GW - 28

WORK PLANS

1991

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April 19, 1991

Mr. Rich Mayer,
Hazardous Waste Management Division
U. S. Environmental Protection Agency
1445 Ross Ave. - Suite 1200
Dallas, TX 75202-2733

Dear Mr. Mayer:

We enjoyed the opportunity to meet with you and Mr. Costello earlier this month. We all felt the meeting was very helpful and thank you for the opportunity to discuss certain environmental issues pertinent to our facility.

As instructed, I enclosed under this cover, our response to the Phase II Deficiencies. As you can see, we have endeavored to provide comprehensive responses consistent with your instructions and our discussions at the meeting. By necessity, of course, some of our plans are tentative in nature, and may be modified, depending upon future data accumulated, our ongoing analysis and your continued input.

As we discussed, we have considered alternatives to the ponds, none have proven viable and we feel for the present time, evaporation remains the most environmentally sound approach. Nonetheless, we continue to analyze our alternatives, as well as the means of reducing our waste water volume.

We trust the enclosed fully addresses your concerns. If you need anything additional from us, please let me know. I look forward to speaking with you in the near future.

Sincerely,

Matthew P. Clifton
Vice President, Economics & Engineering

MPC/pb

enclosures

cc: James E. Costello, U.S. EPA

PHASE II RFI

PHASE II WORK PLAN DEFICIENCY NO. 1:

The Phase II Work Plan to determine the vertical and horizontal extent of contamination for the evaporation ponds is deficient. Additional wells horizontally and vertically (cluster wells) will be needed. Also, some wells presently in place around the ponds appear to be in poor condition and will need to be replaced.

In addition, the Agency will require Navajo to close the evaporation ponds within six (6) months and will require a closure plan to the Agency for those units within three (3) months from the date of this letter.

RESPONSE:

In response to EPA's concerns in the first paragraph of the Phase II Work Plan Deficiencies No. 1, Navajo proposes to perform the following:

The scope of investigation delineated in the Phase II Work Plan, Section 3.1.1.2.1, as well as, the below described investigation of both the horizontal and vertical influence of the ponds.

HORIZONTAL AND VERTICAL IMPACTS:

The horizontal impact of the evaporation ponds has been evaluated in numerous studies by the New Mexico Oil Conservation Division and U. S. EPA. The data assimilated for the areal and diurnal basis is extensive. As previously discussed, the requirements of the RFI will be properly responded to by Navajo, including delineation of the horizontal migration limitations of the evaporation ponds. It is proposed that the delineation will be completed by installing additional well(s) to confirm the apparent plume boundaries.

Prior to the installation of additional horizontal impact wells, Navajo will perform a geostatistical analysis of the applicable available data to determine the areas of highest and lowest probability with respect to plume delineation. Additional wells will subsequently be located, based on the models determination of deficient areas (i.e. areas where the determination of a plume limit exceed the average error by more than 20%), or areas of less than 60% confidence. Navajo recommends that this analysis precede the installation of any horizontal impact well(s) so as to avoid unnecessary data acquisition and to provide the U. S. EPA with additional data analysis upon which to base its conclusions.

Based on this geostatistical analysis, Navajo will install at least three (3) wells into the second zone of saturation (shallow valley fill formation) directly underlying the first zone of saturation (river alluvium formation) in order to assess the potential vertical impact of the evaporation ponds. The installation of the lower aquifer wells will enable us to gather geotechnical (i.e. permeability/porosity) and hydrogeologic data (i.e. head differential),as well as to confirm the existence of evaporation pond material at depth. These wells will be located in areas outside of the determined/identified plume areas to prevent cross contamination of aquifers. If it is determined, based on physical and hydrogeologic barriers, that cross-contamination is possible, an additional well may be placed within the apparent contaminant plume, depending on the environmental risk associated with this task. These wells will be located adjacent to existing (or new) shallow wells, providing a well cluster to facilitate hydraulic (head) comparisons.

During the installation of the vertical impact wells, two (2) geophysical samples will also be collected from the soil layer dividing/separating the upper and lower formations. These samples will be analyzed for grain size and falling head permeability to determine a coefficient of transmission (if any) which may exist between these zones.

An analysis of existing wells will be performed to determine well integrity. This procedure includes analysis of the original as-built drawings, redevelopment of the well and, if necessary, pressure testing. Navajo requests further specification from the U. S. EPA respecting which wells are in "poor condition.

CONTINUED USE OF PONDS:

Regarding the continued use of the ponds, Navajo, based on discussions at the meeting at EPA, Region VI, on April 3, 1991, proposes to initiate a response to the U.S. EPA concerns. This initiative will include the continuation of a Waste Water Treatment Program, designed to improve the quality of the water discharged to the pond system, the long-term monitoring of the system, the closure of a portion of the system and a program designed for future re-evaluation of the continued use of specific ponds within this system.

A. WASTE WATER TREATMENT PROGRAM:

Navajo will continue a long-term program of improving the quality of the waste water discharged to the ponds. Navajo has instituted the following improvements since 1987:

(a) Improvements Instituted:

1. Construction of a new Wastewater Treatment Plant in 1987, which consists of an oil separator basin downstream of its two (2) existing API

Separators,a Flocculator, a Dissolved Air Flotation (DAF) Unit and a 40,000 barrel equalization tank.

2. In 1987, Navajo installed a pipeline from its new Wastewater Treatment Plant to the evaporation ponds and thus evacuated an open ditch previously used to transport effluent wastewater to the ponds.

3. In 1987, Navajo, in conjunction with the above stated pipeline project, bypassed the first pond (Pond #1) and began the drying process.

4. In early 1990, Navajo, after receiving approval from EPA Region VI, initiated tilling activities within Pond #1 to enhance the degradation process. Such activities continue to date.

5. In the latter part of 1990, Navajo ceased the use of chromate cooling tower treatment chemicals.

6. In September 1990, Navajo installed a stripper tower on a portion of its wastewater stream to strip benzene from the wastewater, thus ensuring that Navajo's wastewater stream remains below 500 PPB of benzene.

7. In 1991, Navajo installed a blower on it's equalization tank to improve the operating efficiency of the Waste Water Treatment Plant.

(b) Planned Improvements:

1. Navajo is in the process of constructing a new trickling filter, downstream of its current Wastewater Treatment Plant. This aggressive biological treatment unit will provide additional improvements in the quality of the water discharged to the ponds.

2. Continued and aggressive evaluation of mehtods by which the volume of wastewater generated may be reduced.

B. MONITORING OF THE POND SYSTEM:

The appropriate monitoring points associated with the pond system and the sampling frequency will be agreed upon after the completion of the Phase II Work Plan and subsequent discussions with EPA.

C. CLOSURE OF POND #1:

Navajo will submit a formal closure plan for Evaporation Pond #1. Since closure operations are presently in progress, the closure plan will be based upon work currently being performed.

D. RE-EVALUATION OF FUTURE USE OF CERTAIN PONDS:

Upon completion of the closure plan for Pond #1, the evaluation of subsequent monitoring results will be made to determine if any additional portions of the pond system should be closed and/or whether additional waste water quality improvements (additional secondary treatment) should be installed. As with Item B above, we anticipate ongoing discussions with the U. S. EPA and continued evaluation of the collected data.

PHASE II WORK PLAN DEFICIENCY NO. 2:

The Phase II Work Plan to determine the vertical and horizontal extent of contamination along the Three-Mile Ditch is deficient. Navajo needs to (by some methods) determine areas where the ditch ponded and overflowed to determine the areal extent of contamination (unsaturated and saturated). This may include a combination of soil sampling, geophysics, soil-gas surveys, and groundwater monitoring. New monitoring wells will be needed, reliance totally on hydropunch ground water technology is not acceptable. Also, some of the monitoring wells along the Three-Mile Ditch will need to be replaced because they are in poor condition.

PHASE II WORK PLAN DEFICIENCY RESPONSE NO. 2:

As discussed in the meeting of April 5, 1991, Navajo will undertake closure of the Three-Mile Ditch, based on the information obtained during the Phase I RFI. Because of the extensive nature of this facility (three (3) miles long and six (6) feet wide), Navajo proposes to accept the responsibility of remediation of the deposition material rather than attempt to define the extent using standard field methodologies. The Phase I RFI data indicates a distinctive visual layer of material within the ditch. Materials will be removed based on a predetermined closure criteria (to be submitted under separate cover as Three-Mile Ditch Closure Plan). As determined in the Phase I work, areas along the ditch where ponding and possible overflow have occurred will be determine by visual inspection. In these areas, additional sampling will be performed to determine horizontal and vertical extent of migration. Additional

monitoring wells will be installed in areas where the vertical migration extends through the unsaturated zone.

The criteria for removal will be proposed in the closure plan. Determinations as to numbers and placement of monitoring wells will be based on the information uncovered in the remediation.

PHASE II WORK PLAN DEFICIENCY QUESTION NO. 3:

Navajo needs to indicate all wells/windmills (this includes production groundwater wells) within two (2) miles of the evaporation ponds and the Three-Mile Ditch; and within a one (1) mile radius of the refinery. Some of these wells need to be sampled to assure no contamination of any usable deep or shallow aquifers.

PHASE II WORK PLAN DEFICIENCY RESPONSE NO. 3:

Navajo has compiled a list of the water wells in the area requested. Table 3-1 lists the wells completed in the Shallow Valley Fill Aquifer. Table 3-2 lists the wells completed in the Deep Artesia Aquifer. Correspondingly, Figure 3-3 illustrates the locations of the wells listed in Table 3-1 for the Shallow Valley Fill Aquifer and Figure 3-4 illustrates the locations of the wells listed in Table 3-2 for the Deep Artesia Aquifer.

Navajo has highlighted on Figures 3-3 and 3-4 those wells that U. S. EPA may want to select to be sampled to assure that no contamination of usable water is occurring in either aquifer. Navajo intends that these well analyses be a one time event barring the discovery of any contamination. Navajo suggests that SEO (State Engineer's Offic) well number 2649 and the windmill in the evaporation ponds area and SEP well number 6612 in the refinery area be sampled as representative of the Shallow Valley Fill Aquifer. Navajo also suggests that SEO well numbers 602 and 768 be sampled as representative of the Deep Artesian Aquifer in the refinery area. There dosen't appear to be any good well candidates in the Deep Artesian Aquifer in the area of the ponds, perhaps SEO number 895 could be sampled, as it is the closest Deep Artesian well to the ponds.

The above referenced tables and figures are attached hereto.

PHASE II WORK PLAN DEFICIENCY QUESTION NO. 4:

Navajo needs to submit a thorough plan in the Phase II Work Plan to delineate and remediate groundwater contamination in the wells downgradient and upgradient of the Truck Bypass Landfarm. In addition, the source(s) for this contamination must be identified in the plan.

PHASE II WORK PLAN DEFICIENCY RESPONSE NO. 4:

Navajo has completed an investigation of the contamination that has shown up in both the upgradient and downgradient wells around the Truck Bypass Landfarm. The groundwater monitoring wells, both upgradient and downgradient of the Truck Bypass Landfarm, have been impacted by a migrating plume of hydrocarbons. The hydrocarbon plume consists of diesel fuel which was lost from underground transfer lines serving two (2) tanks that were formerly located where Navajo's FCC Unit is presently located. The plume under the Truck Bypass Landfarm was first identified and recovery/remediation efforts begun in 1982, with the installation of RW-1 and RW-2 (see drawing 90-35-D). These first two (2) wells cut off the plume from possible contamination of Eagle Draw. Next RW-3 was installed in the downgradient area of the plume in an attempt to cut off the source area from continuing to migrate downgradient. RW-3's location was based on calculations of downgradient dispersion, taking data from an array of exploratory wells. These first three wells appeared to be effectively remediating the plume until the relatively sudden appearance of the plume in monitoring wells surrounding the TEL impoundment adjacent to the Southern boundary of the Truck By-pass Landfarm. The plume rapidly moved under the TEL site and the landfarm. A recent discovery of a ruptured 2" fresh water line is now the prime suspect responsible for the driving force that pushed the diesel plume rapidly into these new areas. In response to the discovery of this plume movement, Navajo has installed recovery wells, RW-9 and RW-10, along the Eastern and Northern boundaries of the combined Truck By-pass Landfarm/TEL Site. Navajo is monitoring the impact of the new recovery wells on the plume and has replaced the ruptured water line. Future observations of the plume and the relative effect of the recovery operations may dictate the installation of additional well(s). Additional information on Navajo's hydrocarbon recovery system is available, should U. S. EPA have need of it.

PHASE II WORK PLAN DEFICIENCY QUESTION NO. 5:

Navajo needs to submit a map and a narrative indicating/ discussing the various plumes originating from the refinery and any offsite migrating plumes. Navajo should also include a discussion of all ground water remediation projects at the Refinery.

PHASE II WORK PLAN DEFICIENCY RESPONSE NO. 5:

Drawing No. 90-35-D, attached hereto illustrates the hydrocarbon plumes known to exist at the Navajo Refinery. Also shown on drawing 90-35-D are the locations of the ten (10) recovery wells that have been installed over the past nine (9) years.

In October 1982, hydrocarbon recovery wells, RW-1 and RW-2, were installed by Groundwater Technology Corporation. These wells were installed in response to the appearance of a very small hydrocarbon stain on the South bank of Eagle Draw, adjacent to where Freeman Street crosses the draw. Navajo informed the New Mexico Oil Conservation Division, responsible for groundwater protection and spill remediation at oil refineries, of the situation and proceeded with the help of Groundwater Technology Corp. to investigate and install the first two (2) recovery wells. Navajo, with the assistance of Professional Geologist, E. E. Kinney, drilled twelve (12) exploratory wells in June of 1983. The objectives of this exploration program were to determine the presence or absence of water and/or hydrocarbons in the subsurface and to use this information to determine the locations of additional recovery wells. This 1983 effort resulted in the installation of RW-3 in a downgradient extension of the plume that RW-1 and RW-2 were recovering. Additionally, a separate plume, this time consisting of gasoline, was discovered to the South. Recovery well RW-4 was installed in this plume at that time.

Observation of RW-4 and the exploratory wells around it eventually led to the need to install recovery wells, RW-5 and RW-6, in the same plume. It was determined that the radius of influence extending from RW-4 was insufficient to most effectively recover the plume. This led to RW-5 and RW-6 installation in the Summer of 1985. The source of the gasoline plume being recovered by RW-4, RW-5 and RW-6, was leaks from the underground lines associated with the finished product tanks located West-Southwest of RW-6. These finished product tanks feed the truck loading rack located adjacent to RW-4 and the pipeline pump station about 1,500 feet North of the tanks.

Recovery operations from the six (6) wells proceeded for several years until groundwater monitoring in 1989 indicated the presence of a plume of diesel fuel in the area of the North Colony Landfarm, and a portion of the first diesel plume was found moving and expanding in the Truck By-pass Landfarm/TEL Site area. Recovery wells, RW-7 and RW-8, were installed during the Summer of 1990, to begin recovery of new diesel plume. At the same time RW-9 and RW-10 were installed to mitigate the plume expanding under the Truck By-pass Landfarm/TEL Site.

It was determined by Navajo's consulting geologist, Mr Bob Newcomer, that the new diesel plume impacting the North Colony Landfarm (NCLF) had originated from the tank farm, just South of the NCLF. The two (2) tanks just South of the NCLF are diesel storage, which are served by underground lines. Further investigation confirmed the integrity of the tanks themselves, but indicated a problem with the underground lines.

Following the first discovery of underground line leaks leading to recovery/remediation efforts nine (9) years ago, Navajo instituted a corporate policy of removing underground

lines from service and replacing them with above ground lines whenever and wherever possible. In addition to removing underground lines, New Mexico Oil Conservation Division requires Navajo to leak test all remaining underground lines annually. This leak test program is even being extended to all sewer lines in service longer than 25 years.

Most, but not all, recovery wells produce groundwater as a part of the mechanism for drawing the hydrocarbon to the recovery well pumps. This groundwater, which is lightly contaminated from contact with the free phase hydrocarbons is discharged into the refinery oily water sewer system, where it is processed through the Waste Water Treatment Plant and discharged to the evaporation ponds.

PHASE II WORK PLAN DEFICIENCY NO. 6:

Navajo agrees to send all analytical samples to a laboratory which meets the terms and conditions stated in the statement of work for the Contract Lab Program. This will include reporting the ten (10) highest Tentatively Identified Compounds (TIC) in every sample analyzed.

TABLE 3-1
WELLS COMPLETED IN THE SHALLOW VALLEY FILL AQUIFER[1]

WELL IDENTIFICATION (SEO NUMBER)	YEAR COMPLETED	WELL LOCATION T.R.S.1/4S	TOTAL DEPTH (FT)	CASING DIAMETER (IN)	COLLAR ELEVATION (FAMSL)[2]	DEPTH BELOW SURFACE SCREENED INTERVAL (FT)	LITHOLOGY SCREENED INTERVAL	DEPTH SATURATED INTERVAL (FT)	LITHOLOGY SATURATED INTERVAL	WATER LEVEL AFTER COMPLETION (FT)	WATER LEVEL ELEVATION LAST SURVEY[2] (FT);(YEAR)
48	1985	17.26.12.1111	23	2	3311	8-18	Sl, Sd, Cl	6-23	Cl, Sl, Sd	8	
1183[3]		17.26.15.21124	225		3341						3301.1; 1979
1251	1909	17.26.15.31334	212	10	3352	Well open below 85					3287.3; 1984
1300	1937	17.26.10.430	210	8	3340			18	Gyp		3289.7; 1984
								36-40	Grl		
								157-175	Sd		
								206-210	Sd		
1380	1936	17.26.4.331	212	12-1/2				18-23	Grl		
				10							
1412[3]		17.26.18.43333	170	14	3423						3330.7; 1984
1414	1939	17.26.11.310	105	12-1/2[2]	3322						3301.5; 1984
1440	1941	17.26.9.213	320	12-1/2				110-130	Sd		
				10				196-225	Sd		
								245-260	Sd		
								285-320	Sd		
1453-B; 1604-S	1977	17.26.7.131113[2]	252	12-3/4	3426	150-252	Sd, Grl	55-80	Sd, Grl		3281.5; 1984
								120-130	Grl		
								215-246	Sd		
1453-C	1953	17.26.7.221132	303	10-1/2	3408	142.6-299	Cl, Sd, Gyp	175-185	Sd	72	3310.8; 1979
1479	1959	17.26.6.413344	220	16	3425	100-180	Sd, Cl, Grl	90-110	Sd	80	3291.3; 1984
				9				145-155	Grl		
1488	1960	17.26.3.33334	283	16	3338	101-251	Cl, Sd, Grl	40-150	Sd	13	3297.5; 1984
								170-195	Sd, Grl		
								235-240	Grl		
1512; 2202[3]		17.26.7.34430	129	12-1/2	3416						3280.0; 1984
1578[3]		17.26.15.413111	192		3342						3298.4; 1979
1587-S-2	1955	17.26.1.11221	151	16	3311,	50-151	Cl, Sd, Grl	81-138	Sd, Grl		3290.6; 1984
1606; 3430	1937	17.26.3.231214[2]	104	12-1/2	3331						3296.6; 1984
1606-S	1983	17.26.2.13123	125	13-3/8	3324	90-120	Sd, Grl	50-60	Sd, Grl	45	3295.5; 1984
								70-80	Sd, Grl		
								110-120	Sd, Grl		
1668	1938	17.26.3.430	98	12	3331						3305.1; 1979
1749	1940	17.26.17.400	105	6				53-105	Sd, Grl		
2034[3]		17.26.13.33111	90		3303						3295.2; 1984

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TABLE 3-1
WELLS COMPLETED IN THE SHALLOW VALLEY FILL AQUIFER[1]
(CONTINUED)

WELL IDENTIFICATION (SEO NUMBER)	YEAR COMPLETED	WELL LOCATION T.R.S.1/4S	TOTAL DEPTH (FT)	CASING DIAMETER (IN)	COLLAR ELEVATION (FAMSL)[2]	DEPTH BELOW SURFACE SCREENED INTERVAL (FT)	LITHOLOGY SCREENED INTERVAL	DEPTH SATURATED INTERVAL (FT)	LITHOLOGY SATURATED INTERVAL	WATER LEVEL AFTER COMPLETION (FT)	WATER LEVEL ELEVATION LAST SURVEY[2] (FT);(YEAR)
2568	1950	17.26.16.113	232	7 5-3/16		216-232	Sd, Co	216-220	Sd	42	
2649	1950	17.26.12.411	150	6		114-130	Sd, Grl	114-130	Sd, Grl	85	
2698	1951	17.26.9.244	140	8 7		Well open below 63	Sd, Cl, Grl	18-30 50-80 130-140	Gyp Cl, Grl Grl	10	
2723	1951	17.26.9.434	318	7 6		233-318	SS, Cl, Sd	240-318	SS	40	
2749	1951	17.26.14.211	241	8 7 6		214-241	Sd	213-241	Sd		
3225	1954	17.26.9.112	100	6		65-94	Sd, Cl	65-70 80-94	Sd Sd	25	
3262	1954	17.26.5.444	100	6		70-96	Sd, Cl	70-80 87-96	Sd Sd	40	
3282	1954	17.26.9.112	125	7		105-125	Sd, Grl, Cl	80-92 105-123	Sd Sd, Grl	60	
3353	1952	17.26.15.121	295	8 7 5		232-295	Sd, Cl	260-295	Sd, Cl		
3368	1955	17.26.10.213	240	6		193-215	Sd, Grl	193-215	Sd, Grl	40	
4110	1965	17.26.16.411214[2]	240	7	3362	200-239	Sd, Cl	50-80 180-220	Grl Sd	80	3289.6; 1979
4196	1960	17.26.10.333	294	7		275-294	Cl, Sd, Grl	280-292	Sd, Grl	80	
4438	1966	17.26.12.244	228	5-1/2		185-228	Sd, Grl	190-228	Sd, Grl		
4922	1963	17.26.10.110	218	7		118-139	Sd	25-35 96-139	Sd Sd	25	
5815	1973	17.26.2.21243	26	7	3304	20-24	Sd, Cl	5-23	Sd	5	3298.0; 1979
6143 Navajo #3	1977	17.26.12.12322	23	8		3-22	Sd	0	Sd	0	
6143-x-2 Navajo #1	1977	17.26.12.111113	20	8		3-19	Sd	0	Sd	0	
6143-x-5 Navajo #5	1977	17.26.1.43314	21	8		3-20	Sd	0	Sd	0	
6143-x-7 Navajo #7	1977	17.26.1.44412	22	8		3-21	Sd	0	Sd	0	

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TABLE 3-1
WELLS COMPLETED IN THE SHALLOW VALLEY FILL AQUIFER[1]
(CONTINUED)

WELL IDENTIFICATION (SEO NUMBER)	YEAR COMPLETED	WELL LOCATION T.R.S.1/4S	TOTAL DEPTH (FT)	CASING DIAMETER (IN)	COLLAR ELEVATION (FAMSL)[2]	DEPTH BELOW SURFACE SCREENED INTERVAL (FT)	LITHOLOGY SCREENED INTERVAL	DEPTH SATURATED INTERVAL (FT)	LITHOLOGY SATURATED INTERVAL	WATER LEVEL AFTER COMPLETION (FT)	WATER LEVEL ELEVATION LAST SURVEY[2] (FT):(YEAR)
6143-x-9 Navajo #9	1977	17.26.12.24243	21	8		3-20	Sd	0	Sd	0	
6143-x-12 Navajo #12	1977	17.26.12.41234	19	8		3-18	Sd	0	Sd	0	
6143-x-13 Navajo #13	1977	17.26.12.42233	21	8		3-20	Sd	0	Sd	0	
6550	1979	17.26.10.12323	125	7		90-120	Sd	95-120	Sd	50	
6612	1980	17.26.9.34430	325	7		273-303	Sd, Grl	273-303	Sd, Grl	225	
6775-E Navajo #16	1981	17.26.12.1224	60	8-5/8	3307			10-35	Sd	10	
6776-E Navajo #17	1981	17.26.12.1243	30	8-5/8	3305			10-28	Sd	10	
7180	1983	17.26.10.12323	220	6-5/8		180-220	Sd, Cl	100-210	Sd	80	
Windmill No#		17.26.12.311323	40		3304						3298.7; 1984
MW-1[4]	1986	17.26.12	20	2	3310	Could not be located on map	Sl-Cl			10-1/2	3301.9; 1987
MW-2[4]	1986		18	2	3310	Could not be located on map	Sl-Cl			7	3304.1; 1987
MW-3[4]	1986	17.26.12.12441	17	2	3308		Cl-Sl			7-1/2	3300.6; 1987
MW-4[4]	1986	17.26.12.14221	18	2	3311		Cl-Sl			8	3298.2; 1987
MW-5[4]	1986	17.26.12.21434	19	2	3307		Sl-Cl			9-1/2	3301.3; 1987
MW-6[4]	1986	17.26.12.12341	15	2	3312		Sl-Cl			5	3298.7; 1987
MW-7[4]	1986	17.26.12.22342	20	2	3306		Cl-Sl			5	3299.8; 1987
MW-8[4]	1986	17.26.10.1443	20	2			Sd-Cl, Cl-Sd			8	
MW-9[4]	1986	17.26.10.1443	20	2			Sd-Cl, Cl-Sd			8-1/2	
Pump Test Well	1986	Could not be identified on map	32								
P87-1	1987	17.26.12.1442	6-10	2	3308						
P85-2	1985	17.26.12.2413			3305						
P87-2	1987	17.26.12.2341	6-10	2	3308						
P87-3	1987	17.26.12.3124	6-10	2	3309						
P87-4	1987	17.26.12.3224	6-10	2	3301						

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TABLE 3-1
WELLS COMPLETED IN THE SHALLOW VALLEY FILL AQUIFER[1]
(CONTINUED)

WELL IDENTIFICATION (SEO NUMBER)	YEAR COMPLETED	WELL LOCATION T.R.S.1/4S	TOTAL DEPTH (FT)	CASING DIAMETER (IN)	COLLAR ELEVATION (FAMSL)[2]	DEPTH BELOW SURFACE SCREENED INTERVAL (FT)	LITHOLOGY SCREENED INTERVAL	DEPTH SATURATED INTERVAL (FT)	LITHOLOGY SATURATED INTERVAL	WATER LEVEL AFTER COMPLETION (FT)	WATER LEVEL ELEVATION LAST SURVEY[2] (FT);(YEAR)
P87-5	1987	17.26.12.3411	6-10	2	3306						
P87-6	1987	17.26.12.3422	6-10	2	3305						
P87-7	1987	17.26.12.4321	6-10	2	3303						
P87-8	1987	17.26.12.3433	6-10	2	3304						
P87-9	1987	17.26.12.3444	6-10	2	3303						
P87-9E	1987	17.26.12.4343			3303						
P87-10	1987	17.26.12.1133	6-10	2	3309						
P87-11	1987	17.26.12.1331	6-10	2	3307						
P87-12	1987	17.26.12.3113	6-10	2	3306						
P87-13	1987	17.27.7.1131	6-10	2	3307						
P87-14	1987	17.27.7.1313	6-10	2	3307						
P87-15	1987	17.26.12.2431	6-10	2	3306						
P87-16	1987	17.26.12.4214	6-10	2	3304						
P87-17	1987	17.27.7.3113	6-10	2	3307						
P87-19	1987	17.26.12.4123	6-10	2	3307						
HP-1		17.27.18.1113									
HP-2		17.26.13.2112									
HP-3		17.26.12.3344			3302						

(1) Unless otherwise noted, all information is from the State Engineer's Office (SEO) Drill Logs (Appendix B).
(2) Data compiled from USGS Water Level Survey T17S, R2E.
(3) No SEO well logs available; see note (1).
(4) Data from Geoscience Consultants Limited (GCL) Report, 1987.

TABLE 3-2
WELLS COMPLETED IN DEEP ARTESIAN AQUIFER[1]

WELL IDENTIFICATION (SEO NUMBER)	YEAR COMPLETED	WELL LOCATION T.R.S.1/4S	TOTAL DEPTH (FT)	CASING DIAMETER (IN)	COLLAR ELEVATION (FAMSL)[2]	DEPTH BELOW SURFACE SCREENED INTERVAL (FT)	LITHOLOGY SCREENED INTERVAL	DEPTH SATURATED INTERVAL (FT)	LITHOLOGY SATURATED INTERVAL	WATER LEVEL AFTER COMPLETION (FT)	WATER LEVEL ELEVATION LAST SURVEY[2] (FT);(YEAR)
City Standpipe	1909	17.26.17.21	968	11-5/8 8 6				890-920	LS?		
7	1958	17.26.9.213121[2]	1205	10-3/4 8	3352	Hole open below 890	LS	1105-1135	LS?	16	3310.3; 1984
307	1926	17.26.10.33	1263	12-1/2 10		Hole open below 930	SS, LS	1086-1106	LS?		
313[3]		17.26.9.344411	1157		3364				LS		3305.6; 1984
397, 3195	1909	17.26.10.43331[2]	1007	8 4	3341			856-865	SH		3302.6; 1984
602, 3832	1963	17.26.9.113331[2]	1180	10-3/4 8-5/8	3363	Hole open below 998	LS	1158-1157	LS		3304.8; 1984
768	1943	17.26.9.323	1214	13 10-3/4		Hole open below 875	LS	875-1214	LS?		
785[3]		17.26.14.443311	929	14	3311				Gyp		3307.3; 1984
889, 2368	1962	17.26.5.111141[2]	1261	13-3/8 10-3/4	3398	Hole open below 780	LS	850-910	LS	150	3316.2; 1984
889-S-2	1906	17.26.5.11111[2]	801	6	3399	Hole open below 670	LS?		Gyp[1]		3280.2; 1985
895	1952?	17.26.14.211231[2]	1013	10-3/4 8-3/4	3313	806-990	LS, SS, Sh	863-870	LS?	Surface	3305.1; 1979
1044	1960	17.26.16.311113[2]	1225	13-3/8 10-3/4	3375	Hole open below 897	LS	1095-1105	LS?	98	3308.4; 1984
1090	1930	17.26.16.110	1233	12-1/2				912-1220	LS		
1097	1930	17.26.8.42	1123	8		Hole open below 609	SS, Sh, LS	880-1117	LS?		
2155	1944	17.26.17.233	1071	13-3/8 10-3/4		Hole open below 842	LS	875-1068	LS		

[1] Unless otherwise noted, all information is from the State Engineer's Office (SEO) Drill Logs (Appendix C).
[2] Data compiled from USGS Water Level Survey T17S, R26E.
[3] No SEO well logs available; see note (2)

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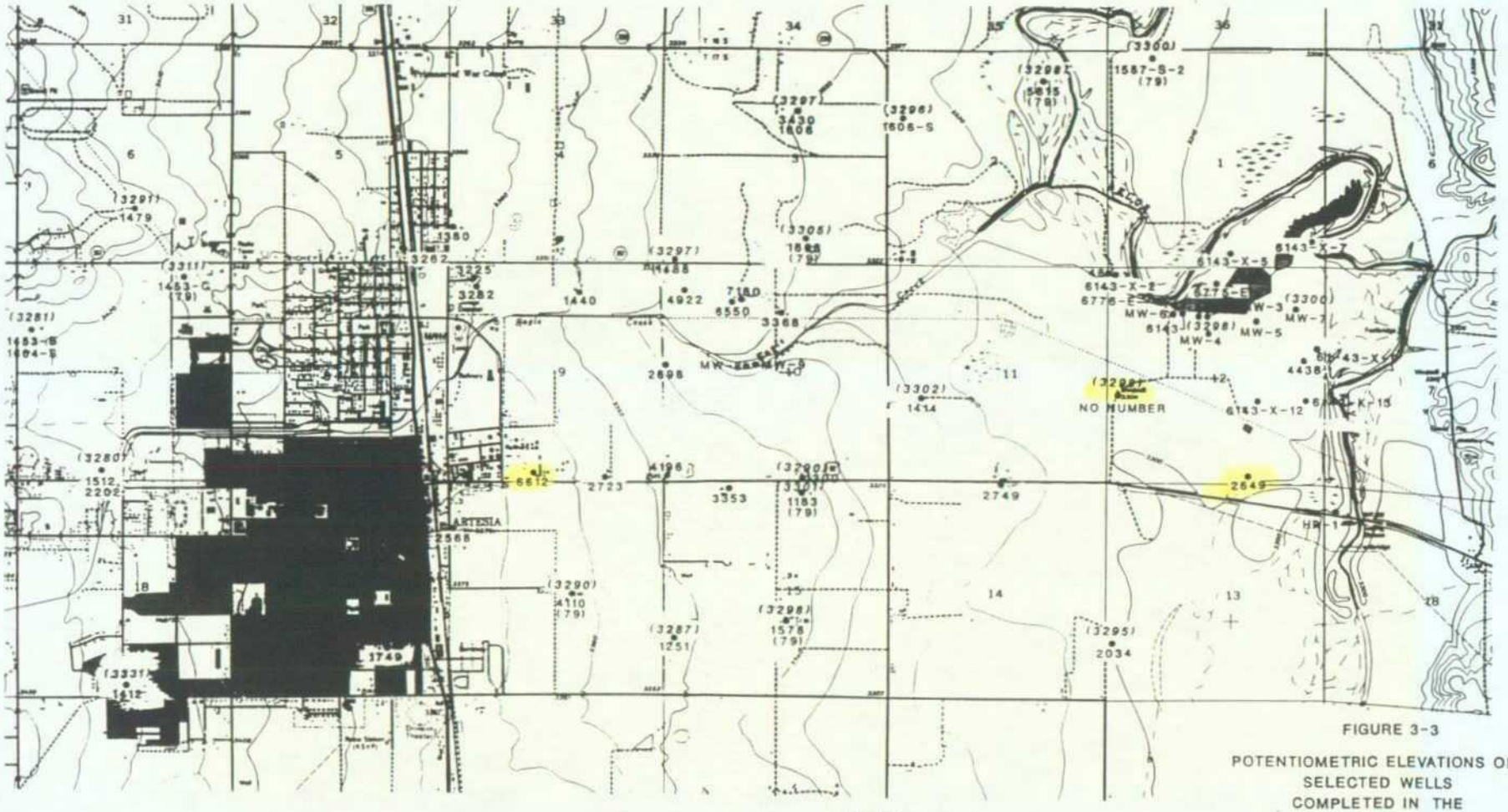

LEGEND

(3303)	ELEVATION OF WATER LEVEL (ft amsl)
•	WELL
1578	SEO NUMBER
(79)	YEAR WATER LEVEL MEASURED

NOTES: *If there is no year listed, water level was measured in 1984. For those wells recorded with two SEO numbers, both are provided.*

FIGURE 3-3

POTENTIOMETRIC ELEVATIONS OF SELECTED WELLS COMPLETED IN THE SHALLOW VALLEY FILL AQUIFER ARTESIA, NEW MEXICO

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ARTESIA, NEW MEXICO

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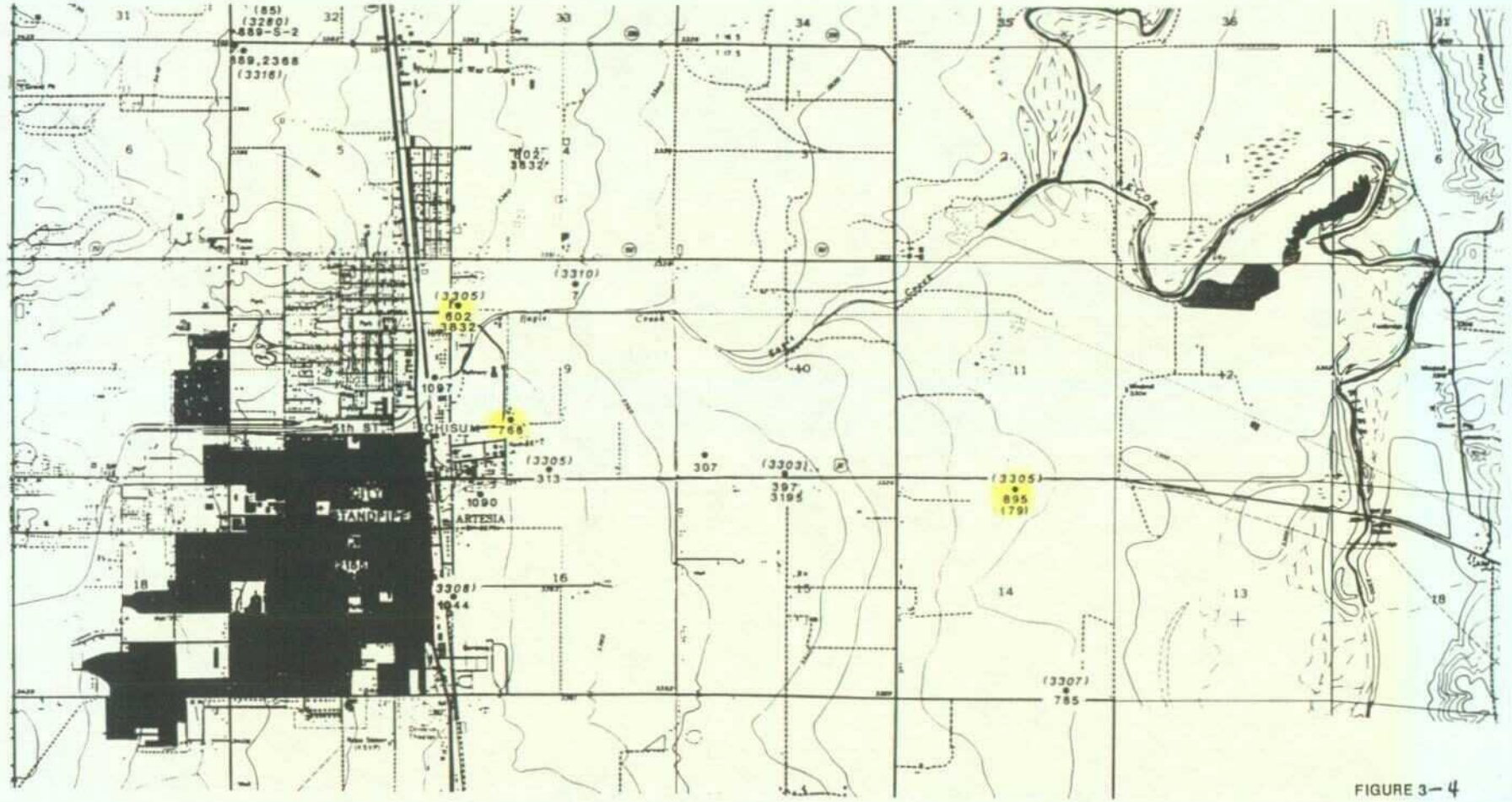

LEGEND

(3303)	ELEVATION OF WATER LEVEL (ft amsl)
•	WELL
1578	SEO NUMBER
(79)	YEAR WATER LEVEL MEASURED

NOTES: *If there is no year listed, water level was measured in 1984.*
For those wells recorded with two SEO numbers, both are provided.

0 1 MILE
SCALE

FIGURE 3-4

SELECTED WELLS COMPLETED IN THE DEEP ARTESIAN AQUIFER ARTESIA, NEW MEXICO

PREPARED FOR

NAVAJO REFINING COMPANY
ARTESIA, NEW MEXICO

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