12 GROUNDWATER DQOs

CHAPTER CONTENTS

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Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
106-04	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-100	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-101	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-102	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-103	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-104	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-105	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-119	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-120	Chemical/Animal Holes Sr-90		Bypass Detection																						X		2d
106-121	Chemical/Animal Holes Sr-90		Bypass Detection																						X		2d
106-122	Chemical/Animal Holes Sr-90		Bypass Detection																						X		2d
106-125	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-13	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-14	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-15	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-16	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-22	Chemical/Animal Holes Sr-90		Sentinel																						X		2d
106-23	Chemical/Animal Holes Sr-90		Sentinel																						X		2d
106-46	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-47	Chemical/Animal Holes Sr-90		Plume Perimeter																						X	X	2d
106-48	Chemical/Animal Holes Sr-90		Plume Perimeter																						X		2d
106-49	Chemical/Animal Holes Sr-90		Plume Core																						X	X	2d
106-50	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-62	Chemical/Animal Holes Sr-90	OU III Middle Road	Sentinel	X																					X		2d
106-63	Chemical/Animal Holes Sr-90		Sentinel																						X		2d
106-94	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-95	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-96	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-97	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-98	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-99	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
106-135	Chemical/Animal Holes Sr-90	CH-MW01-2012	Plume Core																						X		2d
CAH-MW01-2015	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
CAH-MW02-2015	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
CAH-MW03-2015	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
CAH-MW04-2015	Chemical/Animal Holes Sr-90		Plume Core																						X		2d
087-09	CLF		Background	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf								2f
087-11	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf								2f
087-23	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf				X[a]	X[a]	X[a]		2f
087-24	CLF		Downgradient	X[a]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf								2f
087-26	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf								2f
087-27	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf				X[a]	X[a]	X[a]		2f
088-109	CLF		Downgradient	X					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf				X[a]	X[a]	X[a]	X	4
088-110	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf								2f
088-21	CLF		Downgradient	X[f]					Xf	Xf	Xf	Xf	Xf	Xf	Xf	Xf			Xf				X[a]	X[a]	X[a]		2f
088-22	CLF		Downgradient	X[a]					X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]								1a
088-23	CLF		Downgradient	X[a]					X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]								1a
086-42	FLF		Background	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X	X[a]		1g
086-72	FLF		Background	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]		1g
087-22	FLF		Background	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]		1g
097-17	FLF		Downgradient	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]		1g

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
097-277	FLF		Downgradient	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]		1g
097-64	FLF		Downgradient	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]		1g
106-02	FLF		Downgradient	Xg			Xg	Xg	Xg	Xg	Xg	Xg	Xg	Xg	Xg	X[a]			Xg		Xg		Xg	Xg	Xg		1a
106-20	FLF		Downgradient																						Xf		1g
106-21	FLF		Downgradient																						Xf		1g
106-30	FLF		Downgradient	X[a]			X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]			X[a]		X[a]		X[a]	X[a]	X[a]	X	1g
106-43	FLF		Downgradient																						Xf		1g
106-44	FLF		Downgradient																						Xf		1g
106-45	FLF		Downgradient																						Xf		1g
106-64	FLF		Downgradient																						Xf		1g
087-21	OU I (South Boundary)		Background	Xb																			Xb	Xb	Xb		1b
088-13	OU I (South Boundary)		Background	Xb																			Xb	Xb	Xb		1b
088-14	OU I (South Boundary)		Background	Xb																			Xb	Xb	Xb		1b
088-20	OU I (South Boundary)		Background	Xb																			Xb	Xb	Xb		1b
088-26	OU I (South Boundary)		Plume Perimeter	X																			Xb	Xd	Xd		2d
098-21	OU I (South Boundary)		Plume Perimeter	Xd																			Xb	Xd	Xd		2d
098-30	OU I (South Boundary)		Plume Perimeter	Xd																			Xb	Xd	X		4
098-33	OU I (South Boundary)		Plume Perimeter	Xb																							1b
098-58	OU I (South Boundary)		Plume Perimeter	Xb																							1b
098-59	OU I (South Boundary)		Plume Core	Xd																						X	2d
098-61	OU I (South Boundary)		Plume Perimeter	Xb																							1b
099-04	OU I (South Boundary)		Plume Perimeter	Xd																			Xb	Xd	Xd		2d
107-10	OU I (South Boundary)		Plume Perimeter	Xb																					Xb		1b
107-23	OU I (South Boundary)		Plume Perimeter	Xb																				Xb			1b
107-24	OU I (South Boundary)		Plume Perimeter	Xd																			Xb	Xd	Xd		2d
107-25	OU I (South Boundary)		Plume Perimeter	Xb																							1b
107-26	OU I (South Boundary)		Plume Core	Xd																					Xd		2d
107-40	OU I (South Boundary)		Plume Core	X																			Xb	Xd	Xd		4
107-41	OU I (South Boundary)		Plume Core	X																							2
108-08	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
108-12	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
108-13	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
108-14	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
108-17	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
115-03	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
115-13	OU I (South Boundary)		Plume Core	Xd																			Xb	Xd	Xd		2d
115-14	OU I (South Boundary)		Plume Core	Xd																			Xb	Xd	Xd		2d
115-15	OU I (South Boundary)		Plume Core	Xd																			Xb	Xd	Xd		2d
115-16	OU I (South Boundary)		Plume Core	X																			Xb	Xd	Xd		4
115-28	OU I (South Boundary)		Plume Core	Xd																			Xb	Xd	Xd		2d
115-29	OU I (South Boundary)		Plume Core	Xd																			Xb	Xd	Xd		2d
115-30	OU I (South Boundary)		Plume Perimeter	Xb																			Xb	Xb	Xb		1b
115-31	OU I (South Boundary)		Plume Core	Xd																			Xb	X	X		2d
115-36	OU I (South Boundary)		Plume Core	Xd																				Xd			2d
115-41	OU I (South Boundary)		Bypass Detection	X																			Xb	X	X		2d
115-42	OU I (South Boundary)		Bypass Detection	X																			Xb	X	X		2d
115-50	OU I (South Boundary)	OU III Magothy		X																							1b
116-05	OU I (South Boundary)		Plume Perimeter	X																			Xb	Xd	Xd		2d
116-06	OU I (South Boundary)		Plume Perimeter	X																			Xb	Xd	Xd		2d
107-34	OU I (South Boundary)		TBD																						X		2d
107-35	OU I (South Boundary)		TBD																						X		4

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Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
108-43	OU I (South Boundary)		TBD																						X		2d
108-44	OU I (South Boundary)		TBD																						X		2d
108-18	OU I (South Boundary)		Plume Perimeter	Xb																					Xb		1b
115-51	OU I (South Boundary)	OUI-MW01-2010	Plume Perimeter	X																					Xd		4
107-42	OU I (South Boundary)	OUI-MW02-2010	Plume Perimeter																						Xd		2d
108-45	OU I (South Boundary)	OUI-MW03-2010	Plume Perimeter																						Xd		2d
108-55	OU I (South Boundary)	OUI-MW01-2011	Plume Perimeter																						Xd		2d
108-56	OU I (South Boundary)	OUI-MW02-2011	Plume Perimeter																						Xd		2d
000-428	OU III (Airport)	OU III (Magothy)	Plume Perimeter	Sample with Magothy																							4
800-100	OU III (Airport)		Plume Core	X																							4
800-101	OU III (Airport)	OU III (Magothy)	Plume Core	X																							4
800-102	OU III (Airport)	OU III (Magothy)	Plume Core	X																							4
800-103	OU III (Airport)		Plume Core	X																							4
800-104	OU III (Airport)		Plume Perimeter	X																							4
800-105	OU III (Airport)	OU III (Magothy)	Plume Perimeter	X																							4
800-106	OU III (Airport)		Plume Core	X																							4
800-108	OU III (Airport)		Bypass Detection	X																							4
800-126	OU III (Airport)		Bypass Detection	X																							4
800-127	OU III (Airport)		Bypass Detection	X																							4
800-128	OU III (Airport)		Bypass Detection	X																							4
800-129	OU III (Airport)		Plume Perimeter	X																							4
800-130	OU III (Airport)		Plume Perimeter	X																							4
800-131	OU III (Airport)		Bypass Detection	X																							4
800-133	OU III (Airport)		Bypass Detection	X																							4
800-43	OU III (Airport)		Plume Core	X																							4
800-44	OU III (Airport)		Plume Core	X																							4
800-50	OU III (Airport)		Plume Perimeter	X																							4
800-59	OU III (Airport)		Plume Core	X																				Xa			4
800-60	OU III (Airport)		Sentinel	X																				Xa			4
800-63	OU III (Airport)	OU III North Street	Plume Core	Sample with OU III North Street																							
800-90	OU III (Airport)	OU III (Magothy)	Plume Core	Sample with Magothy																							
800-92	OU III (Airport)		Plume Core	X																							4
800-94	OU III (Airport)		Plume Core	X																							4
800-95	OU III (Airport)		Plume Core	X																						X	4
800-96	OU III (Airport)		Plume Perimeter	X																							4
800-97	OU III (Airport)		Plume Core	X																							4
800-98	OU III (Airport)		Plume Core	X																							4
800-99	OU III (Airport)	OU III (Magothy)	Plume Core	X																						X	4
800-138	OU III (Airport)	AP-MW01-2013	Plume Core	X																						X	4
065-37	OU III (AOC 29/HFBR Tritium)	BGRR/WCF Sr-90	Outer Plume Perimeter																			Xa		Xa	Xf		2f
065-41	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			1a
075-11	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X		X	2f
075-224	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			4
075-225	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			4
075-226	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			2f
075-227	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			2f
075-228	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			4
075-229	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			4
075-230	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-231	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-232	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			2f

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Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
075-233	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-234	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-235	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			2f
075-236	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			2f
075-237	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-238	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			2f
075-239	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-240	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-241	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-242	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-244	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-245	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			4
075-285	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			2f
075-286	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			1a
075-287	OU III (AOC 29/HFBR Tritium)		Plume Core																					X			1a
075-288	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			1a
075-40	OU III (AOC 29/HFBR Tritium)	BGRR/WCF Sr-90	Plume Perimeter	X																				X	X		1a
075-42	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			12
075-43	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X		X	12
075-44	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			12
075-45	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			12
075-558	OU III (AOC 29/HFBR Tritium)		Plume Perimeter																					X			2f
085-02	OU III (AOC 29/HFBR Tritium)		Plume Perimeter	Xa																							1a
095-93	OU III (AOC 29/HFBR Tritium)		Plume Perimeter	Xf																							2f
065-03	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
065-04	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
065-06	OU III (BGRR/WCF Sr-90)		Background	X																					X		1a
065-160	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-161	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-162	OU III (BGRR/WCF Sr-90)		Outer Plume Perimeter																						X		1a
065-163	OU III (BGRR/WCF Sr-90)		Background																						X		1a
065-164	OU III (BGRR/WCF Sr-90)		Plume Core																						X	X	1a
065-165	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-166	OU III (BGRR/WCF Sr-90)		Background																						X		1a
065-167	OU III (BGRR/WCF Sr-90)		Background																						X		1a
065-169	OU III (BGRR/WCF Sr-90)		Plume Perimeter																		X				X		1a
065-170	OU III (BGRR/WCF Sr-90)		Plume Perimeter																		X				X		1a
065-171	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-172	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
065-173	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-174	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
065-175	OU III (BGRR/WCF Sr-90)		Plume Core																						X	X	2f
065-176	OU III (BGRR/WCF Sr-90)		Background																						X		1a
065-178	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-18	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
065-19	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
065-20	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
065-360	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-361	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
065-362	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
065-363	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
065-364	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
065-365	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-405	OU III (BGRR/WCF Sr-90)	065-366 replacement	Plume Perimeter																						X		1a
065-367	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
065-37	OU III (BGRR/WCF Sr-90)	OU III (AOC 29/HFBR Tritium)	Plume Perimeter	Sampled under OU III (AOC 29/HFBR Tritium) Program.																		X					
065-38	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		2f
065-384	OU III (BGRR/WCF Sr-90)		Sentinel																					X			2f
065-385	OU III (BGRR/WCF Sr-90)		Sentinel																					X			2f
065-39	OU III (BGRR/WCF Sr-90)		Plume Core																						X		2f
065-40	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		2f
075-09	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
075-10	OU III (BGRR/WCF Sr-90)		Plume Perimeter	X																					X		1a
075-188	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-189	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-190	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-191	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-192	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-193	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-194	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-195	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-196	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-197	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-198	OU III (BGRR/WCF Sr-90)		Plume Core																						X	X	1a
075-199	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-200	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-201	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-202	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-203	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-210	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						Xf		2f
075-39	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-40	OU III (BGRR/WCF Sr-90)	OU III (AOC 29/HFBR Tritium)	Plume Perimeter	Sampled under OU III (AOC 29/HFBR Tritium) Program.																							
075-41	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-46	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-47	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-48	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-663	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-664	OU III (BGRR/WCF Sr-90)		Plume Core																						X		12
075-665	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-666	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-667	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-668	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-669	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-670	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-671	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-672	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-673	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-674	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-675	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-680	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-681	OU III (BGRR/WCF Sr-90)		Sentinel																						X		1a
075-682	OU III (BGRR/WCF Sr-90)		Plume Core																						X		2f

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Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
075-683	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-684	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-85	OU III (BGRR/WCF Sr-90)		Plume Core																						X		1a
075-86	OU III (BGRR/WCF Sr-90)		Plume Perimeter																						X		1a
075-87	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
075-705	OU III (BGRR/WCF Sr-90)	BGRR-2010-B	Plume Core																						X		2f
075-706	OU III (BGRR/WCF Sr-90)	BGRR-2010-C	Plume Perimeter																						X		2f
075-707	OU III (BGRR/WCF Sr-90)	BGRR-2010-D	Plume Core																						X		2f
065-401	OU III (BGRR/WCF Sr-90)	BGRR-MW-01-2011	Plume Perimeter																						X		2f
075-699	OU III (BGRR/WCF Sr-90)	BGRR-MW-02-2011	Plume Core																						X		2f
075-700	OU III (BGRR/WCF Sr-90)	BGRR-MW-03-2011	Plume Perimeter																						X		2f
065-402	OU III (BGRR/WCF Sr-90)	BGRR-MW-04-2011	Background																						X		2f
075-701	OU III (BGRR/WCF Sr-90)	BGRR-MW-05-2011	Plume Core																						X		12
065-404	OU III (BGRR/WCF Sr-90)	BGRR-MWA-2011	Plume Core																						X		2f
085-398	OU III (BGRR/WCF Sr-90)	BGRR-MW01-2012	Sentinel																						X		2f
085-399	OU III (BGRR/WCF Sr-90)	BGRR-MW02-2012	Sentinel																						X		2f
085-402	OU III (BGRR/WCF Sr-90)	BGRR-MW03-2012, 085-400	Sentinel																						X		2f
065-325	OU III (BGRR/WCF Sr-90)		Plume Core																						X		2f
BGRR-MW01-2015	OU III (BGRR/WCF Sr-90)		Sentinel																						X		2f
085-335	OU III (Bldg 96)		Plume Core	X																							4
085-347	OU III (Bldg 96)		Plume Core	X																							2f
085-348	OU III (Bldg 96)		Plume Core	X																							4
085-349	OU III (Bldg 96)		Plume Core	X																							4
085-350	OU III (Bldg 96)		Plume Core	X																							4
085-351	OU III (Bldg 96)		Plume Core	X																							4
085-352	OU III (Bldg 96)		Plume Core	X																							4
085-354	OU III (Bldg 96)		Plume Core	X																							4
095-159	OU III (Bldg 96)		Plume Core	X																							4
095-161	OU III (Bldg 96)		Plume Perimeter	X																							4
095-162	OU III (Bldg 96)		Plume Core	X																							4
095-163	OU III (Bldg 96)		Bypass Detection	X																							4
095-164	OU III (Bldg 96)		Bypass Detection	X																							4
095-165	OU III (Bldg 96)		Bypass Detection	X																						X	4
095-166	OU III (Bldg 96)		Bypass Detection	X																							4
095-167	OU III (Bldg 96)		Bypass Detection	X																							4
095-168	OU III (Bldg 96)		Bypass Detection	X																							4
095-169	OU III (Bldg 96)		Bypass Detection	X																							4
095-170	OU III (Bldg 96)		Bypass Detection	X																							4
095-171	OU III (Bldg 96)		Plume Perimeter	X																							1a
095-172	OU III (Bldg 96)		Plume Core	X																							4
095-294	OU III (Bldg 96)		Plume Core	X																							2f
095-295	OU III (Bldg 96)		Plume Perimeter	X																							2f
095-305	OU III (Bldg 96)		Plume Core	X																							4
095-306	OU III (Bldg 96)		Plume Core	X																							4
095-307	OU III (Bldg 96)		Plume Core	X																							2f
095-308	OU III (Bldg 96)		Plume Core	X																							2f
095-312	OU III (Bldg 96)		Plume Core	X																							4
095-313	OU III (Bldg 96)	Building 452 Freon	Plume Core	Sampled with Building 452																							
095-84	OU III (Bldg 96)		Plume Core	X																							4
095-85	OU III (Bldg 96)		Plume Perimeter	X																							4
095-318	OU III (Bldg 96)	B96-MW01-2010	Sentinel	X																							4

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Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
085-378	OU III (Bldg 96)	B96-MW02-2010	Background	X																							4
085-379	OU III (Bldg 96)	B96-MW04-2010	Plume Core	X																							4
085-293	OU III (Bldg 96) (formerly well ID 095-160)		Plume Core	X																							4
085-236	OU III Carbon Tetrachloride			Sampled under Facility Monitoring Service Station Project																							
085-237	OU III Carbon Tetrachloride			Sampled under Facility Monitoring Service Station Project																							
085-17	OU III Carbon Tetrachloride			Sampled under Facility Monitoring Service Station Project																							
104-11	OU III Carbon Tetrachloride			Sampled under OU III Middle Road																							
104-36	OU III Carbon Tetrachloride			Sampled under OU III Middle Road																							
105-23	OU III Carbon Tetrachloride			Sampled under OU III Middle Road																							
105-42	OU III Carbon Tetrachloride			Sampled under OU III Middle Road																							
065-02	OU III (central)			Xa																							1a
076-28	OU III (central)	OU IV (AOC 6 Sr-90)		Xa																					Xd		2da
076-317	OU III (central)	OU IV (AOC 6 Sr-90)		Xa																					Xa		1a
076-373	OU III (central)	OU IV (AOC 6 Sr-90)		Xa																					Xa		1a
083-01	OU III (central)			Xa																							1a
083-02	OU III (central)			Xa																							1a
084-04	OU III (central)			Xa																							1a
109-03	OU III (central)			X																			X	X	X	X	4
109-04	OU III (central)			X																			X	X	X		4
000-211	OU III (Industrial Park East)	North Street, OU III Magothy	Plume Perimeter	Sampled Under North Street																							1a
000-490	OU III (Industrial Park East)	OU III Magothy	Plume Perimeter	X																							1a
000-492	OU III (Industrial Park East)	OU III Magothy	Plume Perimeter	X																							1a
000-494	OU III (Industrial Park East)	OU III Magothy	Bypass Detection	X																							2f
000-495	OU III (Industrial Park East)	OU III Magothy	Plume Perimeter	X																							1a
122-24	OU III (Industrial Park East)	OU III Magothy	Plume Core	X																							2f
122-25	OU III (Industrial Park East)	OU III Magothy	Plume Core	X																							2f
000-526	OU III (Industrial Park East)	OU III Magothy (Temp ID MW-Mag)	Plume Perimeter	X																							1a
000-426	OU III (Industrial Park East)	OU III Magothy	Plume Perimeter	Sampled under OU III Magothy																							1a
000-427	OU III (Industrial Park East)	OU III Magothy	Plume Perimeter	Sampled under OU III Magothy																							1a
000-429	OU III (Industrial Park East)	OU III Magothy	Plume Core	Sampled under OU III Magothy																							1a
000-112	OU III (Industrial Park)		Plume Core	X																							4
000-114	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-245	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-246	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-247	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-248	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-249	OU III (Industrial Park)	OU III Magothy	Plume Core	X																							4
000-250	OU III (Industrial Park)	OU III Magothy	Plume Perimeter	X																							1a
000-251	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-252	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-253	OU III (Industrial Park)		Plume Core	X																						X	4
000-254	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-255	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-256	OU III (Industrial Park)		Plume Core	X																						X	4
000-257	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-258	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-259	OU III (Industrial Park)		Plume Core	X																							4
000-260	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-261	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-262	OU III (Industrial Park)		Plume Core	X																							4
000-263	OU III (Industrial Park)		Plume Perimeter	X																							1a

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Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
000-264	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-265	OU III (Industrial Park)		Plume Core	X																							4
000-266	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-267	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-268	OU III (Industrial Park)		Plume Core	X																							4
000-269	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-270	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-271	OU III (Industrial Park)		Plume Core	X																							4
000-272	OU III (Industrial Park)		Plume Perimeter	X																							1a
000-273	OU III (Industrial Park)		Bypass Detection	X																							2f
000-274	OU III (Industrial Park)		Bypass Detection	X																							2f
000-275	OU III (Industrial Park)		Bypass Detection	X																							2f
000-276	OU III (Industrial Park)		Bypass Detection	X																							2f
000-277	OU III (Industrial Park)		Bypass Detection	X																							2f
000-278	OU III (Industrial Park)		Bypass Detection	X																							2f
000-279	OU III (Industrial Park)		Plume Core	X																							4
000-280	OU III (Industrial Park)	OU III South Boundary	Plume Perimeter	X																			Xc	Xc	Xc		1ac
000-431	OU III (Industrial Park)		Bypass Detection	X																							2f
000-432	OU III (Industrial Park)		Bypass Detection	X																							2f
000-530	OU III (Industrial Park)	IP-MW01-2012	Plume Core	X																							4
000-531	OU III (Industrial Park)	IP-MW02-2012	Plume Core	X																							4
000-529	OU III (Industrial Park)	IP-MW01-2013	Plume Core	X																							4
000-528	OU III (Industrial Park)	IP-MW02-2013	Plume Core	X																							4
000-537	OU III (Industrial Park)	Magothy	Plume Core	X																							4
000-538	OU III (Industrial Park)		Plume Core	X																							4
127-08	OU III (Industrial Park)	Magothy	Plume Core	X																							4
127-09	OU III (Industrial Park)	Magothy	Plume Core	X																							4
000-541	OU III (Industrial Park)	Magothy	Plume Core	X																							4
000-542	OU III (Industrial Park)	Magothy	Plume Perimeter	X																							4
000-543	OU III (Industrial Park)	Magothy	Plume Perimeter	X																							4
000-544	OU III (Industrial Park)	Magothy	Bypass Detection	X																							4
IP-MW01-2015	OU III (Industrial Park)	Magothy	Bypass Detection	X																							4
000-101	OU III (LIPA)		Plume Perimeter	X																							2f
000-102	OU III (LIPA)	Magothy	Plume Perimeter	X																							2f
000-104	OU III (LIPA)		Plume Core	X																						X	2f
000-105	OU III (LIPA)	Magothy	Plume Perimeter	X																							2f
000-130	OU III (LIPA)	Magothy	Plume Core	X	See Note																						2f
000-131	OU III (LIPA)		Bypass Detection	X																							4
000-425	OU III (LIPA)	Magothy	Plume Core	X																							2f
000-445	OU III (LIPA)		Plume Perimeter	X																							2f
000-446	OU III (LIPA)		Plume Perimeter	X																							2f
000-447	OU III (LIPA)		Plume Core	X																							2f
000-448	OU III (LIPA)		Plume Core	X																							2f
000-449	OU III (LIPA)		Plume Core	X																							2f
000-450	OU III (LIPA)		Plume Perimeter	X																							4
000-451	OU III (LIPA)		Bypass Detection	X																							4
000-452	OU III (LIPA)		Bypass Detection	X																							4
000-458	OU III (LIPA)	OU III (Magothy)		Sample with Magothy																							4
000-459	OU III (LIPA)	OU III (Magothy)		Sample with Magothy																							4
000-460	OU III (LIPA)	OU III (Magothy)	Plume Perimeter	Sample with Magothy																							
000-102	OU III (Magothy)	OU III (LIPA)		Sampled under OU III (LIPA)																							

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000-105	OU III (Magothy)	OU III (LIPA)		Sampled under OU III (LIPA)																							
000-130	OU III (Magothy)	OU III LIPA	Magothy	X																							2f
000-211	OU III (Magothy)	OU III (Industrial Park East), OU III North Street		Sampled under OU III North Street																							
000-215	OU III (Magothy)	OU III North Street East		Sampled under OU III North Street East																							
000-249	OU III (Magothy)	OU III (Industrial Park)	Magothy	Sampled under OU III Industrial Park																							
000-250	OU III (Magothy)	OU III (Industrial Park)	Magothy	Sampled under OU III Industrial Park																							
000-343	OU III (Magothy)	OU III North Street		X																							2f
000-425	OU III (Magothy)	OU III LIPA		X																							2f
000-426	OU III (Magothy)	OU III (Industrial Park East)		X																							1a
000-427	OU III (Magothy)	OU III (Industrial Park East)		X																							1a
000-428	OU III (Magothy)	OU III (Airport)		X																							4
000-429	OU III (Magothy)	OU III (Industrial Park East)		X																							1a
000-458	OU III (Magothy)	OU III LIPA		X																							4
000-459	OU III (Magothy)	OU III LIPA		X																							4
000-460	OU III (Magothy)	OU III LIPA		X																							4
000-490	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
000-491	OU III (Magothy)			X																							1a
000-492	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
000-493	OU III (Magothy)			X																							1a
000-494	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
000-495	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
000-526	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
109-12	OU III (Magothy)	Suffolk County Health Services		X																							4
109-13	OU III (Magothy)	Suffolk County Health Services		X																							4
113-09	OU III (Magothy)	OU III Middle Road		Sampled under OU III Middle Road																							
113-19	OU III (Magothy)	OU III Middle Road		Sampled under OU III Middle Road																							
113-22	OU III (Magothy)	OU III Middle Road		Sampled under OU III Middle Road																							
115-50	OU III (Magothy)	OU I (South Boundary)		Xa																							1a
121-40	OU III (Magothy)	OU III (South Boundary)		X																							2f
121-44	OU III (Magothy)	OU III (South Boundary)		X																							2f
122-05	OU III (Magothy)	OU III (South Boundary)		Sampled under OU III (South Boundary)																							
122-20	OU III (Magothy)	OU III (South Boundary)		Sampled under OU III (South Boundary)																							
122-24	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
122-25	OU III (Magothy)	OU III (Industrial Park East)		Sampled under OU III (Industrial Park East)																							
122-41	OU III (Magothy)	OU III (South Boundary)		X																							2f
130-04	OU III (Magothy)	OU III (Western South Boundary)		Sampled under OU III (Western South Boundary)																							
800-101	OU III (Magothy)	OU III (Airport)		Sampled under OU III Airport																							
800-102	OU III (Magothy)	OU III (Airport)		Sampled under OU III Airport																							
800-105	OU III (Magothy)	OU III (Airport)		Sampled under OU III Airport																							
800-90	OU III (Magothy)	OU III Airport		X																							4
800-99	OU III (Magothy)	OU III (Airport)		Sampled under OU III Airport																							
000-97	OU III (off-site)			X																							1a
000-98	OU III (off-site)			X																							1a
000-99	OU III (off-site)			X																							1a
800-21	OU III (off-site)			X																							1a
800-22	OU III (off-site)			X																							1a
800-23	OU III (off-site)			X																							1a
800-40	OU III (off-site)			X																							1a
800-41	OU III (off-site)			X																							1a
800-51	OU III (off-site)			X																							1a
800-52	OU III (off-site)			X																							1a

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs-137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
800-53	OU III (off-site)			X																							1a
000-280	OU III (South Boundary)	OU III Industrial Park and (South Boundary) Radionuclide	Bypass Detection	Sampled With OU III Industrial Park																							
114-06	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc		3cf
114-07	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
121-06	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
121-07	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter																				Xc	Xc	Xc		1c
121-08	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc		3cf
121-09	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
121-10	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
121-11	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc	X	3cf
121-12	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
121-13	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc	X	3cf
121-14	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
121-18	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
121-19	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter																				Xc	Xc	Xc		1c
121-20	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
121-21	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
121-22	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc		3cf
121-23	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
121-40	OU III (South Boundary)	OU III Magothy	Plume Perimeter	Sampled with OU III Magothy																							2f
121-43	OU III (South Boundary)		Bypass Detection	Xf																							2f
121-44	OU III (South Boundary)	OU III Magothy	Plume Perimeter	Sampled with OU III Magothy																							2f
121-45	OU III (South Boundary)	OU III Middle Road	Plume Core	Sampled with Middle Road Program																							
122-02	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter																				Xc	Xc	Xc		2ac
122-04	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xa																			Xc	Xc	Xc		2ac
122-05	OU III (South Boundary)	OU III (South Boundary) Radionuclide, Magothy	Plume Core	Xf																			Xc	Xc	Xc		3cf
122-09	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc		3cf
122-10	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
122-15	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter																				Xc	Xc	Xc		1c
122-16	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter																				Xc	Xc	Xc		1c
122-17	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc	X	3cf
122-18	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xc																			Xc	Xc	Xc		1c
122-19	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa																			Xc	Xc	Xc		2ac
122-20	OU III (South Boundary)	OU III (South Boundary) Radionuclide, Magothy	Plume Core	Xa																			Xc	Xc	Xc		2ac
122-21	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xa																			Xc	Xc	Xc		2ac
122-22	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
122-31	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa																			Xc	Xc	Xc		2ac
122-32	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xa																			Xc	Xc	Xc		2ac
122-33	OU III (South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa																			Xc	Xc	Xc		2ac
122-34	OU III (South Boundary)		Bypass Detection	Xa																							1a
122-35	OU III (South Boundary)		Bypass Detection	Xa																							1a
122-41	OU III (South Boundary)	OU III Magothy		Sampled with OU III Magothy																							2f
121-49	OU III (South Boundary)	SB-MW01-2011	Plume Perimeter	X																							**4**
121-47	OU III (South Boundary)	SB-MW01-2012	Plume Core	Xf																							2f
121-48	OU III (South Boundary)	SB-MW02-2012	Plume Core	Xf																							2f
121-54	OU III (South Boundary)	SB-MW-02-2014		X																							4
103-15	OU III (Western South Boundary)		Plume Core	X																							4
119-06	OU III (Western South Boundary)		Plume Core	X																							4
121-42	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
126-01	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa																			Xc	Xc	Xc		2ac
126-11	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
126-13	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
126-14	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
126-15	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
126-16	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Bypass Detection	X																			Xc	Xc	Xc		4
127-04	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
127-06	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Core	Xf																			Xc	Xc	Xc		3cf
127-07	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Bypass Detection	X																			Xc	Xc	Xc		4
130-02	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc		3cf
130-03	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Plume Perimeter	Xf																			Xc	Xc	Xc	X	3cf
130-04	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide, Magothy	Plume Perimeter	Xa																			Xc	Xc	Xc		2ac
130-08	OU III (Western South Boundary)	OU III (South Boundary) Radionuclide	Bypass Detection	X																			Xc	Xc	Xc		4
126-17	OU III (Western South Boundary)	WSB-MW01-2010	Plume Core	X																							4
119-10	OU III (Western South Boundary)	WSB-MW01-2012	Plume Core	X																							4
095-92	OU III Middle Road		Sentinel	X																							2f
104-11	OU III Middle Road		Plume Perimeter	X																							2f
104-36	OU III Middle Road		Plume Perimeter	X																							2f
104-37	OU III Middle Road		Plume Core	X																							4
104-38	OU III Middle Road		Plume Perimeter	X																							2f
105-23	OU III Middle Road		Plume Core	X																							4
105-25	OU III Middle Road		Plume Core	X																							2f
105-42	OU III Middle Road		Plume Perimeter	X																							2f
105-44	OU III Middle Road	OU III (AOC 29/HFBR Tritium)	Plume Core	X																				Xa			2f
105-52	OU III Middle Road		Plume Perimeter	X																							1a
105-53	OU III Middle Road		Plume Core	X																							2f
105-54	OU III Middle Road		Plume Core	X																							1a
105-66	OU III Middle Road		Plume Core	X																							4
106-55	OU III Middle Road		Plume Core	X																							2f
106-56	OU III Middle Road		Plume Core	X																							2f
106-58	OU III Middle Road		Plume Core	X																							2f
106-62	OU III Middle Road	Chemical/Animal Holes Sr-90	Plume Perimeter	X																					Xf		2f
113-06	OU III Middle Road		Plume Perimeter	X																							1a
113-07	OU III Middle Road		Plume Core	X																							1a
113-08	OU III Middle Road		Plume Core	X																							2f
113-09	OU III Middle Road	Magothy	Plume Core	X																						X	2f
113-11	OU III Middle Road		Plume Core	X																							2f
113-16	OU III Middle Road		Bypass Detection	X																							1a
113-17	OU III Middle Road		Bypass Detection	X																							4
113-18	OU III Middle Road		Bypass Detection	X																							1a
113-19	OU III Middle Road	Magothy	Bypass Detection	X																							4
113-20	OU III Middle Road		Bypass Detection	X																							1a
113-21	OU III Middle Road		Plume Core	X																							1a
113-22	OU III Middle Road	Magothy	Plume Core	X																							2f
113-29	OU III Middle Road		Plume Core	X																							4
114-12	OU III Middle Road		Bypass Detection	X																							4
121-45	OU III Middle Road	OU III South Boundary	Bypass Detection	X																							4
113-30	OU III Middle Road	MR-MW01-2010	Plume Perimeter	X																							4
105-67	OU III Middle Road	MR-MW02-2010	Plume Core	X																							4
113-31	OU III Middle Road	OU3-MR-MW01-2012	Plume Perimeter	X																							4
105-68	OU III Middle Road	MRMW-01-2013	Plume Core	X																							4
121-53	OU III Middle Road	MRMW-03-2013	Plume Core	X																							4
095-323	OU III Middle Road			X																							4

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
095-322	OU III Middle Road			X																							4
000-108	OU III North Street		Plume Core	X																							4
000-153	OU III North Street		Plume Core	X																							4
000-154	OU III North Street		Plume Core	X																							4
000-211	OU III North Street	Magothy, Industrial Park East		X																							1a
000-212	OU III North Street		Plume Core	X																							4
000-213	OU III North Street		Bypass Detection	X																							2f
000-343	OU III North Street	OU III Magothy		Sampled with OU III Magothy																							
000-463	OU III North Street		Plume Core	X																							4
000-464	OU III North Street		Plume Core	X																							4
000-465	OU III North Street		Plume Core	X																							4
000-466	OU III North Street		Bypass Detection	X																							2f
000-467	OU III North Street		Plume Core	X																							4
000-468	OU III North Street		Bypass Detection	X																							2f
000-470	OU III North Street		Plume Core	X																							4
000-472	OU III North Street		Plume Core	X																							4
000-474	OU III North Street		Plume Core	X																							4
000-475	OU III North Street		Plume Perimeter	X																							4
000-476	OU III North Street		Plume Perimeter	X																							1a
800-63	OU III North Street	OU III Airport	Bypass Detection	X																							2f
000-394	OU III North Street East		Plume Perimeter	X																							1a
000-124	OU III North Street East		Plume Core	X																						X	2f
000-137	OU III North Street East		Plume Perimeter	X																							1a
000-138	OU III North Street East		Plume Core	X																							2f
000-215	OU III North Street East	Magothy	Plume Perimeter	X																							1a
000-477	OU III North Street East		Plume Core	X																							2f
000-478	OU III North Street East		Plume Core	X																							2f
000-479	OU III North Street East		Plume Core	X																							2f
000-480	OU III North Street East		Plume Core	X																							2f
000-481	OU III North Street East		Plume Core	X																							2f
000-482	OU III North Street East		Plume Core	X																							2f
000-483	OU III North Street East		Plume Core	X																							2f
000-484	OU III North Street East		Plume Core	X																							2f
000-485	OU III North Street East		Plume Core	X																							2f
000-486	OU III North Street East		Bypass Detection	X																							2f
000-525	OU III North Street East	NSE-MW01-2012	Plume Core	X																							2f
066-189	OU IV (AOC 6 Sr-90)		Background																						X		1b
076-07	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-09	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-13	OU IV (AOC 6 Sr-90)		Plume Core																						X	X	4
076-168	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		2d
076-169	OU IV (AOC 6 Sr-90)		Plume Core																						X	X	2d
076-181	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-182	OU IV (AOC 6 Sr-90)		Sentinel																						X		1b
076-184	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-22	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-24	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		2d
076-25	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-262	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		1b
076-263	OU IV (AOC 6 Sr-90)		Plume Perimeter																						X		2d
076-28	OU IV (AOC 6 Sr-90)	OU III (central)	Plume Perimeter	Sample with OU III Central																							

Table 12-1
Groundwater Protection Group CERCLA Monitoring Schhedule for 2016

Well ID	Project 1	Project 2	Decision Subunit	EPA 524.2 VOCs	EPA 504 EDB	EPA 625 Semi-VOCs	Pesticides Method 608	PCBs Method 608	TSS/TDS	Sufates/Chloride/Alkalinity	TK Nitrogen	Total Nitrogen	Nitrates	Nitrites	Ammonia	TAL Metals	Total Chromium	Hexavalent Chromium	Cyanide	Perchlorate	EPA 900 Gross Alpha/Beta	Isotopic Cs -137	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr 90	Bind Duplicate/MS/MSD	Frequency (events/year)
076-317	OU IV (AOC 6 Sr-90)	OU III (central)	Plume Perimeter	Sample with OU III Central																							
076-373	OU IV (AOC 6 Sr-90)		Plume Perimeter	Sample with OU III Central																							1a
076-415	OU IV (AOC 6 Sr-90)	650-MW01-2010	Plume Perimeter																						X		2d
076-416	OU IV (AOC 6 Sr-90)	650-MW02-2010	Plume Perimeter																						X		2d
076-417	OU IV (AOC 6 Sr-90)	650-MW03-2010	Plume Perimeter																						X		2d
000-110	OU VI EDB		Plume Core	Xa	X																						2f
000-173	OU VI EDB		Plume Core	Xa	X																					X	2f
000-174	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-175	OU VI EDB		Plume Core	Xa	X																						2f
000-176	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-177	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-178	OU VI EDB		Plume Core	Xa	X																						4
000-179	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-201	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-209	OU VI EDB		Plume Core	Xa	X																						2f
000-283	OU VI EDB		Plume Core	Xa	X																						2f
000-284	OU VI EDB		Plume Core	Xa	X																						2f
000-497	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-498	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-499	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-500	OU VI EDB		**Plume Core**	Xa	X																						2f
000-501	OU VI EDB		Plume Perimeter	Xa	X																						2f
000-507	OU VI EDB		Plume Core	Xa	X																						2f
000-508	OU VI EDB		Bypass Detection	Xa	X																						4
000-519	OU VI EDB		Bypass Detection	Xa	X																						4
099-11	OU VI EDB	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa	X																			Xa		X	1a
100-12	OU VI EDB	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa	X																			Xa			1a
100-13	OU VI EDB	OU III (South Boundary) Radionuclide	Plume Perimeter	Xa	X																			Xa			1a
000-520	OU VI EDB	EDB-MW-01-2011	Plume Core	Xa	X																						4
000-524	OU VI EDB	EDB-MW-01-2012	Plume Perimeter	Xa	X																						4
000-527	OU VI EDB	EDB-MW01-2013	Bypass Detection	Xa	X																						4
017-01	Site Background		Background	X																							1b
017-03	Site Background		Background	X																							1b
017-04	Site Background		Background	X																							1b
018-01	Site Background		Background	X																							1b
018-02	Site Background		Background	X																							1b
018-04	Site Background		Background	X																							1b
018-05	Site Background		Background	X																							1b
034-02	Site Background		Background	X																							1b
034-03	Site Background		Background	X																							1b
063-09	Site Background		Background	X																						X	1b

NOTES:
a: Collect in 4th Quarter only.
b: Collect in 3rd Quarter Only.
c: Collect in 3rd Quarter Only.
d: Collect in 1st and 3rd Quarters
f: Collect in 2nd and 4th Quarters.
g: Sample in even numbered years. Next sampling in CY2016.

085-17	OU III (Carbo	Facility Monit	Plume Core	X				
085-236	OU III (Carbo	Facility Monit	Plume Core	X				
085-237	OU III (Carbo	Facility Monit	Plume Core	X				

								X

2f		Carbon Treat	none	SITEWD-O3C STL-Mo
2f		Carbon Treat	none	SITEWD-O3C STL-Mo
2f		Carbon Treat	none	SITEWD-O3C STL-Mo

INTRODUCTION AND MONITORING SCHEDULE

DQO START DATE January 1, 2012

REVISION NUMBER/DATE Rev. 5, December 7, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186

Groundwater monitoring is driven by regulatory requirements, DOE Orders, best management practices, and BNL's commitment to environmental stewardship. The Laboratory monitors its groundwater resources for the following reasons:

GROUNDWATER RESOURCE MANAGEMENT

- To support initiatives in protecting, managing, and remediating groundwater by refining the conceptual hydrogeologic model of the site and maintaining a current assessment of the dynamic patterns of groundwater flow and water-table fluctuations.
- To determine the natural background concentrations for comparative purposes. The site's background wells provide information on the chemical composition of groundwater that has not been affected by BNL's activities. These data are a valuable reference for comparison with the groundwater quality data from affected areas. The network of wells can also warn of any contaminants originating from potential sources that may be located upgradient of the BNL site.
- To ensure that potable water supplies meet all regulatory requirements.

GROUNDWATER FACILITY MONITORING

- To verify that operational and engineered controls effectively prevent groundwater contamination.
- To trigger early action and communication, should the unexpected happen (e.g., control failure).
- To determine the efficacy of the operational and engineered control measures designed to protect the groundwater.
- To demonstrate compliance with applicable requirements for protecting and remediating groundwater.

GROUNDWATER -CERCLA MONITORING

- To track a dynamic groundwater cleanup problem when designing, constructing, and operating treatment systems.
- To measure the performance of the groundwater remediation efforts in achieving cleanup goals.

- To protect public health and the environment during the cleanup period.
- To define the extent and degree of groundwater contamination.
- To provide early warning of the arrival of a leading edge of a plume, which could trigger contingency remedies to protect public health and the environment.

BNL's CERCLA groundwater monitoring has been streamlined into five general phases**:**

Start-up Monitoring

A quarterly sampling frequency is implemented on all wells for a period of 2 years. This increased sampling frequency provides sufficient data while the system operation is in its early stages.

Operations and Maintenance (O&M) Monitoring

This is a period of reduced monitoring during the time when the system is in a routine operational state. The timeframe for each system varies. This phase is also utilized for several plume monitoring programs not requiring active remediation.

Shutdown Monitoring

This is a 2-year period of monitoring implemented just prior to petitioning for system shut down. The increased sampling frequency provides the necessary data to support the shutdown petition.

Standby Monitoring

This is a period of reduced monitoring up to a 5-year duration to identify any potential rebounding of contaminant concentrations. If concentrations remain below maximum concentration levels (MCLs), the petition for closure and decommissioning of the system is recommended.

Post Closure Monitoring

This is a monitoring period of varying length for approximately 20 percent of the key wells in a given project following system closure. Monitoring continues until the Record of Decision (ROD) goal of meeting MCLs in the Upper Glacial aquifer is reached. This is expected to occur by 2030. This phase is considerably longer for the Magothy and strontium-90 (Sr-90) cleanups due to greater length of the time to reach MCLs required for those projects.

The groundwater monitoring well networks for each program are organized into background, core, perimeter, bypass, and sentinel wells. The wells are designated as follows:

- Background –water quality results will be used to determine upgradient water quality.
- Plume Core – utilized to monitor the high concentration or core area of the plume.
- Perimeter – used to define the outer edge of the plume both horizontally and vertically.
- Bypass – used to determine whether plume capture performance is being met.
- Sentinel – an early warning well to detect the leading edge of a plume.

Table 12.1-1. CERCLA Groundwater Monitoring Program – Well Sampling Frequency

Project Activity Phase	Well Type	Phase Duration (yrs.)	Sampling Freq. (events/yr.)****
Start-up Monitoring	Plume Core	2	4x
	Plume Perimeter	2	4x
	Sentinel/Bypass	2	4x
Operations & Maintenance (O&M) Monitoring	Plume Core	End Start-up to Shutdown*	2x
	Plume Perimeter	End Start-up to Shutdown*	2x
	Sentinel/Bypass	End Start-up to Shutdown*	4x
Shutdown Monitoring	Plume Core	2	4x
	Plume Perimeter	2	4x
	Sentinel/Bypass	2	4x
Standby Monitoring	Key Plume Core	5	2x
	Plume Perimeter	5	1x
	Sentinel/Bypass	5	2x
Post Closure Monitoring***	20% of key wells	Up To 2030**	1x

Notes:

*- Duration varies by project.

** - S. Boundary Rad: 2038; Chemical Holes Sr-90: 2045; Magothy: 2065; BGRR Sr-90: 2070

*** - Verification monitoring for achieving maximum contaminant levels (MCLs).

****- Srontium-90 (Sr-90) monitoring projects use approximately half the defined sampling frequency.

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CHEMICAL/ANIMAL HOLES STRONTIUM-90

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

Proposed changes for calendar year (CY) 2016 for the chemical/animal holes strontium-90 (Sr-90) treatment system and groundwater monitoring program include:

- Install four permanent shallow wells to monitor the residual Sr-90 upgradient of EW-1.

DESCRIPTION AND TECHNICAL BASIS

Between 1960 and 1966, waste, glassware containing chemical and radioactive waste, and animal carcasses containing radioactive tracers were disposed in shallow pits in an area directly east of the Chemical/Animal Holes area. Used glassware continued to be disposed in shallow pits directly north of this area from 1966 through 1981. Remediation of the impacted soil in the Chemical/Animal Holes area, including waste excavation, treatment, and disposal, was completed in September 1997.

The monitoring well network for the Chemical/Animal Holes consists of 36 wells. Twenty-nine wells are downgradient of the Chemical/Animal Holes area. There are also three bypass detection wells located immediately downgradient from extraction well EW-3 (106-120, 106-121, and 106-122). In addition, there are four sentinel wells along Middle Road (106-22, 106-23, 106-62, and 106-63). No upgradient wells are sampled as part of this program. The wells comprising the Chemical/Animal Holes program are listed in Table 12.2.2. Well locations are shown on Figure 12.2.1. The wells have been sampled annually to semi-annually for strontium-90 (Sr-90) analysis.

Sr-90 has routinely been detected downgradient of the Chemical/Animal Holes at levels exceeding the New York State groundwater standard. None of the sentinel wells contained Sr-90 at levels exceeding the New York State groundwater standard.

In February 2003, an Sr-90 Pilot Study began operation. The objective of this study was to evaluate the effectiveness of extraction and treatment of Sr-90 in groundwater prior to implementation of the final remedy. The Sr-90 Pilot Study, now known as the Chemical/Animal Holes Sr-90 Treatment System, currently extracts groundwater at a rate of between 5 to 15 gallons per minute, treats it with an ion exchange system, and discharges the groundwater to dry wells located just east of the treatment system building. In 2007, two new extraction wells (EW-2 and EW-3) were installed. The leading edge of the plume, as defined by drinking water standards (DWS) of 8 pCi/L, is being captured by well EW-3.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The Chemical/Animal Holes area has been an historic source of Sr-90 contamination to groundwater. In response, BNL has conducted remediation (waste excavation, treatment, and disposal) to eliminate future releases. Data are needed to confirm that the soil remediation was adequate and to track existing contaminant plumes downgradient of the Chemical/Animal Holes area. In addition, data are required during the design process in the immediate pilot study area for design decisions and potential system modifications. The pilot study was targeted for the area of high Sr-90 concentrations.

Problem Statement: Existing Sr-90 plume has degraded groundwater quality downgradient of the Chemical/Animal Holes area and could impact downgradient receptors. Data are needed to:

- Verify that the soil source areas have been remediated
- Track the distribution of the high concentration area currently being addressed by the treatment system
- Verify the effectiveness of the treatment system in removing Sr-90 from the groundwater

Step 2: Identify the Decisions

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goals of meeting drinking water standards been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Sr-90 results in groundwater
- Locations of existing wells relative to flow patterns
- Regulatory drivers (Operable Unit [OU] III ROD)
- Action Levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Estimated retardation rate for Sr-90
- Variability of data

Step 4: Define the Study Boundaries

The decision unit limits for this project are the area impacted by detectable activities of Sr-90 from the Chemical/Animal Holes and Former Landfill areas. The vertical limits are from the water table surface to the deep zone of the Upper Glacial aquifer.

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. Due to the low travel velocity for Sr-90 in groundwater, decisions for most wells will be made on a timeframe of 365 days. Since wells 106-04, 106-16, 106-48, 106-49, 106-50, 106-62, 106-63, 106-125, 106-119, 106-120, 106-121, and 106-122 are located within critical areas to be addressed by the ongoing treatment system, decisions will be made using a timeframe of 180 days to ensure that the design of the system will be effective.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

If the detected Sr-90 activities are consistent with the groundwater model results and professional judgment, **then** continue monitoring. **If not**, **then** consider refining the conceptual model and/or conducting an evaluation to determine whether outside factors (such as additional contaminant sources) are affecting the results.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from all wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and sentinel wells. If the system is performing as planned, actual Sr-90 concentrations in plume perimeter and sentinel wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation for the reason for the difference.
If the system is performing as planned (based on groundwater model predictions, trend analysis, and expert judgment), **then** continue to operate. **If not**, **then** consider operational adjustments and/or an engineering evaluation. Note: When the majority and/or “key” wells, as defined by a subject matter expert, are performing as planned, the system as a whole is considered to be properly operating.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

The clean-up objective is to reach maximum contaminant levels (MCLs) in the aquifer by 2040 via hydraulic control and treatment of the highest concentration Sr-90 within the capture zone of Sr-90 extraction wells. Groundwater modeling will be performed to demonstrate that the Sr-90 concentrations remaining in the groundwater after system shutdown would naturally attenuate to below MCLs by 2040. **If** evaluation of analytical results for Sr-90 in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are Sr-90 concentrations in plume core wells above or below 8 pCi/L?

If the Sr-90 concentration in each plume core well has been reduced to less than 8 µg/L, **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than 10 years, **then** continue treatment. **If not** ,and treatment has occurred for at least 10 years, **then** consider performing an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2040.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after the system has been shut down completely or entered pulse pumping mode. **If yes**, **then** continue operation. **If yes**, and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If no**, significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Has the groundwater cleanup goal of meeting drinking water standards_been achieved?

If the concentration of Sr-90 in groundwater after system shutdown remains less than 8 pCi/L for several years, **then** petition for system closure. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.2.1 summarizes the decision and possible decision errors for this project.

Table 12.2.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the high-concentration Sr-90 plume addressed by the treatment system?	See Step 3 for inputs.	(1) Data indicate plume is not located in treatment system area when it is. (2) Data indicate plume is located in treatment system area when it is not.	(1) Wasted resources modifying system design, potentially inaccurate results/. (2) Potential ROD goals not being met.

Step 7: Optimize the Design

Number and Locations of Wells

The existing monitoring well network of 32 wells will be supplemented by two new monitoring wells.

Parameters and Frequency

All 32 existing and two new monitoring wells in the groundwater monitoring program will be sampled on a semi-annual schedule and analyzed for Sr-90.

A summary of the proposed revised sampling program for this project is shown in Table 12.2.2.

DATA REVIEW REQUIREMENTS

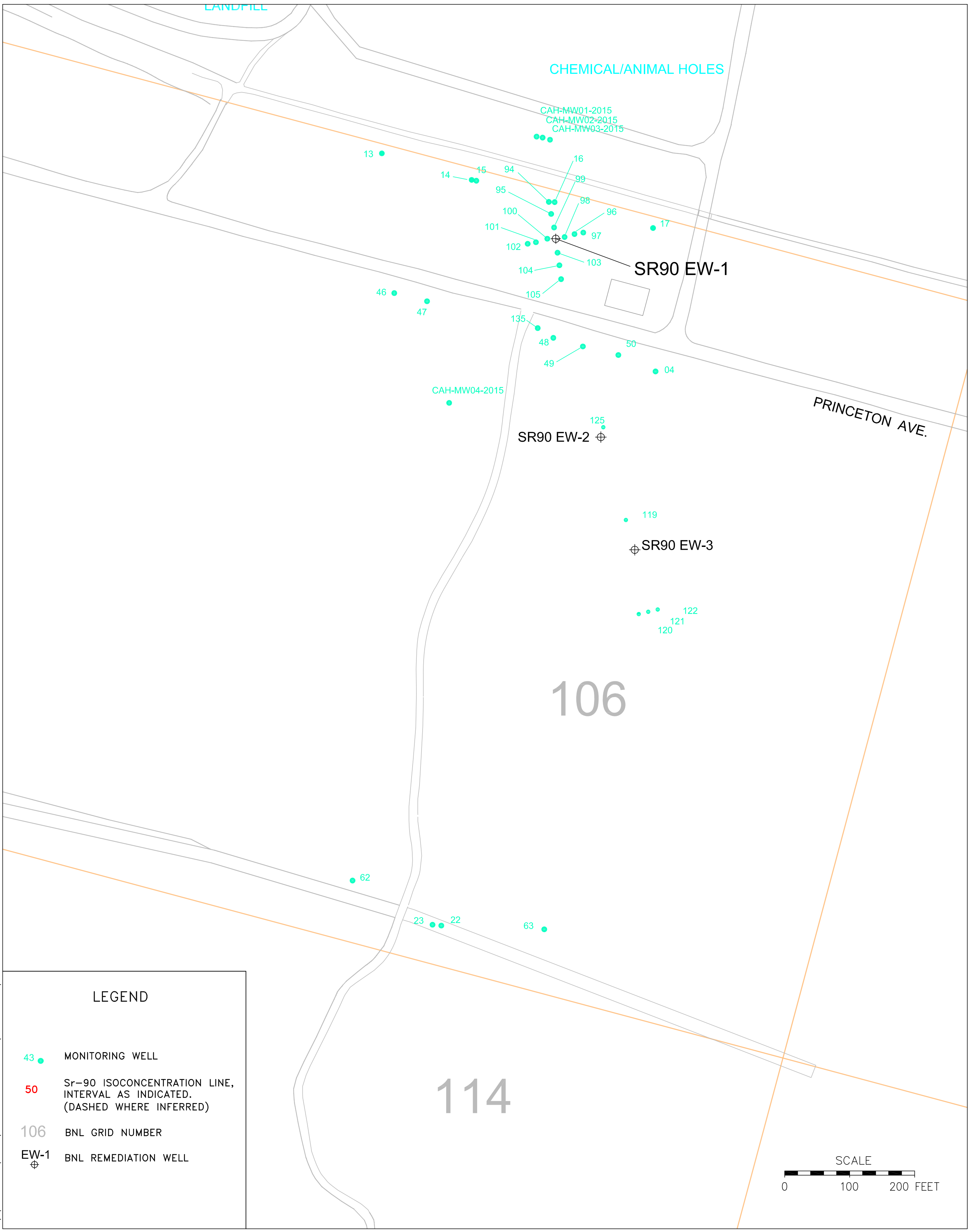
Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification, and all system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.2.2 Proposed Modifications to the Chemical/Animal Holes Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency	Affected Parameters
106-04	Semi-annually	No Change	None
106-13	Annually	Semi-annually	Sr-90
106-14	Annually	Semi-annually	Sr-90
106-15	Annually	Semi-annually	Sr-90
106-16	Semi-annually	No Change	None
106-22	Annually	Semi-annually	Sr-90
106-23	Annually	Semi-annually	Sr-90
106-46	Annually	Semi-annually	Sr-90
106-47	Annually	Semi-annually	Sr-90
106-48	Semi-annually	No Change	None
106-49	Semi-annually	No Change	None
106-50	Semi-annually	No Change	None
106-62	Semi-annually	Semi-annually	Sr-90
106-63	Semi-annually	Semi-annually	Sr-90
106-94	Annually	Semi-annually	Sr-90
106-95	Annually	Semi-annually	Sr-90
106-96	Annually	Semi-annually	Sr-90
106-97	Annually	Semi-annually	Sr-90
106-98	Annually	Semi-annually	Sr-90
106-99	Annually	Semi-annually	Sr-90
106-100	Annually	Semi-annually	Sr-90
106-101	Annually	Semi-annually	Sr-90
106-102	Annually	Semi-annually	Sr-90
106-103	Annually	Semi-annually	Sr-90
106-104	Annually	Semi-annually	Sr-90

Well ID	Current Sampling Frequency	Proposed Sampling Frequency	Affected Parameters
106-105	Annually	Semi-annually	Sr-90
106-125	Semi-annually	No Change	None
106-119	Semi-annually	No Change	None
106-120	Semi-annually	No Change	None
106-121	Semi-annually	No Change	None
106-122	Semi-annually	No Change	None
106-135	Semi-annually	No Change	None
CAH-MW01-2015	None	Semi-annually	Sr-90
CAH-MW02-2015	None	Semi-annually	Sr-90
CAH-MW03-2015	None	Semi-annually	Sr-90
CAH-MW04-2015	None	Semi-annually	Sr-90

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: CHEMICAL/ANIMAL HOLES Sr-90 WELL LOCATIONS EMP	DWN: JEB	VT: HZ.: –	DATE: 12/07/11	PROJECT NO.: 20335
		CHKD: JEB	APPD: – –	REV.: 12/15/15	NOTES: –
		FIGURE NO.: 12.2.1			

FORMER LANDFILL POST-CLOSURE

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 13, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Robert Howe (631) 344-5588

SUMMARY OF CHANGES

There are no proposed changes for calendar year (CY) 2016 for the Former Landfill monitoring program

DESCRIPTION AND TECHNICAL BASIS

The Former Landfill Area includes three unlined areas historically used for waste disposal: the Former Landfill, the Slit Trench, and the Interim Landfill. Due to the proximity of these areas, they have been addressed collectively under the term Former Landfill Area.

The Former Landfill was used by the United States Army during World War I and World War II and by BNL from 1947 through 1966. Material disposed in the landfill by the Laboratory included construction and demolition debris, sewage sludge, chemical and low-level radioactive waste, used equipment, and animal carcasses. The Slit Trench was reportedly used during the 1960s. In November 1996, the Former Landfill and Slit Trench were capped in accordance with NYCRR Part 360 requirements. The Interim Landfill was reportedly used for 1 year after closure of the Former Landfill and was capped in October 1997.

The monitoring well network for the Former Landfill Area consists of 14 existing wells, including 3 wells upgradient of the Former Landfill Area (086-42, 086-72, and 087-22), 1 well upgradient of the Former Landfill and downgradient of the Interim Landfill (097-277), 4 wells downgradient of the Former Landfill Area (097-17, 097-64, 106-02, and 106-30) and 6 wells downgradient of the Former Landfill specifically designed for strontium-90 (Sr-90) monitoring (106-20, 106-21, 106-43, 106-44, 106-45, and 106-64). All wells except 086-42 and 106-20 are screened in the shallow Upper Glacial aquifer. Wells 086-42 and 106-20 are screened in the mid-Upper Glacial aquifer. The screen zone and aquifer screened by each of the wells currently sampled are summarized in Table 12.3.1. For well locations, see Figure 12.3.1.

Table 12.3.1 Former Landfill Area Well Network

Well	Screen Zone	Aquifer Screened
086-42	65–75	Mid Upper Glacial
086-72	41.5–56.5	Shallow Upper Glacial
087-22	43–53	Shallow Upper Glacial
097-17	29–39	Shallow Upper Glacial
097-64	29–44	Shallow Upper Glacial
097-277	40–55	Shallow Upper Glacial
106-02	55–65	Shallow Upper Glacial
106-20	85-95	Mid Upper Glacial
106-21	55-65	Shallow Upper Glacial
106-30	29–44	Shallow Upper Glacial

Well	Screen Zone	Aquifer Screened
106-43	43-53	Shallow Upper Glacial
106-44	44-54	Shallow Upper Glacial
106-45	44-55	Shallow Upper Glacial
106-64	30-40	Shallow Upper Glacial

Contaminants of concern for the former landfill wells are volatile organic compounds (VOCs) and Sr-90. VOC concentrations have been low in all of the Former Landfill Area wells over the past several years with no exceedances of the New York State Ambient Water Quality Standard (NYS AWQS) since June 1998. Little or no VOCs have been detected in upgradient wells 87-22, 87-72, and 86-42. TCE and DCA consistently were detected in the downgradient wells (97-17, 97-64, 106-02, and 106-30), though NYS AWQS for these compounds have not been exceeded since 1998 (in well 106-30).

Sr-90 was formerly detected in well 97-64, which is screened at the water table and located less than 100 feet downgradient of the landfill footprint. Sr-90 concentrations in this well have shown a steadily declining trend since 1998, when it was last detected above the New York State Drinking Water Standard (DWS) of 8 pCi/L (at a concentration of 12 pCi/L).

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

_X_ Compliance
_X_ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Potential failure of the landfill cap could lead to continued releases from the Former Landfill Area into groundwater at levels exceeding New York State groundwater standards.

Step 2: Identify the Decisions

Are the controls effectively improving groundwater quality below and downgradient of the Former Landfill Area?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow.
- Comparison of pre- and post-capping groundwater quality by analysis of VOCs, pesticides, PCBs, metals, cyanide, radionuclides, tritium and landfill water quality parameter concentrations in groundwater.
- Locations of existing wells relative to flow patterns (Figure 12.3.1)
- Regulatory drivers (New York Codes, Rules, and Regulations [NYCRR] Part 360).
- Action Levels (MCLs and/or baseline groundwater concentrations).
- Analytical methods and detection limits, as described in the BNL Environmental Monitoring Plan.

Step 4: Define the Study Boundaries

The decision unit limits for this project are the immediate vicinity of the Former Landfill and the eight wells that comprise the groundwater monitoring program. The period for which the decisions will be made depends on the individual parameters, as summarized in Table 12.3.2.

The periods over which decisions will be made were determined based on the low risk to potential receptors of contamination from the Former Landfill. The factors considered to determine that risk is low are:

- engineered control (landfill cap) is a proven conventional technology with a low failure rate
- low travel velocities for some of the contaminants
- proximity of the downgradient monitoring network
- absence of downgradient receptors
- the resource has already been degraded

Table 12.3.2 Factors Affecting the Period for Decisions for the Former Landfill

Parameter	Relative Travel Time*	Above MCLs 1997–2006	Trend, 1997–2006	Time for Decision
VOCs	< 60 days	Yes	Stable	365 days
Tritium	< 60 days	No	Stable	365 days
Metals/Cyanide	Varies	Yes	Stable to increasing	365 days
Sr-90	1,200 days	Yes	Stable to Decreasing	2 years **
Gross alpha	--	No	Stable	2 years **
Gross beta	--	No	Stable	2 years **
Gamma Spectroscopy	--	NA	--	2 years **
Leachate Parameters	< 60 days	No	Stable to decreasing	365 days

* Relative travel time is an approximate time for contamination to travel from the waste pile to downgradient wells.
** Based on trend

Step 5: Develop the Decision Rules

Decision 1

Are the controls effectively eliminating further discharges to soils and groundwater below the landfill?

The sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If, for any downgradient well, the current annual mean concentration for an individual contaminant of concern exceeds the mean concentration in that well computed from data collected from that well over the past 3 years and is greater than MCLs, and this result is confirmed by resampling appropriate wells, as well as by an evaluation of upgradient and downgradient conditions, **then** an evaluation will be made as to whether an increase in sampling frequency for that parameter or parameter group (for example, metals) would be appropriate. **If not, then** continue detection monitoring.

Decision 2

Is the capping system performing as planned?

If the system is performing as planned (based on groundwater model prediction, trend analysis and expert judgment), **then** continue monitoring. **If not**, **then** consider an engineering evaluation.

Notes:
1. Use concentration plots over time to visually assess data for trends and model predictions.
2. Slope analysis suggests that the goal will be achieved within the planned period (2–10 years).
3. If the water quality for the majority or key wells (as defined by the Subject Matter Expert) is improving as planned, then the entire system is considered to be properly operating.

Step 6: Specify Acceptable Error Tolerances

Table 12.3.3 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are the controls effective at eliminating further discharges to groundwater below the Former Landfill?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are.	(1) A discrete contaminant slug could exist and not be detected. (2) Delay in notifying stakeholders and taking corrective actions.

There are no potential receptors immediately downgradient of the Former Landfill, and groundwater travel time to the site boundary is approximately 10 to 15 years. Due to these factors, it is very unlikely that decision error will result in adverse consequences to human health or noncompliance with the Operable Unit III (OU III) Record of Decision (ROD). The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, and erosion of stakeholder trust and BNL credibility.

Step 7: Optimize the Design

Number and Locations of Wells

The 14 monitoring wells around the Former Landfill Area are adequate, considering the potential consequences of a decision error. The current well network was developed using expert judgment and groundwater modeling. No refinements are recommended at this time, as the groundwater flow direction has been relatively constant in recent years and the size of the source area is relatively small.

Parameters and Frequency

The sampling frequency for all Former Landfill monitoring wells is once every two years with the exception of metals in well 106-02. Sampling for metals will continue on an annual basis for well 106-02. The next sampling event is scheduled for 2014. Sampling for metals will continue on an annual basis for well 106-02.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.3.4 Modifications to the Chemical/Animal Holes Monitoring Wells

Well ID	Current Sampling Frequency	New Sampling Frequency	Affected Parameters
086-42	Once Every 2 Years	No Change	None
086-72	Once Every 2 Years	No Change	None
087-22	Once Every 2 Years	No Change	None
097-17	Once Every 2 Years	No Change	None
097-277	Once Every 2 Years	No Change	None
097-64	Once Every 2 Years	No Change	None
106-02	Once Every 2 Years	No Change	None
106-30	Once Every 2 Years	No Change	None
106-20	Once Every 2 Years	No Change	None
106-21	Once Every 2 Years	No Change	None
106-43	Once Every 2 Years	No Change	None
106-44	Once Every 2 Years	No Change	None
106-45	Once Every 2 Years	No Change	None
106-64	Once Every 2 Years	No Change	None

See Appendix B for the monitoring program for this DQO.

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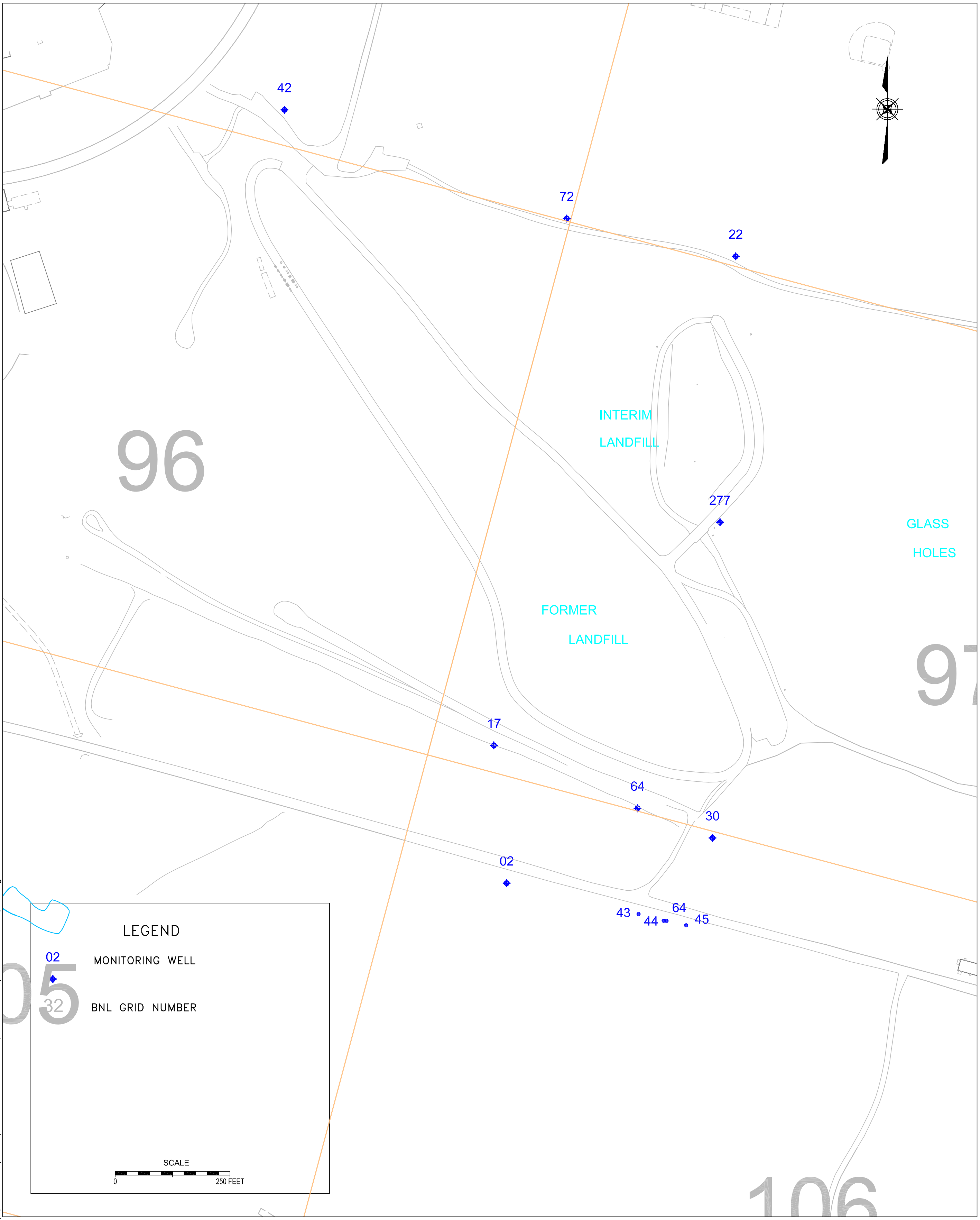

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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTALPROTECTION DIVISION

TITLE:

OU I FORMER LANDFILL POST-CLOSURE MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/7/11	20335
CHKD:	APPD:	REV.:	NOTES:
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FIGURE NO.: 12.3.1

CURRENT LANDFILL POST-CLOSURE

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 13, December 9, 2015
IMPLEMENTATION DATE	January 1, 2015
POINT OF CONTACT	William Dorsch (631) 344-5186 Robert Howe (631) 344-5588

SUMMARY OF CHANGES

There are no proposed changes for calendar year (CY) 2016 for the Current Landfill monitoring program.

DESCRIPTION AND TECHNICAL BASIS

The Current Landfill operated from 1967 through 1990. Putrescible waste, sludge from the BNL Water Treatment Plant (WTP), anaerobic digester sludge from the BNL Sewage Treatment Plant (STP), and limited quantities of Laboratory waste were disposed in the landfill. The landfill was capped in accordance with the New York Code, Rules, and Regulations (NYCRR) Part 360 requirements in 1995.

The monitoring well network for the Current Landfill consists of 11 existing wells, including 1 upgradient well (087-09), 3 wells immediately downgradient of the landfill (087-11, 088-109 and 088-110), and 7 wells further downgradient of the landfill (087-23, 087-24, 087-26, 087-27, 088-21, 088-22 and 088-23). Well locations are shown in Figure 12.4.1. All 11 wells are sampled and analyzed for VOCs, metals, strontium-90 (Sr-90), tritium, gamma spectroscopy, and landfill leachate parameters.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

_X_ Compliance (NYCRR Part 360)
_X_ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The Current Landfill has been an historic source of contamination and remains a potential source of contaminants to groundwater. In response, BNL has constructed an engineered cap over the landfill to mitigate future releases.

Problem Statement: Potential failure of the landfill cap could lead to continued releases from the Current Landfill into groundwater at levels exceeding maximum contaminant levels (MCLs).

Step 2: Identify the Decision

- Are the controls effectively improving groundwater quality below and downgradient of the landfill?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow.
- Comparison of pre- and post-capping groundwater quality by analysis of VOCs, metals, radionuclides, tritium, and landfill water quality parameter concentrations in groundwater.
- Locations of existing wells relative to flow patterns.
- Regulatory drivers (New York Codes, Rules, and Regulations [NYCRR] Part 360).
- Action Levels (MCLs and/or baseline groundwater concentrations).
- Analytical methods and detection limits as described in this Environmental Monitoring Plan (EMP).

Step 4: Define the Study Boundaries

The decision unit limits for this project are the immediate vicinity of the Current Landfill and the 11 wells that comprise the groundwater monitoring program. The period for which the decisions will be made depends on the individual parameters, as summarized in Table 12-4.1.

Table 12.4.1 Factors Affecting the Period for Decisions for the Current Landfill

Parameter	Historical Detection?	Relative Travel Time **	Above MCLs 1995–2002?	Trend 1995–2002	Time for Decision
VOCs	Yes	< 60 days	Yes	Decreasing	365 days
Tritium	Yes	< 60 days	No	Decreasing	365 days
Metals	Yes	Varies	Yes	Stable	2 years *
Sr-90	Yes	1,200 days	Yes	Stable	2 years *
Gross alpha	Yes	--	No	Stable	2 years *
Gross beta	Yes	--	No	Stable	2 years *
Gamma spectroscopy	Yes	--	NA	Stable	2 years *
Leachate parameters	Yes	< 60 days	Yes	Decreasing	365 days

Notes:
* Based on trend.
** Relative travel time is approximate time for contamination to travel from waste pile to surrounding wells.

The periods over which decisions will be made were determined based on the low risk to potential receptors of contamination from the Current Landfill. The factors considered to determine that risk is low are:

- Engineered control (landfill cap) is a proven conventional technology with a low failure rate.
- Low travel velocities for contaminants.
- Absence of downgradient receptors.
- Resource has already been degraded.
- A groundwater pump and treat system is currently operating downgradient of the Current Landfill (to address historical releases from the landfill).

Step 5: Develop the Decision Rules

Decision 1

Are the controls effectively eliminating further discharges below the landfill?

The sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If for any downgradient well, the current annual mean concentration for an individual contaminant of concern exceeds the mean concentration in that well computed from data collected from that well over the past 3 years, and is greater than MCLs, and this result is confirmed by resampling appropriate wells, as well as by an evaluation of upgradient and downgradient conditions, **then** an evaluation will be made as to whether an increase in sampling frequency for that parameter or parameter group (for example, metals) would be appropriate. In addition, consider conducting an engineering evaluation to determine whether the capping system is performing as planned. **If** the current annual mean concentration for an individual contaminant of concern does not exceed the mean concentration in that well computed from data collected from that well over the past 3 years, **then** continue detection monitoring.

Notes:
a. Use concentration plots over time to visually assess data for trends and model predictions.
b. Slope analysis suggests that the goal will be achieved within the planned period (2–10 years).
c. If the water quality for the majority and/or key wells (as defined by the subject matter expert) is improving as planned, then "the system" as a whole is considered to be properly operating.

Step 6: Specify Acceptable Error Tolerances

Table 12.4.2 summarizes the decision and possible decision errors for this project.

Table 12.4.2 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are the controls effective at eliminating further discharges to groundwater below the Current Landfill?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are.	(1) A discrete VOC contaminant slug of up to 300 feet long and 300 feet wide could exist and not be detected. (2) Delay in notifying stakeholders and taking corrective actions, prolonged operation of the OU I RA V groundwater treatment system.

There are no potential receptors immediately downgradient of the Current Landfill and groundwater travel time to the site boundary is approximately 10 to 15 years. In addition, a groundwater treatment system is already operating and treating historical releases from the landfill.

Due to these factors, it is very unlikely that decision error will result in adverse consequences to human health or noncompliance with the Operable Unit (OU) I Record of Decision (ROD). The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, and erosion of stakeholder trust and BNL credibility.

Step 7: Optimize the Design

Number and Locations of Wells

The 11 existing monitoring wells around the landfill are adequate considering the potential consequences of a decision error. The current network was developed using expert judgment, groundwater models, and particle-tracking computer codes. No refinements are recommended at this time since the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small in size.

Parameters and Frequency

Table 12.4.3 lists the changes to the sampling schedule.

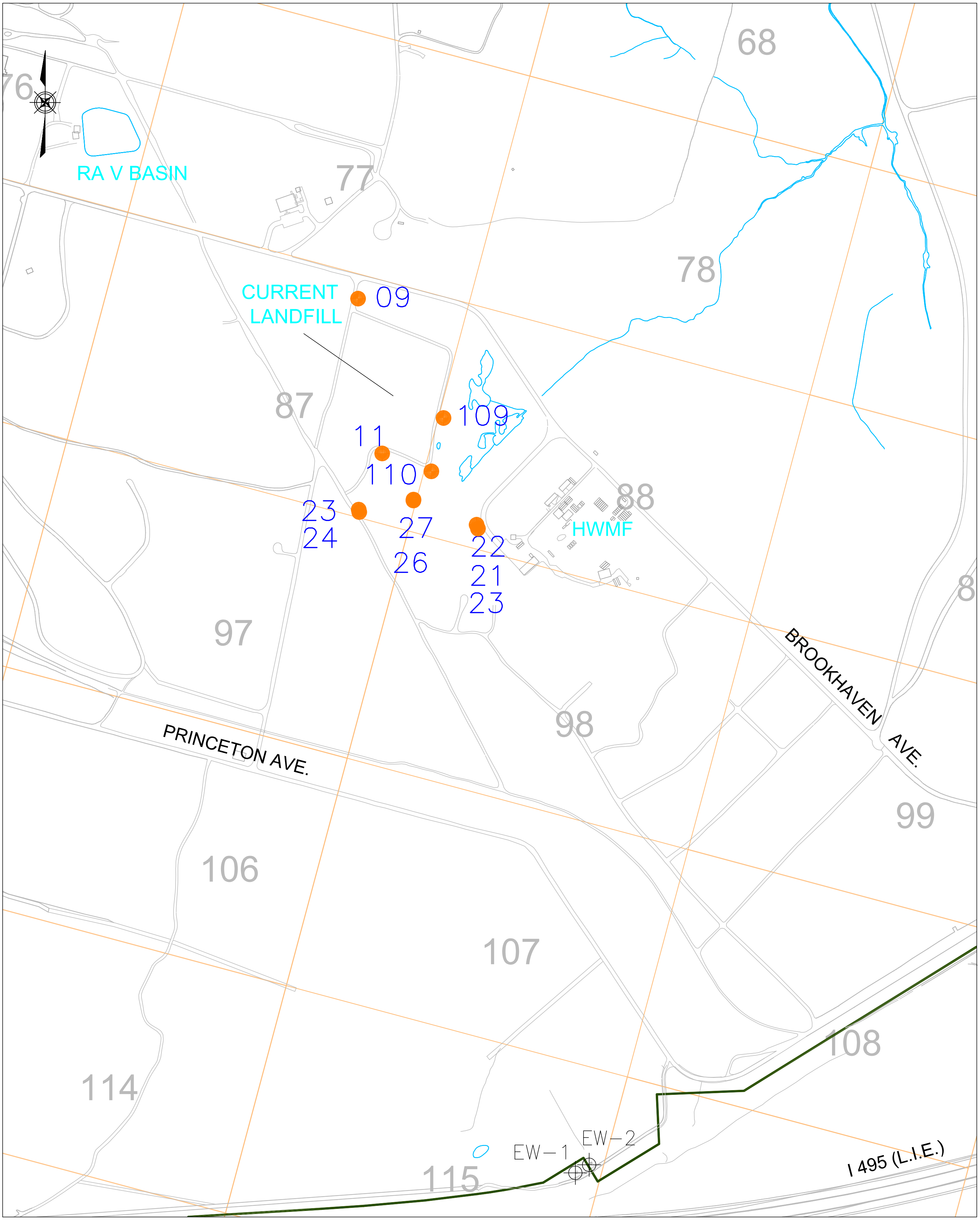
Table 12.4.3 Proposed Modifications to the Current Landfill Monitoring Wells

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
087-09	Semi	No Change	None
087-11	Semi	No Change	None
087-23	Semi	No Change	None
087-24	Semi	No Change	None
087-26	Semi	No Change	None
087-27	Semi	No Change	None
088-21	Semi	No Change	None
088-22	Annual	No Change	None
088-23	Annual	No Change	None
088-109	Quarterly	No Change	None
088-110	Semi-annual	No Change	None

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY EP DIVISION	TITLE: OU I CURRENT LANDFILL POST-CLOSURE MONITORING WELL LOCATIONS	DWN: JEB	VT:HZ.: –	DATE: 12/07/11	PROJECT NO.: 20335
		CHKD: --	APPD: --	REV.: 1	NOTES: –
		FIGURE NO.:		12.4.1	

OU I South Boundary (RA V Remedial Action)

DQO Start Date January 1, 2003

Revision Number/Date Rev. 13, December 9, 2015

Implementation Date January 1, 2015

Point of Contact William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

Summary of Changes

There are no proposed changes for calendar year (CY) 2016 for the Operable Unit (OU) I South Boundary Pump and Treat System and groundwater monitoring program.

Description and Technical Basis

The OU I South Boundary project monitors the downgradient extent of commingled contaminant plumes from several sources, including the Current Landfill and the former Hazardous Waste Management Facility (HWMF). The groundwater contaminant plume, consisting of VOCs, extends approximately 3,000 feet south of the BNL property boundary. Since December 1996, a remediation system comprised of two extraction wells screened within the deep Upper Glacial aquifer has been in operation at the southern property boundary to prevent groundwater with total VOCs exceeding 50 micrograms per liter (µg/L) from migrating off site. The extracted groundwater is treated via air stripping and recharged northwest of the source areas. In addition, radiological parameters, including tritium and strontium-90 (Sr-90), have been detected in several wells near the source areas.

The monitoring well network for the OU I South Boundary project consists of 49 wells. Well locations are shown on Figure 12.5.1. The wells are sampled semi-annually for analysis of VOCs, tritium, and Sr-90, and annually for gamma spectroscopy, as shown in Table 12.1-2.

The contaminants of concern associated with the OU I South Boundary plume are VOCs and Sr-90. The leading edge of the Sr-90 contamination is approximately 175 feet south of well 107-35. Since the area impacted by Sr-90 at levels above New York State groundwater standards is limited, this evaluation will focus mainly on the VOC contamination.

Drivers for Monitoring Being Conducted under This Change

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A plume of groundwater contaminated by VOCs has been identified within the Upper Glacial aquifer in the southern portion of the BNL Site and off site. In response, groundwater remediation was implemented at the southern site boundary in December 1996. A plume of contaminated groundwater off site to the south is addressed by the North Street East remediation system which began operation in June 2004.

Data are needed to demonstrate that:

- The existing groundwater remediation system is intercepting the on-site groundwater plume.
- Influent concentrations to the existing treatment system will not exceed the design criteria.
- Groundwater quality is improving according to plan.

Problem Statement: A VOC plume that could represent a potential risk to human health has been defined on the BNL site. Remediation of the on-site plume has been conducted since December 1996. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project include:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) by 2030 been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Background (upgradient) wells (Decisions 1 and 2)
- Plume Core wells (Decisions 1, 2, 3, 4 and 5)
- Plume Perimeter wells, used to define the extent of the plume (Decisions 1, 2 and 5)
- Bypass Detection wells (Decisions 2 and 3)

The wells included in each subunit are shown in Table 12.5.1. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs and radionuclides in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.5.1)

- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- north side of the Current Landfill to the north
- wells 115-41 and 115-42 to the south
- west side of the Current Landfill and well 077-02 to the west
- wells 088-19, 088-62, 088-63, and 108-30 to the east
- saturated thickness of the Upper Glacial aquifer

Separate decisions will be made in the subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire study system. The temporal boundaries of the study area vary, based on the decision. Some decisions are based on the most recent sampling event, while others are based on historic trends (two to three years). Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells. **If** conditions indicate that the BNL Groundwater Contingency Plan needs to be implemented, **then** the Contingency Plan will be implemented.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency

Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal within 30 years, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goals, **then** a petition for shutdown will be issued to the regulatory agencies.

4a.
Are TVOC/Sr-90 concentrations in plume core wells above or below 50 µg/L or 8 pCi/L, respectively?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L and the Sr-90 concentrations are below 8 pCi/L, **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than 7 to 10 years, **then** continue treatment. **If not** ,and treatment has occurred for at least 7 to 10 years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, and system has operated for less than 7 to 10 years, **then** continue operation. **If yes**, and system has operated for more than 7 to 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d to help with this decision). **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Has the groundwater cleanup goal of meeting MCLs by 2030 been achieved?

If the concentration of total VOCs in groundwater from all plume core wells over the previous two years is less than 50 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation. Note: This assumes that system operation is already considered "optimal."

Step 6: Specify Acceptable Error Tolerances

Table 12.5.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan activated?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues, ultimate project delays. (2) Wasted resources , project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff, potential to have to restart system. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The well network consists of 49 wells located both on and off site.

Parameters and Frequency

The wells are sampled semi-annually for analysis of VOCs, tritium, gamma, and Sr-90, as shown in Table 12.1.2.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring program for this DQO.

Table 12.5.2 Proposed Modifications to the OU I South Boundary Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
087-21	Annually	No Change	None
088-13	Annually	No Change	None
088-14	Annually	No Change	None
088-20	Annually	No Change	None
088-26	Quarterly	No Change	None
098-21	Semi-annual	No Change	None
098-22	Semi-annual	No Change	None
098-30	Semi-annual	No Change	None
098-33	Annually	No Change	None
098-58	Annually	No Change	None
098-59	Semi-annual	No Change	None
098-61	Semi-annually	No Change	None
099-04	Semi-annually	No Change	None
107-10	Semi-annually	No Change	None
107-23	Semi-annually	No Change	None
107-24	Semi-annually	No Change	None
107-25	Semi-annually	No Change	None
107-26	Semi-annually	No Change	None
108-08	Annually	No Change	None
108-12	Annually	No Change	None
108-13	Annually	No Change	None
108-14	Annually	No Change	None
108-17	Annually	No Change	None
108-18	Annually	No Change	None
115-03	Annually	No Change	None
115-13	Semi-annually	No Change	None
115-14	Semi-annually	No Change	None
115-15	Semi-annually	No Change	None
115-16	Semi-annually	No Change	None
115-28	Semi-annually	No Change	None
115-29	Semi-annually	No Change	None
115-30	Annually	No Change	None
115-31	Semi-annually	No Change	None
115-36	Semi-annually	No Change	None
115-41	Semi-annually	No Change	None
115-42	Semi-annually	No Change	None
116-05	Semi-annually	No Change	None
116-06	Semi-annually	No Change	None
108-43	Semi-annually	No Change	None
108-44	Semi-annually	No Change	None
107-34	Semi-annually	No Change	None
107-35	Semi-annually	No Change	None
107-40	Quarterly	No Change	None
107-41	Quarterly	Semi-annually	VOCs
115-51	Quarterly	No Change	None
107-42	Semi-annually	No Change	None
108-45	Semi-annually	No Change	None
108-55	Semi-annually	No Change	None
108-56	Semi-annually	No Change	None

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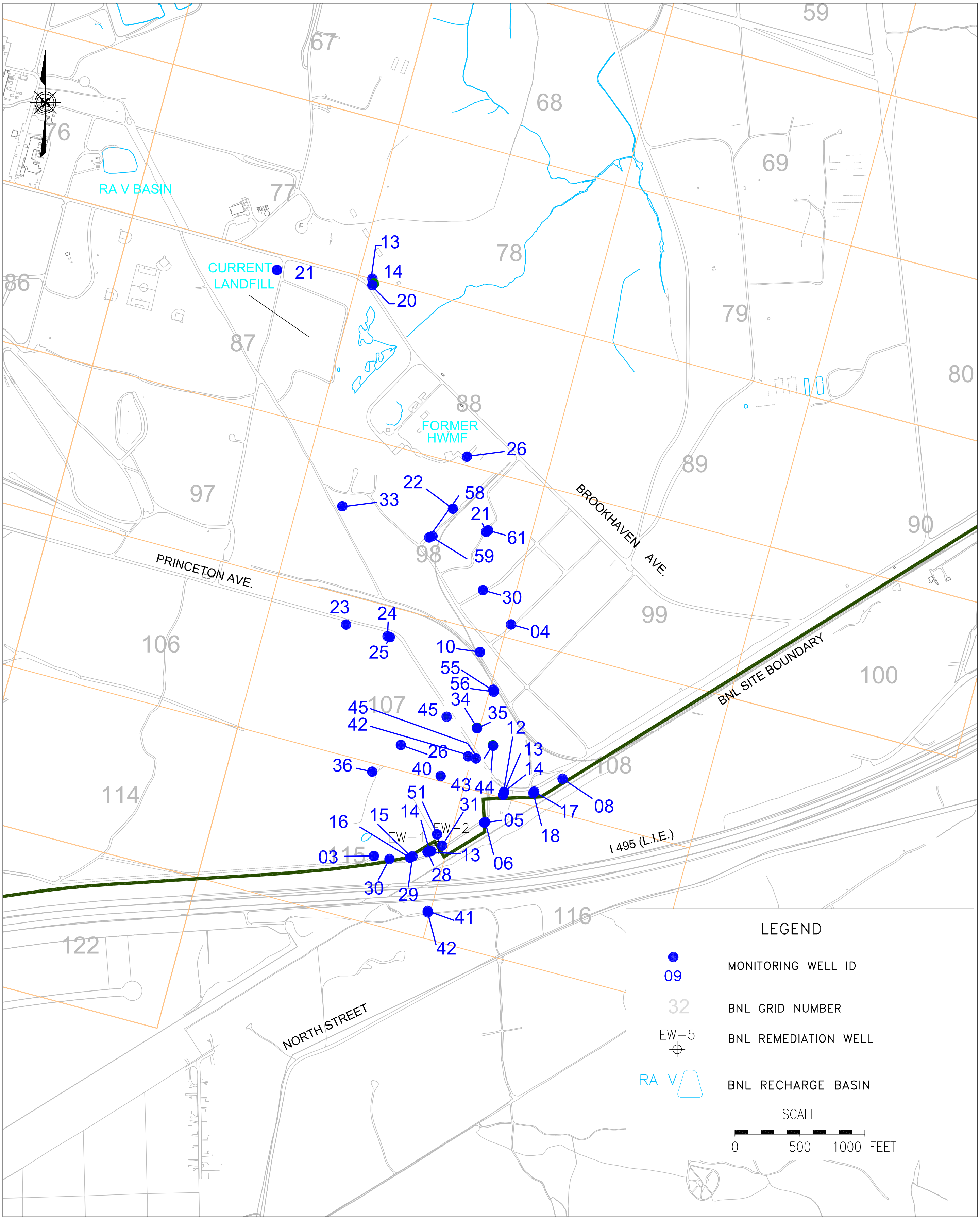

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE: OU I SOUTH BOUNDARY (RA V REMOVAL ACTION) PUMP AND TREAT SYSTEM MONITORING WELL LOCATIONS

DWN: JEB	VT: HZ.: —	DATE: 12/10/12	PROJECT NO.: 20335
CHKD: −−	APPD: −−	REV.: 11/12/14	NOTES: —
FIGURE NO.: 12.5.1			

OU III North Street

DQO Start Date

January 1, 2003

Revision Number/Date

Rev. 13, December 9, 2015

Implementation Date

January 1, 2016

Point of Contact

William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

Summary of Changes

The proposed changes for calendar year (CY) 2016 for the North Street Pump and Treat System and groundwater monitoring program include:

- Increase sampling of core monitoring wells to quarterly to obtain additional data to support treatment system shutdown petition.

Description and Technical Basis

The OU III North Street project monitors the downgradient extent of commingled contaminant plumes from several sources, including the Former Landfill, Chemical/Animal Holes, and the OU IV fuel oil/solvent spill. A groundwater remediation system began full operation in 2004. Groundwater treatment consists of two extraction wells operating at a combined pumping rate of 450 gpm. This pumping captures the higher concentration portion of the volatile organic compound (VOC) plume (i.e., TVOC concentrations greater than 50 µg/L) in the Upper Glacial aquifer, and minimize the potential for VOC migration into the Magothy aquifer. The source areas for this plume, including the Former Landfill, Chemical/Animal Holes, and Building 650 area, are monitored under separate projects.

The monitoring well network for the North Street project presently consists of 19 wells. Well locations are shown on Figure 12.6.1. The wells are sampled quarterly for analysis of VOCs. A monitoring schedule is provided in Table 12.1.1.

The primary VOCs associated with this plume are carbon tetrachloride, PCE, and TCA. TVOC concentrations greater than 1,000 µg/L were observed in 1997 and 1998, but have steadily declined since then.

Drivers for Monitoring Being Conducted under This Change

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

Data Quality Objective Analysis

Step 1: State the Problem

Groundwater in the south-central portion of the BNL site and off site has been impacted by VOCs at concentrations exceeding New York State groundwater standards. Monitoring data are needed to verify the effectiveness of the treatment system and attenuation of the VOC contaminants.

Step 2: Identify the Decision

The decisions for the project are:

- Are unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goals been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- VOC and radionuclide analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits

Step 4: Define the Study Boundaries

The project decision unit limits are:

- Background water quality is defined by the three monitored wells upgradient of the plume core wells (086-05, 086-43, and 086-70).

- The VOC plume core is defined as the area impacted by TVOCs above 50 µg/L, including wells 000-108, 000-153, 000-154, 000-212, 000-463, 000-464, 000-465, 000-467, 000-470, 000-472, and 115-32.

- The VOC plume fringe is the area surrounding the plume core (horizontally and vertically) where TVOC concentrations are less than 50 µg/L.

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. Because the VOC contaminant plume has already passed the southern BNL site boundary and therefore has the potential to impact off-site receptors, tracking the plume configuration over time is of critical importance. Since the analytical results from the plume core and plume fringe wells are used to monitor the VOC plume configuration, the timeframe for decisions using these results is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells. **If** conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume perimeter or bypass detection wells to above 50 µg/L (if currently less than 50 µg/l) or a significant increase in TVOC concentration (if currently above 50 µg/L).

If the TVOC concentration trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this is consistent with professional judgment, and the TVOC concentration is less than 50 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 µg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L?

If the TVOC concentration in each plume core well has been reduced to less than 50 µg/L **then** proceed with pulsed operation of the system. **If not**, **then** continue full time treatment. **If not**, and treatment has occurred for at least 10 years, **then** consider performing an evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, **then** continue operation. **If yes**, and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 4

Has the groundwater cleanup goal been achieved?

If the concentration of VOCs in groundwater are less than MCLs, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.6.1 summarizes the decision and possible decision errors for this project.

Table 12.6.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Does the existing contaminant plume represent a potential risk to downgradient receptors?	See Step 3 for inputs.	(1) Data indicate the plume represents a risk when it does not. (2) Data indicate the plume does not represent a risk when it does.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential risk to downgradient receptors.
Is the remediation system adequate to intercept and treat the existing contamination to prevent impacts to potential downgradient receptors?	See Step 3 for inputs.	(1) Data indicate the system is not adequate when it will be. (2) Data indicate the system is adequate when it will not be.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential bypass of contaminants.
Are there off-site radionuclides that would trigger additional actions?	See Step 3 for inputs.	(1) Data indicate evidence for a plume when one does not exist. (2) Data indicate no evidence for a plume when one exists.	(1) Wasted resources evaluating and implementing additional actions. (2) Potential risk to downgradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The well network consists of 19 wells located both on and off site. The location of the wells are shown in Figure 12.6-1.

Parameters and Frequency

A summary of the revisions to the sampling program is provided in Table 12.6.2.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.6.2 Proposed Modifications to the OU III North Street Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-108	Semi-Annual	Quarterly	VOCs
000-153	Semi-Annual	Quarterly	VOCs
000-154	Semi-Annual	Quarterly	VOCs
000-211	Annual	None	None
000-212	Semi-Annual	Quarterly	VOCs
000-213	Semi-Annual	None	None
000-343	Annual	None	None
000-463	Quarterly	None	None
000-464	Semi-Annual	Quarterly	VOCs
000-465	Quarterly	None	None
000-466	Semi-Annual	None	None
000-467	Semi-Annual	Quarterly	VOCs
000-468	Semi-Annual	None	None
000-470	Semi-Annual	Quarterly	VOCs
000-472	Quarterly	None	None
000-472	Annual	None	None
000-474	Semi-Annual	Quarterly	VOCs
000-475	Annual	Quarterly	VOCs
000-476	Annual	None	Tritium
800-63	Semi-Annual	None	None

See Appendix B for the monitoring program for this DQO.

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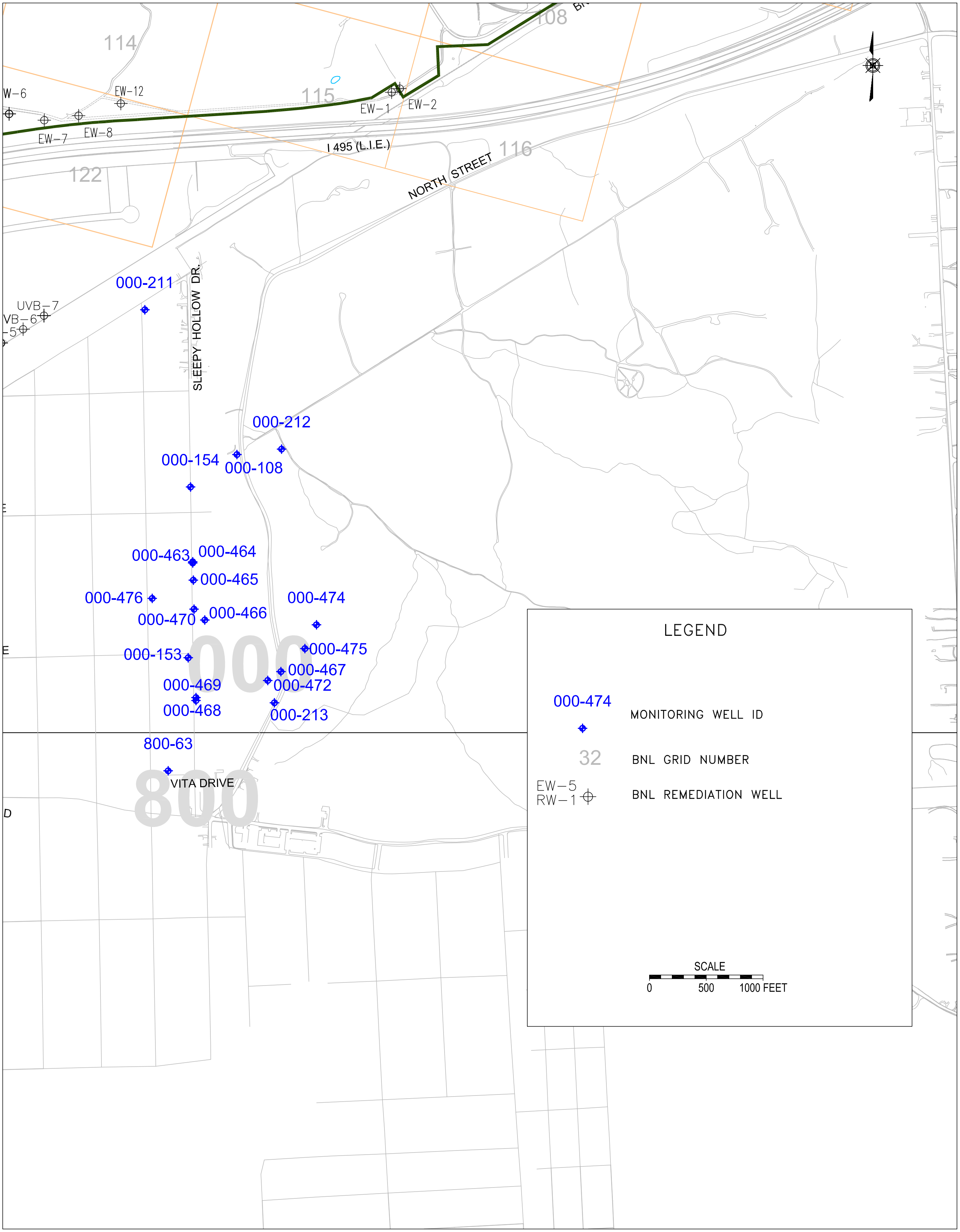

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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III NORTH STREET MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
KCK	–	12/10/12	20335
CHKD: WRD	APPD: WRD	REV.: JEB	NOTES: –

FIGURE NO.: 12.6.1

OU III HIGH FLUX BEAM REACTOR

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 13, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

Proposed changes for calendar year (CY) 2016 for the HFBR Tritium Pump and Recharge System and groundwater monitoring program include:

- Discontinue sampling of 24 monitoring wells located south of Temple Place. Due to the attenuation of the plume, the monitoring program has been limited to the wells in the immediate vicinity of the HFBR.

DESCRIPTION AND TECHNICAL BASIS

In late 1996, tritium was detected in wells near the HFBR. The source of the release was traced to the HFBR spent fuel pool. In response, the fuel rods were removed from the pool for off-site disposal, the spent fuel pool was drained, and the HFBR was removed from service in 1997. Also, numerous monitoring wells were constructed to characterize the tritium plume downgradient of the HFBR. In May 1997, operation of a three-well groundwater extraction system began. This system was constructed on Princeton Avenue approximately 3,500 feet downgradient of the HFBR to capture the tritium contamination and ensure that off-site migration of the plume would not occur. Extracted water was recharged through the RA V recharge basin. As described in the Operable Unit (OU) III Record of Decision (ROD), the selected remedy to address the HFBR tritium plume included implementation of monitoring and low-flow extraction programs to prevent or minimize plume expansion. Because it had been demonstrated that the remaining tritium plume would naturally attenuate to below drinking water standards before reaching the BNL site boundary, the extraction system was initially placed on standby status in September 2000.

In 2007, the detection of tritium at concentrations above 25,000 pCi/L in wells at the Chilled Water Plant Road and above 20,000 pCi/L in wells along Weaver Drive necessitated the reactivation of the Princeton Avenue pumping system. After tritium concentrations in areas south of Cornell Avenuedecreased to less than 20,000 pCi/L, the system was placed back on standby status in May 2013.

Because the tritium concentrations south of Cornell Avenue has attenuated to <20,000 pCi/L over the past several years, starting in 2016 monitoring has been reduced to the wells in the immediate vicinity of the HFBR. The monitoring well network for the OU III HFBR project includes 36 wells that provide groundwater quality data in the vicinity of the source area. Well locations are shown on Figure 12.7.1. Depending on location, wells are sampled quarterly, semi-annually, or annually for analysis of tritium. Three monitoring wells are analyzed for volatile organic compounds (VOCs), as shown in Table 12.1.1. If concentrations of tritium increase, this monitoring program may be supplemented with temporary wells .

Groundwater flow in the vicinity of the HFBR can be influenced by BNL pumping and recharge sources in the area. In general, groundwater flow is toward the south or southeast. Evaluation of groundwater flow and quality data indicates that the downgradient portion of the tritium plume (south of Brookhaven Avenue) has shifted to the east since 1997, in response to changing flows to the HO recharge basin, the use of the OU III recharge basin, and the pumping of BNL supply wells 10, 11, and 12.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater beneath the BNL site has been impacted by tritium from historical leakage from the HFBR spent fuel pool. Data are needed to verify that the tritium is naturally degrading according to the attenuation model.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected? Is the plume attenuating as expected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

Step 3: Identify Inputs to the Decision

The project was divided into two decision subunits to reflect the categories of wells for which decisions will be made with respect to the tritium plume. The identified subunits and the decisions supported by each are:

- Plume core wells, located within the high concentration segment of the plume (Decisions 1, 2, 3 and 5)
- Perimeter wells, located outside the high concentration segment of the plume and contain tritium at low or non-detect activities (Decisions, 2, 3 and 4)

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Tritium analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels defined in the OU III ROD
- Analytical methods and detection limits
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- Rutherford Drive on the north
- Princeton Avenue (wells 105-22, 105-23, 105-29, 105-43, and 105-44) on the south
- Wells 096-117 and 096-118 on the east
- Rochester Street, on the west
- Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. Due to variability in groundwater flow direction for different areas of the plume and the specific actions to be taken in response to certain observed conditions (as specified in the ROD), the project has also been divided into geographic segments based on the timeframe for decisions to be made for wells in these areas. The segments and timeframes for each decision subunit within the area are:

- *HFBR Area:* This segment encompasses the wells around the HFBR, including upgradient wells and the area extending to approximately 250 feet south of Temple Place. The decision timeframe for plume core and perimeter wells in the HFBR area is 90 days, due to the expected slow change in tritium activities for these wells. For the outer perimeter wells, decisions will be made using a 365-day timeframe, because perimeter wells are located between the outer perimeter wells and the plume core wells.

- *RA V Recharge Basin:* Since the treatment system has been placed in stand by status, monitoring around the recharge basin has been discontinued.

- *Brookhaven Avenue:* This segment is downgradient of the HFBR area and includes the wells along Brookhaven Avenue, except those around the RA V basin. Wells in this area measure the rate of attenuation. Decisions for plume core and perimeter wells will be made using a 90-day timeframe. As with the HFBR area, the decision timeframe for outer perimeter wells in this segment is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Rowland Street:* This segment includes the wells along Rowland Street. Evaluation of data from these wells measures plume attenuation. Therefore, a timeframe for decisions of 90 days for plume core and perimeter wells in this area is warranted. As with the HFBR area, the decision timeframe for outer perimeter wells in this segment is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Chilled Water Plant Road and Weaver Drive:* The wells in these two segments are located along and east of the Chilled Water Plant Road (Chilled Water Plant Road segment) and along Weaver Drive and Grove Street (Weaver Drive segment). Because data from wells in these segments will be utilized to determine whether the contingency actions specified in the ROD will be implemented, the decision timeframe for plume core and perimeter wells in these segments is 90 days. As with the HFBR area and Rowland Street segments, the decision timeframe for outer perimeter wells in these segments is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

- *Princeton Avenue:* This segment includes outer perimeter wells downgradient of the plume along Princeton Avenue and Middle Road. As with the other outer perimeter wells, because perimeter wells are located between these wells and the plume core wells, the decision time-frame is 365 days. Due to the attenuation of the tritium plume, monitoring in this area has been discontinued. If upgradient concentrations increase, monitoring can be re-initiated.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells immediately downgradient of the HFBR source area will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine whether additional source controls are needed.

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high tritium concentrations.. **If** these conditions occur, **then** the Contingency Plan will be implemented.

Decision 2

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high tritium concentrations,, or the detection of tritium in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Is the plume attenuating as expected?

If the detected tritium concentrations are consistent with the attenuation model, groundwater model results, and professional judgment, **then** continue attenuation monitoring. **If not**, **then** consider refining the conceptual model or conducting an engineering evaluation to determine if other actions are required.

Decision 4

Has the downgradient migration of the plume been controlled?

As described in the OU III ROD, plume growth is defined as a detection of tritium at an activity above 25,000 pCi/L in wells at the Chilled Water Plant Road or above 20,000 pCi/L in wells along Weaver Drive. Exceedances of these activities will necessitate implementation of specific actions described in the ROD.

If the detected tritium activity exceeds 25,000 pCi/L in perimeter wells at the Chilled Water Plant Road or 20,000 pCi/L in perimeter wells at Weaver Drive, **then** implement the response actions prescribed in the OU III ROD.

Decision 5

Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

If tritium concentrations from Weaver Drive to extraction well EW-16 drop below 20,000 pCi/L, **then** EW-16 will be placed in stand-by mode.

Step 6: Specify Acceptable Error Tolerances

Table 12.7-1 summarizes the decision and possible decision errors for this project.

Step 7: Optimize the Design

Given the current knowledge of the position of the plume, based on the recent characterization data and the extensive volume of historical data, the sampling frequencies have been reduced in the following manner:

- Due to the attenuation of the plume, the monitoring program is now limited to the wells in the immediate vicinity of the HFBR where tritium concentrations occasionally exceed 20,000 pCi/L. Therefore, sampling of 24 monitoring wells located south of Temple Place has been discontinued.

Number and Locations of Wells

The network of 36 wells is used for the HFBR Groundwater Monitoring Program is shown in Figure 12.7.1. Table 12.1.1 presents the decision subunits. Up to six monitoring wells are sched-uled to be installed immediately north of Cornell Ave. in 2016 to supplement the current source area monitoring well network. In addition, this monitoring program may be supplemented with temporary wells, as needed.

Parameters and Frequency

The monitoring schedule is shown in Table 12.1.1. The analytical parameters and sampling frequency currently conducted for this project are considered adequate.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.7-1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is the tritium plume growth minimized?	See Step 3 for inputs.	(1) Data indicate that the plume is growing when it is not. (2) Data indicate that the plume is not growing when it is.	(1) Wasted resources, loss of stakeholder confidence. (2) Potential bypass of tritium, project delays, potential risk to downgradi-ent receptors.
Are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements. (2) Potential bypass of tritium, project delays, potential risk to downgradi-ent receptors.
Is the tritium plume migrating toward the zone of influence of BNL water supply wells 10, 11, and 12?	See Step 3 for inputs.	(1) Data indicate that the plume is migrating toward the supply wells when it is not. (2) Data indicate that the plume is not migrating toward the supply wells when it is.	(1) Wasted resources conducting continued unnecessary monitoring. (2) Potential bypass of tritium, project delays, potential risk to receptors.
Has any segment of the plume migrated beyond the current monitoring network?	See Step 3 for inputs.	(1) Data indicate that plume has migrated beyond the network when it has not. (2) Data indicate that plume has not migrated beyond the network when it has.	(1) Wasted resources conducting evaluation of alternatives. (2) Potential bypass of tritium, project delays, potential risk to downgradi-ent receptors.

Note: See also Table 12.7.2 for sampling frequency and affected parameters.

Table 12.7-2 Modifications to the HFBR Monitoring Wells

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
065-37	Annually	No Change	None
065-41	Annually	No Change	None
075-11	Semi-annually	No Change	None
075-208	Semi-annually	None	Tritium
075-209	Annually	None	Tritium
075-210	Annually	None	Tritium
075-211	Annually	None	Tritium
075-224	Quarterly	No Change	None
075-225	Quarterly	No Change	None
075-226	Semi-annually	No Change	None

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
075-227	Semi-annually	No Change	None
075-228	Quarterly	No Change	None
075-229	Quarterly	No Change	None
075-230	Quarterly	No Change	None
075-231	Quarterly	No Change	None
075-232	Semi-annually	No Change	None
075-233	Quarterly	No Change	None
075-234	Quarterly	No Change	None
075-235	Semi-annually	No Change	None
075-236	Semi-annually	No Change	None
075-237	Quarterly	No Change	None
075-238	Semi-annually	No Change	None
075-239	Quarterly	No Change	None
075-240	Quarterly	No Change	None
075-241	Quarterly	No Change	None
075-242	Quarterly	No Change	None
075-244	Quarterly	No Change	None
075-245	Quarterly	No Change	None
075-285	Semi-annually	No Change	None
075-286	Annually	No Change	None
075-287	Annually	No Change	None
075-288	Annually	No Change	None
075-291	Semi-annually	None	Tritium
075-292	Semi-annually	None	Tritium
075-293	Semi-annually	None	Tritium
075-295	None	Tritium	None
075-40	Annually	No Change	None
075-42	Monthly	No Change	None
075-43	Monthly	No Change	None
075-44	Monthly	No Change	None
075-45	Monthly	No Change	None
075-558	Semi-annually	No Change	None
075-88	Semi-annually	None	Tritium
075-89	Semi-annually	None	Tritium
096-55	Quarterly	None	Tritium
096-82	Quarterly	None	Tritium
105-22	Quarterly	None	Tritium
105-29	Quarterly	None	Tritium
105-43	Quarterly	None	Tritium
105-44	Quarterly	None	Tritium
105-65	Quarterly	None	Tritium
096-115	Quarterly	None	Tritium
096-116	Quarterly	None	Tritium
096-117	Quarterly	None	Tritium
096-118	Quarterly	None	Tritium

See Appendix B for the monitoring program for this DQO.

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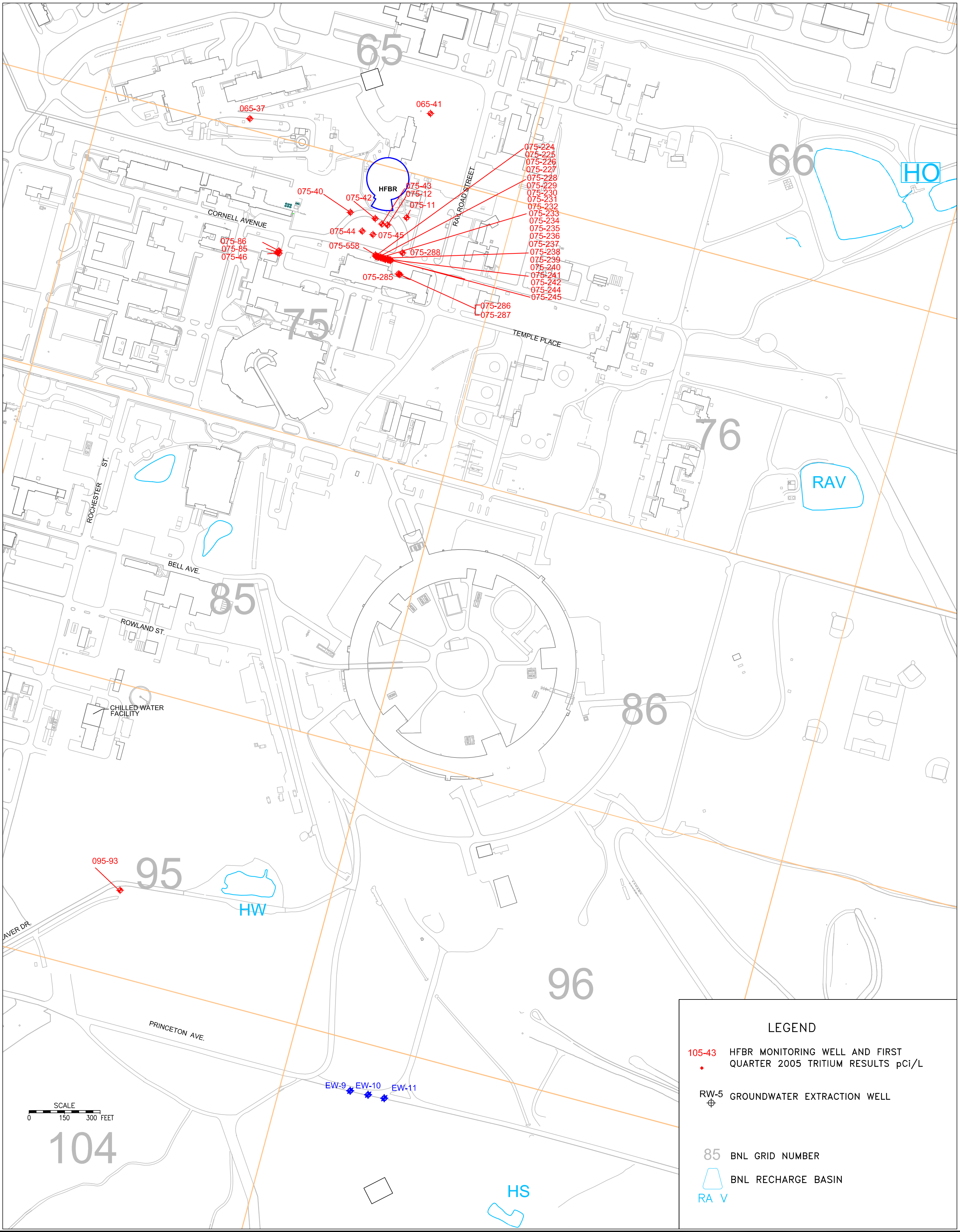

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BROOKHAVEN NATIONAL LABORATORY EP DIVISION	TITLE: OU III HFBR AOC 29 TRITIUM MONITORING WELL LOCATIONS	DWN: JEB	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
		CHKD: – –	APPD: –	REV.: 12/15/15	NOTES: –
		FIGURE NO.: 12.7.1			

OU III BGRR/WCF STRONTIUM-90

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 13, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES/PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 for the Brookhaven Graphite Research Reactor (BGRR) Waste Concentration Facility (WCF) Groundwater Treatment System and Monitoring Program.

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DESCRIPTION AND TECHNICAL BASIS

The Operable Unit (OU) III BGRR/WCF project monitors the extent of a Sr-90 plume in groundwater on site. Some of the wells included in the OU III BGRR/WCF network are also monitored for tritium as part of the OU III Area of Concern (AOC) 29 High Flux Beam Reactor (HFBR) Tritium program. The overlapping wells are sampled concurrently for both programs to avoid duplication of effort. As this summary only addresses the OU III BGRR/WCF project, evaluation of the sampling frequency and analytical parameters for the OU III HFBR Tritium project is conducted separately.

The OU III BGRR/WCF project only monitors the existing Sr-90 groundwater plumes and was not designed to monitor the contaminant sources. Other monitoring programs have been implemented to address the demolition of the BGRR. The current monitoring well network for the OU III BGRR/WCF project consists of 95 wells. The locations are shown on Figure 12.8.1. The wells are sampled annually to semi-annually for analysis of Sr-90. The monitoring schedule is provided in Table 12.1.1.

The analytical results show several distinct areas of elevated Sr-90−one emanating from the WCF and extending approximately 1,300 feet south and another beginning south of the BGRR and extending south approximately 1,200 feet. The third area of elevated Sr-90 concentrations begins at the PFS area and extends south for a distance of approximately 600 feet. Variability in groundwater flow directions due to changes in pumping and recharge patterns in the plume vicinity over time have resulted in lateral spreading of the contamination.
In addition, evaluation of various scenarios for potable water supply at the BNL site has shown that if eastern supply wells 10, 11, and 12 are used as the primary source of potable water for an extended period of time, the capture zone for these supply wells may extend to near the BGRR. This could result in the Sr-90 contamination being drawn into the supply wells. The BNL Water and Sanitary Planning Committee is charged with monitoring supply well usage across the site to minimize any impacts from changing groundwater flow on contaminant plumes.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

In the Upper Glacial aquifer beneath the central portion of the BNL site, there is an area of groundwater contaminated by Sr-90. In response, groundwater characterization and remediation is in progress. Data are needed to continue to track the vertical and horizontal extent of the contamination.

Step 2: Identify the Decisions

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Sr-90 analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Regulatory drivers (OU III Record of Decision [ROD])
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data
- Status of potential downgradient receptors
- Estimated retardation rate for Sr-90

Step 4: Define the Study Boundaries

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. The horizontal extent of the study area is defined by the area of the Upper Glacial aquifer downgradient of the BGRR/WCF with detectable activities of Sr-90. Due to the slow travel time for Sr-90 in groundwater, the timeframe for decisions is 180 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as a significant increase in Sr-90 concentration in plume perimeter or bypass detection.

If the trend in each plume perimeter and bypass detection well has a negative or zero slope based on the four most recent consecutive samples and this trend is consistent with professional judgment, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from all wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume core and bypass detection wells. **If** the system is performing as planned, **then** actual Sr-90 concentrations in plume core and bypass detection wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation of the reason for the difference.

If the system is performing as planned (based on groundwater model predictions, trend analysis, and expert judgment), **then** continue to operate. **If not**, **then** consider operational adjustments and/or engineering evaluation. Note: When the majority and/or “key” wells, as defined by a subject matter expert, are performing as planned, the system as a whole is considered to be properly operating.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

All of the following decision subunits must be satisfied in order to shut down an extraction well.

4a. Are the Sr-90 concentrations in the plume core wells above or below 8 pCi/L?

This decision also applies to the plume core wells. **If** the Sr-90 concentration remain below 8 pCi/L, **then** it is reasonable to expect (based on model projections) that monitored natural attenuation of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs by 2070. **If** the Sr-90 concentration remains above 8 pCi/L, **then** consider operational adjustments and/or engineering evaluation.

4b. Has there been a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, and system has operated for less than 10 years, **then** continue operation. **If yes**, and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If no**, significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Step 6: Specify Acceptable Error Tolerances

Table 12.8-1 summarizes the decision and possible decision errors for this project.

Table 12.8-1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Was the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is the extent of the Sr-90 plume still defined by the existing monitoring well network?	See Step 3 for inputs.	(1) Data indicate the plume is not defined by existing wells when it is. (2) Data indicate the plume is defined by existing wells when it is not.	(1) Wasted resources evaluating, possibly constructing and sampling additional wells. (2) Potential bypass of contaminants and potential risk to downgradient receptors.
Can Sr-90 contamination impact existing or planned groundwater remediation systems?	See Step 3 for inputs.	(1) Data indicate the plume will impact systems when it will not. (2) Data indicate the plume will not impact systems when it will.	(1) Wasted resources conducting technical evaluations and possible system modifications. (2) Potential for inadequate treatment or system failure due to contamination beyond design limits.
Is the Sr-90 plume migrating toward BNL supply wells 10, 11 and 12?	See Step 3 for inputs.	(1) Data indicate the plume is migrating toward supply wells when it is not.	(1) Wasted resources conducting technical evaluations; loss of use of supply wells 10, 11

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
		(2) Data indicate the plume is not migrating toward supply wells when it is.	and 12. (2) Potential risk to receptors through ingestion of im- pacted water.
Is the plume controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not con- trolled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is perform-ing as planned when it is not. (2) Determine system is not per- forming as planned when it is.	(1) Delay in making opera- tional adjustments; avoidable growth of plume. (2) Wasted resources considering/implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic con- ditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program, consisting of 95 monitoring wells.

Parameters and Frequency

Monitoring wells are sampled on either an annual or semiannual schedule. Well-specific sam- pling frequency and parameter information is provided in Table 12.1.1.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.8-2 Modifications to the BGRR Monitoring Wells

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
065-03	Annual	No Change	None
065-04	Annual	No Change	None
065-06	Annual	No Change	None
065-160	Annual	No Change	None
065-161	Annual	No Change	None
065-162	Annual	No Change	None
065-163	Annual	No Change	None
065-164	Annual	No Change	None
065-165	Annual	No Change	None
065-166	Annual	No Change	None
065-167	Annual	No Change	None
065-169	Annual	No Change	None
065-170	Annual	No Change	None

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
065-171	Annual	No Change	None
065-172	Annual	No Change	None
065-173	Annual	No Change	None
065-174	Annual	No Change	None
065-175	Semiannual	No Change	None
065-176	Annual	No Change	None
065-178	Annual	No Change	None
065-18	Annual	No Change	None
065-19	Annual	No Change	None
065-20	Annual	No Change	None
065-360	Annual	No Change	None
065-361	Annual	No Change	None
065-362	Annual	No Change	None
065-363	Annual	No Change	None
065-364	Annual	No Change	None
065-365	Annual	No Change	None
065-405	Annual	No Change	None
065-367	Annual	No Change	None
065-37	Annual	No Change	None
065-38	Semiannual	No Change	None
065-384	Semiannual	No Change	None
065-385	Semiannual	No Change	None
065-39	Semiannual	No Change	None
065-40	Semiannual	No Change	None
075-09	Annual	No Change	None
075-10	Annual	No Change	None
075-188	Annual	No Change	None
075-189	Annual	No Change	None
075-190	Annual	No Change	None
075-191	Annual	No Change	None
075-192	Annual	No Change	None
075-193	Annual	No Change	None
075-194	Annual	No Change	None
075-195	Annual	No Change	None
075-196	Annual	No Change	None
075-197	Annual	No Change	None
075-198	Annual	No Change	None
075-199	Annual	No Change	None
075-200	Annual	No Change	None
075-201	Annual	No Change	None
075-202	Annual	No Change	None
075-203	Annual	No Change	None
075-39	Annual	No Change	None
075-40	Annual	No Change	None
075-41	Annual	No Change	None
075-46	Annual	No Change	None
075-47	Semiannual	No Change	None
075-48	Semiannual	No Change	None
075-663	Annual	No Change	None
075-664	Monthly	No Change	None
075-665	Annual	No Change	None
075-666	Annual	No Change	None

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
075-667	Annual	No Change	None
075-668	Annual	No Change	None
075-669	Annual	No Change	None
075-670	Semiannual	No Change	None
075-671	Semiannual	No Change	None
075-672	Annual	No Change	None
075-673	Annual	No Change	None
075-674	Annual	No Change	None
075-675	Annual	No Change	None
075-680	Annual	No Change	None
075-681	Annual	No Change	None
075-682	Semiannual	No Change	None
075-683	Annual	No Change	None
075-684	Annual	No Change	None
075-85	Annual	No Change	None
075-86	Annual	No Change	None
075-87	Semiannual	No Change	None
075-705	Semiannual	No Change	None
075-706	Semiannual	No Change	None
075-707	Semiannual	No Change	None
065-401	Semiannual	No Change	None
075-699	Semiannual	No Change	None
075-700	Semiannual	No Change	None
065-402	Semiannual	No Change	None
075-701	Monthly	No Change	None
065-404	Semiannual	No Change	None
085-398	Semiannual	No Change	None
085-399	Semiannual	No Change	None
085-402	Semiannual	No Change	None
065-325	Semiannual	No Change	None

See Appendix B for the monitoring schedule for this DQO.

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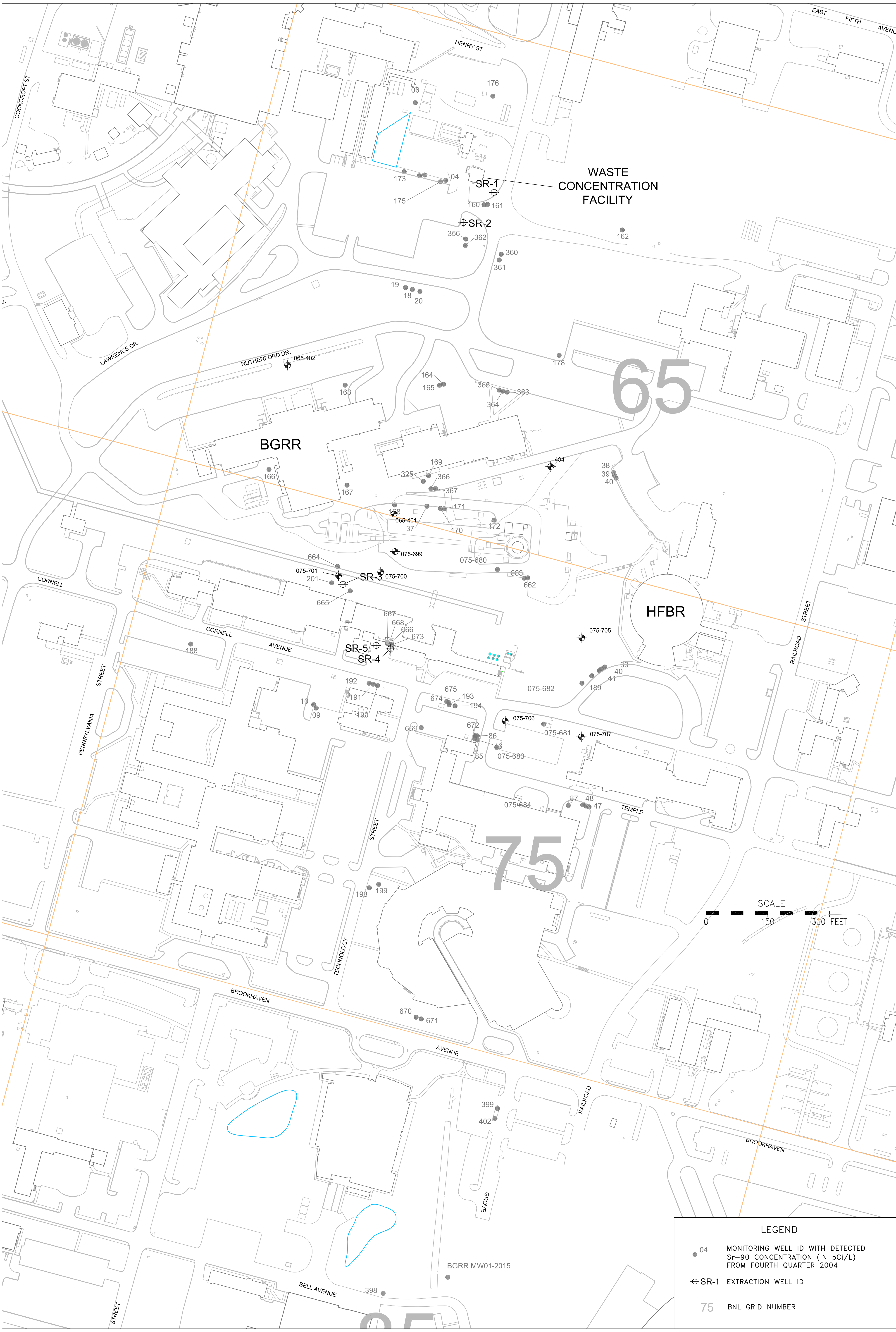


T:\Technical Support\LOGO.BMP EP DIVISION	TITLE: OU III BGRR/WCF MONITORING WELL LOCATIONS	DWN: JEB	VT:HZ.: –	DATE: 12/10/12
		CHKD: – –	APPD: – –	REV.: 12/15/15
			PROJECT NO.: 20335	NOTES: –
		FIGURE NO.: 12.8.1		

OU III CENTRAL POST-ROD

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 for the OU III Central Groundwater Monitoring Program.

DESCRIPTION AND TECHNICAL BASIS

The OU III Remedial Investigation identified several low-level (less than 100 µg/L) source areas and nonpoint contaminant sources within the developed central areas of the BNL site. These sources include spills within the Alternating Gradient Synchrotron (AGS) Complex and at the storage area for site maintenance equipment (Building 208), and other sources. Because these sources are not significant enough to warrant a dedicated monitoring program, they are monitored under the OU III Central project. In addition, this project includes sentinel wells for the Suffolk County Water Authority (SCWA) William Floyd Parkway well field, and wells 109-03 and 109-04 near the BNL site boundary.

The monitoring well network for the OU III Central project consists of 9 wells that provide groundwater quality data in the vicinity of the source areas and at downgradient locations. Well locations are shown on Figure 12.9.1. The wells are sampled quarterly for analysis of VOCs and annually for analysis of gross alpha/beta, gamma spectroscopy, tritium, and strontium-90 (Sr-90), as shown in Tables 12.1.1 and 12.1.2.

The contaminants of concern associated with the sources monitored by the OU III Central wells are VOCs. During calendar year (CY) 2010, most of the wells contained VOCs at concentrations less than the New York State groundwater standards, with the exception of wells 065-02 and 076-317. Well 065-02 had a TCA concentration of 7.6 µg/L and well 076-317 had a PCE concentration of 6.2 µg/L, which are both above the NYS AWQS of 5 µg/L for each compound. No radionuclides were detected at an activity above New York State groundwater standards in any of the OU III Central wells. Groundwater flow in the central portion of the BNL site is locally variable due to BNL pumping and recharge sources in the area. In general, groundwater flow is toward the south or southeast.

Drivers for Monitoring Being Conducted under This Change

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

Data Quality Objective Analysis

Step 1: State the Problem

Groundwater beneath the BNL site has been impacted by low levels of VOCs from historic operations at several isolated areas. Because active remediation of these commingled plumes is not being conducted, data are needed to verify that the contaminants are naturally degrading according to the attenuation model.

Step 2: Identify the Decision

The decisions for the project are:

- Is the contamination naturally attenuating as expected?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- VOC analytical results in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.9.1)
- Regulatory drivers (OU III Record of Decision [ROD])
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- Cornell Avenue (well 064-03) on the north
- Middle Road (wells 113-06 and 113-07) and Ashton Lane (wells 109-03 and 109-04) on the south
- HO Basin and RA V Basin on the east
- William Floyd Parkway on the west
- Upper Glacial and shallow Magothy aquifers

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Is the contamination naturally attenuating as expected?

If the detected contaminant concentrations are consistent with the expected results, **then** continue attenuation monitoring. **If not**, consider conducting an engineering evaluation to determine if other actions are required.

Decision 2

Has the groundwater cleanup goal of meeting MCLs been achieved?

According to the ROD for OU III, concentrations of individual VOCs will be reduced to below MCLs within 30 years. Portions of the plumes may attenuate to below MCLs before active remediation is instituted.

If, for all wells the mean concentration of each VOC in groundwater computed from the previous four consecutive sampling events is less than the compound-specific MCL, and the computed mean is consistent with professional judgment, **then** petition for closure of the remedial action. Otherwise, continue attenuation monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.9.1 summarizes the decision and possible decision errors for this project.

Table 12.9.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Are performance objectives met?	See Step 3 for inputs.	(1) Data indicate that MCLs have not been met when they have. (2) Data indicate that MCLs have been met when they have not.	(1) Wasted resources conducting continued unnecessary monitoring. (2) Potential bypass of contaminants; project delays, potential risk to downgradient receptors.
If not, are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements and introducing supplements. (2) Potential bypass of contaminants; project delays; potential risk to downgradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consisting of 9 monitoring wells is sufficient to monitor the OU III Central area.

Parameters and Frequency

The wells are sampled annually for VOCs with the exception of 109-03 and 109-04, which are sampled quarterly. Select wells are analyzed annually for radionuclides, as shown in Table 12.10.2.

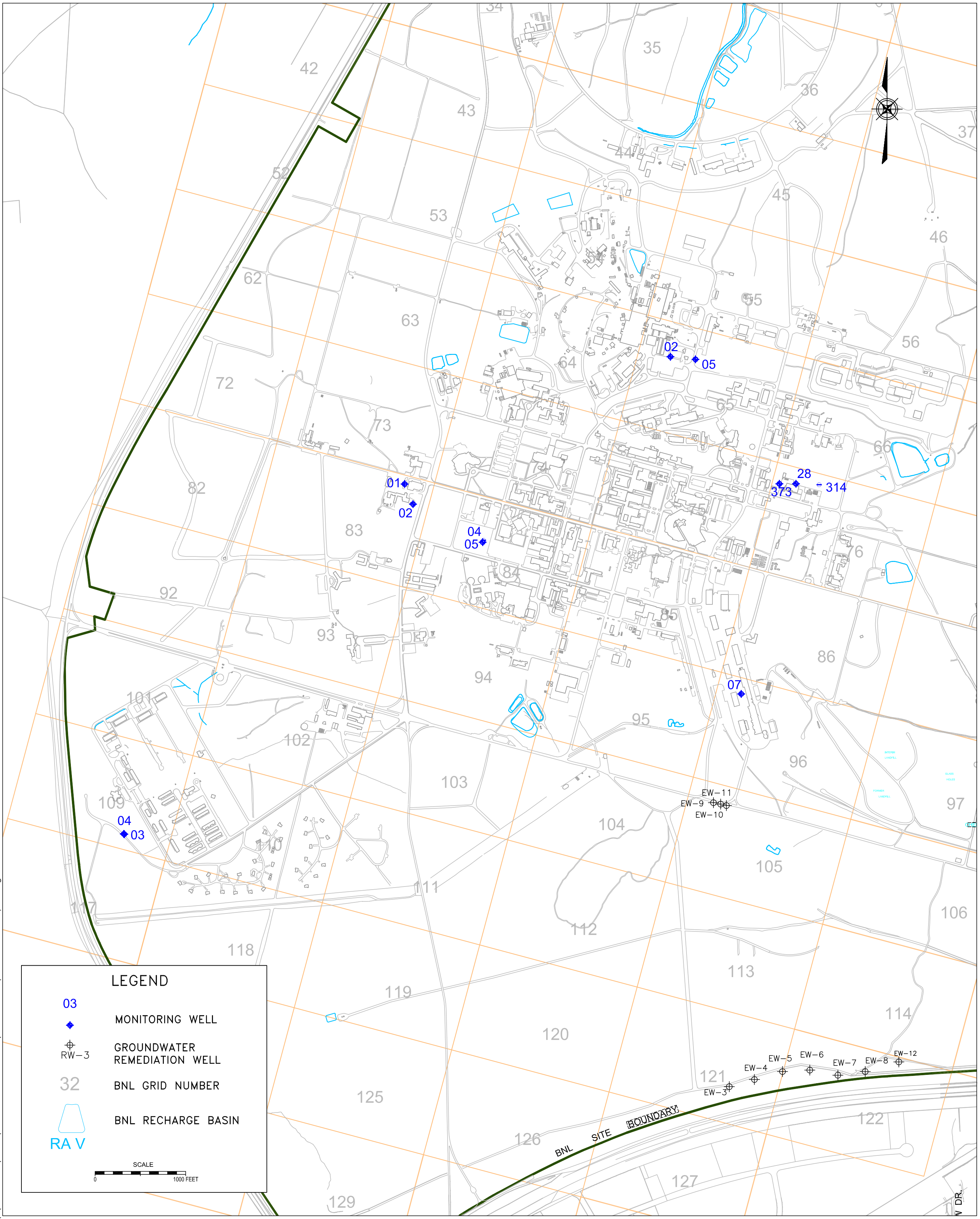
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

12.9.2 Modifications to the OU III Central Sampling Program

Well	Current Sampling Frequency	Sampling Frequency Changes	Affected Parameters
065-02	Annually	No Change	None
076-28	Annually	No Change	None
076-317	Annually	No Change	None
076-373	Annually	No Change	None
083-01	Annually	No Change	None
083-02	Annually	No Change	None
084-04	Annually	No Change	None
109-03	Quarterly	No Change	None
109-04	Quarterly	No Change	None

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III CENTRAL POST-ROD MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	—	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
JEB	--	11/12/14	—

FIGURE NO.: 12.9.1

OU III BUILDING 96 AREA

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Robert Howe (631) 344-5588

SUMMARY OF CHANGES

Proposed changes for calendar year (CY) for the OU III Building 96 groundwater monitoring program include:

- Due to significant reduction of hexavalent chromium in the monitoring wells over the last several years, further sampling will be eliminated.

DESCRIPTION AND TECHNICAL BASIS

Solvents were historically used at a former vehicle maintenance and drum storage area located immediately west of the Supply and Materiel area. While no spills were documented in this area, soil and groundwater samples collected during the Operable Unit (OU) III Remedial Investigation contained high concentrations of PCE and TCA, especially in shallow groundwater. These results indicate that spillage has historically occurred in this area and a narrow plume (approximately 200 feet wide) has been defined migrating south from the area of Building 96.

The identified groundwater contamination was addressed by construction of a treatment system consisting of four recirculation wells (RTW-1, -2, -3, and -4). Well RTW-1 is in the area where the highest concentrations of volatile organic compounds (VOCs) were detected. The remaining three wells (RTW-2, -3, and -4) are further south (downgradient) in an east–west line to intercept the plume migrating south of RTW-1. Well locations are shown on Figure 12.11.1. Impacted groundwater is extracted through the well's lower screen, treated via air stripping, and recharged through the well's upper screen. Operation of the system began during CY 2001. On July 13, 2004, wells RTW-2, -3, and -4 were placed in standby mode due to reduced VOC concentrations in the plume. The system continued to operate utilizing well RTW-1 only. Influent samples from wells RTW-2, -3, and -4 continued to be collected quarterly. Due to the high concentrations remaining upgradient of extraction well RTW-1, an engineering evaluation of additional treatment technologies was performed as part of the recommendation to place the three downgradient wells in standby. The proposed remedy resulting from the screening process was chemical oxidation by *in situ* permanganate injection. As of June 2005, all recovery wells were placed in standby mode. However, due to increasing VOC concentrations in a well immediately upgradient, recovery well RTW-1 was turned back on in October 2005. As noted above, RTW-1 was placed in standby mode in June 2006. Due to increasing VOC concentrations, well RTW-2 was restarted in October 2007.

As noted in the 2006 Groundwater Status Report, the continued operation of RTW-1 as a recirculation well may have been causing adverse impacts on the plume. On December 12, 2007, RTW-1 effluent resample results from two different labs indicated hexavalent chromium Cr(VI) at 124 µg/L and 131 µg/L. Subsequent data suggest that the most likely cause of the elevated Cr(VI) levels was the treatment of soils with $KMnO_4$. One of the byproducts of the reaction is manganese oxide, which oxidizes trivalent chromium to Cr(VI). It is expected that over time, the Cr(VI) will revert back to trivalent chromium (the less toxic form). In May 2008, Well RTW-1 was modified from a recirculation well to a pumping well with hexavalent chromium ion-exchange treatment and discharge to the nearby surface drainage culvert which ultimately discharges to the recharge basin HS south of the Building 96 area.

The remediation wells were located to intercept the area of greatest contaminant concentrations. Groundwater flow maps indicate that existing contamination currently downgradient of the Building 96 remediation system will be intercepted by OU III Middle Road treatment system extraction wells, which are approximately 1,500 feet downgradient of the Building 96 area. As a result, the Building 96 contamination is not expected to migrate off site.

The monitoring well network for the OU III Building 96 program consists of 35 wells, all of which are screened in the shallow Upper Glacial aquifer. Three of the wells (085-97, -293, and 378) are upgradient of the former Building 96 source area. The remaining wells, except 095-171, are within the plume core and serve to define the lateral extent of the contamination approximately 300 feet downgradient of the former source area. Well 095-171 was constructed to monitor the plume perimeter downgradient of the source area. Well locations are shown on Figure 12.10.1. The monitoring wells are currently sampled quarterly for analysis of VOCs to monitor the plume configuration and the effectiveness of the remediation system. A monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The remediation system for the Building 96 VOC plume consists of four recovery wells. Data are needed to verify that this system is reducing the identified contamination according to plan. In 2007, it was determined that the three applications of the oxidizer potassium permanganate performed in 2005 and 2006 were ineffective in addressing the continuing source of VOCs. In 2008, the source of the VOCs was determined to be a localized area of soil contamination above the water table.

Step 2: Identify the Decisions

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 4, and 5)
- Plume perimeter wells (Decisions 1, 2, and 5)
- Bypass detection wells (Decisions 2 and 5)

The decision units for each of the wells in the current monitoring network are shown in Table 12.11.1. The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.10.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in. The decision unit limits for this project are the area being remediated in the vicinity of Building 96, as defined by a perimeter extending approximately 100 feet beyond the groundwater remediation wells. The Building 96 plume becomes commingled with other plumes immediately downgradient of the system.

The potential risk to downgradient receptors from the Building 96 VOC plume was determined to be low based on the following factors:

- Public water hookups have been provided off site.
- This contamination is not within the capture zone of BNL supply wells.
- Travel time is approximately 20 years to the BNL site boundary.
- Once the source is addressed, contamination that is not captured by the Building 96 treatment system will be intercepted by the Middle Road treatment systems before reaching the BNL site boundary.

The rate of source removal from the aquifer was expected to be relatively quick, as the treatment system was originally projected to operate for less than three years. The rate of groundwater migration is less than 1 foot per day. However, there is a continuing source of VOC contamination.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and sentinel wells. **If** the system is performing as planned, **then** actual VOC concentrations in plume perimeter and sentinel wells will compare well to predicted values, based on model runs. A significant difference between actual and predicted concentrations indicates the need for an evaluation for the reason for the difference.

Decision 4

Can individual extraction wells or the entire treatment system be shut down or placed in pulse pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal by 2030, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are TVOC concentrations in plume core wells above or below 50 µg/L ?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes**, and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of VOCs in groundwater is less than MCLs, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.10.1 summarizes the decision and possible decision errors for this project.

There are no potential receptors immediately downgradient of the Building 96 area and groundwater travel time to the site boundary is approximately 20 years. In addition, groundwater remediation was implemented in this area during 2001, and other remediation systems (OU III Middle Road) are in place downgradient of the Building 96 area.

Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust and BNL credibility, and potentially wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

Two new core monitoring wells and one upgradient monitoring well are needed to supplement the current sampling program of 35 monitoring wells.

Parameters and Frequency

The monitoring wells are sampled quarterly for VOCs. Hexavalent chromium was added to the parameter list during 2008 as a quarterly parameter to monitor the levels created by the potassium permanganate injections. Influent and effluent sampling is conducted monthly when the system is in operation, except for RTW-1, which is sampled weekly. A summary of the revised sampling program for this project is provided in Table 12.11.2.

Table 12.10.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Was the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Have the source control objectives been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.10.2 Modifications to the Building 96 Treatment System Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
085-97	Quarterly	Dropped	Hexavalent Chromium
085-293	Quarterly	Dropped	Hexavalent Chromium
095-84	Quarterly	Dropped	Hexavalent Chromium
095-85	Quarterly	Dropped	Hexavalent Chromium
095-159	Quarterly	Dropped	Hexavalent Chromium
095-161	Quarterly	Dropped	Hexavalent Chromium
095-162	Quarterly	Dropped	Hexavalent Chromium
095-163	Quarterly	Dropped	Hexavalent Chromium
095-164	Quarterly	Dropped	Hexavalent Chromium
095-165	Quarterly	Dropped	Hexavalent Chromium
095-166	Quarterly	Dropped	Hexavalent Chromium
095-167	Quarterly	Dropped	Hexavalent Chromium
095-168	Quarterly	Dropped	Hexavalent Chromium
095-169	Quarterly	Dropped	Hexavalent Chromium
095-170	Quarterly	Dropped	Hexavalent Chromium
095-171	Quarterly	Dropped	Hexavalent Chromium
095-172	Quarterly	Dropped	Hexavalent Chromium
085-335	Quarterly	Dropped	Hexavalent Chromium
085-294	Quarterly	Dropped	Hexavalent Chromium
085-295	Quarterly	Dropped	Hexavalent Chromium
085-296	Quarterly	Dropped	Hexavalent Chromium
095-305	Quarterly	Dropped	Hexavalent Chromium
095-306	Quarterly	Dropped	Hexavalent Chromium
095-307	Quarterly	Dropped	Hexavalent Chromium
095-308	Quarterly	Dropped	Hexavalent Chromium
085-347	Quarterly	Dropped	Hexavalent Chromium
085-348	Quarterly	Dropped	Hexavalent Chromium
085-349	Quarterly	Dropped	Hexavalent Chromium
085-350	Quarterly	Dropped	Hexavalent Chromium
085-351	Quarterly	Dropped	Hexavalent Chromium
085-352	Quarterly	Dropped	Hexavalent Chromium
085-353	Quarterly	Dropped	Hexavalent Chromium
085-354	Quarterly	Dropped	Hexavalent Chromium

See Appendix B for the monitoring program for this DQO.

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III BUILDING 96 AREA

DWN: AJZ	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
CHKD: JEB	APPD: WRD	REV.: 11/12/14	NOTES: –
FIGURE NO.:		12.10.1	

OU III South Boundary Pump and Treat System

DQO Start Date January 1, 2003

Revision Number/Date Rev. 12, December 9, 2015

Implementation Date January 1, 2016

Point of Contact William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

Summary of Changes

There are no proposed changes for calendar year (CY) 21016 for the OU III South Boundary Pump and Treat System.

Description and Technical Basis

The Operable Unit (OU) III South Boundary Pump and Treat System was designed to capture contamination consisting of volatile organic compounds (VOCs) in the Upper Glacial aquifer. These systems, working together, are designed to remediate the OU III volatile organic compound (VOC) plume. Some VOC contamination present in the upper portion of the Magothy aquifer and is being addressed by the new Long Island Power Authority (LIPA) and Industrial Park East off-site systems.

The OU III South Boundary groundwater extraction and treatment system includes eight extraction wells. Extraction well EW-17 was installed during 2013. Extracted groundwater is treated via air stripping and recharged upgradient of the plume. The system has been in operation since 1997. The monitoring network for the OU III South Boundary system includes 45 wells. Well locations are shown in Figure 12.11.1. Currently, the wells are sampled semi-annually or annually for analysis of VOCs and annually for tritium, gamma spectroscopy, and strontium-90 (Sr-90), as shown in Tables 12.1.1.

Drivers for Monitoring Being Conducted Under This Change

___ Compliance
___ Support Compliance
___ Surveillance
X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health has been defined on the BNL site. In response, capture and remediation of the plume was implemented in the fall of 1997. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decisions

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are total volatile organic compound (TVOC) concentrations in plume core wells above or below 50 µg/L?
- Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?
- Has the groundwater cleanup goal of meeting maximum contamination levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4, 5 and 6)
- Perimeter wells, used to define the extent of the plume (Decisions 1, 2 and 6)
- Bypass detection wells (Decisions 2 and 6)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Middle Road to the north
- Long Island Expressway to the south
- well 122-33 to the east
- wells 121-06, 121-07 and 121-08 to the west

- Upper Glacial and Magothy aquifers.

Separate decisions will be made in the three subunits described in Step 3. However, Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in TVOC concentration (if currently above 50 µg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goals, **then** a petition for shutdown will be issued to the regulatory agencies.

Decision 4

Are TVOC concentrations in plume core wells above or below 50 µg/L?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not, then** continue treatment.

Decision 5

Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision applies to the plume core wells:

If, for each plume core well, the slope of mean concentrations for all contaminants of concern are not different from the previous 3 years and if subject matter experts on BNL hydrogeology and hydrochemistry concur with the results of the statistical analysis, **then** petition for system closure.

Decision 6

Has the groundwater cleanup goal of meeting MCLs been achieved?

Analytical results from plume core wells will be utilized for this decision. It has been determined that in order to meet cleanup goals in the required timeframe (30 years), groundwater extraction should be continued until plume core wells show TVOC concentrations below 50 µg/L. At that time, the project could be reclassified as Monitored Natural Attenuation.

If the mean concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous 2 years, is less than the established cleanup goal for that parameter and the computed mean is consistent with professional judgment, **then** the cleanup goals for this remedial action have been achieved. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.11.1 summarizes the decision and possible decision errors for this project.

Table 12.11.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consists of 45 monitoring wells located along the south boundary of the site.

Parameters and Frequency

Plume wells will be monitored on a semi-annual frequency for VOCs. Select wells are analyzed either annually or quarterly for VOCs. These frequencies are based on historic data and proximity to the recovery wells. Monitoring schedule details are provided in Tables 12.1.1. Changes to the monitoring schedule details are provided in Table 12.12.2.

DATA REVIEW REQUIREMENTS

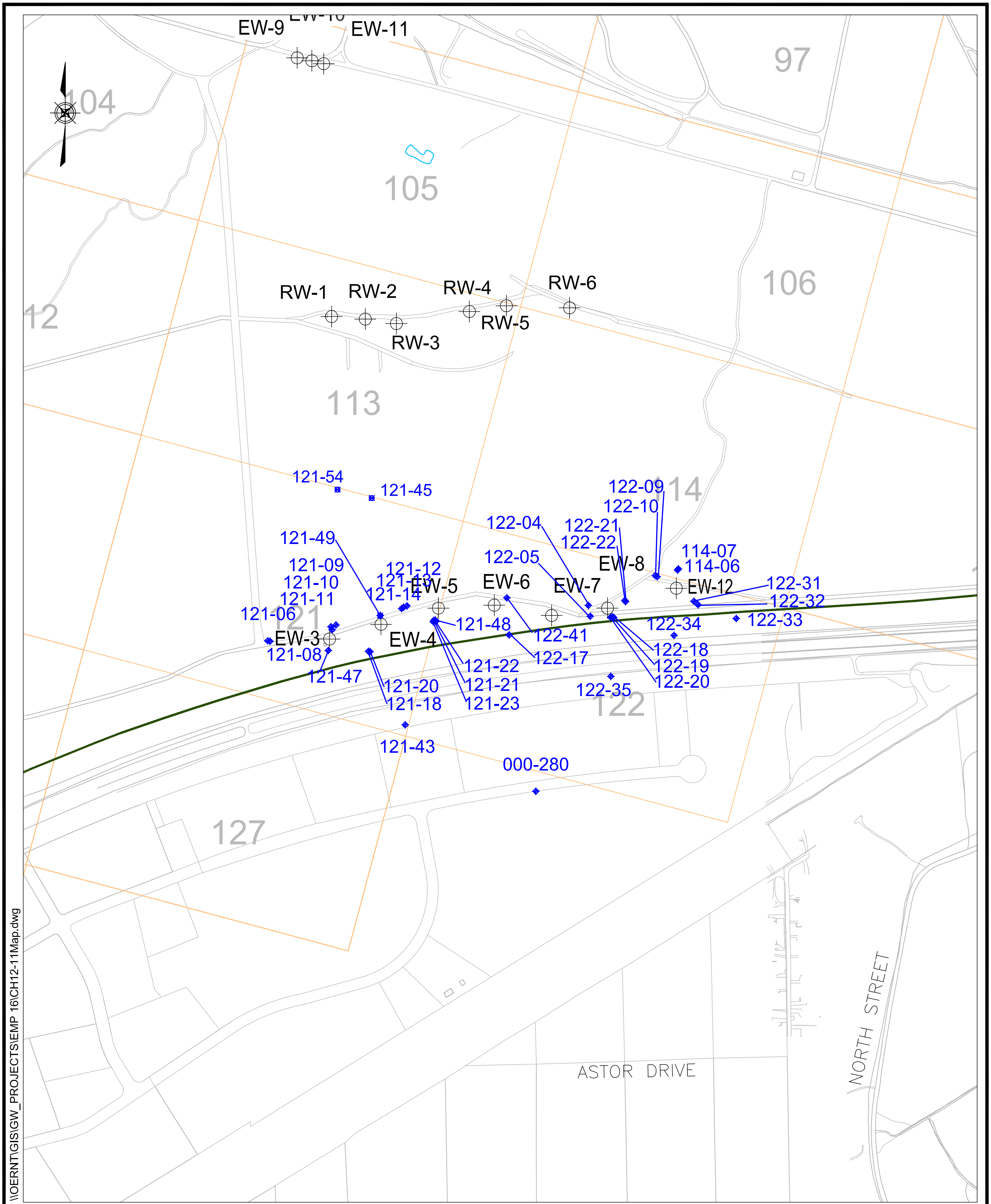
Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.11.2 Proposed Modifications to the South Boundary Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-280	Annual	No Changes	None
114-06	Semiannual	No Changes	None
114-07	Semiannual	No Changes	None
121-06	Annual	No Changes	None
121-08	Semiannual	No Changes	None
121-09	Annual	No Changes	None
121-10	Semiannual	No Changes	None
121-11	Semiannual	No Changes	None
121-12	Annual	No Changes	None
121-13	Semiannual	No Changes	None
121-14	Semiannual	No Changes	None
121-18	Annual	No Changes	None
121-20	Semiannual	No Changes	None
121-21	Annual	No Changes	None
121-22	Semiannual	No Changes	None
121-23	Semiannual	No Changes	None
121-40	Semiannual	No Changes	None
121-43	Semiannual	No Changes	None
121-44	Semiannual	No Changes	None
121-45	Quarterly	No Changes	None
122-04	Annual	No Changes	None

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
122-05	Semiannual	No Changes	None
122-09	Semiannual	No Changes	None
122-10	Annual	No Changes	None
122-17	Semiannual	No Changes	None
122-18	Annual	No Changes	None
122-19	Annual	No Changes	None
122-20	Annual	No Changes	None
122-21	Annual	No Changes	None
122-22	Semiannual	No Changes	None
122-31	Annual	No Changes	None
122-32	Annual	No Changes	None
122-33	Annual	No Changes	None
122-34	Annual	No Changes	None
122-35	Annual	No Changes	None
122-41	Semiannual	No Changes	None
121-47	Semiannual	No Changes	None
121-48	Semiannual	No Changes	None
121-49	Quarterly	No Changes	None
SB-MW-02-2014	Quarterly	No Changes	None

See Appendix B for the monitoring program for this DQO.



BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: OU III SOUTH BOUNDARY PUMP AND TREAT SYSTEM MONITORING WELL LOCATIONS	DWN: JEB	VT: HZ.: –	DATE: 12/10/12
		CHKD: – –	APPD: – –	REV.: 12/15/15
		FIGURE NO.: 12.11.1		

PROJECT NO.: 20335

NOTES: –

OU III South Boundary Radionuclide

DQO Start Date January 1, 2003

Revision Number/Date Rev. 11, December 9, 2015

Implementation Date January 1, 2016

Point of Contact William Dorsch (631) 344-5186

Summary of Proposed Changes

There are no proposed changes for calendar year (CY) 2016 for the OU III South Boundary Radionuclide Treatment System.

Deleted: for calendar year (CY) 2016

Description and Technical Basis

As part of Data Quality Objective (DQO) analysis for the Operable Unit (OU) III South Boundary and Western South Boundary Pump and Treat Systems, it was recommended that analysis for radionuclides be eliminated from these programs. However, in order to confirm that groundwater impacted by radionuclides is not flowing off site, periodic analysis for radionuclides at the BNL southern property boundary may be warranted.

Drivers for Monitoring Being Conducted under This Change

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

Data Quality Objective Analysis

Step 1: State the Problem

Data are needed to evaluate whether groundwater impacted by radionuclides is migrating off site.

Step 2: Identify the Decision

The decision for the project is:

- Were unexpected levels or types of contaminants detected?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow

- Analytical results for radionuclides in groundwater
- Locations of existing wells relative to flow patterns
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Middle Road to the north
- the BNL site boundary to the south
- wells 121-31 and 121-32 to the east
- William Floyd Parkway to the west
- Upper Glacial and upper Magothy aquifers

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contaminants detected?

The sample results will be evaluated in context with historical data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be determined for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants and detection of contaminants in wells where those contaminants have not previously been detected.

If radionuclides are detected in any well at unusually high concentrations (relative to the historical baseline) and the results are confirmed by resampling, **then** implement actions as prescribed in the BNL Groundwater Contingency Plan.

Step 6: Specify Acceptable Error Tolerances

Table 12.12.1 summarizes the decision and possible decision errors for this project.

Table 12.12.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is groundwater impacted by radionuclides migrating off site?	See Step 3 for inputs.	(1) Data indicate that groundwater impacted by radionuclides is flowing off site when that is not true. (2) Data indicate that there is not groundwater impacted by radionuclides flowing off site when there is.	(1) Investigation and/or remediation of groundwater contamination may be undertaken by BNL when it is not warranted. (2) Delays in addressing contamination, possible actions by regulatory agencies.

Step 7: Optimize the Design

Number and Locations of Wells

The current sampling program consists of 48 monitoring wells located along the south boundary of the site. The wells to be sampled are summarized in Table 12.12.2. Well locations are shown on Figure 12.12.1.

Parameters and Frequency

The wells will be sampled on an annual basis for radionuclides. Since results from historic samples indicate that there is currently little potential for groundwater impacted by radionuclides to flow off site along the western BNL site boundary, sampling for radionuclides should be conducted annually. Such sampling should be conducted in conjunction with the current monitoring programs for the OU III South Boundary and Western South Boundary projects to eliminate additional costs for sample collection. The monitoring schedule is provided in Table 12.1.1.

DATA REVIEW REQUIREMENTS

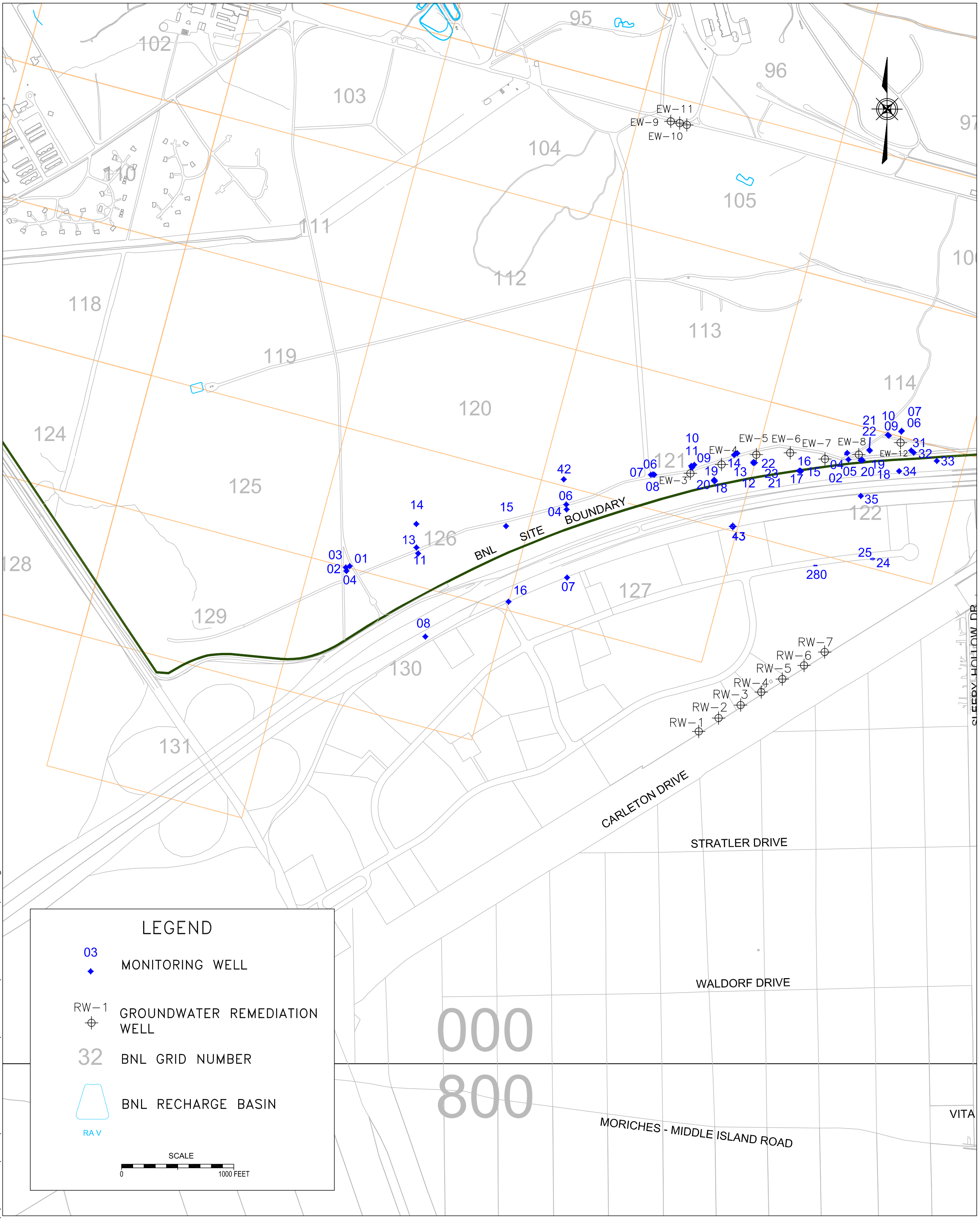
Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.12.2 Proposed Modifications to the South Boundary Radionuclide Monitoring Wells

Well	Current Sampling Frequency	Proposed Frequency Changes	Affected Parameters
000-280	Annually	No Change	None
114-06	Annually	No Change	None
114-07	Annually	No Change	None
121-06	Annually	No Change	None
121-07	Annually	No Change	None
121-08	Annually	No Change	None
121-09	Annually	No Change	None
121-10	Annually	No Change	None
121-11	Annually	No Change	None
121-12	Annually	No Change	None
121-13	Annually	No Change	None
121-14	Annually	No Change	None
121-18	Annually	No Change	None
121-19	Annually	No Change	None
121-20	Annually	No Change	None
121-21	Annually	No Change	None
121-22	Annually	No Change	None
121-23	Annually	No Change	None
122-02	Annually	No Change	None
122-04	Annually	No Change	None
122-05	Annually	No Change	None
122-09	Annually	No Change	None
122-10	Annually	No Change	None
122-15	Annually	No Change	None
122-16	Annually	No Change	None
122-17	Annually	No Change	None
122-18	Annually	No Change	None
122-19	Annually	No Change	None
122-20	Annually	No Change	None

Well	Current Sampling Frequency	Proposed Frequency Changes	Affected Parameters
122-21	Annually	No Change	None
122-22	Annually	No Change	None
122-31	Annually	No Change	None
122-32	Annually	No Change	None
122-33	Annually	No Change	None
121-42	Annually	No Change	None
126-01	Annually	No Change	None
126-11	Annually	No Change	None
126-13	Annually	No Change	None
126-14	Annually	No Change	None
126-15	Annually	No Change	None
126-16	Annually	No Change	None
127-04	Annually	No Change	None
127-06	Annually	No Change	None
127-07	Annually	No Change	None
130-02	Annually	No Change	None
130-03	Annually	No Change	None
130-04	Annually	No Change	None
130-08	Annually	No Change	None

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III SOUTH BOUNDARY RADIONUCLIDE MONITORING MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
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FIGURE NO.: 12.12.1

OU III MIDDLE ROAD PUMP AND TREAT SYSTEM

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 12, December 9, 2015
IMPLEMENTATION DATE	January 1, 2016
POINT OF CONTACT	William Dorsch (631) 344-5186 Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

Proposed changes for calendar year (CY) 2016 for the OU III Middle Road groundwater monitoring program include:

- Increase sampling in well 105-23 from semi-annual to quarterly to monitor for the deeper VOCs in this area.

DESCRIPTION AND TECHNICAL BASIS

The OU III Middle Road Pump and Treat system was designed to capture contamination consisting of volatile organic compounds (VOCs) in the Upper Glacial aquifer upgradient of the BNL south property boundary. It includes seven extraction wells. The newest extraction well (RW-7) was installed and began operations in November 2013 to capture deeper contamination migrating along the western side of the plume. Extracted groundwater is treated via air stripping and recharged upgradient of the plume. The system has been in operation since the fall of 2001. Shallow groundwater flow in this area is toward the south.

As described in the Operation and Maintenance Manual for the Operable Unit (OU) III Middle Road project, the monitoring network includes 39 wells. Two of the wells in the OU III Middle Road project are also sampled as part of the OU III High Flux Beam Reactor (HFBR) project, and one other well is sampled as part of the Chemical/Animal Holes project. Well locations are shown on Figure 12.13.1.

A routine operation and maintenance monitoring frequency was implemented in August 2003. Plume core and perimeter wells will be monitored on a semi-annual frequency. Bypass wells will continue to be sampled at a quarterly frequency. Samples will be analyzed for VOCs.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health has been defined on the BNL site. In response, capture and remediation of the plume was implemented in the fall of 2001. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into three decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2 and 3)
- Perimeter wells, used to define the extent of the plume (Decisions 2 and 4)
- Bypass detection wells (Decisions 2 and 4)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are:

- Princeton Avenue to the north
- Approximately 500 feet south of Middle Road (wells 113-16, -17, -18, -19 and -20)
- well 122-33 to the east
- well 113-08 to the west
- Upper Glacial and upper Magothy aquifers

Separate decisions will be made in the three subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire study system. As described below, the temporal boundaries of the study area are currently the same for each decision subunit. However, as more data are collected, the timeframe for decisions in a subunit may be modified. Therefore, the subunits have been described separately.

- *Plume Core:* Plume core wells will be used to provide data for measuring the performance of the system. Because the system is in its third year of operation and is in the Operations and Maintenance (O&M) phase, data are needed on a less frequent basis. Therefore, the time-frame for decisions for this subunit is 180 days.

- *Perimeter:* The wells included in this subunit define the plume horizontally and vertically, which is used to determine whether the plume is being captured. . Because the system is in its third year of operation and is the O&M phase, data are needed on a less frequent basis. Therefore, the timeframe for decisions for this subunit is 180 days.

- *Bypass Detection Area:* Because the wells in this area indicate whether the plume capture performance objective is being met, the decision timeframe for this area is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedures [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in perimeter or bypass detection wells to above 50 μg/L (if currently less than 50 μg/L) or a significant increase in total VOC concentration (if currently above 50 μg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal within 30 years, **then** a petition for shutdown will be issued to the regulatory agencies.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L?

This decision also applies to the plume core wells. If this occurs, then it is reasonable to expect (based on model projections) that MNA of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs within 30 years. **If** the TVOC concentration remains above 50 µg/L, **then** consider operational adjustments and/or engineering evaluation.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes,** and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d to help with this decision). **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

Analytical results from plume core wells will be utilized for this decision. It has been determined that, in order to meet cleanup goals in the required timeframe (2030 years), groundwater extraction should be continued until plume core wells show total VOC concentrations below 50 µg/L. At that time, the project could be reclassified as Monitored Natural Attenuation.

If the mean concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous 2 years, is less than the established cleanup goal for that parameter and the computed mean is consistent with professional judgment, **then** the cleanup goals for this remedial action have been achieved. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.13.1 summarizes the decision and possible decision errors for this project.

Table 12.13.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The existing monitoring well network of 39 wells will be supplemented with the addition of 1 new monitoring wells.

Parameters and Frequency

A routine operation and maintenance monitoring frequency was implemented in August 2003. Plume core and perimeter wells will be monitored on a semiannual frequency. Bypass wells will continue to be sampled at a quarterly frequency.

A summary of the proposed sampling program is shown in Table 12.13.2.

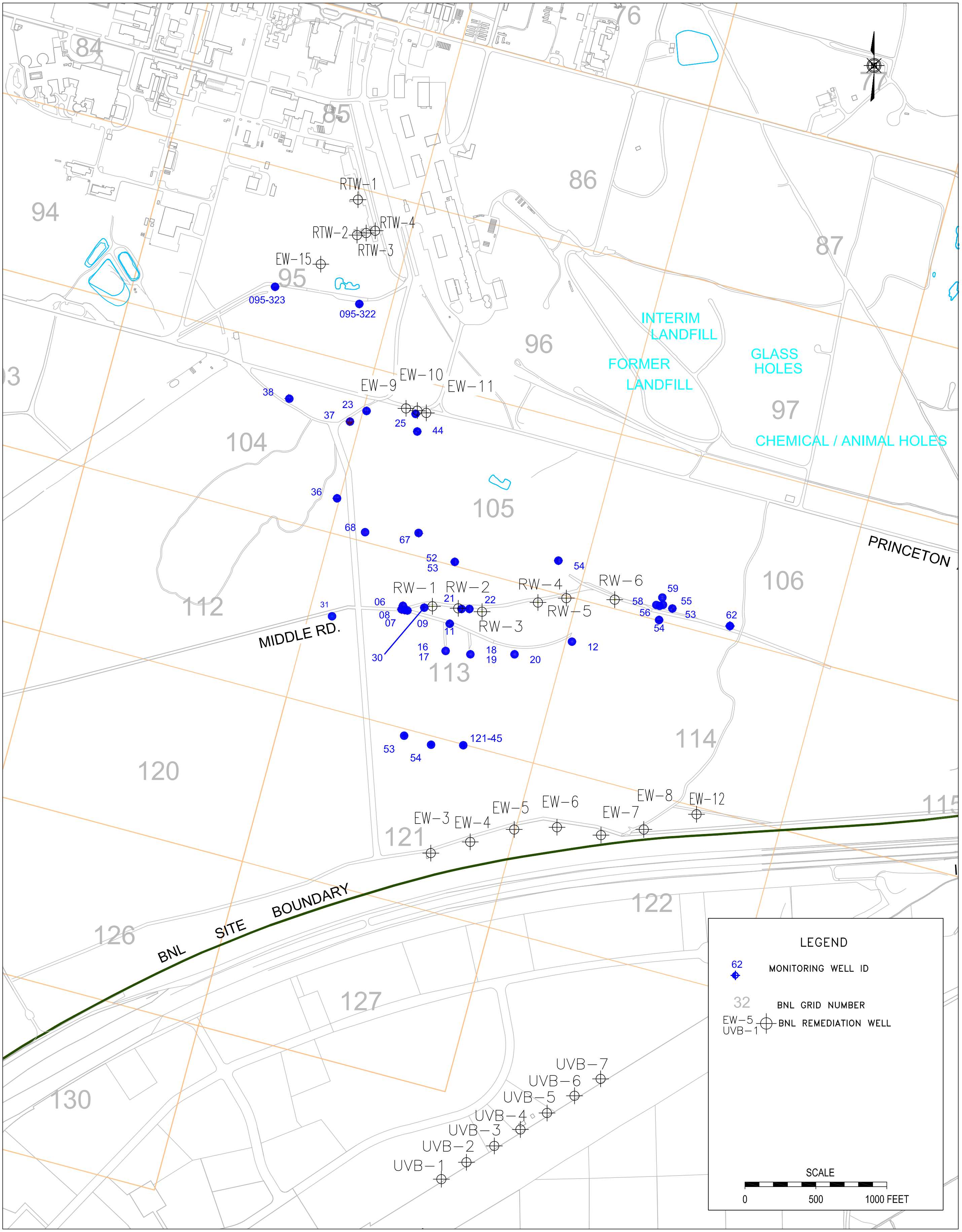
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.13.2 Proposed Modifications to the Middle Road Project Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
095-92	Semi-annually	No Change	None
104-11	Semi-annually	No Change	None
104-36	Semi-annually	No Change	None
104-37	Quarterly	No Change	None
104-38	Semi-annually	No Change	None
105-52	Annual	No Change	None
105-53	Semi-annually	No Change	None
105-54	Annual	No Change	None
105-66	Quarterly	No Change	None
113-16	Annual	No Change	None
113-17	Quarterly	No Change	None
113-18	Annual	No Change	None
113-19	Quarterly	No Change	None
113-20	Annual	No Change	None
113-21	Annual	No Change	None
113-22	Semi-annually	No Change	None
114-12	Quarterly	No Change	None
105-23	Semi-annually	Quarterly	VOC
105-25	Semi-annually	No Change	None
105-42	Semi-annually	No Change	None
105-44	Semi-annually	No Change	None
113-06	Annual	No Change	None
113-07	Annual	No Change	None
113-08	Semi-annually	No Change	None
113-09	Semi-annually	No Change	None
113-11	Semi-annually	No Change	None
106-55	Semi-annually	No Change	None
106-56	Semi-annually	No Change	None
106-58	Semi-annually	No Change	None
106-62	Semi-annually	No Change	None
121-45	Semi-annually	No Change	None
113-29	Quarterly	No Change	None
113-30	Quarterly	No Change	None
105-67	Quarterly	No Change	None
113-31	Quarterly	No Change	None
105-68	Quarterly	No Change	None
121-53	Quarterly	No Change	None
095-322	Quarterly	No Change	None
095-323	Quarterly	No Change	None

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III MIDDLE ROAD PUMP AND TREAT SYSTEM MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	—	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
— —	— —	12/15/15	—

FIGURE NO.: 12.13.1

OU III WESTERN SOUTH BOUNDARY PUMP AND TREAT SYSTEM

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 12, December 9, 2015
IMPLEMENTATION DATE	January 1, 2016
POINT OF CONTACT	William Dorsch (631) 344-5186 Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes for the OU III Western South Boundary Pump and Treat System for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The OU III Western South Boundary Pump and Treat System was designed to capture the higher concentrations of volatile organic compounds (VOCs) in the Upper Glacial aquifer along the western portion of the BNL south property boundary. This system captures and remediates a portion of the OU III VOC plume to reduce future off-site migration of the contamination and potential discharge of the VOC plume to the Carmans River.

The OU III Western South Boundary groundwater extraction and treatment system has been operational since May 2002. The system includes two extraction wells along the BNL south property boundary. Extracted groundwater is treated via air stripping and recharged at the western end of Middle Road upgradient and cross-gradient of the plume. Groundwater flow in this area is toward the south.

The monitoring network for the OU III Western South Boundary program includes 18 wells. Well locations are shown on Figure 12.14.1. Groundwater samples are collected and analyzed for VOCs on a semi-annual or quarterly basis, as shown in Tables 12.1.1 and 12.1.2.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment (off-site sensitive receptor, the Carmans River) has been defined on the BNL site. In response, capture and remediation of the higher concentrations of VOCs is being implemented along the western site boundary. Data are needed to verify that the remediation is occurring according to plan.

Step 2: Identify the Decision

The decisions for the project include:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3 and 4)
- Perimeter wells, used to define the extent of the plume (Decision 1 and 2)
- Bypass detection wells (Decisions 1 and 2)
- Perimeter (recharge basin) wells (Decisions 1 and 2)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Locations of existing wells relative to flow patterns
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Middle Road to the north
- Long Island Expressway eastbound service road and wells 127-07, 126-16, and 130-08 to the south
- unpaved north-south access road and wells 121-06, 121-07, and 121-08 to the east
- western south boundary recharge basin and wells 119-03, 125-01, and 125-02 to the west
- Upper Glacial and upper Magothy aquifers

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all four subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 20 µg/L (if currently less than 20 µg/L) or a significant increase in total VOC concentration (if currently above 20 µg/L).

If the trend in each plume fringe and bypass detection well has a negative slope based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 20 µg/L, **then** continue to operate the system. If not, then consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that one or more treatment system recovery wells have met the shutdown criteria of achieving the cleanup goal by 2030, **then** the well will be shut down or placed in pulse pumping mode.

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends, indicates that the treatment system has met the shutdown criteria of achieving the cleanup goal within 30 years, **then** a petition for shutdown will be issued to the regulatory agencies.

3a. Are TVOC concentrations in plume core wells above or below 20 ug/L?

This decision also applies to the plume core wells. It is anticipated that approximately 7 to 10 years of active groundwater treatment will reduce the mean total volatile organic compound (TVOC) concentrations in the plume core to less than 20 µg/L.

If this occurs, **then** it is reasonable to expect (based on model projections) that MNA of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs within 30 years. **If** the TVOC concentration remains above 20 µg/L, **then** consider operational adjustments and/or engineering evaluation.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system pulsing. **If yes**, **then** continue operation. **If yes**, and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted. **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous 2 years, is less than 20 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation. Note: This assumes that system operation is already considered “optimal.”

Step 6: Specify Acceptable Error Tolerances

Table 12.14.1 summarizes the decision and possible decision errors for this project.

Table 12.14.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The groundwater monitoring program for the Western South Boundary Pump and Treat System contains 18 monitoring wells. An additional monitoring well is scheduled to be added during CY 2012 to monitor the downgradient extent of the Freon-12 observed in well 103-15.

Parameters and Frequency

Groundwater monitoring will continue in an Operations & Maintenance (O&M) phase mode. Plume core and perimeter wells will be monitored on a semiannual frequency. Bypass wells will continue to be sampled at a quarterly frequency (see Tables 12.1.1 and 12.1.2).

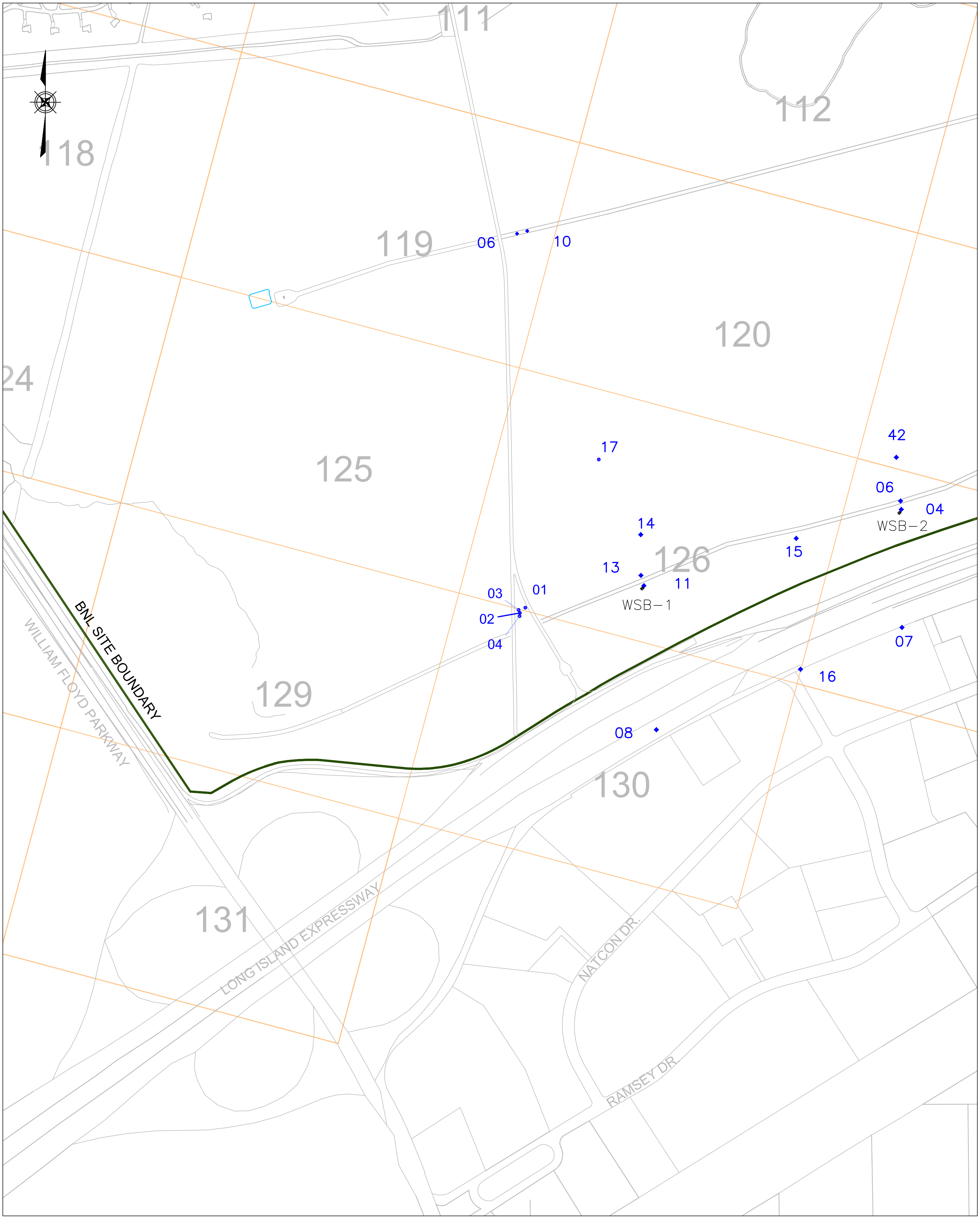
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.14.2 Proposed Modifications to the Western South Boundary Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
119-06	Quarterly	No Change	None
126-01	Semi-annual	No Change	None
130-02	Semi-annual	No Change	None
130-03	Semi-annual	No Change	None
130-04	Semi-annual	No Change	None
126-11	Semi-annual	No Change	None
126-15	Semi-annual	No Change	None
121-42	Semi-annual	No Change	None
127-04	Semi-annual	No Change	None
126-13	Semi-annual	No Change	None
126-14	Semi-annual	No Change	None
127-06	Semi-annual	No Change	None
127-07	Quarterly	No Change	None
126-16	Quarterly	No Change	None
130-08	Quarterly	No Change	None
130-15	Quarterly	No Change	None
126-17	Quarterly	No Change	None
119-10	Quarterly	No Change	None

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III WESTERN SOUTH BOUNDARY PUMP AND TREAT SYSTEM MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
--	--	11/12/14	–

FIGURE NO.: 12.14.1

OU III OFF-SITE POST ROD

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 12, December 9, 2015
IMPLEMENTATION DATE	January 1, 2016
POINT OF CONTACT	William Dorsch (631) 344-5186 Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes for the OU III Off-Site Post-ROD groundwater monitoring program for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The sources for the plumes monitored by the Operable Unit (OU) III Off-Site program are located within the developed central areas of the BNL Site. Due to the proximity of the plume source areas and variability in groundwater flow direction in the vicinity of the source areas, the plumes are commingled south of the BNL site boundary. Groundwater flow south of the BNL site boundary is toward the south.

The monitoring well network for the OU III Off-Site project consists of 11 wells that provide groundwater quality data south of the western portion of the BNL site boundary. The screen zone and aquifer screened by each of the wells currently sampled are summarized in Table 12.15.1. Well locations are shown in Figure 12.15.1. Wells are sampled annually for analysis of volatile organic compounds (VOCs), as shown in Tables 12.1.1 and 12.1.2.

The contaminants of concern associated with the sources monitored by the OU III Off-Site wells are VOCs.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

Table 12.15.1 Current OU III Off-Site Wells

Well	Screen Zone *	Aquifer Screened
000-97	284-304	Magothy
000-98	190-210	Deep Upper Glacial
000-99	83-93	Shallow Upper Glacial
800-21	202-222	Magothy
800-22	105-125	Deep Upper Glacial
800-23	35-45	Shallow Upper Glacial
800-40	166-186	Deep Upper Glacial
800-41	203-223	Magothy
800-51	70-80	Shallow Upper Glacial
800-52	140-160	Deep Upper Glacial
800-53	190-210	Mid Upper Glacial

* Feet below ground surface

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater south of the BNL site boundary has been impacted by VOCs at concentrations exceeding New York State groundwater standards. Because active remediation of these commingled plumes is currently being planned or designed, data are needed to verify that the contaminants are naturally degrading in the interim and to determine the nature and extent of the VOC plumes for system design.

Step 2: Identify the Decision

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Is the contamination naturally attenuating as expected
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- VOC analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- Carleton Drive on the north
- wells 800-21, 800-22 and 800-23, and Flower Hill Drive on the south

- Boxwood Drive (well 000-107) on the east
- Carmans River (wells 800-21, -22 and -23) and Westend Avenue (wells 800-51,-52 and -53) on the west
- Upper Glacial and upper Magothy aquifers

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Is the contamination naturally attenuating as expected?

If performance objectives have not been met, **then** it must be determined whether VOC concentrations in groundwater are being reduced according to the attenuation model.

If the detected VOC concentrations are consistent with the attenuation model, groundwater model results, and professional judgment, **then** continue attenuation monitoring. **If not**, then consider refining the conceptual model and/or implementing supplements to bolster the attenuation process.

Decision 3

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of VOCs in groundwater is less than MCLs, **then** petition for sampling to be discontinued. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.15.2 summarizes the decision and possible decision errors for this project.

Table 12.15.2 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Are performance objectives met?	See Step 3 for inputs.	(1) Data indicate that MCLs have not been met when they have. (2) Data indicate that MCLs have been met when they have not.	(1) Wasted resources conducting continued unnecessary monitoring. (2) Potential bypass of contaminants, project delays, potential risk to down-gradient receptors.
If not, are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements and introducing supplements. (2) Potential bypass of contaminants, project delays; potential risk to down-gradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The number and locations of wells for this program are considered adequate.

Parameters and Frequency

The monitoring wells in the OU III Off-Site program were sampled for VOCs semi-annually. Since there were no detections of VOCs above standards, the sampling frequency was reduced to annually. A summary of the modifications to the OU III Off-Site sampling programs is provided in Table 12.15.3.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.15.3 Modifications to the OU III Off-Site Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency	Proposed Analytical Parameters
000-97	Annual	None	None
000-98	Annual	None	None
000-99	Annual	None	None
800-21	Annual	None	None
800-22	Annual	None	None
800-23	Annual	None	None
800-40	Annual	None	None
800-41	Annual	None	None
800-51	Annual	None	None
800-52	Annual	None	None
800-53	Annual	None	None

See Appendix B for the monitoring program for this DQO.

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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III OFFSITE
POST-ROD
MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
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FIGURE NO.: 12.15.1

OU III INDUSTRIAL PARK

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no proposed changes to the Operable Unit (OU) III Industrial Park Treatment System and groundwater monitoring program for CY2016.

DESCRIPTION AND TECHNICAL BASIS

The sources for the VOC plumes addressed by the OU III Industrial Park program are located within the developed central areas of the BNL site. Due to the proximity of the plume source areas and variability in groundwater flow direction in the vicinity of the source areas, the plumes are commingled south of the BNL site boundary.

A portion of the commingled VOC plume migrated beyond the BNL site boundary prior to construction and operation of the OU III South Boundary groundwater extraction and treatment system. In response, the seven in-well air stripping treatment wells that comprise the OU III Industrial Park System were constructed within the Industrial Park, located south of the west-central portion of the BNL southern site boundary. This system was constructed to provide hydraulic control to prevent further downgradient migration of the VOC plume and to remediate the portion of the plume with a concentration of total VOCs above 50 µg/L in the deep Upper Glacial aquifer. The system has been operated since December 1999. During 2014 two new groundwater extraction wells were installed in the Industrial Park. These wells became operational in January 2015. The wells are screened deeper than the adjacent wells to capture deeper VOC contamination identified just upgradient of this area

The monitoring well network for the OU III Industrial Park project consists of 53 wells, 8 recirculation wells and two extraction wells. These wells monitor the VOC plume in the vicinity of the Industrial Park, as well as the effectiveness of the seven in-well groundwater treatment systems. The contaminants of concern associated with the OU III Industrial Park are VOCs.

Well locations are shown on Figure 12.16.1. The monitoring schedule is provided in Table 12.1.2.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance

X Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, remediation of the plume has been ongoing since September 1999. Data are needed to verify the effectiveness of the remediation.

Step 2: Identify the Decision

The decisions for the project are:

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 50 ug/L?
- Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The project is divided into four decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4, 5 and 6)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1, 2 and 6)
- Bypass detection wells (Decisions 1, 2, and 6)
- Magothy (Decision 1, 2, and 6)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.16.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Long Island Expressway to the north
- Carleton Drive to the south
- Boxwood Drive (well 000-272) to the east
- Lockwood Drive (well 000-245) to the west
- the Upper Glacial aquifer
- the upper section of the Magothy aquifer.

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits are utilized for this decision. Sample results are evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume fringe and bypass detection wells. **If** the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in TVOC concentration in plume fringe or bypass detection wells to above 50 µg/L (if currently less than 50 µg/L) or a significant increase in TVOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 µg/L, **then** continue to operate the system. If not, then consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Are TVOC concentrations in plume core wells above or below 50 ug/L?

If the TVOC concentration in each plume core well has been reduced to less than 50 µg/L **then** proceed with pulsed operation of the system. **If not**, **then** continue treatment. **If not** ,and treatment has occurred for at least 7 to 10 years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

Decision 4

Can individual recirculation/extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 µg/L TVOC for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 5

Is there a significant concentration rebound in core wells and/or extraction wells following shut-down?

If there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode, **then** continue operation. **If yes**, and system has operated for more than 7 to 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 6

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of VOCs in groundwater is less than MCLs, **then** petition for sampling to be discontinued. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.16.1 summarizes the decision and possible decision errors for this project.

Table 12.16.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Have cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary, wasted resources.
Is the system performing as planned?	See Step 3 for inputs.	(1) Determine system is performing as planned when it is not. (2) Determine system is not performing as planned when it is.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.
Have asymptotic conditions been demonstrated?	See Step 3 for inputs.	(1) Determine asymptotic conditions reached when they are not. (2) Determine asymptotic conditions not reached when they are.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The groundwater monitoring program for the III Industrial Park In-Well Air Stripping System contains 53 monitoring wells. Well locations are provided on Figure 12.16-1.

Parameters and Frequency

A summary of the sampling program for this project is provided in Table 12.16.2.

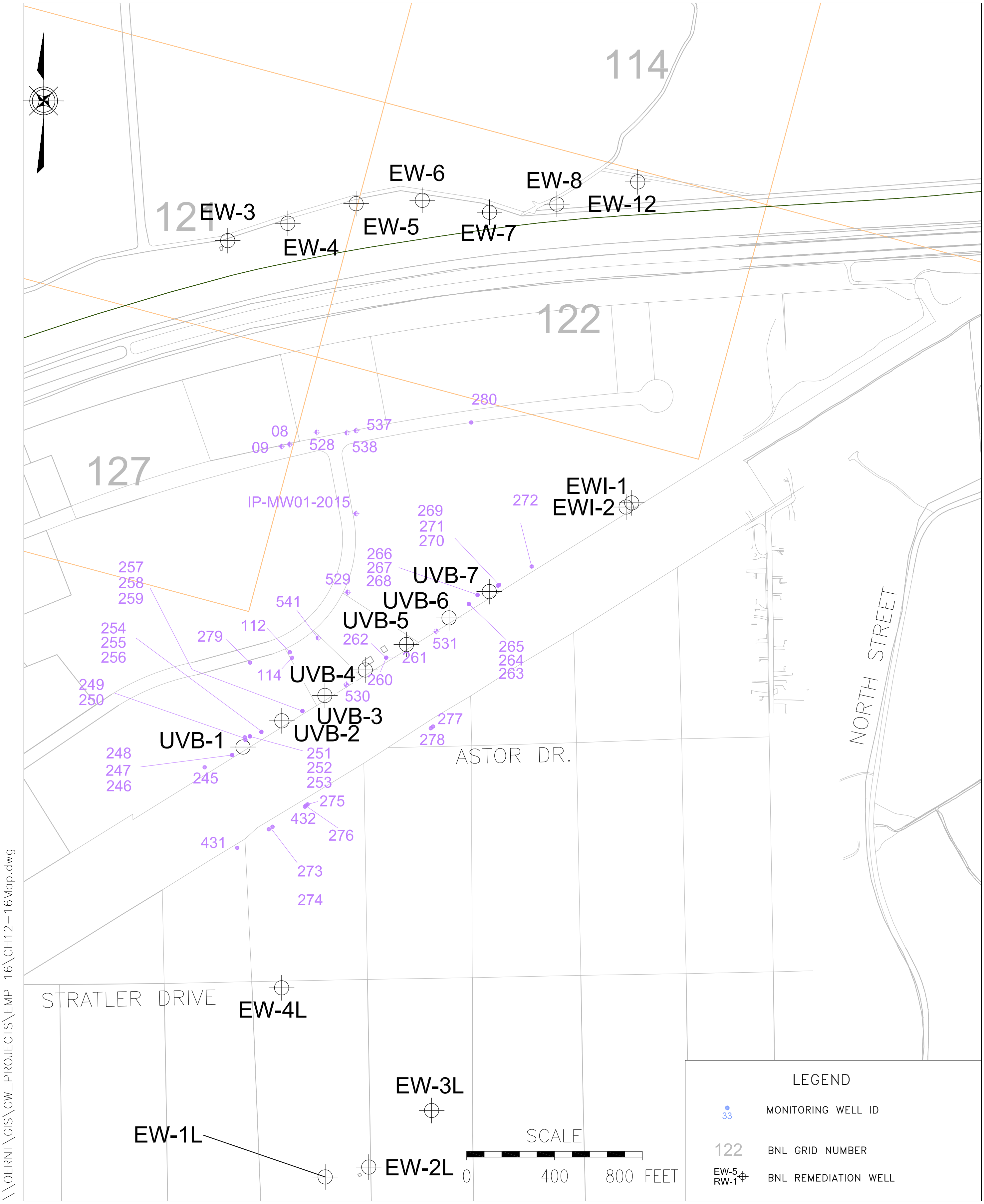
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data collected, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.16.2 Proposed Modifications to the Industrial Park Project Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-112	Quarterly	No Change	None
000-114	Quarterly	No Change	None
000-245	Quarterly	No Change	None
000-246	Quarterly	No Change	None
000-247	Quarterly	No Change	None
000-248	Quarterly	No Change	None
000-249	Quarterly	No Change	None
000-250	Quarterly	No Change	None
000-251	Quarterly	No Change	None
000-252	Quarterly	No Change	None
000-253	Quarterly	No Change	None
000-254	Quarterly	No Change	None
000-255	Quarterly	No Change	None
000-256	Quarterly	No Change	None
000-257	Quarterly	No Change	None
000-258	Quarterly	No Change	None
000-259	Quarterly	No Change	None
000-260	Quarterly	No Change	None
000-261	Quarterly	No Change	None
000-262	Quarterly	No Change	None
000-263	Quarterly	No Change	None
000-264	Quarterly	No Change	None
000-265	Quarterly	No Change	None
000-266	Quarterly	No Change	None
000-267	Quarterly	No Change	None
000-268	Quarterly	No Change	None
000-269	Quarterly	No Change	None
000-270	Quarterly	No Change	None
000-271	Quarterly	No Change	None
000-272	Quarterly	No Change	None
000-273	Quarterly	No Change	None
000-274	Quarterly	No Change	None
000-275	Quarterly	No Change	None
000-276	Quarterly	No Change	None
000-277	Quarterly	No Change	None
000-278	Quarterly	No Change	None
000-279	Quarterly	No Change	None
000-280	Quarterly	No Change	None
000-426	Quarterly	No Change	None
000-427	Quarterly	No Change	None
000-429	Quarterly	No Change	None
000-431	Quarterly	No Change	None
000-432	Quarterly	No Change	None
000-530	Quarterly	No Change	None
000-531	Quarterly	No Change	None
000-529	Quarterly	No Change	None
000-528	Quarterly	No Change	None
000-537	Quarterly	No Change	None
000-538	Quarterly	No Change	None
127-08	Quarterly	No Change	None
127-09	Quarterly	No Change	None
000-541	Quarterly	No Change	None
000-542	Quarterly	No Change	None
000-543	Quarterly	No Change	None
000-544	Quarterly	No Change	None
IP-MW01-2015	Quarterly	No Change	None

See Appendix B for the monitoring program for this DQO.



BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III INDUSTRIAL PARK
MONITORING WELL LOCATIONS

DWN: JEB	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
CHKD: – –	APPD: – –	REV.: 12/15/15	NOTES: –

FIGURE NO.: 12.16.1

OU III AIRPORT

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev.12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes for the OU III Airport Pump and Treat System and groundwater monitoring program for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The Operable Unit (OU) III Airport remediation system consists of six groundwater recirculation wells along the northern boundary of the Brookhaven Airport. The recirculation wells are designed to remediate volatile organic compound (VOC) contamination residing in the deep portion of the Upper Glacial aquifer. The contamination in this area had migrated off site prior to the startup of the OU I (RA V) South Boundary treatment system in December 1996 and consists primarily of 1,1,1-TCA, PCE, and carbon tetrachloride. The contamination consists of commingled plumes from several sources, including the chemical/animal holes, former landfill, and OU IV area. The plume is migrating in a southerly direction with groundwater flow.

This system is designed to achieve the OU III Record of Decision (ROD) objectives of preventing or minimizing plume growth and meeting MCLs in the Upper Glacial aquifer by 2030. The system will address the highest VOC concentration portion of the plume (above 50 μg/L).

The monitoring well network for the OU III Airport project consists of 31 wells, all of which are located from Crestwood Drive to the northern portion of the Brookhaven Airport between Lockwood Drive and Girald Drive. Well locations are shown on Figure 12.17.1. The wells will be sampled quarterly and analyzed for VOCs. The monitoring schedule is provided in Tables 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, a groundwater remediation system has been constructed to treat this plume. Data are needed to verify that the remediation is occurring according to plan. Based on groundwater modeling, the extraction wells are scheduled to operate for up to 15 years.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 10 ug/L for the Airport ?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into a total of five decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 2, 3, 4 and 5)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 2)
- Bypass detection wells (Decisions 1 and 4)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.37.1)
- Evaluation of capture zone for extraction wells
- Action Levels
- Analytical methods and detection limits as described in the BNL Quality Assurance Program Plan (QAPP)
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:
- Crestwood Drive to the north

- east of Lockwood Drive
- west of Girald Drive
- northern portion of Brookhaven Airport
- the Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?
Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume perimeter or bypass detection wells to above 10 µg/L (if currently less than 10 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope based on the four most recent consecutive samples and this trend is consistent with professional judgment and the total VOC concentration is less than 10 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 10 µg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 4

Are TVOC concentrations in plume core wells above or below 10 ug/L for the Airport?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L, **then** proceed with pulsed operation of the system. **If not then** continue treatment. **If not** ,and treatment has occurred for at least 10 years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If yes, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4e. to help with this decision). **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 10 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous 2 years, is less than 10 µg/l, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.17.1 summarizes the decision and possible decision errors for this project.

Table 12.17.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Has the plume been controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shut-off; project delays. (2) Continue remediation longer than necessary; wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues–ultimate project delays. (2) Wasted resources; project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shut-off; potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments; avoidable growth of plume. (2) Wasted resources considering/implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU III Airport project consists of 31 wells, all of which are located between Crestwood Drive and the northern portion of Brookhaven Airport.

Parameters and Frequency

The wells will be sampled quarterly and analyzed for VOCs.

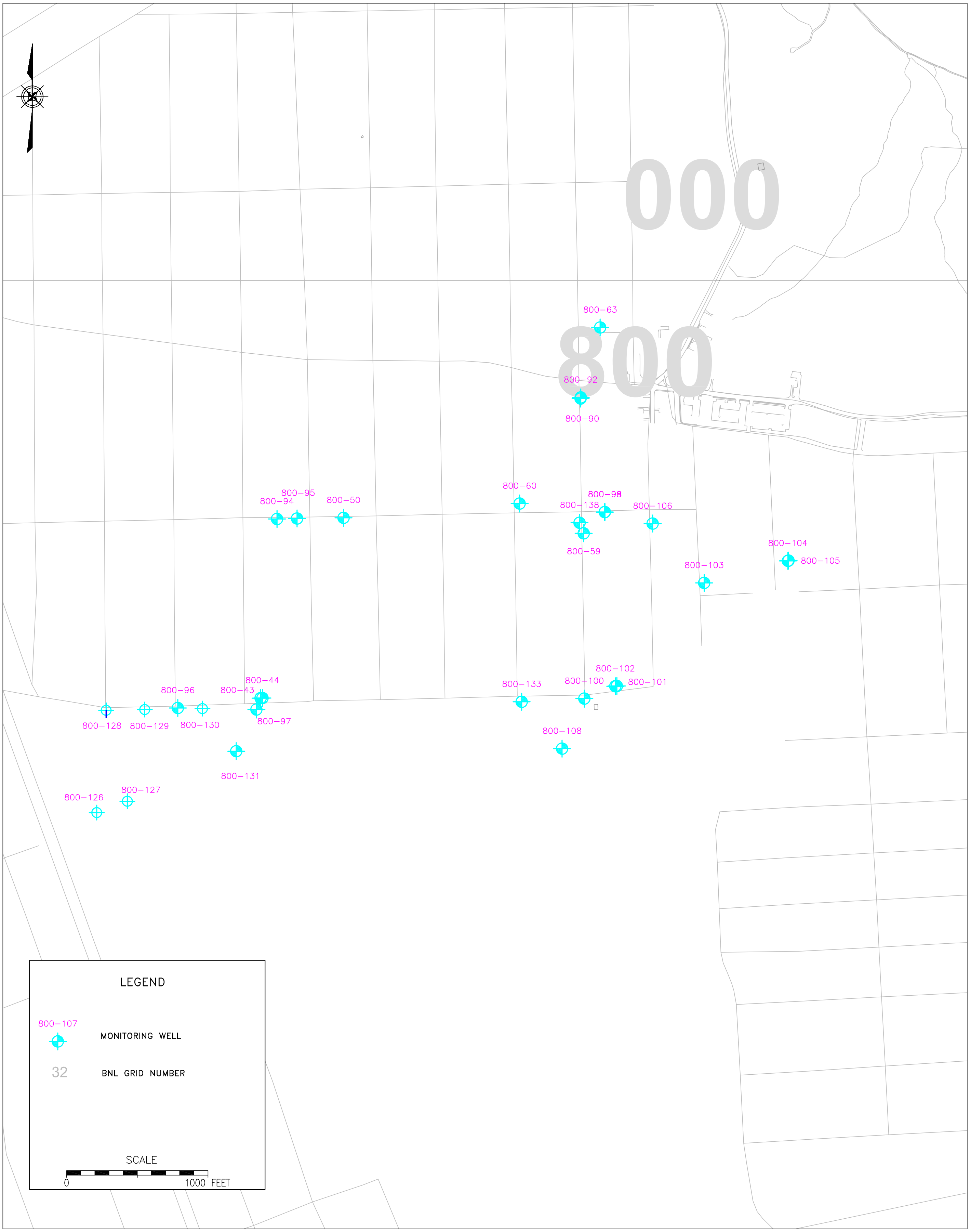
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-428	Quarterly	None	None
800-100	Quarterly	None	None
800-101	Quarterly	None	None
800-102	Quarterly	None	None
800-103	Quarterly	None	None

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
800-104	Quarterly	None	None
800-105	Quarterly	None	None
800-106	Quarterly	None	None
800-108	Quarterly	None	None
800-126	Quarterly	None	None
800-127	Quarterly	None	None
800-128	Quarterly	None	None
800-129	Quarterly	None	None
800-130	Quarterly	None	None
800-131	Quarterly	None	None
800-133	Quarterly	None	None
800-43	Quarterly	None	None
800-44	Quarterly	None	None
800-50	Quarterly	None	None
800-59	Quarterly	None	None
800-60	Quarterly	None	None
800-63	Quarterly	None	None
800-90	Quarterly	None	None
800-92	Quarterly	None	None
800-94	Quarterly	None	None
800-95	Quarterly	None	None
800-96	Quarterly	None	None
800-97	Quarterly	None	None
800-98	Quarterly	None	None
800-99	Quarterly	None	None
800-138	Quarterly	None	None

See Appendix B for the monitoring program for this DQO.



R:\GW_PROJECTS\EMP 16\CH12-17Map.DWG

BROOKHAVEN NATIONAL LABORATORY	TITLE:	DWN: JEB	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
ENVIRONMENTAL PROTECTION DIVISION	OU III AIRPORT MONITORING WELL LOCATIONS	CHKD:	APPD: RH	REV.: 11/17/14	NOTES: –
		FIGURE NO.: 12.17.1			

OU III LONG ISLAND POWER AUTHORITY (LIPA)

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes for the OU III Long Island Power Authority (LIPA) treatment system for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The Operable Unit (OU) III LIPA remediation system consists of three groundwater extraction wells (south of the BNL boundary and Long Island Expressway [LIE] along the LIPA right of way between Rowlinson Drive and Starlight Drive) that address volatile organic compound (VOC) contamination in the Upper Glacial aquifer, and an extraction well located along Starlight Drive in the vicinity of Rowlinson Drive in North Shirley that treats VOCs in the Magothy aquifer. One of the extraction wells is designed to remediate carbon tetrachloride contamination entering the upper portion of the Magothy aquifer. During system design, a determination was made to combine the Airport and LIPA projects into a single groundwater treatment system. The water from the three LIPA and the one Magothy pumping well will be piped approximately 6,000 feet to a combined groundwater treatment system at Brookhaven Avenue. These areas of contamination had already migrated south of the site boundary prior to the startup of the OU III South Boundary Pump and Treat System in 1997.

This Upper Glacial aquifer system is designed to achieve the OU III ROD objectives of minimizing plume growth and meeting MCLs in the Upper Glacial aquifer in 30 years or less. The southernmost portions of this plume will be eventually addressed by the Brookhaven Airport remediation system as it continues travel south with the regional groundwater flow. The Magothy extraction well will capture and treat the highest TVOC concentrations (>7,000 µg/L) identified in the uppermost portion of the Magothy aquifer.

The Upper Glacial monitoring well network for the OU III LIPA project consists of 11 wells, plus the three Upper Glacial aquifer extraction wells. The Magothy monitoring well network consists of seven wells in addition to the Magothy aquifer extraction well. These wells monitor the Upper Glacial VOC plume south of the LIE to Waldorf Drive in the North Shirley residential area, and Upper Magothy VOC plume from the Industrial Park area south to Waldorf Drive, as well as the effectiveness of the groundwater treatment systems. The contaminants of concern associated with the OU III LIPA Upper Glacial and Magothy aquifer contamination project include 1,1,1-TCE, 1,1-DCE, carbon tetrachloride, trichloreylene, and tetrachloeoethylene. Well locations are shown on Figure 12.18.1. The monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

VOC plumes that could represent a potential risk to human health or the environment have been defined south of the BNL site. In response, a groundwater remediation system has been constructed to treat these plumes in both the Upper Glacial and Magothy aquifers. Data are needed to verify that the remediation is occurring according to plan. Based on groundwater modeling, both the Upper Glacial and Magothy extraction wells are scheduled to operate for up to 10 years.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Are TVOC concentrations in plume core wells above or below 50 ug/L?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into a total of eight decision subunits (four each for the Upper Glacial and Magothy systems) to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are as follows:

Upper Glacial System:

- plume core wells (Decisions 1, 2, 3, 4, and 5)
- plume perimeter wells, used to define the extent of the plume (Decisions 1 and 5)
- bypass detection wells (Decision 2)

Magothy System:

- plume core wells (Decisions 1, 2, 4, and 5)
- plume perimeter wells, used to define the extent of the plume (Decisions 1 and 3)
- bypass detection wells (Decisions 1, 3, and 4)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- direction and velocity of groundwater flow
- analytical results for VOCs in groundwater
- location of existing wells relative to flow patterns (Figure 12.18.1)
- evaluation of capture zone for extraction wells
- action levels
- analytical methods and detection limits described in the BNL Quality Assurance Program Plan
- variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Long Island Expressway to the north
- Waldorf Drive to the south
- Starlight Drive to the east
- Rowlinson Drive to the west
- Upper Glacial aquifer (Upper Glacial System)
- Upper Magothy aquifer (Magothy System).

Separate decisions will be made in the eight subunits described in Step 3. However, some of the decisions, such as system performance, are based on the entire system (Upper Glacial or Magothy). The temporal boundaries of the study area vary, based on the decision.

- *Plume Core:* Plume Core: Due to the need for frequent data collection during the system startup period, the timeframe for decisions for this subunit is 90 days.

- *Plume Perimeter:* Because the wells in this subunit define the plume horizontally, which is used to determine whether the plume is being captured, the timeframe for decisions here is 90 days. The wells are screened outside the known extent of the plume at the depth of contamination in the plume core. Although the plume is not expected to shift laterally due to changing flow conditions, the decision timeframe for this area will be 90 days during the 2-year system startup phase.

- *Bypass Detection Area:* Because the wells in this area indicate whether the plume capture performance objective is being met, the decision timeframe for this area is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) will be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously “clean” wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells.

If the cleanup goals have not been met, **then** it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 μg/L (if currently less than 50 μg/L) or a significant increase in total VOC concentration (if currently above 50 μg/L).

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 20 μg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

Decision 4

Are TVOC concentrations in plume core wells above or below 50 ug/?
If the total VOC concentration in each plume core well has been reduced to less than 50 μg/L, **then** proceed with pulsed operation of the system. **If not then** continue treatment.

4a. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If *yes,* ***then*** *continue operation.* ***If yes****, and system and the groundwater may not reach MCLs by 2030,* ***then*** *an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4e. to help with this decision).* ***If*** *no significant rebound is observed within a 1-year time period,* ***then*** *petition for system shutdown and continue with MNA.*

Decision 5

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 μg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 50 μg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system closure and continue with MNA until MCLs are met. If not, then consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.18.1 summarizes the decision and possible decision errors for this project.

Table 12.18.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues, ultimate project delays. (2) Wasted resources, project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff, potential to have to restart system. (2) Continue remediation that is no longer effective.
Have the groundwater cleanup goals been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

Step 7: Optimize the Design

Number and Locations of Wells

The Upper Glacial monitoring well network for the OU III LIPA project consists of 11 wells, plus the three Upper Glacial aquifer extraction wells. The Magothy monitoring well network consists of seven wells in addition to the Magothy aquifer extraction well.

Parameters and Frequency

The groundwater monitoring frequency will continue in the O&M phase (core and perimeter wells sampled semi-annually, and sentinel wells sampled quarterly).

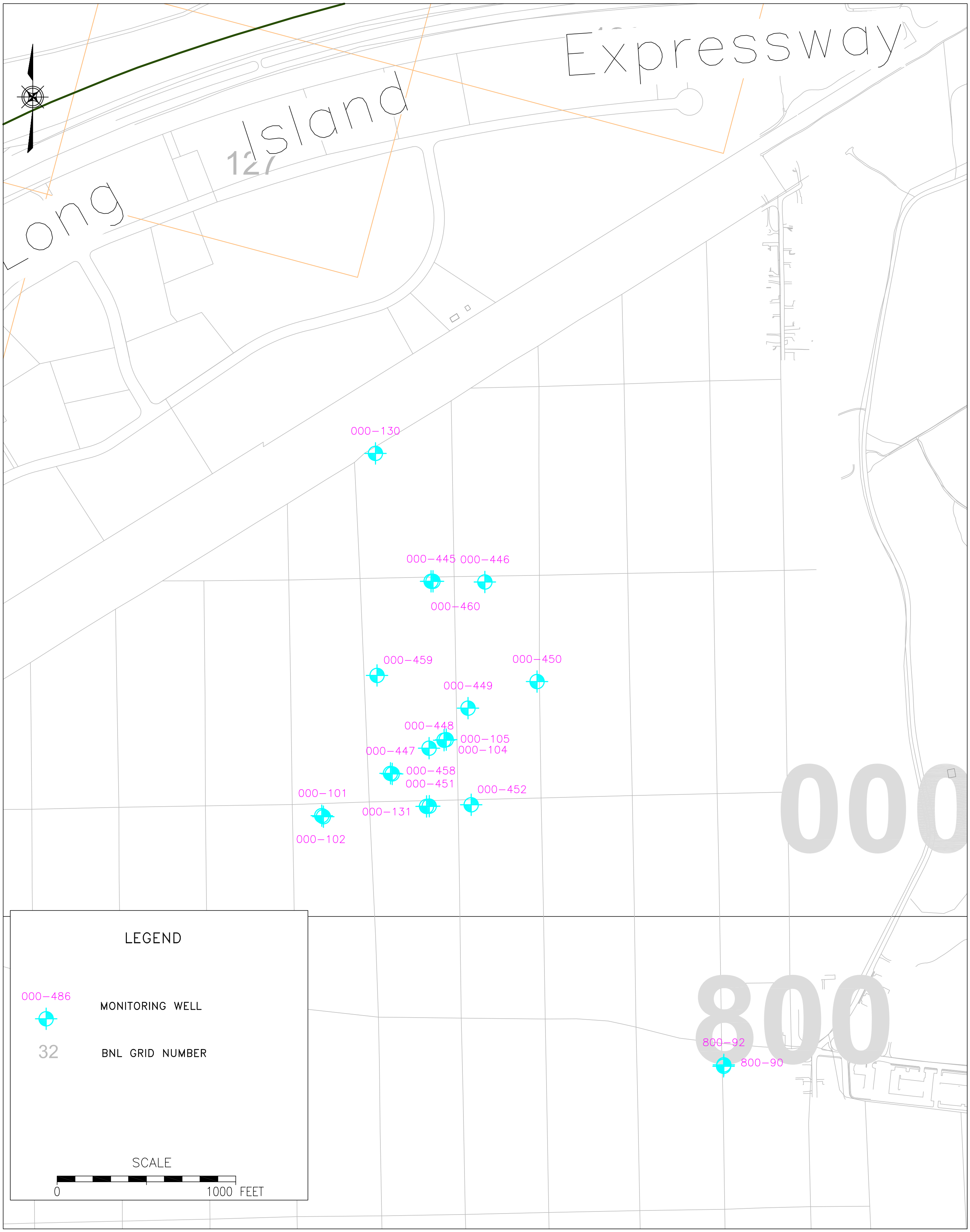
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-101	Semiannual	None	None
000-102	Semiannual	None	None
000-104	Semiannual	None	None
000-105	Semiannual	None	None
000-130	Semiannual	None	None
000-131	Quarterly	None	None
000-425	Semiannual	None	None
000-445	Semiannual	None	None
000-446	Semiannual	None	None
000-447	Semiannual	None	None

000-448	Semiannual	None	None
000-449	Semiannual	None	None
000-450	Quarterly	None	None
000-451	Quarterly	None	None
000-452	Quarterly	None	None
000-458	Quarterly	None	None
000-459	Quarterly	None	None
000-460	Quarterly	None	None

See Appendix B for the monitoring program for this DQO.



BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III LIPA
MONITORING WELL LOCATIONS

DWN: JEB	VT:HZ.: –	DATE: 12/10/12	PROJECT NO.: 07926
CHKD:	APPD: RH	REV.: –	NOTES: –

FIGURE NO.: 12.18.1

OU III INDUSTRIAL PARK EAST

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

There are no proposed changes to the Industrial Park East groundwater monitoring program for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The Operable Unit (OU) III Industrial Park East remediation system was approved for closure in June 2013. The system had consisted of two groundwater extraction wells and diffusion wells located south of the BNL boundary and Long Island Expressway (LIE) and immediately east of the OU III Industrial Park Treatment System. One of the extraction wells was designed to remediate volatile organic compound (VOC) contamination entering the upper portion of the Magothy aquifer. A second well was designed to treat VOC contamination in the Upper Glacial aquifer. This contamination originated in the central, developed areas of the BNL site and migrates southward in the direction of groundwater flow. The area of contamination had already migrated south of the site boundary prior to the startup of the OU III South Boundary Pump and Treat System in 1997.

This system was designed to achieve the OU III Record of Decision (ROD) objectives of minimizing plume growth and meeting Maximum Contaminant Levels (MCLs) in the Upper Glacial aquifer by 2030. The system addressed the highest VOC concentration portion of the plume (above 50 µg/L) and was shut down in 2009. The southernmost portions of this plume will eventually be addressed by the Brookhaven Airport remediation system, as it continues to travel south with the regional groundwater flow.

The Magothy monitoring well network for the OU III Industrial Park East project consists of 11 wells. The monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, a groundwater remediation system had been constructed to treat this plume. The treatment system has been shut down since 2009. Data are needed to verify that the plume is naturally attenuating.

Step 2: Identify the Decision

- Were unexpected levels or types of contamination detected?
- Is the plume naturally attenuating as expected?
- Has the groundwater cleanup goal of meeting MCLs been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into a total of eight decision subunits (four each for the Upper Glacial and Magothy systems) to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are as follows:

Upper Glacial System:

- plume core wells (Decisions 1, 2, 4, 5, 6 and 7)
- plume perimeter wells, used to define the extent of the plume (Decisions 1 and 7)

Magothy System:

- plume core wells (Decisions 1, 2, 4, 5, 6 and 7)
- plume perimeter wells, used to define the extent of the plume (Decisions 1 and 7)

The wells included in each subunit are shown in Table 12.1.1. The inputs necessary for the decisions include:

- direction and velocity of groundwater flow
- analytical results for VOCs in groundwater
- location of existing wells relative to flow patterns (Figure 12.19.1)
- action levels
- variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Long Island Expressway to the north
- Astor Drive to the south
- Upper Glacial aquifer (Upper Glacial System)
- Upper Magothy aquifer (Magothy System).

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Is the plume naturally attenuating as expected?

If the detected VOC concentrations are consistent with the attenuation model, groundwater model results, and professional judgment, **then** continue attenuation monitoring. If not, consider refining the conceptual model or conducting an engineering evaluation to determine if other actions are required.

Decision 3

Has the groundwater cleanup goal of meeting MCLs been achieved?

If, for all wells the mean concentration of each VOC in groundwater computed from the previous four consecutive sampling events is less than the compound-specific MCL, and the computed mean is consistent with professional judgment, **then** petition for closure of the remedial action. Otherwise, continue attenuation monitoring. MCL's have been met in the Upper Glacial Aquifer but not yet for the Magothy for this remedial action..

.

Step 6: Specify Acceptable Error Tolerances

Table 12.19.1 summarizes the decision and possible decision errors for this project.

Table 12.19.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays. (2) Lost time in addressing problem, loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff, project delays. (2) Continue remediation longer than necessary, wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU III Industrial Park East project consists of 11 wells.

Parameters and Frequency

The wells will be monitored for VOCs. The monitoring well sampling frequency is in the Post-Closure phase which is annual and semiannual, depending on the well location. Frequency details are given on Table 12.1.1.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.19.2 Proposed Modifications to the OU III Industrial Park East Monitoring Wells

Well	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-211	Annual	None	None
000-490	Annual	None	None
000-492	Annual	None	None
000-494	Semiannual	None	None
000-495	Annual	None	None
122-24	Semiannual	None	None
122-25	Semiannual	None	None
000-526	Annual	None	None
000-426	Annual	None	None
000-427	Annual	None	None
000-429	Semiannual	None	None

See Appendix B for the monitoring program for this DQO.

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III INDUSTRIAL PARK EAST

MONITORING WELL LOCATIONS

DWN:	VT:HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
	RH	12/16/15	–

FIGURE NO.: 12.19.1

OU III NORTH STREET EAST

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 9, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF CHANGES

Proposed changes for calendar year (CY) 2016 for the Operable Unit (OU) III North Street East groundwater remediation system and monitoring program:

- As per the Petition for Shutdowns recommendations, reduce groundwater monitoring to the standby monitoring frequency (semi-annual for core and bypass wells and annual for perimeter wells).

DESCRIPTION AND TECHNICAL BASIS

The OU III North Street East remediation system consists of two groundwater extraction wells and four diffusion wells (to be shared with the OU III North Street system) located east of North Street, south of the Long Island Expressway (LIE), and north of Moriches-Middle Island Road, in East Yaphank. The extraction wells are designed to remediate volatile organic compound (VOC) contamination residing in the middle portion of the Upper Glacial aquifer. The contamination in this area had migrated off-site prior to the start-up of the OU I (RA V) South Boundary treatment system in December 1996 and consists primarily of 1,1,1-TCA, 1,1-DCE, and TCE. The contamination consists of commingled plumes from several sources, including the Current Landfill and the former Hazardous Waste Management Facility (HWMF). The plume is migrating in a southerly direction with groundwater flow.

This system is designed to achieve the OU III Record of Decision (ROD) objectives of minimizing plume growth and meeting Maximum Contaminant Levels (MCLs) in the Upper Glacial Aquifer in 30 years or less. The system will address the highest VOC concentration portion of the plume (above 50 µg/L).

The monitoring well network for the OU III North Street East project consists of 16 wells, all of which are located off site and south of the LIE. Well locations are shown on Figure 12.20.1. The wells will be sampled quarterly and analyzed for VOCs. The monitoring schedule is provided in Table 12.1.1.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
___ Surveillance
_x_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

A VOC plume that could represent a potential risk to human health or the environment has been defined south of the BNL site. In response, a groundwater remediation system has been constructed to treat this plume. Data are needed to verify that the remediation is occurring according to plan. Based on groundwater modeling, the extraction wells are scheduled to operate for up to 10 years.

Step 2: Identify the Decision

Were unexpected levels or types of contamination detected?
Has the downgradient migration of the plume been controlled?
Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
Have the groundwater cleanup goals been achieved?

Step 3: Identify Inputs to the Decision

The project was divided into a total of five decision subunits to reflect the categories of wells for which decisions will be made with respect to the VOC contamination. The identified subunits and the decisions supported by each are:

- Plume core wells (Decisions 1, 3, and 4)
- Plume perimeter wells, used to define the extent of the plume (Decisions 1 and 2)
- Bypass detection wells (Decisions 1, and 2)

The wells included in each subunit are shown in Table 12.1.2. The inputs necessary for the decisions include:

- Direction and velocity of groundwater flow
- Analytical results for VOCs in groundwater
- Location of existing wells relative to flow patterns (Figure 12.20.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

As currently defined, the spatial boundaries of the study area are defined by:

- Long Island Expressway to the north
- east of North Street
- north of Moriches–Middle Island Road
- the Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

Analytical results from wells in all subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (EM-SOP-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 2

Has the downgradient migration of the plume been controlled?

This decision applies to the plume perimeter and bypass detection wells. If the cleanup goals have not been met, then it must be verified that the plume is not growing. Plume growth is defined as an increase in total VOC concentration in plume fringe or bypass detection wells to above 50 μg/L (if currently less than 50 μg/L) or a significant increase in total VOC concentration (if currently above 50 μg/L).

If the trend in each plume perimeter and bypass detection well has a negative or zero slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the total VOC concentration is less than 50 μg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 3

Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?

In order to shut down the treatment system, the shutdown criteria of reaching less than 50 μg/L TVOCs for at least four consecutive sampling rounds must be met in the core monitoring and extraction wells.

3a. Are TVOC concentrations in plume core wells above or below 50 ug/L?

If the total VOC concentration in each plume core well has been reduced to less than 50 µg/L in less than 7 to 10 years of active remediation, **then** proceed with pulsed operation of the system. **If not**, and treatment has occurred for less than 7 to 10 years, **then** continue treatment. **If not** ,and treatment has occurred for at least 7 to 10 years, **then** perform an engineering evaluation to predict the fate of the remaining contamination and determine whether MCLs will be met by 2030.

3b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

This decision is to determine whether there is significant concentration rebound after system has been shut down completely or entered pulse pumping mode. **If yes**, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d. to help with this decision). **If no**, significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 4

Have the groundwater cleanup goals been achieved?

If the mean concentration of TVOCs in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 50 µg/L, and if the mean TVOC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous 2 years, is less than 50 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.20.1 summarizes the decision and possible decision errors for this project.

Table 12.20.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based On Data	Potential Consequences
Is the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process,; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues; ultimate project delays. (2) Wasted resources; project delays.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff; potential to have to restart system. (2) Continue remediation that is no longer effective.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU III North Street East project consists of 16 wells, all of which are located off-site south of the LIE.

Parameters and Frequency

Groundwater monitoring wells are sampled quarterly for VOCs.

Table 12.21.2 Proposed Modifications to the North Street East Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-394	Quarterly	Annual	VOCs
000-124	Quarterly	Semi-annual	VOCs
000-137	Quarterly	Annual	VOCs
000-138	Quarterly	Semi-annual	VOCs
000-215	Quarterly	Annual	VOCs
000-477	Quarterly	Semi-annual	VOCs
000-478	Quarterly	Semi-annual	VOCs
000-479	Quarterly	Semi-annual	VOCs
000-480	Quarterly	Semi-annual	VOCs
000-481	Quarterly	Semi-annual	VOCs
000-482	Quarterly	Semi-annual	VOCs
000-483	Quarterly	Semi-annual	VOCs
000-484	Quarterly	Semi-annual	VOCs
000-485	Quarterly	Semi-annual	VOCs
000-486	Quarterly	Semi-annual	VOCs
000-525	Quarterly	Semi-annual	VOCs

See Appendix B for the monitoring program for this DQO.

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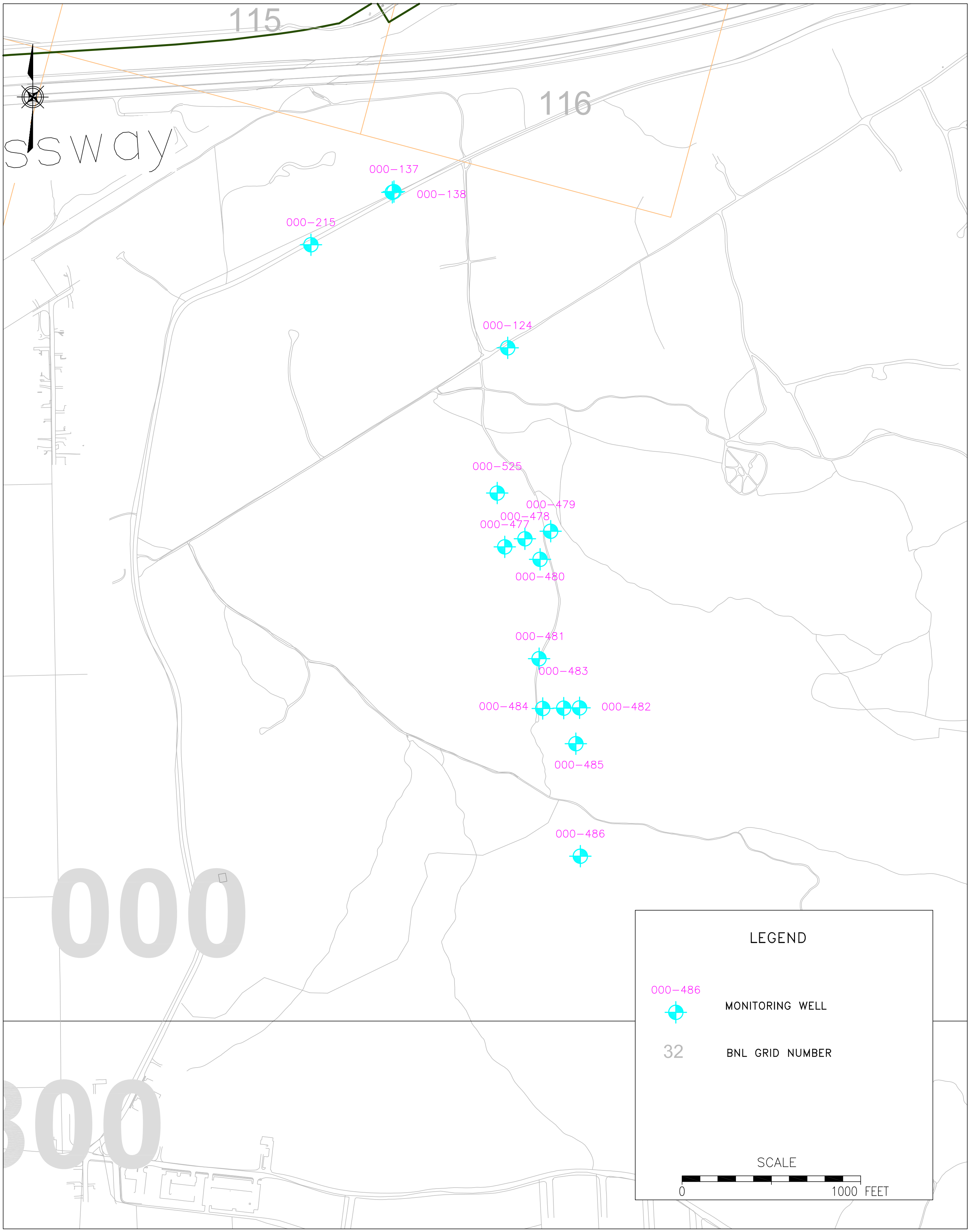

BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: OU III North Street East MONITORING WELL LOCATIONS	DWN: JEB	VT: HZ.: –	DATE: 12/10/12	PROJECT NO.: 20335
		CHKD:	APPD: RH	REV.: 11/19/14	NOTES: –
		FIGURE NO.: 12.20.1			

OU III – Building 452 Freon-11 Source Area and Groundwater Plume

DQO Start Date January 1, 2012

Revision Number/Date Rev. 4, November 1, 2015

Implementation Date January 1, 2016

Point of Contact Douglas Paquette (631) 344-7046

Summary of Changes

Proposed changes for calendar year (CY) 2016 for the OU III - Building 452 Freon-11 Source Area and Groundwater Plume monitoring program include:

- Discontinuing sampling of well 085-43. Following regulatory agency approval of a planned Petition of Shutdown, it is anticipated that the Freon-11 treatment system will be placed on standby mode starting in early 2016. All monitoring wells will continue to be sampled on a quarterly basis during this period.

Description and Technical Basis

In early April 2011, BNL received analytical data indicating the detection of the refrigerant Freon-11 (Trichlorofluoromethane) in a shallow groundwater monitoring well located in the Former Building 96 area. The Freon-11 concentration in well B96-MW02-2010 was 46 µg/L. The New York State Ambient Water Quality Standard (NYS AWQS) for this compound is 5 µg/L. The Laboratory immediately resampled the well to confirm the result in monitoring well 085-73, located approximately 100 feet upgradient near Building 452, where BNL had maintained an inventory of refrigerant gasses, and where the Lab recovers compressor oils and refrigerants from decommissioned air conditioning units. From April through early August 2011, BNL installed 42 temporary groundwater monitoring wells and analyzed approximately 350 groundwater samples to characterize the vertical and horizontal extent of Freon-11 in the groundwater. The plume was found to extend from the Building 452 area approximately 600 feet downgradient to Former Building 96 groundwater extraction well RTW-1. At its maximum, the plume was approximately 300 feet wide. The maximum Freon-11 concentration detected in the plume was 38,000 µg/L in a permanent well installed approximately 100 feet downgradient of Building 452.

Groundwater extraction well EW-18 was installed in early 2012 to intercept the upgradient area of greatest Freon-11 concentrations. This extraction well began operation in April 2012. Existing Building 96 groundwater extraction well RTW-1 is used to capture the downgradient, lower concentration portion of the plume. The treated water from both wells is discharged to the nearby surface drainage culvert which ultimately discharges to the Recharge Basin HS.

A network of 14 monitoring wells was established to monitor the source area and to evaluate the effectiveness of the groundwater treatment system. The remediation goals for the plume are described in an Explanation of Significant Differences (ESD) to the Operable Unit III (OU III) Record of Decision (ROD) that was approved by the regulatory agencies in 2012. As defined in the ESD, active remediation of the plume will continue until Freon-11 concentrations have decreased to less than the 50 µg/L cleanup goal.

DRIVERS FOR MONITORING

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The remediation system for the Building 452 Freon-11 plume consists of new extraction well EW-18 and existing Building 96 extraction well RTW-1. Routine collection of groundwater samples is required to verify that the remediation system is controlling plume migration and reducing Freon-11 concentrations in the aquifer at the expected rate.

Step 2: Identify the Decisions

Is the plume being controlled and remediated as planned, and have the cleanup objectives been met?

Step 3: Identify Inputs to the Decision

The project was divided into two decision subunits to reflect the categories of wells for which decisions will be made with respect to the Freon-11 contamination. The identified subunits and the decisions supported by each are:

- Source area wells (Decisions 1 and 2)
- Downgradient wells (Decision 1)

The decision units for each of the wells in the current monitoring network are shown in Table 12.43.1. The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Regulatory requirements: Environmental Services Division for Building 452 Freon-11 Source Area and Groundwater Plume
- Analytical results for Freon-11 in groundwater (Environmental Protection Agency [EPA] Method 524.2)
- Locations of existing wells relative to flow patterns (Figure 12.21.1)
- Evaluation of capture zone for extraction wells
- Action levels
- Variability of data

Step 4: Define the Study Boundaries

The decision boundary for this monitoring program is defined by the Building 452 source area and the downgradient extent of the plume which is being captured by Building 96 extraction wells RTW-1. The potential risk to downgradient receptors from the Building 452 Freon-11 plume was determined to be low based on the following factors:

- Public water hookups have been provided off site.
- This contamination is not within the capture zone of BNL supply wells.
- Travel time is approximately 20 years to the BNL site boundary.
- Once the source and main portion of the Freon-11 plume are addressed, contamination that is not captured by the Building 452 or Building 96 treatment systems will be intercepted by the Middle Road treatment system before reaching the site boundary.

Groundwater modeling predicted that Freon-11 concentrations in groundwater would drop to less than the NYS AWQS within 3 to 5 years after the start of active remediation. Based upon data collected through 2015, Freon-11 concentrations have decreased to less than the 50 µg/L cleanup goal defined in the ESD. A Petition for Shutdown will be submitted to the regulatory agencies in late 2015. Continued monitoring will be required evaluate potential concentration rebound following shutdown, and to verify that NYSAWQS are met.

Step 5: Develop the Decision Rules

Decision 1

Are there unexpected results in the monitoring wells for this project?

If monitoring results indicate unexpected levels of contamination or failure to adequately control and remediate the plume, **then** the BNL Groundwater Contingency Plan will be implemented. Monitoring results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, or monitoring indicates that the extraction wells are not controlling the downgradient movement of the plume.

Decision 2

Have the source control objectives been met?

The ESD requires source area controls and remediation of the Freon-11 plume to prevent or reduce downgradient impacts. As this is a source control activity, setting specific cleanup goal concentrations is not necessary to ensure that the system is operated in an efficient manner. Rather, the removal of a significant portion of the contaminant mass is the appropriate decision metric for determination of shut-down criteria defined in the ESD. The treatment system has a capture goal of 50 µg/L, and the reduction of Freon-11 concentrations within the plume to below 50 µg/L will be used as the shutdown/pulse pumping criteria for the treatment system. **(Note: This reduction goal was met by late 2014, and pulsed pumping operations for EW-18 were started in February 2015.)**

If pulsing of the remediation system does not result in significant rebound in contaminant concentrations, and model predictions indicate that any remaining contamination will not prevent achievement of cleanup objectives, **then** consider termination of system operation. **If not**, then continue operation of the system. **(Note: Since the beginning of pulsed pumping of EW-18 in February 2015, there has not been a significant rebound in Freon-11 concentrations.)**

Step 6: Specify Acceptable Error Tolerances

Table 12.43.1 summarizes the decision and possible decision errors for this project. There are no potential receptors immediately downgradient of the Building 452 area and groundwater travel time to the site boundary is approximately 20 years. In addition, other remediation systems (former Building 96 and OU III Middle Road) are in place downgradient of the Building 452 area.

Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust and BNL credibility, and potentially wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the Building 452 program consists of 14 wells, all of which are screened in the shallow portion of the Upper Glacial aquifer. Seven of the wells (085-43, 085-73, 085-293, 085-380, 085-381, 085-382, 085-383, and 085-384) monitor the Building 452 source area. The remaining seven wells (085-385, 085-386, 085-387, 085-388, 095-313, 095-314 and 095-315) monitor the downgradient portions of the plume.

Well locations are shown on Figure 12.21.1.

Parameters and Frequency

The monitoring wells are currently monitored on a quarterly basis for VOCs to evaluate the plume configuration and the effectiveness of the remediation system. A monitoring schedule is provided in Table 12.24.1. The monitoring well samples are analyzed for VOCs using EPA Method 524.2. Influent and effluent sampling requirements for the treatment systems are presented in the Building 452 and Building 96 treatment system operation and maintenance (O&M) manuals. Starting in 2016, monitoring of well 085-43 will be discontinued because it is located outside of the defined plume. Following the anticipated shutdown of extraction well EW-18 in early 2016, sampling frequency will continue to be conducted quarterly for at least one year to verify that a significant rebound in Freon-11 concentrations does not occur. A summary of the monitoring well sampling program for this project is provided in Table 12.43.2.

Table 12.21.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Was the Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process, project delays (2) Lost time in addressing problem, loss of stakeholder confidence.
Have the source control objectives been met?	See Step 3 for inputs.	(1) Determine cleanup goals have been met then they are not. (2) Fail to determine cleanup goals are met when they are.	(1) Delay in making operational adjustments, avoidable growth of plume. (2) Wasted resources considering/ implementing operational adjustments.

DATA REVIEW REQUIREMENTS

Based upon the amount of monitoring data available for this program acquired since 2011, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.21.2 Comparison of 2015 and 2016 Sampling Programs

Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
085-43	Semiannual	None	--
085-73	Quarterly	Quarterly	None
085-380	Quarterly	Quarterly	None
085-381	Quarterly	Quarterly	None
085-382	Quarterly	Quarterly	None
085-383	Quarterly	Quarterly	None
085-384	Quarterly	Quarterly	None
085-385	Quarterly	Quarterly	None
085-386	Quarterly	Quarterly	None
095-313	Quarterly	Quarterly	None
085-387	Quarterly	Quarterly	None
085-388	Quarterly	Quarterly	None
095-314	Quarterly	Quarterly	None
095-315	Quarterly	Quarterly	None

See Appendix B for the monitoring program for this DQO.

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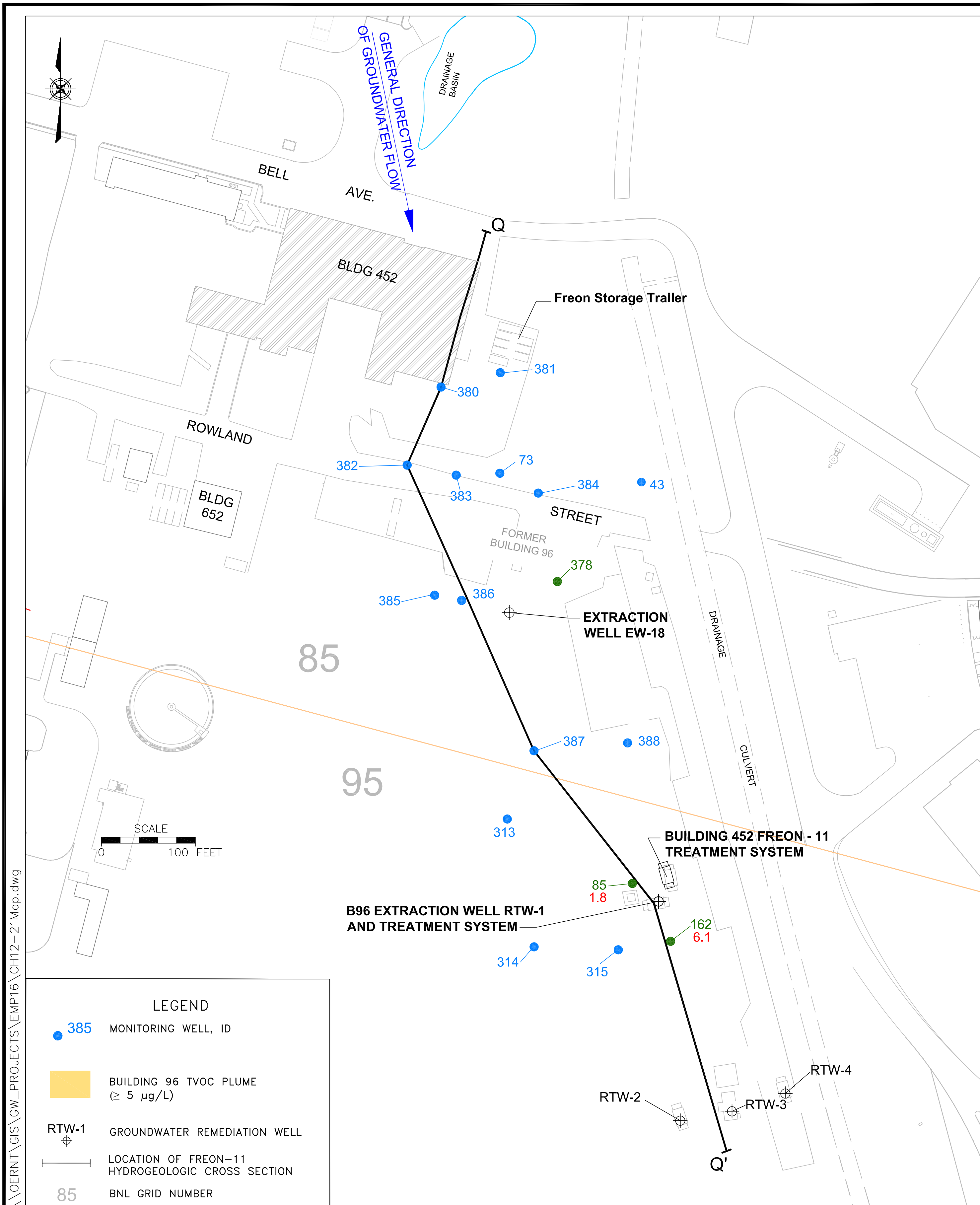

BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: BUILDING 452 AREA FREON–11 MONITORING WELL NETWORK	DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
		CHKD: JEB	APPD: DEP	REV.: 12/16/15	NOTES: –
		FIGURE NO.: 12.21.1			

OU IV Area of Concern (AOC) 6 – Building 650 Sump Outfall Area

DQO Start Date January 1, 2003

Revision Number/Date Rev. 11, December 15, 2015

Implementation Date January 1, 2016

Point of Contact William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

Summary of Changes

Proposed changes for calendar year (CY) 2016 for the Operable Unit (OU) IV Area of Concern (AOC) 6 - Building 650 Sump Outfall Area include:

- Increase the frequency of sampling well 076-13 from semiannual to quarterly to monitor the former source area.
- Install several temporary wells immediately north of the NSLS-II to site a place for a permanent sentinel monitoring well.

Description and Technical Basis

The OU IV AOC 6 project monitors a Sr-90 plume emanating from contaminated soil within an area known as the Building 650 Sump Outfall Area. This area is a natural depression at the terminus of a discharge pipe from Building 650. The pipe conveyed discharges from decontamination of radioactively contaminated clothing and equipment that was conducted on an outdoor pad at Building 650 beginning in 1959. Impacted soil within the sump outfall area was excavated during CY 2002. Groundwater flow in this area is toward the south–southwest.

The monitoring well network for the OU IV AOC 6 project consists of 20 wells. The wells are located to monitor groundwater downgradient of the decontamination pad and Building 650 Sump Outfall Area. Some wells were constructed south of the leading edge of the plume to act as sentinel wells. Well locations are shown on Figure 12.22.1. In accordance with the Record of Decision (ROD) for OU IV, the wells are sampled semi-annually for analysis of Sr-90, gross alpha/beta, gamma spectroscopy, and tritium. A schedule is provided in Table 12.1.1.

In general, Sr-90 activity trends are stable for the wells within the plume, and in wells downgradient of the plume.

Drivers for Monitoring Being Conducted under This Change

___ Compliance
___ Support Compliance
___ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Groundwater in the vicinity of Building 650 and the Building 650 Sump Outfall Area, and downgradient of these areas, has been impacted by Sr-90 at activities exceeding New York State groundwater standards. Data are needed to define the extent of the Sr-90 plume.

Step 2: Identify the Decision

The decisions for the project are:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?
- Were unexpected levels or types of contamination detected?
- Is the plume naturally attenuating as expected?
- Has the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include

- Direction and velocity of groundwater flow
- Radionuclide analytical results in groundwater
- Locations of existing wells relative to flow patterns
- Action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

The project decision unit limits are defined by:

- HO Basin (well 066-190) on the north
- Brookhaven Avenue on the south
- Railroad Street (wells 076-373 and 076-317) on the west
- HO Basin and RA V Basin on the east
- shallow and mid-depth Upper Glacial aquifer

Section 12.1 details the general sampling frequency based on the phase the monitoring program is in.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

For each future sampling event, sample results will be evaluated in context with historic data. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Is the plume naturally attenuating as expected?

If performance objectives have not been met, **then** it must be determined whether Sr-90 activities in groundwater are consistent with the attenuation model (e.g., results are on track to attenuate to less than MCLs within 30 years).

If the detected Sr-90 activities are consistent with the attenuation model, groundwater model results and professional judgment, **then** continue monitoring. If not, consider refining the conceptual model and/or conducting an evaluation to determine whether outside factors (such as additional contaminant sources) are affecting the results.

Decision 4

Has the groundwater cleanup goal of meeting MCLs been achieved?

If the concentration of Sr-90 in groundwater is less than 8 pCi/L, **then** petition for the end of monitoring. **If not**, **then** continue monitoring.

Step 6: Specify Acceptable Error Tolerances

Table 12.22.1 summarizes the decision and possible decision errors for this project.

Table 12.22.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the BNL Groundwater Contingency Plan triggered?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Are performance objectives met?	See Step 3 for inputs.	(1) Data indicate that performance objectives have not been met when they have. (2) Data indicate that performance objectives have been met when they have not.	(1) Wasted resources conducting continued unnecessary monitoring. (2) Potential bypass of contaminants, project delays, potential risk to down-gradient receptors.
If not, are observed conditions consistent with attenuation model?	See Step 3 for inputs.	(1) Data indicate that conditions are not consistent with model when they are. (2) Data indicate that conditions are consistent with model when they are not.	(1) Wasted resources conducting attenuation model refinements and introducing supplements. (2) Potential bypass of contaminants, project delays; potential risk to down-gradient receptors.

Step 7: Optimize the Design

Number and Locations of Wells

The existing monitoring well network consists of 20 wells. Locations are shown on figure 12.22-1.

Parameters and Frequency

A summary of the sampling program for this project is provided in Table 12.17.2.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.22.2 Proposed Modifications to the AOC 6 Project Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
076-07	Annually	No Change	None
076-09	Annually	No Change	None
076-181	Annually	No Change	None
076-182	Annually	No Change	None
076-184	Annually	No Change	None
076-22	Annually	No Change	None
076-24	Semi-annually	No Change	None
076-13	Semi-annually	Quarterly	Sr-90
076-168	Semi-annually	No Change	None
076-169	Semi-annually	No Change	None
076-25	Annually	No Change	None
076-262	Annually	No Change	None
076-263	Semi-annually	No Change	None
076-28	Semi-annually	No Change	None
076-314	Annually	No Change	None
076-317	Annually	No Change	None
076-373	Annually	No Change	None
076-415	Semi-annually	No Change	None
076-416	Semi-annually	No Change	None
076-417	Semi-annually	No Change	None
New Well	None	Annually	Sr-90

See Appendix B for the monitoring program for this DQO.

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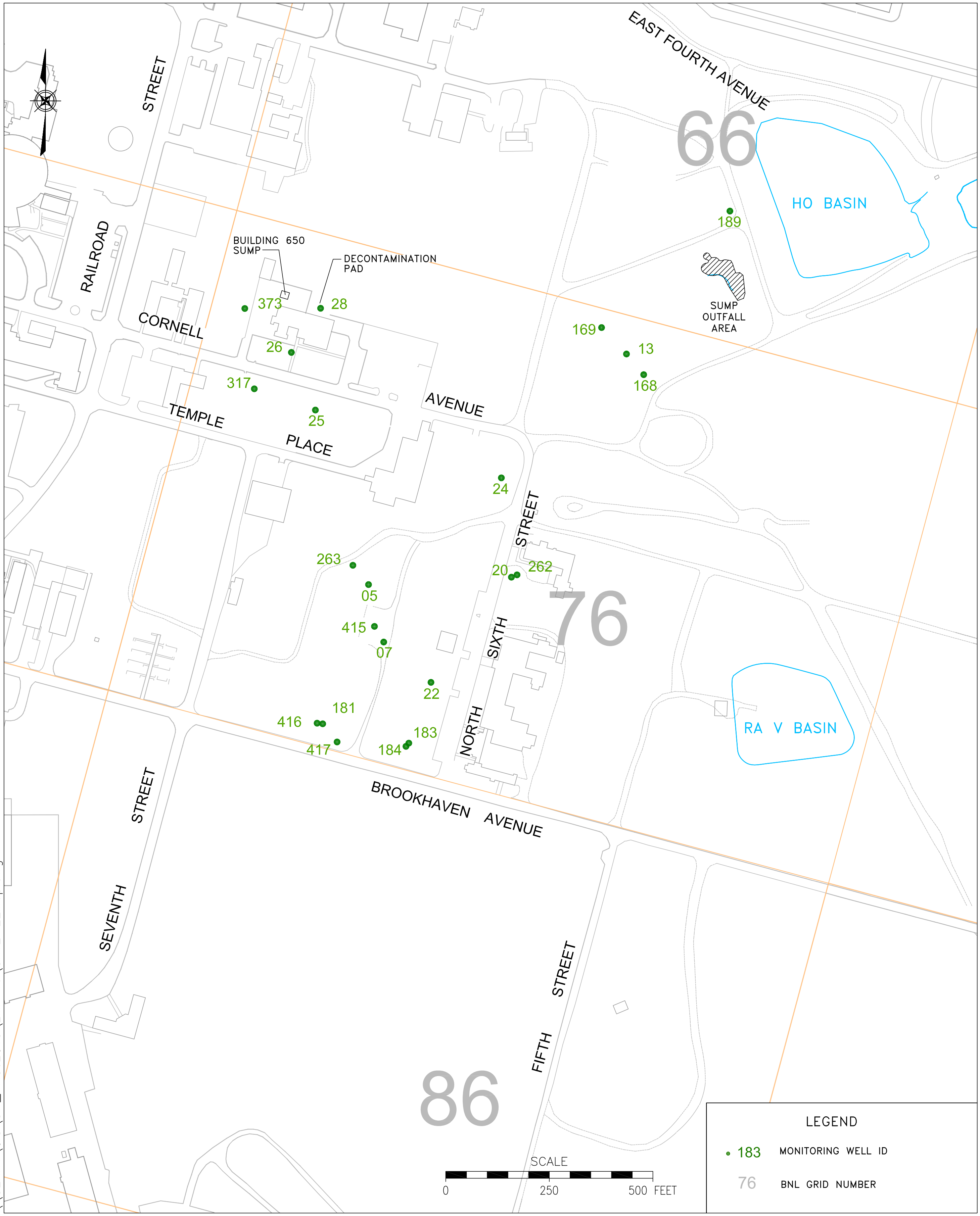

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU IV AOC 6
MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
JEB	--	12/16/15	–

FIGURE NO.: 12.22.1

OU VI ETHYLENE DIBROMIDE

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 11, December 15, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186
Vincent Racaniello (631) 344-5436

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for the Operable Unit (OU) VI Ethylene Dibromide (EDB) Treatment System and groundwater monitoring programs for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The monitoring well network for the OU VI EDB Project consists of 26 wells. Well locations are shown on Figure 12.21.1. The wells are sampled annually for analysis of volatile organic compounds (VOCs) and EDB, and annually for analysis of tritium. Table 12.1.1 shows the monitoring schedule for CY 2015.

The contaminant of concern associated with the OU VI plume is EDB.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
____ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

There is an existing plume of groundwater contaminated by EDB that has migrated south of the BNL Site boundary. In response, a groundwater remediation system is currently being designed. Data are needed to confirm the vertical and horizontal extent of the EDB plume so that the design of the remediation system can be optimized

Step 2: Identify the Decision

The decisions for the project include:

- Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

- Were unexpected levels or types of contamination detected?
- Has the downgradient migration of the plume been controlled?
- Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?
- Have the groundwater cleanup goal of meeting maximum contaminant levels (MCLs) been achieved?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- EDB analytical results in groundwater
- Locations of existing wells relative to flow patterns (Figure 12.23.1)
- Regulatory drivers (OU I Record of Decision [ROD])
- action levels (New York State groundwater standards and/or baseline groundwater concentrations)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan
- Variability of data
- Status of potential downgradient receptors

Step 4: Define the Study Boundaries

The horizontal extent of the study area is the existing EDB plume and surrounding wells at, and south of, the southern BNL site boundary. These limits are defined by well 100-12 to the north, wells 000-519 and 000-524 to the south, wells 000-285 and 000-180 to the east, and wells 099-06,and 000-117 to the west. The vertical extent of the study area is the saturated thickness of the Upper Glacial aquifer.

Because the contaminant plume has already passed the southern BNL site boundary, tracking the plume configuration over time is of critical importance. In addition, the remediation system design will depend on the plume configuration. The timeframe to consider analytical results is 90 days.

Step 5: Develop the Decision Rules

Decision 1

Is there a continuing source of contamination? If present, has the source area been remediated or controlled?

Analytical results from plume core wells will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. **If** plume core wells located in the source area continue to show elevated levels of contaminants with no decreasing trend, **then** an evaluation of the source area will be conducted to determine if the source should be remediated or controlled.

Decision 2

Were unexpected levels or types of contamination detected?

Analytical results from wells in all three subunits will be utilized for this decision. Future sample results will be evaluated in context with historic data for each sampling event. As part of that evaluation, circumstances that would require implementation of the BNL Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure [EM-SOP]-309) would be ascertained for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, detection of previously undetected contaminants, and detection of contaminants in previously "clean" wells.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Decision 3

Has the downgradient migration of the plume been controlled?

This decision applies to the perimeter and bypass detection wells. If the cleanup goals have not been met, it must be verified that the plume is not growing. Plume growth is defined as an increase in EDB concentration in perimeter or bypass detection wells to above 0.05 µg/L (if currently less than 0.05 µg/L) or a significant increase in total VOC concentration (if currently above 50 µg/L).

If the trend in each perimeter and bypass detection well has a negative slope, based on the four most recent consecutive samples, this trend is consistent with professional judgment, and the EDB concentration is less than 0.05 µg/L, **then** continue to operate the system. **If not**, **then** consider an engineering evaluation or operational adjustments to optimize system operation.

Decision 4

4. *Can individual extraction wells or the entire treatment system be shut down or placed in pulsed pumping operation?*

If evaluation of analytical results for any contaminant of concern in any upgradient or plume core well sample, in conjunction with historic analytical results and trends indicates that the treatment system have met the shutdown criteria of achieving the cleanup goal by 2030, **then** a petition for shutdown will be issued to the regulatory agencies.

4a. Are EDB concentrations in plume core wells above or below 0.05 µg/L?

This decision also applies to the plume core wells. It is anticipated that approximately 7 to 10 years of active groundwater treatment will reduce the mean total volatile organic compound (TVOC) concentrations in the plume core to less than 50 µg/L.

If this occurs, **then** it is reasonable to expect (based on model projections) that MNA of the remaining contamination in the plume core will be reduced further to meet the cleanup goals of restoring the Upper Glacial aquifer to MCLs within 30 years. **If** the TVOC concentration remains above 50 µg/L, **then** consider operational adjustments and/or engineering evaluation.

4b. Is there a significant concentration rebound in core wells and/or extraction wells following shutdown?

If yes, **then** continue operation. **If** yes and system has operated for more than 10 years, **then** an engineering evaluation should be performed to evaluate whether continued operation of the system is warranted (see Decision subunit 4d to help with this decision). **If** no significant rebound is observed within a 1-year time period, **then** petition for system shutdown and continue with MNA.

Decision 5

Have the groundwater cleanup goal of meeting MCLs been achieved?

If the mean concentration of EDB in groundwater, calculated from analytical results from all plume core wells for the most recent sampling event, is less than 0.05 µg/L, and if the mean EDBC concentration of each contaminant of concern in groundwater in each plume core well, computed from measurements over the previous two years, is less than 0.05 µg/L, and pulsing of the remediation system has not resulted in significant rebound of contaminant concentrations, **then** petition for system shutdown and continue with MNA until MCLs are met. **If not**, **then** consider the need for continued remediation.

Step 6: Specify Acceptable Error Tolerances

Table 12.23.1 summarizes the decision and possible decision errors for this project.

Table 12.23.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is the Contingency Plan activated?	See Step 3 for inputs.	(1) Trigger Contingency Plan unnecessarily. (2) Fail to trigger Contingency Plan when it should have been triggered.	(1) Unnecessary administrative process; project delays. (2) Lost time in addressing problem; loss of stakeholder confidence.
Is plume growth controlled?	See Step 3 for inputs.	(1) Determine plume is controlled when it is not. (2) Determine plume is not controlled when it is.	(1) Premature petition for system shutoff; project delays. (2) Continue remediation longer than necessary; wasted resources.
Is the system operating as planned?	See Step 3 for inputs.	(1) Determine system operating as planned when it is not. (2) Determine system isn't operating as planned when it is.	(1) Premature petition for system shutoff; potential to have to restart system. (2) Continue remediation that is no longer effective.
Can the groundwater treatment system be shut down?	See Step 3 for inputs.	(1) Determine system can be shut down when operation should continue. (2) Determine to continue operating system when shut down is warranted.	(1) Plume growth continues; ultimate project delays. (2) Wasted resources; project delays.

Step 7: Optimize the Design

Number and Locations of Wells

The monitoring well network for the OU VI EDB Project consists of 26 existing. The locations of the wells are shown in Figure 12.23-1.

Parameters and Frequency

VOCs are samples annually and EDB is sampled quarterly to annually, depending on the monitoring well. A summary of sampling parameters and frequency is provided in Table 12.23.2.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.23.2 Modifications to the Ethylene Dibromide Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
000-110	Semi-Annually	No Change	None
000-173	Semi-Annually	No Change	None
000-174	Semi-Annually	No Change	None
000-175	Semi-Annually	No Change	None
000-176	Semi-Annually	No Change	None
000-177	Semi-Annually	No Change	None
000-178	Quarterly	No Change	None
000-179	Semi-Annually	No Change	None
000-201	Semi-Annually	No Change	None
000-209	Semi-Annually	No Change	None
099-11	Annually	No Change	None
100-12	Annually	No Change	None
100-13	Annually	No Change	None
000-283	Semi-Annually	No Change	None
000-284	Semi-Annually	No Change	None
000-497	Semi-Annually	No Change	None
000-498	Semi-Annually	No Change	None
000-499	Semi-Annually	No Change	None
000-500	Semi-Annually	No Change	None
000-501	Semi-Annually	No Change	None
000-507	Semi-Annually	No Change	None
000-508	Quarterly	No Change	None
000-519	Quarterly	No Change	None
000-520	Quarterly	No Change	None
000-524	Quarterly	No Change	None
000-527	Quarterly	No Change	None

See Appendix B for the monitoring program for this DQO.

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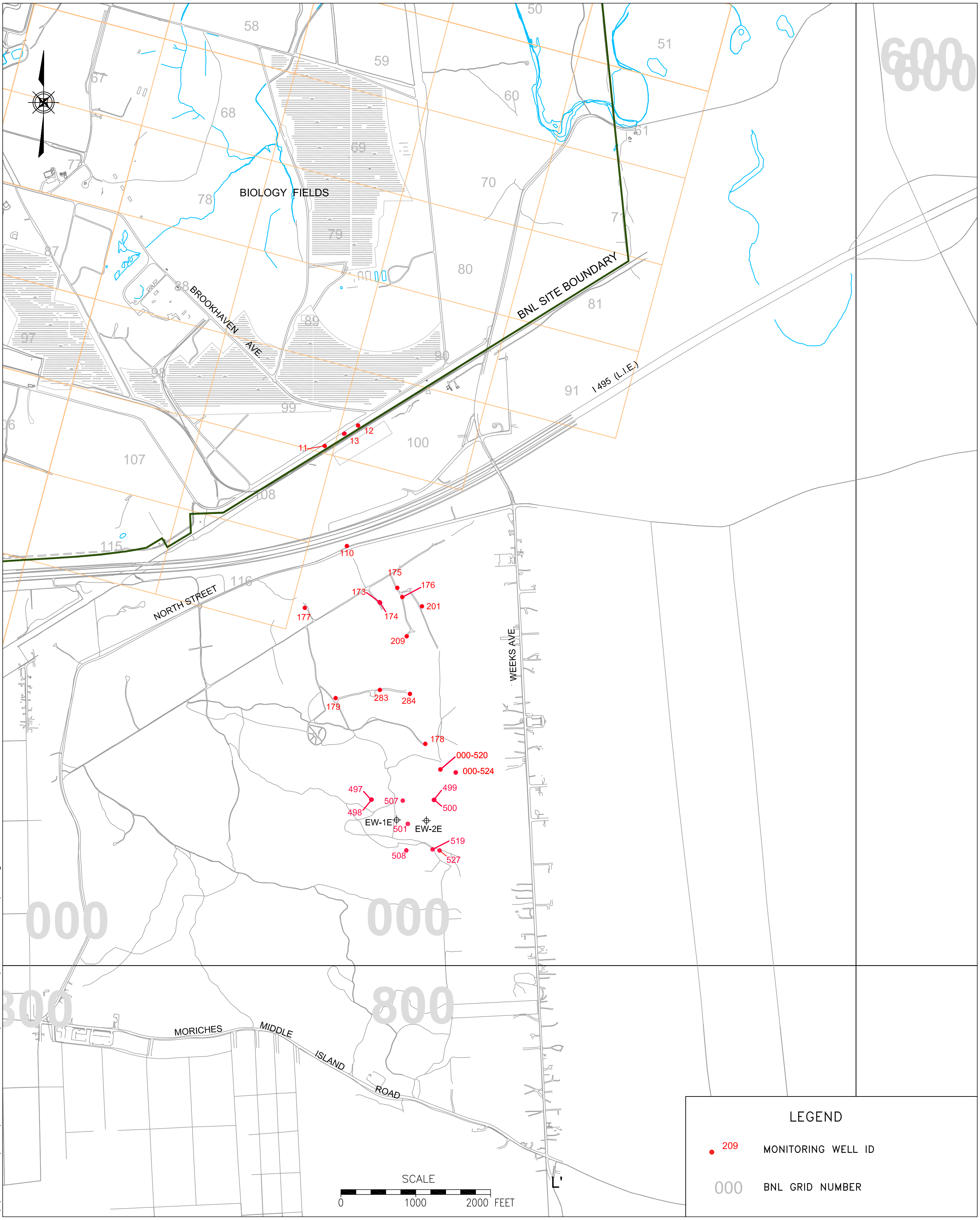


BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU VI EDB MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	12/10/12	20335
CHKD:	APPD:	REV.:	NOTES:
JEB	––	11/17/14	–

FIGURE NO.: 12.23.1

SITE BACKGROUND

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 15, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for the Site Background treatment system for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

Background water quality at BNL has been monitored since 1996. The current program includes 10 wells located in the northwestern portion of the BNL property (017-01, 017-03, 017-04, 018-01, 018-02, 018-04, 018-05, 034-02, 034-03, and 063-09) and three wells off site to the north (000-118, 000-119, and 000-120). Well locations are shown on Figure 12.24.1

Samples are collected semi-annually and analyzed for the contaminants of concern identified for groundwater characterization work conducted for the various remedial investigations and removal actions at BNL, including volatile organic compounds (VOCs), metals, and leachate parameters. Analytical results are reviewed to determine whether contaminants from off-site, upgradient sources are being transported onto the BNL facility. Historically, low levels of VOCs (less than New York State groundwater standards) have been detected in the deeper portion of the Upper Glacial aquifer and in the Magothy aquifer. Aluminum, iron, manganese, and sodium have been detected sporadically at concentrations exceeding New York State groundwater standards in some Site Background wells.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

____ Compliance
____ Support Compliance
_X_ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

During CY 2011, groundwater flow in the northwestern portion of the BNL facility within the shallow and deep portions of the Upper Glacial aquifer was toward the east to south-southeast and groundwater flow within the Magothy aquifer was toward the east-southeast. This is consistent with historic groundwater flow patterns at the BNL facility. Site Background wells are positioned to detect contamination migrating onto the BNL site.

PROBLEM STATEMENT

Data are needed to evaluate whether off-site, upgradient sources of groundwater contamination are impacting the BNL facility and to establish baseline/background levels of naturally occurring constituents, including metals and radionuclides, that are not impacted by BNL activities.

Step 2: Identify the Decision

Were unexpected levels or types of contamination detected?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Locations of existing wells relative to flow patterns (Figure 12.24.1)
- Analytical methods and detection limits as described in the BNL Environmental Monitoring Plan (EMP)
- Variability of data

Step 4: Define the Study Boundaries

The study boundaries for the Site Background program are the northwestern (upgradient) portion of the BNL facility and nearby off-site areas within the Upper Glacial and shallow Magothy aquifers.

Step 5: Develop the Decision Rules

Decision 1

Were unexpected levels or types of contamination detected?

The sample results will be evaluated in context with historical data. As part of that evaluation, circumstances that would require implementation of the Groundwater Contingency Plan (Environmental Monitoring Standard Operating Procedure {EM-SOP]-309) would be determined for each sampled well. Examples of such circumstances are unusually high contaminant concentrations, including detection of previously undetected contaminants and detection of contaminants in wells where those contaminants have not previously been detected.

If conditions dictate, **then** the BNL Groundwater Contingency Plan will be implemented.

Step 6: Specify Acceptable Error Tolerances

Table 12.24.1 summarizes the decision and possible decision errors for this project.

Table 12.24.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Is groundwater quality at BNL being impacted by off-site, upgradient source(s) of contamination?	See Step 3 for inputs.	(1) Data indicate the existence of an upgradient source when one does not exist (data indicate detected contamination is from an off-site source when it is not). (2) Data indicate that there is not an upgradient source when one does exist (data indicate detected contamination is from an on-site source when it is not).	(1) On-site contaminant source(s) will not be investigated and/or remediated and may continue to degrade groundwater quality. (2) Investigation and/or remediation of groundwater contamination may be undertaken by BNL when it is not warranted.

Because the wells included in the Site Background Program are located in the upgradient portion of the BNL facility, travel time for contamination detected in these wells to the nearest potential receptor (on-site potable supply wells) is on the order of 10 years. It is therefore unlikely that decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust and BNL credibility, and wasted resources.

Step 7: Optimize the Design

Number and Locations of Wells

The number and locations of wells for this program are considered adequate.

PARAMETERS AND FREQUENCY

The analytical parameters and sampling frequency currently conducted for this project are considered adequate. Therefore, no modifications are recommended at this time. A summary of the proposed modifications to the Site Background sampling program is provided in Table 12.24.2.

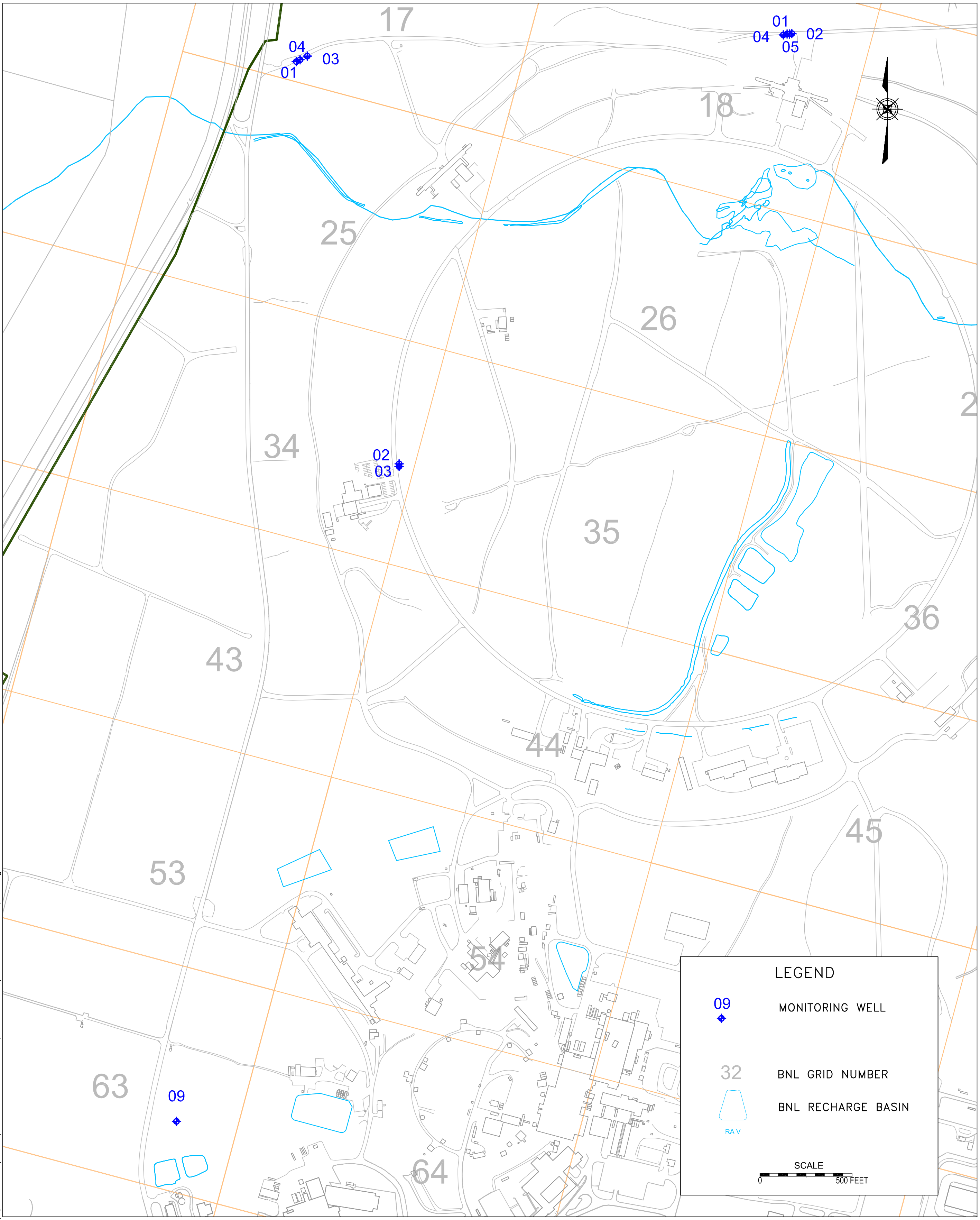
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data, full validation of the analytical results for this project is not necessary. All groundwater monitoring results will undergo data verification. All system monitoring results will undergo a review by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.24.2 Modifications to the Site Background Monitoring Wells

Well ID	Current Sampling Frequency	Proposed Sampling Frequency Changes	Affected Parameters
017-01	Annually	No Change	None
017-03	Annually	No Change	None
017-04	Annually	No Change	None
018-01	Annually	No Change	None
018-02	Annually	No Change	None
018-04	Annually	No Change	None
018-05	Annually	No Change	None
034-02	Annually	No Change	None
034-03	Annually	No Change	None
063-09	Annually	No Change	None

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

SITE BACKGROUND MONITORING WELL LOCATIONS

DWN: JEB	VT: HZ.: —	DATE: 12/10/12	PROJECT NO.: 20335
CHKD: --	APPD: --	REV.: 11/17/14	NOTES: —
FIGURE NO.: 12.24.1			

GROUNDWATER ELEVATION MONITORING

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, December 15, 2015

IMPLEMENTATION DATE January 1, 2016

POINT OF CONTACT William Dorsch (631) 344-5186

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for the Groundwater Elevation Monitoring system for calendar year (CY) 2016.

DESCRIPTION AND TECHNICAL BASIS

The purpose of the groundwater elevation monitoring program is to characterize the groundwater flow direction and rate across the BNL site and off site in multiple aquifers of interest to the groundwater protection and cleanup programs. The aquifers or sub-aquifers are:

- *Shallow Upper Glacial aquifer*: This portion of the aquifer is first to be impacted by any BNL releases and is currently contaminated in portions of the site. Groundwater flow direction and rate vary, depending on the discharge area (Peconic River, Carmans River, or Moriches Bay), as well as BNL water supply well and groundwater remediation well pumping and recharge basin operations.

- *Deep Upper Glacial aquifer*: This portion of the aquifer is utilized by BNL's water supply wells and is also contaminated in certain areas on and off site. The deep Upper Glacial aquifer is also the target of numerous groundwater remediation systems. Groundwater flow direction and rate vary, depending on the discharge area (Peconic River, Carmans River, or Moriches Bay), as well as BNL water supply well and groundwater remediation well pumping and, to a lesser extent, recharge basin operations.

- *Upper Magothy aquifer*: This aquifer is contaminated in isolated off-site areas and is currently the focus of a comprehensive characterization study. This aquifer is also utilized by the SCWA for off-site community water supply purposes (BNL's plumes are currently not an immediate threat to these wells). This aquifer tends to have different flow patterns and rates (i.e., more east-southeast and slower) than the Upper Glacial aquifer.

Synoptic groundwater elevation measurements are currently collected from approximately 780 wells on a semiannual basis. Measured wells are screened at various depths within the Upper Glacial aquifer and the upper portion of the Magothy aquifer. Most of the wells included in the groundwater elevation monitoring program are located on site, although off-site wells constructed by BNL and by the United States Geological Survey are also measured. In addition, because wells in some areas are more closely spaced than necessary for the groundwater elevation monitoring program, only a representative number of wells are monitored and not all existing wells are included in the program.

The resulting groundwater elevation data are used to develop groundwater elevation contour maps. The information contained on these maps is utilized to evaluate horizontal groundwater flow directions and rates throughout the BNL site, as well as to determine vertical gradients within and between the Upper Glacial and Magothy aquifers. These data are used to confirm that monitoring and extraction wells are located properly, to confirm that existing remediation systems are effective at capturing the targeted contamination, and that monitoring of operational and engineered controls for groundwater protection is capable of rapidly detecting an unexpected release of contamination.

DRIVERS FOR MONITORING BEING CONDUCTED UNDER THIS CHANGE

___ Compliance
___ Support Compliance
_X_ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

To monitor groundwater quality and the effectiveness of groundwater protection and cleanup activities, comprehensive groundwater flow information is required. Groundwater level information is required to generate groundwater flow information. Data are needed to evaluate groundwater flow directions and rates, and horizontal and vertical gradients in multiple aquifer segments across the BNL site and off site.

Step 2: Identify the Decision

This project generates comprehensive and regional data inputs for decisions to be made in various groundwater remediation and groundwater protection projects. These decisions are not discussed here. The decisions related to this project are:

- Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?

- Is the groundwater flow system approaching a steady state condition that could justify changes in monitoring?

Step 3: Identify Inputs to the Decision

The groundwater flow inputs generated by this project that are necessary for decisions in other projects include:

- Quarterly depth to water measurements in selected wells, measured to the nearest 0.01 foot
- Measuring point elevations for measured wells, measured to the nearest 0.01 foot
- Locations of measured wells

Step 4: Define the Study Boundaries

Because wells located throughout the BNL site and off site are included in this program, the study boundaries are the groundwater watershed areas for the Upper Glacial and upper Magothy aquifers in the vicinity of the BNL site.

Step 5: Develop the Decision Rules

Decision 1

Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?

These decision rules should be applied for each of the three aquifer segment or layers of interest. The data generated for each measurement round will be reviewed by experts on BNL hydrogeology with respect to historic data and pumping and recharge rates for supply wells and existing remediation systems.

If data generated for each measurement round for each of the three aquifer segments of interest are considered adequate as input for decisions to be made for other projects, **then** utilize the data for project-specific decisions. Otherwise, consider modifying the suite of wells that are measured to address the identified data gap(s).

Decision 2

Is the groundwater flow system approaching a steady state condition that could justify changes in elevation monitoring?

If, for any of the three aquifer segments of interest, significant change in groundwater flow direction or gradient is observed during any four consecutive measuring periods, **then** continue with the existing monitoring program for that aquifer segment.

If significant change in groundwater flow direction or gradient is not observed in one or more of the three aquifer segments of interest during any four consecutive measuring periods, **then** apply expert judgment to consider reducing monitoring frequency or the number of measured wells for that aquifer segment(s).

Step 6: Specify Acceptable Error Tolerances

Table 12.25.1 summarizes the decision and possible decision errors for this project.

Table 12.25.1 Decisions, Potential Decision Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are the groundwater flow direction and rate data developed for this project of sufficient level of detail and confidence to support other projects?	See Step 3 for inputs.	(1) Data indicate data are sufficient when they are not. (2) Data indicate data are not sufficient when they are.	(1) Potential for decision or monitoring errors in other projects due to inadequate data. (2) Wasted resources considering/ implementing operational or monitoring adjustments in other projects.
Is the groundwater flow system approaching a steady state condition that could justify changes in elevation monitoring?	See Step 3 for inputs.	(1)Data indicate that the groundwater system is approaching a steady state condition when it is not. (2) Data indicate that the groundwater system is not approaching a steady state condition when it is.	(1) Potential for variations in groundwater flow direction to be missed due to decreased monitoring frequency; loss of stakeholder trust. (2) Wasted resources conducting unnecessary water level monitoring.

Step 7: Optimize the Design

Number and Locations of Wells

Groundwater data have been reviewed and are considered to be sufficient to support the decisions to be made in other projects. The number and locations of wells currently measured are considered adequate. Therefore, no modifications to the program are recommended.

Frequency

Based on the volume of historic water level data, the frequency for the full synoptic round of water levels are collected annually. Central campus water level monitoring is conducted three times per year.

See Appendix B for the monitoring program for this DQO.

Well ID	Area	Sub Area	Decision Subunit	EPA 524.2 VOCs	EPA 625 Semi-VOCs	EPA 608 Pest/PCBs	Sulfate/Chloride/Nitrate	Metals	EPA 900 Gross Alpha/Beta	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr-90	Floating Product	Frequency (events/year)
054-61	BLIP		Upgradient								X			0
064-46	BLIP		Upgradient								X			1
064-47	BLIP		Downgradient								X			2
064-48	BLIP		Downgradient								X			2
064-49	BLIP		Downgradient								X			0
064-50	BLIP		Downgradient								X			0
064-67	BLIP		Downgradient								X			2
054-08	AGS	NSRL	Downgradient								X			1
054-191	AGS	NSRL	Downgradient								X			1
064-51	AGS	Booster Beam Stop	Downgradient								X			1
064-52	AGS	Booster Beam Stop	Downgradient								X			1
064-03	AGS	B-914	Downgradient								X			1
064-53	AGS	B-914	Downgradient								X			1
064-54	AGS	B-914	Downgradient								X			1
054-62	AGS	Bkgd. J-10 Beam Stop	Upgradient								X			1
054-63	AGS	J-10 Beam Stop	Downgradient								X			1
054-64	AGS	J-10 Beam Stop	Downgradient								X			1
054-65	AGS	g-2 Beam Stop/Plume Sour	Upgradient								X			1
054-66	AGS	g-2 Beam Stop	Downgradient								X			1
054-67	AGS	g-2 Beam Stop	Downgradient								X			1
054-68	AGS	g-2 Beam Stop	Downgradient								X			1
054-124	AGS	g-2 Beam Stop	Downgradient								X			1
054-125	AGS	g-2 Beam Stop	Downgradient								X			1
054-127	AGS	Fm. U-Line Target	Upgradient								X			1
054-128	AGS	Fm. U-Line Target	Downgradient								X			1
054-129	AGS	Fm. U-Line Target	Downgradient								X			1
054-130	AGS	Fm. U-Line Target	Downgradient								X			1
054-168	AGS	Fm. U-Line Stop	Downgradient								X			1
054-169	AGS	Fm. U-Line Stop	Downgradient								X			1
054-69	AGS	B-912	Upgradient								X			1
055-14	AGS	B-912	Upgradient								X			1
065-120	AGS	B-912	Downgradient								X			1
065-125	AGS	B-912	Downgradient								X			1
065-126	AGS	B-912	Downgradient								X			1
065-195	AGS	B-912	Downgradient								X			1
055-31	AGS	B-912	Downgradient								X			1
055-15	AGS	B-912	Downgradient								X			1

Well ID	Area	Sub Area	Decision Subunit	EPA 524.2 VOCs	EPA 625 Semi-VOCs	EPA 608 Pest/PCBs	Sulfate/Chloride/Nitrate	Metals	EPA 900 Gross Alpha/Beta	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr-90	Floating Product	Frequency (events/year)
055-16	AGS	B-912	Downgradient								X			1
065-192	AGS	B-912	Downgradient								X			1
055-29	AGS	B-912	Downgradient								X			1
055-30	AGS	B-912	Downgradient								X			1
055-32	AGS	B-912	Downgradient								X			1
065-121	AGS	B912/g-2 Tritium Plume	Downgradient								X			1
065-122	AGS	B912/g-2 Tritium Plume	Downgradient								X			1
065-193	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-123	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-124	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-194	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-321	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-322	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-323	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
065-324	AGS	B-912/g-2 Tritium Plume	Downgradient								X			1
064-55	AGS	E-20 Catcher	Downgradient								X			1
064-56	AGS	E-20 Catcher	Downgradient								X			1
064-80	AGS	E-20 Catcher	Downgradient								X			1
054-07	AGS/g-2	g-2 Tritium Plume Source	Downgradient								X			2
054-184	AGS/g-2	g-2 Tritium Plume Source	Downgradient								X			2
054-185	AGS/g-2	g-2 Tritium Plume Source	Downgradient								X			2
064-95	AGS/g-2	g-2 Tritium Plume Source	Downgradient								X			2
054-126	AGS/g-2	g-2 Tritium Plume Source	Downgradient								X			2
025-01	RHIC	B/Y Beam Stop Area	Upgradient								X			2
025-03	RHIC	B/Y Beam Stop Area	Downgradient								X			2
025-04	RHIC	B/Y Beam Stop Area	Downgradient								X			2
025-05	RHIC	B/Y Beam Stop Area	Downgradient								X			2
025-06	RHIC	B/Y Beam Stop Area	Downgradient								X			2
025-07	RHIC	B/Y Beam Stop Area	Downgradient								X			2
025-08	RHIC	B/Y Beam Stop Area	Downgradient								X			2
034-05	RHIC	B/Y Collimator Area	Downgradient								X			2
034-06	RHIC	B/Y Collimator Area	Downgradient								X			2
043-01	RHIC	B/Y Collimator Area	Downgradient								X			2
043-02	RHIC	B/Y Collimator Area	Downgradient								X			2
044-13	RHIC	B/Y Collimator Area	Downgradient								X			2
044-14	RHIC	B/Y Collimator Area	Downgradient								X			2
044-29	RHIC	W-Line Stop	Downgradient								X			2

Well ID	Area	Sub Area	Decision Subunit	EPA 524.2 VOCs	EPA 625 Semi-VOCs	EPA 608 Pest/PCBs	Sulfate/Chloride/Nitrate	Metals	EPA 900 Gross Alpha/Beta	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr-90	Floating Product	Frequency (events/year)
084-12	BMRR		Downgradient						X	X	X			1(e)
084-13	BMRR		Downgradient						X	X	X			1(e)
084-27	BMRR		Downgradient						X	X	X			1(e)
084-28	BMRR		Upgradient						X	X	X			1(e)
102-05	Motor Pool	Gasoline USTs	Downgradient	X									X	1
102-06	Motor Pool	Gasoline USTs	Downgradient	X									X	1
102-08	Motor Pool	B-326	Upgradient											(a)
102-10	Motor Pool	B-326/USTs	Downgradient	X									X	1
102-11	Motor Pool	B-326	Downgradient	X										1
102-12	Motor Pool	B-326	Downgradient	X										1
102-13	Motor Pool	B-326	Downgradient	X										1
085-17	Gas Station	Pump Island	Downgradient	X										1
085-235	Gas Station	Gasoline USTs	Downgradient	X										1
085-236	Gas Station	Gasoline USTs	Downgradient	X									X	1
085-237	Gas Station	Gasoline USTs	Downgradient	X									X	1
055-03	WMF	Bkgd.	Upgradient	X			X(b)	X(b)	X	X	X			2
055-10	WMF	Bkgd.	Upgradient	X			X(b)	X(b)	X	X	X			2
056-21	WMF	RCRA Bldg.	Downgradient											(f)
056-22	WMF	Rad. Bldg.	Downgradient											(f)
056-23	WMF	Rad. Bldg.	Downgradient											(f)
066-07	WMF	Bkgd	Upgradient											(f)
066-83	WMF	Mixed Waste Bldg.	Downgradient											(f)
066-84	WMF	Bkgd.	Upgradient											(f)
066-220	WMF	RCRA Bldg.	Downgradient	X			X(b)	X(b)	X	X	X			2
066-221	WMF	RCRA Bldg.	Downgradient	X			X(b)	X(b)	X	X	X			2
066-222	WMF	Rad. Bldg.	Downgradient	X			X(b)	X(b)	X	X	X			2
066-223	WMF	Rad. Bldg.	Downgradient	X			X(b)	X(b)	X	X	X			2
066-224	WMF	Mixed Waste Bldg.	Downgradient											0
076-16	MPF	Tank Area	Downgradient	X	X								X(d)	2
076-17	MPF	Tank Area	Downgradient	X	X								X(d)	2
076-18	MPF	Tank Area	Downgradient	X	X						X(h)		X(d)	2
076-19	MPF	Tank Area	Downgradient	X	X						X(h)		X(d)	2
076-25	MPF	Tank Area	Upgradient	X	X								X(d)	2
076-378	MPF	Tank Area	Downgradient	X	X								X(d)	2
076-379	MPF	Tank Area	Downgradient	X	X								X(d)	2
076-380	MPF	Tank Area	Downgradient	X	X								X(d)	2
039-87	STP	Recharge Basins - Upgrad	Downgradient					X						1

Well ID	Area	Sub Area	Decision Subunit	EPA 524.2 VOCs	EPA 625 Semi-VOCs	EPA 608 Pest/PCBs	Sulfate/Chloride/Nitrate	Metals	EPA 900 Gross Alpha/Beta	EPA 901 Gamma Spec	EPA 906 Tritium	EPA 905 Sr-90	Floating Product	Frequency (events/year)
039-88	STP	Holding Ponds/Recharge B	Downgradient					X						1
039-89	STP	Holding Ponds/Recharge B	Downgradient					X						1
039-90	STP	Holding Ponds	Downgradient					X						0
039-115	STP	Recharge Basins	Downgradient					X						1
048-08	STP	Recharge Basins	Downgradient					X						1
048-09	STP	Recharge Basins	Downgradient					X						1
048-10	STP	Recharge Basins	Downgradient					X						1
085-43	B452	Source Area	Downgradient											0
085-73	B452	Source Area	Downgradient	X										2
085-380	B452	Source Area	Downgradient	X										4
085-381	B452	Source Area	Downgradient	X										4
085-382	B452	Source Area	Downgradient	X										4
085-383	B452	Source Area	Downgradient	X										4
085-384	B452	Source Area	Downgradient	X										2
085-385	B452	Downgradient	Downgradient	X										4
085-386	B452	Downgradient	Downgradient	X										4
085-387	B452	Downgradient	Downgradient	X										4
085-388	B452	Downgradient	Downgradient	X										4
095-313	B452	Downgradient	Downgradient	X										4
095-314	B452	Downgradient	Downgradient	X										4
095-315	B452	Downgradient	Downgradient	X										4
076-18	NSLS-II	Linac	Upgradient								X			1(h)
076-19	NSLS-II	Linac	Upgradient								X			1(h)
086-123	NSLS-II	Linac	Downgradient								X			1
086-124	NSLS-II	Linac	Downgradient								X			1
086-125	NSLS-II	Linac	Downgradient								X			1
086-126	NSLS-II	Linac	Downgradient								X			1

Notes:

AGS = Alternating Gradient Synchrotron

BLIP = Brookhaven Linear Isotope Producer

BMRR = Brookhaven Medical Research Reactor

MPF = Major Petroleum Facility

NSLS-II = National Synchrotron Light Source II

NSRL = NASA Space Radiation Laboratory

RCRA = Resource Conservation and Recovery Act

RHIC = Relativistic Heavy Ion Collider

GROUNDWATER MONITORING AT THE AGS

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, November 1, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 to the groundwater monitoring program for the Alternating Gradient Synchrotron (AGS) area.

DESCRIPTION AND TECHNICAL BASIS

BNL monitors groundwater quality at the AGS facility to evaluate the effectiveness of engineered controls used to prevent rainwater infiltration into activated soil shielding. The monitoring program has demonstrated that groundwater quality had been impacted by tritium originating from activated soil shielding at the former g-2 experiment, former U-Line beam stop, and the former E-20 catcher. In these areas, rainwater was able to infiltrate activated soil shielding and leach tritium into the groundwater. Tritium concentrations were found to exceed the 20,000 pCi/L maximum contaminant level (MCL) in these three locations. BNL installed impermeable caps over the activated soil shielding areas to prevent additional rainwater infiltration. Following these corrective actions, tritium concentrations in the former U-Line beam stop and the former E-20 catcher areas dropped to well below the 20,000 pCi/L standard. However, tritium is still routinely detected at concentrations greater than 20,000 pCi/L in several wells downgradient of the g-2 source area (see DQO Statement 12-36). Monitoring at other potential soil activation areas such as the J-10 beam stop, Booster beam stop, the NASA Space Radiation Laboratory (NSRL), Building 914 transfer tunnel, and Building 912 continue to demonstrate that groundwater has not been significantly impacted by these operations and that existing engineered controls are working.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
X Surveillance
X Restoration/IAG

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles are created near beam loss points, beam targets, and beam stops. These particles have the potential to escape into the soils surrounding the accelerator tunnels or into the soils underlying target and beam stop areas in the experimental halls. Although considerable effort is taken to design appropriate shielding and other engineering controls into these systems, many secondary particles will still interact with soils surrounding the tunnels and underlying floors. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22. Once present in the soils, some of these radionuclides can be leached downward into groundwater by means of rainwater percolation. Only radionuclides with long half-lives, namely tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years), are detected in the groundwater below the AGS. Tritium has been detected at concentrations that exceed the 20,000 pCi/L drinking water standard at several locations (e.g., g-2). Sodium-22 is rarely detected at concentrations above the 400 pCi/L drinking water standard, and is only detected in wells located close to the source areas. BNL has taken steps to either reduce the amount of radioactivity produced in soils (by means of additional shielding or modifying operating procedures) or by the construction of impermeable caps to prevent the leaching of these materials to groundwater. Another potential source of groundwater contamination is the inadvertent release of activated water from the AGS's primary cooling water systems. To reduce this threat, the piping systems have been modified to reduce the volume of water that can be exposed to beam line losses, and piping containing high levels of tritiated water is located inside facility structures where they can be visibly inspected.

The collection of groundwater samples from wells downgradient of the soil activation areas is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by use of internal shielding material and beam focusing
- Primary cooling water management
- Installation and maintenance of impermeable caps (geomembrane, gunite, etc.)
- Storm water management

Step 2: Identify the Decision

Are the operational and engineered controls employed at the AGS complex effective in preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest wells downgradient of each identified soil activation area)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the AGS
- Modeled estimates or direct measurements on the amount of soil activation at each beam stop and target area
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements (DOE Order 458.1)

- Action levels:
  - Action levels are defined by the BNL Groundwater Protection Contingency Plan
- Analytical methods and detection limits:
  - Tritium: EPA Method 906
  - Gamma spectroscopy (optional analysis): EPA Method 901

In 2004, the routine testing of groundwater samples for sodium-22 was discontinued. Since that time, the focus has been placed on tritium analyses because tritium is more mobile than sodium-22 and has a longer half-life. Therefore, the presence of tritium in groundwater is a better early indicator of a potential failure in an engineered storm water control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the AGS complex and the nearest practicable monitoring points (i.e., "points of assessment") near each of the identified soil activation areas. The period for which decisions are made is 365 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.
- Once the tritium migrates to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically 100 feet from the source) is likely to be between 130 to 275 days.
- Decision periods of 365 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective (e.g., J-10 Beam Stop, Booster Beam Stop, Building 914 Transfer Tunnel, Former U-Line Target, former E-20 Catcher, and Building 912).

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see environmental monitoring [EM]-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.27.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium from activated soil shielding to the groundwater?	See Step 3 for inputs	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected.* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stake-holder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the AGS complex and groundwater travel time to the nearest potential receptor (Potable Well 10) is greater than 2 years. Because of existing groundwater contamination in and near the AGS complex (e.g., g-2 tritium plume and the Waste Concentration Facility Sr-90 plume), operations of Potable Well 10 have been significantly reduced since 2000. The restrictions placed on the operations of Well 10 reduce the likelihood that a plume from the AGS area will be captured by this well, and reduced pumping helps to stabilize groundwater flow directions in the AGS area. Due to these factors and additional Land Use and Institutional Controls developed for the AGS area, it is unlikely that a decision error will result in adverse consequences to human health. Consequences associated with (short-term) decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or another regulatory program.

Step 7: Optimize the Design

Number and Locations of Wells

The wells located around the AGS are biased toward detecting contamination originating from activated soils associated with current and former beam stop and target areas (see Figure 12.27.1). The wells are located as close as possible to these potential source areas to allow for early detection of contaminant releases. The current approved monitoring network allows for the timely evaluation of potential impacts and is considered adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

- Groundwater quality in the AGS complex is routinely evaluated using approximately 50 monitoring wells. Over 10 years of analytical data are available to assess potential impacts from activated soil shielding and the effectiveness of engineered stormwater controls. Tritium and sodium-22 have been detected in groundwater downgradient of several activated soil shielding areas. Whereas tritium had exceeded the 20,000 pCi/L drinking water standard in several areas prior to improvements in storm water controls, sodium-22 rarely exceeded the 400 pCi/L standard. Because tritium is easily leached from activated soils, is highly mobile in groundwater and has a longer half-life, monitoring well samples are currently only analyzed for tritium. Samples are periodically analyzed for sodium-22. Furthermore, based upon proven effectiveness of the engineered storm water controls, groundwater samples are collected annually.

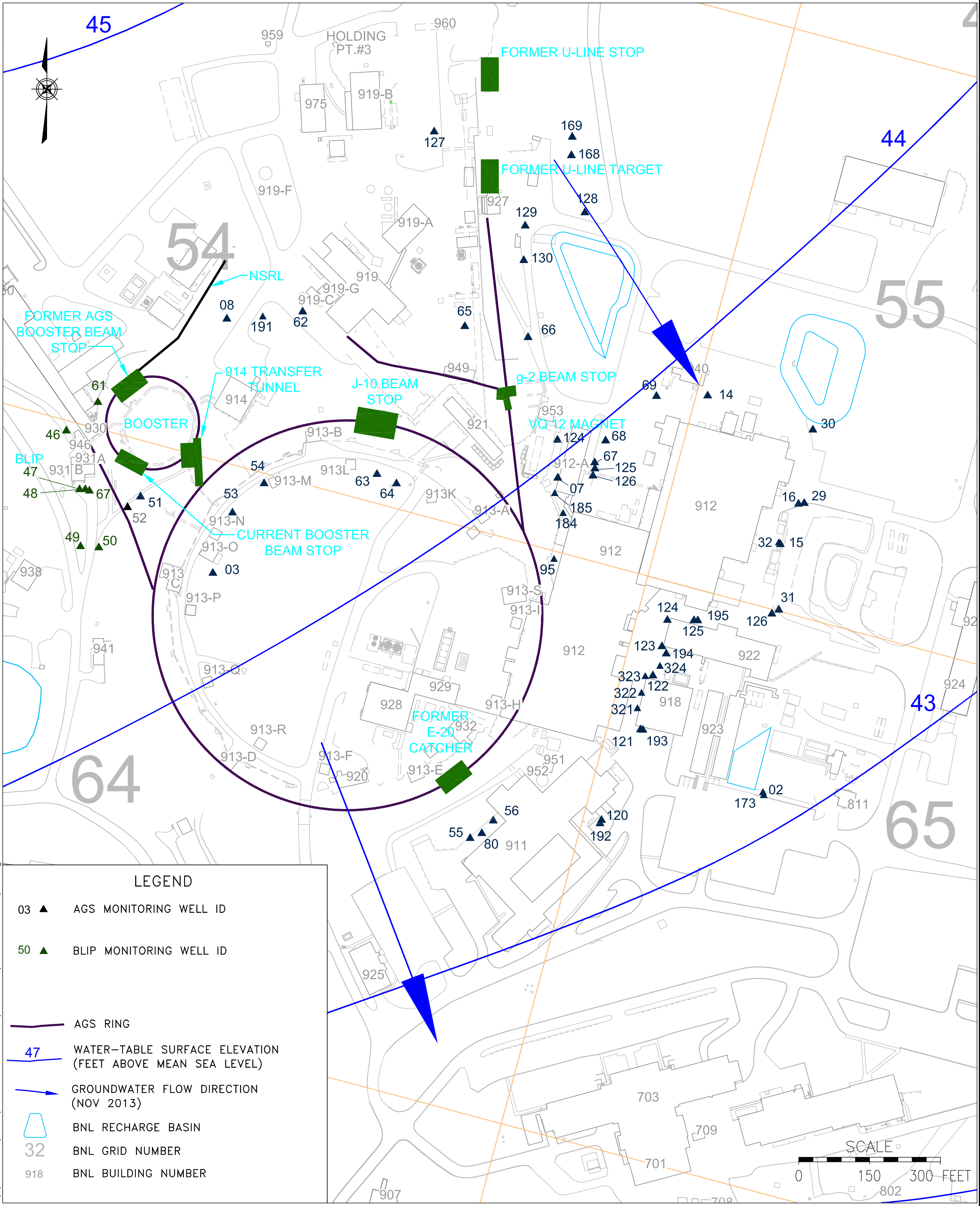
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

Table 12.27.2 Comparison of 2016 and 2016 Monitoring Program

Well	Monitoring Sub-Area	CY 2015 Sampling Frequency	CY 2016 Sampling Frequency	Affected Parameters
054-08	NSRL beam stop	Annual	Annual	None
054-191	NSRL beam stop	Annual	Annual	None
064-51	Booster beam stop	Annual	Annual	None
065-52	Booster beam stop	Annual	Annual	None
064-03	Bldg 914	Annual	Annual	None
064-53	Bldg 914	Annual	Annual	None
064-54	Bldg 914	Annual	Annual	None
054-62	Bkgd. J-10 beam stop	Annual	Annual	None
054-63	J-10 beam stop	Annual	Annual	None
054-64	J-10 beam stop	Annual	Annual	None
054-65	g-2 beam stop/plume source	Annual	Annual	None
054-66	g-2 beam stop	Annual	Annual	None
054-67	g-2 beam stop	Annual	Annual	None
054-68	g-2 beam stop	Annual	Annual	None
054-124	g-2 beam stop	Annual	Annual	None
054-125	g-2 beam stop	Annual	Annual	None
054-127	U-line target	Annual	Annual	None
054-128	U-line target	Annual	Annual	None
054-129	U-line target	Annual	Annual	None
054-130	U-line target	Annual	Annual	None
054-168	U-line stop	Annual	Annual	None
054-169	U-line stop	Annual	Annual	None
054-69	Bldg 912/U-line stop	Annual	Annual	None
055-14	Bldg 912/U-line stop	Annual	Annual	None
065-120	Bldg 912	Annual	Annual	None
065-125	Bldg 912	Annual	Annual	None
065-126	Bldg 912	Annual	Annual	None
065-195	Bldg 912	Annual	Annual	None
055-15	Bldg 912	Annual	Annual	None
055-16	Bldg 912	Annual	Annual	None
065-192	Bldg 912	Annual	Annual	None
055-29	Bldg 912	Annual	Annual	None
055-30	Bldg 912	Annual	Annual	None
055-31	Bldg 912	Annual	Annual	None
055-32	Bldg 912	Annual	Annual	None
065-121	Bldg 912/g-2 plume	Annual	Annual	None
065-122	Bldg 912/g-2 plume	Annual	Annual	None
065-193	Bldg 912/g-2 plume	Annual	Annual	None
065-123	Bldg 912/g-2 plume	Annual	Annual	None
065-124	Bldg 912/g-2 plume	Annual	Annual	None
065-194	Bldg 912/g-2 plume	Annual	Annual	None
065-321	Bldg 912/g-2 plume	Annual	Annual	None
065-322	Bldg 912/g-2 plume	Annual	Annual	None
065-323	Bldg 912/g-2 plume	Annual	Annual	None
065-324	Bldg 912/g-2 plume	Annual	Annual	None
064-55	E-20 Catcher	Annual	Annual	None
064-56	E-20 Catcher	Annual	Annual	None
064-80	E-20 Catcher	Annual	Annual	None

See Appendix B for the monitoring requirements for this DQO.



BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE: FACILITY MONITORING PROGRAM, AGS AND BLIP FACILITY AREA MONITORING WELL LOCATIONS

DWN:	VT:HZ.:	DATE:	PROJECT NO.:
AJZ	–	06/12/14	–
CHKD:	APPD:	REV.:	NOTES:
JEB	DEP	–	–

FIGURE NO.: 12.27.1

GROUNDWATER MONITORING AT THE BLIP

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 11, November 1, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 for the BLIP groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

The 1998 discovery of tritium and sodium-22 in groundwater downgradient of the Brookhaven Linear Isotope Producer (BLIP) indicated that rainwater was leaching these radionuclides from activated soil shielding located near the BLIP target vessel. To prevent continued rainwater infiltration, BNL made improvements to several engineered controls, including the reconnection of the building's rain gutters, sealing paved areas, construction of an impermeable cap, and the injection of a grouting material to reduce the permeability of the activated soils. In late 2004, the impermeable cap was extended over the Linac-to-BLIP spur. The Laboratory installed seven monitoring wells to evaluate the effectiveness of these engineered controls.

Since July 2006, tritium concentrations in groundwater downgradient of BLIP have remained below the 20,000 pCi/L drinking water standard. Na-22 concentrations have continuously remained below the 400 pCi/L standard. The g-2/BLIP/UST Record of Decision (ROD) requires continued groundwater monitoring to verify the effectiveness of the engineered controls. Because tritium concentrations have been continuously <20,000 pCi/L since mid-2006, in 2009 the monitoring frequency for the wells immediately downgradient of BLIP was reduced from quarterly to semiannually, and the remaining BLIP area wells were reduced to annually. In 2013, the groundwater monitoring program was further reduced by eliminating one upgradient and two downgradient wells (see Tables 12.26.1 and 12.26.2).

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
_X_ Surveillance
_X_ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles created at the BLIP target vessel and along the Linac to BLIP beam line have activated some of the soils that surround portions of the vessel and tunnel walls. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22. Some of these radionuclides can be leached downward into ground-water by means of rainwater percolation. Only radionuclides with long half-lives such as tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years) are detected in the groundwater below the BLIP. As noted previously, BNL has taken steps to prevent the leaching of these materials to groundwater by improving rainwater management.

During 1998, rainwater management initiatives included the reconnection of the building's rain gutters, sealing paved areas, and constructing an impermeable gunite cap. In conjunction with the Environmental Restoration program, in 2000 colloidal silica grout was injected into the activated soil area to reduce the permeability of the soils. In late 2004, the impermeable cap was extended over the Linac-to-BLIP spur. Another potential source of groundwater contamination could be the inadvertent release of activated water from the BLIP's primary cooling water system. However, these water systems are located inside the BLIP building and can be visually inspected.

As defined in the g-2/BLIP/Underground Storage Tank (UST) ROD, the continued collection of groundwater samples from wells downgradient of the BLIP is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by beam focusing
- Primary cooling water management
- Reducing the permeability of the activated soils using colloidal silica grout
- Installation and maintenance of impermeable caps (gunite and asphalt)
- Conveying storm water away from the building foundation

Step 2: Identify the Decision

Are the operational and engineered controls employed at BLIP effective at preventing additional releases of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at BLIP
- Modeled estimates on the amount of soil activation near the target vessel
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to the soil activation area
- Regulatory requirements are g-2/BLIP/UST ROD and DOE Order 458.1
- Action levels as described in the Groundwater Protection Contingency Plan
  - g-2/BLIP/UST ROD did not define any additional action levels
- Analytical methods and detection limits:
  - Tritium: EPA) Method 906

- Gamma spectroscopy (optional analysis): EPA Method 901

Starting in 2004, the requirement for routine sodium-22 analyses was dropped from the monitoring program. Because tritium is more mobile than sodium-22 and has a longer half-life, the presence of high levels of tritium in groundwater would be a better early indicator of a failure in an engineered storm water control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area immediately downgradient of BLIP. The monitoring period is 180 days, based upon a semiannual monitoring frequency. This time frame is considered adequate based upon the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be on the order of 30 to 60 days.
- Once the radionuclides have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessments, which are located approximately 50 feet from the source) is on the order of 90 days.
- Because tritium at concentrations in downgradient monitoring wells have been less than the 20,000 pCi/L drinking water standard since early-2006, a decision period of 180 days is sufficient to evaluate the effectiveness of the engineered controls. Therefore, the three wells located immediately downgradient of BLIP will be sampled on a semiannual basis. The sampling frequency for the upgradient is annually.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan (either response Action Level 2 or 3 of the plan) would be ascertained for each sampled well or set of wells (see EM SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.28.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and sodium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not, (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the BLIP, and groundwater travel time to the nearest potential downgradient receptor (Potable Well 4) is greater than five years. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require additional remedial actions.

Step 7: Optimize the Design

Number and Locations of Wells

The wells near the BLIP are biased toward detecting contamination originating from activated soils adjacent to the target vessel and to evaluate potential contamination that could originate from upgradient sources such as the LINAC-to-BLIP beam line (Figure 12.28.1). Three downgradient wells (064-47, 064-48, and 064-67) are located as close as possible to the BLIP building to enable early detection of contaminant releases. The current monitoring well network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at BLIP is routinely evaluated using four monitoring wells. The primary focus of the monitoring program is the detection of tritium because it is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life.

Since early-2006, tritium concentrations in groundwater immediately downgradient of the BLIP facility have remained well below the 20,000 pCi/L drinking water standard. This sustained reduction in tritium concentrations suggests that the caps and other storm water controls are effectively preventing rainwater from infiltrating the activated soil shielding, and the amount of tritium remaining in the vadose zone close to the water table has declined due to the water table flushing mechanism and by natural radioactive decay. The sampling frequency for downgradient wells 064-47, 064-48, and 064-67 is semiannual.

Table 12.28.2. Comparison of CY 2015 and CY 2016 Monitoring Programs

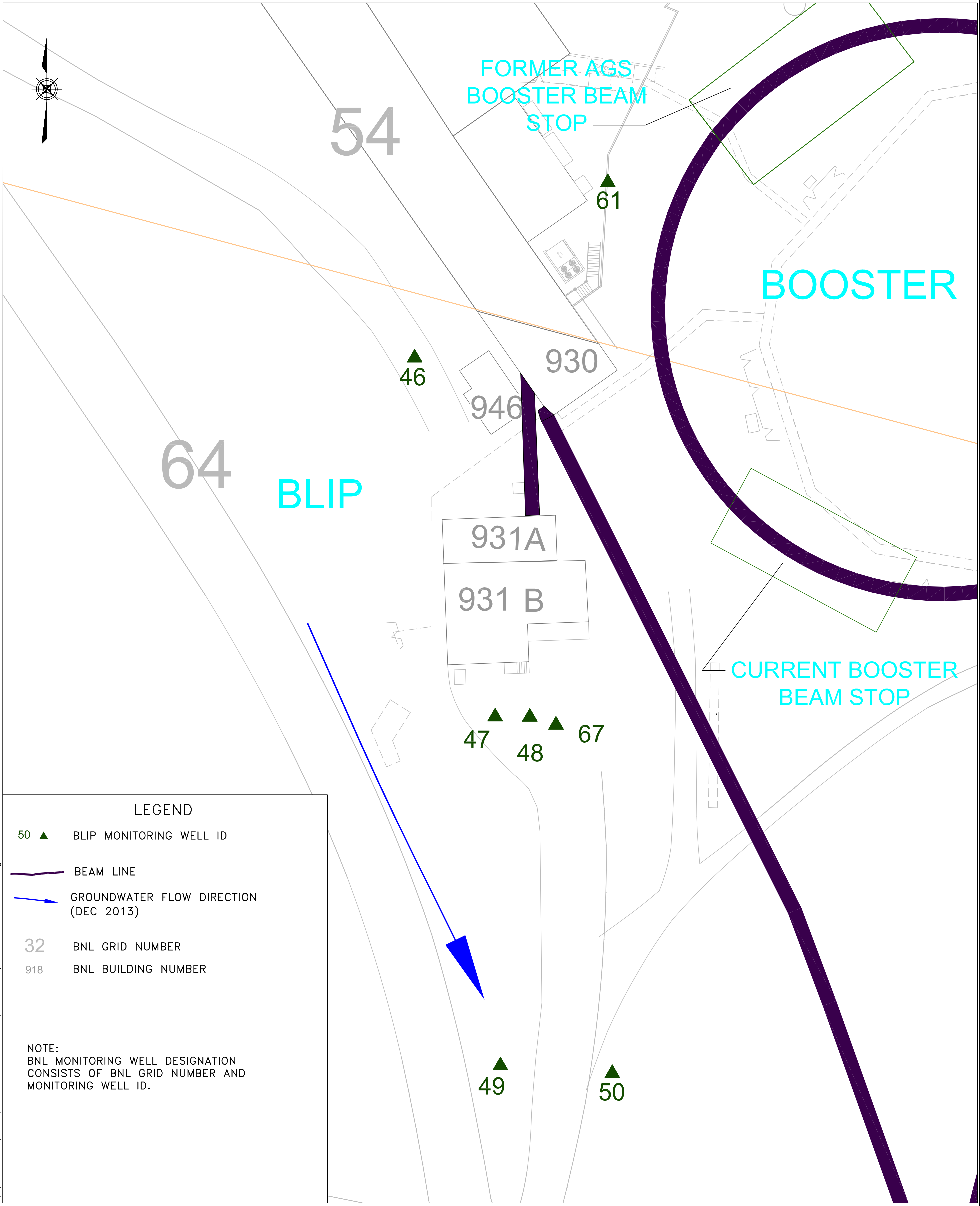
Well	CY 2015 Sampling Frequency	CY 2016 Sampling Frequency	Affected Parameters
054-61	None	None	--
064-46*	Annually	Annually	None
064-47	Semiannually	Semiannually	None
064-48	Semiannually	Semiannually	None
064-49	None	None	--
064-50	None	None	--
064-67	Semiannually	Semiannually	None

*Upgradient well

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: FACILITY MONITORING PROGRAM, BLIP FACILITY AREA MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/13	PROJECT NO.: –
		CHKD: JEB	APPD: DEP	REV.: –	NOTES: –
		FIGURE NO.: 12.28.1			

GROUNDWATER MONITORING AT THE RELATIVISTIC HEAVY ION COLLIDER

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 11, November 1, 2015
IMPLEMENTATION DATE	January 1, 2016
Point of Contact	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes in calendar year (CY) 2016 for the Relativistic Heavy Ion Collider (RHIC) monitoring program.

DESCRIPTION AND TECHNICAL BASIS

BNL installed 13 monitoring wells to evaluate the effectiveness of the engineered (caps) and operational controls designed to protect groundwater quality near activated soil shielding at the Relativistic Heavy Ion Collider (RHIC) beam stop and collimator areas. Monitoring conducted to date indicates that the controls are effectively protecting the activated soils. For 2016, RHIC monitoring wells will continue to be monitored semi-annually (see Tables 12.26.1 and 12.26.2).

DRIVERS FOR MONITORING

___ Compliance
___ Support Compliance
_X_ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Secondary particles created near the RHIC beam stops and collimators have the potential to escape into the soils surrounding the accelerator tunnel. Although considerable effort is taken to design appropriate shielding and other engineering controls into these systems, many secondary particles will still interact with soils surrounding the tunnels and underlying floors. The types of radionuclides created from this interaction include tritium, beryllium-7, carbon-11, nitrogen-13, oxygen-15, and sodium-22. Some of these radionuclides can be leached downward into groundwater by means of rainwater percolation. These leaching processes are usually quite slow and, therefore, only radionuclides with long half-lives such as tritium ($t_{1/2}$ = 12.3 years) and sodium-22 ($t_{1/2}$ = 2.6 years) are likely to be detected in the groundwater. BNL has taken steps to reduce the amount of radioactivity produced in soils (by means of additional shielding or modifying operating procedures) and/or to prevent the leaching of these materials to groundwater by the construction of impermeable caps.

The collection of groundwater samples from wells located downgradient of the soil activation areas is required to demonstrate that the operational and engineered controls are effective in protecting groundwater quality. These controls include:

- Limiting the amount of soil activation by use of internal shielding material and beam focusing
- Installation and maintenance of impermeable geomembrane caps over each potential soil activation area (e.g., three beam stops and two collimators)
- Storm water management

Step 2: Identify the Decision

Are the operational and engineered controls employed at RHIC effective at preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells near each of the identified soil activation areas)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the RHIC
- Modeled estimates on the amount of soil activation at each beam stop and collimator
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements (DOE Order 458.1)
- Action levels (as described in the Groundwater Protection Contingency Plan)
- Analytical methods and detection limits:
  - Tritium: Environmental Protection Agency (EPA) Method 906
  - Gamma spectroscopy (optional analysis): EPA Method 901

Starting in 2004, routine sodium-22 analyses were discontinued from the monitoring program. Focus is now placed on tritium analyses because tritium is more mobile than sodium-22 and has a longer half-life. Therefore, tritium’s presence in groundwater would be a better early indicator of a failure in an engineered stormwater control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the beam stop and collimator areas within RHIC facility and the nearest practicable monitoring points (i.e., “points of assessment”) near each of the identified potential soil activation areas. The period for which decisions are made is 180 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.
- Once the radionuclides have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically 100 to 200 feet from the source) is approximately 130 to 260 days.

- Decision periods of 180 to 360 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.29.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and sodium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected.* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) located immediately downgradient of the RHIC beam stop and collimator areas, and groundwater travel time to the nearest potential downgradient receptor (Potable Well 10) is greater than five years. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or other regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The 14 wells located at the RHIC are biased toward detecting contamination originating from activated soils associated with the facility’s beam stops and collimators (Figure 12.29.1). The wells are located as close as possible to these potential source areas to enable early detection of contaminant releases. The current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. No additional wells are recommended for this program.

Parameters and Frequency

Groundwater monitoring wells at the RHIC beam stop and collimator areas have been monitored at least semi-annually since their installation in 1999 and 2000. Because tritium is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life than the other radionuclides detected in activated soil shielding, the primary focus of the monitoring program is the detection of tritium. For 2013, groundwater samples will be collected on a semi-annual (180 day) basis. Samples will be analyzed only for tritium. Should tritium be detected in any of the wells, samples could also be collected to test for the presence of sodium-22.

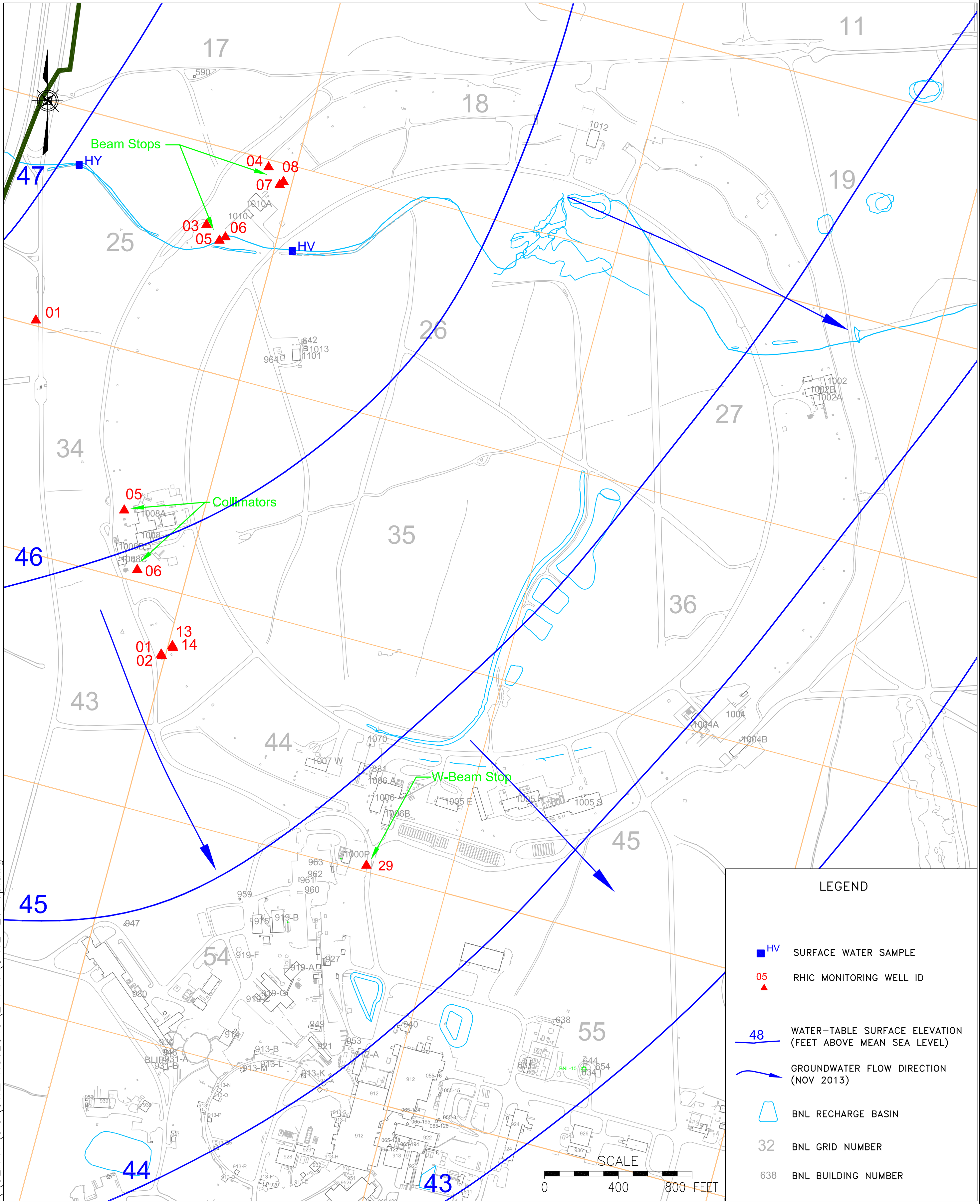
DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

Table 12.29.2 Comparison of 2015 and 2016 Sampling Programs

Well ID	CY 2015 Sampling Frequency	CY 2016 Sampling Frequency	Affected Parameters
025-03	Semi-annual	Semi-annual	None
025-04	Semi-annual	Semi-annual	None
025-05	Semi-annual	Semi-annual	None
025-06	Semi-annual	Semi-annual	None
025-07	Semi-annual	Semi-annual	None
025-08	Semi-annual	Semi-annual	None
034-05	Semi-annual	Semi-annual	None
034-06	Semi-annual	Semi-annual	None
043-01	Semi-annual	Semi-annual	None
043-02	Semi-annual	Semi-annual	None
044-13	Semi-annual	Semi-annual	None
044-14	Semi-annual	Semi-annual	None
044-29	Semi-annual	Semi-annual	None

See Appendix B for the Monitoring Program for this DQO.



BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE: FACILITY MONITORING PROGRAM, RELATIVISTIC HEAVY ION COLLIDER, MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
	CHKD: JEB	APPD: DEP	REV.: 12/16/15	NOTES: –
	FIGURE NO.:		12.29.1	

GROUNDWATER MONITORING AT THE WASTE MANAGEMENT FACILITY

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 12, November 1, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes in calendar year (CY) 2016 to the Waste Management Facility (WMF) groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

The WMF is designed to safely handle, repackage, and temporarily store BNL-derived wastes prior to shipment to an off-site disposal or treatment facility. The WMF has been designed as a state-of-the-art facility, with administrative and engineered controls that meet all applicable federal, state, and local environmental protection requirements. Moreover, institutional controls such as spill prevention plans, operations management plans, maintenance, and personnel training ensure that the facility is operated in a manner that is protective of the environment and human health.

The WMF currently consists of three buildings: the Operations Building (Building 860), the Reclamation Building (Building 865), and the Resource Conservation and Recovery Act (RCRA) Waste Building (Building 855). The former Mixed Waste Building (Building 870) is no longer used for WMF operations.

In addition to administrative controls (procedures, contingency plans, etc.), engineering controls have been designed for these buildings and the outlying paved areas to ensure that any spills and leaks will be contained and detected prior to a release to the environment. Outdoor storage of hazardous or mixed waste only occurs within secondary containment. Sealed floors and isolated drainage areas mitigate potential accidental releases of liquid wastes in the Reclamation Building and the RCRA Building. All storage area floors are pitched inward to ensure that any spills remain inside the buildings. For added protection, sealed concrete floors in liquid waste handling and storage areas are underlain by 20-mil. high-density polyethylene (HDPE) tertiary containment membranes with monitoring access pipes that can be used to determine whether there has been any leakage through the concrete from the storage cells. Spills in paved areas would be mitigated by concrete curbs and isolated drainage. (Note: The drain at the east roadway exit from the yard adjacent to the Reclamation Building and the drain northeast of the Reclamation Building do not have isolation valves, but lead to the stormwater system that discharges to the Recharge Basin HO—SPDES Outfall 003. This outfall is routinely monitored under the State Pollutant Discharge Elimination System [SPDES] permit.) There are no RCRA-regulated above or belowground tanks in the WMF. However, all above and belowground storage tanks that are used to store non-RCRA-regulated waste were designed, installed, and maintained in conformance with Article 12 of the Suffolk County Sanitary Code. The underground storage tanks located at the Waste Reclamation building have never been used and there are no plans for their future use. These tanks have been officially taken out of service and will be abandoned.

The WMF is located within 2 years of groundwater travel to BNL potable water supply Wells 11 and 12, which are south of East Fifth Avenue and just north of the WMF site. (Note: Well 12 has been out of service since October 2008.) Because of the proximity of the WMF to Wells 11 and 12, it is imperative that the engineering and administrative controls discussed above ensure that waste handling operations at the WMF do not degrade the quality of the soils and groundwater in this area. The WMF groundwater monitoring program supplements the engineered and administrative controls by providing additional means of detecting potential contaminant releases from the WMF. The groundwater monitoring requirements are defined in the facility's RCRA Part B Permit.

To account for changes in the predominant groundwater flow pathway since the groundwater monitoring program was established in 1997, five new downgradient monitoring wells were installed in late 2007. The new wells were fully integrated into the WMF monitoring program in 2008. From 1997 through the fall of 2003, WMF monitoring wells were sampled quarterly for a wide variety of organic, inorganic, and radiological constituents. Monitoring results indicate that WMF operations have not impacted groundwater quality. Based on the low probability of an undetected release of either chemical or radiological contaminants from the WMF, the quarterly monitoring frequency was reduced to semi-annual in 2004. The adequacy of the semi-annual groundwater monitoring program is based, in part, on the assumption that a low-volume contaminant release would slowly leach into the aquifer and not result in a rapid concentration increase between sample collection periods. Secondly, because the supply wells pump large volumes of water over a large area, considerable mixing of contaminated and uncontaminated water would result in the dilution of any contaminant(s). In accordance with the BNL Groundwater Protection Contingency Plan, the monitoring program will be reevaluated immediately if a significant contaminant release to the environment were to occur in the WMF area or if the monitoring wells within the WMF were to indicate that contaminants have been released from the facility due to a previously undetected spill or leak.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The collection of groundwater samples from wells located at the WMF is required to demonstrate that controls are effective in protecting groundwater quality by means of spill prevention and early detection. Outdoor storage of hazardous or mixed waste only occurs within secondary containment. Potential accidental releases of liquid wastes in the Reclamation Building, the RCRA Building, and the Mixed Waste Building are mitigated by sealed floors and isolated drainage areas. All storage area floors are pitched inward to ensure that any spills would remain inside the building. For added protection, sealed concrete floors in liquid waste handling and storage areas are underlain by HDPE tertiary containment membranes with monitoring access pipes can be used to determine whether there has been any leakage through the concrete from the storage cells. Spills in paved areas would be mitigated by concrete curbs and isolated drainage.

All liquid waste storage tanks were designed, installed, and maintained in conformance with Article 12 of the Suffolk County Sanitary Code.

Step 2: Identify the Decision

Are the operations of the WMF impacting groundwater quality? If so, do concentrations exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the WMF
- Direction and velocity of groundwater flow
- Contaminant concentrations in groundwater
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements (DOE Order 458.1; NYSDEC RCRA Part B Permit)
- Action levels:
  - Detection of volatile organic compounds (VOCs) or radionuclides at concentrations exceeding levels outlined in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits:
  - VOCs: EPA Method 524.2/624
  - Tritium: EPA Method 906
  - Gamma spectroscopy: EPA Method 901
  - Gross alpha/beta: EPA Method 900
  - Anions: chlorates, sulphates, and nitrates
  - Metals: EPA Method 200 Series

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area immediately downgradient of the WMF. A decision period of 180 days is sufficient to provide a secondary means of verifying that the operational and engineered controls in place at the WMF are effective. This timeframe is based on the following considerations:

- As described above, the WMF has a number of engineered and operational controls that are designed to prevent release of contaminants to the environment. A more frequent monitoring program can be implemented if a leak is found or suspected.

- The time required for small volumes of contaminants to migrate through the vadose zone and reach the groundwater table is likely to be 90 days or more. It is important to note that most waste materials that are stored at the WMF are not readily mobile in soils. (See waste profile descriptions in the RCRA Part B Permit, pages 99 through 113.) Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, typically within 50 to 100 feet of a storage building) is on the order of 130 days.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the release of contaminants to groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan (either response Action Level 2 or 3 of the plan) would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.30.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Errors Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the release of contaminants to soils and groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination, potentially up to several hundred feet long, could exist and not be detected.* (2) Need to re-sample well and resulting additional unplanned costs; potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

BNL potable water supply wells 11 and 12 are located immediately adjacent to the WMF. (Note: water supply well 12 has been out of service since October 2008.) Although it is possible that a decision error could result in adverse consequences to human health, the WMF is designed and operated in a manner that eliminates or limits any potential contaminant release to the environment. In addition to the groundwater monitoring program, the supply wells are also routinely monitored for the contaminants of concern in accordance with Safe Drinking Water Act (SDWA) requirements. Because these supply wells draw water from a large area (i.e., zone of contribution), it is likely that low-level contamination would undergo considerable dilution before entering the water distribution system. Under current potable water system operating parameters, these wells supply less than 25 percent of the water demand for the site. Consequences associated with decision errors for this program relate primarily to impacts to BNL's water supply and possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require the short-term or long-term shut down of the supply wells, and possible remedial actions under applicable New York State regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are located as close as possible to potential WMF source areas to allow for early detection of contaminant releases (see Figure 12.30.1). When the WMF monitoring program began in 1997, the predominant groundwater flow pathway in the WMF area was to the north. This northerly flow pattern was the result of a significant groundwater mound below recharge basin HO located to the south of the WMF and significant pumpage from water supply wells 11 and 12 located to the north of the WMF. To accommodate this northerly flow pathway, four downgradient monitoring wells were positioned between waste storage facilities and the potable supply wells, with the four remaining wells positioned to detect potential contamination from upgradient sources (e.g., Building 830, Basin HO, and the AGS research complex). However, since 1997, there has been a significant reduction in cooling water discharges to basin HO and restrictions have been placed on prolonged pumpage of water from supply wells 11 and 12. This has resulted in a return to a more natural southeasterly flow pathway in the WMF area. In late 2007, five new downgradient monitoring wells were installed to account for this change in groundwater flow direction.

The current sampling protocol, as described in the RCRA Part B Permit, calls for the running of supply wells 11 and 12 for a 2-week period prior to sampling the WMF wells in order to establish a south to north groundwater flow direction. However, starting in 2008, the natural southeasterly groundwater flow pathway will be maintained for at least one month prior to sampling the new downgradient monitoring wells. The older downgradient wells will be kept in reserve and will only be sampled if supply wells 11 and 12 have been in continuous operation for 2 or more weeks prior to the sampling period. Because the monitoring well network is designed to act as a secondary means of verifying proper facility operation, the current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

Groundwater quality at the WMF area is evaluated using two upgradient and four downgradient monitoring wells during a sample period. As described in the NYSDEC-approved groundwater monitoring plan for the WMF, the monitoring wells are sampled semi-annually. Samples are analyzed semi-annually for VOCs and radioactivity, and annually for anions and metals.

Table 12.30.2. Comparison of 2015 and 2016 Sampling Programs

Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
055-03 (Upgradient Well)	Semi-annual	Semi-annual	None
055-10 (Upgradient Well)	Semi-annual	Semi-annual	None
056-21 (Downgradient Well)	None (a)	None (a)	--
056-22 (Downgradient Well)	None (a)	None (a)	--
056-23 (Downgradient Well)	None (a)	None (a)	--
066-07 (Upgradient Well)	None (a)	None (a)	--
066-83 (Downgradient Well)	None (a)	None (a)	--
066-84 (Downgradient Well)	None (a)	None (a)	--
066-220 (Downgradient Well)	Semi-annual (b)	Semi-annual (b)	None
066-221 (Downgradient Well)	Semi-annual (b)	Semi-annual (b)	None
066-222 (Downgradient Well)	Semi-annual (b)	Semi-annual (b)	None
066-223 (Downgradient Well)	Semi-annual (b)	Semi-annual (b)	None
066-224 (Downgradient Well)	None (c)	None (c)	--

(a) These wells will be sampled only if supply wells 11 and 12 have been in continuous operation for two weeks or more prior to the scheduled sampling date. The pumping induced groundwater flow pattern in the WMF area would be to the north.

(b) These are the preferred downgradient monitoring wells for the WMF. These wells will be sampled only if supply wells 11 and 12 have not been in continuous operation for one month or more prior to the scheduled sampling date. The normal groundwater flow pattern in the WMF area would be to the southeast.

(c) Following the 2012 NYSDEC approval of the closure plan for the Mixed Waste building, this well is no longer sampled on a routine basis.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring requirements for this DQO.

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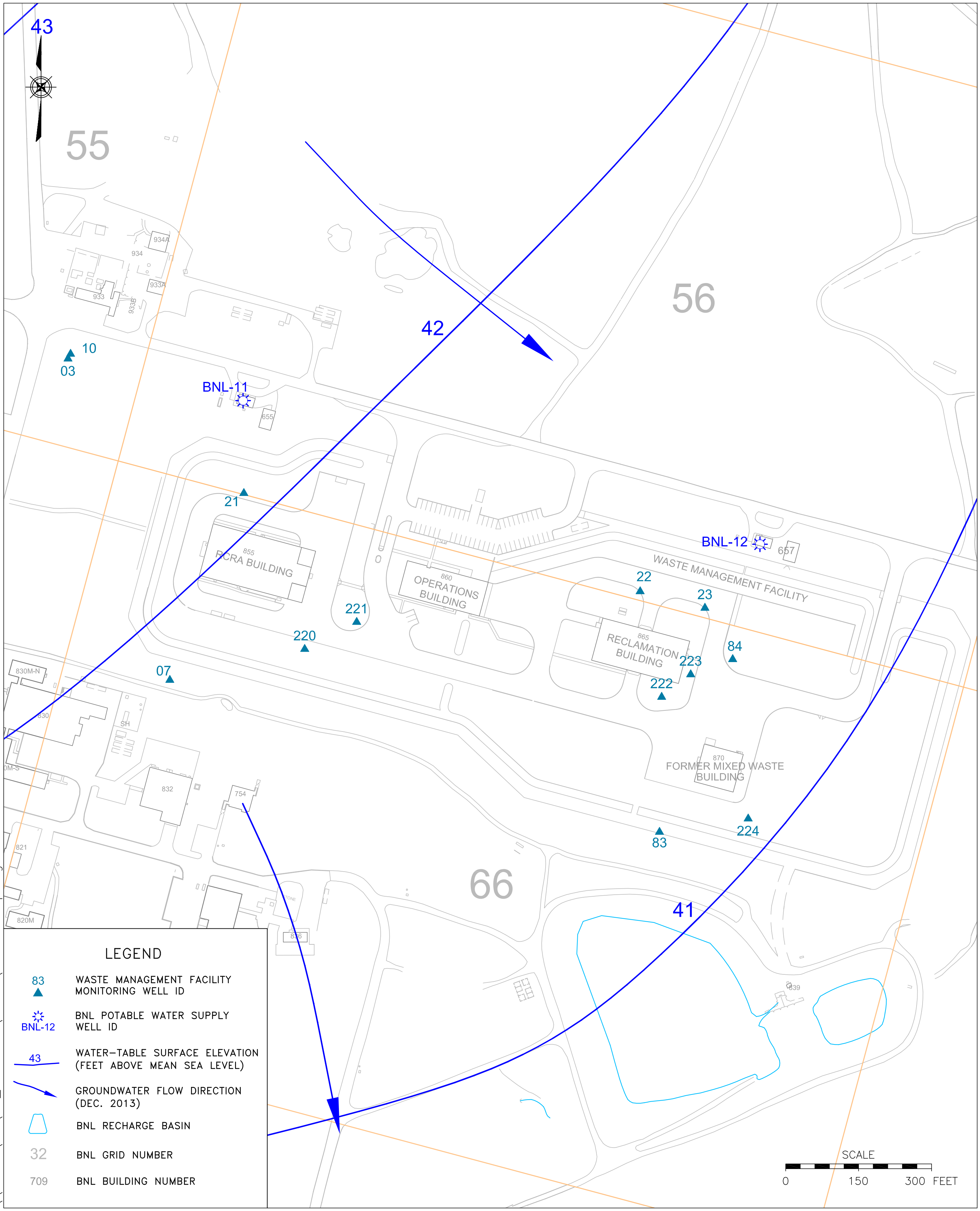

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BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: FACILITY MONITORING PROGRAM, WASTE MANAGEMENT FACILITY MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
		CHKD: JEB	APPD: DEP	REV.: –	NOTES: –
		FIGURE NO.: 12.30.1			

GROUNDWATER MONITORING AT THE BROOKHAVEN MEDICAL RESEARCH REACTOR (BMMR)

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 12, November 1, 2015
IMPLEMENTATION DATE	January 1, 2016
Point of Contact	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

Proposed changes for calendar year (CY) 2016 for the BMMR monitoring program include:

- Because tritium levels in the groundwater have been consistently below the 20,000 pCi/L drinking water standard (DWS) since the start of the monitoring program in 1997 and all cooling water systems within the Brookhaven Medical Research Reactor (BMRR) have been drained, the sampling frequency was changed from annually to once every 2 years.
- The last groundwater samples were collected during calendar year (CY) 2014; therefore, the next samples will be collected during CY 2016.

DESCRIPTION AND TECHNICAL BASIS

Tritium has routinely been detected in groundwater downgradient of the BMRR since monitoring started in 1997, but at concentrations below the 20,000 pCi/L drinking water standard (DWS). Tritium concentrations have declined from a maximum of 17,100 pCi/L in 1999 to <2,500 pCi/L since 2002. To date, no other potential BMRR-related radionuclides have been detected in groundwater. Some residual tritium remains in the vadose zone below the facility and it is expected that some amount will migrate into groundwater by natural processes (i.e., water table fluctuation) over many years. Operational and engineered controls were implemented in 1997; since that time, all nuclear fuel was removed from the BMRR and all primary cooling water lines were drained. Monitoring well sampling frequency and methods of analysis is summarized in Tables 12.26.1 and 12.26.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Following the discovery of tritium in groundwater downgradient of the High Flux Beam Reactor (HFBR) in 1997, BNL installed groundwater monitoring wells at the BMRR to evaluate any potential impacts to groundwater quality. Tritium was detected at concentrations up to 11,800 pCi/L in several of the new monitoring wells directly downgradient of the BMRR facility. A 1997 review of systems and operations within the BMRR facility identified two potential sources for the tritium detected in groundwater: (1) spills that occurred during the transfer of radioactive liquids to a former aboveground storage tank, and (2) a floor drain system and associated sump that had received primary cooling water on several occasions. Primary coolant contained tritium at a concentration up to 465 µCi/L. Although small volume releases occurred while transferring liquids to an outdoor storage tank on several occasions, the most likely source for the tritium detected in groundwater is primary cooling water discharges to the floor drain system and an associated unlined 150-gallon SU-2 sump in the basement of the BMRR. Reactor operations records indicated 16 spills or discharges totaling nearly 800 gallons of primary water to the floor drains or directly to the SU-2 sump. The last such discharge occurred in January 1987. Although most of the primary water that was discharged was properly disposed, qualitative leak-rate testing conducted in 1997 indicated that the sump and/or floor drain piping system was not entirely leak tight and some amount of radioactive water may have leaked to the underlying soils. Furthermore, until 1997, secondary (nonradioactive) coolant water was routinely discharged to the SU-2 sump and floor drain system. Leakage of secondary water could have provided sufficient water volume to drive the tritium through the unsaturated zone and into the groundwater beneath the reactor building.

To prevent potential future releases of radioactive materials to the soils and groundwater below the BMRR, the floor drain system was abandoned in 1997. BNL also sealed the SU-2 sump and a plastic container was installed in the sump pit. A liquid sensor installed in the sump is used to detect the presence of any liquids outside the plastic container. In addition, the BMRR facility has been designated for decommissioning and demolition. Issues related to the decommissioning and demolition is not addressed in this data quality objective (DQO). All nuclear fuel has been removed from the facility and the activated primary cooling water was drained in 2005.

Following the removal of the fuel and primary cooling water, continued groundwater surveillance is required to evaluate the periodic small-scale releases of residual tritium from the vadose zone beneath the reactor facility. Based on an average groundwater flow velocity of 0.75 feet per day, the travel time from the point where contaminants may enter the soils below the reactor building, migrate through the vadose zone, and travel to the monitoring wells is likely to be greater than 100 days. Since 2002, tritium concentrations in groundwater have been <2,500 pCi/L. No other reactor-related radionuclides have been detected in the groundwater.

Step 2: Identify the Decision

Are the controls effective at eliminating further discharges to soils and groundwater below the BMRR (i.e., are performance objectives met)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Maintenance of reactor structure and future decontamination and decommissioning (D&D) activities
- Direction and velocity of groundwater flow
- Regulatory driver (DOE Order 458.1)
- Action levels, as described in the BNL Groundwater Protection Contingency Plan)
- Analytical methods and detection limits:
  - Tritium: EPA Method 906
  - Gross alpha/beta: EPA Method 908 (optional analysis)
  - Gamma spectroscopy: EPA Method 901 (optional analysis)
  - Sr-90: EPA Method 905 (optional analysis)

Step 4: Define the Study Boundaries

The decision for this program applies to the area in the immediate vicinity of the BMRR facility. The period for which the individual decisions will be made is 730 days, based on the following factors:

- Tritium concentrations in groundwater have remained <2,500 pCi/L since 2002.
- Currently, there are no pathways for new releases of tritiated water. (Note: The primary cooling water system was drained in 2005.)
- No other reactor-related radionuclides have been detected in groundwater.
- There are no nearby drinking water supply wells.

Step 5: Develop the Decision Rules

Are the controls effective at eliminating further discharges to soils and groundwater below the BMRR?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.31.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of radionuclides to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to ~400 feet long and 30 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Protection Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and operational and engineered controls (i.e., leak detection or secondary containment) were to fail. Note, however, that the primary cooling water system was completely drained in 2005.

There are no potential receptors immediately downgradient of the BMRR. Travel time to the nearest current potential downgradient receptor is greater than 10 years. Furthermore, most homes south of BNL have been connected to public water. Contaminant concentrations have historically not exceeded the DWS and are not expected to exceed them in the future because the BMRR operations ended in 2000. The nuclear fuel has been removed and activated primary cooling water was removed during 2005. Therefore, it is very unlikely that decision error will result in adverse consequences to human health. The consequences of decision error relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions.

Step 7: Optimize the Design

Number and Locations of Wells

Three of the BMRR wells are biased toward surveillance of groundwater quality immediately downgradient of the facility. One well is immediately upgradient of the BMRR. The monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders (see Figure 12.31.1). Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small in area, no refinements are recommended.

Parameters and Frequency

- The four BMRR surveillance wells were monitored semi-annually from 1997 through 2004, with samples tested for tritium, gross alpha, gross beta, gamma spectroscopy, and occasionally for Sr-90. Because tritium has not been observed at concentrations above the DWS and because of the declining concentration trend, the frequency of monitoring was reduced to annually starting in 2005 and biannually starting in 2007.

- A significant amount of groundwater data has been collected since 1997. Tritium concentrations have never exceeded the 20,000 pCi/L DWS, and have remained <2,500 pCi/L since 2002. Because tritium concentrations for the past several years have been less than one quarter of the DWS and the primary cooling water system has been drained, under current conditions, the collection of groundwater samples every two years should provide adequate groundwater surveillance data for the BMRR.

- Since the beginning of the monitoring program in 1997, no other reactor-related radionuclides have been observed in the groundwater downgradient of the BMRR.

- Future evaluation of the sampling program for optimization purposes will need to consider that the facility is scheduled for full decommissioning and demolition.

Table 12.31.2. Comparison of 2015 and 2016 Monitoring Programs

Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
084-12	Annual	None	Tritium
084-13	Annual	None	Tritium
084-27	Annual	None	Tritium
084-28	Annual	None	Tritium

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring program for this DQO.

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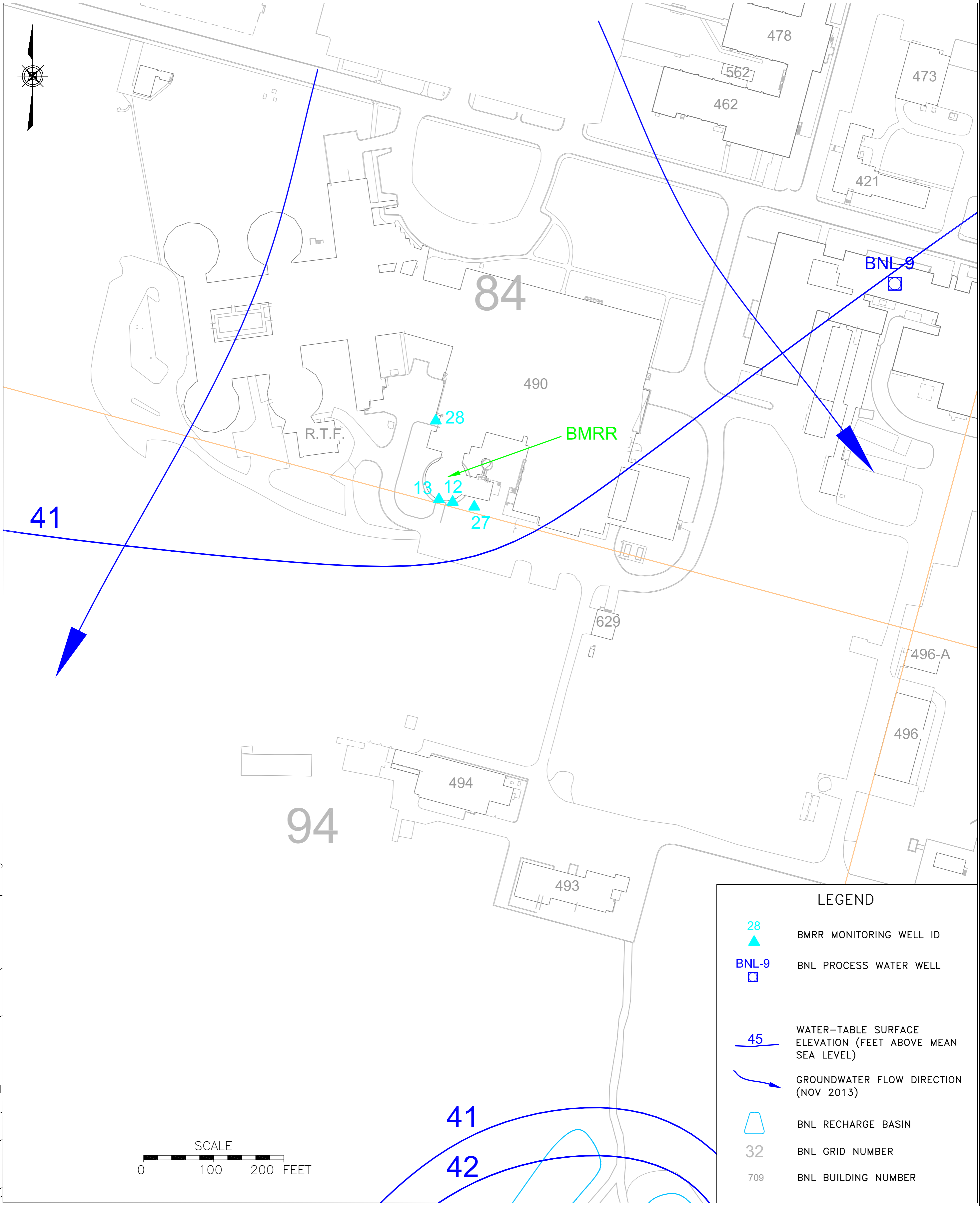

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BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: FACILITY MONITORING PROGRAM, BROOKHAVEN MEDICAL RESEARCH REACTOR MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
		CHKD: JEB	APPD: DEP	REV.: –	NOTES: –
		FIGURE NO.: 12.31.1			

GROUNDWATER MONITORING AT THE SEWAGE TREATMENT PLANT

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 11, November 1, 2015
Implementation Date	January 1, 2016
Point of Contact	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

The groundwater monitoring program for the Sewage Treatment Plant (STP) was modified in late 2014 due to a switch from discharging STP treated effluents from the Peconic River to newly constructed recharge basins. The STP filter beds have been decommissioned. The new monitoring well network was established to monitor groundwater quality near the new recharge basins, and consists of one upgradient and six downgradient wells (Figure 12.32.1).

DESCRIPTION AND TECHNICAL BASIS

The primary monitoring program for the STP is the effluent sampling conducted in accordance with BNL's State Pollutant Discharge Elimination System (SPDES) permit. As noted above, starting in the fall of 2014, STP effluent was redirected to newly constructed recharge basins. Because all of the water sent to the STP filter beds will be recharged directly to groundwater, a groundwater monitoring program has been established to provide a secondary means of detecting potential impacts of STP operations. The groundwater sampling parameters and frequencies are defined in the new SPDES permit.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The STP processes sanitary sewage for BNL facilities at an average of 0.72 million gallons per day (MGD) during non-summer months and approximately 1.25 MGD during summer months. Treatment of the sanitary waste stream includes primary treatment to remove settleable solids and floatable materials, aerobic oxidation for secondary removal of the biological matter and nitrification of ammonia, secondary clarification. Oxygen levels are regulated during the treatment process; nitrogen can be biologically removed using nitrate-bound oxygen for respiration.

Water goes through a final treatment step at the STP filter building, and is then discharged to the new recharge basins (SPDES Outfall 001). The discharge is regulated under New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) permit #1-4788-00032/00072.

Two emergency holding ponds are used for the emergency storage of sanitary waste in the event of an upset condition or if the influent contains contaminants in concentrations exceeding BNL administrative limits and/or SPDES permit effluent release criteria. The holding ponds are equipped with fabric reinforced plastic liners that are heat-welded along all seams. The first lined holding pond was constructed in 1978 and has a capacity of approximately 4 million gallons. A second 4-million gallon lined pond was constructed in 1989. The combined capacity of nearly eight million gallons enables BNL to divert all sanitary system effluent for approximately 12 days. As part of the Phase III STP Upgrades project in 2001, the original single liners were replaced with double liners and an integrated leak detection system.

Groundwater samples are used to demonstrate that operational and engineered controls are effective in protecting groundwater quality. These controls include the following:

- BNL has developed a comprehensive pollution prevention program, which includes worker education on proper use and disposal of hazardous materials. These programs are integrated into the BNL Standards-Based-Management System (SBMS).

- In accordance with BNL's current SPDES permit, the Laboratory carefully monitors both the influent and effluent from the STP. STP influent and effluent monitoring is the primary means of ensuring that the engineered and operational controls are working.

Step 2: Identify the Decision

Are the operations of the STP impacting groundwater quality? If so, do concentrations exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the STP
- Direction and velocity of groundwater flow
- Sampling parameters and frequencies defined in the SPDES permit
- Locations of background and downgradient wells
- Regulatory requirements (DOE Order 458.1; DOE Order 436.1, NYS SPDES Permit)
- Action levels, as described in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits: Metals
- Nature of use of emergency holding ponds

Step 4: Define the Study Boundaries

The decision boundaries for this monitoring program apply to the area in the immediate vicinity of the STP facility, with specific emphasis on the new recharge basin area and the existing emergency holding ponds. The new SPDES permit issued in 2014 requires the collection of groundwater samples annually to determine the concentrations of specific metals (e.g., copper, iron, lead, mercury, nickel, silver, and zinc). The sampling frequency for the monitoring program is adequate based on the following:

- Influent and effluent of the STP is carefully monitored, as required by the SPDES permit. A more frequent monitoring program can be implemented if a significant contaminant release to the sanitary system is discovered or suspected.
- Groundwater monitoring conducted for the past 10 years has demonstrated that STP operations are not significantly affecting groundwater quality in the area. All VOC, radionuclide, and anion concentrations have been below applicable water quality standards. Some metals, such as sodium, are occasionally detected at concentrations slightly above standards.
- Once contaminants have migrated to groundwater, the travel time from the STP area to the site boundary is estimated to be greater than 10 years. Although there is a potential for contaminated groundwater originating from the recharge basin areas to enter the Peconic River via groundwater discharge during certain hydrologic conditions, the time of travel is likely to be more than 180 days.
- There are no drinking water supply wells near the STP.
- The double liners and integrated leak detection system installed in the emergency holding ponds significantly reduce the risk of leaks of contaminated water that may be diverted to the ponds.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of contaminants to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan or SPDES required notifications would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.32.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the discharge of contaminants to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 300 feet long could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and one or more operational and engineered controls (i.e., SPDES monitoring, leak detection, secondary containment) were to fail.

There are no potable water supply wells immediately downgradient of the STP area, although during certain hydraulic conditions (i.e., seasonal water table rises), local groundwater can discharge into the nearby Peconic River. Groundwater travel time from the STP area to the BNL eastern boundary is greater than 10 years and most homes east of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under applicable New York State regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are as close as possible to the recharge basins and holding ponds to enable early detection of contaminant releases (see Figures 12.32.1). The new monitoring program will have one upgradient and six downgradient wells near the recharge basins. Three of the wells are near the emergency holding ponds. The monitoring network will be adequate for meeting the acceptable risk levels of stakeholders.

Parameters and Frequency

As defined in the new SPDES permit, the six wells monitoring the new recharge basin area will be sampled annually. The groundwater samples will be analyzed for total metals with the following metals being reported to NYSDEC under the SPDES permit: copper, iron, lead, mercury, nickel, silver, and zinc.

DATA REVIEW REQUIREMENTS

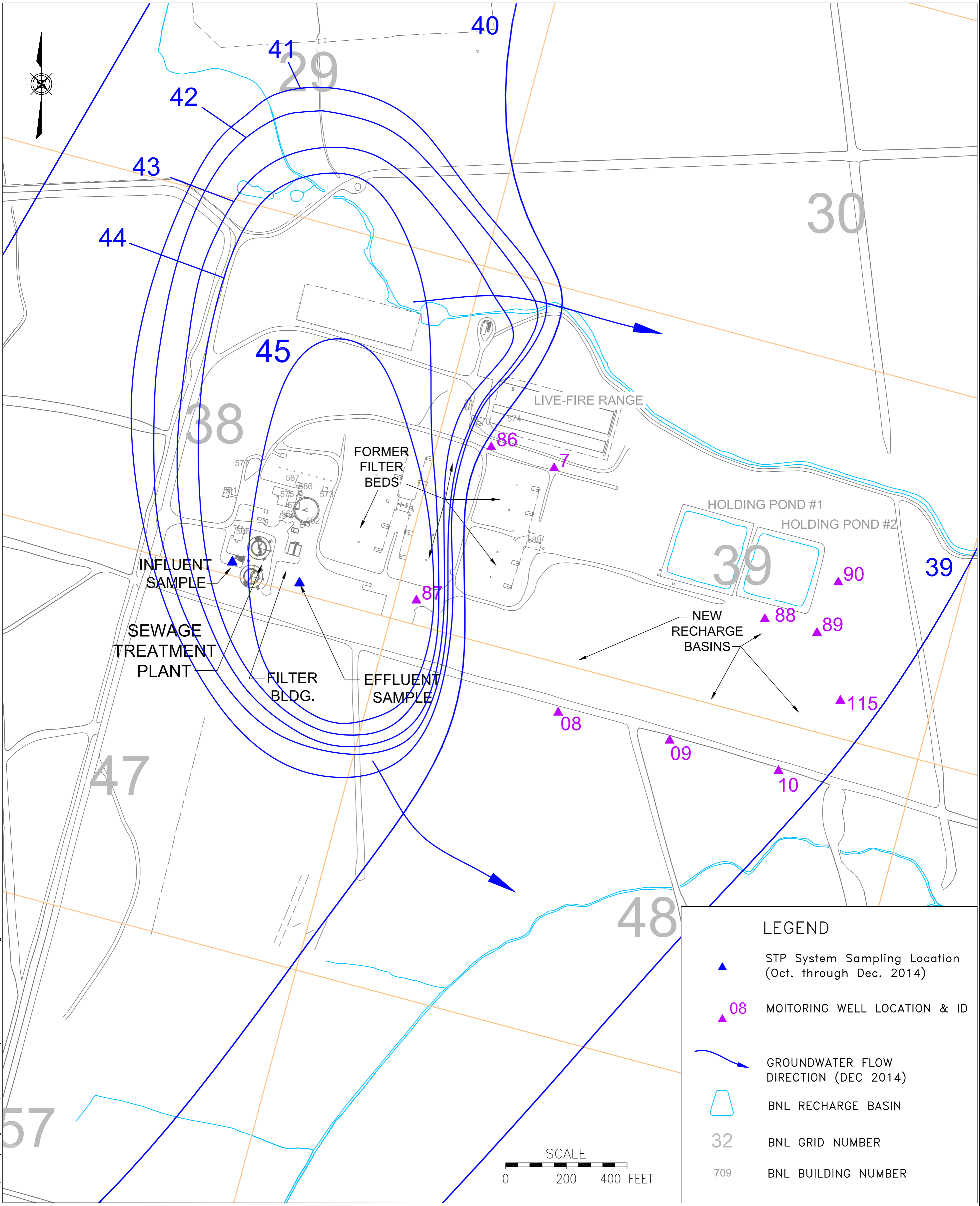
Based on the amount of monitoring data available for groundwater in the STP area, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

Table 12.32.2 Comparison of 2015 and 2016 Sampling Programs – New SPDES Monitoring Program

Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
039-87(a)	Annual	Annual	None
039-88 (b)	Annual	Annual	None
039-89 (b)	Annual	Annual	None
048-08 (b)	Annual	Annual	None
048-09 (b)	Annual	Annual	None
048-10 (b)	Annual	Annual	None
039-115 (b)	Annual	Annual	None
039-90(c)	Annual	None	---

(a) Upgradient well for new recharge basin area
(b) Well sampling required by SPDES permit
(c) Holding pond monitoring well, not monitored under SPDES permit. Sampled as needed for surveillance program.

See Appendix B for the monitoring requirements for this DQO.



BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTION DIVISION	TITLE: FACILITY MONITORING PROGRAM, SEWAGE TREATMENT PLANT AND LIVE-FIRE RANGE MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/15	PROJECT NO.: –
		CHKD: JEB	APPD: RFH	REV.: –	NOTES: –
		FIGURE NO.: 12.32.1			

GROUNDWATER MONITORING AT THE BNL MOTOR POOL FACILITY

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 11, November 1, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact DOUGLAS PAQUETTE (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 to the Motor Pool groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

In 1996, BNL installed two monitoring wells downgradient of the gasoline USTs. Data from these wells indicate that current fuel storage and dispensing operations are not impacting groundwater quality. In 1999, the Laboratory installed six additional monitoring wells to evaluate the potential impact to groundwater quality from two oil spills. Although the monitoring results indicated that the two oil spills had not impacted groundwater quality, the degreasing agent 1,1,1-trichloroethane (TCA) and several gasoline by-products were observed. Based on solvent handling and spill controls that have been in effect for the past 20 years, these contaminants are likely to have originated from historical small-scale spills resulting from vehicle maintenance activities. Semi-volatile organic compounds (SVOCs) were not detected in any samples, and sampling for these compounds was discontinued in 2002. Although low levels of several VOCs continue to be detected in some Motor Pool area wells, since 2012 all VOC concentrations have been less than applicable drinking water standards. Monitoring well sampling frequency and methods of analysis is summarized in Tables 12.26.1 and 12.26.2.

DRIVERS FOR MONITORING

___ Compliance
___ Support Compliance
X Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Potential environmental concerns at the Motor Pool include the historical and current use of USTs for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning. In August 1989, the USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. Following the removal of the old USTs, there were no obvious signs of soil contamination. The present tank inventory includes two 8,000 gallon USTs used for the storage of unleaded gasoline, one 260 gallon UST for waste oil, and one 3,000 gallon

UST for No. 2 fuel oil. The facility also has five vehicle lift stations. In 2002, the petroleum-based hydraulic fluid for the lifts was replaced with a vegetable-based product.

In December 1996, BNL removed an underground propane tank near the Site Maintenance Facility (Building 326). During this removal, the surrounding soils had a distinct petroleum staining and smell. These soils were contaminated from a previously unknown oil spill. Although approximately 60 cubic yards of contaminated soil were removed, there was clear evidence that contaminated soils remained. In February 1998, it was discovered that hydraulic fluid was leaking from one of the lift stations in Building 423. The lift was excavated and approximately 50 cubic yards of contaminated soils were removed. In response to a New York State Department of Environmental Conservation (NYSDEC) request, the Laboratory installed six new monitoring wells in the Motor Pool (Building 423/326) area to evaluate the potential impacts of the two spills.

Groundwater monitoring is conducted to verify the effectiveness of the remedial actions (i.e., removal of contaminated soils) and that the current operational and engineered controls are effective in protecting groundwater quality. These controls include:

- All USTs, pump islands, and associated piping conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms.
- BNL maintains an inventory/accounting of gasoline stored in USTs at the Motor Pool.
- BNL maintains an inventory of all chemical degreasers in use at the Motor Pool.
- All spent degreasing agents are properly stored and disposed of.

Step 2: Identify the Decision

The decision for this monitoring program is:

Are the operations of the Motor Pool impacting groundwater quality? If so, do concentrations exceed water quality standards at the point of assessment (i.e., the closest downgradient well(s)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the Motor Pool
- Direction and velocity of groundwater flow
- VOC concentrations in groundwater
- Floating product determination measurements
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements (DOE Order 436.1)
- Action levels (as described in the Groundwater Contingency Plan)
- Analytical methods and detection limits
  - VOCs (EPA Method 524.2)

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the Motor Pool/Site Maintenance Buildings. The period for which decisions are made is 365 days. This timeframe is based on the following:

- The USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. A more frequent monitoring program can be implemented if a leak is found or suspected. Vegetable-based products replaced petroleum-based hydraulic fluids in the vehicle lift stations.

- The time required for contaminants from small-scale petroleum hydrocarbon spills and solvent spills to migrate through the vadose zone and reach the groundwater table is likely to be 30 or more days.

- Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, approximately 20 feet from the USTs or historical spill areas) is on the order of 30 days.

- Fifteen years of monitoring data has confirmed that the current operational and engineered controls have been effective. Therefore, decision periods of 365 days are sufficient to provide a secondary means of verifying that the current controls are effective, and to evaluate ongoing impacts from historical solvent, oil, and gasoline spills.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of petroleum hydrocarbons and solvents to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.33.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching lead to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 480 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of Motor Pool area. Travel time from the Motor Pool area to the BNL southern boundary is greater than 15 years, and most homes south of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility.

Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under New York State regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells at the Motor Pool are biased toward detecting contamination that could originate from the UST area and petroleum contaminated soils associated with the spills discussed above (see Figure 12.33.1). The wells are as close as possible to these potential source areas, to enable early detection of any contaminant releases. The current monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at the Motor Pool/Site Maintenance Facility area has been evaluated using monitoring wells that were installed during 1997-1999. Therefore, more than 15 years of analytical data are available to assess potential impacts from current operations and historical spills. Although low levels of several VOCs continue to be detected in some Motor Pool area wells, since 2012 all VOC concentrations have been less than applicable drinking water standards.

Groundwater samples are collected on an annual basis, and are analyzed for VOCs. Floating product determination measurements are conducted in wells downgradient of the USTs.

Table 12.33.2 Comparison of CY 2015 and CY 2016 Sampling Programs

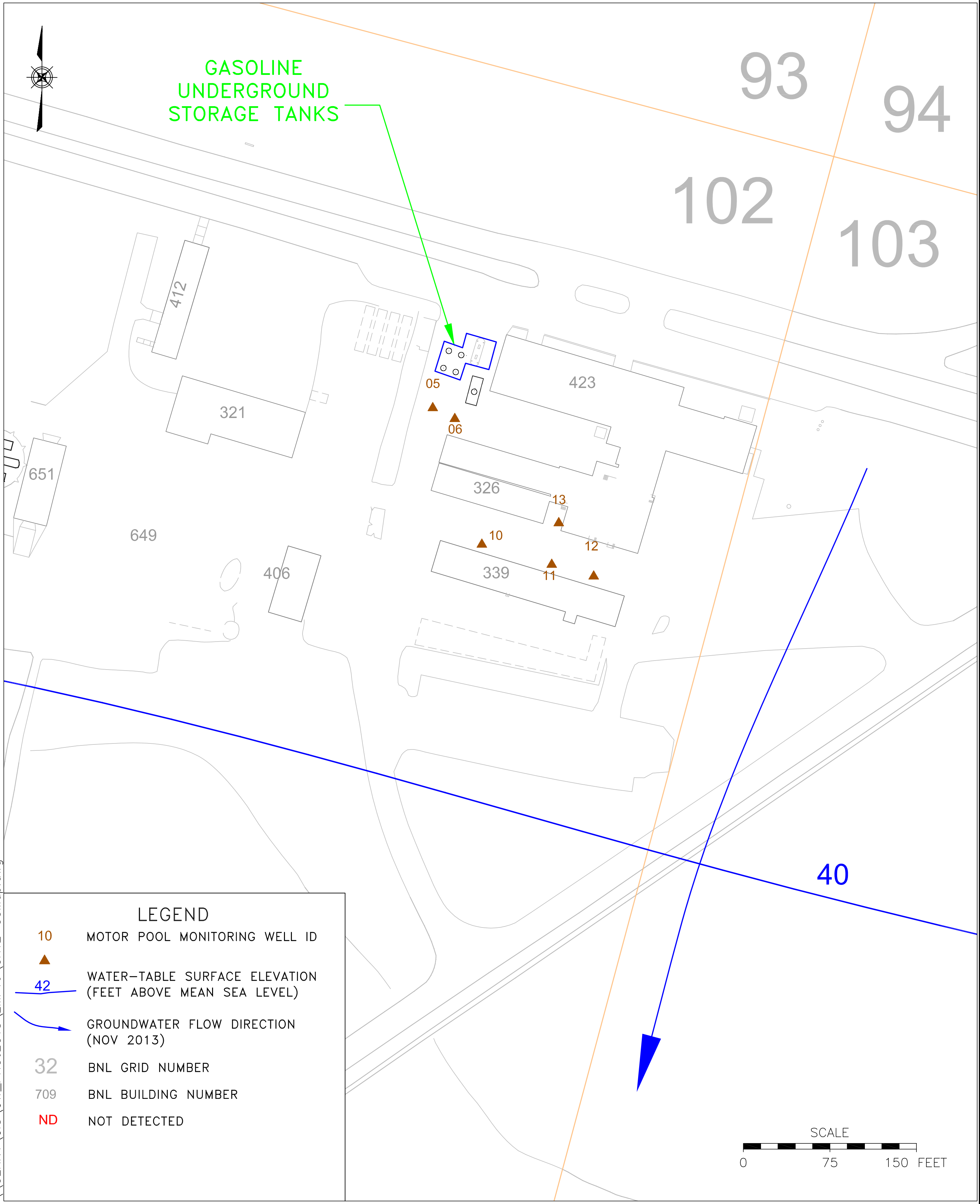
Well ID	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
102-05	Annual	Annual (a)	None
102-06	Annual	Annual (a)	None
102-10	Annual	Annual (a)	None
102-08	Annual	Annual	None
102-11	Annual	Annual	None
102-12	Annual	Annual	None
102-13	Annual	Annual	None

(a): Wells downgradient of the USTs are also checked for floating product.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring requirements for this DQO.



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BROOKHAVEN NATIONAL LABORATORY ENVIRONMENTAL PROTECTON DIVISION	TITLE: FACILITY MONITORING PROGRAM, MOTOR POOL MONITORING WELL LOCATIONS	DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
		CHKD: JEB	APPD: DEP	REV.: –	NOTES: –
		FIGURE NO.: 12.33.1			

GROUNDWATER MONITORING AT THE UPTON SERVICE STATION

DQO START DATE	January 1, 2003
REVISION NUMBER/DATE	Rev. 11, November 1, 2015
IMPLEMENTATION DATE	January 1, 2016
Point of Contact	DOUGLAS PAQUETTE (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 to the Service Station groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

Since 1996, BNL has been monitoring groundwater quality downgradient of the Upton service station. Monitoring results indicate that while the underground storage tanks (USTs) are not impacting groundwater quality, small-scale historical spillage of petroleum hydrocarbons and degreasing solvents have impacted the groundwater. Semi-volatile organic compounds (SVOCs) have not been detected in groundwater and routine analysis for these compounds was suspended in 2005. Monitoring well sampling frequency and analytical methods are summarized in Tables 12.24.1 and 12.24.2.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Potential environmental concerns at the Upton service station include the historical and current use of USTs for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning. In 1989, the USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices and overfill alarms. Following the removal of the old USTs, there were no obvious signs of soil contamination. The present tank inventory includes three 8,000-gallon USTs for storing unleaded gasoline, and one 500-gallon UST for waste oil. The facility also has five vehicle lift stations. In 2002, the petroleum-based hydraulic fluids in the vehicle lift stations were replaced with a vegetable oil product.

Groundwater monitoring in the service station area is used to demonstrate that current operational and engineered controls are effective in protecting groundwater quality. These controls include:

- All USTs, pump islands, and associated piping conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms.
- BNL maintains an inventory/accounting of gasoline stored in USTs at the service station.
- BNL maintains an inventory of all chemical degreasers in use at the service station.
- All spent degreasing agents are properly stored and disposed of.

Step 2: Identify the Decision

The decision for this monitoring program is:

Are the operations of the Upton service station impacting groundwater quality? If so, do concentrations exceed drinking water standards at the point of assessment (i.e., the closest downgradient wells)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the service station
- Direction and velocity of groundwater flow
- VOC concentrations in groundwater
- Floating product determination measurements in wells downgradient of the USTs
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements: Best management practice under BNL's Environmental Management System (DOE Order 436.1)
- Action levels (as described in the BNL Groundwater Contingency Plan)
- Analytical methods and detection limits (as described in this report)
  - VOCs (EPA Method 524.2)
- Fuel inventory and waste management records

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the service station facility. The timeframe of 365 days is based on the following:

- The USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. A more frequent monitoring program can be implemented if a leak is found or suspected.

- The time required for contaminants from small-scale petroleum hydrocarbon spills and solvent spills to migrate through the vadose zone and reach the groundwater table is likely to be 30 or more days.

- Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, approximately 20 feet from the USTs) is on the order of 30 days.

- Fifteen years of monitoring data has confirmed that the current operational and engineered controls have been effective. Therefore, decision periods of 365 days are sufficient to provide a secondary means of verifying that the current controls are effective, and to evaluate ongoing impacts from historical solvent, oil, and gasoline spills.

Step 5: Develop the Decision Rule

Are the operational and engineered controls effective at preventing the introduction of petroleum hydrocarbons and solvents to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.34.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling release of contaminants to the groundwater.	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 480 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of service station area and many of the VOCs that have been detected in the groundwater (e.g., BTEX compounds) degrade in the aquifer within a relatively short distance (typically within 500 feet) from the station. Furthermore, the travel time from the service station area to the BNL southern boundary is greater than 15 years, and most homes south of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under applicable NYS regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are located as close as possible to these potential source areas to enable early detection of contaminant releases (see Figure 12.34.1). The current monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at the service station is currently evaluated using four monitoring wells. Multiple sets of analytical data are available to assess potential impacts from current operations and historical spills:

- Since 2000, petroleum hydrocarbon compounds, such as xylenes and ethylbenzene, and the solvent tetrachloroethylene have been detected in several monitoring wells directly downgradient of the service station at concentrations above the New York State Ambient Water Quality Standard (NYS AWQS). Evaluations of service station operations have indicated that the USTs and associated distribution lines are not leaking and that all waste oils and used solvents were being properly stored and recycled. Therefore, the petroleum hydrocarbon–related compounds and tetrachloroethylene detected in groundwater are likely to have originated from small-scale releases from historical vehicle maintenance and fuel dispensing operations.

- From 2000–2002, high levels of carbon tetrachloride (>1,000 μg/L) were detected in a number of groundwater monitoring wells upgradient and downgradient of the service station. This contamination was related to the inadvertent release of carbon tetrachloride during an April 1998 removal of a UST that was located approximately 200 feet northwest (upgradient) of the station. The remediation system met its cleanup goals and was fully decommissioned in 2010.

Groundwater samples are collected on an annual basis to verify that continued operations at the service station are not affecting groundwater quality. Samples from four service station monitoring wells are analyzed for VOCs. Floating product determination measurements in wells downgradient of the USTs are also be conducted annually.

Table 12.34.2. Comparison of 2015 and 2016 Sampling Programs

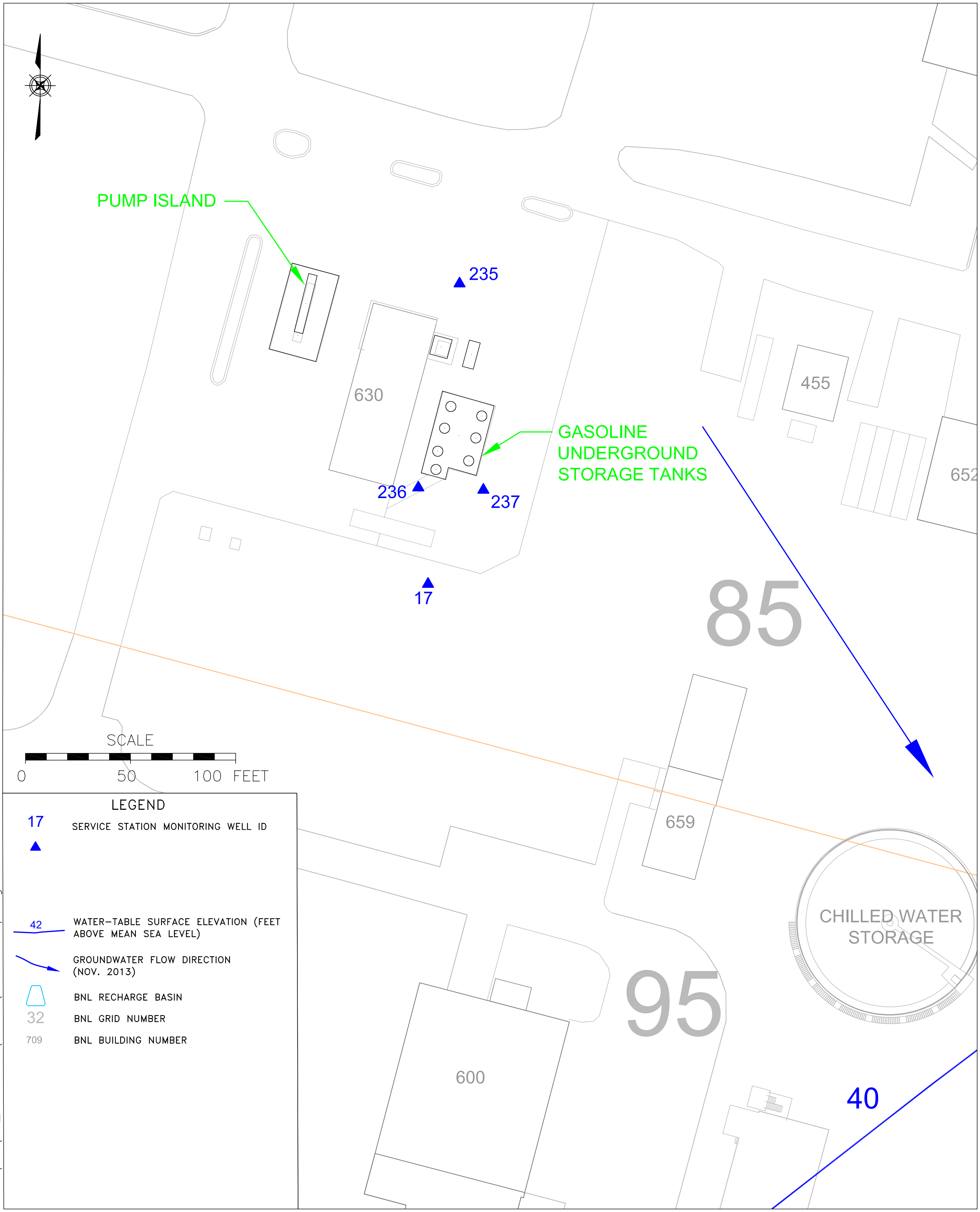
Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
085-17	Annual	Annual	None
085-235	Annual	Annual	None
085-236	Annual	Annual (a)	None
085-237	Annual	Annual (a)	None

(a): Wells downgradient of the USTs are also checked for floating product.

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring requirements for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

FACILITY MONITORING PROGRAM, SERVICE STATION MONITORING WELL LOCATIONS BTEX CONCENTRATIONS 4TH QUARTER 2013

DWN:	VT:HZ.:	DATE:	PROJECT NO.:
AJZ	–	06/12/14	–
CHKD:	APPD:	REV.:	NOTES:
JEB	DEP	–	–

FIGURE NO.: 12.34.1

GROUNDWATER MONITORING AT THE MAJOR PETROLEUM FACILITY

DQO START DATE January 1, 2003

REVISION NUMBER/DATE Rev. 11, November 1, 2015

IMPLEMENTATION DATE January 1, 2016

Point of Contact Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 to the Major Petroleum Facility (MPF) groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

In accordance with the New York State (NYS) operating license for the MPF, BNL routinely monitors groundwater quality downgradient of the MPF's bulk oil storage tanks. The monitoring program was initiated in the 1980s with five wells. Three additional wells were installed in 1999. In accordance with the operating license, the MPF wells are monitored semi-annually for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), and monthly for floating petroleum products. To date, no fuel-related compounds or floating products have been detected.

DRIVERS FOR MONITORING

_X_ Compliance
___ Support Compliance
___ Surveillance
___ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

The MPF is the holding area for fuels used at the Central Steam Facility (CSF). Fuel oil for the CSF is held in a network of seven aboveground storage tanks, two of which are currently inactive. All fuel storage tanks are in bermed containment areas that have a capacity to hold >110 percent volume of the largest tank within each bermed area. The bermed areas have bentonite clay liners consisting of either Environmat (consisting of bentonite clay sandwiched between geotextile materials) or bentonite clay mixed into the native soils to form an impervious soil/clay layer. Nevertheless, there is a potential that small-scale leakage from the base of the tanks may go undetected.

The collection of groundwater samples from wells downgradient of the bulk storage area is required to demonstrate that current operational and engineered controls are effective in protecting groundwater quality. These controls include:

- The fuel storage tanks are connected to the CSF by aboveground pipelines that have secondary containment and leak detection devices.
- All fuel storage tanks are located in bermed containment areas that have a capacity to hold >110 percent of the volume of the largest tank within each bermed area.
- The bermed areas have bentonite clay liners consisting of either Environmat (consisting of bentonite clay sandwiched between geotextile materials) or bentonite clay mixed into the native soils to form an impervious soil/clay layer.
- All fuel unloading operations were consolidated in one centralized building that has secondary containment features.
- BNL maintains an accurate inventory/accounting of fuel oil stored at the MPF.

Step 2: Identify the Decision

The decision for this monitoring program is:

Are the operations of the MPF impacting groundwater quality? If so, do concentrations exceed water quality standards at the point of assessment (i.e., the closest downgradient well(s)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the MPF
- Direction and velocity of groundwater flow
- SVOC concentrations in groundwater
- Floating product determination measurements
- Locations of background and downgradient wells relative to known or potential source areas
- Regulatory requirements: New York State Department of Environmental Conservation (NYSDEC) operating permit
- Action levels: detection of floating petroleum on the water table, or detection of SVOCs at concentrations exceeding levels outlined in the BNL Groundwater Contingency Plan
- Analytical methods and detection limits (as described in the Environmental Monitoring Plan)
- VOCs (EPA 624 including methyl tertiary butyl either [MTBE])
- SVOCs (EPA Method 625)
- Fuel inventory records

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediately downgradient of the MFP. A decision period of 180 days is sufficient to provide a secondary means of verifying that the operational and engineered controls in place at the MPF are effective. This timeframe is based on the following:

- As described above, the MPF has a number of engineered and operational controls that are designed to prevent leakage of fuel oil to the environment. The monitoring frequency for the wells can be increased if a leak is found or suspected.

- The time required for contaminants from small-scale petroleum hydrocarbons to migrate through the vadose zone and reach the groundwater table is likely to be 90 or more days.

- Once contaminants have migrated to groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, approximately 100 feet from the tanks) is on the order of 130 days.

- The MPF is outside the 5-year capture zone for the BNL potable water supply wells.

Step 5: Develop the Decision Rules

Are the operational and engineered controls effective at preventing the introduction of petroleum hydrocarbons to the groundwater?

The sample results will be evaluated in context with historical data. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.35.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the release of contaminants to the groundwater?	See Step 3 for inputs.	(1) Data indicate controls are effective when they are not. (2) Data indicate controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A discrete slug of contamination potentially up to 200 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

* Assumes results from one sample period were inaccurate and all operational and engineered controls (i.e., inventory resolution, leak detection, secondary containment) were to fail.

There are no potential receptors (i.e., potable water supply wells) immediately downgradient of the MPF area. Groundwater travel time from the MPF area to the BNL southern boundary is greater than 15 years, and most homes south of BNL have been connected to public water. Therefore, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial actions under applicable NYS regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells are as close as possible to potential MPF source areas to enable early detection of contaminant releases (see Figure 12.35.1). The current approved monitoring network is considered adequate for meeting the acceptable risk levels of stakeholders. Because the groundwater flow direction has been relatively constant in this area in recent years, and the potential source is relatively small, no refinements are recommended.

Parameters and Frequency

Groundwater quality at the MPF area is evaluated using eight monitoring wells. Multiple rounds of analytical data are available to assess potential impacts from past and current operations. No impacts from MPF operations have been observed to date. Low levels of 1,2-dichlorethene and tetrachloroethylene are occasionally detected in several MPF wells at concentrations exceeding the New York State Ambient Water Quality Standard (NYS AWQS) of 5 µg/L. This contamination is thought to have originated from historical spills near the CSF.

In accordance with the NYSDEC operating permit, groundwater samples will continue to be collected on a semi-annual basis for VOCs (including MTBE) and SVOCs, and the wells will be checked monthly for the presence of floating petroleum.

Table 12.35.2. Comparison of 2015 and 2016 Sampling Programs

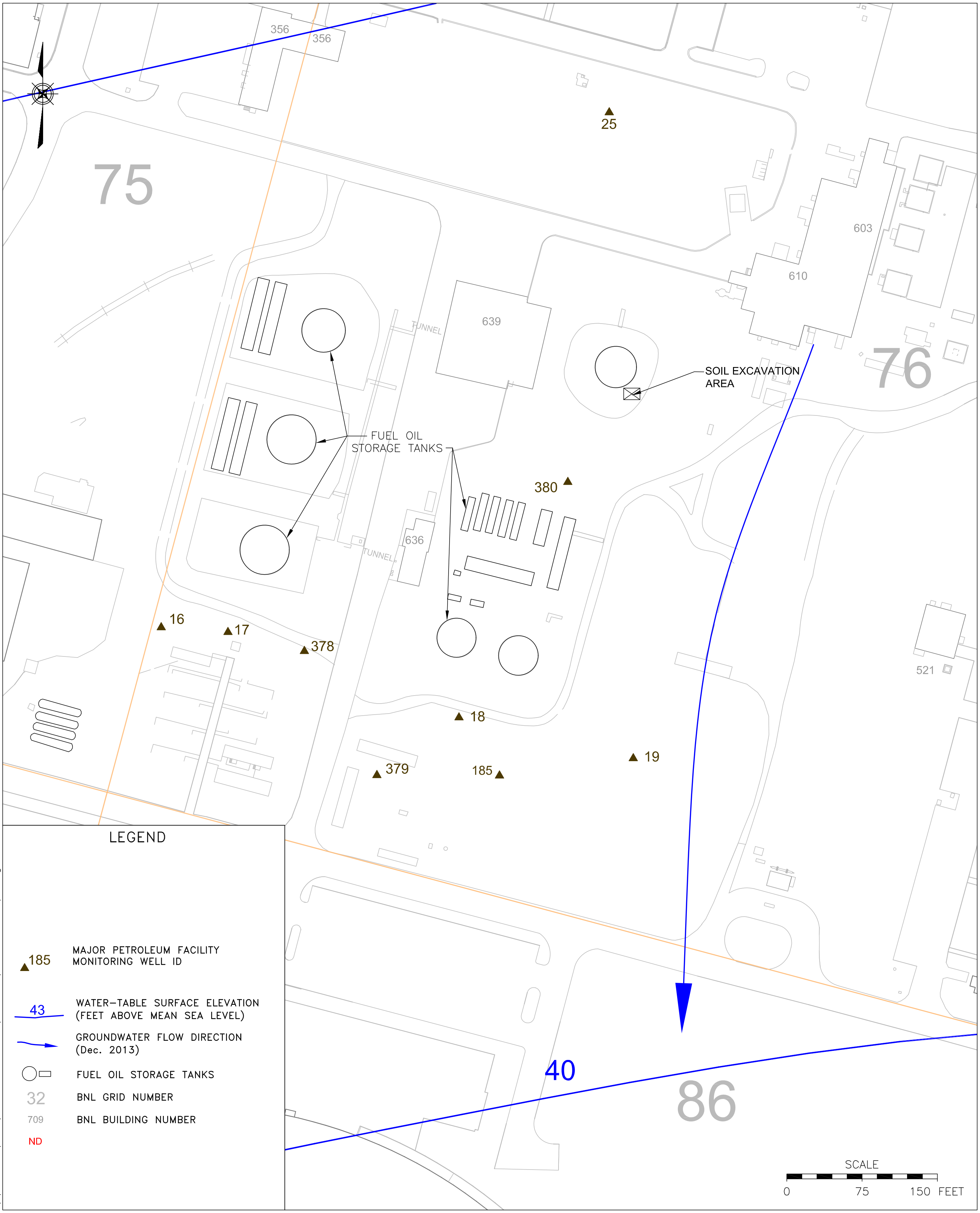
Well	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
076-16	Semi-annual	Semi-annual (a)	None
076-17	Semi-annual	Semi-annual (a)	None
076-18	Semi-annual	Semi-annual (a)	None
076-19	Semi-annual	Semi-annual (a)	None
076-25	Semi-annual	Semi-annual (a)	None
076-378	Semi-annual	Semi-annual (a)	None
076-379	Semi-annual	Semi-annual (a)	None
076-380	Semi-annual	Semi-annual (a)	None

(a) Monitoring wells are checked monthly for floating petroleum

DATA REVIEW REQUIREMENTS

Based on the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification and the results will be reviewed by the project manager. If anomalous analytical results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring requirements for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:	DWN:	VT:HZ.:	DATE:	PROJECT NO.:
FACILITY MONITORING PROGRAM, MAJOR PETROLEUM FACILITY MONITORING WELL LOCATIONS	AJZ	–	06/12/14	–
	CHKD: JEB	APPD: DEP	REV.: –	NOTES: –
	FIGURE NO.: 12.35.1			

GROUNDWATER MONITORING FOR THE G-2 TRITIUM SOURCE AREA AND PLUME

DQO START DATE	January 2, 2008
REVISION NUMBER/DATE	Rev. 8, November 1, 2015
IMPLEMENTATION DATE	January 1, 2016
Point of Contact	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

Proposed changes for calendar year (CY) 2016 for the G-2 Tritium Source Area and Plume monitoring include:

- Because tritium concentrations in the downgradient segment of the g-2 tritium plume located south of Brookhaven Avenue have attenuated to less than the 20,000 pCi/L drinking water standard, no additional temporary wells will be installed.

DESCRIPTION AND TECHNICAL BASIS

In November 1999, tritium was detected in the groundwater near the g-2 experiment at concentrations above the 20,000 pCi/L drinking water standard. Sodium-22 was also detected in the groundwater, but at concentrations well below the 400 pCi/L drinking water standard. An investigation into the source of the contamination revealed that the tritium and sodium-22 originated from activated soil shielding located adjacent to the g-2 target building where approximately 5 percent of the beam was inadvertently striking the beam-line's VQ12 magnet. Rainwater was able to infiltrate the activated soils and carry the tritium and sodium-22 into the groundwater. To prevent additional rainwater infiltration into the activated soil shielding, a concrete cap was constructed over the soil shielding in December 1999. Other corrective actions included refocusing the beam and improved beam loss monitoring to reduce additional soil activation, stormwater management improvements, and additional groundwater monitoring. The g-2 experiment concluded its operations in 2001.

Following the concurrence from the New York State Department of Environmental Conservation (NYSDEC), a Record of Decision (ROD) was signed by DOE and the Environmental Protection Agency (EPA) in early 2007. This ROD requires continued routine inspection and maintenance of the impermeable cap, groundwater monitoring of the source area to verify the continued effectiveness of the storm water controls, and monitoring the tritium plume until it attenuates to less than the 20,000 pCi/L drinking water standard.

Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality. Contingency actions have been developed if tritium levels greater than 1,000,000 pCi/L are detected within the plume, or if the tritium plume does not attenuate to below the 20,000 pCi/L drinking water standard before reaching Brookhaven Avenue.

DRIVERS FOR MONITORING

___ Compliance
___ Support Compliance
_X_ Surveillance
_X_ Restoration/IAG

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

Although the cap and other stormwater controls appear to be effectively protecting the activated soils, long-term monitoring is required to verify the continued effectiveness of these controls. Monitoring data indicate that natural fluctuations in the position of the water table periodically flush small amounts of residual tritium that was leached to close to the water table before the controls were put in place. The amount of residual tritium near the water table will be reduced by this flushing mechanism and by natural radioactive decay. Since 2004, tritium concentrations in surveillance wells located immediately downgradient of the source area have generally been <100,000 pCi/L, and <50,000 pCi/L since June 2012.

Monitoring results have indicated the presence of two disconnected tritium plume segments, one located in the source area resulting from ongoing, small-scale releases, and a second plume segment that was located south of Brookhaven Avenue, near the west side of the NSLS-II facility. Monitoring of the southern tritium plume segment was conducted to verify the expected attenuation of the plume (via natural radioactive decay and dispersion) to below the 20,000 pCi/L drinking water standard. Monitoring conducted in 2015 verified that tritium concentrations attenuated to <20,000 pCi/L.

Step 2: Identify the Decision

Are the engineered controls employed at the g-2 source area effective at preventing additional leaching of tritium from the activated soil shielding? Furthermore, are the tritium concentrations within the g-2 tritium plume declining at the rate and within the geographical area predicted by groundwater modeling?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater
- Locations of background and downgradient wells
- Regulatory requirements: g-2/BLIP/UST ROD, DOE Order 458.1
- Action levels:
  - As defined in the g-2/BLIP/UST ROD, BNL will determine whether additional remedial actions are required if future tritium levels exceed 1,000,000 pCi/L in groundwater immediately downgradient of the g-2 source area or within the downgradient sections of the g-2 tritium plume
  - As defined in the g-2/BLIP/UST ROD, BNL will determine whether additional remedial actions are required if future tritium levels within the plume exceed 20,000 pCi/L south of

Brookhaven Avenue. (This action level was triggered in December 2011. The follow-up action was continued monitoring until the plume segment attenuates to <20,000 pCi/L.)

- Analytical methods and detection limits:
  – Tritium: EPA Method 906

Note: The focus of the monitoring program is on evaluating changes in tritium concentrations in groundwater. Because tritium is more mobile than sodium-22 and has a longer half-life (12.6 years compared to 2.3 for sodium-22), the presence of tritium in groundwater is a better early indicator of a failure in an engineered storm water control. Furthermore, detectable levels of sodium-22 are only observed in groundwater monitoring wells located immediately downgradient of activated soil shielding source areas.

Step 4: Define the Study Boundaries

The decision for the g-2 source area monitoring program applies to the nearest monitoring wells, which are located near Building 912A, between 275 to 300 feet downgradient of the source. The period for which decisions are made is 90 days. This timeframe is based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.

- Once tritium has migrated into the groundwater, the tritium migrates at the same rate as groundwater (approximately 0.75 feet/day). The travel time between the source area and the nearest downgradient wells (near Building 912A) is expected to be approximately 365 days.

- Decision periods of 90 days are acceptable for the g-2 source area where historical monitoring has demonstrated that groundwater quality has already been significantly impacted. A decision period of 90 days is required to continually evaluate the effectiveness of engineered controls designed to prevent additional storm water infiltration.

Step 5: Develop the Decision Rules

Are the engineered controls effective at preventing the leaching of radionuclides from activated soils to the groundwater? Is the plume attenuating at the rate and within the geographic area predicted by groundwater modeling?

The sample results will be evaluated in context with historical data and the contingency requirements defined in the ROD. In accordance with the ROD, DOE will determine whether additional remedial actions are required for the g-2 source area or plume control should future tritium levels exceed 1,000,000 pCi/L within any section of the g-2 plume. In 2011, a ROD contingency action was implemented when remnants of the leading edge of the tritium plume were found to have migrated beyond Brookhaven Avenue at concentrations that exceed 20,000 pCi/L. The resulting action was to continue to monitor the plume segment until it attenuated (via natural radioactive decay and dispersion) to below the 20,000 pCi/L drinking water standard. Because monitoring results for 2015 indicated that tritium concentrations in the plume segment declined to <20,000 pCi/L, monitoring of the residual tritium south of Brookhaven Avenue will be discontinued starting in 2016.

The monitoring results will also be evaluated in accordance with the BNL Groundwater Contingency Plan (EM-SOP-309). The contingency plan has three action levels, with action Level 1 monitoring results being defined as unexpected, but not considered a cause for undue concern. Level 2 and 3 responses are defined below.

Decision Rule for a Level 2 Response

A BNL Groundwater Contingency Plan Level 2 response could be implemented if monitoring data indicate a significant increase over recent baseline tritium concentrations in source area monitoring wells. Consideration for a Level 2 response should be given if for any monitoring well, the tritium concentrations are greater than 50 percent, but less than 100 percent of the 1,000,000 pCi/L ROD Trigger Level (and this result is confirmed by re-sampling).

Step 6: Specify Acceptable Error Tolerances

Table 12.36.1 Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium from the g-2/VQ12 activated soil shielding to the groundwater.	See Step 3 for inputs	(1) Data indicate that source controls are effective when they are not. (2) Data indicate source controls are not effective when they are because of sampling or analytical error, or wells not properly located.	(1) A slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected.* (2) Need to re-sample well and resulting additional unplanned costs. Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

Although the g-2 source area is within a 2-year capture zone of BNL potable supply well 10, restrictions have been placed on the operation of potable Well 10 since early 2000 to prevent the possible capture of the g-2 plume by this well, and to also help stabilize groundwater flow directions in the AGS area. Due to these factors, and existing Land Use and Institutional Controls, it is unlikely that a decision error will result in adverse consequences to human health. Consequences associated with (short-term) decision errors for this program relate primarily to possible enforcement actions for continued environmental degradation, erosion of stakeholder trust, and loss of BNL credibility.

Parameters and Frequency

During 2016, the g-2 source area will be monitored as follows:

- Wells immediately downgradient of the source area will continue to be sampled semiannually for tritium.

- The permanent wells downgradient of Building 912 used to track the g-2 plume will continue to be sampled on an annual basis for tritium.

DATA REVIEW REQUIREMENTS

Based upon the amount of monitoring data available for this program, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification, and the results will be reviewed by the project manager. If anomalous results are reported, a further review of the data will be conducted.

Table 12.36.2 Comparison of 2015 and 2016 Monitoring Program – Permanent Wells

Well	Monitoring Sub-Area	2015 Sampling Frequency	2016 Sampling Frequency	Affected Parameters
054-65	Bkgd. g-2	Annual	Annual	None
054-07	g-2/VQ12 source	Semiannual	Semiannual	None
054-184	g-2/VQ12 source	Semiannual	Semiannual	None
054-185	g-2/VQ12 source	Semiannual	Semiannual	None
064-95	g-2/VQ12 source	Semiannual*	Semiannual*	None
054-126	g-2/VQ12 source	Semiannual	Semiannual	None
054-124	912/g-2 tritium plume	Annual	Annual	None
065-122	912/g-2 tritium plume	Annual	Annual	None
065-123	912/g-2 tritium plume	Annual	Annual	None
065-124	912/g-2 tritium plume	Annual	Annual	None
065-125	912/g-2 tritium plume	Annual	Annual	None
065-126	912/g-2 tritium plume	Annual	Annual	None
065-194	912/g-2 tritium plume	Annual	Annual	None
065-195	912/g-2 tritium plume	Annual	Annual	None
055-31	912/g-2 tritium plume	Annual	Annual	None
065-321	912/g-2 tritium plume	Annual	Annual	None
065-322	912/g-2 tritium plume	Annual	Annual	None
065-323	912/g-2 tritium plume	Annual	Annual	None
065-324	912/g-2 tritium plume	Annual	Annual	None

* Access to well 064-95 is periodically restricted because it is within a posted radiation area when AGS/RHIC is in operation.

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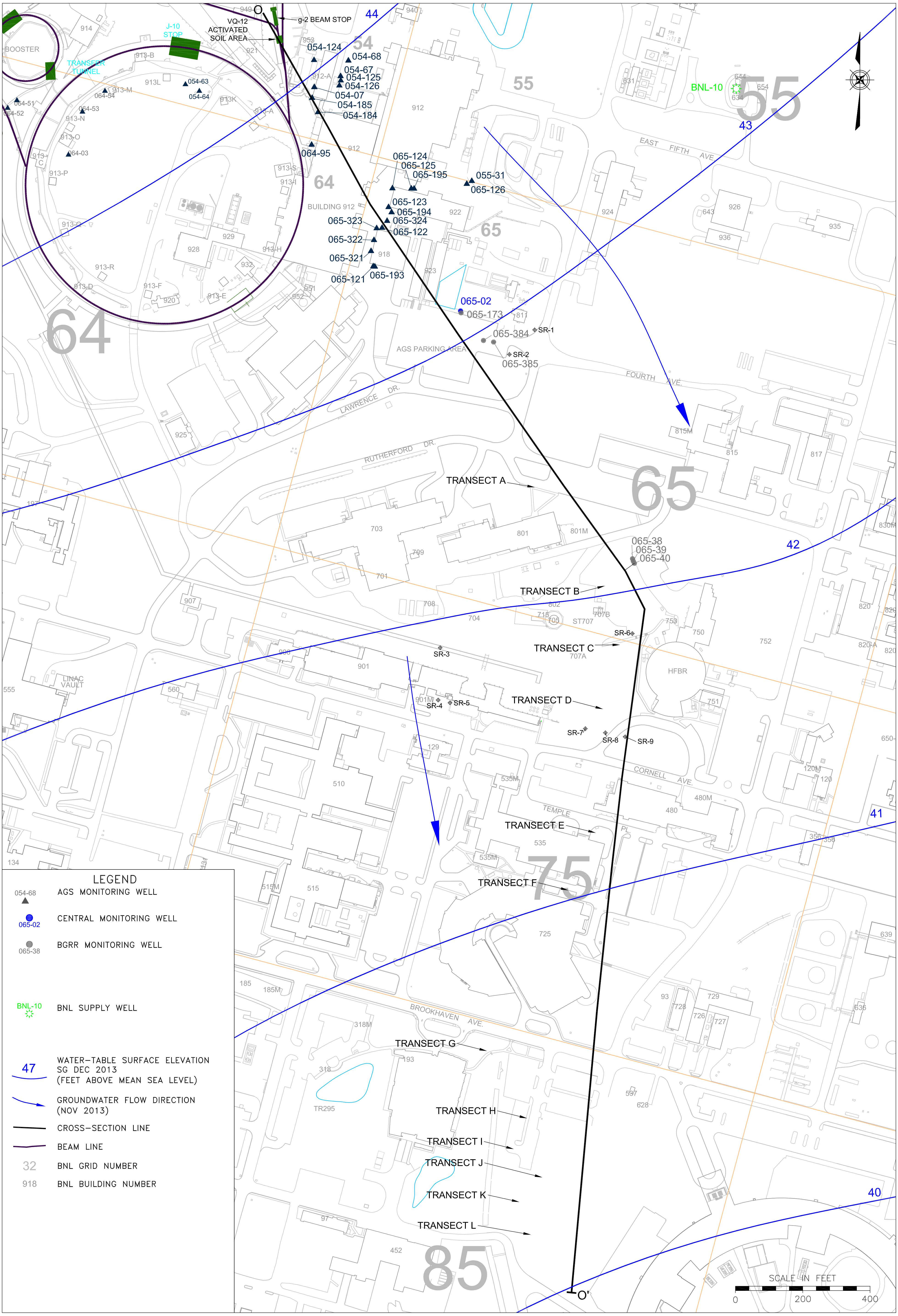


BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE: FACILITY MONITORING PROGRAM, AOC 16T g-2 TRITIUM PLUME

DWN: AJZ	VT:HZ.: –	DATE: 06/12/14	PROJECT NO.: –
CHKD: DEP	APPD: DEP	REV.: –	NOTES: –
FIGURE NO.: 12.36.1			

GROUNDWATER MONITORING AT THE NATIONAL SYNCHROTRON LIGHT SOURCE II

DQO START DATE	January 1, 2012
REVISION NUMBER/DATE	Rev. 4, November 1, 2015
IMPLEMENTATION DATE	January 1, 2016
POINT OF CONTACT	Douglas Paquette (631) 344-7046

SUMMARY OF PROPOSED CHANGES

There are no proposed changes for calendar year (CY) 2016 to the NSLS-II groundwater monitoring program.

DESCRIPTION AND TECHNICAL BASIS

BNL installed four downgradient monitoring wells to evaluate the effectiveness of the engineered and operational controls designed to protect groundwater quality near anticipated low-level activated soil shielding at the NSLS-II linear accelerator (Linac)/Booster facility. The Linac/Booster facility began startup testing operations in 2012, and full facility operations began in late 2014. The interaction of neutrons with the soils below the tunnel floor and surrounding soil shielding (berm) have the potential to create very low levels of tritium and Na-22 in the adjacent soil shielding. There is also the potential to create very low levels of tritium in the water used to cool the magnets and other accelerator components.

To date, the focus of the NSLS-II groundwater surveillance program has been the collection of pre-operation samples to establish baseline values for tritium and Na-22 downgradient of the NSLS-II Linac/Booster area.

DRIVERS FOR MONITORING

____ Compliance
____ Support Compliance
_X_ Surveillance
____ Restoration

DATA QUALITY OBJECTIVE ANALYSIS

Step 1: State the Problem

High-energy particle interactions in water, air, and soil can produce radioactivity from spallation reactions or neutron capture in nitrogen, oxygen, or other materials. In high-energy proton accelerators, such as BNL’s Alternating Gradient Synchrotron (AGS) and the Relativistic Heavy Ion Collider (RHIC), these interactions can produce significant environmental issues. However, electron accelerators such as the NSLS-II have significantly reduced potential for environmental impacts, and can produce only about 1 to 5 percent of the induced activity of a proton accelerator.

Soil Activation: Although light source facilities throughout the world have not been found to create radiological environmental issues, analyses as required by the BNL Standards-Based Management System (SBMS) Accelerator Safety Subject Area have been conducted to estimate the rate of formation of tritium (^{3}H) and sodium-22 (^{22}Na) in the surrounding soils during the operation of the NSLS-II Linac, Booster, and Storage Ring.

In the calculations, the neutron source inside the accelerators is assumed to be at 1.2 m from the floor and 2 m from the inboard wall. The floor is 0.51 m of standard concrete in the Linac. A minimum concrete wall of 0.5 m is assumed before soil is encountered beyond the side walls. Using the methodology established in the BNL SBMS Accelerator Safety Subject Area, the leachable concentration created in the soil has also been calculated. Based upon published reports, it is assumed that nearly 100 percent of tritium and 7.5 percent of the Na-22 can be leached from activated soils by rainwater infiltration. A water concentration factor of 1.1 is taken due to the annual rainfall of 55 cm. (Note: the soil beneath the concrete floor is not exposed to rainfall, so the potential leaching of radioactive isotopes from the soil to the water table at these locations will be minimal.)

Table 12.37.1 Predicted Activity in NSLS-II Soil at Beam Loss Locations

Soil Location	Electron Loss (nC/s)	Electron Loss(e/s)	Neutron Flux (n/cm^2.s)	Neutron Flux (Av) (n/cm^2.s)	^{3}H (pCi/L)	^{3}H Leachable (pCi/L)	^{22}Na (pCi/L)	^{22}Na Leachable (pCi/L)
Linac Dump 230MeV	22	1.37E11	4.4E2	92	0.54	0.60	5.2	0.39
Linac Slit 230MeV	11	6.86E10	2.2E2	46	0.41	0.46	3.9	0.29
Booster Dump 3 GeV	15	9.36E10	3.9E3	815	4.83	5.31	46.7	3.50

Assumptions:
200 times per year the Linac and Booster are used to fill the Storage Ring from scratch. Each fill cycle lasts 3 minutes. Total operating time is 200 x 3 min = 10 hours.
500 hours per year of Linac and Booster study.
5,000 hours of top-off operation, 3 pulses per minute operation, effective hours of operation = 5,000 x 180/3,600 = 250 hours.
500 hours per year of operation for each beam dump and 760 hours of operation for the Linac slit.

These calculated values are well within the BNL-defined administrative Action Levels of 1,000 pCi/L for tritium and 100 pCi/L for sodium-22 (defined in the BNL Accelerator Safety Subject Area). Therefore, no additional engineered safeguards are required. Electron losses during the late 2011 commissioning period are not expected to be as high as estimated for a full operating year and, therefore, these calculations represent an upper value for soil activation during this period.

As a monitoring tool for soil activation levels near the Linac, ~1 liter soil samples will be positioned within the Linac enclosure near predicted high loss points. These soil samples will be tested periodically to estimate the buildup of sodium-22 and tritium in the surrounding soils. In addition, analysis of groundwater samples from wells installed downgradient of the Linac beam stop/Booster area will be used to demonstrate that the operational and engineered controls at the NSLS-II are effective in protecting groundwater quality.

Cooling Water Activation: Activation of water used to cool the magnets and other accelerator components is estimated by a similar method. The primary reactions leading to the activation of cooling water are the bremsstrahlung interactions with ^{16}O in water. In the Linac, the highest beam loss point in a component with water cooling is the first bending magnet downstream of the

Linac. Of the nuclides of concern for groundwater protection, tritium will attain saturation only after decades of operation. After 5,000 hours of continuous operation, the concentration of tritium in the Storage Ring Septum area will be only 3 percent of the saturation value, with an estimated concentration of only 5 pCi/L. Other smaller loss points, including the Linac bending magnet, will provide additional small increments to the total inventory of tritium within the system. The cooling water system will be tested periodically for tritium once operations have begun.

Step 2: Identify the Decision

Are the operational and engineered controls employed at NSLS-II effective at preventing the release of tritium and sodium-22 to groundwater at concentrations that exceed drinking water standards at the point of assessment (i.e., the closest wells downgradient of the identified potential soil activation areas at the Linac)?

Step 3: Identify Inputs to the Decision

The inputs necessary for the decision include:

- Current and planned operations at the NSLS-II
- Modeled estimates on the amount of soil activation at Linac beam loss areas.
- Direction and velocity of groundwater flow
- Tritium concentrations in groundwater.
- Locations of background and downgradient wells relative to each identified soil activation area
- Regulatory requirements: DOE Order 458.1, Radiation Protection of the Public and the Environment
- Action levels (as described in the BNL Groundwater Protection Contingency Plan)
- Analytical methods and detection limits:
  - Tritium: Environmental Protection Agency (EPA) Method 906
  - Gamma spectroscopy (optional analysis if tritium is detected): EPA Method 901

During 2011, the focus of the NSLS-II groundwater surveillance program was the collection of pre-operation samples to establish baseline values for tritium and Na-22. Following the initial beam line testing operations during 2012, only tritium is being tested for because it is more mobile than sodium-22 and has a longer half-life (12.6 years compared to 2.6 years). Therefore, tritium's presence in groundwater would be a better early indicator of a failure in an engineered control.

Step 4: Define the Study Boundaries

The decision for this monitoring program applies to the area in the immediate vicinity of the NSLS-II Linac and Booster. The period for which decisions are made is 365 days. These timeframes are based on the following:

- The time required for tritium to migrate through the vadose zone and reach the groundwater table (by means of rainwater leachate) is likely to be between 30 to 60 days.

- Once tritium migrates into the groundwater, the typical travel time to the nearest downgradient well (i.e., point of assessment, ranging from 150 to 350 feet from the potential sources) is approximately 300 to 700 days.

- Decision periods of 365 days are acceptable for areas where monitoring has demonstrated that current engineered and operational controls are effective.

Step 5: Develop the Decision Rules

Are the engineered and operational controls effective at preventing or reducing the leaching of radionuclides from activated soils to the groundwater?

The sample results will be evaluated in context with historical groundwater data, including data from upgradient wells, operations of the Linac/Booster area, and measured and estimated radioactivity buildup in soil shielding. As part of the evaluation, circumstances that would require the implementation of the BNL Groundwater Protection Contingency Plan would be ascertained for each sampled well or set of wells (see EM-SOP-309 for details on plan implementation).

Step 6: Specify Acceptable Error Tolerances

Table 12.37.2: Decisions, Potential Errors, and Potential Consequences

Decision	Inputs	Potential Error Based on Data	Potential Consequences
Are controls effective at eliminating or controlling the leaching of tritium and soium-22 from activated soil shielding to the groundwater?	See Step 3 for inputs.	Data indicate controls are effective when they are not.	A discrete slug of contamination potentially up to 100 feet long and 20 feet wide could exist and not be detected.*
		Data indicate controls are not effective when they are, due to sampling or analytical error, or wells not properly located.	Need to re-sample well (as per Groundwater Contingency Plan). Potential erosion of stakeholder confidence.

*Assumes results from one sample period were inaccurate.

There are no potential receptors (i.e., potable water supply wells) to potentially contaminated groundwater in the NSLS-II Linac/Booster area and the distance to the BNL property boundary is over 1 mile. Due to these factors, it is very unlikely that a decision error will result in adverse consequences to human health. Consequences associated with decision errors for this program relate primarily to possible enforcement actions for environmental degradation, erosion of stakeholder trust, and loss of BNL credibility. Ultimately, a decision error could result in degradation of groundwater quality to such an extent as to require remedial action under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or other regulations.

Step 7: Optimize the Design

Number and Locations of Wells

The wells located at the NSLS-II are biased toward detecting contamination originating from activated soils associated with the facility’s Linac/Booster area (Figure 12.37.1). The wells are located as close as possible to these potential source areas to enable early detection of contaminant releases. The monitoring network installed in 2011 is considered adequate for meeting the monitoring requirements under DOE Order 458.1 and acceptable risk levels of stakeholders.

Parameters and Frequency

Groundwater quality in the NSLS-II Linac/Booster area is evaluated using four downgradient monitoring wells. Two upgradient wells from the Major Petroleum Facility monitoring program are used to evaluate background tritium levels. Because tritium is easily leached from activated soils, is highly mobile in groundwater, and has a longer half-life (12.3 years compared to 2.6 for sodium-22), the primary focus of the operations phase of the groundwater monitoring program is the detection of tritium. Groundwater samples are collected on an annual (365 day) basis, or more frequently, as required. Should tritium be detected in any of the wells, samples will also be tested for the presence of Na-22.

Table 12.37.3 Comparison of 2015 and 2016 Sampling Programs

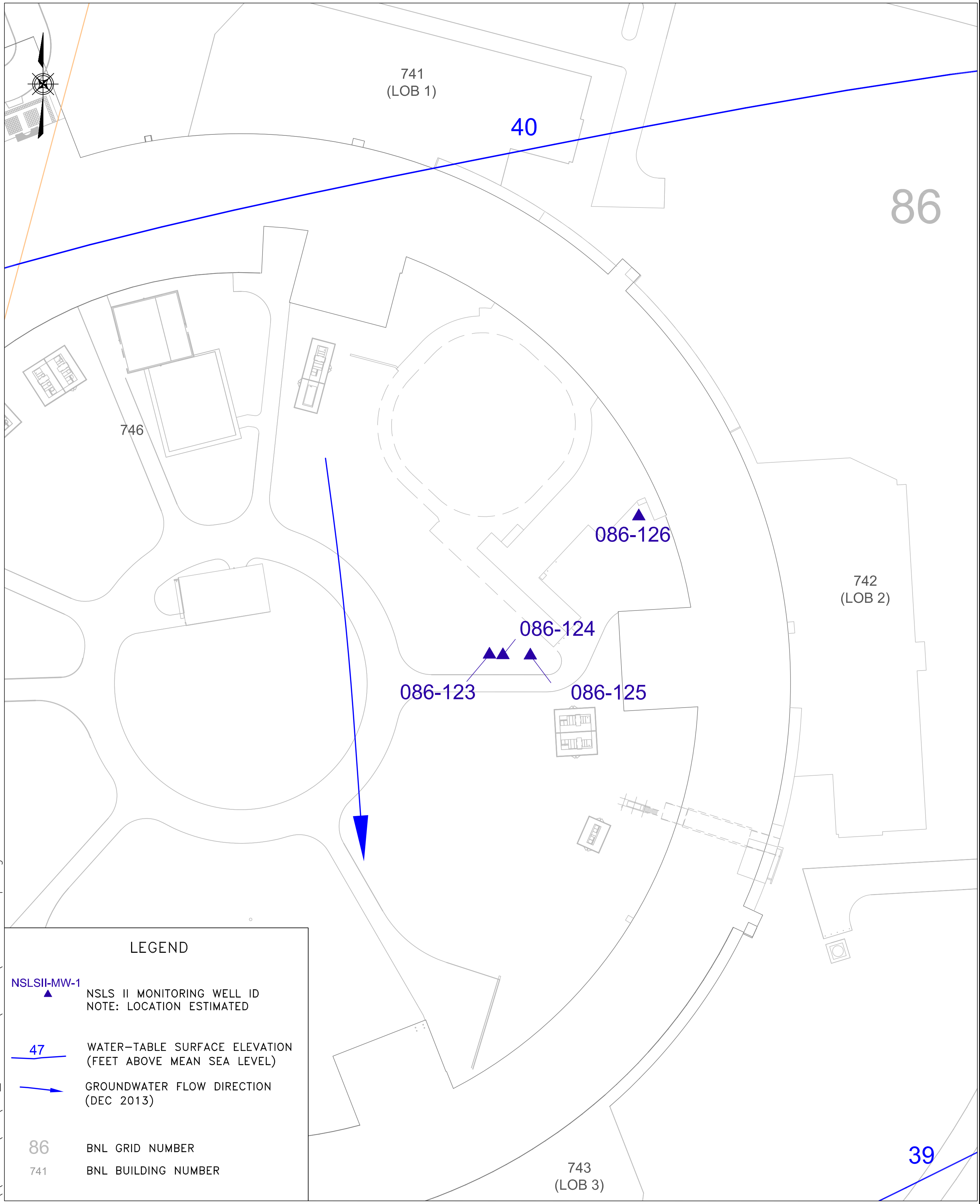
Well ID	CY 2015 Sampling Frequency	CY 2016 Sampling Frequency	Affected Parameters
076-18 (a)	Annual	Annual	None
076-19 (a)	Annual	Annual	None
086-123 (NSLSII-01)	Annual	Annual	None
086-124 (NSLSII-02)	Annual	Annual	None
086-125 (NSLSII-03)	Annual	Annual	None
086-125 (NSLSII-04)	Annual	Annual	None

(a) Well is part of the MPF monitoring program, and is sampled to determine background tritium concentrations for the NSLS-II monitoring program

DATA REVIEW REQUIREMENTS

Based upon the amount of monitoring data available for the NSLS-II area, full validation of the analytical results is not necessary. All groundwater monitoring results will undergo data verification, and the results will be reviewed by the project manager. If anomalous results are reported, a further review of the data will be conducted.

See Appendix B for the monitoring program for this DQO.



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BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

FACILITY MONITORING PROGRAM
NATIONAL SYNCHROTRON LIGHT SOURCE II
MONITORING WELL LOCATIONS

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
JEB	–	06/12/14	–
CHKD: JEB	APPD: DEP	REV.: –	NOTES: –

FIGURE NO.: 12.37.1