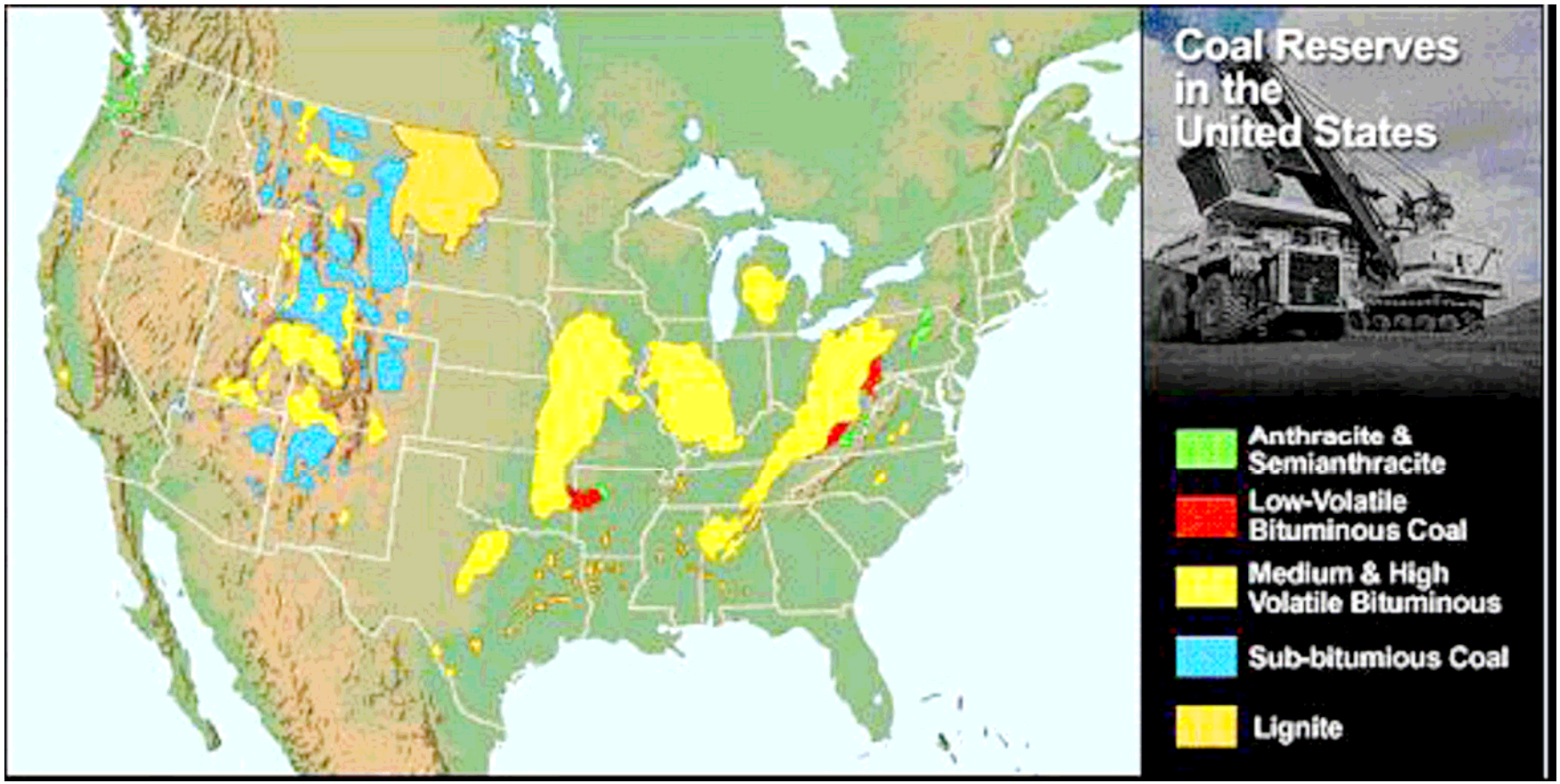
Impact on Delaware

- **Economic Benefits**
  - Indian River Generating Station currently employs 170 full-time employees from the local area
  - Many additional contract employees are employed during maintenance outages
  - IGCC construction would bring approximately 400 - 900 additional jobs during the construction period
  - IGCC facility would add an additional 85 - 100 permanent full-time jobs
  - IGCC is economically beneficial to the state as a capital investment of approximately $1.5 billion will be invested in Delaware
  - Emission reduction projects investments are approximately $330 million

Why IGCC?

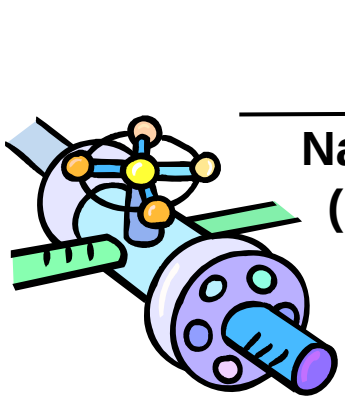
- **Coal generation preferred**
  - **US retains ample coal supply (the "Saudi Arabia of coal").**
  - **Coal is the cheapest generation resource option – assures lower energy cost to consumers**
  - **Other fuels options are scarce and subject to technology or infrastructure limitations.**
  - **Using domestic fuel reserves reduces dependency on foreign oil and gas imports – reduces exposure to world events**
- **Environmental regulations**
  - **require major coal plant investments and/or retirements**
  - **limitations on new technology**
  - **IGCC is "Clean Coal Technology"**
- **IGCC preferred over pulverized coal options**

Why Coal?



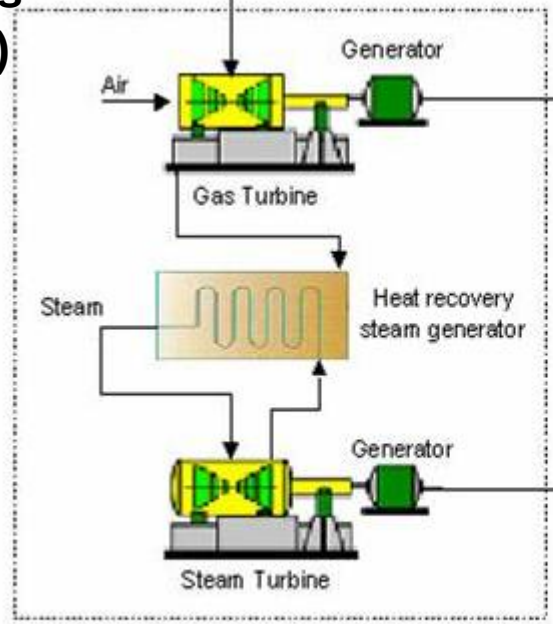
What Is IGCC?

- **IGCC turns coal into a clean synthetic gas which fuels a gas turbine instead of using natural gas**

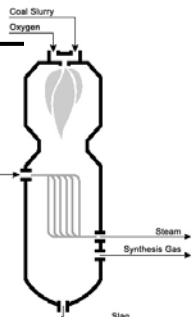


Natural Gas (methane)

Gasifier



Synthesis Gas (H2 & CO)



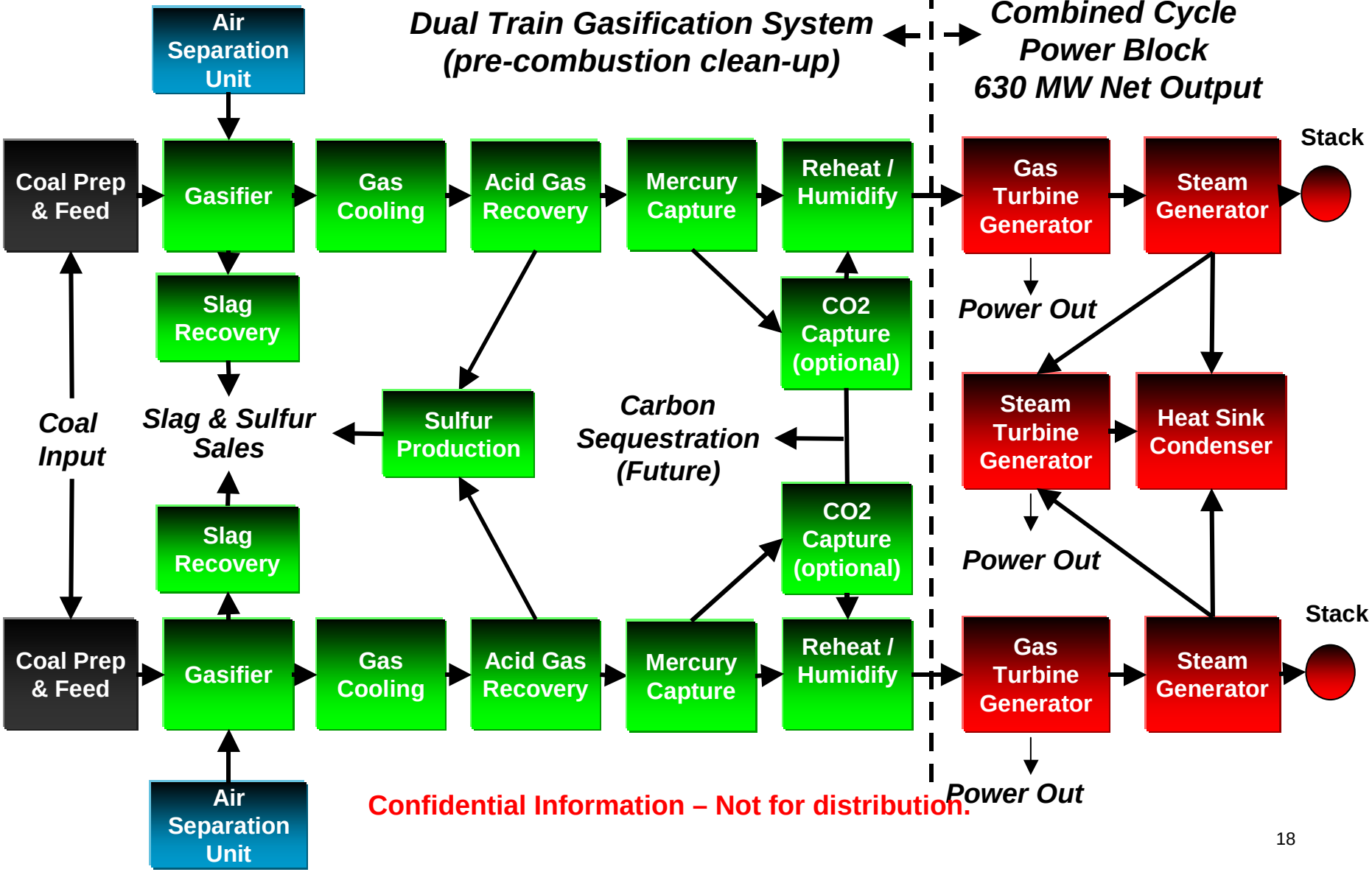
Coal

***NGCC*: Natural Gas Combined Cycle**

***Combined Cycle*: Gas turbine cycle plus a steam turbine cycle**

***IGCC*: Integrated Gasification Combined Cycle**

630 IGCC MW Configuration



IGCC Plant Emissions

- SO2 0.05 #/MBTU
- NOx 0.016 #/MBTU
- Hg 90+% reduction
- CO2 Installed with equipment that will enable the capture of approximately 66% of the CO2 and be comparable to a natural gas combined cycle plant

Overall Emissions Reductions

Overall Emissions Rate Reductions

- The expected emissions reductions (including the IGCC and emissions controls projects) are shown below:
- SO2 90% reduction
- NOx 80% reduction
- Hg 75%-90% reduction

CO2 Capture

IGCC has ability to capture carbon

- **CO_2 capture costs based on available technology**
- **CO2 capture adds 15% to 30% $/MWH in market**
- **Cost = $14 to $24 per ton**
- **Cost does not include sequestration**
- **Sequestration limited to geological configuration**

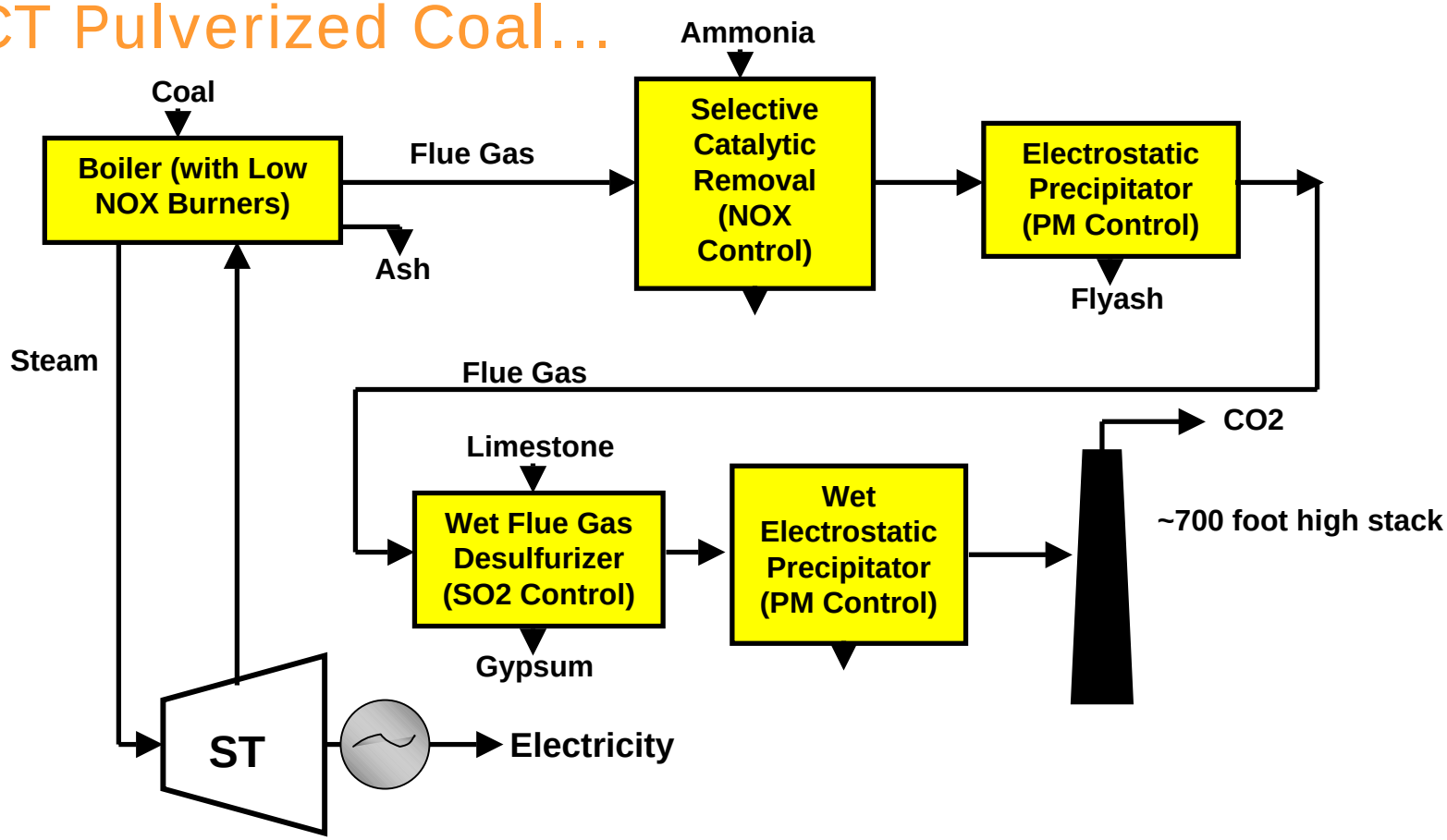
IGCC vs. New Pulverized Coal

Advantages of IGCC vs. Best PC

- More fuel efficient – 4-5% lower heat rate
- Fuel flexibility – optimize sources & cost
  - Most coals, petcoke & even biomass
- 20-30% less water consumption
- 40-60% less solid waste
  - Saleable “slag” & sulfur
- Lower emissions – NOx, SO2, PM, & VOCs
- 90%+ Hg removal
- Carbon capture capable – much lower cost
- Broad stakeholder support for IGCC

IGCC Overview

BACT Pulverized Coal…

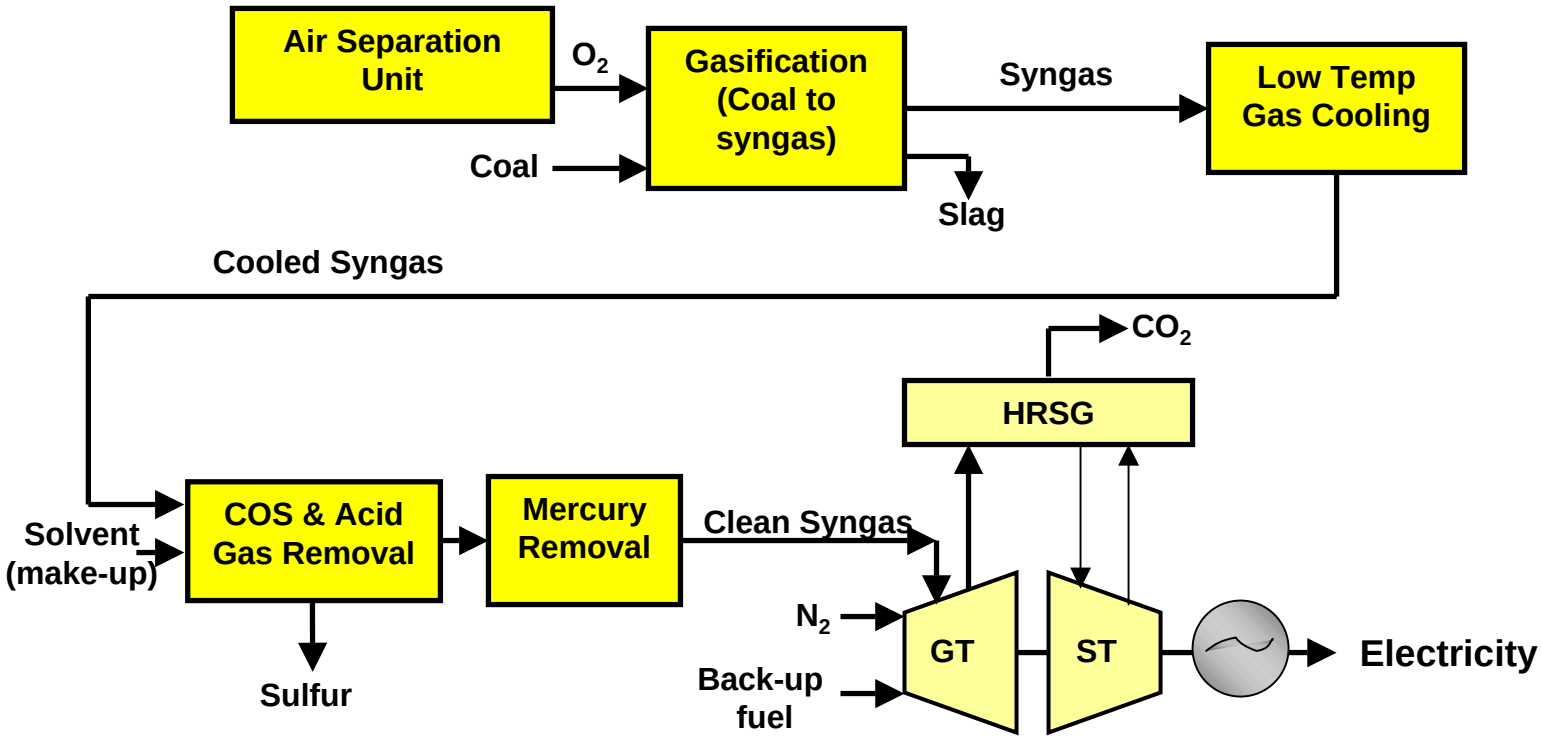


Notes:

1. *Based on recent PC environmental permit filings*
2. *Limestone to gypsum releases CO2*
3. *Amount of limestone is proportional to coal sulfur*

IGCC Overview

BACT IGCC…

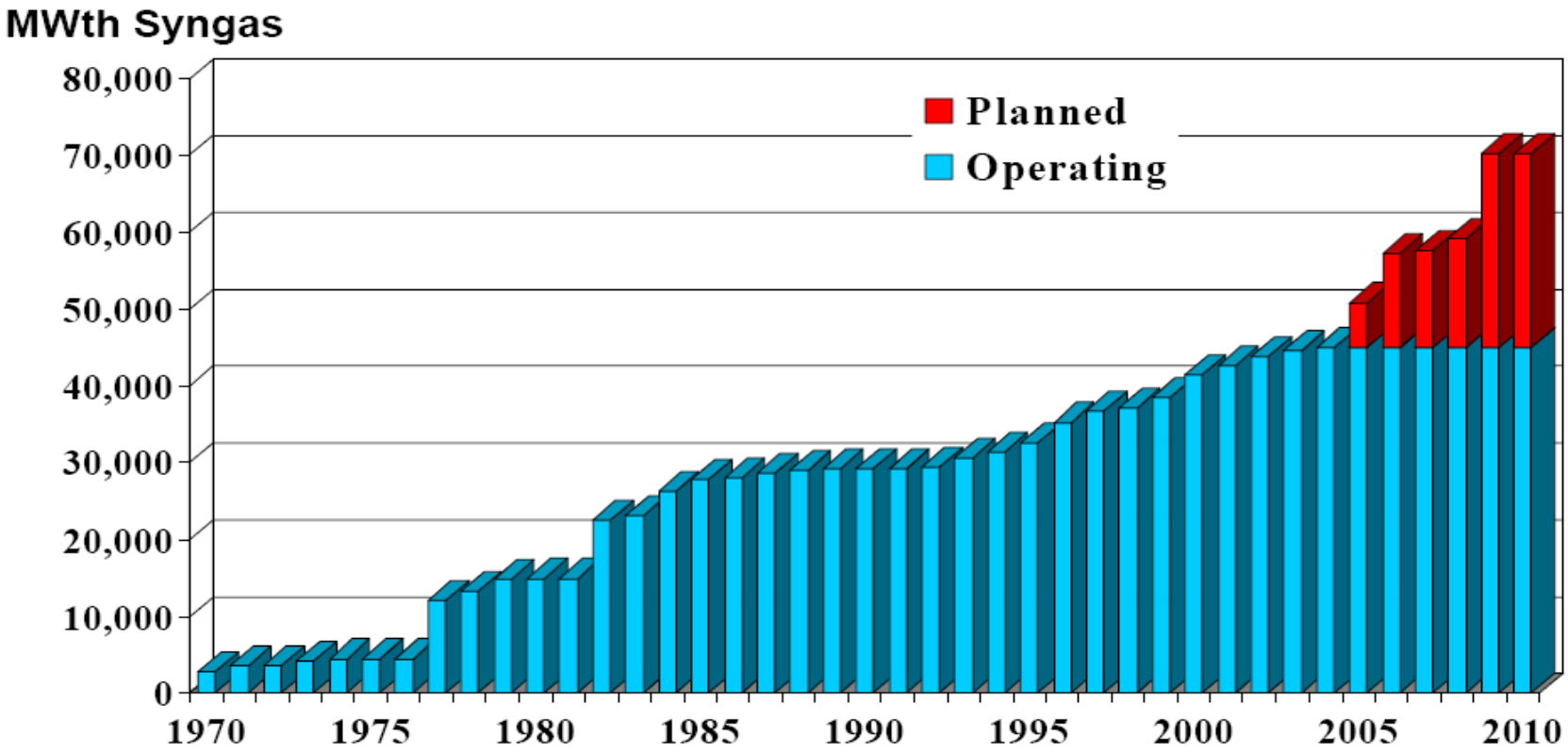


Notes:

1. *Based on IGCC environmental permit filing*
2. *Limestone is not required*
3. *Minimum sulfur removal level is 98%*
4. *NOX from GT is ~15 ppm*

Gasification - Is it well established?

Cumulative Worldwide Gasification Capacity and Growth



Childress Gasification Database 11/2004

Phase II Development
Indian River

Where are we in the project?

IGCC Phases Of Development

Four Project Phases

- **Phase I - Assess Opportunity 3 Months**
  - Is IGCC an option
  - Location
- **Phase II - Project Definition 6 Months**
  - Preliminary Engineering
  - Cost Estimation
  - Environmental Assessment
- **Phase III – Detailed Development 18 to 24 Months**
  - Agreements
  - Contracts
  - Engineering
  - Permitting
- **Phase IV – Construction 40 to 46 Months**
  - Actual Construction
  - Tie Ins
  - Start Up

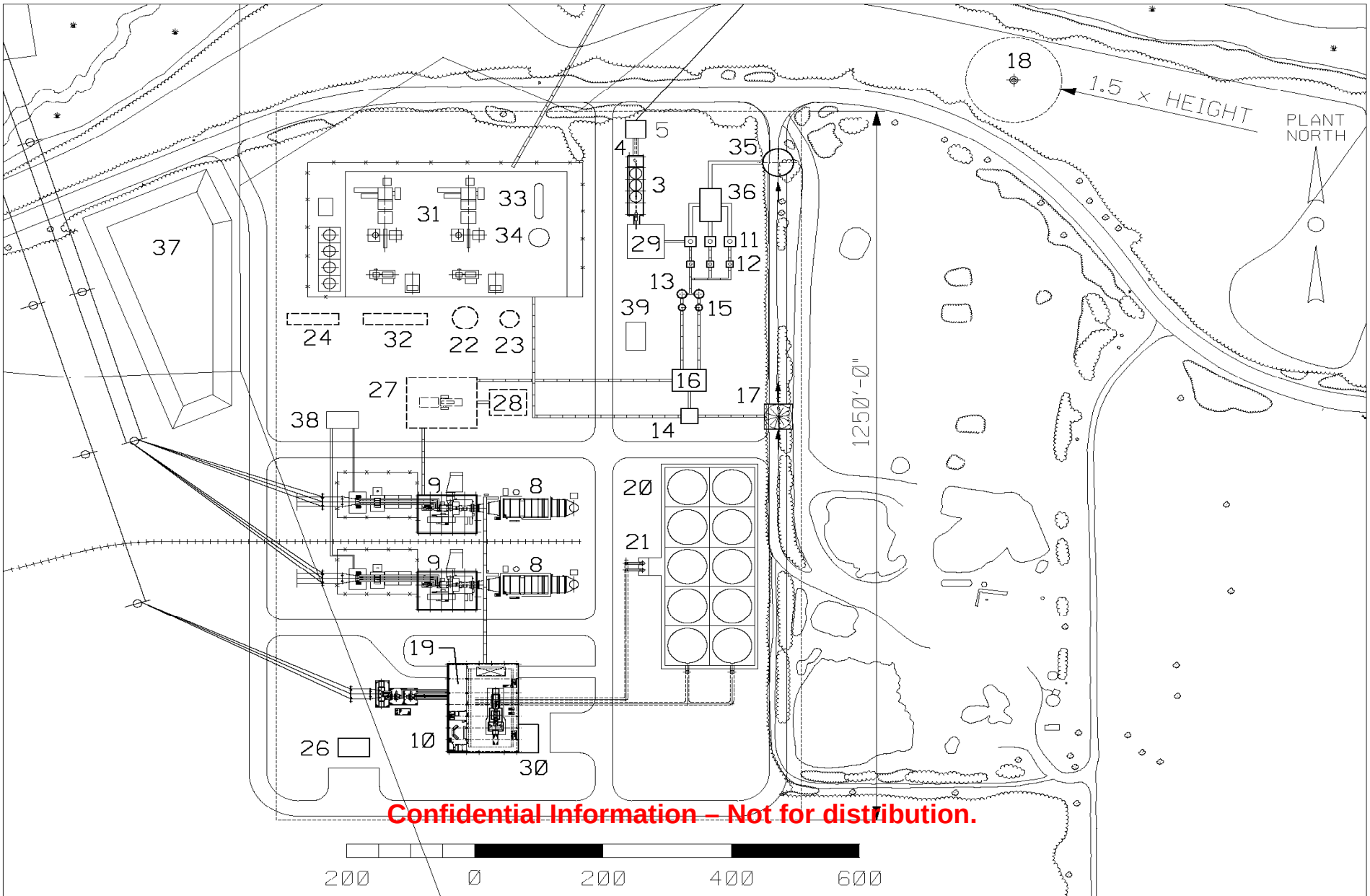
Indian River Capacity with IGCC

UNIT ID	CAPACITY MW	FUEL	START	RETIRE
1	80	Coal	1957	-
2	80	Coal	1959	-
3	150	Coal	1970	-
4	410	Coal	1980	-
10	17	#2 FO	1967	-
Total Current	737			
IGCC	630	Coal/Petcoke	2011-12	-
Total w/ IGCC	1,367			

Phase II – Site Assessments

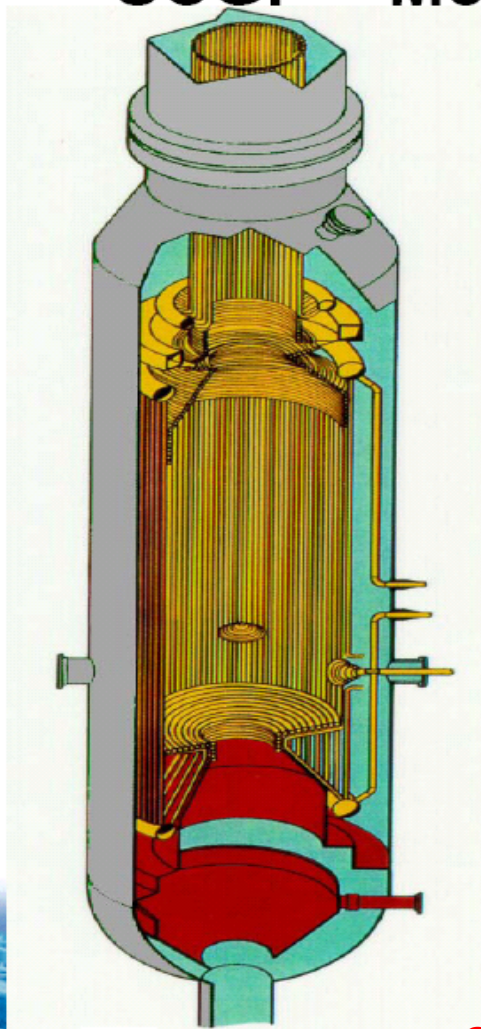
Assessments	Indian River
Available Space (acres)	1100
Net Capacity (MW)	633
Steam Turbine	New
Cooling System	New Tower
Water Source	Existing Indian River & Wells
Fuel Delivery	Existing Rail
Fuel Storage	Existing or new Yard
Slag / Sulfur Transport	Existing Rail / Truck
Grid Interconnection	Existing 230 kV
Startup / Backup Fuel	Existing Oil

Indian River Site Plan - Theoretical

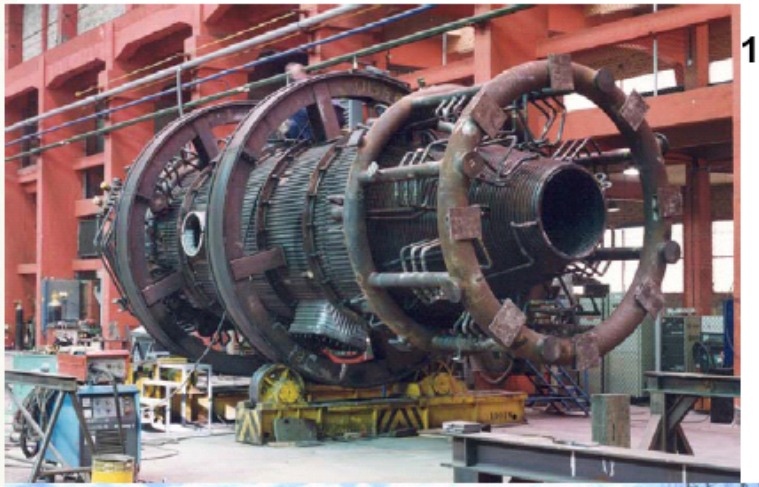


Typical IGCC Approach – Boiler Tube Wall

SCGP – Membrane wall gasifier manufacturing



3. Ready assembled gasifier



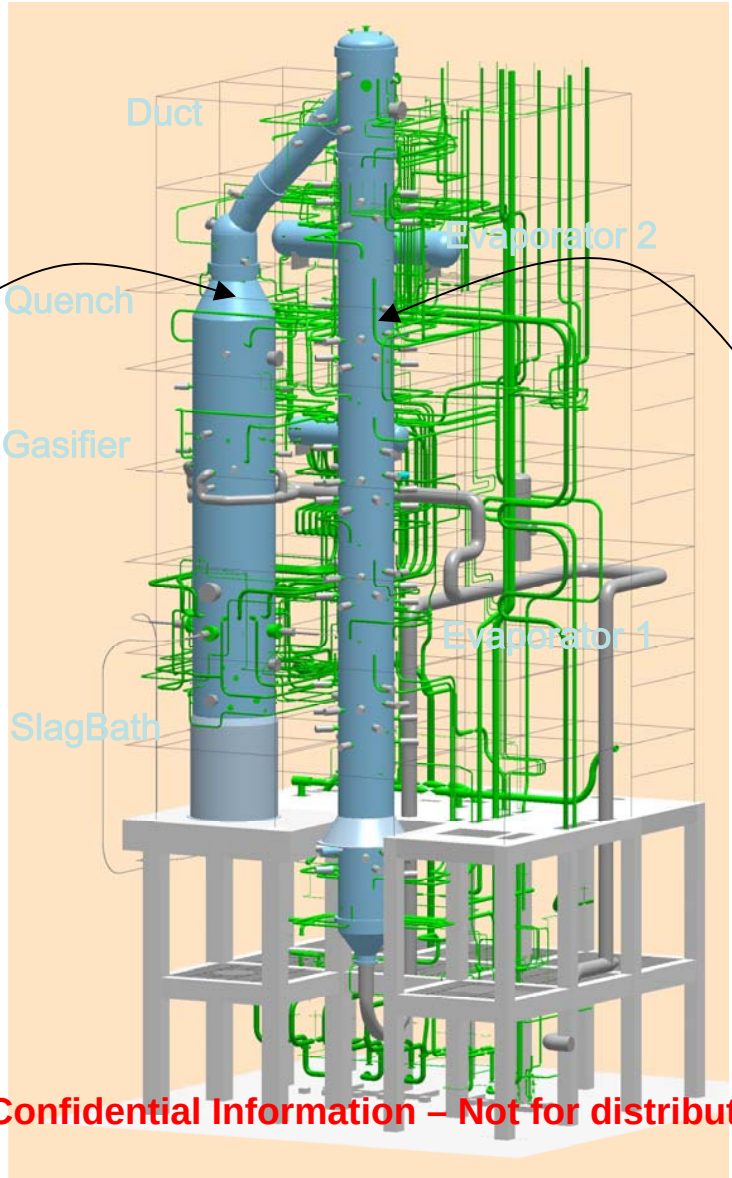
1. Membrane wall during manufacturing in the workshop

Courtesy of Babcock Borsig Espana, Bilbao, Spain

2. Erection of membrane wall into the gasifier pressure vessel at site (or in the workshop)

Courtesy of Elcogas, Puertollano, Spain

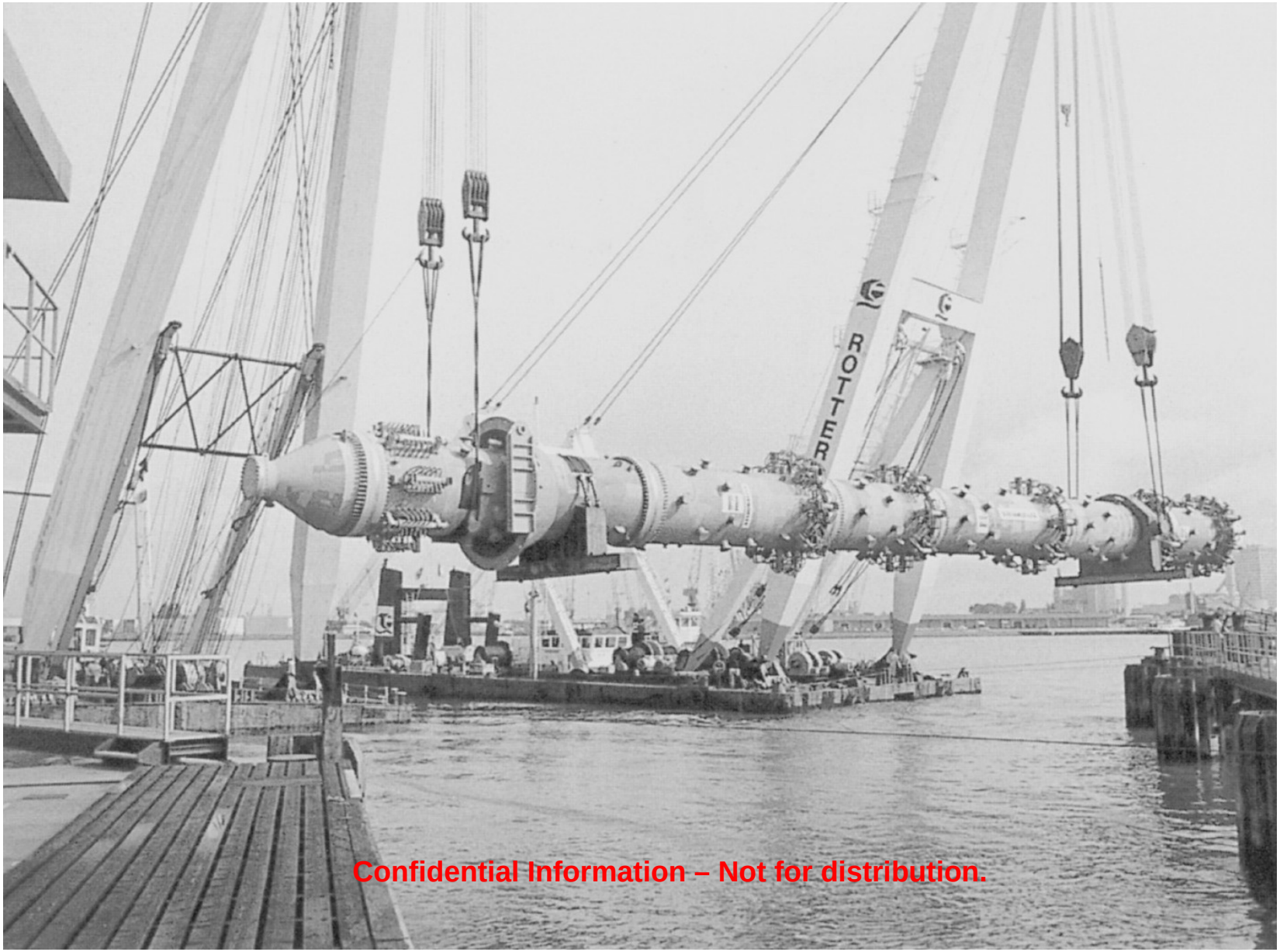
Gasifier & Syngas Cooler (Shell Design)



Gasifier

Syngas Cooler

Syngas Cooler Being Delivered via Barge



Syngas Cooler Being Erected

Nuon IGCC Plant – Buggenum, NL

Permitting Roadmap

- **14-24+ months – potential critical path**

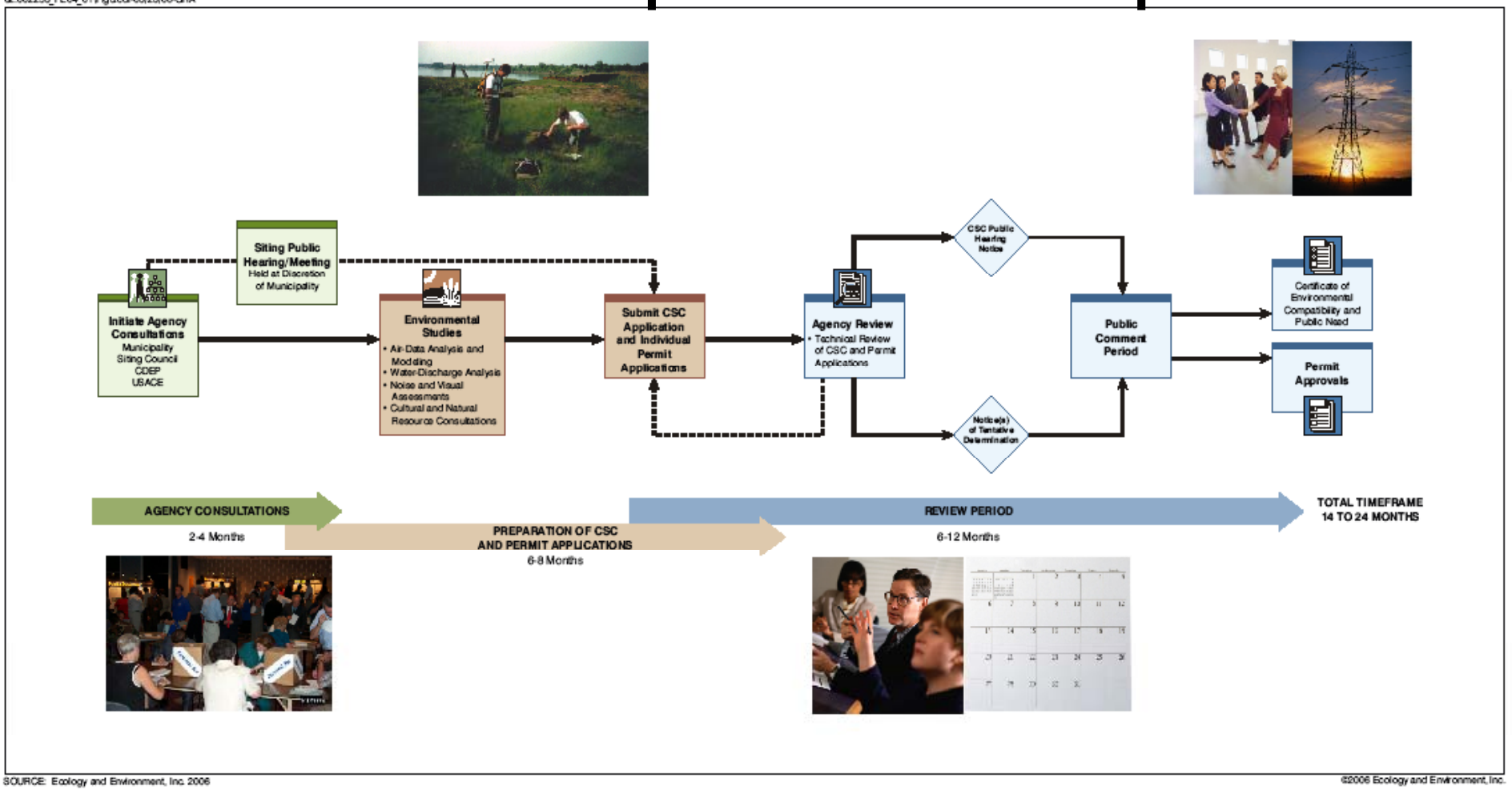


Figure 3 CSC CERTIFICATION AND PERMIT PROCESS OVERVIEW FOR MONTVILLE, CONNECTICUT

Indian River Permits Required

Permit or Approval	Agency	Expected Agency Review Time
FEDERAL		
Acid Rain Permit	USEPA	6 months
Army Corps of Engineers (USACE) Construction Permit	USACE	3 -18 months
Federal Endangered Species Consultation	US Fish and Wildlife Service	2 – 6 months
Notice of Proposed Construction or Alteration	FAA	1-2 months
STATE		
Construction, Installation, Alteration and Operation Air Permit	DNREC	6 – 12 months
Title V - State Operating Permit	DNREC	6 – 12 months
Coastal Zone Permit	DNREC	6 months
Solid Waste Permit	DNREC	1-2 months
NPDES Surface Water Discharge Permit	DNREC	6 - 12 months
NPDES Industrial Storm Water Discharge Permit	DNREC	1-2 months
NPDES Storm Water Permit for Construction Activity	DNREC	2 - 4 months
Water Allocation Permit	DNREC	3-6 months
Subaqueous Land / Wetlands Permit	DNREC	3-5 months
401 Water Quality Certification	DNREC	3-5 months
Wastewater Treatment Plant License	DNREC	Not Applicable
RCRA Hazardous Waste Identification Number	DNREC	Not Applicable

INDIAN RIVER GENERATING STATION

Aquatic Studies Overview

Center for the Inland Bays Scientific & Technical Advisory Committee

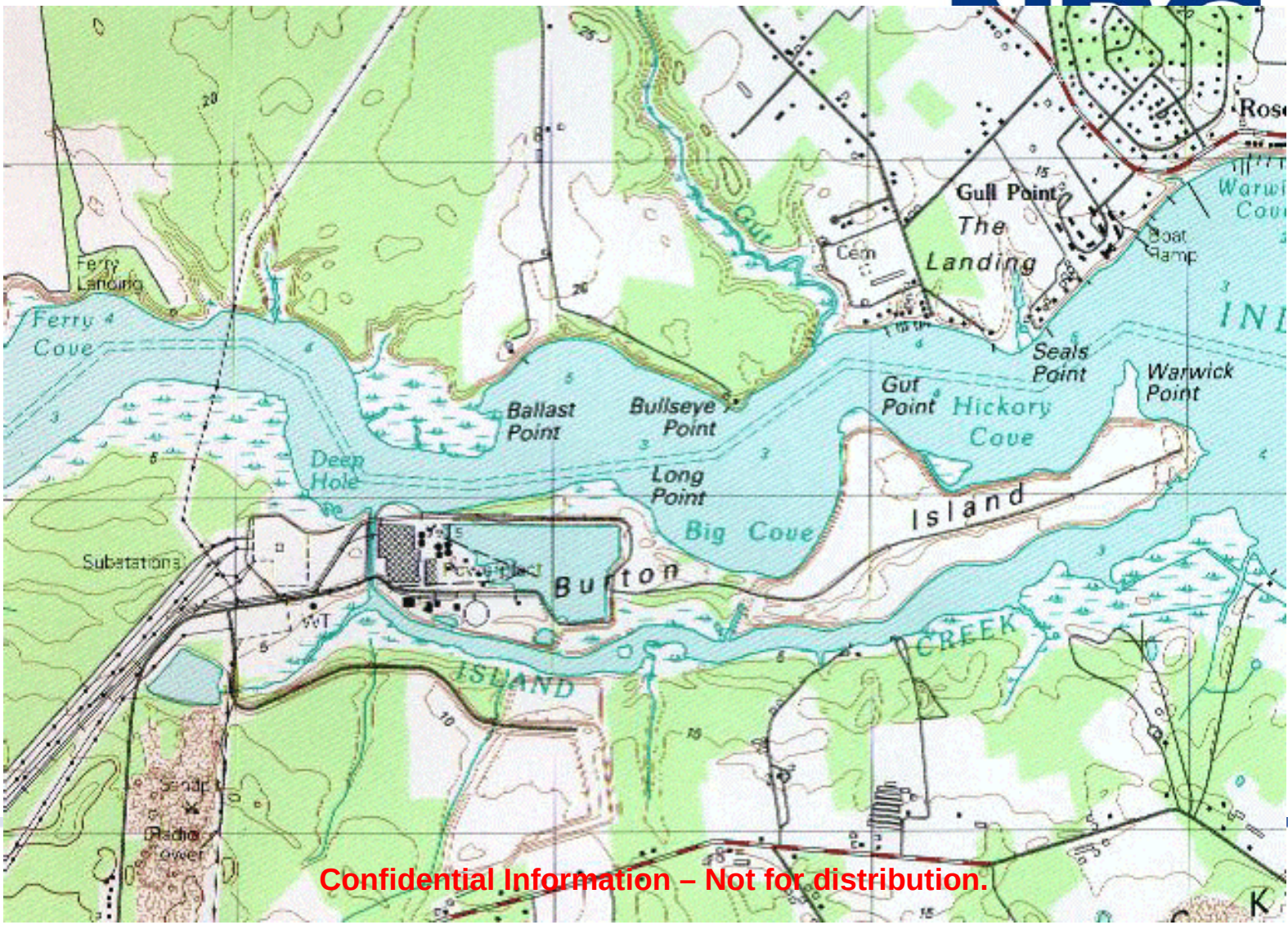
September 15, 2006

OBJECTIVES

- OVERVIEW OF PLANT
- NPDES PERMIT HISTORY
- 316(a) THERMAL VARIANCE
- 316(b) IMPINGEMENT & ENTRAINMENT

INDIAN RIVER GENERATING STATION

SITE LOCATION



INDIAN RIVER GENERATION STATION

Unit	Year	Cooling Water	MGD
1	1957	Once-Through	108
2	1958	Once-Through	108
3	1970	Once-Through	162
4	1980	Cooling Tower	26

Aquatic Studies

- **316(a) Thermal Impact Assessment**
  - Study plan developed in cooperation w/ DNREC, others
  - Field studies conducted: April ‘98 – Nov ’99
  - Report submitted to DNREC: Jan ’01
- **316(b) Impingement & Entrainment**
  - Study plan developed in cooperation w/ DNREC, others
  - Field studies conducted: Dec ’99 – Nov ’01
  - Report submitted to DNREC: Aug ’03

316(a) THERMAL IMPACT STUDIES PURPOSE

- Delineate thermal plume
- Evaluate potential effects of temperature on biological communities
- Evaluate interaction between temperature, dissolved oxygen, and nutrients
- ERES Resource Assessment

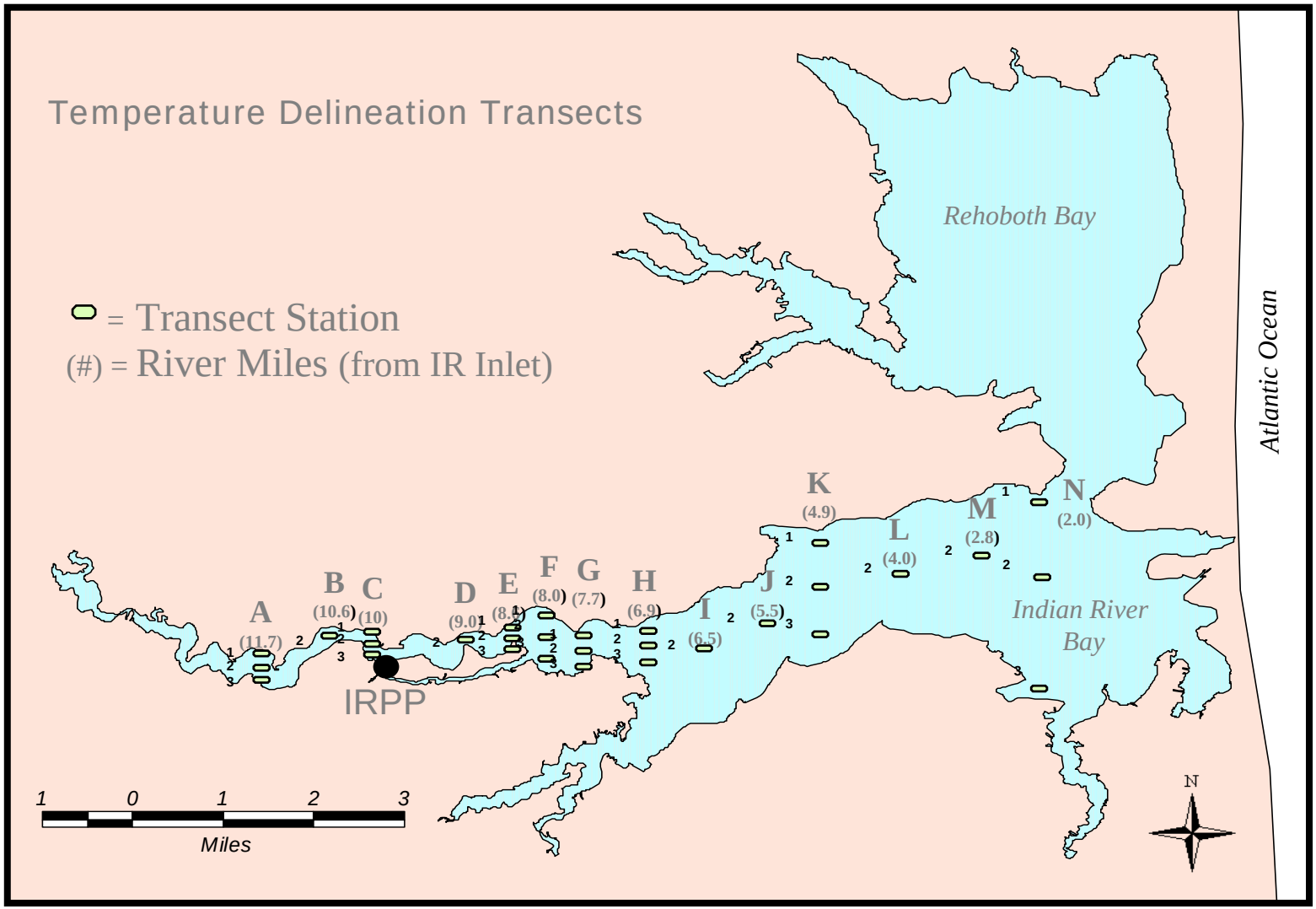
316(a) THERMAL IMPACT STUDIES SCOPE

- Water quality assessment
  - Temperature, dissolved oxygen, nutrients, other
- Thermal plume delineation
  - Extent of thermal plume under various tidal & meteorological conditions
- Fisheries assessment
  - Risk assessment (thermal tolerance)
  - Weight of evidence (population trends)

316(a) THERMAL IMPACT STUDIES SAMPLING PLAN

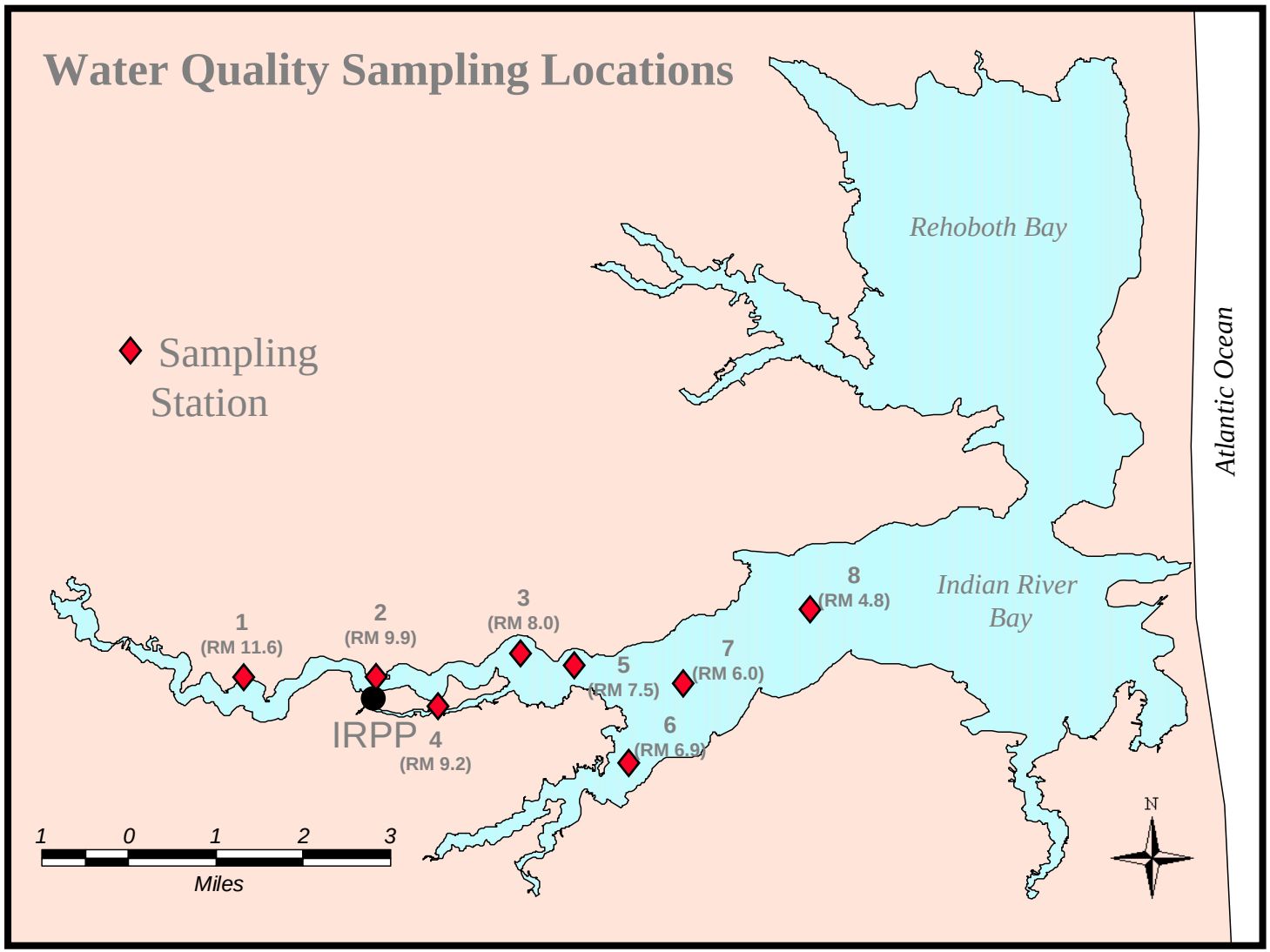
- Sampling period
  - April 1998 - October 1999
- Data collection programs
  - Instantaneous water quality (grab)
  - Temperature plume mapping
  - Datasonde monitoring
  - Ancillary parameters
  - Plant data
  - Meteorological data

THERMAL PLUME DELINEATION



Confidential Information – Not for distribution.

WATER QUALITY SAMPLING

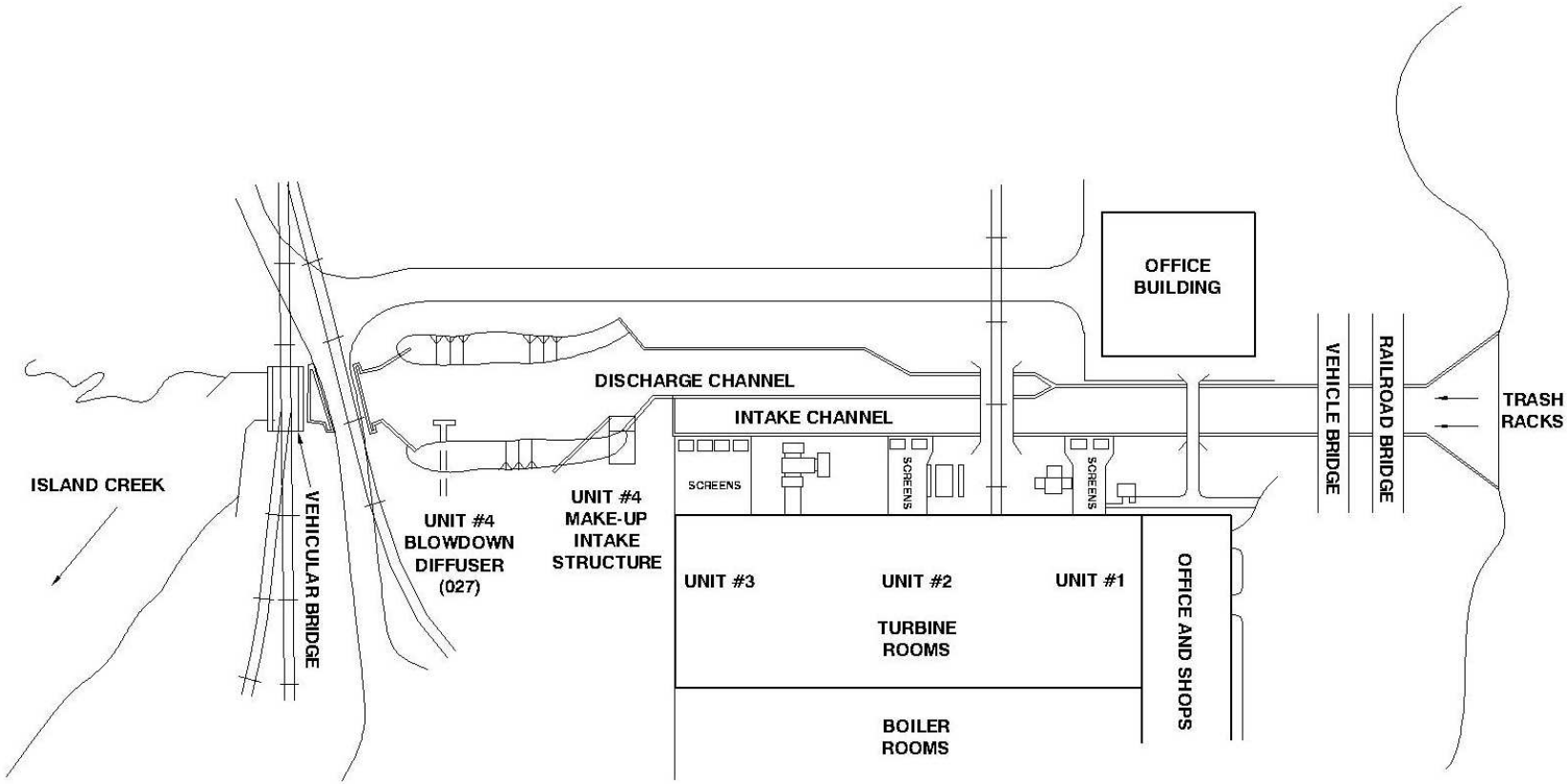


316(a) THERMAL IMPACT STUDIES CONCLUSIONS

- No appreciable harm has occurred to the fish and shellfish populations in the Indian River Estuary from the IRGS discharge
- No blockage to migration results from the IRGS discharge
- Viability of the fish and shellfish populations in the Indian River Estuary is unaffected by the IRGS discharge

COOLING WATER INTAKE

COOLING WATER INTAKE / DISCHARGE CANAL



316(b)
IMPINGEMENT & ENTRAINMENT STUDIES
PURPOSE

- Collect current data on I/E of representative important species (RIS) of fish and shellfish
- Evaluate potential effects of the CWIS on RIS populations of the Indian River Estuary and Rehoboth Bay
- Evaluate whether operation of the CWIS is resulting in an Adverse Environmental Impact

316(b)
IMPINGEMENT & ENTRAINMENT STUDIES SCOPE

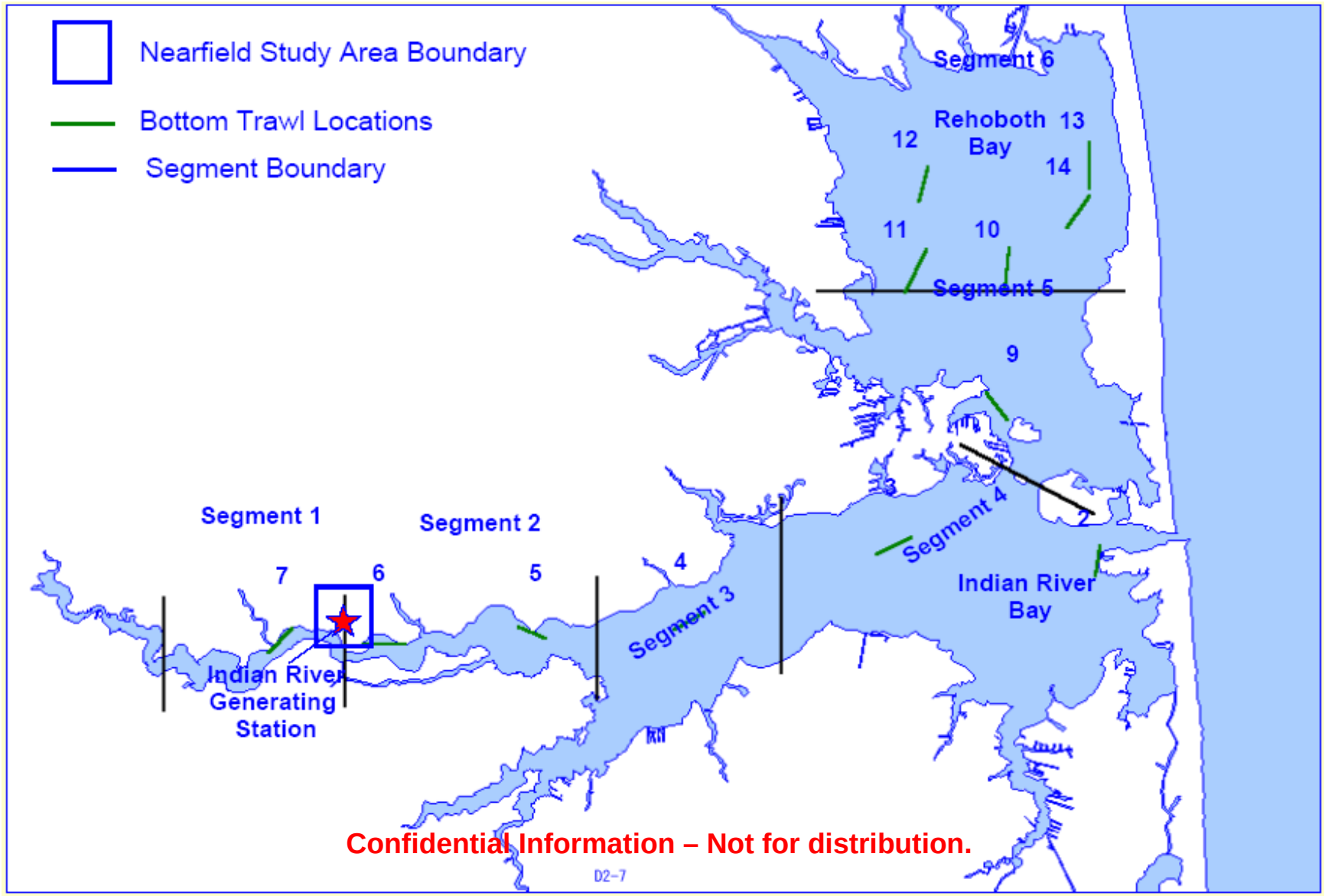
- **Assessment of I/E of six RIS:**
  - Bay anchovy, Atlantic Menhaden, Spot, Atlantic Croaker, Winter Flounder, Blue Crab
- **Population studies**
  - Finfish trawls (monthly)
  - Ichthyoplankton tows (weekly)
- **Plant studies**
  - Impingement sampling (biweekly Dec-Apr; weekly May-Nov)
  - Entrainment sampling (weekly)

316(b)
IMPINGEMENT & ENTRAINMENT STUDIES
SAMPLING PLAN

- Sampling period
  - December 1999 – November 2001

- Data collection
  - Finfish trawls (coord w/ DNREC program)
  - Ichthyoplankton tows (near/far field)
  - Impingement sampling (traveling screens)
  - Entrainment sampling (intake canal)

STUDY AREA & SAMPLING LOCATIONS



316(b)
IMPINGEMENT & ENTRAINMENT STUDIES
IMPACT ASSESSMENT

- **Ecological Risk Assessment Framework**

- **Impact Assessment Models**
  - Emperical Transport Model
  - Equivalent Adult Model
  - Equivalent Yield Model
  - Production Foregone Model

- **Weight of Evidence Analysis**

316(b)
IMPINGEMENT & ENTRAINMENT STUDIES CONCLUSIONS

- Low risk of Adverse Environmental Impact to all Representative Important Species populations

- Operation of the Cooling Water Intake Structure is protective of a balanced indigenous community and long-term sustainability of fish and blue crab populations

SUMMARY / STATUS

- **316(a) Thermal Impacts**
  - Recent studies completed
  - Report submitted to DNREC
  - Formal request submitted for renewal of thermal variance
- **316(b) Intake Impacts**
  - Recent studies completed
  - Report submitted to DNREC
  - Preparing plan to achieve compliance with EPA Phase II reg