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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

June 12, 2009

UN#09-280

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3,
RAI No. 101, Groundwater

Reference:
1) John Rycyna (NRC) to Robert Poche (UniStar), "RAI No 101 RHEB 2092.doc (PUBLIC)" email dated April 20, 2009

2) UniStar Nuclear Energy Letter UN#09-272, from Greg Gibson to Document Control Desk, U.S. NRC, Response Schedule to Request for Additional Information for RAI No. 99, Probable Maximum Tsunami Flooding; RAI No.101, Groundwater; RAI No. 103, Probable Maximum Surge and Seiche Flooding, dated June 2, 2009

The purpose of this letter is to respond to a request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated April 20, 2009 (Reference 1). This RAI addresses Groundwater, as discussed in Section 2.4.12 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Combined License Application (COLA), Revision 4.

Reference 1 requested UniStar Nuclear Energy to respond to the RAI within 30 days. Reference 2 indicated that responses to Questions 02.04.12-1, -3, -5, -6 and -12 would be provided by June 12, 2009.

Enclosure 1 provides our responses to RAI No. 101, Questions 02.04.12-1, -3, -5, -6 and -12 and includes revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA. Enclosure 2 provides the electronic input files for the numerical model of the Aquia aquifer within a 5-mile radius of CCNPP Unit 3, as requested in Question 02.04.12-5.

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NRO

Our responses to RAI No. 101, Questions 02.04.12-1, -3, -5, -6 and -12 do not include any new regulatory commitments.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Michael J. Yox at (410) 495-2436.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on June 12, 2009

Greg Gibson

Enclosures: 1) Response for Request for Additional Information RAI No. 101, Questions 02.04.12-1, -3, -5, -6 and -12, Groundwater, Calvert Cliffs Nuclear Power Plant Unit 3

2) Electronic Input Files for Aquia Aquifer Numerical Modeling

cc: John Rycyna, NRC Project Manager, U.S. EPR COL Application
Laura Quinn, NRC Project Manager, Environmental Projects Branch 2
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

Enclosure 1

Response for Request for Additional Information RAI No. 101, Questions 02.04.12-1, -3, -5, -6 and -12, Groundwater, Calvert Cliffs Nuclear Power Plant Unit 3

RAI No. 101

Question 02.04.12-1

Legends of some FSAR figures in the electronic version are unreadable at any magnification (e.g., 2.4-68 and 2.4-70). Figures in Calculation No. 25237-103-KOC-HMMG-00001, Groundwater Flow Model of Surficial Aquifer, provided to Staff via the reading room, are in black and white and are less informative than they would have been if they had been in color and they are unreadable in some cases. Provide legible, color copies of all figures in FSAR section 2.4 and in Calculation No. 25237-103-KOC-HMMG-00001.

Response

FSAR Figure Nos. 2.4-64, 2.4-65, 2.4-68, 2.4-70, 2.4-71, 2.4-72, 2.4-73, 2.4-75, 2.4-76, 2.4-77, 2.4-78, 2.4-80, 2.4-81, 2.4-82, 2.4-83, 2.4-85, 2.4-86, 2.4-99, 2.4-100, 2.4-101, 2.4-102, 2.4-103, 2.4-104 and 2.4-105 have been revised to enlarge their legends. Figures in Calculation No. 25237-103-KOC-HMMG-00001, Rev 0, Groundwater Flow Model of the Surficial Aquifer, were provided in color in the reading room at the office of Tetra Tech NUS in Richland, Washington by way of transmittal letter 25237-000-T8S-HY00-00002, dated October 10, 2008. Figures in color for Rev 1 of Calculation No. 25237-103-KOC-HMMG-00001 were provided in the reading room at the office of Tetra Tech NUS in Richland, Washington by way of transmittal letter 25237-000-T8S-HY00-00003, dated December 23, 2008.

COLA Impact

Figures 2.4-64, 2.4-65, 2.4-68, 2.4-70, 2.4-71, 2.4-72, 2.4-73, 2.4-75, 2.4-76, 2.4-77, 2.4-78, 2.4-80, 2.4-81, 2.4-82, 2.4-83, 2.4-85, 2.4-86, 2.4-99, 2.4-100, 2.4-101, 2.4-102, 2.4-103, 2.4-104 and 2.4-105 in FSAR Section 2.4 will be updated as follows in a future COLA revision.

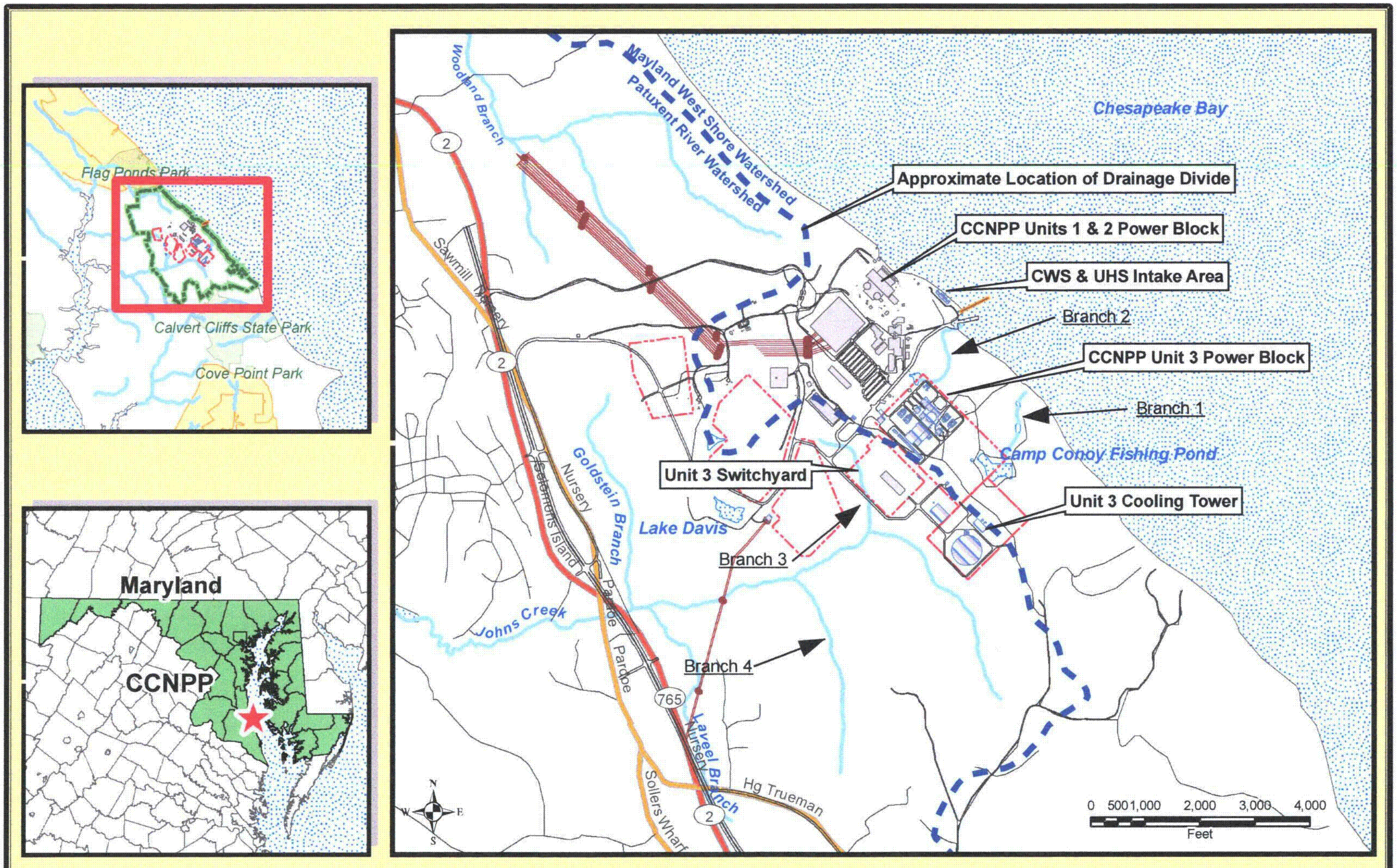
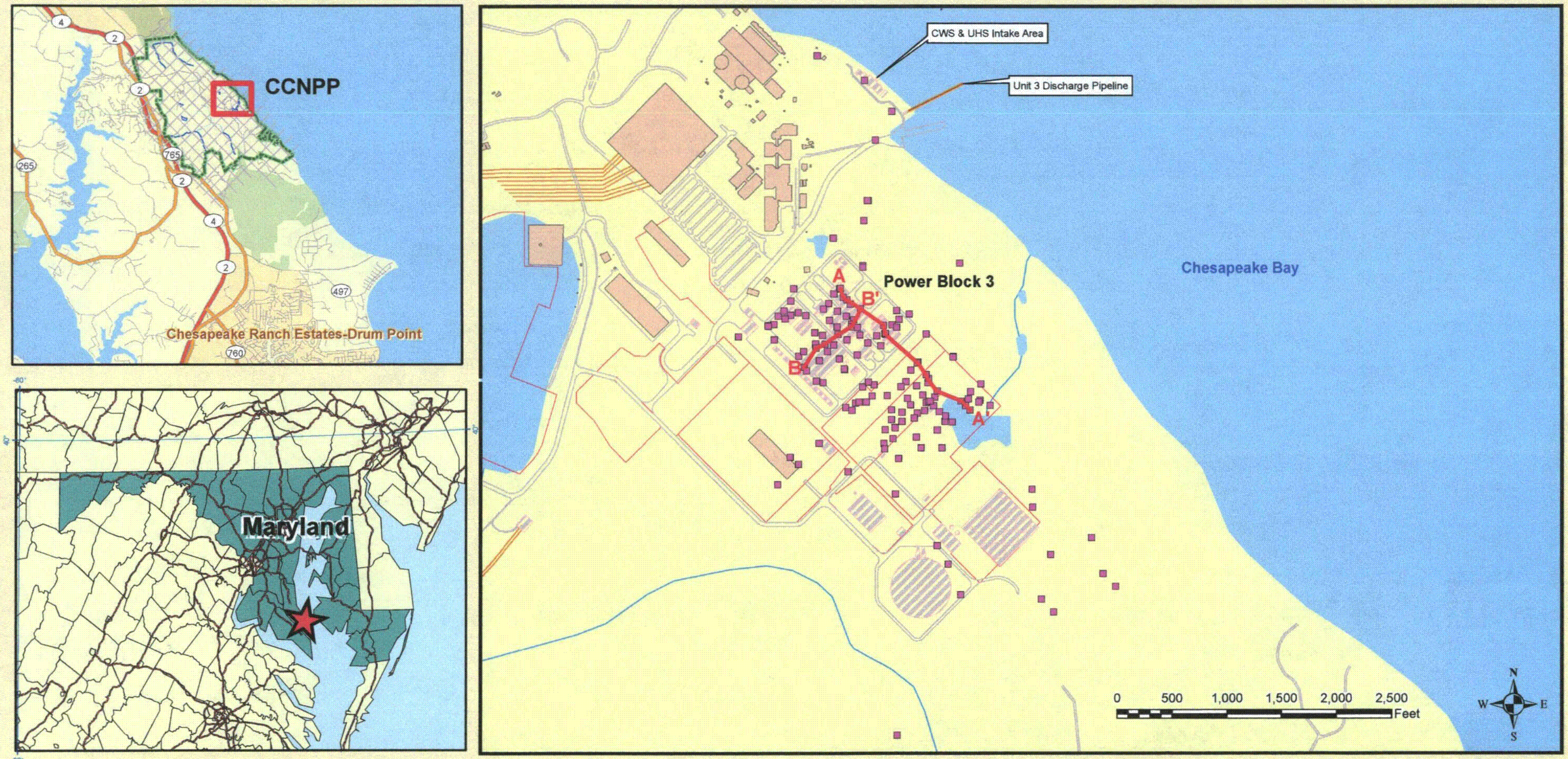


Figure 2.4-64 - CCNPP Site Area Topography and Drainage

GIS Map Code: US-CALV-000105-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927
Display: Calvert Cliffs Plant Grid

Watershed Boundary; Transmission Lines; Planned Structures; Future Land Use; Calvert Cliffs Site Boundary
Unit 3 Discharge Pipeline; Roads; Existing Structures; Waterbodies

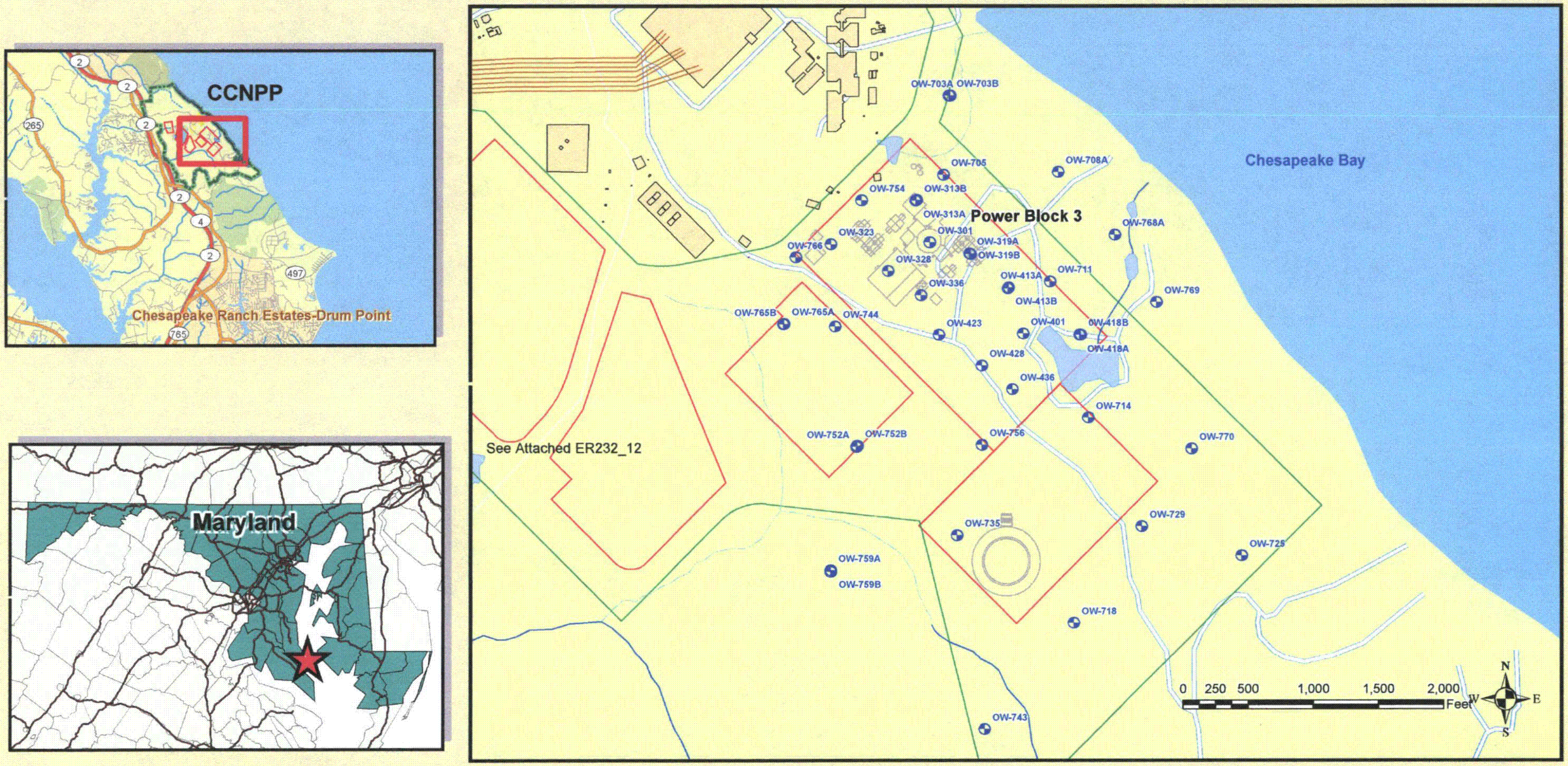


GIS Map Code: US-CALV-000134-R000E
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-65 — Cross-Section and Soil Boring Locations in the Vicinity of CCNPP Unit 3

Legend

- Borehole Location
- Unit 3 Discharge Pipeline
- Existing Structures
- Transmission Lines
- Waterbodies
- Cross-Section
- Planned Structures
- Roads
- Future Land Use

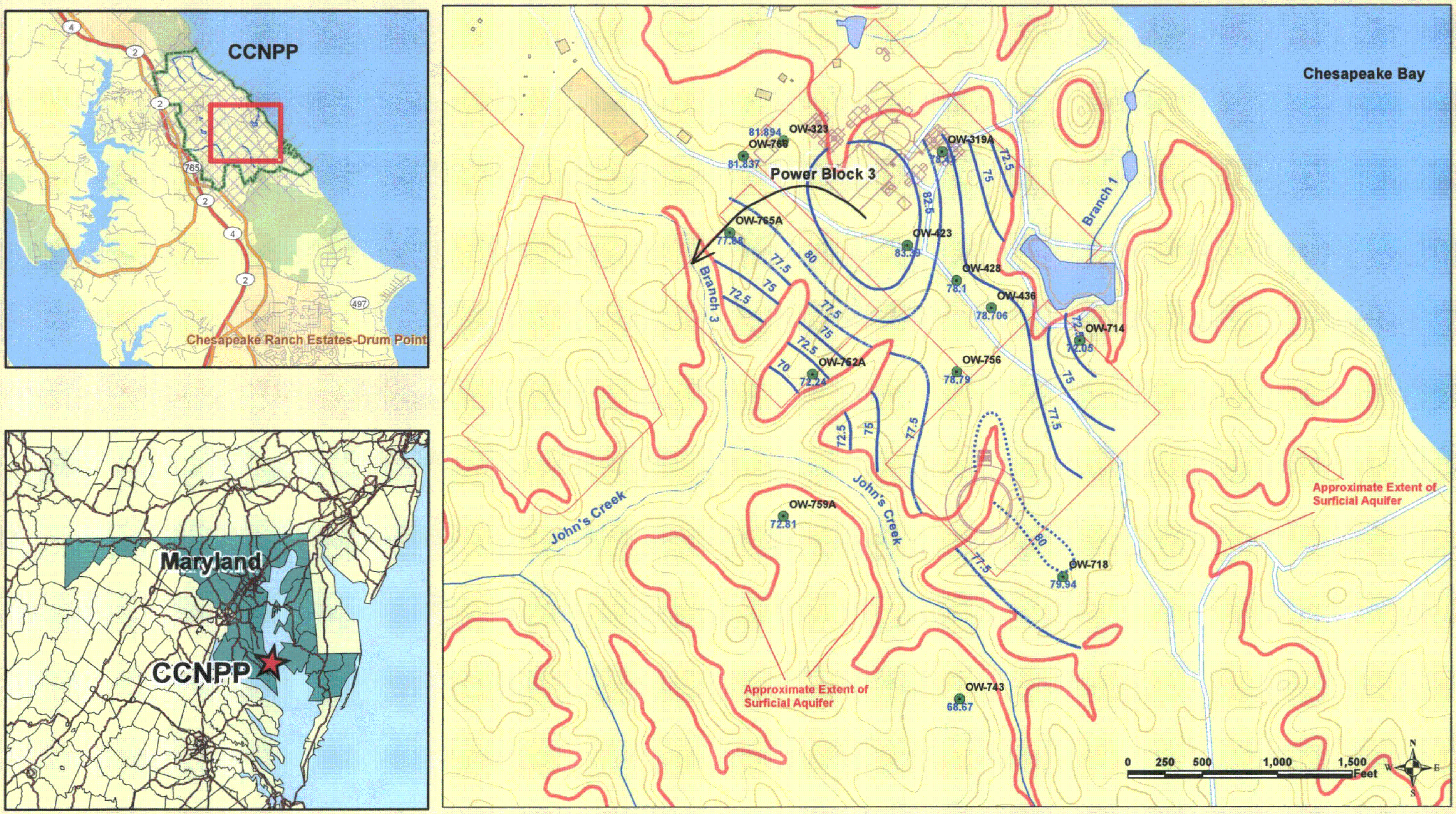


GIS Map Code: US-CALV-000138-R000E
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-68 — Ground Water Observation Wells in the Vicinity of CCNPP Unit 3

Legend

- Observation Wells
- Transmission Line
- Road, Existing
- Road, Proposed
- Cross-Section
- Power Block
- Existing Structure
- Lake or Pond
- Stream, Permanent
- Stream, Intermittent
- Project Area
- Reserve Area



GIS Map Code: US-CALV-000118-R000F
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-70 --- Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, July 2006

Legend

Surficial Aquifer Well	Elevation (10-ft interval)	Transmission Line	Power Block	Structure, Existing
Surficial Aquifer Elev. (ft)	Elevation (50-ft interval)	Road, Existing	Stream, Permanent	Lake or Pond
Interpolated Aquifer Elev. (ft)	Aquifer Extent	Road, Proposed	Stream, Intermittent	Reserve Area

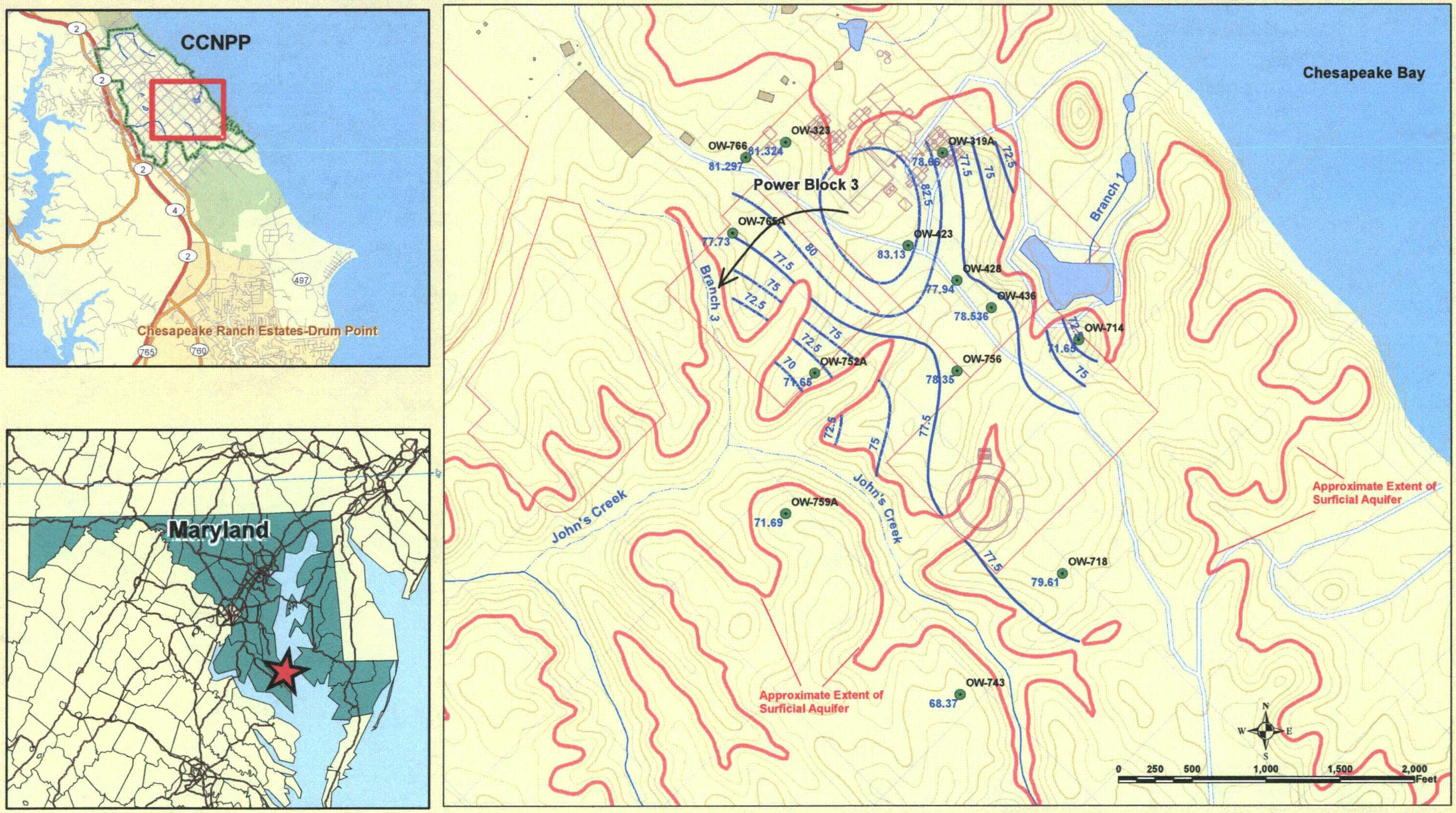
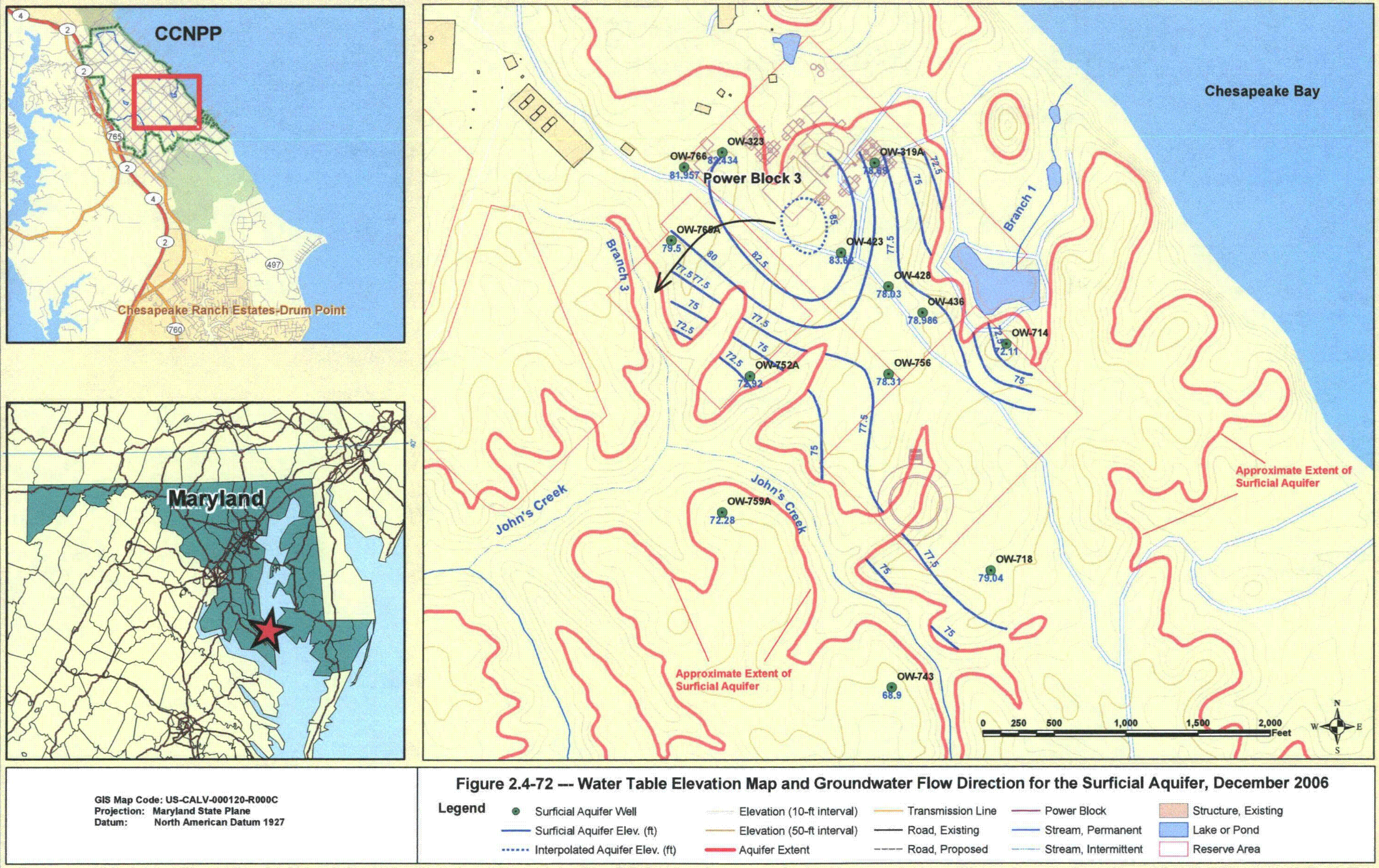


Figure 2.4-71 — Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, September 2006

GIS Map Code: US-CALV-000119-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

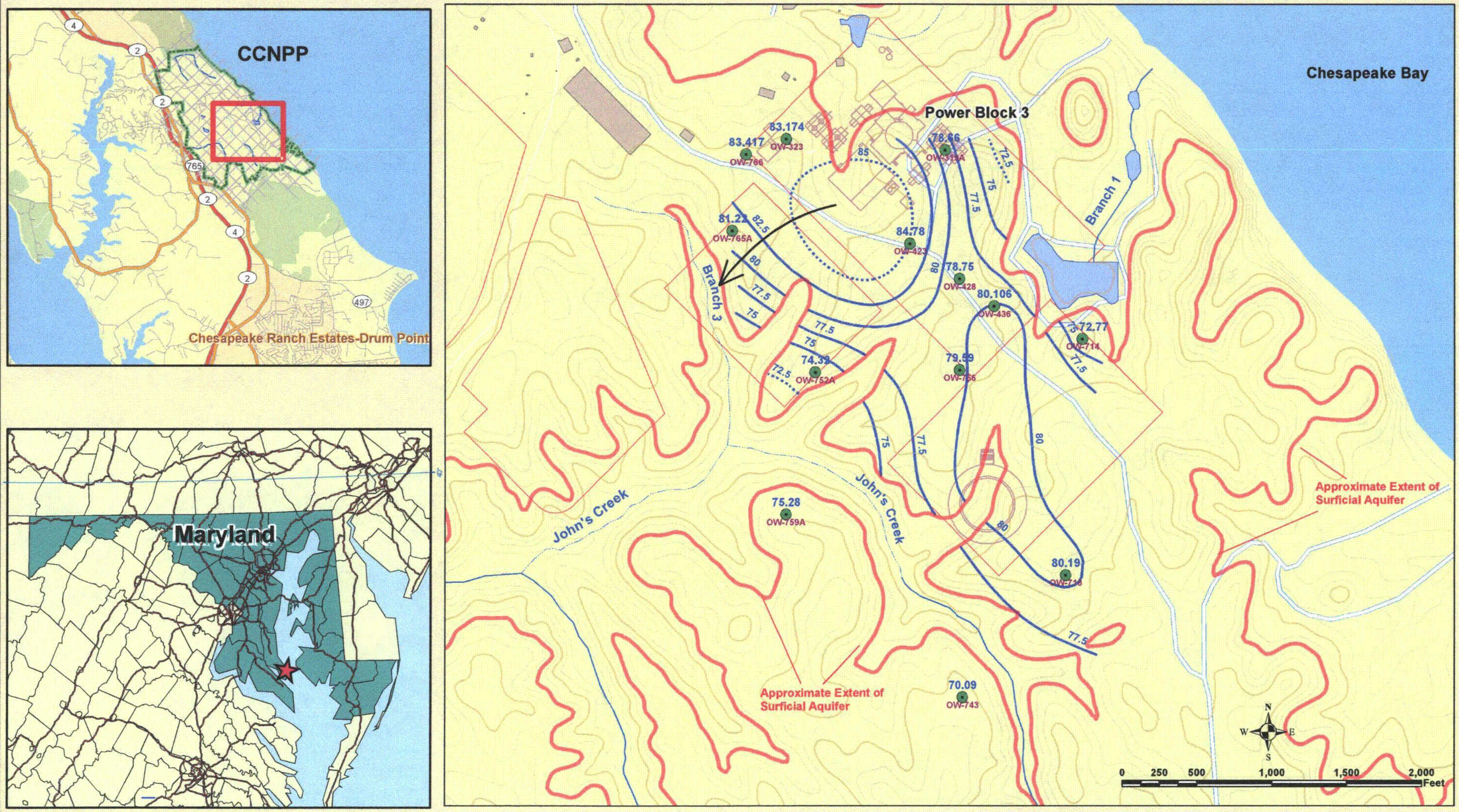
Legend

- Surficial Aquifer Well
- Surficial Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area



GIS Map Code: US-CALV-000120-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-72 --- Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, December 2006

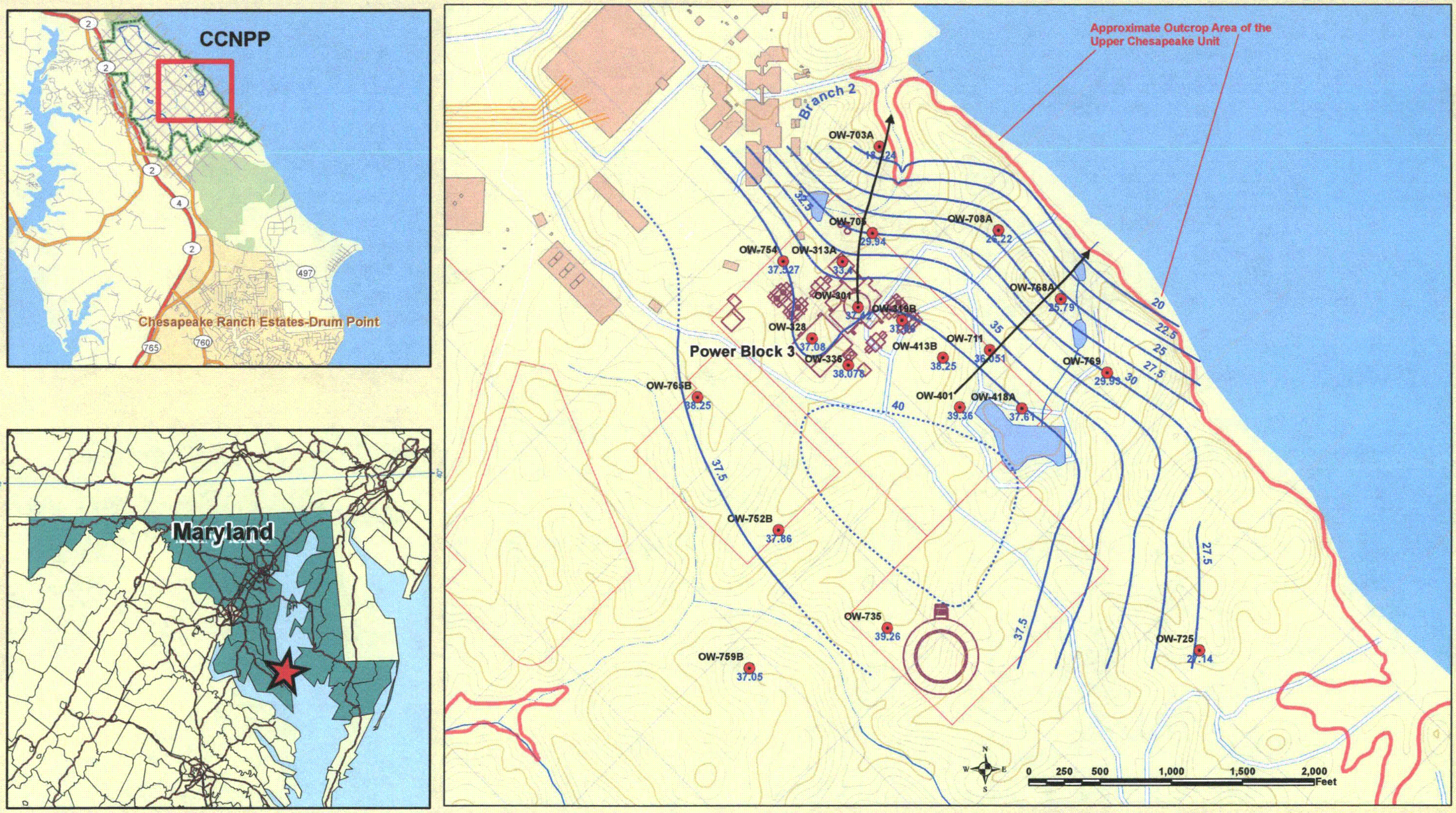


GIS Map Code: US-CALV-000121-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-73 --- Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, March 2007

Legend

Surficial Aquifer Well	Elevation (10-ft interval)	Transmission Line	Power Block	Structure, Existing
Surficial Aquifer Elev. (ft)	Elevation (50-ft interval)	Road, Existing	Stream, Permanent	Lake or Pond
Interpolated Aquifer Elev. (ft)	Aquifer Extent	Road, Proposed	Stream, Intermittent	Reserve Area



GIS Map Code: US-CALV-000124-R000D
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-75 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Upper Chesapeake Unit, July 2006

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

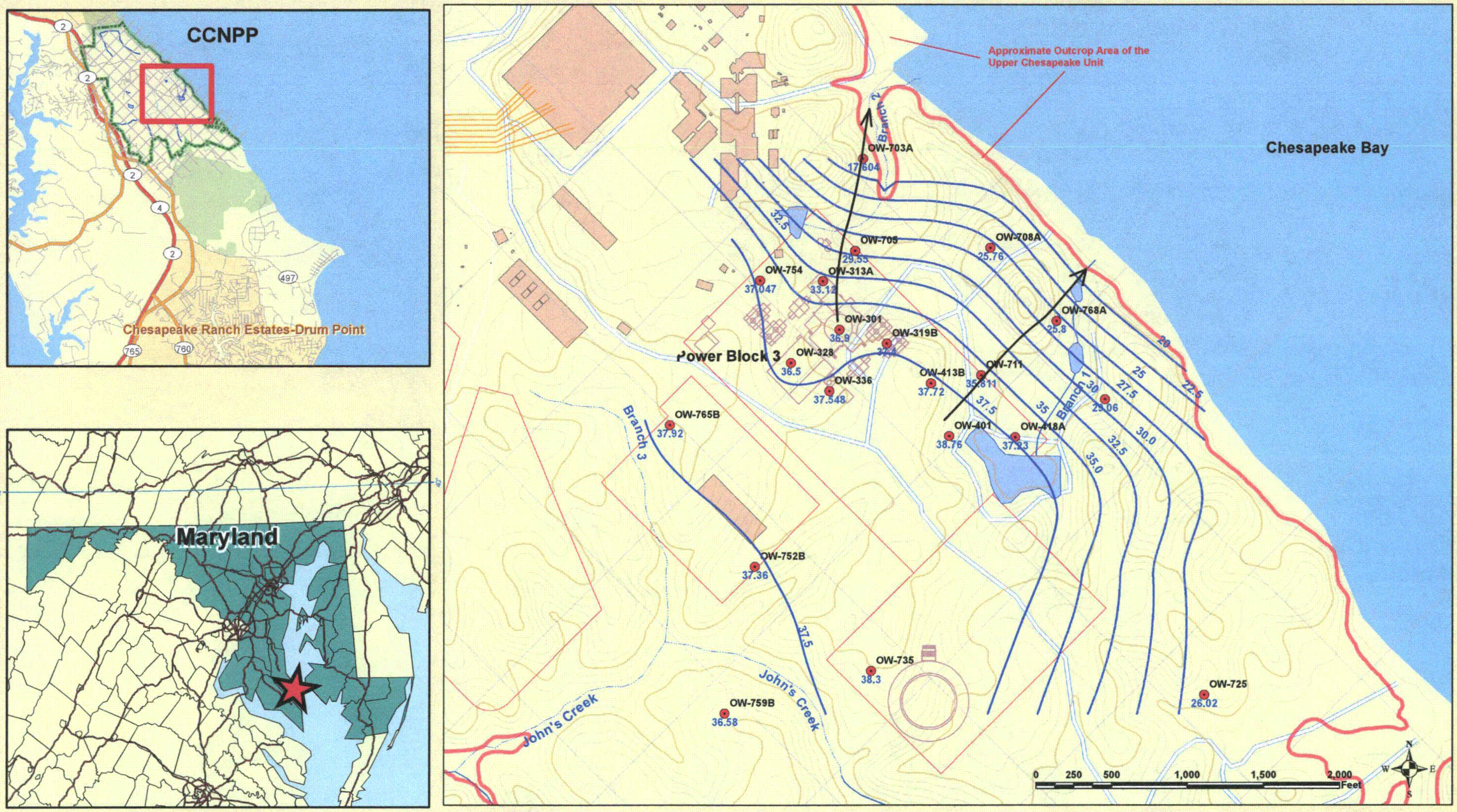


Figure 2.4-76 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Upper Chesapeake Unit, September 2006

GIS Map Code: US-CALV-000123-R000E
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

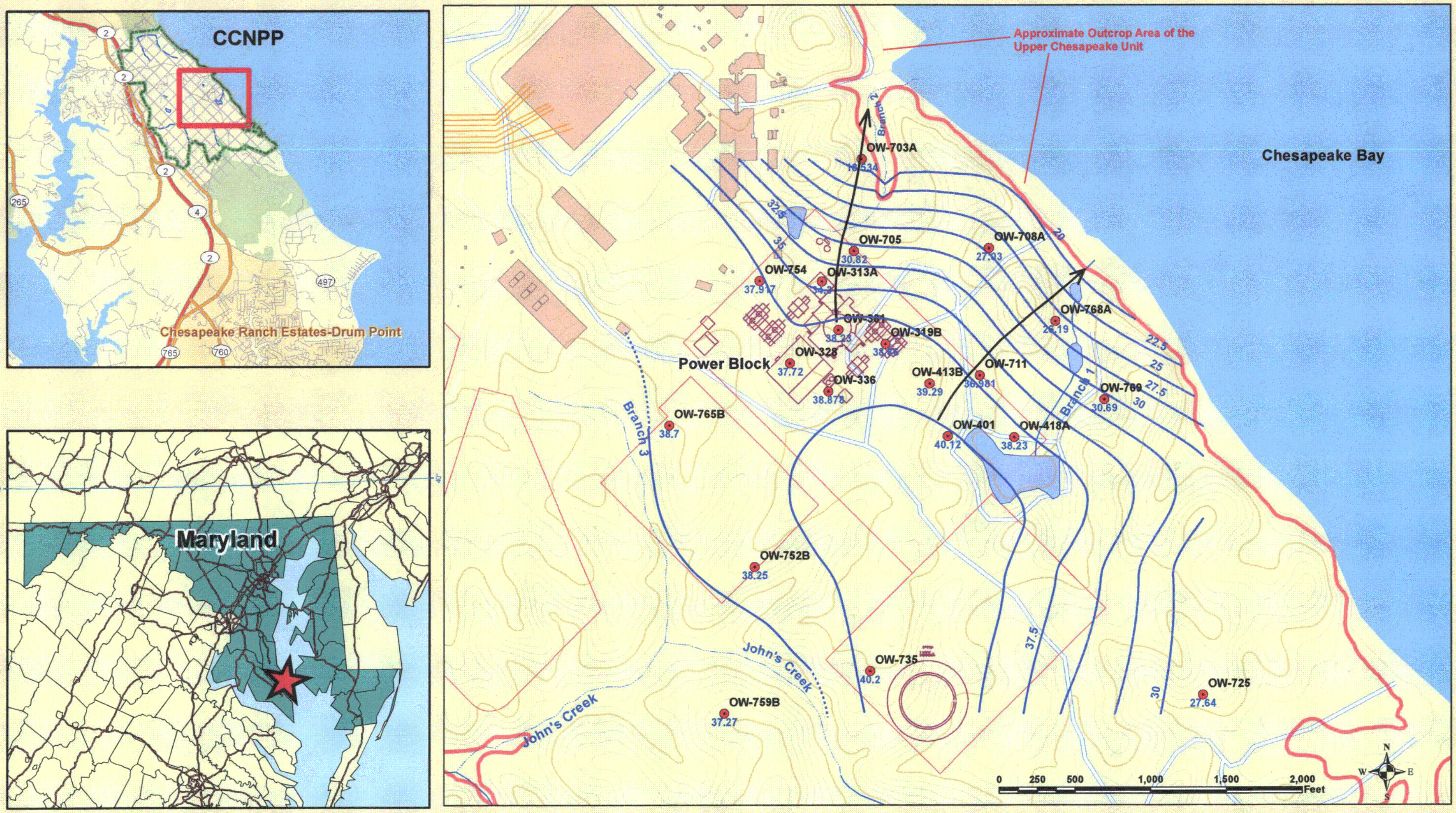


Figure 2.4-77 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Upper Chesapeake Unit, December 2006

GIS Map Code: US-CALV-000139-R000D
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

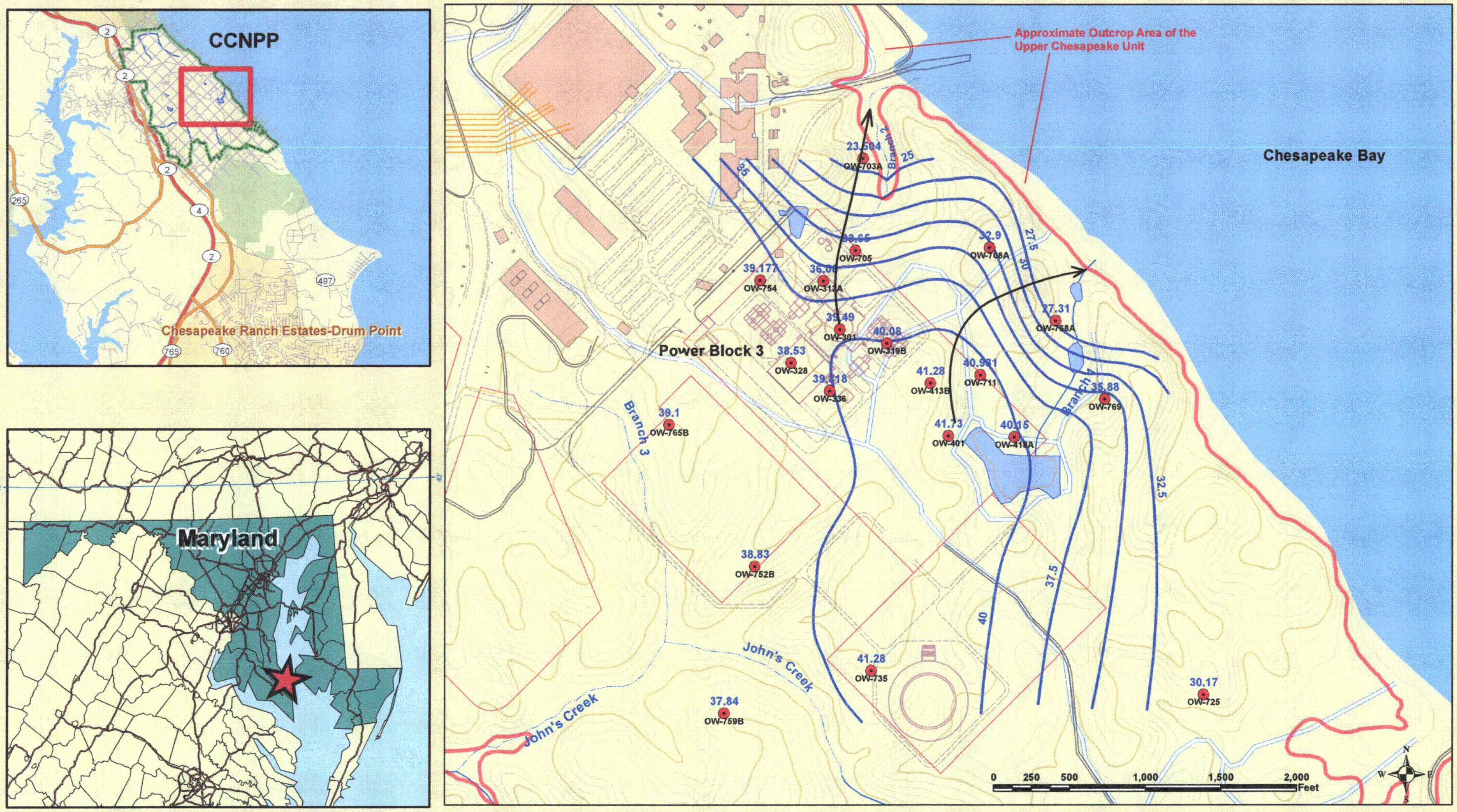
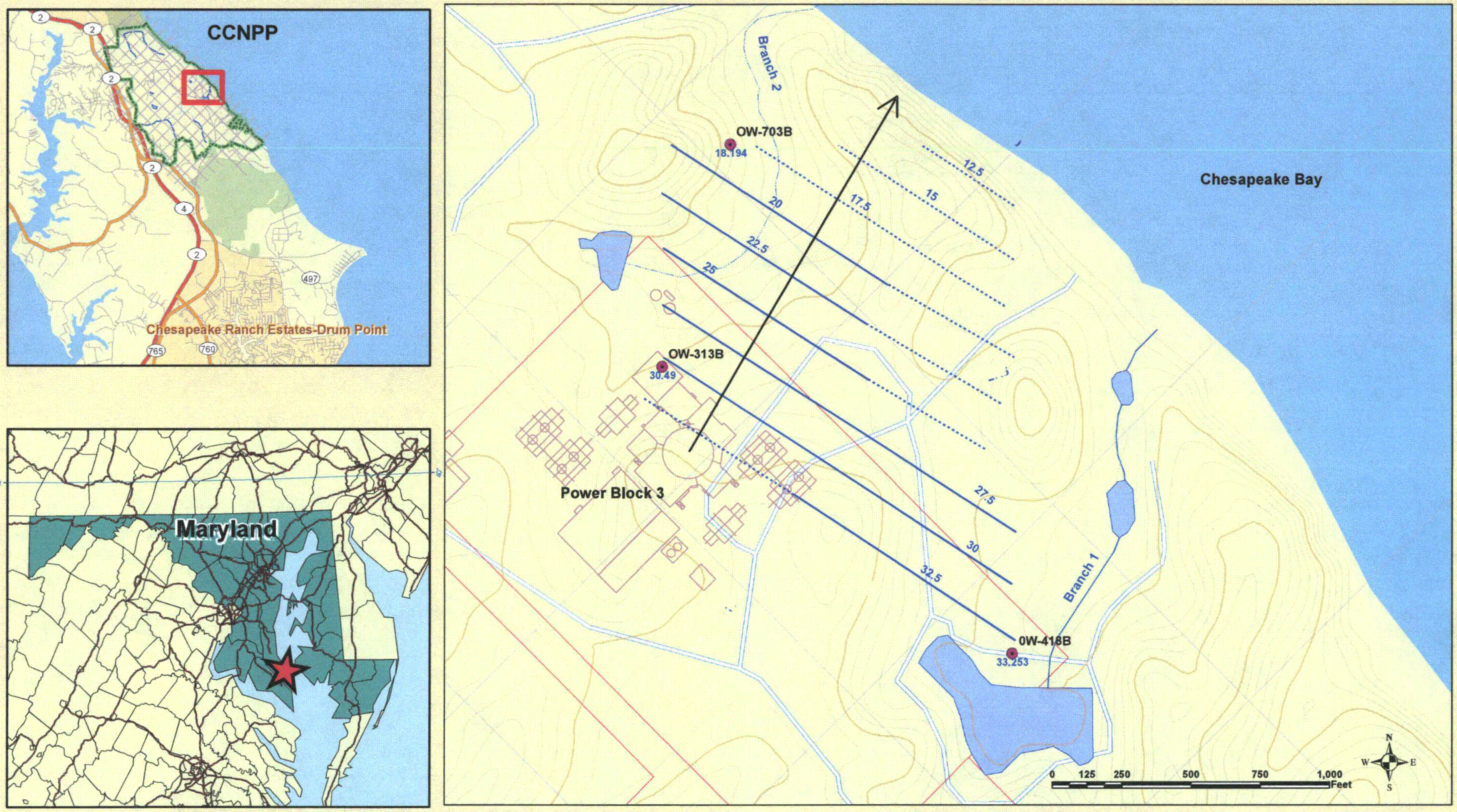


Figure 2.4-78 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Upper Chesapeake Unit, March 2007

GIS Map Code: US-CALV-000125-R000D
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area



GIS Map Code: US-CALV-000127-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-80 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Lower Chesapeake Unit, July 2006

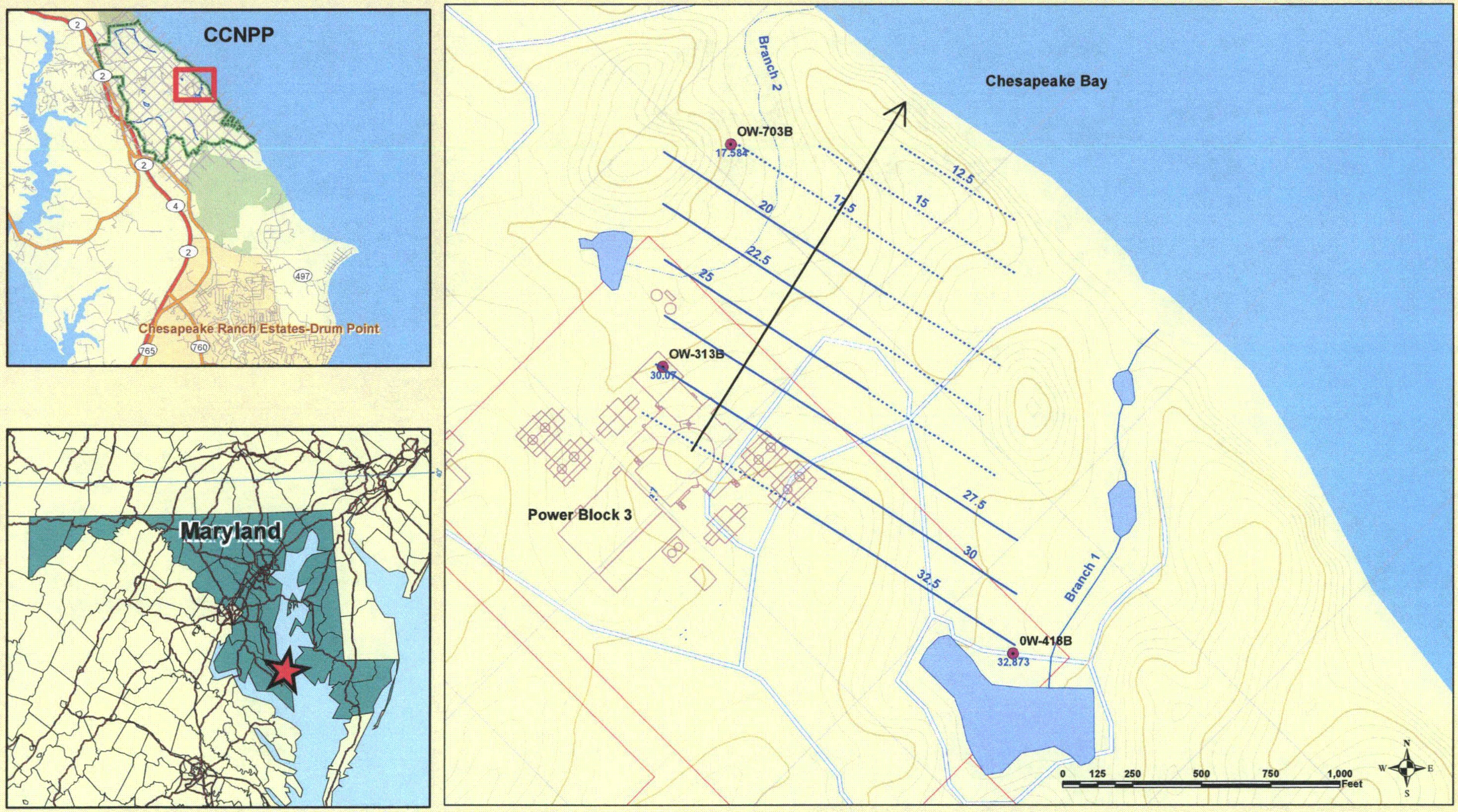


Figure 2.4-81 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Lower Chesapeake Unit, September 2006

GIS Map Code: US-CALV-000126-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

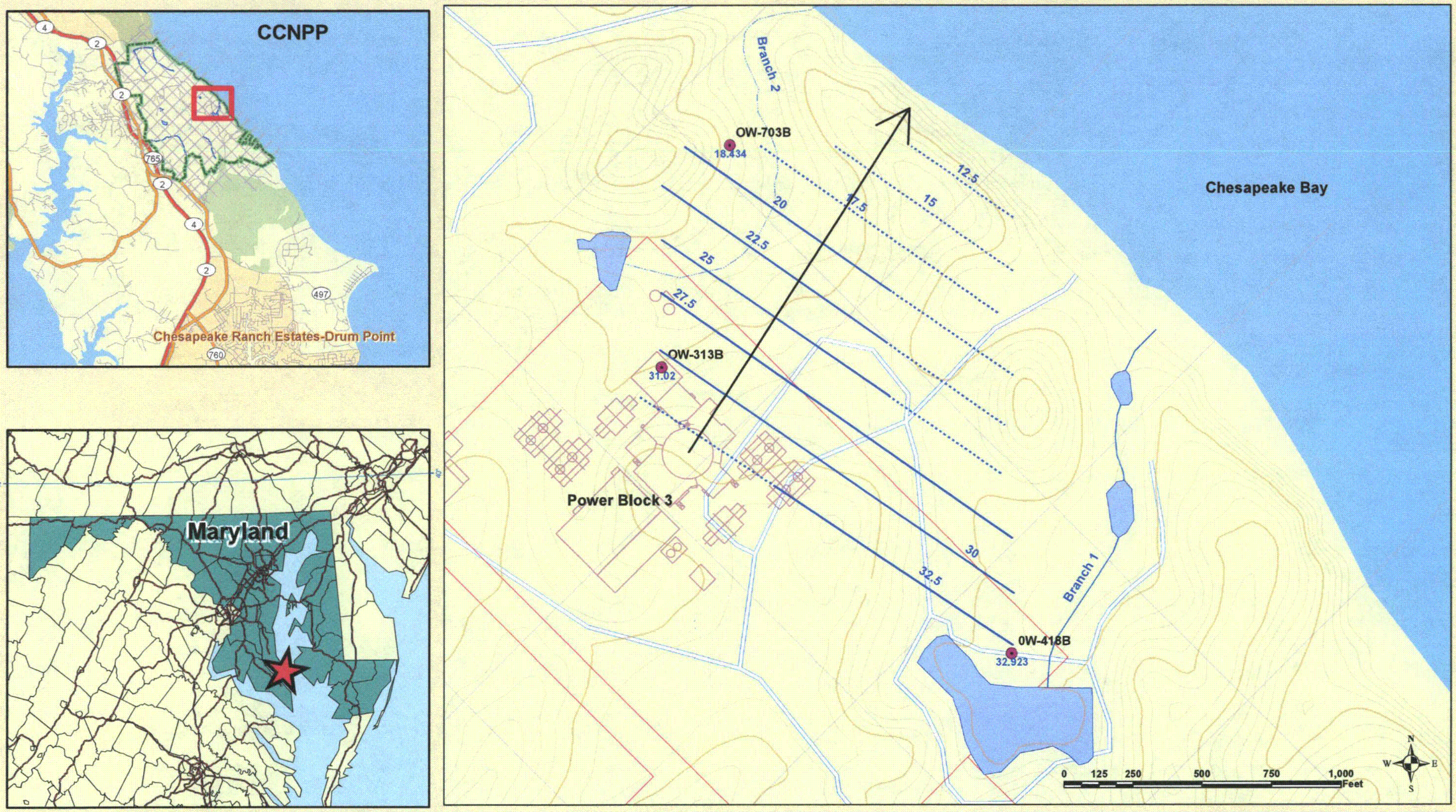
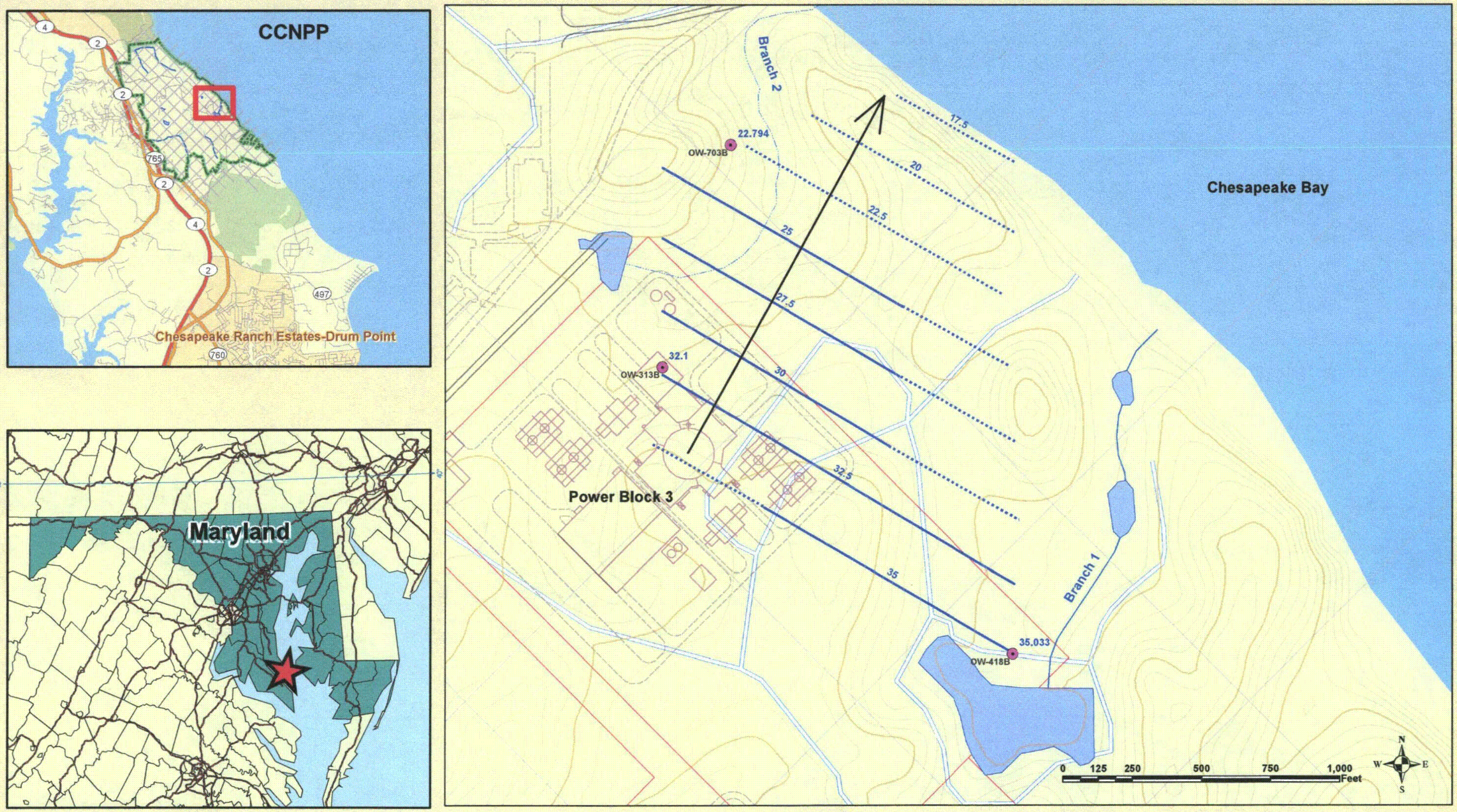


Figure 2.4-82 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Lower Chesapeake Unit, December 2006

GIS Map Code: US-CALV-000135-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

Lower Chesapeake Aquifer Well	Elevation (10-ft interval)	Transmission Line	Power Block	Structure, Existing
Lower Chesapeake Aquifer Elev. (ft)	Elevation (50-ft interval)	Road, Existing	Stream, Permanent	Lake or Pond
Interpolated Aquifer Elev. (ft)	Aquifer Extent	Road, Proposed	Stream, Intermittent	Reserve Area

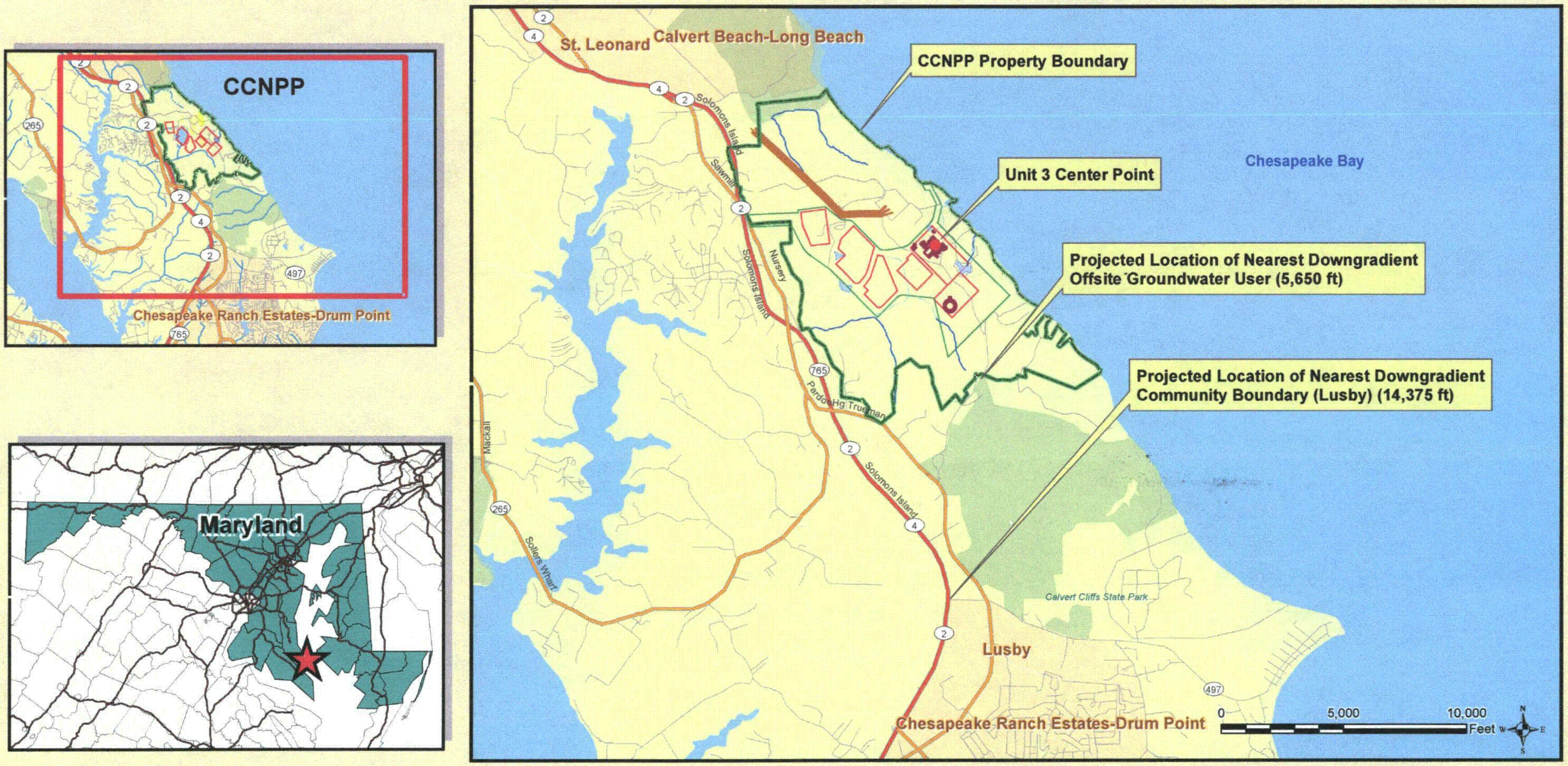


GIS Map Code: US-CALV-000136-R000D
Projection: Maryland State Plane
Datum: North American Datum 1927
Display: Calvert Cliffs Plant Grid

Figure 2.4-83 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Lower Chesapeake Unit, March 2007

Legend

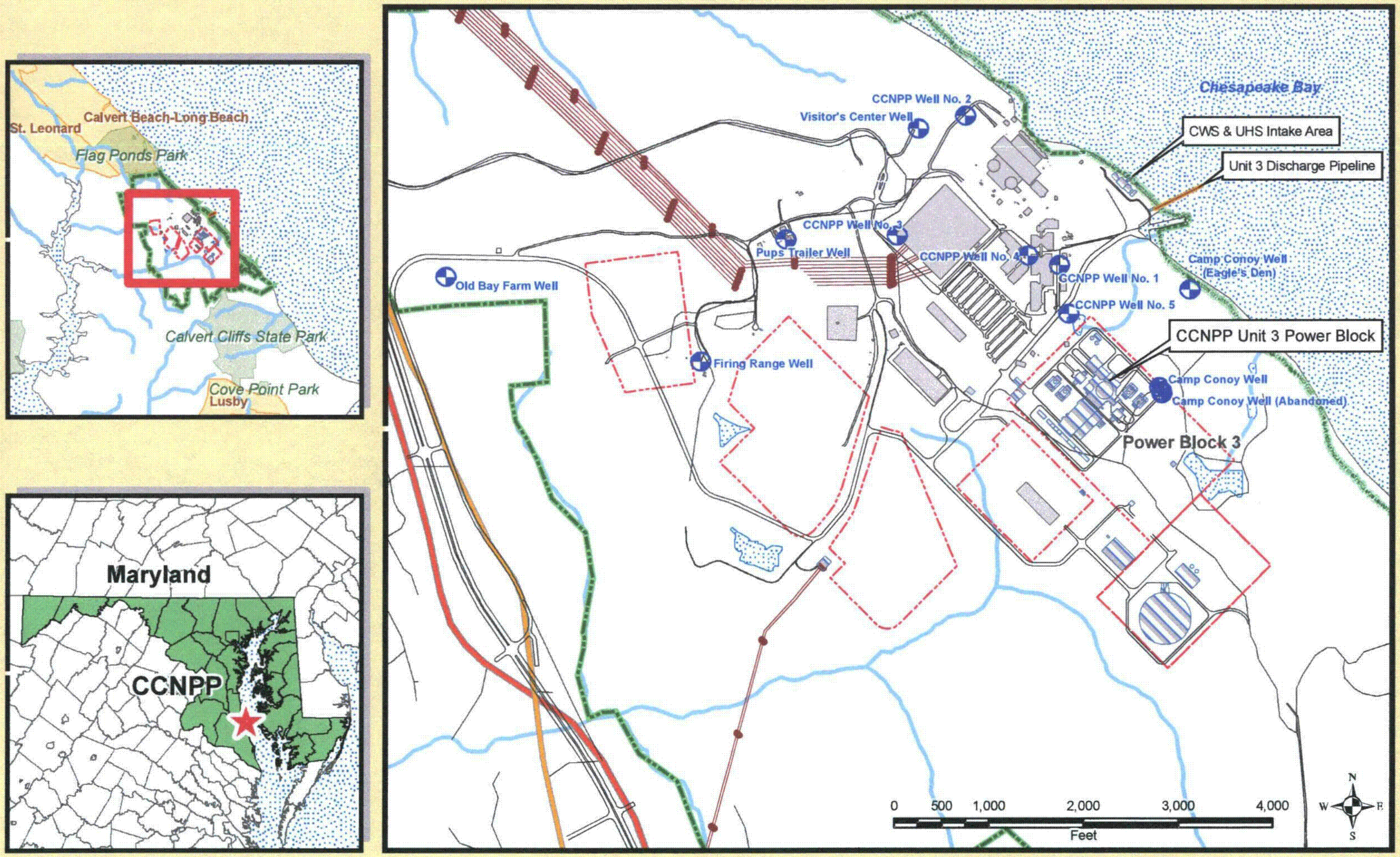
- Lower Chesapeake Aquifer Well
- Lower Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area



GIS Map Code: US-CALV-000130-R000D
Projection: Maryland State Plane
Datum: North American Datum 1927

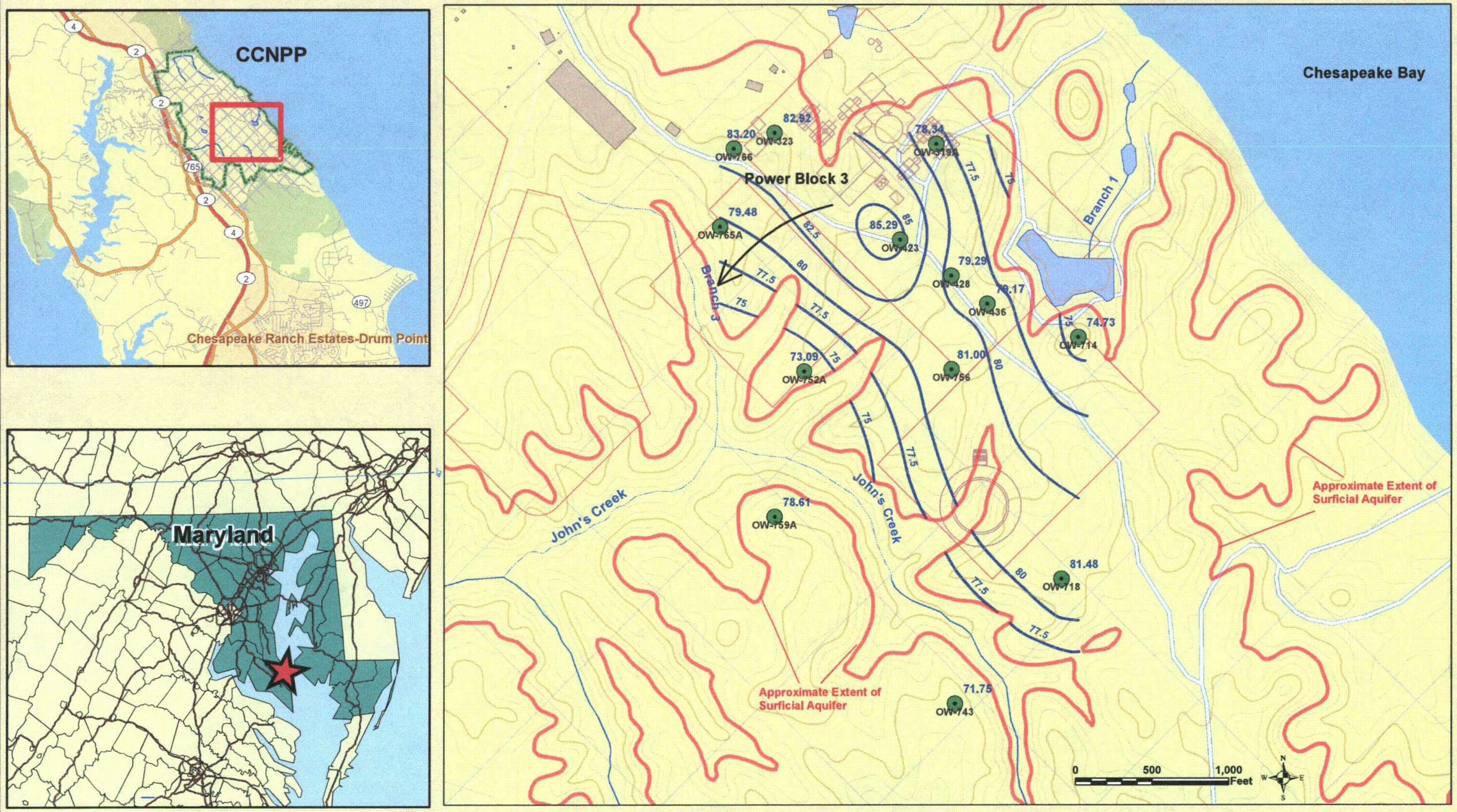
Figure 2.4-85 — Projected Location of Nearest Off-Site Groundwater Well and Community Water Supply System

Legend
Transmission Line
Calvert Cliffs Site Boundary
Stream, Permanent
Lake or Pond
Power Block
Reserve Areas
Stream, Intermittent



GIS Map Code: US-CALV-000150-R000A
Projection: Maryland State Plane
Datum: North American Datum 1927
Display: Calvert Cliffs Plant Grid

Figure 2.4-86 - CCNPP Water Production Wells



GIS Map Code: US-CALV-000155-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-99 --- Water Table Elevation Map and Groundwater Flow Direction for the Surficial Aquifer, June 2007

Legend

Surficial Aquifer Well	Elevation (10-ft interval)	Transmission Line	Power Block	Structure, Existing
Surficial Aquifer Elev. (ft)	Elevation (50-ft interval)	Road, Existing	Stream, Permanent	Lake or Pond
Interpolated Aquifer Elev. (ft)	Aquifer Extent	Road, Proposed	Stream, Intermittent	Reserve Area

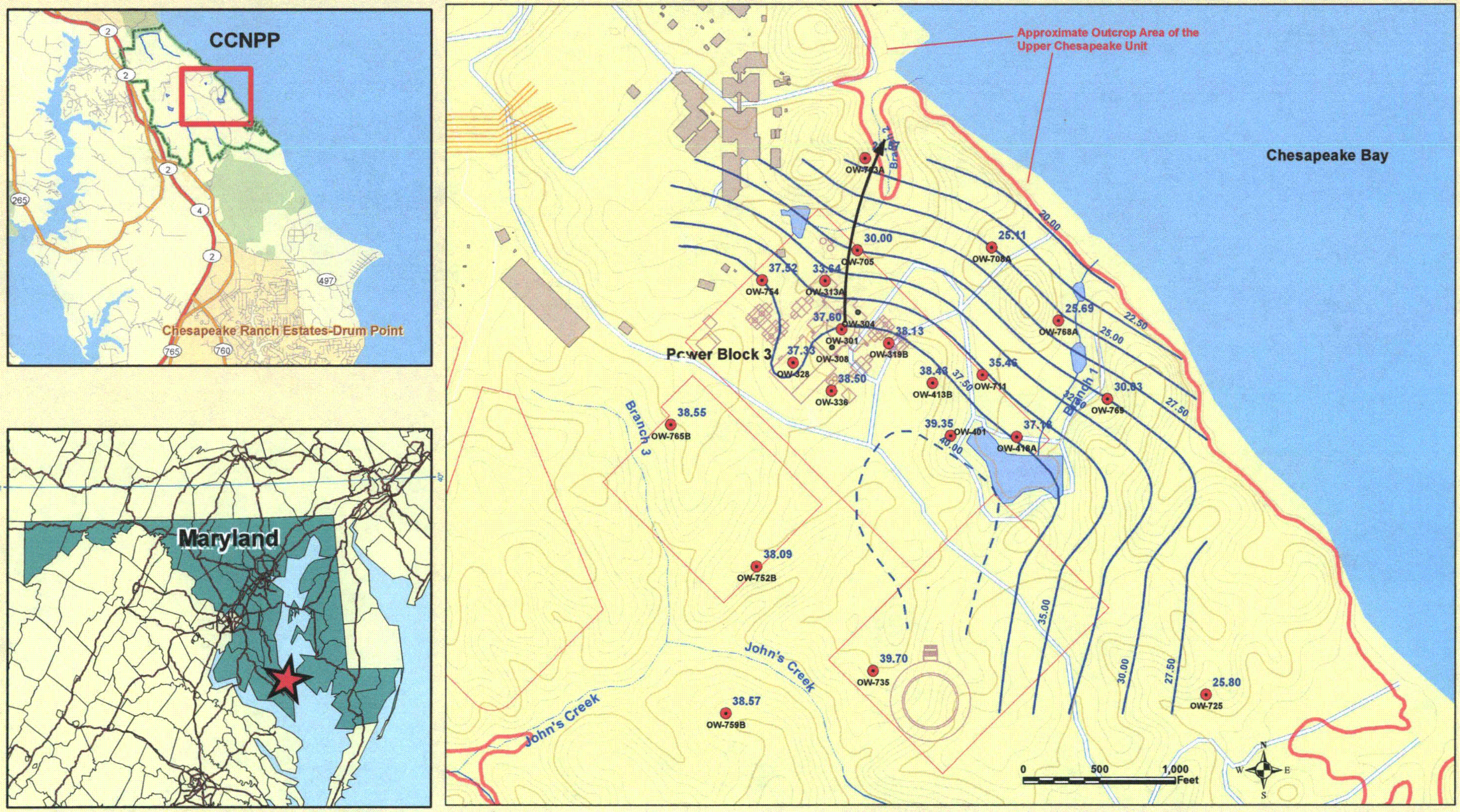


Figure 2.4-100 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Upper Chesapeake Unit, June 2007

GIS Map Code: US-CALV-000156-R000B
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

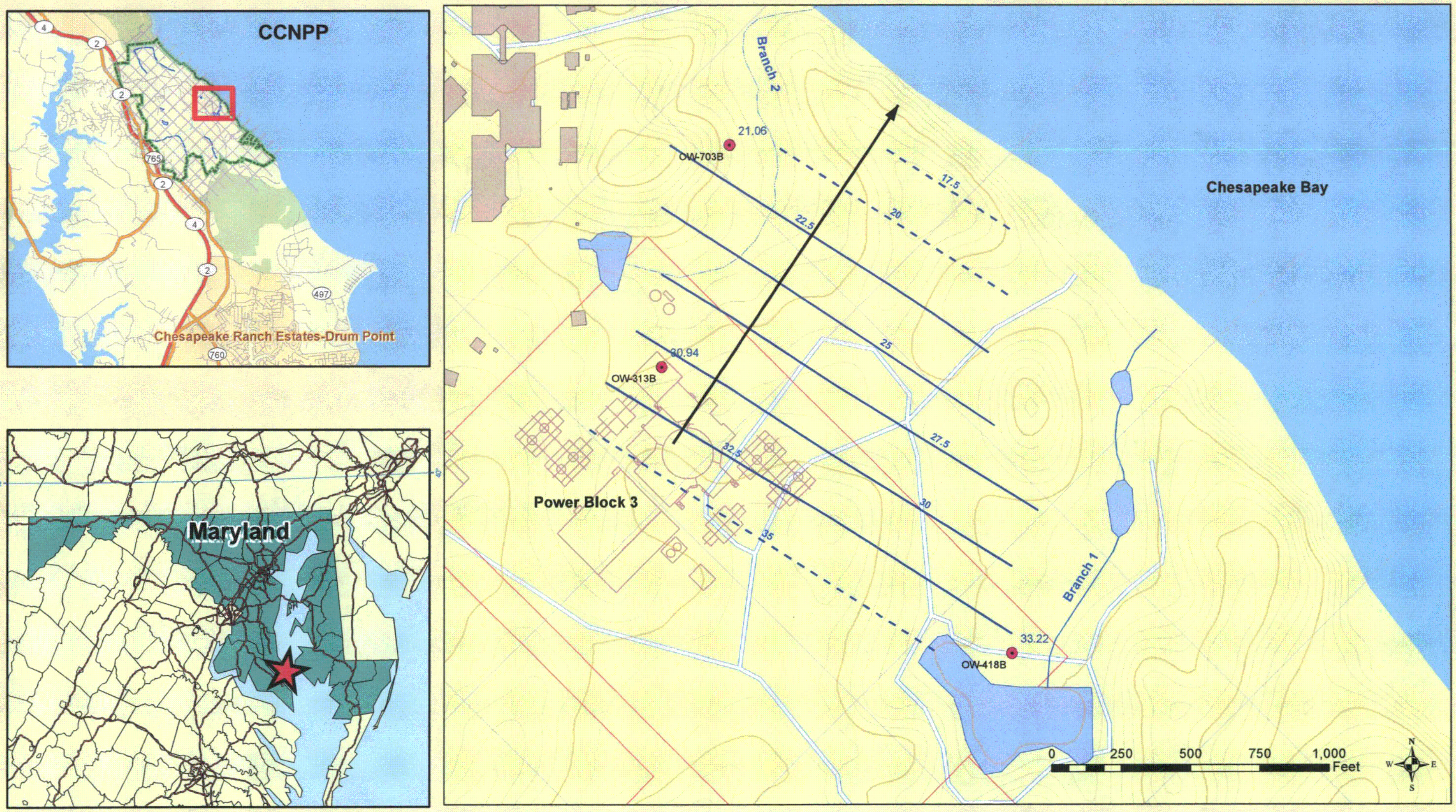


Figure 2.4-101 --- Potentiometric Surface Elevation Map and Groundwater Flow Directions for the Lower Chesapeake Unit, June 2007

GIS Map Code: US-CALV-000157-R000C
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Lower Chesapeake Aquifer Well
- Lower Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

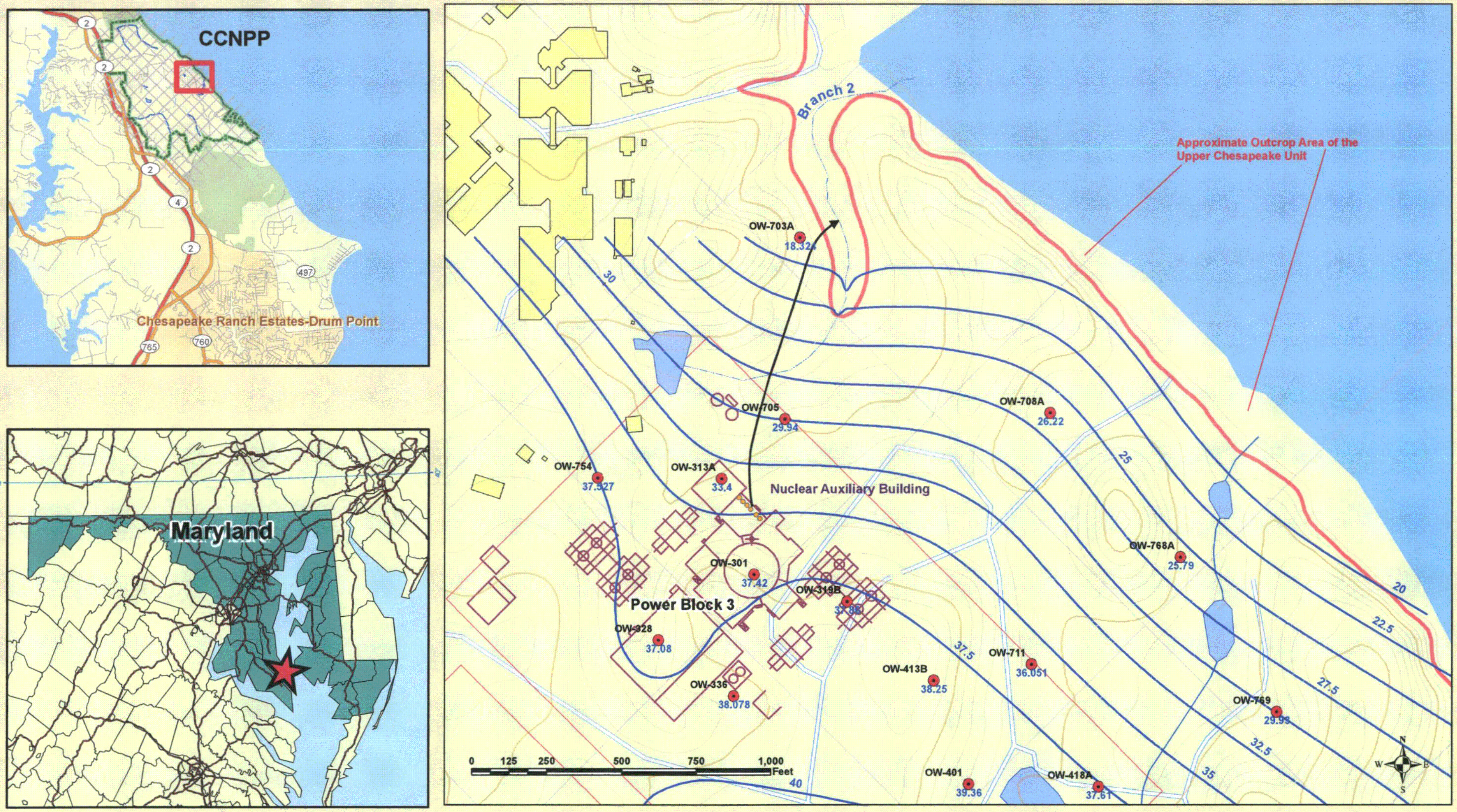
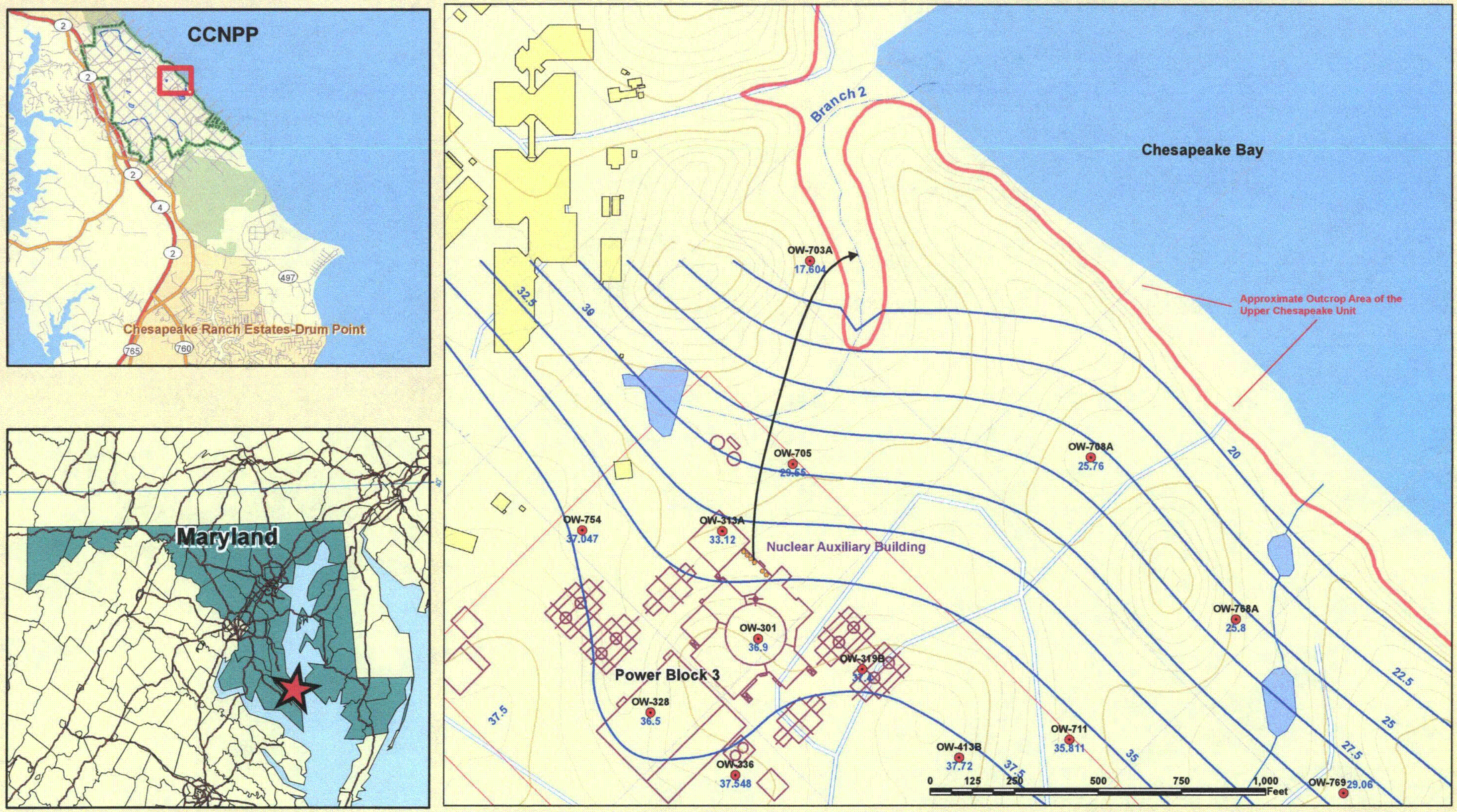


Figure 2.4-102 — Upper Chesapeake Unit Flow Direction from the Nuclear Auxiliary Building to Branch 2, July 2006

GIS Map Code: US-CALV-000132-R000E
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area



GIS Map Code: US-CALV-000133-R000E
Projection: Maryland State Plane
Datum: North American Datum 1927

Figure 2.4-103 — Upper Chesapeake Unit Flow Direction from the Nuclear Auxiliary Building to Branch 2, September 2006

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

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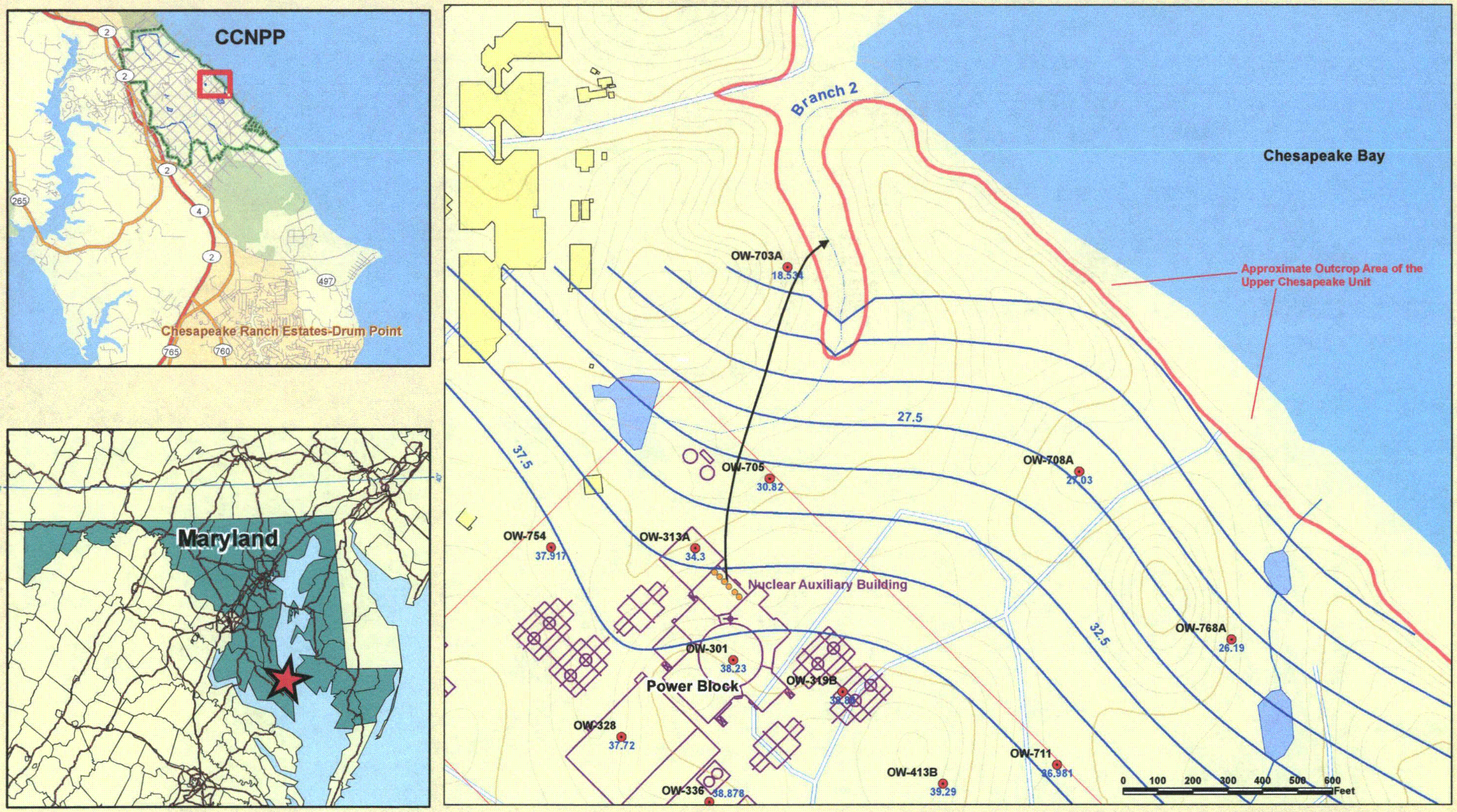

Figure 2.4-104 — Upper Chesapeake Unit Flow Direction from the Nuclear Auxiliary Building to Branch 2, December 2006

GIS Map Code: US-CALV-000129-R000F
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

N W E S

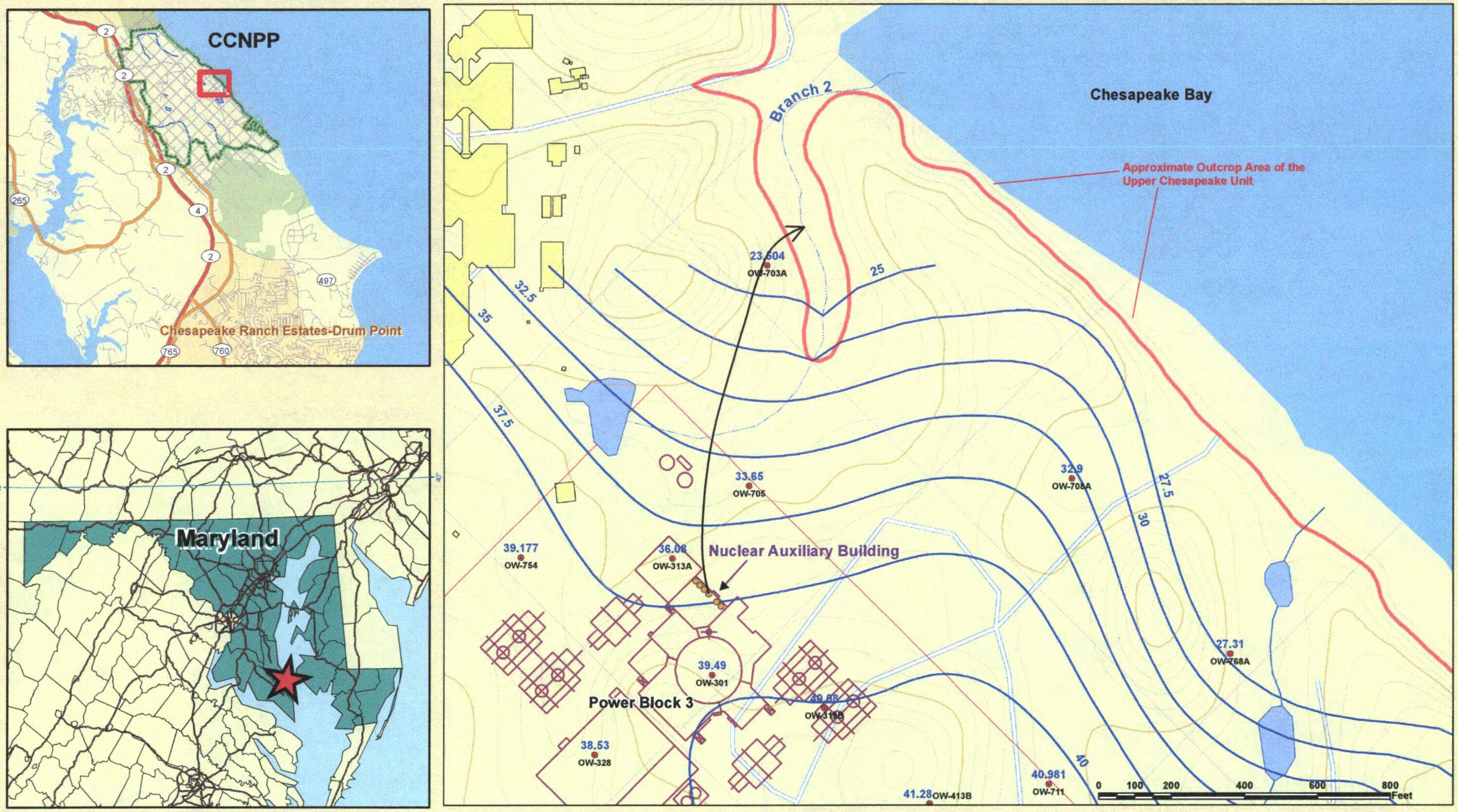

Figure 2.4-105 --- Upper Chesapeake Unit Flow Direction from the Nuclear Auxiliary Building to Branch 2, March 2007

GIS Map Code: US-CALV-000137-R000F
Projection: Maryland State Plane
Datum: North American Datum 1927

Legend

- Upper Chesapeake Aquifer Well
- Upper Chesapeake Aquifer Elev. (ft)
- Interpolated Aquifer Elev. (ft)
- Elevation (10-ft interval)
- Elevation (50-ft interval)
- Aquifer Extent
- Transmission Line
- Road, Existing
- Road, Proposed
- Power Block
- Stream, Permanent
- Stream, Intermittent
- Structure, Existing
- Lake or Pond
- Reserve Area

RAI No. 101

Question 02.04.12-3

FSAR Section 2.4.12.4 states both that (1) water for operation of CCNPP Unit 3 would come from a desalination plant and (2) water for construction and operation of CCNPP Unit 3 will be met from desalination **or** by appropriating ground water from Units 1 and 2. Clarify the CCNPP CCNPP Unit 3 ground water use projections given these ambiguous statements. Also, state in this section whether projected future on-site and off-site groundwater use, and the resulting reduction in groundwater heads, will affect plant safety (e.g., through subsidence). At the site hydrology audit, the applicant stated that additional groundwater modeling would be undertaken to address this issue. Provide a description of this additional modeling and provide electronic copies of the model input files used.

Response

Source of Water for CCNPP Unit 3

The sole source of fresh water for the operation of CCNPP Unit 3 will be a desalinization plant drawing water from the Chesapeake Bay. Other sources of fresh water will be required to support construction of Unit 3 before the desalinization plant is operational. Construction activities requiring fresh water include concrete mixing and curing, dust suppression, sanitary and potable use by the construction workforce, hydrostatic testing of pipes and tanks, and wash water. The water needed during the projected 68 months (approximately 6 years) of construction of CCNPP Unit 3 will be supplied by new production wells drilled into the Aquia aquifer. Other sources of fresh water that may be used to support construction are the groundwater pumped for construction dewatering and water trucked or barged from off site.

The Maryland Public Service Commission has issued a proposed Certificate of Public Convenience and Necessity (CPCN) to UniStar[1]. Condition 17 of the proposed CPCN authorizes UniStar to appropriate and use ground water from the Aquia aquifer to support the construction of CCNPPUnit 3. The groundwater allocation granted by this appropriation is limited to a daily average of 100,000 gallons on a yearly basis and a daily average of 180,000 gallons for the month of maximum use.

Potential Impacts to Plant Safety from Groundwater Withdrawals

Groundwater withdrawals from the coastal plain aquifers of southern Maryland over the past decades have resulted in significant drawdowns of regional extent. These drawdowns extend to the CCNPP site. A series of modeling studies have been conducted by the Maryland Geological Survey (MGS) and an ongoing multiyear effort is planned in cooperation with the U.S. Geological Survey[2] to evaluate the water-supply potential of the coastal plain aquifers of

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1 **MPSC, 2009**. Maryland Public Service Commission Case No. 9127, Appendix II, Proposed Order of Hearing Examiner, Final Licensing Conditions, Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, April 28, 2009.

2 **USGS, 2006.** Sustainability of the Ground-Water Resources in the Atlantic Coastal Plain of Maryland, USGS Fact Sheet FS 2006-3009, U.S. Geological Survey, 2006.

southern Maryland. Land subsidence caused by large declines in potentiometric head resulting from groundwater withdrawals has not been documented in Maryland[3].

A useful approach to evaluating the potential impacts associated with increasing groundwater withdrawal from the Aquia aquifer during construction of CCNPP Unit 3 is to use the results of the groundwater flow numerical model developed by the MGS and used to evaluate the water-supply potential of the coastal plain aquifers in Calvert, Charles and St. Mary's Counties[3,4]. This model was used by the MGS to evaluate the effects of continued groundwater withdrawal at either the current rates or various scenarios of projected rates until the year 2030. The model was calibrated to reproduce the potentiometric head measured in various aquifers in 2002. Figure 4b[4] indicates a predicted water level in 2002 of about –80 ft msl in the Aquia aquifer in the vicinity of the CCNPP. This predicted water level is close to the –81.5 ft msl observed level in 2002 (FSAR Figure 2.4-93).

Results of the MGS model indicate that increasing the annual water withdrawal from domestic users and public-supply wells to account for projected population increases while maintaining other major users (defined as those with withdrawals in excess of 10,000 gpd) at their actual withdrawal rates measured in 2002 (Scenario 1[3,4]) results in an additional drawdown in the Aquia aquifer in the vicinity of CCNPP of between 20 and 30 ft by 2030 (Figure 10b[4] and Figure 94[3]). Simulated drawdowns in the Piney Point-Nanjemoy aquifer in 2030 near CCNPP for the same withdrawal scenario are less than 10 ft (Figure 93[3]).

Increasing the withdrawal rates of domestic water users by the same amount as modeled in Scenario 1[3,4] and setting the water use of major users at the average rates authorized by their Maryland Department of the Environment Water Appropriation Permit (WAP) instead of their actual withdrawal rates measured in 2002 (Scenario 4[3,4]) also results in an additional drawdown in the Aquia aquifer near CCNPP of between 20 and 30 ft by 2030 (Figure 114[3]). At CCNPP, this scenario corresponds to increasing groundwater withdrawal from the Aquia aquifer by about 58,000 gpd from 391,833 gpd (the average rate in 2002, FSAR Table 2.4-42) to the permitted rate of 450,000 gpd for Units 1 and 2.

Simulated drawdowns near CCNPP in the Piney Point-Nanjemoy aquifer at 2030 for Scenario 4 are also less than 10 ft (Figure 113[3]). These increased drawdowns are principally the result of increased withdrawals by domestic and other users of this aquifer, rather than leakage across the low vertical conductivity Middle Confining Bed due to increased pumping from the underlying Aquia aquifer.

The published results described above assume that the increased groundwater withdrawals continue for the entire 28 years of the simulated period from 2002 to 2030. A more relevant analysis of the effects of increasing the groundwater withdrawal at CCNPP Units 1 and 2 to the permitted value of 450,000 gpd is to examine the model results at year 2010. This date corresponds to a period of 8 years of increased withdrawal, which is still more than the anticipated construction period of about 6 years. The unpublished intermediate simulation

3 **MGS, 2007**. Water Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers, Maryland Geological Survey Report of Investigation No. 76, Maryland Geological Survey, D. Drummond, August 2007.

4 **MGS, 2005**. Water Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers, Maryland Geological Survey Administrative Report, Maryland Geological Survey, D. Drummond, June 2005.

results for 2010 were provided by the MGS[5]. These results indicate a drawdown from 2002 water levels in the vicinity of CCNPP of between 5 and 10 feet in the Aquia aquifer and less than 5 feet in the Piney Point – Nanjemoy aquifer.

Bechtel Power Corporation developed a separate numerical model of the Aquia aquifer within a 5-mile radius of CCNPP (Bechtel 2008[6]), based upon the MGS model. The Bechtel model simulates the effect on Aquia aquifer water levels by pumping the CCNPP Units 1 and 2 wells for six years at their combined maximum permitted rate plus 200 gpm (total of 738,000 gpd). This withdrawal rate is an increase of about 346,000 gpd from the average rate of 391,833 gpd in 2002. Using this rate, the Bechtel model predicts increased drawdown after six years of about 52 feet at CCNPP and about 14 feet in the closest off-site wells of major water users. These are the Beaches Water Company, approximately 2.75 miles to the north in Long Beach and the Dominion Cove Point LNG Terminal, approximately 3.85 miles to the south. This model also predicts that following the six-year pumping period, water levels return in approximately three years to where they would have been if the pre-construction pumping rate had been maintained. Electronic copies of the Bechtel model input files are provided with this response.

Land subsidence may be caused by large drawdown in potentiometric head resulting from groundwater withdrawals if sediments are compressed due to loss of hydrostatic pressure. Generally, compaction of sediments induced by groundwater pumpage is relatively small until water-level declines exceed the previous maximum stress on the sediments, which is referred to as the preconsolidation stress[3].

It has been estimated[3] that, for the Atlantic Coastal Plain, the preconsolidation stress equivalent is about 65 ft below sea level and that water levels reduced to the 80-percent management level in the Aquia aquifer near Lexington Park in St. Mary's County, Maryland could result in land subsidence of 0.73 ft to 1.09 ft. The 80-percent management level is defined by the Maryland Department of the Environment as 80 percent of the total available drawdown, measured from the pre-pumping water level to the top of the aquifer. Figure 45[3] shows that the elevation of the 80-percent management level in the Aquia aquifer near Lexington Park is -358 ft msl. Based upon these data, the maximum ratio of subsidence to drawdown to be expected in the Aquia aquifer is about 0.0037:

1.09 ft subsidence / [-65 ft – (-358 ft)] drawdown = 0.0037

Therefore, if pumping during the 6-year construction period for CCNPPUnit 3 were to induce 52 ft of water-level drawdown in the Aquia aquifer at CCNPP, a maximum of about 0.192 ft (2.31 inches) or about 0.032 ft per year (0.38 inch per year) of subsidence could potentially occur. Because of the length of time required for drainage of the thick confining units above the Aquia[3] aquifer, the actual subsidence rate is likely to be less than this value and subsidence would continue after water levels in the aquifer have stabilized. This estimated subsidence rate is the maximum that could occur over the area of greatest drawdown. A lower average rate would apply over the area of influence of the pumping wells and subsidence would be distributed over a large area as the stresses are redistributed vertically.

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5 **MGS, 2008.** Results of simulated drawdowns, 2002 to 2010, based on Scenario 4 of Maryland Geological Survey Report of Investigation No. 76.

6 **Bechtel, 2008.** Evaluation of Potential Impacts of Construction Pumping on Declining Potentiometric Levels in the Aquia Aquifer, Bechtel Power Corporation, December 8, 2008.

It should be noted that the simulated rate of pumping in the Bechtel model during the construction period (728,000 gpd) is substantially greater than the 550,000 gpd that could be withdrawn (up to 450,000 gpd authorized by the WAP for Units 1 and 2 plus 100,000 gpd authorized by the proposed CPCN for construction of CCNPP Unit 3). The total authorized withdrawal rate is about 75 percent of the rate simulated in the Bechtel model. For this reason, the simulation results of the Bechtel model should be considered a bounding analysis of the maximum drawdown that can reasonably be expected from increased groundwater withdrawals to support construction of CCNPP Unit 3.

Based on this analysis, there would be no significant impact to plant safety from increasing groundwater withdrawals from the Aquia aquifer by the 100,000 gpd authorized by the proposed CPCN for the approximately six years of Unit 3 construction. Although the water level in the vicinity of CCNPP will be lowered temporarily, the Bechtel model predicts (even at the higher rate modeled) that following the six-year pumping period, water levels return in approximately three years to where they would have been if the pre-construction pumping rate had been maintained.

The additional groundwater withdrawal will support construction activities which are expected to last approximately 6 years. After that time, a desalinization plant will be operational. That plant is designed to produce 1,225 gpm (1,764,000 gpd) of fresh water.

COLA Impact

FSAR Section 2.4.12.1.4 will be revised as follows in a future COLA revision:

2.4.12.1.4 CCNPP Unit 3 Ground Water Use Projections

~~The proposed water source to meet the water demand requirements during the operation of CCNPP Unit 3 is a desalinization plant utilizing water from the Chesapeake Bay. An additional source of water will be required during construction activities until the desalinization plant is operational. Construction water needs are expected to be satisfied by appropriating water from CCNPP Units 1 and 2 by utilizing the established ground water permits.~~
~~2.4~~

~~It is currently estimated that a peak water supply of up to approximately 1200 gpm (4542 lpm) will be required for CCNPP Unit 3 construction activities (demands include those for construction personnel, concrete manufacturing, dust control, and hydro testing and flushing). Average construction demand would be less. In addition to appropriating water from CCNPP Units 1 and 2, the potential sources of water for construction include off-site water trucked to the construction site, and on-site storage tanks.~~

The sole source of fresh water for the operation of CCNPP Unit 3 will be a desalinization plant drawing raw water from the Chesapeake Bay. Other sources of fresh water will be required to support construction of CCNPP Unit 3 before the desalinization plant is operational. Construction activities requiring fresh water include concrete mixing and curing, dust suppression, sanitary and potable use by the construction workforce, hydrostatic testing of pipes and tanks, and wash water. The water needed during the projected 68 months (approximately 6 years) of construction of CCNPP Unit 3 will be supplied by new production wells drilled into the

Aquia aquifer. Other sources of fresh water that may be used to support construction are the groundwater pumped for construction dewatering and water trucked or barged from off site.

The Maryland Public Service Commission has issued a proposed Certificate of Public Convenience and Necessity (CPCN) to UniStar (MPSC, 2009). Condition 17 of the proposed CPCN authorizes UniStar to appropriate and use ground water from the Aquia aquifer to support the construction of CCNPP Unit 3. The groundwater allocation granted by this appropriation is limited to a daily average of 100,000 gallons on a yearly basis and a daily average of 180,000 gallons for the month of maximum use (MPSC, 2009).

If properly managed, construction activities at CCNPP and any additional ground water withdrawals for construction of CCNPP Unit 3 should not adversely affect the local or regional ground water systems. There are currently no known or projected site discharges that do or could affect the local ground water system. Construction activities will affect the shallower, non-utilized water-bearing units beneath the site (the Surficial aquifer and upper units within the Chesapeake Group). ~~Water demands for construction and operation of the proposed CCNPP Unit 3 will be met from desalinization of Chesapeake Bay water or by appropriating ground water from CCNPP Units 1 and 2 in accordance with the established ground water permits.~~

FSAR Section 2.4.12.6 will be supplemented as follows in a future COLA revision:

2.4.12.6 References

MPSC, 2009. Maryland Public Service Commission Case No. 9127, Appendix II, Proposed Order of Hearing Examiner, Final Licensing Conditions, Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, April 28, 2009.

RAI No. 101

Question 02.04.12-5

Provide a description of the water budget at the site. This description should include estimates of recharge to the surficial aquifer, recharge to the Chesapeake units from the surficial aquifer, and recharge to the Piney Point-Nanjemoy aquifer from the Chesapeake. Regional information can be used in developing these estimated recharge values. Provide a three-dimensional conceptual description of groundwater flow within and between these units (Surficial aquifer, Chesapeake units and Piney-Point Nanjemoy aquifer), provide an interpretation of the available groundwater head data (particularly from well OW-744) within the context of the three-dimensional conceptual description, and discuss the potential for a groundwater pathway from the CCNPP facility to the Piney-Point Nanjemoy aquifer.

Response

Water Budget and Conceptual Groundwater Flow Model

The Surficial aquifer is exposed at the surface of the CCNPP Unit 3 site above an elevation of approximately 65 ft msl. Recharge to this aquifer is directly from precipitation. A study by Chinkuyu et al.[7] determined that average groundwater recharge at the USDA Agricultural Research Center in Beltsville, Maryland is about 20 to 25 percent of annual precipitation. However, because the slope of the land surface at the CCNPP Unit 3 site is much greater than that at the Beltsville site, recharge at CCNPP should be comparatively lower. Groundwater recharge at the CCNPP Unit 3 site has been estimated by a numerical model prepared by Bechtel simulating flow within the Surficial aquifer. Calibration of that model determined that recharge to the Surficial aquifer is about 11.5% of the mean annual precipitation of 43.56 inches, or about 5 inches per year (1.14×10^{-3} ft/day).

The Surficial aquifer is directly underlain by the Upper Confining Bed, a hydrogeologic unit correlated to the Chesapeake Group of Miocene age.[8] The Piney Point – Nanjemoy aquifer underlies the Chesapeake Group. Although the Chesapeake Group comprises a regional aquitard consisting primarily of silt and clay, two layers of water-bearing silty sand exist within the Group at the site of CCNPP Unit 3. These relatively thin aquifers are referred to informally as the Upper Chesapeake Unit and the Lower Chesapeake Unit. The Upper Chesapeake aquitard separates the Surficial aquifer from the Upper Chesapeake Unit. The Middle Chesapeake aquitard separates the Upper Chesapeake Unit from the Lower Chesapeake Unit, and the Lower Chesapeake aquitard separates the Lower Chesapeake Unit from the Piney Point – Nanjemoy aquifer. Cross-sections showing the relationship between the units are shown in revised FSAR Figures 2.4-66 and 2.4-67. FSAR Section 2.4.12.1.3.1 has been revised to be consistent with the revised Figures 2.4-66 and 2.4-67. A summary of the hydrostratigraphic units, from youngest to oldest, and their average total thicknesses is shown in Table 1, below.

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7 Chinkuyu, A., A. Guber, T. Gish, D. Timlin, J. Starr, T. Nicholson, R. Cady, A. Schwartzman, 2008; Field Studies to Confirm Uncertainty Estimates of Ground-Water Recharge, U.S. Nuclear Regulatory Commission, NUREG/CR-6946, August 2008.

8 **MGS, 1996.** Hydrostratigraphic Framework of the Piney Point-Nanjemoy Aquifer and Aquia Aquifer in Calvert and St. Mary's Counties, Maryland, Maryland Geological Survey, Open File Report No. 96-02-8, Maryland Geological Survey, H. Hansen, 1996.

Table 1

Hydrostratigraphic Unit	Average Total Thickness (ft)
Surficial aquifer	29
Upper Chesapeake aquitard	20
Upper Chesapeake Unit	45
Middle Chesapeake aquitard	11
Lower Chesapeake Unit	35
Lower Chesapeake aquitard	170
Piney Point – Nanjemoy aquifer	105

Most of the recharge to the Surficial aquifer discharges at ground surface by lateral flow to springs that occur where erosion has exposed the underlying Upper Chesapeake aquitard (FSAR Figures 2.4-70, -71, -72, -73 and -99). These springs form the headwaters for tributaries flowing westward to John's Creek and eastward to the Chesapeake Bay. A portion of the Surficial aquifer recharge flows vertically downward to recharge the Upper Chesapeake Unit. Most of this recharge to the Upper Chesapeake Unit flows laterally north and east to discharge near the shore of Chesapeake Bay, where the unit is exposed at land surface (FSAR Figures 2.4-75, -76, -77, -78 and -100). A portion of the recharge to the Upper Chesapeake Unit flows vertically downward to recharge the Lower Chesapeake Unit. Groundwater within the Lower Chesapeake Unit flows laterally northeast (FSAR Figures 2.4-80, -81, -82, -83 and -101) to discharge from subaqueous exposures of the aquifer that are presumed to occur offshore beneath Chesapeake Bay and vertically downward to recharge the Piney Point – Nanjemoy aquifer.

Groundwater levels have been monitored monthly for one year in observation wells completed in the Surficial aquifer, the Upper Chesapeake Unit and the Lower Chesapeake Unit (FSAR Table 2.4-36). Water levels measured in pairs of adjacent wells completed in these aquifers demonstrate a downward vertical flow potential from the shallowest to the deepest of these units. This relationship indicates that recharge from the Surficial aquifer to the deeper units is occurring. The rate of flux between the units is a function of the hydraulic gradient between the aquifers and the hydraulic conductivity of the intervening aquitards.

The vertical hydraulic conductivity of the Upper Confining Bed has been estimated from laboratory analysis of core samples and through calibration of groundwater models. The model-calibrated values range from 8.6×10^{-4} to 8.6×10^{-8} ft/day, with an average of 10^{-4} ft/day[9] used in recent modeling.

The difference in potentiometric head between the Surficial aquifer and the Upper Chesapeake Unit is monitored in four observation well pairs at the CCNPP Unit 3 site. The average annual water table elevation in the four wells in the Surficial aquifer is 76.24 ft msl (FSAR Table 2.4-36). The average annual potentiometric surface elevation in the four wells in the Upper Chesapeake Unit is 38.28 ft msl (FSAR Table 2.4-36). Therefore, there is an average downward vertical flow potential of about 38 ft between the two units. The intervening Upper Chesapeake aquitard has an average vertical thickness of about 20 ft (FSAR Figures 2.4-66 and 2.4-67) and an average vertical hydraulic conductivity of about 10^{-4} ft/day. Therefore, an average vertical flux of about 1.9×10^{-4} ft/day exists between the Surficial aquifer and the Upper Chesapeake Unit. This flux

[9] **MGS, 1996.** Hydrostratigraphic Framework of the Piney Point-Nanjemoy Aquifer and Aquia Aquifer in Calvert and St. Mary's Counties, Maryland, Maryland Geological Survey, Open File Report No. 96-02-8, Maryland Geological Survey, H. Hansen, 1996.

provides an average groundwater recharge to the Upper Chesapeake Unit that is about 16.5% of the recharge to the Surficial aquifer.

Within the three observation well pairs that monitor water levels between the Upper Chesapeake Unit and the Lower Chesapeake Unit, the data in Table 2.4-36 indicate a downward vertical flow potential with an average difference of about 2.7 ft between the units. The intervening Middle Chesapeake aquitard has a vertical thickness of about 11 ft (FSAR Figures 2.4-66 and 2.4-67) and an average vertical hydraulic conductivity of about 10^{-4} ft/day. The resulting average vertical flux between the Upper and Lower Chesapeake Units is about 2.5×10^{-5} ft/day. This flux provides an average groundwater recharge to the Lower Chesapeake Unit that is about 13% of the recharge to the Upper Chesapeake Unit and 2.2% of the recharge to the Surficial aquifer.

The average annual elevation of the potentiometric surface measured in the three observation wells in the Lower Chesapeake Unit at the CCNPP Unit 3 site is 28.18 ft msl (FSAR Table 2.4-36). The elevation of the potentiometric surface in the Piney Point – Nanjemoy aquifer is about -3 ft msl in the vicinity of CCNPP (FSAR Figure 2.4-92). The intervening Lower Chesapeake aquitard has a vertical thickness of about 170 ft and an average vertical hydraulic conductivity of about 10^{-4} ft/day. The resulting average vertical flux between the Lower Chesapeake Unit and the Piney Point – Nanjemoy aquifer is about 1.8×10^{-5} ft/day. This flux provides an average groundwater recharge to the Piney Point – Nanjemoy aquifer that is about 72% of the recharge to the Lower Chesapeake Unit, 9.5% of the recharge to the Upper Chesapeake Unit and 1.6% of the recharge to the Surficial aquifer.

This analysis demonstrates that there is a potential for groundwater flow from the Surficial to the Piney Point – Nanjemoy aquifer. The magnitude of that flow is directly related to the estimated vertical hydraulic conductivity of the aquitards within the Chesapeake Group. Based upon the limited available regional estimates for this parameter[10], approximately 1.6% of groundwater recharged to the Surficial aquifer may leak vertically to recharge the Piney Point – Nanjemoy aquifer. This relatively small amount of leakage would be further diluted by horizontal groundwater flow within the Piney Point – Nanjemoy aquifer, which is recharged by direct infiltration of precipitation that falls on the outcrop area of units comprising the aquifer: the lower Calvert Formation in northern Calvert County and the Nanjemoy Formation in Prince George's and Anne Arundel Counties.[4]

The general flow direction in the Piney Point – Nanjemoy aquifer is to the southeast[11] at a horizontal gradient of about 2 ft/mi. Considering a transmissivity of between 500 and 1,000 ft^2/day[4], the horizontal flow rate in the Piney Point - Nanjemoy aquifer in the vicinity of CCNPP is about 0.2 to 0.4 ft^3/day per foot of flow-path width perpendicular to the direction of flow. With a vertical flux of about 1.8×10^{-5} ft/day between the Lower Chesapeake Unit and the Piney Point – Nanjemoy aquifer, over the length of the CCNPP Unit 3 site of approximately 2,000 ft in the southeast direction of flow, there is a vertical flux to the Piney Point – Nanjemoy aquifer of about 0.036 ft^3/day per foot of flow-path width perpendicular to the direction of flow. Therefore, the magnitude of the horizontal flow within the Piney Point – Nanjemoy aquifer is about 5.5 to11

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10 **MGS, 1997**. Hydrogeology, Model Simulation, and Water-Supply Potential of the Aquia and Piney Point-Nanjemoy Aquifers in Calvert and St. Mary's Counties, Maryland, Report of Investigation, No. 64, Maryland Geological Survey, G. Achmad, and H. Hansen, 1997.

11 **MGS, 2007.** Water Supply Potential of the Coastal Plain Aquifers in Calvert, Charles, and St. Mary's Counties, Maryland, with Emphasis on the Upper Patapsco and Lower Patapsco Aquifers, Maryland Geological Survey Report of Investigation No. 76, Maryland Geological Survey, D. Drummond, August 2007.

times greater than the vertical leakage from the Lower Chesapeake Unit. This horizontal flow would dilute the vertical leakage 5.5 to 11 times.

Well OW-744

Observation well OW-744 is screened in a discontinuous silty sand unit vertically isolated from the Upper and Lower Chesapeake Units. Therefore, water-level elevation data from this well is not used in the hydrogeologic evaluations of these units. An evaluation of the geologic logs for the soil borings in which observation wells were constructed reveals that the stratigraphy encountered in well OW-744 differs from that in the nearby wells. Figure 2.4-68 shows that the eight Surficial aquifer wells OW-323, OW-423, OW-428, OW-436, OW-752A, OW-756, OW-765A and OW-766 are located in the vicinity of OW-744. The screen for each of these eight nearby wells is completed in a layer of silty sand that extends generally from the ground surface to a clay layer whose top surface is at an elevation that ranges from 77 to 60 ft msl. This clay layer is an aquitard whose bottom elevation ranges from about 47 to 31 ft msl.

At well OW-744 a relatively thin layer of silty sand extends from the ground surface to an elevation of 82 ft msl. Sandy clay underlies this layer, to an elevation of 67 ft msl. Below the sandy clay is a lens of silty sand from 67 to 51 ft msl. More sandy clay exists below this interval. The screen for OW-744 is in the interval from 59.5 to 49.5 ft msl, whereas the screens for the closest wells in the Surficial aquifer (each 10 ft long) are completed higher in the section, within the interval from 88.9 to 60.3 ft msl (Figure A). The nearby wells in the Upper Chesapeake Unit have screens completed below the sandy clay aquitard (Figure B) and the four closest to OW-744 (OW-328, OW-336, OW-752B and OW-765B) are within the interval from 37.1 to 0.8 ft msl.

OW-744 is screened in a discontinuous silty sand lens not hydraulically connected with the shallower silty sand in which the wells in the Surficial aquifer are screened or the deeper silty sand in which the wells in the Upper Chesapeake Unit are screened. As a result, the water level in OW-744 is consistently lower than the water levels in the nearby Surficial aquifer wells and higher than the water levels in the nearby Upper Chesapeake Unit wells. FSAR Table 2.4-35 shows that during the period July 2006 through June 2007, the water level in OW-744 ranged from 66.29 to 68.48 ft msl, whereas the water levels in the eight nearby Surficial aquifer wells ranged from 71.64 to 85.74 ft msl and the water levels in the four nearby Upper Chesapeake Unit wells ranged from 36.45 to 40.31 ft msl. These relationships are illustrated on the attached cross-sections.

Figure A - Stratigraphy, Screen Interval and Groundwater Levels in Observation Well OW-744 Relative to Nearby Wells in the Shallow Aquifer

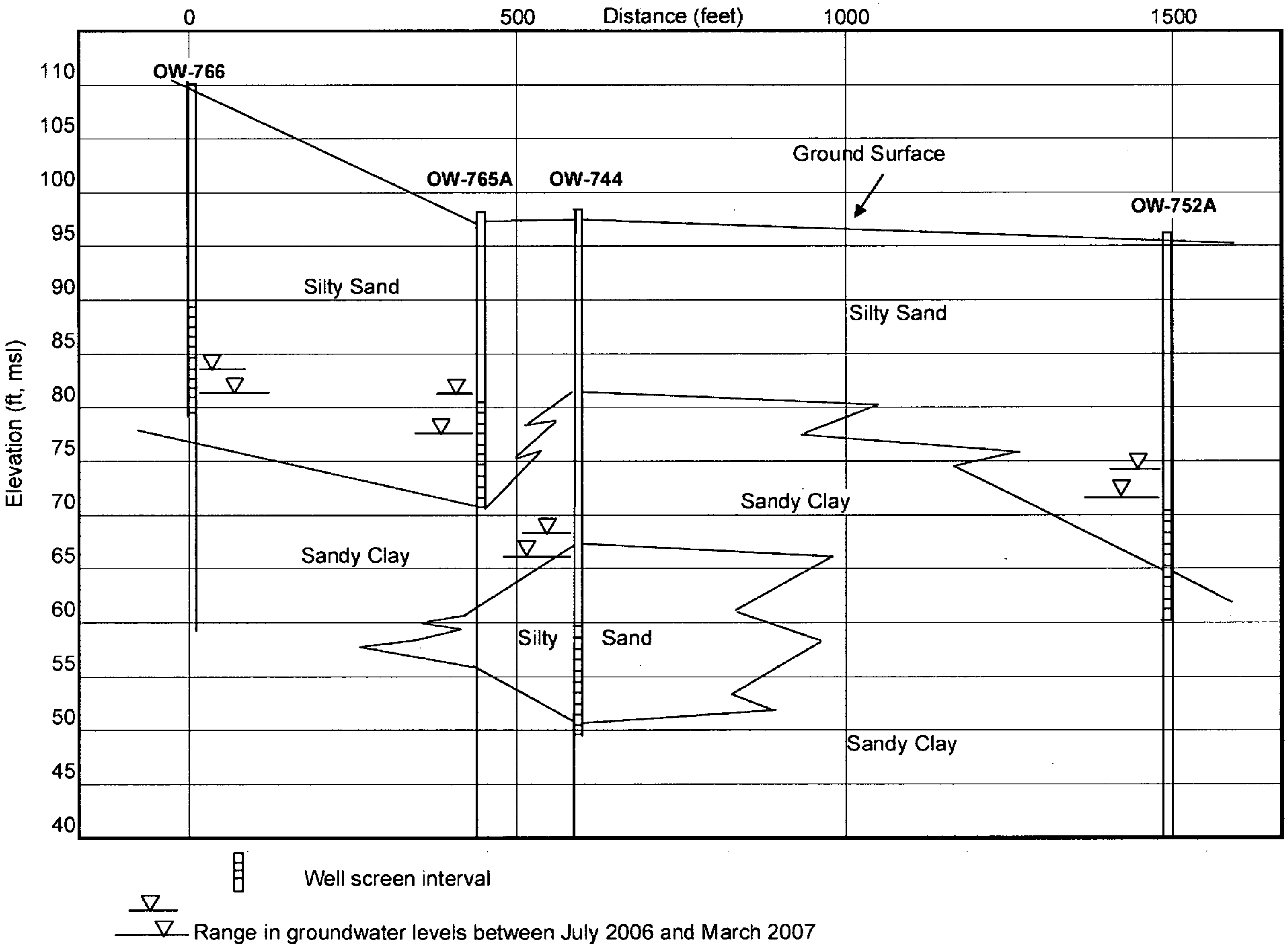
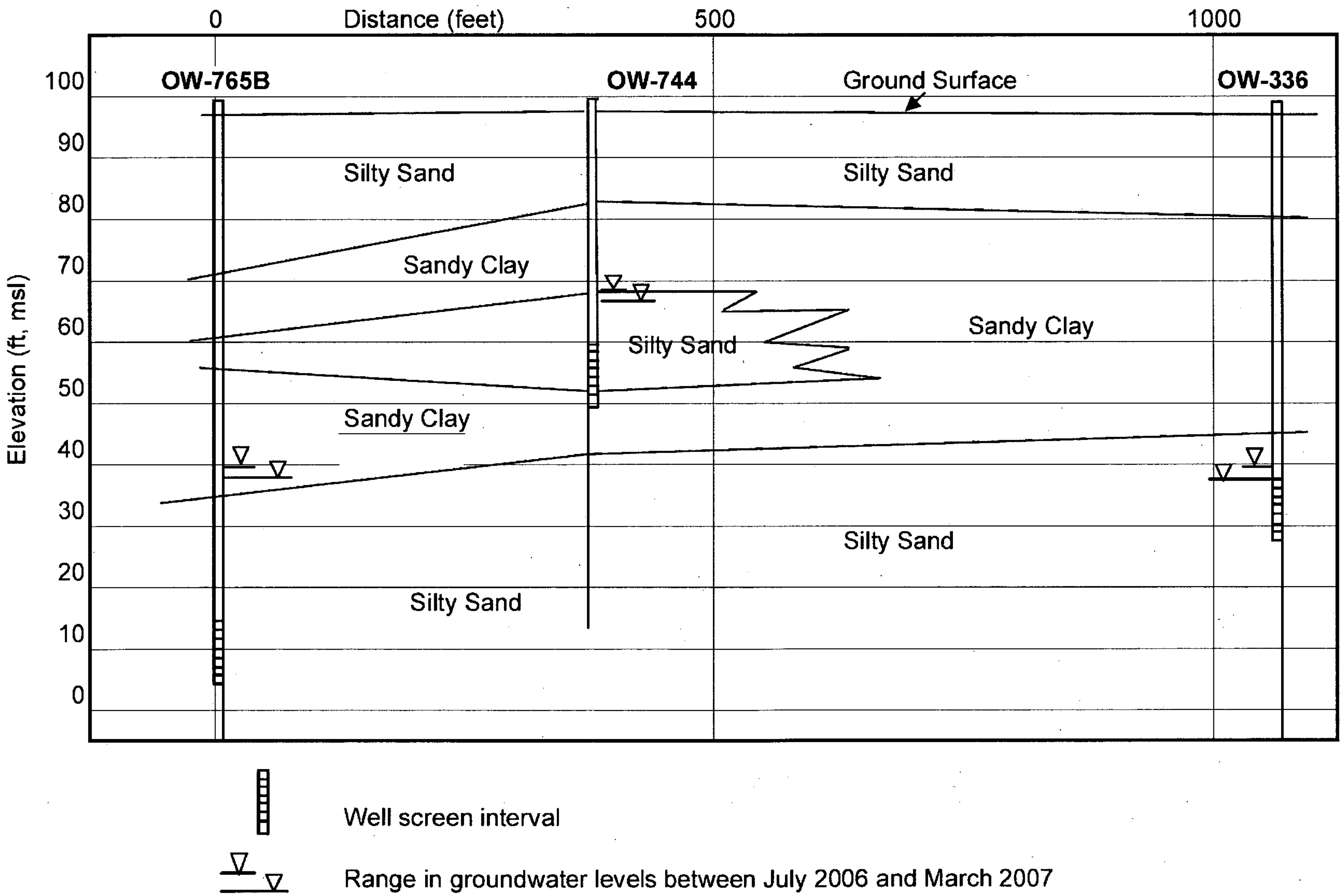


Figure B - Stratigraphy, Screen Interval and Groundwater Levels in Observation Well OW-744 Relative to Nearby Wells in the Upper Chesapeake Unit



COLA Impact

Figures 2.4-66 and 2.4-67 in FSAR Section 2.4 will be updated as follows in a future COLA revision.

FSAR Section 2.4.12.1.3.1 will be revised as follows in a future COLA revision:

2.4.12.1.3.1 Geohydrology

The elevations, thicknesses, and geologic descriptions of the sediments comprising the shallow hydrogeologic units (depths to 400 ft (122 m)) below ground surface) were determined from CCNPP Unit 3 geotechnical and hydrogeological borings. Geotechnical and geological descriptions of the material encountered are described in Section 2.5.

Surficial Aquifer

The elevations, thicknesses, and geologic descriptions of the sediments comprising the Surficial aquifer, as determined from the CCNPP Unit 3 geotechnical and hydrogeological borings, are summarized as follows.

- The unconsolidated sediments comprising the Surficial aquifer consist primarily of fine to medium grained sands and silty or clayey sands. At relatively few locations and intervals, coarse grained sands were observed to comprise the bulk of the interval sampled.

- The Surficial aquifer is present above an elevation <u>of</u> ~~ranging from~~ approximately 65 ~~to 70~~ ft (19.8 ~~to 21.3~~ m) msl at the CCNPP site (Figure 2.4-66 and Figure 2.4-67). The thickness of the Surficial aquifer ranges from 0 ft (0 m), where local drainages have dissected the unit, to approximately 55 ft (16.8 m) at the site's higher elevations.

Chesapeake Confining Unit

The Chesapeake Confining Unit thickens from northwest to southeast in Calvert County and ranges in thickness from approximately 115 to 300 ft (35 to 91.4 m). A boring log from a production well at the CCNPP site indicates that the base of the Chesapeake Confining Unit is at an elevation of approximately -205 ft (-62.5 m) msl and its total thickness is approximately 250 ft (76.2 m) (MGS, 1996). The CCNPP Unit 3 soil borings advanced to this depth confirm this observation.

The elevations, thicknesses, and geologic descriptions of the sediments comprising the Chesapeake Confining Unit, as determined from the CCNPP Unit 3 geotechnical and hydrogeological borings, are summarized as follows.

- The unconsolidated sediments comprising the Chesapeake Confining Unit consist primarily of silty clays, silt, and silty fine-grained sands. Thin, interbedded fine- to medium-grained fossiliferous sands are common. <u>Some of these sands are cemented with calcite.</u>

- The base of the Chesapeake Confining Unit is observed at an elevation of approximately –205 ft (-62.5 m) msl in Boring B-401 ~~B-301~~ and -215 ft (-65.5 m) msl in Boring B-301 ~~B-401~~.

- The top of the Chesapeake Confining Unit ranges from an elevation of approximately 8 ft (2.4 m) msl in Boring B-701 at the Chesapeake Bay shore to approximately 65 ft ~~to 70 ft~~ (19.8 ~~to 21.3~~ m) msl in borings where the overlying Upland Deposits comprising the Surficial aquifer were encountered.

- The thickness of the Chesapeake Confining Unit, as observed in Borings B-301 and B-401, is approximately 278 ~~280~~ ft (84.8 ~~85.3~~ m) ~~and 277 ft (84.4 m), respectively~~.

- Two thin, semi-continuous, water-bearing sand units were encountered in the upper portion of the Chesapeake Confining Unit. These units are informally referred to as the Upper Chesapeake Unit ~~unit~~ and the Lower Chesapeake Unit ~~unit~~.

- The base of the Upper Chesapeake Unit ~~unit~~ ranges from approximately 16 ~~8~~ ft (4.9 ~~2.4~~ m) msl to -17 ~~19~~ ft (-5.2 ~~5.8~~ m) msl in elevation, has a mean thickness of approximately 46 ~~21~~ ft (14.9 ~~6.4~~ m), and reaches a maximum thickness of approximately 63 ~~44~~ ft (19.2 ~~13.4~~ m) at boring B-331. The minimum, observed thickness of the Upper Chesapeake Unit ~~unit~~ is ~~was~~ 17 ~~8~~ ft (5.2 ~~2.4~~ m) at borings B-701 ~~B-720~~ and B-702 ~~B-721~~. The elevation of the top of the Upper Chesapeake unit averages approximately elevation 41 ~~20~~ ft (12.5 ~~6.1~~ m) msl.

- The Lower Chesapeake Unit ~~unit is thicker than the Upper Chesapeake unit and~~ contains a higher silt and clay content than the Upper Chesapeake unit. The base of the Lower Chesapeake Unit ~~unit~~ ranges in elevation from ~~of~~ approximately -38 ft (-11.6 m) msl to -92 ft (-28.0 m) msl, has a mean thickness of approximately 36 ft (11 m), and reaches a maximum thickness of approximately 62 ft (18.9 m) at boring B-313 ~~B-311~~. The minimum observed thickness of the Lower Chesapeake Unit ~~unit~~ was 19 ft at boring B-327 ~~B-323~~.

- The Upper Chesapeake Unit ~~unit~~ is separated from the overlying Surficial aquifer by the informally named relatively thin Upper Chesapeake aquitard. The Upper Chesapeake aquitard ranges in thickness from approximately 4 to 36 ft (1.2 to 11 m) and averages approximately 20 ft (6.1 m). The Lower Chesapeake Unit ~~unit~~ is separated from the underlying Piney Point - Nanjemoy aquifer by the informally named and relatively thick Lower Chesapeake aquitard. Two CCNPP Unit 3 soil borings penetrated the Lower Chesapeake aquitard, which is approximately 170 ~~190~~ ft (51.8 ~~57.9~~ m) thick.

Figure 2.4-66--Cross-Section A-A' Through Proposed Unit 3 Power Block Area

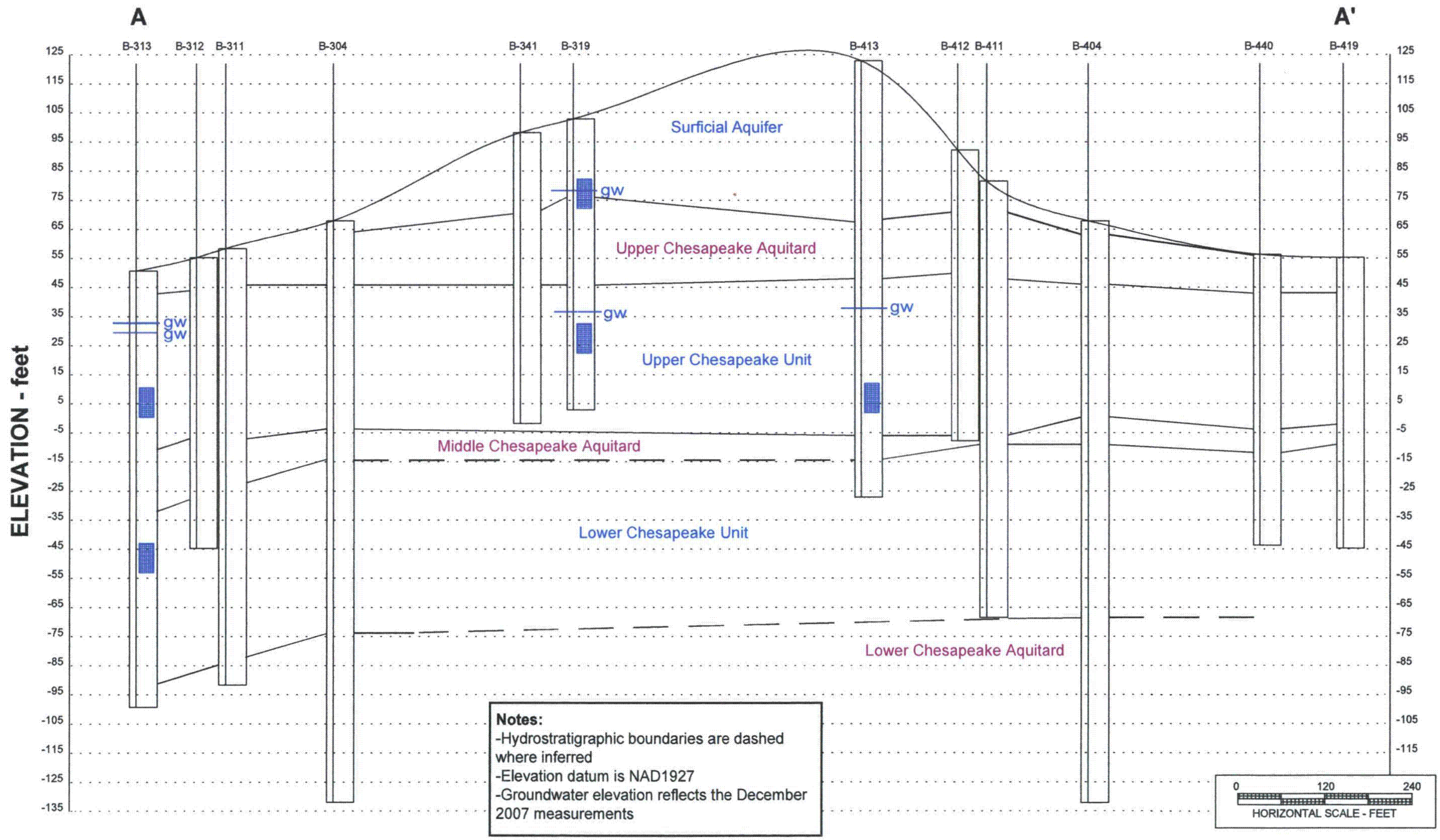
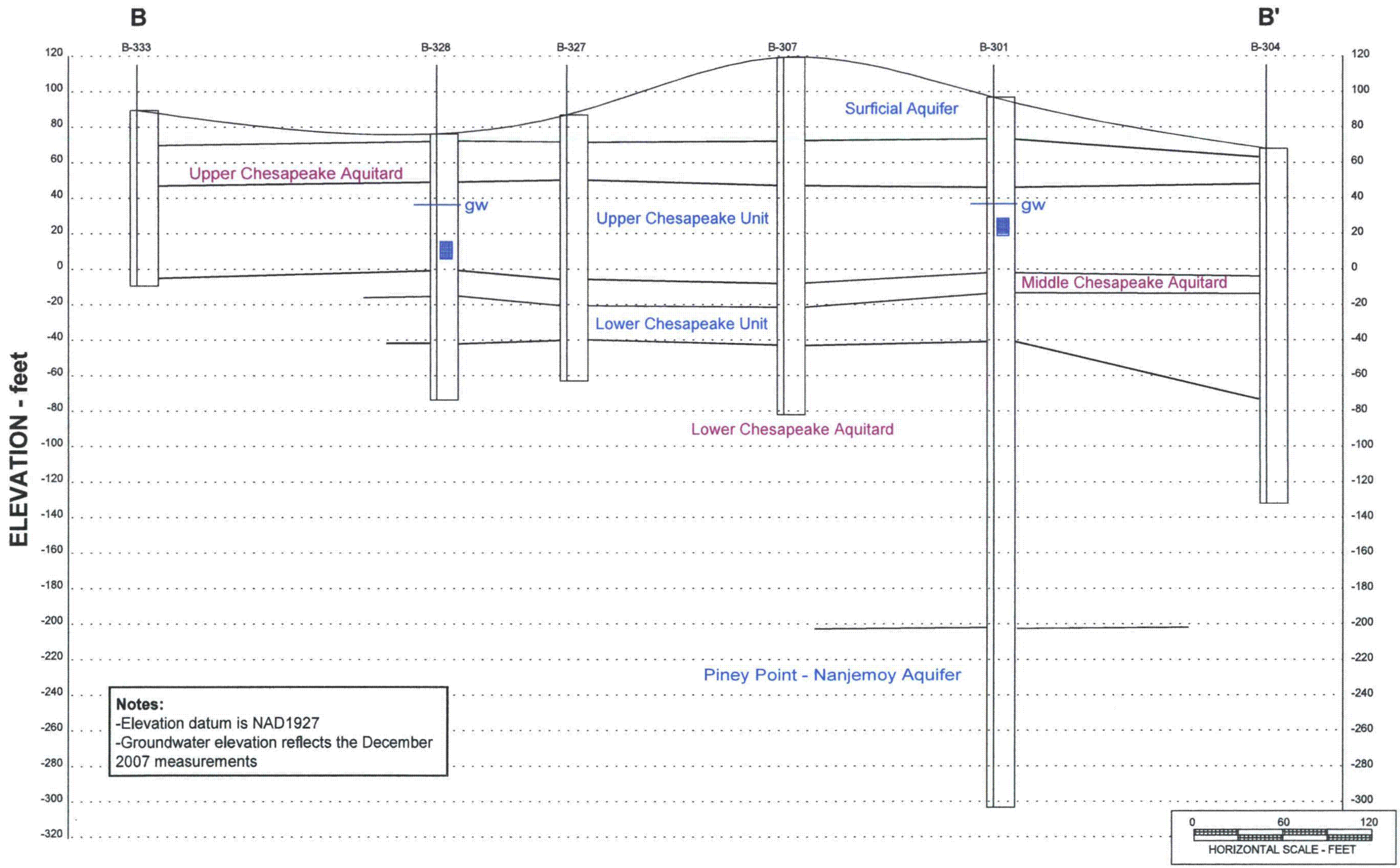


Figure 2.4-67--Cross-Section B-B' Through Proposed Unit 3 Power Block Area



RAI No. 101

Question 02.04.12-6

Groundwater heads and estimated hydraulic gradients were observed to be variable in time. Given the limited number of observations (one year of monthly head data) provide a discussion of the potential impact of temporal variability in head on the estimated groundwater velocities and travel times.

Response

Based on the attached well hydrographs, the months of high and low head in the three water bearing units monitored at the site are presented below:

- Surficial aquifer High = May 2007 Low = September 2006
- Upper Chesapeake Unit High = April 2007 Low = August 2006
- Lower Chesapeake Unit High = April 2007 Low = August 2006

The quarterly potentiometric surface maps for the months closest to those described above and provided in FSAR Section 2.4.12 were used to determine hydraulic gradients. These hydraulic gradients were then used to determine horizontal flow velocities and travel times as described below:

V = Ki/*p* where:

V = horizontal flow velocity (feet/day)
K = horizontal hydraulic conductivity (feet/day)
i = hydraulic gradient (unitless)
p = effective porosity (unitless)

T = L/V where

T = Travel time
L = travel path length (feet)

Surficial aquifer

<u>High head</u>

K = 0.910 ft/day
i = 0.0104
p = 0.341
L= 1315 ft

V = (0.910 ft/day x 0.0104)/0.341 = 0.028 ft/day
T = 1315 ft/0.028 ft/day = 46,964 days (129 years)

<u>Low head</u>

K = 0.910 ft/day
i = 0.0100
p = 0.341
L = 1315 ft

V = (0.910 ft/day x 0.0100)/0.341 = 0.027 ft/day
T = 1315 ft/0.027 ft/day = 48,704 days (133 years)

Upper Chesapeake Unit

<u>High head</u>

K = 0.740 ft/day — V = (0.740 ft/day x 0.0144)/0.370 = 0.029 ft/day
i = 0.0144 — T = 1425 ft/0.029 ft/day = 49,138 days (135 years)
p = 0.370
L = 1425 ft

<u>Low head</u>

K = 0.740 ft/day — V = (0.740 ft/day x 0.0174)/0.370 = 0.035 ft/day
i = 0.0174 — T = 1425 ft/0.035 ft/day = 40,714 days (111 years)
p = 0.370
L = 1425 ft

Lower Chesapeake Unit

<u>High head</u>

K = 0.045 ft/day — V = (0.045 ft/day x 0.0115)/0.412 = 0.0013 ft/day
i = 0.0115 — T = 1540 ft/0.0013 ft/day = 1,184,615 days (3243 years)
p = 0.412
L = 1540 ft

<u>Low head</u>

K = 0.045 ft/day — V = (0.045 ft/day x 0.0152)/0.412 = 0.0017 ft/day
i = 0.0152 — T = 1540 ft/0.0017 ft/day = 905,882 days (2480 years)
p = 0.412
L = 1540 ft

As shown above, the gradient in the Surficial aquifer decreases slightly from periods of high head to low head. The resulting flow velocity decreases slightly, and the corresponding travel time increases approximately 3% from periods of observed maximum to minimum head.

The opposite effect is observed in the two Chesapeake units where gradient increases from periods of high head to low head, the resulting flow velocities increase, and the corresponding travel times decrease. In the Upper Chesapeake Unit the travel time decreased approximately 18% from periods of observed maximum to minimum head, whereas in the Lower Chesapeake Unit the decrease was approximately 24% from observed maximum to minimum head.

COLA Impact

Figures 2.4-69, 2.4-74 and 2.4-79 in FSAR Section 2.4 will be updated as follows in a future COLA revision.

Figure 2.4-69 Groundwater Elevations for the Surficial Aquifer, July 2006 through June 2007

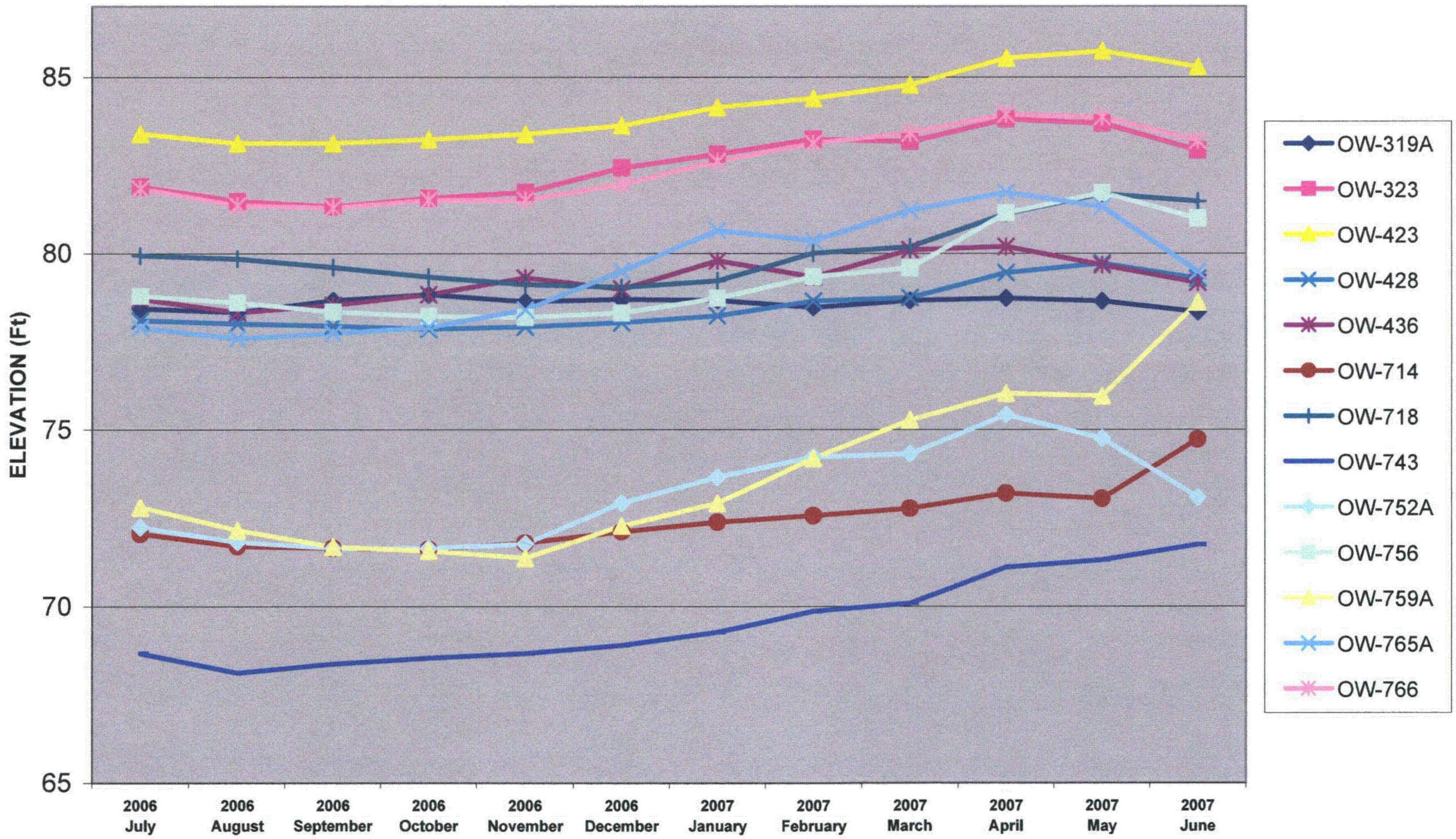


Figure 2.4-74 - Groundwater Elevations for the Upper Chesapeake Unit, July 2006 through June 2007

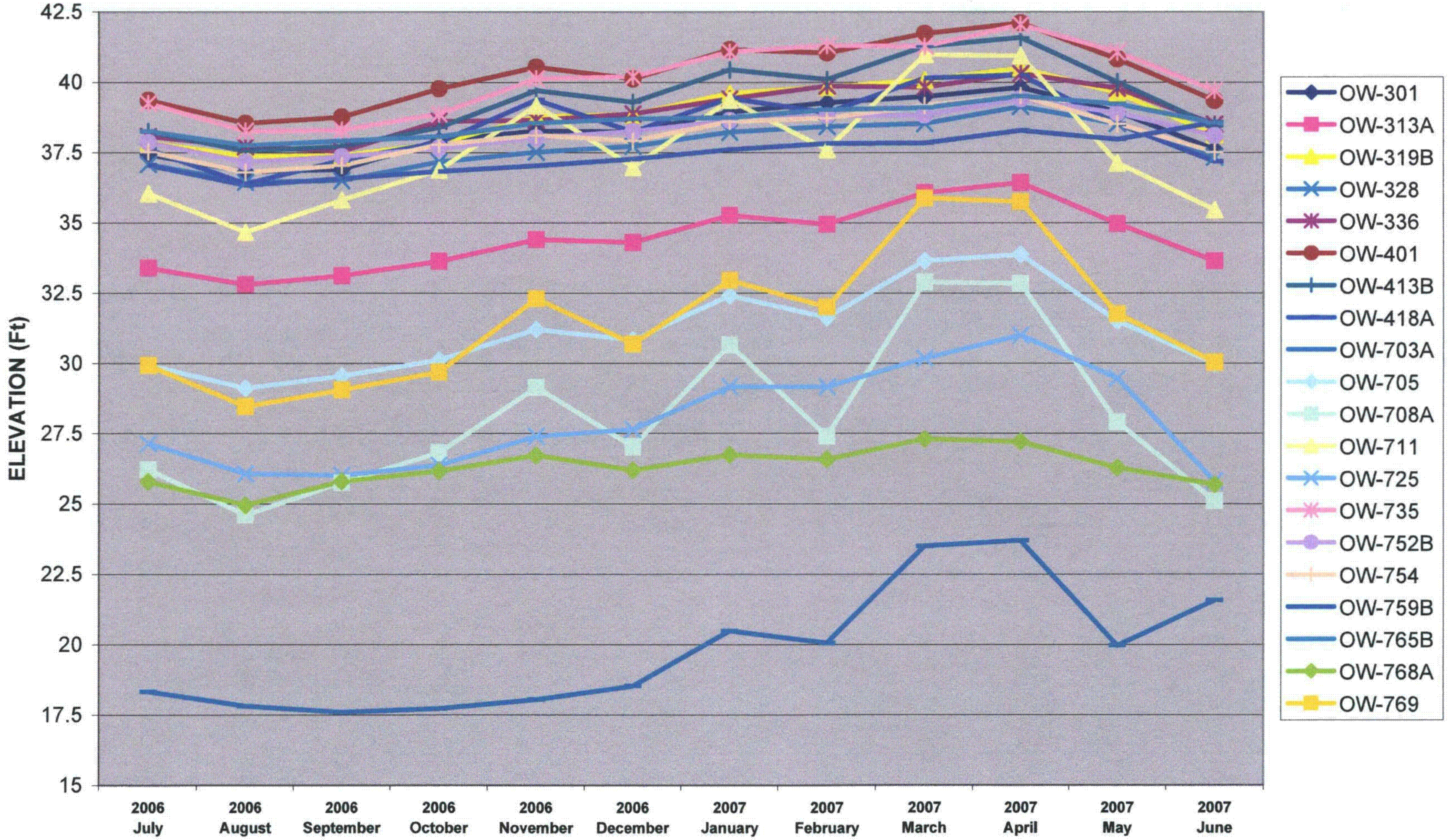
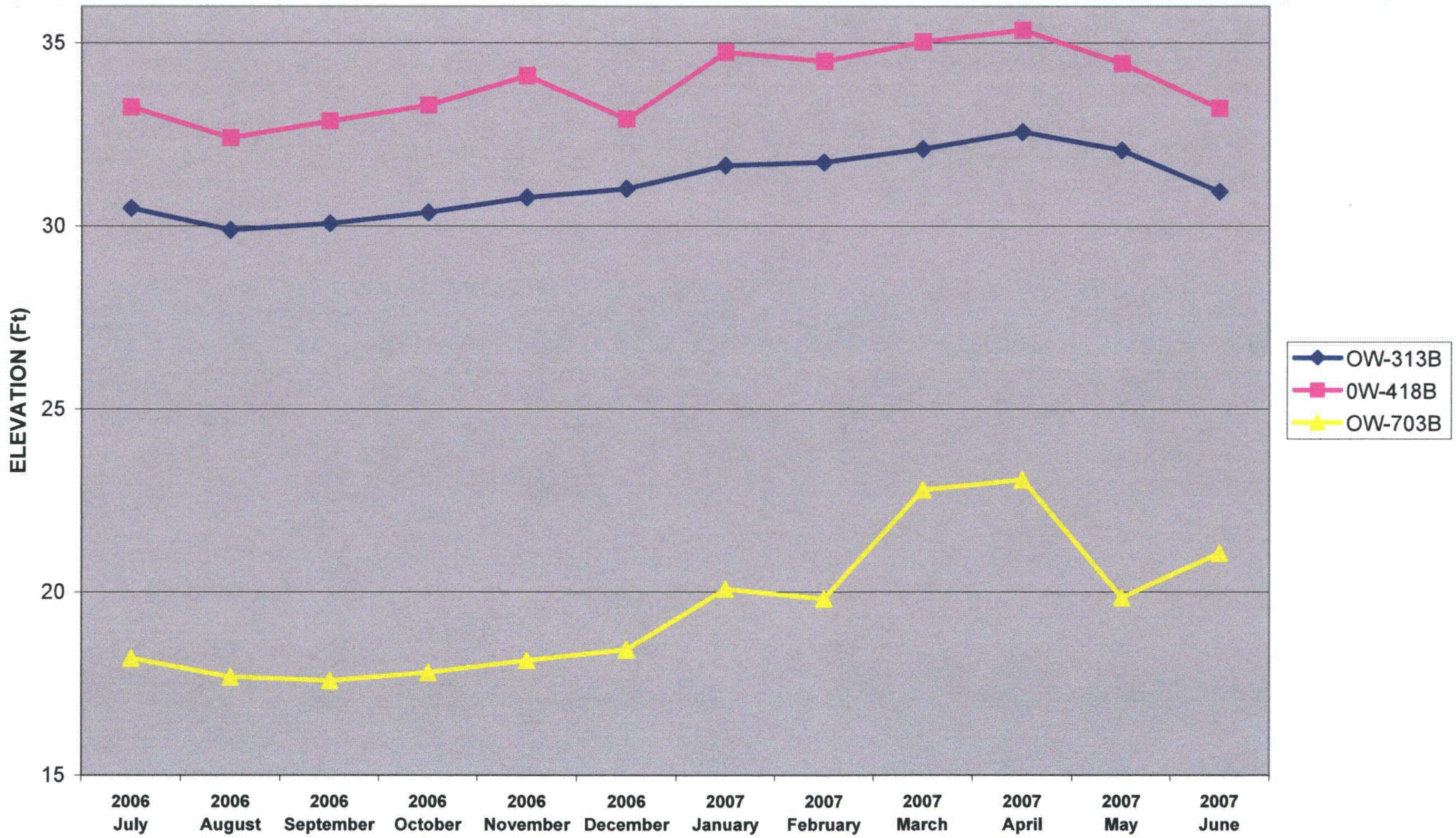


Figure 2.4-79 - Groundwater Elevations for the Lower Chesapeake Unit, July 2006 through June 2007



Question 02.04.12-12

Clarify whether the electrical manholes referred to in the last paragraph of FSAR Section 2.4.12.5 are safety-related.

Response

The classification (i.e., safety-related/nonsafety-related) of the manholes is determined by the structures, systems or components powered or controlled by the electrical cable duct banks with which they are associated. The classification of the manholes identified in the last paragraph of FSAR Section 2.4.12.5 has yet to be determined. This classification will be completed during the detailed design phase.

COLA Impact

None.

Enclosure 2

Response for Request for Additional Information RAI No. 101,
Input Files for the Numerical Model of the Aquia Aquifer Within a 5-mile Radius,
Calvert Cliffs Nuclear Power Plant Unit 3

(One Disk)