WILLIAM & MARY
VIMS

Virginia Institute of Marine Science
School of Marine Science

March 12, 2003

Mr. William A. Pruitt
Commissioner, Virginia Marine Resources Commission
2600 Washington Avenue, Third Floor
Newport News, VA 23607

Commissioner Pruitt:

This letter responds to the Virginia Marine Resources Commission's November 12th request for comments on the proposed King William reservoir. Faculty of the Office of Research and Advisory Services, the Department of Fisheries Science, the Department of Physical Sciences, the Department of Biological Sciences, the Department of Coastal and Ocean Policy, and the Center for Coastal Resources Management contributed to this review. Our assessment addressed only the potential environmental consequences associated with the construction, placement and operation of the intake structure in the vicinity of Scotland Landing on the Mattaponi River. We did not conduct environmental assessments on other aspects of the proposed project since it is our understanding that these are not included in the Commission's purview and were generally addressed through the National Environmental Policy Act review. Our comments specifically describe potential adverse impacts to local and anadromous fish stocks, and general concerns of river ecology and cumulative watershed impacts. Members of our project review team will be present at the public hearing should you, your staff, or Associate Members desire clarification or explanation of our comments.

The area of concern scales from within the immediate vicinity of the intake structure to the greater York River watershed. The York River watershed covers approximately 6,900 square kilometers (2,664 square miles) of Virginia's Piedmont and Coastal Plain and includes the subwatersheds of the Pamunkey River (3, 768 square kilometers or 1,455 square miles) and the Mattaponi River (2,274 square kilometers or 878 square miles). About two-thirds of the watershed's land cover is forested with the remaining land use comprised of agriculture (25%), wetlands (7%), and urban areas (1.4%) (US EPA 1996, NOAA 1989). Average total freshwater inflow to the York River is estimated at 70 m^3/sec annually (Bender 1986). Mean annual fall line discharge is approximately 31.3 m^3/sec on the Pamunkey River and 16.3 m^3/sec on the Mattaponi River, with average annual spring discharge rates of 47.5 m^3/sec and 27.2 m^3/sec, respectively (Belval *et al.* 1995, Bilkovic 2000, USGS 2002). The York River is a partially mixed microtidal estuary characterized by a two-layer flow of saltwater movement upstream at depth and downstream freshwater surface flows. Tidal ranges are 0.7 meters near the York River mouth, 0.9 m at West Point, and reach 1.2 meters in the Mattaponi River and 1.0 meters in the

Pamunkey River. Salinities generally range from 18-20 parts per thousand at Gloucester Point and decrease to zero in the Pamunkey and Mattaponi at locations dependent on the amount of seasonal freshwater flow, but generally within 10-20 kilometers (6 to 12 river miles) of their confluence.

Our analysis of fisheries and habitat issues within the area of concern was based on VIMS' anadromous fish monitoring program, the doctoral dissertation *Assessment of Spawning and Nursery Habitat Suitability for American Shad (Alosa sapidissima) in the Mattaponi and Pamunkey Rivers* (Bilkovic 2000) and further publications from this work (Bilkovic 2002a, 2002b), and ongoing research. VIMS has monitored juvenile abundances of alosines since 1979. Collections by pushnet occur weekly from June through August at set stations in the York River watershed. The monitoring program was discontinued in 1988-1990, but contains 19 years of data. VIMS has monitored striped bass juvenile abundance since 1967. This monitoring program was discontinued in 1974-1979 but contains 30 years of data. Collections by beach seine occur bi-weekly from July to September at set stations in the York River. In addition to striped bass, juveniles of other species (including white perch and yellow perch) are captured. These data are used to calculate juvenile indices of abundance for use in assessing annual recruitment success.

The work of Bilkovic (2000) entailed collections of eggs, yolk sac larvae, and post-yolk sac larvae from the Mattaponi and Pamunkey Rivers generally during April and May of 1997-1999. In 1997, sampling protocol included weekly collections during daylight hours using stepped oblique tows of a bongo frame fitted with two 333 μm mesh nets (60 cm diameter). Catches from both nets were combined. The same ten stations were sampled weekly on each river within the tidal freshwater reaches. The stations were located at approximately 3.2 River kilometer (Rkm) intervals between Rkms 68 to 102 on the Mattaponi River and Rkms 72 to 106 on the Pamunkey River (the proposed intake structure is located at approximately Mattaponi Rkm 91). In 1998 and 1999, station locations were extended upriver to include more shallow stations due to the low abundance of American shad eggs in 1997. Bongo nets could not be used, and sampling included pushnet surveys in the upper reaches of the rivers (31 March through 20 May 1998 and from 11 April through 7 May 1999). The weekly sampling on each river consisted of pushnet (accommodating two plankton nets (333 µm, 60 cm)) tows at approximately one meter below the surface at each station. Catches from both nets were combined. In 1998, eight stations per river were systematically sampled that bracketed Rkms 94 to 120 on the Mattaponi River and Rkms 109 to 131 on the Pamunkey River. In 1999, two stations at Rkms 124 and 128 were added on the Mattaponi River, and six upriver stations (Rkms 135-154) and one downriver station (Rkm 104) was added to the Pamunkey River. Bongo and push nets were fitted with a flow meter for volumetric measurements and tow times were adjusted (three to seven minutes) to meet a lower limit of 50 m^3 of water filtered through both nets combined.

Other information used in our assessment included a project using stable isotope analysis to define critical nursery habitat and quantify contributions of various dietary components to growth of young shad on the Mattaponi River. These data provided information on larger ecological issues associated with habitat-fish interactions.

Status of Fish Stocks

The early life history stages of white perch, yellow perch, striped bass, American shad and river herrings are most likely to be impacted by the King William Reservoir project. The status of most fish stocks in the York River watershed, and specifically in the Mattaponi River, is largely unknown. Interstate Fishery Management Plans, which includes any available stock assessment information, exist only for striped bass, American shad and river herring. There have been no formal stock assessments for white perch, yellow perch or river herrings. Commercial catch-per-unit-effort (CPUE) data are lacking and there are no fishery-independent surveys of adult abundance of white perch, yellow perch and river herring in the York River. Below we present a synopsis of the information on each species' stock status.

White perch (*Morone americana*):

VMRC records of total Virginia commercial landings (1973-2001) depict variable harvest with peaks of about 250,000 lbs in 1973 and 1987 and an average annual harvest of 149,000 lbs. Figure 1 shows York River commercial landings for comparison. Since 1993, annual harvest in the York River has averaged about 12,000 lbs. Recreational harvests (1984-2001) peaked in 1991 (102,000 lbs) and 1997 (139,00 lbs) with an average annual harvest of about 30,000 lbs. In recent years, recreational harvests have declined while commercial harvests remain at average levels. Virginia stocks of white perch appear to be lower in abundance than those in Maryland waters.

Recruitment in the York River is low with strong juvenile cohorts appearing infrequently (1987 and 2000, Figure 2). There is, however, no evidence of recent recruitment failure (successive years of low juvenile production).

Figure 1. White perch commercial fishery landings for the York River.

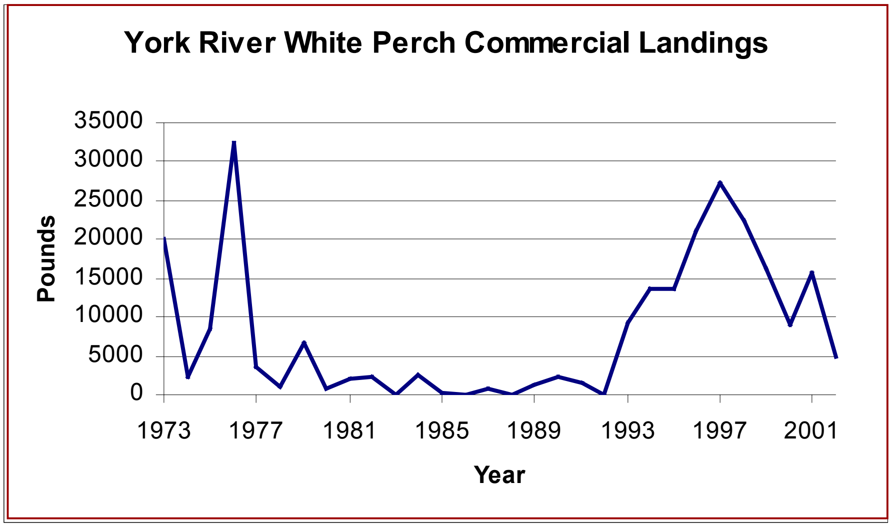
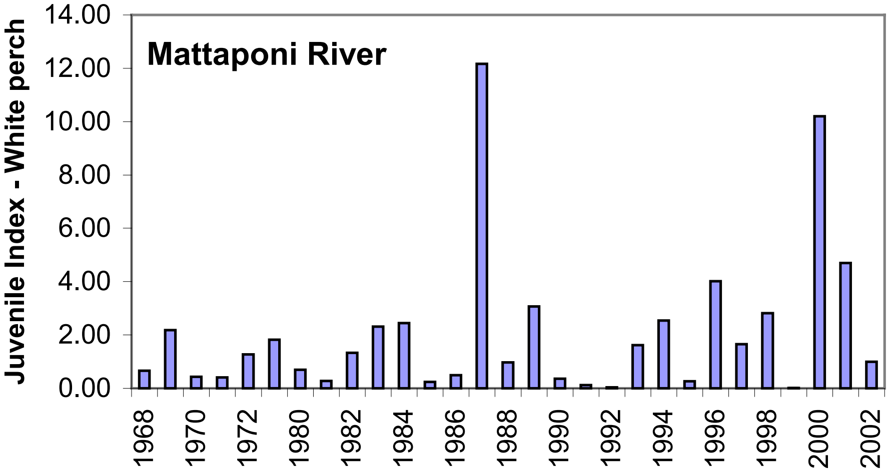


Figure 2. White perch juvenile indices for the Mattaponi River.



Yellow perch (*Perca flavascens*):

VMRC records of commercial landings (1996-2001) reveal statewide harvests of approximately 5,000-30,000 lbs. York River commercial landings are low, averaging about 200 lbs since 1992 (Figure 3). Juvenile recruitment in the Mattaponi River is low but generally stable with relatively strong juvenile cohorts appearing in 1990 and 1996-1999 (Figure 4). The VIMS seine survey grid may not encompass the full nursery ground for this species. Thus, recent low levels of abundance may reflect drought conditions that have shifted nursery grounds up-river. In general, the status of adult populations in the Mattaponi River is unknown.

Figure 3. Yellow perch commercial fishery landings for the York River.

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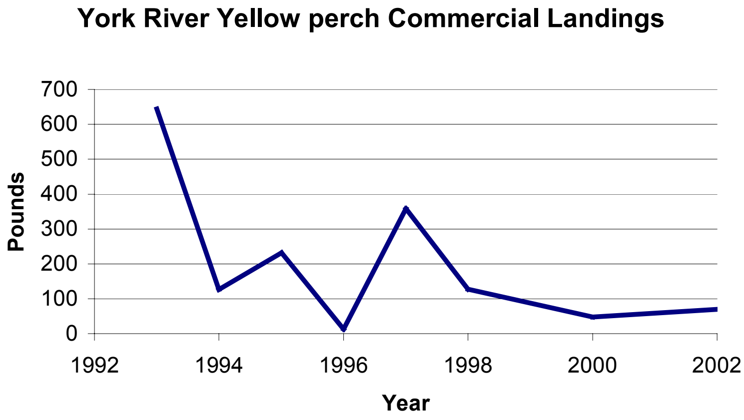
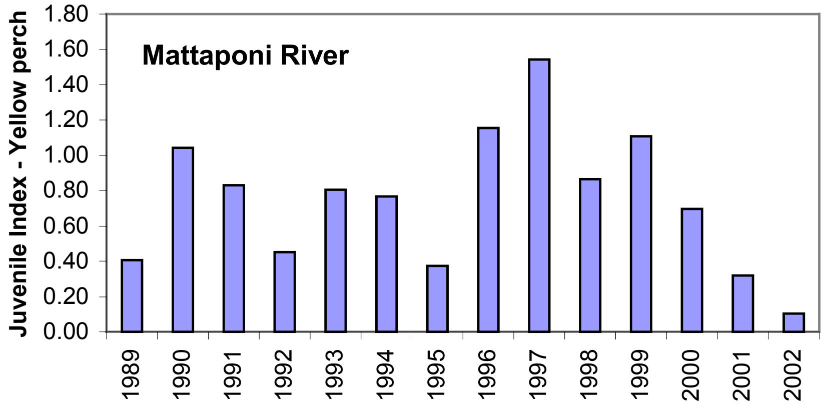


Figure 4. Yellow perch juvenile indices for the Mattaponi River.



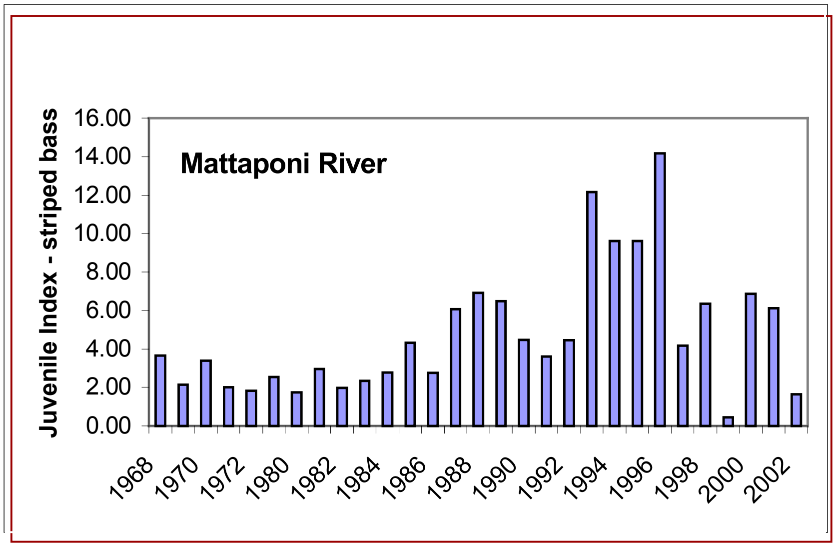
Striped bass (*Morone saxatilis*):

Currently, Atlantic stocks of striped bass are considered fully exploited and at a relatively high biomass level. Table 1 presents an index of abundance of sub-adult striped bass for the James, York, and Rappahannock rivers. These indices depict relatively stable abundance during the period 1998-2001 with a slight decrease in abundance in 2002. Juvenile recruitment in the Mattaponi River is variable with relatively strong juvenile cohorts appearing in 1993-1996 and lower recruitment in recent years (Figure 5). Although year classes produced in 1999 and 2002 on the Mattaponi River were exceptionally poor, there is no evidence of recent recruitment failure.

Table 1. An index of abundance of striped bass ages 4-6 (age classes just prior to maturation and spawning) captured in staked gill nets. Values are reported as seasonal average numbers of fish per unit area of net.

Year	James River	York River	Rappahannock River
1998	0.27	0.15	0.02
1999	0.42	0.09	0.14
2000	0.44	0.21	0.13
2001	0.16	0.14	0.16
2002	0.06	0.03	0.07

Figure 5. Striped bass juvenile indices for the Mattaponi.



River herring (*Alosa* species):

Although river herrings are species listed in Amendment 1 to the ASMFC management plan for American shad, there are no requirements for monitoring. VMRC records of commercial landings are difficult to interpret since catches are likely a mixture of several species. Throughout Virginia catches of river herrings have generally declined and historic fisheries have collapsed. Statewide harvests of 'alewife' ranged from 13,500-52,300 lbs in 1996-2001. In general, the status of adult populations of river herring on the Mattaponi River is not known but stocks are believed to be declining in abundance.

The index of abundance (plotted as the geometric mean number of fish per tow) of juvenile alewife and blueback herring (Figures 6 & 7) depicts peaks in 1982, 1984 and 1985 but generally low juvenile abundance in the 1990s. Abundance of juveniles of both species has declined in recent years and there have been no recent years of high juvenile production for either species. Alewife juveniles are less abundant than blueback herring juveniles on both rivers. In most years, blueback herring juveniles are more abundant on the Pamunkey River than on the Mattaponi River. The opposite pattern is observed for alewife. Our preliminary assessment is that river herring, especially blueback herring, are potentially vulnerable to recruitment failure in the York River watershed in the absence of a year of strong juvenile production in the near future.

Figure 6. Blueback herring juvenile indices for the Mattaponi River.

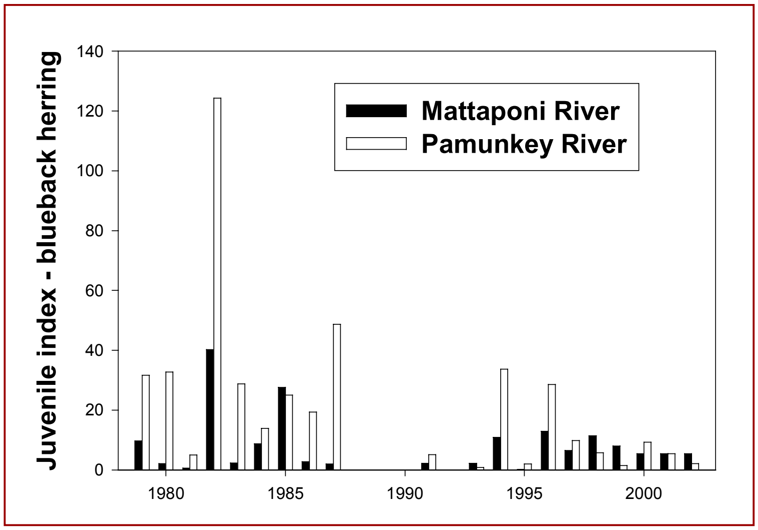
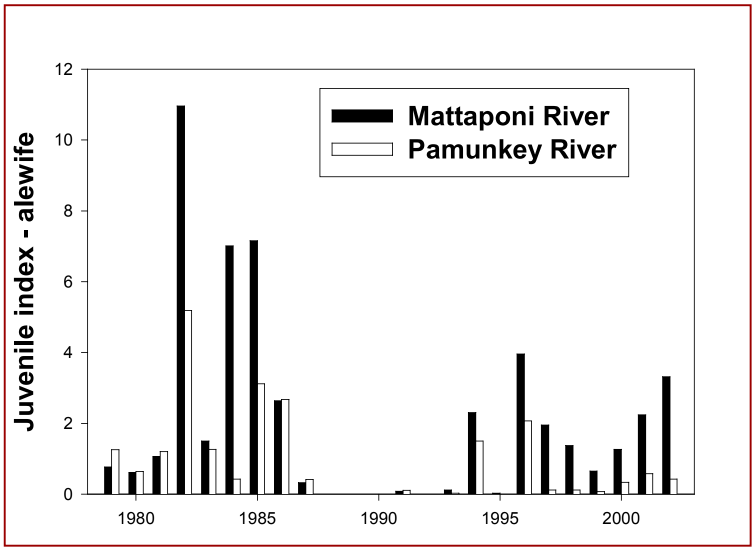


Figure 7. Alewife juvenile indices for the Mattaponi River.



American shad (*Alosa sapidissima*):

The most recent Atlantic States Marine Fisheries Commission (ASMFC) stock assessment (1999) reported evidence of recent and persistent stock declines in the York River, but no clear evidence of recruitment failure. Production of juvenile American shad on the Mattaponi River has increased dramatically in the last decade and has remained relatively strong except for three years of low juvenile abundance (1995, 1999 and 2002; Figure 8). Table 2 presents the results of VIMS' in-river stock abundance monitoring program. These indices reveal annually variable catch rates in the York River with peak catches observed in 1998 and 2001. In each year, catches in the York River are higher than those in the James and Rappahannock rivers. Figure 9 presents historic comparisons that show current catch rates to be higher than those recorded just prior to the closure in the 1990s and close to the levels recorded in the 1980's. Current catch rates are lower than peak catch rates (after adjustment for gear differences) recorded in the 1950s, a period when landings of American shad were relatively stable in the York River. Thus, the York River stock is considered to be strengthening but below the level of full recovery.

Figure 8. American shad juvenile indices for the Mattaponi River.

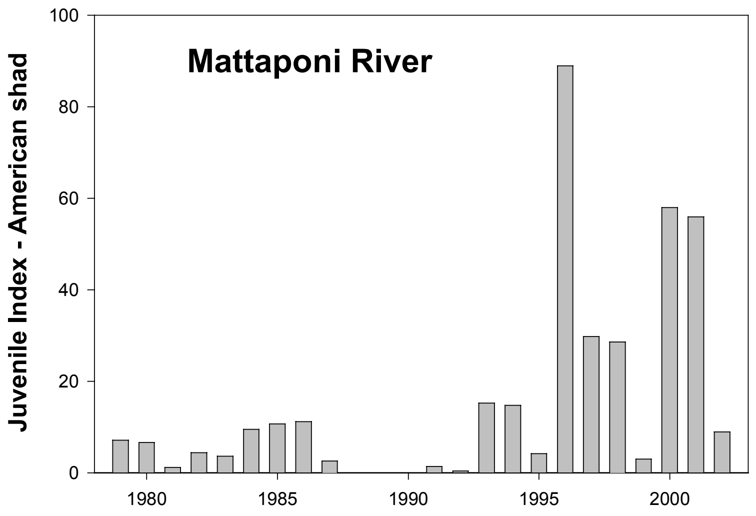
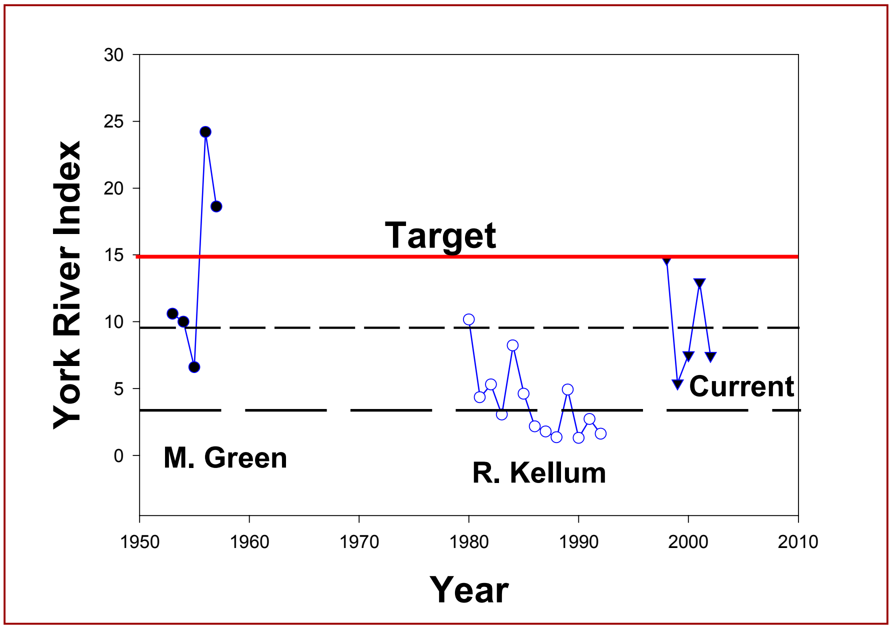


Table 2. An index of abundance of female American shad captured in staked gill nets. Values are the area under the curve of catch rate versus day of the season.

Year	James River	York River	Rappahannock River
1998	2.6	14.7	1.5
1999	2.9	5.4	1.3
2000	6.6	7.5	1.8
2001	5.0	12.9	5.8
2002	5.6	7.5	3.1

Figure 9. Indexes of current (1998-2002) and historic catch rates (1950-1959, 1980-1992) of mature female American shad by staked gill nets in the lower York River. Each index value is the area under the curve of daily catch (female kg/m of net) versus day of the season. Current data result from VIMS monitoring. Historic data were obtained from voluntary logbooks of commercial catches provided by Gloucester County fishermen Malvin Green (1950s) and Raymond Kellum (1980s). Using the results of calibration trials conducted in 2002, older logbook data were adjusted to account for gear differences between the 1950s (multifilament nets) and the 1980s (monofilament nets). Horizontal lines are the mean index value for each time period (solid line, 1950s; short dashes, current monitoring; long dashes, 1980s). The mean of the 1950s data (solid line) is the suggested restoration target for the York River stock.



The York River watershed is the most productive Virginia Bay tributary for American shad. Data from VIMS' juvenile monitoring program provide evidence of the importance of the Mattaponi River as a shad spawning and nursery ground within the larger York River system. Table 3 shows a comparison of Mattaponi River and Pamunkey River American shad juvenile (25-80 mm total length) indices (JIs) for the 19-year time series as a ratio of relative abundance. The geometric mean (GM) is the back-transformed average of the logarithmic transformation of all catches at all stations.

For reasons yet unknown, the index of abundance of American shad in the York River watershed is more heavily influenced by production in the Mattaponi River than in the Pamunkey River.

Table 3. Ratios of the value of the index of juvenile abundance (JI) for American shad in the Mattaponi and Pamunkey rivers (Mattaponi JI / Pamunkey JI). Ratios <1 are underlined and indicate that juvenile abundance in the Pamunkey River exceeded abundance in the Mattaponi River in that year. The JI is calculated as a geometric mean number of juveniles per tow. From Wilhite *et al.* In Press.

Year	**Geometric mean**
1979	1.4
1980	5.6
1981	1.1
1982	7.7
1983	2.2
1984	12.7
1985	3.2
1986	3.5
1987	14.0
1991	0.8
1992	17.9
1993	69.0
1994	6.8
1995	4.7
1996	6.0
1997	12.3
1998	26.6
1999	3.7
2000	6.6

Fish Eggs and Larvae

Bilkovic (2000) collected American shad eggs over a 44 Rkm reach in the Mattaponi River (Rkms 81- 124) and a 53 Rkm reach in the Pamunkey River (Rkms 98-150). Highest egg densities (numbers/100 m^3) occurred between Rkms 96 and 124 on the Mattaponi and Rkms 104 and 131 on the Pamunkey. Striped bass spawning occurred over a 27 Rkm reach in the Mattaponi River and a 60 Rkm reach in the Pamunkey River. Generally, striped bass spawning occurred downstream of American shad spawning in both rivers, but some overlap was noted in the Pamunkey River.

Distribution of larval American shad (6.1 - 19.2 millimeters total length) generally overlapped striped bass spawning areas in both rivers. American shad larvae were collected from Rkms 68 to 124 in the Mattaponi River and Rkms 76 to 128 on the Pamunkey River. Highest larval densities (again, numbers/100 m^3) were found between Rkms 94 and 102 on the Mattaponi River and at Rkms 102, 105, and 124 on the Pamunkey River.

On the Mattaponi River larval striped bass were collected from Rkms 68 to 94, with highest densities found from Rkm 68 to Rkm 80. Pamunkey River striped bass larvae were found from Rkm 72 to Rkm 109, with highest densities found from Rkm 72 to Rkm 91.

Bilkovic's (2000) data also are consistent with VIMS' monitoring data with respect to relative importance of the Mattaponi River and Pamunkey River, dependent upon species. She found that average densities of individual American shad life stages were greater in the Mattaponi River than the Pamunkey River, with striped bass having the opposite pattern.

Assessment of Potential Impacts

Our assessment of potential impacts directly attributable to the intake structure proper focused on the response of local benthic resources to construction, maintenance, and structure-induced scour; and probable effects on nekton from structure noise and its effect as an attractant.

Benthic Resources and Fish Behavior

Direct impacts to subaqueous bottom and the littoral oligohaline-freshwater system attributable to the construction of the intake are expected to be minimal and temporary. The loss of subaqueous bottom from structure fill would be permanent, but would also be expected to have minimal adverse impact upon the littoral system. We are unsure of the intake's maintenance requirements and procedures and cannot provide guidance on the potential environmental effects associated with this activity.

The intake would be a permanent and prominent structure in a relatively narrow (400 feet) river section. As such, the intake has the potential to alter local flows and sedimentation patterns that could subsequently affect the littoral environment, flora, and fauna. These issues were addressed in the 1997 FEIS and we agree with the findings of Basco (1996) that the structure will result in chronic but localized disturbances of flow and sedimentation with minimal associated adverse environmental effects to the benthos and tidal wetlands in the vicinity of the intake.

River ecology and fish behavior could primarily be affected by the structure's function as a fish attractant and/or from noise during operation. It is well recognized that fish are attracted to structures within the water column. Fish eggs and larvae are a food source for higher predators and predator aggregation could further contribute to the loss of eggs, larvae, and other prey in the vicinity of the intake. We are unable to quantify the probable effects to general Mattaponi River ecology associated with alterations in localized predator-prey interactions and food chain dynamics. The potential for adverse impacts range from significant local to the intake and decrease with distance from the intake.

The noise level generated by the operation of the intake is unknown. Noise travels faster and farther in the aquatic environment relative to air, and associated effects can potentially occur well beyond the structure boundary. Little is known of the effects of noise on estuarine fauna; however, some evidence exists linking excessive and prolonged non-natural noise to alterations of migratory behavior in fish (Gregory 2000). Any effects on anadromous fish migratory behavior in the Mattaponi River could impact spawning success. The Mattaponi River in the area of Scotland Landing is a relatively narrow corridor to upriver areas, and we would reasonably expect potential adverse noise impacts to increase with decreasing river cross-sectional area. In the absence of adequate information to guide us on this issue it is our best professional judgement that the potential for adverse effects from noise is a concern that warrants careful consideration. Chronic disruption of adult spawning behavior could have significant negative effects on anadromous fish stocks.

Water Withdrawals and Salinity Regimes

The probability of adverse environmental impacts associated with intake operation and water withdrawal involves changes in watershed habitat suitability from alterations of flow and salinity distribution, and direct impacts on living resources through removal from the littoral system.

The intake structure is designed to remove a maximum of 75 million gallons per day (mgd), varying seasonally and dependent upon river flow. It is unrealistic to base potential adverse environmental impacts on designed maximum water removal rates, and the applicant provided information on simulated withdrawal rates under 2040 to 2050 conditions, when full use of safe yield is projected. However, the modeling analysis does not include withdrawal rates during reservoir loading. Therefore, we analyzed impacts based on the potential maximum water removal rate and on our understanding of the applicant’s best-estimate normal water removal rate after 2040 of 14.5 mgd.

VIMS conducted a study of potential changes to the salinity regime and the potential for adverse impacts to tidal wetlands in the Mattaponi River from operation of the intake in 1991 (Hershner *et al.*). At that time we concluded that alterations to the Mattaponi River’s normal salinity patterns were insignificant and would not affect tidal wetland vegetation communities. These data were further critiqued and validated by the United States Army Corps of Engineers.

In an effort to determine confidence in our previous study, we again modeled potential salinity changes using recent data. A hydrodynamic model simulation was conducted using hydrology data from 1991-2002 with the purpose of determining if the recent prolonged drought period from 1997 through 2001 would result in different conclusions on the habitat change drawn from the previous 30-year simulation.

Our simulations suggest that the average seasonal salinities have increased in the river reaches above West Point. The increases may be sufficient to drive a shift in marsh plant community composition. Tidal marsh plants in the transition zone from salt water to freshwater each have a limited range of tolerance for exposure to salinity. As a result, tidal freshwater marshes and tidal swamp communities may retreat upstream in the face of continued increases in salinity levels throughout the rivers. This process may occur regardless of the new reservoir operation.

It is noteworthy that our modeling is specific only to the consumption proposed for this project and does not account for other existing or future consumptive uses of the Mattaponi River.

Tidal Excursion

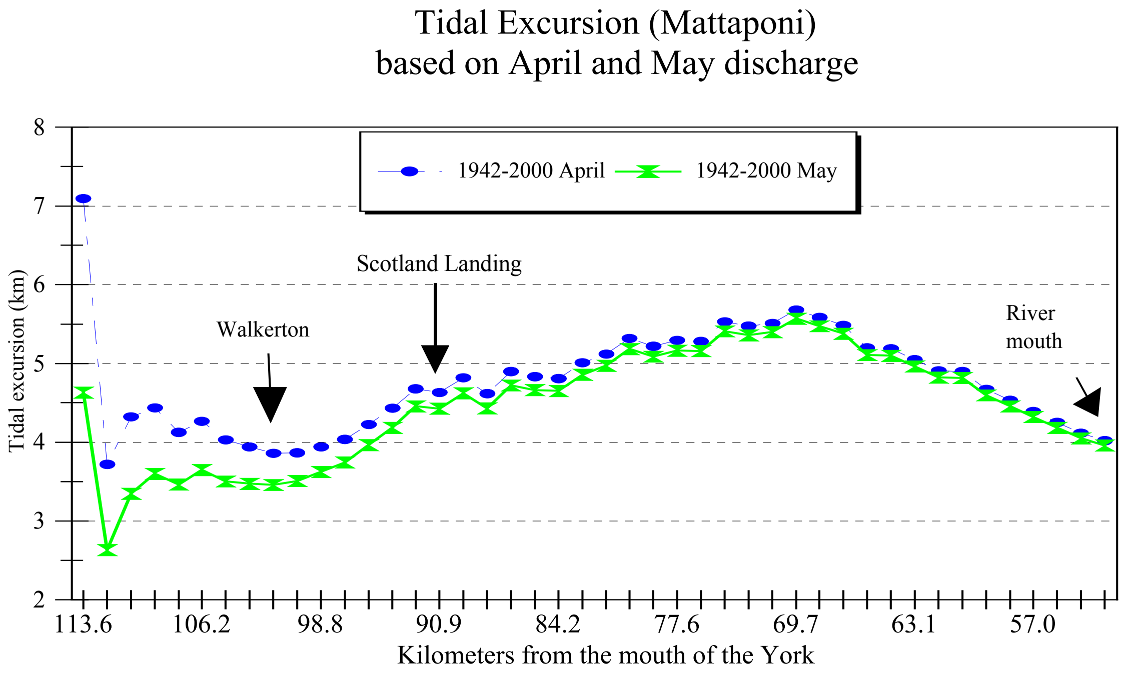
Early life stages of estuarine fish are generally transported with the ebb and flow of the tide while in the water column and eggs and larvae distributed near the intake have the potential to be exposed to the intake structure over multiple tidal cycles. Therefore, estimates of tidal excursion were necessary to assess potential encounters in the vicinity of the intake. The average tidal excursion is defined as the horizontal distance traveled by water-born materials for an ebb cycle and is described by the equation:

$$TE = [(2/\pi)*u_t + Q/A] * T/2$$

where TE = Tidal Excursion (m); u_t = maximum tidal current (m/s); $(2/\pi)*u_t$ = average tidal current (m/s); T/2 = ebb tidal cycle = 6.21h; Q = median discharge (m^3/s); $\pi = 3.14$; and A = cross-sectional area (m^2). We estimated tidal excursion for the Mattaponi and Pamunkey rivers for the months of April and May, using maximum tidal current amplitudes acquired from VIMS tide gauges in each river (Sisson et al. 1997). Median monthly discharge (1942-2000) was obtained from United States Geological Survey stream gauge stations located approximately at the fall lines of the Pamunkey and Mattaponi rivers (Hanover station (number 01673000); Beulahville station (number 01674500), respectively).

For the Mattaponi River, tidal excursion values in the vicinity of Scotland Landing are estimated to be approximately 2.5 nautical miles (Figure 10). We can reasonably assume that the eggs and early larval stages dispersed within the water column are generally subject to the effects of water withdrawal throughout multiple tide cycles within the limits of tidal excursion. Thus, the intake structure's zone of influence is taken to be a section of river stretching from 2.5 nautical miles upriver of Scotland Landing to 2.5 nautical miles downriver of Scotland Landing. Egg and larval densities from this area of the Mattaponi River were used to assess potential impacts.

Figure 10. Mattaponi tidal excursion based on April and May discharge.



Species collected by Bilkovic (2000) from the intake structure's estimated zone of influence included Alosa *aestivalis* (Blueback herring), *Alosa pseudoharengus* (alewife), *Alosa sapidissima* (American shad), *Morone Americana* (White Perch), *Morone saxatilis* (Striped Bass) and *Perca flavescens* (Yellow perch).

Mortality of Fish Eggs

While entrainment of American shad eggs (2.5 mm to 3.8 mm) and striped bass eggs (2.4 mm to 3.9 mm) is unlikely due to their size relative to that of the 1 mm intake screen, impingement will induce mortality due to the fragile nature of the eggs. Striped bass are at a reduced risk relative to American shad due to their predominance downstream of the proposed intake. Other species present in significant numbers within the intake structure's zone of influence have eggs that range in diameter from 0.75 mm to 1.3 mm. Therefore, some unknown proportion of the eggs of Alewife (0.8 mm to 1.27mm), blueback herring (0.87 mm to1.11 mm), and white perch (0.75 mm to 1.09 mm) are considered vulnerable to entrainment (Jones et al. 1978). Herring eggs are slightly adhesive within the first hours after spawning and then become pelagic. It is thus expected that herring eggs are generally located throughout the water column and subject to potential impingement and entrainment. White perch eggs are typically demersal, but may also float free. Yellow perch eggs are semi-buoyant and attach to vegetation or bottom material, making entrainment or impingement less likely. No yellow perch eggs were observed in the collections of Bilkovic (2000).

Mortality of Fish Larvae

Since larval stages of American shad, perches and river herrings are weak swimmers with thin, thread-like and fragile bodies, their vulnerability to impingement and entrainment during encounters with the intake structure is increased. There is little question that such encounters will result in mortality of these life stages.

While it is difficult to accurately predict the absolute abundance of fish that will encounter the intake structure, reasonable estimates can be derived from distribution data and the early larval stages' physical characteristics and life histories. The average rate of egg and larval loss (Q) can be estimated as follows:

$$Q = \text{(pumping rate)} \times \text{(concentration of fish larvae or eggs)}^{n} \times \text{(1 - efficiency of fish larvae or eggs escaping from the pumping device)}$$

The superscript n is dependent on the density, size, and behavior of the fish egg/larvae and is a power function of the concentration. It can be obtained by fitting a log-transformed linear equation to the data (see Kelso et al., 1979). For neutrally buoyant eggs and larvae the superscript n= 1, which means that the concentration is not modified by physical characteristics. The heavier and larger the eggs/larvae are, the more likely they will be carried by the inertia force created by the ambient tidal current; thus it is less likely that they would be influenced by the withdrawal than neutrally buoyant eggs and larvae. This results in the superscript n having a value of less than one which functionally decreases the concentration of eggs and larvae vulnerable to loss. Conversely, the lighter the eggs and larvae are, the more vulnerable they are to entrainment/impingement given the same flow rate. This phenomenon would result in a value for the superscript n of greater than one and a functional increase in the concentration of eggs and larvae.

Great uncertainty exists surrounding the efficiency factor. Efficiency is a function of intake design, the ability of eggs and larvae to resist the force exerted by the pumping, and other unknown factors such as the turbulence level and current direction. There is an indication, however, that fish eggs and early larval stages are often free floating or have minimum swimming ability (Turnpenny, 1983). In the absence of clear guiding information we assigned the efficiency factor a conservative value of 0.

Our estimate of Q utilized values of the estimated density of fish eggs and larvae distributed throughout the water column. Fish larvae may undergo diurnal vertical migrations and thereby aggregate at depth. In addition, physical forcing (currents and fronts) and spawning behavior can accumulate fish eggs and larvae in vertical concentrations. The kinds and abundances of fish eggs and larvae in Bilkovic's (2000) study were detected using oblique, daylight tows of a plankton net that filtered water from near bottom to the surface. As a result, detailed data on concentrations of eggs and larvae at any particular depth or during evening hours are not available. Since larval fishes can avoid plankton nets, especially during daylight, and since the eggs of the species of concern are not fully neutrally buoyant, it is likely that Bilkovic (2000) underestimated abundances of early life history stages of these fishes. Therefore, it is our opinion that egg and larval mean densities within the structure's zone of influence, coupled with the probability of increased loss near the intake from prey aggregation and the potential for multiple interactions with the intake as shown from the tidal excursion model, are a basis for reasonable, yet conservative, estimates of loss when compared to withdrawal volumes.

The potential significance of the intake's zone of influence varies with species and life history stage. The proportion of each species' eggs and larvae that Bilkovic (2000) collected in the intake's zone of influence versus the entire Mattaponi River sampling range is presented in Table 4. Relatively large proportions of American shad and white perch eggs, and larvae of American shad, herring, white perch, and yellow perch were found within the intake's zone of influence during the 1997 – 1999 sampling period.

Table 4. Proportion of fish distributed within the proposed intake zone of influence based on spring 1997-1999 collections on the Mattaponi River. The total density is the sum of each density value obtained per sampling event for the years 1997-99 by species and life stage.

	NM	RKM	Total Density (#/100m^3)	Total Density in intake zone of influence	Proportion of fish in intake zone of influence (%)
American Shad Eggs	49-67	91-124	57.57	11.31	19.6
American Shad Larvae	37-67	69-124	180.07	105.56	58.6
Striped Bass Eggs	37-51	69-94	217.99	3.11	1.4
Striped Bass Larvae	37-53	69-98	1344.88	133.72	9.9
Herring Eggs	37-67	69-124	1103.76	16.40	1.5
Herring Larvae	37-69	69-128	2234.02	882.41	39.5
White Perch Eggs	39-67	72-128	199.18	31.51	15.8
White Perch Larvae	37-59	72-109	5259.25	2003.28	38.1
Yellow Perch Larvae	37-69	69-128	790.01	271.85	34.4

Table 5 presents a comparison of average and high density values for the life stages of the species of primary concern. High density is defined as the greatest value recorded by Bilkovic (2000) over the three-year study period. The column titled Entire Sampling Area presents values that were combined from all of Bilkovic's sampling stations, and the Intake Zone column presents data only from the structure's zone of influence. High and average densities are presented for comparison and as an example of observed variability. The values differentiated by location (entire sampling area and intake zone) are presented to compare the relative importance of the structure's zone of influence within the larger Mattaponi River spawning and nursery habitat. Values are presented in bold type for emphasis and present situations where intake zone values are equal to or exceed the values of the larger study area.

Table 5. High and average density values for ichthyoplankton in the Mattaponi River (1997-99).

	High Density (#/100m^3)		Average Density (#/100m^3)	
	Entire Sampling Area	**Intake Zone**	**Entire Sampling Area**	**Intake Zone**
American Shad Eggs	5.77	3.49	0.58	0.28
American Shad Larvae	16.29	**16.29**	1.13	**2.40**
Striped bass Eggs	39.83	1.39	5.97	0.09
Striped bass Larvae	398.61	84.53	32.90	6.42
Herring Eggs	474.91	7.46	11.51	0.52
Herring Larvae	116.45	**116.45**	13.74	**21.35**
White Perch Eggs	19.92	10.24	2.07	0.99
White Perch Larvae	578.06	**578.06**	64.81	**59.44**
Yellow Perch Larvae	94.46	**94.46**	8.03	**10.69**

In order to place these data in context with respect to withdrawals, it is necessary to convert the number of larvae per 100 cubic meters within the structure's intake zone of influence to number of larvae per million gallons of withdrawal. This conversion is presented in the table below (Table 6), only for the structure's zone of influence, and based on the conversion factor of one million gallons equals 3,780 cubic meters. These values can be applied to planned withdrawals to estimate egg and larval loss.

Table 6. High density and average density of eggs and larvae in the intake's zone of influence (Intake zone) presented as number per million gallons of water.

	High Density (#/million gallons)	Average Density (#/million gallons)
	Intake Zone	**Intake Zone**
American Shad Eggs	131.9	10.6
American Shad Larvae	615.8	90.7
Striped bass Eggs	52.5	3.4
Striped bass Larvae	3,195.2	242.7
Herring Eggs	282.0	19.7
Herring Larvae	4,401.8	807.0
White Perch Eggs	387.1	37.4
White Perch Larvae	21,850.7	2,246.8
Yellow Perch Larvae	3,570.6	404.1

Table 7 shows that daily estimates of spawning season average loss under a 75 mgd withdrawal scenario range from 255 striped bass eggs and 6,802 American shad larvae to 2,805 white perch eggs and 168,510 white perch larvae. Average daily estimated losses would range from 49 striped bass eggs and 1,315 American shad larvae to 542 white perch eggs and 32,578 white perch larvae under a 14.5 mgd withdrawal scenario.

Table 7. Estimates of daily average loss during the spawning season from maximum withdrawal and estimated normal (2040-2050) withdrawal scenarios. Numbers are based on the average number of eggs and larvae per million gallons of water within the structure's zone of influence (shown in the last column of Table 6).

	Estimated Average Daily Loss under a 75 mgd Scenario	**Estimated Average Daily Loss under a 14.5 mgd Scenario**
American Shad Eggs	795	153
American Shad Larvae	6,802	1,315
Striped bass Eggs	255	49
Striped bass Larvae	18,202	3,519
Herring Eggs	1,477	285
Herring Larvae	60,525	11,701
White Perch Eggs	2,805	542
White Perch Larvae	168,510	32,578
Yellow Perch Larvae	30,307	5,859

The structure's zone of influence has an approximate volume of 44,129,932 cubic meters, or 11,674,585,000 gallons of water at mean tide level. If average egg and larval densities are applied to total volume of the structure's zone of influence, then the eggs and larvae potentially vulnerable to loss from water withdrawal appear relatively small. This must, however, be placed in the context of processes such as natural mortality and true loss to the adult population (discussed below). It is significant that the egg and larval densities of American shad demonstrated by Bilkovic (2000) are the result of severely depressed stocks with little evidence of robust stock recovery. It is also important that the mortalities associated with water withdrawal represents an as yet unrealized source of additional mortality beyond natural mortality and harvests.

Assessment of Losses to Fish Populations

We cannot estimate the probable losses to adult stocks of American shad, white perch, yellow perch, striped bass or river herring based on our analysis of impingement and/or entrainment of eggs and larvae by the intake structure. It is widely held that subtle changes in rates of mortality of fish eggs and larvae can produce large fluctuations in recruitment to adult stocks. It is also known that low recruitment is generally associated with stocks that are low in abundance while stocks that are higher is abundance produce more offspring. Thus, small increases in daily mortality of eggs and larvae of stocks that are low in abundance could result in recruitment failure.

Methods are available to estimate the numbers of adults that survive various levels of hatchery production of American shad but the variation around such estimates are high and the methods do not apply to all species. The value of these methods to provide recommendations for management decisions is questionable. We therefore have little confidence in the notion of "adult equivalents," that is, estimating the number of hatchery-produced larvae that would be required to mitigate environmental challenge. In the case of American shad, the York River watershed is pivotal to the restoration of depleted stocks in the James River since fertilized eggs of York River brood stock are used to enhance the James River population. All Virginia stocks of American shad are currently closed to fishing. Although the York River stock is recovering, its population levels are well below those necessary to sustain a fishery. Where robust stocks support fisheries, as is the case for striped bass, exploitation is controlled to maximize harvest while sustaining reproductive potential. Each fish in the exploited population has a value but that value is predicated on the knowledge that its removal will not jeopardize the resource. For American shad stocks under restorations, removals are prohibited because of the expected contribution of each individual to the rebuilding process. In the case of river herrings, low juvenile production suggests low stock abundance. Fishing for river herrings has not been prohibited but aggressive management may be required in the near future. In both cases, any loss of early life history stages must be viewed as counter to prevailing approaches to fishery management in support of stock rebuilding and protection.

Preliminary information from an ongoing VIMS study of young-of-the-year (both larvae and juveniles) American shad in the Mattaponi River suggests early growth may be influenced by distinct food web characteristics that vary with location on the scale of five to ten river miles (approximately 8 Rkm to 16 Rkm). Differences in stable muscle tissue carbon-to-nitrogen isotope ratios were found between young-of-the-year American shad captured in upstream and downstream stations in 2002. These differences were consistent during different growth stages, which suggests that the nursery zone is heterogeneous with respect to food webs that support American shad growth and that American shad young-of-the-year probably remain within these distinct zones of production throughout their nursery ground residence time. We do not yet know the reason for these observed differences, which compounds the difficulty of predicting the potential impacts of water withdrawal on the general ecological processes within the intake's zone of influence and the greater watershed. However, if differences in habitat suitability exist and influence residence time in distinct river reaches the ecological impacts with respect to American shad may vary with respect to the location and operation of the intake.

Other environmental concerns to the York River watershed from water withdrawal and those associated with water exchange from the Mattaponi River basin to the Pamunkey River basin via Cohoke Creek are addressed in the 1997 FEIS and the Final Recommended Record of Decision of the District Commander (Norfolk District Corps 2001).

Recommendations

The decision on whether to allow adverse impacts to local fish populations should be weighed within the comprehensive sphere of concern and activity surrounding anadromous fish stocks. Additional and ongoing burdens placed on depressed stocks at this time may have negative impacts on larger scale restoration commitments and efforts. In response to dramatic declines in commercial landings the Atlantic States Marine Fisheries Commission developed and adopted the Interstate Fisheries Management Plan for Shad and River Herring in 1985 with the goal to "restore alosine stocks to their former levels of abundance." Amendment 1 to the IFMP, approved in 1999, expanded the original goal to "protect, enhance, and restore east coast migratory spawning stocks of American shad, hickory shad, and river herrings in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass." Virginia's strategy in addressing this goal has included hatchery and stocking efforts and a harvest moratorium since 1994.

It is also important to note the guidance of sections 2.1.4D and 2.1.4E from Amendment 1. Section 2.1.4D directs states to "ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account flow needs for alosine migration, spawning and nursery usage." Section 2.1.4E further recommends that management actions "ensure that water withdrawal (e.g., cooling water, drinking water) effects (e.g., impingement and entrainment mortalities, turbine mortalities) do not affect alosine stocks to the extent that they result in stock declines."

Through the Chesapeake 2000 Agreement the Chesapeake Executive Council (whose membership is comprised of the Governors of Virginia, Pennsylvania, and Maryland, the Administrator of the U.S. Environmental Protection Agency, the Mayor of the District of Columbia and the Chair of the Chesapeake Bay Commission) committed to several initiatives with respect to shad, herrings, striped bass, and all other native Bay migratory species:

- By June 2002, identify the final initiatives necessary to achieve our existing goal of restoring fish passage for migratory fish to more than 1,357 miles of currently blocked river habitat by 2003 and establish a monitoring program to assess outcomes.

- By 2002, set a new goal with implementation schedules for additional migratory and resident fish passages that addresses the removal of physical blockages. In addition, the goal will address the removal of chemical blockages caused by acid mine drainage. Projects should be selected for maximum habitat and stock benefit.

- By 2002, assess trends in populations for priority migratory fish species. Determine tributary-specific target population sizes based upon projected fish passage, and current and projected habitat available, and provide recommendations to achieve those targets.

- By 2003, revise fish management plans to include strategies to achieve target population sizes of tributary-specific migratory fish.

To date, significant effort and public resources have been expended implementing measures to achieve these goals.

Available information suggests the potential for significant adverse impacts associated with the operation of the intake. However, the degree to which this project will directly affect local fish stock health, watershed ecology, and ongoing and future stock restoration and fisheries management efforts is unclear. The difficulty in providing clear science-based guidance is compounded by our inability to overlay a reasonable forecast of land use change resulting from reservoir build-out. Population and land-use changes within the York River watershed will undoubtedly supply additional stress to adjacent aquatic resources.

Stressors to Virginia's Bay environment from projected growth are not unique to this issue. Growth within the Chesapeake Bay watershed is expected to increase significantly (Chesapeake Executive Council 1988, Chesapeake Bay Program 2003) and additional water sources will be coincidentally necessary. In the absence of comprehensive water allocation strategies to address planned growth Virginia's Bay water environment could become subject to competing goals and commitments. The Commonwealth and its local partners should limit incongruity between economic and environmental initiatives where possible to promote sustainability and ensure the efficient and effective use of public funds. Therefore, if the option exists, we recommend delaying any decision on placement of the intake structure until the development of a comprehensive regional water allocation strategy. Such a plan could provide clearer guidance to the Commission on the cost-benefits of water withdrawal locations and needs versus the potential and/or known estuarine environmental consequences. In the absence of a comprehensive plan, the Commission and Virginia's Bay community may be confronted with future large-scale economic and environmental issues associated with water supply without adequate information.

Our assessment has provided information that raises potentially significant concerns for the health of ecologically and economically important York River watershed fish stocks resulting from the operation of the intake in the proposed location. If it is deemed inappropriate to delay the larger reservoir decision until such time that a comprehensive Virginia water allocation strategy is adopted, then we recommend placing the intake structure in an area that significantly reduces the probability of adverse impacts to living resources of concern. If it is necessary to locate the intake structure within the York River watershed we do not recommend placement in the Mattaponi River due to its demonstrated importance as a spawning and nursery habitat. Although surface water allocation for the Pamunkey River has been of recent concern, placement within the Pamunkey River is preferred from the perspective of local and anadromous fish stocks. It is, however, uncertain how additional Pamunkey River withdrawals will advance cumulative ecological impacts to living resources; a concern also expressed by the applicant (United States Army Corps of Engineers Norfolk District 1997). This option warrants careful consideration with respect to water allocation and river carrying capacity, and intake placement.

The applicant presented a comprehensive assessment of numerous alternative reservoir sites as outlined in the Final Environmental Impact Statement (United States Army Corps of Engineers Norfolk District 1997). This is mentioned only to denote that alternative intake sites in the Pamunkey River and other watersheds also were analyzed, although not as sources for the King William reservoir. The practicability and economic feasibility of withdrawal from remote watersheds notwithstanding, these should be considered from the perspective of the estuarine environment.

Several factors should be considered if the proposed intake location is deemed acceptable. Based on our understanding of planned withdrawal requirements (greater withdrawals during high flow periods) and the applicant's need to provide a safe yield, modifying spring withdrawals to mitigate the probable adverse effects to anadromous fish populations may be impracticable; and we are not prepared to recommend specific changes beyond the postulate that withdrawals should be reduced to the greatest extent possible between mid-March and mid-May. This action is recommended only to reduce the probable adverse impacts to anadromous fish stocks and may not mitigate other potential environmental impacts.

If intake construction is allowed either at the proposed location or within other areas conflicting with alosine life history, management and restoration requirements outlined in the Chesapeake 2000 Agreement and the Interstate Fisheries Management Plan for Shad and River Herring should be considered when debating compensatory mitigation. It is noteworthy in this context to provide information on the historical success of American shad stocking programs. The effectiveness of stock restoration from hatchery releases to the wild has yet to be demonstrated to the degree that we can confidently recommend this strategy. Ongoing Chesapeake Bay hatchery release programs have quantified relatively minimal returns through many years of operation, in spite of significant resource investments. A hatchery release program would also bear concerns for the location of larval releases. It is preferable to release larvae in an area of optimum suitability for growth and survival. The data from VIMS' juvenile monitoring program and Bilkovic (2000) show that the most suitable areas (based on relative abundance of eggs, larvae, and juveniles) may be within the intake's zone of influence. Compensatory mitigation, in large part, depends upon the final permitted project conditions; therefore, we are unprepared to recommend specific strategies at this time. We are prepared to work with the Commission on this issue when appropriate.

If a water intake structure is allowed, regardless of location within tidal waters, we recommend monitoring the effects of intake operation on the local physical environment (especially salinity and flow) and Bay fauna and flora. We are not prepared to provide specific recommendations at this time since the elements of monitoring programs are generally determined and designed on a site-specific and project-specific basis. We are available to advise the Commission on specific monitoring issues subsequent to a decision on the location and operation of the intake.

Please contact me if you have questions.

Sincerely,

Roger Mann

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Director for Research and
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Cc: Mr. Ed Maroney, City Manager, City of Newport News
Mr. Brian Ramaley, Director, Newport News Waterworks
Mr. Bruce Schwenneker, Malcolm Pirnie, Inc.
The Honorable W. Tayloe Murphy, Secretary of Natural Resources
Mr. Mike Murphy, Department of Environmental Quality
Mr. William L. Woodfin, Jr., Department of Game and Inland Fisheries
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U.S. Environmental Protection Agency, Region III
U.S. Fish and Wildlife Service
National Marine Fisheries Service

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