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General Electric Company
Pittsfield, Massachusetts

Housatonic River – Rest of River
Revised Corrective Measures Study Report

October 2010

- On August 28, 2007, EPA issued a "conditional approval" letter for the MIA-S. That letter contained additional directives with respect to the East Branch boundary conditions proposed by GE in the MIA-S.[5]

CMS Report

On March 21, 2008, GE submitted to EPA the CMS Report (ARCADIS and QEA, 2008) pursuant to Special Condition II.G of the Permit. The CMS Report evaluated a number of remedial alternatives for the Rest of River, including eight alternatives for addressing sediments (designated SED 1 through SED 8), seven alternatives for addressing floodplain soil (designated FP 1 through FP 7), and five alternatives for treatment and/or disposition of sediments and soils that may be removed from the River and floodplain (designated TD 1 through TD 5). These alternatives were evaluated under nine criteria specified in the Permit, consisting of three General Standards and six Selection Decision Factors. The evaluations utilized the PCB fate, transport, and bioaccumulation model developed by EPA, the IMPGs that had been required by EPA based on EPA's HHRA and ERA, and various other inputs and procedures that EPA directed GE to use in the CMS. Based on these EPA-required inputs and procedures, the CMS Report concluded that the alternatives known as SED 3, FP 3, and TD 3 would best meet EPA's remedy selection criteria under the Permit.

The CMS Report noted, however, that GE disagreed with, and reserved its right to challenge, many of the assumptions, input values, interpretations, and conclusions in EPA's risk assessments and thus underlying the approved IMPGs, as well as several of the other inputs and procedures that EPA directed GE to use in the CMS. As a result, GE made clear that the CMS Report should not be regarded as GE's endorsement of the evaluations and conclusions set forth therein. In fact, GE reported that, other than monitoring the ongoing natural recovery of the River, it is neither necessary nor appropriate to conduct additional response actions in the Rest of River area, especially given the adverse impacts on the environment of those response actions. GE continues to adhere to that view.

Comments on CMS Report and Responses to Them

The public and the Commonwealth criticized the CMS Report's conclusions. For example, the Commonwealth's Secretary of Energy and Environmental Affairs, Ian Bowles, wrote to EPA on June 16, 2008, that "there are fundamental inadequacies in the draft study" and a

[5] On September 11, 2007, GE invoked dispute resolution on EPA's May 24, 2007 conditional approval letter for the MIA and its August 28, 2007 conditional approval letter for the MIA-S. Following discussions, EPA and GE exchanged letters on September 17, 2007, in which EPA eliminated one of the disputed conditions in its May 24, 2007 conditional approval letter and GE agreed that it would not proceed with the dispute resolution proceeding, while reserving its future rights regarding those or any of the other conditions in EPA's May 24 and August 28, 2007 letters.

"need for extensive discussion with GE and other stakeholders," which "must consider options that do not lie within the four corners of the Corrective Measures Study."

On September 9, 2008, EPA provided 166 comments on the CMS Report. In its letter transmitting the comments, EPA wrote that an "overriding concern with the CMS is that it failed to recognize the unique character of the Housatonic River below the confluence," that the CMS analysis of the East and West Branches "must provide a detailed discussion of how each alternative will provide species habitat protection through avoidance of negative impacts where possible or restoration where impacts are unavoidable, and if necessary, mitigation," and that "[u]ntil the CMS has been supplemented to satisfactorily address the concerns presented here, EPA believes it is premature to opine on which alternative or combination of alternatives best satisfy the permit criteria." EPA requested that GE provide substantial additional information and analyses regarding the alternatives evaluated in the CMS Report. It also indicated its willingness to consider the development and analysis of additional remedial alternatives.

Upon receiving EPA's September 9, 2008 letter, GE began extensive additional evaluations of the ecological impacts of the alternatives evaluated in the CMS Report. Based on those additional evaluations, GE began work on the development of a more ecologically sensitive alternative (ESA), also known as SED 10/FP 9.

GE subsequently discussed the development of that new alternative with EPA and the Commonwealth on December 19, 2008. On February 5, 2009, EPA sent GE a letter indicating that GE should, by March 9, 2009, respond to EPA's September 9 comments respecting the remedial alternatives evaluated in the CMS Report. The letter also indicated that the new alternative "should be further developed and analyzed and compared to the existing suite of alternatives on an equal footing under the CMS process." To facilitate that evaluation, EPA indicated that, after further discussions, GE should develop and submit to EPA for approval a work plan for evaluation of that new alternative, and that following EPA approval of that work plan, GE should complete the evaluations and should submit a revised CMS Report integrating that alternative and other necessary revisions to the CMS.

On March 6, 2009, GE submitted a Response to EPA's Interim Comments on CMS Report (Interim Response; ARCADIS, Anchor QEA, & AECOM, 2009), which responded to most of EPA's September 9, 2008 comments (except those that would be affected by the further definition of remedial alternatives or that required additional time to complete).

Subsequently, on March 30, 2009, the Commonwealth's Secretary of Energy and Environmental Affairs designated the Upper Housatonic River as an ACEC. The ACEC includes the River and its floodplain in the Primary Study Area (PSA), which extends from the Confluence to Woods Pond Dam. The Secretary also found that the wetland resource areas included in the ACEC are significant to a variety of specified public interests under the

Massachusetts Wetlands Protection Act. The significance of the designation of the Upper Housatonic River as an ACEC is that a number of specific additional environmental requirements under state regulations apply to actions that may affect its resources.

Work Plan for Evaluation of Additional Remedial Alternatives

In correspondence to GE dated April 1 and April 14, 2009, EPA advised GE to proceed with submission of a draft work plan for the evaluation of the new alternative that had previously been discussed. EPA further requested that that work plan should also propose to evaluate an additional sediment remediation alternative, which would use "wet excavation" techniques to remove PCBs from the sediment and riverbank soil in approximately the first seven miles of the Rest of River (Reaches 5A and 5B). EPA noted that these alternatives should be evaluated "on an equal footing" with the previously evaluated alternatives, and stated that the work plan should describe GE's approach to doing so.

On May 1, 2009, GE submitted a draft Work Plan for the Evaluation of Additional Remedial Alternatives. EPA provided comments on that draft work plan in a meeting on July 8, 2009 and in electronic correspondence to GE on the same day. In those comments, EPA provided further information regarding the new sediment remediation alternative that EPA requested be evaluated, including the assumption that, in Reaches 5A and 5B, that alternative would involve wet excavation by equipment operating within the river channel. EPA also identified and described an additional floodplain remedial alternative that EPA wanted GE to evaluate. In addition, EPA provided direction to GE on the comparative analysis of alternatives.

GE submitted the final Work Plan for Evaluation of Remedial Alternatives on August 31, 2009 (2009 Work Plan; ARCADIS and Anchor QEA, 2009). That work plan proposed to evaluate the alternative identified as the ESA (which consisted of sediment and floodplain components designated as SED 10 and FP 9) and the additional remedial alternatives identified by EPA (designated SED 9 and FP 8). It included a description of those alternatives and the methodology that GE proposed to use in evaluating them, as well as in a revised evaluation of the previous alternatives, under the Permit criteria; and it explained that those evaluations would be presented in a Revised CMS Report.

On January 15, 2010, EPA issued a conditional approval letter for the 2009 Work Plan, specifying a number of conditions and directives for GE's evaluation of the additional remedial alternatives, as well as for the overall revised evaluations to be presented in the Revised CMS Report.[6] On January 29, 2010, GE invoked dispute resolution under the Permit on two

[6] As EPA requested in that conditional approval letter, the combined sediment/floodplain alternative identified in GE's 2009 Work Plan as the ESA will be referred to herein, when referencing its individual sediment and floodplain components, as SED 10 and FP 9, and will be referred to jointly as SED 10/FP 9.

Table 2-1 – IMPGs for PCBs Based on Human Direct Contact (Soil/Sediment)

Revised CMS Report, Housatonic River – Rest of River
General Electric Company – Pittsfield, MA

Type of Area/Exposure Scenario	Receptor	RME or CTE	Assumed Frequency of Use	IMPGs (in mg/kg)			
				Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer
Residential (Actual/Potential Lawn areas)	All	RME	150 d/yr	**2*** (per Consent Decree)			
Residential (banks, steep slopes, wet areas)	All	Both	Variable	Use IMPGs for general recreation scenarios based on appropriate exposure frequencies for parcel-specific conditions			
High-use general recreation	Young child (high use)	RME	90 d/yr	**1.3***	13	134	**4.6***
		CTE	30 d/yr	18	184	1,842	32
	Young child (low use)	RME	15 d/yr	**8.0***	80	802	**27***
		CTE	15 d/yr	37	368	3,684	63
	Older child	RME	90 d/yr	**3.9***	39	388	**27***
		CTE	30 d/yr	51	514	5,143	176
	Adult	RME	90 d/yr	**1.4***	14	143	**38***
		CTE	30 d/yr	63	630	6,305	234

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				Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer
Medium-use general recreation	Young child	Not assessed		NA	NA	NA	NA
	Older child	RME	60 d/yr	**5.8***	58	582	**40***
		CTE	30 d/yr	51	514	5,143	176
	Adult	RME	60 d/yr	**2.1***	21	215	**58***
		CTE	30 d/yr	63	630	6,305	234
Low-use general recreation	Young child	Not assessed		NA	NA	NA	NA
	Older child	RME	30 d/yr	**12***	116	1,165	**80***
		CTE	15 d/yr	103	1,029	10,286	353
	Adult	RME	30 d/yr	**4.3***	43	429	**115***
		CTE	15 d/yr	126	1,261	12,610	468

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				Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer
Bank fishing	Older child	RME	30 d/yr	**6.2***	62	619	**42***
		CTE	10 d/yr	52	524	5,237	180
	Adult	RME	30 d/yr	**2.6***	26	256	**56***
		CTE	10 d/yr	70	702	7,015	220
Dirt biking/ATVing	Older child	RME	90 d/yr	**2.0***	20	205	**14***
		CTE	30 d/yr	29	290	2,901	99
Marathon canoeist	Adult	RME	150 d/yr	**0.78***	7.8	78	**13***
		CTE	90 d/yr	5.8	58	575	25
Recreational canoeist	Older child	RME	30 d/yr	**6.2***	62	619	**42***
		CTE	15 d/yr	35	349	3,491	120
	Adult	RME	60 d/yr	**1.2***	12	121	**28***
		CTE	30 d/yr	13	129	1,286	73

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				Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer
Waterfowl hunting	Older child	RME	14 d/yr	**41***	408	4080	**140***
		CTE	7 d/yr	233	2325	23,253	399
	Adult	RME	14 d/yr	**9.0***	90	904	**196***
		CTE	7 d/yr	75	752	7,518	537
Agricultural use (based on direct contact by farmer)	Adult	RME	40 d/yr	**1.2***	12	118	**43***
		CTE	10 d/yr	42	419	4,195	348
High-use commercial (groundskeeper scenario)	Adult	RME	150 d/yr	**1.8***	18	177	**25***
		CTE	150 d/yr	17	166	1,664	57
Low-use commercial (groundskeeper scenario)	Adult	RME	30 d/yr	**8.9***	89	885	**126***
		CTE	15 d/yr	166	1,664	16,642	571

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				Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer
Utility worker	Adult	RME	5 d/yr	**17***	169	1,694	**242***
		CTE	5 d/yr	209	2,093	20,933	718
Sediments	Older child	RME	36 d/yr	**4.5***	45	453	**31***
		CTE	12 d/yr	36	365	3,645	125
	Adult	RME	36 d/yr	**1.3***	13	135	**40***
		CTE	12 d/yr	28	280	2,800	152

Notes:
1. CTE = central tendency exposure
2. d/yr = days per year
3. EPA = United States Environmental Protection Agency
4. IMPGs = interim media protection goals
5. mg/kg = milligram per kilogram
6. PCBs = polychlorinated biphenyls
7. RME = reasonable maximum exposure
8. * = Points of departure, as specified by EPA.

Table 2-2 – IMPGs for PCBs in Fish and Waterfowl Tissue Based on Human Consumption

Revised CMS Report, Housatonic River – Rest of River
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Tissue Type and Constituent	Assessment Type	RME or CTE	IMPGs (in mg/kg)				
			Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer – Child	Non-Cancer – Adult
Bass fillets – PCBs	Deterministic	RME	**0.0019***	0.019	0.19	**0.026***	**0.062***
		CTE	0.049	0.49	4.9	0.19	0.43
	Probabilistic	RME (5^{th} percentile)	**0.0064***	0.064	0.64	**0.059***	**0.12***
		CTE (50^{th} percentile)	0.057	0.57	5.7	0.71	1.5
Trout fillets – PCBs	Deterministic	RME	**0.0048***	0.048	0.48	**0.069***	**0.16***
		CTE	0.11	1.1	11	0.40	0.93
	Probabilistic	RME (5^{th} percentile)	**0.014***	0.14	1.4	**0.13***	**0.27***
		CTE (50^{th} percentile)	0.12	1.2	12	1.5	3.1

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Tissue Type and Constituent	Assessment Type	RME or CTE	IMPGs (in mg/kg)				
			Cancer Risk @ 10^{-6}	Cancer Risk @ 10^{-5}	Cancer Risk @ 10^{-4}	Non-Cancer – Child	Non-Cancer – Adult
Duck breast – PCBs	Deterministic	RME	**0.0084***	0.084	0.84	**0.12***	**0.28***
		CTE	0.066	0.66	6.6	0.25	0.58
	Probabilistic	RME (5^{th} percentile)	**0.0075***	0.075	0.75	**0.080***	**0.17***
		CTE (50^{th} percentile)	0.072	0.72	7.2	0.67	1.4

Notes:
1. CTE = central tendency exposure
2. EPA = United States Environmental Protection Agency
3. IMPGs = interim media protection goals
4. mg/kg = milligram per kilogram
5. PCBs = polychlorinated biphenyls
6. RME = reasonable maximum exposure
7. * = Points of departure, as specified by EPA.

9. In the dispute resolution proceeding on certain of those directives, EPA issued a decision upholding the EPA staff's recommendations without any modifications. While GE disagrees with that decision, it has used the inputs specified by EPA in the modeling of SED 9.[49]

The sections below provide a summary of the application of the model and the various model inputs used during the evaluations, as described in the CMS Proposal, the MIA, the MIA-S, the 2009 Work Plan, and EPA's conditional approval letters for those documents. In its conditional approval letters for the CMS Proposal, the MIA, and the MIA-S, EPA set forth several conditions directing GE to use alternate lower-bound values for certain inputs, resulting in two sets of input values that were used in the model simulations (i.e., a "base case" and a "lower bound"); these lower-bound inputs are also discussed in the sections below.

3.2.1 Scale of Model Application

Temporal Scale

As described in the CMS Proposal, EPA's model calibration and validation efforts were conducted over decadal timescales. Specifically, EPA's model validation simulated the 26-year period between 1979 and 2004. Remedial scenario projections presented in this Revised CMS Report simulated a 52-year period that consists of two cycles of the 26-year validation period. The length of the numerical model simulations has been extended for certain sediment alternatives (SED 7 and SED 8) so as to provide a minimum of 30 years following completion of the simulated remedy; Section 3.2.4 below provides a discussion of the model projection period used for the different sediment alternatives, which was based on the estimated timeframe for each remedy presented in Section 3.1.6.

In addition, as directed by EPA, mathematical functions were developed to project the model trajectory beyond the end of the numerical model simulations; the purpose of this extrapolation was to estimate the time it might take to achieve various IMPGs that are not

[49] In addition to the above submittals, as discussed further in Section 3.2.4, on May 14, 2007, GE submitted certain proposed revisions to the model code to be used in the model simulations in the CMS. EPA conditionally approved those revisions on July 11, 2007, directing GE to modify the code to address certain comments. GE addressed those comments and provided EPA with a revised code on September 21, 2007. In November 2007, EPA called to GE's attention certain flaws in the model and subsequently issued two corrected subroutines for the model on November 30, 2007. Also, in the 2009 Work Plan, GE noted that it was necessary to make additional modifications to the model code in order to simulate SED 9 (specifically, to simulate sediment removal to a depth greater than the thickness of the replacement cap in Woods Pond) and SED 10 (specifically, to simulate the removal of sediment to a specified depth in Woods Pond without replacement). These code modifications were described in an attachment to that work plan and approved by EPA through its January 15, 2010 conditional approval letter.

predicted to be achieved within the model simulation period.[50] This extrapolation consisted of using least squares regression to fit an exponential decay function to the model-predicted PCB concentrations in sediment and fish (expressed on an annual average basis) over the last 20 years of the simulations.[51] In cases where the calculated slope was greater than zero (i.e., indicative of an increase), such extrapolation was not performed. Furthermore, analysis of preliminary extrapolation results indicated that there were several cases where the regressions produced very small slopes that were sensitive to annual variations in predicted PCB levels over Years 32 to 52. These preliminary results were also confounded by the fact that the IMPGs that were the subject of the extrapolation were often two to three orders of magnitude lower than the levels predicted by the model at the end of the projection period. It was found that nearly all these cases produced estimated times to achieve IMPGs that exceeded 250 years, which corresponds to extrapolation over a period ten-fold longer than the regression period. It was therefore considered that further extrapolations based on such small slopes to estimate 100-fold or greater additional reductions (which could range into timescales of a millennium or more) were so unreliable as to be meaningless. As such, the times to achieve IMPGs in these cases are presented as ">250 years" in Section 6.

This approach of projecting the model trajectory beyond the model simulation period is highly uncertain because simple empirical functions are not a reliable replacement for the model's equations, which represent the complex underlying mechanisms that determine the fate, transport, and bioaccumulation of PCBs. As a result, predictions of the ability of an alternative to meet IMPGs in the period beyond the model simulation period are highly speculative.

Model Domain

The spatial domain for the EPA model extends from the Confluence to Rising Pond Dam and is simulated by two separate models. The "PSA Model" extends from the Confluence to Woods Pond Dam and includes the main river channel, backwaters, and associated 10-year floodplain over this reach. The "Downstream Model" extends from Woods Pond Dam to

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[50] For example, where the model predicts that the RME IMPGs based on unrestricted human consumption of fish would not be achieved the model simulation period, this extrapolation has been used to estimate the number of years that it would take to achieve such levels (using, for this purpose, the RME IMPGs based on a 10^{-5} cancer risk as well as non-cancer impacts). As discussed further below, such estimates are highly speculative, but have been used due to EPA's direction.

[51] The last 20 years was selected as representative of the alternatives' post-remediation trajectory since the model simulations were all run to span a minimum of 30 years following the completion of the remedies, and fish concentrations require an additional 10 years after remediation to respond to changes in exposure concentrations associated with the remediation (i.e., the oldest fish represented in EPA's model is age 10 largemouth bass). For SED 1 and SED 2, where no remedial action was simulated, the regression period was extended to cover 42 years, which provides a longer period over which to estimate the temporal trajectory, yet allows for a 10-year response period for fish.

Rising Pond Dam and includes the main river channel and associated 10-year floodplain.[52] These two models are linked at the Woods Pond Dam boundary and together have been used to predict water, sediment, and fish PCB concentrations in Reaches 5 through 8.

Since the model developed by EPA does not extend below Rising Pond Dam, it cannot be used to predict the response of the River downstream of that point. For this reason, GE developed a semi-quantitative framework that incorporates the available data from the Connecticut section of the River, as well as predictions from the EPA model, to provide estimates of future changes in PCB concentrations in the four major impoundments in the Connecticut portion of the River. That framework, labeled the "CT 1-D Analysis," is summarized in Section 3.2.5 and described in detail in Appendix J.

3.2.2 Model Boundary Conditions

Application of the model to forecast natural recovery and the River's response to various sediment remediation scenarios required specification of future hydrologic conditions, as well as future solids and PCB loadings to the system, for each model boundary (i.e., boundary conditions). The model boundaries include the East Branch, West Branch, tributaries, and direct drainage inputs.

3.2.2.1 Flow

As described in the CMS Proposal, the 26-year hydrograph for the model validation period (i.e., 1979-2004) provides a good statistical representation of the historical flow record on the River. Therefore, specification of future hydrologic conditions for the model was achieved by repeating the 26-year validation period hydrograph twice, producing a 52-year hydrograph, which was used for the model simulations. As discussed in Section 3.2.1, some simulations were extended beyond 52 years to provide a minimum projection period that included 30 years beyond the simulated completion of the remedy. In these cases, the 26-year hydrograph was repeated additional times until the necessary post-remediation period was achieved.

To represent the potential impact of an extreme hydrologic event on future sediment, water column, and fish PCB levels, the hydrograph from an extreme event was included in the 52-year hydrograph used for the model projections. The methodology used by EPA to develop the hydrograph for this extreme event was described in the MIA. Specifically, a 20-day period

[52] In response to EPA's Specific Comment 44 on the CMS Report, the spatial domain of the Downstream Model has been modified to treat an additional portion of Reach 7B (Columbia Mill Dam impoundment) and all of Reach 7C (former Lee/Eagle Mill Dam impoundment) as impoundments for purposes of defining the areal extent of remediation; these areas were not treated as such in the remediation simulations in the CMS Report.