CITY OF NIAGARA FALLS
DRINKING WATER TREATMENT PLANT

- **Assessment of Groundwater Table Contours and Geologic Conditions**

S-Area Remedial Program

June 1988
Ref. No. 1769

CONESTOGA-ROVERS & ASSOCIATES

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report reviews groundwater table elevation data and presents a groundwater table contour map of the City of Niagara Falls Water Treatment Plant (WTP). The mapping is used to identify groundwater mound conditions and assess whether such mounding is the result of leakage. The above work was conducted in accordance with Addendum I, sub-paragraph E(5)(a)&(b) of the "Stipulation and Judgment Approving Settlement Agreement," (hereinafter Judgment). This report also presents a brief summary of the WTP construction history, subsurface construction and the site hydrogeology. Figure 1 illustrates the WTP location in reference to the S-Area and OCC's Niagara Plant.

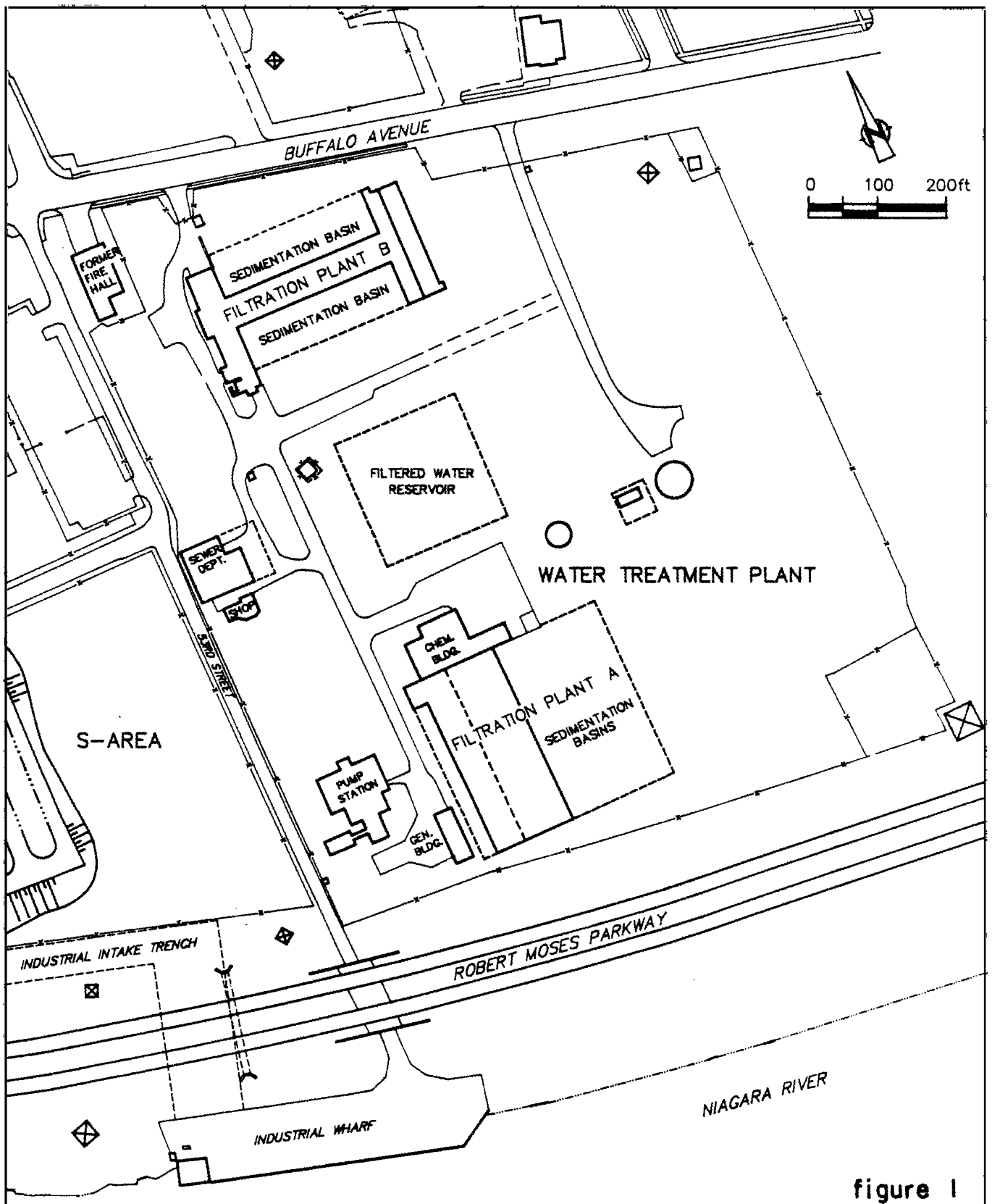


figure 1

NIAGARA FALLS WATER TREATMENT PLANT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

2.0 BACKGROUND

2.1 WATER TREATMENT PLANT CONSTRUCTION HISTORY

The original treatment facility, designated as Filtration Plant B, was constructed between 1908 and 1912, and consisted of a 48-inch diameter main intake line extending approximately 1,400 feet into the east branch of the Niagara River (East Branch Intake) and 16 - 1 million gallons per day (mgd) capacity filters.

From 1935 to 1937, the following major construction occurred:

1. Construction of a shore shaft and a river intake tunnel in the bedrock extending approximately 1720 feet to an intake structure in the east branch of the Niagara River (New East Branch Intake). Figure 2 shows a plan and profile view of the shore shaft and intake.

2. Expansion of Filtration Plant B with the addition of eight 2 mgd capacity filters.

3. Construction of a 54-inch diameter water line from the shore shaft to Filtration Plant B.

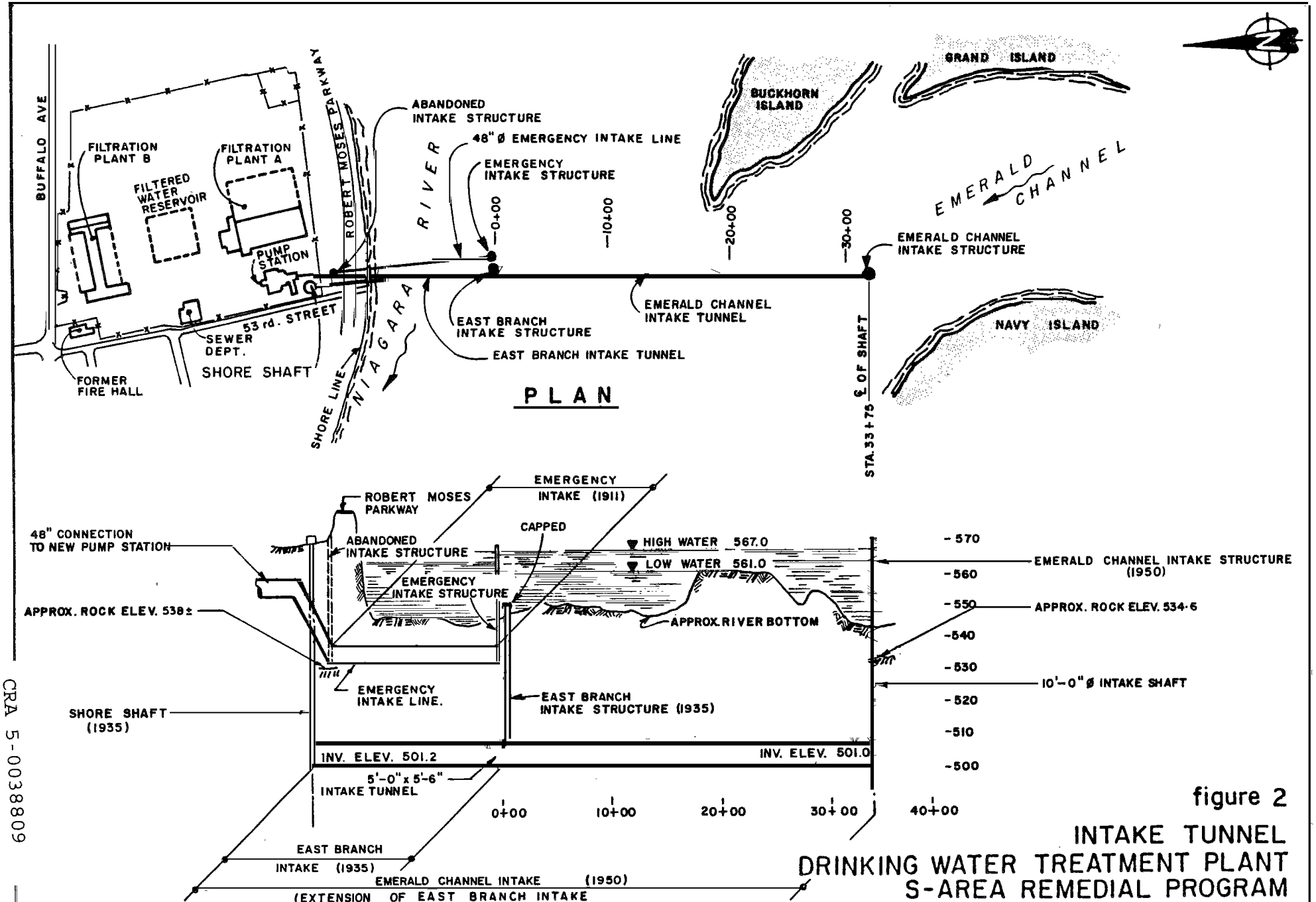


figure 2

INTAKE TUNNEL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

CRA 5-0038809

1769 - 5/05/88 - 34 - D - 1

The above construction replaced the East Branch Intake which had been constructed in 1911. The Old East Branch Intake has subsequently been renamed the Emergency Intake.

Completion of the construction in 1937 resulted in a capacity of 32 mgd.

In 1943, the water treatment facility was augmented by the construction of a 4,000,000-gallon underground Filtered Water Reservoir.

Sometime during the period 1943 to 1948, in order to augment the flow, a pump equipped with a 20-inch diameter service line was installed from the shore shaft to a valve chamber located on a 36-inch diameter raw water line.

From 1950 to the mid 1950s, the following construction occurred at the water treatment facility:

1. The New East Branch Intake constructed between 1935 and 1937 was extended approximately 3,580 feet to a new intake structure in the Emerald Channel. This new intake located between Navy Island and Buckhorn Island in the west branch of the Niagara River is known as the Emerald

Channel Intake. Figure 2 shows in plan and profile the shore shaft and tunnel out to the Emerald Channel Intake.

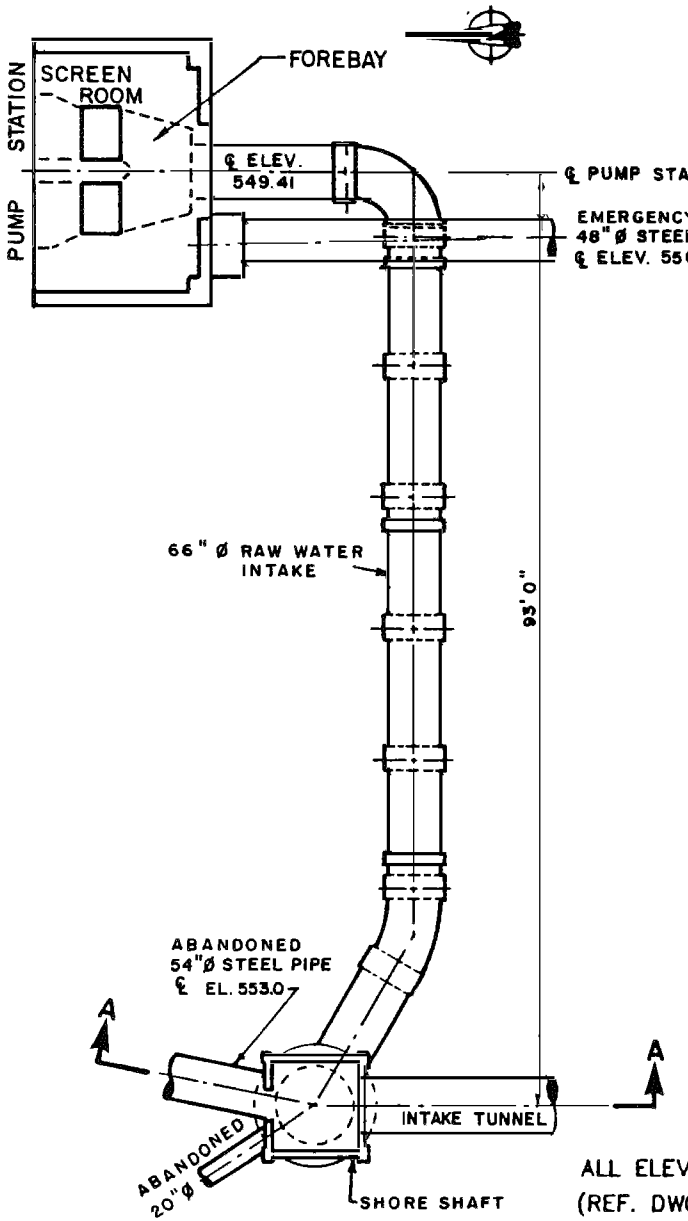
2. A new raw water/high-lift Pump Station was constructed.

3. The raw water Pump Station received water from the shore shaft through a 115-foot long, 66-inch diameter cast steel pipe. Figure 3 details in plan view the 66-inch diameter cast steel pipe.

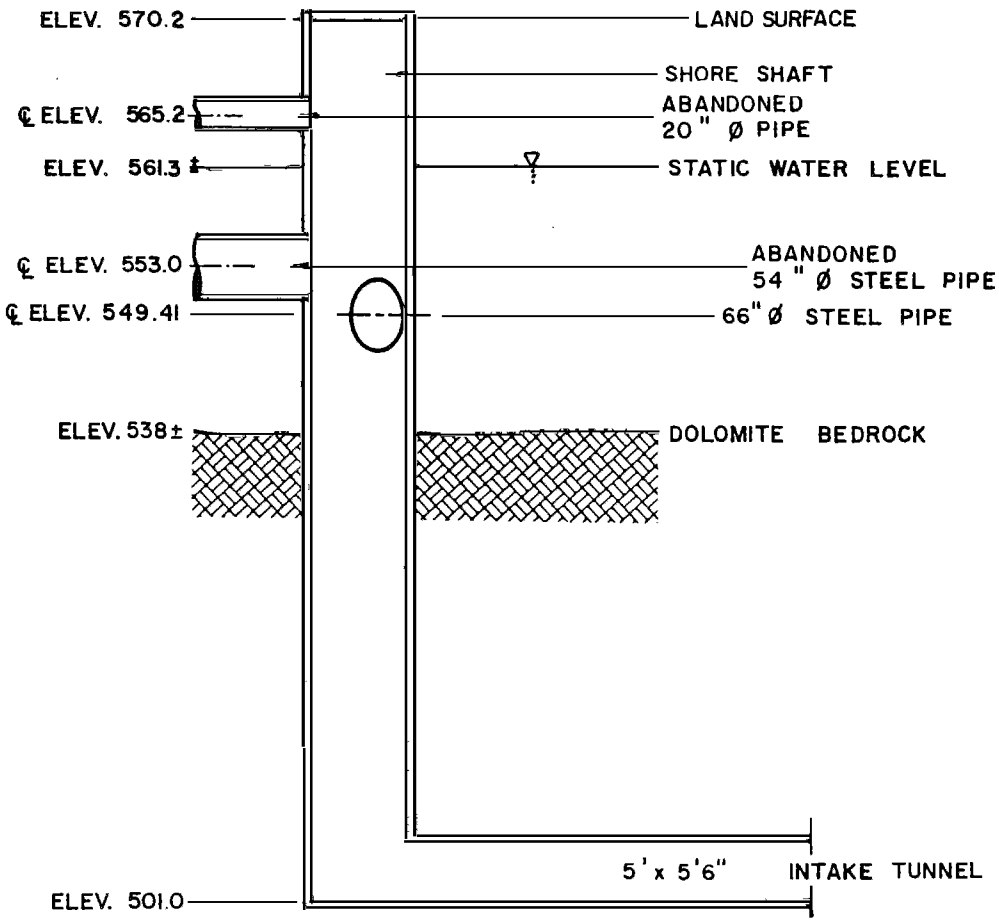
4. Filtration Plant A consisting of a filter building containing eight filters each of 4 mgd capacity was constructed. This capacity of 32 mgd gave the water treatment facility a normal rated capacity of 64 mgd.

5. With the construction of the raw water/high-lift Pump Station, the shore shaft pump, the 20-inch diameter service line and the 54-inch diameter line were abandoned and removed from service. The 48-inch diameter intake line was connected to the forebay of the raw water Pump Station.

From 1978 to 1981, a side stream treatment facility was constructed to collect and store filter backwash water and sedimentation basin sludge.



PLAN OF 66" RAW WATER INTAKE
FROM SHORE SHAFT TO FOREBAY
SCALE 1" = 20'



SHORE SHAFT
CROSS SECTION A-A
SCALE 1/16" = 1'-0"

ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

DATA FROM GREELEY AND HANSEN (1950)

figure 3

SHORE SHAFT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

CRA 5-0038812

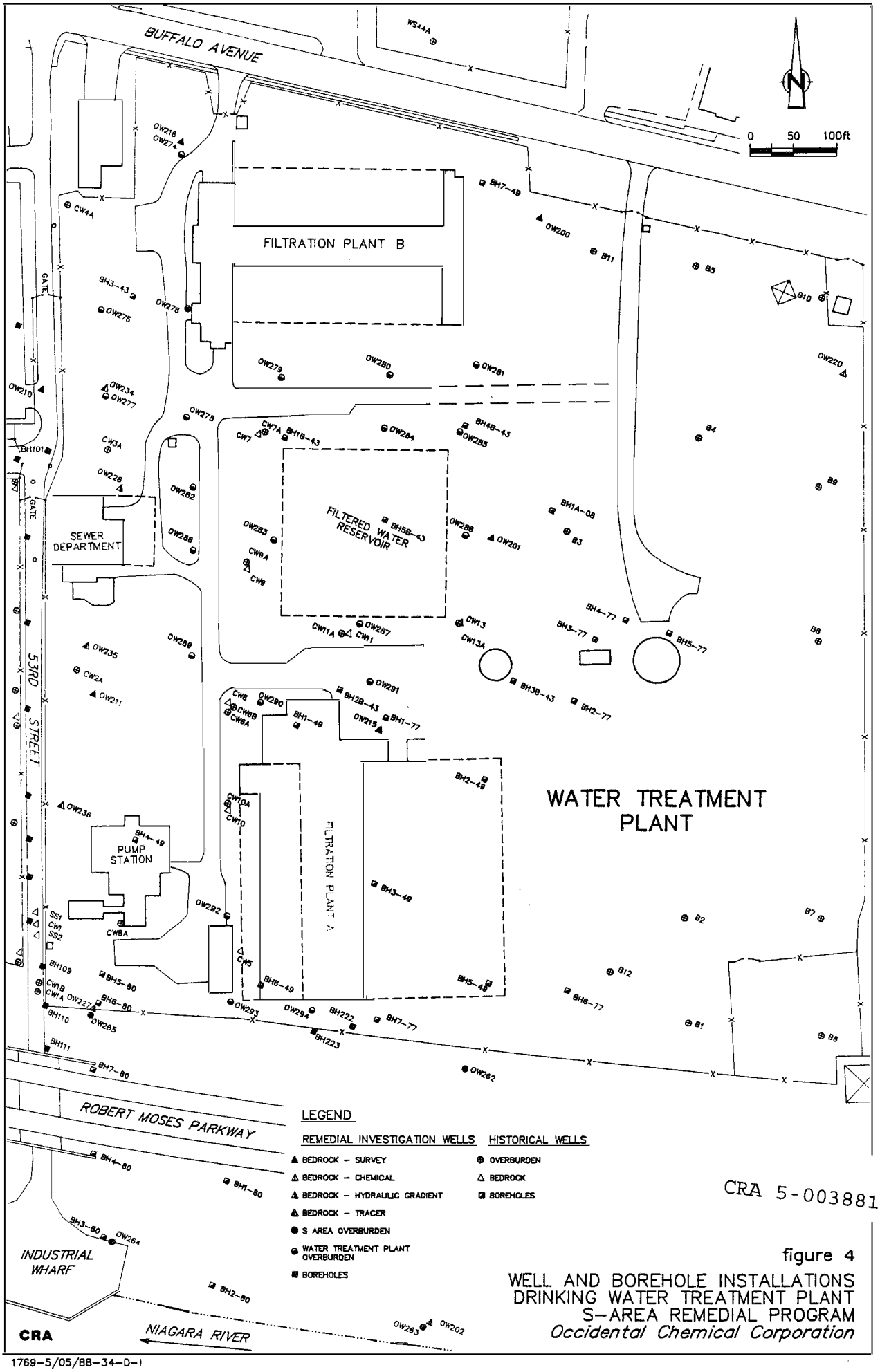
1769-5/05/88-34-D-1

2.2 HISTORIC WELL AND BOREHOLE INSTALLATIONS

In order to better define the area's geology and the overburden groundwater regime, all historical well and borehole installations at the WTP and the surrounding areas were utilized. These include WTP installations, Niagara Plant installations and the Power Authority of the State of New York (PASNY) installations, located on PASNY properties to the south and east of the WTP. A complete chronology of the historic geologic investigations at the WTP and OCC's Niagara Plant is presented in Table 1. The stratigraphic database is presented in the report entitled "S-Area Remedial Program Information Summary Report, June 1988". The following gives a brief description of the well and borehole installations at the WTP.

Prior to December 1983, 35 well installations and 23 boreholes existed on the WTP. These locations are presented on Figure 4. The well installations at the WTP include Wells B1 through B12, CW1 through CW13, SS1 and SS2. The boreholes include BH1A-08, BH1B-43 through BH5B-43, BH1-49 through BH7-49, BH1-77 through BH7-77, BH5-80 and BH6-80.

Wells B1 through B12 were installed in 1982 and the stratigraphy was not recorded. Eight of these wells are currently functioning as monitoring wells and four have



CRA 5-0038814

figure 4

WELL AND BOREHOLE INSTALLATIONS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-5/05/88-34-D-1

TABLE 1

CHRONOLOGY OF HISTORICAL GEOLOGIC INVESTIGATIONS
WATER TREATMENT PLANT AND OCC NIAGARA PLANT

Drilling Program Number	Borehole/Well Number	Date	Primary Drilling Location	Information Source
1	Boreholes BH1A-08 through BH4A-08	1908	Niagara River	City of Niagara Falls Greely & Hansen Engineers "Location Plan & Logs of Land and Water Borings" (April 1950)
2	Boreholes BH1B-43 through BH5B-43 and old test boring No. 3	1943	City of Niagara Falls Water Treatment Plant - Existing Underground Water Reservoir	City of Niagara Falls Greely & Hansen Engineers "Location Plan & Logs of Land and Water Borings" (April 1950)
3	Boreholes BH1-49 through BH7-49	1949	City of Niagara Falls Water Treatment Plant - New Filtration Plant, Chemical Building and New Pumping Station	City of Niagara Falls Greely & Hansen Engineers "Location Plan & Logs of Land and Water Borings" (April 1950)
4	Boreholes B1-77 through BH7-77	1977 October	City of Niagara Falls Water Treatment Plant - Sludge Thickener	City of Niagara Falls Empire Soils Investigations Soil Logs (October 1977)

continued....

TABLE 1

CHRONOLOGY OF HISTORICAL GEOLOGIC INVESTIGATIONS
WATER TREATMENT PLANT AND OCC NIAGARA PLANT

Drilling Program Number	Borehole/Well Number	Date	Primary Drilling Location	Information Source
5	Wells WS-1 through WS-47 and CW1 through CW-13 and SP-1 through SP-8	1979 January through July	Entire Hooker Plant, City of Niagara Falls Water Treatment Plant and Robert Moses Parkway	Hooker Chemicals & Plastics Corp. Leggette, Brashears & Graham, Inc. "Hooker Chemicals & Plastics Corp. Niagara Falls Plant, New York Geologic Logs" (May 1980)
6	Boreholes BH1-80 through BH7-80	1980 January	South of the City of Niagara Falls Water Treatment Plant	Hooker Chemicals & Plastics Corp. (Whiteman, Osterman & Hanna) Conestoga-Rovers & Associates "Subsurface Soil Investigation for City of Niagara Falls Proposed Water Intake" (March 1980)
7	Wells OW1S-80 through OW9S-80	1980 February	Hooker Plant - S-Area	Hooker Chemicals & Plastics Corp. Leggette, Brashears & graham, Inc. "Hooker Chemicals & Plastics Corp. Niagara Falls Plant, New York-Geologic Logs" (May 1980)

continued....

TABLE 1

CHRONOLOGY OF HISTORICAL GEOLOGIC INVESTIGATIONS
WATER TREATMENT PLANT AND OCC NIAGARA PLANT

Drilling Program Number	Borehole/Well Number	Date	Primary Drilling Location	Information Source
8	Wells WS-53 through WS-137 and SP-9	1980 June through August	Entire Hooker Plant	Hooker Chemicals & Plastics Corp. Conestoga-Rovers & Associates "Report on Wastewater Outfall Sewers Niagara Plant Comprehensive Water Management Study - Hooker Chemicals & Plastics Corp. - Volume II, Field Investigation" (September 1980)
9	Boreholes BH1-81 through BH8-81 and BH14-81	1981 December	Hooker Plant - S-Area	Hooker Chemicals & Plastics (Wald, Harkrader & Ross) Conestoga-Rovers & Associates "Overburden Investigation - S-Area" (January 1982)
10	Boreholes BH1 through BH4, BH6, BH9 and BH10	1981	PASNY Property (east of WTP)	Hooker Chemicals & Plastics Corp. Conestoga-Rovers & Associates "Hydrogeological Conditions East of S-Area at the Drinking Water Treatment Plant and PASNY Property"

continued....

TABLE 1

CHRONOLOGY OF HISTORICAL GEOLOGIC INVESTIGATIONS
WATER TREATMENT PLANT AND OCC NIAGARA PLANT

Drilling Program Number	Borehole/Well Number	Date	Primary Drilling Location	Information Source
11	Boreholes BH9-82 and BH15-82 through BH23-82	1982 March	Hooker Plant - Area South and West of the S-Area	Hooker Chemicals & Plastics (Wald, Harkrader & Ross) Conestoga-Rovers & Associates "Overburden Investigation - S-Area Phase II (March 1982)
12	Wells OW1-82 through OW5-82	1982 June	PASNY Property (east of WTP)	Hooker Chemicals & Plastics Corp. Conestoga-Rovers & Associates "Hydrogeological Conditions East of S-Area at the Drinking Water Treatment Plant and PASNY Property"
13	Wells B-1 through B-12	1982	East Side of Niagara Falls Water Treatment Plant	Correspondence with City of Niagara Falls and Clayton Environmental

been inadvertently destroyed. Wells CW1 through CW13, installed in 1979, consist of 13 overburden wells and 8 bedrock wells with stratigraphic information for each of the 13 locations. The overburden wells are denoted by a letter designation following the well number (i.e. CW1A). Wells SS1 and SS2, also installed in 1979, are shore shaft bedrock wells located in the immediate vicinity of CW1 and therefore overburden stratigraphic information was not recorded.

2.3 REMEDIAL PROGRAM WELL AND BOREHOLE INSTALLATIONS

To better define the WTP's geology, stratigraphic information from the S-Area Surveys and Studies and contemporaneous drilling activities (Surveys) were used. These include 21 overburden survey wells, 5 bedrock survey wells, 3 bedrock tracer wells, 2 bedrock hydraulic gradient wells and one bedrock chemical monitoring well; all installed at the WTP pursuant to Addendum I of the Judgment. The stratigraphic information for the above installations is presented in the report entitled "S-Area Remedial Program Information Summary Report, June 1988". The well and borehole locations at or near the WTP are presented in Figure 4.

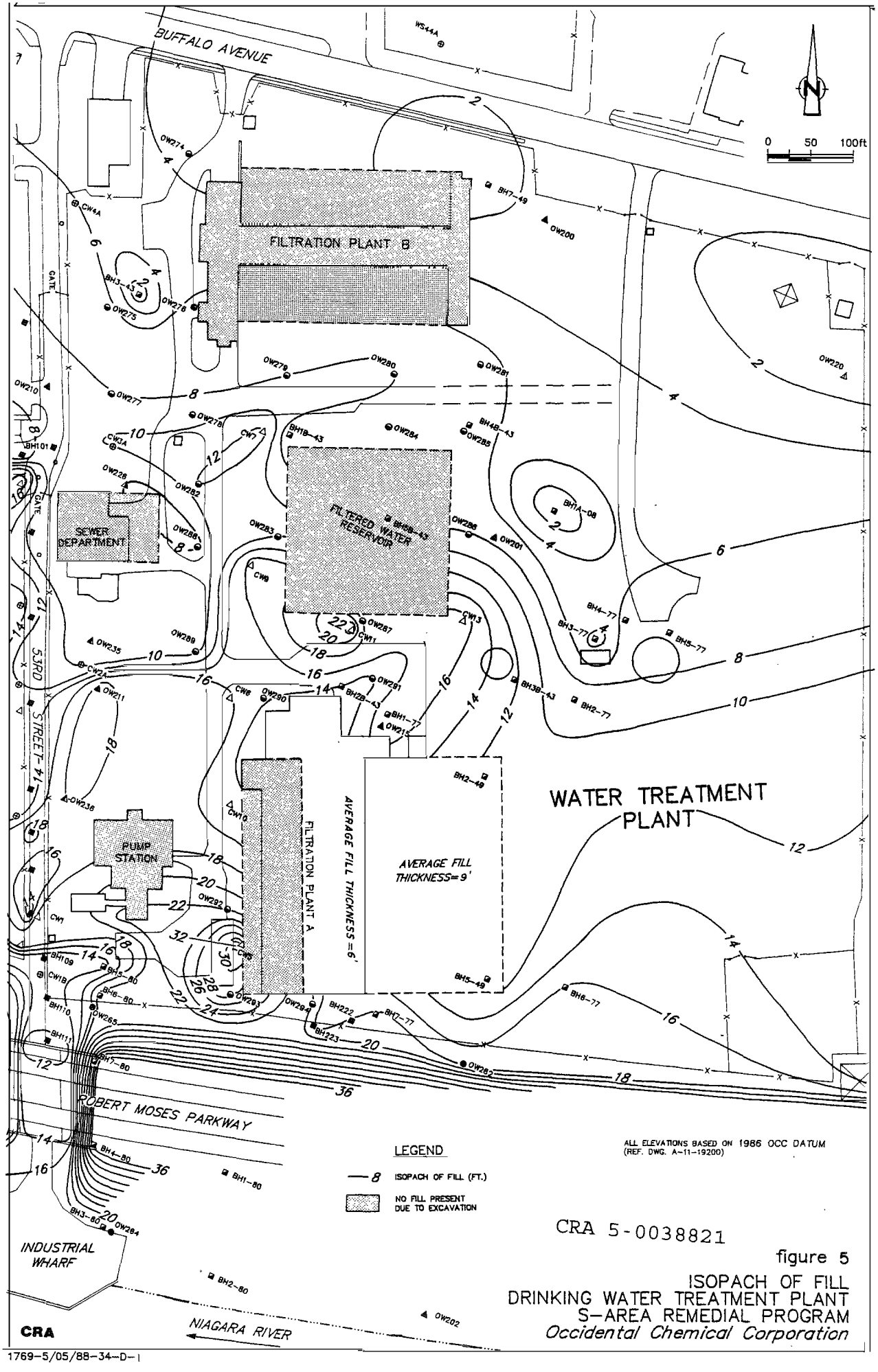
3.0 SITE GEOLOGY

The overburden at the WTP is comprised of four main stratigraphic layers:

i) fill, overlaying,
ii) native alluvial river deposits (alluvium), overlaying,
iii) native glaciolacustrine clay (clay), overlaying,
iv) native glacial till (till).

The uppermost soil unit, the fill layer, consists largely of silty, sandy, gravelly soils, cinders, flyash, slag and construction type rubble including bricks, wood and concrete. The thickness of fill varies at the WTP from two feet to 30 feet as shown in Figure 5. The thickness of fill increases as one progresses south across the site with thicker areas at certain locations immediately adjacent to the WTP Facilities due to excavation and construction activities. Fill is merely disturbed native soil in many cases. The fill increases in thickness to the south due to the extended shoreline and construction of the Robert Moses Parkway.

The uppermost native overburden layer, the alluvium, consists predominantly of silty sand with varying amounts of gravel, clay and cobbles. The alluvium varies in thickness from zero feet in the area of the Filtered Water



CRA 5-0038821

figure 5

ISOPACH OF FILL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

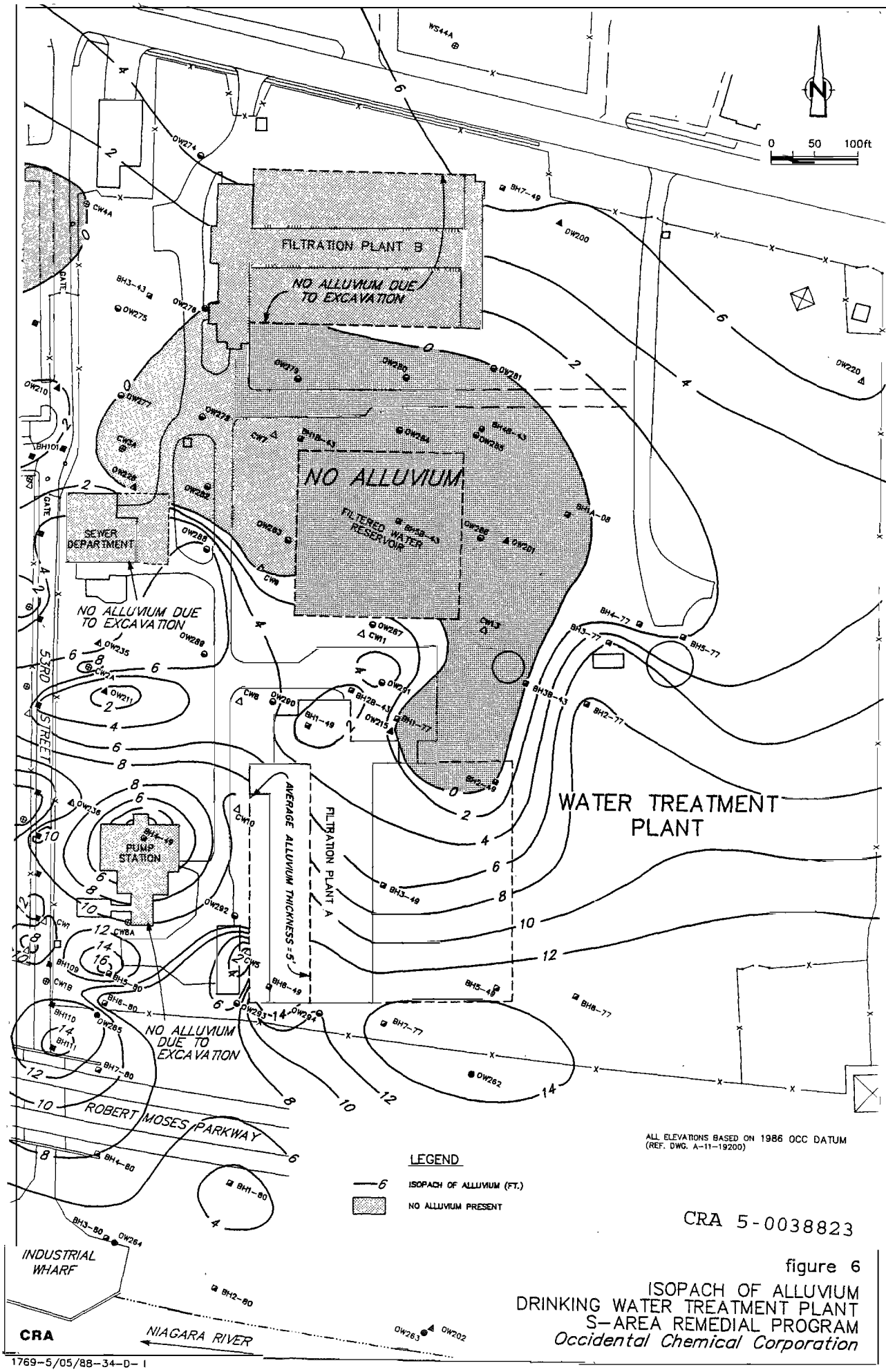
1769-5/05/88-34-D-1

Reservoir to 14 feet at the southern edge of the WTP. The isopach of alluvium thickness and top of alluvium contours are presented in Figures 6 and 7, respectively.

The top of alluvium and thickness of alluvium are very irregular in the area of the WTP facilities due to excavation for construction. In the area of the Filtered Water Reservoir where no alluvium was encountered, the alluvial soils may have been removed to clear the site for construction.

The third overburden layer, the clay layer, consists of a silty clay with varying amounts of fine sand and occasionally a trace of gravel. The clay varies in thickness from zero feet in the southwestern corner of the WTP to approximately 25 feet (see Figure 8). The clay is relatively uniform in the northern portion of the WTP varying from 18 to 25 feet in thickness. Progressing southerly from OW201, the thickness of the clay layer decreases steadily to approximately zero feet at the southern boundary of the WTP.

Figure 9 illustrates the top of clay contours which indicate a flat section at the northern half of the WTP, sloping downward toward the river over the southern portion of the WTP. Both the isopach of clay thickness and top of clay contours show small local mounds and depressions

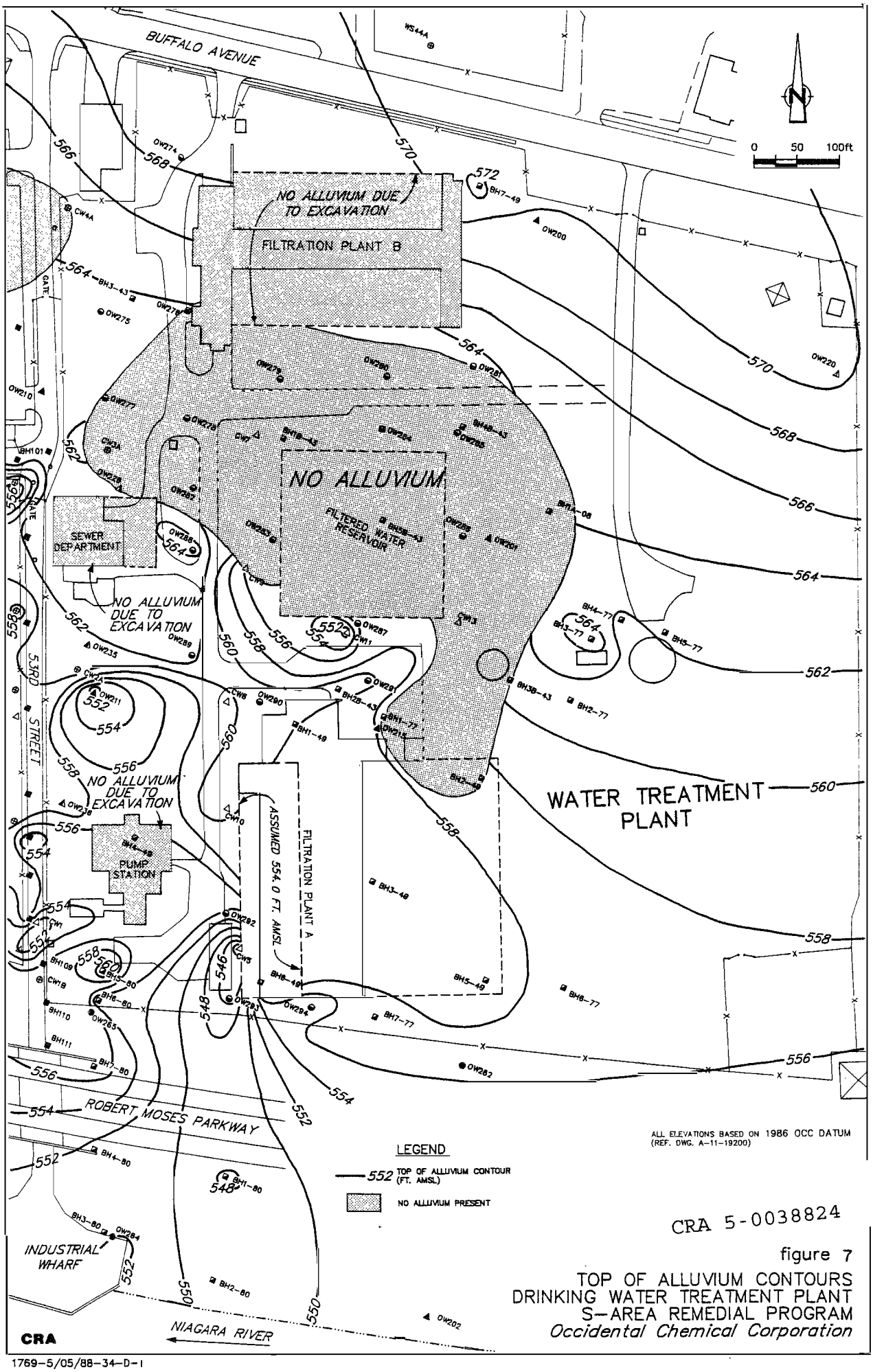


CRA 5-0038823

figure 6
ISOPACH OF ALLUVIUM
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

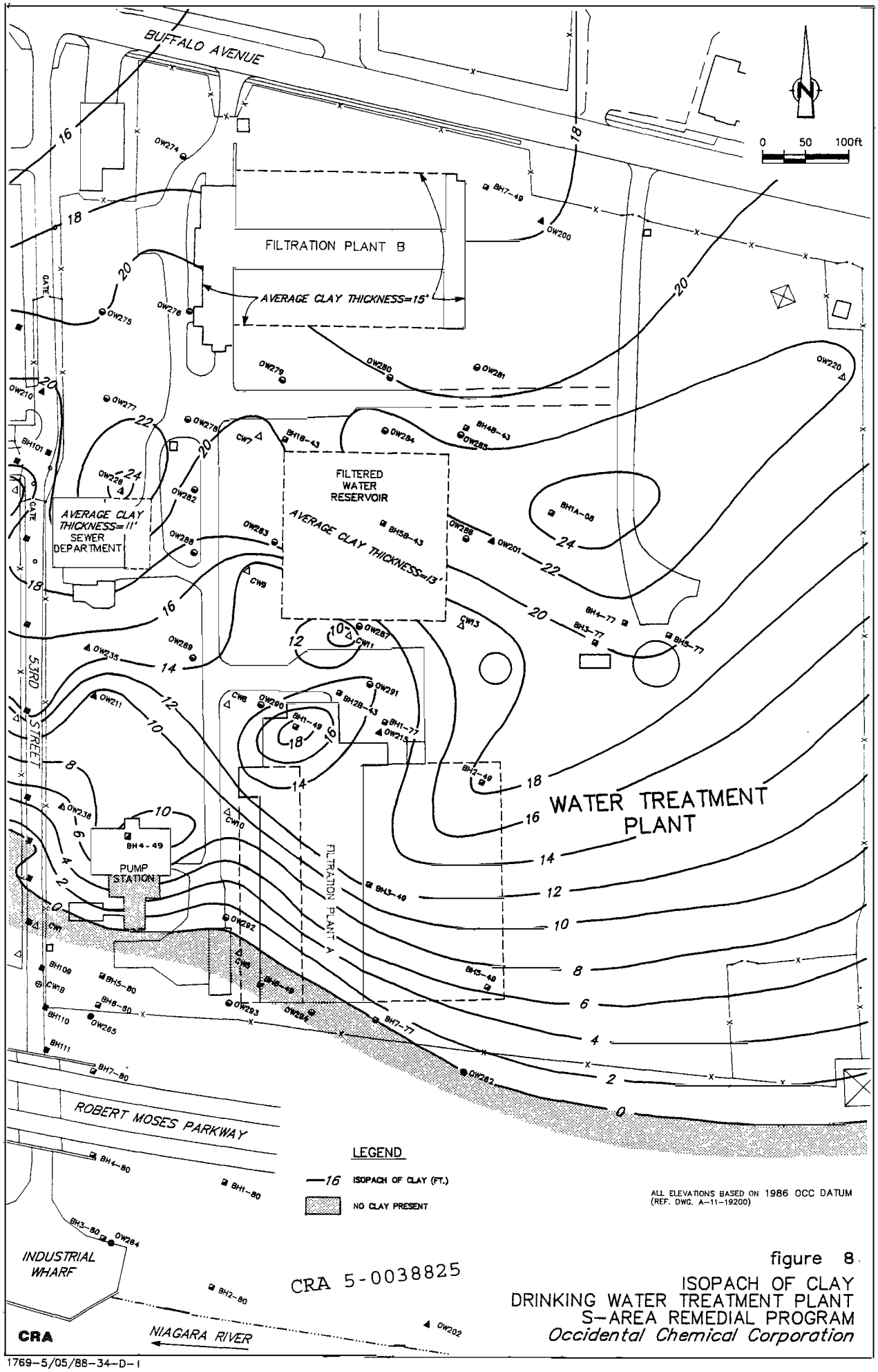


CRA 5-0038824

figure 7

TOP OF ALLUVIUM CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

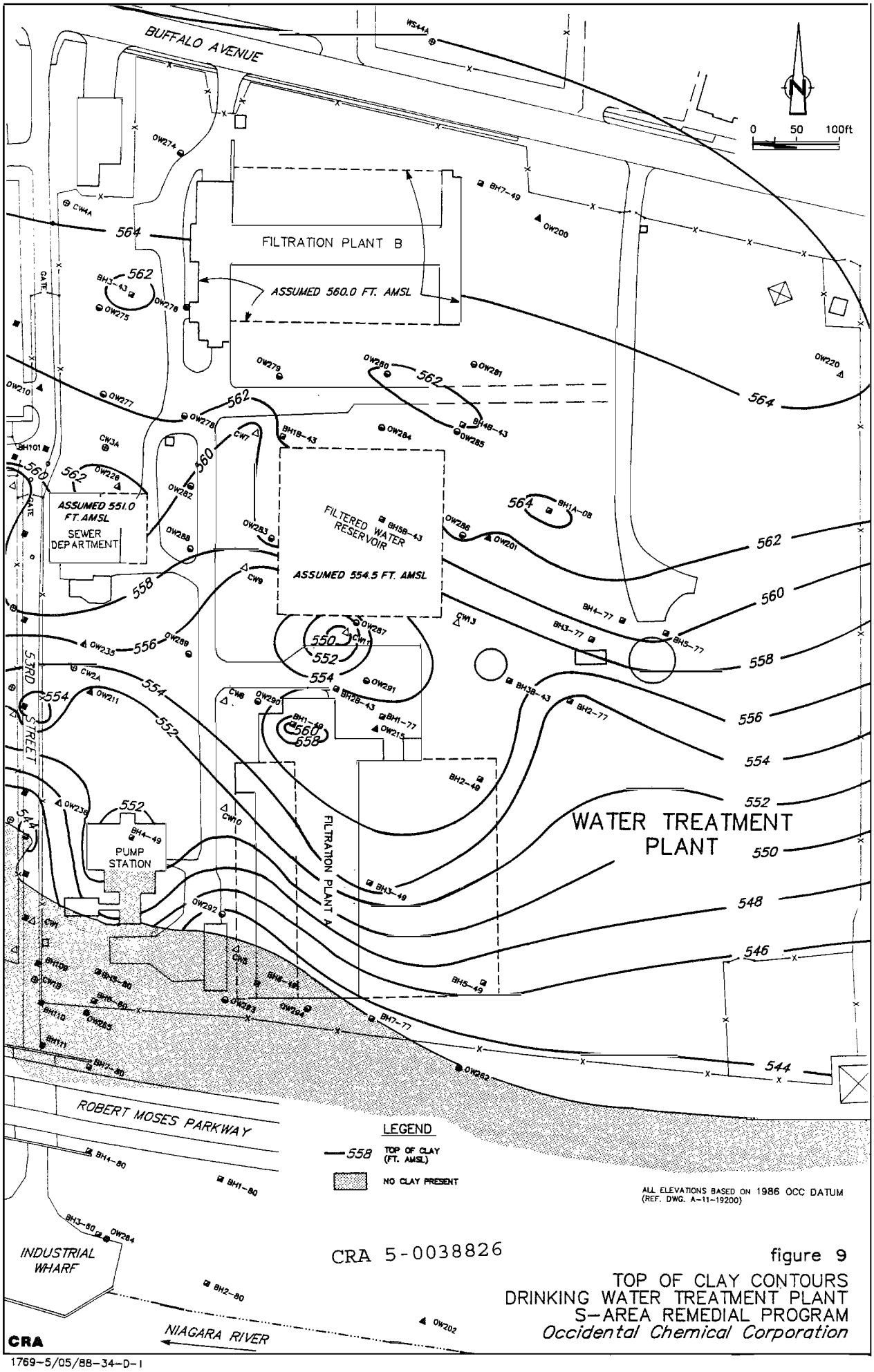
1769-5/05/88-34-D-1



CRA 5-0038825

figure 8.
ISOPACH OF CLAY
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-5/05/88-34-D-1



CRA 5-0038826

figure 9

TOP OF CLAY CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

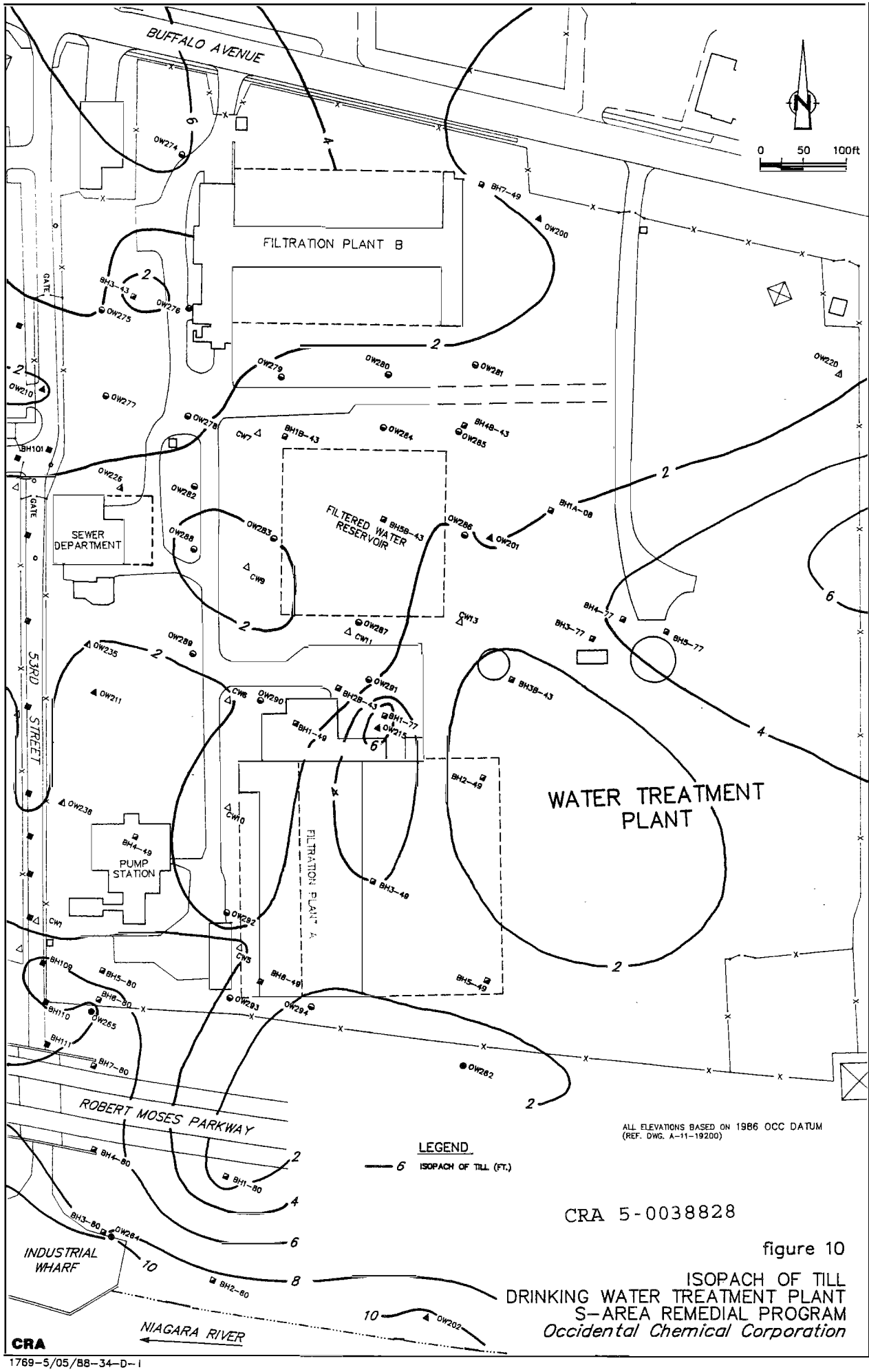
1769-5/05/88-34-D-1

in the area of the WTP Facilities, again due to excavation and construction activities and/or naturally occurring events (ie. erosion, glaciation, etc.).

The overburden layer immediately overlaying the bedrock is the till layer which consists of a sandy silt, with varying amounts of clay and fine gravel. Figures 10 and 11 illustrate the isopach and top of till contours, respectively. The thickness of till varies from zero to seven feet with the till thickness over the majority of the WTP in the zero to four-foot range. The top of till contours are relatively flat with a slight downward grade to the south and small mounds and depressions across the WTP.

The depth to bedrock in the area of the WTP varies from 26.0 feet to 37.5 feet below ground surface. The elevation varies from 536 feet AMSL to 544 feet AMSL with the lowest bedrock area being in the central-eastern portion of the WTP. The upper bedrock zone, part of the Lockport Group, consists of a highly fractured gray dolostone formation. Figure 12 illustrates the top of bedrock contours at the WTP.

To further illustrate the site geology and hydrogeology, four cross-sections were generated using the stratigraphic information, contours, isopachs, and available pipe invert and location details. The locations of the



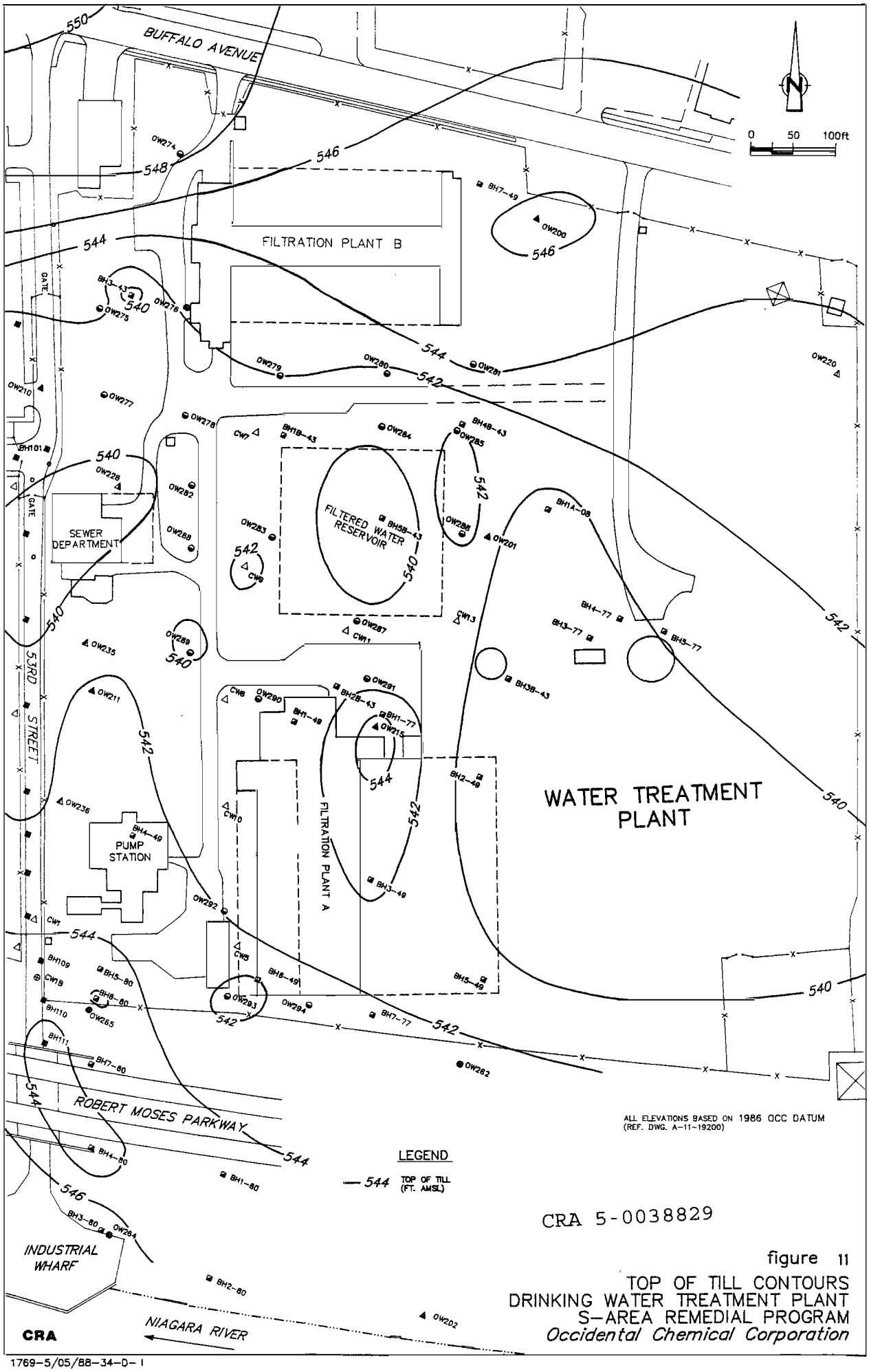
CRA 5-0038828

figure 10

ISOPACH OF TILL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



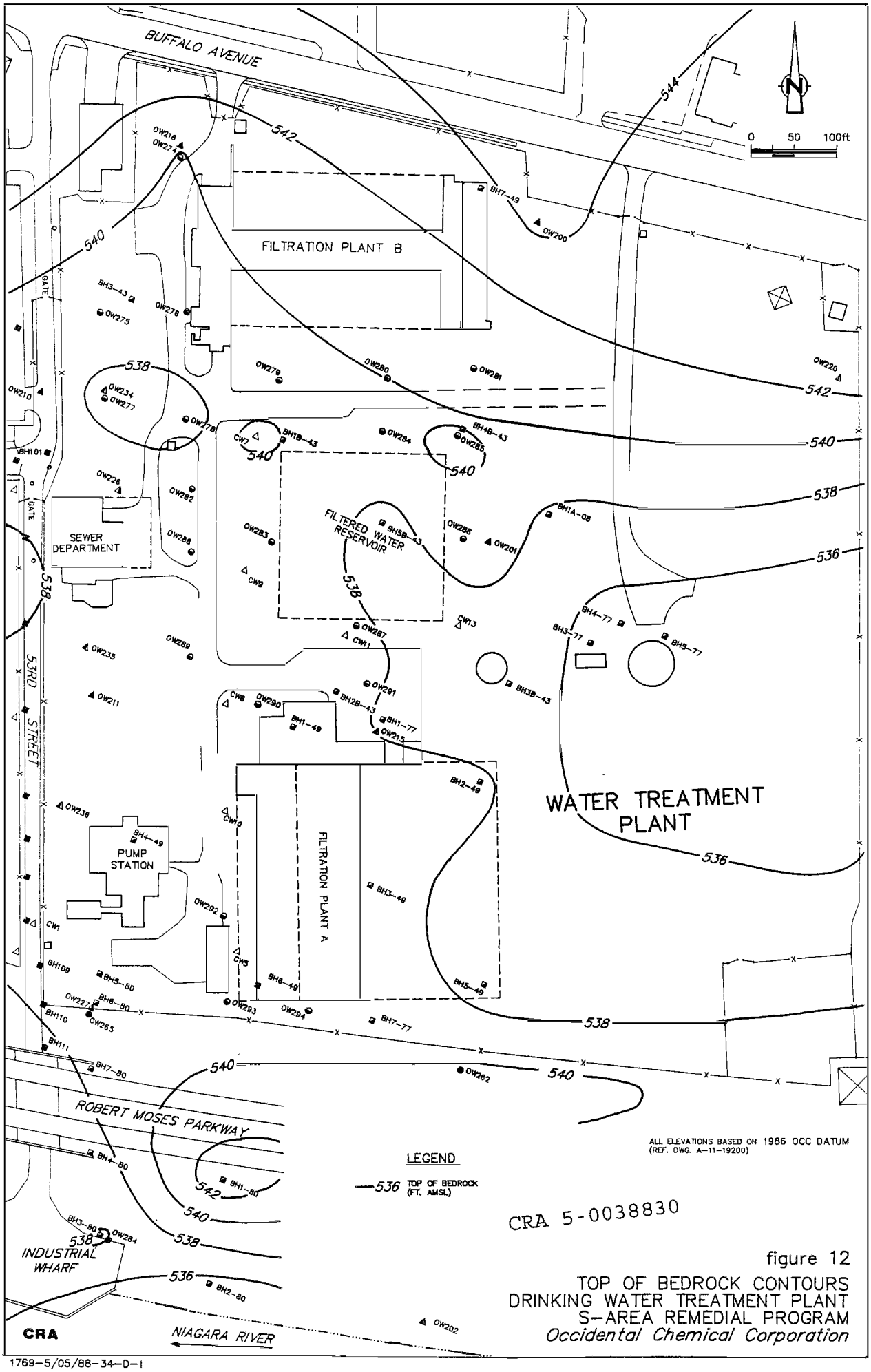
CRA 5-0038829

figure 11

TOP OF TILL CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



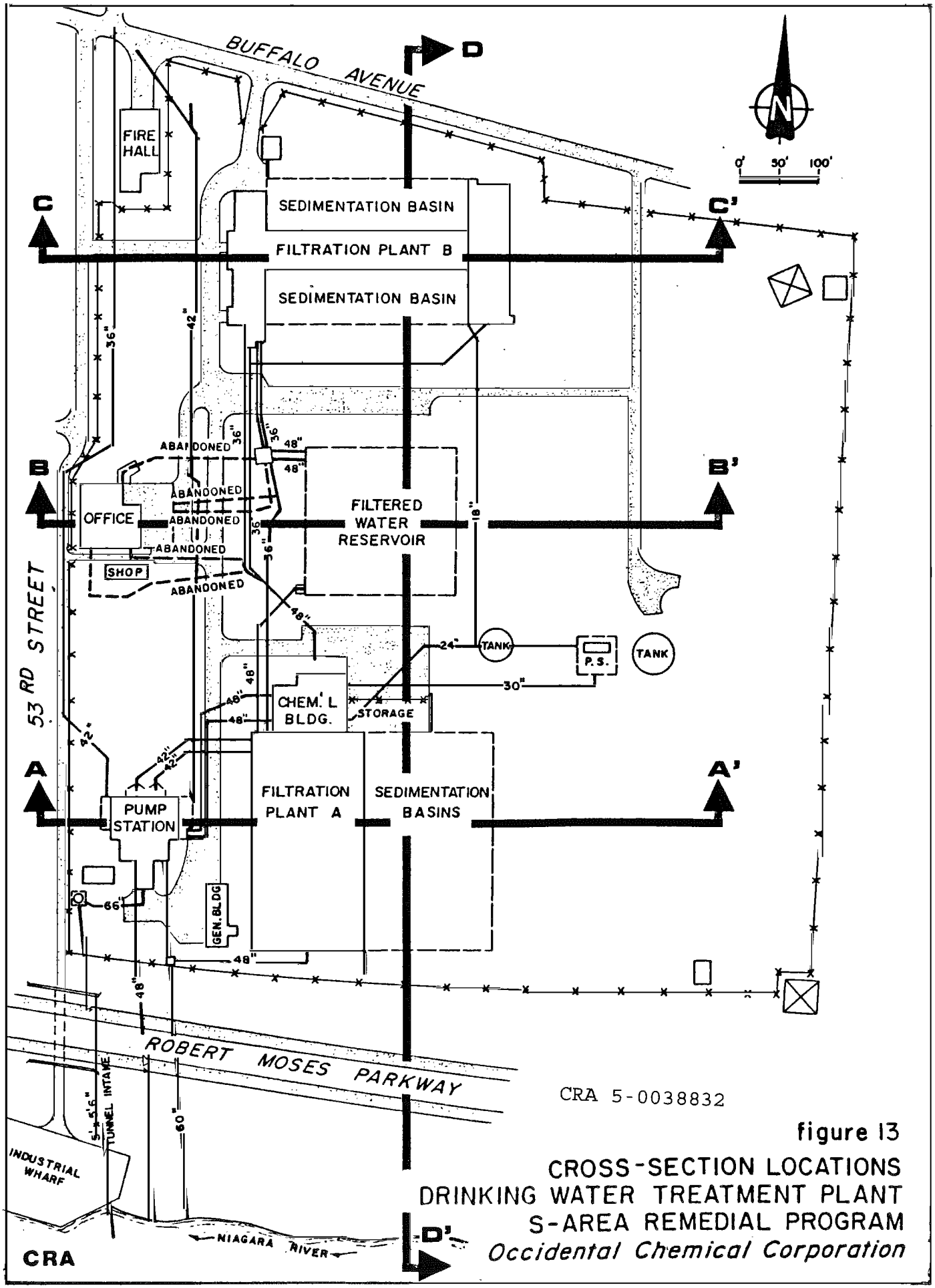
CRA 5-0038830

figure 12

TOP OF BEDROCK CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-5/05/88-34-D-1

cross-sections are outlined on Figure 13 and cross-sections A-A' through D-D' are illustrated on Figures 14 through 17, respectively.

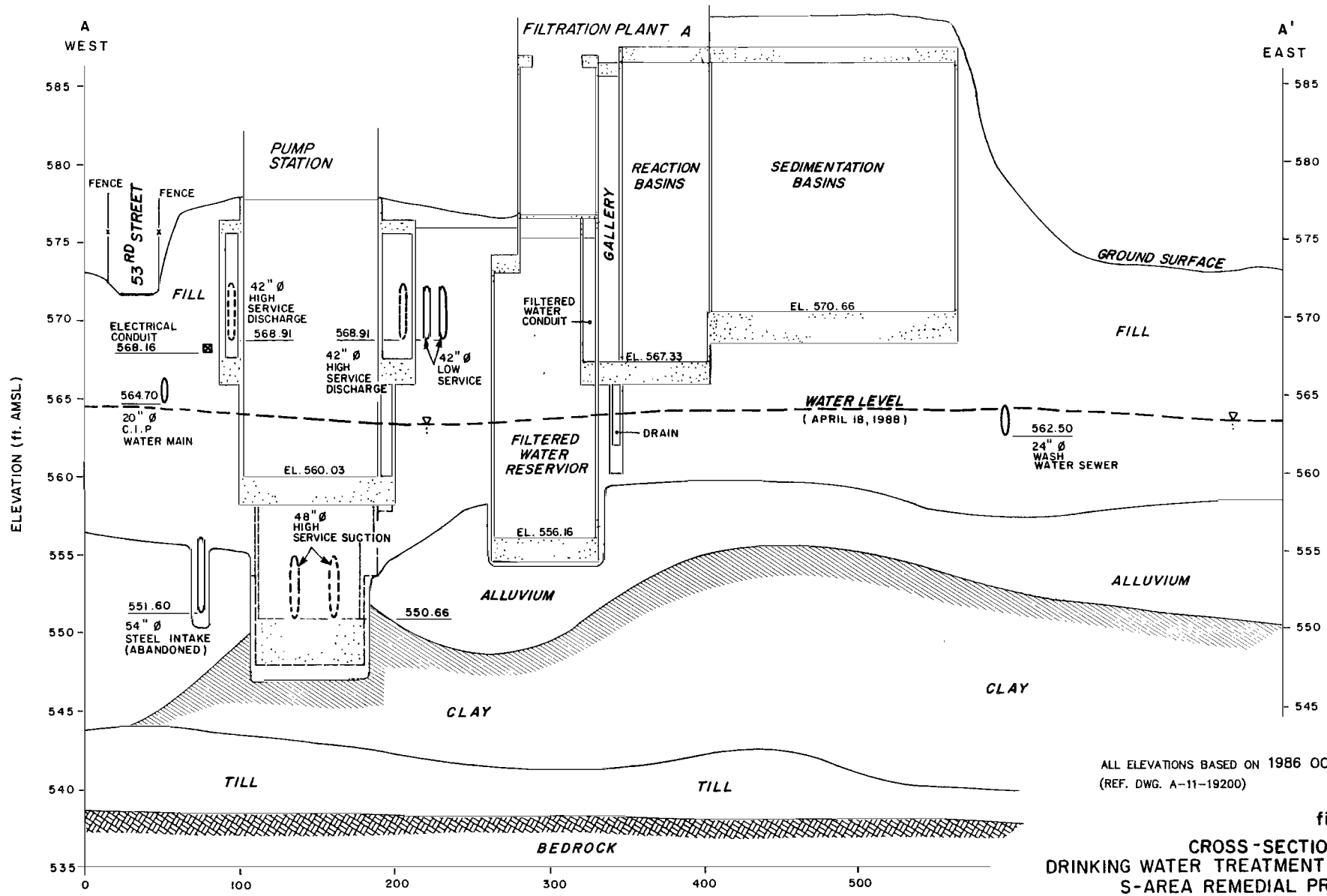


CRA 5-0038832

figure 13

CROSS-SECTION LOCATIONS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769 - 5/05/88-34-D-1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

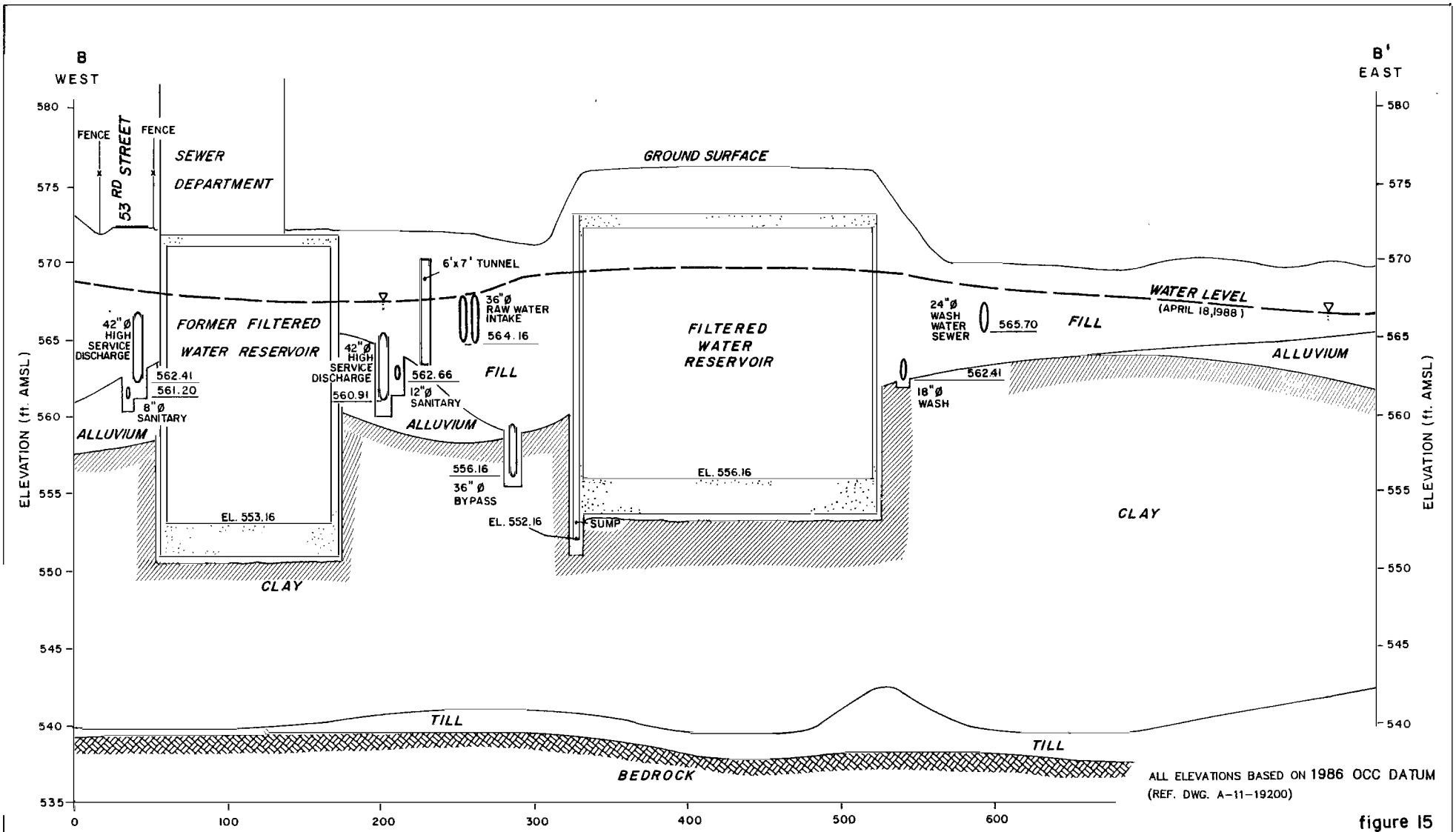
figure 14

CROSS-SECTION A-A'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

CRA 5-0038833



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

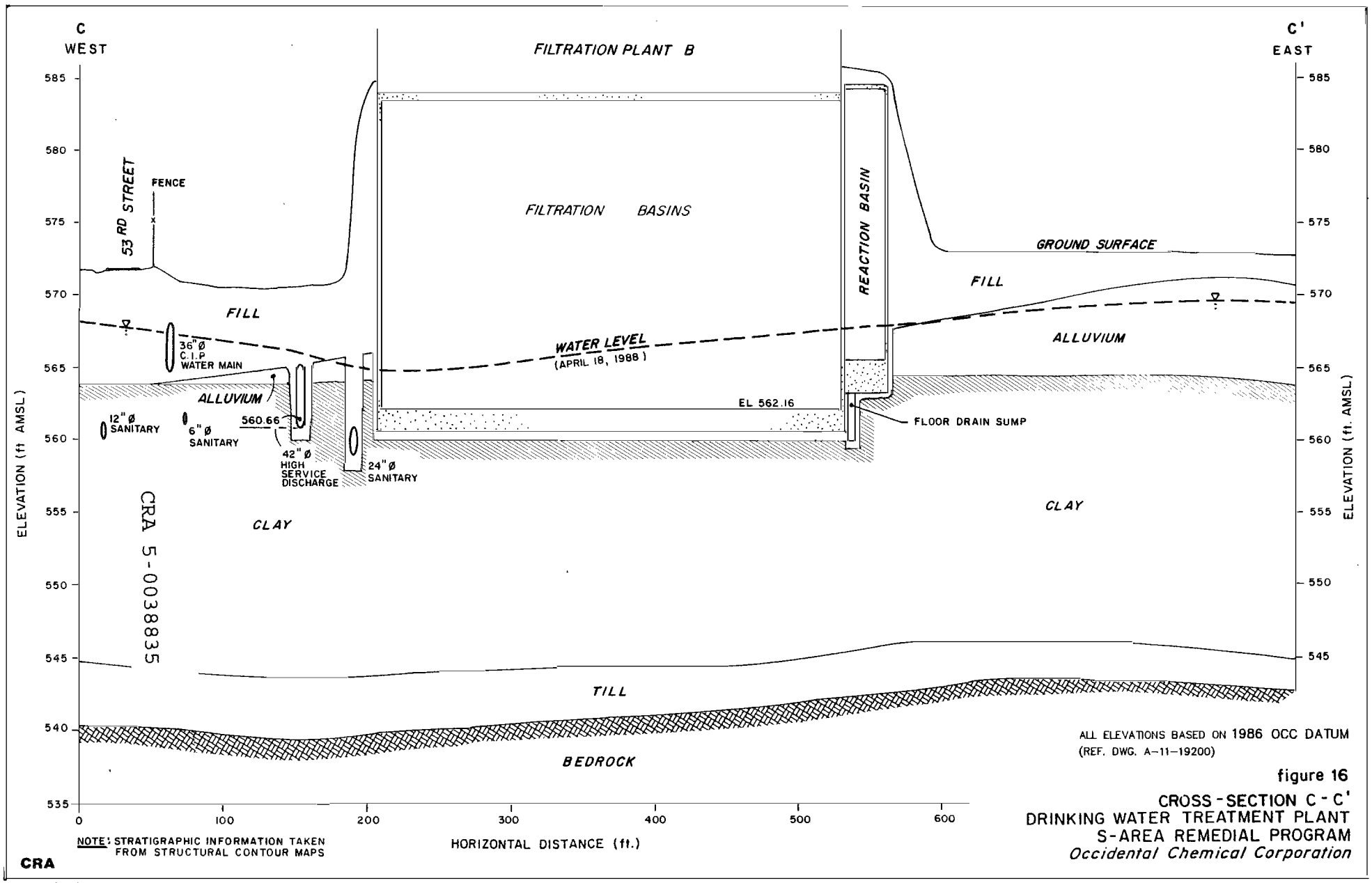
ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 15

CROSS-SECTION B-B'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1679 - 5/05/88-34-D-1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

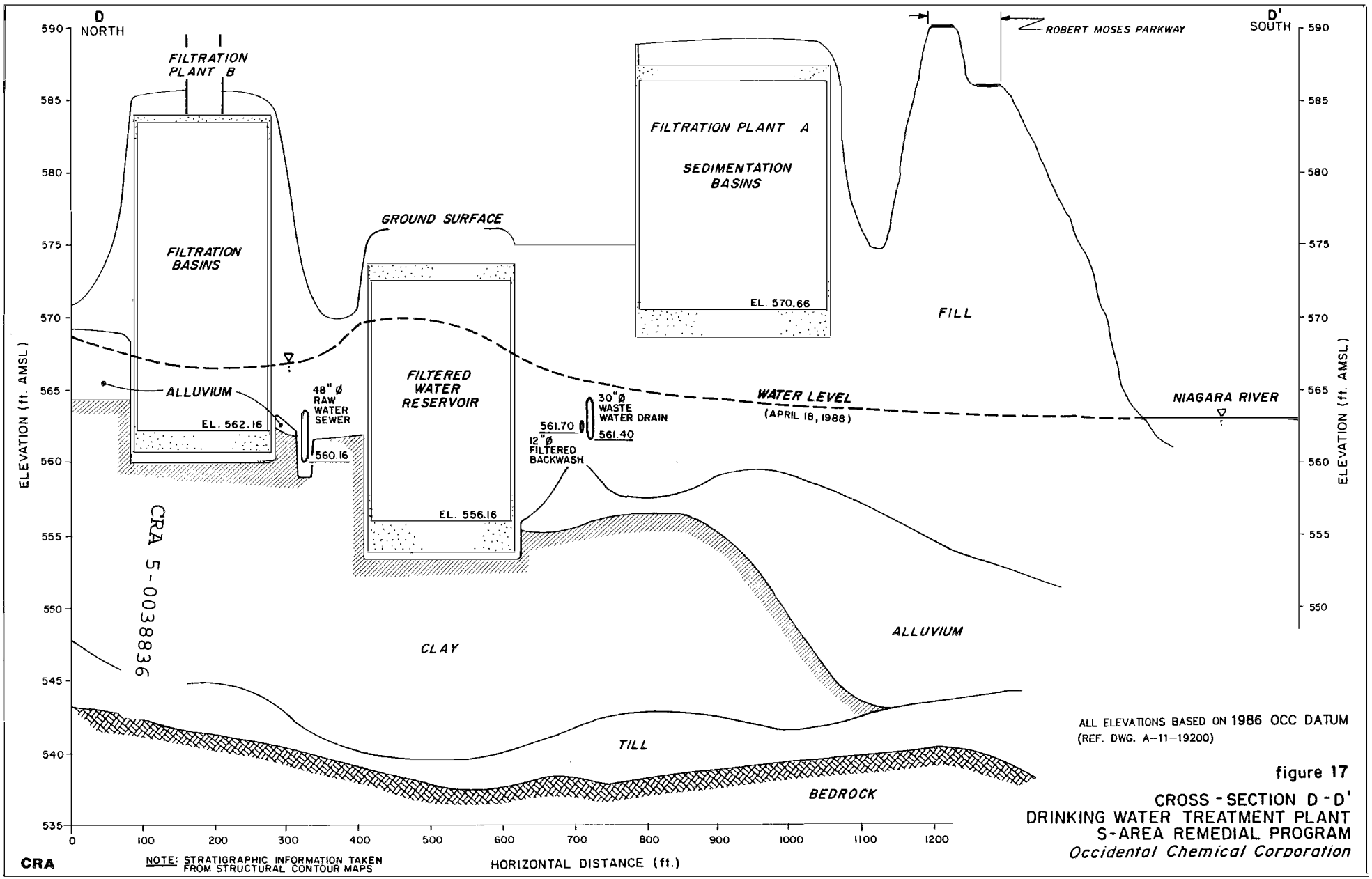
ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 16

CROSS-SECTION C - C'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769 - 5/05/88 - 34 - D - 1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 17

CROSS - SECTION D - D'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

4.0 SITE HYDROGEOLOGY

The overburden at the WTP consists of two major hydrogeologic units. The uppermost water-bearing zone is contained in the alluvium and fill layers which acts as an unconfined aquifer. The clay and till layers form an aquitard separating the alluvium/fill aquifer and the next water-bearing zone which is contained in the fractured bedrock formation.

The alluvium/fill aquifer discharges to the Niagara River to the south of the WTP. The horizontal hydraulic gradient is toward the river as expected, since the top of aquitard stratum elevations are approximately 10 feet higher to the north of the WTP than the groundwater elevation at the river's edge. A downward vertical gradient exists between the alluvium/fill aquifer and the fractured bedrock zone.

Recharge to the uppermost groundwater regime is provided by infiltration (i.e. precipitation), regional upgradient flow and local sources at the WTP. Potential local sources include leaking watermains, WTP water storage facilities, local surface drainage patterns and surface features.

The rate of infiltration varies across the WTP depending on the surface features and local surface water drainage patterns. Paved areas result in minimal infiltration while gravel areas promote increased infiltration.

The aquitard below the unconfined aquifer consists of the non-water-bearing zones found within the clay and till layers. The clay is relatively impermeable with a typical hydraulic conductivity of approximately 1×10^{-8} cm/sec. The till is a similar material comprised of a clayey silty sand resulting in a low permeability and a hydraulic conductivity generally less than 1×10^{-7} cm/sec. The flow within the clay and till layers is predominantly vertical with almost all horizontal flow in the overburden occurring in the alluvium and fill layers. Given that the clay/till layer is an aquitard, groundwater flow through this stratum will not be discussed further.

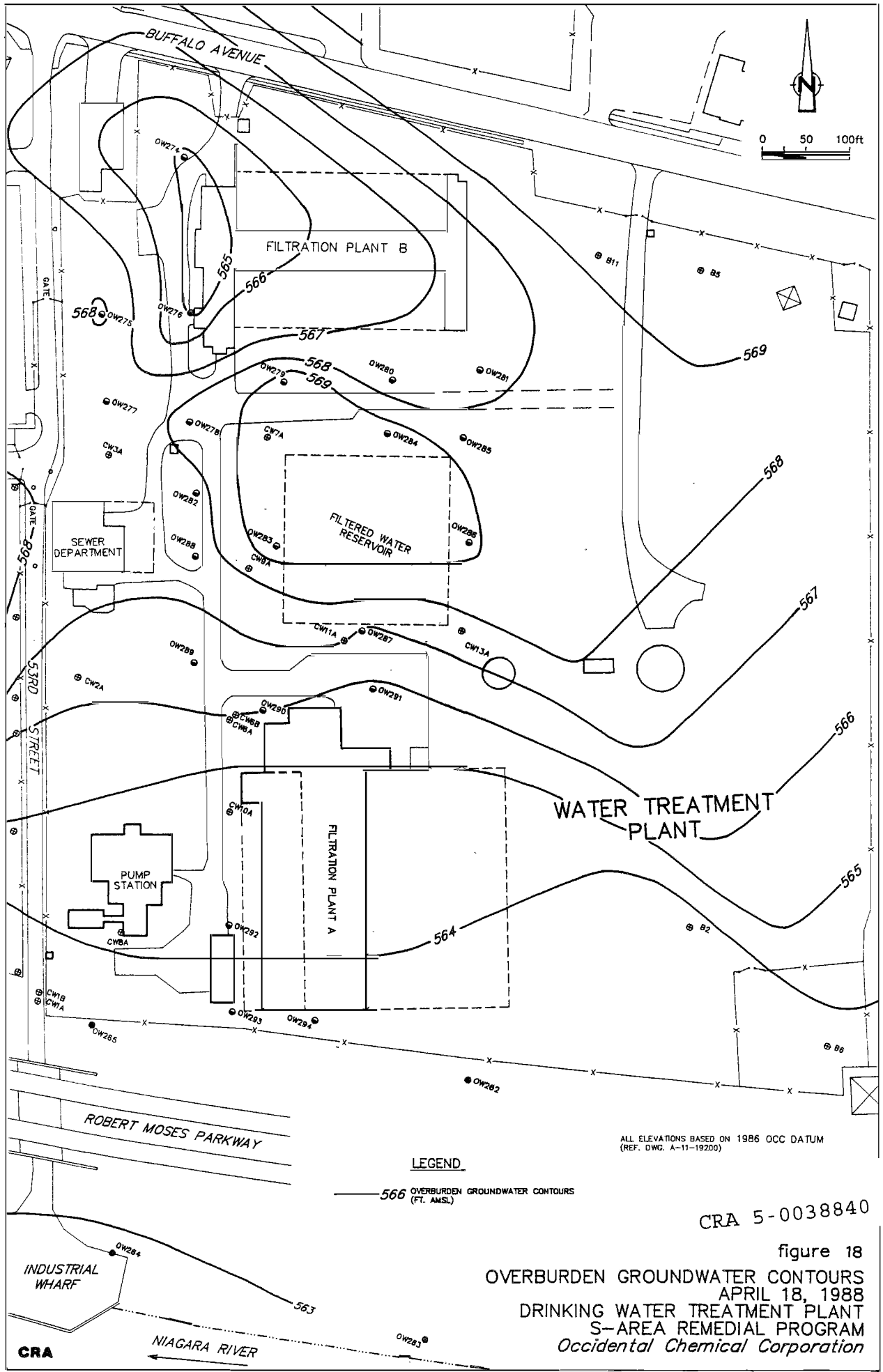
The following sections present the groundwater contours in the overburden at the WTP. Horizontal and vertical gradients were calculated using the recent water level data. The locations of the WTP subsurface facilities in relation to the water table and the various geological units are discussed.

4.1 POTENTIOMETRIC SURFACE MEASUREMENT

Four recent rounds of water levels have been collected and compiled for the S-Area. The results are presented in Table 2. Included in Table 2 is information from the Survey wells, both on the WTP and adjacent to the WTP, the historic WTP wells, and Niagara Plant wells adjacent to the WTP. A table of historic water levels recorded between October 11, 1979 to February 9, 1988 is presented in the "S-Area Remedial Program Information Summary Report, June 1988".

Figures 18 and 19 illustrate the groundwater contours for the overburden taken on April 18 and February 8, 1988, respectively.

The S-Area overburden Survey Wells were finally completed in March 1988 and therefore the latest round, measured April 18, 1988, contains water levels for all of the overburden Survey Wells except OW280 which was recovering from a March 1988 sampling event. The water levels recorded February 8, 1988 were taken at all of the completed overburden Survey Wells except for wells OW273, OW274, OW279, OW286 and OW288 which were inaccessible due to burial under several feet of snow or a frozen well cap. Blank entries on Table 2 for the historical well installations indicate the well was not monitored or was inaccessible.



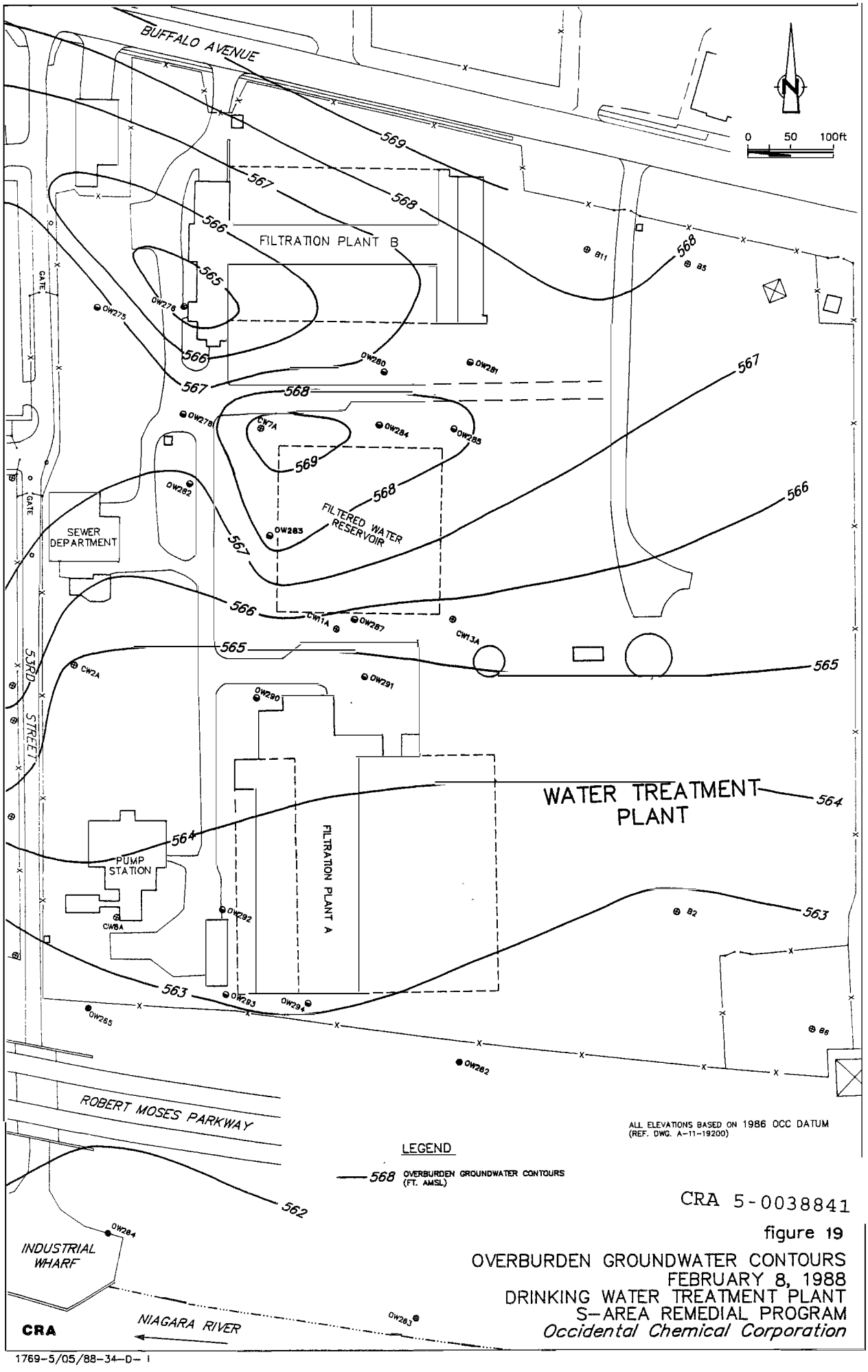
CRA 5-0038840

figure 18

OVERBURDEN GROUNDWATER CONTOURS
APRIL 18, 1988
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



CRA 5-0038841

figure 19

OVERBURDEN GROUNDWATER CONTOURS
FEBRUARY 8, 1988
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

TABLE 2

WATER ELEVATIONS - OVERBURDEN
S-AREA/WATER TREATMENT PLANT/NIAGARA PLANT

Overburden Wells	Reference Elevations	Jan. 5-8/88	Feb. 8/88	Feb. 29/88	Apr. 18/88	Minimum	Maximum
S-Area RI Wells							
OW260	567.80	561.80	562.13		563.15	561.80	563.15
OW261	569.10	561.27	561.79		562.94	561.27	562.94
OW262	574.31	562.47	562.54		563.49	562.47	563.49
OW263	570.54	561.99	561.79		563.01	561.79	563.01
OW264	568.21	561.73	561.46		562.92	561.46	563.44
OW265	574.02	563.11	562.66		563.48	562.66	563.48
OW266	568.10				563.02	563.02	563.02
OW267	571.78				563.00	563.00	563.00
OW268	578.24				563.00	563.00	563.00
OW269	573.12	562.61	562.77		563.44	562.61	563.44
OW270	571.90	562.02	562.35		563.85	562.02	563.85
OW271	574.10		561.49		562.79	561.49	562.79
OW272	571.70	561.72	561.73		562.80	561.72	562.80
OW273	570.48	562.21			563.33	562.21	563.33
OW274	571.97	564.47		564.75	564.84	564.47	564.84
OW275	570.34	567.87	567.50	567.68	568.17	567.50	568.17
OW276	571.27	563.60	564.21	564.81	564.92	563.60	564.92
OW277	569.84			567.34	567.77	567.34	567.77
OW278	570.24	566.67	567.23	567.48	568.51	566.67	568.51
OW279	570.38	569.34		569.09	569.36	569.09	569.36
OW280	569.78	567.47	567.14	567.92		567.14	567.92
OW281	570.06	567.06	566.98	567.51	567.75	566.98	567.75
OW282	570.61	567.28	566.77	567.28	567.38	566.77	567.38
OW283	571.56	569.37	568.54	568.79	569.91	568.54	569.91
OW284	569.47	568.60	568.93	569.00	569.38	568.60	569.38
OW285	569.52	568.45	568.30	568.51	568.79	568.30	568.79
OW286	570.39	568.63		568.62	569.50	568.62	569.50
OW287	574.19			565.62	566.92	565.62	566.92
OW288	571.66	567.07		567.07	567.31	567.07	567.31
OW289	572.89			565.82	565.97	565.82	565.97
OW290	574.63	565.56	564.71	565.05	566.15	564.71	566.15
OW291	573.82	565.22	564.49	564.89	565.75	564.49	565.75
OW292	575.72	563.82	563.29	563.70	564.08	563.29	564.08
OW293	575.28	563.25	562.99	563.30	563.79	562.99	563.79
OW294	574.06	563.36	563.04	563.23	563.86	563.04	563.86

continued....

TABLE 2

WATER ELEVATIONS - OVERBURDEN
S-AREA/WATER TREATMENT PLANT/NIAGARA PLANT

Overburden Wells	Reference Elevations	Jan. 5-8/88	Feb. 8/88	Feb. 29/88	Apr. 18/88	Minimum	Maximum
WTP Wells							
B1	575.90	562.67	562.63		563.35	562.32	563.58
B2	576.13	563.17	562.81		563.40	562.42	564.02
B3	571.89	562.19	561.98		562.23	561.91	563.29
B5	576.48	568.78	567.80		569.71	563.78	572.42
B6	574.98	562.58	562.56		563.28	562.27	563.44
B10	576.22	559.84	559.79		561.27	559.79	562.27
B11	576.07	568.67	568.81		569.20	565.43	572.13
B12	576.92	563.00	562.87		563.60	562.47	564.98
CW1A	569.70	563.30			564.15	559.69	565.72
CW1B	570.01	563.41			563.68	562.02	564.66
CW2A	570.33		564.92		566.37	564.92	567.61
CW3A	571.05				567.65	566.30	568.69
CW6A	575.25	565.89		565.78	566.06	564.46	567.90
CW6B	574.66			566.86	565.26	564.73	567.68
CW7A	570.43	569.10	569.51	569.57	569.64	564.70	570.53
CW8A	577.07	564.06	563.57		564.16	562.96	565.24
CW9A	572.06	567.97		567.40	568.10	561.88	569.60
CW10A	576.72	563.73		563.90	564.07	561.48	567.03
CW11A	574.22		565.23	565.81	567.03	564.15	570.40
SP4A	573.55		562.18		563.03	561.97	563.59
SP6A	567.91	552.34	551.28		554.40	549.97	556.52
SP7A	572.84		561.73		562.82	560.98	563.65
SP8A	570.30	563.04	563.50		563.80	561.28	563.89
SP9A	573.60	558.68	558.73		560.50	558.68	568.15
WS10A	569.34	566.46	566.83			565.99	569.57
WS14A	573.35	566.13	565.40		565.50	561.23	567.00
WS14B	573.08	563.43	563.67		564.20	558.50	566.91
WS15A	573.84	565.55	564.55		565.26	563.65	567.23
WS16A	571.94	563.48	562.91		563.64	560.71	565.27
WS17A	574.13	565.91	565.55		565.87	565.41	567.15
WS18A	574.85	568.29	567.66		568.02	566.96	569.00
WS20A	572.36	565.54	566.02		565.65	564.50	571.64
WS21A	573.09	571.75			564.04	568.02	573.09
WS28A	570.32	567.75	567.68			559.65	569.50
WS30A	571.78	567.88	568.20		567.92	566.79	571.08
WS33A	570.58	567.00	567.01			565.30	567.34
WS35A	569.46	565.68	565.95		566.10	565.68	567.37
WS36A	577.12	568.39	568.39			559.19	568.89
WS39A	571.95					570.54	571.95
WS40B	572.15	563.63	566.02			555.85	566.02
WS45A	574.77	566.54	566.41		566.51	566.04	567.15
WS46A	573.59				567.61	560.25	568.73

continued....

TABLE 2

WATER ELEVATIONS - OVERBURDEN
S-AREA/WATER TREATMENT PLANT/NIAGARA PLANT

Overburden Wells	Reference Elevations	Jan. 5-8/88	Feb. 8/88	Feb.29/88	Apr. 18/88	Minimum	Maximum
WTP Wells							
WS47A	575.08	565.04	564.69		565.09	564.19	565.66
WS54	570.32					566.85	568.60
WS55	571.87	567.62			568.66	556.60	568.81
WS56	571.79	567.00	566.67		567.24	566.17	568.83
WS57	572.03	567.16	566.61		567.15	566.16	569.22
WS58	570.08	567.97	567.88			567.09	568.54
WS89	572.59	565.17	564.87		565.37	564.78	566.34
WS93	572.94	569.94	570.10		570.83	568.30	571.59
WS94	572.62	569.05	569.09		569.71	561.68	570.28
WS95	572.30	568.01	567.90		568.00	564.70	569.66
WS96	576.28	568.66	569.11			567.27	572.67
WS97	573.55	568.98	569.04			566.67	570.56
WS98	573.50	571.84	571.05			565.50	572.19
WS107	573.61	572.10	572.10			568.88	573.17
WS109	572.43	586.96	568.84			568.52	571.28
WS113	571.46	567.66	567.75			564.39	569.00
OW1S-80	580.18	569.56	568.61		568.91	564.75	569.56
OW2S-80	577.66	563.38	562.63		563.45	562.63	564.22
OW3S-80	576.27	564.46	564.41		564.27	563.75	565.16
OW4S-80	575.22	565.06	564.75		565.88	553.83	569.51
OW5S-80	582.79	572.39	571.75		571.68	568.05	572.47
OW6S-80	574.99	566.32	565.91		566.39	565.91	568.36
OW7S-80	582.78	571.60	570.77		571.31	556.70	572.21
OW8S-80	573.34	561.97	561.51		562.38	561.51	563.15
OW9S-80	573.27	555.02	555.09		555.14	552.31	563.51

Notes:

1) The following is a list of the non-functioning well installations (buried, destroyed, plugged) not presented in the table but used for stratigraphic information: SP1A, SP2A, SP3A, CW13A, WS9A, WS11A, WS12A, WS13A, WS19A, WS22A, WS24A, WS29A, WS31A, WS32A, WS37A, WS38A, WS40A, WS42A, WS43A, WS44A, WS53, WS59, WS83, WS84 and WS105.

2) Well installations located on the PASNY property east of the Niagara Falls Water Treatment Plant have been removed (i.e. wells OW1-82 through OW5-82).

3) All elevations are based on 1986 OCC Datum (Ref. Dwg. A-11-19200).

4) Blank entries indicate water level not measured.

The groundwater elevation measurements collected from all of the overburden wells at or near the WTP were used to generate the contours with the exception of wells B1, B3, B10 and B12. These wells monitor the till at the till/bedrock interface. Wells B10 and B3, located on the northern portion of the WTP, monitor the till below the clay layer. In this area the clay ranges in thickness from 20 to 25 feet. The water levels recorded at wells B10 and B3 are below the top of clay elevations, thereby confirming that the wells are monitoring the groundwater conditions of the till and/or bedrock formations, and not the alluvium/fill.

Wells B1 and B12, located within 150 feet of the southern boundary of the WTP, were also installed to the bedrock. In this area, the clay and till layers are relatively thin and insufficient data exists to confirm the monitored interval. Since it is unclear as to whether the wells monitor the overburden and/or the bedrock, data from wells B1 and B12 were not included in the generation of the contours. In any event, the wells are east of the WTP Facilities and should not be in an area subjected to influence of the WTP.

4.2 LOCATION OF PIPE INVERT, UTILITY AND FLOOR ELEVATIONS

In assessing the hydrogeology of the WTP, it is important to note the locations of pipe inverts, utility

and floor elevations in relation to the water table and the geological units; primarily the clay/till formation. The reference water elevations used for this assessment were the April 18, 1988 water levels. Historically, the yearly maximum water levels occur between December and April and of the three rounds taken in 1988, the April 18 levels give the highest water table elevation. The April 18 round includes all of the Survey Wells and the historic wells at the WTP and in the immediately adjacent areas.

Enclosed Plan 1 illustrates the pipes, conduits, forcemains, etc., complete with invert elevations. Approximately 80 percent of all the pipes, utilities, etc., are partially or totally below the water table. The solid toned utilities of Plan 1 indicate the utilities with known invert elevations which are below the water table. Dashed tone indicates utilities which are probably below the water table, but exact invert elevations are not available. The cross-sections presented on Figures 14 through 17, indicate which utilities, pipes, structures, etc., are above or below the water table and where they lie in relation to the geologic layers. The following section of this report provides a brief description of the location of the major pipes and structures.

4.3 PLANT OPERATIONS

Figure 20 shows a schematic of water flow through the present WTP.

The water from the Niagara River enters the Pump Station via a 48-inch diameter emergency intake (former East Branch Intake). The main intake tunnel was removed from service in April 1983. Two 42-inch diameter low service discharge lines transport the untreated water from the Pump Station to the Chemical Building for chemical treatment. The two 42-inch lines are located in fill material and enter the Chemical Building at an elevation approximately equal to the water table.

A portion of the chemically treated water leaves the Chemical Building via a 48-inch diameter line which enlarges to two 36-inch diameter lines for 250 feet and reverts back to a 48-inch diameter line before entering Filtration Plant B. The initial 120 feet and the final 50 feet of the 48-inch diameter line are above the water table. The remaining section, including the two 36-inch diameter water lines, are below the water table. The entire system is above the clay layer except for approximately 220 feet running east-west immediately south of Filtration Plant B. The clay layer in this area extends to approximately 2 to 3.5 feet above the invert.

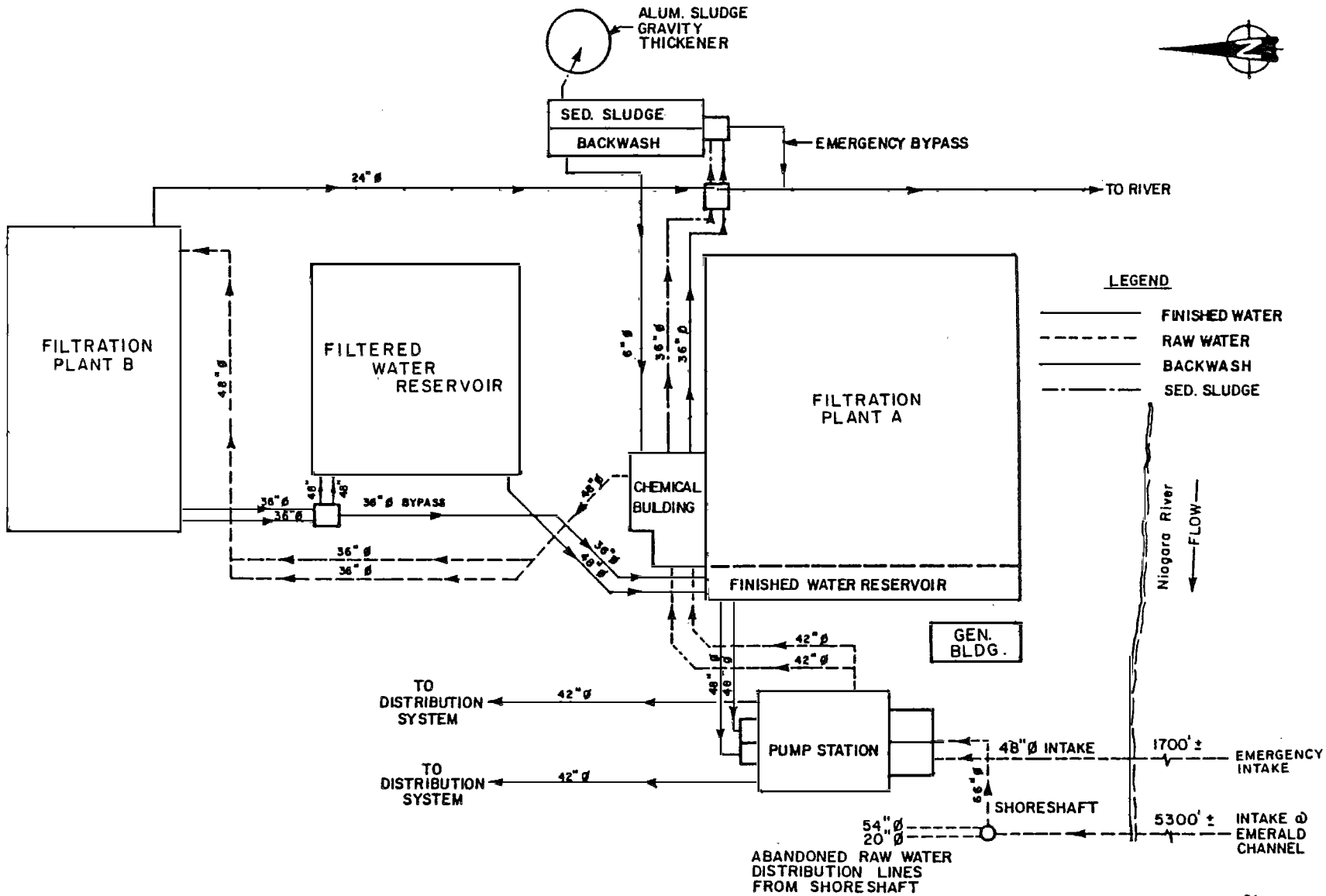


figure 20

SCHEMATIC - WATER TREATMENT PLANT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA 5-0038848

CRA

1769-5/05/88-34-D-1

The filtered water then leaves Filtration Plant B via two 36-inch diameter filtered water lines to a large manhole structure at the northwest corner of the Filtered Water Reservoir. The entire length of the 36-inch diameter lines is below the water table and partially to completely below the top of the clay layer. This is also the case for the two 48-inch diameter filtered water lines from the manhole structure to the Filtered Water Reservoir.

The 36-inch diameter bypass line from the manhole structure to Filtration Plant A is below the water table with the bedding and/or pipe partially below the top of the clay layer for approximately 120 to 200 feet from the manhole structure.

The 48-inch diameter filtered water line from the Filtered Water Reservoir to Filtration Plant A is located below the water table, and the clay layer is approximately at the pipe's centerline.

The two 48-inch diameter high service lines from Filtration Plant A to the Pump Station containing treated water for distribution, are below the water table and partially below the top of the clay layer.

The two 42-inch diameter high service discharge lines leaving the north end of the Pump Station

deliver water to the City of Niagara Falls distribution system. The two lines are initially above the water table in the fill material, as shown in Figure 14. Both lines are below the water table before reaching the Sewer Department Offices and Garage, and remain below the water table until they leave the WTP at Adams Avenue, north of the S-Area, and at the northwest corner of the WTP crossing Buffalo Avenue to 53rd Street. The lines are generally above the clay layer except for the northern portion of the 42-inch diameter high service discharge line closest to Filtration Plant B, as illustrated on Figure 16.

The floors of the filtration basin of Filtration Plant B, the Filtered Water Reservoir, the filtered water reservoir of Filtration Plant A, and the Pump Station are below the water table approximately 5, 13, 7.5 and 15.5 feet, respectively. All the above structures, except for the filtered water reservoir of Filtration Plant A, have floor elevations below the top of the clay layer.

It also should be noted that the floor of the 6 by 7-foot tunnel between the Chemical Building, the Chemical Unloading Vault and Filtration Plant B is between 0.5 to 6.0 feet below the water table, and the northern 50 feet is at or below the top of the clay layer.

4.4 GROUNDWATER ELEVATION ASSESSMENT

Review of the water levels presented on Figures 18 and 19 indicate three local hydraulic anomalies in the overburden groundwater regime; a mound in the vicinity of the Filtered Water Reservoir, a small mound at well OW275, and a sink immediately west of Filtration Plant B.

The mound in the area of the Filtered Water Reservoir has existed historically and indicates that the Filtered Water Reservoir is probably leaking, acting as a recharge to the overburden groundwater regime. The mound is defined by four wells, CW7A, OW283, OW284 and OW286, located around the circumference of the Filtered Water Reservoir (see Figure 18). Should the "Filtration Plant/Reservoir Collection System" be required, as per Addendum I sub-paragraph E(2) of the Judgment, the collection system in the vicinity of the Filtered Water Reservoir will include drain tile laterals as shown conceptually on Figure E-4 of the Judgment. A detailed assessment of the above sub-paragraph will be presented in the report entitled "City of Niagara Falls Drinking Water Treatment Plant Filtration Plant A and B, Filtered Water Reservoir, ° Hydrogeologic and Environmental Conditions, ° Collection System Design Considerations, S-Area Remedial Program".

The small mound at well OW275 is surrounded by utilities including an 8-inch and 36-inch diameter watermain and a 42-inch diameter high service discharge line as shown on Plan 1. It should be noted that the mound is not reflected at OW277, located 100 feet south, equidistant from the same utilities possibly indicating a leak in one of the lines in the vicinity of OW275. However, there are two other local conditions which may explain the presence of this small mound. To the west of the above utilities, along 53rd Street, lies a 12-inch diameter sewer which may act as a drain for groundwater flow and, therefore, the mound may exist due to the potential groundwater sinks east and west of OW275. Also, well OW275 is located in an area of high precipitation infiltration due to the gravel ground surface. The surface drainage characteristics in the area of the gravel parking area are poor, often resulting in water ponding in this area. On occasion, the area has been flooded and water levels at OW275 could not be taken. Therefore, a local mound could also exist due to the increased recharge in this area.

Given the local surface characteristics and the magnitude of the above mound, it is more likely that the mound is a result of the natural surface conditions. There is insufficient evidence to confirm a leaking watermain as the source of the slightly elevated water table at OW275. In addition, a leak of this magnitude in this area would not

affect the design considerations for either the Filtration Plant B or the Filtered Water Reservoir collection systems. Therefore, no drain tile laterals in this area are required pursuant to sub-paragraph 5(b) of the Judgment.

It should be noted that the 12-inch diameter sewer located immediately west of 53rd Street extends south 10 feet past the Sewer Department Offices and Garage, and terminates in the Carpenter Shop. In the area of the 12-inch diameter sewer the water table is relatively flat, possibly due to the local influence of the sewer and other nearby utilities. South of the Sewer Department Offices and Garage where the sewer terminates, the horizontal hydraulic gradient is towards the river.

The sink in the potentiometric surface west of Filtration Plant B indicates the local groundwater may be affected by the sewer and/or sewer bedding in the area. Overburden wells OW274 and OW276 lie within five feet of a sanitary sewer which is 24 inches in diameter at OW274 and 12 inches in diameter at OW276. The invert of the sewer is approximately five feet below the water table elevation. Therefore, the sanitary sewer may offer an alternate route for off-site groundwater flow. Only two wells currently define the sink, but it may extend northward to Buffalo Avenue where the sewer discharges to a 24-inch diameter sanitary sewer under Buffalo Avenue (see Plan 1).

4.5 HORIZONTAL AND VERTICAL GRADIENTS

The groundwater flow in the overburden at the WTP is generally north to south towards the Niagara River. Groundwater flow for approximately 80 percent of the WTP is to the south. The remaining 20 percent flows toward local influences in the area west of Filtration Plant B. The horizontal hydraulic gradient along the east boundary of the WTP is approximately 0.005 to 0.007. The hydraulic gradient from the mound area in the vicinity of the Filtered Water Reservoir to the southern boundary of the WTP is slightly larger, ranging from 0.008 to 0.011.

To calculate the vertical gradient between the overburden and the bedrock at the WTP, the CW series wells were used. The results are presented in Table 3. The vertical hydraulic gradient is downward through the overburden to the bedrock and ranges from approximately 0.099 to 0.393. It should be noted that the vertical hydraulic gradient within the water-bearing zones (i.e. fill/alluvium) is very small and the vertical direction reverses periodically through the year as indicated by historic water levels measured at CW1A & CW1B and CW6A & CW6B. The vertical gradient exists largely through the clay/till aquitard.

TABLE 3

VERTICAL GRADIENTS

Well	Water Level	Date	Monitor Interval	Gradient
CW6	559.67	01/08/88	541.1 - 538.1	+ 0.237
CW6A	565.89	01/08/88	569.1 - 559.1	
CW6	561.37	04/18/88	541.1 - 538.1	+ 0.177
CW6A	566.06	04/18/88	569.1 - 559.1	
CW7	560.28	01/08/88	539.9 - 534.9	+ 0.360
CW7A	569.10	01/08/88	566.9 - 556.9	
CW7	559.89	02/08/88	539.9 - 534.9	+ 0.393
CW7A	569.51	02/08/88	566.9 - 556.9	
CW7	561.17	04/18/88	539.9 - 534.9	+ 0.346
CW7A	569.64	04/18/88	566.9 - 556.9	
CW9	559.65	01/08/88	539.0 - 534.0	+ 0.347
CW9A	567.97	01/08/88	565.5 - 555.5	
CW9	561.40	04/18/88	539.0 - 534.0	+ 0.279
CW9A	568.10	04/18/88	565.5 - 555.5	
CW10	559.70	01/08/88	539.6 - 534.6	+ 0.153
CW10A	563.73	01/08/88	570.1 - 550.1	
CW10	561.41	04/18/88	539.6 - 534.6	+ 0.099
CW10A	564.07	04/18/88	570.1 - 550.1	

Notes:

Positive values indicate downward hydraulic gradient.
Negative values indicate upward hydraulic gradient.

5.0 CONCLUSIONS

The following conclusions are made based on the assessment of the physical hydrogeology of the Niagara Falls Water Treatment Plant.

i) The overall groundwater flow in the overburden at the Water Treatment Plant is toward the Niagara River.

ii) A mound exists in the area of the Filtered Water Reservoir, most likely due to leakage from the reservoir. Should the collection system in the vicinity of the Filtered Water Reservoir be required as per Addendum I sub-paragraph E(2) of the Judgment, drain tile laterals as shown conceptually on Figure E-4 of the Judgment will be constructed.

iii) A small mound exists approximately 100 feet west of Filtration Plant B in the area of well OW275. The mound may exist due to the local influence of the underground watermains and/or sewers in the area, or due to the combination of increased infiltration through the gravel ground surface and poor surface drainage. Given the local surface conditions and the magnitude and location of the mound, it is concluded that this mound will not impact the groundwater levels

in the vicinity of either the Filtration Plant B or Filtered Water Reservoir collection systems. Should the collection systems be required pursuant to sub-paragraph E(2), drain tile laterals will not be required in the vicinity of OW275.

iv) A sink exists in the area immediately west of Filtration Plant B, probably due to the influence of the sewer and/or sewer bedding running north-south.

v) The lower floor elevations of the filtration basins of Filtration Plant B, the Filtered Water Reservoir, the water reservoir of Filtration Plant A, the Pumping Station, and 80 percent of the underground utilities at the WTP are below the water table.

vi) The horizontal gradient in the overburden ranges from 0.005 to 0.011 and the vertical gradient ranges from 0.099 to 0.393 downward towards the bedrock.

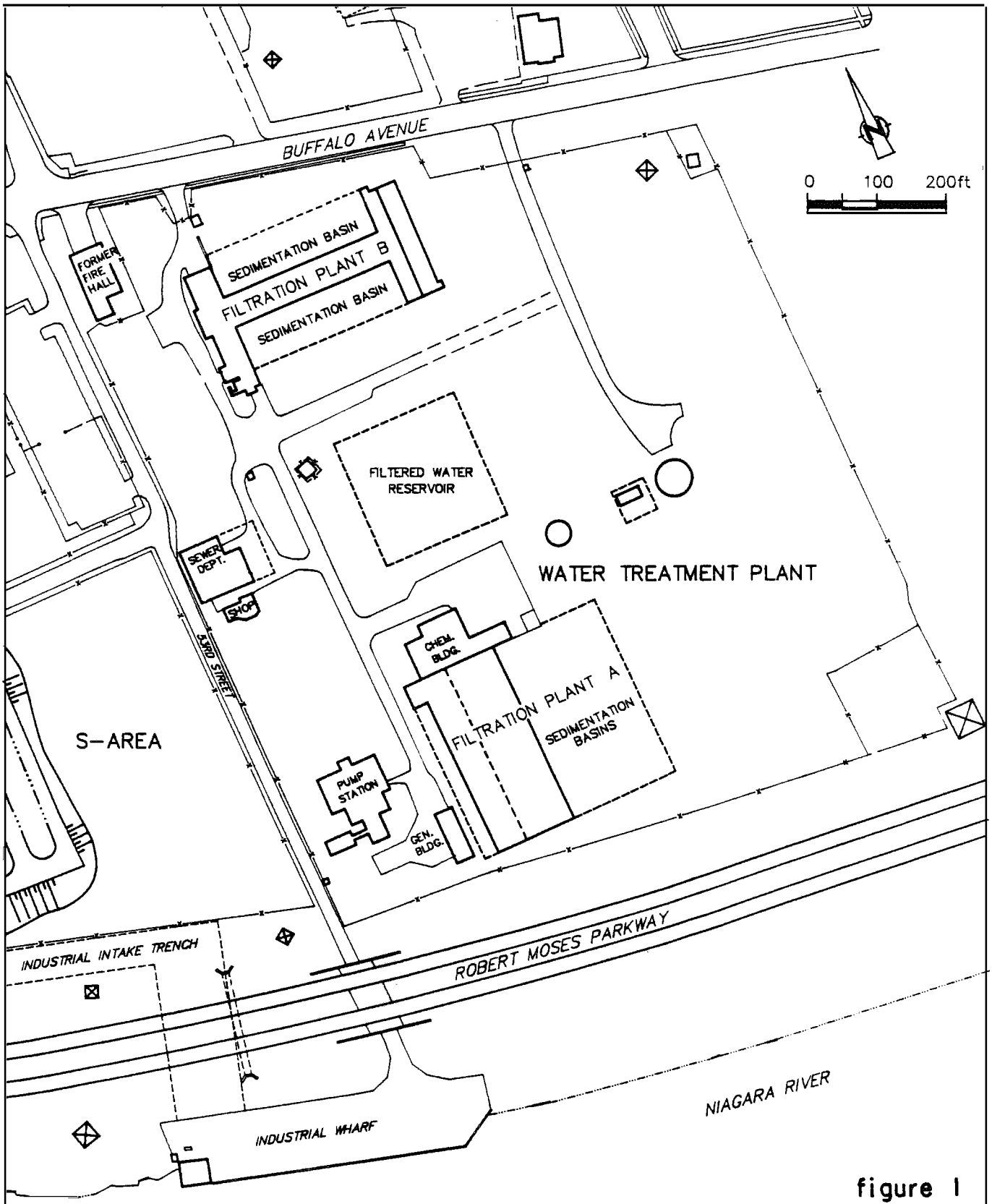


figure 1

NIAGARA FALLS WATER TREATMENT PLANT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

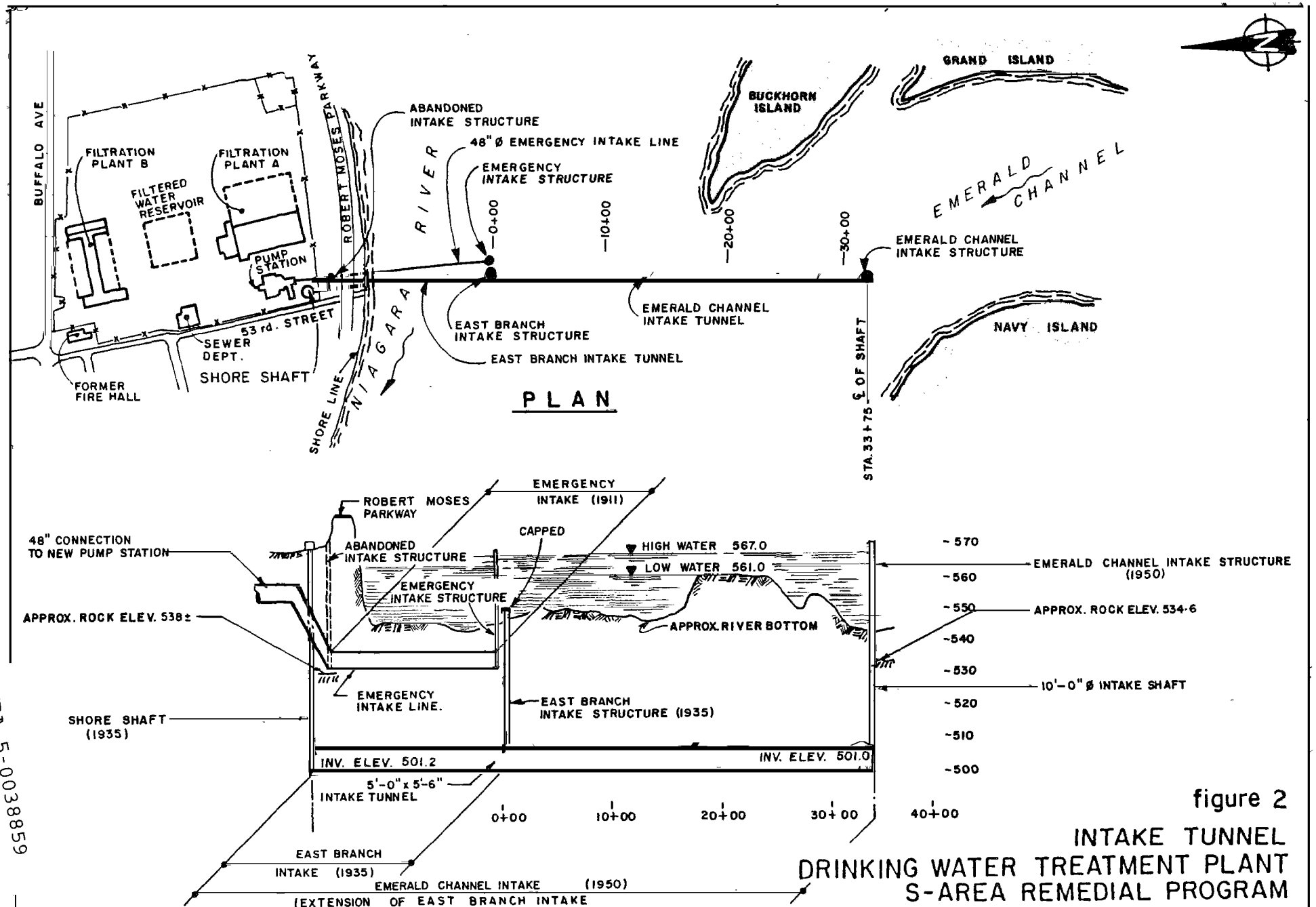


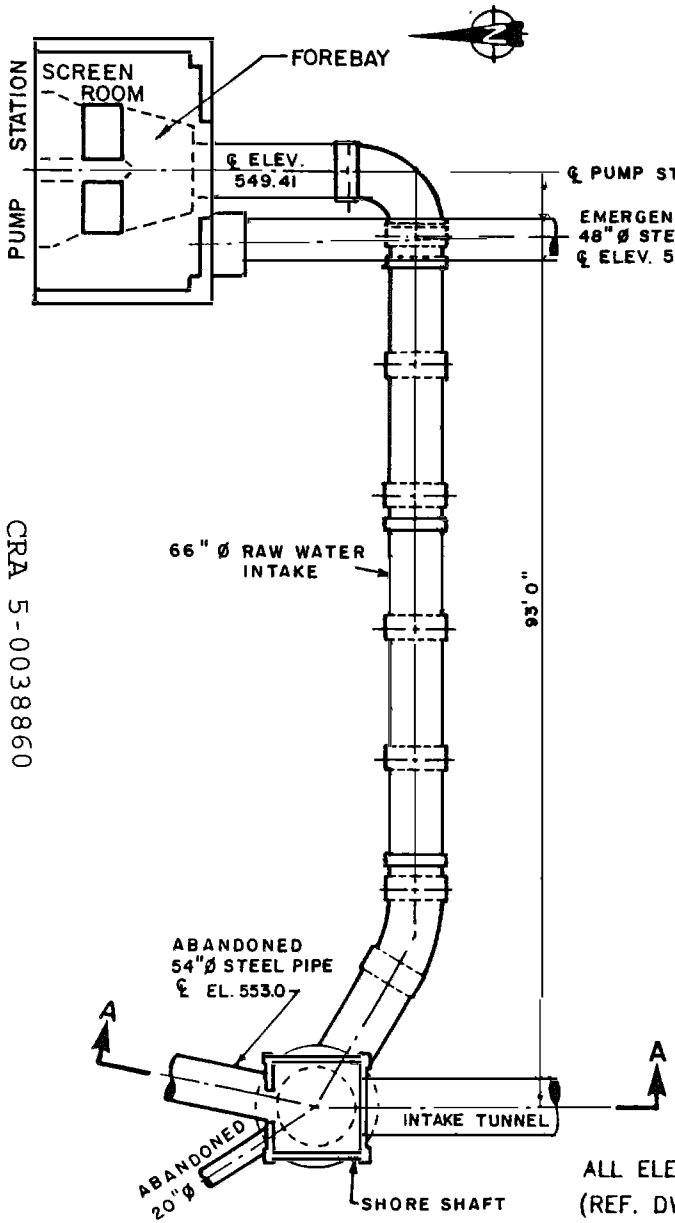
figure 2

INTAKE TUNNEL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

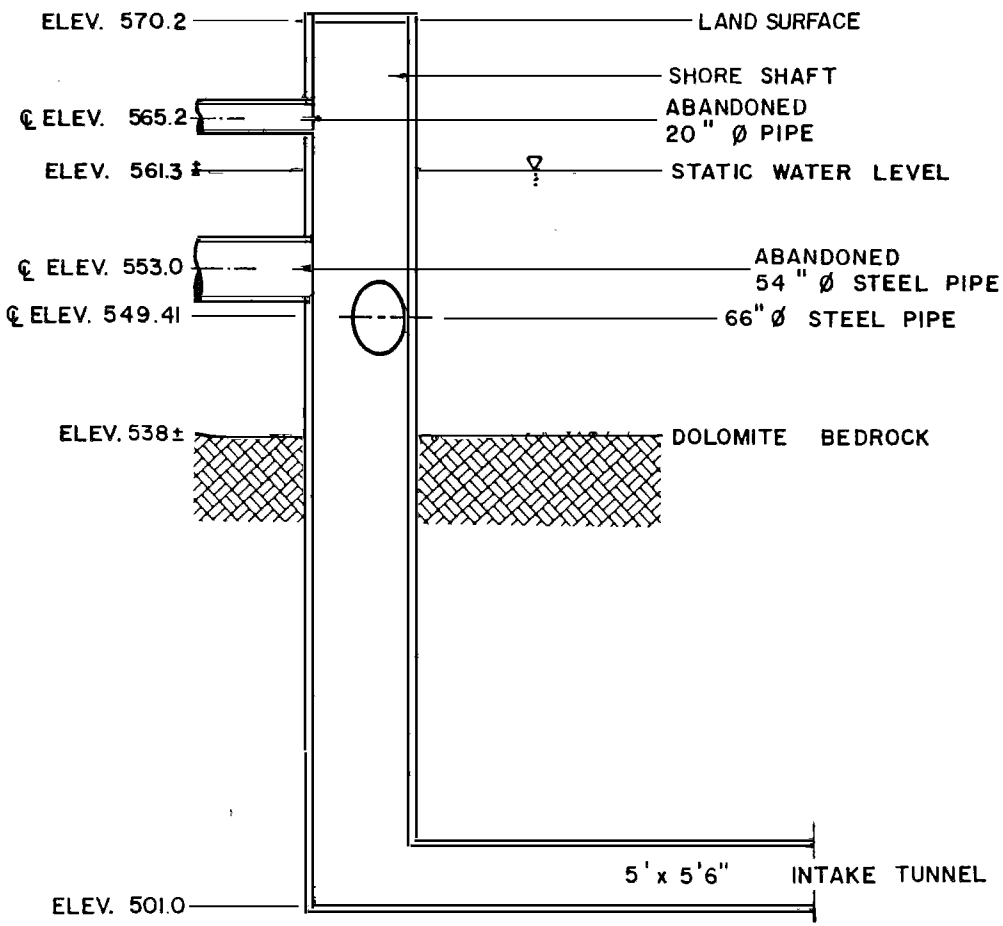
CRA

CRA 5-0038859

1769 - 5/05/88 - 34 - D - 1



PLAN OF 66" RAW WATER INTAKE
FROM SHORE SHAFT TO FOREBAY
SCALE 1"=20'



SHORE SHAFT
CROSS SECTION A–A
SCALE 1/16" = 1'-0"

ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

DATA FROM GREELEY AND HANSEN (1950)

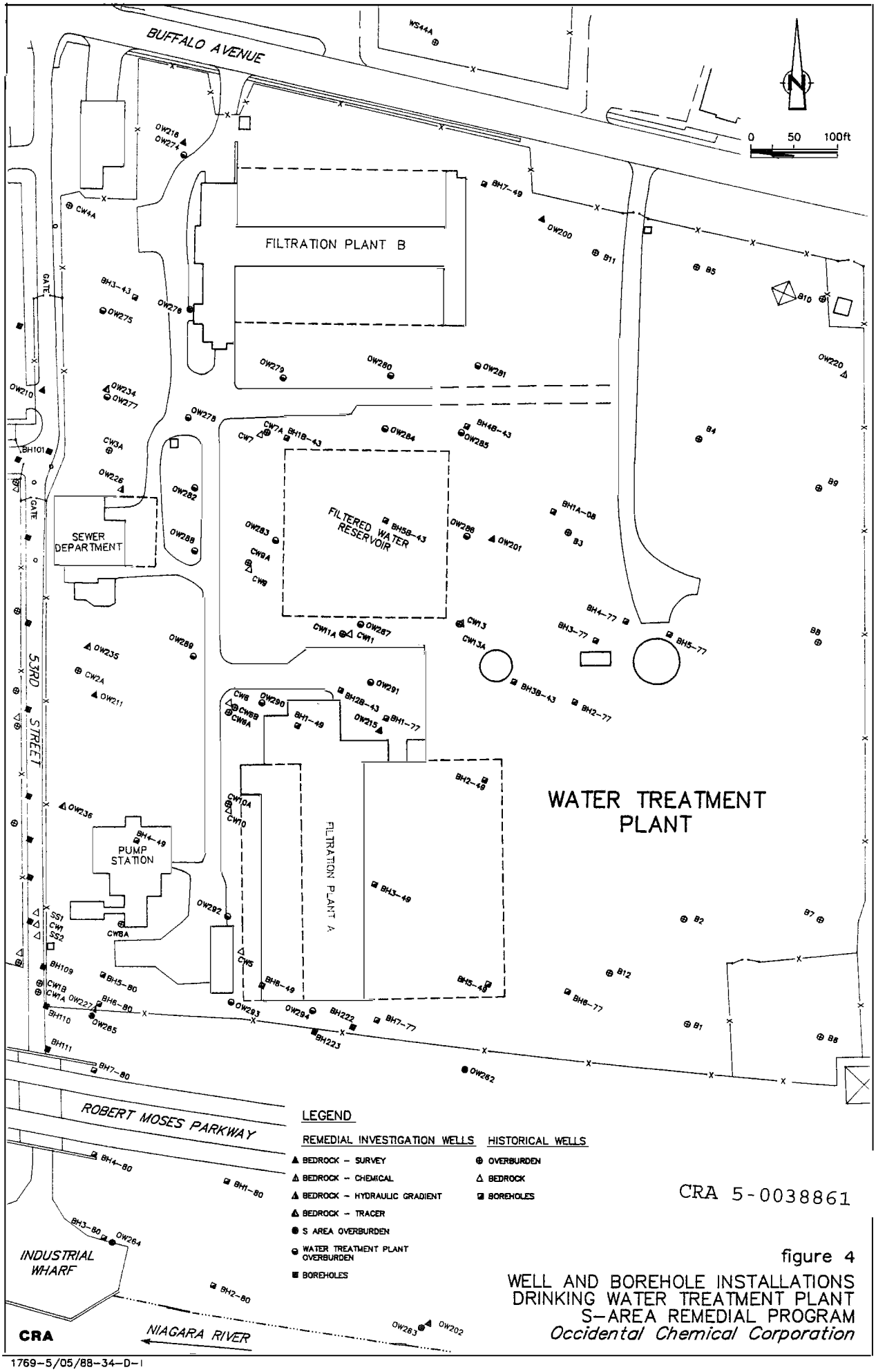
figure 3

SHORE SHAFT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

CRA 5-0038860

1769-5/05/88-34-D-1



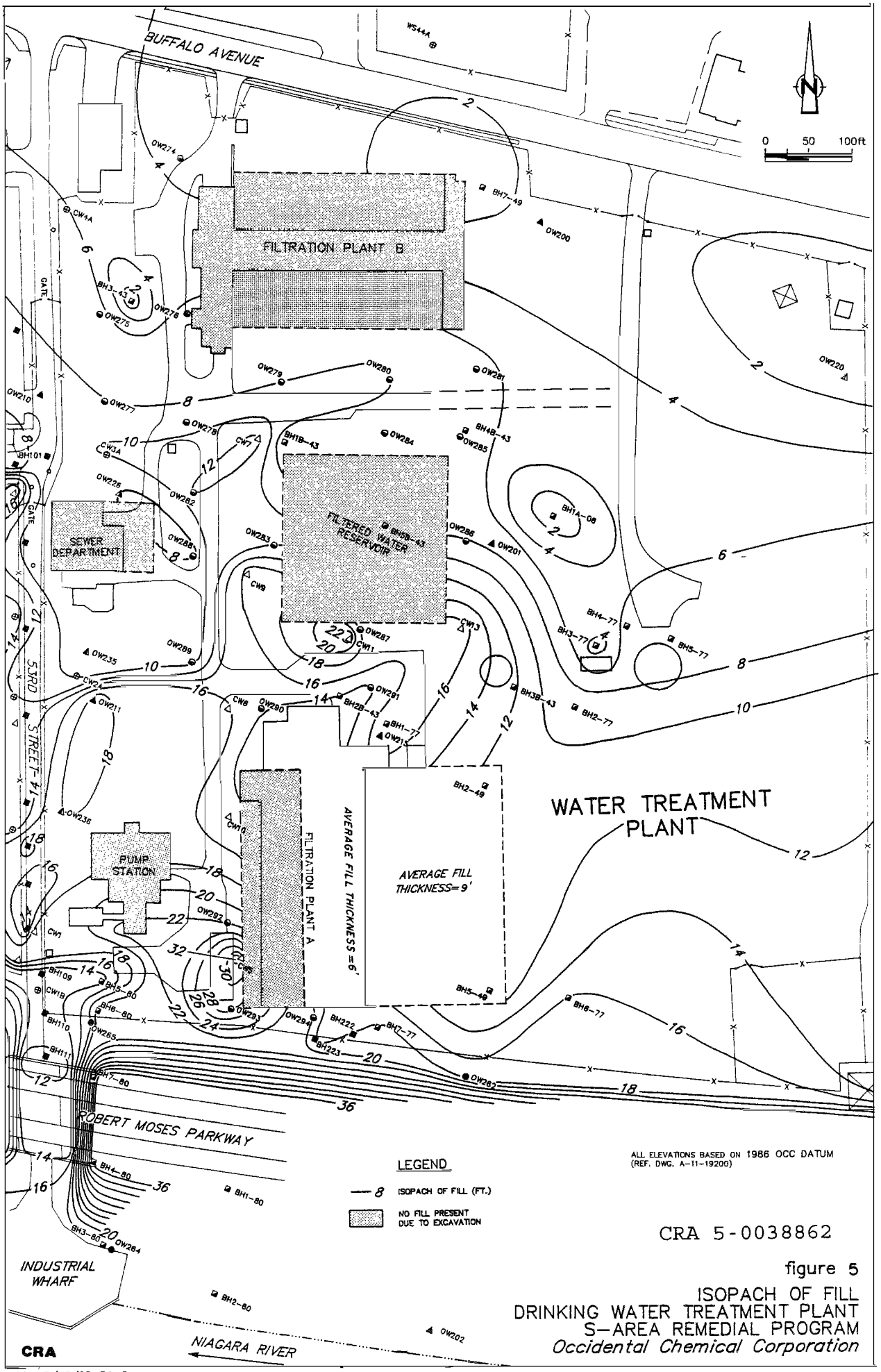
CRA 5-0038861

figure 4

WELL AND BOREHOLE INSTALLATIONS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



CRA 5-0038862

figure 5

ISOPACH OF FILL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

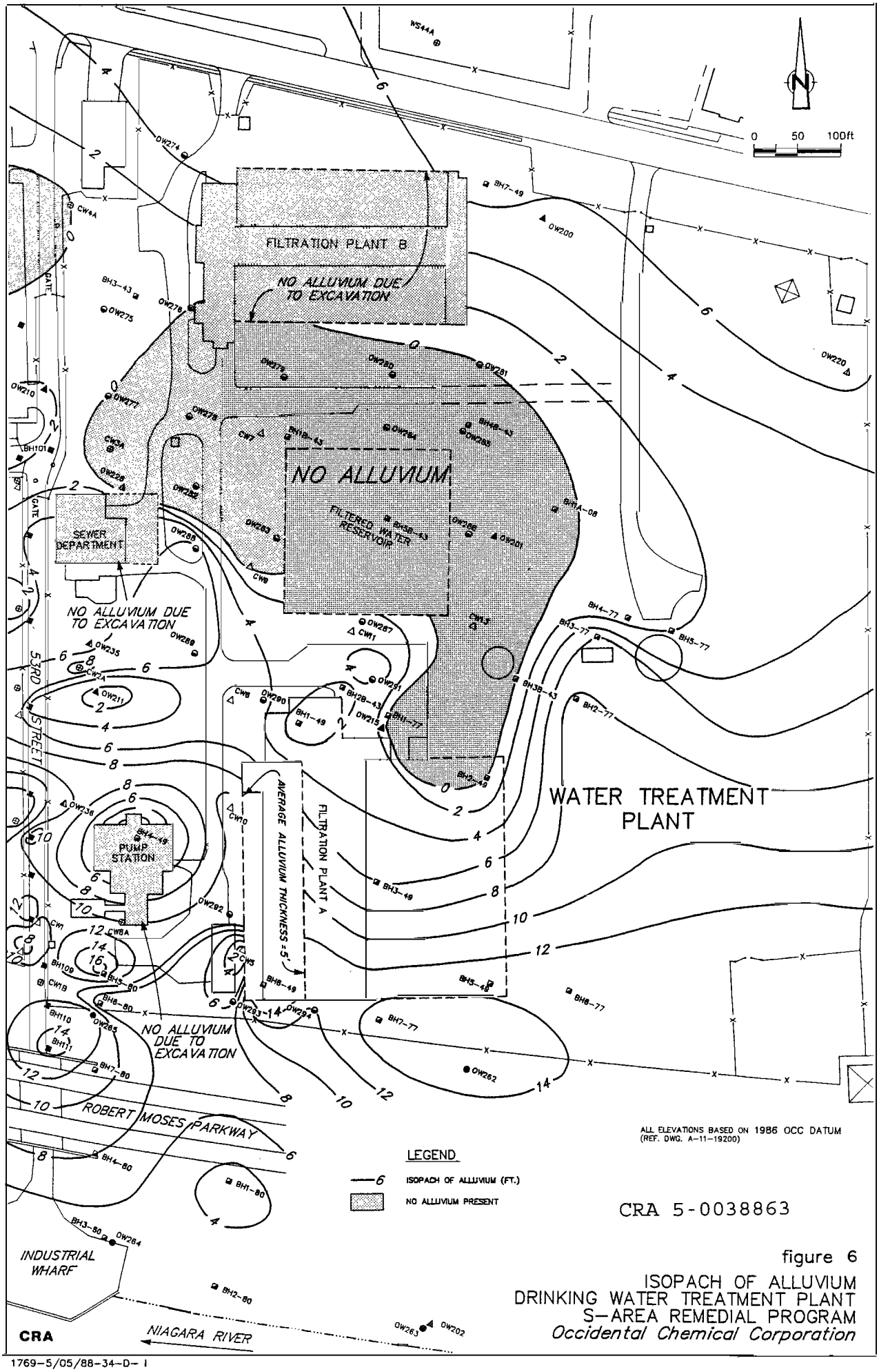
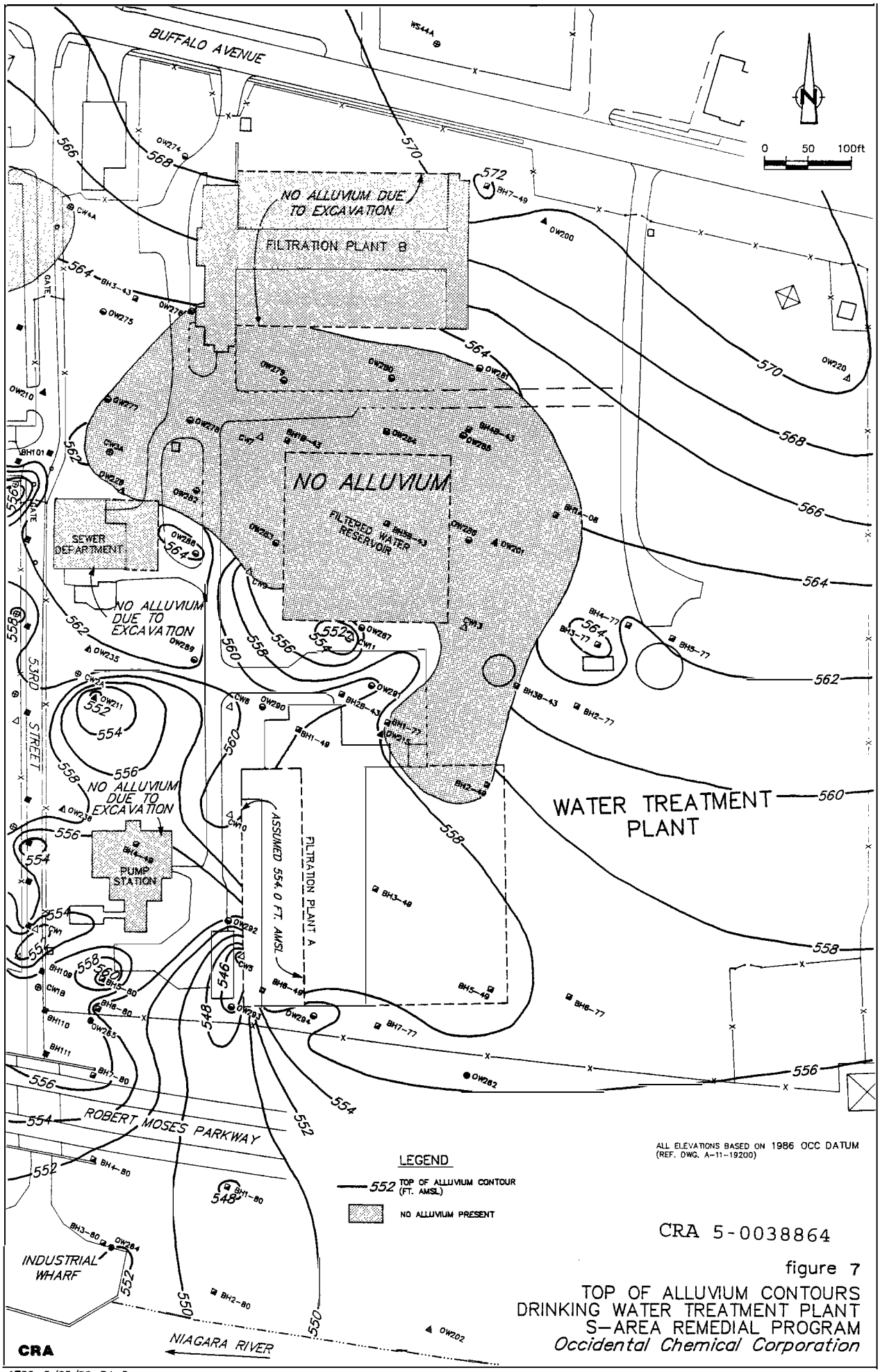


figure 6

ISOPACH OF ALLUVIUM
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

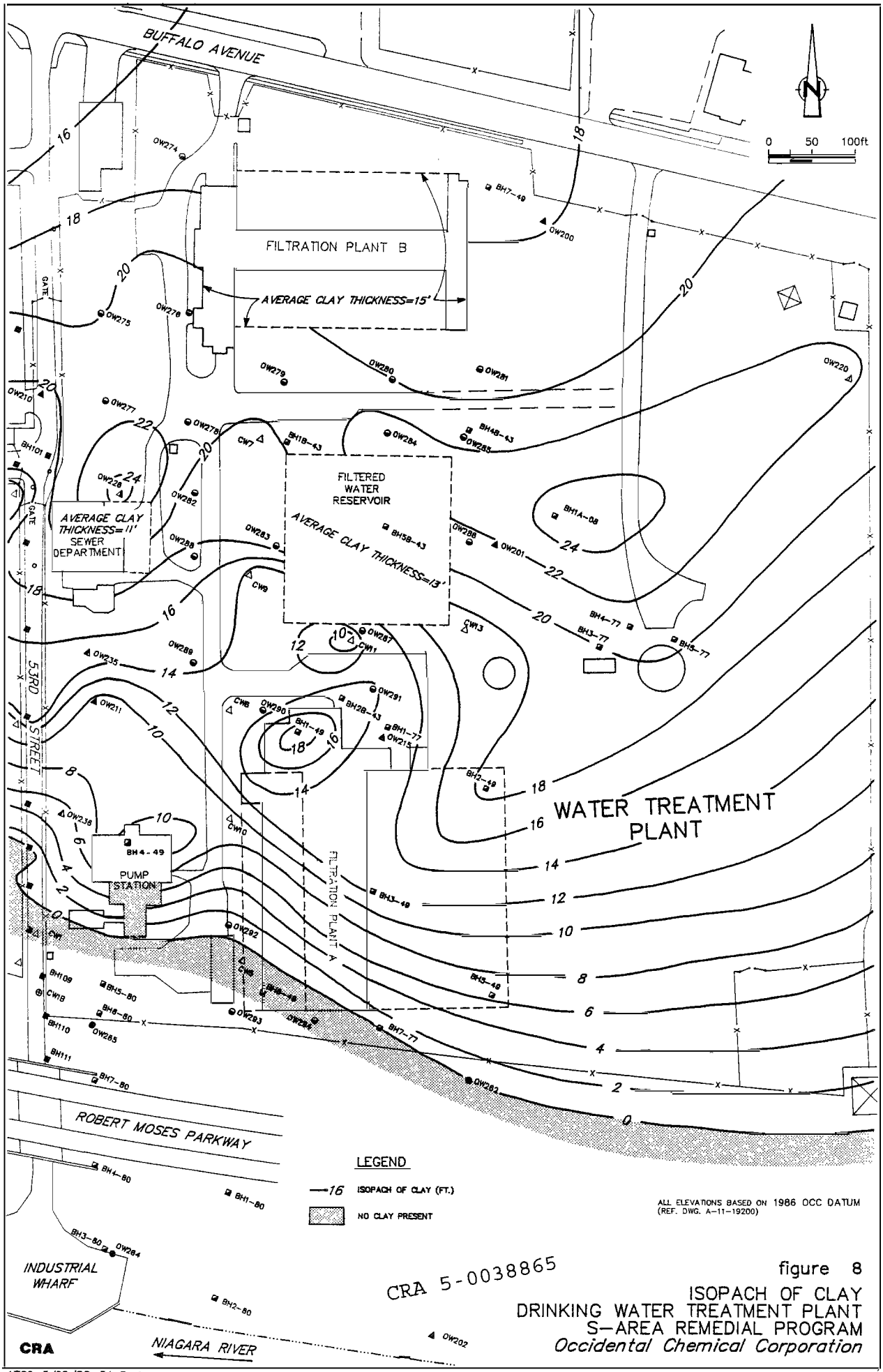


CRA 5-0038864

figure 7

TOP OF ALLUVIUM CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

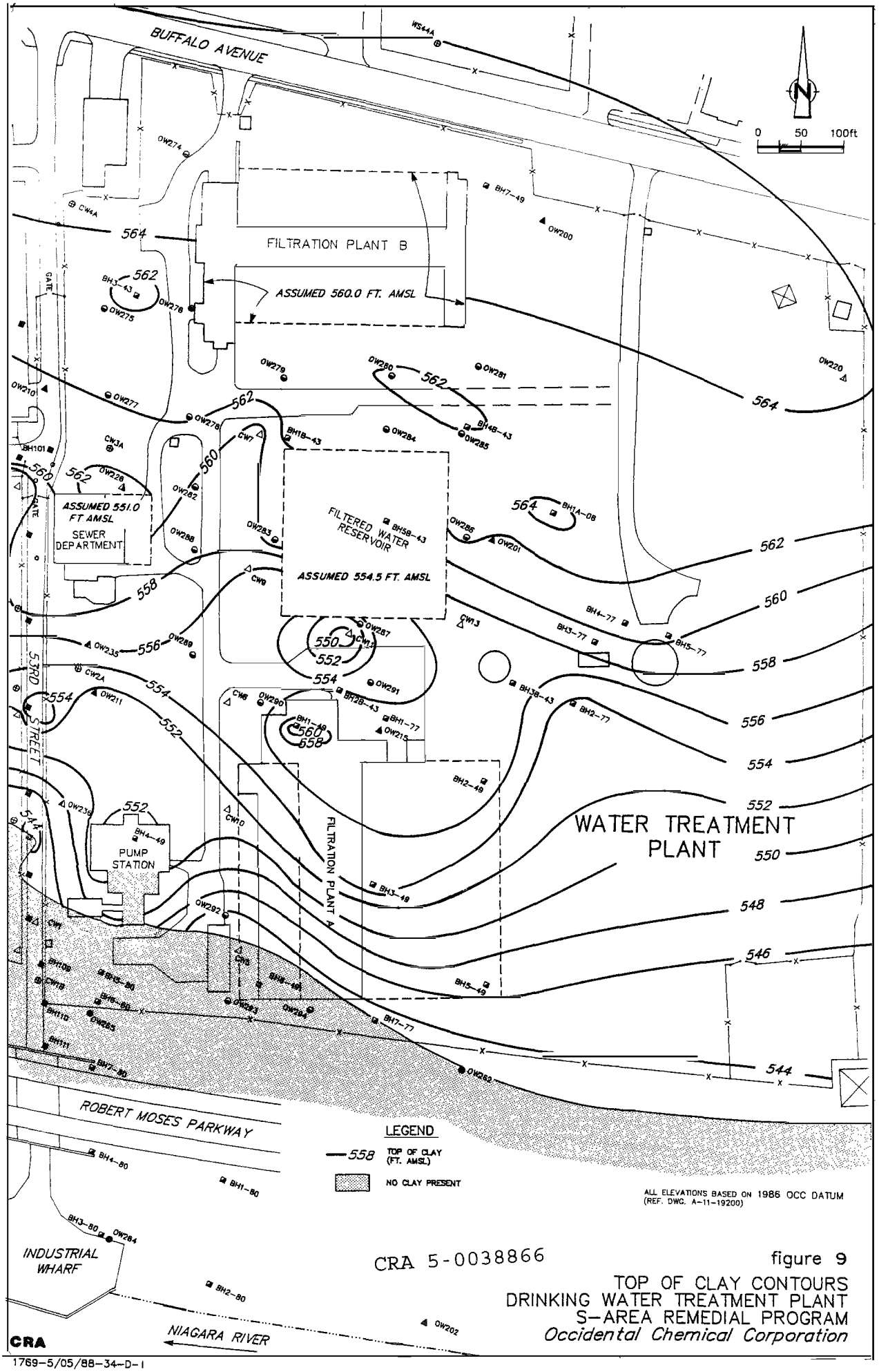
1769-5/05/88-34-D-1



CRA 5-0038865

figure 8
ISOPACH OF CLAY
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-5/05/88-34-D-1



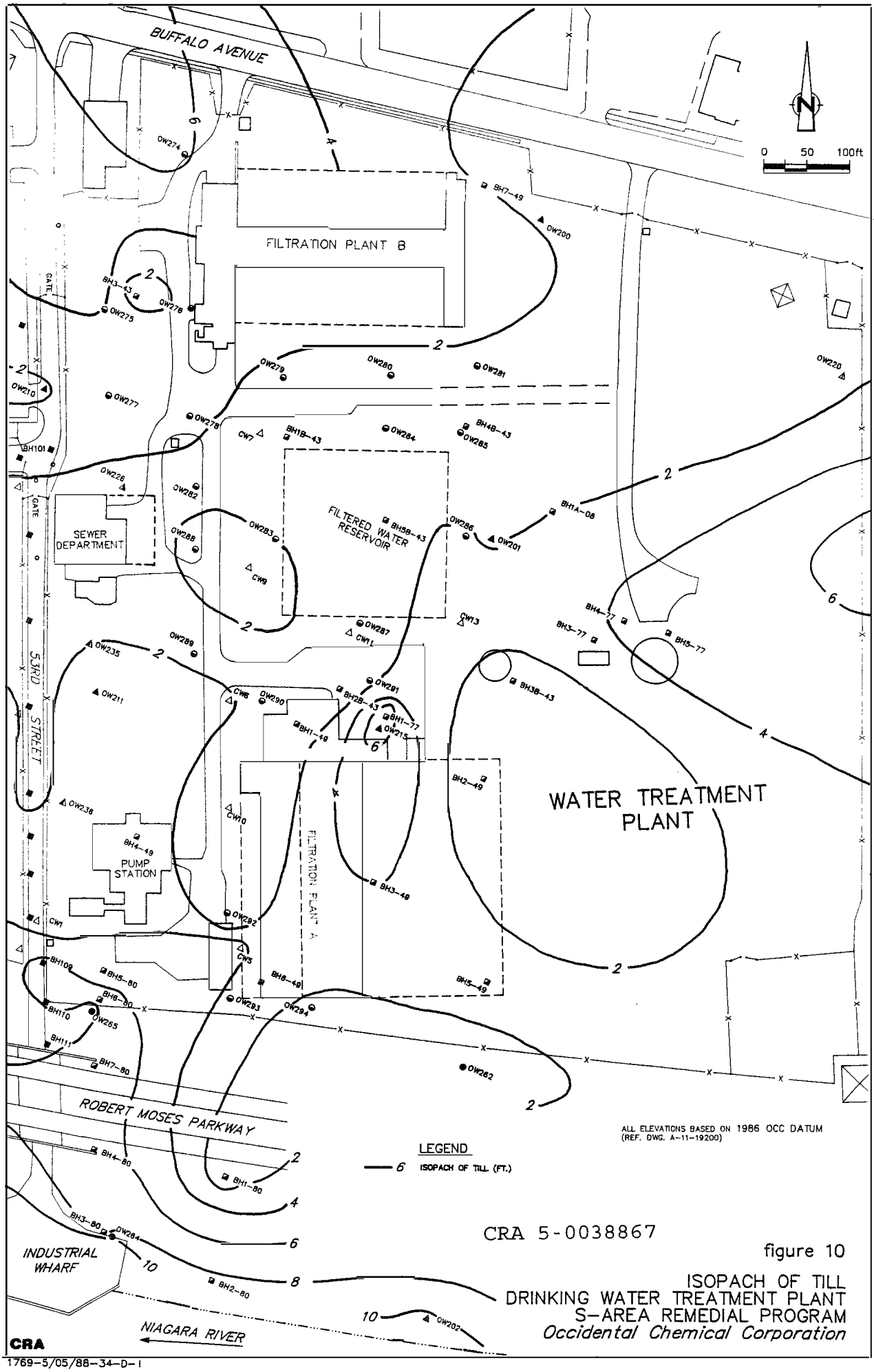
CRA 5-0038866

figure 9

TOP OF CLAY CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



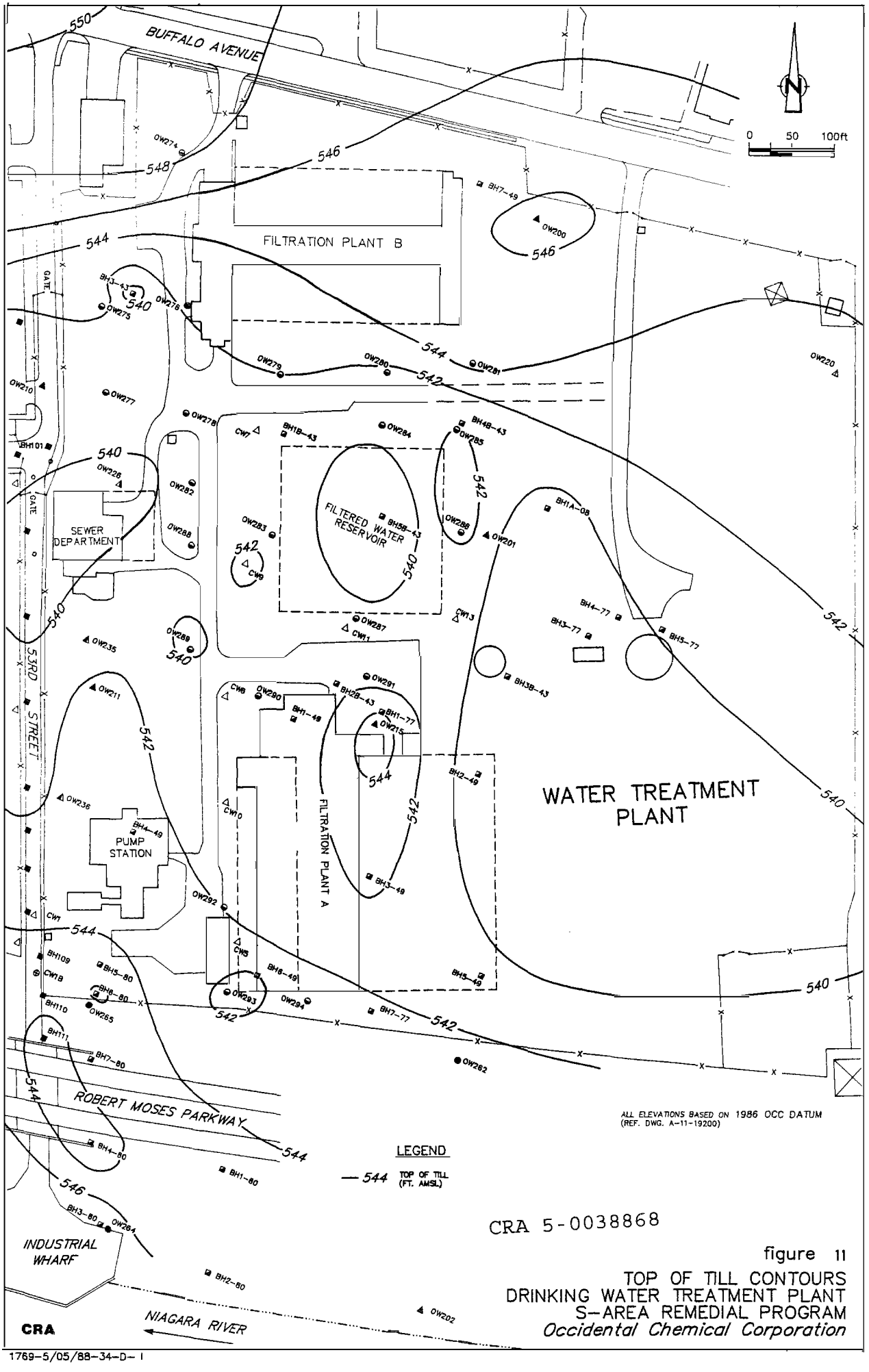
CRA 5-0038867

figure 10

ISOPACH OF TILL
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



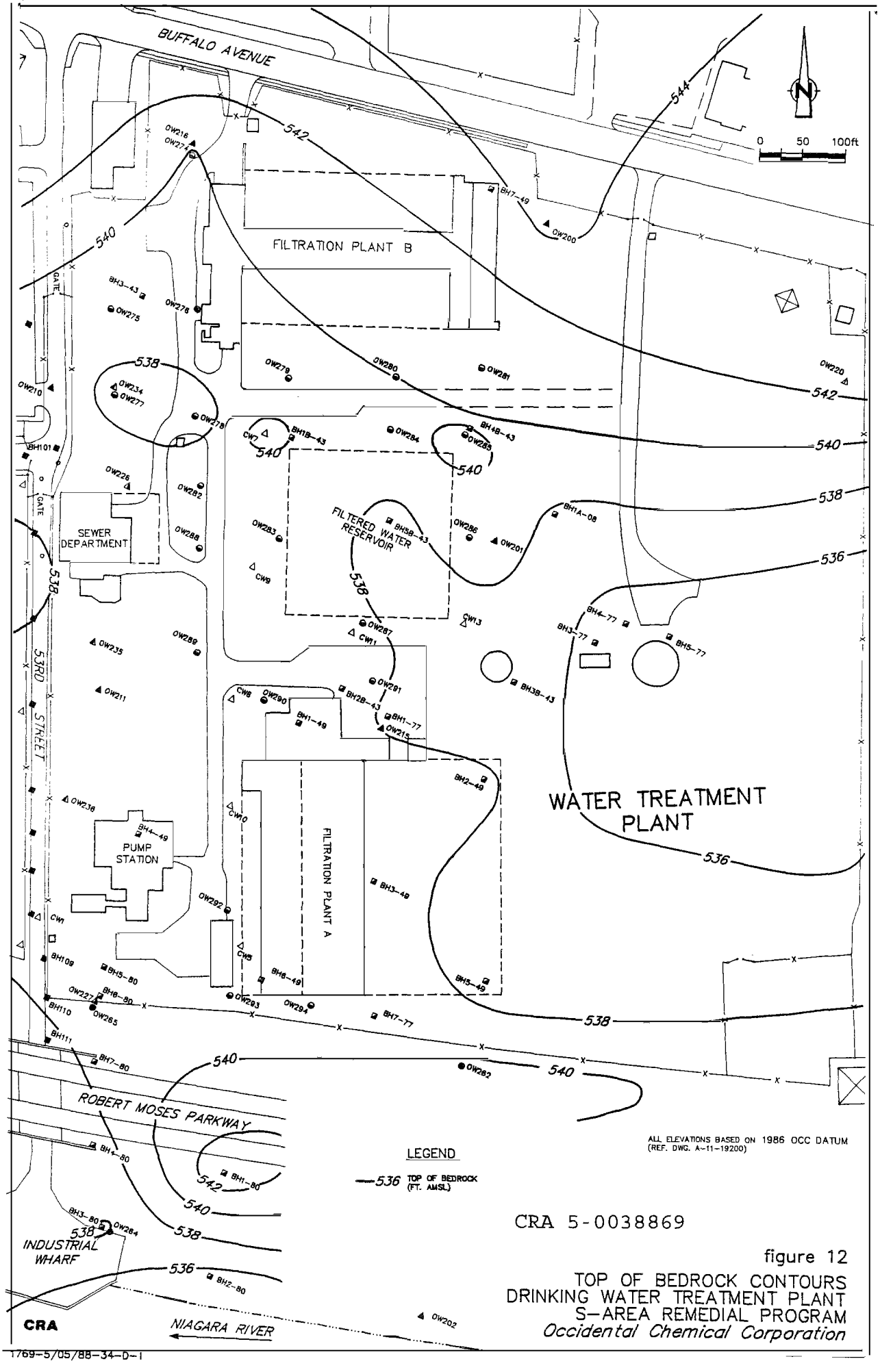
CRA 5-0038868

figure 11

TOP OF TILL CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

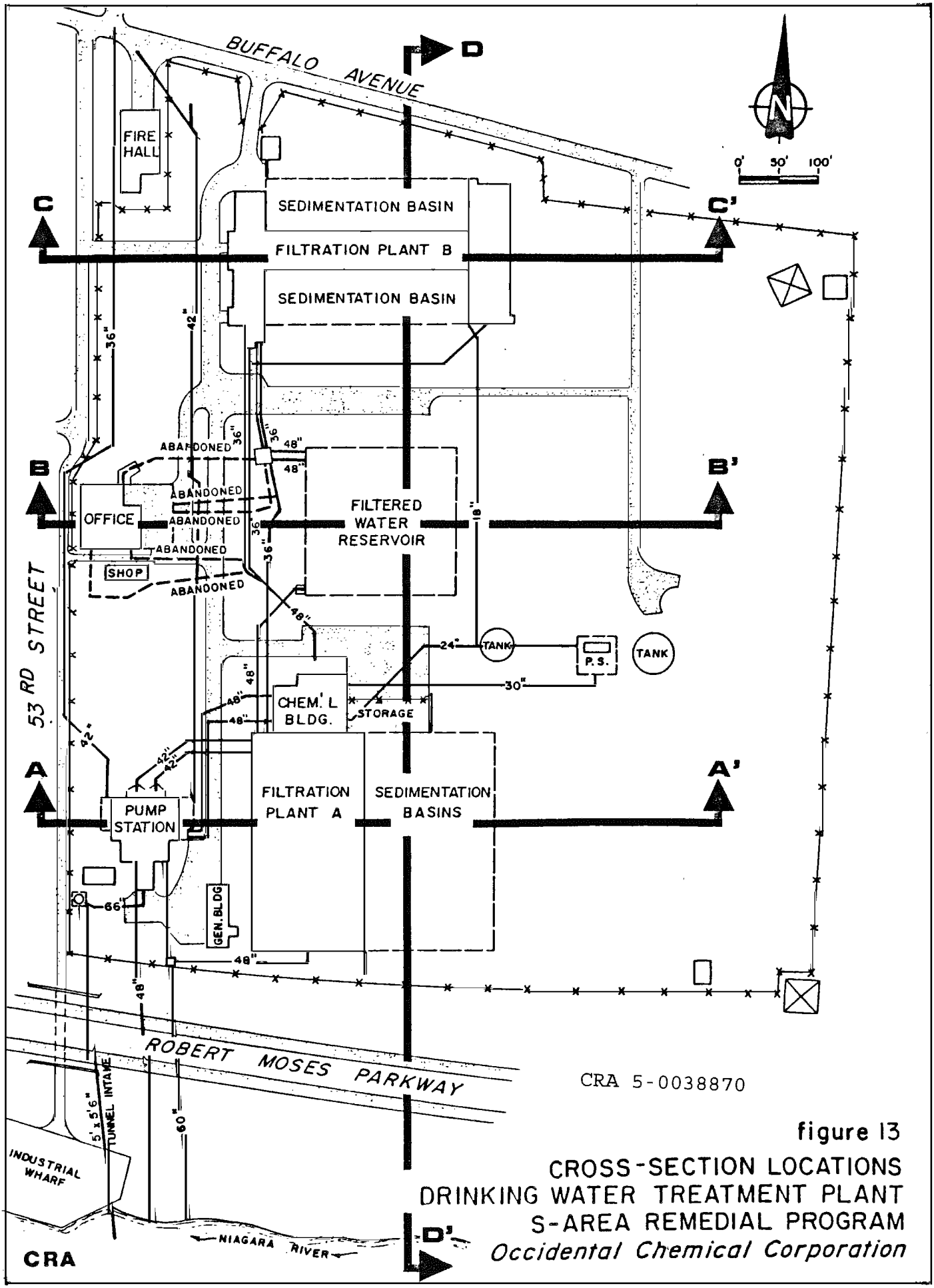


CRA 5-0038869

figure 12

TOP OF BEDROCK CONTOURS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769-5/05/88-34-D-1

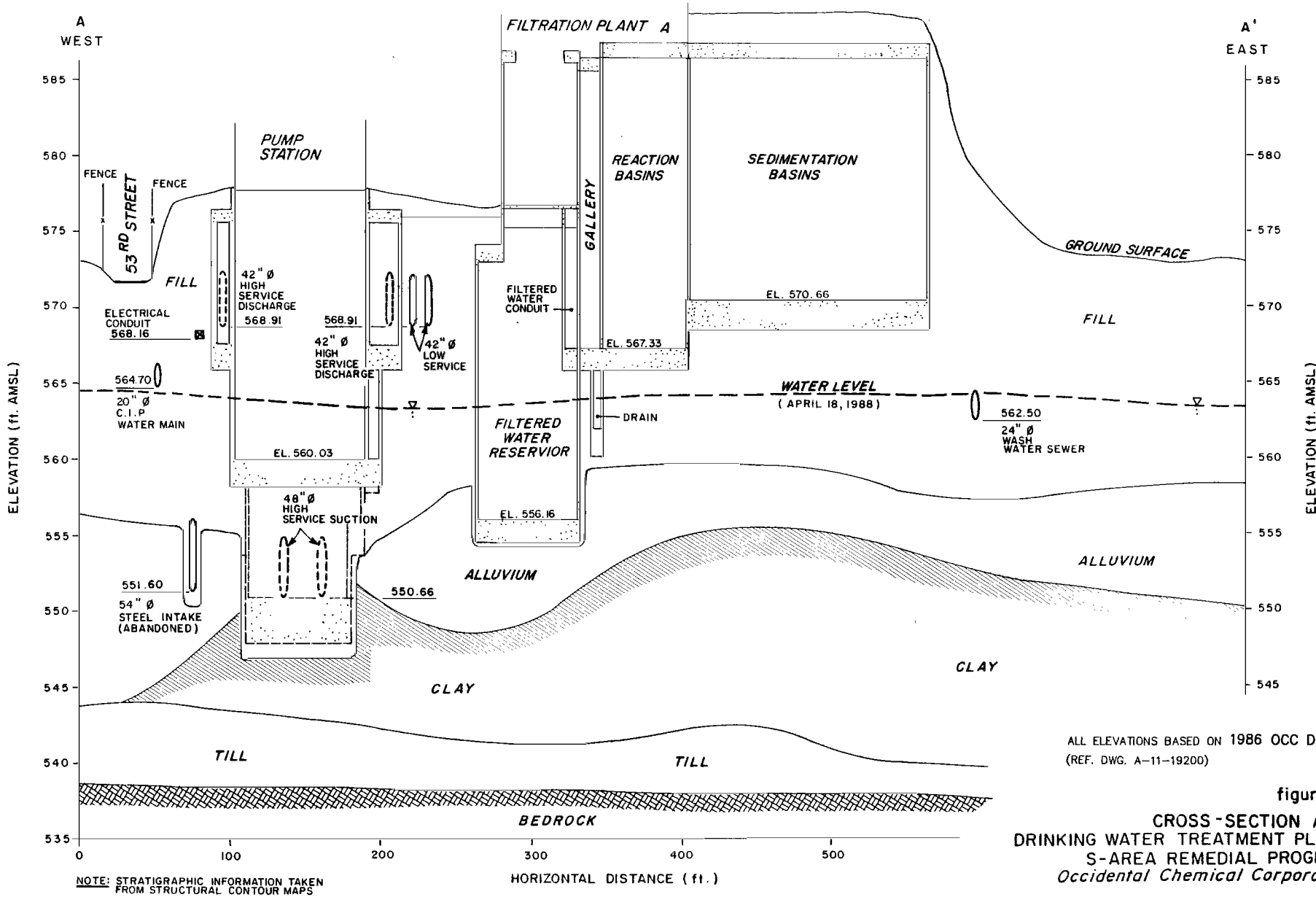


CRA 5-0038870

figure 13

CROSS-SECTION LOCATIONS
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

1769 - 5/05/88-34-D-1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

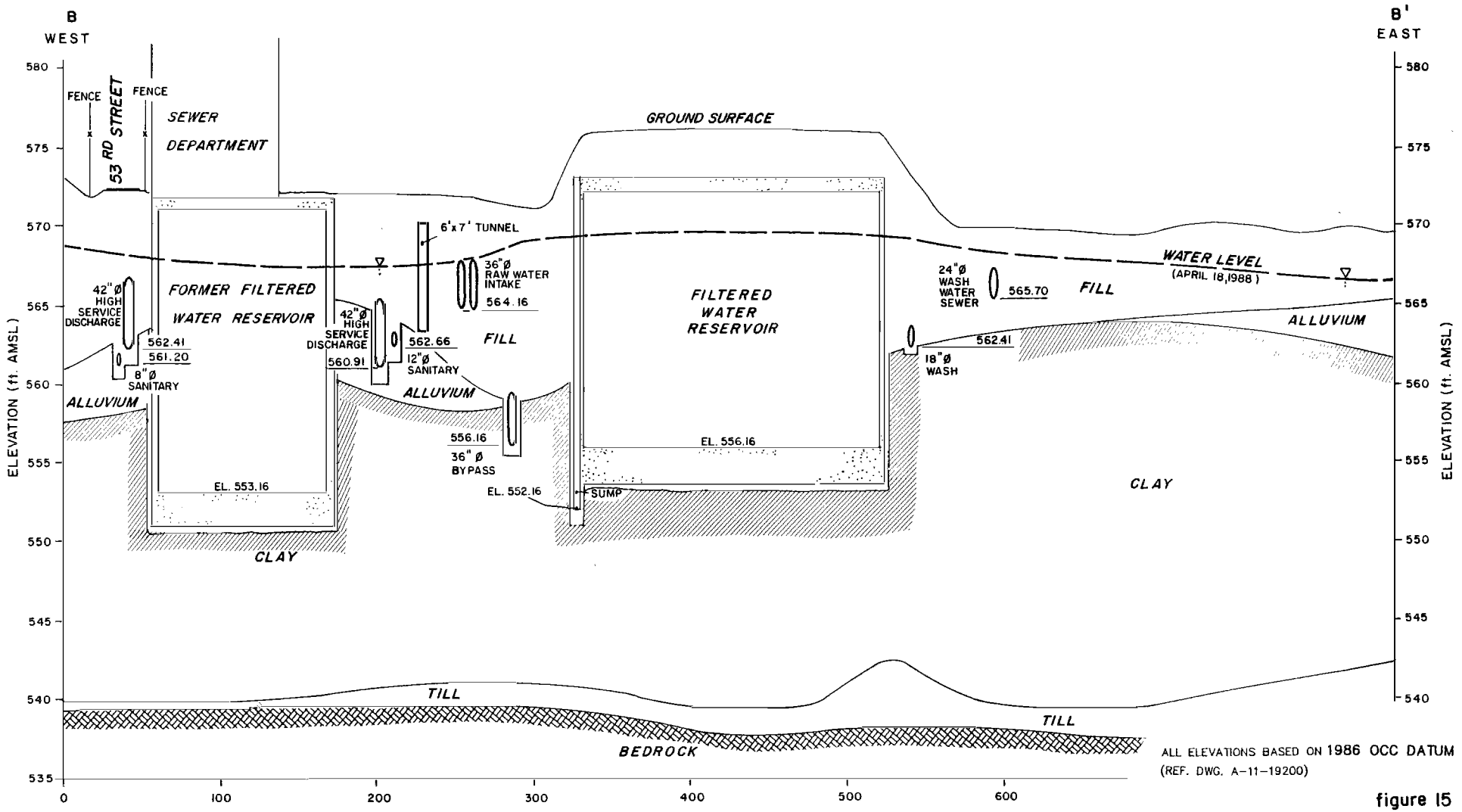
figure 14

CROSS-SECTION A-A'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

CRA 5-0038871



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

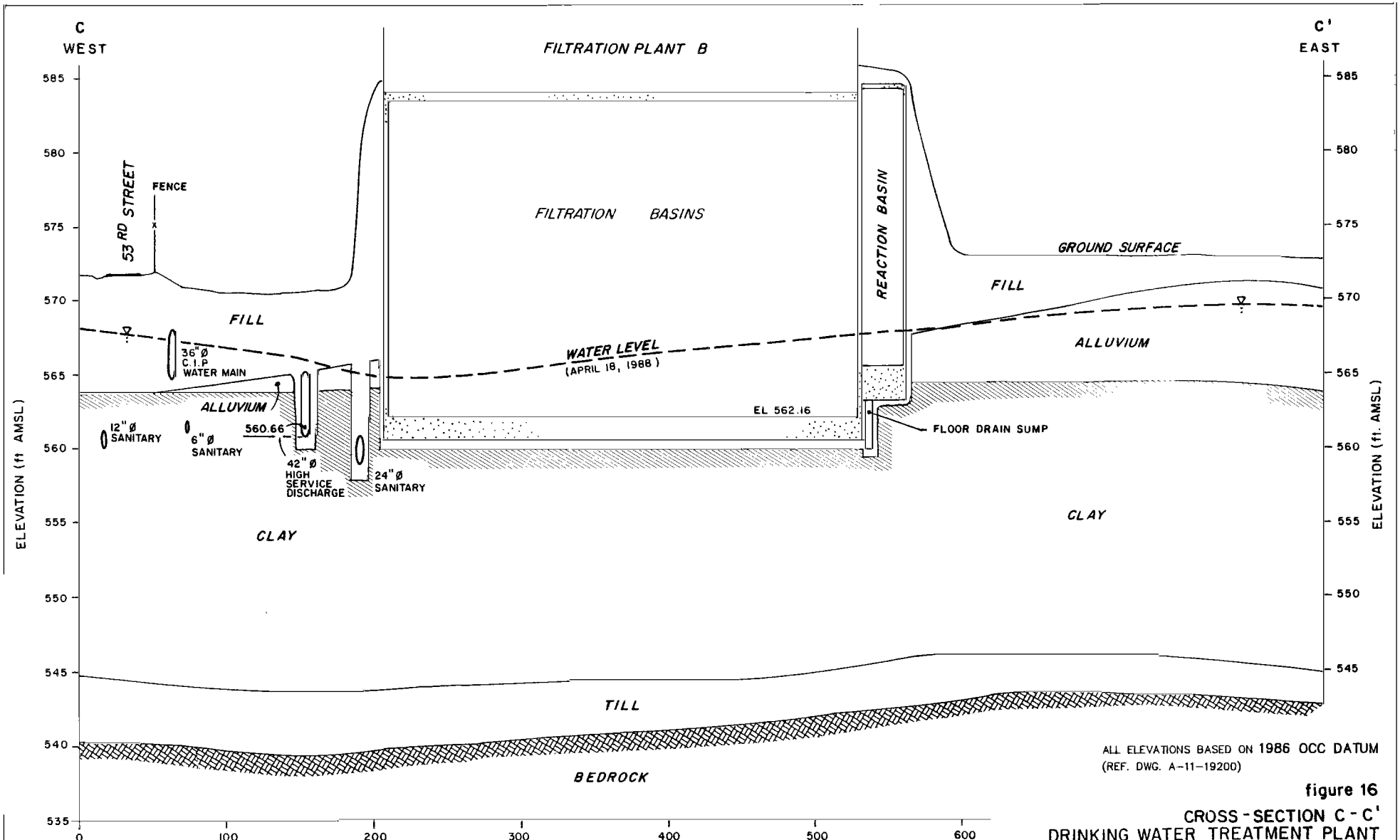
ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 15

CROSS-SECTION B-B'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1679 - 5/05/88 - 34 - D - 1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

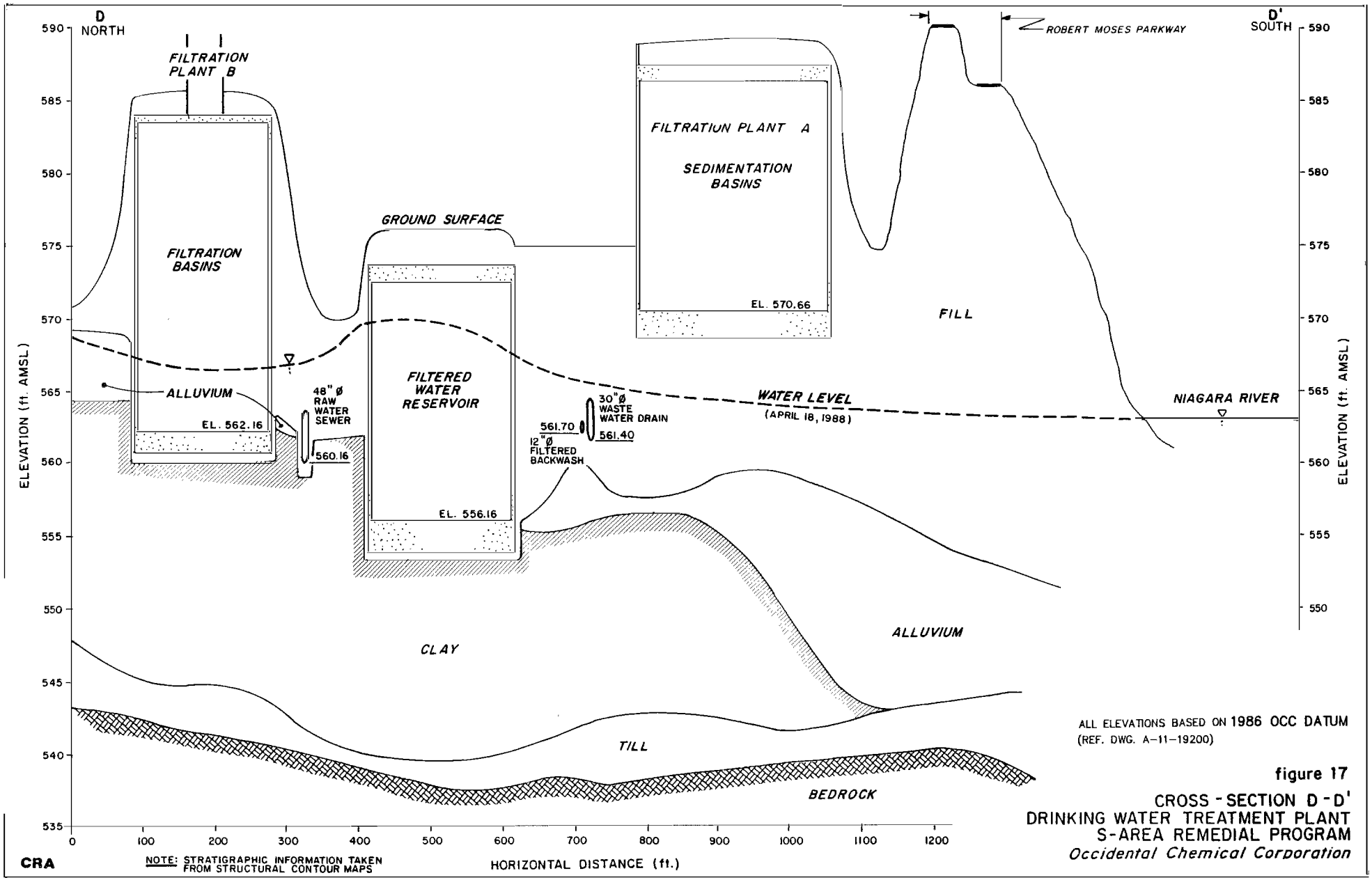
ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 16

CROSS-SECTION C-C'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



NOTE: STRATIGRAPHIC INFORMATION TAKEN FROM STRUCTURAL CONTOUR MAPS

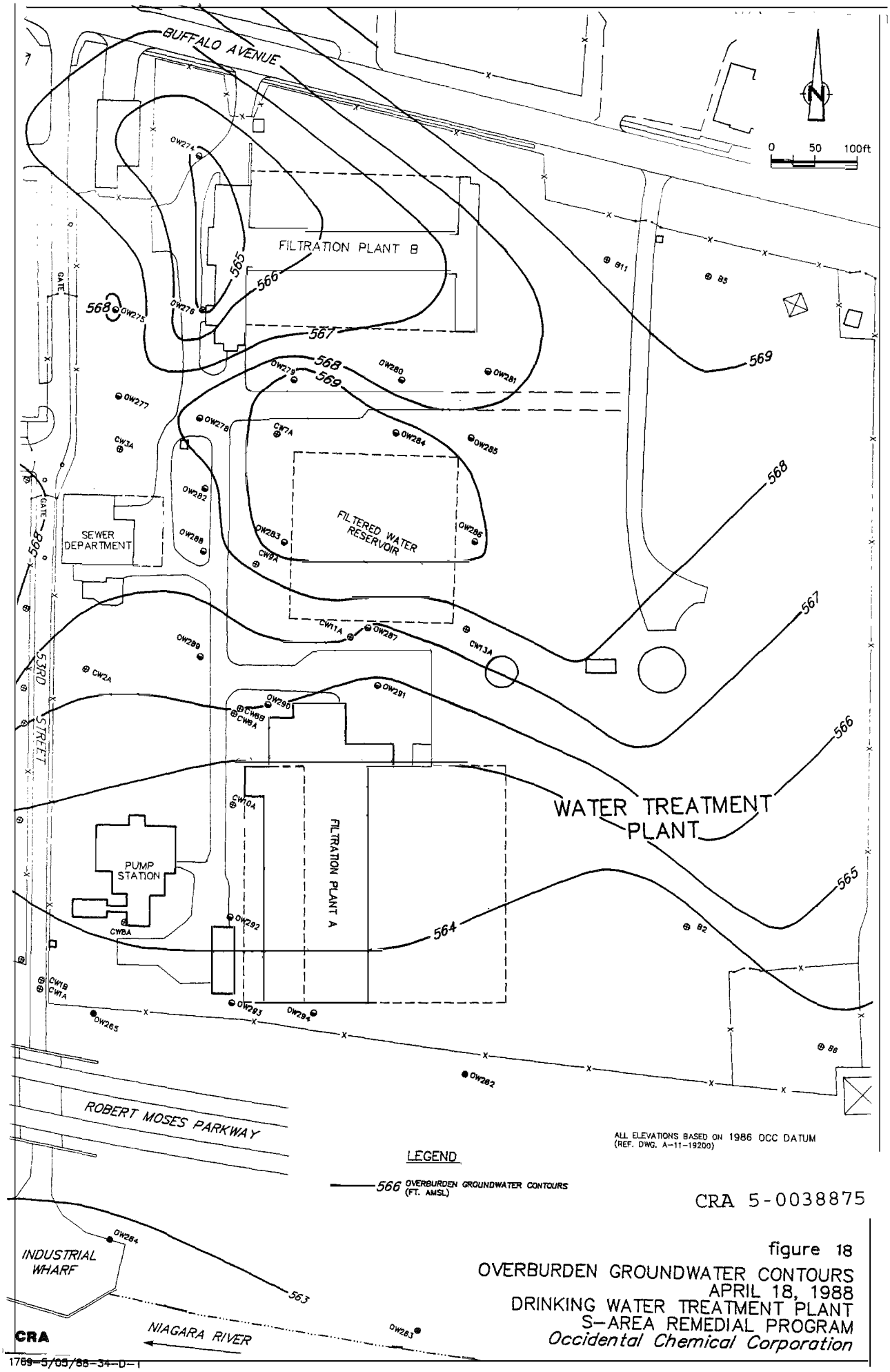
ALL ELEVATIONS BASED ON 1986 OCC DATUM
(REF. DWG. A-11-19200)

figure 17

CROSS - SECTION D - D'
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1

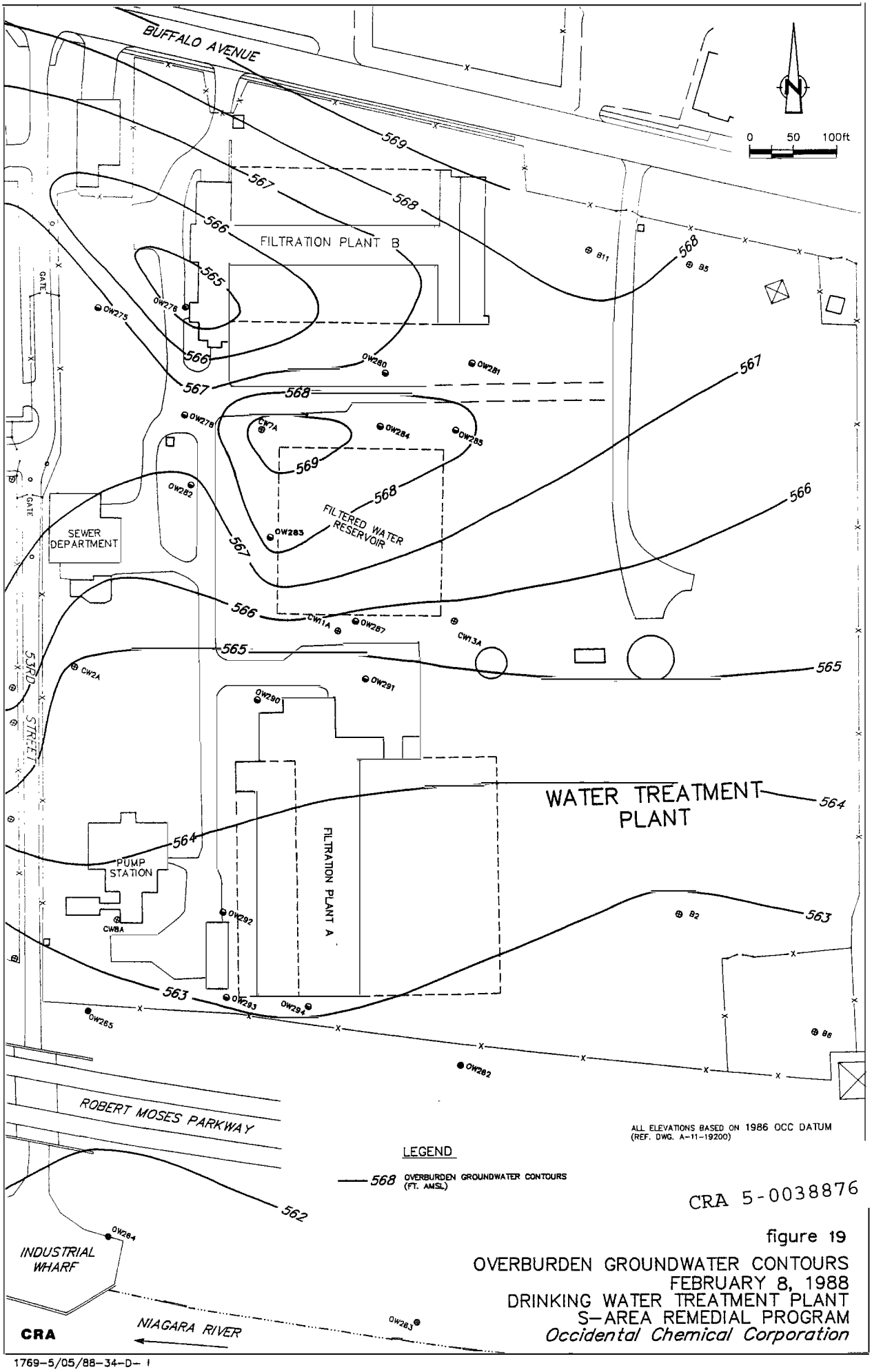


CRA 5-0038875

figure 18
OVERBURDEN GROUNDWATER CONTOURS
APRIL 18, 1988
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



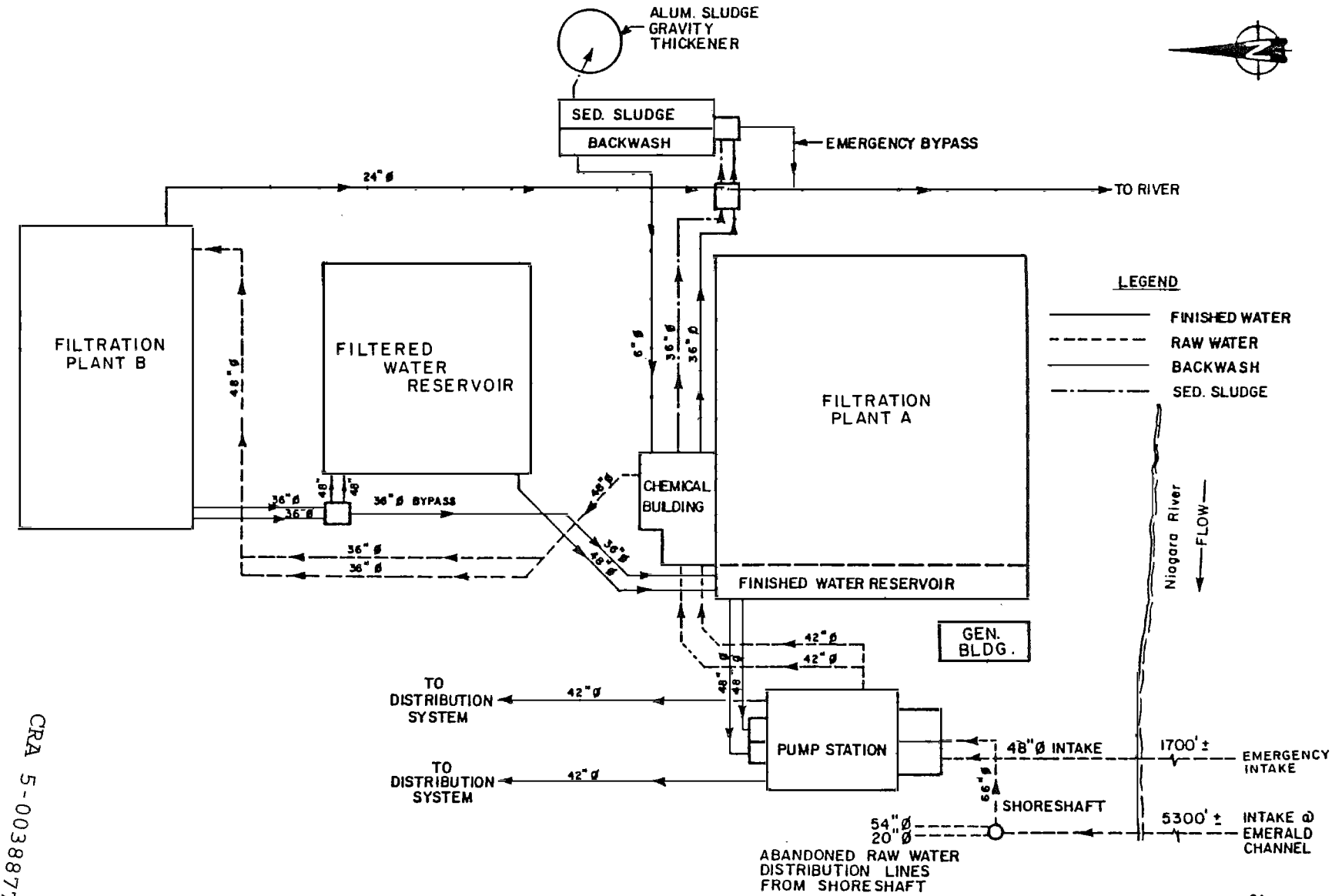
CRA 5-0038876

figure 19

OVERBURDEN GROUNDWATER CONTOURS
FEBRUARY 8, 1988
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1



CRA 5-0038877

figure 20

SCHEMATIC - WATER TREATMENT PLANT
DRINKING WATER TREATMENT PLANT
S-AREA REMEDIAL PROGRAM
Occidental Chemical Corporation

CRA

1769-5/05/88-34-D-1