Amendment to VMRC Permit Application # 93-0902
April 1, 2004

Introduction:

The changes proposed by this amendment to the permit application concern the operations of the water intake structure, which have been revised to address concerns about effects on fish spawning. Details of construction, including the use of a sheet pile baffle structure and a turbidity curtain during installation of the intake screens, also are described. There are no physical changes to the permanent facilities considered by the Commission in 2003.

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Section 1: In-River Construction

This section provides additional details regarding in-river construction of the proposed water intake structure. As stated above, no physical changes are proposed to be made to the permanent facilities considered by the Commission in 2003.

The existing water depth at the intake location varies from approximately 22 to 24 feet at Mean Low Water, based on measurements of actual surface water levels at the intake site. The top of the cylindrical screens will be set a minimum of 8 feet below Mean Low Water. This will provide at least 7 feet of vertical clearance between the bottom of the screens and the river bottom, which will be restored to pre-existing contours. The surface will be restored with riprap to minimize the potential for damaging scour to occur around the base of the riser pipes.

Dredging and work from barges will be required to construct the buried intake screen header piping, concrete encasement, and riser pipes. In-river construction, including dredging, is not permitted between February 15 and June 30. Clamshell or backhoe excavator equipment will be used for dredging within a sheet pile enclosure, to minimize the area of disturbance on the bottom and the movement of turbid water. This equipment will produce a dredge spoil with the lowest possible water content, thus reducing hauling and disposal costs. Barges will be loaded with the dredge spoil within an area enclosed by a temporary turbidity curtain. All dredge spoils will be disposed of at the Craney Island Dredged Material Area (CIDMA) or the Craney Island Rehandling Basin (CIRB). The total estimated volume of material to be excavated is 2,500 cubic yards. The sheet piles will be removed after construction of the intake is complete.

During construction, an unobstructed 100 foot wide corridor with a depth of at least 10 feet at MLW will be maintained between the work area and the north shore, so movement of recreational and commercial boating traffic will not be impeded. The intake facilities will be located in King William County at least 50 feet from the King and Queen County line.

Only granular and stone materials will be used for backfill of the intake pipes and associated concrete embedment. Dredge spoils will not be reused in any way at the site.

The top of the screens will be set a minimum of 8 feet below Mean Low Water and the intake area will be marked by warning buoys, so recreational craft should neither interfere with nor be endangered by the screens. Approximately 120 feet of unobstructed water at least 20 feet deep at MLW and approximately 200 feet of unobstructed water at least 10 feet deep at MLW will exist channelward of the screens once construction is complete. The screens will be positioned landward of the deepest section of the river, so the passage of large commercial or pleasure craft on the river will not be affected. An area identified on nautical charts as De Farges Bar is approximately 1.3 miles downstream of the intake site. The deeper water adjacent to De Farges Bar is indicated to have depths of 11, 17 and 12 feet. The area of water with a depth of at least 10 feet is narrower at De Farges Bar than at the intake site. Based on these observations, the natural river conditions in the De Farges Bar area will be more limiting to the movement of large craft up the river than the intake screens.

Revised Appendices G and J (Mattaponi River Intake) are attached.

Section 2: Mitigation of Fisheries Impacts

This section describes new or amplified measures to identify and mitigate potential impacts on fisheries.

KING WILLIAM RESERVOIR FISHERIES PANEL

To address issues raised concerning the potential for the proposed King William Reservoir water withdrawals to impact Mattaponi River fish stocks, the Regional Raw Water Supply Study Group (RRWSG) formed the King William Reservoir Fisheries Panel (Panel) to conduct an objective and comprehensive review of fish impact issues and develop recommendations that would address the issues identified. The Panel is a group of seven fisheries scientists who offer demonstrated expertise in all aspects of fish impact assessment and project design and operations that might affect Mattaponi River fish populations, including wedgewire screen technology and effectiveness of various water intake screening technologies for fish protection; water withdrawal effects on anadromous fish populations and monitoring and mitigating those effects; monitoring and assessment of Virginia riverine anadromous and resident fish communities; American shad and river herring life history and biology; estuarine and anadromous fish monitoring; fish impact assessment and fisheries management; and fish population and impact assessment modeling. Members of the Panel include:

- Mr. Stephen Amaral, Director, Fisheries, Alden Research Laboratory, Inc., Holden, Massachusetts; special expertise in wedgewire screen technology and effectiveness of various water intake screening technologies for fish protection
- Dr. Charles Coutant, Distinguished Research Ecologist, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee; special expertise in water withdrawal effects on anadromous fish stocks and monitoring and mitigating those effects
- Mr. William Dey, Senior Scientist, ASA Analysis & Communication, Inc., New Hampton, NY; special expertise in fisheries damage and impact assessments in estuarine habitats
- Dr. Gregory Garman, Professor, Virginia Commonwealth University, Richmond, Virginia; special expertise in monitoring and assessment of Virginia estuarine anadromous and resident fish communities
- Dr. Karin Limburg, Associate Professor, SUNY College of Environmental Science & Forestry, Syracuse, New York; special expertise in American shad and river herring life history and biology
- Dr. William A. Richkus, Vice President of Versar, Inc., Columbia, Maryland (Fisheries Panel Coordinator); special expertise in estuarine and anadromous fish monitoring, fisheries impact assessment and fisheries management
- Dr. Kenneth Rose, Professor, Department of Oceanography & Coastal Sciences/Coastal Fisheries Institute, Louisiana State University, Baton Rouge, Louisiana; special expertise in fisheries population and impact assessment modeling.

The charge to the Panel was (1) to evaluate the potential for the KWR intake to impact Mattaponi River American shad population and other fish species, and (2) to provide recommendations on monitoring, operation and mitigation that would ensure that there would be virtually no impact of KWR water withdrawal to the Mattaponi River American shad population and minimal impacts to other important Mattaponi anadromous and resident fish species. The RRWSG made available to the Panel all documents in the existing KWR permitting record relating to fish impacts, including the comprehensive assessments by VIMS and ASA (Mann 2003; ASA 2003). The Panel also drew upon each Panel member's literature information sources as appropriate to the topic being addressed. In particular, extensive ichthyoplankton data from a 30-year monitoring program in the Hudson River was used to investigate potential temperature triggers for a spawning season pumping hiatus, and Alden Laboratories' extensive literature library on intake screening technologies and their effectiveness was used in assessing the value of wedgewire screens for protecting fish from intake impacts. The RRWSG provided results of salinity and safe yield modeling to the Panel, and the Panel used the results to assess potential effects of any changes in flows and salinity on Mattaponi River fish species.

The RRWSG is adopting every recommendation made by the Panel, as outlined below and detailed in the accompanying Panel report, as part of its permit application; with the sole exception of the Panel's recommendation that the RRWSG withdraw its proposed hatchery augmentation mitigation measure, which the RRWSG leaves to the Commission for decision. With that exception, therefore, *measures described herein as Panel recommendations are also included in the RRWSG's proposed permit conditions.* In no instance was the Panel directed by RRWSG representatives to alter or modify any of its findings, conclusions or recommendations.

POTENTIAL IMPACTS TO MATTAPONI RIVER FISH POPULATIONS

The Panel identified four modes of potential impact that warranted assessment: construction (short-term, during construction, and long-term, as a result of the existence of the intake structures in the river); water withdrawal effects (entrainment, impingement and screen contact); changes in flow and salinity; and noise.

The Panel found that only totally or nearly immotile life stages (*i.e.*, eggs and yolk-sac larvae) of fish in the vicinity of the intake would be vulnerable to water withdrawal effects. Juvenile and adult stages of nearly all Mattaponi River species have swimming capabilities sufficient to avoid any contact with or effect from the intake screens. The Panel also determined that organisms located more than one tidal excursion distance downstream of the intake will not be exposed to water withdrawal effects.

The intake screens will be located about 110 feet from the mean low water mark on the near (south) side of the Mattaponi River and approximately in the middle of the water column, *i.e.*, mid-way between the water surface and the river bottom. Experimental results suggest that the intake would withdraw water primarily from the center of the river cross section and that organisms present near the surface and bottom and in the shoals would have very low to zero probability of encountering the intake screen when passing the intake. The Panel found that vulnerable organisms present in the hydraulic zone of influence, the portion of water column from which water is withdrawn, will have very low probability of encountering the intake screen during the majority of the tidal cycle, when tidal velocities are substantially higher than through-slot velocities.

SHORT-TERM CONSTRUCTION IMPACTS

In-river construction is prohibited between February 15 and June 30 by the State Water Control Board's Virginia Water Protection Permit (VWP Permit). Thus, the Panel found that the majority of the more sensitive early life stages of any spring spawning species (*i.e.*, all anadromous species and most resident species) will not be exposed to any construction effects during the spring spawning period. Fish and other aquatic organisms occurring in the vicinity of the proposed intake location outside of this time period could be potentially exposed to effects of construction activities. However, dredging for placement of the intake screen supports (the principal potential construction stressor) will be conducted within a sheet pile enclosure, and loading of dredged sediments into transport barges will be done within a temporary turbidity curtain. The procedures will result in minimal dispersion of suspended sediments and turbidity. The Panel concluded that no significant impacts would be expected from such minimal environmental perturbation.

LONG-TERM CONSTRUCTION IMPACTS

The Panel found that placement of the KWR intake structure in the Mattaponi River is analogous to the addition of any hard structure (*e.g.*, pier, bridge, artificial reef) to a portion of a waterbody in which none had previously existed. While both forage fish and predators may concentrate in the vicinity of such a structure, those concentrations would result from redistribution of existing populations. Fish aggregations around the intake may make fish more vulnerable to exploitation by fishermen. The intake would not hydraulically create concentrations of non-motile life stages (*e.g.*, eggs and larvae) except during infrequent slack tide periods. The creation of increased densities of predators and prey may result in some increase in predation rates, because of their enhanced proximity, but it is the opinion of the Panel that any such increase would likely be small and most likely inconsequential within the context of the Mattaponi River ecosystem.

WATER INTAKE

The KWR intake screens have very small (1 mm) slot widths and very low through-slot water velocities (<0.25 ft/sec). The Panel found that only totally or nearly immotile life stages (*i.e.*, eggs and early larval stages) would be unable to avoid the intake screens. Thus, juvenile and adult stages of nearly all Mattaponi River species have swimming capabilities sufficient to avoid any contact with or effect from the intake screens.

The existing KWR record illustrated that there was considerable uncertainty with regard to the magnitude of impacts to the American shad population that would result from KWR water withdrawal and also about the significance of those impacts to that population. To address these concerns, the RRWSG instructed the Panel to develop a means of establishing a pumping hiatus that would, with a high degree of reliability, encompass the period during which vulnerable early life stages of American shad would be present in the vicinity of the KWR intake. Such a hiatus was anticipated to also provide a high level of protection to early life stages of the other potentially vulnerable species.

MATTAPONI RIVER SALINITY

The Panel did not undertake independent analyses or modeling to address the salinity issue, but relied on prior modeling conducted by VIMS and safe yield modeling conducted by Malcolm Pirnie for the RRWSG for its evaluation. According to the Panel, the potential consequences to salinity regimes from water withdrawals would be migration of the fresh water/salt water interface upstream from where it would naturally occur in the absence of withdrawals, and a change in a portion of the tidal freshwater portion of the river into an oligohaline environment. The Panel emphasized that natural annual variability in river flows results in significant changes in the salinity regime from year to year. Implementation of a pumping hiatus in most years precludes any KWR-induced changes in salinity regimes during the spring spawning period in those years. Given the special concern regarding potential project impacts to anadromous fish species, particularly American shad, at issue is whether water withdrawals would alter salinity regimes in summer and fall, when the tidal freshwater portions of the Mattaponi serve as nursery grounds for those species. The Panel's interpretation of the modeling results indicated that the minimum instream flow (MIF) requirements imposed in the VWP Permit often preclude and consistently restrict the magnitude of water withdrawal during most summer and fall periods, when river flows are low. These are the periods when salinity regimes are most likely to be affected by freshwater withdrawals. The modeling results also indicated that changes would be so small as to be immeasurable, given natural variability and measurement error. The Panel found that an additional level of protection is provided by conditions of the VWP Permit which require the RRWSG to monitor salinity regimes so as to detect any salinity-induced changes in the spawning and nursery grounds of anadromous fish. Given that no significant changes in salinity regimes are predicted, and that a comprehensive monitoring program will provide a basis for confirming those predictions, the Panel concluded that no long-term consequences to fish are anticipated.

NOISE

The implementation of a pumping hiatus during the primary spawning period for all of the Mattaponi River anadromous fish species ensures that anadromous fish will not encounter any KWR intake-related noise during a major part of their spring spawning migrations in years of normal operation. But since no data was available on the magnitude and frequencies of sounds that might be generated by such an intake, the Panel recommended to the RRWSG that a survey be conducted of sounds produced at a similar wedgewire screen intake, located in Lake Gaston, that operates in a manner similar to that proposed for the KWR intake. Based on the sound measurements at the Lake Gaston water intake, the Panel anticipates no effects to fish from additional sounds produced by normal operation of the KWR intake. The results of the field studies indicate that there are no sounds generated by the intake at the high frequencies to which the American shad, blueback herring and alewife are especially sensitive. There may be momentary startle responses from a rapid increase in low-frequency noise due to cleaning air bursts, which would occur infrequently. Frequency of cleaning air bursts may be as low as once per week to as much as 2 to 3 times per day, depending on site specific characteristics that may vary in response to environmental conditions and season (*e.g.*, amount of suspended debris, such as leaves). Total duration of air burst cleaning of the screen array would be about 90 seconds for any single cleaning event. The Panel found that these brief and infrequent cleaning events would not result in a sustained adverse effect on normal fish behavior.

MITIGATION MEASURES

This section describes the various mitigation measures that the RRWSG proposes to minimize and avoid potential fisheries impacts, including measures recommended by the Panel and adopted by the RRWSG as well as measures required by the VWP Permit and proposed by the RRWSG itself. Details of these proposed mitigation measures are provided in the Panel's report.

CONSTRUCTION

As specified in the VWP Permit, in-river construction is precluded from February 15 through June 30 as a measure to protect fish early life stages from exposure to any increased turbidity and suspended solids. Appropriate erosion and sediment controls will be used during construction to prevent the release of suspended sediments into surrounding waters.

MATTAPONI RIVER PUMPING HIATUS

In response to concerns raised by VIMS and in consideration of its specific suggestions, the RRWSG asked the Fisheries Panel to develop a means of establishing a pumping hiatus (*i.e.*, a seasonal shutdown of water withdrawal operations) that would, with a high degree of reliability, encompass the period during which vulnerable early life stages of American shad would be present in the vicinity of the KWR intake. Eggs and yolk-sac larvae were identified as the vulnerable early life stages of American shad that require protection. Temperature was identified as the best trigger for a hiatus because it is easily measurable and a highly reliable indicator of presence of vulnerable life stages. The RRWSG asked the Panel about the feasibility of providing 100 percent protection. The Panel advised that feasible criteria for levels of protection, based on results of analyses of Hudson River data, would be a minimum of 97 percent protection of the standing crops of eggs and yolk-sac larvae in 7 of 8 years of study, and no less than 95 percent protection of the standing crops of eggs and yolk-sac larvae in any single year.

Based on available data from a long-term sampling program in the Hudson River, the Panel concluded that a KWR pumping hiatus which begins when water temperatures reach 10° C and ends when water temperatures reach 22° C would provide absolute protection to 100 percent of American shad yolk-sac larvae standing stock and absolute protection to no less than 97 percent of American shad egg standing stock in 18 of 18 years for which complete data were available. With respect to other potentially vulnerable species, minimum protection levels were 98 percent for river herring eggs and yolk sac larvae, 99 percent for striped bass eggs and yolk sac larvae, and 99 percent for white perch eggs and yolk sac larvae. Most post-yolk-sac larvae that are relatively large, such as those of American shad (9-27 mm) would not be vulnerable to entrainment or impingement. The post-yolk-sac larvae of species that have smaller larvae (such as river herring and white perch) are at greater risk to entrainment and impingement, but the

10° C and 22° C triggers still provide relatively high levels of protection to this life stage for such species.

The duration of a pumping hiatus defined by those temperature triggers would vary annually from 44 to 83 days, averaging 61 days. The RRWSG has determined that if these same triggers were applied on the Mattaponi River, the KWR would still be capable of meeting its water supply objectives with pumping hiatuses of that average magnitude during non-drought emergency years.

The Panel recognized that while analyses of the surrogate Hudson River data established the feasibility of using temperature as a trigger for an effective pumping hiatus, triggers developed from the Hudson data might not be reliable for such use in the Mattaponi. The Panel therefore recommended an intensive long-term preoperational ichthyoplankton monitoring program, which would provide a minimum of 8 (and probably several more) years of detailed data on water temperature and early life stage density and distribution over time. Those data would then be used, following the same methods used on the Hudson River surrogate data, to establish Mattaponi River-specific temperature triggers that would define the pumping hiatus period. The monitoring plan is described in the Panel report at Section 5.2.3.2 and in detail in its Appendix D.

The Panel recommended that the RRWSG commit to implementation of a pumping hiatus over a temperature range of at least 12° C, corresponding to the range between the temperatures of 10° C and 22° C, even if results from the preoperational monitoring program suggest that a smaller temperature range would achieve the protection objectives. The RRWSG's commitment to a hiatus duration in terms of temperature range rather than specific temperatures allows for a Mattaponi-specific hiatus that may be initiated at a somewhat higher or lower temperature than 10° C if monitoring results indicate that would be appropriate. Results of preoperational monitoring could result in an expansion of the hiatus temperature range beyond a 12° C range but not in a contraction of that range.

The Panel believes that a pumping hiatus implemented following its recommended procedures will assure nearly complete protection to the vulnerable life stages of the Mattaponi River American shad population in years of normal operation. The hiatus also is expected to provide a high level of protection to vulnerable life stages of many other species.

The Panel also recommends concurrent implementation of a hatch date study that will document the "date of birth" of juvenile American shad produced in each year. These data would contribute to verifying the efficacy of the Mattaponi River-specific hiatus temperature triggers derived from the preoperational icthyoplankton monitoring surveys.

In order to protect public health and welfare, the normal pumping hiatus during the shad spawning season would be lifted if a severe water supply emergency exists. Only during such rare times when the Governor has declared a water supply emergency would the intake be operated during any portion of the shad spawning season. The earliest that such a declaration is predicted to coincide with the spring shad spawning season is 2025. The additional storage provided by the King William Reservoir, when combined with existing storage in the Lower

Peninsula systems, would serve to meet projected demands in earlier years even under severe drought conditions.

Safe yield modeling, using projected year 2040 water system demands, showed that out of all of the spring seasons during a 74 year historical period (1928 to 2001), only the spring months of 1931 and 1955 were within drought periods capable of depleting reservoir levels to VDEQ drought action trigger levels. Water withdrawal in declared drought situations predicted after 2025 could only be done in compliance with VWP Permit minimum instream flow (MIF) requirements, which in many instances preclude withdrawals or restrict them to very low levels during drought years when river flows naturally are low.

Intake Screens

The Panel confirmed that the KWR intake design provides a high level of protection from impingement, entrainment and screen contact to any relatively immotile organisms that might be present within the area of influence of the intake when any water withdrawal is occurring, further reducing the potential for impacts in years of spring withdrawals. The design of the intake screens was based on Virginia DGIF guidelines and required by the VWP Permit. The small slot size (1 mm) excludes entrainment of larger organisms, and the low through-slot water velocities (maximum 0.25 feet (3 inches) per second) minimize the risk of impingement. (While the maximum design through-slot velocity of the KWR intake screens is 0.25 ft/sec, velocities in the range of 0.025 ft/sec (3/10 of an inch per second) or less are expected to occur half of the time, and velocities of less than 0.1 ft/sec (1.2 inch/sec) are expected to occur at least 75 percent of the time.)

The Panel has concluded that organisms present within the area of influence of the intake when the hiatus is not in effect (during drought emergency years and outside the hiatus trigger temperatures) are afforded a high degree of protection by the design of the KWR intake (wedgewire screens in a linear array parallel to the river channel, fine mesh, low through-slot velocities and high sweep velocities) and VWP Permit minimum instream flows. The magnitude of that protection to the vulnerable life stages of all species is difficult to quantify, but because the benefits of each of the factors are cumulative, the total level of protection is expected to be high.

Migration Blockage Removal

The VWP Permit identifies three sites in the York River basin, on one of which fish passage might be provided by the City as mitigation for project construction and operation. The locations recommended for consideration by VDGIF are Ashland Mill Dam on the South Anna River, Herring Creek Millpond Dam, and Gravatt's Millpond Dam on Millpond Creek, with Ashland Mill Dam having the highest priority. The Panel determined that the fish passage measures included in the VWP Permit could potentially result in the addition of thousands of individuals to the annual production of local populations of river herring, shad, and other anadromous fish species if the newly accessible habitat were fully utilized by those species.

The City has also offered to improve fish passage at culverts present on small tributaries of the Mattaponi River. The Panel found that provision of access past culverts will open new spawning areas for river herring, but there is no literature or information available from which to predict the potential benefit of such increased spawning area to stock size.

HATCHERY AUGMENTATION

The RRWSG previously offered to provide 1 million shad larvae for release into the Mattaponi River as mitigation for any losses caused by the water withdrawals. Given that the implementation of a spawning period pumping shutdown during the shad spawning season will provide nearly complete protection to American shad, however, the Panel considers this proposed mitigation measure unnecessary. The Panel also advised that issues of genetic bottle-necking (*i.e.*, a reduction of genetic variation associated with low number of breeders) suggested against implementing that mitigation measure.

Given that the project as now proposed includes a pumping hiatus during most of the American shad spawning period and that the intake screens provide a high level of protection to early life stages when pumping is occurring, the Panel concluded that the hatchery mitigation proposal was no longer needed to ensure no net impact to American shad, and that the potential for adverse consequences outweighed the potential benefit to the Mattaponi River American shad population. The Panel therefore recommended that that proposed mitigation measure be dropped from the project.

The RRWSG nevertheless will adhere to its previous commitment, subject to the Commission's final decision whether to include this mitigation measure as a permit condition or not.

ENTRAINMENT ICHTHYOPLANKTON SURVEY

The Fisheries Panel also recommended a post-construction entrainment ichthyoplankton survey, which will be incorporated into a comprehensive eco-monitoring plan to be submitted to the Department of Environmental Quality as required by the VWP Permit. Entrainment sampling can be conducted only when pumping is occurring and will be conducted only when early life stages are anticipated to be present. No sampling will be conducted in normal years, when the spawning season pumping hiatus is in effect. During drought emergency years, when pumping occurs during the normal non-pumping times, screening entrainment sampling will be collected beginning March 1, consisting of two samples taken in the vicinity of the intake screens weekly. The samples will be processed as quickly as possible for American shad eggs, and when any American shad eggs are found in a screening survey sample, entrainment sampling will be initiated and conducted until the temperature for pumping initiation in normal years is reached. Entrainment sampling will consist of two repeated samples taken simultaneously in the river (adjacent to the intake screens) and within the intake pipe at some point behind the intake screens, every 6 hours over a 24-hour period. Entrainment sampling will be accompanied by sampling throughout the American shad spawning reach within the Mattaponi River over the entire entrainment sampling period. Estimates will be made of the numbers of eggs and yolk-sac larvae that pass into the piping (and are lost to the river) and of the percentage of the eggs and yolk-sac larvae standing stocks lost to entrainment during the drought-emergency pumping for all periods when entrainment sampling is conducted.

MULTIPLE LAYERS OF PROTECTION

In the process of evaluating the various measures that would contribute to protection of early life stages of American shad and other species from intake-related impacts, the Panel developed the concept of "layers of protection." The "layers" are the various design and operational attributes of the KWR intake, each of which could contribute in different, but cumulative, ways to the avoidance of impacts and protection of fish populations from water withdrawal effects.

PUMPING HIATUS

For species with vulnerable life stages that may occur within the area of influence of the intake, the implementation of a pumping hiatus when those vulnerable life stages are present is the primary layer of protection. This measure will be implemented in years of normal operation (*i.e.*, 72 out of 74 years), and it will totally eliminate the potential for impingement and entrainment impacts for the period of time during which no pumping occurs. It will provide absolute protection to nearly all, but at minimum 97 percent, of the egg and yolk-sac-larval stages of American shad in years of normal operation. It will also provide a high degree of protection to vulnerable life stages of other species.

MINIMUM INSTREAM FLOWS

The minimum instream flows (MIF) requirements of the VWP Permit, which the Panel considered the second layer of protection, act to constrain the volume of water that can be withdrawn to below maximum design withdrawal levels. The Panel found that in the two instances when pumping may occur when vulnerable life stages are present (*i.e.*, outside the hiatus period and in spring of drought emergency years), the protection provided by the MIF requirements will be significant. Water withdrawals in the spring months, in drought emergency years when springtime pumping is allowed, would regularly be constrained to much less than maximum. The level of protection provided by the MIF requirements is highest when flows are lowest; but even at high flows, when maximum withdrawals might be permitted, the withdrawals would represent a relatively small proportion of the total water available and thus the potential for impacts even under those circumstances is limited. The MIF requirements substantially restrict the volume of water that can be withdrawn in summer months. The Panel also found that the level of protection will be highest under low flow conditions; that American shad larval survival rates have been shown to be inversely proportional to river flow and water temperature; and therefore that the MIF requirements may provide the greatest degree of protection under circumstances most favorable to early life stage survival.

INTAKE SCREENS - 1-MM SLOT WIDTH, LOW THROUGH-SLOT INTAKE VELOCITIES

While the level of protection from withdrawal impacts afforded by the pumping hiatus is absolute, it is not possible to guarantee that 100 percent of the vulnerable early life stages of fish will only be present during the pumping hiatus, and early life stages would be vulnerable under the mandate that the spawning season pumping hiatus can be lifted when the Governor has declared a drought emergency. Thus, there remains a residual potential for withdrawal effects on organisms that are present outside the hiatus window in years of normal operation and throughout the spawning period under drought emergency conditions.

Under those circumstances, additional protection layers are provided by the design and mode of operation of the KWR wedge-wire intake screens. The very small slot size (1 mm, or 1/25 inch) excludes entrainment of larger organisms, and the very low through-slot water velocities (maximum 0.25 feet, or 3 inches, per second) minimize the risk of impingement. While the maximum design through-slot velocity of the KWR intake screens is 0.25 ft/sec, it is expected that through-slot velocities will be less than 0.1 ft/sec at least 75 percent of the time.

The design of the intake screens was based on recommendations presented in the Virginia DGIF guidelines for water intake screens that are protective of fish populations (Gowan, Garman and Shuart, 1999). Perhaps most importantly, the design of the screens results in hydraulic characteristics of withdrawal flows within natural tidal river flows such that particles suspended in the water, including eggs and early life stages of fish, have different probabilities of being drawn to the intake screen depending on their distance from the face of the intake screen. Probability of encountering the intake screen decreases with distance from the screen and is zero or near zero in a substantial portion of the river cross section.

HYDRAULIC ZONE OF INFLUENCE (HZI)

The Panel determined that only organisms within the intake's hydraulic zone of influence (HZI) have any probability of encountering or passing through the intake screen. Water entering the intake approaches from a narrow region directly upstream or downstream (depending on the direction of the tidal flow) of the structure. The Scotland Landing intake would withdraw water primarily from the center of the river cross section, and organisms present near the surface or bottom or in the shoals would not be at risk of entrainment or impingement during their movement past the intake.

TIDAL VELOCITIES

Experimental data described in the Panel's report demonstrate the importance of tidal sweeping velocities in preventing impingement of passive organisms (*i.e.*, eggs). Experiments using surrogate striped bass eggs, a life stage with no mobility, showed that impingement was higher at higher slot velocities and when the sweep velocity is lower than the slot velocity. No impingement occurred when sweep velocity was twice the slot velocity, however, and impingement was less than 1% when the two velocity components were equal.

At a slot velocity of 0.1 ft/s or less, complete exclusion is predicted to occur for larvae 12 mm or greater when channel velocities reach 0.4 ft/s, which occurs over most of the tidal cycle. Complete exclusion of larvae greater than 5 mm is predicted to occur at this slot velocity when channel velocities are 0.7 ft/s or greater, which occurs approximately 80 percent of a tidal cycle.

INTAKE AVOIDANCE

Visual observations and estimated entrainment rates of fish that are small enough to pass through intake screens have demonstrated that swimming ability contributes to effective exclusion, even for smaller larvae (< 10 mm). Several studies show that the percentage of fish larvae capable of swimming away from an operating screen and avoiding entrainment and impingement, in the absence of sweeping flows, increases with fish size (*i.e.*, larger fish are stronger swimmers). While the data on swimming speeds of fish larvae are limited, and the Panel found no specific data on swimming speeds of American shad larvae, the Panel found that existing data confirm that primarily eggs and yolk-sac larvae (which range in size from 5.7 to 10 mm) would be vulnerable to entrainment and impingement by the KWR intake screens.

SURVIVAL AFTER IMPINGEMENT OR SCREEN CONTACT

There are few studies that directly assess mortality of eggs and larvae in contact with wedgewire screens, but the Panel identified several studies of impingement-induced mortality at other types of exclusion devices that provide insight into potential effects. One study, conducted to estimate mortality of American shad eggs induced by impingement on the Gunderboom Marine Life Exclusion System (a fabric-like material designed to exclude eggs and larvae from entrainment in water intakes), reported survival rates of 99 percent or higher of American shad eggs which remained impinged for periods ranging from one to four hours. Another study, which quantified potential mortality to striped bass eggs associated with impingement on wedgewire screens, reported that mortality attributable to impingement ranged from 0 to 11.9 percent; but the mean impingement mortality ranged only from 0 to 2.0 percent, and the overall mean mortality for all developmental stages was 1.4 percent. The Panel concluded that the results of these and other studies summarized in Appendix E to the Panel's report are sufficient to reject the hypothesis that American shad eggs and larvae would suffer 100 percent mortality from contact with the KWR intake screens, regardless of whether they were impinged.

CUMULATIVE PROTECTION BENEFITS OF MITIGATION MEASURES

The pumping hiatus, to be implemented in accordance with the recommendations of the Panel and consistent with suggestions from VIMS, will provide absolute total protection to nearly all of the vulnerable life stages of American shad and other resident and anadromous species in years of normal operation, with the exception of any losses that may result from collision with the intake structure (in the same manner as such losses may result from impacts with any other hard structure in the river). Under the infrequent circumstances during which vulnerable life stages may be present when water withdrawal is occurring (*i.e.*, outside the pumping hiatus period and in drought emergency years after 2025), the Panel has concluded that any vulnerable life stages that may be present in the vicinity of the intake would have potential for experiencing intake effects. Analysis of the surrogate Hudson River data suggest that the 10° C to 22° C hiatus would encompass the period when nearly all American shad eggs and yolk-sac larvae would be present, and when high percentages of early life stages of other vulnerable species would be present in most years. The Panel's review of the most current studies of wedgewire screen effectiveness and hydraulic characteristics of wedgewire intake screens indicated that the intake design provides a high level of protection from impingement, entrainment and screen contact to any relatively immotile organisms that might be present within the area of influence of the intake outside the pumping hiatus. Thus, the project as currently designed provides multiple layers of protection that cumulatively provide to fish a high level of protection from water withdrawal impact.

FISHING MORATORIUMS

While not directly related to the KWR Project, it also is worth noting that the current moratorium on American shad fishing in the Chesapeake Bay and its tributaries (4 VAC 20-530-30) and the forthcoming Coastal Area American shad fishing moratorium (4 VAC 20-530-26(C)) are designed to reduce fishing mortality in order to preserve the adult population and allow American shad stocks to recover. By reducing fishing stresses on the remaining population, these moratoriums will work synergistically with the Project-related measures described above to provide yet another layer of protection for fish that otherwise would be at risk of continued depletion.

APPENDIX G - FILL
(not associated with backfilled shoreline structures)

Questions:

1. What is the source (i.e. quarry, borrow pit, etc.) and quantity of the fill material, and area of the fill site? Source: Quarry, borrow pit, concrete plant Amount: 2,000 (cubic yards) Area: 4,000 (sq feet)

2. State the type and composition percentage of the fill material (e.g. 80% sand, 15% clay, 5% silt): Approximately 20% riprap, 30% crushed stone and sand, and 50% concrete

3. Explain the purpose of the filling activity & the type of structure to be built on the filled area, if any:
Back fill of excavation required for installation of water intake pipes.

4. Will any of the fill be placed on wetlands or subaqueous land? X Yes __ No. If your answer is yes, complete table below:

	Tidal (sq. ft.)	Nontidal (sq. ft.)
Vegetated	--	*
Nonvegetated	0	*
Subaqueous land	5,000	*

*** If nontidal wetland impacts will occur, please complete Part IV or V of the JPA.**

5. If filling activity is proposed in wetlands, name the nearest waterbody and give the distance from the activity: N/A

6. What is the approximate drainage area and average stream flow? DA: 781 square miles Flow: 753 cubic feet per second

Specific Information for Plan View Drawing:

- width of the waterway, measuring from mean high water to mean high water (tidal areas) or ordinary high water to ordinary high water (nontidal areas)
- channelward encroachment relative to mean high/mean low water lines (tidal) or ordinary high water line (nontidal)
- fill area (labeled)

Specific Information for Cross-Sectional Drawing:

- existing contours of the bottom (depths relative to MLW or OHW)
- elevation of proposed fill
- structure or method used to contain fill

Note: *Land disturbance or removal of vegetation associated with projects located in Chesapeake Bay Preservation Areas will require approval from local governments. Please contact your local government to determine local Chesapeake Bay Preservation Act requirements concurrent with this application.*

APPENDIX J - DREDGING, MINING, & EXCAVATING

Questions:

1. Complete the table below with the volumes (cu. yds.) and areas (sq. ft.) of material to be removed from waters by each method, for each category:

	NEW				MAINTENANCE			
	Hydraulic	Dragline	Clamshell	Other	Hydraulic	Dragline	Clamshell	Other
Vegetated Wetlands*	--	--	--	--				
Nonveg. Wetlands*	--	--	--	--				
Subaqueous Land*	--	--	2,500 CY** tidal	--				
Totals:	0	0	2,500	0	--	--	--	--

* Report tidal and/or nontidal

2 State the composition of the material (e.g. clay 25%, sand 25%, silt 50%): clay 50%, sand 20%, silt 30%

3 How will the dredged material be retained to prevent re-entry into the waterway?
Placed on barges for transport to and disposal at Craney Isand.

4 Will the dredged material be used for any commercial purpose? __ Yes X No

5. For mining projects: Explain the operation plans on a separate sheet of paper. Include the frequency (e.g. every 6 wks), duration (e.g. Apr - Sep), and volume (cu. yds.) to be removed per operation; the temporary storage and handling methods of dredged material; and how equipment will access the dredge site. Have you applied for a permit from the VA Dept of Mines, Minerals, & Energy? __ Yes __ No

6. For maintenance dredging projects: When was dredging last performed? N/A
Provide permit number ____________. Attach a copy of the permit.

7. What is the approximate drainage area and average stream flow? 781 sq mi 753 cfs

Specific Information for Plan View Drawing:

- width of the waterway, measuring from mean high water to mean high water (tidal areas) or ordinary high water to ordinary high water (nontidal areas)
- location and dimensions of area proposed to be dredged
- location of existing channels
- location of dredged material disposal area if located on-site** (for off-site areas: Provide a drawing
- that includes the location, dimensions, benchmarks, berms, and/or spillways. Also provide an explanation of how the material will be transported, including the location of the proposed transfer site(s). For non-commercially owned/operated disposal areas, attach local approvals for proposed disposal areas.
- location and dimensions of buffer zone between dredge cut and vegetated wetlands
- existing and proposed depths in the project area based on mean low water (tidal) or ordinary high water (nontidal)

Specific Information for Cross-Sectional Drawing of Dredge Area:

- existing contours of the bottom (depths relative to MLW or OHW); include reference station & datum
- dredge cut: slopes, average depth, bottom & top width
- proposed project depths (after dredging)

Specific Information for Cross-Sectional Drawing of Disposal Area:

- proposed berms & spillways
- ponding depth of dredged material

Note: *Land disturbance or removal of vegetation associated with projects located in Chesapeake Bay Preservation Areas will require approval from local governments. Please contact your local government to determine local Chesapeake Bay Preservation Act requirements concurrent with this application.*