<u>Excerpt 10</u>

PSD Permit Application, dated February, 2011 ("Application"), AR I.B.1.a

Energy Answers International, Inc.

Arecibo Puerto Rico Renewable Energy Project

Prevention of Significant Deterioration (PSD) Air Permit Application

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Prevention of Significant Deterioration Air Permit Application

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Quality Board. The data will also be shared by the digital control system of the Project for performance monitoring.

2.2.8 Ash Handling System

Two types of ash are generated when PRF is combusted:

1. Bottom ash is the heavier, coarse fraction of the ash that remains on the boiler grate and is collected at the bottom of the boiler.

2. Fly ash is the lighter, finer fraction of the ash that is carried by combustion gases to the air pollution control equipment where it is removed.

These two ash streams represent a total of approximately 20% (by weight) of the PRF combusted at the Project.

Recognizing that the two ash streams have different chemical and physical properties, the fly ash and bottom ash will be collected and managed separately. This approach to ash management increases the opportunity to recover marketable materials from the bottom ash, while isolating the fly ash for appropriate conditioning and re-use, or disposal.

Descriptions of the bottom ash and fly ash handling and collection systems are as follows:

Bottom Ash Handling System: Each boiler will be equipped with six (6) bottom ash hoppers and four (4) sifting hoppers which will discharge into a bottom ash discharge conveyor located at each hopper outlet. Dry bottom ash is continuously removed from the ash hopper outlets at a rate approximately equal to the ash generation rate in the boiler, while maintaining a seal to avoid introduction of tramp air into the boiler.

The bottom ash hopper discharge systems discharge onto one of two redundant collection conveyors passing under each boiler. The collection conveyors will be of the slip-stick type. Each of the common redundant collection conveyors will have a design conveying capacity of 125% to 150% based on the maximum hourly design and production rate of all boilers discharging to the same conveyor.

<u>Fly Ash Handling System</u>: Fly ash will be collected from the air heater hoppers, Turbosorp® hoppers and fabric filter hoppers using screw conveyors and drag flight conveyors, and transported into a single, common fly ash storage silo.

2.2.9 Steam Turbine/Generator

The steam turbine will be a single-casing, single-flow extraction machine with three uncontrolled extractions and a downward or axial exhaust. The turbine will be directly coupled to an electrical generator that operates at 3,600 RPM. The turbine will be sized at 110% of the rated flow of both boilers. Turbine throttle conditions will be 850 psig and 830°F. The generator will be specified to produce approximately 77 MW at a 0.85 power factor.

2.2.10 Electrical Distribution to the Grid

Electric power exported from the Project will be transmitted through a switchyard to the Puerto Rico Electric Power Agency distribution systems. The main and auxiliary transformers will be located at the Electrical Switchyard, located south of the Power Building, and will be equipped with containment dikes to retain oil in the event of leakage. The Electrical Switchyard will additionally contain a circuit breaker, a disconnect switch, provisions for electric power metering and other interconnection criteria. The transmission line will run underground on the Site to a takeoff tower which will provide the interface with the above ground transmission lines running to the connection point to the PREPA grid.

The necessary power for the Project will be provided by an auxiliary transformer which will receive power from the switchyard. The auxiliary transformer will be sized such that it will be capable of providing auxiliary power during normal, start-up, and shutdown operations. The auxiliary transformer will supply the 4.16 kV switchgear which will be the distribution source for all large motors, the 480 V load centers, motor control centers, and all other station loads.

2.2.11 Condensate and Cooling System

The exhaust steam from the steam turbine will be condensed using a water-cooled condenser with a mechanical draft cooling tower. Steam travels from the turbine exhaust flange into the shell side of the surface condenser where it is condensed. Circulating water flows through the tube-side of the condenser and to the top of the cooling tower modules. Water falls through fill to break it up into droplets for evaporative-cooling, assisted by propeller-type fans drawing air through the sides of the tower, and counter-flow to the dropping water. Condensate is collected in a hotwell that supplies suction to the condensate pumps for reuse in the feedwater system. Demineralized water will be used as make-up to the turbine cycle.

An equipment cooling system provides closed-loop cooling water for equipment applications such as generator air coolers, turbine oil coolers, and fan and pump bearings. The system is comprised of a water-to-water heat exchanger with an open side circulated through the cooling tower and a closed loop side circulated through the equipment. Water is pumped in each circulating water loop by redundant pumps.

2.2.12 Ash Processing

The bottom ash will be conveyed from the boilers to the Ash Processing Building where it will be processed using Energy Answers' proprietary system. This system will separate it into three (3) components: ferrous metal, non-ferrous metals (aluminum, brass, copper, etc.) and a granular material known as Boiler Aggregate™. Boiler Aggregate™ has been demonstrated to have useful applications as a substitute for conventional aggregate in asphaltic underlayment and other construction related products. The bottom ash processing system enables nearly 100% bottom ash recovery, reuse or recycling.

Fly ash will be conditioned with Energy Answers' patented process. Conditioned fly ash will be transported from the facility in the form of a non-hazardous mortar which sets and hardens in the landfill used for its disposal. This process prevents the release of heavy metals and other harmful elements to the environment. Energy Answers is currently researching potential uses for the conditioned product.

To control particulate matter emissions from the Ash Processing Areas, all ash processing equipment and conveyor transfer points will be enclosed and maintained under negative draft by the dust collection system. The dust control system will include a total of five baghouse filter dust collectors. Two redundant (one operating and one standby) dust collectors will collect dust from the bottom ash removal and transfer conveyors located in and adjacent to the boiler building. Two more redundant (one operating and one standby) dust collectors will collect dust from the bottom ash storage bunkers where the ash will be stockpiled on a continuous basis in preparation for reclaim and feed to the ash product recovery process during scheduled processing hours. The fifth dust collector will collect dust from the ash product recovery process. The exhaust from these fabric filters will be vented to the atmosphere.

PRF and ash processing, storage and equipment areas will not be heated or air conditioned because of the large volumes of ventilation airflow required for dust and odor control.

2.2.15 Water Supply and Wastewater Systems

2.2.15.1 *Water Supply System*

Energy Answers conducted an in-depth study of potential sources of water which included:

- Puerto Rico Aqueduct and Sewer Authority (PRASA) water main
- Groundwater
- Surface Water
- Brackish Water from Cano Tiburones; and
- Reclaimed water from Arecibo Waste Water Treatment Plant

This study recommends (i) potable water from PRASA (0.1 million gallons per day [MGD]) for personnel usage, and (ii) brackish water discharged from Cano Tiburones (1.7 MGD) for the cooling tower and boilers, since they are the most environmentally responsible and reliable alternatives to fulfill the needs of the Project.

All piping and systems will be installed per applicable design practices, including proper designation and signage as a non-potable water system. Brackish water will be treated, as necessary, to mitigate bio-fouling potential and will be stored in the Project's Raw Water Storage Tank and/or pond(s).

At least 180,000 gallons will be maintained in the Raw Water Storage Tank at all times for fire protection. This exceeds the firewater storage requirements of the National Fire Protection Association (the NFPA).

The Project will include a demineralizer system to provide high-purity demineralized boiler makeup water as required to maintain boiler system performance. Supply to the demineralization system will be from the Raw Water Storage Tank. The demineralized makeup water will offset the boiler blow down (typically 1% of the steam production rate) necessary to maintain required steam quality and cycle performance. The demineralization system will be a three-stage process, based on can be expected to be achieved from gas reburning technologies range between 50 and 60%. Considering the need for gaseous fuel supply and the size of the proposed Energy Answers boilers, gas reburning is not a feasible option for NOx control. The relatively large quantity of gaseous fuels needed would not be compatible with the Energy Answers boiler design and the relative scarcity of natural gas supply on the island. Gas Reburning is also not consistent with Energy Answers' general philosophy to maximize energy recovery from non-fossil fuel sources. This method of reducing NO_x emissions is better suited for boilers that use natural gas as a primary fuel.

5.2.1.6 *Combustion Techniques (include Low NO_x Burners)*

The most practical and economical NO_x control method is the use of a properly designed, controlled and operated combustion system to achieve good combustion efficiency and minimal NO_x, CO, non-methane hydrocarbon ("NMHC") and trace organic pollutant emissions. Uniform distribution of primary air for flame temperature control and prevention of high excess air conditions, adequate mixing of flue gases in the grate enclosure, and use of overfire air ensure complete combustion and minimal NO_x emissions.

An optimum underfire-to-overfire air ratio minimizes NO_x formation without adversely affecting CO, NMHC, or trace organic emissions. Combustor design and control properly distributes overfire and underfire air to provide uniform air flow over the entire grate area for good mixing and avoidance of hot spots, since high temperature gradients increase NO_x. The control scheme utilizes steam demand, temperature, and CO and oxygen concentrations as parameters to control the combustion process. Modern MWC plants incorporate this method to minimize baseline emissions. Energy Answers will be implementing good combustion practices for minimizing potential emissions of NO_x, CO and NMHC. By itself, however, good combustion practices are not considered BACT for NO_x.

5.2.1.7 *BACT Determination for NO_x Emissions from Boilers*

Based on a review of available control technologies for emissions of NOx from MSW-fired boilers, RSCR technology implemented with good combustion practices is proposed as BACT for this application due to its high NO_x removal efficiency. The lowest NO_x emission limit in the RBLC for MWC is 90 ppmdv on a 12 month rolling average which was permitted for the Hillsborough County Resource Recovery Facility in Hillsborough Florida. Energy Answers is proposing to use RSCR technology to achieve NO_x emissions level of control to 45 ppmdv for its boilers. This level of control expected to be achieved using RSCR technology is significantly higher than what has been achieved using the SNCR systems at similar facilities. SCR was not found to be used at MWC units due to potential for catalyst poisoning and other operational limitations. Since this technology achieves a greater level of control than other MWCs and because it has been proposed as the technology capable of achieving the Lowest Achievable Emission Rate (LAER) in Maryland and Connecticut, RSCR constitutes BACT. However, when costs considerations are made, this technology exceeds what may be expected for sources located in Puerto Rico. Energy Answers, therefore, is voluntarily installing RSCR which, when including cost considerations, is a level of control that may be above and beyond the BACT requirement at this time.

5.2.2 BACT for VOC from Boilers

VOC emissions result from the incomplete combustion of carbon and organic compounds. Factors affecting VOC emissions include firing temperatures, residence time in the combustion zone and combustion chamber mixing characteristics. Because higher combustion temperatures will increase oxidation rates, emissions of VOCs will generally increase when combustion temperatures are lower. Generally, decreased combustion zone temperature will result in an increase in VOC emissions, but a decrease in NO_x formation. An increase in combustion zone residence time, and improved mixing of fuel and combustion air, will increase oxidations rates, thus causing a decrease in VOC emission rates; however, these combustion enhancements typically result in increased NO_x formation. Emissions of NO_x and VOC are thus often inversely related. Accordingly, boiler vendors have had to consider the competing factors involved in NO_x and VOC formation in order to develop units that achieve acceptable emission levels for both pollutants. Depending on the fuels, fuel blends, and combustor design, the level of VOC control achievable by optimizing combustion efficiency may not be sufficient. In those cases, add-on control technologies can be used. The available technologies used for controlling VOC from boilers are thermal oxidation, including catalytic oxidation. Oxidation technologies for VOC control are discussed below.

5.2.2.1 *Thermal and Catalytic Oxidation*

Noble metal (commonly platinum or palladium) oxidation catalysts are used to promote oxidation of VOCs to CO_2 and water at temperatures lower than would

In principle, this enables effective particulate removal at lower pressure drops than with other media.

For removal of collected particulate from the surface of the FF medium, two (2) alternative cleaning techniques are used: pulsejet and reverse-air collectors. Where the FF application is continuous duty, as with MWC operation, pulsejet collectors are most commonly used, with automatic on-line or off-line cleaning. Pulsejet cleaners collect the captured particulate outside of the FF (outside-in cleaning airflow). Both felted and woven fabrics can be used with pulsejet cleaning. Reverse-air cleaners collect the captured particulate inside the FF (inside-out cleaning airflow). They are used predominantly with on-line cleaning cycles. Felted, not woven, fabrics are needed given the very low cleaning air velocities used with reverse-air cleaning.

The advantages claimed for FFs are:

- High removal efficiency is possible over a wide range of particle sizes and inlet loadings,
- Removal performance is normally insensitive to the volumetric gas flow rate,
- Removal performance is not affected by particle resistivity,
- Superior acid gas control for dry scrubber absorption applications, and
- Lower capital cost compared to ESP's.

The disadvantages of FF systems are:

- Potential clogging (blinding) of the filter medium,
- Potential cementation of the filter medium should the flue gas approach the dew point (humid, low temperature conditions),
- Emissions excursions accompanying failure of fabric filter compartment(s), and
- Potential damage from fires.

5.2.3.5 *Proposed BACT for Particulate Matter from the Boilers*

Table 5-3 summarizes PM emission limits listed in the RBLC from comparable MWC-fired electric generation plants. Fabric Filters have been selected as the BACT for PM at each of these units. Consistent with these RBLC findings, Energy Answers proposes to use a fabric filter as BACT for PM from the boilers.

When comparing FF with ESP, the performance data demonstrate that modern fabric filter (FF) and electrostatic precipitator (ESP) can both provide excellent removal of particulate matter. However, FF performance on PRF emissions has tested better than ESP performance for reducing total particulate emissions. Also, the removal efficiencies and performance of ESP's has been observed to decline for particles in the submicron size range. Recent advancements in fabric filter materials have also yielded higher performance levels for capturing PM, PM_{10} and $PM_{2.5}$. And, with respect to compatibility with other air quality control technologies, FF's have a clear advantage over ESP's when considering applications that use alkali reagents for controlling acid gases because of their capacity for capturing unreacted alkali from the spray dryer absorbers. On the filters, the reagent further reacts with acid gases, thereby improving overall acid gas control efficiency for a given amount of reagent.

Specifically, the fabric filters for Energy Answers' boilers will be designed to achieve a PM outlet grain loading of 10 µg/DSCM, corrected to 7% O_2, as measured by EPA Method 5 (excluding condensable matter). The proposed FF's will be equipped with Ryton® felt bags or similar and pulsejet cleaning systems. The proposed emission limit is half of the NSPS emission limit of 20 mg/dscm, corrected to 7% O_2, for new large MWCs. It is also less than the recently permitted PM emission limit for the MSW fired unit in Hillsborough, Florida. Because the proposed PM emission limit is as stringent as (or more stringent than) the top level of control, it is considered BACT and no further analysis is needed. The most stringent emission level found in the RBLC is 12 mg/dscm for the Hillsborough County Resource Recovery Facility in Hillsborough, Florida, a 600 ton per day MWC unit. This limit is permitted for the facility in order to avoid PSD.

5.2.4 BACT for Fine Particulate Matter ($PM_{2.5}$) from the Boilers

5.2.4.1 *BACT for $PM_{2.5}$ – Non-precursors*

Electrostatic precipitators (ESP's) and fabric filters (FF's), or baghouses, are the most widely used control systems for reduction of particulate matter from PRF energy plants. In the United States, wet scrubbers have been used for the reduction of particulate and sulfur dioxide emissions from coal-fired boilers. Wet scrubbers have rarely been used for particulate matter control on MWC energy plants, primarily because of complexities associated with wet sludge and wastewater discharges, high energy requirements, and the total system costs. At most facilities, ESP's or FF's are used because they are the most effective types of control demonstrated to operate reliably on energy plants. In addition, when a spray dryer/absorber is used to emissions of H_2SO_4 from the facility. This proposed BACT limit is approximately equivalent to 0.22 lb/ton.

5.2.6 BACT for Sulfur Dioxide

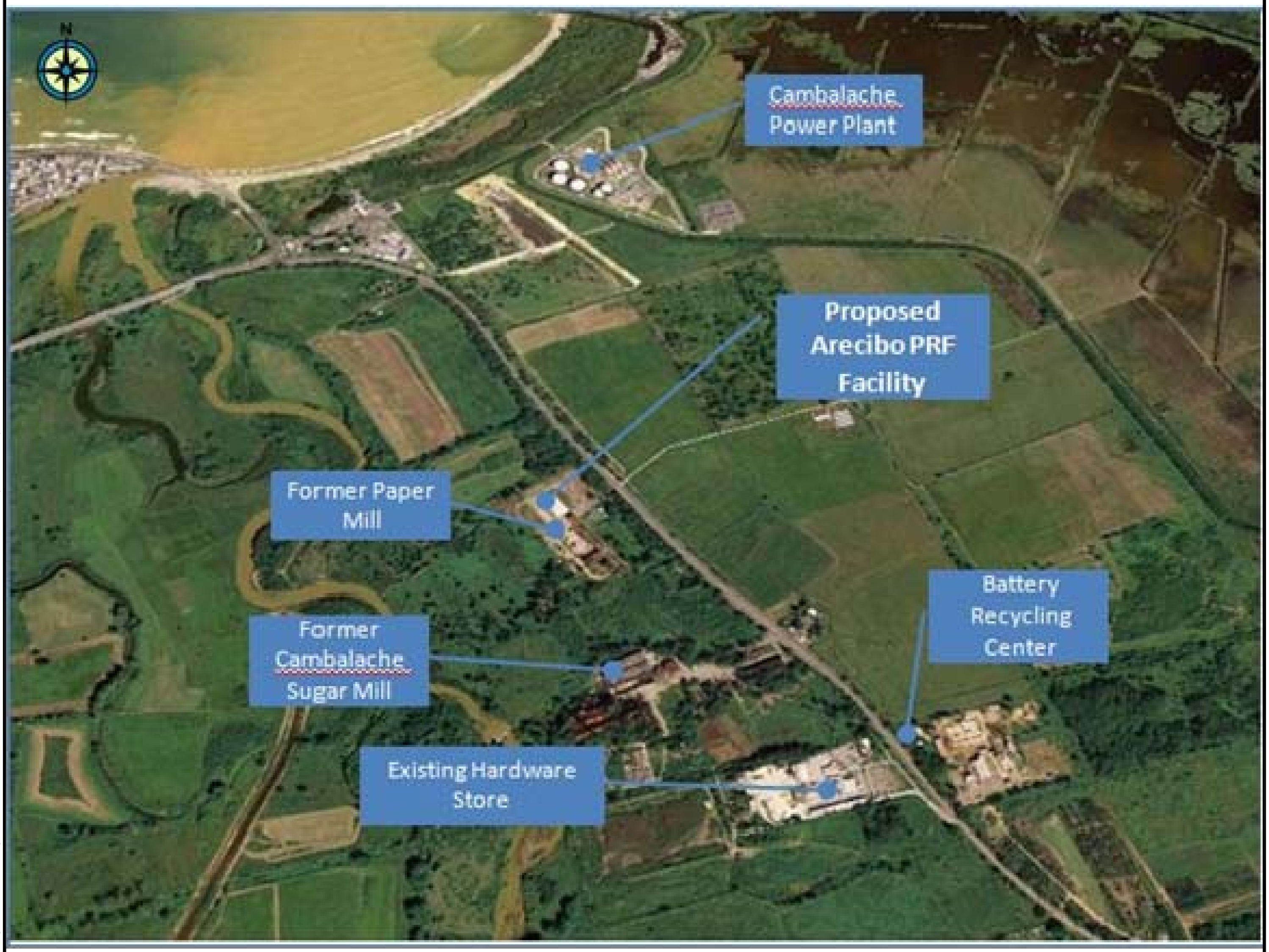
Table 5-7 summarizes emission limits from the RBLC and permits for SO_2 emissions. The lowest demonstrated emission limit is 10.9 ppmdv for the Grayling Generating Station in Crawford, Michigan. The NSPS Subpart Eb limit is 30 ppmdv, corrected to 7% O_2 and 80% efficiency. Energy Answers proposes to achieve a level of control more stringent than the Subpart Eb limit per the vendor performance guarantee of 85% SO_2 reduction or 24 ppmdv, corrected to 7% O_2, whichever is less stringent. This level of control will be achieved using a Turbosorp® Dry Circulating Bed Scrubber/fabric filter and is approximately equivalent to an emission rate of 0.06 lbs/MMBTU. Energy Answers proposes to install a CEMS for SO_2 to demonstrate that actual emissions remain below this limit.

5.2.7 BACT for Carbon Monoxide Emissions from Boilers

Carbon monoxide (CO) is a product of incomplete oxidation of carbon compounds. The source of carbon compounds at MWC facilities can be the fuel, pyrolysis products formed near the fuel bed, compounds in the combustion air, and/or intermediate combustion products. Factors including fuel-rich conditions and low combustion temperatures cause incomplete oxidation of carbon compounds. According to the USEPA, the factors that can lead to excessive CO emissions from MWC are:

- Insufficient bulk oxygen levels to accommodate variations in fuel composition/feed characteristics,
- Insufficient combustion temperature, resulting in quenching of reactions,
- Poor air distribution, and/or inadequate mixing which result in localized oxygen-deficient conditions within the boiler, and
- Excessive carryover of particulate-bound organics from the boiler into the downstream lower-temperature regions of the combustion system, prior to completion of combustion.

Such factors can be produced by introducing overly-wet or low heat-content fuel to the boiler or by poor air or fuel distribution, or when there is inadequate combustion air and residence time.

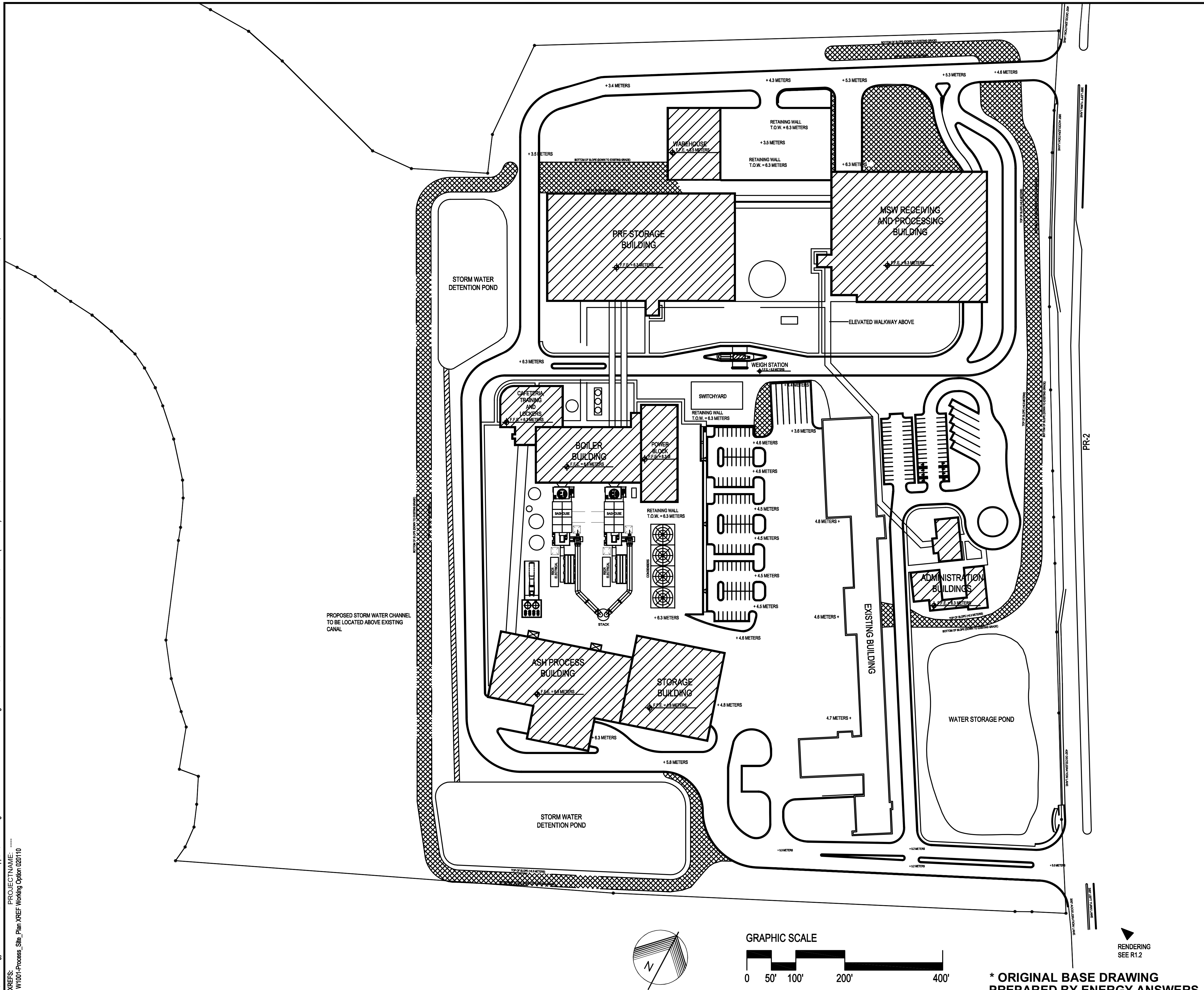


ENERGY ANSWERS INTERNATIONAL, INC.
PUERTO RICO

ARECIBO AREA AERIAL MAP AND LOCATION OF FACILITY

ARCADIS

FIGURE 1-2



* ORIGINAL BASE DRAWING PREPARED BY ENERGY ANSWERS

ARECIBO RESOURCE RECOVERY PROJECT

SCHEMATIC SITE PLAN

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FIGURE **2-3**