Environmental Water Sampling Program

Special Analyses

Byron Station

Prepared by Sharon D. Brown
Health Physicist

Reviewed by Kit I Weaver 4/16/84
Station Health Physicist

Approved by [illegible] 4/16/84
Radiation-Chemistry Supervisor

In June of 1983, an NRC auditor observed that Byron Station had a higher quantity of gross beta detected at the discharge point (BY-11) as compared to the intake point (BY-10) of the plant cooling water from the Rock River. The average gross beta concentrations for the sampling period of June 28 through December 27, 1982 was 3.9 pCi/l at the intake point and 21.7 pCi/l at the discharge point.

Byron Station began an environmental water sampling program to determine the reason for this observation. Several sample points were selected. Samples were collected and analyzed for gross alpha and beta concentrations and gamma/isotopic concentrations. The data from this study, lasting four months, was sporadic and inconclusive due to differing laboratory techniques, short count times, and system testing that delayed sampling.

A second sampling program was initiated in December of 1983. This program concentrated on the actual flowpath of the water flowing out the discharge. Except during the hot functional testing of Byron Unit 1, discharge to the Rock River consisted solely of sewage treatment discharge. The origin of this water is the onsite deep well, not the intake point BY-10. (See Attachment A) The average gross beta concentration for the sampling period of July 2 through December 6, 1982 was 6.3 pCi/l for the onsite deep well. Figure 3.3-1 of the Environmental Report, the Water Usage Flow Diagram (See Attachment B), shows the flowpath as it will occur in the operating license stage. During 1982 and 1983, there was no steam generator blowdown, radwaste, or natural draft cooling tower blowdown except during the hot functional testing, as previously mentioned.

To eliminate error in the second sampling program, the same technician collected and analyzed the samples, the sample volume for gross alpha and beta was increased from 10 to 50 ml, and isotopic analysis duration was set at 90 minutes.

The results from this study showed only naturally occuring radionuclides (including K-40) were present in the water samples. Isolating the reason for the increase along the flowpath was not possible but this study did show that no contamination of the water was occuring. (See Attachments C and D)

For the third study, we concentrated on accurate gross beta counts to see if there was a significant increase in one particular section of the water flowpath. Counting times were increased from 10 minutes to 60 minutes to give a ±25% counting error for the gross alpha and beta analysis. Followup isotopic analyses were conducted for 24 hours.

The results from this study showed a definite increase of gross beta at the sewage treatment plant. (See Attachment E) The isotopic analyses could not isolate the isotope due to background fluctuation and such low levels of activities. (See Attachment F)

For our fourth and final study, we sent samples to Teledyne Isotopes Midwest Laboratories for in-depth analysis. Teledyne's analyses included overnight gamma spectroscopy, gross beta, and atomic absorption. The laboratory had to use atomic absorption since activity levels were too low to be detected accurately with gamma spectroscopy.

Teledyne's results showed a nearly perfect correlation between K-40 and elevated gross beta concentrations. (See Attachment G) These data are reported in 1983 Final Report for Byron Nuclear Power Station Environmental Radiological Monitoring Program. The study showed K-40 accounting for approximately 70-90% of the beta activity at the sewage treatment plant and the discharge point. When the discharge had a high gross beta concentration, the K-40 concentration was also elevated.

In summary, Byron Station concludes that:

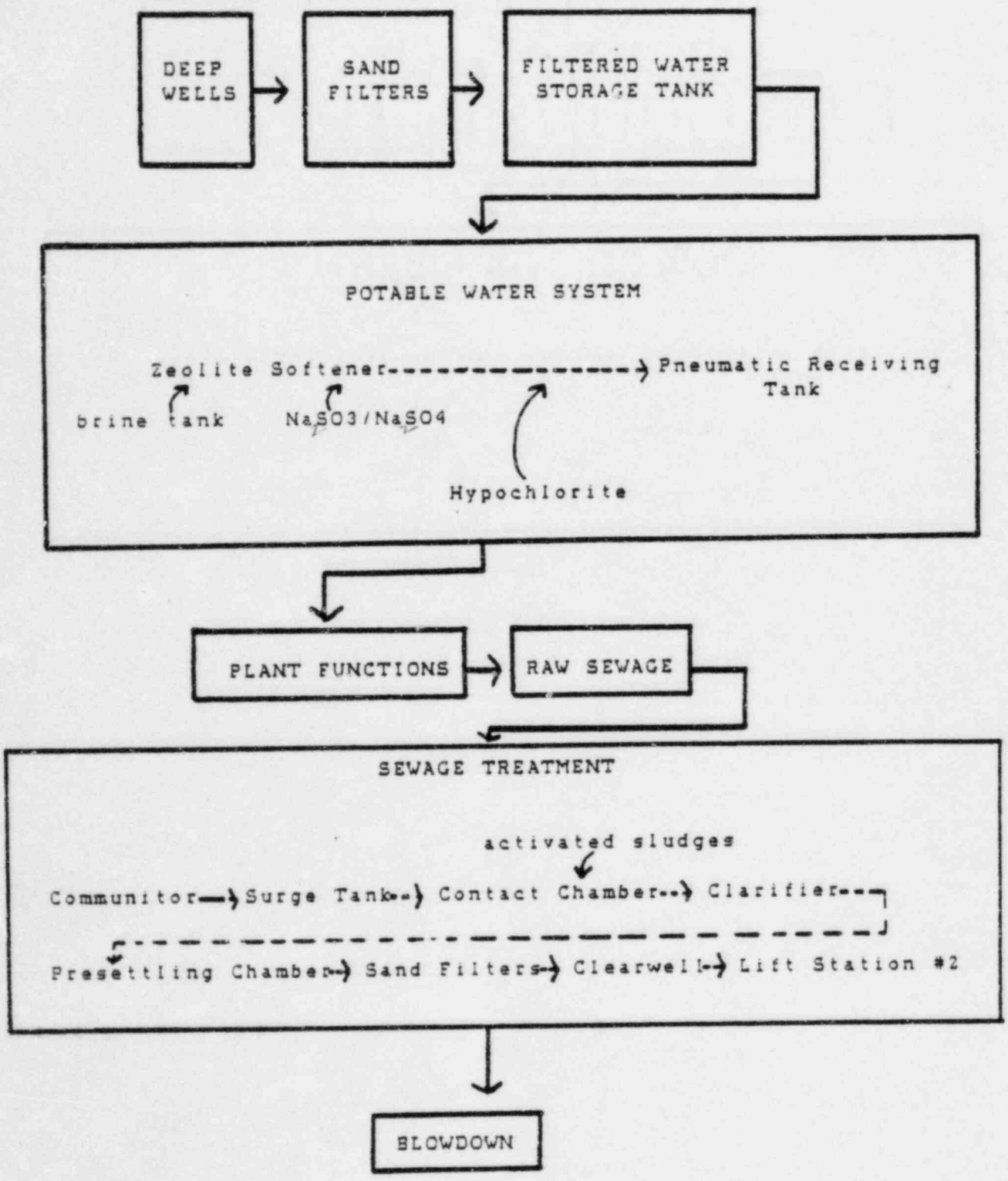
1. No contamination of the plant discharge water is occurring. Only naturally occurring isotopes were revealed.

2. Elevated gross beta concentrations were noticed in the sewage treatment plant.

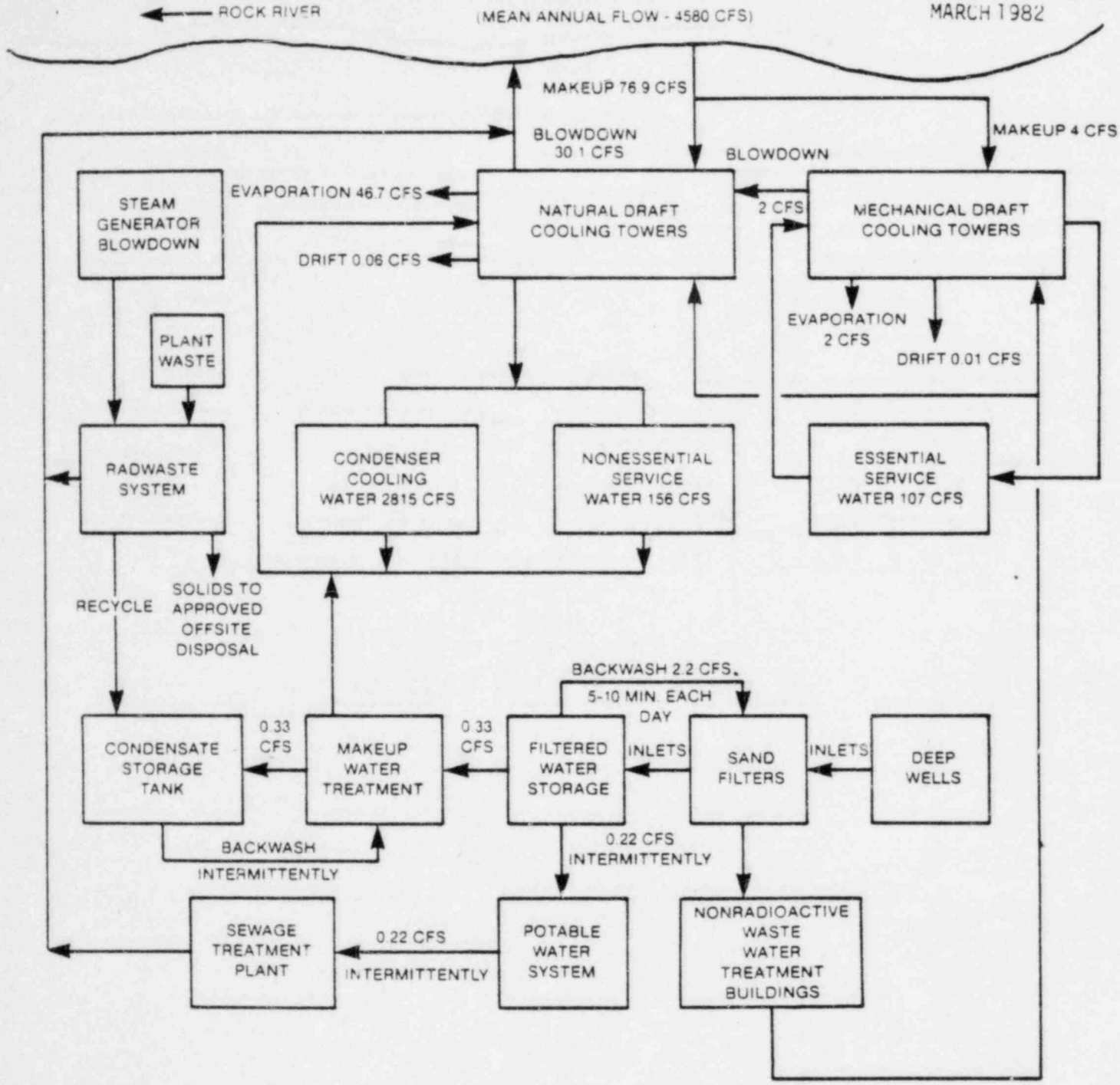
3. When gross beta concentrations at the discharge point were elevated, an elevated concentration of K-40 was noticed.

In conclusion, the reason for the increase in gross beta concentrations at the discharge point BY-11 is due to the addition of potassium-40 through human excretion to the water flowpath originating from the onsite deep well.

Attachment A



AMENDMENT NO. 3
MARCH 1982



BYRON NUCLEAR GENERATING STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT - OPERATING LICENSE STAGE

FIGURE 3.3-1

WATER USAGE FLOW DIAGRAM

Attachment C

Isotopic Data Summary - 2nd Study

Energy (keV)	Nuclide	Deep Well	Filtered Water Storage Tank	Potable Water	Lift Station 2	Discharge Pipe	Discharge Bay
238	Pb-212 Thorium Series				*	*	*
352	Pb-214 Uranium Series	*	*	*			
511	Tl-208 Thorium Series	*	*	*	*	*	*
609	Bi-214 Uranium Series	*	*	*			*
1332	Co-60		*			*	*
1460	K-40	*	*	*	*	*	*
1764	Bi-214 Uranium Series		*				

NOTE: Due to variable background, these data are to be used for qualitative analyses only. Samples were collected once a day for 5 days.

* - This nuclide detected more than one time at the specified sample point.

Attachment D

Gross Alpha/Beta Counts - 2nd Study

	Deep Well	Filtered Water Storage Tank	Potable Water	Lift Station 2	Discharge Pipe	Discharge Bay
1-13 alpha	5.05	6.06	4.04	0	0	1.01
1-13 beta	4.65	7.75	2.33	3.49	6.29	9.30
1-16 alpha	2.02	6.06	7.07	0	0	0
1-16 beta	4.65	1.93	4.65	1.93	2.32	1.93
1-17 alpha	4.04	12.12	4.04	0	0	0
1-17 beta	3.87	7.36	8.91	5.42	5.81	7.36
1-18 alpha	4.04	8.08	7.07	2.02	0	0
1-18 beta	2.32	6.20	4.26	3.10	5.81	5.81
1-19 alpha	6.06	6.06	7.07	1.01	1.01	0
1-19 beta	3.87	6.58	3.48	7.75	6.58	4.26

NOTE: The units for the above are dpm/50ml.

Multiply the above numbers by 9.0 to convert to pCi/l.

Attachment E

Gross Alpha/Beta Counts - 3rd Study

	Deep Well	Filtered Water Storage Tank	Potable Water	Lift Station 2	Discharge Pipe	Discharge Bay
1-30 alpha	4.04	1.21	1.82	0.81	0	0.71
1-30 beta	3.80	2.71	1.94	4.85	0	0.89
1-31 alpha	5.96	2.53	0.51	0	0.20	0.51
1-31 beta	3.06	0.62	0	0	0	0
2-01 alpha	0	0	0.16	0.84	3.53	0
2-01 beta	0.50	4.90	0.62	2.18	1.15	0
2-02 alpha	1.82	2.53	1.31	1.01	0.50	0.61
2-02 beta	2.02	0.19	0.78	4.84	0.58	0.08
2-03 alpha	0	3.33	2.83	0	0.20	1.31
2-03 beta	0	2.64	2.02	5.81	0	0.27

NOTE: The above units are in dpm/50ml. To convert to pCi/l, multiply the above numbers by 9.0.

Attachment F

Isotopic Data Summary - 3rd Study

			Water Sample 24-hour Counts					
Energy (keV)	Isotope	Background Counts	Deep Well		Lift Station 2		Discharge Pipe	
			Gross	Net	Gross	Net	Gross	Net
77		0	281.0	281.0	0	0	0	0
93		212.1	303.0	90.9	0	0	357.9	145.8
186		237.1	0	0	0	0	0	0
239	Pb-212 Thorium Series	449.1	434.9	0	418.4	0	376.8	0
295	Pb-214 Uranium Series	0	216.2	216.2	0	0	0	0
351	Pb-214 Uranium Series	0	246.7	246.7	0	0	0	0
511	Tl-208 Thorium Series	554.0	575.8	21.8	585.9	31.9	505.4	0
583	Tl-208 Thorium Series	113.7	119.0	5.3	81.0	0	118.3	4.5
609	Bi-214 Uranium Series	0	250.2	250.2	0	0	0	0
1172	Co-60	37.0	183.4	115.4	90.7	52.7	312.2	275.2
1332	Co-60	94.5	231.9	137.4	102.4	7.9	257.7	163.2
1460	K-40	375.4	350.5	0	357.1	0	377.5	2.1
1593		0	29.1	29.1	0	0	0	0
1764	Bi-214 Uranium Series	70.1	90.6	20.5	53.6	0	53.9	0

Attachment G

Table 1. Analyses for K-40 (by atomic absorption), gross beta, and gamma-emitting isotopes in special samples collected at Byron Nuclear Power Station.
Units: pCi/l

Lab Code Date Collected Location	BYSW-834 3-13-84 Discharge	BYSW-835 3-14-84 Discharge	BYSW-836 3-15-84 Discharge	BYSW-837 3-13-84 Sewage Treatment	BYSW-838 3-14-84 Sewage Treatment	BYSW-839 3-15-84 Sewage Treatment	BYWW-840 (Dup of 839) Sewage Treatment	BYWW-841 3-13-84 Deep Well	BYWW-842 3-14-84 Deep Well	BYWW-843 3-15-84 Deep Well
K-40 (AA)	25.9±0.2	4.2±0.1	4.2±0.1	30.0±0.2	31.1±0.2	31.2±0.2	31.5±0.2	3.4±0.1	3.5±0.1	3.6±0.1
Gross Beta	30.5±2.2	6.1±1.2	5.6±1.2	33.2±2.3	33.5±2.3	34.4±2.4	32.5±2.3	9.6±1.3	9.7±1.3	10.4±1.4
Be-7	<27.8	<26.4	<29.4	<30.5	<40.3	<33.5	<45.6	<21.7	<36.5	<17.0
Mn-54	<3.3	<2.0	<3.2	<3.4	<3.9	<3.3	<4.9	<2.5	<3.7	<2.6
Co-58	<3.4	<3.1	<3.5	<3.6	<4.2	<3.4	<4.4	<2.5	<3.8	<2.8
Co-60	<3.6	<2.3	<3.2	<3.6	<4.1	<3.6	<4.7	<2.6	<3.7	<1.9
Fe-59	<6.6	<4.0	<6.8	<7.6	<6.6	<6.0	<8.8	<5.0	<7.4	<4.0
Zn-65	<6.6	<3.4	<6.9	<7.6	<8.5	<7.6	<8.9	<4.8	<8.5	<4.2
Zr-95	<6.2	<4.2	<6.5	<6.7	<7.3	<5.8	<8.6	<4.5	<6.6	<3.1
Nb-95	5	<2.8	<3.6	<3.9	<4.2	<3.4	<4.9	<3.1	<4.0	<2.8
Ru-103	.4	<3.0	<3.6	<3.6	<4.2	<3.5	<4.8	<2.2	<3.8	<2.2
Ru-106	<31.5	<17.0	<30.4	<31.6	<36.7	<31.1	<45.3	<17.0	<32.9	<17.0
I-131	<4.5	<3.0	<4.5	<5.1	<5.8	<4.2	<5.8	<5.0	<5.7	<3.0
Cs-134	<3.4	<2.5	<3.6	<3.7	<4.0	<3.3	<4.7	<2.5	<3.7	<1.7
Cs-137	<3.8	<2.2	<4.0	<3.9	<4.2	<4.1	<4.8	<3.4	<3.9	<2.8
Ba-140	<14.6	<10.4	<15.0	<16.3	<16.5	<12.7	<18.5	<11.9	<15.6	<8.2
La-140	<4.2	<2.5	<4.6	<4.8	<4.1	<3.1	<4.4	<3.1	<3.7	<1.9
Ce-141	<5.9	<6.8	<6.1	<6.4	<8.5	<6.8	<9.4	<4.6	<7.8	<3.6
Ce-144	<26.5	<29.4	<26.8	<27.6	<38.8	<33.3	<44.4	<29.5	<35.9	<15.5

The error given is the probable counting error at the 95% confidence level. Less than (<) values are based on 4.66 sigma counting error for background samples.
All results are decay corrected to the time of collection.