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Y-12

OAK RIDGE Y-12 PLANT

MARTIN MARIETTA

ENGINEERING REPORT FOR THE CENTRAL MERCURY TREATMENT SYSTEM

Process Design Engineering

Central Engineering Services

March 1995

Prepared by the
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
managed by
Martin Marietta Energy Systems, Inc.
for the
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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
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Oak Ridge Y-12 Plant

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Approved for Martin Marietta Energy Systems, Inc. **Date**
(Process Design Engineering)

1.0 INTRODUCTION

Mercury was used at the Oak Ridge Y-12 Plant between 1950 and 1963. The legacy of contamination resulting from use and storage of mercury has prompted a series of remedial measures. Since the mid-1980s, a series of engineered projects, maintenance activities, and general improvement in work practices has resulted in a decreasing trend of mercury concentration in East Fork Poplar Creek (EFPC). Some of the mercury in the soils surrounding past mercury-use buildings enters the building sumps which are discharged to the EFPC. The overall goal of increased environmental quality management is to reduce the mercury contamination of the EFPC to no more than 5 g/day. This project will create the Central Mercury Treatment System (CMTS) to reduce the mercury contribution to the EFPC by installing carbon adsorption units to treat the effluent from buildings 9201-4, 9201-5 and 9204-4. The use of carbon adsorption will be the long-term strategy for reduction of mercury in plant effluent.

2.0 GENERAL DATA

The Y-12 Plant, which is located on the Department of Energy (DOE) Oak Ridge Reservation, lies within the Valley and Ridge Physiographic Province. The location geology, seismology, and soil characteristics have been studied extensively. For a general overview of these geologic features, reference is made to Document Y/TS-730, "Environmental Assessment," published in March 1991. Because of the nature of the proposed project, the geologic characteristics of the area are not considered to be of significance.

The headwaters of the EFPC originate in the Y-12 Plant area. Stream flow is equalized by Lake Reality, which is located on the east side of the plant. After leaving the lake, the stream flows northwest before changing to an approximate southwest course. The creek flows through the city of Oak Ridge before entering pasture lands and hardwood forests. The stream first joins Bear Creek, and then Poplar Creek, before discharging into the Clinch River near the K-25 Site.

3.0 COLLECTION SYSTEM

A typical building sump system is shown on Figure 1. Under the revised plan, some waste water will be trucked and some will be piped from other buildings as shown on Figure 2. The buildings plan for collection is as follows:

Building 9201-5 — A connection to the existing headers in the basement will be provided by a separate project to collect the groundwater. The groundwater will be transferred to an existing in-ground tank on the South side of Building 9201-4.

Building 9201-4 — The CMTS project will provide two new pumps at the existing in-ground tank on the South side of Building 9201-4. These pumps will be used to transfer all of the groundwater to the influent equalization tanks.

Building 9204-4 — One 600 gallon poly tank will collect waste. The poly tank will be transported to the treatment facility for emptying and then returned to the building for reconnection. A separate project will provide the tank and collection equipment.

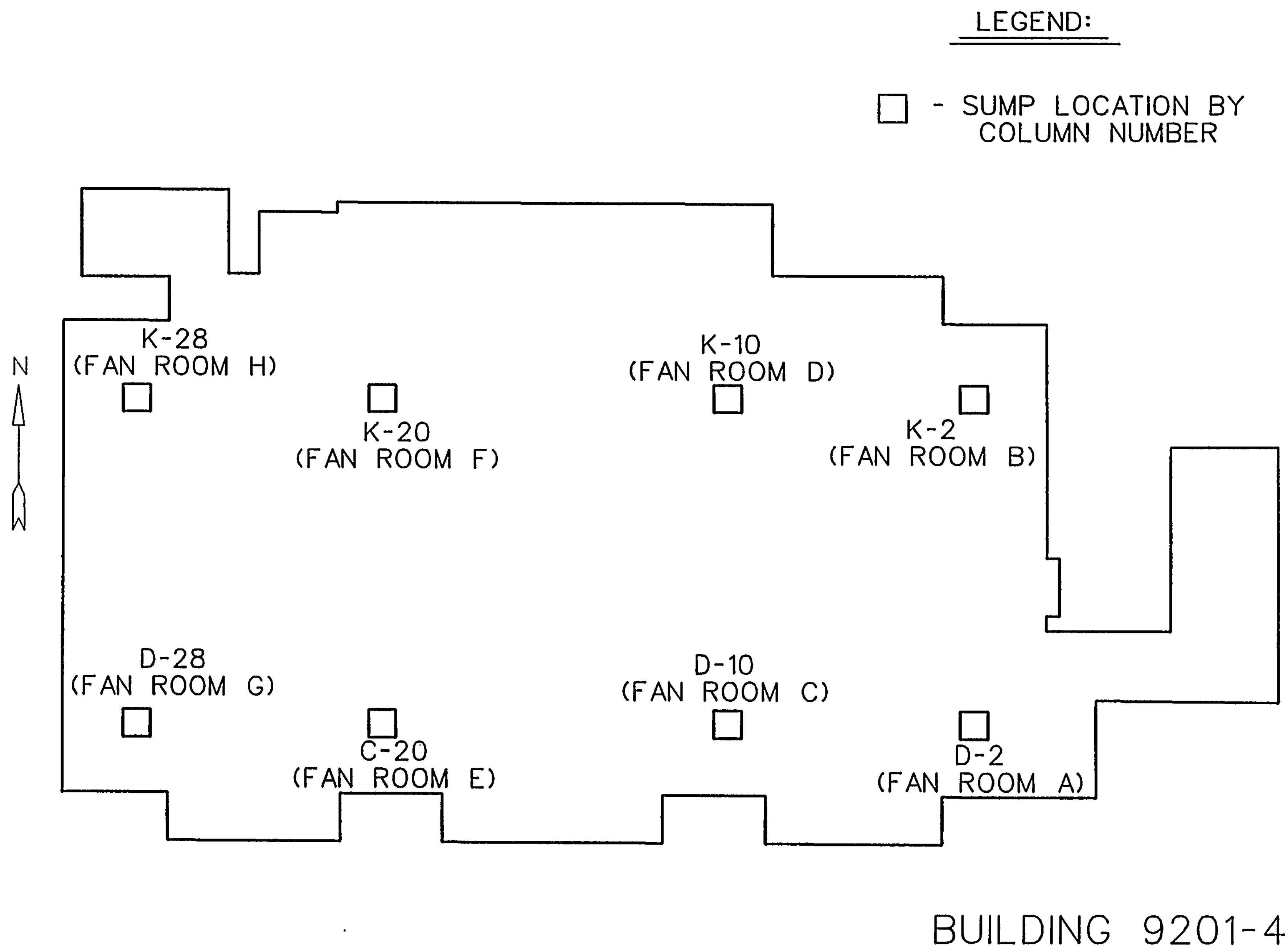

FIG. 1 : TYPICAL BUILDING SUMP LOCATIONS

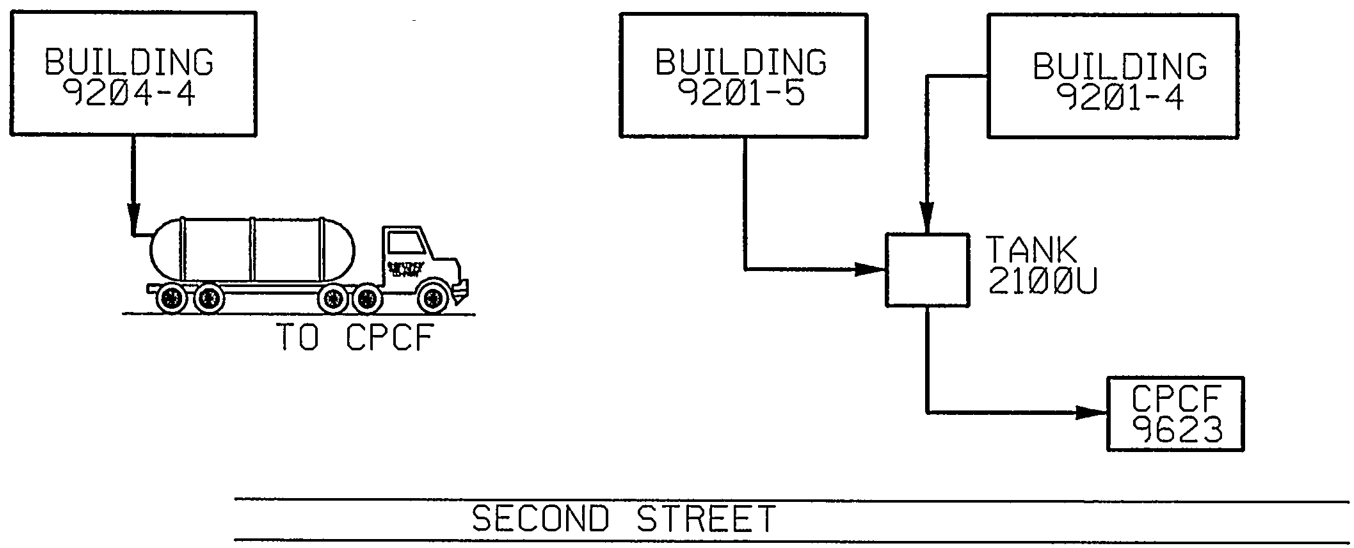

FIG. 2 : PIPE ROUTES FROM BLDGS. TO CPCF

Current data indicate average total flows of approximately 50 gpm of mercury contaminated groundwater.

4.0 WASTEWATER AND TREATMENT RESIDUE CHARACTERISTICS

Only limited mercury data is currently available for the building sumps. The most recent mass balance data collected by the Compliance Monitoring Organization are shown in Table 1. (Based on these data, this project addresses some of the largest contributors to the creek.) Additional data is shown in the Appendix.

The mercury-contaminated groundwater is not Resource Conservation and Recovery Act (RCRA) hazardous waste and is not considered to be radioactive. The residue from the treatment system will consist of spent granular activated carbon (GAC). The disposition of these materials will depend on their regulatory status. If they are found to be characteristically hazardous, they will be stored as other hazardous wastes generated at the Y-12 Plant. If they are hazardous and can be shown to have "no-radioactivity added", off-site disposal will be considered. Samples of each shipment of virgin carbon shall be obtained so a before/after comparison can be made to ascertain the degree of radioactivity added during use.

5.0 PILOT PLANT/TREATABILITY STUDIES

Pilot plant studies were conducted at the interim treatment unit and a treatability study, "Treatability Study Report for Mercury in East Fork Poplar Creek, Oak Ridge, Tennessee," prepared by Radian Corporation personnel in February 1993, provided guidance data. The study evaluated various packed media for mercury removal. Media types include Bio-Fix Beads (U.S. Bureau of Mines), Ionac ASB-2 resin (Sybron), SBG1 resin (ResinTech), SBG1P resin (ResinTech), WBMP resin (ResinTech), Ionac AFP-329 resin (Sybron), SIR-200 resin (ResinTech), standard GAC, and granular high sulfur coal. The Radian studies concluded that GAC and Ionac SR-4 resin were the most effective in removing mercury from these sump waters. The GAC was chosen for design because of the ease in incorporating it into the current use and handling of GAC at the Y-12 Plant. The existing interim carbon adsorption unit performance data have confirmed the selection of GAC as capable of achieving the treatment goals of this project.

6.0 ALTERNATIVES

The alternatives considered were:

1. Removal of the source of mercury

2. Provide mercury treatment at the Central Pollution Control Facility (CPCF) by activated carbon and truck or pipe sump water to the CPCF for treatment.

3. Provide mercury treatment at the CPCF by sulfide precipitation and truck or pipe sump water to the CPCF for treatment.

	9201-4		9201-5		9204-4	
	AVG	MAX	AVG	MAX	AVG	MAX
Mercury, ppb	56.50	440	32.12	1000	62.39	230
pH	7.8	9.3	7.5	8.2	6.7	6.8
Flow gpm	7.17	-	17.79	-	.04	-
Nitrate, ppm	34.31	132	673.65	3344	6820	7040
Total Toxic Organics, ppm	600.36	1235	187.87	1677	361.5	401
Lithium, ppm	2.70	132	.80	5.41	.88	0.89
Tc-99 pCi/L	U	U	38.47	550	9000	9500

TABLE 1. Average Flow Weighed Concentration Data and Maximum Sump Value Data for Buildings 9201-4, 9201-5 and 9204-4.

4. Provide mercury treatment and treat the sump water on-site.

Alternative 1 was not selected because the contamination is in the soils around and under major buildings which cannot be remediated in the near-term without high cost and disruption of facility activities. Alternative 2 was judged desirable because it would make use of centralized treatment facilities. Alternative 3 would require continued monitoring to adjust sulfide dosages as the mercury concentrations change and ultra-low final concentrations cannot be ensured without effluent polishing. Alternative 4 can be accomplished with standard equipment and within available space in a short amount of time, but would require multiple, duplicate treatment systems which would increase total capital and operating costs. Alternative 2 was the preferred alternative because it is easy to control and has low operating costs.

7.0 TREATMENT FACILITIES

The Central Mercury Treatment System (CMTS) process will be a treatment train located near but separate from the existing CPCF process. The flow through the CMTS will be 25 to 50 gallons per minute (gpm). Design should be for 50 gpm with flow control capability down to 25 gpm. Influent mercury concentrations are estimated to be 20 to 500 ppb. The ground water will require treatment for mercury (Hg) removal down to 0.2 ppb or better if economically and technically feasible.

The facility shall be designed for continuous operation. Influent waste holding capacity to equalize peak hydraulic flows and down time for maintenance will be required adjacent to the CPCF. The majority of the waste water to be treated will be groundwater contaminated with low levels of mercury (ppb levels). Carbon adsorption for mercury removal prior to discharge for these waste waters shall be sufficient.

The block flow diagram (Figure 3) provides the suggested treatment scheme. The treatment scheme includes:

influent waste holding capacity to equalize flowrate and mercury concentrations,

pH monitoring and adjustment to ensure a pH in the 6 to 9 range,

bag filtration to remove suspended solids that might clog the adsorption columns,

granular activated carbon columns (in series with operational control monitoring between columns) for mercury removal,

bag filtration to remove suspended solids generated by backflushing and carbon changeout activities,

and discharge through a National Pollutant Discharge Elimination System (NPDES) monitoring station.

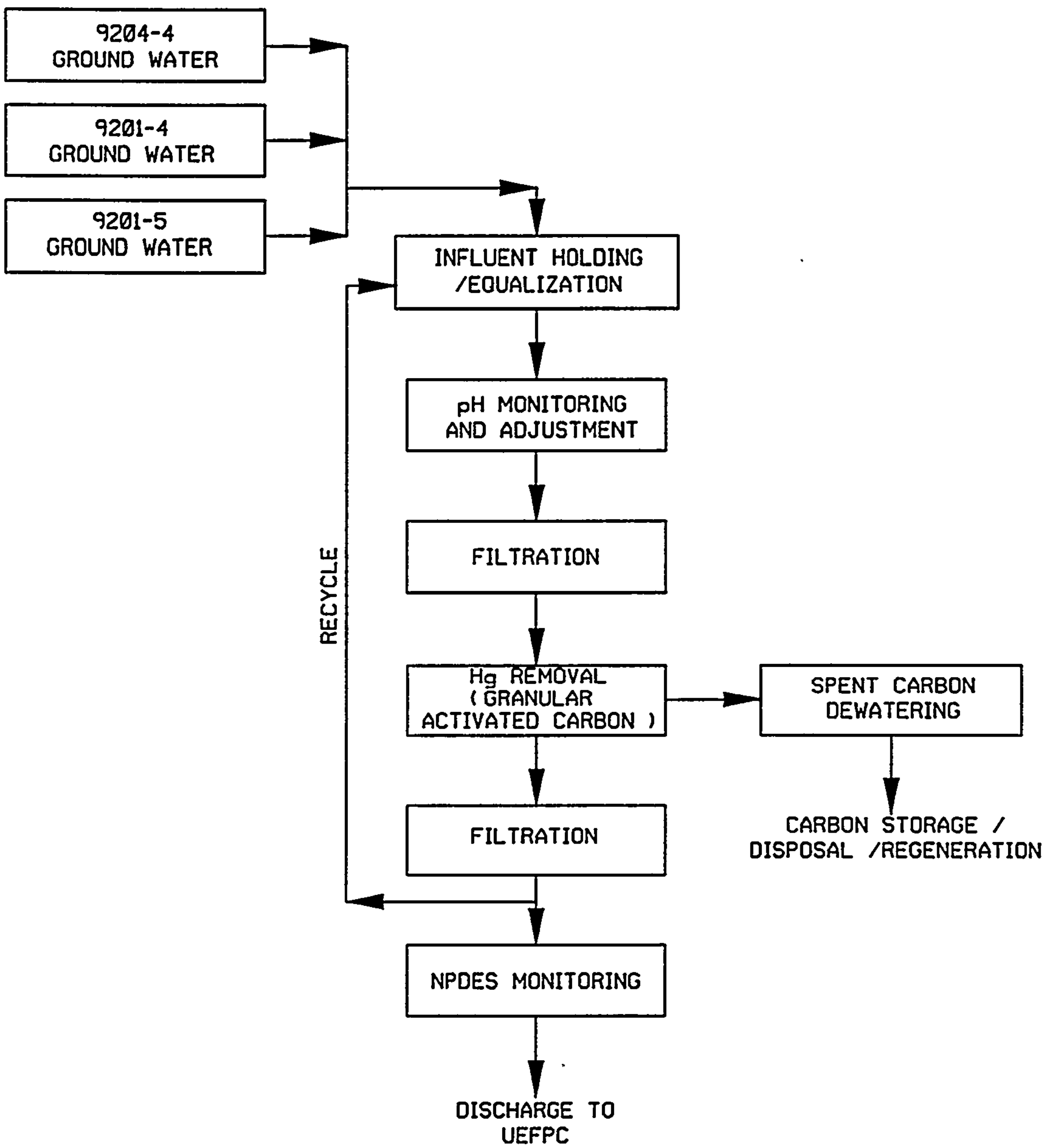

FIG. 3 : BLOCK FLOW DIAGRAM

The sludge generated by the bag filtration process shall be treated to meet the waste acceptance criteria for storage as a mixed waste at the K-25 Site. Spent carbon shall also be processed for such storage. This processing shall consist of dewatering to remove all free liquid. It is planned that the carbon can be regenerated or disposed of at the Y-12 landfill. However, for the purpose of this project, storage will be assumed and is the worst case cost.

Consideration will be given to provide flexibility for reconfiguration (modularity) and expanded flowrate. For all unit operations, packaged units shall be employed where practical.

Demolition will be required for some tanks, piping, electrical equipment, etc. to provide needed space in the CPCF area. Demolition utilizing photographs will be acceptable. Demolition and removal of any abandoned equipment shall be included in the cost estimate.

Composite sampling capability shall be provided prior to the NPDES discharge point.

8.0 COST AND SCHEDULE

The cost of this project for design and installation is estimated to be between 5 and 8 million dollars. Design will be performed by Foster Wheeler with construction by the Energy Systems on site contractor, MK Ferguson. The current schedule of construction and operation is as follows.

Begin procurement Spec.	February 1995
Issue Procure Spec. TDEC for Approval	June 1995
Begin System Installation Design	May 1995
Issue Design to TDEC Approval	August 1995
Begin Construction	November 1995
Test and Check-out	May 1996
TDEC Approval to Operate	July 1996
NPDES Date	January 1998

9.0 RECEIVING STREAM

A discharge point will be established (OF551) for the treated sump water. A NPDES monitoring station will be provided for monitoring this treated effluent prior to discharge to EFPC.

10.0 LIQUID EFFLUENT STANDARDS

No National Pollutant Discharge Elimination System (NPDES) limits currently exist for this proposed facility. The effluent criteria for design is to achieve significant reduction of mercury in support of the larger goal to reduce mercury input to the EFPC. Based on the waste characterization in Table 1, the only constituent requiring treatment is mercury. The objective of this project is to treat waters from past mercury-use buildings, (9201-4, 9201-5, and 9204-4), which are being discharged to the EFPC with the optimum technology indicated by available treatability studies. The Central Mercury Treatment System is being designed to comply with conditions of the new NPDES permit of 2 ppb mercury for the monthly average and 4 ppb mercury for the daily maximum and will discharge through OF551.

APPENDIX

TABLE 1. Average Flow Weighed Concentration Data and Maximum Sump Value Data for Building 9201-4, 9201-4 amd 9204-4. (ppm unless noted)

	9201-4		9201-5		9204-4	
	AVG	MAX	AVG	MAX	AVG	MAX
Biochemical Oxygen Demand	<5	<5	<5	<5	<5	<5
Chemical Oxygen Demand	<5	<5	<5	<5	<5	<5
Total Organic Carbon	<5	<5	<5	<5	<5	<5
Total Suspended Solids	0.75	1.93	0.99	3.0	0.75	1.0
Temperature	23.0	26.1	28.1	64.3	24.0	24.9
Total Residual Chlorine	0.027	0.06	0.046	0.16	1.22	1.24
Fluoride	0.13	1.2	0.23	0.38	0.06	0.065
Phosphorus	0.046	0.7	0.038	0.24	U	U
Sulfate	40.9	230	47.3	93	15.5	19
Aluminum	U	0.06	U	0.07	U	U
Barium	0.098	0.14	0.33	1.32	6.74	6.88
Boron	0.16	0.48	0.051	0.091	0.013	0.013
Cobalt	U	U	U	U	U	U
Magnesium	4.60	10.7	22.8	65.1	194	196
Titanium	U	U	U	U	U	U
Beryllium	U	U	U	0.003	U	U
Cadmium	U	U	U	U	U	U
Chromium	U	U	U	U	U	U
Copper	0.030	0.13	0.071	0.22	U	U
Manganese	0.009	0.032	0.25	2.28	6.53	6.58
Lead	U	U	U	U	U	U
Nickel	U	0.016	U	0.013	0.186	0.19
Selenium	U	U	U	U	U	U

Silver	U	U	U	U	U	U
Thallium	U	U	U	U	U	U
Zinc	0.003	0.07	0.011	0.06	0.175	0.20
Calcium	47.6	79.1	203	679	1635	1690
Cerium	U	U	U	U	U	U
Gallium	U	U	U	U	U	U
Iron	0.053	0.69	0.13	0.65	0.31	0.32
Potassium	1.63	9.9	3.83	5.8	10.1	10.1
Sodium	8.58	25.2	16.8	31.8	96.5	97.2
Strontium	0.14	0.41	0.60	1.76	4.73	4.81
Uranium	0.002	0.022	0.008	0.027	0:012	0.012
Conductivity	330	780	1658	7000	9750	10,000
Alkalinity	101	260	95	170	185	190
Chloride	8.68	31	15.7	29	75.5	94
Tc-99 pCi/L	U	U	38.47	550	9000	9500
Alpha pCi/L	U	U	2.28	12	270	270
Beta pCi/L	U	U	11.93	93	5500	5500
Acetone	U	U	7.87	52	U	U
Benzene	U	U	U	U	1	2
Bromodichloromethane	U	U	U	U	U	U
Bromoform	U	U	U	U	U	U
Bromomethane	U	U	U	U	U	U
Carbon tetrachloride	0.035	1	U	U	U	U
Chlorobenzene	U	U	U	U	U	U
Chloroethane	U	U	U	U	U	U
2-Chloroethylvinyl ether	U	U	U	U	U	U
Chloroform	0.352	2	0.697	2	3.5	4
Chlomomethane	U	U	U	U	U	U
Dibromochloromethane	U	U	U	U	U	U
1,1-Dichloroethane	1.175	7	0.893	11	0.5	1

1,2-Dichloroethane	U	U	U	U	0.5	1
1,1-Dichloroethene	3.096	11	1.107	15	7.5	9
cis-1,2-Dichloroethene	38.862	270	2.289	13	20	23
trans-1,2-Dichloroethene	0.070	1	U	U	U	U
1,2-Dichloropropane	U	U	U	U	U	U
cis-1,3-Dichloropropene	U	U	U	U	U	U
trans-1,3-Dichloropropene	U	U	U	U	U	U
3,7-Dimethyl-1,7-octanediol	U	U	0.221	U	U	U
Ethylbenzene	U	U	U	U	U	U
Methylene chloride	U	U	0.028	1	8.5	10
2,2-Oxybis-dinitraethanol	U	U	U	U	4	8
1,1,2,2-Tetrachloroethane	U	U	U	U	U	U
Tetrachloroethene	507.535	1100	164.359	1400	305	340
Toluene	U	U	U	U	U	U
1,1,1-Trichloroethane	1.301	3	0.105	3	U	U
1,1,2-Trichloroethane	U	U	U	U	U	U
Trichloroethene	30.718	160	1.392	9	11	13
Trichlorofluoromethane	U	U	U	U	U	U
Trichlorotrifluoroethane	17.219	72	17.404	260	U	U
Vinyl chloride	U	U	U	U	U	U

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