Bechtel Associates Professional Corporation
Ann Arbor, Michigan

TECHNICAL SPECIFICATION

FOR

SUBCONTRACT FOR

AREA DEWATERING SYSTEM

FOR THE

CONSUMERS POWER COMPANY

MIDLAND PLANT

MIDLAND MICHIGAN

DRAFT FOR REVIEW

INCLUDES ONLY SECTIONS 6 (PARTIAL), 8 AND 10

No.	DATE	REVISIONS	BY	CH K	APPR
7		Incorporated SCN 11001; added Section 10; revised as noted on facing sheet			
6	2-7-81	Revised as noted on facing sheet; incorporated SCN 10003 and 10004. Incorp. Level I Fines Monitoring procedure	RCA	CR for BD	LHE
5	7-24-80	Revised title block		CR for BD	LHE/
4	7-15-80	Revised as noted on facing sheet; incorporated SCNs 10002, 5 and NCR 2999, revised Metar No. 8		CR for BD	LHE/
3	3-13-80	Revised as noted on facing sheet; inc SCN9002,9003,10001		CR	
2	11-12-79	Revised as noted on facing sheet; INC SCN 9001		CR	
1	7/11/79	Issued for subcontract - revised as noted on facing sheet			
0	6/12/79	ISSUE FOR BIDS			

ORIGIN: BAPC

BECHTEL

CONSUMERS POWER COMPANY
MIDLAND PLANT UNITS 1&2
MIDLAND MICHIGAN

JOB No. 7220

SPEC DES GUIDE No. C-88-Q

REV

SHEET 1 OF

AA-G-100373

6. INSPECTION

A. CONTRACTOR

1) Contractor shall inspect the effluent of the well points to determine the amount of material (fines) being removed by the dewatering operation. This monitoring is Q-listed and shall be in accordance with 10 CFR 50, Appendix B.

2) The dewatering system shall be accepted by Contractor based on the quantity of fines measured in the discharge line and correlated with the quantity of groundwater being discharged through a water meter calibrated in gallons. The average quantity of fines shall not exceed the ratio of 10 ppm. The average quantity of fines shall be determined by testing a sample of water from the discharge line every Monday and Thursday that the 4

pumping is in operation using a suitable filtration apparatus (see note). The filter medium shall not be coarser than 0.05 millimeters. The corresponding number of gallons of groundwater pumped through an In-Line flowmeter located on the discharge line shall be recorded by Contractor and the average ppm calculated. Contractor shall also monitor the number of gallons of recirculating water in Subcontractors eductor system. Contractor shall supply a suitable filtration apparatus (see note) and filter medium (no coarser than 0.05 millimeters) for the testing, and three flowmeters; one on the recirculation water line (8-inch Sparling In-Line with totalizer, Saddle Mount Series FM103) one on the discharge line (6-inch Sparling In-Line with totalizer Saddle Mount Series FM103) and one on the hydrant (3-inch Sparling In-Line with totalizer Series 162). The above meter sizes may be modified by project engineering if different flowrates are encountered, as determined by the onsite geotechnical engineer. As a backup to the flow meters, a calibrated container and timing device can be used to determine flow measurements. If an individual test indicates the fines are greater than 10 ppm but the average ratio of fines to ground water pumped is less than 10 ppm, Subcontractor shall be alerted. If the quantity of fines exceeds the average ratio of 10 ppm for the total quantity of groundwater pumped, Subcontractor shall be notified that it has 24 hours to correct the condition. If, after 24 hours, Subcontractor has not been able to correct the problem, Contractor shall begin a systematic testing of each individual dewatering well. Any dewatering wells found to produce greater than 10 ppm of fines shall be repaired by Subcontractor or removed from the system. Subcontractor shall notify Contractor whenever it intends to purge any collected fines from the eductor tank. Subcontractor will estimate the quantity of water purged, and Contractor will collect all material from Subcontractor's eductor tank. The discharged bottom material shall be sieved through a Number 325 U.S. standard screen. The collected material shall be retained and stored for inspection by the onsite field geotechnical engineer.

Note: Suitable filtration apparatus shall be a filter holder, Duran 50 glass filtration apparatus for low pressure (S and G GV050/0 or an equivalent filtration apparatus.

4) After the dewatering system is in operation, each individual well shall be tested monthly to determine the amount of fines removed. This monthly testing of each well is for information only and is not to be part of the QA program. Results of this testing shall be forwarded to the onsite geotechnical engineer. ⚠3

5) Records shall be maintained for each well and for the entire system, including the amount of fines (ppm) each time readings are taken.

B. QUALITY ASSURANCE REQUIREMENTS

A. The monitoring of the fines initially, as indicated in Article 6, Section A.3, and during operation, as indicated in Article 6, Section A.2, is Q-listed and shall be performed and controlled by Contractor's quality assurance program. ⚠3

B. Contractor has the authority to stop or regulate any part of the dewatering operation to prevent damage to any part of Contractor's work.

C. The initial monitoring of the fines for wells installed by Section 10 criteria shall conform to requirements of Section 10.H, in lieu of Article 6, Section A.3 requirements. ⚠

10. GRAVEL-PACKED WELL

A. GENERAL

This section describes the material and construction methods required for the installation of the gravel-packed well for the drawdown/recharge test. This series of wells will be added to the existing system and is subject to all fines monitoring procedures required under this specification.

B. ABBREVIATIONS

ASTM - American Society for Testing and Materials

AWWA - American Water Works Association

C. REFERENCED CODES AND STANDARDS

Sponsor	Number	Subject
ASTM	F 480-76	Standard Specification for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios
AWWA	A-100-66	Standard for Deep Wells
State of Michigan	Act 218 P.A.	Groundwater Quality - Dewatering Well Records
State of Michigan	Act 294-1965	Groundwater Quality Control
State of Michigan	Act 315-1969	Mineral Well Act

D. DEWATERING WELLS

1) Materials and Equipment

Subcontractor shall furnish all material specified in Section 10, Paragraph E including, but not limited to, blank casing, centralizers, screens, gravel pack, bentonite, piezometer tips and tubing, and miscellaneous fittings necessary to drill and install a series of gravel-packed dewatering wells.

2) Documentation

a) During drilling operations, Subcontractor shall keep an accurate log of the top and bottom, and a description of each stratum penetrated, and the depth of the water table during the drilling of each hole. Soil descriptions are to be provided by Contractor's representative at the time of the drilling operation. This information is to be documented and submitted to Contractor as part of

the documentation required by Section 10, Paragraphs D.2.b and D.2.c.

b) Subcontractor shall submit to Contractor three reproducible copies of as-built drawings of each well installation, including well number, location, diameter of hole, total length, and description of each type of casing; a log of subsurface materials encountered; and a complete compilation of all field data obtained during drilling, installation, and developing of all the wells.

c) Completion of a dewatering record for wells is required by Act 218, P.A. 1972, which is an amendment of the Dewatering Well Act 294, P.A. 1965, the Ground Water Quality Control Act.

The dewatering well record form is to be completed for every well or a composite record may be made for several wells where the subsurface conditions are similar, the surface relief relatively level, and the static water level is at a constant depth. Depending on the length of the line of the holes, one or several composites of well records may be necessary.

Copies of the records are required to be submitted to Contractor within 15 days after completion of each well.

3) SAMPLING

In conjunction with the documentation required by Section 10 Paragraph D.2, Subcontractor shall make available to Contractor samples taken from the cuttings from each 5-foot interval of drilling and at every formation change. Subcontractor shall place the samples in 16-ounce vapor-seal glass jars. These sample jars shall be clearly identified using a waterproof marking showing job name, well number, sample number, and top and bottom depth at which the sample was taken. These samples shall be available to Contractor and shall become property of Owner at the completion of the subcontract.

E. MATERIALS

1) General

Each well shall be constructed as a gravel-pack well comprising the following principal items supplied by Subcontractor.

a) Well casings, temporary caps, and screens shall be 6-inch nominal diameter polyvinyl chloride (PVC) conforming to ASTM F 480. All well casings and screens shall be new material, minimum Schedule 80, with a wall thickness of 0.49 inch.

b) Well screens shall be No. 18 (0.018 inch) slotted, plastic wire wrapped. A minimum 5-foot length of blank 6-inch PVC well casing shall be fitted to the bottom of the well screen. The blank section shall be sealed at the bottom with a cap.

c) Piezometer tips shall be the Casagrande type, 1-1/2" od x 1" id x 1'-0" long, Norton porous stone, such as Model 51451 manufactured by Slope Indicator Company. The piezometer tips shall be attached to a 1/2-inch Class 160 thermoplastic riser pipe. The tip shall be placed at the bottom of each dewatering and observation well within the gravel pack between the well casing and the hole wall. The riser pipe and piezometer tip shall be secured to the well casing. A temporary 1/2-inch PVC cap shall be placed on the piezometer riser pipe.

d) A gravel pack shall be installed between the hole wall and the well screen from the bottom of the well to the bottom of the bentonite seal. The gravel pack shall be composed of clean, well-rounded, medium sand particles containing no clay, organic matter, calcareous particles, or other deleterious materials. The gravel pack shall meet the following requirements:

Uniformity Coefficient = 2.1

Sieve Size Designation (No.)	Acceptable Range of % Retained
4	0-10
6	0-14
8	6-22
12	14-31
16	24-40
20	35-51
30	51-67
40	90-100

2) Certificates of Compliance

a) A certificate of compliance from an approved testing laboratory stating the quality and gradation of gravel pack material shall be submitted to Contractor by Subcontractor before the material is used.

b) Subcontractor shall submit to Contractor a Certificate of Compliance with ASTM Specification F 480, for the well casings, caps and screens prior to use of these items.

F. CONSTRUCTION OF PERMANENT DEWATERING WELLS

1) Drilling

a) The bored hole for each dewatering well shall be drilled in accordance with the controlled jetting method. Extreme care shall be taken in drilling the first 15 feet due to the presence of underground ducts, pipes, and conduit as shown in the design drawings.
b) The dewatering wells shall be drilled without any obstructions to permit free and easy installation of the well casing and gravel pack as well as installation and operation of submersible pumps and level switches to be installed by others, as applicable.
c) A surface or temporary casing of sufficient size and weight may be placed in the hole to prevent the hole from caving in during drilling. Such casing must be removed by Subcontractor before completion of the well.
d) Each hole shall be a minimum of 14 inches in diameter (16 inches maximum) to the depth indicated in the design drawings. The actual total depth of each well may vary depending on actual subsurface conditions and as directed by Contractor.
e) Subcontractor shall not continue well installation procedures following the drilling of well holes without Contractor authorization based on review of the applicable well log records and samples taken from the hole, as described in Section 10, Paragraphs D.2.a and D.3.

2) INSTALLATION

a) Centering devices shall be installed on the casing to locate and hold the casing and screen sections in proper position.
b) After the assembled casings, screens, piezometer tips, and tubing are located in the drilled hole, the gravel pack shall be placed by slow, continuous pouring from the surface. To avoid particle segregation, sufficient material shall be stockpiled to ensure that the ensure gravel pack is installed without interruption.
c) After the gravel pack is in place, circulation shall continue until the gravel pack is consolidated and cleaned. As the gravel pack settles, more material shall be added. Subcontractor shall keep an accurate record of the amount of gravel pack material added during placement and consolidation. The record shall be submitted to Contractor as part of the documentation required by Section 10, Paragraph D.2.b.
d) After placement of the gravel pack, a 21-foot minimum thickness of an approved, heavy, bentonite-sand water slurry shall be placed at the top of the

gravel pack between the 6-inch casing and the drilled hole.

G. DEVELOPMENT

1) Development

Subcontractor shall furnish all necessary pumps or other equipment and shall develop the dewatering wells using the methods necessary to give the maximum yield of water per foot of drawdown from the water-bearing material and minimize the quantity of sand. The development process shall include backwashing using intermittent pumping and/or jetting. Development shall begin as soon as practical following the placement of the gravel pack and bentonite seal.

2) Drawdown Test

a) After the wells are developed and qualified for sand content, eductors shall be installed in them. These eductors shall be capable of lowering and maintaining the groundwater table at elevation 585' in the pumped wells. The wells shall be connected to the existing construction dewatering header lines. The wells shall be pumped until otherwise directed by the onsite geotechnical engineer.

b) Upon completion of the drawdown test and removal of the pumping equipment, a 6-inch diameter PVC cap shall be installed on the 6-inch well casing for protection of the well.

H. MONITORING OF SAND CONCENTRATIONS

1) Although Subcontractor will not be responsible for the amount of sand produced, final acceptance of the system is based on the criterion that the system will not produce more than 10 ppm sand by weight. In this specification, sand is defined as inorganic material coarser than 0.05 millimeters.

Therefore, each individual dewatering well shall be monitored by Contractor during development in accordance with the following criteria. These criteria shall be used as the acceptance criteria for all wells. Each time water samples are taken, records shall be maintained for each well indicating the amount (in ppm) of sand.

a) If the sand concentration measured is 10 ppm or less during the development, the well shall be accepted.

b) If the concentration of sand measured exceeds 10 ppm, Subcontractor shall take actions to lower the amount of sand removed by further development or by other means as directed by Contractor.

c) If the well has not met the acceptance criteria for the sand within three retests, Contractor shall direct abandonment of the well.
d) During operation of the wells, the sand concentration shall be monitored as described in Paragraphs 6.A.1, 6.A.2, 6.A.4, 6.A.5, 8.A (except deletion of Paragraph 6.A.3), 8.B, and 8.C.

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE MANUAL

TM 5-297
AFM 85-23

WELL DRILLING OPERATIONS

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

SEPTEMBER 1965

AGO 5807A

valve to deliver air down the air line, with the air cock preferably open. This will pump water out of the well through the discharge pipe. When the water comes clear, cut off the air and allow the water in the well to regain its static level. This can be determined by listening to the escape of the air through the air cock as the water rises in the casing. Close the air cock and turn the 3-way valve to direct the air supply down the bypass to the top of the well. This will force the water out of the casing and back through the screen, agitating the sand and breaking down the bridges of sand grains. When the water has been pushed down to the bottom of the drop pipe, air escapes through the drop pipe. If the drop pipe is kept above the screen, it will prevent air logging the formation.

(2) When the air is heard escaping out of the discharge pipe or when the pressure stops increasing, cut off the supply of air and reopen the air cock to allow the water to reach static level. Turn the 3-way valve and again direct the air supply down the air line to pump the well.

(3) Repeat this procedure until the well is thoroughly developed. It is seldom necessary to bail the well after this, because the velocity of the water usually cleans out the sand brought into it. However, if the well was not bailed thoroughly at first to remove the first large slugs of sand, these may be too heavy for this type or airlift to clean out properly, and bailing will be necessary.

150. Development by Backwashing

a. The surging effect, or reversal of flow required to develop the formation can be obtained by three or four backwashing methods. One of these methods consists of alternately lifting water to the surface by pumping and letting the water run back into the well through the pump-column pipe. About the only type of pump besides the airlift that can be used practically for this purpose is a deep-well turbine pump (paras 172 and 173) without a foot valve. The pump is started, but as soon as water is lifted to the ground surface the pump is shut off. The water then falls back into the well through the column pipe. The pump is started and stopped as rapidly as the power unit and starting equipment will permit. The effect is to intermittently lower and raise the water level in the well which produces the inflow and outflow, respectively, through the screen openings. During the procedure, the well may be pumped to waste from time to time to remove the sand that has been brought in by the surging. After completing the surging, the pump must be removed and any material remaining in the screen must be bailed out.

b. Another method is to backwash by pouring water into the well as rapidly as possible, thus producing outflow through the screen openings. Inflow through the screen is then produced by bailing water out of the well as rapidly as possible. As can be seen, this is not a very rapid means of surging as the time required for a complete cycle will be several minutes under best conditions. If the static water level is high enough to permit pumping by suction lift, a small centrifugal pump can be used instead of the bailer and this will speed up the work. If there is room in the well casing, the discharge side of the pump can be connected to a string of small diameter pipe that is let down in the well, so that the water added is pumped down inside the screen. The turbulence thus created inside the screen will assist in development of the formation.

c. A third method that can be used if a rotary or jetting-type drilling rig is available is to improvise a little jetting tool that can be operated inside the screen. To do this, screw a coupling to a 1-, 1½-, or 2-inch pipe and weld a plate over the open end of the coupling. Drill two or three ¼-inch holes, located so they will pass through both the wall of the coupling and the pipe (fig. 118). Lower this tool into the screen on a string of pipe. Connect the upper end of the pipe to the kelly or to the discharge side of the mud pump. Pump water into the screen and rotate the jetting tool very slowly so that the horizontal jets of water will wash out through the screen openings. Raise the string of pipe little by little and continue rotating to backwash the entire inner surface of the screen.

A pump pressure of 100 pounds per square inch should be used if possible. This method of backwashing is particularly effective in removing the cake of drilling mud that is plastered on the walls of holes drilled by the rotary or jetting method. Its disadvantage in military field operations is that considerable supply of water is required.

d. Occasionally, wells are backwashed by capping the casing and pumping water into the well under pressure. This is similar, as far as pushing water out through the screen openings is concerned, to the closed-well method of using compressed air for development. The disadvantage of this method is that it is almost impossible to produce a surging effect. It is not a very efficient method of development. As in using compressed air in the closed-well method, care must be taken exercised to seal the casing very tightly in the hole and prevent water from being forced up around the outside of the casing.

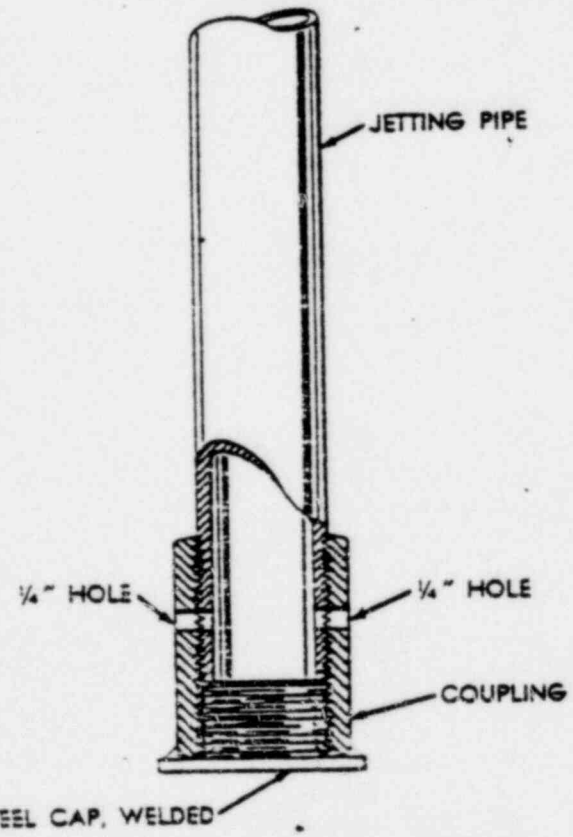


Figure 118. Improvised jetting tool.

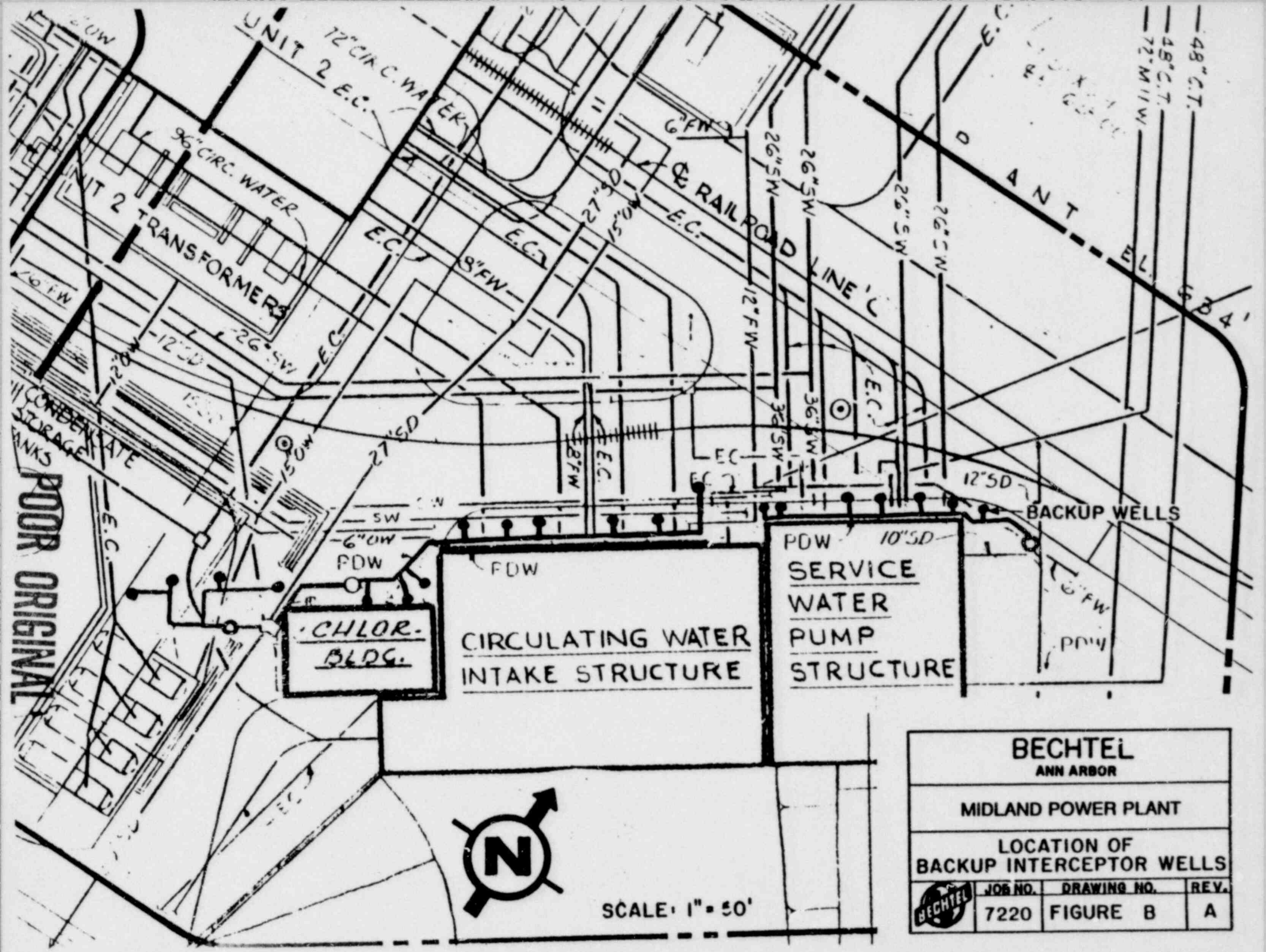
151. Artificial Gravel Treatment of Wells

a. When the natural water-bearing sand does not contain any relatively coarse material to permit development and the formation of a natural gravel-pack around the screen, it is sometimes desirable to introduce artificially the necessary coarse material around the screen. Artificial gravel packing is of great value where the water-bearing formation is composed of fine sand in which the individual grains are of a uniform size. Such a formation requires a screen with a firm slot to hold out the sand. Gravel packing will facilitate the use of a screen with large slots. The increased slot size will permit the maximum quantity of water to enter the well.

b. The most important feature of artificial gravel packing is the selection of the correct sizes of the gravel and the screen slot openings. The grading of the gravel should be in proper relation to the grading of the sand making up the water-bearing formation. The use of gravel that is too coarse can cause trouble. Figure 119 shows how fine sand may fill the voids in a coarse gravel-pack and reduce the yield of the well. Another result may be that sand will pass through the gravel-pack when the well is pumped, making the well a sand pumper. Coarse, uniformly graded, filter sand, of about ⅛ inch maximum size, makes the best gravel-pack for most fine sand formations. Fine gravel up to ¼ inch maximum size should be used to pack a formation consisting of medium or coarse sand. The screen to be used should have openings that will retain from 75 to 90 percent of the gravel.

c. There are two common methods of artificially gravel treating a well. One of these is to feed coarse material down around the screen as the screen is installed by the baildown method. The baildown shoe used in this case is made somewhat larger than the screen so that coarse sand or fine gravel being added will follow down around the screen as it sinks in the formation. Figure 120 shows schematically how the operation is done.

d. In the above described method it is evident that development work is an essential part of the operation, just as it is in producing the natural gravel packing described in paragraph 147. The screen openings must be large



BECHTEL ANN ARBOR			
MIDLAND POWER PLANT			
LOCATION OF BACKUP INTERCEPTOR WELLS			
JOB NO.	DRAWING NO.	REV.	
7220	FIGURE B	A	

BECHTEL

WELL INSTALLATION DATA SHEET

WELL NUMBER _____

PROJECT _____ JOB NO. _____ SUBCONTRACTOR _____

COORDINATES _____ _____ SURFACE ELEVATION _____

DATE STARTED _____ DATE COMPLETED _____ NO. OF SAMPLES _____

TYPE OF SAMPLES _____

JETTING PROCEDURE

JETTING PRESSURES: (PSI)
MAX _____
AVG _____

HOLE DIAMETER _____ HOLE DEPTH _____
SPECIAL CONDITIONS _____
_____

WELL INSTALLATION

WELL SCREEN CONFORMANCE REPORT ☐ GRAVEL PACK CONFORMANCE REPORT ☐

SCREEN SLOT SIZE _____ SCREEN DIAMETER _____ SCREEN LENGTH _____

CENTRALIZERS: _____
_____

LENGTH OF BLANK BELOW SCREEN _____ LENGTH OF RISER ABOVE SCREEN _____
LENGTH OF GRAVEL PACKED ZONE _____ CALCULATED AMOUNT OF GRAVEL PACK _____
ACTUAL AMOUNT OF GRAVEL PACK _____ CIRCULATION DURING GRAVEL PACKING ☐
CASAGRANDE TIP DEPTH _____ THICKNESS OF SEAL _____
TYPE OF SEAL _____ CALCULATED AMOUNT OF SEAL _____
ACTUAL AMOUNT OF SEAL _____

WELL DEVELOPMENT

TYPE OF DEVELOPMENT _____
DEVELOPING TIME _____ AMOUNT OF MATERIAL REMOVED _____ (est)
SAND CONCENTRATION: (ppm by weight)
DURING DEVELOPMENT _____ SPECIAL CONDITIONS _____
FIRST RETEST _____ _____
SECOND RETEST _____ _____
THIRD RETEST _____ _____

STATIC WATER LEVEL _____ DATE _____ EDUCTOR SETTING _____

SUBCONTRACTOR SUBMITTALS:
SUBSURFACE LOG ☐
AS-BUILT DRAWING ☐
MICHIGAN DEWATERING WELL RECORD ☐

SUPERVISED BY
GEOLOGIST/HYDROGEOLOGIST _____

PUMPING WELL CONSTRUCTION SUMMARY

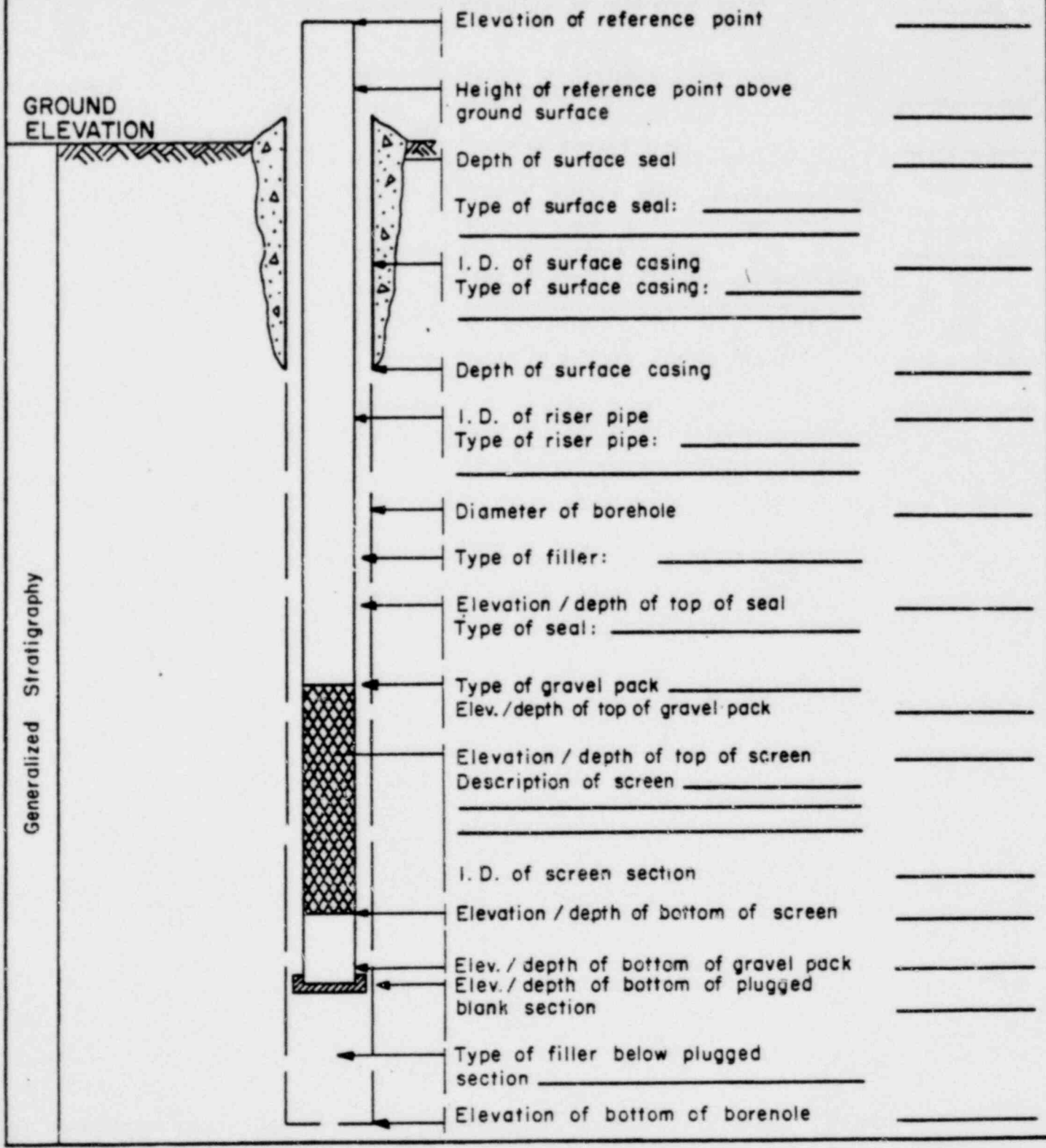
PROJECT _____ WELL NO. _____

SITE _____

COORDINATES _____ AQUIFER _____

DATE COMPLETED _____

SUPERVISED BY
GEOL/HYDROGEOL _____



Elevation of reference point _____

Height of reference point above ground surface _____

Depth of surface seal _____

Type of surface seal: _____

I. D. of surface casing _____

Type of surface casing: _____

Depth of surface casing _____

I. D. of riser pipe _____

Type of riser pipe: _____

Diameter of borehole _____

Type of filler: _____

Elevation / depth of top of seal _____

Type of seal: _____

Type of gravel pack _____

Elev. / depth of top of gravel pack _____

Elevation / depth of top of screen _____

Description of screen _____

I. D. of screen section _____

Elevation / depth of bottom of screen _____

Elev. / depth of bottom of gravel pack _____

Elev. / depth of bottom of plugged blank section _____

Type of filler below plugged section _____

Elevation of bottom of borenole _____

GT-79

WELL LOG

PROJECT	JOB NUMBER	SHEET NUMBER OF	WELL NUMBER
SITE	LOCATION	LOGGED BY GEOL/HYDROGEOL	

BEGUN	COMPLETE	DRILLER	DRILL MAKE/MODEL	HOLE SIZE	TOP OF ROCK	TOTAL DEPTH

SCREEN DIA./LENGTH/SLOT	TOP OF CASING EL	GROUND SURF. EL	DEPTH/EL GROUND WATER (DATE)

ELEVATION	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION	NOTES:

WELL LOG

PROJECT	JOB NUMBER	SHEET NUMBER OF	WELL NUMBER
SITE	LOCATION		

ELEVATION	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION	NOTES: