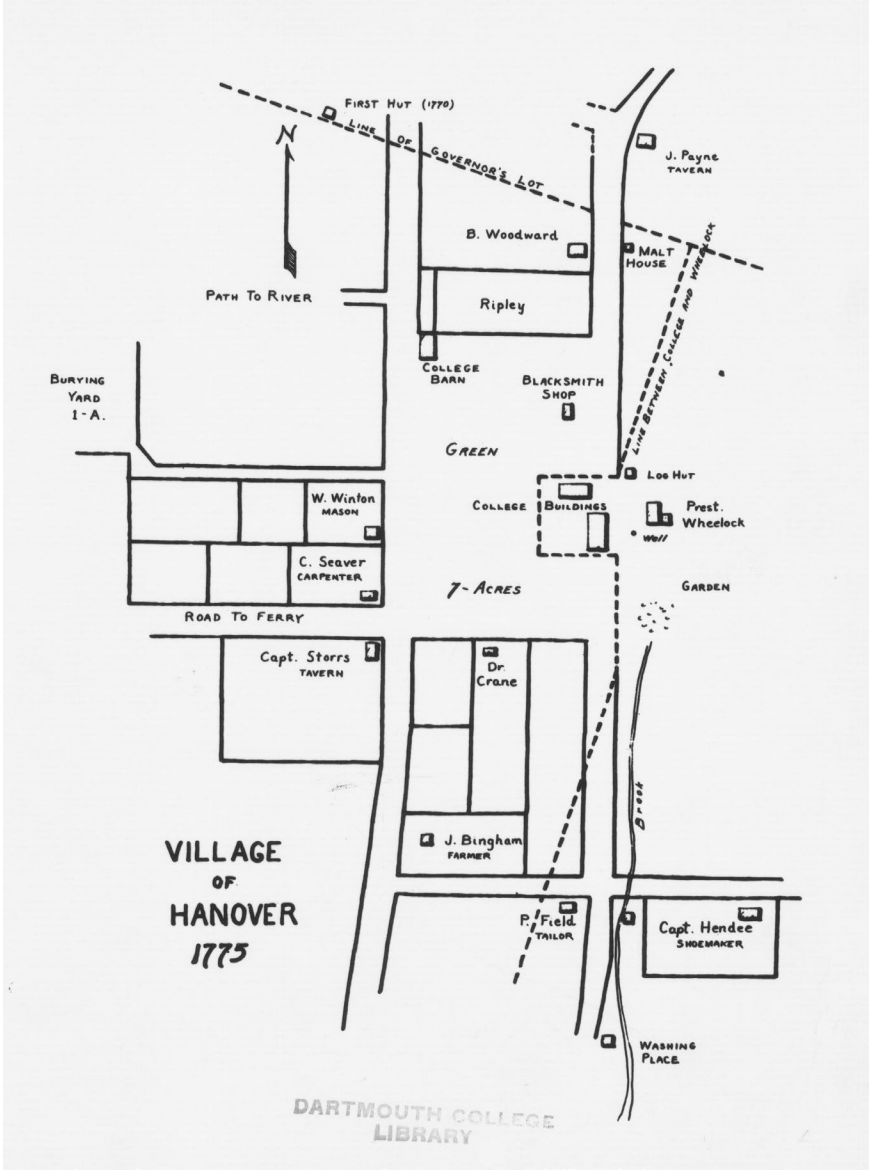
HANOVER DRINKING WATER

MEMBRANES & MILESTONES: HANOVER'S PATH TO PURE WATER


FIRST HUT (1770)
LINE OF GOVERNOR'S LOT
N
PATH TO RIVER
B. Woodward
Ripley
COLLEGE BARN
BLACKSMITH SHOP
J. Payne TAVERN
MALT HOUSE
LINE BETWEEN COLLEGE AND WHEELOCK
BURYING YARD 1-A.
GREEN
LOG HUT
COLLEGE BUILDINGS
Prest. Wheelock
W. Winton MASON
C. Seaver CARPENTER
ROAD TO FERRY
7-ACRES
GARDEN
Capt. Storrs TAVERN
Dr. Crane
J. Bingham FARMER
BROOK
VILLAGE OF HANOVER 1775
P. Field TAILOR
Capt. Hendee SHOEMAKER
WASHING PLACE
DARTMOUTH COLLEGE LIBRARY


1868


1870
VIEW OF DARTMOUTH COLLEGE FROM PRES'S GARDEN.

MAP OF HANOVER, N. H.,

SHOWING LOCATION OF

Dartmouth College and Associated Institutions.

From surveys by students of the THAYER SCHOOL OF CIVIL ENGINEERING, under direction of Prof. R. FLETCHER, PhD., and Prof. H. A. HITCHCOCK, C. E.

Correct reproduction from the original map drawn to a scale of 200 feet to the inch. Completed November, 1890.

COLLEGE BUILDINGS, PUBLIC BUILDINGS AND PLACES OF BUSINESS.

D. H. Dartmouth Hall. (1784-91). Built in 1788.
Old Chapel. Recitation rooms. Dormitory.
W. H. Wentworth Hall. Built in 1828.
Recitation rooms. Dormitory.
T. H. Thornton Hall. Dormitory. Built in 1828.
THAYER SCHOOL OF CIVIL ENGINEERING.
R. H. Reed Hall. Physical laboratories. Nineveh mural inscriptions. Dormitory. 1840.
Ob. Shattuck Observatory. 1855.
B. H. Bissell Hall. Gymnasium. 1866.
Lib. Wilson Hall. Libraries and reading rooms. 1884.
Ch. Rollins Chapel. 1884.
C. A. Building of Y. M. C. A. 1890.
M. C. N. H. Medical College. 1810.
H. H. Mary Hitchcock Memorial Hospital. Built by Hiram Hitchcock, Esq. 1890.
C. S. CHANDLER SCHOOL OF SCIENCE AND ARTS. Building of former Moor's Charity School. Recitation and lecture rooms.
C. H. Culver Hall. (Dart. Coll. in part.) 1869.
N. H. COLL. AGRIC. AND MECH. ARTS. Chemical laboratories, museums.
Co. H. Conant Hall. Dormitory. Boarding. 1874.

D. Rectory and Chapel.
E. Catholic Church.
F. Precinct Hall. Fire engines.
G. District Schools.
H. Hanover Creamery.
I. Gas-house.

J. Bank. N. S. Huntington, President; C. P. Chase, Cashier. College Treasurer, C. P. Chase. 1
K. Davison's. Dry goods, groceries, etc. 2
E. D. Carpenter, tailor. 3
Ka. Rand, furniture, undertaker. 4
Kb. Livery Stable. Haskell. 5
L. Parmort. Boarding.
La. Cobb. Groceries, hardware, etc. Est. 1865. 6
Storrs. Books and stationery, insurance, telephone. 7
Lb. Amaral. Barber. 8
Newell. Clock maker and machinist. 9
O'Grady, Shoemaker.
Hotel Wheelock. Tucker.
M. Carter Brothers. Groceries. 10
J. N. Chase. Boots and shoes. 11
N. H. L. Carter. Restaurant. 12
N. A. Frost. Watches, jewelry, insurance, telegraph.

R. Mrs. Walker's place.
Mrs. Hawkins. Millinery.
S. Livery Stable. George H. Allen, late Ira B. Allen. Est. 1845. 18
T. Dartmouth Press. Whitcomb, Proprietor. 19
"The Dartmouth." Hanover Gazette.
Express Office, Russell.
Miss Demman. Millinery. 20
Livery Stable. Howe. 22
Phelps. Machinist. e
Carpenter Shop. Baker. 23
Hind's meat market. Mr. Bly.
Masterson & Sons, Blacksmiths. 24
Pierce. Blacksmith.
Dr. F. Dr. Frost. Dean of Medical College.
Dr. S. Dr. Smith.
Hotel and "Opera House." Kibling.
L. Boutwell. Cabinet maker.
D. B. Pelton. Carpenter. Sexton.
Colby. Bookbindery.
Lewin. Butcher. Slaughter house.
George Waterman. Painter.
Ford. Plumber and steam fitter.
Wainwright's shop. Tin ware and fittings.
S. Waterman. Carpenter.
Barker. Carriage painter.

DWELLINGS AND RESIDENTS.

39. Prof. Sherman.
40. Prof. Colby. (Mrs. Pike.)
41. Prof. H. A. Hitchcock.
42. Mr. Clifford. (G. W Smith's.)
43. Prof. Hazen.
44. Mr. Morse.
45. Prof. Campbell. (Smith estate.)
46. Mr. George Hitchcock.
47. Mrs. Paige.
48. Miss McMurphy.
49. Prof. Parker.
b. President Bartlett, late Dr. Noyes'.
50. Hiram Hitchcock, Esq.
c. Prof. Worthen, late Dr. Dixi Crosby's.
51. Mrs. Quimby, late Prof. Quimby.
52. Mrs. Brown.
53. Mrs. Proctor.
d. Prof. Bisbee.

62. Prof. Fletcher.
63. Prof. Pollens.
64. Prof. Scott.
65. Dr. Conner's lot.
66. Mrs Everett. (Prof. Emerson's.)
67. John Scott.
68. Misses Dewey.
69. Prof. Hardy.
70. Prof. Lord.
71. Mrs. A. Dewey.
72. Prof. Emerson.
73. Ed. Haskell.
f. Janitor's house. Mr. Hall.
g. College Shops. Mr. Porter.
74. Prof. C. H. Hitchcock.
75. Prof. Pettee.
76. Mrs. Swett.
h. Currier house. J. Minor.
J. N. Brown.
77. Mrs. Richards.

92. O'Leary place.
93. Mr. Henry Carter.
94. P. Marquette.
95. Mr. Calnan.
96. Mrs. McNally. A. Hutchins.
97. Mr. Poole.
98. McCarthy.
99. Mr. Wainwright.
i. Gates house. Moved from site of library.
j. Thompson house.
100. D. E. Currier.
101. Mr Cote.
102. Mrs. Chamberlain.
103. J. G. Currier.
104. Studio.
105. Mr. Wood.
k. Site of old South Hall and two other college tenements, burned July, 1888.
106. Mr. Haynes.

121. Mr. Smalley.
122. Mr. Pelton.
123. Mr. Lang.
124. Kling place.
125. Mr. J. McCarthy.
126. M. Newton
127. Mr. Given.
128. Mr. Clancy.
129. Mr. H. Waterman.
130. H. C. Brown.
131. Mr. Crowley.
132. Mr. E. Carter.
133. Mr. Ed. Gunn.
134. Mrs. Crowley.
135. Mr. Richardson.
136. Mr. Donaldson.

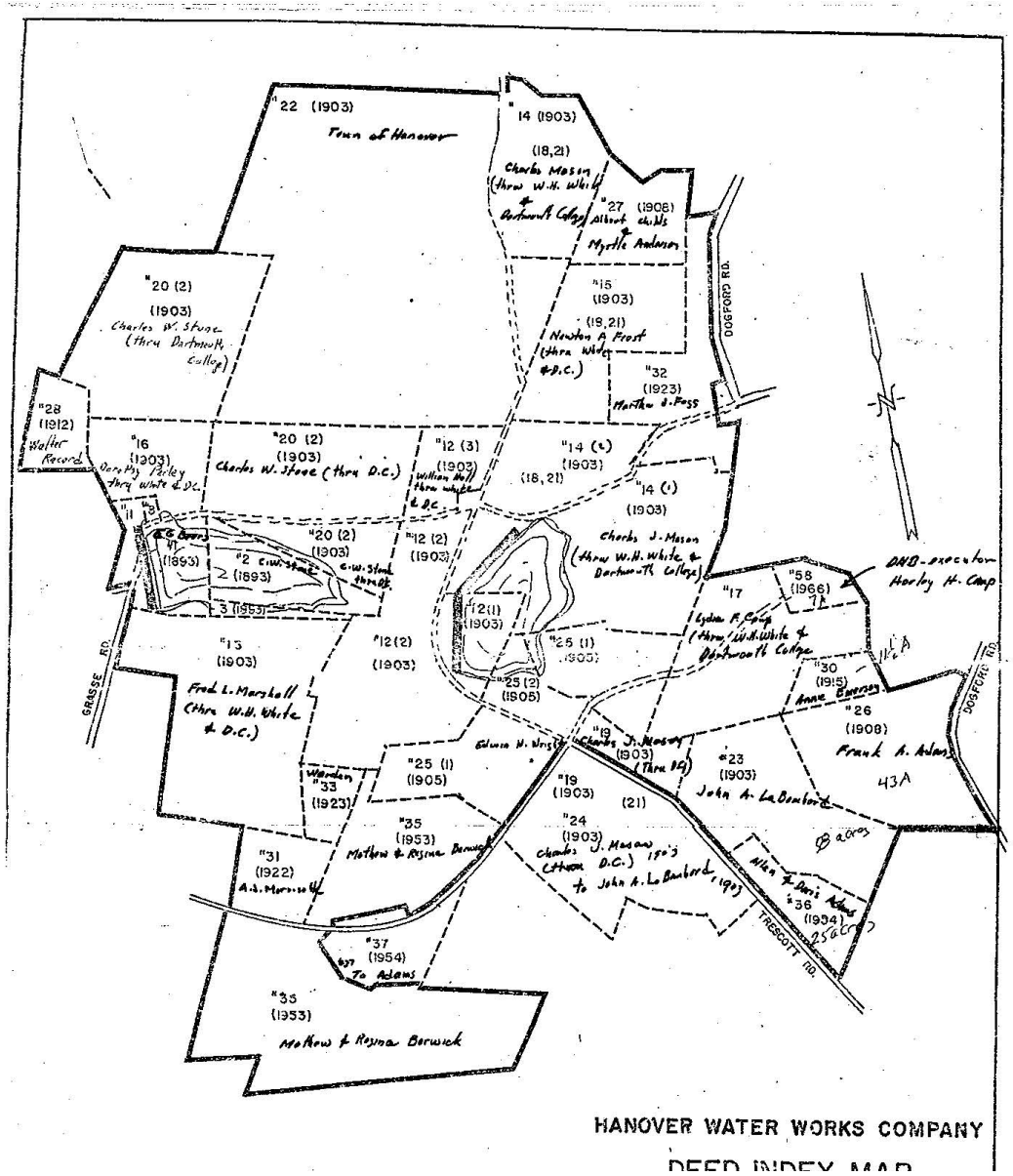
- 1880 A DISASTROUS FIRE IN THE VILLAGE INDICATES THE NEED OF FIRE PROTECTION.
- 1887 PROFESSOR CHARLES PETTEE RECOMMENDS THAT THE VILLAGE BUILD A SYSTEM TO IMPOUND THE WATER OF CAMP BROOK AND CONSTRUCT A NEW DISTRIBUTION SYSTEM. THE STATE AUTHORIZES THE HANOVER VILLAGE PRECINCT TO RAISE $20K ($700K TODAY) TO IMPLEMENT PROFESSOR PETTEE'S PLAN. HOWEVER, THE AMOUNT IS INADEQUATE.
- 1890 ANOTHER SERIOUS FIRE EMPHASIZES THE NEED FOR FIRE PROTECTION.
- 1893 DARTMOUTH TRUSTEES AUTHORIZE AN APPROPRIATION OF $25K TO CONSTRUCT THE PROPOSED PROJECT. ($45K TODAY IS $1.6M)
- 1893 THE HANOVER WATER WORKS COMPANY IS INCORPORATED ON AUGUST 1, 1893, AS A JOINT DARTMOUTH COLLEGE AND HANOVER VILLAGE PRECINCT COMPANY.

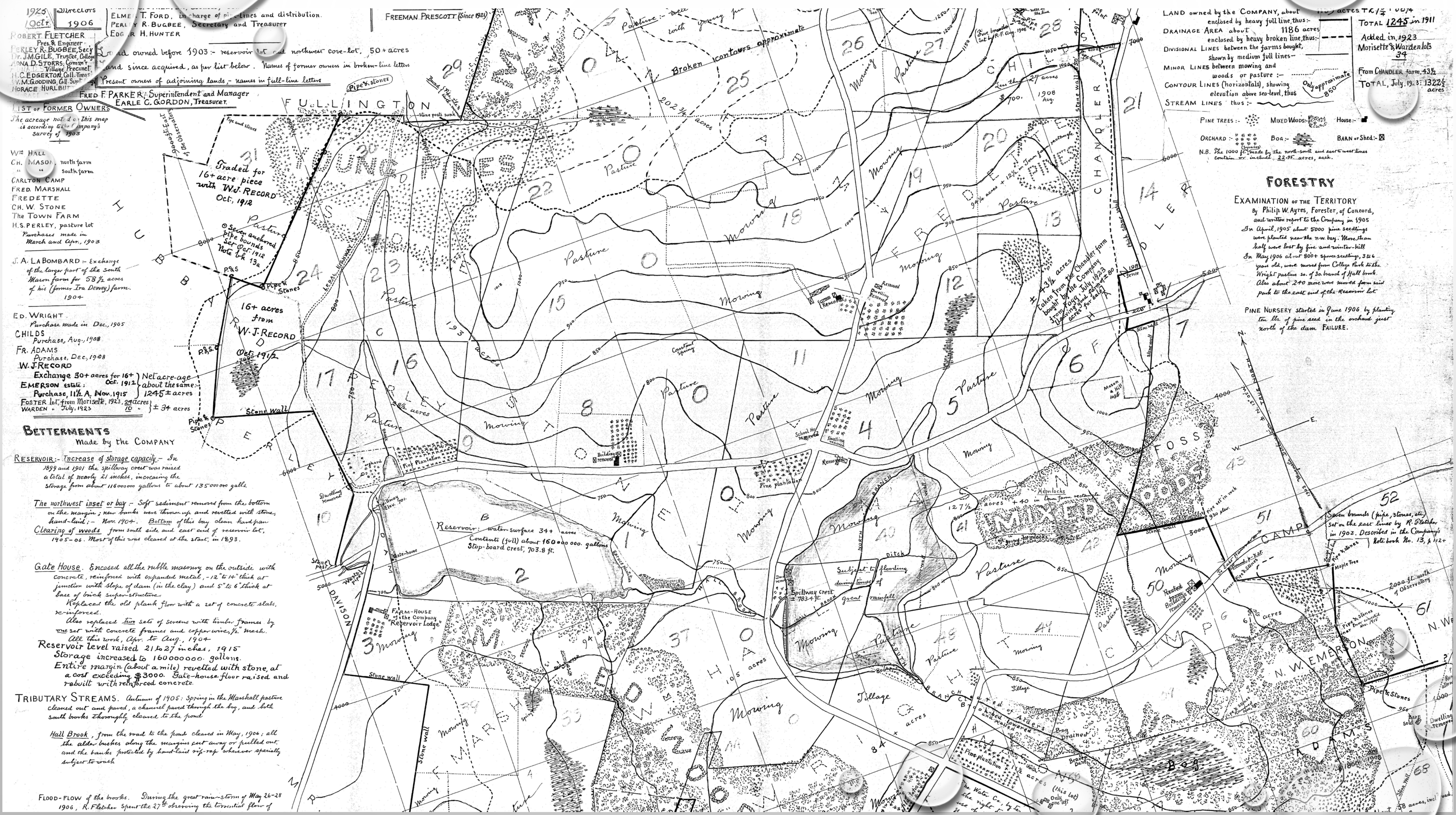

1893


2


16

Health concern due to a1903 Typhoid fever outbreak in Ithica, NY (1,340 cases in a population of 3,000 people) prompted HWWCo to purchased all the land within the watershed.




1925 Octr.
Directors 1906
ELMER T. FORD, in charge of pipe-lines and distribution.
PERLEY R. BUGBEE, Secretary and Treasurer
EDGAR H. HUNTER
FREEMAN PRESCOTT (Since 1921)
ROBERT FLETCHER Pres. & Engineer
PERLEY R. BUGBEE, Sec'y
Dr. J.M. GILE, Trustee, College
ADNA D. STORRS, Comm'r Village Precinct
H.C. EDGERTON, Coll. Treas.
W.M. GOODING, Coll. Supt.
HORACE HURLBUTT
Land owned before 1903:- reservoir lot and northwest cove-lot, 50+ acres
Land since acquired, as per list below. Names of former owners in broken-line letters
Present owners of adjoining lands,- names in full-line letters
FRED F. PARKER, Superintendent and Manager
EARLE C. GORDON, Treasurer.
LIST OF FORMER OWNERS
The acreage noted on this map is according to the Company's survey of 1903
Wm HALL
CH. MASON, north farm
" " south farm
CARLTON CAMP
FRED. MARSHALL
FREDETTE
CH. W. STONE
The TOWN FARM
H.S. PERLEY, pasture lot
Purchases made in March and Apr., 1903
J. A. LABOMBARD :- Exchange of the larger part of the south Mason farm for 58½ acres of his (former Ira Dewey) farm. 1904
ED. WRIGHT. Purchase made in Dec., 1905
CHILDS Purchase, Aug., 1908
FR. ADAMS Purchase, Dec., 1908
W. J. RECORD Exchange 30+ acres for 16+ Oct. 1912
EMERSON estate: Purchase, 11½ A. Nov., 1915
Net acre-age about the same:- 1245± acres
FOSTER lot, from Morisette, 1923, 24 acres
WARDEN " July, 1923 10 "
± 34 acres
BETTERMENTS
Made by the COMPANY
RESERVOIR:- Increase of storage capacity.- In 1899 and 1901 the spillway crest was raised a total of nearly 21 inches, increasing the storage from about 116000000 gallons to about 135000000 galls.
The northwest inset or bay.- Soft sediment removed from the bottom on the margin; new banks were thrown up and revetted with stone, hand-laid;- Nov. 1904. Bottom of this bay clean hardpan
Clearing of woods from south side and east end of reservoir lot, 1905-06. Most of this was cleared at the start, in 1893.
Gate House. Encased all the rubble masonry on the outside with concrete, reinforced with expanded metal, -12" to 14" thick at junction with slope of dam (in the clay) and 5" to 6" thick at base of brick super-structure.
Replaced the old plank floor with a set of concrete slabs, re-inforced.
Also replaced two sets of screens with timber frames by one set with concrete frames and copper wire, ½" mesh.
All this work, Apr. to Aug., 1904
Reservoir level raised 21 to 27 inches, 1915
Storage increased to 160000000. gallons.
Entire margin (about a mile) revetted with stone, at a cost exceeding $3000. Gate-house floor raised and rebuilt with reinforced concrete.
TRIBUTARY STREAMS. Autumn of 1905: Spring in the Marshall pasture cleaned out and paved, a channel paved through the bog, and both south brooks thoroughly cleared to the pond
Hall Brook, from the road to the pond cleared in May, 1906; all the alder bushes along the margins cut away or pulled out, and the banks protected by hand-laid rip-rap wherever specially subject to wash
FLOOD-FLOW of the brooks. During the great rain-storm of May 26-28 1906, R. Fletcher spent the 27th observing the torrential flow of
Traded for 16+ acre piece with W.J. RECORD Oct., 1912
Seven anchored pipe bounds Set Oct. 1912 Note bk 13a
16+ acres from W.J. RECORD Oct. 1912
YOUNG PINES
FULLINGTON
Broken contours approximate
Reservoir: water-surface 34+ acres
Contents (full) about 160000000. gallons
Stop-board crest, 703.8 ft.
FARM-HOUSE of the Company "Reservoir Lodge"
Spillway Crest ±783.4 ft.
Subject to flooding during times of great rainfall
MIXED WOODS
+43½ acres taken from the Chandler farm bought by the Company from Fogg, July, 1923 (acres for sale)
Seven bounds (pipe, stones, etc.) Set on the east lines by R. Fletcher in 1903. Described in the Company's Note book No. 13, p. 112+
N.W. EMERSON
ADAMS
CAMP
FOSS
CHANDLER
LAND owned by the COMPANY, about enclosed by heavy full line, thus:-
DRAINAGE AREA about 1186 acres enclosed by heavy broken line, thus:-
DIVISIONAL LINES between the farms bought, shown by medium full lines-
MINOR LINES between mowing and woods or pasture :-
CONTOUR LINES (horizontals), showing elevation above sea-level, thus
Only approximate 850
STREAM LINES thus :-
TOTAL 1245 in 1911
Added in 1923 Morisette & Warden lots 34
From CHANDLER farm, 43½
TOTAL, July, 1923: 1322½ acres
PINE TREES :-
MIXED WOODS:-
House:-
ORCHARD :-
BOG:-
BARN or Shed:-
N.B. The 1000 ft. (squares) made by the north-south and east to west lines contain or include 22.95 acres, each.
FORESTRY
EXAMINATION OF THE TERRITORY
By Philip W. Ayres, Forester, of Concord, and written report to the Company in 1905
In April, 1905 about 5000 pine seedlings were planted near the n.w. bay. More than half were lost by fire and winter-kill
In May 1906 about 800+ spruce seedlings, 3 to 6 years old, were moved from College Park to the Wright pasture so. of So. branch of Hall brook. Also about 240 more were moved from said park to the east end of the Reservoir lot.
PINE NURSERY started in June 1906 by planting ten lbs. of pine seed in the orchard just north of the dam. FAILURE.

Trescott Area with 1939 Air Photo

Legend

- Trescott Boundary (Approximate)

Road Class:

- Class I and II
- Class V
- Class VI
- Historic
- Other (e.g. Private)

HANOVER CONSERVANCY

Map compiled for the Hanover Conservancy
by Stonehouse Mtn Mapping
October, 2015

1915

The original reservoir level was raised to increase the impounded storage to 134,000,000 gallons.

1924

A second reservoir built on Camp Brook adds 150,000,000 gallons to impounded storage.

1951

The flow-line of the second reservoir raised increasing the impounded storage to 206,000,000 gallons.

1954

The capacity of the original reservoir increased to 219,000,000 gallons resulting in a total impounded storage 425,000,000 gallons.

1955

Continuous chlorination of supply commenced.

1958

After several public hearings, continuous fluoridation of the supply started.

1959

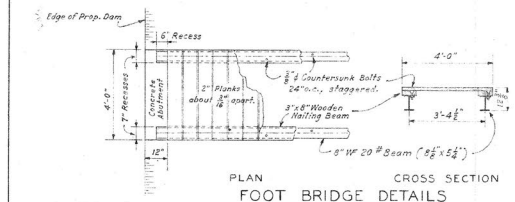
The installation of meters on all service lines commenced.

1962

A third reservoir was constructed on a tributary of Mink Brook in Hanover Center. increases storage to 525,000,000 gallons.

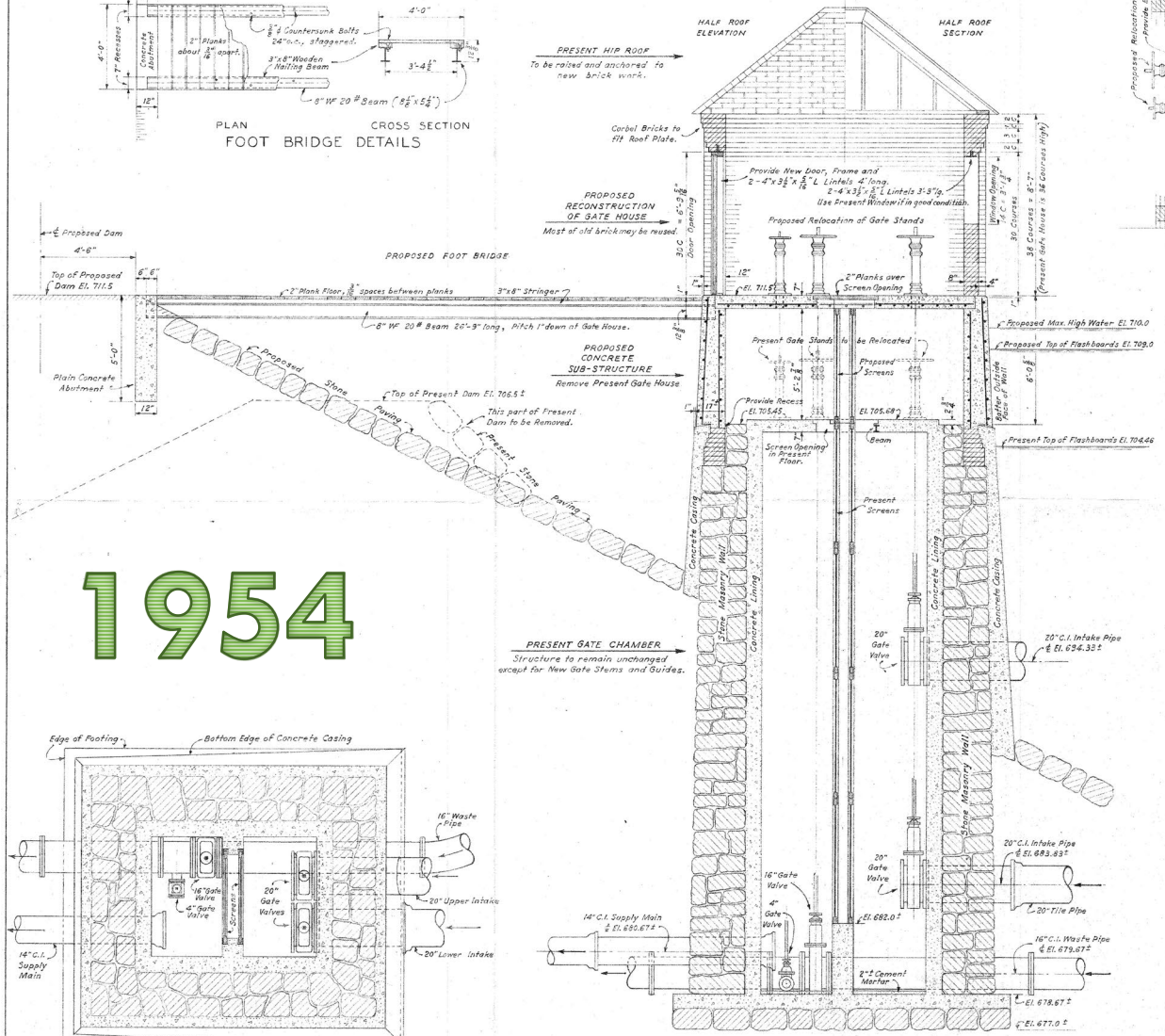

1924

1954



PLAN CROSS SECTION

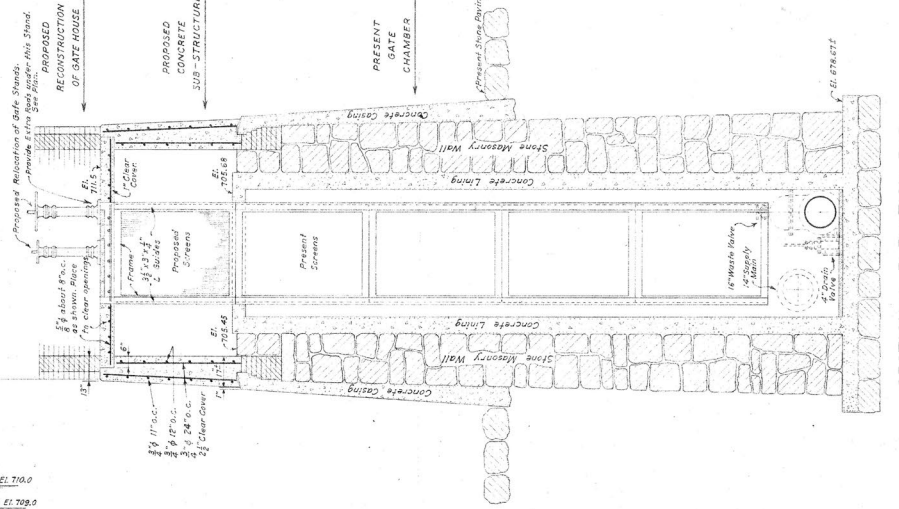
FOOT BRIDGE DETAILS



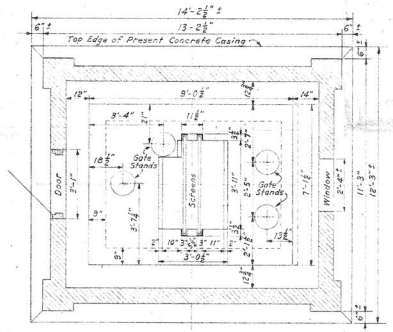
SECTIONAL ELEVATION A-A

SECTIONAL PLAN

PRESENT GATE CHAMBER

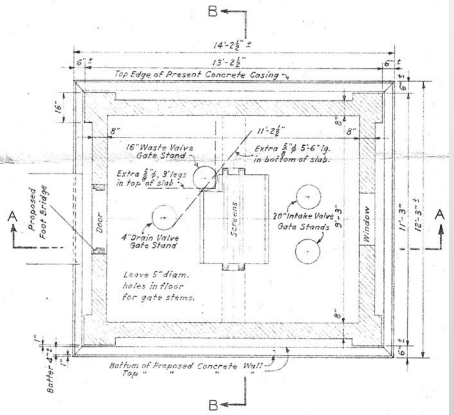


SECTIONAL ELEVATION B-B



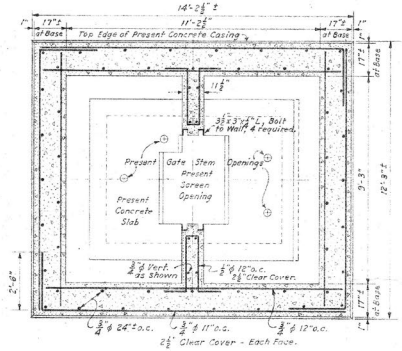
FLOOR PLAN OF GATE HOUSE

PRESENT CONSTRUCTION



FLOOR PLAN OF GATE HOUSE

PROPOSED RECONSTRUCTION



SECTIONAL PLAN

PROPOSED CONCRETE SUB-STRUCTURE

HANOVER WATER WORKS CO.

HANOVER, NEW HAMPSHIRE

RAISING LOWER RESERVOIR

GATE CHAMBER AND GATE HOUSE

SCALE 3/8" = 1'-0"

JULY — 1954

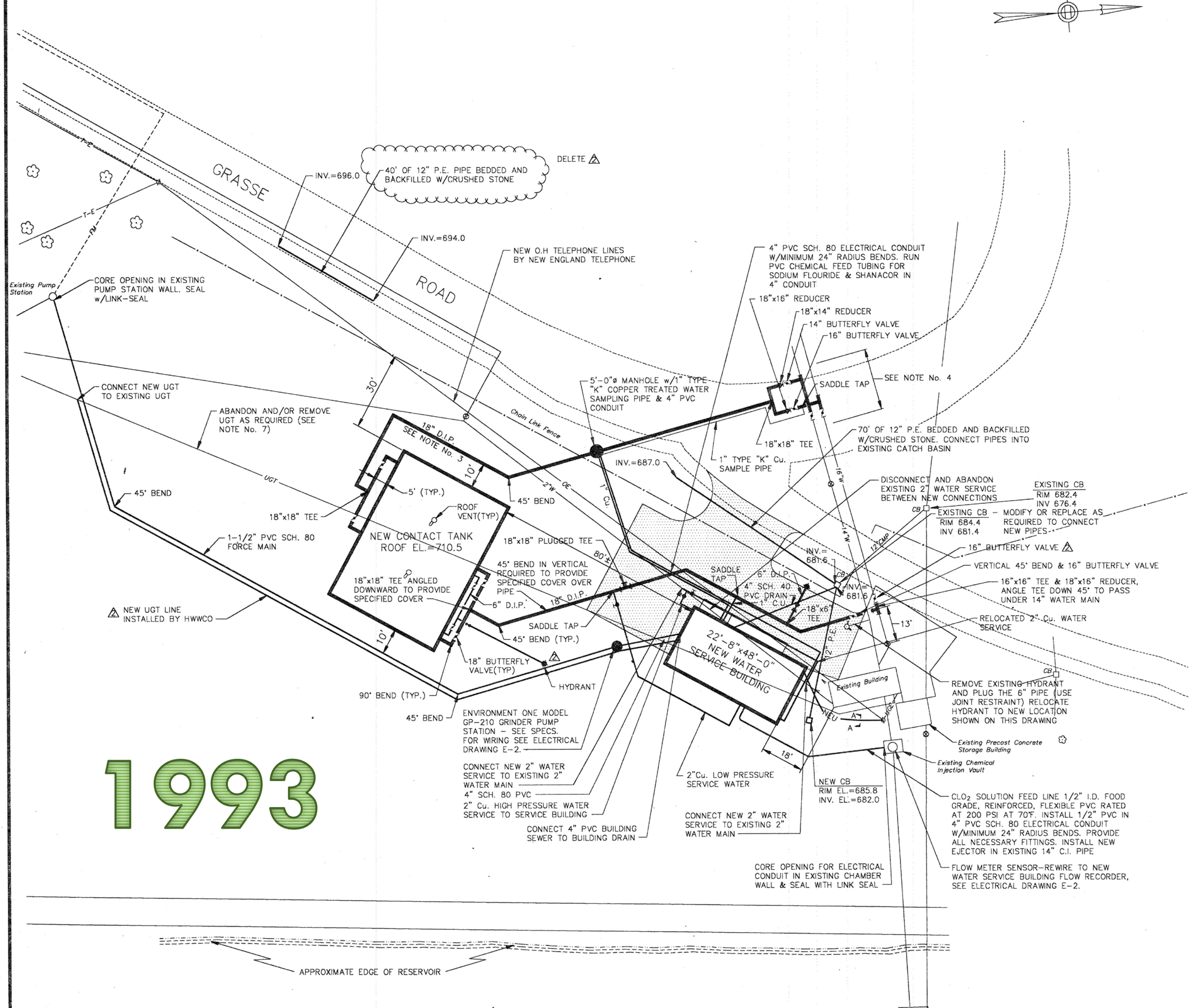
WESTON & SAMPSON

CONSULTING ENGINEERS

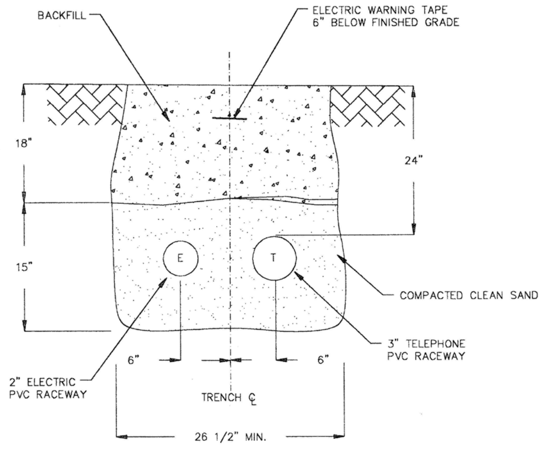
BOSTON, MASS.

18/29

1962



1993



SECTION A–A

NOTES:

1. SEE SHEET No. C–1 FOR GENERAL NOTES & LEGEND.
2. THE CONTRACTOR SHALL MAINTAIN FLOW IN EITHER THE 14" OR 16" WATER MAINS AT ALL TIMES. NO WATER MAIN SHALL BE REMOVED FROM SERVICE WITHOUT WRITTEN APPROVAL FROM HANOVER WATER WORKS CO.
3. DEFLECT PIPE JOINTS OR PROVIDE ADDITIONAL PIPE BENDS IN VERTICAL PLANE AS REQUIRED TO MAINTAIN THE SPECIFIED COVER OVER THE PIPE.
4. NEW VALVE INSTALLATION & PIPE CONNECTIONS ARE TO BE MADE IN THE DRY. REMOVE SECTIONS OF 14" & 16" PIPE AS REQUIRED AND REPLACE WITH NEW PIPE & FITTINGS. (SEE NOTE No. 10 ABOVE). INVERT ELEVATION OF 14" PIPE SHALL BE LOWERED TO ALLOW NEW 18" CONNECTION TO 16" PIPE TO PASS OVER IT.
5. DRAIN LINE FROM WATER SERVICE BUILDING TO CATCH BASIN TO BE 3'–0" BELOW GRADE.
6. 4" PVC CONDUIT TO BE BURIED 5'–0" BELOW GRADE AND BE SCHEDULE 80 ELECTRICAL CONDUIT WITH 24" RADIUS BENDS. INSTALL A PULLING WIRE AT TIME OF INSTALLATION.
7. COPPER SAMPLE PIPE TO BE BURIED 5'–0" BELOW GRADE.
8. PIPE RESTRAINT SHALL BE ACCOMPLISHED BY USING JOINT RESTRAINTS.
9. REFER TO ELECTRICAL DRAWINGS FOR CONDUIT SIZE AND WIRE FOR NEW UNDERGROUND ELECTRIC LINES.

CONTRACT NO.1

CHLORINE DIOXIDE DISINFECTION SYSTEM

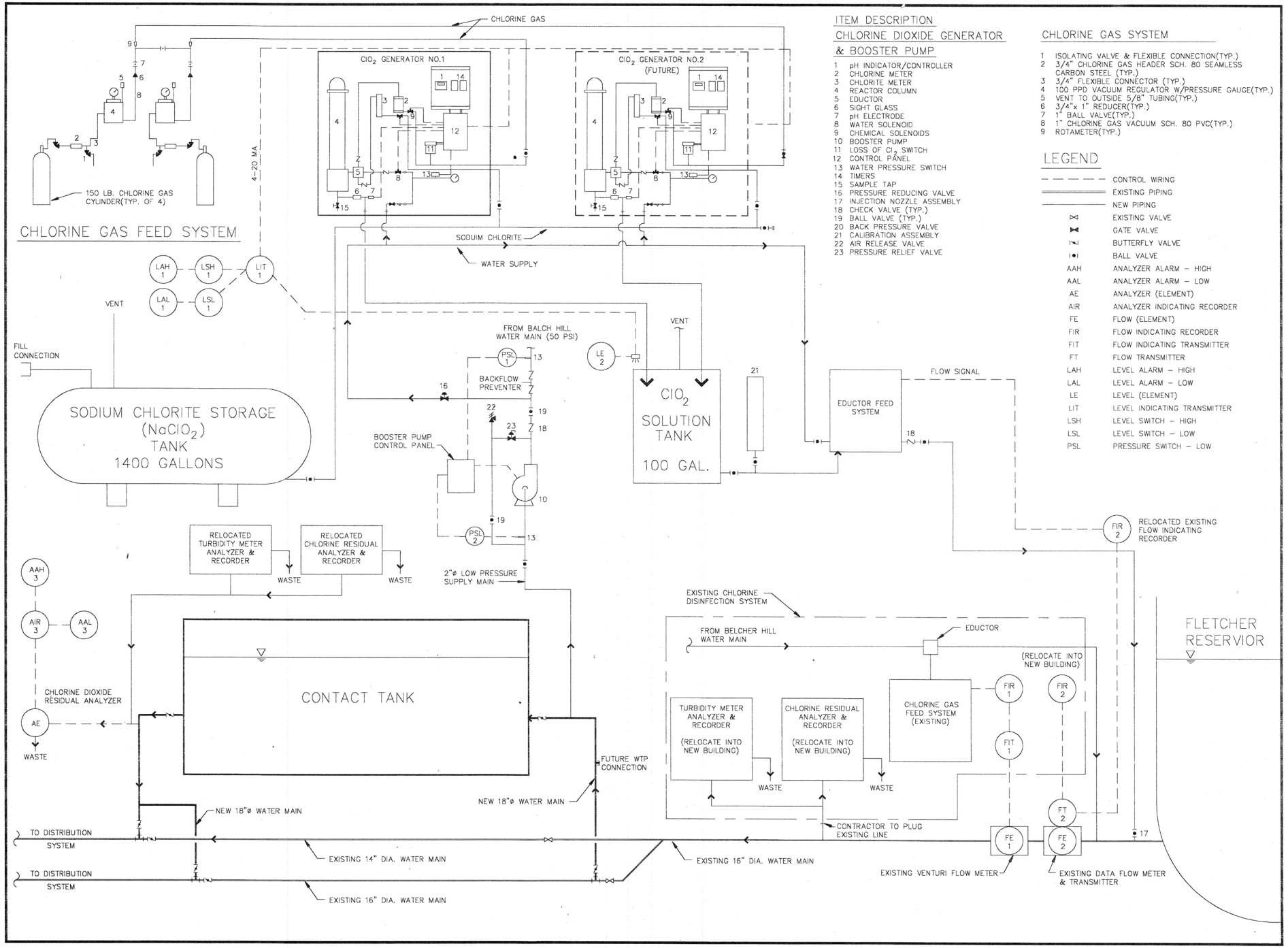
HANOVER WATER WORKS COMPANY
HANOVER, NEW HAMPSHIRE

Anderson-Nichols
engineers
environmental consultants
architects
BOSTON, MA

Proj. No.	6948
Scale	1"=20'
Desn. By	PJF
Drn. By	DSG
Chkd. By	EPD
Appd. By	SAC
Date	MAY 21, 1993

Date	Description
9/93	REVISED PER ADDENDUMS/CHANGE ORDER No. 1

UTILITY RELOCATION & PIPING PLAN



ITEM DESCRIPTION

CHLORINE DIOXIDE GENERATOR & BOOSTER PUMP

1 pH INDICATOR/CONTROLLER
2 CHLORINE METER
3 CHLORITE METER
4 REACTOR COLUMN
5 EDUCTOR
6 SIGHT GLASS
7 pH ELECTRODE
8 WATER SOLENOID
9 CHEMICAL SOLENOIDS
10 BOOSTER PUMP
11 LOSS OF Cl_2 SWITCH
12 CONTROL PANEL
13 WATER PRESSURE SWITCH
14 TIMERS
15 SAMPLE TAP
16 PRESSURE REDUCING VALVE
17 INJECTION NOZZLE ASSEMBLY
18 CHECK VALVE (TYP.)
19 BALL VALVE (TYP.)
20 BACK PRESSURE VALVE
21 CALIBRATION ASSEMBLY
22 AIR RELEASE VALVE
23 PRESSURE RELIEF VALVE

CHLORINE GAS SYSTEM

1 ISOLATING VALVE & FLEXIBLE CONNECTION(TYP.)
2 3/4" CHLORINE GAS HEADER SCH. 80 SEAMLESS CARBON STEEL (TYP.)
3 3/4" FLEXIBLE CONNECTOR (TYP.)
4 100 PPD VACUUM REGULATOR W/PRESSURE GAUGE(TYP.)
5 VENT TO OUTSIDE 5/8" TUBING(TYP.)
6 3/4"x 1" REDUCER(TYP.)
7 1" BALL VALVE(TYP.)
8 1" CHLORINE GAS VACUUM SCH. 80 PVC(TYP.)
9 ROTAMETER(TYP.)

LEGEND

CONTROL WIRING
EXISTING PIPING
NEW PIPING
EXISTING VALVE
GATE VALVE
BUTTERFLY VALVE
BALL VALVE
AAH ANALYZER ALARM – HIGH
AAL ANALYZER ALARM – LOW
AE ANALYZER (ELEMENT)
AIR ANALYZER INDICATING RECORDER
FE FLOW (ELEMENT)
FIR FLOW INDICATING RECORDER
FIT FLOW INDICATING TRANSMITTER
FT FLOW TRANSMITTER
LAH LEVEL ALARM – HIGH
LAL LEVEL ALARM – LOW
LE LEVEL (ELEMENT)
LIT LEVEL INDICATING TRANSMITTER
LSH LEVEL SWITCH – HIGH
LSL LEVEL SWITCH – LOW
PSL PRESSURE SWITCH – LOW

CONTRACT NO.1
CHLORINE DIOXIDE DISINFECTION SYSTEM
HANOVER WATER WORKS COMPANY
HANOVER, NEW HAMPSHIRE

Anderson-Nichols
engineers
environmental consultants
architects
BOSTON, MA

Rev.	Date	Description
2	9/93	REVISED PER ADDENDUMS/CHANGE ORDER No. 1

Proj.No. 6948
Scale NONE
Drawn By PJF
Des. By DSG
Chkd. By EPD
Appd. By SAC
Date MAY 21, 1993

PROCESS SCHEMATIC

Plate No.
PI-1


MANUAL
DECREASE
INCREASE

Town of Hanover
Hanover Water Company
Water Quality Parameters

Turbidity (NTU)

As of 5/19/04

Date	Raw	Contact Tank	Kendal CRREL	Fire Station	Kellogg Building	Fairbanks	Food Stop	Hopkins Center	High School COMMUNITY CENTER
01/06/04	0.79	1.01	0.96	1.04	1.02	1.22	0.98	1.49	1.06
01/20/04	0.63	0.83	0.89	0.74	0.67	0.70	0.64	*5.63	0.77
02/03/04	0.69	1.12	0.82	0.82	0.87	0.91	0.92	1.19	0.99
02/19/04	0.92	0.96	1.11	1.14	1.00	0.89	1.08	1.89	0.87
03/02/04	0.61	0.75	1.00	0.78	0.83	0.83	1.39	1.54	0.89
03/23/04	0.56	0.99	0.75	0.96	0.66	0.86	0.91	1.64	0.80
04/06/04	1.02	1.38	1.13	1.18	1.53	1.48	1.11	1.84	0.98
04/20/04	1.13	1.30	1.36	1.38	1.66	1.63	1.52	2.25	1.42
05/03/04	1.27	1.61	1.20	1.29	2.17	1.08	1.19	1.24	0.95
05/19/04	0.69	0.79	0.77	0.66	0.74	0.81	0.65	1.15	0.88
06/01/04	0.87	0.81	0.95	0.84	0.99	0.88	1.05	1.10	0.76
06/15/04	0.92	0.89	0.99	1.16	1.27	0.80	1.00	0.91	0.79
07/06/04	0.94	1.10	1.69	1.19	1.05	1.10	1.13	1.26	1.53
07/21/04	0.86	0.78	0.99	0.88	0.87	0.80	0.92	1.36	0.79
08/10/04	0.98	0.82	1.38	0.86	0.87	0.80	0.81	1.16	0.77
08/17/04	0.68	0.59	0.83	0.64	0.91	0.89	0.68	1.20	0.82
09/07/04	0.69	0.71	0.92	0.65	0.70	0.60	0.65	1.36	0.68
09/21/04	0.85	0.67	1.07	1.14	0.84	0.77	0.88	1.03	1.05
10/04/04	1.05	0.95	0.83	0.77	0.89	0.83	0.81	1.05	0.86
10/19/04	1.17	1.33	1.44	1.40	1.37	1.23	1.36	1.55	1.19
11/09/04	1.21	1.29	1.31	1.30	1.29	1.18	1.29	0.14	1.09
11/23/04	0.72	0.89	1.18	0.95	1.04	0.96	0.90	0.96	1.05
12/14/04	0.84	0.81	0.96	0.87	0.93	0.81	0.83	1.05	0.85
12/21/04	0.79	0.95	0.94	0.89	0.95	0.96	0.90	0.95	0.91
Average	0.87	0.97	1.06	0.98	1.05	0.96	0.98	1.27	0.95
High	1.27	1.61	1.69	1.38	2.17	1.63	1.52	2.25	1.53
Low	0.56	0.75	0.75	0.66	0.66	0.70	0.64	0.91	0.76

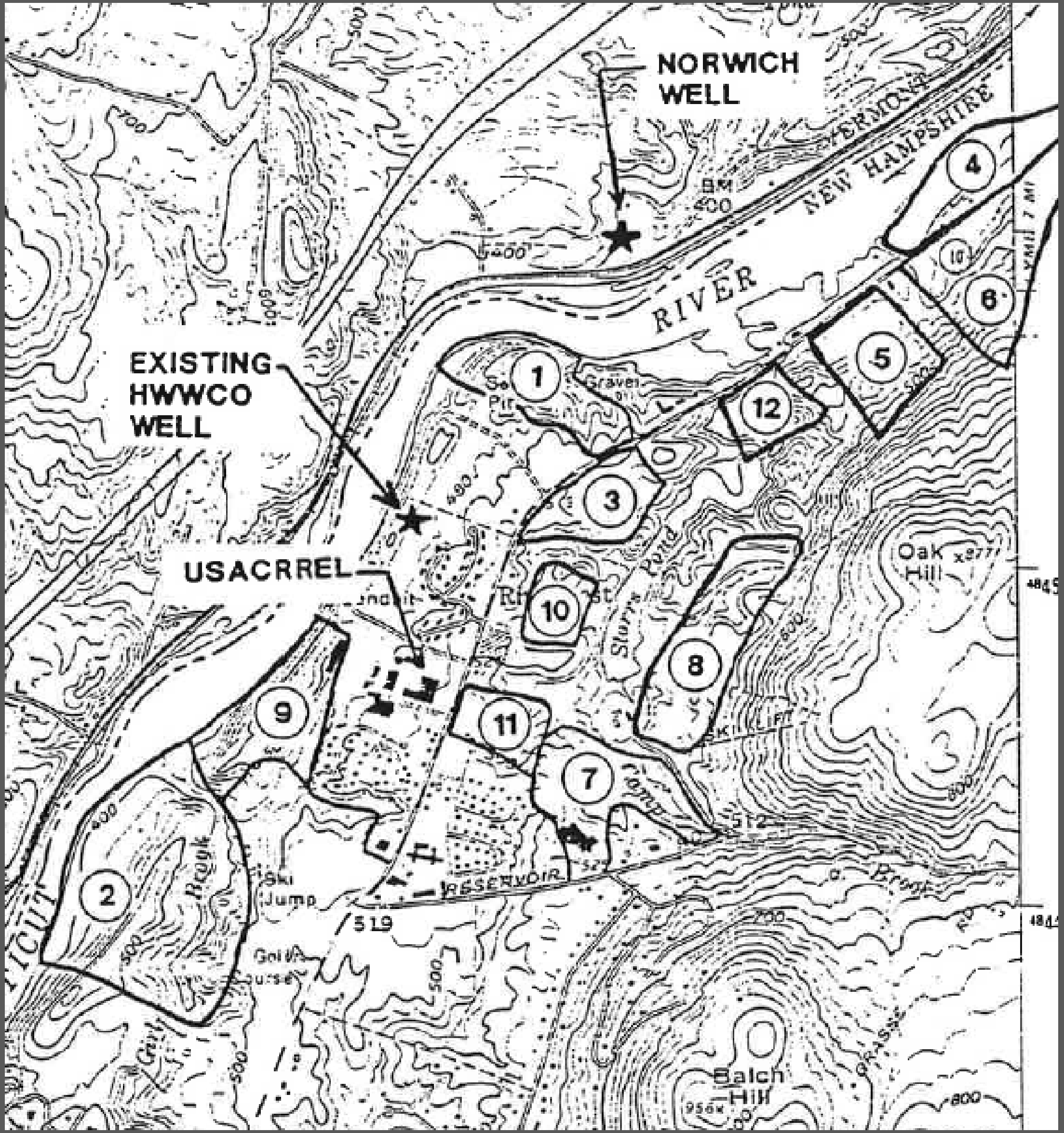
Still had the following issues

- TASTE AND ODOR COMPLAINTS
- COMPLIANCE WITH THE LEAD AND COPPER RULE
- COMPLIANCE WITH CURRENT AND PROPOSED SURFACE WATER RULES AND REGULATIONS.
- SAFE YIELD REDUCED DUE TO REQUIRED CHLORINE CONTACT REQUIREMENTS AND NO POST TREATMENT STORAGE IN THE MAIN SYSTEM

Options considered:

No Filtration
Ground Water – TCE present in ground water near CRREL, high iron & manganese.
Conventional Filtration – more economical > 10 MGD, higher capital cost and larger land area required.
Slow Sand Filtration, color < 10, < 5 NTU, ineffective at removal of TOC, can get higher with Granular Activated Carbon (GAC) and pre-ozonation
Package Filtration packaged mixed media – 10 NTU limit, alkalinity < 20 mg/l, color < 60
Membrane filtration – 6 log removal of giardia & cryptosporidium, color, iron & manganese, THM precursors, TOC, 0.1micron pore size. Effective at removing higher turbidity levels (450 NTU)

- Limited land area to construct a facility
- A need to maximize yield due to safe yield conclusions
- Address present and scheduled future federal and state surface water treatment and disinfection-by-product rules and regulations
- Address Taste and Odor
- Cost
- Desire to minimize staff requirements


NORWICH
WELL
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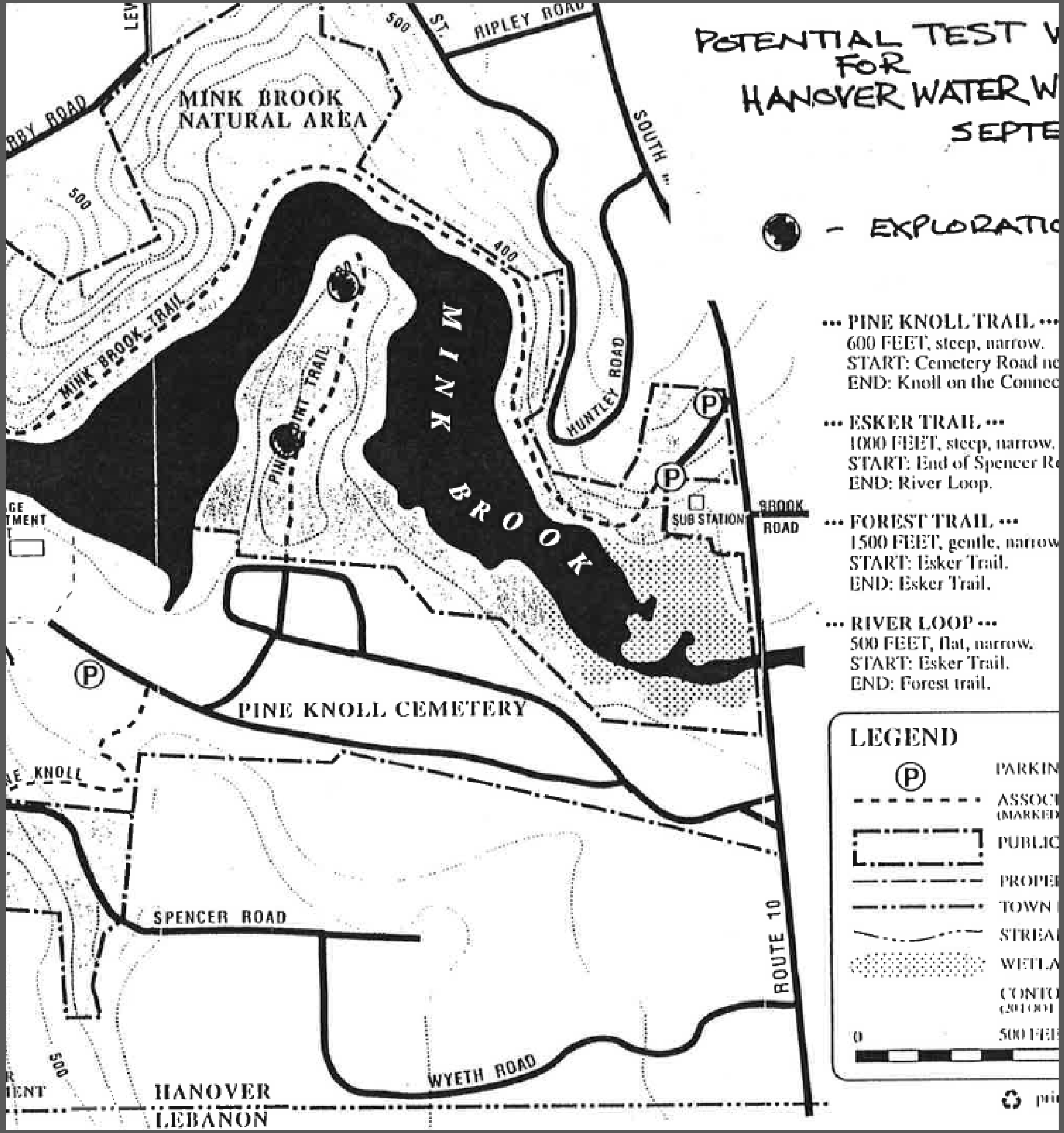

POTENTIAL TEST W
FOR
HANOVER WATER W
SEPTE
- EXPLORATIO
MINK BROOK
NATURAL AREA
MINK BROOK
MINK BROOK TRAIL
PINE KNOLL CEMETERY
SPENCER ROAD
WYETH ROAD
HUNTLEY ROAD
RIPLEY ROAD
ROUTE 10
SUB STATION
BROOK
ROAD
HANOVER
LEBANON
••• PINE KNOLL TRAIL •••
600 FEET, steep, narrow.
START: Cemetery Road ne
END: Knoll on the Connec
••• ESKER TRAIL •••
1000 FEET, steep, narrow.
START: End of Spencer Ro
END: River Loop.
••• FOREST TRAIL •••
1500 FEET, gentle, narrow
START: Esker Trail.
END: Esker Trail.
••• RIVER LOOP •••
500 FEET, flat, narrow.
START: Esker Trail.
END: Forest trail.
LEGEND
PARKIN
ASSOC
(MARKED
PUBLIC
PROPE
TOWN
STREA
WETLA
CONTO
0
500 FEE

Filtration Technology Comparison

- Kinetico Pressure Vessel Filtration System
- U.S. Filter Microfloc “Trident” System
- Pall Membrane “Aria” Microfiltration System

Screening and Rank of Alternatives

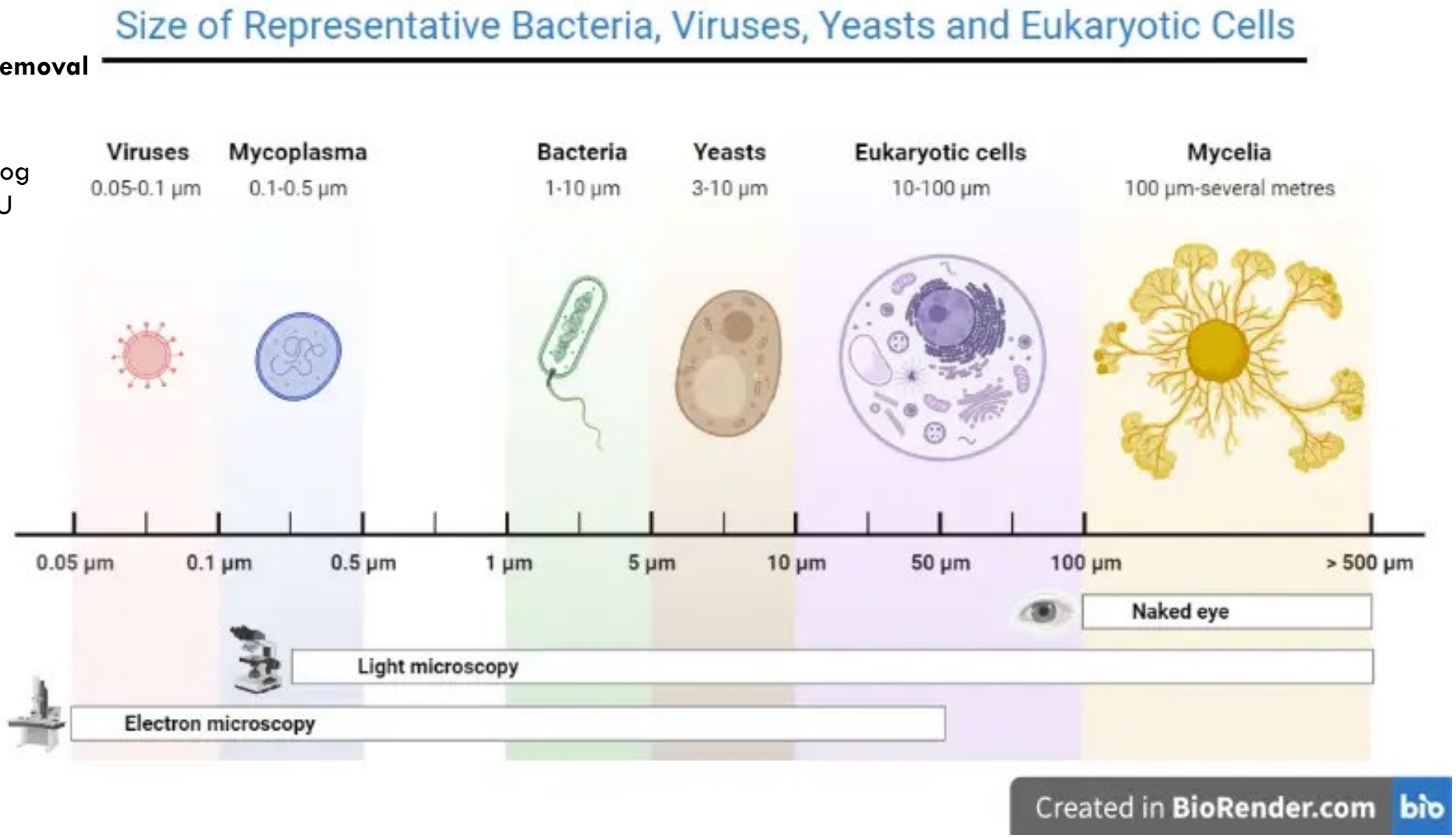
Criteria	Points	*OPTION 1* KINETICO FILTRATION[1]	*OPTION 2* PACKAGED MICROFLOC[1]	*OPTION 3* MEMBRANE MICRO FILTRATION
Health and Safety	1-5	5	5	5
Equipment Cost	1-5	2	3	4
O & M Cost	1-5	2	3	4
Meets LT2SWTR Rule	1-5	4	4	5
Addresses Primary Contaminant Issues	1-5	4	4	4
Meets Disinfection By-Product Rule	1-5	4	4	4
Additional Land Required	1-5	4	4	5
Water Use Efficiency	1-5	4	4	4
Ease of Operation	1-5	3	3	4
Power Requirements	1-5	4	4	2
Hazardous Chemical Handling	1-5	4	4	3
Waste Generation	1-5	3	3	4
Totals	**12-60**	**43**	**45**	**48**

Primary Contaminant Treatment Comparison

Contaminant	MF Removal	Package Treatment Removal
Viruses	1-2.5 log	1-log
Cryptosporidium Oocysts	6-log	2.5-3.0-log
Giardia Cysts	6-log	2.5-log
Fecal Coliforms	6-log	3.0-4.0-log
Turbidity	0.04-0.1 NTU	0.08-0.3 NTU
Dissolved Metals	1.0-2.0-log	1.0-2.0-log
Dissolved Natural Organic Matter	40-60 Percent	40-70 Percent

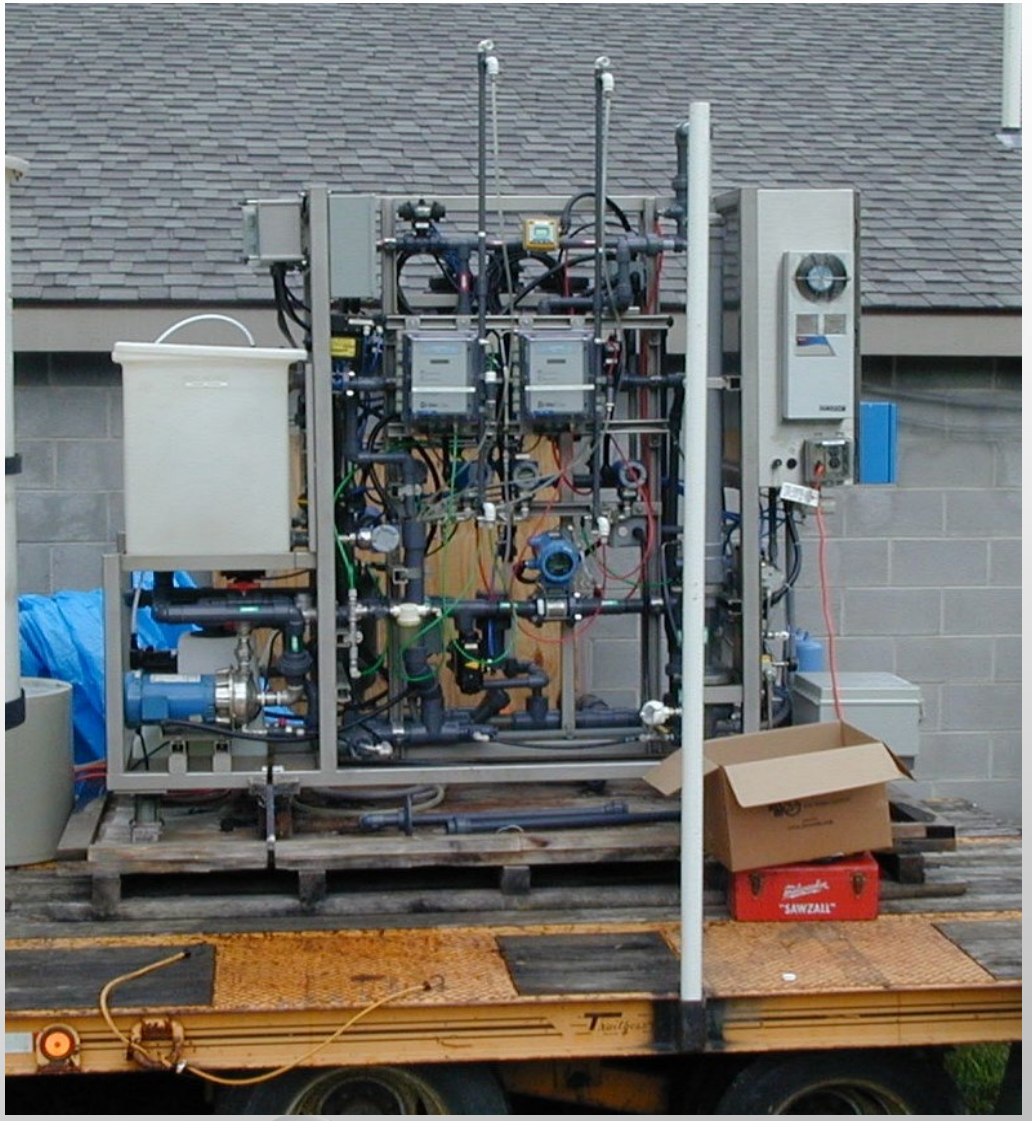
Membrane Filtration

Contaminate	**Typical removal**
Giardia	> 6 log
Cryptosporidum	> 6 log
E. Coli	0.5 - 3 log
Turbidity	<0.1 NTU



US Filter Memcor

Pall Aria



PARALLEL PILOTS

PRETREATMENT AND COMPRESSOR SYSTEM

PHASE 1 (NO PRETREATMENT) LAB RESULTS

PARAMETER	FEED WATER		PALL AND U.S. FILTER FILTRATE	
	Concentration Range	Average Concentration	Concentration Range	Average Concentration
Turbidity (NTU)	0.331 – 0.421	0.367	0.021 – 0.027	0.024
Color (CU)	3 – 23	11.6	0 – 21	9.5
Iron (mg/L)	0.02 – 0.05	0.04	0.00 – 0.01	0.004
Manganese (mg/L)	0.006 – 0.078	0.015	0.000 – 0.007	0.001
Hardness (mg/L)	18– 21	19.4	17 – 22	19.7
TDS (mg/L)	43-49	45.9	41 – 48	42.3
Alkalinity (mg/L)	12.0 – 18.5	14.6	13.5 – 15.0	14.4
pH	6.8 – 7.5	7.05	6.9 – 7.4	7.08

PARAMETER

- Both filters provide similar filtered water quality results
- Both filters utilize an air scrub and backwash process.
- **Pall Aria** utilizes two additional cleaning processes a heated chlorinated water soak and rinse and a Clean in Place (CIP). The CIP utilizes citric acid and caustic soda allowing for longer filter runs reducing operating costs and longer lasting membranes.
- **Pall Aria** was chosen based on the lower maintenance costs, more effective filter cleaning, and less required operator interaction.

Raw water filtered without coagulant

TABLE B-5
Phase 1 Daily Water Quality Data
On Site Analysis – August 26 through September 15, 2003

Date	Turbidity		Color		Iron		Manganese		Alkalinity		pH	
	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate
8/26/03	0.419	0.021	6	0	0.03	0.00	0.078	0.000	16	15	7.22	7.23
8/27/03	0.421	0.021	13	15	0.04	0.01	0.009	0.001	14	14	6.85	6.98
8/28/03	0.377	0.022	14	12	0.03	0.00	0.014	0.007	13	13.5	7.12	7.25
8/29/03	0.372	0.027	7	10	0.05	0.00	0.011	0.001	12	14.5	6.95	7.02
9/02/03	0.339	0.021	7	0	0.02	0.00	0.019	0.001	15	15.5	7.13	7.10
9/03/03	0.351	0.022	18	17	0.05	0.01	0.012	0.000	14.5	13.5	6.83	6.88
9/04/03	0.337	0.027	15	9	0.04	0.01	0.009	0.001	13.5	14.5	7.16	6.93
9/05/03	0.353	0.021	12	10	0.04	0.01	0.008	0.001	15	15	6.72	6.87
9/08/03	0.331	0.021	9	14	0.03	0.00	0.009	0.001	15	14.5	6.84	6.75
9/09/03	0.342	-	10	-	0.04	-	0.011	-	14.5	-	6.81	-
9/10/03	0.358	0.027	3	3	0.04	0.01	0.006	0.001	18.5	14.0	7.35	7.37
9/11/03	0.370	0.027	21	3	0.03	0.00	0.010	0.001	15.0	14.5	7.52	7.42
9/12/03	0.383	0.027	5	21	0.03	0.00	0.010	0.001	15.0	14.0	7.18	7.26
9/15/03	0.387	0.027	23	10	0.03	0.00	0.010	0.001	15.0	15.0	7.02	6.96
Average	0.367	0.024	11.6	9.5	0.04	0.004	0.015	0.001	14.6	14.4	7.05	7.08

Phase 1 Lab results

Parameter	Location		
	Raw Water	Pall MF Filtrate	US Filter MF Filtrate
Total Suspended Solids (mg/L)	<4	<4	<4
Color (CU)	15	5	5
Total Iron (mg/L)	0.09	<0.02	0.03
Total Manganese (mg/L)	0.04	0.03	<0.02
Total Organic Carbon (mg C/L)	4.2	4.0	4.3
Dissolved Organic Carbon (mg C /L)	4.8	3.8	3.7
THM Formation Potential (ppb)	103.6	-	90.7
Total Coliforms	Present	Absent	Absent
E. Coli	Present	Absent	Absent

PHASE 2 (PRETREATMENT WITH PACL) RESULTS

Parameter	Feed Water		Pall and U.S. Filter Filtrate	
	Concentration Range	Average Concentration	Concentration Range	Average Concentration
Turbidity (NTU)	1.307 – 10.72	2.393	0.026 - 0.033	0.028
Color (CU)	1 - 23	15.8	0	0
Iron (mg/L)	0.06 – 0.19	0.10	0.00 – 0.02	0.01
Manganese (mg/L)	0.006 – 0.154	0.043	0.000 – 0.070	0.030
Hardness (mg/L)	16.5 – 20.1	18.2	16.0 – 19.0	18.1
TDS (mg/L)	35 - 37	35.3	42 - 46	43.5
Alkalinity (mg/L)	12.5 – 15.0	14.1	10.0 – 12.0	11.3
pH	6.42 – 6.98	6.69	6.22 – 6.96	6.65

PHASE 2 TOC RESULTS

Parameter	Location	
	Pall MF Raw Water	**Pall MF Filtrate**
Total Organic Carbon (mg C/L) (1.8 mg/L as AL)	3.3	1.9
Total Organic Carbon (mg C/L) (2.2 mg/L as AL)	3.4	1.8

Table B-10
Phase 2 Daily Water Quality Data
On Site Analyses – October 7 through November 6, 2003

Date	Turbidity		Color		Iron		Manganese		Alkalinity		pH	
	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate
Polyaluminum Chloride (Holland Co. PCH-101) Dosage Equals 10 mg/L as Aluminum												
10/07/03	1.134	0.022	24	5	0.13	0.00	0.052	0.068	7.0	7.0	6.64	6.53
10/08/03	1.253	0.020	28	6	0.10	0.00	0.052	0.067	15.0	7.6	6.78	6.63
10/09/03	1.758	0.021	16	2	0.22	0.01	0.037	0.056	14.0	14.0	6.61	6.32
10/10/03	1.134	0.021	18	4	0.19	0.01	0.039	0.052	14.5	14.5	6.65	6.61
10/11/03	1.184	0.020	5	0	0.10	0.00	0.046	0.058	6.5	7.0	6.57	6.48
10/12/03	1.067	0.020	9	0	0.12	0.02	0.050	0.054	9.5	8.0	6.71	6.48
10/13/03	1.125	0.020	12	4	0.19	0.00	0.057	0.054	6.5	6.5	6.22	6.22
Polyaluminum Chloride (Holland Co. PCH-180) Dosage Equals 5 mg/L as Aluminum												
10/20/03	1.173	0.020	18	0	0.15	0.00	0.043	0.040	7.5	5.5	6.55	6.36
10/21/03	0.834	0.020	25	0	0.17	0.01	0.031	0.001	-	-	6.65	7.00
10/22/03	1.108	0.021	11	0	0.11	0.00	0.020	0.037	8.0	9.0	6.34	6.37
10/23/03	1.205	0.021	16	0	0.14	0.02	0.027	0.034	8.5	9.0	6.74	6.68
10/24/03	1.685	0.021	11	0	0.16	0.00	0.014	0.031	10.5	11.5	7.22	7.07
10/27/03	2.440	0.021	4	0	0.09	0.00	0.013	0.010	11.0	10.0	6.51	6.50
10/28/03	0.985	0.021	27	13	0.10	0.00	0.015	0.038	11.5	10.0	6.53	6.57
10/29/03	1.211	0.021	17	0	0.11	0.01	0.113	0.037	11.0	9.5	6.29	6.48
10/30/03	1.110	0.021	14	8	-	-	0.032	0.036	-	-	6.75	6.76
10/31/03	2.719	0.021	52	0	-	-	0.038	0.029	-	-	6.55	6.64
11/03/03	1.164	0.021	28	0	0.11	0.00	0.029	0.039	13.0	13.0	7.02	6.94
11/05/03	3.261	0.021	61	12	0.22	0.00	0.040	0.037	14.5	12.5	7.27	7.21
11/06/03	1.642	0.021	17	0	0.11	0.00	0.044	0.034	-	17.0	6.97	7.05

Phase 2 addition of PAC for disinfection byproduct and color removal

Table B-11
Phase 2 Daily Water Quality Data
On Site Analysis – December 6 through 17, 2003

Date	Turbidity		Color		Iron		Manganese		Alkalinity		pH	
	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate	Feed	Filtrate
Polyaluminum Chloride (Holland Co. PCH-180) Dosage Equals 2.2 mg/L as Aluminum												
12/06/03	1.597	0.027	23	0	0.18	0.00	0.051	0.070	12.5	10.0	6.42	6.38
12/07/03	1.455	0.026	12	0	0.11	0.02	0.154	0.034	14.0	11.0	6.74	6.71
12/08/03	1.616	0.026	18	0	0.06	0.00	0.026	0.028	14.0	10.5	6.55	6.60
12/09/03	1.436	0.026	1	0	0.07	0.01	0.006	0.000	14.0	11.0	6.93	6.78
12/10/03	10.72	0.026	14	0	0.08	0.00	0.042	0.032	14.5	12.0	6.98	6.97
12/11/03	1.787	0.027	22	0	0.19	0.02	0.028	0.028	13.5	12.0	6.96	6.96
Polyaluminum Chloride (Holland Co. PCH-180) Dosage Equals 1.8 mg/L as Aluminum												
12/12/03	1.387	0.031	15	0	0.08	0.00	0.020	0.022	14.0	11.0	6.74	6.69
12/15/03	1.310	0.033	16	0	0.08	0.00	0.037	0.029	15.0	12.0	6.57	6.55
12/16/03	1.316	0.031	20	0	0.08	0.01	0.030	0.028	14.5	11.0	6.44	6.22
12/17/03	1.307	0.031	17	0	0.09	0.00	0.034	0.024	15.0	12.0	6.54	6.59
Average	2.393	0.028	15.8	0	0.10	0.01	0.043	0.030	14.1	11.3	6.69	6.65

Phase 2 addition of PAC for disinfection byproduct and color removal

based on pilot expected 30 hrs at 1.8-2.2 mg/l of PAC before CIP

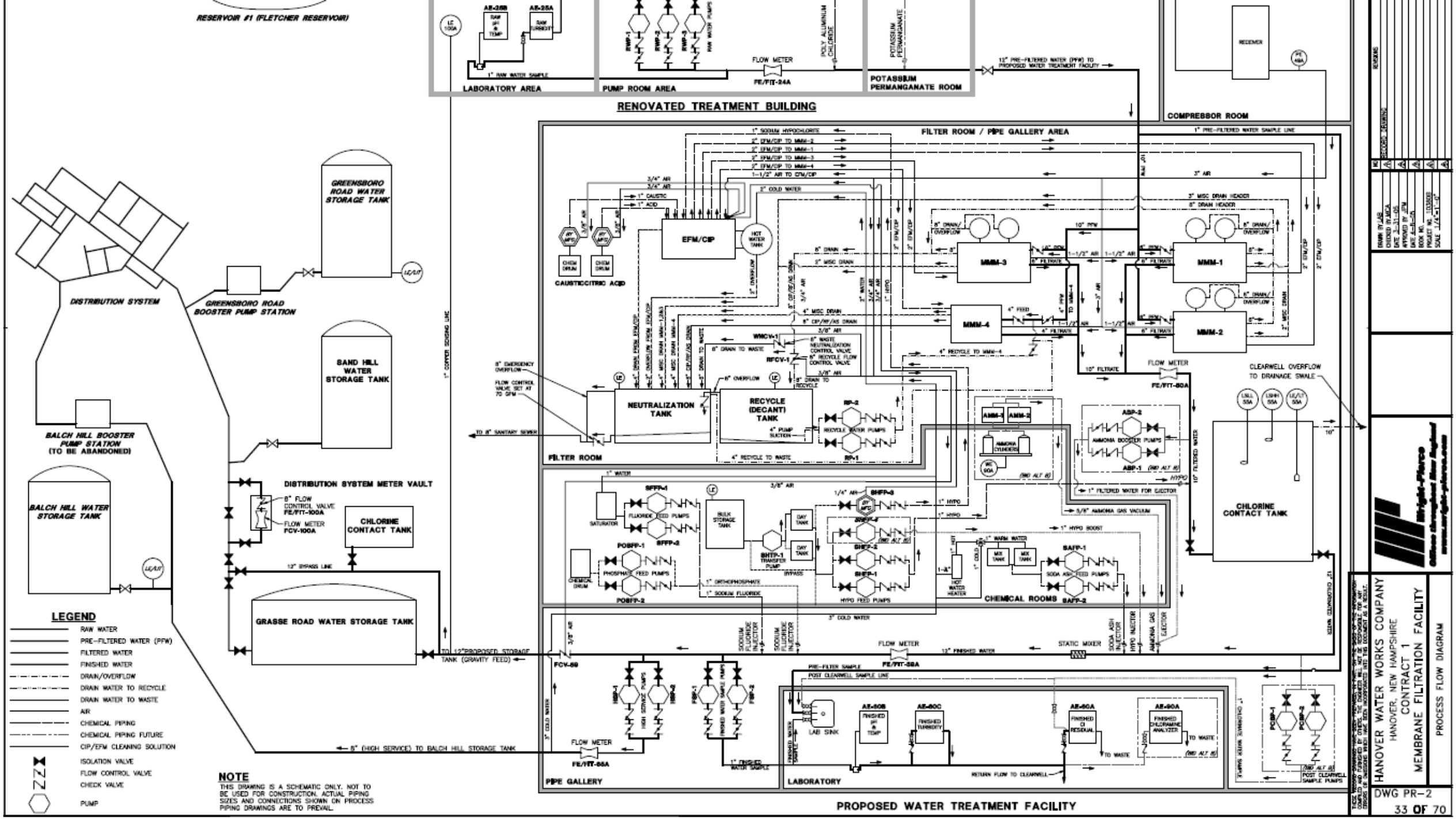
DURING DESIGN THIS HAPPENED

JUNE 10, 2005

Town of Hanover
Hanover Water Company
Water Quality Parameters

Turbidity (NTU)

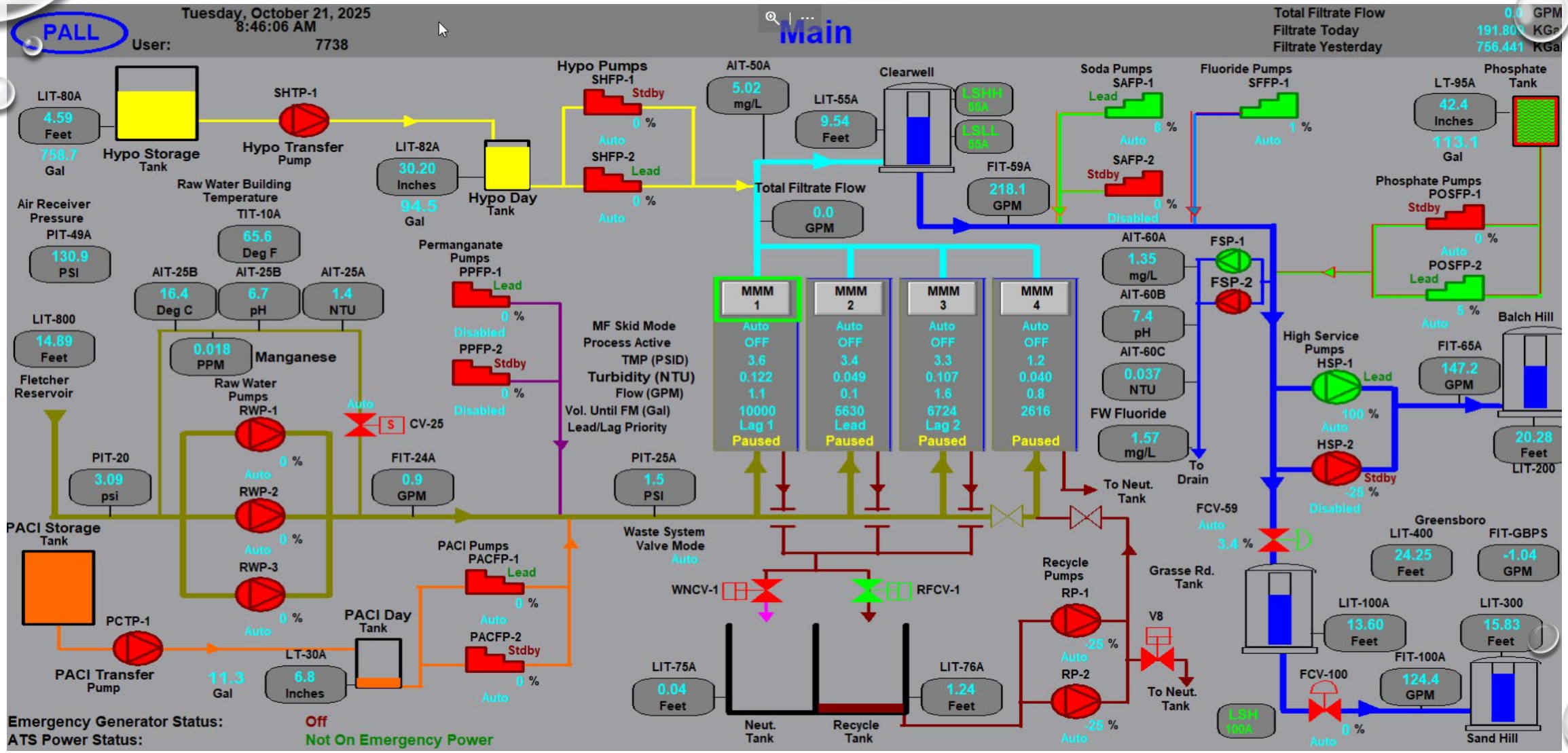
Date	Raw	Contact Tank	CRREL	Fire Station	Kellogg Building	Fairbanks	Food Stop	Hopkins Center	High School
01/04/05	0.57	0.77	0.88	0.83	1.03	0.84	0.85	0.99	1.06
01/26/05	0.57	0.78	0.87	0.76	0.81	0.86	0.82	0.82	0.79
02/01/05	0.73	0.84	0.96	0.84	0.99	0.92	0.91	0.99	0.75
02/23/05	0.47	0.80	0.86	0.90	0.84	0.87	0.82	0.78	0.76
03/08/05	0.41	0.56	0.81	0.85	0.62	0.77	0.60	0.68	0.69
03/22/05	0.57	0.56	0.76	0.52	0.57	0.58	0.52	0.59	0.49
04/05/05	1.58	2.09	1.78	1.84	1.86	1.78	1.74	1.72	0.71
04/21/05	1.90	1.64	1.98	3.51	1.88	1.73	1.56	1.79	1.59
05/04/05	1.14	1.21	1.30	1.12	1.15	1.10	1.02	1.37	1.15
05/18/05	0.63	0.57	0.73	0.55	0.75	0.55	0.53	0.69	0.57
06/01/05	0.77	0.70	0.71	0.66	0.68	0.68	0.60	0.86	0.67
06/13/05	46.00	9.25	22.20	13.10	21.30	17.90	12.70	16.50	4.53
07/12/05	5.18	4.14	6.08	8.86	12.00	4.54	4.17	4.68	3.77
07/25/05	1.81	2.54	2.85	2.38	5.46	2.77	3.07	2.99	2.12
08/02/05	NA	NA	NA	NA	NA	NA	NA	NA	NA
08/23/05	0.93	1.30	3.82	1.75	1.97	3.16	2.19	1.04	2.26
09/06/05	1.22	0.88	1.38	1.00	1.59	0.96	1.24	1.14	1.20
09/20/05	1.75	1.08	5.19	2.86	1.02	0.93	1.58	1.40	0.89
10/06/05	0.95	0.83	2.37	2.47	1.25	2.06	1.32	1.53	0.73
10/26/05	1.46	1.68	2.02	1.71	1.57	1.77	1.78	1.95	1.27
11/01/05	1.48	1.51	1.60	1.50	1.48	1.47	1.50	1.62	1.55
11/15/05	NA	NA	NA	NA	NA	NA	NA	NA	NA
12/06/05	3.25	1.56	2.11	1.86	3.15	1.78	2.11	3.65	1.04
12/15/05	1.34	1.35	1.92	1.59	1.56	1.30	1.72	2.26	1.07
Average	3.40	1.67	2.87	2.34	2.89	2.24	1.97	2.27	1.35
High	46.00	9.25	22.20	13.10	21.30	17.90	12.70	16.50	4.53
Low	0.41	0.56	0.71	0.52	0.57	0.55	0.52	0.59	0.49


RESERVOIR #1 (FLETCHER RESERVOIR)
LABORATORY AREA
PUMP ROOM AREA
POTASSIUM PERMANGANATE ROOM
COMPRESSOR ROOM
RENOVATED TREATMENT BUILDING
FILTER ROOM / PIPE GALLERY AREA
FILTER ROOM
PIPE GALLERY
LABORATORY
CHEMICAL ROOMS
CHLORINE CONTACT TANK
NEUTRALIZATION TANK
RECYCLE (DECANT) TANK
EFM/CIP
MMM-1
MMM-2
MMM-3
MMM-4
FLOW METER FE/FIT-24A
FLOW METER FE/FIT-50A
FLOW METER FE/FIT-55A
FLOW METER FE/FIT-59A
CLEARWELL OVERFLOW TO DRAINAGE SWALE
12" PRE-FILTERED WATER (PFW) TO PROPOSED WATER TREATMENT FACILITY
PROPOSED WATER TREATMENT FACILITY
DISTRIBUTION SYSTEM
GREENSBORO ROAD WATER STORAGE TANK
GREENSBORO ROAD BOOSTER PUMP STATION
SAND HILL WATER STORAGE TANK
BALCH HILL BOOSTER PUMP STATION (TO BE ABANDONED)
BALCH HILL WATER STORAGE TANK
DISTRIBUTION SYSTEM METER VAULT
8" FLOW CONTROL VALVE FE/FIT-100A
FLOW METER FCV-100A
CHLORINE CONTACT TANK
12" BYPASS LINE
GRASSE ROAD WATER STORAGE TANK
TO 12"PROPOSED STORAGE TANK (GRAVITY FEED)
8" (HIGH SERVICE) TO BALCH HILL STORAGE TANK
1" COPPER SENSING LINE
8" EMERGENCY OVERFLOW
FLOW CONTROL VALVE SET AT 70 GPM
TO 8" SANITARY SEWER
LEGEND
RAW WATER
PRE-FILTERED WATER (PFW)
FILTERED WATER
FINISHED WATER
DRAIN/OVERFLOW
DRAIN WATER TO RECYCLE
DRAIN WATER TO WASTE
AIR
CHEMICAL PIPING
CHEMICAL PIPING FUTURE
CIP/EFM CLEANING SOLUTION
ISOLATION VALVE
FLOW CONTROL VALVE
CHECK VALVE
PUMP
NOTE
THIS DRAWING IS A SCHEMATIC ONLY. NOT TO BE USED FOR CONSTRUCTION. ACTUAL PIPING SIZES AND CONNECTIONS SHOWN ON PROCESS PIPING DRAWINGS ARE TO PREWAIL.
HANOVER WATER WORKS COMPANY
HANOVER, NEW HAMPSHIRE
CONTRACT 1
MEMBRANE FILTRATION FACILITY
PROCESS FLOW DIAGRAM
DWG PR-2
33 OF 70


FILTERED
PRE TREATED WATER
DRAIN
WARNING
DRAIN


PALL


DRAIN


PALL
Tuesday, October 21, 2025
8:46:06 AM
User:
7738
Main
Total Filtrate Flow
Filtrate Today
Filtrate Yesterday
LIT-80A
4.59 Feet
758.7 Gal
Hypo Storage Tank
SHTP-1
Hypo Transfer Pump
LIT-82A
30.20 Inches
94.5 Gal
Hypo Day Tank
Hypo Pumps
SHFP-1
SHFP-2
Stdby
Lead
Auto
AIT-50A
5.02 mg/L
LIT-55A
9.54 Feet
Clearwell
LSHH
LSLL
FIT-59A
218.1 GPM
Total Filtrate Flow
0.0 GPM
Soda Pumps
SAFP-1
SAFP-2
Disabled
Fluoride Pumps
SFFP-1
LT-95A
42.4 Inches
113.1 Gal
Phosphate Tank
Phosphate Pumps
POSFP-1
POSFP-2
Air Receiver Pressure
PIT-49A
130.9 PSI
Raw Water Building Temperature
TIT-10A
65.6 Deg F
AIT-25B
16.4 Deg C
AIT-25B
6.7 pH
AIT-25A
1.4 NTU
Permanganate Pumps
PPFP-1
PPFP-2
Disabled
LIT-800
14.89 Feet
Fletcher Reservoir
0.018 PPM
Manganese
Raw Water Pumps
RWP-1
RWP-2
RWP-3
CV-25
MF Skid Mode
Process Active
TMP (PSID)
Turbidity (NTU)
Flow (GPM)
Vol. Until FM (Gal)
Lead/Lag Priority
MMM 1
MMM 2
MMM 3
MMM 4
Auto
OFF
3.6
0.122
1.1
10000
Lag 1
Paused
3.4
0.049
0.1
5630
Lead
Paused
3.3
0.107
1.6
6724
Lag 2
Paused
1.2
0.040
0.8
2616
Paused
AIT-60A
1.35 mg/L
AIT-60B
7.4 pH
AIT-60C
0.037 NTU
FW Fluoride
1.57 mg/L
FSP-1
FSP-2
To Drain
To Neut. Tank
High Service Pumps
HSP-1
HSP-2
Balch Hill
FIT-65A
147.2 GPM
20.28 Feet
LIT-200
PIT-20
3.09 psi
FIT-24A
0.9 GPM
PIT-25A
1.5 PSI
Waste System Valve Mode
FCV-59
Greensboro
LIT-400
24.25 Feet
FIT-GBPS
-1.04 GPM
PACI Storage Tank
PCTP-1
PACI Transfer Pump
11.3 Gal
LT-30A
6.8 Inches
PACI Day Tank
PACI Pumps
PACFP-1
PACFP-2
WNCV-1
RFCV-1
Recycle Pumps
RP-1
RP-2
V8
Grasse Rd. Tank
LIT-100A
13.60 Feet
LIT-300
15.83 Feet
FIT-100A
124.4 GPM
FCV-100
LSH 100A
Sand Hill
LIT-75A
0.04 Feet
Neut. Tank
Recycle Tank
LIT-76A
1.24 Feet
Emergency Generator Status:
Off
ATS Power Status:
Not On Emergency Power