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The Chemical Composition of Sewage of the Iowa State College Sewage Plant

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Class I. Waters of Great Organic Purity. All waters in which the oxygen absorbed does not exceed .5 parts per million.

Class II. Waters of Medium Purity. Waters in which the oxygen absorbed ranges from .5 to 1.5 parts per million.

Class III. Waters of Doubtful Purity. Waters in which the oxygen absorbed ranges from 1.5 to 2.2 parts per million.

Class IV. Impure Waters. Waters in which the oxygen absorbed exceeds 2.2 parts per million.

The Michigan standard is that water should not require over 2.2 parts of oxygen per million.

It is of interest to note that some of the deep well waters come within the first class of waters according to Tidy's classification and the larger number within the Michigan standard. The application of any standard to the sanitary analysis of the deep well waters is unsatisfactory and misleading in many ways. The most important results, that of albuminoid ammonia and nitrogen as nitrites and nitrates show conclusively that the waters are not contaminated in any manner. The oxygen absorption is valuable in many respects, but the other results vary to such a degree that no standard can be selected which could be applied to the deep well waters as can be done for the waters from shallow wells.

THE CHEMICAL COMPOSITION OF SEWAGE OF THE IOWA STATE COLLEGE SEWAGE PLANT.

BY J. B. WEEMS, J. C. BROWN AND E. C. MYERS.

The sewage plant of the college was constructed in 1898 from the designs and under the supervision of Prof. A. Marston, the college engineer. The plans and a short description of the work of the plant have been recently published* and only the chemical investigations will be considered in this paper.

*The Iowa State College Sewage Disposal Plant and Investigations. Marston, Weems and Pammel. Proceedings Iowa Engineering Society, 1900.

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The chemical work began in 1898 and continued from the seventh to twenty-sixth of October of that year. Commencing in 1899 samples were taken from January 10 to October 1, 1901. During this period samples of the manhole or raw sewage, tank and effluent were taken weekly and analyzed as soon as possible on reaching the laboratory. After October 1, 1901, samples were taken each month only.

DATE.	AMMONIA.			SOLIDS.			NITROGEN AS		OXYGEN CONSUMED.		ORIGIN.
	Free.	Albuminoid.	Chlorine.	On evaporation.	At 180°.	On ignition.	Nitrites.	Nitrates.	Fifteen min.	Four hours.	
1898											
Oct. 7	25.1	4.3	.....	1941	1857	......	0	0	.....	....	Manhole.
Oct. 7	26.4	7.5	....	1804	1696	.....	......	T	....	......	Tank.
Oct. 7	2.9	.7	......	1692	1629		....	10.	....	....	Effluent.
Oct. 13	43.	30.2	110.	3302	3000	2055	0	T	......	......	Manhole.
Oct. 13	16.0	3.95	80.	2616	2330	2278	0	T	....	....	Tank.
Oct. 13	.13	.32	80.5	2407	2150	2036	.3	10.	....	....	Effluent.
Oct. 21	26.8	5.95	,99.	2438	2310	1994	.1	.15	....	....	Manhole.
Oct. 21	26.05	10.45	77.	1086	928	822	T	.15	....	....	Tank.
Oct. 21	.1	.24	92.	2596	2462	2384	.5	.4	....	....	Effluent.
Oct. 26	49.3	33.5	99.	3402	3042	2440	0	T	....	....	Manhole.
Oct. 26	27.8	7.35	77.	2660	2476	2296	0	T	....	.....	Tank.
Oct. 26	.46	1.69	61.	2418	2244	2174	.6	.75	......	....	Effluent.
1899.											
May 10	36.7	22.8	88	1182	1147	1040	0	T	81.6	129.6	Manhole.
May 10	12.3	14.6	107	1628	1510	1409	0	T	78.4	177.6	Tank.
May 10	.20	22	112	1709	1675	1554	.16	10	6.4	44.8	Effluent.
May 17	31.7	20.0	80	1232	1179	1001	.1	.4	16.	99.2	Manhole.
May 17	10.7	7.4	113	1590	1522	1215	0	T	48.	153.6	Tank.
May 17	.24	.7	96	1670	1658	1528	.3	6.0	[illegible].8	24.0	Effluent.
May 24	46.6	15.7	83	1223	983	789	.6	1.6	64.	252.8	Manhole.
May 24	13.1	12.2	119	1612	1526	1217	.4	T	142.4	344.0	Tank.
May 24	.52	.36	168	1361	1351	1162	.16	8.0	9.6	100.8	Effluent.
May 31	27.4	6.7	62	1384	1330	1141	0	0	88.	129.6	Manhole.
May 31	14.3	14.7	125	1927	1857	1425	.16	0	152.0	425.6	Tank.
May 31	2.9	0.25	111	1597	1461	1272	T	4.0	3.2	24.0	Effluent.
June 7	56.6	42.7	91	1676	1673	1392	0	0	85.6	22.2	Manhole.
June 7	17.3	30.1	150	2008	1941	1555	0	0	121.6	352.	Tank.
June 7	.8.16	6.9	140	1740	1735	1468	0	0	33.6	116.8	Effluent.
June 14	55.6	20.3	94	1569	1505	1305	0	0	56.	204.8	Manhole.
June 14	16.8	14.1	70	1498	1420	1265	0	0	38.4	219.2	Tank.
June 14	.72	5.36	62	1489	1460	1307	.2	6.0	17.6	43.2	Effluent.
June 21	24.8	14.5	39	1275	1212	1096	.6	4.0	8.	97.6	Manhole.
June 21	9.1	4.0	40	1230	1175	1031	.8	1.0	8.	129.6	Tank.
Effluent	not br	ought	in.								
June 28	2.02	2.58	43	1175	1120	981	.8	2.0	6.4	48.	Manhole.
June 28	5.62	16.58	112	1534	1395	1096	0	T	102.4	219.2	Tank.
June 28	.13	.43	86	1340	1322	1146	0	2.0	4.8	36.8	Effluent.
July 6	15.8	9.8	51	1095	998	914	.96	2.0	148.8	379.2	Manhole.
July 6	3.0	16.8	144	1520	1332	1007	.8	1.0	233.6	860.8	Tank.
July 6	2.2	5.0	56	1223	1178	931	.16	6.0	41.6	336.	Effluent.
July 12	16.0	78.5	63	1239	1117	899	.1	.4	123.2	304.0	Manhole.
July 12	2	38.0	168	1860	1356	962	T	0	36.8	387.2	Tank.
July 12	1.4	1.8	.....	1[illegible]01	1474	1052	.16	26.	14.4	23[illegible].2	Effluent.
July 19	10.4	29.6	412	1269	1189	970	.3	.8	22.4	94.4	Manhole.
July 19	5.8	18.2	141	1682	1383	972	0	0	177.6	371.2	Tank.
July 19	3.4	6.0	120	1433	1400	1188	.08	6.0	1.6	48.0	Effluent.
July 26	10.7	15.8	24	865	793	475	.8	2.0	54.4	14[illegible].8	Manhole.
July 26	9.2	17.3	22[illegible]	1534	1444	1030	0	0	81.6	232.0	Tank.
July 26	.32	1.54	110	1527	1448	1190	.2	10.	10.4	40.	Effluent.
Aug. 2	47.9	28.2	50	1100	995	815	.6	2.0	75.2	209.6	Manhole.
Aug. 2	12.8	13.8	32	808	780	496	0	0	43.2	150.4	Tank.

DATE.	AMMONIA.		Chlorine.	SOLIDS.			NITROGEN AS		OXYGEN CONSUMED.		ORIGIN.
	Free.	Albuminoid.		On evaporation.	At 180°.	On ignition.	Nitrites.	Nitrates.	Fifteen min.	Four hours.	
Aug. 2	.16	1.24	89	983	921	786	T	6.0	4.8	82.	Effluent.
Aug. 9	57.7	48.4	88	1454	1132	864	.8	.4	126.4	198.4	Manhole.
Aug. 9	17.9	16.9	85	971	870	705	.04	T	33.6	140.8	Tank.
Aug. 9	.84	1.74	62	1181	1022	903	.16	10.	8.0	12.8	Effluent.
Aug. 17	49.7	30 6	107	879	776	604	0	0	105.6	206.4	Manhole.
Aug. 17	18.4	19.9	49	1086	951	794	0	0	83.2	192.0	Tank.
Aug. 17	.8	.66	100	1383	1302	1221	.4	10.0	9.6	62.4	Effluent.
Aug. 25	....	86.0	76	......	1425	1345	T	0	....	......	Manhole.
Aug. 25	......	72.	122	1796	1664	1456	T	0	....	....	Tank.
Aug. 25	....	14.2	115	1618	1568	1441	.12	6.0	....	....	Effluent.
Aug. 29	27.7	31.2	92	1730	1532	1406	0	0	97.6	238.4	Manhole.
Aug. 29	32.3	21.3	23	1917	1608	1500	0	0	96.0	248.	Tank.
Aug. 29	.7	.72	78	1651	1595	1540	.24	6.0	11.2	46.4	Effluent.
Sept. 5	3.4	3.8	79	1418	1:69	1140	0	0	14.4	60.8	Manhole.
Sept. 5	14.5	13.1	89	1524	1381	122	.4	0	27.2	140.8	Tank.
Sept. 5	1.08	1.58	96	1610	1571	1350	.4	5.0	3.2	48	Effluent.
Sept. 12	48.5	37.1	175	1624	1535	1191	0	0	73.6	193.6	Manhole.
Sept. 12	28.8	38.6	85	1692	1603	1306	0	0	83.2	220.8	Tank.
Sept. 12	.48	.66	94	1515	1415	1195	.8	6.0	9.6	38.4	Effluent.
Sept. 19	56.5	22.7	67	1141	1024	950	1.0	.2	136.0	307 2	Manhole.
Sept. 19	36.5	20.9	67	1260	1165	1026	1.0	T	78.4	172.8	Tank.
Sept. 19	.9	.62	104	1730	1635	1606	.12	8.0	9.6	56.0	Effluent.
Sept. 25	65.9	29.2	251	1318	1230	830	0	0	164.8	438.4	Manhole.
Sept. 25	27.4	26.1	67	1063	812	681	0	0	124.8	304.0	Tank.
Sept. 25	.7	1.34	45	903	843	611	.6	7.0	9.6	59.2	Effluent.
Oct. 2	84.3	34.8	142	1693	1620	1221	0	T	118.4	422.4	Manhole.
Oct. 3	52.5	19.5	147	1814	1547	1295	0	0	120.0	326.4	Tank.
Oct. 3	1.02	1.68	87	1661	1580	1243	.24	9.0	6.4	48 0	Effluent.
Oct. 10	42.8	23.2	84	1768	1720	1374	0	T	107 2	251.2	Manhole.
Oct. 10	23.8	12.8	95	1719	1523	1289	0	0	94.4	228.8	Tank.
Oct. 10	.24	.12	91	1701	1697	1430	.3	10.0	11.2	64.0	Effluent.
Oct. 17	16.6	9.6	70	1421	1347	1212	.4	0	16.0	145.6	Manhole.
Oct. 17	19.2	6.0	71	1545	1532	1275	0	0	40.0	174.4	Tank.
Oct. 17	.94	.96	75	1670	1538	1385	.1	8.0	4.8	51.2	Effluent.
Oct. 24	39.8	17.2	105	1620	1443	1276	0	0	240.0	332 8	Manhole.
Oct. 24	44.	28.2	100	1651	1592	1346	0	0	259.2	531.2	Tank.
Oct. 24	.32	.84	90	1642	1510	1282	.24	T	3.2	35.2	Effluent.
Oct. 31	25.9	20.8	99	1803	1520	1316	0	0	131.2	329.6	Manhole.
Oct. 31	24.9	9.7	119	1820	1757	1437	0	0	83.2	230.4	Tank.
Oct. 31	.16	.18	87	1580	1564	1336	.1	10.	4.8	46.4	Effluent.
Nov. 7	40.3	16 2	151	1747	1677	1407	.04	0	96.0	244.8	Manhole.
Nov. 7	18.2	8.5	103	1769	1686	1489	0	0	43.2	217.6	Tank.
Nov. 7	.68	.58	76	1800	1712	1623	.7	9.0	6.4	36.8	Effluent.
Nov. 14	16.3	7.4	71	1867	1752	1419	.4	0	35.2	251.6	Manhole.
Nov. 14	28.7	9.7	139	1562	1443	1356	0	....	134.4	198.4	Tank.
Nov. 14	1.08	.58	90	1743	1702	1441	.4	5.0	4.8	12.8	Effluent.
Nov. 21	34.7	164.7	1877	9330	8356	4157	0	T	1356.8	2656.0	Manhole.
Nov. 21	12.7	9.9	77	1660	1368	1205	0	0	153.6	249.6	Tank.
Nov. 21	1.78	.58	94	1696	1685	1455	.6	4.	6.4	8.0	Effluent.
Dec. 1	94.7	54.7	213	900	760	525	0	0	187.2	2.208	Manhole.
Dec. 1	10.4	6.9	98	1416	1384	813	.7	0	40.0	103.6	Tank.
Dec. 1	.12	.38	141	1588	1545	1260	.08	2.0	32.	54.8	Effluent.
Dec. 20	8.02	19.77	30	1658	1326	1043	0	0	134.4	219.2	Manhole,
Dec. 20	9.55	3.78	69	1160	1086	782	1.5	0	25.6	100.8	Tank.
Dec. 20	2 39	1.97	96	1061	1006	812	.5	2.0	9.6	54.4	Effluent.
1900											
Jan. 10	15 4	9.0	172	1548	1476	1154	.7	0	65.6	168.0	Manhole.
Jan. 10	34.0	26.2	133	1408	1237	953	T	0	132.8	219.2	Tank.
Jan. 10	5.28	2.0	73	1194	1016	85[illegible]	.7	T	48.0	73.6	Effluent.
Jan. 19	20.7	30.4	1345	3772	3719	2908	0	T	158.4	412.8	Manhole.
Jan. 19	24.1	54.7	116	3385	2986	1870	0	0	412.8	627.2	Tank.
Jan. 19	6.14	1.84	100	1407	1361	1218	.4	.8	25 6	99.2	Effluent.
Jan. 24	7.0	17.3	755	3370	2770	201[illegible]	.0	T	209.6	472.4	Manhole.
Jan. 24	21.4	20.3	397	2495	2235	1746	.0	0	187.2	419.2	Tank.
Jan. 24	5.38	1.38	155	1895	1731	1421	1.0	.8	86.4	152.0	Effluent.
April 12	5.2	2.9	42	1426	1392	1178	.12	T	8.	29.2	Manhole.
April 12	12.7	4.7	48	1498	1450	1170	.08	T	27.2	41.6	Tank.
April 12	7.84	1.98	85	1646	1594	1346	.08	T	12.8	19.2	Effluent.
April 17	26.9	11.8	58	1464	1298	1124	.12	0	16.	30.	Manhole.

DATE.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Solids. On evaporation.	Solids. At 180°.	Solids. On ignition.	Nitrogen as Nitrites.	Nitrogen as Nitrates.	Oxygen consumed. Fifteen Min.	Oxygen consumed. Four hours.	ORIGIN.
April 17	17.4	3.9	47	1460	1314	1160	.2	T	10.8	13.2	Tank.
April 17	.84	.48	49	1378	1228	974	1.2	T	2.8	4.4	Effluent.
April 24	36.2	17.4	75	1520	1446	1152	0	0	16.4	42.	Manhole.
April 24	18.9	13.4	100	1980	1920	1528	0	0	28.	50.4	Tank.
April 24	8.08	.4	43	1480	1460	1246	.4	6.0	3.2	6.0	Effluent.
May 1	38.9	18.5	71	1720	1686	1326	0	T	21.2	40.8	Manhole.
May 1	17.4	2.9	46	1406	1356	1240	0	T	5.6	8.8	Tank.
May 1	.6	.3	70	1546	1532	1332	.2	16.	2.8	3.6	Effluent.
May 8	56.6	23.2	81	1734	1686	1246	0	T	28.8	44.16	Manhole.
May 8	9.7	4.2	48	1466	1406	1146	.2	T	11.84	12.8	Tank.
May 8	.44	.48	58	1540	14·6	1180	.24	20.	2.56	3.2	Effluent.
May 15	65.7	22.7	25	1384	830	456	.8	12.	16.0	31.04	Manhole.
May 15	44.0	3.4	50	1128	728	414	.9	4.	10.88	13.76	Tank.
May 15	8.44	.48	20	1070	836	556	.3	20.	.96	1.28	Effluent.
May 22	37.6	12.0	59	1088	988	668	1.2	8.	15.68	23.04	Manhole.
May 22	9.7	4.2	15	886	814	500	1.2	4.	9.92	12.48	Tank.
May 22	2.08	.68	28	1040	960	672	.2	20.	3.2	3.84	Effluent.
May 29	12.7	9.8	32	1144	1056	584	.6	4.	14.08	24.96	Manhole.
May 29	8.0	9.7	50	1036	996	510	.8	4.	15.04	33.28	Tank.
May 29	.84	.28	28	948	888	548	.16	30.	.96	1.28	Effluent.
June 5	8.0	19.3	118	1760	1540	666	0	T	80.96	101.44	Manhole.
June 5	23.5	10.3	38	1176	1108	480	0	T	18.88	41.28	Tank.
June 5	1.2	.24	37	1012	968	778	4.0	20.	1.28	1.92	Effluent.
June 15	2.7	12.3	36	4090	3950	3540	1.0	10.	23.04	41.60	Manhole.
June 15	7.0	5.7	95	3882	3730	3392	.6	4.	16.32	29.44	Tank.
June 15	.14	.1	32	3344	3296	3094	.04	20.	1.60	2.56	Effluent.
June 19	1.7	2.0	63	4236	4054	3802	.8	0	17.6	18.88	Manhole.
June 19	2.5	1.7	30	3246	3106	2880	.6	4.0	8.96	12.16	Tank.
June 19	.7	.54	12	29·4	2704	2510	.04	24.	.64	1.28	Effluent.
June 26	3.2	28.3	84	7360	7038	6404	.4	T	70.40	101.12	Manhole.
June 26	5.7	6.7	45	4230	4180	3900	.6	T	8.64	19.52	Tank.
June 26	.04	.04	10	3424	3362	3102	.24	15.	1.28	1.60	Effluent.
July 5	6.3	9.5	297	*1111*	*1111*	*1111*	1.0	T	11.84	14.40	Manhole.
July 5	4.2	1.7	28	......	......	......	.8	1.	3.2	5.42	Tank.
July 5	.7	.26	43	......	......	......	T	8.	.64	.96	Effluent.
July 12	7.5	2.1	20	......	......	......	.8	.8	9.92	13.12	Manhole.
July 12	3.2	17.	25	......	......	......	.4	1.4	4.48	4.80	Tank.
July 12	.44	.24	35	......	......	......	T	8.	.64	1.92	Effluent.
July 17	5.2	2.7	19	......	......	......	.6	.8	4.48	5.44	Manhole.
July 17	8.2	6.2	155	......	......	......	.6	1.	22.72	39.68	Tank.
July 17	.5	.1	15	......	......	......	T	8.	.32	1.92	Effluent.
July 23	3.5	5.0	30	......	......	......	.2	0	8.32	12.48	Manhole.
July 23	4.0	3.1	57	......	......	......	4.	0	6.72	8.00	Tank.
July 23	.2	.48	66	......	......	......	T	16.	.64	2.56	Effluent.
Aug. 1	1.0	3.5	16	..	......	......	.5	T	10.24	30.40	Manhole.
Aug. 1	2.3	1.7	14	......	......	......	.6	4.	......	6.40	Tank.
Aug. 1	0	.24	23	......			T	16.	......	3.20	Effluent.
Aug. 7	4.4	5.7	20	790	684	554	6.	3.2	32.	41.6	Manhole.
Aug. 7	1.2	4.0	17	820	780	568	.12	T	26.24	32.32	Tank.
Aug. 7	.4	.8	36	910	810	640	T	4.	4.48	11.20	Effluent.
Aug. 21	6.2	23.5	258	1574	1442	982	.84	0	5.44	28.80	Manhole.
Aug. 21	5.5	9.0	44	1288	1220	1054	.62	T	3.52	22.08	Tank.
Aug. 21	0	.24	41	812	766	516	.12	16.	.96	2.88	Effluent.
Sept. 5	2.1	6.1	43	1992	1592	1206	.40	0	14.40	24.00	Manhole.
Sept. 5	21.5	5.9	50	1814	1488	1140	.12	0	12.8	17.38	Tank.
Sept. 5	.1	.46	86	1720	1466	1194	.04	12.	.96	1.6	Effluent.
Sept. 12	6.2	5.7	43	1660	1600	1366	.4	0	4.16	6.08	Manhole.
Sept. 12	15.7	5.7	58	1460	1434	1180	0	T	8.32	9.28	Tank.
Sept. 12	.2	.26	54	1346	1280	1060	.04	16.	1.28	1.92	Effluent.
Sept. 17	16.0	16.0	96	2330	1852	1280	0	0	11.52	38.72	Manhole.
Sept. 17	10.3	12.6	95	1730	1524	1172	0	0	6.72	16.64	Tank.
Sept. 17	.16	.88	63	1384	1360	1048	.8	12.	.96	2.24	Effluent.
Oct. 2	9.0	12.6	63	2092	1952	1592	.4	0	9.20	31.04	Manhole.
Oct. 2	11.2	10.1	50	1940	1774	1580	.4	0	4.80	15.68	Tank.
Oct. 2	1.54	7.	54	1756	1476	1230	.4	10.	1.92	2.56	Effluent.
Oct. 8	29.6	12.8	58	1514	1460	1194	.4	0	6.40	9.28	Manhole.
Oct. 8	7.4	3.2	54	1292	1260	1006	.6	T	2.56	4.16	Tank.
Oct. 8	1.76	.44	55	1360	1340	1226	.8	8.	.96	1.28	Effluent.
Oct. 15	11.0	8.0	50	1468	1374	1194	.4	0	......	7.68	Manhole.

DATE.		Ammonia.			Solids.			Nitrogen as		Oxygen consumed.		ORIGIN.
		Free.	Albuminoid.	Chlorine.	Evaporation.	At 180°.	On ignition.	Nitrites.	Nitrates.	Fifteen min.	Four hours.	
1899												
Oct.	15	14.8	8.2	42	1438	1398	1224	0	0	......	11.52	Tank.
Oct.	15	2.76	. .	6.)	2338	2238	1978	0	16.	......	1.28	Effluent.
Oct.	22	42.1	20.0	106	1714	1546	12 4	.6	0	18.56	35.52	Manhole.
Oct.	22	8.1	2.9	57	1300	1248	1068	.6	0	8.32	15.04	Tank.
Oct.	22	.26	.40	61	1446	1414	1200	.6	16.	1.92	2.56	Effluent.
Nov.	5	4.9	4.5	57	1294	1268	1068	.8	4.6	5.12	8.64	Manhole.
Nov.	5	5.5	9.8	55	1192	1152	900	1.2	4.8	8.96	15.36	Tank.
Nov.	5	1.64	.42	55	1080	1074	860	.2	12.	.64	1.28	Effluent.
Nov.	12	6.3	4.0	55	1274	1194	1074	.4	4.0	5.76	11.52	Manhole.
Nov.	12	8.2	7.5	58	1428	1274	1180	.4	.8	10.56	21.12	Tank.
Nov.	12	.32	.26	55	1186	1126	1006	.24	16.	.96	1.28	Effluent.
Nov.	19	23.0	18.3	65	1474	1294	1074	0	.8	13.76	24.0	Manhole.
Nov.	19	11.4	3.8	43	1152	1066	906	.6	.8	2.24	3.84	Tank.
Nov.	19	.82	.62	50	1128	1088	920	.08	16.	.96	1.28	Effluent.
Nov.	26	13.6	8.7	58	1634	1500	1246	.2	1.2	10.88	19.84	Manhole.
Nov.	26	20.3	15.7	67	1648	1428	1174	.2	3.	16.	23.36	Tank.
Nov.	26	.68	.56	58	1414	1374	1114	.08	16.	.96	1.28	Effluent.
Dec.	3	8.3	8.3	52	1300	1280	946	.2	T	6.72	12.48	Manhole.
Dec.	3	11.6	7.3	48	1360	1320	1046	.2	T	11.52	23.04	Tank.
Dec.	3	1.98	.46	50	1414	1374	1180	.16	12.	.64	.96	Effluent.
Dec.	17	27.7	19.1	62	1408	1394	1068	.2	0	29.76	52.16	Manhole.
Dec.	17	23.4	12.8	40	1488	1394	1020	T	0	25.92	49.92	Tank.
Dec.	17	5.84	1.36	50	1200	1120	980	.16	16.	1.60	5.76	Effluent.
1901.												
Jan.	8	6.7	21.6	62	1480	1422	1090	1.5	0	8.96	15.08	Manhole.
Jan.	8	3.2	8.3	55	1220	1208	1016	1.5	0	7.04	15.68	Tank.
Jan.	8	1.84	1.36	45	1214	1164	1020	.24	12	2.56	4.80	Effluent.
Jan.	14	13.5	110.8	95	3800	3420	1772	.6	0	78.44	339.2	Manhole.
Jan.	14	10.7	13.0	52	1200	1168	972	.04	0	15.6	38.0	Tank.
Jan.	14	.94	1.92	55	1268	1218	1144	0	0	1.28	2.80	Effluent.
Jan.	21	7.9	13.8	62	1670	1576	1162	.5	0	18.88	60.80	Manhole
Jan.	21	5.2	20.1	62	1478	1414	1008	0	0	15.04	59.68	Tank.
Jan.	21	.44	1.36	50	1258	1242	1036	T	10.	1.28	1.60	Effluent.

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DATE.		AMMONIA.		Chlorine.	SOLIDS.			NITROGEN		OXYGEN CONSUMED.				ORIGIN.
		Free.	Albuminoid.		On evaporation.	At 180°.	On ignition.	As nitrites.	As nitrates.	Three min.	Fifteen min.	Four hours.	Association method.	
Jan.	28	16.4	15.1	91	2548	2486	2088	.04	T	......	19.84	42.88	......	Manhole.
Jan.	28	17.9	15.6	60	1270	1252	1026	.1	.8	......	29.12	44 48	.. ...	Tank.
Jan.	28	2.5	1.32	54	1358	1346	1142	T	10.		.96	2.88		Effluent.
Feb.	5	19.7	25.3	40	1156	1044	560	.40	1.0	1.57	38.12	....	155.6	Manhole.
Feb.	5	9.7	8.5	40	696	662	516	.30	1.	.39	16 32	19.9	31.6	Tank.
Feb.	5	.94	1.2	45	854	838	688	T	2.0	.19	1.2	3.6	10.	Effluent.
Feb.	11	7.7	18.3	70	1800	1600	1066	T	0	.59	6.4	31.4	145.6	Manhole.
Feb.	11	8.9	5.8	66	1266	1180	906	.04	T	.19	2.4	....	46.8	Tank.
Feb.	11	1.32	1.16	72	894	814	654	.04	6.0	.19	.4	3 60	4.	Effluent.
Feb.	19	22.4	21.0	85	1850	1794	1326	.08	0	1.37	24.0	68 4	103.2	Manhole.
Feb.	19	14.4	18.2	65	1234	1196	966	.1	T	.59	1.0	9.2	40.4	Tank.
Feb.	19	2.72	1.62	50	1290	1282	1098	.20	6.0	.05	....	.4	6.8	Effluent.
Feb.	26	25.7	39.8	89	2112	2078	1234	0	0	.98	54.2	76.6	240.4	Manhole.
Feb.	26	28.4	16.1	68	1338	1314	1116	0	0	.59	4.6	10 8	34.20	Tank.
Feb.	26	4.06	2.58	72	1440	1402	1260	.16	6.0	.39	....	.4	6.8	Effluent.
March	4	24.0	16.3	78	1322	1300	1078	.04	0	.39	9.6	11.6	67.2	Manhole.
March	4	11.2	10.5	59	1170	1158	896	.08	T	.39	8.6	2.9	42.	Tank.
March	4	6.24	2.82	65	1302	1132	1006	.32	4.0	.39	5.2	7 6	18.	Effluent.
March	28	25.8	18.3	88	1396	1316	1046	.15	T	2.75	....	38.42	37.58	Manhole.
March	28	13.8	9.6	59	1212	1164	934	.1	T	2.56	9.8	29.56	58.08	Tank.
March	28	5.04	1.26	59	1336	1304	1298	.08	12.	1.18	....	....	7.26	Effluent.
April	4	19.6	9.1	56	1340	1270	1024	.15	0	2.16	......	19.7	25.4	Manhole.
April	4	17.6	11.1	53	1142	1098	932	.18	.4	1.57	....	11.82	34.49	Tank.
April	4	4.1	2.8	67	1244	1206	1060	.06	4.0	.78	......	1.97	6.89	Effluent.
April	11	9 2	12.4	47	1350	1286	1062	.10	T	1.18	2.22	10.09	34.49	Manhole.
April	11	12.6	12.4	51	1324	1268	1018	.08	T	1.18	6.75	12.83	49.65	Tank.
April	11	4.7	1.4	54	1270	1242	840	.18	4.0	.28	.63	1.37	5.45	Effluent.
April	19	8.4	10.4	52	2490	1874	1570	.04	0	2.75	10.07	22.	102.00	Manhole.
April	19	12.0	13.6	44	1244	1240	1234	.12	T	1.97	7.41	18.2	47.27	Tank.
April	19	5.56	1.96	45	1112	1110	1022	.08	6.0	0	1.77	3.58	3.26	Effluent.
April	26	14.6	9.6	55	1348	1328	984	.4	0	5.12	54.4	63.16	178.80	Manhole.
April	26	13.8	10.4	46	1162	1124	924	.6	0	1.77	8.89	18.33	53.36	Tank.
April	26	7.32	.96	45	1228	1206	994	.30	14.	0	.59	1.57	5.45	Effluent.
May	2	4.8	12.6	55	2988	2922	2250	.2	0	1.81	6.11	56.77	89.6	Manhole.
May	2	10.2	10.0	69	1684	1678	1224	0	0	1.51	2.36	42.67	87.4	Tank.
May	2	4.42	.5	49	1310	1292	1098	.12	14.	.08	.72	2.16	4.27	Effluent.
May	9	15.8	11.6	62	1792	1546	960	0	0	2.75	16.6	22.392	91.9	Manhole.
May	9	17.0	7.0	51	1260	1236	960	.15	05	1.57	7.84	10.54	26.49	Tank.
May	9	1.8	.6	61	1372	1358	1098	.04	12.	.79	.168	1.9	6.1	Effluent.
May	16	22.	32.5	67	1930	1890	1530	T	0	3.94	14.7	34.89	90.7	Manhole.
May	16	21.0	32.5	94	1910	1904	1380	.02	0	3.15	16.24	44.52	132.1	Tank.
May	16	1.38	1.06	65	1570	1570	1282	.16	14.	.79	.906	1.96	4.3	Effluent
May	23	38.	28.	68	1890	1868	1234	0	0	5.51	25.8	83.20	170.6	Manhole.
May	23	39.5	24.	84	1278	1248	1066	.3	0	.19	9.8	18.	45.7	Tank.
May	23	1.38	.55	59	1232	1226	1082	.12	12.	1.18	1.34		8.3	Effluent.
May	30	32.0	17.0	88	1886	1832	1246	.04	0	2.36	12.81	31.3	95.1	Manhole.
May	30	24.	14.	68	1230	1204	1034	.08	0	1.57	5.54		22.5	Tank.
May	30	1.44	.58	66	1440	1436	1310	.30	20.		.53	3.58	6.53	Effluent.
June	6	17.5	17.	60	1736	1644	1162	.1	0	1.77	15.8	38.39	132.85	Manhole.
June	6	31.	18.	66	1336	1220	1068	.15	T	1.57	7.1	13.26	19.60	Tank.
June	6	1.04	.66	73	1536	1512	1268	.04	18.	.....	.26	1.76	3.99	Effluent.
June	13	55.5	25.	63	2096	2096	1330	0	0	3.94	41.90	124.91	362.27	Manhole.
June	13	....	10.	43	1224	1224	1080	0	0	.15	5.16	7.25	27.59	Tank.
June	13	1.98	1.4	70	1612	1596	1352	.1	24.	.78	3.64	6.40	18.10	Effluent.
June	20	16.5	11.5	59	1236	1226	1008	.2	0	.39	1.67	7.4	23.6	Manhole.
June	20	1.0	6.5	67	1600	1432	127	.4	0	.58	......	2.28	30.8	Tank.
June	20	.7	.42	44	1130	1114	966	.06	12.	.39	.40	5.6	12.	Effluent.
June	28	56.	257.	136	5094	4406	1952	0	0	9.6	127.63	272.6	483.6	Manhole.
June	28	10.5	5.5	44	1302	1274	1100	0	0	1.41	5.64	10.63	25.2	Tank.
June	28	1.14	.2	60	1540	1514	1380	0	24.	.59	1.27	2.40	5.2	Effluent.
July	5	15.5	26.5	22	1618	1580	1212	.04	0	1.41	6.77	20.60	48.4	Manhole.
July	5	10.5	8.	52	1242	1218	1112	.2	0	1.55	2.88	5.09	13.2	Tank.
July	5	.28	2.15	27	1510	1466	1396	T	20.	1.14	1.14	1.71	6.0	Effluent.
July	11	8.5	8.5	94	5824	5788	5498	.04	0	1.13	15.69	41.77	122.8	Manhole.
July	11	23.	28.5	54	1848	1804	1290	0	0	2.09	17.92	75.73	156.	Tank.
July	11	.1	.82	70	1524	1496	1334	.2	12.	.56	.97	2.97	7.6	Effluent.
July	18	14.	7.50	93	2120	2080	1820	0	T	1.83	8.4	16.68	48.	Manhole.
July	18	12.50	7.50	69	1114	960	782	0	0	2.97	10.80	18.6	44.0	Tank.
July	18	1.36	1.44	48	1472	1420	1332	.2	16.	1.13	2.3	4.26	5.6	Effluent.

DATE.	AMMONIA.			SOLIDS.			NITROGEN		OXYGEN CONSUMED.				ORIGIN.
	Free.	Albuminoid.	Chlorine.	On evaporation.	At 180°.	On ignition.	As nitrites.	As nitrates.	Three min.	Fifteen min.	Four hours.	Association method.	
July 25	26.5	82.	50	1650	1590	1206	0	0	2.25	25.16	49.78	127.6	Manhole.
July 25	27.50	11.50	74	1618	1588	1280	0	0	20 99	28.55	46.54	72.0	Tank.
July 25	.66	.7	87	1472	1468	1322	0	8.	1.42	1.50	1.63	4.0	Effluent.
Aug. 1	20.	31.5	71	1408	1360	1190	.04	0		10.586	24.13	57.20	Manhole.
Aug. 1	16.5	17.5	98	1714	1676	1370	0	0	......	29.26	59.31	95.60	Tank.
Aug. 1	.64	5.5	97	1342	1326	1234	0	8.	......	2.117	....	6.00	Effluent.
Aug. 9	10.5	47.	37	876	870	752	.4	.8		1.35	5.62	16.80	Manhole.
Aug. 9	12.5	17.5	51	660	652	552	0	0	1.809	4.87	12.71	44.00	Tank.
Aug. 9	.96	1.8	50	1318	1314	1194	0	4.	......		2.27	4.00	Effluent.
Aug. 15	25.	24.50	57	952	924	772	.04	0	1.99	8.59	11.24	35.60	Manhole.
Aug. 15	29.00	24.00	65	1392	1372	1184	0	0	4.52	11.54	23.55	35.20	Tank
Aug. 15	.64	1.04	48	1420	1404	1332	0	20	.72	.67	2.56	3 20	Effluent.
Aug. 22	36.	81.5	21	2686	2276	...	0	0	1.26	33.31	178.00	357.60	Manhole.
Aug. 22	25.5	66.	25	1356	1320	1180	T	0	2.53	6.396	14.02	26.80	Tank.
Aug. 22	.76	.36	15	1398	1370	1240	0	16.	.72	.72	1.93	4 40	Effluent.
Aug. 29	34.	16.	48	1648	1546	1270	0	0	3.79	10.07	29.40	65.20	Manhole.
Aug. 29	17.	0	72	1310	1270	1126	0	0	1.99	3.94	11.02	43.60	Tank.
Aug. 29	.5	.5	64	1442	1408	1088	0	24.	.72	.72	1.26	2.40	Effluent.
Sept. 4	51.	42.5	62	1584	1522	1228	.4	0	5.00	36.40	47.52	102.80	Manhole.
Sept. 4	18.	30.	26	1124	1074	920	0	0	1.80	8.70	8.74	13.20	Tank.
Sept. 4	.55	.08	38	1054	844	.....	0	12.	.60	.60	2.04	2.40	Effluent.
Sept. 13	51.5	7 5	68	1504	1464	1220	T	0	1.80	11 44	19.18	12.00	Manhole.
Sept. 13	54.5	17.5	54	1428	1366	1112	0	0	2.60	8.06	15.15	25.20	Tank.
Sept. 13	.136	.5	47	2020	2014	1608	0	12.	.40	2.30	4.78	12.40	Effluent.
Sept. 20	35.0	32.0	70	1758	1658	1478	.04	0	13.40	37.40	52.96	144.80	Manhole.
Sept. 20	40.5	15.0	55	1266	1238	1120	0	0	2.20	8.96	15.48	35.60	Tank.
Sept. 20	.46	1.16	54	1448	1432	1304	.04	12.	.90	.90	1.38	2.00	Effluent.
Sept. 25	28.5	19.0	.	1414	1382	1186	.08	....	.80	4.52	13.22	24.80	Manhole.
Sept. 25	43.5	17.5	..	1420	1378	1190	0		6.00	11.52	21.12	29.20	Tank.
Sept. 25	.68	.70	...	1582	1446	1330	T	....	0	.63	2.12	4.40	Effluent.
Oct. 2	21.0	9.5	...	1266	1262	1166	.08	....	......	.80	3.34	8.40	Manhole.
Oct. 2	20.5	22.0	...	1326	1284	1158	.06	..	......	5.40	7.80	17.60	Tank.
Oct. 2	44	.48	..	1486	1412	1322	T			.80	1.40	1.60	Effluent.
Nov. 4	21.0	25.5	80	1792	1582	1360	.04		3.20	16.64	19.68	109.20	Manhole.
Nov. 4	43.5	32.5	64	1816	1808	1298	.02	....	1.60	15.68	45.76	103.30	Tank.
Nov. 4	1.6	.18	54	1294	1292	1194	T		.00	.36	.57	4.40	Effluent.
Dec. 11	39.	14.5	94	1522	1464	1304	.12	T	1.57	3.41	27.75	38.40	Manhole.
Dec. 11	41.	42.	68	1500	1436	1262	.12	0	3.93	7.46	28.29	31.46	Tank.
Dec. 11	2.86	4.5	59	1528	1500	1432	T	8.	.39	1.02	1.75	3.80	Effluent.

It is a well known fact that the simplest and best method of destroying organic matter, that is liable to provide favorable conditions for the growth of disease germs, is to destroy it by burning or oxidation. If the matter is in a solid condition and dry naturally, burning is the most suitable. If in solution and a large quantity of water is present other means must be used. The modern process of bacterial purification of sewage is therefore simply using the nitrification process to oxidize the organic matter and ultimately changing the nitrogenous matter to nitric acid. The raw sewage or that which is designated as the manhole sample contains the organic matter in its most stable form. The raw sewage on passing into the septic tank undergoes a process which is complicated from a chemical point of view and by many it has been called a digestion process. The organic matter in the sewage after it has remained in the tank for some time, undergoes a change which prepares it so that it can be oxidized much more readily in the nitrification process. As an illustration to show the changes which the sewage has undergone, the results of the determination of free ammonia may be taken. The results taken are for the cubic centimeters of the standard ammonia as determined by each tube.

NUMBER OF TUBE.	MANHOLE.	TANK.	EFFLUENT.
1	31.5	11.	3.3
2	7.5	3.	.8
3	3.	1.2	.2
4	2.2	.8	.2
5	1.0	.5	.0
6	1.2	.5	
7	1.0	.3	
8	.7	.2	
9	.7	.2	
10	.8	.0	
11	1.0		
12	.8		
13	.5		
14	.8		
15	1.0		
16	1.2		
17	.8		
18	.8		

It will be noticed that after the distillation of 18 tubes in the manhole sample the free ammonia showed no signs of decreasing or is there any period in the analysis where the distillation of the free ammonia may be said to be complete. In the tank sample ten tubes were only required for the complete distillation of free ammonia while the effluent was complete with five tubes. Another interesting change which takes place as the result of the decomposition in the septic tank is in the determination of solids. In the solids at 180° C. it is noticed that the residue in the manhole sample is quite black and shows very strongly that organic matter is present. The sample from the tank in contrast gives very readily a grayish or nearly white residue. The chemical changes which take place in the septic tank are very complicated and offer a field for special research.

The sewage of the college is generally very concentrated when compared with the sewage of other places. The sewage analyzed by the Massachusetts state board of health gave the following interesting results:

	PARTS PER MILLION.		
	Lawrence.	Framingham.	Gardner.
Chlorine	119.0	64.2	42.0
Solids on evaporation	....	1031.	508.
Loss on ignition	....	676.	345.
Albuminoid ammonia	10.2	10.2	9.8
Free ammonia	34.7	26.4	29.8
Nitrites	0.18	0.26	0.01
Nitrates	1.56	0.14	0.06
Oxygen consumed	90.2	97.9	57.3

While the college sewage is more concentrated than that of many of the larger cities in the East, that of some of the western cities which contain manufactures may be expected to have sewage stronger than that of the college. In a recent investigation of the sewage of Marshalltown the following results were obtained and will show the composition of sewage of this nature:

	DATE SAMPLE TAKEN.			
	March 22, 1900, 2 P. M.	March 22, 1900, 8 P. M.	March 23, 1900, 2 A. M.	March 23, 1900, 8 A. M.
Chlorine	84	84	52	34
Total solids	1460	3480	1000	1940
Solids after drying at 180° C	900	2160	660	1400
Solids after ignition	580	1560	560	960
Albuminoid ammonia	16.0	6.6	3.4	37.0
Free ammonia	8.0	5.2	1.0	8.6
Nitrites	T	0.8	0.2	0.16
Nitrates	0	0	1.6	0.8
Oxygen consumed (15 min.)	* 358.4	* 108.8	* 16.0	* 60.8
Oxygen consumed (4 hours)	* 556.8	* 345.6	* 22.4	* 256.0
Acidity (NaOH to neutralize)	48	256	56	56

*These results obtained by different methods, giving much higher results than that used for state college. (The temperature of the determination being 80° C.)

In addition to the above the following analyses of Mt. Pleasant and Grinnell sewage will serve to show the composition of sewage from the smaller cities of the state.

	MT. PLEASANT.	GRINNELL.
Chlorine	165.	96.
Solids on evaporation,	5402.	1010.
Solids at 180° C	5332.	906.
Solids on ignition	1450.	664.
Albuminoid ammonia	31.5	10.0
Free ammonia	53.5	13.6
Nitrites	0.0	0.8
Nitrates	0.0	4.0
Oxygen consumed, 3 minutes	32.6	1.18
Oxygen consumed, 15 minutes	34.62	8.4
Oxygen consumed (4 hours)	45.46	10.30
Oxygen consumed, Asso. meth	94.40	20.7

The water used by the college is furnished from a well 2,215 feet deep and a recent sanitary analyses gave the following results:

	PARTS PER MILLION.
Free ammonia	.18
Albuminoid ammonia	.024
Chlorine	51.
Solids on evaporation	1226.
Solids at 180° C	1180.
Solids on ignition	1040.
Nitrogen as nitrites	.4
Nitrogen as nitrates	T.
Oxygen consumed, 15 minutes	.32
Oxygen consumed, 4 hours	.48

The large amount of solids and of chlorine increases the amount of these substances in the results obtained from the sewage and should be considered when comparisons are made with the sewage from other localities.

The chemical composition of the sewage is of great importance, but the test of its purification is the composition of the effluent. Some effort has been made to establish standards for the effluents, and the limit allowed by the Mersey and Irwell Joint Committee is that the effluent shall not absorb over one grain of oxygen per gallon in four hours (one grain per imp. gallon equals 14.3 parts per million). The same committee limits the albuminoid ammonia in the effluent to .1 grain per gallon, or 1.43 parts per million. From an examination of the results it will readily be seen that the college effluent meets these requirements with a few exceptions. The exceptions where the albuminoid ammonia is especially high results from the extra work required from the beds when the amount of sewage is increased by storm water. When comparing the results of the oxygen absorption, attention may be called to the fact that previous to April 17, 1900, the temperature at which the determinations were made was 80° C. and after that date 80° F. as recommended by the Society of Public Analysts of England. The results made since April 17, 1900, are directly comparable with the results of the English investigations and it will be seen that the results readily meet the limit of the Mersey and Irwell Joint Committee. Since June 28, 1901, the determinations made of oxygen absorption have been the 3 minute test, the 15 minute test, the 4 hour test and the Association test. The object of the first three tests may be explained by the following statement of Mr. Frank Scudder before the Society of Chemical Industry.

The object of using these various time tests is to differentiate the quality of the organic matter and in order to make the point clear, he (Mr. Scudder) divided the quality of the organic matter in the Safford effluents into three divisions as follows:

I. The three minute test showed the putrid matter decomposing permanganate at once with acid. Angus Smith said that this test measured the organic matter decomposed or putrid or at least certain gases which it left behind capable of decomposing permanganate.

II. The fifteen minute test, that is fifteen minutes less the three minute test equals a twelve minute test, showed ma ter readily putrefying and rapdly decomposing permanganate with acid. Angus Smith classed this as organic matter readily decomposed and probably ready to become putrid.

III. The four hour test minus the 15 minutes and minus the 3 minute test which equals a 225 minute test for the action of the permanganate, showed matter capable of putrefying, although slow to decompose.

It is a matter of interest in connection with the three minute test that in addition to the organic matter decomposed, nitrites and ferrous iron or hydrogen sulphide if present react upon the permanganate.

The explanation of the object of the time tests shows that the results indicate to a certain extent the condition of a part of the organic matter present in the sewage, but these tests do not indicate the action on the entire quantity of organic matter which may be present in the sewage and not in a decomposing state. In order to obtain a result which will indicate the action of the permanganate on the organic matter that is not in a more or less decomposing state a method must be used where the conditions are more favorable for the oxidizing agent, and for this reason the association method is used to complete the series of determinations.

The effluent naturally is high in nitrogen as nitrates yet it is not as bad as the water furnished by some shallow wells and which is sometimes used for household purposes. For comparison the following analysis of water from a shallow well may be of interest. The analysis is from a recent investigation: *

	PARTS PER MILLION.
Free ammonia	.104
Albuminoid ammonia	.086
Solids on evaporation	874.
Solids at 180°	714.
Solids on ignition	506.
Nitrogen as nitrites	.16
Nitrogen as nitrates	40.
Oxygen consumed in 15 minutes	.64
Oxygen consumed in 4 hours	.96
Chlorine as Chlorides	26.

The results of the investigation of the College Sewage Plant indicates that the purification of the sewage from the towns and cities by the bacterial method is possible under the conditions present in the state. The fact that the sewage is more concentrated than that of many other localities does not prevent the production of an effluent which will meet any reasonable standard for purity.

*A study of a contaminated water supply. Weems and Brown. Proceedings of the Iowa Academy of Sciences. Vol. 7, p. 91.