RECORD OF DECISION

DOUBLE EAGLE REFINERY SITE
GROUNDWATER OPERABLE UNIT

OKLAHOMA CITY, OKLAHOMA

7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

APRIL 1994

CONCURRENCE DOCUMENTATION

FOR THE

DOUBLE EAGLE GROUND WATER OPERABLE UNIT RECORD OF DECISION

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DECLARATION
DOUBLE EAGLE REFINERY SITE
GROUNDWATER OPERABLE UNIT

Statutory Preference for Treatment as a Principal Element is not Met and Five-Year Review is Required

SITE NAME AND LOCATION

Double Eagle Refinery Site
Oklahoma City, Oklahoma

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Double Eagle Refinery Site (DER site), in Oklahoma City, Oklahoma, for the Ground Water Operable Unit. The Source Control Operable Unit Record of Decision (ROD) for this site was completed and signed on September 28, 1992. The remedy for the DER site was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Contingency Plan (NCP). This decision is based on the Administrative Record for this site.

The State of Oklahoma concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This Record of Decision (ROD) addresses the contamination in the groundwater. Principal threat wastes include "pools" of dense non-aqueous phase liquids (DNAPLs) submerged beneath the ground water or in fractured bedrock. Although there was no free phase contamination noted during drilling operations at the site, certain chemicals were detected that are contaminants associated with DNAPLs. This Ground Water Operable Unit (GOU) addresses the principal threat at the site by monitoring the ground water to ensure that the contaminant levels are reduced with time due to natural attenuation, once the surface contamination is addressed, so that the surface contamination will no longer provide a source of contamination to the ground water.

Past oil production activities have rendered the upper ground water zone non-useable (Class III aquifer) due to the presence of high Total Dissolved Solids. The data also suggests the possibility of an offsite source of contamination. Therefore, implementation of a ground water recovery and treatment system is not considered appropriate at this time. However, a potential exists for contaminants to migrate vertically to a potential drinking water aquifer. Therefore, monitoring to ensure that migration does not occur is appropriate.

This action is the second and final operable unit for the DER site. This second operable unit is also referred to as the "Ground Water Operable Unit" (GOU). The first operable unit for the DER site, termed the Source Control Operable Unit (SCOU), addressed the source of contamination both onsite and offsite, which included surface sludges, contaminated surface water and sediment, and contaminated soil and debris.

The major components of the selected remedy include:

- Installation of additional ground water monitoring wells.
- Establishment of a routine monitoring and maintenance program for ground water sampling and modeling, to evaluate contaminant level reductions, upon removal of the surface contaminant source materials.
- To the extent that site access is available, new monitoring wells will be placed to determine whether there is an off site source of contamination.
- A five-year review to analyze the data obtained and computer modeling to determine if contaminant level reductions are being achieved as expected, once the surface source of contamination is stabilized.
- Contingency action that could be implemented if the contaminant concentrations increase or the contaminant plume migrates horizontally or vertically to a usable water supply.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions to the maximum extent practicable for the conditions at the site. However, treatment of the hazardous constituents in the ground water was found to be inpracticable.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of public health, welfare, and the environment.

4-19-94

Jane N. Saginaw
Regional Administrator
Region 6

Date

DECISION SUMMARY
FOR THE
DOUBLE EAGLE REFINERY SITE
GROUNDWATER OPERABLE UNIT
OKLAHOMA CITY, OKLAHOMA

I. SITE NAME, LOCATION, AND DESCRIPTION

The Double Eagle Refinery Site ("DER site", or "the site") occupies the Southeast Quarter (SE 1/4) of Section 35, Township 12 North, Range 3 West, Indian Meridian, Oklahoma City, Oklahoma County, Oklahoma. Located at 1900 NE First Street, the site is bounded to the north by the Union Pacific Railroad tracks (also referred to as the ATSF-Santa Fe railroad), and to the west and south by vacant lots zoned for industrial land use. Martin Luther King Boulevard lies on the east side of the site as an overpass to the railroad tracks. The DER site is fenced and extends over approximately 12 acres.

The Fourth Street Refinery Superfund Site ("FSR site") lies about 500 feet northeast of the DER site, just north of the railroad tracks and just east of Martin Luther King (MLK) Boulevard. The DER and FSR sites are separated only by the MLK overpass, and contain very similar waste material since both sites recycled used oils. Due to the fact that these sites are in such close proximity, and migration of contaminants in certain cases overlap, this Record of Decision (ROD) will make reference to the FSR site as necessary. The FSR site was addressed in a separate ROD. Figure 1 provides a general location map. Figure 2 provides a schematic of both the DER and FSR Superfund sites, and shows the location of each site in relation to the other. Figure 3 provides a site layout for the DER site.

Although industrial areas immediately surround the site, the land use within a 1 mile radius of the DER site is mixed industrial and residential. One residence is located to the north of the railroad tracks and to the east of Martin Luther King Boulevard, adjacent to the FSR site. A small neighborhood is located about 1/4 mile to the north, on the other side of the industrial complex adjacent to the railroad tracks which border the site. Four schools (Douglas High School, Dunbar School, Bath School, and Edwards School) are located within a 1 mile radius of the site. Recreational areas close to the site include the Douglas Community Center, Douglas Community Park, and Washington Park. Drug Recovery, Inc. is the only medical facility located within a 1 mile radius of the site.

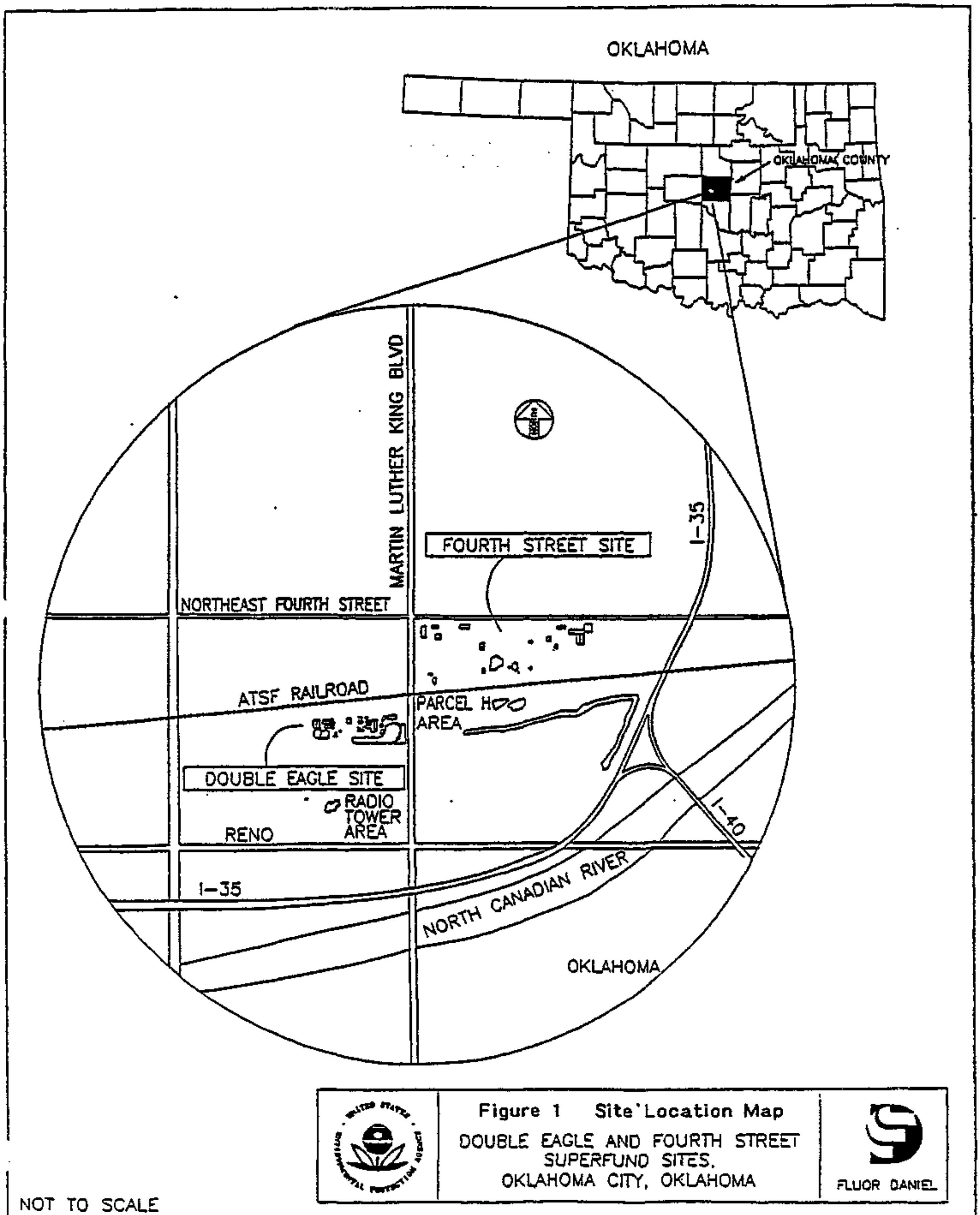

Figure 1 Site Location Map
DOUBLE EAGLE AND FOURTH STREET SUPERFUND SITES, OKLAHOMA CITY, OKLAHOMA

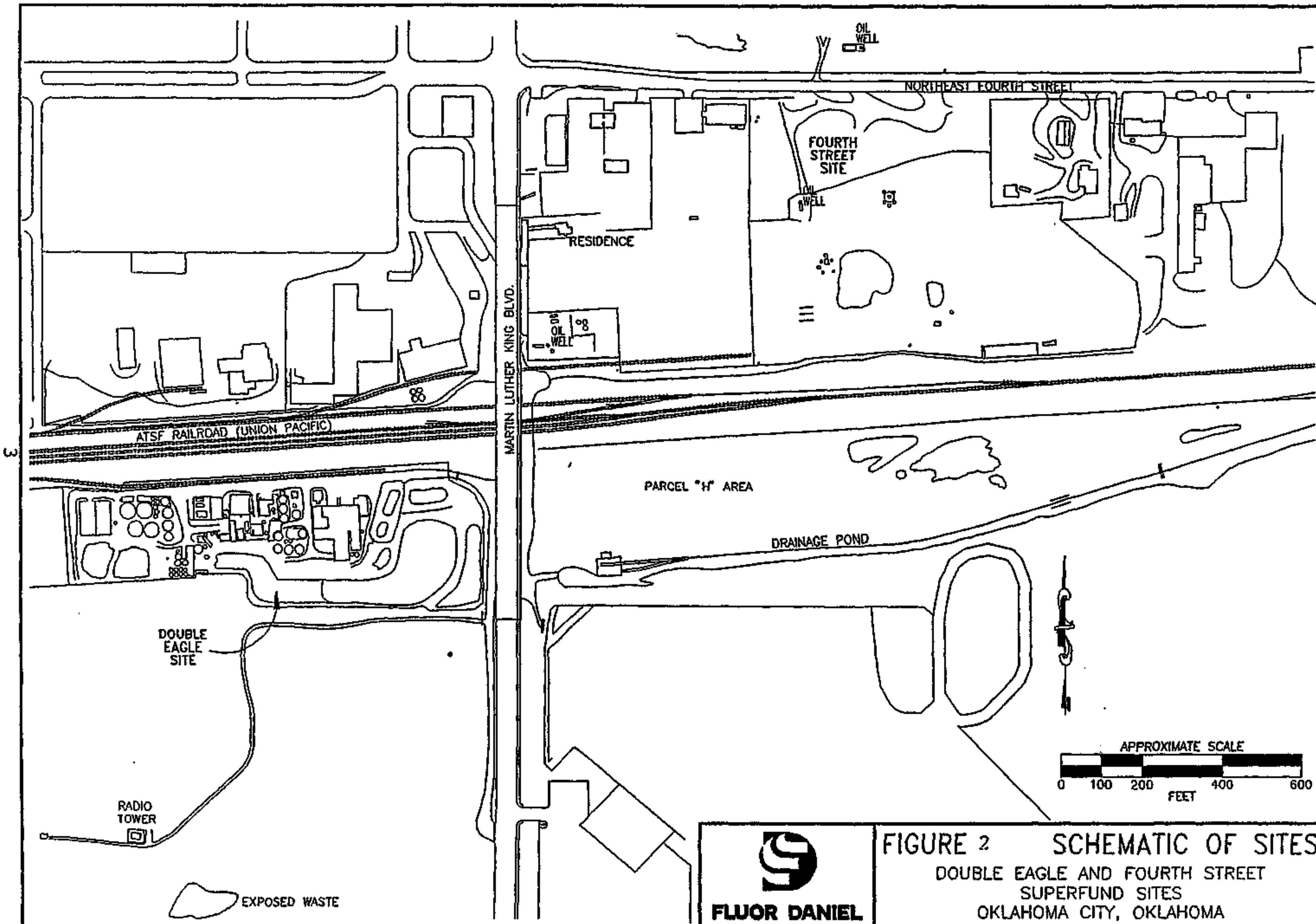

FIGURE 2 SCHEMATIC OF SITES
DOUBLE EAGLE AND FOURTH STREET SUPERFUND SITES
OKLAHOMA CITY, OKLAHOMA

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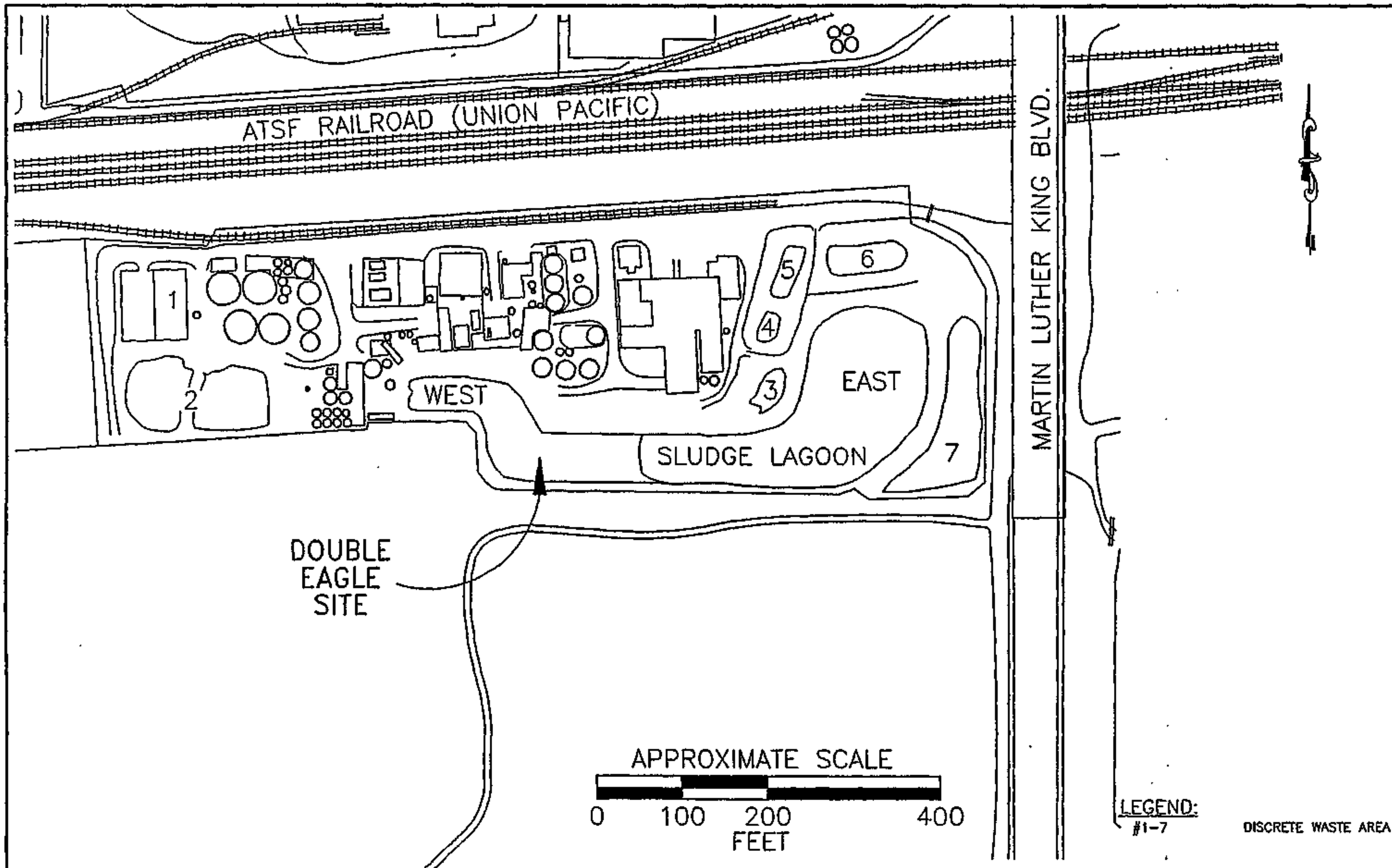

FIGURE 3 SCHEMATIC OF DOUBLE EAGLE
DOUBLE EAGLE AND FOURTH STREET SUPERFUND SITES
OKLAHOMA CITY, OKLAHOMA

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The DER site has contributed to offsite contamination at offsite areas called the "Radio Tower area" and "Parcel H". The Radio Tower area is located just south of the Double Eagle site and Parcel H is located just south of the Fourth Street site. The North Canadian River is located just south of Interstate 35, approximately one half mile south of the site. Although no endangered species have been identified in these areas, wildlife in the area includes migratory fowl and small mammals.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Site History

The Double Eagle Refinery collected, stored, and re-refined used oils and distributed the recycled product. The refinery was active as early as 1929 with historical aerial photographs available as early as 1941. Generally, early refining was conducted on the western portion of the site and expanded toward the eastern portion as the operations increased.

The DER recycled approximately 500,000 to 600,000 gallons of used motor oil per month into finished lubricating oil. The recycling process consisted of the addition of sulfuric acid, settling, and filtration with bleaching clays via a filter press. This process generated approximately 80,000 gallons of oily sludge per month. Sludges were initially sent to an off-site disposal facility, now the Hardage Criner Superfund Site located in Criner, Oklahoma. Later, sludges were disposed of in onsite impoundments and a sludge lagoon until the late 1960's to early 1970's.

Onsite and offsite visual inspections, by the Environmental Protection Agency (EPA) Field Investigations Team in May of 1985, indicated that a preliminary sampling inspection should be conducted. An Expanded Site Inspection was conducted by EPA in 1987-88 which confirmed that the site should be ranked for inclusion on the National Priorities List (NPL). In March 1989, the DER site was added to the NPL, pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. Section 9605, as amended.

The Remedial Investigation/Feasibility Study (RI/FS) for the Groundwater Operable Unit (GOU) was initiated in June 1992 for the DER site; and the RI and FS were both completed in July 1993. Due to the close proximity of the DER and FSR sites, and due to the similar types of wastes present at both sites, EPA assigned one contractor to conduct the RI/FS projects concurrently. Therefore, distinguishable characteristics of each site could be easily identified, and mobilization and remedial alternative development efforts would not be duplicated for the overall study area.

In conjunction with the site investigations and related studies performed by the EPA, the U.S. Fish and Wildlife Service (Department of Interior -DOI) conducted a Preliminary Natural Resource Survey (PNRS) for the DER site. Technical information was gathered from site visits, National Wetland Inventory maps, EPA analytical data, and personal communications with the Oklahoma Department of Wildlife Conservation (ODWC) and EPA. The study revealed that the DER site is upgradient of a small "oxbow lake" (created by damming natural drainage) which lies south of the Parcel H area. The site is also upgradient of the North Canadian River. The varied habitat adjacent to the Parcel H ponds, oxbow lake, and the North Canadian River is capable of supporting good populations of common urban fish and wildlife species. According to the PNRS report, a dead opossum and a ring-billed gull was recovered from the concrete vat (basin), and a dead opossum were noted in one of the lagoons on site during the site visit by the DOI.

As a result of the site investigation performed by the DOI (U.S. Fish and Wildlife) the EPA prepared an "Action Memo" dated September 13, 1993, which was signed by the Director, Environmental Services Division. The Action Memo authorizes the EPA to expend funds to install protective netting over an approximate 2.5 acre sludge lagoon to preclude access by wildlife, and provide a barrier to the highly toxic and acidic contamination present at the surface. The PRPs have been offered the opportunity to conduct the planned action at the site.

EPA Enforcement Activities

In December 1988 EPA issued an Unilateral Administrative Order (UAO) to the site owner, requesting that the north side of the site be fenced to prevent people and animals from coming into direct contact with the hazardous substances. The owner complied with the AO and completed the fencing in February 1989, which mitigated the immediate risk to public health.

Prior to initiating the RI/FS for the Source Control Operable Unit (SCOU) in May 1990, EPA conducted a search for Potentially Responsible Parties (PRPs). EPA sent Special Notice letters to 17 PRP's identified in the search. The letters included a notification of potential liability under Section 107 of CERCLA. The letters also included a demand for reimbursement of EPA's past costs as well as an offer affording the PRPs an opportunity to perform the RI/FS. None of the parties receiving the Special Notice made a good faith offer to conduct the RI/FS, nor did any parties offer to reimburse the EPA for the past costs incurred.

EPA conducted the RI/FS for the SCOU as a Fund lead project. Simultaneously with the performance of the RI/FS, EPA proceeded to pursue leads regarding other unidentified PRPs. In October 1992, several previously undiscovered boxes of manifests were located at the Oklahoma State Department of Health (OSDH) archives, now the

Oklahoma Department of Environmental Quality (ODEQ), which contained records of shipments of waste oil and other hazardous wastes to the DER facility. These manifests were from the time period of 1980-1982. From these records 46 Special Notice letters were issued on December 16, 1992. A PRP group formed in January 1993, and the EPA met with the group on February 11, 1993. At this meeting the EPA provided the PRPs the liability information linking the PRPs to the site and past cost documentation for funds expended by the EPA. A group of 22 PRPs made a good faith offer to "cash out" on March 31, 1993. EPA anticipates future negotiations with respect to the SCOU.

EPA conducted the RI/FS for the GOU as a Fund lead project also; however, the newly identified PRP's were sent General Notice letters on February 9, 1993, affording them the opportunity to participate in the GOU Remedial Design/Remedial Action, and informing them of GOU RI/FS activities.

Negotiations with the EPA and the PRPs, pertaining to all aspects of enforcement activities are ongoing.

State Enforcement Activities

During 1977 and 1978 numerous inspections conducted by the Oklahoma Water Resources Board (OWRB) indicated that un-permitted releases of hazardous waste occurred both onsite and offsite. Subsequent inspections conducted by OWRB revealed that the Double Eagle facility continued to discharge hazardous substances in violation of the facility permit. As a result of the unpermitted releases of hazardous waste, OWRB referred this case to their General Counsel, seeking a Cease and Desist Order on September 14, 1985.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

This decision document presents the selected remedial action for the GOU for the DER Superfund site, in Oklahoma City, Oklahoma. This action is chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the National Contingency Plan (NCP), 40 CFR Part 300. The decision for this site is based on the administrative record. An index for the administrative record is included as Attachment A to this document.

The public participation requirements of CERCLA, sections 113(k)(2)(B)(i-v) and 117, were met during the remedy selection process. The Remedial Investigation and the Feasibility Study reports and the Proposed Plan were released on August 5, 1993, and were all made available to the public in both the administrative record and information repositories. The repositories are maintained at the Ralph Ellison Branch Library, the ODEQ Central Office in Oklahoma City, Oklahoma, and the EPA Region 6 Office in Dallas, Texas. The notice of availability for these documents was published in The Black Chronicle, on August 5, 1993.

The EPA and ODEQ held an Open House in Oklahoma City on February 18, 1993, to explain the Superfund process and to notify the public that RI activities for the GOU had begun. The RI fieldwork for the GOU was discussed and general information about the site as well as new developments pertaining to the SCOU were provided to the public by the EPA.

A 30-day public comment period was held from August 5, 1993 to September 4, 1993. On August 16, 1993, the EPA received a request for a thirty-day extension in accordance with 40 CFR § 300.430, from one of the PRP representatives on behalf of the participating PRPs. On August 27, 1993, the EPA responded to the PRP representative granting the 30-day extension request, which extended the public comment period until October 7, 1993 (due to a holiday weekend within this period). Two commenters submitted written comments during the public comment period.

A public meeting was held in Oklahoma City on August 12, 1993. At this meeting, representatives from the EPA presented information on the RI, Risk Assessment and FS. EPA and ODEQ answered questions about the site, the remedial alternatives under consideration, and the Proposed Plan of Action. Responses to the comments received at this meeting, as well as the comments received in writing during the public comment period, are included in the Responsiveness Summary, which is included in this ROD as Attachment B.

IV. SCOPE AND ROLE OF OPERABLE UNIT 2 WITHIN THE SITE STRATEGY

During the RI/FS project for the SCOU for the DER site, the issues related to ground water beneath the site were acknowledged as complex in comparison to those obvious with respect to the surface contamination, consisting of the sludges and tar mats, and the contaminated soil, sediment and surface water. During the investigations required for ranking the site for inclusion on the NPL, the resulting reports indicated that there was a continuous shale layer acting as an "aquitard" beneath the site, since this is generally the regional geology. However, during the field investigations conducted as part of the RI for the SCOU, the shale layer was not present beneath the site. Shallow and deep alluvial wells were installed around the perimeter of both the DER and FSR sites, but the determination of vertical and lateral migration of ground water contaminants required further study. Therefore, the site was separated into two Operable Units to address the surface contamination and the ground water problems individually. The impact of the migration of contaminants in ground water and possibly to the North Canadian River is addressed in this ROD for Operable Unit 2 (Ground water Operable Unit - GOU).

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. The principal threats at the DER site pertaining to the surface contamination are the acidic sludges within the sludge lagoon and contaminated ponds. These were addressed in the SCOU ROD which was signed on September 28, 1992.

Low-level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of a release. The low-level threats at the site are the contaminated surface soils and tar matrices. These low-level threat wastes were also addressed in the SCOU ROD. The Remedial Design for the SCOU was initiated on June 21, 1993.

Principal threat wastes pertaining to ground water are defined as "pools" of dense non-aqueous phase liquids (DNAPLs) submerged beneath ground water or in fractured bedrock. The contaminated ground water in the immediate area of the site is classified as a Class III aquifer by EPA, and the ODEQ agrees with this classification. Class III aquifers are considered unusable due to the presence of Total Dissolved Solids (TDS) in excess of 10,000 parts per million (ppm). The average and maximum concentrations of TDS in the alluvial aquifer were 2,460 ppm and 13,100 ppm, respectively; and in the upper portion of the Garber-Wellington (bedrock) aquifer the TDS were 34,680 ppm and 110,000 ppm, respectively, for the wells installed at the DER site. The remedial objectives of the GOU are to minimize potential exposure by direct contact (which includes accidental ingestion and dermal contact) or inhalation, and to reduce the potential for migration of contaminants into the surface waters and useable ground water supplies.

V. SUMMARY OF SITE CHARACTERISTICS

General Overview

The DER site and offsite areas (Parcel H and the Radio Tower area) are not located in the 100 year floodplain. Generally, the local surface drainage flows to the south and east of the DER site. Prior to construction of Interstate 35, the North Canadian River meandered through the adjacent FSR site. During construction of the highway, the river was diverted to the south side of I-35, and is now located approximately one half-mile to the south of the DER site.

Ponds on the DER site and portions of the Parcel H Area appear on the National Wetlands Inventory Maps (NWI) (U.S. Dept. of Interior, Fish and Wildlife Service, 1989). These maps are based on interpretation of aerial photographs and not on actual site surveys. The NWI maps are prepared by review of the aerial photographs and do not distinguish between pristine ponds and sludge lagoons covered with surface water, or other types of waste water treatment ponds. Migratory fowl have no way of discriminating between clean and contaminated surface waters, therefore, the DER site is considered a wetland area until the remedial action for the SCOU is complete. Once the SCOU remedy is implemented, no ponds will remain, and the site will essentially be left as a dry field. Therefore, the DER site will no longer be a wetland after the Remedial Action.

The North Canadian River is located just south of Interstate 35, approximately one-half mile south of the site. Although no endangered species have been identified for these areas, wildlife in the area includes migratory fowl and small mammals.

Nine alluvial monitoring wells were installed at the DER site. Five of the alluvial monitoring wells were installed in the shallow alluvium with the top of 5 foot screens placed at depths varying from 10 to 19 feet. The remaining four alluvial wells were installed with the top of five foot screens placed between 28 to 34 feet below ground surface. Six "bedrock" monitoring wells were installed around the perimeter of both the DER and FSR sites with the top of 10 feet screens placed about 5 feet into the top of the Garber sandstone. The top of the Garber sandstone varies from 25 to 57 feet below ground surface across the DER site. The monitoring well locations are shown on Figure 4. The terms "bedrock" or "upper bedrock" used in this ROD shall refer to the uppermost portion of the Garber-Wellington aquifer, and the terms may be used interchangeably.

General Geology and Hydrogeology Characterization

The DER site is situated on Quaternary alluvial deposits which represent recent deposition by the nearby North Canadian River. The floodplain deposits typically consist of unconsolidated and interfingering lenses of sand, silt, clay, and gravel. These alluvial sediments are predicted to have relatively high permeabilities and porosities. The alluvium in Oklahoma County ranges in thickness from several inches to 90 feet below ground surface along the river basin.

Directly below the alluvial deposits are the Garber and Wellington formations. Regionally, these bedrock formations (i.e., lithified strata below the alluvial channel fill) have a gentle westward homoclinal dip of 30 to 40 feet per mile. However, the DER site is located on the northeast flank of the Oklahoma City oil field surface anticline. Beneath the site, the dip of the Garber sandstone is to the east-northeast, which is opposite of the regional dip. The bedrock formation beneath the DER site begins approximately 25 to 57 feet below the ground surface. Collectively, the Garber-Wellington consists of massive, cross-bedded sandstones irregularly interbedded with siltstones and shales. The "red bed" sandstones and shales of the Garber and Wellington Formations are similar in lithology and conform gradationally. Therefore, these formations are commonly mapped as a single lithologic unit and classified as a single aquifer (the Garber-Wellington aquifer). Cross section locations and a Geologic Cross Section are shown on Figures 5 and 6, respectively.

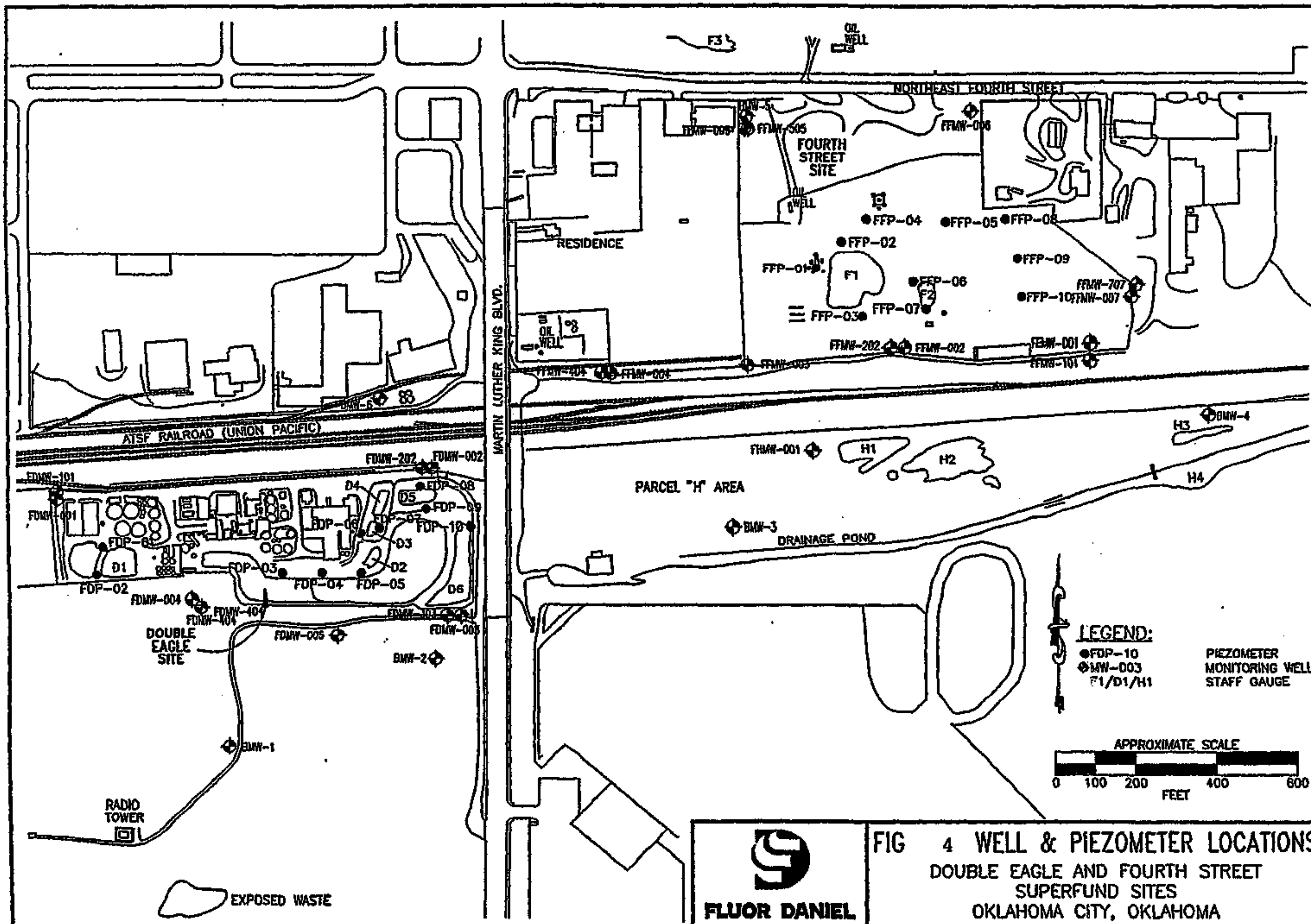

FIG 4 WELL & PIEZOMETER LOCATIONS
DOUBLE EAGLE AND FOURTH STREET SUPERFUND SITES
OKLAHOMA CITY, OKLAHOMA

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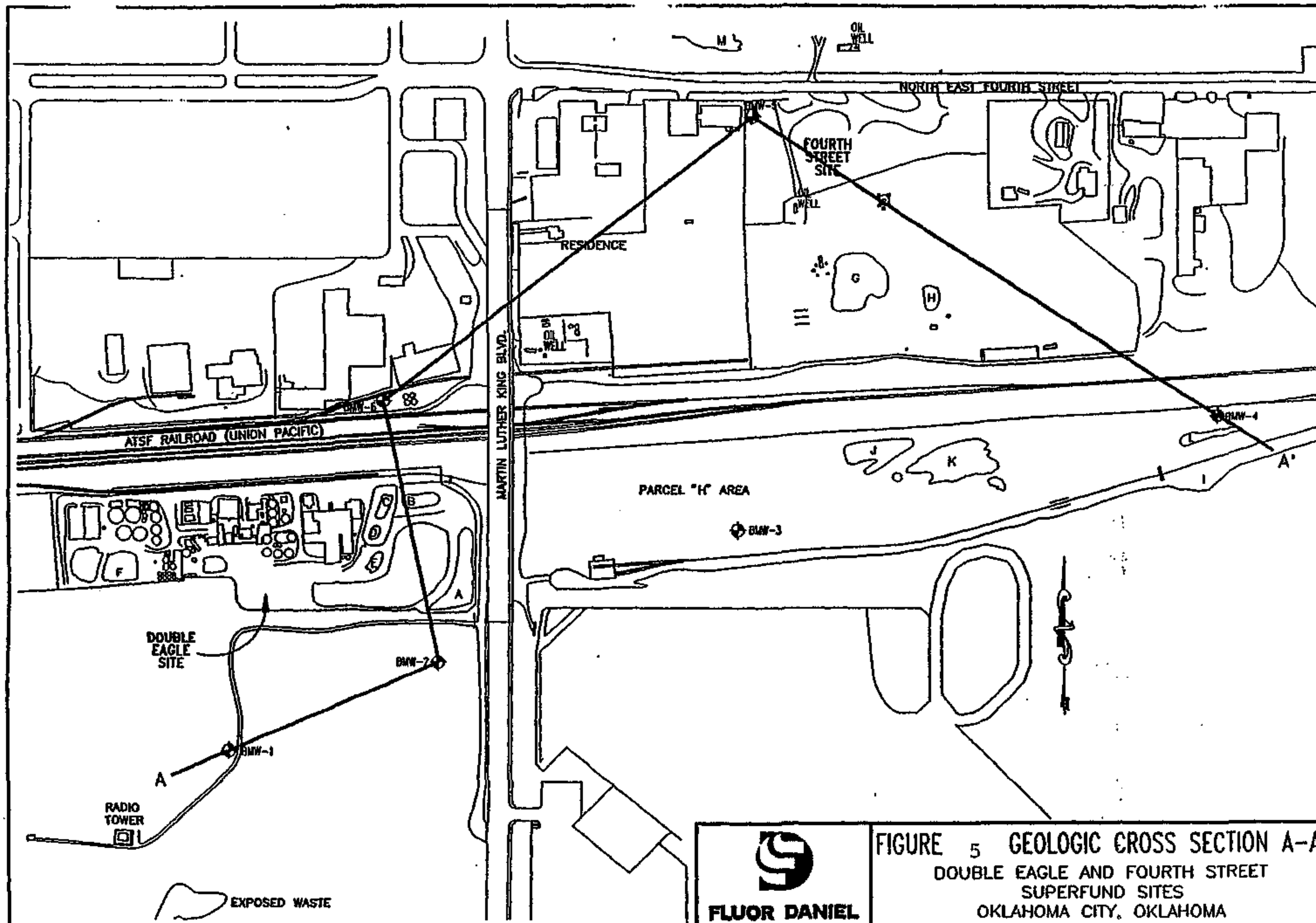

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FIGURE 5 GEOLOGIC CROSS SECTION A–A'
DOUBLE EAGLE AND FOURTH STREET SUPERFUND SITES
OKLAHOMA CITY, OKLAHOMA

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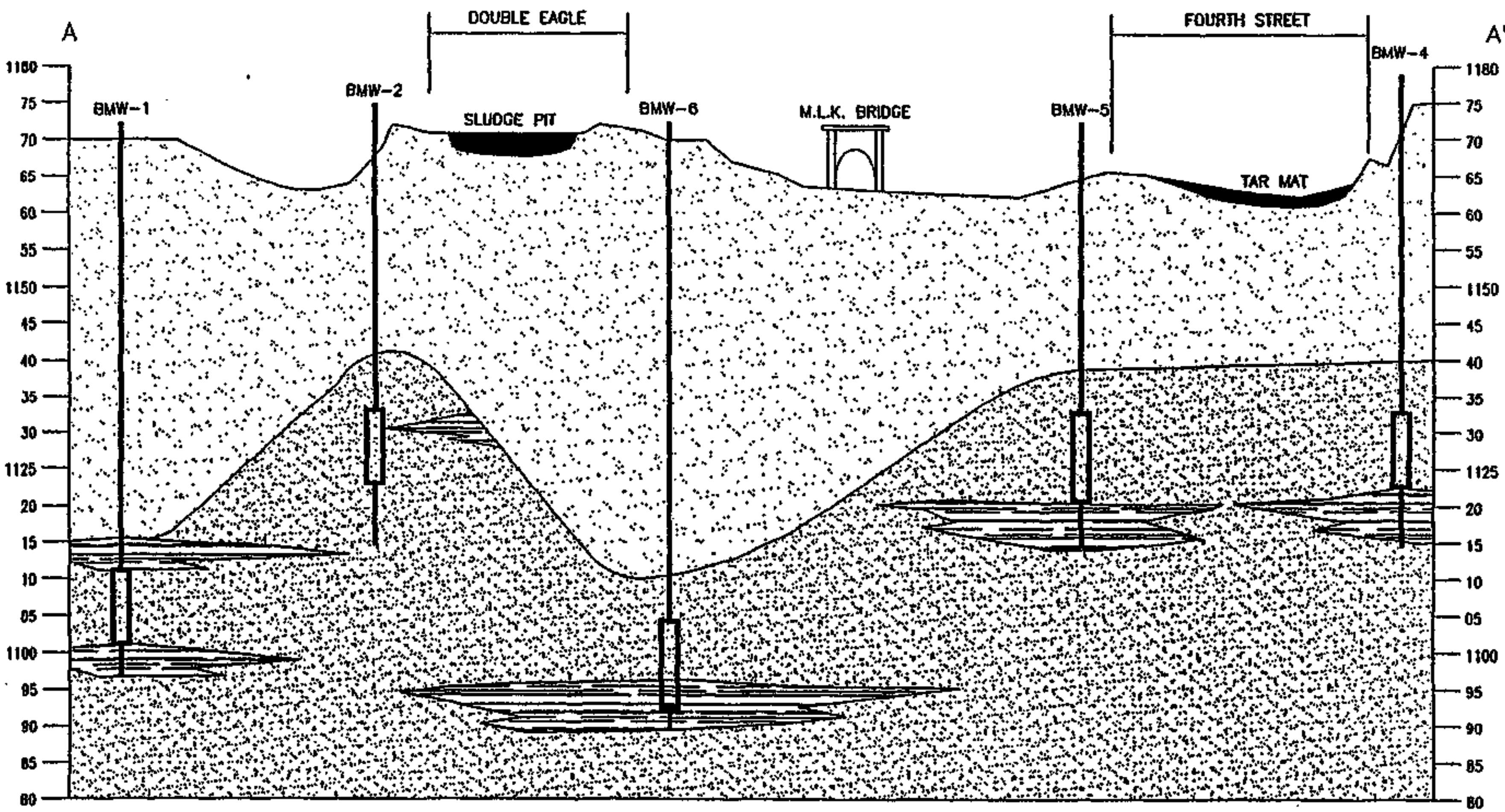

LEGEND

ALLUVIUM

SHALE

GARBER-SANDSTONE

V.E. = 20

SCREENED INTERVAL

NOTES:

1. SUBSURFACE GEOLOGIC INTERPRETATIONS ARE BASED ON SAMPLE DESCRIPTIONS FROM MONITORING WELL BORING LOGS. GEOLOGIC CONDITIONS SHOWN AWAY FROM MONITORING WELLS ARE INTERPRETIVE AND MAY NOT REPRESENT ACTUAL CONDITIONS.

2. SEE FIGURE 3-2 FOR THE LOCATION OF THE CROSS-SECTION.

HORIZONTAL IS NOT TO SCALE

FIGURE 6
GEOLOGIC CROSS SECTION A-A'
DOUBLE EAGLE & FOURTH STREET
SUPERFUND SITES
OKLAHOMA CITY, OKLAHOMA

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The Garber-Wellington aquifer constitutes the most important source of ground water in Oklahoma County. Wells drilled into the water bearing zone may penetrate as much as 200 to 300 feet of water bearing sandstone. Artesian conditions exist below 200 feet in areas in which the aquifer is overlain by the Hennessey Group. The depths of municipal, institutional, and industrial wells screened in the Garber-Wellington range from 100 to approximately 1,000 feet in Oklahoma County. Yields of wells less than 250 feet deep range from 5 to 115 gallons per minute (gpm) and average 35 gpm. Reported yields of wells more than 250 feet deep range from 70 to 475 gpm and average 240 gpm. The principal hydrologic factor controlling the development of the aquifer for fresh water supply is the presence of high Total Dissolved Solids (TDS) in the ground water. Shallow ground water (water encountered at a depth less than 100 feet) in the area is not used as a water supply due to TDS levels in excess of 10,000 ppm. The high TDS content in the ground water is attributed to past oil and gas production activities in the area.

No drinking water wells currently exist within a 1 mile radius of the site. Residents and industries in the area utilize water obtained from reservoirs surrounding the city. Results from sampling the alluvial ground water beneath the DER site revealed that the TDS ranged from 310 ppm to 13,100 ppm with an average of about 2,500 ppm for the nine alluvial wells at the DER site. Results from sampling the upper bedrock monitoring wells (installed with a 10 feet screen placed approximately 5 feet below top of Garber sandstone) indicate TDS from 5,200 ppm to 110,000 ppm with an average of about 35,000 ppm for the three bedrock wells installed around the perimeter of the DER site (BMW #1, #2 and #6). Therefore, this zone is considered a Class III aquifer due to the high TDS, which would prohibit use of the shallow ground water for domestic purposes. Class III aquifers are characterized by TDS concentrations greater than 10,000 parts per million (ppm). Figure 7 shows the degree of contamination with respect to the TDS, based on data obtained from sampling from the upper bedrock monitoring wells.

Site Hydrogeologic Conditions

The site is underlain by unconsolidated deposits of alluvium material consisting of about 1 to 3 feet of topsoil, beneath which is a mixture of mostly sandy material mixed with silt and clayey gravel. The thickness of the alluvium varies from about 25 to 57 feet below the ground surface. Underlying these alluvial deposits is the bedrock material. The uppermost bedrock formation is the Garber Sandstone.

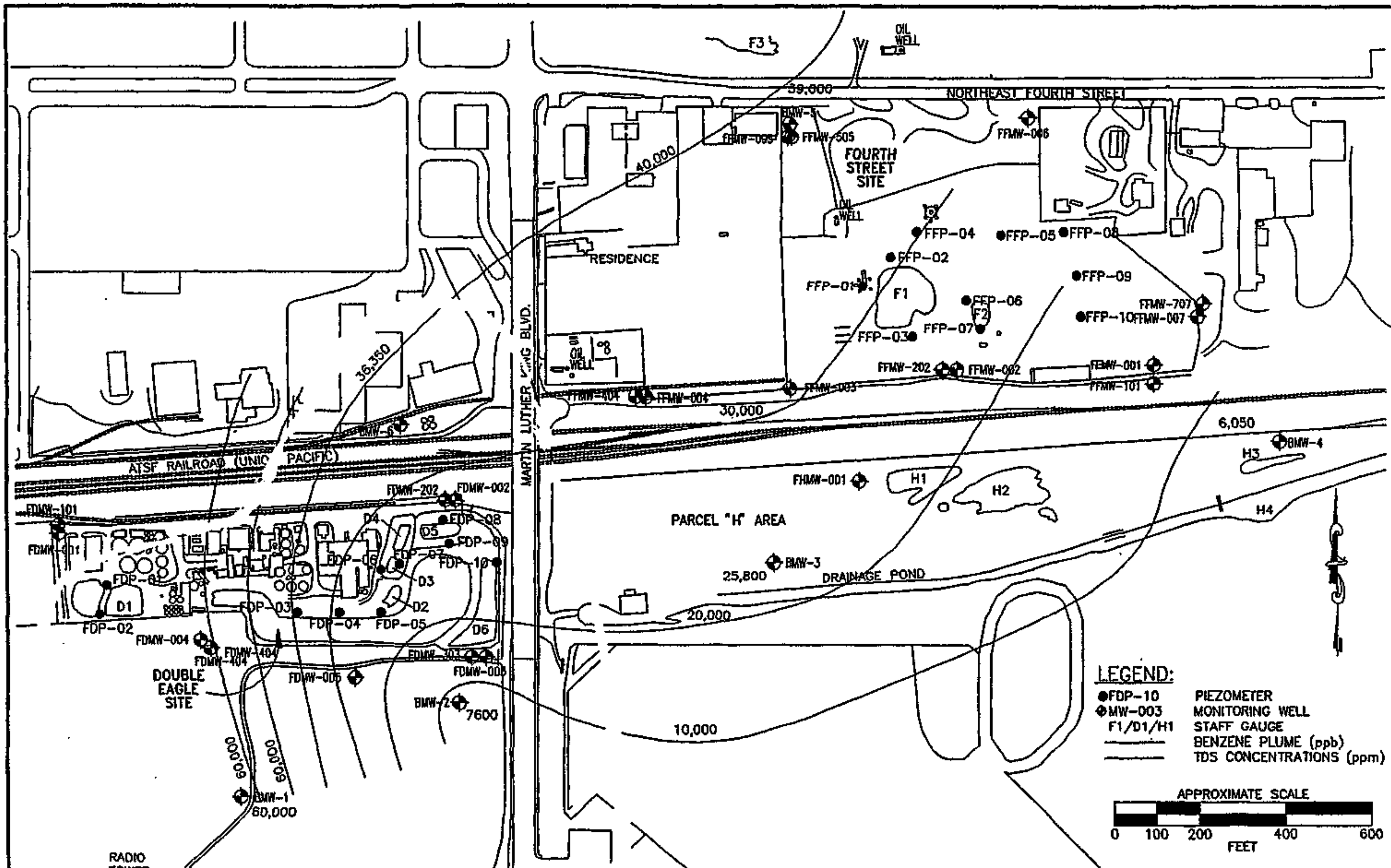

FIG. 7 TDS CONCENTRATIONS

DOUBLE EAGLE SUPERFUND SITE
OKLAHOMA CITY, OKLAHOMA

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The Hennessey Group formation, predominantly reddish-brown shale containing some layers of siltstone and fine-grained sandstone, overlies the Garber-Wellington Formation in parts of the region. However, this shale layer was not encountered above the Garber-Wellington aquifer (as originally anticipated) in the deeper borings drilled at both the DER and FSR sites in March of 1992, indicating that the shale has been completely removed by erosion in the area of the site prior to the deposition of the alluvium by the North Canadian River system. This shale material was originally believed to have been a continuous layer beneath the site, which acted as an "aquitard" that separated the upper and lower ground water aquifers. However, the more recent studies revealed that no Hennessey shale is present beneath the site, concluding that there is no aquitard between the upper alluvial material and the bedrock. Therefore, the upper and lower water bearing zones are hydraulically connected. Due to the absence of the Hennessey Shale beneath the site, this Operable Unit was initiated to assess the vertical migration and potential impact of site contaminants on the deeper Garber-Wellington aquifer.

In addition, the lateral migration and potential impact of site contaminants in the ground water on the nearby Canadian River has been investigated, and the results presented herein. Although the Garber-Wellington aquifer is the most important source of ground water in the Oklahoma City area, the City of Oklahoma City currently receives its public water supply from lakes in the area.

During drilling operations at the site, ground water was encountered at varying depths that ranged from 7 to 20 feet below ground surface. Subsequent ground water monitoring indicates that the ground water levels range from about 7 to 17 feet below the ground surface. The ground water levels were determined periodically and exhibited moderate seasonal fluctuations due to seasonal variations in rainfall.

Nature and Extent of Contamination

The Groundwater RI/FS was focused to provide information for discrete areas of concern and subsequent migration pathways.
From all the chemicals detected in the ground water at the site, certain chemicals were identified as potential Contaminants of Concern (COC) based on the COCs from the SCOU. The RI/FS revealed that numerous contaminants similar to those found in the sludges, sediments, and soils onsite, were detected in the ground water sampled from the alluvial and upper bedrock monitoring wells. The contaminants found were primarily organic chemicals and heavy metals related to the refinery process. The most commonly found organic chemicals were Chlorinated Hydrocarbons and Benzene compounds. Lead was the primary metal contaminant found in ground water samples taken during the investigation. The COCs are discussed in detail in Section VI - Summary of Site Risks.

Other chemicals detected consisted of Dichloroethane, Trichloroethane, and Dichlorobenzene. Some or all of the contaminants identified in this section are "hazardous substances" as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14), and 40 C.F.R. § 302.4. Although there was no free phase contamination noted during drilling operations, these chlorinated benzene compounds are contaminants associated with Dense Non-Aqueous Phase Liquids (DNAPLs), and suggest the presence of DNAPLS at the site.

A summary of the ground water sampling data is presented in Table 1. The maximum, minimum, and mean concentrations of contaminants were calculated for all samples collected at all screen depths. This data represents the contamination encountered in the alluvial and upper portion of the Garber-Wellington (bedrock) aquifer. Ground water samples taken at the site also contained high concentrations of Total Dissolved Solids (TDS). All three upper bedrock monitoring wells have shown concentrations equal to or greater than 10,000 ppm, indicating that the upper portion of the Garber-Wellington (bedrock) aquifer in the vicinity of the site is a Class III aquifer according to the EPA Ground Water Classification System.

Samples were collected from both the alluvial and upper portion of the Garber Wellington (bedrock) aquifers, to identify the level of contamination in the ground water. Data obtained from the bedrock monitoring wells represented the current level of contamination at a depth (60 feet) of the <u>assumed</u> future residential well. Data obtained from the upper aquifer were used in ground water modeling to predict the concentration in the lower aquifer at a future date and to determine exposure point concentrations for the risk calculations.

The results of the ground water samples were used in a model to predict worst-case contamination levels in an imaginary drinking water well located in the top of the bedrock aquifer at the DER site boundary. The model was also used to predict the impact that a contaminant plume in the alluvial aquifer may have on the North Canadian River. In developing the model, it was assumed that the regional ground water gradient is to the southeast. Modeling was also performed to estimate the extent of contamination in the upper portion of the Garber-Wellington (bedrock) aquifer. These results were used to estimate the risk from potential use of the bedrock aquifer as a drinking water supply.

<u>Contaminant Migration in the Alluvial Aquifer</u>

The water level measurements taken in conjunction with the RI reveal that a downward ground water gradient exists at the site; however, any mounding effect, due to standing water on the ponds and lagoon, beneath the DER site is considered negligible. Regionally, the ground water in the alluvium flows towards the North Canadian River (southeast). The average ground water flow rate for the DER site was estimated to be 20 ft/year for the

Table 1

Monitoring Well Statistical Data Summary

PARAMETER	NO. OF DETECTS	MAXIMUM (UG/L)	MINIMUM (UG/L)	MEAN (UG/L)
Aluminum	23/36	67900.00	152.00	10802.28
Antimony	1/36	14.70	14.70	14.35
Arsenic	25/36	149.00	5.20	14.64
Barium	35/36	1790.00	118.00	535.80
Beryllium	14/36	4.00	1.30	1.13
Cadmium	1/36	1.30	1.30	1.65
Calcium	36/36	1190000.00	77400.00	292922.22
Chromium	17/36	71.90	2.80	11.43
Cobalt	15/36	29.40	5.70	8.53
Copper	8/36	22.60	7.20	7.35
Iron	31/36	55800.00	1710.00	16295.48
Lead	27/36	73.20	1.70	14.04
Magnesium	36/36	375000.00	12700.00	77936.11
Manganese	36/36	5350.00	310.00	1659.42
Nickel	11/36	54.10	7.40	13.07
Potassium	36/36	24200.00	630.00	9410.89
Selenium	6/36	12.80	2.10	2.92
Sodium	35/36	3130000.00	120.00	395531.11
Vanadium	30/36	180.00	3.00	43.83
Zinc	25/36	214.00	7.40	54.06
Vinyl Chloride	6/36	27.00	9.00	7.89
Methylene Chloride	13/36	12.00	1.00	4.86
Acetone	10/36	380.00	4.00	23.81
Carbon Disulfide	1/36	9.00	9.00	4.56
1,1-Dichloroethene	1/36	2.00	2.00	4.36
1,1-Dichloroethane	7/36	12.00	2.00	4.99
1,2-Dichloroethene (total)	8/36	29.00	3.00	5.82
1,2-Dichloroethane	3/36	36.00	22.00	5.86
2-Butanone	2/36	8.00	7.00	6.39
1,1,1-Trichloroethane	1/36	4.00	4.00	4.35
Trichloroethene	6/36	11.00	2.00	4.72
Benzene	11/36	240.00	2.00	12.19
Chlorobenzene	2/36	28.00	5.00	5.08
Ethyl Benzene	1/36	9.00	9.00	4.49
Xylenes (total)	5/36	200.00	10.00	10.94
Phenol	4/36	170.00	6.00	10.78
bis(2-Chloroethyl) ether	2/36	3.00	2.00	5.14
1,3-Dichlorobenzene	1/36	0.50	0.50	5.15
1,4-Dichlorobenzene	2/36	3.00	2.00	5.14
1,2-Dichlorobenzene	8/36	27.00	1.00	6.36
4-Methylphenol	1/36	6.00	6.00	5.31
Isophorone	1/36	2.00	2.00	5.19
2,4-Dimethylphenol	2/36	7.00	2.00	5.11
Naphthalene	6/36	35.00	2.00	6.18
2-Methylnaphthalene	3/36	0.70	0.60	4.91
Acenaphthylene	1/36	0.04	0.04	5.14
Acenaphthene	3/36	0.90	0.50	4.92
Diethylphthalate	3/36	1.00	0.80	4.94
Phenanthrene	1/36	0.40	0.40	5.15
Anthracene	1/36	0.40	0.40	5.15
Di-n-butylphthalate	12/36	2.00	0.90	4.11
Butylbenzylphthalate	1/36	0.60	0.60	5.18
bis(2-Ethylhexyl)phthalate	14/36	200.00	0.50	9.44
Carbazole	1/18	0.80	0.80	4.77
Lindane (gamma-BHC)	1/27	0.11	0.11	0.04
delta-BHC	2/27	0.07	0.05	0.03

contaminant transport model. The major source areas for the alluvial aquifer were assumed to occur at areas where sludge material was placed in the past, and standing water was observed. Dispersion represents an important mechanism for contaminant migration, and results in the spreading of the contaminant plume and also causes the reduction of maximum concentrations. Figure 8 shows the predicted benzene plume in the alluvial aquifer based on the most conservative values used for dispersivity. Based on the results of the model, contaminant concentrations will decrease over time. Maximum Contaminant Levels for the contaminants of concern should be attained in 30 to over 150 years. This is discussed in more detail in Section VI - Summary of Site Risks (Risk Summary). It is important to note that contaminant mass loading rates were estimated to provide an estimation of contaminant concentrations at the current well locations. Although the modelling results successfully approximate the maximum concentrations of COCs from four sampling events, seasonal and analytical variability was observed.

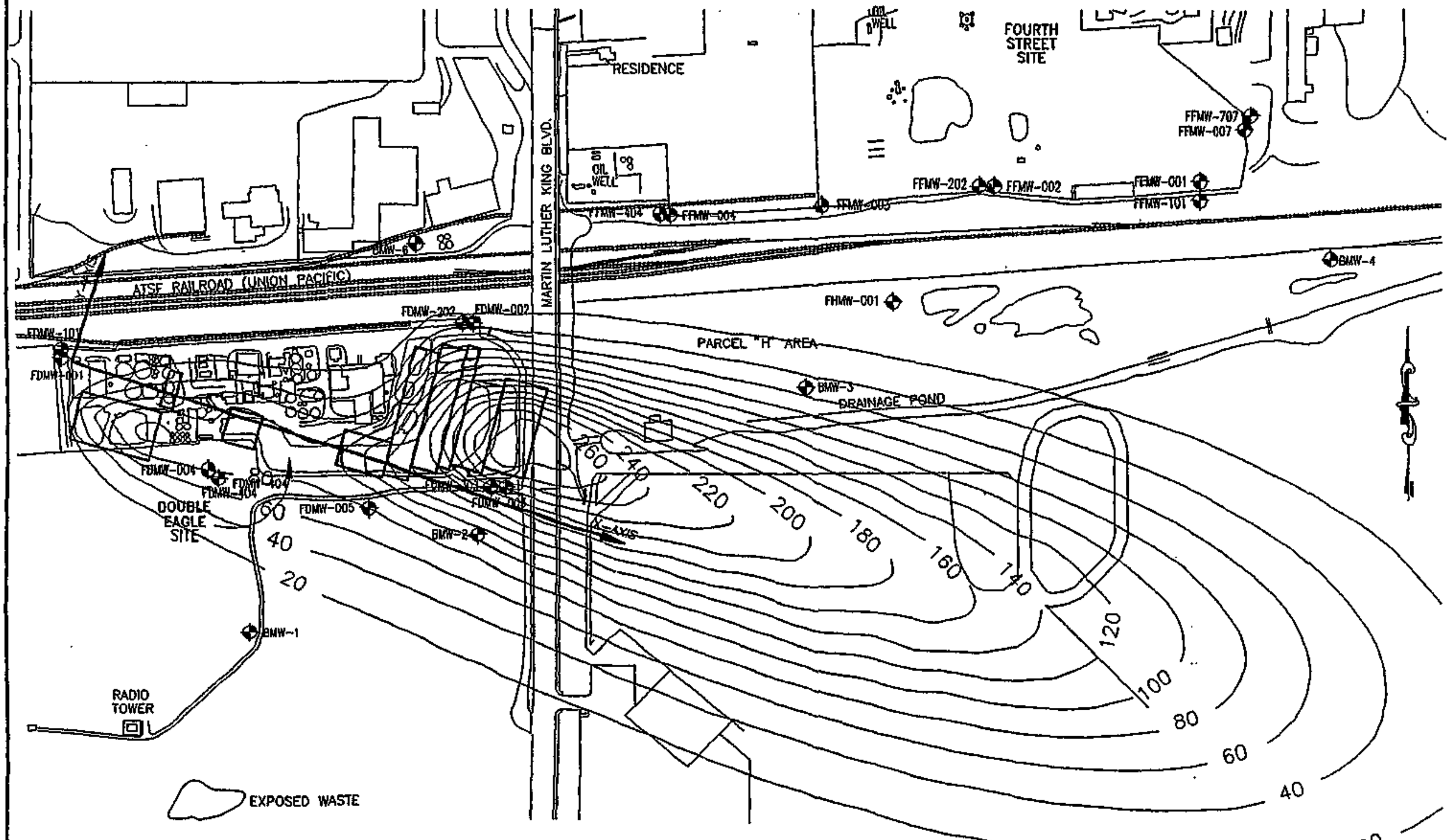
Contaminant Migration in the Bedrock Aquifer

The water level measurements from the upper bedrock monitoring wells indicate that the flow direction in the upper portion of the Garber-Wellington aquifer is generally to the south. The average flow rate for the upper bedrock aquifer was assumed to be 10 ft/year for the contaminant transport model. The major source area was assumed to be the contamination present in the alluvial aquifer, since the surface contamination was assumed to have been removed. Dispersivity values for the bedrock modelling were considered to be the same as the alluvial aquifer of 50 and 20 feet for the longitudinal and transverse dispersivity, respectively. Figure 9 shows the predicted current benzene plume in the bedrock aquifer based on the aforementioned assumptions. Table 2 shows a comparison of model predicted contaminant concentrations and analytical results for the samples from the bedrock monitoring wells. Also, Figure 10 is provided to show the current benzene plume at 20 ppm, with the respective level of TDS contamination.

Impact on the North Canadian River

The receptor point for the alluvial aquifer was assumed to be the North Canadian River (River). Figure 11 shows the predicted benzene plume, when the peak concentration is predicted in the alluvial aquifer just before discharging to the North Canadian River. For predicting the impact on the North Canadian River, the observed contamination in the monitoring wells was attributed to the DER site.

Table 4 shows the maximum concentration predicted by the model in the alluvial aquifer just before the ground water is discharged to the river. The background data in Table 4 are the results of sampling directly from the river, and indicates that mixing of



LEGEND:

⊕ MW-003 MONITORING WELL

—— 20 —— CONTAMINANT PLUME (ppb)

APPROXIMATE SCALE

0 100 200 400 600

FEET

FLUOR DANIEL

FIG. 8 PREDICTED CURRENT BENZENE PLUME IN ALLUVIUM FOR 50' LONGITUDINAL DISPERSIVITY
DOUBLE EAGLE SUPERFUND SITE
OKLAHOMA CITY, OKLAHOMA

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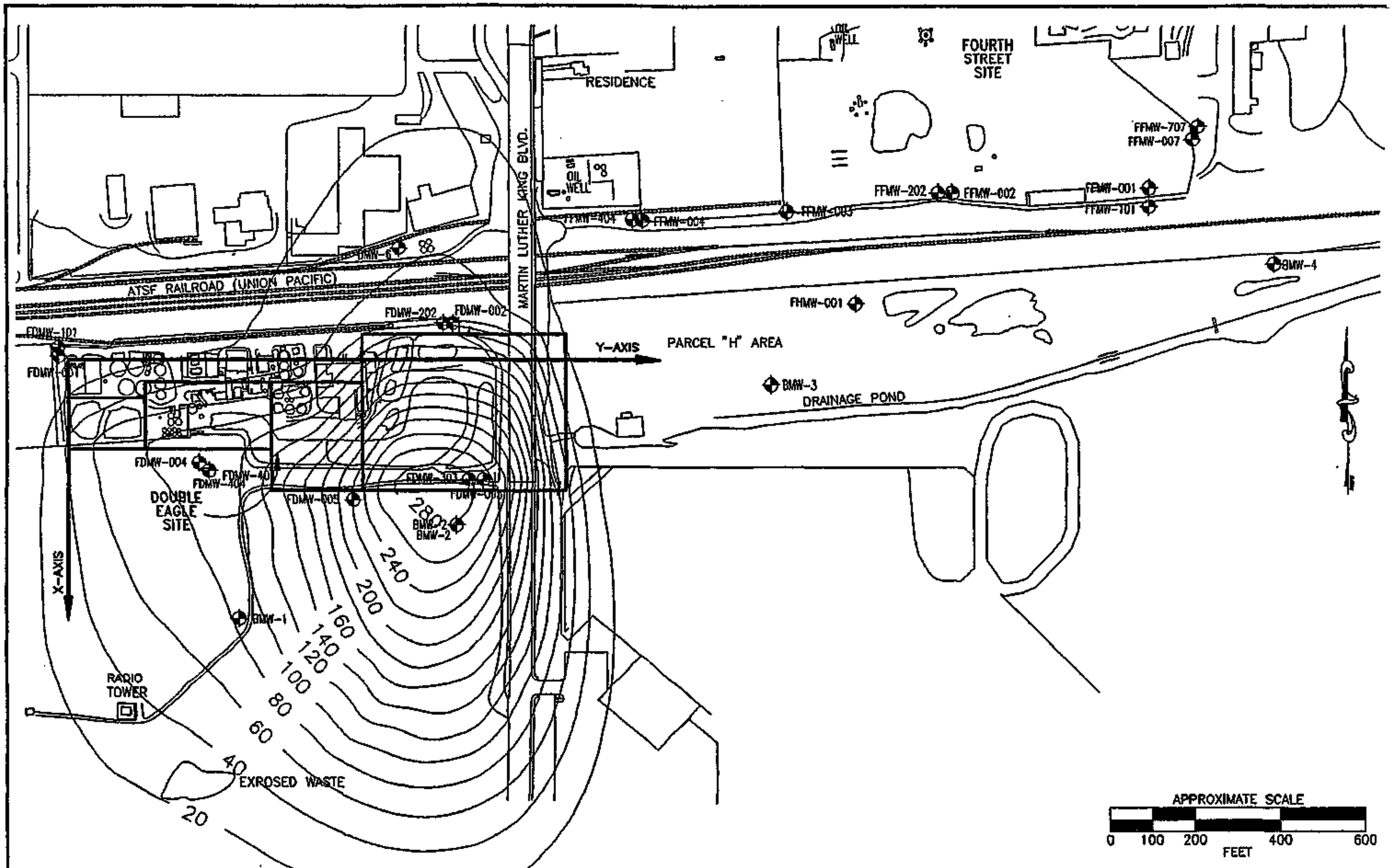

FLUOR DANIEL

FIGURE 9

PREDICTED CURRENT BENZENE PLUME IN BEDROCK
DOUBLE EAGLE SUPERFUND SITE
OKLAHOMA CITY, OKLAHOMA

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Table 2

COMPARISON OF OBSERVED AN MODEL PREDICTED CONTAMINANT CONCENTRATIONS IN BEDROCK MONITORING WELLS

ANALYTE	BMW-1			BMW-2			BMW-6		
	OBSERVED MAY 1992	OBSERVED MAR 1993	PREDICTED	OBSERVED MAY 1992	OBSERVED MAR 1993	PREDICTED	OBSERVED MAY 1992	OBSERVED MAR 1993	PREDICTED
BARIUM	2990	3470	2992	188	120	10350	1340	588	1158
MANGANESE	16200	8060	16210	6010	4300	56920	3910	9950	8273
ALDRIN	ND	ND	0.32	0.12	0.08	1.11	0.15	ND	0.15
BENZENE	78	87	81	110	100	280	170	120	38
bis(2-CHLOROETHYL) ETHER	ND	ND	1	4	ND	4	ND	ND	0.5
CHLOROBENZENE	ND	ND	1	4	ND	4	ND	ND	0.5
CHLOROFORM	2	ND	2	ND	ND	7	ND	ND	1
1,4-DICHLOROBENZENE	ND	ND	0.3	1		1	ND	ND	0.1
1,2-DICHLOROETHANE	ND	ND	110	380	380	380	ND	90	52
1,1-DICHLOROETHENE	ND	ND	0.9	3	ND	3	ND	ND	0.4
2,4-DIMETHYL PHENOL	2	ND	2	ND	ND	7	1400	260	1
HEPTACHLOR	ND	ND	0.21	0.4	ND	0.74	ND	ND	0.1
HEPTACHLOR EPOXIDE	0.3	ND	0.03	0.2	ND	0.1	ND	ND	0.01
KETONES			457			1580			214
METHYLENE CHLORIDE	ND	ND	0.6	2	ND	2	250	ND	0.3
TRICHLOROETHENE	ND	ND	10	35	28	35	ND	30	5
VINYL CHLORIDE	ND	ND	10	35	32	35	ND	23	5

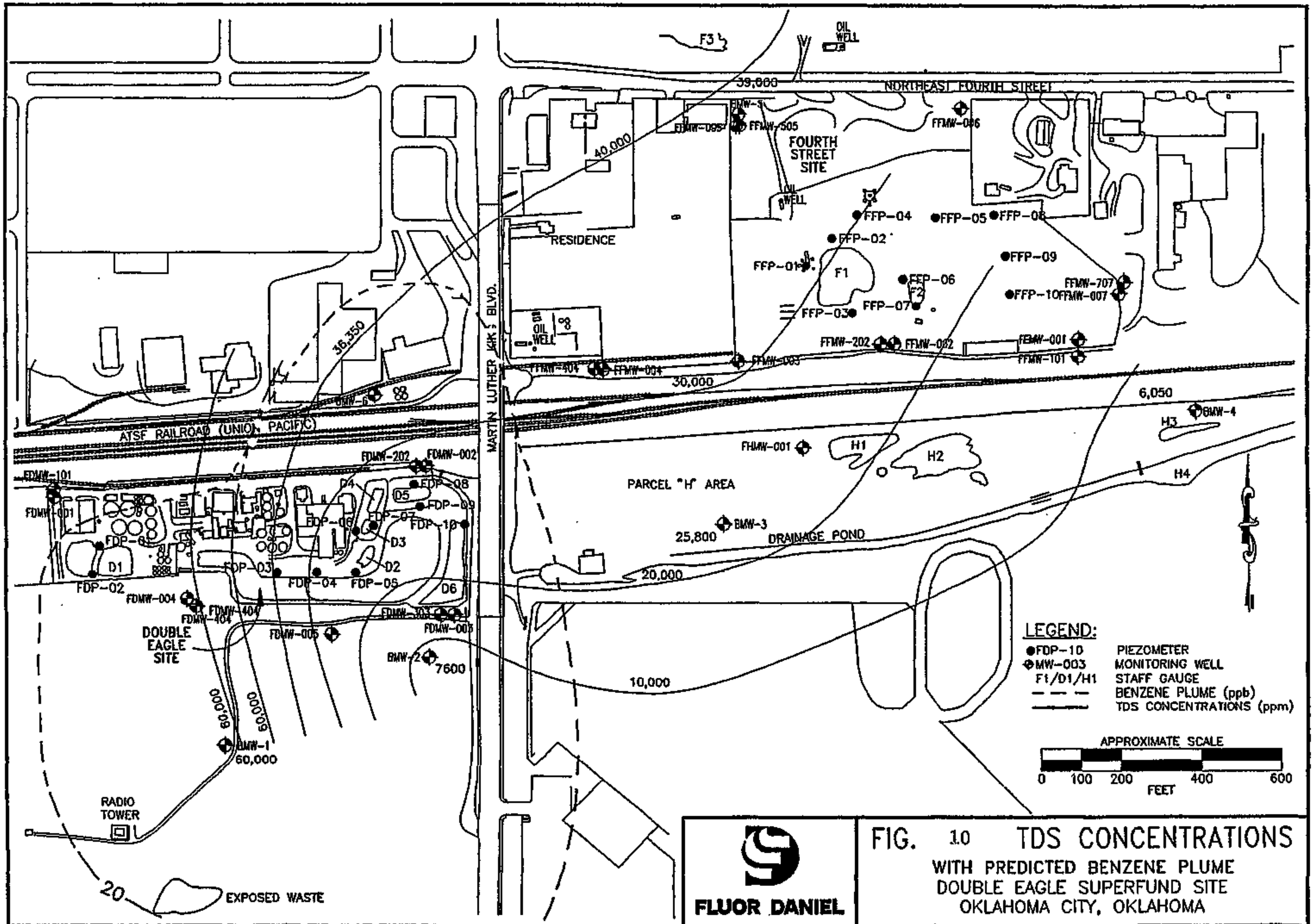

FIG. 10 TDS CONCENTRATIONS
WITH PREDICTED BENZENE PLUME
DOUBLE EAGLE SUPERFUND SITE
OKLAHOMA CITY, OKLAHOMA

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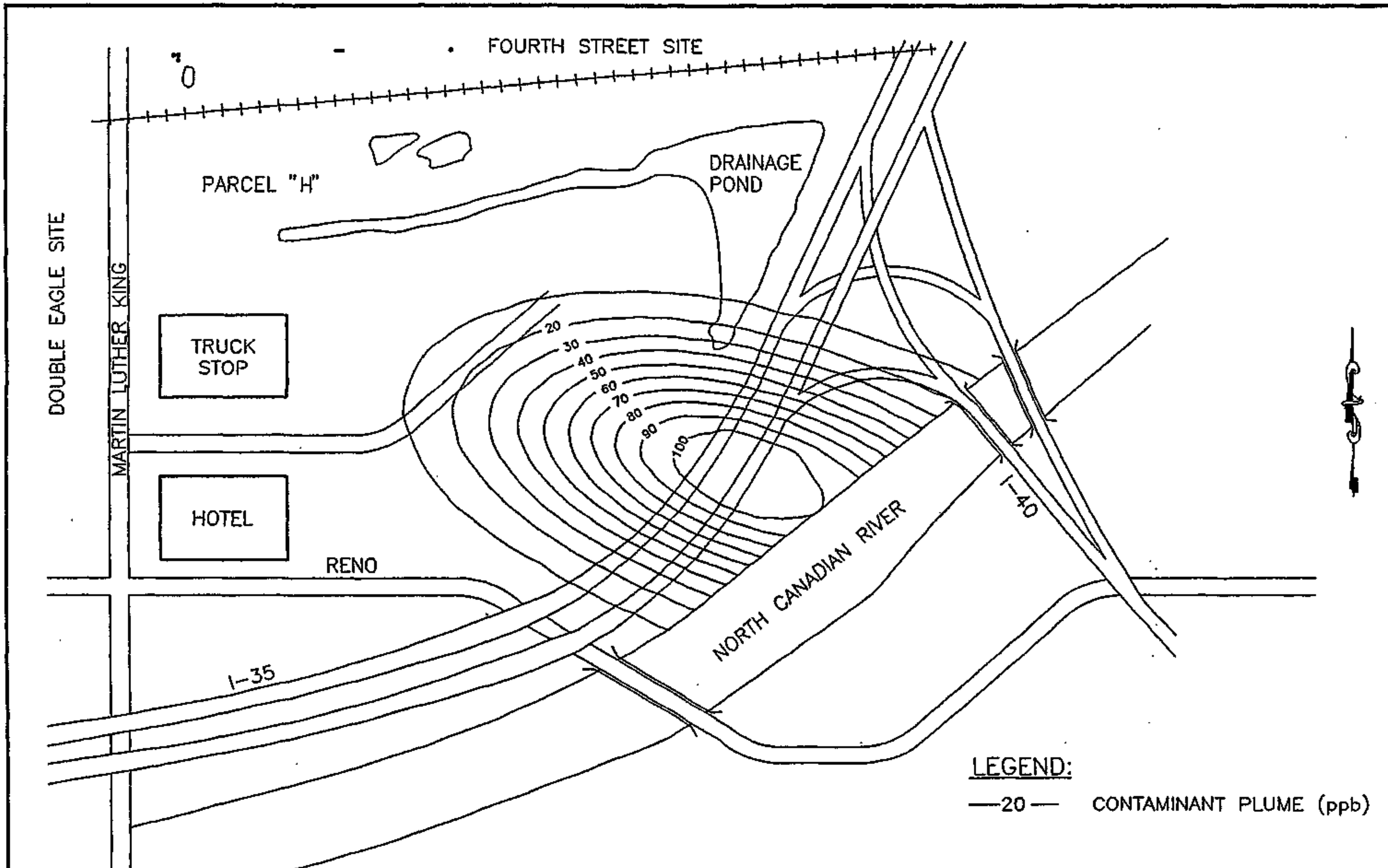

FIG. 11 PREDICTED BENZENE PLUME
IN ALLUVIUM AT PEAK CONCENTRATIONS ARRIVE @ N. CANADIAN RIVER
DOUBLE EAGLE SUPERFUND SITE
OKLAHOMA CITY, OKLAHOMA

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Table 4
IMPACT OF DOUBLE EAGLE SITE ON NORTH CANADIAN RIVER THROUGH ALLUVIUM AQUIFER

Parameter	Background	On-site Concentration		Maximum Concentration at Receptor Point		
		Maximum	Location	Aquifer	River	Arrival Time[1]
Vinyl Chloride	0 ug/L[3]	27 ug/L	FDMW404	37 ug/L	0.034 ug/L	115 years
1,2-Dichloroethane	0 ug/L[3]	36 ug/L	FDMW303	16 ug/L	0.014 ug/L	115 years
Trichloroethene	0 ug/L[3]	11 ug/L	FDMW404	15 ug/L	0.014 ug/L	115 years
Benzene	0 ug/L[3]	240 ug/L	FDMW303	104 ug/L	0.096 ug/L	115 years
Chlorobenzene	0 ug/L[3]	28 ug/L	FDMW404	38 ug/L	0.035 ug/L	115 years
1,4-Dichlorobenzene	0 ug/L[3]	3 ug/L	FDMW404	4 ug/L	0.004 ug/L	115 years
bis(2-Chloroethyl) ether	0 ug/L[3]	3 ug/L	FDMW303	1 ug/L	0.001 ug/L	115 years
Arsenic	3.6 ug/L	149 ug/L	FDMW004	201 ug/L	3.781 ug/L	1250 years
Barium	148 ug/L	1870 ug/L	FDMW005	2155 ug/L	149.8 ug/L	115 years[2]
Berylium	0 ug/L[3]	4 ug/L	FDMW004	5 ug/L	0.005 ug/L	2000 years
Cadmium	0 ug/L[3]	1.3 ug/L	FDMW004	2 ug/L	0.002 ug/L	1150 years
Chromium	0 ug/L[3]	71.9 ug/L	FDMW004	98 ug/L	0.089 ug/L	115 years[2]
Lead	2.6 ug/L	73.2 ug/L	FDMW004	98 ug/L	2.688 ug/L	15000 years
Nickel	0 ug/L[3]	59.2 ug/L	FDMW005	69 ug/L	0.063 ug/L	2800 years
Vanadium	7.6 ug/L	180 ug/L	FDMW004	242 ug/L	7.814 ug/L	900 years

1 – No adsorption assumed for organic contaminants. See Table 4–2 for retardation factors for metals.
2 – For barium and chromium, no retardation due to adsorption was assumed.
3 – Contaminant concentrations were qualified U, incicating the contaminant was not detected at the contract required quantitation limit (CRQL).

ground water with the surface water in the river reduces contaminant concentrations significantly. This results in concentrations significantly below the ambient water quality criteria for the river as shown in Table 5.

VI. SUMMARY OF SITE RISKS

Human Health Risks

As part of the Remedial Investigation for the GOU at the DER site, a quantitative risk assessment was performed to estimate human health risks posed by the migration of contaminants within the groundwater, and lateral migration of contaminants to surface waters from the DER site. The methods used in the development of the risk assessment are based on the following EPA guidance documents: Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual (Part A), 1989, also known as "RAGS", Exposure Factors Handbook (1989b), Risk Assessment Guidance for Superfund; Volume I: Human Health Evaluation Manual, Part B (EPA 1991), Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual (EPA, 1989c), Superfund Exposure Assessment Manual (EPA, 1988), Health Effects Assessment Summary Tables (EPA, 1990c), and the National Contingency Plan. This section presents a summary of the Baseline Human Health Risk Assessment for exposure of humans to contaminants existing within the groundwater that are attributable to the site. The baseline risk assessment provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. It serves as the baseline indicating what risks could exist if no action were taken at the site. This section of the ROD reports the results of the baseline risk assessment conducted for this site.

The purpose of this risk assessment was to compile and evaluate information collected in the site investigation in order to estimate the upper limit of potential health risk which may be present at the site with respect to ground water. In the evaluation of potential human exposure scenarios, on-site sampling and analytical results were used in conjunction with current federal and state guidance documents and professional judgement to estimate the potential human health risk attributable to ground water contamination resulting from past site-related operations.
The "risk" values generated within this human health risk assessment will reflect the plausible upper limit to the actual risk of cancer posed by the site under the exposure scenarios evaluated. These estimates were compared to the EPA's target risk range of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000 respectively) excess cancer risks for hazardous waste site remediations. The NCP stipulates a 1×10^{-6} risk level as a point of departure in risk management. When evaluating ground water contamination, EPA also considers the Maximum Contaminant Levels (MCLs) in the Safe Drinking Water Act as appropriate remedial

Table 5
Water Quality Criteria for the Protection of Fresh Water Aquatic Life
Ecological Risk Assessment
Double Eagle Site

Contaminant of Concern	Predicted Surface Water Concentration (ug/L)[1]	Toxicity Value (ug/L)					
		Acute			Chronic		
		Oklahoma WQC[2]	USEPA WQC[3]	Other Criteria[4]	Oklahoma WQC[2]	USEPA WQC[3]	Other WQC[4]
Vinyl Chloride	0.034	--[5]	--	--	--	--	--
1,2-Dichloroethane	0.014	--	--	118,000	--	--	20,000
Trichloroethane	0.014	--	--	18,000	--	--	8,400
Benzene	0.096	--	--	5,300	2,200	--	--
Chlorobenzene	0.035	--	--	250	--	--	50
1,4-Dichlorobenzene	0.004	--	--	1,120	--	--	763
bis(2-Chloroethyl)ether	0.001	--	--	238,000	--	--	--
Arsenic	3.781	360	360	--	190	190	--
Barium	149.8	--	--	50,000	--	--	--
Beryllium	0.005	--	--	130	--	--	5.3
Cadmium[6]	0.002	143	17	--	3.10	3.10	--
Chromium[7] (Total)	0.089	--	16	--	50	11	--
Lead[6]	2.688	417	417	--	16	16	--
Nickel[6]	0.063	4200	4200	--	466	466	--
Vanadium	7.814	--	--	--	--	--	--

1. From Table 5-11
2. Oklahoma Water Quality Criteria (1989)
3. USEPA Water Quality Criteria (1986)
4. From Clements (1985) or estimated lowest observed effect value (USEPA 1986).
5. Not available or not applicable
6. Based on hardness value of 360 mg/l as $CaCO_3$ as provided in Section 4.0
7. USEPA Criteria for hexavalent Cr and Oklahoma Criteria for total Cr.

Shaded boxes indicate exceedance of water quality criteria value.

targets. Such estimates, however, do not necessarily represent an actual prediction of the risk. Non-carcinogenic impacts are quantified by the "Hazard Index" which is the ratio of site concentrations of a contaminant of concern to a reference concentration that causes a non-carcinogenic impact. EPA's remedial goal is to reduce the "Hazard Index" at a site to less than 1.0.

The risk assessment was performed based on the assumption that a residential well was installed at the site boundary to be utilized for domestic use. This imaginary well was assumed to be installed at a depth of 60 feet, which is assumed to be about five to ten feet into the top of the Garber-Wellington (bedrock) aquifer. This assumption is considered the "worst case scenario". Also, in predicting the exposure point concentrations it was assumed that the surface contamination at the site has been removed and will not contribute to further ground water contamination.

The calculated risks are based on a well being installed in the most shallow useable water-bearing zone. Ground water in the alluvial and upper Garber-Wellington (bedrock) zones is considered unusable due to TDS concentrations in excess of 10,000 ppm. Since there are no private wells installed in the vicinity of the site at the present time, no complete pathway exists for current exposure to contaminated ground water. However, ground water beneath the upper portion of the Garber Wellington (bedrock) aquifer (at an approximate depth of 100 feet) could potentially be used as a domestic supply. The risk assessment was conducted to estimate the impact on public health should the pathway be completed in the future. The risk assessment is based on the establishment of a future pathway by the installation of an immaginary drinking water well at the boundary of the site at a depth of 60 feet below the ground surface. This is the depth at which a well may be screened in a water supply with relatively low TDS. Calculating the risk based on a well installed at this point is the most conservative method, and results in the most protective risk assessment values.

The values which are calculated in this assessment are considered representative of the cancer risk posed by the ground water contamination at the site only in that they represent estimates of the plausible upper bound limit of what is most probably the risk range. The true risk within the range of the upper limit and zero is indeterminable. What is estimated is the projected reasonable maximum potential additional lifetime cancer risk and potential for adverse health effects. The reasonable maximum potential risk is calculated in order to be health protective ("health protective" assumptions are also referred to as "conservative" assumptions in risk assessment terminology).

It should be noted that the risk is an additional risk - it is present in addition to the baseline. The national risk, or probability, that an individual may develop some form of cancer from everyday sources, over a 70-year life span is estimated at a baseline of three in ten. Activities such as too much exposure to the sun, occupational exposures, or dietary or smoking habits contribute to this high risk. This three in ten probability is considered the "natural incidence" of cancer in the United States. To protect human health, the EPA has set the range from one in ten thousand to one in one million excess cancer incidents as the remedial goal for Superfund sites. A risk of one in one million means that one person out of one million people might develop cancer as a result of a lifetime exposure to the site. This risk is above and beyond the "natural incidence" of three in ten.

Identification of Chemicals of Concern

Contaminants of concern (COCs) are those contaminants which are most likely to contribute significant cancer risks or non-cancer health effects. Fifteen COCs were originally considered for performance of the risk assessment, since these chemicals provided an excess risk from the Source Control Operable Unit (SCOU). These contaminants were arsenic, barium, beryllium, cadmium, chromium, lead, nickel, vanadium, vinyl chloride, 1,2-dichloroethane, trichloroethane, benzene, chlorobenzene, bis(2-chloroethyl)ether, and 1,4-dichlorobenzene.

In order to ensure compliance with published EPA guidance and verify that contaminants with potential toxic effects were not overlooked, the list of COCs was reanalyzed using a screening process. Initially, the data set for the bedrock monitoring wells was evaluated to identify potential COCs since current contamination is assumed to represent steady-state conditions, and the source of contamination was assumed to be removed. Under steady-state conditions, the contaminant mass currently in the alluvial aquifer would continue to contribute to contamination in the bedrock aquifer. The data obtained from the bedrock monitoring wells represented the current level of contamination at the depth of the "assumed" future residential well. Data obtained from the alluvial aquifer were used in ground water modeling to predict the concentration in the bedrock aquifer, and potential risk, at a future date. This "assumed" future residential well is considered the worst-case scenario. It is highly improbable that anyone will use the ground water at this depth due to the presence of high Total Dissolved Solids (TDS).

As a result of the risk calculations for individual contaminants, the list of potential COCs was further reduced by eliminating those contaminants that presented a cancer risk less than 1 in 10,000,000 and a Hazard Index less than 0.1. A summary of the determination of final COCs for this risk assessment is given in Table 6.

Toxicity Assessment

The objective of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals. Also, the toxicity

Table 6
Determination of Final COCs
Double Eagle Site

Contaminants of Concern	Risk Criterion	Calculated Risk Exposure Pathway and Receptor		
		Dermal Child/Adult	Inhalation Child/Adult	Ingestion Child/Adult
CARCINOGENS				
Aldrin[2]	1E-7	NA[3]	NA[4]	1.1E-4/1.8E-4
Arsenic[1]	1E-7	NA[3]	NA[4]	1.6E-5/3.5E-5
Benzene[1]	1E-7	2.1E-5/4.9E-5	1.2E-4/2.9E-4	4.7E-5/7.8E-5
Beryllium[1]	1E-7	NA[3]	NA[4]	0/0[5]
Bis(2-Chloroethyl)Ether[1]	1E-7	NA[3]	6.3E-5/1.6E-4	2.5E-5/4.2E-5
Chlordane	1E-7	5.8E-8/1.4E-7	NA[4]	6.6E-7/1.1E-6
Chloroform[2]	1E-7	2.0E-7/4.7E-7	8.4E-6/2.1E-5	2.5E-7/4.2E-7
4,4-DDE	1E-7	1.7E-6/4.0E-6	NA[4]	2.9E-07/4.8E-7
1,4-Dichlorobenzene[1]	1E-7	6.3E-8/1.5E-7	NA[4]	1.4E-7/2.3E-7
1,2-Dichloroethane[1]	1E-7	NA[3]	5.0E-4/1.3E-3	2.0E-4/3.3E-4
1,1-Dichloroethene[2]	1E-7	8.6E-7/2.0E-6	5.2E-5/1.3E-4	1.0E-5/1.7E-5
Heptachlor[2]	1E-7	2.4E-6/5.7E-6	NA[4]	1.9E-5/3.2E-5
Heptachlor Epoxide[2]	1E-7	NA[3]	NA[4]	5.6E-6/9.4E-6
Methylene Chloride[2]	1E-7	NA[3]	4.6E-8/1.2E-7	8.7E-8/1.4E-7
Trichloroethene[1]	1E-7	3.6E-6/8.4E-6	3.0E-6/7.5E-6	2.2E-6/3.7E-6
Vinyl Chloride[1]	1E-7	NA[3]	1.5E-4/3.8E-4	3.8E-4/6.3E-4
NON-CARCINOGENS				
Acetone[2]	1E-1	NA[3]	NA[6]	1.1E+0/3.7E-1
Aldrin	1E-1	NA[3]	NA[4]	2.5E+0/8.2E-1
Arsenic[1]	1E-1	NA[3]	NA[4]	3.5E+0/1.5E+0
Barium[1]	1E-1	NA[3]	NA[4]	1.0E+1/3.3E+0
Beryllium[1]	1E-1	NA[3]	NA[4]	0.0[5]
2-Butanone[2]	1E-1	NA[3]	NA[6]	1.7E-1/5.4E-2
Cadmium[1]	1E-1	NA[3]	NA[4]	2.0E-1/8.8E-2
Chlorobenzene[1]	1E-1	2.1E-3/4.8E-3	1.3E-1/6.8E-2	1.3E-2/4.5E-3
Chromium[1]	1E-1	NA[3]	NA[4]	0/0[5]
1,1-Dichloroethane[2]	1E-1	NA[3]	1.7E-1/8.4E-2	6.7E-2/2.3E-2
trans 1,2-Dichloroethene[2]	1E-1	2.3E-3/5.4E-3	NA[4]	2.2E-1/6.7E-2
Endosulfan[2]	1E-1	NA[3]	NA[4]	6.0E-1/2.0E-1
Ketones[2]	1E-1	NA[6]	9.5E-1/5.4E-1	NA[6]
Lead[1]	NA[6]	NA[7]	NA[7]	NA[7]
Manganese[2]	1E-1	NA[3]	NA[4]	7.7E+2/2.6E+2
Methylene chloride[2]	1E-1	NA[3]	3.9E-4/2.0E-4	1.2E+0/9.9E-2
2-Methyl-4-Pentanone[2]	1E-1	NA[3]	NA[6]	8.0E+1/2.6E+1
Nickel[1]	1E-1	NA[3]	NA[4]	0/0[5]
Phenol[2]	1E-1	NA[3]	NA[4]	3.9E+0/1.3E+0
2,4-Dimethyl Phenol[2]	1E-1	NA[3]	NA[4]	2.4E-2/8.1E-3
Thallium[2]	1E-1	NA[3]	NA[4]	1.5E+1/7.3E+0
Toluene[2]	1E-1	9.8E-1/2.3E+0	4.8E+0/2.4E+0	9.7E-01/3.2E-1
Vanadium[1]	1E-1	NA[3]	NA[4]	0/0[5]
Xylene	1E-1	4.6E-3/9.8E-3	2.9E+0/1.5E+0	5.2E-02/1.7E-02

1 COC from list provided by Remedial Project Manager (Allen 1993).
2 COC determined by initial screening process described in Section 5.2.2 of this report.
3 Pathway not applicable to contaminant due to low permeability coefficient. See Section 5.2.4.2 of this report.
4 Pathway not applicable to contaminant due to low Henry's Law Constant and/or molecular weight. See Section 5.2.4.2 of this report.
5 Contaminant not detected in bedrock wells. No significant change expected.
6 Ketones evaluated as a group only for the inhalation pathway.
7 Toxicity values not available for lead.

assessment provides, where possible, an estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects. The types of toxicity information considered in this assessment include the reference dose (RfD) used to evaluate noncarcinogenic effects and the slope factor to evaluate carcinogenic potential. RfDs have been developed by EPA for indicating the potential for adverse health effects from exposure to contaminants of concern exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of acceptable lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of contaminants of concern from environmental media (e.g., the amount of a contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans and to protect sensitive subpopulations) to ensure that it is unlikely to underestimate the potential for adverse noncarcinogenic effects to occur. The purpose of the RfD is to provide a benchmark against which the sum of the other doses (i.e. those projected from human exposure to various environmental conditions) might be compared. Doses that are significantly higher than the RfD may indicate that an inadequate margin of safety could exist for exposure to that substance and that an adverse health effect could occur.

No RfD or slope factors are available for the dermal route of exposure. In some cases, however, noncarcinogenic or carcinogenic risks associated with dermal exposure can be evaluated using an oral RfD or an oral slope factor. Exposures via the dermal route generally are calculated and expressed as absorbed doses. These absorbed doses are compared to an oral toxicity value that is also expressed as an absorbed dose. Toxicity information used in the toxicity assessment for the Site was obtained from the Integrated Risk Information System (IRIS). If values were not available from IRIS, the Health Effects Assessment Summary Tables (HEAST) were consulted.

For chemicals that exhibit noncarcinogenic health effects, authorities consider organisms to have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the health is adversely affected. For example, an organ can have a large number of cells performing the same or similar functions. To lose organ function, a significant number of those cells must be depleted or impacted. This threshold view holds that exposure to some amount of a contaminant is tolerated without an appreciable risk of adverse effects.

Health criteria for chemicals exhibiting noncarcinogenic effects for use in risk assessment are generally developed using EPA's RfDs developed by the Reference Dose/Reference Concentration ("RfD/RfC") Work Group and included in the IRIS.

For chemicals that exhibit carcinogenic effects, most authorities recognize that one or more molecular events can evoke changes in a single cell or a small number of cells that can lead to tumor formation. This is the non-threshold theory of carcinogenesis which purports that any level of exposure to a carcinogen can result in some finite possibility of generating the disease.

EPA's Carcinogenic Risk Assessment Verification Endeavor (CRAVE) has developed slope factors (i.e., dose-response values) for estimating excess lifetime cancer risks associated with various levels of lifetime exposure to potential human carcinogens. The carcinogenic slope factors can be used to estimate the lifetime excess cancer risk associated with exposure to a potential carcinogen. Risks estimated using slope factors are considered unlikely to underestimate actual risks, but they may overestimate actual risks. Excess lifetime cancer risks are generally expressed in scientific notation and are probabilities. An excess lifetime cancer risk of 1×10^{-6} (one in one million), for example, represents the probability that one additional individual in a population of one million will develop cancer as a result of exposure to a carcinogenic chemical over a 70-year lifetime under specific exposure conditions.

Slope factors (SFs) have been developed for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants of concern. SFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied(e.g., to account for the use of animal data to predict effects on humans).

There are varying degrees of confidence in the weight of evidence for carcinogenicity of a given chemical. The EPA system involves characterizing the overall weight of evidence for a chemical's carcinogenicity based on the availability of animal, human, and other supportive data. The weight-of-evidence classification is an attempt to determine the likelihood that the agent is a human carcinogen, and thus, qualitatively affects the estimation of potential health risks. Three major factors are considered in characterizing the overall weight of evidence for carcinogenicity: (1) the quality of evidence from human studies; (2) the quality of evidence from animal studies, which are combined into a characterization of the overall weight of evidence for human carcinogenicity; and (3) other supportive information which is assessed to determine whether the overall weight of evidence should be modified. EPA uses the weight of evidence classification system to categorize carcinogenicity of contamination as one of the following five groups:

Group A - Human Carcinogen: This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer.

Group B - Probable Human Carcinogen: This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of adequate data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2)

Group C - Possible Human Carcinogen : This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified: This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans; This category indicates that there is no evidence for carcinogenicity in at least two adequate animal tests in different species, or in both epidemiological and animal studies.

Several of the initial chemicals of concern have been classified as potential carcinogens by EPA. Each of these also have been assigned a carcinogenicity weight-of-evidence category. These chemicals are presented in Table 7 with the respective Referenced Doses and Potency Factors.

Human Risk Characterization

The purpose of the human risk characterization is to estimate and characterize the potential human cancer risks and non-cancer adverse health effects associated with exposure to contaminants released from the site into the ground water.

Exposure pathways evaluated in this risk assessment included dermal contact, inhalation, and ingestion of contaminants in the ground water to offsite residents. The pathways were based on the assumption that a residential well will be installed at the site boundary.

The risk assessment was based on Reasonable Maximum Exposure (RME) factors as required by EPA guidance (Longest II 1992). Use of the RME factors provided a calculation of the highest exposure that could reasonably be expected for the pathways analyzed. This conservative calculation is intended to account for uncertainties in contaminant concentration and variability in exposure parame-

Table 7
Reference Doses and Slope Factors for Contaminants of Concern
Double Eagle Site

Contaminant of Concern	RfD(O) mg/kg/day	RfD(I) mg/kg/day	SF(O) mg/kg/day	SF(I) mg/kg/day
Acetone	1.0E-01[4]	--[1]	NA[2]	NA[2]
Aldrin	3.0E-05	--[1]	1.7E+01	1.7E+01
Arsenic	3.0E-04	--[1]	1.8E+00	5.0E+01
Barium	7.0E-02	--[1]	NA[2]	NA[2]
Benzene	--	--[1]	2.9E-02	2.9E-02
Bis(2-chloroethyl)Ether	--[1]	--[1]	1.1E+00	1.1E+00
2-Butanone	6.0E-01[7]	2.9E-01	NA[2]	NA[2]
Cadmium	5.0E-04	--[1]	--[1]	6.3E+00
Chlordane	6.0E-05	--[1]	1.3E+00	--[1]
Chlorobenzene	2.0E-02	5.0E-03	NA[2]	NA[2]
Chloroform	1.0E-02	--[1]	6.1E-03	8.1E-02
4,4-DDE	--[1]	--[1]	3.4E-01	--[1]
1,2-Dichloroethane	--[1]	--[1]	9.1E-02	9.1E-02
1,4-Dichlorobenzene	--[1]	2.0E-01	2.4E-02	--[1]
1,1-Dichloroethane	9.0E-03	1.0E-01	NA[2]	NA[2]
1,1-Dichloroethene	9.3E-03	--[1]	6.0E-01	1.2E+00[7]
trans 1,2-Dichloroethene	2.0E-02	--[1]	NA[2]	NA[2]
Endosulfan	5.0E-05	--[1]	NA[2]	NA[2]
Heptachlor	5.0E-04	--[1]	4.5E+00	4.5E+00
Heptachlor Expoxide	1.3E-05	--[1]	9.1E+00	9.1E+00
Ketones[3]	NA[4]	2.9E-01[5]	NA[4]	--[1]
Manganese	5.0E-03	1.0E-04	NA[2]	NA[2]
Methylene Chloride	6.0E-02	8.6E-01	7.5E-03	1.6E-03
2-Methyl-4-Pentanone	5.0E-2[7]	--[1]	NA[2]	NA[2]
Phenol	6.0E-01	--[1]	--[1]	--[1]
Thallium	8.0E-05	--[1]	NA[2]	NA[2]
Toluene	2.0E-01	1.0E-01	--[1]	--[1]
Trichloroethene	--[1]	--[1]	1.1E-02[6]	6.0E-03[6]
Vinyl Chloride	--[1]	--[1]	1.9E+00	3.0E-01
Xylene	2.0E+00	9.0E-02	--[1]	--[1]

RfD(O) = Oral reference dose for non-carcinogenic effects
RfD(I) = Inhalation reference dose for non-carcinogenic effects
SF(O) = Oral slope factor for carcinogenic effects
SF(I) = Inhalation slope factor for carcinogenic effects

1 -- indicates data were not available from IRIS (1993) or HEAST (1992).
2 NA indicates contaminant has not been demonstrated to exhibit carcinogenic effects in humans.
3 Ketones include acetone, 2-butanone, 2-hexanone and 2-methyl-4-pentanone.
4 Ketones evaluated individually for oral pathway.
5 RfD for 2-butanone.
6 Toxicity factors provided by EPA Region 6 (Raucher 1993a).
7 Toxicity factors provided by EPA Region 6 (Raucher 1993b)

ters. An estimate of average exposure is calculated by using average or central tendency factors (Central Tendencies are discussed below).

The exposure point concentrations were based on groundwater modeling performed in the RI. Exposure concentrations were modeled for five year time intervals. The highest concentration occurs atyear 0. Risk calculations for child exposure are based on the assumption that the exposure point concentration remains unchanged over the six-year exposure duration. The highest risk would, therefore, occur using the exposure concentrations from year 0. Risk calculations for adult exposure are completed for five year intervals and added to account for a 30-year exposure to contamination in the bedrock water supply system. The highest risk would, therefore, occur from year 0 through year 29.

Central Tendencies

Based on a February 26, 1992, memorandum from Deputy Administrator F. Henry Habicht, EPA is required to evaluate both "reasonable maximum exposure" (RME) and "central tendency" in the risk assessment at Superfund sites. The exposure assumptions associated with the RME have been used to estimate the baseline risks and ultimately the remedial action goals at sites. The "central tendency" scenario represents the risk from more of an "average" exposure, compared to a "reasonable maximum" exposure.

A comparison of the differences in the risk assumptions between the RME and central tendency is shown in Table 8.

Risk Summary

Potential exposures to contaminants in the ground water at the DER site have been evaluated and the resultant potential for adverse health effects has been estimated. Exposure scenarios were developed based on the assumptions that the source of contamination will be removed, and a residential well will be installed at the site boundary. The only populations exposed would be the adult and child residents using the assumed future well. However, it is highly unlikely that anyone would use the ground water at this depth (60 feet) for domestic purposes.

Thirty contaminants were identified as COCs based on risks presented by dermal contact, inhalation exposure, and ingestion of ground water contaminated by the DER site.

A summary of the risks calculated using RME factors is presented in Table 9. Cancer risks for both adult and child receptors are above the EPA goal of 1 in 1,000,000 for all exposure pathways. Cancer risks for inhalation and ingestion are above the 1 in 10,000 upper end of acceptability. The total cancer risks from residential ground water exposure were 36 in 10,000 (3.6E-03) and 17 in 10,000 (1.7E-03) for adults and children, respectively.

Table 8
Exposure Assumptions for Reasonable Maximum Exposure and Central Tendency
Dermal Contact, Ingestion and Inhalation of Groundwater
Off-site Resident Future Use Scenario
Double Eagle Site

	Reasonable Maximum Exposure		Central Tendency	
	Child	Adult	Child	Adult
DERMAL				
Age Group (years)	1-6	18-70	1-6	18-70
Days Exposed (per year)	350	350	350	350
Years Exposed (per 70 year life)	6	30	6	9
Body Weight (kg)	15	70	15	70
Surface Area Exposed (cm^2)	7200	20,000	7200	20,000
Hours Exposed per Day (hr/day)	0.2	0.2	0.2	0.2
Event Frequency (1/day)	1	1	1	1
INGESTION				
Age Group (years)	1-6	18-70	1-6	18-70
Days Exposed (per year)	350	350	350	350
Years Exposed (per 70 year life)	6	30	6	9
Body Weight (kg)	15	70	15	70
Intake Rate (L/day)	1	2	0.7	1.4
INHALATION				
Age Group (years)	1-6	18-70	1-6	18-70
Days Exposed (per year)	350	350	350	350
Years Exposed (per 70 year life)	6	30	6	9
Body Weight (kg)	15	70	15	70
Intake Rate (m^3/day)	5	15	5	15
Volatilization Factor (L/m^3)	0.5	0.5	0.5	0.5

Table 9
Risk Summary for Groundwater Exposure
Double Eagle Site

	Pathway	Child	Adult
Cancer Risk	**Dermal**	3.0E-05	7.0E-05
	Inhalation	8.9E-04	2.2E-03
	Ingestion	8.1E-04	1.4E-03
	Total Risk	1.7E-03	3.7E-03
Hazard Index (HI)	**Dermal**	9.8E-01	2.3E+00
	Inhalation	9.0E+00	4.6E+00
	Ingestion	8.9E+02	3.0E+02
	Total HI	9.0E+02	3.1E+02

The Hazard Indices for both adult and child receptors were above the EPA goal of 1.0 for the ingestion and inhalation pathways. The total Hazard Index representing residential ground water exposure is 310 (3.1E+02) for adults and 900 (9.0E+02) for children. Results of the risk calculations indicated that adults and children are at hazard from exposure to contamination in the ground water for potential carcinogenic and toxic effects.

A summary of the risks calculated using average exposure factors is presented in Table 10. Although use of these factors decreased the risks for the adult receptors for the dermal and inhalation pathways and for adult and child receptors for the ingestion pathway, the changes were not significant enough to change the conclusions of this assessment. The total cancer risks from residential ground water exposure were reduced to 13 in 10,000 and 15 in 10,000 for adults and children, respectively. The total Hazard Index representing ground water exposure was reduced to 81 for adults and 630 for children.

Site-specific maximum contaminant levels were compared against the drinking water Maximum Contaminant Levels (MCLs) in Table 11. As part of the modeling effort, the estimated time for contaminants to attain MCLs through natural attenuation was calculated. These calculations were made assuming that the surface contamination was removed, and would not contribute as a future source of contamination in the ground water. The MCLs were exceeded for four metals including barium, cadmium, manganese and thallium. Barium is expected to reach the MCL by year 65, based on computer modeling conducted as part of the RI. Manganese is not expected to reach the MCL level in the next 150 years. Since the concentrations of cadmium and thallium were not expected to change significantly over time, no estimate was made as to how long it would take to achieve MCL levels. Barium, cadmium, manganese and thallium are not expected to reach acceptable health risk levels in the next 150 years.

Lead was detected in the alluvial wells and was a contaminant of concern during the SCOU. However, lead was not modelled as part of the GOU RI because lead was not detected during the first round of sampling of the upper Garber-Wellington (bedrock) monitoring wells. Subsequent to the modeling effort however, lead was detected during the second round of sampling. Three "bedrock monitoring wells" (BMWs) are installed around the perimeter of the DER site. BMW-1 and BMW-6 revealed lead at 193 parts per billion (ppb) and 83.6 ppb respectively. BMW-2 revealed lead at less than 5 ppb, which is below the final cleanup level of 15 ppb considered protective for ground water usable for drinking water. Therefore, modeling will be conducted to determine the threat to human health and the environment posed by lead present in the ground water, as part of the Remedial Design (RD) for the GOU, when the RD is initiated.

Table 10
Risk Summary for Groundwater Exposure
Average Exposure Factors
Double Eagle Site

	Pathway	Child	Adult
Cancer Risk	Dermal	3.2E-05	2.8E-05
	Inhalation	8.9E-04	8.6E-04
	Ingestion	5.8E-04	3.7E-04
	Total Risk	1.5E-03	1.3E-03
Hazard Index (HI)	Dermal	9.8E-01	8.8E-01
	Inhalation	9.4E+00	1.8E-01
	Ingestion	6.2E+02	8.0E+01
	Total HI	6.3E+02	8.1E+01

Table 11
Comparison of Contaminant Concentrations
With Drinking Water Maximum Contaminant Levels (MCL)
Double Eagle Site

Contaminant of Concern	Maximum Modelled Concentration mg/L	MCLs mg/L	MCL Excursion
CARCINOGENS			
Aldrin	1.2E-03	NA	NA
Arsenic	1.7E-02	5.0E-02	–
Benzene	3.0E-01	5.0E-03	✓
Beryllium	0.0E+00	4.0E-03	–
Bis(2-chloroethyl)Ether	4.2E-03	NA	NA
Chlordane	7.6E-05	NA	NA
Chloroform	7.6E-03	1.0E-01	–
4,4-DDE	1.6E-04	NA	NA
1,4-Dichlorobenzene	1.1E-03	7.5E-02	–
1,2-Dichloroethane	4.0E-01	5.0E-03	✓
1,1-Dichloroethene	3.2E-03	7.0E-03	–
Heptachlor	7.8E-04	4.0E-04	✓
Heptachlor Epoxide	1.1E-04	2.0E-04	–
Methylene Chloride	2.1E-03	NA	NA
Trichloroethene	3.6E-02	5.0E-03	✓
Vinyl Chloride	3.6E-02	2.0E-03	✓
NON-CARCINOGENS			
Acetone	1.7E+00	NA	NA
Barium	1.1E+01	2.0E+00	✓
2-Butanone	1.6E+00	NA	NA
Cadmium	1.6E-03	5.0E-03	–
Chlorobenzene	4.2E-03	NA	NA
1,1-Dichloroethane	1.1E-01	NA	NA
trans 1,2-Dichloroethene	7.0E-02	1.0E-01	–
Endosulfan	4.7E-04	NA	NA
Ketones	1.7E+00	NA	NA
Lead	0.0E+00	1.5E-02	–
Manganese	6.0E+01	5.0E-02	✓
2-Methyl-4-Pentanone	6.3E+01	NA	NA
Mercury	5.9E-05	2.0E-03	–
Nickel	0.0E+00	5.0E-01	–
Phenol	3.7E+01	NA	NA
Selenium	0.0E+00	5.0E-02	–
Thallium	1.9E-02	2.0E-03	✓
Toluene	3.0E+00	1.0E+00	✓
Xylene	1.6E+00	1.0E+01	–

NA = MCL not promulgated for this contaminant.
– = Maximum concentration did not exceed the MCL.
✓ = Maximum concentration exceeded the MCL.

The MCLs were exceeded by five organics including benzene, 1,2-dichloroethane, heptachlor, trichloroethane, and vinyl chloride. These five contaminants were also the major contributors to the cancer risks calculated for the exposure pathways. Based on groundwater modeling, benzene is expected to reach the MCL level by year 145. 1,2-Dichloroethane is expected to reach the MCL level by year 155. Heptachlor is expected to reach the MCL level by year 30. Trichloroethane is expected to reach the MCL level by year 70. Vinyl chloride is expected to reach the MCL level by year 105. Benzene, heptachlor, trichloroethane, vinyl chloride and 1,2-dichloroethane will take more than 150 years to achieve acceptable concentrations from a human health risk standpoint.

Contaminants in the groundwater present a hazard for all exposure pathways. Contaminant concentrations will continue to decrease; however, some of the contaminant concentrations will remain above acceptable levels 150 years from now both from a risk and a regulatory standpoint.

Uncertainties Associated with the Human Health Risk Calculations

Within the Superfund process, baseline quantitative risk assessments are performed in order to assess the potential human health impacts of a given site under currently existing conditions. They are performed in order to provide risk managers with a numerical representation of the severity of contamination present at the site, as well as to provide an indication of the potential for adverse public health effects. There are inherent and imposed uncertainties in the risk assessment methodologies.

This section addresses potential sources of uncertainty in the risk estimates; possible impacts of the various sources of uncertainty; and potential bias in the risk estimates. This discussion provides a context in which the significance and limitations of the various results can be better understood to evaluate the overall potential health impacts of the DER site.

Site Characterization

This assessment addresses only the risks due to exposures to ground water from a future residential well assumed to be placed at the point of highest contamination at the facility boundary. Analytical results from only one bedrock ground water well sampling event were available during the preparation of this assessment. Results from additional sampling events are required to consider the effects of seasonal variations and analytical variability. All analytical results are understood to exist within a range of potential error due simply to the state of the science of analytical chemistry. However EPA's analytical results are consistent with acceptable standards within the U.S. Science of Analytical Chemistry Community.

Estimation of Exposure Point Concentrations

The ground water modeling utilized to estimate the exposure point concentration is discussed in the RI. The COCs which were not modeled were evaluated by considering a consistent dilution/attenuation factor for the modeled parameters.

Some of the contaminants identified as COCs originally in the SCOU were not detected in the bedrock wells and based on modeling were not expected to move down significantly from the upper aquifer. These contaminants were not evaluated in the risk assessment.

Evaluation of Toxicity and Associated Constants

The estimation of potential human health impacts due to exposure to site-related contamination utilizes various toxicity constants derived by the EPA or approved by EPA for use in human health risk assessments. These constants are developed based on information derived from direct exposure (animal) or human epidemiological studies. Intersex and interspecies extrapolations of toxicological information require that one accept assumptions including metabolism, detoxification ability, neoplastic disease initiation, DNA repair mechanisms, etc. These extrapolations result in inherent errors which increase the uncertainty in estimates of potential effect. Modifying factors and uncertainty factors are inserted which intentionally increase the risk estimates in order to ensure the protection of human health.

The interpretation of the results of the animal studies upon which the initial toxicity evaluation is founded can be difficult. Ambiguous or questionable results may produce a number of equally valid, but conflicting interpretations. Guidelines for the interpretation of laboratory (toxicological) results demand an extremely conservative interpretation of available results. The uncertainty which this builds into the estimates of toxicity is acknowledged, but this conservative approach provides a level of protection for the potentially exposed individuals.

The toxicity factors for some contaminants are not available or have been withdrawn pending further study. To allow for evaluation of these contaminants, they have been grouped with similar chemicals and are evaluated using toxicity factors from contaminants within the group. The contaminants grouped in this assessment are ketones which include 2-butanone, 2-hexanone, acetone, and 2-methyl-4-pentanone.

Exposure Assumptions

The exposure assumptions used in a risk assessment require professional judgement. Often conservative default assumptions are used. The issues regarding determination of appropriate exposure assumptions are:

- The frequency and duration of exposure.
- The transfer of material from environmental media to target organs. That is, the adsorption across skin, the absorption by the gut, the absorption by the lungs; and finally the transfer from the blood to the target organ.
- The quantity of material presented to the body. That is the ingestion rate, the inhalation rate, the surface area exposed and the body weight.

The default assumptions used for this risk assessment were the Reasonable Maximum Exposure (RME) factors. The risk calculations, therefore, represent the highest exposure that could reasonably be expected for the given pathways.

An estimate of average exposure is calculated using average or central tendency factors. Use of the average factors affected the risk calculations for adult exposure in all three pathways since the exposure time was reduced to nine years. Exposure through ingestion of ground water was also affected since the ingestion rates for adults and children were reduced to 1.4 L/day and 0.7 L/day, respectively. To simplify the calculation for adult exposure the contaminant concentration was assumed to be unchanged during the nine year exposure period.

Use of the central tendency factors decreased the calculated risk, but did not significantly affect the status of the COCs.

<u>Risk Characterization</u>

A number of assumptions were also made in estimating the outcome of potential human exposures to site-related compounds. Carcinogens in combination are presumed to exert their effect in an additive fashion, whereas synergism or antagonism may be present in some cases. Non-carcinogens are also presumed to act in an additive fashion; however, this approach does not take into consideration that different contaminants target different organs and organ systems. Particularly sensitive populations or individuals may exist, which may not become obvious until after exposure.

Assumptions regarding exposure are often very conservative. Uncertainties entering into the analysis from the initial measurement of dose and animal weight in the first lab study to the interpretation of lab results to extrapolation between species to the modeling of environmental dispersion, as well as other issues have a compounding (multiplicative) effect on the final uncertainty of the risk estimate.

Effects seen at high doses (such as the doses to which laboratory animals are often exposed) are often not seen at low dose exposures such as those typically experienced in environmental contamination. In order to be conservative, it is commonly assumed that cancer incidence varies with dose in a linear or semi-linear fashion even at extremely low dose levels, but the validity of this assumption is currently an issue of considerable debate.

Ecological Risks

The Ecological Risk Assessment (ERA) is an integral part of the RI/FS for the Double Eagle site. The purpose of the ERA is to determine current and/or potential baseline impacts on ecological receptors that are attributable to toxicological stress from the unremediated Double Eagle site. Specific objectives within the overall purpose include:

- Identification of current/potential toxicant and habitat stressors;
- Identification of representative floral and faunal receptors in the aquatic setting;
- Assessment of endpoints;
- Characterization of biotic receptors;
- Assessment of relationships between toxicant stressors and adverse affects;
- Assessment of exposure using ecological and toxicological stressor components; and
- Integration of all above-noted components for ecological risk estimation and description of sources of uncertainty.

<u>Toxicant Stressors</u>

Concentrations of seven (7) organic and eight (8) inorganic COCs were predicted for surface water in the North Canadian River adjacent to the Double Eagle site from ground water inflow. Further model predictions were used to estimate contaminant concentrations in river-borne suspended sediment and in interstitial water of vadose zone. Table 12 presents the predicted concentrations of the COCs by media and the estimated arrival time for those contaminants. For the purpose of this ERA, all contaminant concentrations used were based on a worst-case scenario. The worst-case scenario was developed by choosing the

Table 12
Predicted Concentrations of Contaminants of Concern for the North Canadian River near the Double Eagle Site

Contaminant of Concern	Predicted Concentration by Media			Estimated Arrival Time[1] (Years)
	Surface Water[1] (ug/L)	Interstitial Water[2] (ug/L)	Suspended Solids[3] (ug/Kg)	
Organics				
Vinyl Chloride	3.40E-02	3.40E-02	0	115
1,2-Dichloroethane	1.40E-02	1.40E-02	0	115
Trichloroethane	1.40E-02	1.40E-02	0	115
Benzene	9.60E-02	9.60E-02	0	115
Chlorobenzene	3.50E-02	3.50E-02	0	115
1,4-Dichlorobenzene	4.00E-03	4.00E-03	0	115
bis(2-chloroethyl)ether	1.00E-03	1.00E-03	0	115
Inorganics				
Arsenic	1.85E-01	1.85E-01	7.56E+01	1250
Barium	1.49E+02	1.49E+02	0	115
Beryllium	5.00E-03	5.00E-03	1.45E-02	2000
Cadmium	2.00E-03	2.00E-03	8.00E-04	1150
Chromium	8.90E-02	8.90E-02	6.67E-01	115
Lead	2.69E+00	2.69E+00	7.08E+01	15000
Nickel	6.30E-02	6.30E-02	6.92E-02	2800
Vanadium	7.81E+00	7.81E+00	1.09E+01	900

1. From Chapter 4.0 of the Remedial Investigation Report dated July 1993.
2. Assumed equal to surface water concentration computer modeling.
3. Determined by the equation:
   Conc. Suspended Solids = Conc. Surface Water x distribution coefficient (Kd)

most conservative assumptions as follows: 1) The average saturated thickness of the alluvial aquifer was assumed to be 20 feet. 2) The low flow rate for seven (7) consecutive days for a 10-year period reported by the USGS was used to show the maximum impact on the river. 3) The background concentrations in the river for organics was assumed to be zero, and for the metals was assumed to be the same as for the alluvial aquifer.

__Conceptual Ecological Model__

For the purpose of this ERA, a conceptual ecological model was developed which depicts those species of flora and fauna, typical of the central Oklahoma area, that may experience stress from habitat alteration or toxicant exposure. The model describes a contiguous ecosystem which includes riverine benthic and surface water communities of the North Canadian River. Toxicant movements in the aquatic system may be described by the following pathways:

- Uptake by vegetation from the vadose (interstitial) zone and directly from the water column;
- Uptake by water column invertebrates;
- Uptake by lower food chain (omnivorous) vertebrates from vegetation, invertebrates and incidental suspended sediment; and,
- Uptake by upper food chain (piscivorus) vertebrates from lower food chain vertebrates and invertebrates.

Generally, toxicants are translocated throughout the ecosystem by the specified pathways where they become available to flora and fauna through bioconcentration and bioaccumulation. In aquatic systems, the effects of toxicants can be noticeable because of the uptake and bioaccumulation in the food web. In the conceptual model, phytolankton (green algae) and rooted vascular macrophytes (milfoil) concentrate toxicants from surface water and sediment interstitial water, respectively. Through bioconcentration, toxicant levels will increase at the base of the food chain. For many toxicants, subsequent depuration or biological transformation may occur; hence, there is no further translocation through the food web. For the purposes of this ERA, all toxicant uptake is considered cumulative with no direct losses due to mitigative factors.

The conceptual model also includes direct uptake (bioconcentration) by cladocerans (water flea) from the water column. Aquatic vegetation (in the form of detritus), invertebrates and incidental suspended sediment are then consumed by omnivorous fish (Fathead Minnow) which in turn are consumed by piscivorous fish (Largemouth Bass). Contaminant uptake routes for each ecological class are summarized in Table 13.

Table 13
General Contaminant Uptake Routes
Conceptual Ecological Model
Ecological Risk Assessment

Ecological Class	Bioconcentration		Bioaccumulation			
	Surface Water	Interstitial Water	Suspended Solids	Vegetation	Invertebrate	Fish
Vegetation						
Phytoplankton (Green Algae)	✓					
Macrophytes (Water Milfoil)		✓				
Invertebrates						
Cladoceran (Water Flea)	✓			✓		
Vertebrates						
Herbivore (Fathead Minnow)	✓		✓	✓	✓	
Piscivore (Largemouth Bass)	✓				✓	✓

Risk Characterization

The potential for acute and chronic toxicity due to contaminants in the water column were evaluated against algae, daphnids, fathead minnows and largemouth bass. The potential for acute and chronic toxicity due to the sediment pore water COC were evaluated against water milfoil. Hazard quotients were calculated for fathead minnow and largemouth bass considering their trophic levels in this conceptualized chain of the food web which accounts for bioconcentration and bioaccumulation. The predicted results for total potential toxic effects and hazard to the aquatic vertebrates as based on contaminant data and published or derived toxicity and concentration/accumulation factors for the conceptualized model are summarized in Tables 14 and 15. Essentially, neither the metals nor the organics suite of contaminants posed a significant potential for toxicity or hazard via trophic transfer in this food chain. At the base of the food chain, heavy metals [beryllium, lead, nickel and vanadium] appeared to: (1) present potential chronic toxic effects to aquatic vegetation and (2) present potential acute and chronic effects to the daphnids. No significant ecological risk, as defined by the hazard quotient of greater than or equal to one (1), was predicted for the minnow or largemouth bass for any of the toxicant stressors. Likewise, the cumulative hazard quotient for both fish was less than one (1).

Summary of Predicted Ecological Risk

The methods used in this predictive ecological assessment indicated that ecological receptors at the base of the food web may experience potential risk from exposure to the toxicant stressors. Organics did not present a significant risk to any ecological compartment while heavy metal concentrations may potentially elicit acute and chronic toxicity. The aquatic ecosystem demonstrated predicted impacts due to direct contact with contaminants and not because of the influence of bioconcentration/bioaccumulation dynamics at the lower trophic levels. A summary of potential acute and chronic toxicity for each ecological compartment for the contaminants of concern is provided in Table 16.

Sources of Uncertainty

The model constructed for this evaluation of ecological risk and the semiquantitative, predictive methodologies used resulted in a very conservative (i.e., over-predictive) approach. This approach was selected because of the a priori decision to weight the evaluation process qualitatively. Uncertainties and assumptions present in this evaluation included:

Table 14
Toxicant Doses and Hazard Quotients
for the Aquatic Omnivore Food Web Receptor
Double Eagle Site

Contaminant of Concern	Receptor Species: Fathead Minnow									
	Concentration in Diet ug/kg			% Diet Composition			Potential Contaminant in Food (ug/kg)	Potential Dietary Dose	Toxicity Reference Value	Hazard Quotient
	V	I	S	V-77	I-15	S-8				
Vinyl Chloride	3.84E-02	5.85E-02	0	2.96E-02	8.78E-03	0	3.84E-02	8.44E-04	9.59E+04	8.80E-09
1,2-Dichloroethane	4.62E-03	2.80E-02	0	3.56E-03	4.20E-03	0	7.76E-03	1.71E-04	2.00E+04	8.53E-09
Trichloroethane	2.24E-03	1.26E-01	0	1.72E-03	1.89E-02	0	2.06E-02	4.54E-04	2.27E+04	2.00E-08
Benzene	6.72E-02	2.16E+01	0	5.17E-02	3.24E+00	0	3.29E+00	7.24E-02	4.41E+03	1.64E-05
Chlorobenzene	1.46E+02	9.76E+01	0	1.13E+02	1.46E+01	0	1.27E+02	2.79E+00	1.41E+03	1.98E-03
1,4-Dichlorobenzene	6.42E-02	8.00E-02	0	4.94E-02	1.20E-02	0	6.14E-02	1.35E-03	6.22E+02	2.17E-06
bis(2-Chloroethyl)ether	2.00E-04	1.10E-02	0	1.54E-04	1.65E-03	0	1.80E-03	3.97E-05	2.64E+04	1.50E-09
Arsenic	1.26E+03	1.26E+03	7.56E+01	9.69E+02	1.09E+02	6.05E-00	1.16E+03	2.56E+01	5.30E+02	4.83E-02
Barium	7.46E+04	1.49E+04	0	5.74E+04	2.34E+03	0	5.96E+04	1.31E+03	5.00E+03	2.62E-01
Beryllium	5.00E-01	5.00E-01	1.45E-02	3.85E-01	7.50E-02	1.16E-03	4.61E-01	1.01E-02	1.50E+01	6.76E-04
Cadmium	2.00E+00	8.00E+00	8.00E-04	1.54E+00	1.20E+00	6.40E-05	2.74E+00	6.03E-02	2.80E-01	2.15E-01
Chromium	3.56E-02	1.70E+02	6.67E-01	2.74E+02	2.67E+01	5.34E+02	3.01E+02	6.62E+00	3.70E+03	1.79E-03
Lead	5.38E+02	5.38E+02	7.08E+01	4.14E+02	8.06E+01	5.66E+00	5.00E+02	1.10E+01	6.50E+02	1.69E-02
Nickel	6.30E+00	6.30E+00	6.92E-02	4.85E+00	9.45E-01	5.54E-03	5.80E+00	1.28E-01	5.30E+01	2.41E-03
Vanadium	7.81E+02	7.81E+02	1.09E+01	6.02E+02	1.17E+02	8.75E-01	7.20E+02	1.58E+01	2.00E+02	7.92E-02
Ingestion Hazard Quotient										6.29E-01
Direct Contact Hazard Quotient										8.89E-02
Total Hazard Quotient										7.18E-01

Table 15
Toxicity Doses and Hazard Quotients
for the Aquatic Piscivore Food Web Receptor
Double Eagle Site

Contaminant of Concern	Receptor Species: Largemouth Bass					
	Potential Contaminant Intake ug/kg		Potential Contaminant in Food ug/kg	Potential Dietary Dose ug/kg/d	Toxicity Reference Value	Hazard Quotient
	Fathead Minnow 85%	Water Flea 15%				
Vinyl Chloride	3.47E-02	8.78E-03	4.35E-02	9.61E-04	1.98E+04	4.85E-08
1,2-Dichloroethane	1.22E-01	4.20E-03	1.27E-01	2.80E-03	6.57E+04	4.27E-08
Trichloroethane	7.02E-02	1.89E-02	8.91E-02	1.96E-03	4.74E+03	4.16E-07
Benzene	1.55E+00	3.24E+00	4.79E+00	1.05E-01	3.67E+03	2.89E-05
Chlorobenzene	1.92E+01	1.46E+01	3.38E+01	7.45E-01	2.37E+03	3.16E-04
1,4-Dichlorobenzene	6.46E-01	1.20E-02	6.58E-01	1.45E-02	5.04E+02	2.89E-05
bis(2-Chloroethyl)ether	6.04E-03	1.70E-03	7.70E-03	1.69E-04	5.66E+03	2.99E-08
Arsenic	1.07E+03	1.89E+02	1.26E+03	2.78E+01	6.90E+02	4.03E-02
Barium	1.27E+03	2.24E+03	3.05E+03	7.75E+01	5.00E+03	1.55E-02
Beryllium	4.25E-01	7.50E-02	5.00E-01	1.10E-02	1.50E+01	7.37E-04
Cadmium	5.10E+00	1.20E+00	6.30E+00	1.39E-01	1.00E+00	1.39E-01
Chromium (VI)	1.51E+01	2.67E+01	4.18E+01	9.25E-01	1.13E+04	8.18E-05
Lead	1.37E+02	8.06E+01	2.18E+02	4.81E+00	4.05E+02	1.19E-02
Nickel	2.14E+00	9.45E-01	3.09E+00	6.82E-02	6.20E+02	1.10E-04
Vanadium	6.46E+02	1.17E+02	7.81E+02	1.73E+01	5.00E+02	3.45E-02
Ingestion Hazard Quotient						2.43E-01
Direct Contact Hazard Quotient						6.01E-02
Total Hazard Quotient						3.03E-01

Table 16
Summary of Potential Acute and Chronic Toxicity for Each Ecological Compartment For the Contaminants of Concern Ecological Risk Assessment Double Eagle Site

Ecological Compartment	Potential Toxicity	
	Acute	Chronic
Freshwater Aquatic Life		
Most Sensitive Species	--	--
Aquatic Vegetation		
Green Algae	--	Vanadium
Water Milfoil	--	Vanadium
Aquatic Invertebrate		
Water Flea	Vanadium	Vanadium
Aquatic Vertebrate		
Fathead Minnow (direct)	--	--
Fathead Minnow (via food chain)	--	--
Fathead Minnow (cumulative hazard)	--	--
Largemouth Bass (direct)	--	--
Largemouth Bass (via food chain)	--	--
Largemouth Bass (cumulative hazard)	--	--

- No corrections were made for biological modification of the contaminants via detoxification, depuration or other such biological processes that can mitigate against concentration/accumulation and magnification;

- No corrections were made for physicochemical factors such as partitioning/mobilization dynamics, pH, percent organic carbon, etc. that control presentation of toxicant dose to organisms;

- All toxicant stressors (i.e., COCs by media) were assumed to be 100 percent bioavailable and fully retained in the organisms;

- All toxicant stressors were assumed to be transferred completely from the abiotic compartments (water, sediment, soil) through the food chain;

- Heavy metal (cadmium, chromium, lead, nickel) toxicity calculations were based on a water hardness of 50 mg/ℓ $CaCO_3$ and total metals analyses;

- Contributory risk from background concentrations of the toxicant stressors was not removed from the overall risk summary;

- Time frame constraints for the predicted arrival of contaminants were not considered and maximum contaminant concentrations were used as a worst-case scenario; and,

- For freshwater species, little data was available for the toxic effects and bioconcentration of vanadium; therefore, the criteria used were based on lowest value known toxic to aquatic life.

VII. REMEDIAL ACTION GOALS

Based on the review of the ground water sampling data from both the alluvial wells and the bedrock monitoring wells at the DER and the FSR sites, EPA has determined the alluvial aquifer and the upper portion of the Garber-Wellington (bedrock) aquifer to be a Class III aquifer in the immediate vicinity of the sites. This classification is due to the high TDS concentrations from past oil and gas production activities in the area. Contaminants of concern detected in the upper portion of the Garber-Wellington (bedrock) aquifer were discussed previously in Section VI, and were provided in Table 6. Concentrations of these contaminants exceed the Maximum Concentration Limits (MCLs) and pose a 36 in 10,000 excess cancer risk to adults that may use these zones as a drinking water supply.

To be classified as a Class III aquifer (Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy, EPA, 1986), an aquifer must have a total dissolved solids concentration greater than 10,000 parts per million (ppm) and/or an aquifer yield of less than 150 gallons per day. Although the subject aquifers yield adequate flow rates to be considered useable, the TDS of the alluvial and upper portion of the Garber-Wellington aquifers are much higher than 10,000 ppm. The average and maximum concentrations of TDS in the alluvial aquifer were 2,460 ppm and 13,100 ppm, respectively; and in the upper portion of the Garber-Wellington (bedrock) aquifer the TDS were 34,680 ppm and 110,000 ppm, respectively, for the wells installed at the DER site.

Two remedial action objectives have been developed for this site:

1) Ensure that future potential users of the lower Garber-Wellington aquifer are not exposed to contaminants from the site (The lower Garber-Wellington aquifer has the potential to be used for domestic purposes);

2) Ensure that the North Canadian River is not impacted by contaminants from the site.

Based on the results of the risk assessment and review of the ARARs, the affected media is the upper portion of the Garber-Wellington (bedrock) Aquifer. Transport of contaminants through the alluvial aquifer to the river was investigated as a migration pathway, however, the resultant contaminant levels in the river were below levels that warrant establishment of remedial action goals (i.e., below risk-based levels and potential ARARs). See Table 4. Therefore, the goals applicable to the contaminated ground water are the Chemical-Specific ARARs identified for the upper Garber-Wellington (bedrock) aquifer and the health based levels for COCs necessary for protection from consumption of ground water.

Table 17 provides a list of the goals (mcls) that the potential remedial action technologies must achieve if the ground water is used as a public drinking water source. These standards are applicable to the upper Garber-Wellington aquifer at a down-gradient well located at the site boundary and at a depth of 60 feet.

Although contaminants in the alluvial aquifer and the upper portion of the Garber-Wellington aquifer are above MCLs for several chemicals, restoration is not warranted since the subject portions of the ground water is categorized as a Class III aquifer. Based on the classification of these aquifers, no further action would be required. However, there is no confining "aquitard" between the upper and lower water bearing zones and there is still concern that downward migration of contaminants to a deeper useable zone could occur.

Table 17

Remedial Action Goals

Analyte	Goal (mg/l)
Arsenic	4.7E-6
Barium	2E+0
	1.1E-1
Beryllium	N/A
Cadmium	N/A
Chromium	N/A
Lead	N/A
Manganese	7.8E-3
Nickel	N/A
Thallium	2E-3
	1.3E-4
Vanadium	N/A
Aldrin	5.0E-7
Benzene	5E-3
	7.8E-5
Bis(2-chloroethyl) ether	2.1E-6
Chlorobenzene	3.1E-3
Chlorodane	1.8E-6
Chloroform	2.8E-5
DDE 4,4 -	3.0E-6
Dichlorobenzene 1,4 -	3.5E-4
Dichloroethane 1,2 -	5E-3
	2.5E-5
Dichloroethene 1,1 -	1.9E-6
Dichloroethene cis - 1,2	7E-2
Dichloroethene trans - 1,2	3.15E-2
Endosulfan	7.8E-5
Heptachlor	1.9E-6
Heptachlor Epoxide	9.4E-7
Ketones	1.8E-1
- Acetone	3.1E-2
- Hexanone 2 -	
- Butonone 2 - (Methyl Ethyl Ketone)	9.4E-1
- 4 - Methyl - 2 - Pentanone	7.8E-2
Methylene Chloride	1.1E-3
Phenol	9.4E-1
Toluene	6.3E-2
Trichloroethene	5E-3
	3.4E-4
Vinyl Chloride	4.5E-6
Xylene	5.6E-2

Because the alluvial and upper portion of the Garber-Wellington aquifers are Class III aquifers, these goals are not applicable.

VIII. DESCRIPTION OF ALTERNATIVES

A Feasibility Study was conducted to develop and evaluate remedial alternatives for the DER site for the GOU. Remedial alternatives were assembled from applicable remedial technology process options and were initially evaluated for effectiveness, implementability and cost based on engineering judgement. The alternatives selected for detailed analysis were evaluated and compared to the nine criteria required by the NCP. As a part of the evaluation, the NCP requires that a no-action alternative be considered at every site. The no-action alternative serves as a point of comparison for the other alternatives.

Remedial Action Alternatives

Four remedial alternatives were initially considered for ground water remedial action in the Feasibility Study for the Double Eagle site. These alternatives are: 1) No Action, 2) Limited Action, 3) Precipitation of Metals and Activated Carbon Treatment of Organic Contaminants, and 4) Precipitation of Metals and Biological Treatment of Organics. During the initial development of these alternatives, Alternative 4 was considered inappropriate and was eliminated. The cost of Alternative 4 was significantly higher than Alternative 3, yet it did not provide an additional level of risk reduction. The following alternatives to address the ground water contamination at the DER site were evaluated:

1. No Action

The "No Action" alternative is required for consideration by the National Contingency Plan and represents a continuation of the current situation. This alternative establishes a baseline for comparison with the other alternatives. This alternative does not provide a means of monitoring of the ground water to determine if contaminant releases are continuing. Under the "No Action" alternative, no activities to address the risks posed by the contaminated ground water at the site would be implemented. Inclusion of this alternative is required by the Superfund law and is the basis for evaluating other alternatives.

There are no costs associated with Alternative 1.

2. Limited Action

Major Components of the Limited Action Alternative: Components of this alternative include: institutional controls to control exposure to contaminated ground water, and continued ground water monitoring to assess changes in the potential for exposure. Installation of warning signs is included in the alternative to require notification prior to drilling in the area. A deed notice would be filed to notify future land owners of the hazards associated with the contaminated ground water in the area of the site. A deed restriction was considered, but was not pursued since the State of Oklahoma does not have the authority to place a restriction in the deed.

This alternative includes the installation of additional ground water monitoring wells and establishment of a routine monitoring and maintenance program for ground water sampling and modeling to evaluate contaminant level reductions following removal of the contaminant source. The new wells will be installed in a deeper zone of the Garber-Wellington than the wells presently installed at the site, at an approximate depth of at least 100 feet below ground surface. The deepest wells present at the DER site are at about 60 feet deep. The installation of additional deeper monitoring wells further down-gradient will allow the EPA to ensure that contaminants do not migrate deeper, or to any receptor point offsite, and determine if an offsite source of contamination exists. Also, these deeper wells will allow the EPA to determine if the ground water beneath 60 feet is useable, or has been previously contaminated by past oil and gas production activities (contains high TDS).

Modeling conducted during the RI indicates that MCLs will be achieved through attenuation in 60 to 150 years. An aspect of this alternative is to allow natural attenuation to reduce these contaminant levels over time. Natural attenuation relies on the ground water's natural ability to lower the contaminant concentrations over time through physical, chemical, and biological processes. Routine inspections would also be included in a formal monitoring and maintenance plan to ensure that public use of the upper zone (less than 60 feet in depth) of the Garber-Wellington aquifer does not occur prior to attainment of the remedial action objectives.

The "Limited Action" alternative would also include monitoring of the existing monitoring wells. The ground water monitoring will be conducted to determine if current conditions improve through time, remain constant, or worsen. The ground water monitoring well sampling will be conducted on a quarterly schedule for the first two years and then semi-annually until the first "five-year review". After the five-year review, the EPA will evaluate all data and determine if the sampling should be conducted annually or less frequently. The site would also be re-evaluated every five years ("five-year review"), to determine if further actions need to be taken with regard to the ground water. The five-year review will analyze the data obtained and include computer modeling to determine if contaminant level reductions are being achieved as expected, once the surface source of contamination is stabilized.

If the ground water monitoring indicates that detectable concentrations of site contaminants are found below the affected upper portion of the Garber-Wellington aquifer, or if the contaminated portions of the ground water show an increase of 30 percent for any contaminant in any of the alluvial or upper Garber-Wellington monitoring wells; the need for contingency measures (including active treatment) will be evaluated. Contingency measures can include one or all of the following elements:

- Installation of additional monitoring wells to determine if the contamination is increasing in concentration or migrating.
- Increasing the frequency of sampling to assure that a complete exposure pathway does not develop.
- Construction of a containment measure such as a slurry wall.
- Implementation of a remedial action plan for extraction, treatment, and disposal of contaminated ground water.

Although this alternative does not meet the Superfund preference for treatment of contaminants, EPA's evaluation of the site specific data indicates that active treatment of the ground water contamination is not warranted at this time. Active treatment is not warranted because 1) the contaminated ground water aquifers are Class III aquifers, and 2) the ground water modeling data showed that by the time the ground water contaminants reach the North Canadian River, the concentrations would be sufficiently low and will not adversely impact the river.

General Components: The estimated time to implement this remedy is 12 months. The estimated cost associated with implementing Alternative 2 are: Capital Costs: $158,000; Annual Operation and Maintenance Costs: $74,880; Total Present Net Worth: $1,463,056.

3. Inorganic Precipitation and Activated Carbon Treatment for Organic Contaminants

__Major Components of the Remedial Alternative.__ The major features of alternative 3 consists of the following key elements: 1) installation of a ground water recovery system, 2) construction of an on site ground water treatment and discharge system, 3) discharge of the treated ground water either to the North Canadian River, to a Publically Owned Treatment Works (POTW), or reinjection to the alluvial aquifer, and 4) implementation of an operation, monitoring, and maintenance program.

Components of the Recovery System: The components of the ground water recovery system include installation of additional ground water recovery wells in the area of the ground water plume with sufficient overlap of the radii of influence to recover the contaminant plume. A system of pipes from the recovery wells would be used to convey the recovered ground water from each well to an equalization tank for subsequent treatment.

Implementation of the proposed ground water recovery system will contain the contaminant plume and reduce the contaminant levels more quickly than natural attenuation. Using the ground water recovery system described above, a period of approximately 25 years would be required for contaminant levels to reach the remedial action goals. Additionally, the contaminant plume will theoretically be contained thereby mitigating further offsite migration of the plume.

Components of the Treatment System: The chemical treatment system that would be employed under this alternative consists of chemical and polymer addition followed by filtration to remove flocculated inorganic constituents. Chemical treatment is performed using a reagent, such as lime, to increase the pH and thereby reduce the solubility of the inorganic constituents. The decrease in solubility will cause the inorganic constituents to form metal hydroxides. The effectiveness of the removal of flocculated solids can be enhanced through the use of a polymer based flocculent. Filtration can then be used to remove the flocculated solids from the treated water.

After the filtration unit, the water would be treated through an activated carbon unit to remove organic COCs followed by direct discharge to the River or discharge to a POTW. Treatment of wastewaters using activated carbon adsorption typically occurs in packed-bed columns piped in series. The activated carbon adsorbs the organic based hazardous constituents by surface attraction in which organic molecules are attracted to the internal pores of the carbon granules. Very high organic removal efficiencies can be achieved using this process.

Components of the Discharge System: The decision to discharge directly to the river or to a POTW is considered a design aspect. The decision would be based on consideration of waste treatability, local standards, and a detailed cost analysis. This alternative would have to meet all applicable (Clean Water Act) statutory requirements contained in a National Pollutant Discharge Elimination System (NPDES) permit, and would require an NPDES permit for an off-site discharge directly to the river.

Components of the Operation and Maintenance Program: Since the ground water recovery and treatment system will require approximately 1 year to install and 25 years to complete remediation, it will be necessary to establish site access controls and an operation, monitoring, and maintenance program similar to the program described under the Limited Action Alternative (Alternative 2).

In addition to the elements included in the Limited Action monitoring and maintenance program (site warning signs, deed notice, sampling and analysis program, etc.), operation and maintenance of the recovery and treatment system will be required under this alternative. Operation and maintenance of the recovery and treatment system includes equipment replacement, maintaining treatment reagent supplies, operation of the treatment system, and disposal of residues (inorganic precipitate residues, spent carbon, etc.) from the treatment of contaminated ground water. The treatment residues may be characterized as a RCRA waste due to the characteristic of toxicity. Disposal of the residues would be done based on the results of a leachability test conducted on the residue. Residues that fail the Toxicity Characteristics Leaching Procedure (TCLP) test would require further treatment to remove the characteristic prior to disposal. If this alternative were implemented, the transportation of the treatment residues would have to meet all applicable requirements of the U.S. Department of Transportation; and the disposal of these residues would be performed in accordance with all requirements contained in 40 CFR Part 268 - Land Disposal Restrictions.

General Components: The estimated time to implement this remedy is 12 months, and approximately 25 to 40 years to complete (to meet the Remedial Action Goals). The estimated costs associated with implementing Alternative 3 are: Total Capital Costs: $775,000; Annual Operation and Maintenance Cost: $354,200; and Total Present Net Worth: $5,996,331.

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The EPA uses nine criteria to evaluate alternatives for addressing a Superfund site. These nine criteria are categorized into three groups: threshold, primary balancing, and modifying. The threshold criteria must be met in order for an alternative to be eligible for selection. The primary balancing criteria are used to weigh major tradeoffs among alternatives. The modifying criteria are taken into account after state and public comment is received on the Proposed Plan of Action.

Nine Criteria

The nine criteria used in evaluating all of the alternatives are as follows:

a) Threshold Criteria

Overall Protection of Human Health and the Environment addresses the way in which an alternative would reduce, eliminate, or control the risks posed by the site to human health and the environment. The methods used to achieve an adequate level of protection vary but may include treatment and engineering controls. Total elimination of risk is often impossible to achieve. However, a remedy must minimize risks to assure that human health and the environment are protected.

Compliance with ARARs, or "applicable or relevant and appropriate requirements", assures that an alternative will meet all related federal, state, and local requirements.

b) Primary Balancing Criteria

Long-term Effectiveness and Permanence addresses the ability of an alternative to reliably provide long-term protection for human health and the environment after the remediation goals have been accomplished.

Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment assesses how effectively an alternative will address the contamination at a site. Factors considered include the nature of the treatment process; the amount of hazardous materials that will be destroyed by the treatment process; how effectively the process reduces the toxicity, mobility, or volume of waste; and the type and quantity of contamination that will remain after treatment.

Short-term Effectiveness addresses the time it takes for remedy implementation. A potential remedy is evaluated for the length of time required for implementation and the potential impact on human health and the environment during implementation.

Implementability addresses the ease with which an alternative can be accomplished. Factors such as availability or materials and services are considered.

Cost (including capital costs and projected long-term operation and maintenance costs) is considered and compared to the benefit that will result from implementing the alternative.

c) Modifying Criteria

State Acceptance allows the state to review the proposed plan and offer comments to the EPA. A state may agree with, oppose, or have no comment on the proposed remedy.

Community Acceptance allows for a public comment period for interested persons or organizations to comment on the proposed remedy. EPA considers these comments in making its final remedy selection. The comments are addressed in the responsiveness summary which is a part of this ROD.

Comparative Analysis

This comparative analysis presents an analysis of each alternative in relation to each other using the nine criteria. The analysis is used to identify the relative advantages of one alternative versus another alternative.

Overall Protection of Human Health and the Environment

Alternative 1 does not achieve the remedial action objectives and does not provide protection to human health and the environment. Although contaminant concentrations should decrease over time upon removal of the source material, Alternative 1 does not provide for monitoring of the contaminant plume.

Alternative 2 provides adequate protection of human health and the environment. Because the alluvial and upper bedrock aquifers are Class III aquifers, they will not likely be used as water supplies. Ground water monitoring will alert EPA to any potential for movement of site contaminants to a potential drinking water aquifer. This alternative will also provide information about changes in contaminant concentrations upon removal of the surface source of contamination. Upon removal of the surface source material, contaminant concentrations would be expected to decrease due to natural attenuation. If contaminants migrate below the bedrock portion of the aquifer or towards the river, or if the contaminant levels are not reduced as expected; contingency measures will be taken to ensure protection of human health and the environment. Federal drinking water standards would be attained in approximately 60 - 150 years.

Alternative 3 would provide the greatest protection of human health and the environment from exposure to contaminants from the site; however, active remediation is not warranted at this time, since removal of site contaminants would not restore the alluvial or upper bedrock aquifers to be usable aquifers due to the presence of high TDS.

Compliance with ARARs

The individual discussions of compliance with ARARs within the Feasibility Study indicated that each alternative will meet their appropriate location-specific and action-specific ARARs. Action-specific ARARs are listed in Table 18. Implementation of Alternative 3 is expected to achieve the remedial action goals listed in Table 17 in approximately 25 years. Alternatives 2 and 3 provide the information necessary to determine achievement of the ground water ARARs. Alternative 1 would not provide sufficient information to assess lateral or vertical contaminant migration. Thus, EPA would not be able to evaluate potentially unacceptable risks from exposure to site contaminants either in the North Canadian River or future use of the lower Garber-Wellington aquifer as a water supply.

Long-term Effectiveness and Permanence

Alternative 3 provides the greatest degree of long-term effectiveness and permanence because the contaminant levels are reduced more quickly than Alternatives 1 or 2. Treatment of the contaminants present in the recovered ground water also provides a

Table 18

Action Specific ARARs

Action	Requirement	Prerequisites for Potential ARAR	Citation
Long-term Groundwater Monitoring Program	Installation and maintenance of groundwater monitoring wells for long-term monitoring program.	Site related contaminants detected in groundwater above background levels.	40 CFR Part 264 (Subpart F)
Discharge of Water	Establishment of treatment standards meeting best available technology, water quality standards or water quality based toxicity limits. Establishment of best management practices to reduce discharge of pollution. May require a permit based on location of receiving water.	Discharge of effluent to waters of the United States.	40 CFR Part 122
Discharge to POTW	Discharge of pollutants that pass through the POTW without treatment, interfere with the POTW operation, contaminate the POTW sludge, or endanger the POTW workers is prohibited.	*Applicable to indirect discharge of pollutants to a POTW.*	40 CFR Part 403
Treatment of Contaminated Groundwater	Treatment of hazardous waste in a unit requires application of certain design and construction requirements. Standards are applicable to tanks, impoundments, land treatment units, incinerators, etc.	Applicable to treatment of hazardous waste in a unit. Does not include in-situ treatment.	40 CFR Part 264

greater degree of long-term effectiveness and permanence because the contaminants are either degraded, absorbed, or altered to a more stable form. Treatment residues associated with the Alternative 3 are manageable and will be disposed in a manner that minimizes the long-term potential for cross media impacts.

However, the success of Alternative 3 at removing the contamination from the alluvial and the upper portion of the Garber-Wellington aquifers is highly questionable since A) there is a possibility of an offsite source of contamination, B) the subject water bearing zones are Class III aquifers, and C) the success of remediation of sites with DNAPL contamination is suspect. Consequently, although Alternative 3 may reduce contaminant levels in the short term, it may not be significantly more effective in the long term for the protection of human health and the environment. Contaminants from other sources and dissolved solids from past oil production activities would continue to impose a risk to human health. Therefore, Alternative 3 may not achieve a significant reduction in overall risk.

Alternative 2 can effectively monitor the contaminant concentrations in the alluvial, and upper and lower Garber-Wellington aquifers. The reduction in concentrations of site contaminants, upon removal of the surface contamination, is expected to be permanent. With the source stabilized, minimal site contaminants will leach into the ground water. The reduction in leachate contaminating the ground water beneath the site is considered permanent. Therefore, the reduction in risk from site contaminants will also be permanent.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 1 and 2 do not provide a reduction in toxicity, mobility, or volume through treatment. Alternative 3 satisfies the preference for treatment as a principal element in the alternative, uses treatment to reduce contaminant levels in recovered ground water, and reduces the potential for transfer of the contaminants from the alluvial and upper bedrock aquifers to the lower Garber-Wellington. However, the overall reduction attributable to Alternative 3 is questionable, because of the presence of another source not related to the DER site. The precipitation of inorganic contaminants, and the carbon absorption under Alternative 3 is considered an irreversible process, and provides a permanent reduction in toxicity and mobility. However, the overall reduction in toxicity may not be significant due to other potential sources of organic contamination in the area.

Short-term Effectiveness

The short-term risk associated with Alternative 1 is a continuation of the risk currently associated with the site. In the short-term, the risk from contaminated ground water is minimal since use of the ground water as a drinking water source is considered a future use exposure scenario. Over the short term, implementation of Alternatives 2 and 3 would not significantly increase the risk to the community or site workers. The additional risk associated with construction of a monitoring system or a recovery system (Alternative 3) can be managed by application of engineering and short-term access controls.

Transportation of treatment residues associated with Alternative 3 can potentially cause exposure to the general public and the environment should a mishap occur during transportation. However, transportation of wastewater treatment residues is a common and well managed practice in the industry and is not expected to cause a significant increase in the short-term risk. The transportation of these residues would have to be conducted in compliance with all applicable requirements of the U.S. Department of Transportation.

Implementability

Alternative 1 is the easiest to implement. Alternative 2 involves installation of a ground water monitoring system which does not require significant construction activity. Alternative 3 requires the same elements of Alternative 2 with the addition of a recovery and treatment system. If the treated ground water were discharged directly to the river, an NPDES permit would be required. This could delay implementation. The construction of a ground water monitoring and/or recovery and treatment system with operation, monitoring, maintenance, and residual material disposal activities are standard practices in the industry and are readily available. Adequately trained and experienced personnel are also readily available for the implementation of the system.

No free phase contamination was encountered during the drilling operations at the DER site, but some of the chemicals detected in the ground water beneath the DER site such as dichloroethane, trichloroethane and dichlorobenzene are associated with DNAPL contamination. Past experience with ground water recovery systems indicates a high degree of difficulty in restoring ground water at sites that contain chemicals associated with DNAPL contamination. Therefore, Alternative 3 may be implementable, but based on historical data, the efficiency of remediating this type of contamination is questionable.

Cost

Alternative 2 at a cost of $1.5 million, provides the same amount of information as Alternative 3 (approximate cost $6 million) with respect to characterization of contaminant level reductions. Alternative 2 does not achieve reductions in contaminant levels in the same time frame as the recovery and treatment of the contaminant plume under Alternative 3. Alternative 2 can be implemented for a significantly reduced cost and provide the flexibility to continue assessment of ground water contaminant levels.

State Acceptance

The State of Oklahoma believes that ground water monitoring is the appropriate alternative for this site. Attachment C is a letter from the ODEQ to the EPA stating that the State of Oklahoma concurs with the Limited Action alternative.

Community Acceptance

Comments received during the public comment period indicate that much of the community questioned whether the Proposed Remedy - Limited Action, was protective of human health and the environment. One commenter provided written opposition to the proposed remedy, and suggested the use of a specific technology termed "bioremediation and metals extraction". All comments received during the public comment period, and EPA responses are in the attached Responsiveness Summary (Attachment B).

X. THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives using the nine criteria, and public comments, the EPA has determined that Alternative 2 - **Limited Action** is the most appropriate alternative for remediating the ground water beneath the Double Eagle site. The major components of this remedy include:

- Installation of warning signs to require notification prior to drilling in the area.
- A deed notice filed to notify future land owners of the hazards associated with the contaminated ground water in the area of the site.
- Installation of additional deeper monitoring wells further down-gradient to ensure that contaminants do not migrate deeper, or to a receptor point offsite, and to determine if an offsite source of contamination exists.
- Establishment of a routine (quarterly sampling for the first two years, then semi-annually for the following three years) monitoring and maintenance program for ground water sampling and modeling to evaluate contaminant level reductions following removal of the contaminant source.
- Routine inspections to ensure that public use of the upper zone of the Garber-Wellington Aquifer does not occur prior to

attainment of the remedial action objectives.

- Five-Year review of the site to determine if further actions need to be taken with regard to the ground water. As part of the 5-year review, data analysis and ground water modeling is included to assess the adequacy of the monitoring and maintenance plan.

- Contingency measures (which include active treatment) that can be implemented if the ground water monitoring indicates an increase in contaminant concentrations (either vertically or horizontally). The contingency measures are described below.

EPA believes that the Limited Action alternative is the most appropriate alternative for the following reasons:

1) The ground water in the vicinity of the site is not used as a water supply;

2) The extremely high concentration of Total Dissolved Solids make the ground water undesirable as a water supply source;

3) Efforts to remove site-related contaminants in the ground water would not improve its over all quality, and;

4) The North Canadian River is not threatened at the present time, nor will it be threatened in the future by site contaminants.

The primary threat posed by the contaminated ground water is the possibility of migration of the contamination downward into a useable drinking water zone, or lateral migration into a surface water body which is the North Canadian river. EPA considers Alternative 2 the most prudent remedy in light of the fact that the upper portion of the Garber Wellington aquifer and the alluvial aquifer are considered Class III aquifers. Also, the data obtained during the investigation stage of the project suggests the possibility of an offsite, upgradient source of contamination. Since the Total Dissolved Solids in the ground water are so high, and there is a possibility of an offsite source of contamination, even if a pump and treat alternative (Alternative 3) was implemented at a much higher cost, the ground water would still remain non-useable.

The goal of the remedial action is to prevent migration of contaminants from the shallow aquifer to the deeper aquifer, thus maintaining the deeper aquifer for its beneficial use. Based on information obtained during the remedial investigation and analysis of all remedial alternatives, EPA believes that the preferred remedy is the most appropriate alternative to achieve this goal. If monitoring does not indicate a reduction in the concentration of ground water contamination or if the ground water plumes continue to expand based on sampling of the specified monitoring points, the contingency measures described below may be implemented.

The preferred remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. Because treatment of the contaminated ground water was not found to be warranted at this time, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Because the preferred alternative will result in hazardous substances remaining on-site above health based levels (in the shallow ground water, including the alluvial and upper portion of the Garber-Wellington aquifers), a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. All work to be performed at the site will be conducted pursuant to 29 CFR Part 1910 (Worker health and Safety Plan).

Contingency measures:

The preferred alternative provides for natural attenuation to reduce contamination levels in the alluvial aquifer and the upper portion of the Garber-Wellington aquifer, and to prevent migration of contaminants from the alluvial aquifer and the upper portion of the Garber-Wellington aquifer to the deeper portion of the Garber-Wellington aquifer. The alternative also provides for ongoing monitoring of all existing site wells to determine 1) whether natural attenuation is working to reduce the contamination level in the ground water aquifers, and 2) whether the contamination has migrated vertically or horizontally.

If during the monitoring, detectable concentrations of site contaminants are found below the affected upper portion of the Garber-Wellington aquifer, or if the contaminated portions of the ground water show an increase of 30 percent for any contaminant in any of the alluvial or upper Garber-Wellington monitoring wells; the well which showed the increase in concentration will be resampled immediately. If the second analysis confirms that there has been a 30 percent increase in contaminant concentration, or resampling of the deeper Garber-Wellington aquifer confirms detection, EPA will evaluate 1) the impacts of any offsite sources of contamination, and 2) the need for additional remedial action to address site related contaminants. Based on these evaluations, EPA may require implementation of any or all of the following actions:

- Installation of additional monitoring wells to determine if the contamination is increasing in concentration or migrating.

- Increasing the frequency of sampling to assure that a complete exposure pathway does not develop.

- Construction of a containment measure such as a slurry wall.

- Implementation of a remedial action plan for extraction, treatment, and disposal of contaminated ground water.

The decision to implement contingency measures may be outlined in an Explanation of Significant Difference, that will be made available to the public in the Administrative Record.

Alternative 2 will provide protection to human health and the environment by allowing the EPA to monitor the ground water to confirm contaminant level reductions (as predicted), and ensure that contaminant migration does not reach a receptor point.

Alternative 1 is not considered appropriate since the "No-Action" alternative will not allow monitoring of the ground water to provide protection to human health and the environment.

Since the data suggests the possibility of an offsite source of contamination, and the industrialized nature of the adjacent properties, an investigation is currently being conducted by other programs within both the State and the EPA which have authority to address a health threat posed by petroleum products from active facilities that are exempt under Superfund. A Resource Conservation and Recovery Act (RCRA) inspection of active facilities in the area is underway. If it is discovered that an unauthorized release has occurred, appropriate action will be taken.

XI. THE STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. Section 121 of CERCLA also requires that the selected remedial action for the site comply with applicable or relevant and appropriate environmental standards established under Federal and State environmental laws, unless a waiver is granted. The selected remedy must also be cost-effective and utilize treatment or resource recovery technologies to the maximum extent practicable. The statute also contains a preference for remedies that include treatment as a principal element. The following sections discuss how the selected remedy for contaminated ground water at the DER site meets the statutory requirements.

Protection of Human Health and the Environment

The future use scenario is the only complete pathway for human exposure to the contaminant plume. Exposure under this scenario would be completed if a 60-foot deep public drinking water well was installed at the site boundary and within the area of the contaminant plume. Alternative 2 provides control of this exposure route by reducing the likelihood that a drinking water well will be installed prior to attainment of the remedial action objectives. Based on the worst-case natural attenuation modeling results, a period of 60 to 150 years is expected before contaminant levels will attenuate to within the remedial action objectives. However, based on levels of TDS at the exposure point, it is unlikely that the upper portion of the bedrock aquifer will be used as a public drinking water source.

The monitoring and maintenance program will be used to demonstrate attenuation of contaminant levels and provide sufficient information to conduct regular ground water modeling. Based on the results of routine monitoring and ground water modeling results, the site controls and monitoring and maintenance plan would be revised as necessary.

A minimum degree of cross-media impacts or short-term risks are associated with this alternative since additional exposure to the contaminated media is minimized. Therefore, to the extent that the upper portion of the bedrock aquifer is not used as a public drinking water source, this alternative provides a high degree of protection to human health and the environment. Through natural attenuation, contaminant levels are expected to be within the remedial action objectives at a future time. If the ground water is used as a public drinking water source, this alternative does not eliminate the risk to human health and the environment during the period that natural attenuation of contaminant levels occurs and contaminant levels exceed the remedial action objectives.

Compliance with ARARs

The ground water at the exposure point is not currently used as a public drinking water source due to the high total dissolved solids from past oil production activities. Continued monitoring will monitor the attenuation of contaminant levels to MCLs. Since modeling results indicate that the contaminant plume will not impact the river, the potential ARARs associated with surface water standards will be achieved. Additional action-specific ARARs associated with implementation of this alternative include standards for installation of additional wells and disposal of miscellaneous wastes associated with the monitoring program such as sampling equipment and produced water. Those wastes will be properly disposed of in an appropriate facility in compliance with the EPA's offsite disposal policy. Compliance with the action-specific ARARs is not expected to present a significant obstacle to implementation of this remedial alterative. Action-specific ARARs are listed in Table 18.

Cost-Effectiveness

The selected remedy is considered cost effective since it is much less expensive than Alternative 3, yet provides adequate protection to human health and the environment. The "No-Action" alternative is not considered acceptable since it provides no protection to human health and the environment.

Utilization of Permanent Solutions and Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Alternative 2 is not considered permanent because this alternative will not actively remove the contamination within the aquifer and restore the ground water to MCLs. Alternative 2 does not use a treatment technology or a resource recovery technology as an aspect of this remedy. However, it is considered the most practical solution since this alternative will allow continued monitoring, to confirm whether an offsite source of contamination exists, and that the classification of the aquifer as a Class III zone remains appropriate.

Alternative 2 is considered permanent in the sense that the five-year review will allow ground water sampling and analysis, and modeling to confirm contaminant level reductions; and if a future threat to human health and the environment becomes apparent, Alternative 3 or a comparable pump and treat operation can be implemented at that time.

Preference for Treatment as a Principal Element

Treatment is not a principal element of alternative 2; however, it is considered the best alternative considering the specific conditions and circumstances at the site.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES:

The overall remedy selected in this ROD is not significantly different from the alternative proposed for public comment. However, a contingency plan for future evaluation of active remediation, should the lower Garber-Wellington aquifer be impacted by contaminants from the DER site, has been included.

ADMINISTRATIVE RECORD INDEX

FINAL

SITE NAME: DOUBLE EAGLE REFINERY SITE

SITE NUMBER: OKD 980696470

INDEX DATE: 03/03/94

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ADMINISTRATIVE RECORD INDEX

FINAL

SITE NAME: DOUBLE EAGLE REFINERY SITE
SITE NUMBER: OKD 980696470

DOCUMENT NUMBER: 005598 - 005625
DOCUMENT DATE: 10/27/92
NUMBER OF PAGES: 028
AUTHOR: Staff Consultants
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Final Project Work Plan
DOCUMENT TITLE: "Final Project Work Plan for the Groundwater Operable Unit Remedial Investigation/Feasibility Study (RI/FS) - Volume 1"

DOCUMENT NUMBER: 005626 - 005851
DOCUMENT DATE: 01/01/93
NUMBER OF PAGES: 226
AUTHOR: Staff Consultants
COMPANY/AGENCY: Fluor Daniel, Inc.
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DOCUMENT TYPE: Final Work Plan
DOCUMENT TITLE: "Final RI/FS Work Plan for Groundwater Operable Unit"

DOCUMENT NUMBER: 005852 - 005867
DOCUMENT DATE: 01/12/93
NUMBER OF PAGES: 016
AUTHOR: Robert K. Franke, ARCS Project Manager and Mark L. deLorimier, P.E., ARCS Program Manager
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: Philip Allen, Remedial Project Manager, U.S. EPA Region 6
DOCUMENT TYPE: Correspondence and Attachment
DOCUMENT TITLE: "Responses to Region 6's and Oklahoma State Department of Health's comments regarding the Final RI/FS Work Plan"

DOCUMENT NUMBER: 005868 - 005868
DOCUMENT DATE: 02/18/93
NUMBER OF PAGES: 001
AUTHOR: EPA Staff
COMPANY/AGENCY: U.S. EPA Region 6
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Open House Invitation
DOCUMENT TITLE: "Invitation to the public to attend the 02/18/93 open house to learn more about Superfund activities at the Double Eagle/Fourth Street Superfund Sites"

ADMINISTRATIVE RECORD INDEX

FINAL

SITE NAME: DOUBLE EAGLE REFINERY SITE
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DOCUMENT NUMBER: 005869 - 005879
DOCUMENT DATE: 12/24/92
NUMBER OF PAGES: 011
AUTHOR: Robert K. Franke, ARCS Project Manager and Mark L. deLorimier, P.E., ARCS Program Manager
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: Philip H. Allen, Remedial Project Manager (RPM), U.S. EPA Region 6
DOCUMENT TYPE: Correspondence and Attachments
DOCUMENT TITLE: "Bedrock Monitoring Well Data - Double Eagle and Fourth Street Refinery Sites"

DOCUMENT NUMBER: 005880 - 005880
DOCUMENT DATE: 02/03/93
NUMBER OF PAGES: 001
AUTHOR: Philip H. Allen, P.E., RPM
COMPANY/AGENCY: U.S. EPA Region 6
RECIPIENT: Robert K. Franke, ARCS Project Manager, Fluor Daniel, Inc.
DOCUMENT TYPE: Correspondence
DOCUMENT TITLE: "Modelling Assumptions for the Risk Assessment for the Ground Water Operable Unit at the Double Eagle and Fourth Street Refinery Sites"

DOCUMENT NUMBER: 005881 - 005886
DOCUMENT DATE: 02/23/93
NUMBER OF PAGES: 006
AUTHOR: Philip H. Allen, P.E., RPM
COMPANY/AGENCY: U.S. EPA Region 6
RECIPIENT: Robert K. Franke, ARCS Project Manager, Fluor Daniel, Inc.
DOCUMENT TYPE: Correspondence and Attachments
DOCUMENT TITLE: "Guidance for the Risk Assessment and the Remedial Investigation/Feasibility Study for the Ground Water Operable Unit - Double Eagle and Fourth Street Refinery Sites"

DOCUMENT NUMBER: 005887 - 005890
DOCUMENT DATE: 02/26/93
NUMBER OF PAGES: 004
AUTHOR: Robert K. Franke, ARCS Project Manager and Mark L. deLorimier, P.E., ARCS Program Manager
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: Philip H. Allen, RPM, U.S. EPA Region 6
DOCUMENT TYPE: Correspondence and Attachments
DOCUMENT TITLE: "Updated Project Schedule - Double Eagle and Fourth Street Refinery Sites"

ADMINISTRATIVE RECORD INDEX

FINAL

SITE NAME: DOUBLE EAGLE REFINERY SITE
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DOCUMENT NUMBER: 005891 - 006450
DOCUMENT DATE: 07/27/93
NUMBER OF PAGES: 560
AUTHOR: Staff Consultants
COMPANY/AGENCY: Flour Daniels, Inc.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Final Remedial Investigation Report
DOCUMENT TITLE: "Ground Water Operable Unit Final Remedial Investigation Report - Double Eagle Superfund Site" (Includes Appendixes A-K)

DOCUMENT NUMBER: 006451 - 006917
DOCUMENT DATE: 07/27/93
NUMBER OF PAGES: 467
AUTHOR: Staff Consultants
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Final Feasibility Study Report
DOCUMENT TITLE: "Ground Water Operable Unit Final Feasibility Study Report - Double Eagle Superfund Site" (Included Appendixes A-E)

DOCUMENT NUMBER: 006918 - 006932
DOCUMENT DATE: 08/05/93
NUMBER OF PAGES: 015
AUTHOR: EPA Staff
COMPANY/AGENCY: U.S. EPA Region 6
RECIPIENT: General Public
DOCUMENT TYPE: Proposed Plan of Action
DOCUMENT TITLE: "EPA Announces Proposed Plan of Action"

DOCUMENT NUMBER: 006933 - 006933
DOCUMENT DATE: 03/31/89
NUMBER OF PAGES:
AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA - Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Guidance Document
DOCUMENT TITLE: "Risk Assessment Guidance for Superfund: Volume 2 - Environmental Evaluation Manual (Interim Final)". EPA/540/1-89/001, March 1989. (See "For Your Information")

ADMINISTRATIVE RECORD INDEX

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SITE NAME: DOUBLE EAGLE REFINERY SITE
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DOCUMENT DATE: 12/31/89
NUMBER OF PAGES:
AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA - Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Guidance Document
DOCUMENT TITLE: "Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part A) (Interim Final)". EPA/540/1-89/002, December 1989. (See "For Your Information")

DOCUMENT NUMBER: 006935 - 006935
DOCUMENT DATE: 12/31/91
NUMBER OF PAGES:
AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA - Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Guidance Document
DOCUMENT TITLE: "Risk Assessment Guidance for Superfund: Volume 1-Human Health Evaluation Manual (Part B, Development Risk-based Preliminary Remediation Goals (Interim)". Publication 9285.7-01B, Dec. 1991. (See "For Your Information")

DOCUMENT NUMBER: 006936 - 006936
DOCUMENT DATE: 12/31/91
NUMBER OF PAGES:
AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA - Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Guidance Document
DOCUMENT TITLE: "Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part C, Risk Evaluation of Remedial Alternatives) (Interim)". Publication 9285.7-01C, December 1991. (See "For Your Information")

DOCUMENT NUMBER: 006937 - 006967
DOCUMENT DATE: 02/28/92
NUMBER OF PAGES: 035
AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA Headquarters - Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Summary Report - Volume 1
DOCUMENT TITLE: "Evaluation of Ground-Water Extraction Remedies: Phase II"

ADMINISTRATIVE RECORD INDEX

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SITE NAME: DOUBLE EAGLE REFINERY SITE
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DOCUMENT DATE: 02/28/92
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AUTHOR: Office of Emergency and Remedial Response
COMPANY/AGENCY: U.S. EPA Headquarters, Washington, D.C.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Case Studies and Updates - Volume 2
DOCUMENT TITLE: "Evaluation of Ground-Water Extraction Remedies: Phase II"

DOCUMENT NUMBER: 007418 - 007547
DOCUMENT DATE: 06/30/92
NUMBER OF PAGES: 130
AUTHOR: Staff Consultants
COMPANY/AGENCY: Fluor Daniel, Inc.
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Draft Remedial Investigation
DOCUMENT TITLE: "Draft Remedial Investigation Phase III Report"

DOCUMENT NUMBER: 007548 - 007589
DOCUMENT DATE: 03/29/93
NUMBER OF PAGES: 042
AUTHOR: Unspecified
COMPANY/AGENCY: U.S. EPA Region 9
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Compendium of Guidance Documents Index
DOCUMENT TITLE: "Compendium of CERCLA Response Selection Guidance Documents Index"

DOCUMENT NUMBER: 007590 - 007628
DOCUMENT DATE: 08/12/93
NUMBER OF PAGES: 039
AUTHOR: Lena Pierce, Court Reporter
COMPANY/AGENCY: National Records Service of Dallas
RECIPIENT: U.S. EPA Region 6 Site Files
DOCUMENT TYPE: Public Meeting Transcript
DOCUMENT TITLE: "Transcript of public hearing held on 08/12/93 at 7:00 p.m., YWCA, McFarland Branch Auditorium, Oklahoma City, OK"

ADMINISTRATIVE RECORD INDEX

FINAL

SITE NAME: DOUBLE EAGLE REFINERY SITE
SITE NUMBER: OKD 980696470

DOCUMENT NUMBER: 007629 - 007634
DOCUMENT DATE: 09/03/93
NUMBER OF PAGES: 006
AUTHOR: Matthew Biddle, Department of Geography
COMPANY/AGENCY: University of Oklahoma - Norman, OK
RECIPIENT: Melanie Ontiveros, U.S. EPA Region 6
DOCUMENT TYPE: Public Comment Letter
DOCUMENT TITLE: "Comments on the proposed plan"

DOCUMENT NUMBER: 007635 - 007653
DOCUMENT DATE: 09/04/93
NUMBER OF PAGES: 019
AUTHOR: Phillip Reeves, President
COMPANY/AGENCY: Enviro-Energy
RECIPIENT: Melanie Ontiveros, U.S. EPA Region 6
DOCUMENT TYPE: Public Comment Letter and Enclosures
DOCUMENT TITLE: "Comments on the proposed plan"

DOCUMENT NUMBER: 007654 - 007656
DOCUMENT DATE: 10/04/93
NUMBER OF PAGES: 003
AUTHOR: LeAnne Burnett, Attorney representing the Double Eagle PRP Group
COMPANY/AGENCY: Crowe & Donlevy
RECIPIENT: Philip Allen, RPM, U.S. EPA Region 6
DOCUMENT TYPE: Public Comment Letter
DOCUMENT TITLE: "Comments regarding the Record of Decision for Operable Unit 2"

ATTACHMENT B

THE RESPONSIVENESS SUMMARY

The Responsiveness Summary has been prepared to provide written responses to comments submitted regarding the Proposed Plan of Action at the Double Eagle Refinery (DER) Superfund site. The summary is divided into two sections.

Section I: Background of Community Involvement and Concerns. This section provides a brief history of community interest and concerns raised during the remedial planning activities at the DER site.

Section II: Summary of Major Comments Received. The comments (both oral and written) are summarized and EPA's responses provided.

I. Background of Community Involvement and Concerns

Interest in the DER site on the part of the residents, local government officials, and potentially responsible parties (PRPs) has been moderate. Community relations activities were initiated in 1989 when the site was proposed for inclusion on the National Priorities List. A Community Relations Plan (CRP) was developed in Dec. 1989, and the final published and released to the public on Jan. 26, 1990. The CRP was prepared to identify and address community concerns raised during the original RI/FS for the SCOU. Copies of the CRP are located in the information repositories. The CRP identified that the primary interest in the DER site lies mostly with the residents who live near the site. Also, several PRPs have come forward concerning the DER site as discussed in this Record of Decision.

II. Summary of Major Comments Received

Public notice announcing the public comment period and opportunity for a public meeting was printed in The Black Chronicle on August 5, 1993. The proposed plan fact sheet was also distributed to the site mailing list on August 5, 1993, and a reminder was published on August 12, 1993 in The Black Chronicle. An open house was conducted the evening of August 12, 1993, to inform the public about the Remedial Investigation and Feasibility Study Reports and the Proposed Plan of Action. The comment period began on August 5, 1993, and was scheduled to end on September 4, 1993. An extension to the public comment period was granted (per the PRP group's request) which extended the comment period until October 7, 1993. At the meeting, EPA and ODEQ officials discussed the contamination problems associated with the ground water beneath the site, presented the various remedial alternatives that were considered, and presented the preferred alternative to address the ground water contamination at the DER site.

Approximately 20 people were in attendance at the meeting. The public was given the opportunity to make comments or ask questions. Seven people made comments or asked questions. A full account of the public meeting can be found in the public meeting transcript which is documented in the DER Administrative Record.

a) Verbal Comments

The comments/questions received orally during the public meeting on August 12, 1993 are as follows:

Comment:

The commenter asked if she could obtain copies of the overhead transparencies that were used during the presentation at the beginning of the Public meeting.

Response:

The commenter was provided copies of the transparencies at the end of the meeting the night of August 12, 1993.

Comment:

The commenter stated that she missed the introduction of the speaker that presented information at the beginning of the meeting and would like to know whom he was.

Response:

The speaker was Philip Allen, the Remedial Project Manager for the Double Eagle site.

Comment:

The commenter stated that five other NPL sites are present in the area; and that EPA investigates these sites separately. Since all of these sites are located above the Garber Wellington aquifer, the commenter expressed concern of migration of contaminants from all the sites into the aquifer. The commenter further stated that the sites need to treated as a Regional problem, with respect to the overall effect in the long term of all these sites on the aquifer.

Response:

The EPA has conducted investigations at all NPL sites within the Oklahoma City area. The results of these investigations indicate that there is no overlap of the contaminant plumes; therefore no cumulative effects which would result in additional risk to human health and the environment are evident. It should be noted that the Double Eagle and Fourth Street sites were investigated simultaneously due to their proximity to each other.

Comment:

The commenter expressed concern that the Proposed Plans for the Double Eagle and Fourth Street were almost identical, and asked if the sites were similar enough to produce two documents so similar.

Response:

The Double Eagle and Fourth Street sites are very similar. The types of operations conducted at the sites, the type of waste, and the contaminants found in the waste are all so similar that the documents are also very similar. These facts coupled with the close proximity of the sites resulted in the EPA using the same contractor to conduct the investigations, and allowed a cost savings to the Government, since duplication of efforts were minimized.

Comment:

The commenter asked what long term effect will these sites have on the North Canadian River and future use of the river.

Response:

The results of the Remedial Investigation indicate that there will be no adverse impact on the North Canadian River as a result of any migration of contaminants from the Double Eagle site.

Comment:

The commenter asked what was anticipated for the future land use of the sites once the remedial action was complete for the source.

Response:

When the remedial action is complete for the Source Control Operable Unit, the land use is anticipated to continue to be industrial use. There will also be a deed notice placed on the deed to notify any potential future land owners of the ground water contamination.

Comment:

The commenter asked if there are any viable PRPs on the sites.

Response:

There are several viable PRPs for the DER site, and a group of 22 participating PRPs have made a settlement offer; however, the negotiations are ongoing, and the PRP search is continuing.

b) Written Comments

The comments received in writing during the public comment period are as follows:

Comment:

The commenter wrote that there was no North arrow or scale on the map provided in the Proposed Plan; and that the abbreviations were confusing.

Response:

The direction North would be pointing straight up on the page and the map is not to exact scale. Additional maps are provided in the Record of Decision with North arrows and scales. The abbreviation "IH" implies Interstate Highway.

Comment:

The Proposed Plan on page 1 identifies the railroad adjacent to the site as "Union Pacific" while the map on page 3 uses Santa Fe (ATSF).

Response:

The railroad lines are essentially identical, and ATSF stands for Atchinson, Topeka and Santa Fe Railroad.

Comment:

The commenter wrote that it is not clear how or why EPA considers lead the "major" contaminant of concern.

Response:

Lead is the contaminant that provided the greatest risk for the Source Control Operable Unit.

Comment:

The commenter wrote that the EPA fails to provide justification for the choice of Alternative 2 in the Proposed Plan.

Response:

The EPA proposed the Limited Action alternative (Alternative 2) in the Proposed Plan on August 5, 1993. The Proposed Plan is intended to be a brief outline of the rationale for proposing a remedy. Further discussion of the rationale and justification is provided in the Record of Decision. EPA believes that the Limited Action alternative is the most appropriate alternative for the following reasons:

1) The ground water in the vicinity of the site is not used as a water supply;

2) The extremely high concentration of Total Dissolved Solids make the ground water undesirable as a water supply source;

3) Efforts to remove site-related contaminants in the ground water would not improve its over all quality, and;

4) The North Canadian River is not threatened at the present time, nor will it be threatened in the future by site contaminants.

Comment:

The commenter wrote that the section in the Proposed Plan discussing ARARs is "vague and ambiguous", and "does not clearly indicate if the chosen alternative actually does comply with Safe Drinking Water Act or Clean Water Act provisions".

Response:

The ground water at the exposure point is not currently used as a public drinking water source due to the high total dissolved solids from past oil production activities. Continued monitoring will monitor the attenuation of contaminant levels to MCLs. Since modeling results indicate that the contaminant plume will not impact the river, the potential ARARs associated with surface water standards will be achieved. Additional action-specific ARARs associated with implementation of this alternative include standards for installation of additional wells and disposal of miscellaneous wastes associated with the monitoring program such as sampling equipment and produced water. Those wastes will be properly disposed of in an appropriate facility in compliance with the EPA's offsite disposal policy. Compliance with the action-specific ARARs is not expected to present a significant obstacle to implementation of this remedial alterative.

Comment:

The commenter wrote that it appears that the EPA's position is that a primary advantage of Alternative 2 is that it can be implemented quickly.

Response:

EPA disagrees with the comment. The "Limited Action" alternative is consistent with Superfund guidance regarding ground water remedies in areas of high Total Dissolved Solids. EPA believes that the ground water in the area of the Double Eagle site would remain unusable after the removal of site related contaminants. Although time to implement a remedy is a consideration in the selection process, the effectiveness of restoring a ground water resource is also considered.

Comment:

The commenter stated that Alternative 2 is a low cost approach, and cost is not the primary criteria. The commenter requested that the EPA consider "bioremediation and metals extraction" and requested an opportunity to present his technology.

Response:

Cost is only one of nine criteria considered in the remedy selection process, and is not considered one of the primary criteria. Effectiveness in reducing risk, however, is a primary criterion. Because the more costly "pump and treat" alternative would not be any more effective in the long term than attenuation, in reducing the risk from use of the upper Garber-Wellington (bedrock) aquifer, EPA does not believe that Alternative #3 is cost-effective. Since a "pump and treat" system is not considered a prudent remedy at the DER site for the contamination in the ground water, a demonstration of the "bioremediation and metals extraction" technology is not being considered at this time.

Comment:

The commenter wrote that the EPA did not give the public an adequate opportunity to review essential information regarding Operable Unit 2 prior to the Public meeting on August 12, 1993; and the RI/FS reports were not available at the information repositories prior to the meeting.

Response:

The public was given ample time to review the RI/FS reports prior to the public meeting, and was given an extension to the normal 30 days. The EPA extended the comment period which allowed the public a total of 64 calendar days to review all documents pertaining to the site and submit written comments. Attachment 1 to this Responsiveness Summary includes 2 Document Transmittal Acknowledgement Forms. One of the Acknowledgement forms is from the Ralph Ellison Branch library and the other is from the Oklahoma State Department of Health.

Comment:

The commenter wrote that no specific monitoring requirements are proposed under the remedial action plan, and that a list of monitoring requirements should be made available for public comment.

Response:

The major components of the selected remedy are outlined in the Record of Decision. The Limited Action alternative includes quarterly ground water monitoring for the first two years, and semi-annually monitoring for the following three years. The specific contaminants that will be analyzed for during monitoring will be determined during Remedial Design.

Comment:

The commenter wrote that data from the ground water RI/FS study show that the Double Eagle site is hydraulically lower and is impacted by polluted ground water from upgradient of the Double Eagle site; and remediation of any ground water contamination coming from upgradient of the Double Eagle site should not be the responsibility of the Double Eagle PRPs.

Response:

The RI/FS states that there is a possibility of an off-site source of contamination but was not conclusive. The contamination in the ground water beneath the Double Eagle site is attributable to the surface contamination, for which the PRPs are responsible. Therefore, the PRPs are responsible for the ground water Remedial Design and Remedial Action for the Selected Remedy - Limited Action.

Comment:

The commenter wrote that part of the proposed Operable Unit 2 remedial design for the Double Eagle and Fourth Street sites is to install 11 ground water monitoring wells; and that there was no clear indication if this means 11 wells total or 11 per site. Regardless, since the ground water is impacted by ground water from upgradient of the site, no responsibility for installing and maintaining monitoring wells on or around the Double Eagle site should be placed on the Double Eagle PRPs.

Response:

The Feasibility Studies for the subject sites estimated 11 wells to be installed during remedial action per site. However, the amount of wells actually necessary to ensure that no future threat to human health and the environment is posed by the contaminated ground water, is a design consideration and the final determination will be made during remedial design. Since the installation of these wells and the subsequent monitoring and maintenance is necessary due to the activities at the site, the PRPs are responsible for this aspect of the site remediation.

Comment:

The commenter wrote that lead levels in the ground water are already below the clean up goals; and EPA should provide to the public not only clean up goals for the contaminants of concern, but also the current levels of contaminants in the ground water. By providing only the list of contaminants of concern and cleanup levels, EPA infers that each of those contaminants is above the cleanup level. This is not the case.

Response:

The Proposed Plan contained the original contaminants of concern. The final contaminants of concern and the Remedial Action Goals are provided in the ROD.

Comment:

The commenter wrote that manganese is not a "hazardous substance" as set forth in Sections 101(14) and 102(a) of CERCLA or 40 CFR Part 302; consequently, EPA does not have jurisdiction under CERCLA to designate this compound as a "constituent of concern" at this site, and thus EPA has no authority to establish cleanup goals in the Proposed Plan for this substance.

Response:

Manganese is not a hazardous substance as set forth in Sections 101(14) and 102(a) of CERCLA or 40 CFR Part 302. However, Section 104(a)(1)(B) states that "Whenever there is a release or substantial threat of release into the environment of any pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare, the President is authorized to act consistent with the national contingency plan, to remove or arrange for the removal of, and provide for remedial action relating to such hazardous substance, pollutant, or contaminant at any time..." Therefore, manganese is still considered a contaminant of concern.

Comment:

The commenter wrote that Heptachlor and Aldrin, among others, have been listed as contaminants of concern. Heptachlor and Aldrin are not, however, typical ground water contaminants from oil recycling.

Response:

Heptachlor and Aldrin are contaminants encountered in the ground water at the site and pose a risk to human health and the environment, and are therefore contaminants of concern. However, Heptachlor and Aldrin are not normally expected to be encountered as contaminants of concern at oil recycling sites.

Comment:

The commenter wrote that all cleanup levels for contaminants of concern are inconsistent with the MCLs.

Response:

The remedial goals that were listed in the Proposed Plan were tentative goals based on information from the Source Control Operable Unit. The final Remedial Action Goals, if a ground water restoration system were implemented, are listed in the ROD in Table 17. However, because the alluvial and upper portion of the Garber-Wellington aquifers are Class III aquifers, these goals are not applicable.

Comment:

The commenter wrote that in light of the low contaminant level in the ground water, the low quality of the area's ground water, and the plans to remove the sources of contamination at the Double Eagle Site, "no action" is a more appropriate and cost effective remedial option than EPA's selected "limited action" remedy.

Response:

The quality of shallow ground water beneath the Double Eagle site has been affected by past oil and gas production activities in the area, and the alluvial and upper bedrock aquifers are considered a Class III zone. However, in order to ensure to the public that no future threat is posed by potential migration of the site related contaminants, continued monitoring and analyses are included in the Limited Action remedy. EPA considers the Limited Action remedy to be the most appropriate and prudent action at the site.

Attachment 1

Document Transmittal Acknowledgment

From: U.S. EPA Region 6

Sent by: Mava Davis

Mava Davis

To: Ms. Denyvetta Davis
Ralph Ellison Branch Library
2000 N.E. 23rd Street
Oklahoma City, OK 73111
(405) 424-1437

I, Denyvetta Davis, acknowledge that on this 4th day of August, 1993, I received from U.S. EPA Region 6, the second submittal of the administrative record for the Double Eagle Refinery Superfund Site - Ground Water Operable Unit.

[Documents included in the second submittal Ground Water Operable Unit AR are the July 27, 1993 Remedial Investigation, the July 27, 1993 Feasibility Study, and the August 5, 1993 Proposed Plan of Action]

Signed ____________________

Please return this form to: Mava Davis, (6H-MC)
U.S. EPA Region 6
1445 Ross Avenue, Ste. 1000
Dallas, TX 75202-2733
(214) 655-6484

cc: DPRA File 3732. 803

Document Transmittal Acknowledgment

From: U.S. EPA Region 6 Sent by: Mava Davis

Mava Davis

To: Mr. Scott Thompson 0206
Oklahoma State Department of Health
1000 N.E. 10th Street
Oklahoma City, OK 73117-1299
(405) 271-7159

I, Scott Thompson, acknowledge that on this 6th day of August, 1993, I received from U.S. EPA Region 6, the second submittal of the administrative record for the Double Eagle Refinery Superfund Site - Ground Water Operable Unit.

[Documents included in the second submittal Ground Water Operable Unit AR are the July 27, 1993 Remedial Investigation, the July 27, 1993 Feasibility Study, and the August 5, 1993 Proposed Plan of Action]

Signed ________

Please return this form to: Mava Davis, (6H-MC)
U.S. EPA Region 6
1445 Ross Avenue, Ste. 1000
Dallas, TX 75202-2733
(214) 655-6484

cc: DPRA File 3732. 803

ATTACHMENT "C"

MARK S. COLEMAN
Executive Director

DAVID WALTERS
Governor

State of Oklahoma

DEPARTMENT OF ENVIRONMENTAL QUALITY

November 15, 1993

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SUPERFUND BRANCH

Don Williams, Chief
Oklahoma/Texas Remedial Section (6H-SR)
United States Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

RE: Double Eagle Superfund Site, Oklahoma City, Oklahoma

Dear Mr. Williams:

My staff and I have reviewed the draft Record of Decision (ROD) for the Ground Water Operable Unit for the Double Eagle Superfund Site that was received by our office on October 25, 1993. Although we concur with the selected remedy that is described in the ROD, we cannot completely concur with the site characterization, ground water modeling, and risk assessment sections. The DEQ does not believe that the hydrological setting or the extent and degree of ground water contamination has been adequately determined. However, DEQ does believe that enough site characterization has been achieved to choose the appropriate remedy for the site and expects the characterization inadequacies to be solved during the Remedial Design.

Sincerely,

for Dennis Hrebec, Ph.D., Director
Superfund Division

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Office of the
Executive Director

1000 Northeast Tenth Street, Oklahoma City, Oklahoma 73117-1212

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