Certain figures in this Report contain sensitive, security-related information protected from public disclosure by Federal and State law. This Report is suitable for public disclosure only after these figures are removed.

ESTIMATED MASS FLUX OF TRITIATED GROUNDWATER TO THE INTAKE & DISCHARGE CANALS OYSTER CREEK GENERATING STATION FORKED RIVER, NEW JERSEY

Prepared For:

Exelon Generation Company, LLC

MAY 2009
REF. NO. 055875 (2)

F38

TABLE OF CONTENTS

			Page
1.0	INTRODUCTION		1
2.0	SCOPE OF WORK		2
3.0	BACKGROUND		4
	3.1	STATION LOCATION	4
	3.2	MONITORING WELL NETWORK	4
	3.2.1	2009 ADDITIONAL MONITORING WELL INSTALLATION	4
	3.3	SURROUNDING LAND USE	5
	3.4	TOPOGRAPHY AND SURFACE WATER FEATURES	5
	3.5	GEOLOGY	7
	3.5.1	REGIONAL GEOLOGY	7
	3.5.2	STATION GEOLOGY	7
	3.5.3	GEOLOGY IN THE VICINITY OF THE CST	9
	3.6	HYDROGEOLOGY AND GROUNDWATER FLOW	11
	3.6.1	REGIONAL HYDROGEOLOGY	11
	3.6.2	STATION HYDROGEOLOGY	11
	3.6.3	HYDROGEOLOGY NEAR THE CST	13
	3.7	AQUIFER CHARACTERIZATION	15
	3.8	GROUNDWATER FLOW RATE	15
	3.9	SOURCE AREA DISCUSSION	16
	3.10	DISTRIBUTION OF TRITIUM	17
	3.10.1	TRITIUM DISTRIBUTION – PRIOR TO APRIL 2009	17
	3.10.2	TRITIUM DISTRIBUTION - APRIL THROUGH MAY 2009	17
	3.10.3	TRITIUM PLUMES	17
4.0	MASS FLUX CALCULATION RESULTS		21
	4.1	METHODOLOGY	21
	4.2	RESULTS	22
5.0	REFERENCES		25

LIST OF FIGURES

FIGURE 1 STATION LOCATION MAP

FIGURE 2 STATION BOUNDARIES AND FEATURES

FIGURE 3 STATION MAP AND MONITORING WELL LOCATIONS

FIGURE 4 MAP OF CST LOCATION AND CROSS-SECTION LOCATIONS

FIGURE 5 GEOLOGIC CROSS-SECTION A–A'

FIGURE 6 GEOLOGIC CROSS-SECTION B-B'

FIGURE 7 GEOLOGIC CROSS-SECTION C-C'

FIGURE 8 POTENTIOMETRIC SURFACE CONTOURS
CAPE MAY FORMATION – APRIL 28, 2009 – ENTIRE SITE

FIGURE 9 POTENTIOMETRIC SURFACE CONTOURS
CAPE MAY FORMATION – APRIL 28, 2009 – AREA OF CONCERN

FIGURE 10 POTENTIOMETRIC SURFACE CONTOURS
COHANSEY FORMATION - APRIL 28, 2009 – ENTIRE SITE

FIGURE 11 POTENTIOMETRIC SURFACE CONTOURS
COHANSEY FORMATION – APRIL 28, 2009 – AREA OF CONCERN

FIGURE 12 POTENTIOMETRIC SURFACE CONTOURS
KIRKWOOD FORMATION – APRIL 28, 2009 – ENTIRE SITE

FIGURE 13 HYDROGEOLOGIC CROSS-SECTION A-A'

FIGURE 14 HYDROGEOLOGIC CROSS-SECTION B-B'

FIGURE 15 TRITIUM CONCENTRATIONS

FIGURE 16 CAPE MAY FORMATION ISOCONCENTRATION MAP

FIGURE 17 ISOCONCENTRATION CROSS-SECTION A-A'

FIGURE 18 ISOCONCENTRATION CROSS-SECTION B-B'

FIGURE 19 LINE OF SECTIONS FOR MASS FLUX CALCULATIONS

LIST OF TABLES

TABLE 1	SUMMARY OF EXISTING MONITORING WELL INFORMATION
TABLE 2	SUMMARY OF GROUNDWATER ELEVATION DATA
TABLE 3	SUMMARY OF SURFACE WATER ELEVATION DATA
TABLE 4	SUMMARY OF CALCULATED VERTICAL HYDRAULIC GRADIENTS AT WELL CLUSTER LOCATIONS
TABLE 5	SUMMARY OF AQUIFER TESTING DATA
TABLE 6	SUMMARY OF TRITIUM DATA
TABLE 7	MASS FLUX CALCULATIONS

LIST OF APPENDICES

APPENDIX A WELL LOGS

1.0 INTRODUCTION

This report presents the results of Mass Flux Calculations prepared for the Exelon Generation Company, LLC (Exelon) in regard to the Oyster Creek Generating Station (Station). Previous investigations at the Station include a Hydrogeologic Investigation Report (HIR) (CRA, 2006) and semi-annual monitoring/sampling of the tritium monitoring network as part of Exelon's Groundwater Protection Program. Conestoga-Rovers & Associates (CRA) prepared this Mass Flux Calculations Report to estimate the tritium concentrations that may be migrating in groundwater to the Intake and Discharge Canals.

This report cites the results of CRA's May 2006 Hydrogeologic Investigation Work Plan (Work Plan) and the September 2006 HIR. Additional resources used in preparation of this document include:

- Routine Groundwater and Surface Water Monitoring Round Reports, AMO Environmental Decisions, Fall 2006 through Fall 2008.
- Routine Groundwater and Surface Water Monitoring Round Data, AMO Environmental Decisions, Spring 2009.
- Personal communication with Exelon and Station personnel.
- Station documentation including construction drawings of pertinent structures.
- CRA's April 2009 Scope of Work - Investigative Activities.
- Summary of monitoring well and staff gauge installation activities.
- Survey data of monitoring wells and staff gauge monitoring points.
- Synoptic groundwater and surface water elevation data.
- Station-provided groundwater and surface water analytical data.

2.0 SCOPE OF WORK

This section presents the scope of work completed to calculate the flux of tritium into the Intake and Discharge Canals. CRA completed five preliminary tasks to support the calculations:

- Geologic and hydrogeologic cross-sections were created between the Turbine Building/CST and the Intake/Discharge Canals. These cross-sections were used to evaluate the geology and groundwater flow in the area of interest.
- CRA evaluated various hydraulic parameters (e.g. hydraulic conductivity) from previous investigations during preparation for the mass flux calculations.
- Groundwater contour maps were developed for the overburden (Cape May and Cohansey) aquifers based on one synoptic, station-wide, water level measurement event completed on April 28, 2009.
- Isoconcentration maps were created by contouring the maximum tritium groundwater concentrations observed in April 2009.
- A hydrogeologic cross-section with isoconcentration contours was created along the shoreline of the Station (eastern shore of the Intake and Discharge Canals). The section follows the "horseshoe" shape of the intake/discharge canals along the western portion of the Station. In general, the section follows the groundwater elevation contours. By defining the section along a contour, the groundwater flow is perpendicular to the cross-section allowing the mass flux calculations.

CRA completed these seven tasks to complete the tritium mass flux estimate:

- Subdivided the overburden aquifer (Cape May and Cohansey) into 30 segments (ranging from 50-feet to 200-feet wide).
- Determined the thickness of the aquifer within each segment. The saturated thickness of the Cape May is approximately 10 feet and the saturated thickness for the Cohansey is approximately 50 feet.
- Determined the groundwater flow directions and hydraulic gradients from the groundwater contour maps.
- The groundwater flow rate (Q) (in gallons per minute) for each segment was determined using the following form of Darcy's Law: $Q = KiA$ where K is the hydraulic conductivity of the aquifer (ft/day), i is the horizontal hydraulic gradient in the direction of flow (dimensionless), and $\mathbf{A}$ is the cross-sectional area perpendicular to the direction of flow (square feet).
- Determined the average tritium concentration (C) for each segment from the isoconcentration cross-section. Where the tritium concentration was reported to be

less than the minimum detectable concentration (MDC), a background tritium concentration was used.

- Calculated the mass flux for tritium for each segment (Curies per year [Ci/yr]) using the formula: Mass flux = ***CQ***.
- Added the mass flux for each segment to get the total mass flux of tritium to the Intake and Discharge canals.

The above seven steps were completed three times - once for the Cape May Formation/Fill and twice for the Cohansey Formation. The entire saturated Cape May Formation/Fill was considered one thickness equal to 10 feet; the Cohansey was subdivided into two equal vertical segments of 25-feet each.

CRA made five conservative assumptions in the mass flux calculations:

- Radioactive decay was ignored.
- Elevated tritium concentrations were used as input for the mass flux calculations. Some of these elevated tritium concentrations have not, and may never, reach the groundwater discharge points at the intake and discharge canals.
- Tritium concentrations were considered constant over time.
- Based on available analytical and hydrogeology data, the Kirkwood Formation is not impacted by tritium and therefore was not considered in the mass flux considerations.

The mass flux results were estimated based on the procedures and data described in the above scope of work tasks. These procedures are clearly defined and were consistently followed to minimize the potential for bias. Therefore, by following the defined procedures, different investigators should arrive at the same mass flux values. The procedures are intended to provide a conservative estimate using a repeatable, simplified method based on the existing data and information.

3.0 BACKGROUND

This section presents an overview of the Station location and background information including a description of groundwater flow and tritium concentrations in groundwater.

3.1 STATION LOCATION

Figure 1 shows the location of the Station and the surrounding area. The Station is on US Route 9 south in Forked River, New Jersey. The Station is divided into two parcels. Parcel 1 and Parcel 2 are shown on Figure 2.

Parcel 1 consists of approximately 144 acres and is referred to as the developed portion of the Station. Figure 3 presents a map of Parcel 1. This area is west of Route 9 and is mostly contained within the "horseshoe" formed by the Intake and Discharge Canals. Parcel 1 also includes approximately 12 acres located outside of the horseshoe along the south bank of Oyster Creek.

Parcel 2 consists of approximately 637 acres located to the east of Route 9 and is referred to as the former Finninger Farm Property. This area is primarily vegetated and undeveloped. The Intake Canal flows from Barnegat Bay westward along the northern portion of Parcel 2, and the Discharge Canal flows eastward from the Station to Barnegat Bay along the southern portion of Parcel 2.

3.2 MONITORING WELL NETWORK

Over the history of the Station numerous monitoring wells were installed for various purposes. In total, there are 69 monitoring wells at the Station. The monitoring wells are completed in the Cape May, Cohansey, and Kirkwood Formations. Figure 3 depicts the locations of the monitoring wells. A summary of monitoring well construction details is provided in Table 1.

3.2.1 2009 ADDITIONAL MONITORING WELL INSTALLATION

Between April 21 and 24, 2009, five groundwater monitoring wells (W-50 through W-54) were installed for the investigation related to the CST pipe leaks. All five monitoring wells were installed in the overburden (Cape May Formation) west of the Turbine Building, to a target depth of 20 feet bgs using the hollow-stem auger (HSA) drilling method. Figure 4 shows the recently installed monitoring wells and previously installed monitoring wells near the CST pipe leaks. Monitoring well construction logs for wells MW-50 through MW-54 are provided in Appendix A.

A staff gauge was installed along the western portion of the Discharge Canal just south of the Intake Canal and designated surface water monitoring location SW-2. The existing and new surface water monitoring locations are depicted on Figures 3 and 4.

On April 28, 2009, the five new monitoring wells along with several existing monitoring wells and new (SW-2) and existing (SW-1, North Bridge, and South Bridge) surface water monitoring locations (staff gauges) were surveyed by a licensed New Jersey surveyor to establish reference elevations relative to mean sea level. The measurement locations, top of each well casings, and ground elevations were surveyed to the nearest 0.01-foot relative to the North American Vertical Datum (NAVD) 1988. The survey points were clearly marked for future reference. The locations of the surface water measurement locations and monitoring well locations were surveyed to the nearest 0.10-foot relative to North American Datum (NAD) 1983. The monitoring well and staff gauge reference elevations and measurements are presented in Tables 2 and 3, respectively.

3.3 SURROUNDING LAND USE

The surrounding land use consists of mixed residential, commercial, and undeveloped property. To the north and east of the Station is mixed residential and commercial properties and marinas. The undeveloped Parcel 2 and Barnegat Bay are also located to the east of the Station. To the south is mixed residential and commercial land. Immediately to the west of the Station is a power generating plant owned by Jersey Central Power & Light (JCP&L)/First Energy, the Forked River Combustion Turbine facility, and further west beyond this facility are undeveloped land and the Garden State Parkway.

3.4 TOPOGRAPHY AND SURFACE WATER FEATURES

The Station is located in the Atlantic Coastal Plain physiographic province. The topography in the region is characterized by a slight, undulating coastal plain having low relief. The land surface gradually rises from sea level at Barnegat Bay, which is east of the Station, to approximately 50 feet above mean sea level (AMSL) two miles inland.

This region of the coastal plain has numerous tidal marshes and is incised by easterly flowing streams and creeks [United States Geological Survey (USGS), Quadrangle Map].

Elevations at the Station property west of Route 9 range from approximately 0 to 15 feet AMSL immediately adjacent to the Intake and Discharge Canals to slightly more than 30 feet AMSL in the northwest portion of the Station property. The 132-acre developed portion of the Station located within the "horseshoe" west of Route 9 has an average elevation of 20 feet AMSL. In the immediate vicinity of the major Station structures, the topography slopes steeply down to the Intake and Discharge Canals.

The remaining 637-acre portion of the Station located east of Route 9 is primarily vegetated and undeveloped. The ground surface is relatively level except for the steep slopes at areas adjacent to the Intake and Discharge Canals.

The Station is located approximately 10,000 feet west of the confluence of Forked River and Barnegat Bay, which flows into the Atlantic Ocean. Oyster Creek is located south and west of the Station, and flows into the Discharge Canal directly south of the Station. Oyster Creek is dammed upstream of the Discharge Canal, creating an impoundment (a.k.a. Fire Pond) that serves as a source of surface water for fire protection.

The mean tidal range at the mouth of Oyster Creek is approximately 0.5 feet (Kennish and Lutz, 1984). Portions of the lower reach of Oyster Creek were excavated to form the Discharge Canal. Therefore, the mouth of Oyster Creek and the outlet of the Discharge Canal are the same feature. The mouth of Forked River is located in Barnegat Bay approximately 5,000 feet north of the mouth of Oyster Creek. Therefore, the tidal influence at the mouth of the Forked River would be expected to be similar to that at Oyster Creek.

The Intake Canal, which is the source of cooling water for the Station, was constructed by enlarging an existing tributary of the Forked River and reversing its flow. The Intake Canal is approximately 9,000 feet long and flows westerly along the northern portion of the Station property toward the intake structure. Approximately 476,000 gallons per minute (gpm) of water are withdrawn from the Intake Canal for Station use (NRC, 2007). The Discharge Canal is located south of the Station and drains to Barnegat Bay. The Discharge Canal is approximately 11,000 feet long and flows easterly along the southern portion of the Station away from the discharge point. Three dilution-water pumps on the western side of the Intake Canal pump water directly from the Intake Canal to the Discharge Canal to provide cooling water to normal station discharge water. The dilution-water pumps have a pumping capacity of 260,000 gpm; however, only two of the three pumps operate concurrently for a typical discharge rate to the Discharge Canal of 520,000 gpm (NRC, 2007). Therefore, the total amount of water taken by the Station from the Intake Canal and discharged to the Discharge Canal is approximately 1 million gpm of water to the Discharge Canal.

3.5 GEOLOGY

3.5.1 REGIONAL GEOLOGY

The regional stratigraphy beneath the Atlantic Coastal Plain is composed of a thick wedge of gently seaward-dipping (southeast) horizontal beds of clay, sand, and gravel. These deposits range in thickness from approximately 1,000 feet in the northern portion of the county to approximately 4,000 feet in the southern part of the county. These thick wedges of clastic sediments are unconformably underlain by early Paleozoic or Pre-Cambrian metamorphosed bedrock. Additional details of regional geology are provided in the HIR (CRA, 2006).

3.5.2 STATION GEOLOGY

In descending order, the following six stratigraphic units have been identified and characterized during prior investigations at the Station:

- Fill;
- Cape May Formation;
- upper clay;
- Cohansey Formation;
- lower clay; and
- Kirkwood Formation.

The descriptions of these units are presented below and are based largely on the interpretations and boring logs presented in reports related to previous Station investigations which are referenced in Section 5.0.

Fill

The fill is a tan, medium- to fine-grained sand, with trace to some silt. Based on the descriptions, a substantial portion of the fill material appears to consist of Cape May Formation deposits relocated during Station construction activities. The thickness of fill varies from 0 to 55 feet but typically ranges from 5 to 10 feet. The maximum fill thickness is estimated to be approximately 55 feet in the immediate area of the Reactor Building due to construction excavation [URS Greiner Woodward Clyde (URSGWC), 2000)].

Cape May Formation

The Cape May Formation is described as a light gray to tan, medium- to fine-grained sand, with trace to some silt and occasional coarse sand. The Formation is generally poorly compacted. At the Station, the Cape May Formation ranges in thickness from 0 to 21 feet, primarily due to the varying amount of material excavated and replaced by fill during Station construction. The base of the Cape May Formation generally is defined by the presence of a dark clay unit, referred to in Station reports as the upper clay unit [WCC, 1984].

Upper Clay

The upper clay is a stiff to hard, gray, plastic organic clay containing inclusions (also described as lenses or partings) of dense fine-grained sand with trace to some organic silt. The deposits of fine-grained sand within the upper clay layer have high relative densities and occur as lenses or inclusions. Some boring logs identify these lenses as the dominant feature in 1- to 5-foot intervals within the upper clay unit.

In the area southwest of the Turbine Building, approximately half of the total thickness of the upper clay is silty sand. The upper clay is present at an approximate depth of 20 feet below grade and is approximately 5 to 10 feet thick, except in areas where it has been removed or thinned by excavation during Station construction. For example, the clay has been breached beneath and immediately around the Reactor and Turbine Buildings. Between the Turbine Building and the Intake and Discharge Canals, the upper clay was removed during construction; however, an artificial clay layer (1.5- to 3-feet thick) was placed in this area at the same time (JCP&L, Drawing #4006-2). It is believed that this clay was constructed to minimize the need for dewatering during construction of the Intake/Discharge tunnels and other surrounding structures. Therefore, the native upper clay is present over much of the Station, but is absent in some areas.

Cohansey Formation

The Cohansey Formation underlies the Cape May Formation and is primarily composed of a light-colored, fine- to very coarse-grained quartzose sand with lenses of silt and clay. The sands in the lower portion of the Cohansey Formation are more dense (as evidenced by higher blow counts during drilling) and distinguishable from the less dense sands in the upper portion of the unit. Although most borings at the Station do not penetrate the entire Cohansey Formation, this formation appears to be approximately 60 to 80 feet thick beneath the Station. A clay sequence, referred to at the Station as the "lower clay", marks the base of the Cohansey Formation, which generally is present at approximately 90 to 100 feet below ground surface (bgs) (NUREG-1427, Supplement 28).

Lower Clay

The lower clay is a dense gray medium- to fine-grained sand containing trace to some organic silt and layers or inclusions of very stiff to hard gray organic clay. The thickness of the lower clay is estimated to be 10 to 20 feet (WCC, 1984).

Kirkwood Formation

The Cohansey Formation is underlain by the Kirkwood Formation, which consists of several stratigraphic units. The Kirkwood Formation is described as a medium- to fine-grained sand with trace silt. The Kirkwood Formation ranges from a light gray to yellow-brown micaceous, ilmenitic, lignitic, very fine- to fine-grained quartz sand to coarse sand with some fine to coarse gravel. The Kirkwood thickness in Ocean County ranges from approximately 300 to 400 feet (WCC, 1977). The thickness of this formation beneath the Station is unknown. This unit is interbedded with thin clay units. Several sequences of clay 20 to 30 feet thick may be present within this unit.

The Station's north domestic supply well is completed in the Kirkwood Formation at a depth of 145 feet bgs. The Station's south domestic supply well is completed in the Kirkwood Formation at a depth of 310 feet bgs. The locations of the two supply wells are shown on Figure 3.

3.5.3 GEOLOGY IN THE VICINITY OF THE CST

Figure 4 presents a map of the area near the CST and Intake/Discharge Canals. The figure also shows the lines of sections for geologic and hydrogeologic profiles. The geologic cross-sections are presented as Figures 5, 6 and 7. These sections were selected to provide cross-sectional views of the area of concern (CST), geology, subsurface structures, and the interface of the Intake and Discharge Canals.

Figure 5 presents a southwest-northeast (A-A′) cross-section from the Discharge Canal to the CST. The geology consists of Fill underlain by the Cohansey Formation. A large portion of the central portion of the Station was excavated and re-contoured thereby removing the native Cape May Formation and portions of the upper clay and Cohansey Formation. Excavations as deep as 50 feet were required for the completion the foundations of the Reactor Building and Turbine Building and up to 30 feet for the intake structure. Fill was subsequently placed in these excavations and Station structures were then constructed. The Fill consisted of re-worked Cape May sand that was compacted during placement. A relatively thin (1.5 to 3-foot) clay layer was installed to minimize the need for dewatering during construction.

Cross-section A-A′ shows the following Station structures: the Turbine Building, CST, Intake/Discharge Tunnels, and Discharge Canal. The CST holds approximately 500,000 gallons of water and rests on a concrete ring with Fill immediately beneath the tank. Several underground pipes connect the CST to other Station structures. Our review of the construction drawings and related reports indicate that the Intake Tunnel was constructed immediately on top of the Discharge Tunnel with no intervening space between the two. Therefore, the Intake/Discharge tunnel structure is considered one continuous structure. The Turbine Building and Intake/Discharge Tunnels are constructed into the Cohansey formation at bottom elevations of -13 feet AMSL and -16 feet AMSL, respectively. The Discharge Canal extends to -21 feet AMSL into the Cohansey Formation.

Figure 6 presents a west-east (B-B′) cross-section from the Intake Canal and Intake Structure to the Turbine Building. The B-B′ cross-section line is positioned just north of the Intake/Discharge Tunnels. The geology consists of Fill underlain by the Cohansey Formation. The artificial clay layer is reportedly present beneath the Intake Structure; however, it is not known whether the clay layer extends to the Turbine Building. The Intake Structure is surrounded by concrete and extends from grade level to the artificial clay horizon at -12 feet AMSL.

Figure 7 presents a west-east (C′C′) cross-section from the Intake Canal and Intake Structure to the Turbine Building. This cross-section is through the Intake/Discharge Tunnels. The Intake Tunnel (+15 to 0.5 feet AMSL) rests on top of the Discharge Tunnel (0.5 to -16 feet AMSL). The Intake Tunnel extends from the Turbine Building to the Intake Structure. Discharge Tunnel 1 extends from the Turbine Building approximately 125 feet to the west, where it turns to the southwest and enters the Discharge Canal. Discharge Tunnel 2 was constructed for Unit 2, which was never completed. Discharge Tunnel 2 is approximately 50 west of Discharge Tunnel 1. As a consequence of this design, there is a gap occupied with Fill material from the north side of the tunnels to the south.

3.6 HYDROGEOLOGY AND GROUNDWATER FLOW

3.6.1 REGIONAL HYDROGEOLOGY

The unconsolidated deposits underlying the New Jersey Coastal Plain comprise one interrelated aquifer that includes several aquifers and confining units. The individual formations may change in physical character and act as an aquifer in one area, but serve as a confining unit elsewhere; additionally, some formations are divided into several aquifers or confining units and adjacent formations may form a single aquifer or confining unit (NUREG-1437, Supplement 28).

Regionally, the Cape May and Cohansey Formations are unconfined units and form the water table aquifer. The Cape May and Cohansey Formations are considered to be hydraulically-connected water table aquifers (NUREG-1437, Supplement 28). However, locally the water table aquifer may contain confined beds, resulting in slightly artesian conditions. Regionally, the Kirkwood Formation is considered to be unconfined and hydraulically connected with the lower portion of the Cohansey Formation. Recharge to the Kirkwood Formation is principally by leakage from the water table aquifer in higher elevation inland areas.

On a regional scale, groundwater generally flows to the south-southeast toward the Atlantic Ocean, following the trend of the coastal plain sedimentary bedding. Locally, groundwater flow in the unconfined water-table aquifer generally mimics the surface topography with flow from higher areas towards lower areas. Groundwater discharge provides the base flow to nearby surface water bodies (e.g., creeks, streams, and rivers) or to Barnegat Bay and the Atlantic Ocean (WCC, 1977). Groundwater flow can be influenced by tidal cycles, with greater influences exerted in areas more proximal to the Atlantic Ocean or major surface water bodies.

3.6.2 STATION HYDROGEOLOGY

At the Station, the hydrogeology of Parcel 1 is influenced by six factors:

- the regional groundwater flow;
- the Intake and Discharge Canals;

- the presence of the native upper clay between the Cape May and Cohansey Formations over most of the site;
- the lack of upper clay immediately surrounding Station Structures due to excavation; particularly near the Turbine Building, Reactor Building and Intake and Discharge Canals; and
- the presence of a thin artificial clay between the Turbine Building and Intake/Discharge Canals that was placed during construction to minimize groundwater infiltration into the excavation and, thus, dewatering. The extent and integrity of this clay layer are not known.
- the relatively impermeable man-made groundwater flow barriers present on site (e.g. Intake Structure, Intake/Discharge tunnels, utility conduits, etc.).

The water table under the Station is found in the unconsolidated deposits of the Cape May Formation and Fill. The depth to groundwater typically is 10 to 15 feet bgs. Figures 8 and 9 present contour maps of the Cape May Formation based on groundwater measurements collected on April 28, 2009. The construction of the Intake and Discharge Canals changed groundwater flow directions and increased the depth-to-water in the Cape May Formation by approximately six feet (WCC, 1984). The figures depict radial flow from the central portion from the Station to the west, north, and south towards the Intake and Discharge Canals. These contours indicate that the Intake and Discharge Canals are the primary controlling influence on groundwater flow in the Cape May Formation.

Figure 8 shows an anomalous groundwater low point or depression north of the Reactor Building. Figure 9 shows an anomalous groundwater high point or mounding northwest of the Turbine Building, near the Torus Water Storage Tank (TWST). A depression in the water table is noted east of the Diesel Generator Building due to the ongoing recovery well operations associated with a former diesel fuel release. In addition, due to the abundance of pipelines and utility lines throughout the site, there is a possibility of Cape May groundwater flow being diverted into the pipeline or utility line itself, which could provide a preferential flow path for groundwater flow. Most of these underground structures are constructed above the water table and therefore, should have minimal affect on the shallow flow. However, deeper structures at and below the water table do exist.

The Cape May and Cohansey Formations are separated by the 10- to 15-foot thick upper clay, which was breached during construction. This breach created an unimpeded hydraulic connection between the Cape May and Cohansey Formations near the Reactor and Turbine Buildings, which combined with the natural downward vertical gradient, promoted groundwater flow from the Cape May Formation to the Cohansey Formation.

Water level measurements from the well pairs screened in the Cape May and Cohansey Formations indicate that a downward vertical gradient exists across the Site. Table 4 presents a summary of vertical flow gradients at select well clusters. Vertical gradients are downward in general and strongest by the intake structure and northern unpaved area of the Station.

Figures 10 and 11 present groundwater contour maps of the Cohansey Formation based on groundwater level measurements collected on April 28, 2009. Groundwater flow in the Cohansey Formation flows radially away from a hydraulic high in the central portion of the horseshoe area toward the Intake and Discharge Canals. These flow patterns indicate that, within the footprint of the Station, the flow of groundwater is primarily influenced by the Intake and Discharge Canals, which are receiving groundwater from the Cohansey Formation.

The underlying Kirkwood Formation reportedly extends to an estimated depth of 500 feet. The lower clay separates the Cohansey and Kirkwood Formations. Water level monitoring data indicate that the Kirkwood Formation is a confined aquifer beneath the Station and can be artesian. Artesian heads as high as 22 feet AMSL have been observed in the Kirkwood Formation (WCC, 1984). Figure 12 presents a contour map of the Kirkwood Formation based on groundwater level measurements collected on April 28, 2009. The potentiometric surface contours for the Kirkwood Formation indicate easterly flow toward Barnegat Bay and the Atlantic Ocean, which is consistent with the regional groundwater flow direction. No station structures directly affect groundwater flow within the Kirkwood Formation.

3.6.3 HYDROGEOLOGY NEAR THE CST

Figure 4 presents a map of the area of the CST and Intake/Discharge Canals. The figure also shows the lines of sections for geologic and hydrogeologic profiles. The hydrogeologic cross-sections are presented as Figures 13 and 14.

Figure 13 presents a southwest-northeast (A-A') cross-section from the Discharge Canal to the CST. The figure includes the piezometric surface for the Fill and Cohansey Formation. Groundwater flow in the Fill on the west side of the Intake/Discharge Tunnels is to the southwest with discharge to the Discharge Canal. Groundwater flow in the Fill on the east side of the Intake/Discharge Tunnels is to the northwest (into the page) towards the Intake Structure. The Intake/Discharge Tunnels act as a hydraulic barrier, preventing groundwater flow from the west to the east (and vice versa) with one exception: the gap between Discharge Tunnel 1 and 2.

Since the lateral extent of the artificial clay is unknown, some groundwater in the Cape May presumably flows downward into the Cohansey Formation around the more permeable Fill. This downward flow into the Cohansey Formation is more likely to occur in areas adjacent to the Turbine Building and Intake/Discharge Tunnels, where the native upper clay was extensively removed. The groundwater flow in the Cohansey Formation is from the northeast beneath the Reactor and Turbine Buildings to the southwest with discharge to the Discharge Canal.

Figure 14 presents a west-east (B-B') cross-section from the Intake Canal and Intake Structure to the Turbine Building. The figure includes the piezometric surface for the Fill and Cohansey Formation. Groundwater flow in the Fill is to the west towards the Intake Structure, where the concrete Intake Structure (with Sheet Piles) acts as a groundwater flow barrier. Groundwater flow is directed to the north around the Intake Structure and/or under the Intake Structure, and then west where it discharges to the Intake Canal. Where the native upper clay or clay fill layer is absent, groundwater may also flow downward into the Cohansey Formation and then to the west with discharge into the Intake Canal.

The Intake/Discharge Tunnels act as a barrier preventing groundwater flow from the north to the south with one exception (the gap between Discharge Tunnel 1 and 2). Since the extent of the artificial clay is unknown, and there is a downward vertical gradient, some groundwater in the Cape May likely flows downward into the Cohansey Formation around the more permeable Fill that is adjacent to the Turbine Building and Intake/Discharge Tunnels. The groundwater flow in the Cohansey Formation is from the east beneath the Reactor and Turbine Buildings to the west with discharge into the Intake Canal.

Near the CST and Intake/Discharge Canals, the difference in hydraulic head between the overlying Fill and underlying Cohansey Formation implies that these are separate hydraulic units. However, there are no wells in the Cohansey Formation in this area to confirm the Cohansey piezometric head values.

3.7 AQUIFER CHARACTERIZATION

Table 5 summarizes the available station-specific hydraulic conductivity data. Based upon historical slug test data, the hydraulic conductivity of the Cape May Formation range from 9.50 to 28.51 feet per day with an average value of 19.53 feet per day (WCC, 1984). Results from prior aquifer pumping tests indicate that the hydraulic conductivity of the Cape May Formation is 1.00 feet per day (WCC, 1992). Based upon historical slug test data, the hydraulic conductivity values of the Cohansey range from 12.10 to 38.88 feet per day with an average value of 27.22 feet per day (WCC, 1984).

3.8 GROUNDWATER FLOW RATE

The horizontal groundwater flow velocity of the Cape May/Fill and Cohansey Formation was calculated in the area of concern using Darcy's Law:

$V=KI/n$

where:

V	horizontal groundwater velocity (length/ time)
K	hydraulic conductivity (length/ time)
I	hydraulic gradient (unitless)
n	effective porosity (unitless)

For the Cape May/Fill, the horizontal hydraulic gradient north and south of the Intake/Discharge Tunnels is 0.06 feet/foot and 0.10 feet/foot, respectively. Assuming an average effective porosity of 0.30 and using the calculated horizontal gradients, the average linear groundwater flow velocity in the Cape May is approximately 1,426 feet/year and 2,376 feet/year north and south of the Intake/Discharge Tunnels, respectively.

For the Cohansey Formation, the horizontal hydraulic gradient north and south of the Intake/Discharge Tunnels is 0.02 feet/foot and 0.01 feet/foot, respectively. Assuming an average effective porosity of 0.30 and using the calculated horizontal gradients, the average linear groundwater flow velocity in the Cohansey Formation is approximately 662 feet/year and 331 feet/year north and south of the Intake/Discharge Tunnels, respectively.

3.9 SOURCE AREA DISCUSSION

Based upon 2006 HIR, CRA identified the following as Areas for Further Evaluation (AFEs):
AFE-Oyster Creek-1: Main Complex
AFE-Oyster Creek-2: Condensate Storage Tank
AFE-Oyster Creek-3: Torus Water Storage Tank
AFE-Oyster Creek-4: Isolation Condenser Vents

The area of concern for the current investigation includes AFE-2, which includes the CST and the pipes between the tank and the Turbine Building. The CST is west of the Turbine Building just north of the Intake Tunnel. AFE-2 includes six systems as identified in the HIR:

- 225 - CRD
- 251 - Spent Fuel Pool Cooling
- 421 - Condensate
- 424 - Condensate Transfer System
- 523 - Demineralized Water
- 578 - Condensate Transfer Building System

Infiltration of water within a ESW vault located atop the Intake Tunnel was identified in April 2009. On April 15th, a sample of the water in the ESW vault indicated elevated concentrations of tritium. Subsequently, two leaks within the Condensate pipes (system #421) were identified. The leaks were identified in an 8-inch pipe and 10-inch pipe on April 25th and 27th, respectively. These leaks were repaired in April 2009. The exact rate and duration of the leaks are unknown. However, based on analytical data from nearby monitoring wells, the leak likely occurred after March 12, 2009. This premise is supported in part by the fact that in March the tritium result in MW-15K-1A was LLD, and subsequent tritium results on April 17th (and subsequent samples in April and May) were above 2,000,000 pCi/L.

Depth to groundwater near the leaks is approximately 10 feet bgs for a corresponding groundwater elevation of 11.37 feet AMSL. The west to east trending Intake and Discharge Tunnels are immediately south of the identified leaks. The top and bottom elevations of the Intake/Discharge Tunnels are 13 feet AMSL and -16 feet MSL, respectively. Typically, the tunnels would act as a hydraulic barrier to flow south of the leaks, however, tritium has been observed at elevated levels south of the tunnels. The occurrence of tritium south of the Intake/Discharge Tunnel structure implies that the leak occurred at an elevation at or above the top of the structure in vadose zone and/or was possibly significant enough to create a temporary groundwater mounding effect. In the latter case, the water table would have to rise to an elevation of 15 ft ASML.

3.10 DISTRIBUTION OF TRITIUM

3.10.1 TRITIUM DISTRIBUTION - PRIOR TO APRIL 2009

As part of the Station's existing Groundwater Protection Initiative (GPI), semi-annual groundwater sampling events are completed for tritium analysis. From May 2006 through March 2009, tritium was intermittently detected in groundwater at low levels (maximum 211 pCi/L). In the majority of the samples, tritium was not detected at concentrations greater than the LLD. In all surface water samples, tritium was not detected above the LLD. Therefore, from May 2006 through March 2009 tritium mass flux to the Intake and Discharge Canals has essentially been zero.

Elevated tritium concentrations were detected in well MW-15K-1A at a concentration of 4,000,000 pCi/L in April 2009. The remainder of this section discusses tritium data collected in April through May 2009.

3.10.2 TRITIUM DISTRIBUTION - APRIL THROUGH MAY 2009

Figure 15 presents a summary of the tritium results for the groundwater and surface water samples collected from March 12 through May 6, 2009 at monitoring wells near the CST and surface water locations. Table 6 presents the tritium analytical results for the April/May 2009 CST investigation sampling. Tritium concentrations in the Cape May exceeded the LLD in six monitoring wells (W-5, W-50, W-51, W-53, W-54, and MW-15K-1A). The tritium concentrations in groundwater ranged from 326 pCi/L (W-5) to 6,050,000 pCi/L (W-51). Tritium was not detected at concentrations greater than the LLD in any of the surface water samples (Intake and Discharge Canals) collected during the March through May 2009 sampling events.

3.10.3 TRITIUM PLUMES

Figure 16 presents an isoconcentration map of the distribution of tritium in the Cape May Formation. Figures 17 and 18 present isoconcentration cross-sections along A-A' and B-B′, respectively. These figures are based on the maximum tritium groundwater concentrations detected during sampling activities completed in 2009.

Review of the tritium isoconcentration maps and cross-sections reveals four separate tritium plumes in the area of concern:

- Cape May/Fill plume south of tunnels;
- Cape May/Fill plume north of tunnels;
- Cape May/Fill plume north of ESW vault; and
- Cohansey plume.

Cape May/Fill plume south of tunnels

Well MW-15K-1A southwest of the CST leak has exhibited tritium concentrations of greater than 5,000,000 pCi/L. This well is on the south side of the Intake/Discharge Tunnels, which act as a barrier to groundwater flow to the south (except through a "window" between Discharge Tunnels 1 and 2). Therefore, it is likely that the leak water mounded on top of the Intake/Discharge Tunnels and "spilled over" to the south where it entered the Cape May and migrated toward MW-15K-1A. Based on a review of the Cape May contour map this water likely continues to migrate to the southwest with discharge to the Discharge Canal. This scenario is supported, in part, by the increasing tritium concentrations in monitoring well MW-53 (LLD [April 25th], 9,000 pCi/L [April 29th], 13,100 pCi/L [May 1st], 15,100 pCi/L [May 6th]). This southern plume may also migrate to the west towards the Intake Canal as evidenced by tritium concentrations in well MW-54 (9,500 pCi/L [May 6th]). Although it is more likely that elevated tritium concentrations in MW - 54 are from a separate source (see Cape May/Fill plume north of vault plume).

Cape May/Fill plume north of tunnels

Wells MW-50 and MW-51 near the CST pipe leaks have exhibited tritium concentrations of greater than 5,000,000 pCi/L. These wells are immediately downgradient of the two known leaks. The tritiated-leak water migrated vertically downward to the Cape May and west towards the Intake Structure. This northern plume is presumably forced to the west due to the Intake/Discharge Tunnels to the immediate south, which act as a hydraulic barrier to groundwater flow. As the plume migrates to the west, it can move to the south through the "window" between Discharge Tunnels 1 and 2. In addition, the plume can continue to migrate toward the Intake Structure, where it is either forced to flow north around the Intake Structure or downward into the Cohansey Formation. The latter scenario is more likely if the artificial clay fill layer has been breached.

Cape May/Fill plume north of ESW vault

A tritium concentration of 7,950 pCi/L was detected in well MW-54 west of the ESW vault where tritium was first detected on April 15, 2009 at an elevated concentration of 136,000 pCi/L. The water in the vault likely accumulated in the vault by migrating along the electrical tunnel on top of the Intake/Discharge Tunnels. After an elevated detection of tritium in the vault, the water was pumped out. Tritium detected in well MW-54 may be from water leaking out of the ESW vault.

Cohansey plume

Based on the groundwater flow and hydrogeologic cross-sections, it appears that the artificial clay fill layer serves as an aquitard between the Cape May and underlying Cohansey aquifer. However, the extent and integrity of the clay fill layer are not known. Furthermore, there are no hydraulic and analytical data for the Cohansey Formation in the area of concern. Therefore, it is possible that some tritiated-water from the CST pipe leaks has migrated vertically downward into the Cohansey (likely around the Turbine building and Intake Structure).

To be conservative, CRA assumed that some tritiated-water has migrated vertically downward into the Cohansey Formation, as shown on the hydrogeologic cross-sections A-A′ and B-B′ (Figures 17 and 18). The Cohansey plume would migrate westward in the shallow Cohansey aquifer (top 25 feet) with eventual discharge to the Intake Canal. Deeper groundwater in the bottom two-thirds of the aquifer (35 feet) is unlikely impacted since groundwater gradients in the Cohansey Formation are upward into the canals.

Summary

At least two tritium plumes have resulted from recent CST pipe leaks near the CST tank. These leaks were above the water table and mounded on top of the Intake/Discharge Tunnels and water table. Tritium plumes have resulted from these leaks. The plumes migrate primarily in the Cape May westward with discharge to the Discharge and Intake Canals. There may be a tritium plume may exist in the Cohansey Formation due to vertical downward migration from the Cape May, but a significant plume is not considered as likely since an artificial clay layer installed during construction of the Station minimizes downward groundwater flow. A Cohansey plume would also migrate to the west and discharge to the Intake and Discharge Canals. It is unlikely that the Kirkwood Formation, which is separated from the Cohansey by a regional clay layer ('lower clay') is impacted by the tritiated water.

4.0 MASS FLUX CALCULATION RESULTS

The work tasks that were required to complete the tritium mass flux estimate and results are presented in this section. For purpose of providing the most conservative mass flux estimate, the mass flux calculation used the maximum tritium concentrations recorded from the three sampling events.

4.1 METHODOLOGY

The work tasks that were required to complete the tritium mass flux estimate are summarized below:

- Create a hydrogeologic cross-section with isoconcentration contours along the western shoreline of the Intake and Discharge Canals. The section follows the groundwater elevation contours. By defining the section along a contour, the groundwater flow is perpendicular to the cross-section allowing the mass flux calculations. Figure 19 presents the line of section.
- Subdivide the aquifer into segments (ranging from 50-feet to 200-feet. A summary of the segment dimensions and areas is presented in Table 7).
- Determine the thickness of the aquifer within each segment. The saturated thicknesses of the Cape May and Cohansey Formations are approximately 10 and 50 feet, respectively.
- Determine the groundwater flow direction and hydraulic gradient for each segment from the groundwater contour maps.
- Determine the groundwater flow rate (in gpm) for each segment.
- Determine the tritium concentration for each segment. The calculated average concentrations include background tritium concentrations where applicable. CRA assumed a conservative background concentration of 175 pCi/L based on an average method detection concentration of 149.1 in the Fall of 2008 for both the Cape May and the Cohansey groundwater samples (AMO, 2008).
- Calculate the mass flux for tritium for each segment in Ci/yr.
- Added together the mass fluxes for each segment to get the total mass flux.
- Subtract the background tritium concentration of 175 pCi/L to get the true mass flux.

4.2 RESULTS

Table 7 presents the results of the mass flux calculations including an estimate of groundwater flow, tritium mass flux (Ci/yr), and tritium concentration (pCi/L) into the Intake and Discharge Canals.

The following documents the uncertainty associated with the mass flux calculations:

- Hydraulic conductivity generated from slug tests completed in the Cape May and Cohansey Formations at the Station were used as input. However, without aquifer tests in the immediate vicinity of the area of concern there is uncertainty in these input values.
- The input tritium concentrations for the Cohansey Formation were assumed to be 1/10th of the tritium concentrations in the overlying Cape May/Fill with the exception of the north plume near the Intake Structure. All tritium input concentrations for the Cohansey Formation are rough estimates as no empirical data in the area of concern exists.
- The input tritium concentrations for the Cape May/Fill were assumed to be on the order of the groundwater concentrations detected in monitoring wells near the CST leak (MW-50/MW-51: >=2,000,000 pCi/L). Tritium concentrations at these values currently are not discharging (and may never discharge) to the canals. This assumption was made in order to be conservative, and with the expectation that such concentrations may occur in the future as the plume migrates and discharges into the canals.
- The tritium concentrations discharging to the canals are constant over time. As noted above, the input concentrations have not reached the canals as of the time of this report. Furthermore, if the leak(s) have been stopped, then tritium that reaches the canals will not be constant (i.e., a "slug" of tritium will reach the canals and then tritium concentrations will decline). Therefore, the assumption of a continuous, elevated source of tritium (assuming all leaks have been identified and fixed) is conservative.
- The Cape May/Fill and Cohansey Formations have been assumed to be of constant thickness over the entire length of the Discharge Canal and Intake Canals. This assumption is believed to be relatively accurate and conservative.
- The Cohansey Formation, which is approximately 50 feet thick in the area of concern, has been divided into two segments each 25-feet thick. All groundwater from the Cohansey Formation has been assumed to discharge to the canals. It is possible that the deeper Cohansey Formation groundwater flows to the east-southeast and does not discharge to the canals.

Groundwater Flow

Table 7 presents a summary of the groundwater flow off the Station. This is the sum of the flows through each rectangle. The following table summarizes the estimated groundwater flow conditions at the Station.

Description	Groundwater Flow (gpm)
Intake Canal	
Cape May/Fill	90
Cohansey Formation	102
SUBTOTAL	193
Discharge Canal	
Cape May/Fill	40
Cohansey Formation	110
SUBTOTAL	151
TOTAL FLOW	343

Notes:

Groundwater flow into the Intake Canal is pulled into the Station through the Intake Pumps.

Mass Flux in Ci/yr

Table 7 presents the results of the mass flux calculations in Ci/yr. The table presents the amount of tritium that discharges to surface water (Intake Canal and Discharge Canal) through the Cape May/Fill and Cohansey Formations. In addition, Table 7 shows the cumulative mass flux. The following table summarizes the estimated tritium discharge by flow zone and discharge point.

Description	Tritium (Ci/yr)
Intake Canal	
Cape May/Fill	0.31
Cohansey Formation	32.10
SUBTOTAL	32.41
Discharge Canal	
Cape May/Fill	32.13
Cohansey Formation	1.04
SUBTOTAL	33.17
TOTAL FLOW	65.58

Notes:

Tritium that discharges into the Intake Canal is pulled into the Station through the Intake Pumps.

Including the tritium contribution from background, CRA estimates that a total of 32.41 Ci/yr of tritium is flowing from the groundwater to the Intake Canal, with 33.17 Ci/yr of tritium flowing to the Discharge Canal.

To assess a true tritium mass flux discharge off the Station, as related to plant operations, it is necessary to subtract the contribution from background. As such, CRA estimates that the background tritium concentrations in groundwater are approximately 175 pCi/L. By subtracting the tritium mass contribution from background from the total tritium mass (0.12 Ci/yr); CRA calculated that a total of 65.46 Ci/yr of tritium mass is flowing from groundwater into the canal system.

The following matrix summarizes the mass flux of tritium with and without the background concentrations of tritium.

	Total Mass Flux With Background (Ci/yr)	Background Contribution (Ci/yr)	Total Mass Flux Without Background (Ci/yr)
Tritium	65.68	0.12	65.46

Based on these results and current conditions at the Station, CRA concludes that the cumulative tritium mass flux from groundwater is 32.34 Ci/yr and 33.12 Ci/yr to the Intake and Discharge Canal, respectively.

Tritium Concentration in pCi/L

The table below presents the flow-weighted average tritium concentrations in pCi/L in groundwater that discharges to surface water bodies (minus background).

Description	Tritium Concentration (pCi/L)
Flow weighted average tritium concentration - Intake Canal (minus background)	84,321
Flow weighted average tritium concentration - Discharge Canal (minus background)	41,462
Flow weighted average tritium concentration - Total (minus background)	125,783

5.0 REFERENCES

AMO Environmental Decisions, 2006 through 2009. Routine Groundwater and Surface Water Monitoring Rounds.

Conestoga-Rovers & Associates, May 2006. "Hydrogeologic Investigation Work Plan-Oyster Creek Generating Station".

Conestoga-Rovers & Associates, September 2006. "Hydrogeologic Investigation Report-Oyster Creek Generating Station".

Freeze, R.A. and J.A. Cherry, 1979. "Groundwater", Prentice-Hall, Inc., Englewood Cliffs, NJ.

http://www.deq.state.mi.us/documents/deq-dwrpd-gws-wpu-Tritium.pdf.

http://www.epa.gov/radiation/radionuclides/tritium.htm.

http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/actionmatrix_summary.html.

Jersey Central Power & Light, Co. (JCP&L), Intake and Turbine Area Excavation & Backfill Plans & Section, Drawing 4006-2.

New Jersey Pollutant Discharge Elimination System (NJPDES) Permit (Permit No. NJ0005550).

NJDEP, 2005, Field Sampling Procedures Manual, August 2005

Oyster Creek Site Characterization Plan.

Oyster Creek Generating Station Radiological Environmental Monitoring Program (REMP) Reports.

Puls and Barcelona, 1996. EPA/540/S-95/504.

U.S. Nuclear Regulatory Commission (NRC), 2007. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 28, Regarding Oyster Creek Nuclear Generating Station, Final Report - Main Report, NUREG-1437, Supplement 28, Washington, D.C, January 2007.

URS Greiner Woodward Clyde, 1999, Preliminary Assessment Report - Non Radiological (Appendix M), December 20, 1999.

URS Greiner Woodward Clyde, February 28, 2000. Remedial Action Work Plan - Non Radiological.

URS Greiner Woodward Clyde, January 31, 2000. Site Investigation/Remedial Investigation - Non Radiological.

URS, February 11, 2005. Remedial Investigation - Response to October 13, 2004, NJDEP Comments Letter.

USGS Quadrangle Map (7 ½ min), Oyster Creek Mosaic, New Jersey.

Woodward-Clyde Consultants, August 1983. Phase I Report, Recommended Groundwater Monitoring System.

Woodward-Clyde Consultants, January 1992. Summary of Injection and Pumping Activities.

Woodward-Clyde Consultants, March 1984. Phase II Report, Groundwater Monitoring System.

TABLES

TABLE 1
SUMMARY OF EXISTING MONITORING WELL INFORMATION
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Sample Location	*Installation Date*	*Northing* (UTM Coordinates [1])	*Easting* (UTM Coordinates [1])	*Surface Elevation* (NAVD 88) [2]	*Reference Elevation* (NAVD 88)	*Boring Total Depth* (ft bgs) [3]	*Screened Interval Top* (ft bgs)	*Screened Interval Bottom* (ft bgs)	*Screened Interval Top* (NAVD 88)	*Screened Interval Bottom* (NAVD 88)	*Well Construction*	*Hydrogeologic Unit Screened*
CST Monitoring Network												
MW-50	*4/21/2009*	357368.20	574436.80	13.25	13.71	*20*	*10.0*	*20.0*	*3.25*	*-6.75*	*PVC - 2"*	Cape May
MW-51	*4/22/2009*	357378.30	574480.80	25.12	25.60	*20*	*10.0*	*20.0*	*15.12*	*5.12*	*PVC - 2"*	Cape May
MW-52	*4/23/2009*	357400.90	574353.00	13.08	13.58	*20*	*10.0*	*20.0*	*3.08*	*-6.92*	*PVC - 2"*	Cape May
MW-53	*4/24/2009*	357272.80	574447.60	14.88	15.25	*20*	*5.0*	*20.0*	*9.88*	*-5.12*	*PVC - 2"*	Cape May
MW-54	*4/24/2009*	357276.20	574311.70	9.43	9.82	*20*	*5.0*	*20.0*	*4.43*	*-10.57*	*PVC - 2"*	Cape May
Radiological Monitoring Network												
W-1	12/8/1983	357030.00	574140.51	21.26	20.93	50.0	40.0	50.0	-18.74	-28.74	PVC [4]	Cohansey
W-2	11/8/1983	356965.07	574555.56	21.79	21.27	57.0	45.0	55.0	-23.21	-33.21	PVC	Cohansey
W-3	11/15/1983	357173.00	574499.10	19.18	18.95	24.0	14.0	24.0	5.18	-4.82	PVC	Cape May
W-4	11/11/1983	357176.21	574497.52	19.03	18.66	55.0	42.0	52.0	-22.97	-32.97	PVC	Cohansey
W-5	11/10/1983	357510.81	574373.89	22.29	21.80	20.5	10.5	20.5	11.79	1.79	PVC	Cape May
W-6	11/9/1983	357513.77	574373.37	22.30	22.18	52.0	42.5	52.5	-20.20	-30.20	PVC	Cohansey
W-7	11/16/1983	--	--	Not Surveyed	--	20.0	10.0	20.0	--	--	PVC	Cape May
W-9	11/1/1983	357289.45	574892.97	21.90	21.25	20.0	10.0	20.0	11.90	1.90	PVC	Cape May
W-10	11/1/1983	357286.42	574890.70	21.90	21.73	60.0	47.0	57.0	-25.10	-35.10	PVC	Cohansey
W-12	12/7/1983	357665.89	574755.45	23.14	22.81	20.0	10.0	20.0	13.14	3.14	PVC	Cape May
W-13	12/6/1983	357668.72	574755.21	22.81	22.67	50.0	40.0	50.0	-17.19	-27.19	PVC	Cohansey
W-14	11/3/1983	357702.60	575018.64	22.01	21.79	53.0	43.0	53.0	-20.99	-30.99	PVC	Cohansey
W-15	11/3/1983	357705.99	575017.61	21.94	21.77	20.0	10.0	20.0	11.94	1.94	PVC	Cape May
W-16	11/4/1983	357967.48	574932.88	22.69	21.62	20.0	10.0	20.0	12.69	2.69	PVC	Cape May
Diesel Fuel Monitoring/Dewatering Wells												
W-18	1/5/1988	357005.94	574621.53	22.09	21.79	20.0	--	--	--	--	PVC	Cape May
W-19	1/4/1988	357078.09	574633.20	21.94	21.65	20.0	--	--	--	--	PVC	Cape May
W-20	12/21/1987	356927.67	574542.41	21.81	21.59	20.0	10.0	20.0	11.59	1.59	PVC	Cape May
W-21	12/22/1987	357009.35	574518.32	22.22	22.08	20.0	--	--	--	--	PVC	Cape May
W-22	1/7/1988	357024.77	574590.11	22.14	21.74	39.0	--	--	--	--	PVC	Cape May
W-23	1/6/1988	357055.18	574564.85	21.86	21.65	20.0	--	--	--	--	PVC	Cape May
W-24	12/2/1988	357129.14	574650.80	21.76	21.23	19.0	8.5	18.5	13.26	3.26	PVC	Cape May
W-25	12/5/1988	356962.80	574677.56	21.78	21.16	20.0	9.5	19.5	12.28	2.28	PVC	Cape May
W-26	12/5/1988	357006.86	574643.90	22.01	21.63	20.0	10.0	20.0	12.01	2.01	PVC	Cape May
W-27	12/6/1988	357042.65	574636.24	22.03	21.49	20.0	10.0	20.0	12.03	2.03	PVC	Cape May
W-28	7/24/1989	356991.49	574573.60	21.90	21.64	19.5	--	--	--	--	PVC	Cape May
W-29	7/25/1989	357012.98	574568.51	21.88	21.63	19.5	--	--	--	--	PVC	Cape May
W-30	7/25/1989	357058.25	574516.64	22.58	22.24	19.5	--	--	--	--	PVC	Cape May
W-31	7/25/1989	357052.05	574495.61	23.05	22.74	19.5	--	--	--	--	PVC	Cape May
W-32	7/26/1989	356978.79	574528.41	22.10	21.86	19.5	--	--	--	--	PVC	Cape May
W-33	7/25/1989	357027.30	574498.92	22.75	22.54	19.5	--	--	--	--	PVC	Cape May
W-34	11/7/1991	357196.27	574649.37	21.82	21.53	40.0	30.0	40.0	-8.18	-18.18	PVC	Cape May

TABLE 1
SUMMARY OF EXISTING MONITORING WELL INFORMATION
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Sample Location	*Installation Date*	*Northing* (UTM Coordinates [1])	*Easting*	*Surface Elevation* (NAVD 88) [2]	*Reference Elevation* (NAVD 88)	*Boring Total Depth* (ft bgs) [3]	*Screened Interval Top* (ft bgs)	*Screened Interval Bottom* (ft bgs)	*Screened Interval Top* (NAVD 88)	*Screened Interval Bottom* (NAVD 88)	*Well Construction*	*Hydrogeologic Unit Screened*
Supplemental Network												
W-1A	11/22/1993	358312.23	574678.80	22.14	21.87	50.0	40.0	50.0	-18.13	-28.13	PVC	Cohansey
W-1B	11/22/1993	358313.27	574685.47	22.26	22.04	20.0	10.0	20.0	12.04	2.04	PVC	Cape May
W-2A	11/24/1993	358105.47	574348.03	19.42	19.12	50.0	40.0	50.0	-20.88	30.88	PVC	Cohansey
W-2B	11/24/1993	358110.86	574348.28	19.72	19.47	20.0	10.0	20.0	9.47	-0.53	PVC	Cape May
W-3A	11/23/1993	358067.86	575664.61	20.58	19.76	50.0	40.0	50.0	-20.24	-30.34	PVC	Cohansey
W-3B	11/24/1993	358070.21	575656.06	20.58	19.59	20.0	10.0	20.0	9.59	-0.41	PVC	Cape May
W-4A	11/24/1993	356913.16	575386.94	20.36	19.87	50.0	40.0	50.0	-20.13	-30.13	PVC	Cohansey
W-4B	11/24/1993	356916.37	575388.51	16.78	16.50	20.0	10.0	20.0	6.5	-3.5	PVC	Cape May
Diversion Well Network												
W-1C	1977	357149.27	572740.94	27.57	27.97	60.0	--	--	--	--	PVC	Cohansey
W-1K	1979	357152.49	572727.89	27.19	26.04	150.0	--	--	--	--	PVC	Kirkwood
W-2C	1977	357923.61	573809.58	22.79	24.27	60.0	--	--	--	--	PVC	Cohansey
W-2K	1979	358031.09	573762.78	20.61	20.51	150.0	--	--	--	--	PVC	Kirkwood
W-3C	1977	356595.27	576663.23	6.62	8.67	60.0	--	--	--	--	PVC	Cohansey
W-3K	1977	356602.30	576675.15	6.44	9.04	100.0	--	--	--	--	PVC	Kirkwood
W-4C	1977	359305.15	575867.72	7.06	10.05	60.0	--	--	--	--	PVC	Cohansey
W-4K	1977	359321.51	575874.25	7.42	10.24	100.0	--	--	--	--	PVC	Kirkwood
W-5C	1977	356758.17	580641.91	3.81	4.64	60.0	--	--	--	--	PVC	Cohansey
W-5K	1979	356743.46	580646.07	3.93	4.67	150.0	--	--	--	--	PVC	Kirkwood
Industrial Site Recovery Act Wells												
MW-1A-2A	12/10/1999	357381.01	575043.41	23.00	24.25	24.0	14.2	24.2	8.80	-1.20	PVC	Cape May
MW-1G-1A	12/1/1999	358551.56	575308.98	21.99	23.66	20.0	8.0	18.0	13.99	3.99	PVC	Cape May
MW-1G-1B	Unknown	358550.95	575316.31	21.83	23.31	45.0	--	--	--	--	Unknown	Cape May
MW-1I-1A	12/10/1999	357598.45	574412.75	22.85	22.29	19.0	9.0	19.0	13.85	3.85	PVC	Cape May
MW-1I-2A	12/3/1999	357579.73	574495.37	25.80	25.31	17.5	7.5	17.5	18.30	8.30	PVC	Cape May
MW-15K-1A	12/10/1999	357297.91	574469.23	13.78	13.43	19.0	9.0	19.0	4.43	-5.57	PVC	Cape May
MW-24-2A	12/1/1999	356838.25	579471.24	10.09	12.79	18.0	8.0	18.0	2.09	-7.91	PVC	Cape May
MW-24-3A	12/1/1999	356828.45	578969.43	10.86	13.09	17.0	7.0	17.0	3.86	-6.14	PVC	Cape May
MW-16D	8/6/2004	357573.05	574746.19	22.33	21.84	25.0	15.0	25.0	6.84	-3.16	PVC	Cape May

TABLE 1
SUMMARY OF EXISTING MONITORING WELL INFORMATION
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Sample Location	*Installation Date*	*Northing* (UTM Coordinates [1])	*Easting*	*Surface Elevation* (NAVD 88) [2]	*Reference Elevation* (NAVD 88)	*Boring Total Depth* (ft bgs) [3]	*Screened Interval Top* (ft bgs)	*Screened Interval Bottom* (ft bgs)	*Screened Interval Top* (NAVD 88)	*Screened Interval Bottom* (NAVD 88)	*Well Construction*	*Hydrogeologic Unit Screened*
Test Wells for 1977 Study of Hypothetical Radionuclide Spill												
LW-1	7/6/1977	357632.62	575570.02	20.39	20.75	21.0	--	--	--	--	PVC	Cape May
LW-2	7/7/1977	357645.52	575581.72	20.32	21.34	21.0	--	--	--	--	PVC	Cape May
LW-3	7/7/1977	357630.10	575575.34	20.37	20.67	21.0	11.0	21.0	10.3	0.3	PVC	Cape May
LW-4	7/7/1977	357652.25	575573.74	20.41	21.03	49.0	39.0	49.0	-17.97	-27.97	PVC	Cohansey
Domestic/Make-up Water Wells												
South Well	11/1964	--	--	Not Surveyed	--	300.0	--	--	--	--	Carbon	Kirkwood
North Well	11/11/1987	--	--	Not Surveyed	--	145.0	--	--	--	--	Black Steel	Kirkwood

Notes:

(1) Universal Transverse Mercator (UTM), Zone 18, NAD 83, in feet
(2) NAVD 88 - North American Vertical Datum, 1988, in feet
(3) ft bgs - feet below ground surface
(4) PVC - polyvinyl chloride
-- Data not available

TABLE 2
SUMMARY OF GROUNDWATER ELEVATION DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED ROVER, NEW JERSEY

Formation	*Sample Location*	*Reference Elevation (NAVD 88) (1)*	*Total Depth (ft below Reference)*	*April 28, 2009* *Depth to Water (ft below Reference)*	*April 28, 2009* *Groundwater Elevation (NAVD 88)*	
Cape May						
	W-1B	22.04	20.6	NA	NA	Access not provided
	W-2B	19.47	21.1	5.73	13.74	
	W-3B	19.59	17.10	6.31	13.28	
	W-4B	16.50	20.3	7.31	9.19	
	W-3	18.95	22.80	15.66	3.29	
	W-5	21.80	20.7	12.37	9.43	
	W-7	unable to survey	20.4	13.63	-	
	W-9	21.25	19.5	15.27	5.98	
	W-12	22.81	19.5	14.80	8.01	
	W-15	21.77	20.0	11.51	10.26	
	W-16	21.62	19.0	9.50	12.12	
	W-20	21.59	19.7	16.24	5.35	
	MW-15K-1A	13.43	18.5	5.87	7.56	
	MW-1A-2A	24.25	24.5	15.36	8.89	
	MW-1I-1A	22.29	17.3	11.81	10.48	
	MW-1I-2A	25.31	16.8	12.14	13.17	
	MW-16D	21.84	24.6	17.72	4.12	
	MW-24-2A	12.79	11.1	10.00	2.79	
	MW-24-3A	13.09	20.4	10.58	2.51	
	LW-3	20.67	21.7	6.96	13.71	
	W-18	21.79	19.4	14.22	7.57	
	W-19	21.65	19.3	14.11	7.54	
	W-21	22.08	19.7	16.07	6.01	
	W-22	21.74	39.0	19.59	2.15	
	W-23	21.65	17.3	-	-	
	W-24	21.23	18.0	13.66	7.57	
	W-25	21.16	18.6	13.39	7.77	
	W-26	21.63	19.4	13.86	7.77	
	W-27	21.49	18.0	13.80	7.69	
	W-28	21.64	19.0	18.85	2.79	
	W-29	21.63	19.4	19.33	2.30	
	W-30	22.24	18.8	16.18	6.06	
	W-31	22.74	19.6	17.04	5.70	
	W-32	21.86	19.5	15.66	6.20	
	W-33	22.54	19.6	16.68	5.86	
	LW-2	21.34	21.5	7.55	13.79	
	MW-1G-1A	23.66	20.4	9.79	13.87	
	LW-1	20.75	8.0	7.05	13.7	
	W-50	13.25	20.0	8.98	4.27	
	W-51	25.12	20.0	13.75	11.37	
	W-52	13.08	20.0	10.74	2.34	
	W-53	14.55	20.0	8.82	5.73	
	W-54	9.43	20.0	7.22	2.21	

TABLE 2
SUMMARY OF GROUNDWATER ELEVATION DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED ROVER, NEW JERSEY

Formation	*Sample Location*	*Reference Elevation (NAVD 88) (1)*	*Total Depth (ft below Reference)*	*April 28, 2009* *Depth to Water (ft below Reference)*	*April 28, 2009* *Groundwater Elevation (NAVD 88)*	
Cohansey						
	W-1	20.93	49.0	18.98	1.95	
	W-1A	21.87	50.0	NA	NA	Access not provided
	W-2A	19.12	51.0	18.24	0.88	
	W-4A	19.87	50.2	12.74	7.13	
	W-2	21.27	53.6	19.61	1.66	
	W-3A	19.76	44.8	17.67	2.09	
	W-4	18.66	48.5	16.88	1.78	
	W-6	22.18	47.7	20.60	1.58	
	W-10	21.73	55.0	17.88	3.85	
	W-13	22.67	48.9	19.68	2.99	
	W-14	21.79	52.0	18.32	3.47	
	LW-4	21.03	48.3	17.93	3.10	
	W-34	21.53	39.5	17.93	3.6	
	MW-1G-1B	23.31	45.1	21.3	2.01	
	W-1C	27.97	48.2	18.04	9.93	
	W-2C	24.27	46.7	22.49	1.78	
	W-3C	8.67	60	5.53	3.14	
	W-4C	10.05	60	9.10	0.95	
	W-5C	4.64	39.0	0.60	4.04	
Kirkwood						
	W-1K	26.04	150.0	9.80	16.24	
	W-2K	20.51	150.0	7.31	13.20	
	W-3K	9.04	100.0	2.70	6.34	
	W-4K	10.24	100.0	5.67	4.57	
	W-5K	4.67	150.0	2.20	2.47	

Notes:

(1) NAVD 88 - North American Vertical Datum, 1988, in feet

TABLE 3
SUMMARY OF SURFACE WATER ELEVATION DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Sample Location	*Reference Elevation (ft AMSL)* (1)	*April 24, 2006*	
		Depth to Water (ft Below Reference)	*Surface Water Elevation (ft AMSL)*
SW-1 (2)	-1.10	1.40	-2.50 (estimated)
SW-2 (3)	1.85	1.15	0.70
North Bridge (4)	11.10	12.78	-1.68
South Bridge	11.10	10.60	0.50

Note:

(1) ft AMSL - feet above mean sea level
(2) Surveyed by others to NGVD 1929, converted to NGVD 1983
(3) Installed, surveyed, and measured on April 28, 2009
(4) Only surface water gauging performed

TABLE 4
SUMMARY OF CALCULATED VERTICAL HYDRAULIC GRADIENTS AT WELL CLUSTER LOCATIONS
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Sample Location	*Formation*	*Top of Screen Elevation (NAVD 88)* [1]	*Bottom of Screen Elevation (NAVD 88)*	*Mid-Point of Screen Elevation (NAVD 88)*	*April 24, 2006*		*April 28, 2009*	
					Water Level (NAVD 88)	*Vertical Gradient (ft/ft downward)* [2]	*Water Level (NAVD 88)*	*Vertical Gradient (ft/ft downward)* [2]
W-3	CM	5.18	-4.82	5.00	3.01	0.035	3.29	0.046
W-4	CO	-22.97	-32.97	-27.97	1.86		1.78	
W-5	CM	11.97	1.79	6.88	7.94	0.190	9.43	0.245
W-6	CO	-20.20	-30.20	-25.20	1.83		1.58	
W-9	CM	11.90	1.90	6.90	5.47	0.042	5.98	0.058
W-10	CO	-25.10	-35.10	-30.10	3.91		3.85	
W-12	CM	13.14	3.14	8.14	7.45	0.141	8.01	0.166
W-13	CO	-17.19	-27.19	-22.19	3.17		2.99	
W-15	CM	11.94	1.94	6.94	9.06	0.170	10.26	0.206
W-14	CO	-20.99	-30.99	-25.99	3.45		3.47	

Notes:

(1) NAVD 88 - North American Vertical Datum, 1988, in feet
(2) Positive value denotes downward vertical gradient; negative value denotes upward vertical gradient
CM Cape May Formation
CO Cohansey Formation

TABLE 5
SUMMARY OF AQUIFER TESTING DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

Well Identification	*Formation*	*Permeability (ft/sec)*	*Permeability (ft/day)*
W-1	Cohansey	3.00E-04	25.92
W-2	Cohansey	2.80E-04	24.19
W-3	Cape May	2.20E-04	19.01
W-4	Cohansey	3.70E-04	31.97
W-5	Cape May	2.60E-04	22.46
W-6	Cohansey	1.40E-04	12.10
W-7	Cape May	2.10E-04	18.14
W-8	Fill	1.30E-03	112.32
W-9	Cape May	3.30E-06	0.29
W-10	Cohansey	3.30E-05	2.85
W-12	Cape May	1.10E-04	9.50
W-13	Cohansey	4.50E-04	38.88
W-14	Cohansey	3.50E-04	30.24
W-15	Cape May	3.30E-04	28.51
W-16	Cape May	2.80E-04	24.19
W-17	Kirkwood	1.50E-04	12.96
	AVG All	**2.99E-04**	**25.85**
	AVG Cape May	**2.02E-04**	**17.44**
	AVG Cohansey	**2.75E-04**	**23.74**
	AVG Kirkwood	**1.50E-04**	**12.96**

Notes:
1) ft/sec = feet per second.
2) Data source for W-1 through W-17: Phase II Report, Groundwater Monitoring System (Woodward Clyde Consultants, March 1984)
3) Data source for W-18 through W-33: (Preliminary Assessment Report - Non Radiological (Appendix M), URS Greiner Woodward Clyde, December 20, 1999)

TABLE 6
SUMMARY OF TRITIUM DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

	W-5	MW-15K-1A		MW-50		MW-51	
Date of Sample	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown
3/12/2009	<200		<200				
4/15/2008							
4/16/2008	<200						
4/17/2008		4,460,000					
4/18/2008							
4/19/2008							
4/20/2008	<200	2,480,000	2,390,000				
4/21/2008				5,050,000			
4/22/2008				5.050,000		6,050,000	
4/23/2008							
4/24/2008							
4/25/2008							
4/26/2008							
4/27/2008							
4/29/2008		4,890,000		4,890,000		3,600,000	
5/1/2009		5,950,000					

Notes:
1) All results in picoCuries per liter (pCi/L)
2) OC = Sample analyzed by Oyster Creek
3) Teledyne Brown = Sample analyzed by Teledyne Brown

TABLE 6
SUMMARY OF TRITIUM DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

	MW-52		MW-53		MW-54		CST -9	
Date of Sample	OC	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown
3/12/2009								
4/15/2008								
4/16/2008								
4/17/2008								
4/18/2008								<200
4/19/2008								
4/20/2008								<200
4/21/2008								
4/22/2008								
4/23/2008								
4/24/2008	<2,000				7,950			
4/25/2008			<2,000					
4/26/2008								
4/27/2008								
4/29/2008			9,000		<LLD			
5/1/2009			13,100		<LLD			

Notes:

1) All results in

2) OC = Sampl

3) Teledyne Brc

TABLE 6
SUMMARY OF TRITIUM DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

	W-3		W-4		W-6	
Date of Sample	OC	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown
3/12/2009		<200		<200		<200
4/15/2008						
4/16/2008						<200
4/17/2008		<200		<200		
4/18/2008				<200		
4/19/2008						
4/20/2008		<200		<200		<200
4/21/2008						
4/22/2008						
4/23/2008						
4/24/2008						
4/25/2008						
4/26/2008						
4/27/2008						
4/29/2008						
5/1/2009						

Notes:
1) All results in
2) OC = Sampl
3) Teledyne Br

TABLE 6
SUMMARY OF TRITIUM DATA
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

	MW-1I-1A		MW-1I-2A		CST-2	
Date of Sample	OC	Teledyne Brown	OC	Teledyne Brown	OC	Teledyne Brown
3/12/2009		<200				
4/15/2008						
4/16/2008						
4/17/2008		<200	Dry		Dry	
4/18/2008						
4/19/2008						
4/20/2008		<200		<200	Dry	
4/21/2008						
4/22/2008						
4/23/2008						
4/24/2008						
4/25/2008						
4/26/2008						
4/27/2008						
4/29/2008						
5/1/2009						

Notes:
1) All results in
2) OC = Sampl
3) Teledyne Br

TABLE 7
MASS FLUX CALCULATIONS
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

ID	Input Tritium Concentration (pCi/L)	Area (sq ft)	Hydraulic Conductivity (ft/day)	Hydraulic Gradient (ft/ft)	Groundwater Flow (gal/min)	Weighted Ave. Concentration (pCi/gal)	Rectangle Mass Flux (pCi/yr)	Subtotal Mass Flux (Ci/yr)	Input Tritium Concentration (pCi/L) MINUS BACKGROUND	Weighted Ave. Concentration (pCi/gal) MINUS BACKGROUND	Rectangle Background Mass Flux (pCi/yr)	Subtotal Mass Flux (Ci/yr)	Subtotal Mass Flux (Ci/yr) - Without Background
INTAKE CANAL													
Cape May Formation													
CM-I-01	175	2,000	20	0.018	3.74	0.90	1,303,155,922		0	0	1,303,155,922		
CM-I-02	175	2,000	20	0.018	3.74	0.90	1,303,155,922		0	0	1,303,155,922		
CM-I-03	175	2,000	20	0.018	3.74	0.90	1,303,155,922		0	0	1,303,155,922		
CM-I-04	175	2,000	20	0.065	13.51	3.24	4,705,840,831		0	0	4,705,840,831		
CM-I-05	175	2,000	20	0.075	15.58	3.74	5,429,816,343		0	0	5,429,816,343		
CM-I-06	175	2,000	20	0.07	14.55	3.49	5,067,828,587		0	0	5,067,828,587		
CM-I-07	175	1,000	20	0.065	6.75	1.62	2,352,920,416		0	0	2,352,920,416		
CM-I-08	275	1,000	20	0.05	5.19	1.96	2,844,189,513		100	1	1,809,938,781		
CM-I-09	275	1,000	20	0.05	5.19	1.96	2,844,189,513		100	1	1,809,938,781		
CM-I-10	1,000	500	20	0.05	2.60	3.56	5,171,253,660		825	3	904,969,391		
CM-I-11	10,000	500	20	0.05	2.60	35.62	51,712,536,605		9,825	35	904,969,391		
CM-I-12	10,000	500	20	0.067	3.48	47.73	69,294,799,050		9,825	47	1,212,658,983		
CM-I-13	10,000	500	20	0.067	3.48	47.73	69,294,799,050		9,825	47	1,212,658,983		
CM-I-14	2,000,000	500	20	0	0.00	0.00	0		1,999,825	0	0		
CM-I-15	2,000,000	500	20	0	0.00	0.00	0		1,999,825	0	0		
CM-I-16	10,000	500	20	0.04	2.08	28.49	41,370,029,284		9,825	28	723,975,512		
CM-I-17	10,000	500	20	0.04	2.08	28.49	41,370,029,284		9,825	28	723,975,512		
CM-I-18	1,000	500	20	0.04	2.08	2.85	4,137,002,928		825	2	723,975,512		
							Subtotal	0.31				0.03	0.28
Cohansey Formation													
CO-I-01-A	175	10,000	25	0.004	5.19	1.25	1,809,938,781		0	0	1,809,938,781		
CO-I-02-A	175	10,000	25	0.004	5.19	1.25	1,809,938,781		0	0	1,809,938,781		
CO-I-03-A	175	10,000	25	0.004	5.19	1.25	1,809,938,781		0	0	1,809,938,781		
CO-I-04-A	175	10,000	25	0.004	5.19	1.25	1,809,938,781		0	0	1,809,938,781		
CO-I-05-A	175	10,000	25	0.006	7.79	1.87	2,714,908,172		0	0	2,714,908,172		
CO-I-06-A	175	10,000	25	0.006	7.79	1.87	2,714,908,172		0	0	2,714,908,172		
CO-I-07-A	175	5,000	25	0.006	3.90	0.93	1,357,454,086		0	0	1,357,454,086		
CO-I-08-A	175	5,000	25	0.006	3.90	0.93	1,357,454,086		0	0	1,357,454,086		
CO-I-09-A	175	5,000	25	0.007	4.55	1.09	1,583,696,434		0	0	1,583,696,434		
CO-I-10-A	175	1,250	25	0.007	1.14	0.27	395,924,108		0	0	395,924,108		
CO-I-10-B	175	1,250	25	0.007	1.14	0.27	395,924,108		0	0	395,924,108		
CO-I-11-A	1,000	1,250	25	0.01	1.62	2.23	3,232,033,538		825	2	565,605,869		
CO-I-11-B	175	1,250	25	0.01	1.62	0.39	565,605,869		0	0	565,605,869		
CO-I-12-A	10,000	1,250	25	0.01	1.62	22.26	32,320,335,378		9,825	22	565,605,869		
CO-I-12-B	175	1,250	25	0.01	1.62	0.39	565,605,869		0	0	565,605,869		
CO-I-13-A	100,000	1,250	25	0.023	3.73	512.02	743,367,713,692		99,825	511	1,300,893,499		
CO-I-13-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
CO-I-14-A	2,000,000	1,250	25	0.023	3.73	10,240.31	14,867,354,273,836		1,999,825	10,239	1,300,893,499		
CO-I-14-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
CO-I-15-A	2,000,000	1,250	25	0.023	3.73	10,240.31	14,867,354,273,836		1,999,825	10,239	1,300,893,499		
CO-I-15-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
CO-I-16-A	100,000	1,250	25	0.023	3.73	512.02	743,367,713,692		99,825	511	1,300,893,499		
CO-I-16-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
CO-I-17-A	100,000	1,250	25	0.023	3.73	512.02	743,367,713,692		99,825	511	1,300,893,499		
CO-I-17-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
CO-I-18-A	10,000	1,250	25	0.023	3.73	51.20	74,336,771,369		9,825	50	1,300,893,499		
CO-I-18-B	175	1,250	25	0.023	3.73	0.90	1,300,893,499		0	0	1,300,893,499		
							Subtotal	32.10				0.04	32.07
TOTAL - INTAKE CANAL				**Subtotal**	**193**	**22,324**		**32.41**		**22,278**		**0.07**	**32.34**

TABLE 7
MASS FLUX CALCULATIONS
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

ID	Input Tritium Concentration (pCi/L)	Area (sq ft)	Hydraulic Conductivity (ft/day)	Hydraulic Gradient (ft/ft)	Groundwater Flow (gal/min)	Weighted Ave. Concentration (pCi/gal)	Rectangle Mass Flux (pCi/yr)	Subtotal Mass Flux (Ci/yr)	Input Tritium Concentration (pCi/L) MINUS BACKGROUND	Weighted Ave. Concentration (pCi/gal) MINUS BACKGROUND	Rectangle Background Mass Flux (pCi/yr)	Subtotal Mass Flux (Ci/yr)	Subtotal Mass Flux (Ci/yr) - Without Background
DISCHARGE CANAL													
Cape May Formation													
CM-D-01	175	2,000	20	0.01	2.08	0.64	723,975,512		0	0	723,975,512		
CM-D-02	175	2,000	20	0.01	2.078	0.64	723,975,512		0	0	723,975,512		
CM-D-03	175	2,000	20	0.016	3.325	1.02	1,158,360,820		0	0	1,158,360,820		
CM-D-04	175	1,000	20	0.02	2.078	0.64	723,975,512		0	0	723,975,512		
CM-D-05	175	1,000	20	0.02	2.078	0.64	723,975,512		0	0	723,975,512		
CM-D-06	175	1,000	20	0.03	3.117	0.96	1,085,963,269		0	0	1,085,963,269		
CM-D-07	175	500	20	0.04	2.078	0.64	723,975,512		0	0	723,975,512		
CM-D-08	175	500	20	0.05	2.597	0.80	904,969,391		0	0	904,969,391		
CM-D-09	1,000	500	20	0.05	2.597	4.56	5,171,253,660		825	4	904,969,391		
CM-D-10	10,000	500	20	0.05	2.597	45.57	51,712,536,605		9,825	45	904,969,391		
CM-D-11	100,000	500	20	0.1	5.19	911.35	1,034,250,732,093		99,825	910	1,809,938,781		
CM-D-12	1,000,000	500	20	0.1	5.19	9,113.49	10,342,507,320,930		999,825	9,112	1,809,938,781		
CM-D-13	2,000,000	500	20	0.1	5.19	18,226.97	20,685,014,641,859						
							Subtotal	32.13				0.01	32.11
Cohansey Formation													
CO-D-01-A	175	10,000	25	0.015	19.48	5.98	6,787,270,429		0	0	6,787,270,429		
CO-D-02-A	175	10,000	25	0.015	19.48	5.98	6,787,270,429		0	0	6,787,270,429		
CO-D-03-A	175	10,000	25	0.015	19.48	5.98	6,787,270,429		0	0	6,787,270,429		
CO-D-04-A	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-04-B	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-05-A	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-05-B	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-06-A	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-06-B	175	2,500	25	0.015	4.87	1.50	1,696,817,607		0	0	1,696,817,607		
CO-D-07-A	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-07-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-08-A	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-08-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-09-A	275	1,250	25	0.01	1.62	0.78	888,809,223		100	0	565,605,869		
CO-D-09-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-10-A	1,000	1,250	25	0.01	1.62	2.85	3,232,033,538		825	2	565,605,869		
CO-D-10-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-11-A	10,000	1,250	25	0.01	1.62	28.48	32,320,335,378		9,825	28	565,605,869		
CO-D-11-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-12-A	100,000	1,250	25	0.01	1.62	284.80	323,203,353,779		99,825	284	565,605,869		
CO-D-12-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
CO-D-13-A	200,000	1,250	25	0.01	1.62	569.59	646,406,707,558		199,825	569	565,605,869		
CO-D-13-B	175	1,250	25	0.01	1.62	0.50	565,605,869		0	0	565,605,869		
							Subtotal	1.04				0.04	1.00
TOTAL - DISCHARGE CANAL				Subtotal	151	29,226		33.17		10,954		0.05	33.12
TOTAL MASS FLUX								65.58				0.12	65.46

TABLE 7
MASS FLUX CALCULATIONS
MASS FLUX REPORT
OYSTER CREEK GENERATING STATION
FORKED RIVER, NEW JERSEY

GROUNDWATER FLOW IN THE CAPE MAY FORMATION TO THE INTAKE CANAL	90	gpm		
GROUNDWATER FLOW IN THE COHANSEY FORMATION TO THE INTAKE CANAL	102	gpm		
GROUNDWATER FLOW TO THE INTAKE CANAL	193	gpm		
GROUNDWATER FLOW IN THE CAPE MAY FORMATION TO THE DISCHARGE CANAL	40	gpm		
GROUNDWATER FLOW IN THE COHANSEY FORMATION TO THE DISCHARGE CANAL	110	gpm		
GROUNDWATER FLOW TO THE DISCHARGE CANAL	151	gpm		
TOTAL GROUNDWATER FLOW OFF STATION	343	gpm		
FLOW WEIGHTED AVE TRITIUM CONCENTRATION - INTAKE CANAL	84,496	pCi/L	84,321	pCi/L
FLOW WEIGHTED AVE TRITIUM CONCENTRATION - DISCHARGE CANAL	110,620	pCi/L	41,462	pCi/L
FLOW WEIGHTED AVE TRITIUM CONCENTRATION OFF STATION	195,116	pCi/L	125,783	pCi/L

Assumptions:	
175	pCi/L = assumed background concentration.
	Maximum tritium concentration was assumed to be 2,000,000 pCi/L.
	Since there are data gaps at the discharge points, there is great uncertainty in this assumption.
Conversions:	
1440	min in a day
7.48	gallons in a cubic foot
28.32	liters in a cubic foot
365	days in a year
1.00E-12	pCi to Ci

APPENDIX A

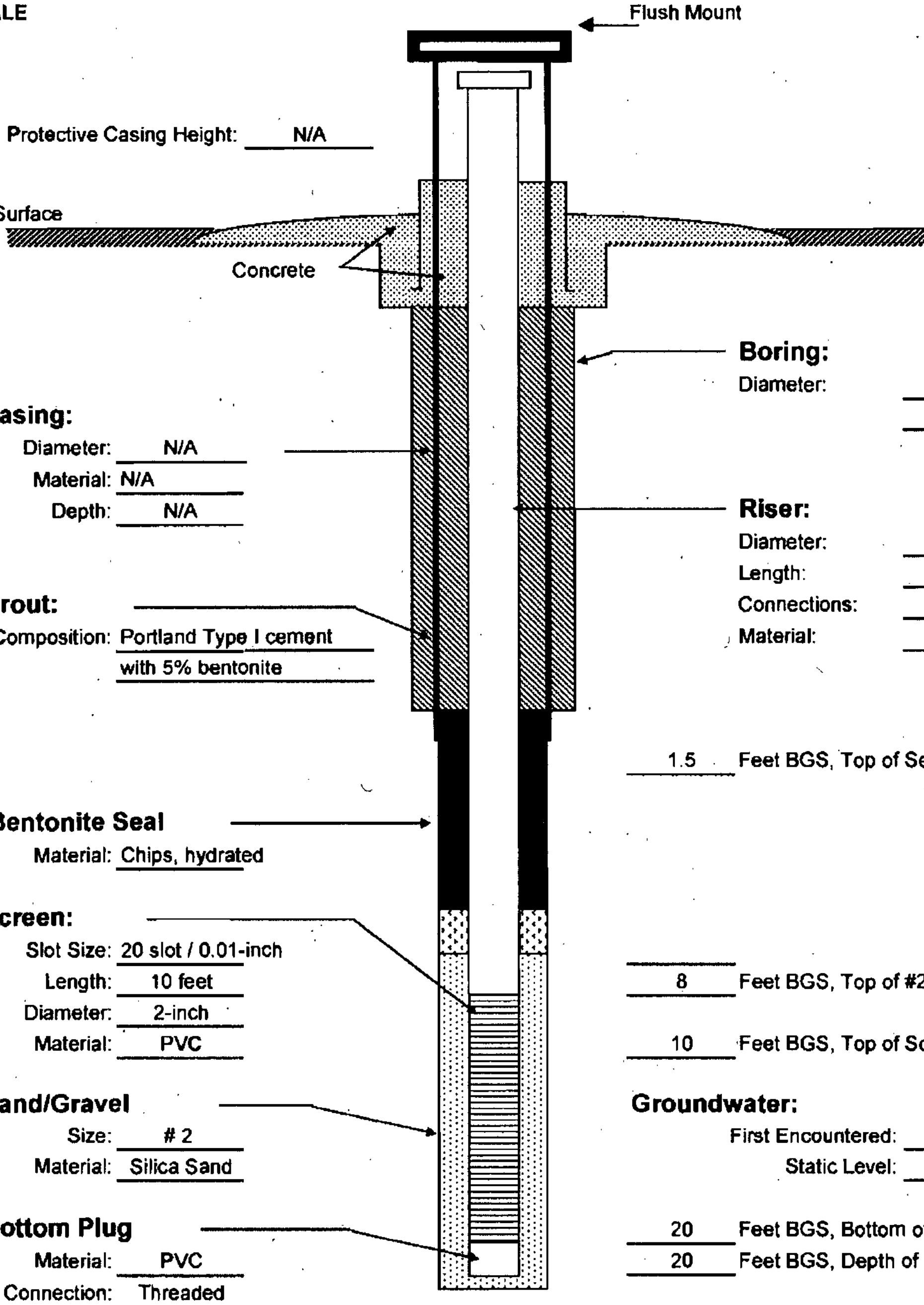
WELL LOGS

WELL CONSTRUCTION LOG

Project Name:	Oyster Creek	Well Designation:	W-50
Project No.:	55875	Date Completed:	4/21/2009
Client:	Exelon	Drilling Method:	Hollow Stem Auger
Location:	Forked River, NJ	CRA Scientist:	Martin Mylet
Survey Information:		Driller:	B.L. Myers
Top of inner casing:	Feet MSL	Northing:	357368.2
Ground surface:	13.25 Feet MSL	Easting:	574436.8

NOT TO SCALE

Flush Mount



Protective Casing Height: N/A

Existing Surface

Boring:
Diameter: HSA Nominal 4.5-inch

Casing:
Diameter: N/A
Material: N/A
Depth: N/A

Riser:
Diameter: 2-inch
Length: 10
Connections: Flush-threaded
Material: PVC

Grout:
Composition: Portland Type I cement with 5% bentonite

1.5 Feet BGS, Top of Seal

Bentonite Seal
Material: Chips, hydrated

Screen:
Slot Size: 20 slot / 0.01-inch
Length: 10 feet
Diameter: 2-inch
Material: PVC

8 Feet BGS, Top of #2 Sand

10 Feet BGS, Top of Screen

Sand/Gravel
Size: # 2
Material: Silica Sand

Groundwater:
First Encountered: Approx12.0
Static Level: 9.20 (24April09)

Bottom Plug
Material: PVC
Connection: Threaded

20 Feet BGS, Bottom of Screen

20 Feet BGS, Depth of Boring

Depths Below Ground Surface (BGS)

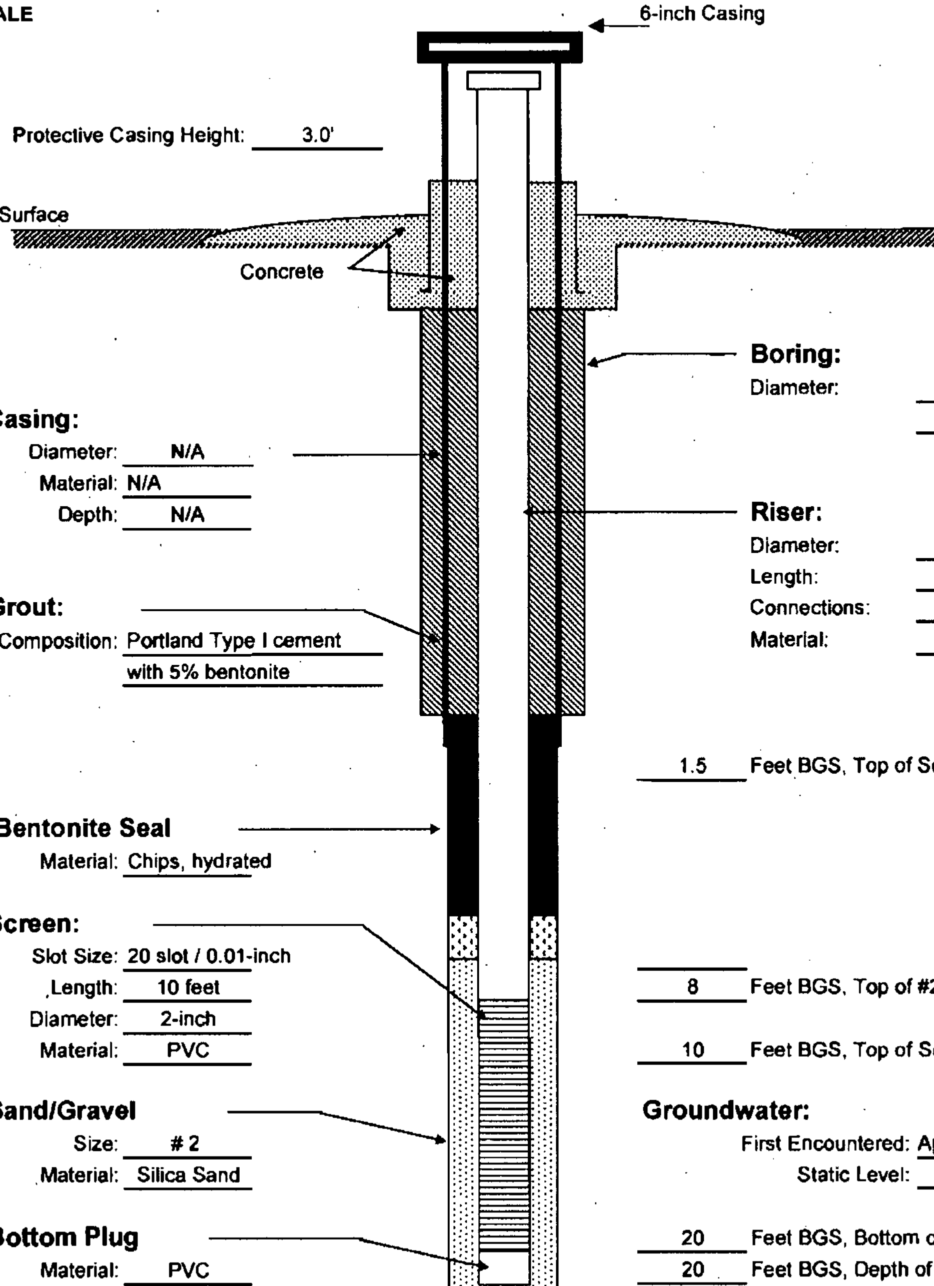
Development was completed by surge and pump technique.

CRA

WELL CONSTRUCTION LOG

Project Name:	Oyster Creek	**Well Designation:**	W-51
Project No.:	55875	**Date Completed:**	4/22/2009
Client:	Exelon	**Drilling Method:**	Hollow Stem Auger
Location:	Forked River, NJ	**CRA Scientist:**	Martin Mylet
Survey Information:		**Driller:**	B.L. Myers
Top of Inner casing:	Feet MSL	**Northing:**	357378.3
Ground surface:	22.5 Feet MSL	**Easting:**	574480.8

NOT TO SCALE



Protective Casing Height: 3.0'

Boring:
Diameter: HSA Nominal 4.5-inch

Casing:
Diameter: N/A
Material: N/A
Depth: N/A

Riser:
Diameter: 2-inch
Length: 13
Connections: Flush-threaded
Material: PVC

Grout:
Composition: Portland Type I cement with 5% bentonite

1.5 Feet BGS, Top of Seal

Bentonite Seal
Material: Chips, hydrated

Screen:
Slot Size: 20 slot / 0.01-inch
Length: 10 feet
Diameter: 2-inch
Material: PVC

8 Feet BGS, Top of #2 Sand

10 Feet BGS, Top of Screen

Sand/Gravel
Size: # 2
Material: Silica Sand

Groundwater:
First Encountered: Approx 12.5' Top of Casing
Static Level:

Bottom Plug
Material: PVC
Connection: Threaded

20 Feet BGS, Bottom of Screen
20 Feet BGS, Depth of Boring

Depths Below Ground Surface (BGS)

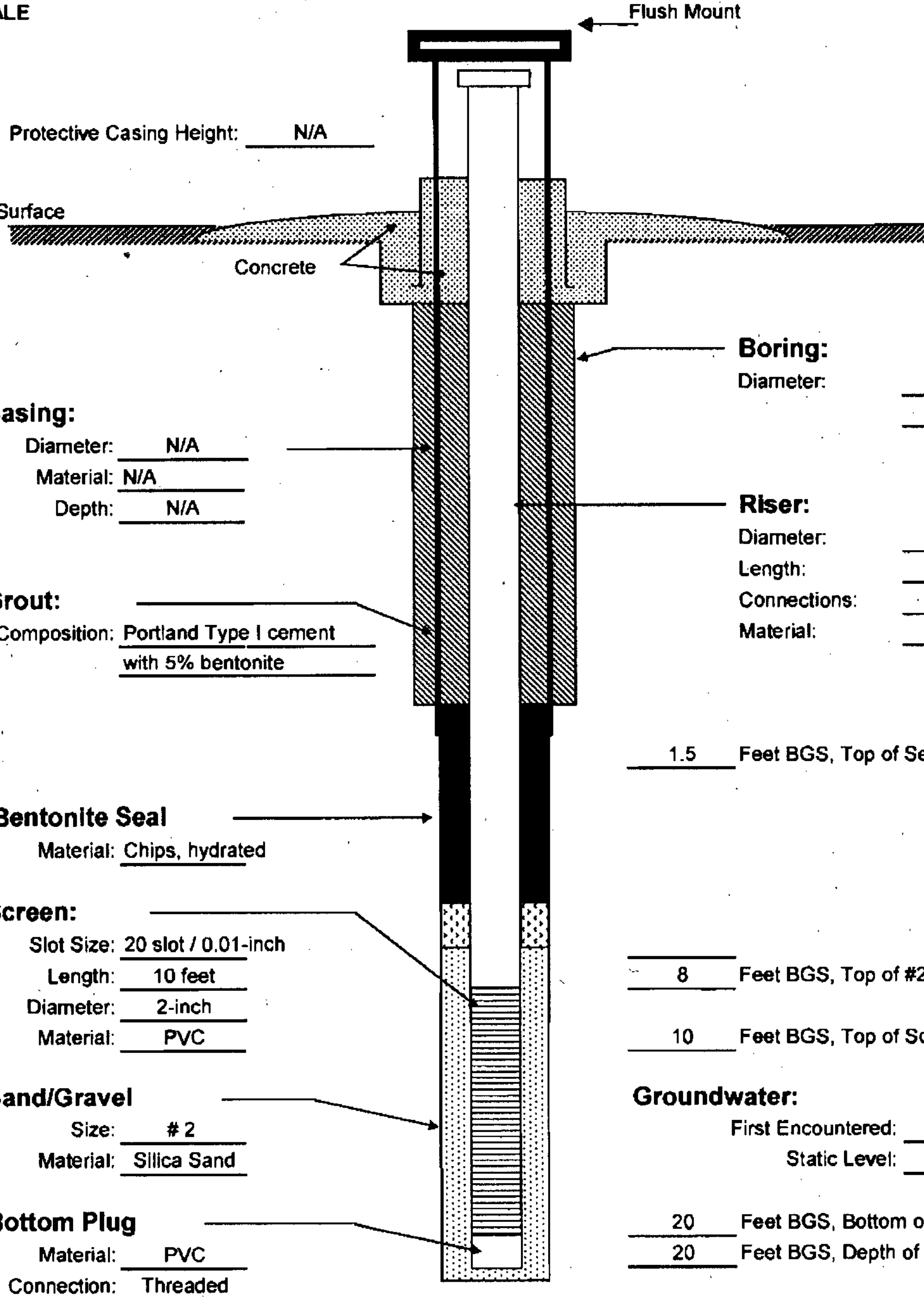
Development was completed by surge and pump technique.

CRA

WELL CONSTRUCTION LOG

Project Name:	Oyster Creek	**Well Designation:**	W-52
Project No.:	55875	**Date Completed:**	4/23/2009
Client:	Exelon	**Drilling Method:**	Hollow Stem Auger
Location:	Forked River, NJ	**CRA Scientist:**	Martin Mylet
Survey Information:		**Driller:**	B.L. Myers
Top of inner casing:	Feet MSL	**Northing:**	357400.9
Ground surface:	13.58 Feet MSL	**Easting:**	574353

NOT TO SCALE



Protective Casing Height: N/A

Casing:
Diameter: N/A
Material: N/A
Depth: N/A

Grout:
Composition: Portland Type I cement with 5% bentonite

Bentonite Seal
Material: Chips, hydrated

Screen:
Slot Size: 20 slot / 0.01-inch
Length: 10 feet
Diameter: 2-inch
Material: PVC

Sand/Gravel
Size: # 2
Material: Silica Sand

Bottom Plug
Material: PVC
Connection: Threaded

Boring:
Diameter: HSA Nominal 4.5-inch

Riser:
Diameter: 2-inch
Length: 10
Connections: Flush-threaded
Material: PVC

1.5 Feet BGS, Top of Seal

8 Feet BGS, Top of #2 Sand

10 Feet BGS, Top of Screen

Groundwater:
First Encountered: Approx 11.0
Static Level: 10.4 (24April09)

20 Feet BGS, Bottom of Screen
20 Feet BGS, Depth of Boring

Depths Below Ground Surface (BGS)

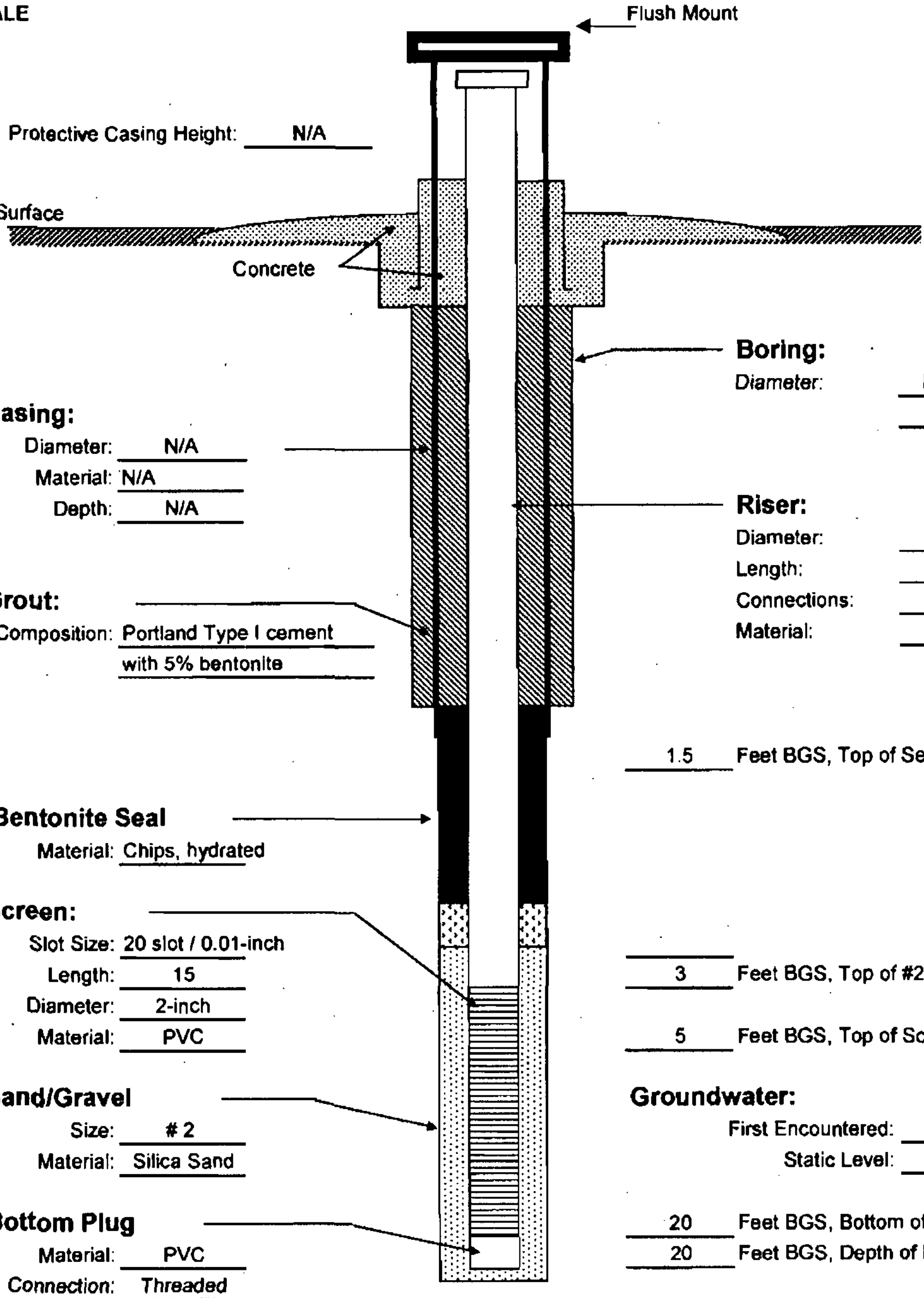
Development was completed by surge and pump technique.

CRA

WELL CONSTRUCTION LOG

Project Name:	Oyster Creek	**Well Designation:**	W-53
Project No.:	55875	**Date Completed:**	4/24/2009
Client:	Exelon	**Drilling Method:**	Hollow Stem Auger
Location:	Forked River, NJ	**CRA Scientist:**	Martin Mylet
Survey Information:		**Driller:**	B.L. Myers
Top of inner casing:	Feet MSL	**Northing:**	357272.8
Ground surface:	15.25 Feet MSL	**Easting:**	574447.6

NOT TO SCALE



Protective Casing Height: N/A

Casing:
Diameter: N/A
Material: N/A
Depth: N/A

Grout:
Composition: Portland Type I cement with 5% bentonite

Bentonite Seal
Material: Chips, hydrated

Screen:
Slot Size: 20 slot / 0.01-inch
Length: 15
Diameter: 2-inch
Material: PVC

Sand/Gravel
Size: # 2
Material: Silica Sand

Bottom Plug
Material: PVC
Connection: Threaded

Boring:
Diameter: HSA Nominal 4.5-inch

Riser:
Diameter: 2-inch
Length: 5
Connections: Flush-threaded
Material: PVC

1.5 Feet BGS, Top of Seal

3 Feet BGS, Top of #2 Sand

5 Feet BGS, Top of Screen

Groundwater:
First Encountered: Approx 11.0
Static Level:

20 Feet BGS, Bottom of Screen
20 Feet BGS, Depth of Boring

Depths Below Ground Surface (BGS)

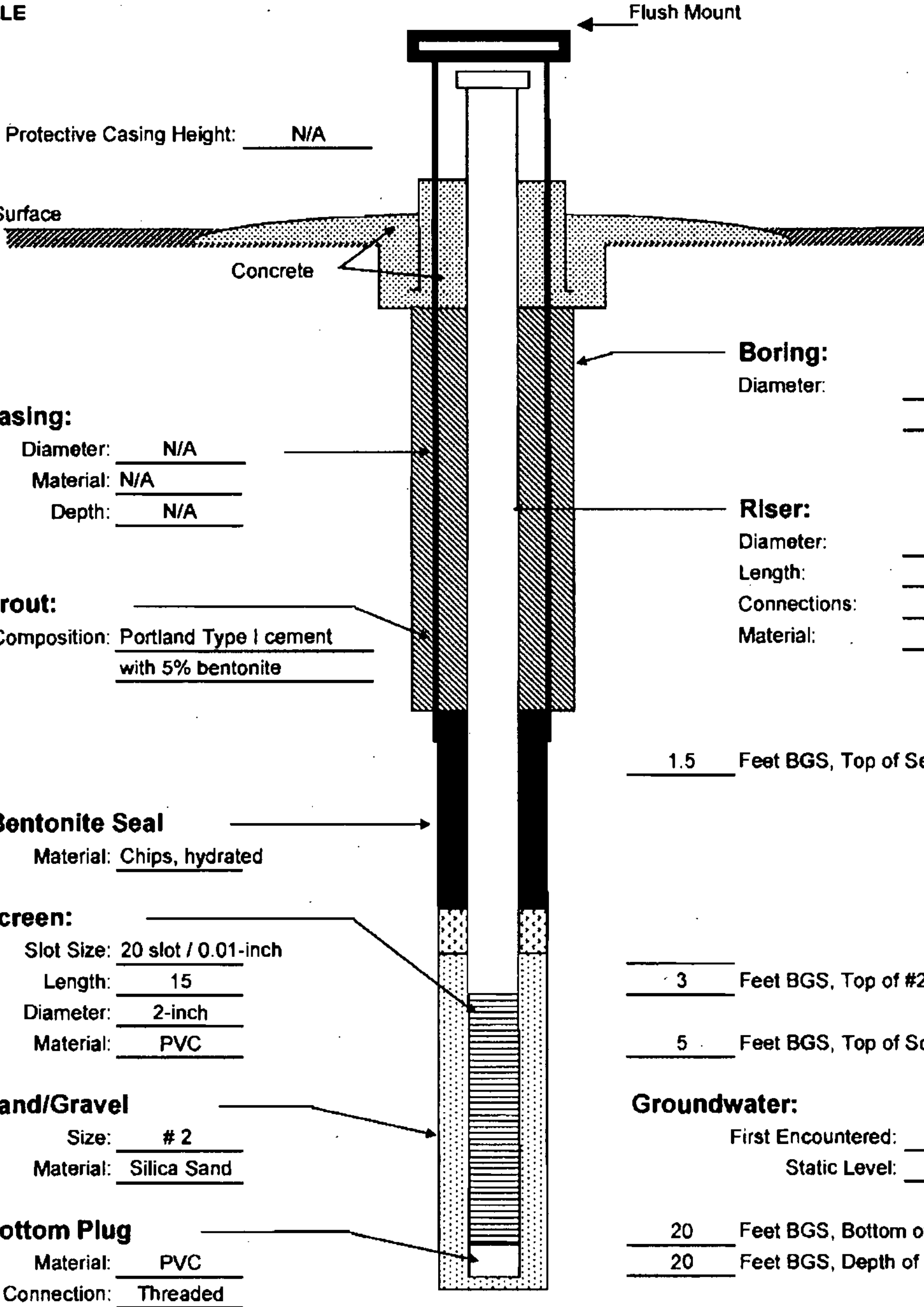
Development was completed by surge and pump technique.

CRA

WELL CONSTRUCTION LOG

Project Name:	Oyster Creek	**Well Designation:**	W-54
Project No.:	55875	**Date Completed:**	4/24/2009
Client:	Exelon	**Drilling Method:**	Hollow Stem Auger
Location:	Forked River, NJ	**CRA Scientist:**	Martin Mylet
Survey Information:		**Driller:**	B.L. Myers
Top of inner casing:	Feet MSL	**Northing:**	357276.2
Ground surface:	9.82 Feet MSL	**Easting:**	574311.7

NOT TO SCALE



Protective Casing Height: N/A

Boring:
Diameter: HSA Nominal 4.5-inch

Casing:
Diameter: N/A
Material: N/A
Depth: N/A

Riser:
Diameter: 2-inch
Length: 5
Connections: Flush-threaded
Material: PVC

Grout:
Composition: Portland Type I cement with 5% bentonite

1.5 Feet BGS, Top of Seal

Bentonite Seal
Material: Chips, hydrated

Screen:
Slot Size: 20 slot / 0.01-inch
Length: 15
Diameter: 2-inch
Material: PVC

3 Feet BGS, Top of #2 Sand

5 Feet BGS, Top of Screen

Sand/Gravel
Size: # 2
Material: Silica Sand

Groundwater:
First Encountered: Approx 13.0
Static Level:

Bottom Plug
Material: PVC
Connection: Threaded

20 Feet BGS, Bottom of Screen
20 Feet BGS, Depth of Boring

Depths Below Ground Surface (BGS)

Development was completed by surge and pump technique.

CRA