Attachment J-4:
Summary Table of Major Modeling Scenarios and Results

Lower Susquehanna River Watershed Assessment
Baseline and Future Predicted Conditions

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer **"LSRWA 24"** (b) fall **"LSRWA 25"** or (c) winter **"LSRWA 21"?**
Modeling Parameters	Models used: CBEMP Land use: 2010 land use. Hydrology: 1991-2000. Reservoir bathymetry/Trapping efficiency: 1991-2000 levels. Scouring: No net scouring of reservoirs accounted for during this period. Stoplight Analysis Attainment period: 1993-1995	Models used: CBEMP Land use: WIPS in place. Hydrology: 1991- 2000 CBEMP. Reservoir bathymetry/Trapping efficiency: 1991-2000 levels. Scouring: No net scouring of reservoirs accounted for during this period. Stoplight Analysis Attainment period:1993-1995	Models used: HEC-RAS/ADH+CBEMP Land use: WIPS in place. Hydrology: 2008-2011 HEC-RAS/ADH; 1991-2000 CBEMP. Reservoir bathymetry/Trapping efficiency: 2011 levels. Scouring: Jan 96 event flow and solids adapted from ADH/HEC-RAS/2011 event nutrient composition. Stoplight Analysis Attainment period: 1996-1998	Models used: HEC-RAS/ADH+CBEMP Land use: 2010 land use. Hydrology: 2008-2011 HEC-RAS/ADH; 1991-2000 CBEMP. Reservoir bathymetry/Trapping efficiency: Computed "full" Conowingo levels. Scouring: Jan 96 event flow and solids adapted from ADH/HEC-RAS/2011 event nutrient composition. Stoplight Analysis Attainment period: 1996-1998.	Models used: HEC-RAS/ADH+CBEMP Land use: WIPs in place. Hydrology: 2008-2011 HEC-RAS/ADH; 1991-2000 CBEMP. Reservoir bathymetry/Trapping efficiency: Computed "full" Conowingo levels. Scouring: Jan 96 event flow and solids adapted from ADH/HEC-RAS/2011 event nutrient composition. Stoplight Analysis Attainment period: 1996-1998.	Models used: HEC-RAS/ADH+CBEMP Land use: WIPs in place. Hydrology: 2008-2011 HEC-RAS/ADH; 1991-2000 CBEMP. Jan. 1996 event moved to June and October. Reservoir bathymetry/Trapping efficiency: 2011 levels. Scouring: Jan 96 event flow and solids adapted from ADH/HEC-RAS /2011 event nutrient composition occurring in January, June and October. Stoplight Analysis Attainment period: 1996-1998. *This analysis estimates storm scour loads in conjunction with watershed loads calculated from CBEMP in order to discern differences in seasonal impacts.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter **"LSRWA 21"?**
General Water Quality Effects	Conditions are usually worst during wet periods of high loading and stratification. Results emphasize summer average (June-August) during wet year (1996).	Predicted WQ improvements (over #1/LSRWA 4) with WIPS in place. Hypoxia reduced, less anoxic conditions, DO levels increase, chlorophyll concentrations and light attenuation decrease.	DO would be depressed in comparison to WIPS in place with no scouring event (#2, LSRWA 3). Storm timing important. Winter scour has minimal impacts to WQ by summer.	Scour under "full" conditions was similar to scour with current conditions (2011 bathymetry). This shows that by 2011, the reservoirs are essentially "full". When flow is below scour threshold full-reservoir conditions are similar to non-full conditions. Solids settle even when reservoir is "full" and settlement rate is not dependent on bathymetry. When flow is below the scour threshold, loads from the reservoir are the same between current bathymetry (2011) and reservoir "full" conditions. Consequently, water quality in the bay is the same, as long as there is no scour event. A full reservoir is influential when scour takes place; more material is scoured under reservoir-full conditions.	When flow is below scour threshold WQ conditions are similar whether reservoir is "full" or not.	June storm has the most deleterious effect on summer water quality. October storm has the least deleterious effect, followed by the January storm.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Dissolved Oxygen (DO)	Bottom-water hypoxia (DO < 1 mg/L) for a 60-km reach extending 80 to 140 km below the Conowingo dam. Bottom waters in this reach exhibit complete anoxia on occasion.	Bottom-water hypoxia (DO < 1 mg/L) in a 20-km reach (was 60-km reach when WIPS are not in effect) extending 80 to 100 km below Conowingo. Minimum summer-average DO is ~ 0.5 mg/L. Occasional excursions to zero (anoxia) mg/L still predicted.	The additional loads from the scour event depress summer-average, bottom-water, DO by 0.05 mg/L for roughly 60 km along the bay axis (along the centerline following the channel) in the summer following the storm. (in comparison to #2 (LSRWA 3/Base) DO values vary-The effect is diminished in shallow areas relative to deeper areas. There are freshwater flow pulses and meteorological events which cause the effect on DO to vary over the course of a season.	Summer-average DO is depressed by 0.04 mg/L (in comparison to scenario #1/LSRWA-4) along a 100 km reach of bay bottom. Examination of the marginal effects on DO can be deceptive: in the region of the worst hypoxia, at the worst location, under existing conditions, average DO is almost zero. It can't go much lower. Therefore DO isn't depressed much because there is nowhere to go. Elsewhere, DO might average 0.5 mg/L so it can go down by 0.5. The greatest magnitude of depression is not where DO is worst, on average.	If a scour event occurs, average bottom DO concentration is depressed by 0.05 mg/L for 60 to 80 km along the bay axis. With WIPS in place, summer-average DO is higher than under 2010 conditions. Since summer-average DO is higher, it can go lower before hitting zero. So the magnitude of depression can be worse for the WIPS than for 2010.	The DO response to a storm is two-phased. As storm water passes there is an initial sharp decrease reflecting the DO concentration in the storm water and, perhaps, the effects of vertical density stratification. Following storm passage, a secondary DO depression results from oxidation of organic matter produced by storm-generated nutrient loads. June storm, the two phases are difficult to separate. Summer-average bottom-water DO depression at the head of the trench (fixed bathymetric feature in Bay) is 0.4 mg/L or more in comparison to Scenario 2. January storm- DO depression (same location as June storm) is 0.2 mg/L and October storm depression is 0.1 mg/L Spatial extent of the storm influence is large and DO depression is readily detected in the lower portion of the Potomac River which joins Chesapeake Bay roughly 200 km below Conowingo Dam.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3"** **"BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? "**LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Chlorophyll Concentration (CHL)	Greatest average CHL concentrations (more than 10 µg/L) occur in surface waters of 60-km reach extending 80 to 140 km below the Conowingo dam.	Surface CHL concentration in this reach declines by 3 µg/L, relative to the current condition, to ~ 7 µg/L.	CHL (summer average) increases by 0.3 µg/L in the worst areas (in comparison to #2 (LSRWA-3/base). The effect on CHL is spatially extensive. An increase of 0.2 µg/L or more extends 150 km along bay axis in the summer following the storm.	CHL (summer average) increases by 0.2 µg/L for a 100 km reach of the bay axis	CHL increases by 0.3 µg/L in the 20 km reach where CHL is maximum. CHL increases by 0.2 µg/L for 120 km or more along the bay axis. It is possible for CHL to increase (worsen) with WIPS in place due to the fact that with WIPS in place the nutrient limitation of algae is more stringent; therefore the added nutrients from the scour event can stimulate a bit more chlorophyll.	CHL response to a storm is two-phased. CHL concentration declines immediately as the storm water passes then CHL increases, stimulated by the nutrients introduced by the storm. January storm, spring bloom, CHL increases as much as 5 µg/L, although the bloom largely precedes the critical SAV growing season. In the summer subsequent to the storm, the increase in CHL concentration is between 0.5 and 1 µg/L over a large reach of the bay, extending to the mouth of the Potomac River. October storm – CHL increases by 0.5 µg/L. June storm introduces nutrients at the beginning of the seasonal peak in primary production, summer-average CHL concentration increases as much as 3 µg/L.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3"** **"BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Light Attenuation (KE)	Greatest computed KE, ~ 1.9/m, occurs immediately downstream of the Conowingo outfall and declines rapidly with distance away from the dam. A secondary peak, 1.2/m, occurs downstream, in the turbidity maximum located 40 km below Conowingo Dam. Guidelines indicate KE should not exceed 1.5/m for survival of SAV at the one-meter depth.	KE just below Conowingo declines by 0.5/m, relative to the current condition (scenario 1), to 1.4/m and by 0.4/m to 0.8/m within turbidity maximum (TM, moves according to flow, during most summers TM is located 20 to 40 km upstream of the head of the trench.).	Summer-average KE increases by 0.01/m (in comparison to(LSRWA-3). Additional solids load disperse and settle before SAV growing season (April-October). KE increase attributed to the organic matter, phytoplankton and detritus, stimulated by the scoured nutrient load. Although solids may be subject to resuspension, the January scour effect on summer KE is negligible. Nutrients associated with the storm event are persistent into summer, while solids are short-lived. They settle out but they are recycled though the chemical and physical processes that the bottom sediments undergo. The effect of the scoured nutrients diminishes with time but is visible five summers subsequent to the scour event.	Impact of the winter scour event on summer KE is minimal (less than 0.02/m increase). This increase due to phytoplankton and organic matter associated with scoured nutrients rather than scoured sediments.	KE increase is ~ 0.01/m or less since additional solids disperse and settle before summer. The minimal KE effects are almost identical to predictions with reservoirs still trapping (i.e. 2011 bathymetry/KE impacts are about the same if there is winter storm whether the reservoir is "full" or as it is now (still trapping) which is expected since the solids scoured have ample time to settle before the critical SAV growth period.	Solids loads from the June storm remain in suspension during the subsequent summer months resulting in KE increase of 2/m to 4/m (in comparison to scenario 2/LSRWA-3/Base) for a reach extending 60 km downstream of the dam . Solids loads from the January and October storms are dispersed and settle long before the subsequent SAV growing season and have negligible effect on KE during this period.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Sediment Loads	CBEMP calculated average solids load over the 10-yr period is 3,056 metric ton/d. Maximum daily load is 181,910 metric ton/d.	CBEMP calculated average solids load over the 10-yr period) is 2,307 metric ton/d. Maximum daily load is 134,960 metric ton/d.	CBEMP calculated - Scour event adds 2.4 metric tons of solids in addition to watershed loads over a four day period.	CBEMP calculated - Scour event adds 2.4 metric tons of solids in addition to watershed loads, over a four day period.	CBEMP calculated- Scour event adds 2.4 metric tons of solids in addition to watershed loads, over a four day period.	CBEMP calculated - The simulated storm event totals 2.78 million metric tons solids over seven days. This includes watershed and scour loads.
Nutrient Loads	Nitrogen- The average total nitrogen load is 147.9 metric ton/d. Of this, 62.9 tons are particulate (organic) nitrogen associated with sediments. Phosphorus- The average total phosphorus load is 6.31 metric tons/day. Of this, 5.22 tons are particulate phosphorus associated with sediments.	Nitrogen- The average total nitrogen load is 104 metric tons/day. Of this, 46.1 tons are particulate (organic) nitrogen associated with sediments. Phosphorus-The average total phosphorus load is 4.72 metric tons/day. Of this, 3.87 tons are particulate phosphorus associated with sediments.	Nitrogen- Scour event adds 7,100 metric tons particulate (organic) nitrogen in addition to watershed loads over a four day period. Phosphorus- Scour event adds 2,400 metric tons particulate phosphorus in addition to watershed loads over a four day period.	Nitrogen-Scour event adds 7, 100 metric tons particulate (organic) nitrogen, in addition to watershed loads over a four day period. Phosphorus – Scour event adds 2,400 metric tons particulate phosphorus, in addition to watershed loads over a four day period. The amount scoured is virtually equal to the amount scoured under existing bathymetry, indicating the existing bathymetry is very close to full.	Nitrogen- Scour event adds 7,100 metric tons Particulate (organic) nitrogen in addition to watershed loads, over a four day period. Phosphorus – Scour event adds 2,400 metric tons particulate phosphorus in addition to watershed loads over a four day period. The amount scoured is not affected by WIPS.	Nitrogen- The simulated storm event adds 13,016 metric tons total nitrogen over seven days. This includes watershed and scour loads. Phosphorus- The simulated storm event adds 2,888 metric tons total phosphorus over seven days. This includes watershed and scour loads.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? "**LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Deep Channel DO Water Quality Standard Achievement for Total Maximum Daily Load (TMDL)	Widespread non-attainment of TMDL of Deep Channel DO. Non-attainment of 23% in the CB4 mainstem, 14% in Eastern Bay, and 28% in the Lower Chester River. This and other areas of non-attainment in the Deep Channel amounted to more than half of the Deep Channel habitat in the Bay.	Complete attainment of the Deep Channel DO standard was estimated to be attained.	An estimated increase of 1% nonattainment at CB4MH, EASMH and CHSMH over Scenario 2(LSRWA-3/Base).	An increase of 1% nonattainment above Scenario 1 (LSRWA- 4) for CB4MH and PATMH.	Increase of 1% nonattainment over Scenario 2 (LSRWA-3/Base) was estimated at CB4MH, EASMH, and CHSMH.	Generally, a June high flow storm event has the most detrimental influence on Deep Channel DO followed by a storm of the same magnitude in January and then October. A 'no large storm" condition has the highest level of Deep Channel DO attainment. The June high flow event scenario (LSRWA-24) had an estimated increase in Deep-Channel nonattainment of 1%, 4%, 8% and 3% in segments CB3MH, CB4MH, CHSMH and EASMH when compared to the No Storm Scenario.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3"** **"BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Deep Water DO Water Quality Standard Achievement for TMDL	Widespread non-attainment of TMDL of Deep Water DO. Estimated Non-attainment of 11% in CB4 mainstem, 2% in Eastern Bay and 11% in Lower Chester River.	Complete attainment of the Deep Water DO standard was estimated to be attained.	An estimated increase of 1% nonattainment over Scenario 2(Base/LSRWA 3) was estimated at CB4MH, CB5MH.	An estimated increase of 1% nonattainment over Scenario 2 was estimated at CB3MH and PAXMH.	An estimated increase of 1% non-attainment over Scenario 2 (Base/LSRWA 3) was estimated at CB4MH and CB5MH.	Generally a June high flow event has the most detrimental influence on Deep Channel DO followed by a storm of the same magnitude in January and then October. A "no large scour event" has the highest levels of Deep Water DO attainment. June high flow event scenario (LSRWA-24) had an estimated increase in Deep-Water nonattainment of 1% in segments CB4MH, CB5MH, and EASMH respectively over Scenario 2(LSRWA-3/Base). For October attainment was the same as Scenario 2 (LSRWA-3/Base).
Open Water DO Water Quality Standard Achievement for TMDL	Widespread, but not complete attainment of the Open Water DO standard was estimated.	Complete attainment was estimated.	Complete attainment was estimated.	Complete attainment was estimated.	Complete attainment was estimated.	Complete attainment was timated.

	1. What is the system's current (existing) condition? **"LSRWA-4"**	2. What is the system's condition if the WIPs are in full effect and reservoirs have not all reached dynamic equilibrium? **"LSRWA-3" "BASE"**	3. What is the system's condition when WIPS are in full effect, reservoirs have not all reached dynamic equilibrium and there is a winter scour event? **"LSRWA-21"**	4. What is the system's condition when WIPS are not in effect, reservoirs have all reached dynamic equilibrium and there is a winter scour event? "**LSRWA-18"**	5. What is the system's condition when WIPs are in full effect, the reservoirs have all reached dynamic equilibrium and there is a winter scour event? "**LSRWA-30"**	6. What is the system's condition if WIPs are in full effect, reservoirs have not all reached dynamic equilibrium and a scour event occurs during (a) summer "**LSRWA 24"** (b) fall "**LSRWA 25**" or (c) winter "**LSRWA 21"?**
Submerged Aquatic Vegetation (SAV) clarity water quality Achievement for Total Maximum Daily Load	Complete attainment was estimated.	Complete attainment was estimated.	Complete attainment was estimated.	Complete esattainment was estimated.	Complete attainment was estimated.	Complete attainment was estimated.

Lower Susquehanna River Watershed Assessment
Sediment Management Scenarios

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
Modeling Parameters	Models used ADH. Land use: Not determined. Hydrology: Five runs varying between 30,000-400,000 cfs on ADH. Reservoir bathymetry/Trapping Capacity: Not determined. Scouring: Not determined. Concept: Re-suspending reservoir bed sediments into the water column by mechanical means through the outlet structures of the dam.. Goal was to determine minimum flow required to maintain the resuspended sediment in suspension to allow transport through outlet structures. Stoplight Analysis Attainment period: Not Determined.	Models used: HEC-RAS/ADH and CBEMP Land use: WIPS in place. Hydrology: 2008-2011 (ADH). 1991-2000 (CBEMP). Reservoir bathymetry/Trapping Capacity: 2011, 3 mcy (2.4 million tons) removed. Scouring Jan 96 event flow and solids/2011 event nutrient composition. Concept: One time removal, of 3 mcy (2.4 million tons) from reservoir system. An area behind Conowingo was selected, 1.0 – 1.5 miles above the dam. Dredging area selected based on the highest deposition rate. Stoplight Analysis Attainment period: 1996-1998	Models used: Google Earth and GIS Desktop Analysis. Land use: Not determined, this was a desktop calculation Hydrology Not determined, this was a desktop calculation Reservoir bathymetry/Trapping Capacity: Not determined, this was a desktop calculation Scouring: Not determined, this was a desktop calculation Concept: 2.4 million tons (3mcy) bypassed over 3 months' time (90 days), one year. Dec -Feb time period. Stoplight Analysis Attainment period: Not Determined.	Models used: CBEMP Land use: WIPs in place. Hydrology: 1991-2000 (CBEMP). Reservoir bathymetry/Trapping Capacity: 2011, 3mcy removed Scouring: Jan 96 event flow and solids/2011 event nutrient composition Concept: 2.4 million tons (3mcy) bypassed over 3 months' time (Dec-Feb) every year for 10 years. Stoplight Analysis Attainment period: 1996-1998	Models used: Google Earth and GIS Desktop Analysis. Land use: Not determined, this was a desktop calculation. Hydrology: Not determined, this was a desktop calculation. Reservoir bathymetry/Trapping Capacity: Not determined, this was a desktop calculation. Scouring: Not determined, this was a desktop calculation. Concept: 2.4 million (3 mcy) tons bypassed over 9 months time, one year (270 days (Sept. – Apr) time period. Stoplight Analysis Attainment period: Not Determined	Models used: HEC-RAS/ADH and CBEMP. Land use: WIPS in place. Hydrology: 2008-2011 (ADH). 1991-2000 (CBEMP). Reservoir bathymetry/Trapping Capacity: 1996. Scouring: Jan 96 event flow and solids/2011 event nutrient composition. Concept: The 1996 bathymetry was modeled. This bathymetry has 25 million tons (31 mcy) less sediment than the 2011 bathymetry. Stoplight Analysis Attainment period: 1996-1998	Models used: Google Earth and GIS Desktop Analysis. Land use: Not determined, this was a desktop calculation. Hydrology: Not determined, this was a desktop calculation. Reservoir bathymetry/Trapping Capacity: Not determined, this was a desktop calculation. Scouring: Not determined, this was a desktop calculation. Concept: Removing 3mcy on an annual basis for 10 years. Stoplight Analysis Attainment period: 1996-1998	Models used: None. Google Earth and GIS Desktop Analysis. Land use: Not determined, this was a desktop calculation. Hydrology: Not determined, this was a desktop analysis. Reservoir bathymetry/Trapping Capacity: Not determined, this was a desktop calculation. Scouring: Not determined, this was a desktop calculation. Concept: Dredging areas within reservoir where scour occurs and placing dredged material in areas within reservoir that is still depositional. Stoplight Analysis Attainment period: Not Determined	Models used: None. Google Earth and GIS Desktop analysis. Land use: Above TMDL/WIP requirements. Hydrology: Not determined, this was a desktop analysis. Reservoir bathymetry/Trapping Capacity: Not determined, this was a desktop calculation. Scouring: Not determined, this was a desktop calculation. Concept: Implementing BMP's Based on CBP E3 scenario includes additional BMPs, in Susquehanna River Watershed above planned WIPs. Scenario estimates a reduction of 243, 000 cubic yards (197, 500 tons) annually. Stoplight Analysis Attainment period: Not Determined.

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
Sediment loads	A minimum flow of 150,000 cfs is required to ensure transport of sediment through dam. This flow occurs on average 12 days per year, usually in the spring which is critical time of year for living resources. Also conditions could be unsafe for operations.	ADH calculated that with strategic dredging the total load to the Bay (2008-2011 time period) was reduced by 1.4 percent from 22.3 to 22.0 million tons. The scour load decreased by 10% from 3.0 to 2.7 million tons and the net reservoir sedimentation increased by 5.0% (4.1-4.3 million tons). Scour load decreased by 3.3% for every million cubic yards removed. CBEMP calculated (1991-2000) time period) that the Jan 1996 scour load was reduced by 32% in comparison to same scour event with existing reservoir bathymetry.	Calculated that daily load to bay increased from 1,490 to 28,200 tons per day for 90 days assuming a base flow of 60,000 cfs out of Conowingo Dam. Total loads	CBEMP calculated an additional sediment load of 2.18 million metric tons/annum.	Calculated a daily load to bay increasing from 1,490 to 8,900 tons per day for 270 days. The impact to daily load concentrations is more severe over 3 months of bypass operations and less concentrated over 9 months of bypass operations. The 9 month bypass approach will have the effect of discharging loads during the SAV growing season which is unacceptable.	Dredging back to 1996 ADH calculated 1.8 million tons of scour for Tropical Storm Lee vs. 3 million tons of scour with 2011 bathymetry thus dredging resulted in a 66% percent reduction in scour load (simulation period 2008 -2011). Total sediment load to the bay with 1996 bathymetry was 20.3 million tons while with 2011 bathymetry it was 22.3 representing a 10% decrease in total load to the Bay. Reservoir sedimentation was 6.0 million tons with 1996 bathymetry and 4.0 million tons compared to 2011 thus a 33% increase in deposition. CBEMP (1991-2000 time periods) calculated that dredging back to the 1996 bathymetry reduced scour of the January 1996 storm by 45% of the scour load of a "full" Conowingo.	In theory this would amount to 31 mcy, roughly the amount equivalent to dredging Conowingo back to 1996 bathymetry. Approximately 1.5 million tons of sediment is estimated to accumulate every year in Conowingo Reservoir. If you removed 3 million cubic yards per year (2.4 million tons per year) for 10 years, you do not go back to the 1996 bathymetry. In addition, because you are increasing storage capacity, more incoming sediment is depositing. Assuming the deposition is 1.5 million tons a year you deposit 15 million and remove 24 million over 10 years, with a net removal of 9 million tons over 10 years (net removal of 0.9 million tons per year). In reality, the benefits are likely to be less than Scenario 5 since deposition will occur during the ten-year interval.	Sediment storage capacity will not change and building up another section of the reservoir with sediment may change flow patterns and induce scour in other areas.	Determined that the maximum available sediment per year that could be reduced by additional BMP implementation above and beyond the WIP implementation throughout the lower Susquehanna River Watershed is approximately a reduction of 243, 000 cubic yards (197, 500 tons) annually. This is about 1/5th of what is estimated to flow over the Conowingo Dam into the Chesapeake Bay on a average annual basis (approximately, 1M tons/year).

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
Nutrient Loads	Not determined.	The nitrogen scour load estimated by CBEMP for the January 1996 storm with strategic dredging is 4,815 metric tons organic nitrogen. The phosphorus scour load estimated by CBEMP is 1,605 metric tons particulate phosphorus. These represent 32% reductions from 1996 scour load calculated with 2011 bathymetry.	The one-time additional nutrient load estimated by CBEMP are 6,545 tons organic nitrogen and 2,182 tons particulate phosphorus.	The additional organic nitrogen and particulate phosphorus loads associated with bypass estimated by CBEMP are 6,545 metric tons/annum and 2,182 metric tons/annum respectively.	Not Determined.	The nitrogen scour load estimated by CBEMP for the January 1996 storm with extreme long-term removal is 3.942 metric tons organic (particulate) nitrogen. The phosphorus scour is 1,314 metric tons particulate phosphorus. These represent 45% reductions from scour load calculated with 2011 bathymetry by CBEMP.	Under ideal circumstances the benefits from this scenario would be the same as Scenario 5. These are the benefits realized from net removal of 3 mcy/year for 10 years. In reality, the benefits are likely to be less since deposition will occur during the ten-year interval. Results in Column 5 should be regarded as the "best case" results from long-term strategic dredging.	Not Determined.	We have no projections for nutrient loads reductions to accompany the solids load reductions. .

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
General Water Quality Effects	Not determined.	Effects of this one-time dredging are most obvious in the summer following the scour event. Dissolved oxygen improvements extend along the trench of the bay from Baltimore Harbor to the mouth of the Potomac and into the Potomac trench. Reductions in chlorophyll are roughly of the same extent. Limited benefits are seen in light attenuation, primarily because the scoured sediments settle our or are dispersed before the SAV growing season.	It was determined this scenario did not merit the time and resources necessary to complete it in full. Dredging and bypassing for solely one year is an unlikely management strategy. We project the effects of one year of bypassing would be no worse in magnitude than Column 3b. The temporal extent would be limited primarily to the summer season following the bypassing. Detrimental effects would diminish with time thereafter.	Water quality deteriorates as a result of sediment bypassing. The effects are widespread, ranging from near the head of the bay to the mouth of the Potomac River and beyond. The lower Potomac River is affected as well. Diminished water quality is seen in all years of our simulation since the bypassing takes place in all years.	Not Determined.	The benefits from dredging back to 1996 conditions extend from above Baltimore harbor to the mouth of the Potomac River and, in some years, into the Potomac River. Since the benefit comes from a one-time storm event, the extent and magnitude of the benefits generally diminish with time following the storm.	The benefits from this scenario, when dredging is completed as a best (but unlikely) case are the same as Scenario #5.	Not Determined.	The water quality effects will vary from year to year depending on hydrology and annual loading. Experience with other scenarios indicates the benefits from solids reductions are limited since the loads largely enter during non-critical periods for SAV. We have no projections for nutrient loads reductions to accompany the solids load reductions.
Dissolved Oxygen (DO)	Not determined.	Summer-average DO improvements are largely 0.01 to 0.02 mg/L. Occasional improvements up to 0.04 mg/L are seen limited areas.	Potential declines of 0.2 to 0.3 mg/L estimated for the summer immediately following the bypassing. This estimate is based on results of the model run completed with sediment bypassing for ten years.	Summer-average declines of 0.2 to 0.3 mg/L are widespread. DO declines more than 0.3 mg/L in portions of the deep trench at the head of the bay.	Not Determined.	The improvement in summer-average DO is 0.02 to 0.04 mg/L in widespread regions of the bay and lower Potomac. Occasional improvements in excess of 0.04 mg/L are noted. The benefits are primarily in the one or two summers following the storm event.	The benefits from this scenario, when dredging is completed, are the same as Scenario 5.	Not Determined.	Not Determined.

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
Chlorophyll Concentration (CHL)	Not determined.	Chlorophyll reductions are largely in the range 0.02 to 0.05 ug/L, with limited regions showing improvements greater than 0.05 ug/L. The improvements are spatially-extensive in the summer following the scour event but diminish in successive years.	Potential increases of 0.5 to 1.5 ug/L for the SAV growing season following the bypassing.	Chlorophyll increases, during the SAV growing season, from 0.5 to 1.5 ug/L over large portions of the upper bay. Excursions greater than 2 ug/L are seen in limited areas.	Not Determined.	Summer-average chlorophyll declines by 0.02 to 0.05 ug/L in a large expanse of the bay and lower Potomac River. The spatial extent of the benefits diminishes with time following the storm event	The benefits from this scenario, when dredging is completed, are the same as Scenario 5.	Not Determined.	Not Determined.
Light Attenuation (KE)	Not determined.	Little change occurs in light attenuation, approximately 0.01/m. The improvement is minimal because the SAV growing season is months after the scour event.	Minimal effects on light attenuation. The solids from bypassing will settle out of the system before the SAV growing season.	Light extinction increases by 0.01 to 0.025/m in the reach of the bay from head to the Potomac River. The increases are attributed to increased chlorophyll rather than suspended sediments.	Not Determined.	Improvements in light attenuation during the SAV growing season are minimal, 0.01/m or less. As with other scenarios, the solids effects from a winter storm do not extend into the prime growing season.	The benefits from this scenario, when dredging is completed, are the same as Scenario 5.	Not Determined.	Not Determined.
Deep Channel DO Water Quality Standard Achievement for Total Maximum Daily Load	Not determined.	An (improved) decrease of 0.2% non-attainment over Scenario with WIPs in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table) was estimated for CB3MH and CB4MH and a 0.1% decrease in non-attainment in EASMH.	Not Determined.	An estimated increase of non-attainment of 4% at CB3MH, 5% at CB4MH , 3% at CHSMH, 4% at EASMH, and 2% at PATMH over Scenario with WIPS in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table.	Not Determined.	An (improved) decrease of non-attainment over Scenario with WIPS in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table) of 0.3% at CB3MH, 0.5% at CB4MH, and 0.2% at EASMH was estimated at CB4MH was estimated.	Not Determined.	Not Determined.	Not Determined.

	1. What are the effects of agitation dredging?	2. What are the effects of strategic dredging? **"LSRWA 28"**	3a. What are the effects of passing sediment downstream for 3 winter months, one time?	3b. What are the effects of passing sediment downstream for 3 winter months, over-time for a period of 10 years? **"LSRWA 29"**	4. What are the effects of passing sediment downstream for 9 months?	5. What are the effects of extreme removal out of system) restoring to 1996 bathymetry? **"LSRWA 31"**	6. What are the effects of long-term strategic dredging over time for a period of 10 years?	7. What are the effects of moving sediment from scour areas to depositional areas?	8. What are the effects of increasing Best management practices in the watershed above that required to meet TMDL?
Deep Water DO Water Quality Standard Achievement for Total Maximum Daily Load	Not determined.	An (improved) decrease of 0.1% nonattainment over Scenario with WIPs in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table) was estimated for CB4MH.	Not determined.	Estimated increases of 2% nonattainment at CB4MH, 1% non-attainment at CSHMH, EASMH, MD5MH and PATMH Scenario with WIPs in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table).	Not determined.	An (improved) decrease of nonattainment over Scenario with WIPs in effect, existing bathymetry, scour event in winter (LSRWA 21/ Scenario 3 of Baseline and Future conditions table) was estimated to be 0.3% at CB3MH, 0.5% at CB4MH, and 0.2% at EASMH was estimated.	Not determined.	Not determined.	Not determined.
Open Water DO Water Quality Standard Achievement for Total Maximum Daily Load	Not determined.	Complete attainment of open water DO standard was estimated.	Not determined.	Complete attainment of open water DO standard was estimated.	Not determined.	Complete attainment of open water DO standard was estimated.	Not determined.	Not determined.	Not determined.
Submerged Aquatic Vegetation (SAV) clarity water quality Achievement for Total Maximum Daily Load	Not determined.	Complete attainment was estimated.	Not determined.	Complete attainment was estimated.	Not determined.	Complete attainment was estimated.	Not determined.	Not determined.	Not determined.

- Conversion: 1 mcy =.81 tons