APPENDIX C

SAMPLE APPLICATIONS OF THE CLASSIFICATION PROCEDURES

SAMPLE APPLICATIONS OF THE CLASSIFICATION PROCEDURES

The following case studies are presented to illustrate the central classification concepts and use of the various classification procedures. Individual case studies are presented in a systematic fashion in accordance with the Classification Procedural Chart (Figure 4-1) and associated worksheet (Table 4-1) - instructions or questions are posed followed by the corresponding information with subsequent directives, or a final class determination. The general format for the case studies begins with a presentation of the preliminary information and concludes with the completion of the Classification Worksheet.

Each case study has been modeled after real activities and physical settings. Data sources have been generalized to avoid identification of the specific site under examination. The particular activity under consideration has also been omitted since classification is essentially independent of the activity type. Place names and localities have been disguised, but my be recognizable to a familiar reader. Costs and other figures used in these case studies are hypothetical. It should also be noted that the final classification decision presented in each case study does not represent the Agency's determination for the real activity from which the case study has been developed since some factors were changed for the purposes of this review. A summary of case studies and related issues addressed in each case is presented in Table C-1.

TABLE C-1
MATRIX OF CASE STUDIES AND RELATED ISSUES

Case Number	Ecologically Vital	Irreplaceability	Substantial Population	Vulnerability	Current Source	Potential Source	Treatability	Interconnection	Subdivided Classification Review Area	Expansion of Classification Review Area	Ground-Water Class Determination
1					X						IIA - Current Source
2						X		X	X		IIB - Potential Source
3						X					IIB - Potential Source
4					X					X	IIA - Current Source
5								X	X		IIIB - Low Interconnection
6							X	X	X		IIIA - Moderate Interconnection with Adjacent Ground Water Units/High Interconnection with Surface Water
7		X	X	X							I - Irreplaceable
8						X		X	X		IIB - Potential Source
9	X			X							I - Ecologically Vital
10			X	X	X						IIA - Current Source
11	X			X						X	I - Ecologically Vital

CASE STUDY 1

Introduction

The following case study is an example of a Class IIA-Current Source of Drinking Water. The standard Classification Review Area, defined by a two-mile radius from the proposed facility, is used in this example. Although a substantial population is involved, the Classification Review Area is not highly vulnerable to ground-water contamination.

Preliminary Information with Respect to the Classification Review Area

General

A permit application is being submitted for a site located in the Eastern United States, east of the City of Hilton Heights. Land use in the area is primarily rural farmland interspersed with chemical industries. The Classification Review Area is shown in Figure C1-1.

Maps provided in this case study were developed from U.S. Geological Survey quadrangle sheets. Text information was collected from ground-water availability studies conducted by the county, U.S. Geological Survey reports, and from U.S. Census Bureau statistics.

Geology/Hydrogeology

The stratigraphic sequence of geologic units regionally present is, in descending order (Figure C1-2):

- Umber Formation - silty sand
- Hunter Formation - clay
- Toth Formation - sandstone
- Crystalline igneous and metamorphic bedrock.

The major aquifers in the area are the Umber and Toth Formations. The Hunter Formation is known to be an unfractured, laterally continuous aquitard.

Well/Reservoir Survey

Two large capacity water-supply wells, screened in the Umber aquifer and registered with the state, are located in the Classification Review Area. These wells provide public water supplies for the City of Hilton Heights, which, according to U.S. Census Bureau statistics, had a population of 3,700 persons in 1980.

FIGURE C1-1
BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

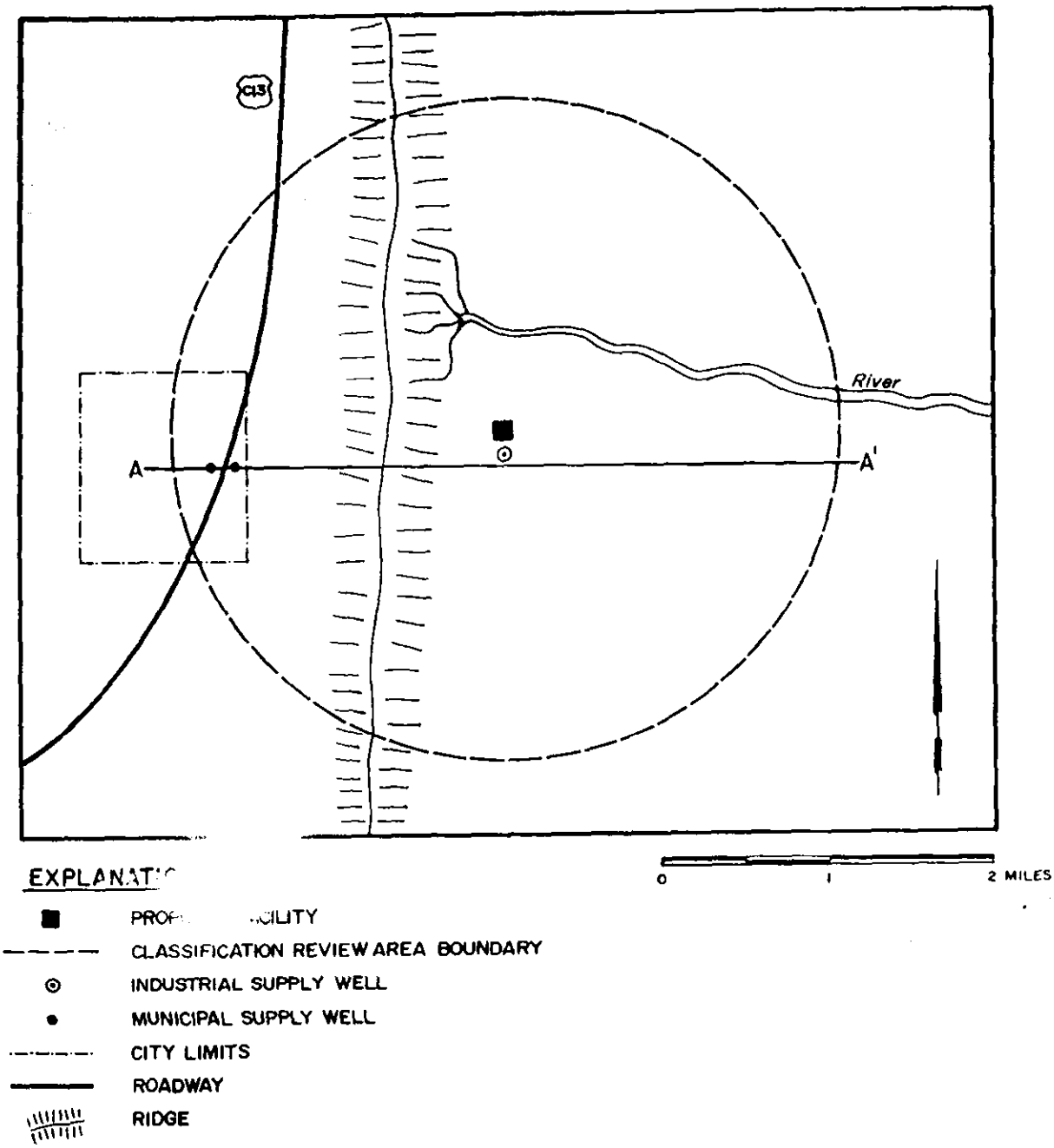
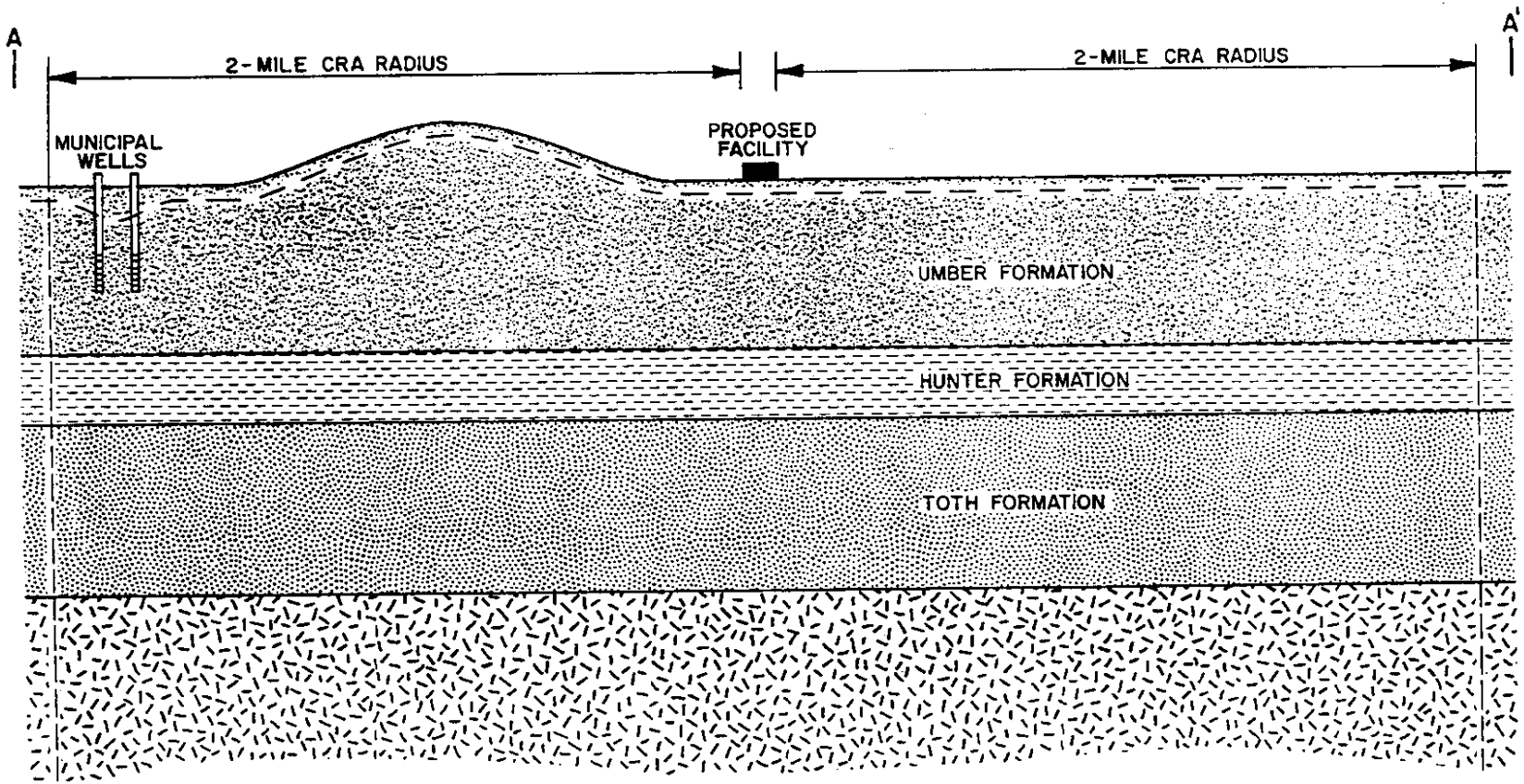


FIGURE C1-2
GENERALIZED CROSS-SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

- SANDSTONE
- CLAY
- SILTY SAND
- IGNEOUS/METAMORPHIC BEDROCK
- WATER TABLE

Additionally, if the proposed activity is permitted, a new well will be constructed at the site. This well will be screened in the deeper Toth aquifer.

No water-supply reservoirs are present in the Classification Review Area.

Demography

The City of Hilton Heights is located west of the proposed facility and has a population of 3,700. All residents are served by ground-water supplies, therefore the well field is considered to serve a substantial population under Option A. As no irreplaceability analysis was performed, the ground waters are assumed to be irreplaceable. Under Option B, the population is considered substantial by recognized experts given the demographics of the region.

Ecologically Vital Areas

U.S. Fish and Wildlife Service records indicate the Classification Review Area does not encompass any Federal lands designated for ecological protection or ecologically vital areas.

Vulnerability

Given that the irreplaceability of the ground waters is assumed, it is necessary to perform a vulnerability analysis for the area. Under Option A for determining vulnerability, DRASTIC is utilized with the following results averaged over the review area:

UMBER FORMATION	Rating	Weight	Number
. Depth to water - 15-30 ft	7	5	35
. Net recharge - approximately 20 in/yr	9	4	36
. Aquifer media - silty sand	6	3	18
. Soil media - loam	5	2	10
. Topography - 2-6%	9	1	9
. Impact of vadose zone media - sand with silt and clay	5	5	25
. Hydraulic conductivity - 100-300 gpd/ft^2	2	3	6
		DRASTIC Index (TOTAL)	139

This area is not considered highly vulnerable to ground-water contamination under Option A since the DRASTIC Index is less than 150.

Under Option B for determining vulnerability, two expert hydrogeologists in the area were consulted. The hydrogeologic setting of loamy soils overlying silty sand aquifers are considered "vulnerable" but not "highly vulnerable" by these experts.

Referring to the Procedural Chart shown in Figure 4-1 and associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility. No CRA subdivision has been performed.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area? . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water? . Yes, go to next Step . No, go to Step 8	Yes, two large-capacity water-supply wells are located within the CRA.
5	Inventory population served by well(s). Does the well(s) serve a substantial population? . Yes, go to next step . No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER	Yes, under Option A, the population served exceeds the 2500-person threshold. Under Option B, the population is considered substantial by recognized experts given the demographics of the region.

Step	Question/Direction	Response/Comment
6	Unless proven otherwise, the drinking water source is assumed to be irreplaceable. Optional - perform irreplaceability analysis. Is the source of drinking water irreplaceable? . Yes, go to next step . No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER	Yes, irreplaceability is assumed.
7	Perform vulnerability analysis. Is the CRA or appropriate subdivision a highly vulnerable hydrogeologic setting? . Yes, then the ground water is CLASS I-IRREPLACEABLE SOURCE OF DRINKING WATER . No, then the ground water is CLASS IIA-CU[illegible] SOURCE OF D[illegible]G WATER	No, under Option A, a DRASTIC index of less than 150 does not constitute a highly vulnerable hydrogeologic setting. Under Option B, the area is not deemed highly vulnerable by hydrogeologic experts.

FINAL CLASS DETERMINATION: CLASS IIA - CURRENT SOURCE OF DRINKING WATER

CASE STUDY 2

Introduction

This case study is a permutation of Case Study 1 leading to a Class IIB - Potential Source of Drinking Water classification. Although the preliminary information remains the same, the Classification Review Area has been subdivided to identify those ground-water units not highly interconnected with the ground-water unit directly beneath the facility. In this manner, we have attempted to illustrate how subdividing the Classification Review Area can alter the final ground-water classification. Subdivision of the Classification Review Area into ground-water units results in a class determination of potential source of drinking water rather than a current source.

Preliminary Information with Respect to the Classification Review Area

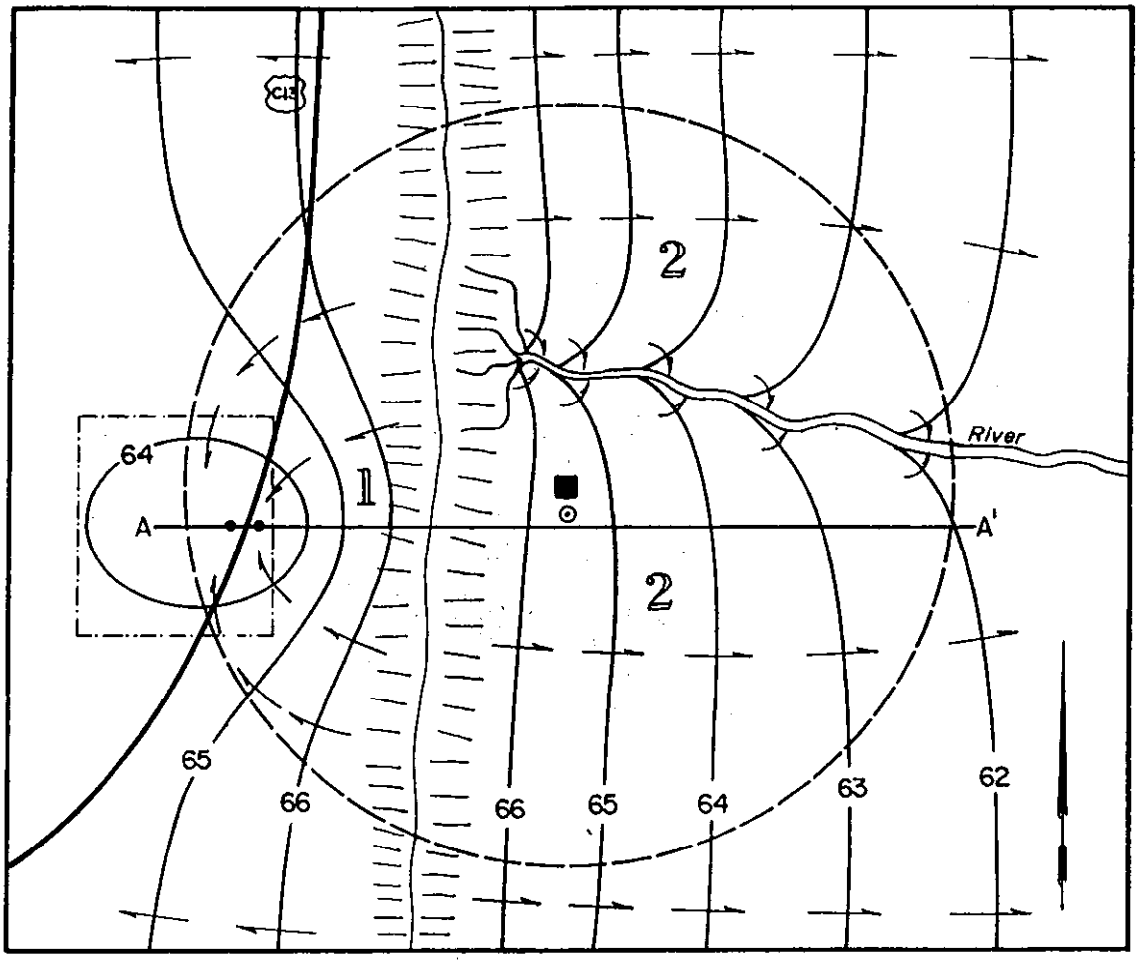
General

Material presented in Case Study 1 is not repeated. Figure C2-1 is a map of the water-table surface developed from U.S. Geological Survey and State Geological Survey well data and water-level measurements made specifically for this study.

Classification Review Area Subdivision (Interconnection)

Three ground-water units can be identified within the Classification Review Area (Figures C2-2 and C2-3). The topographic divide serves as a ground-water flow divide creating ground-water units 1 and 2 (Figure C2-2). Two large capacity water-supply wells, located in ground-water unit 1, provide public water supplies for the City of Hilton Heights. Under pumping conditions, the water pumped by the high-yield wells is derived from ground-water unit 1, resulting in displacement of the ground-water flow divide (Figure C2-2). The river, recharged by ground-water unit 2, does not serve as a ground-water flow divide. Regional investigations conducted by county hydrogeologists have shown that ground-water flow beneath the river occurs in the lowermost Umber Formation. The Hunter Formation, an unfractured, laterally continuous aquitard, restricts vertical flow between the Umber and Toth aquifers. Thus, a third ground-water unit can be identified and is confined to ground-water movement in the Toth aquifer.

FIGURE C2-1
MAP OF THE WATER TABLE

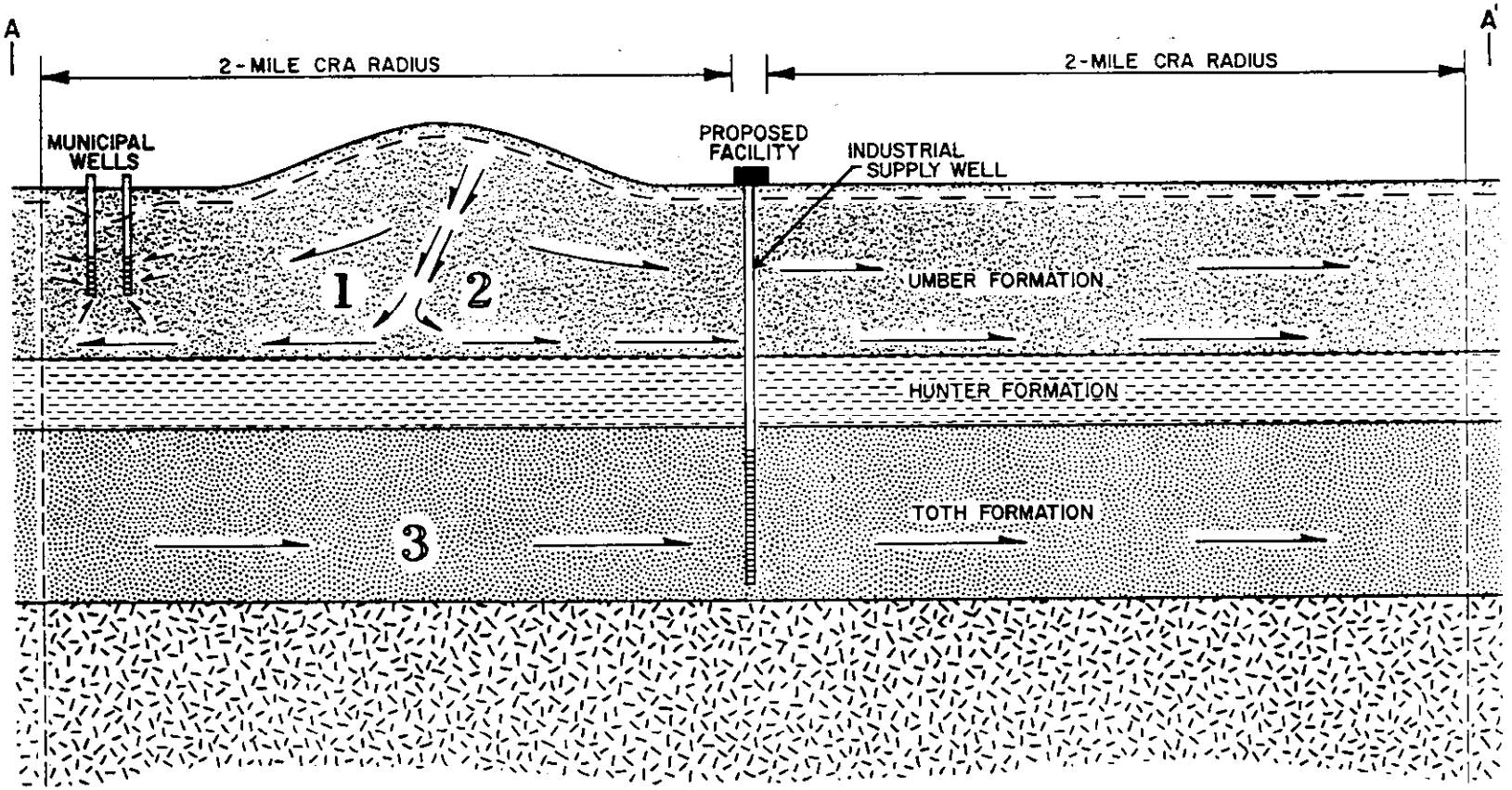


EXPLANATION

0 1 2 MILES

- PROPOSED FACILITY
- CLASSIFICATION REVIEW AREA BOUNDARY
- INDUSTRIAL SUPPLY WELL
- MUNICIPAL SUPPLY WELL
- CITY LIMITS
- ROADWAY
- RIDGE
- 2 GROUND-WATER UNIT NUMBER
- 63 WATER TABLE CONTOUR, IN FEET
- GROUND-WATER FLOW DIRECTION

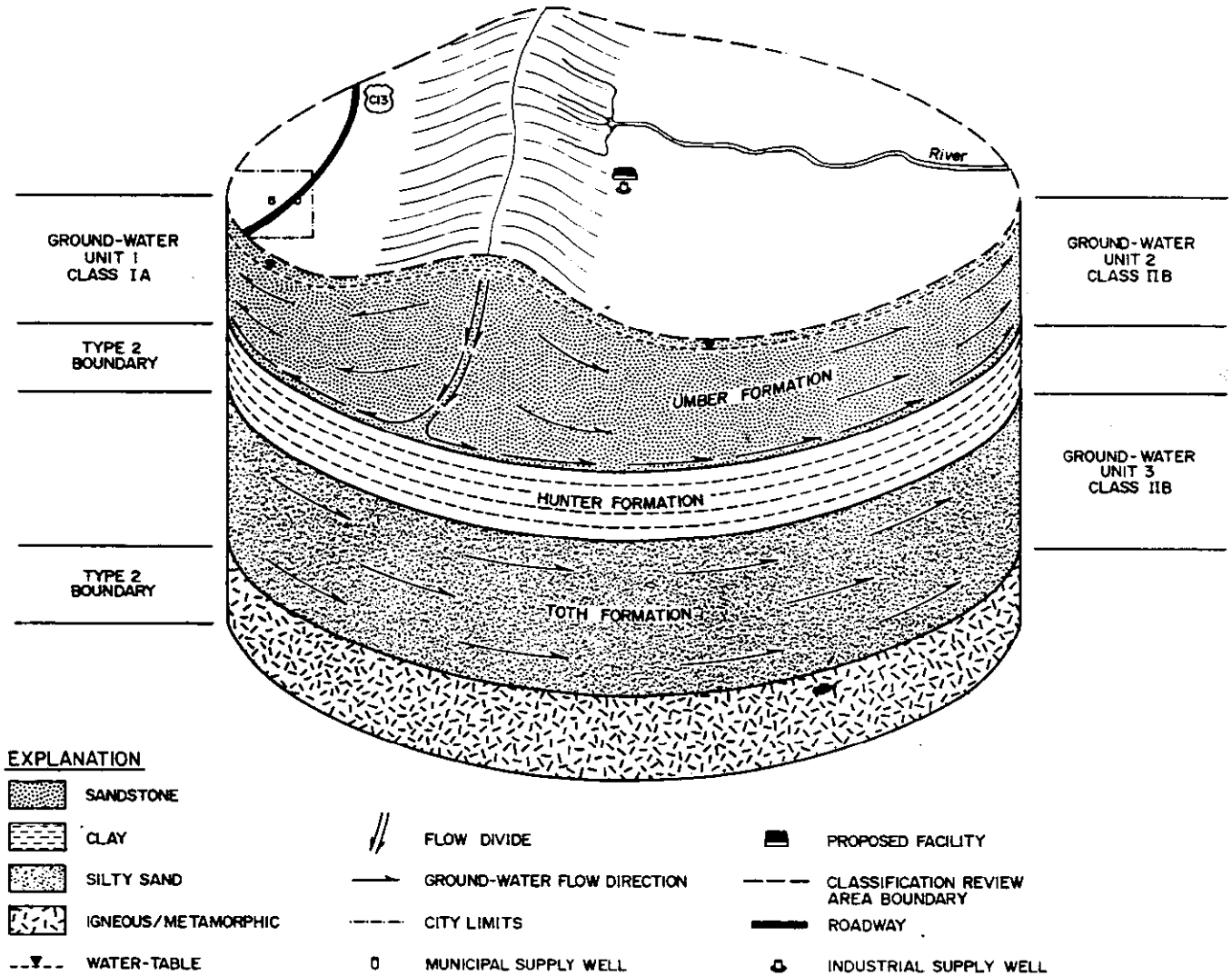
FIGURE C2-2
GENERALIZED CROSS-SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

- SANDSTONE
- CLAY
- SILTY SAND
- IGNEOUS/METAMORPHIC BEDROCK
- WATER TABLE
- GROUND-WATER FLOW DIRECTION
- 2 GROUND-WATER UNIT NUMBER

FIGURE C2-3
THREE-DIMENSIONAL ILLUSTRATION OF THE HYDROLOGY AND GROUND-WATER UNITS WITHIN THE CLASSIFICATION REVIEW AREA



An intermediate degree of interconnection is demonstrated where a Type 1 boundary separates adjacent ground-water units and a Type 2 boundary with a low degree of interconnection is demonstrated due to the presence of an aquitard. Thus, it is possible to subdivide the Classification Review Area in order to restrict ground-water classification to the ground-water unit which is potentially affected by the presence of the proposed facility.

Potential contaminants entering the ground water from the facility would be transported in ground-water unit No. 2 and, ultimately, discharge to the river. The ground water classification decision is thus restricted to ground-water unit No. 2.

The following classification demonstration is limited to ground-water unit No. 2 located beneath the proposed facility. Classification of other ground-water units is not necessary.

Referring to the Procedural Chart shown in Figure 4-1 and associated worksheet in Table 4-1, the ground-water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility. The CRA has been subdivided into three ground-water units. The ground-water classification decision is restricted to ground-water unit No. 2 located beneath the proposed facility.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area? . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water? . Yes, go to next Step . No, go to Step 8	No drinking-water wells are within ground-water unit No. 2.

Step	Question/Direction	Response/Comment
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water? . Yes, go to next step . No, go to Step 9	No reservoirs are present within the subdivided CRA.
9	Determine yield from ground-water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well? . Yes, go to next step . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)	Yes, the ground-water medium is presumed to meet the sufficient yield criterion.
10	Determine water-quality characteristics within the CRA or appropriate subdivision. Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)? (Note: If water quality is unknown then this question must be answered no.) . Yes, go to Step 12 . No, go to next step	No, the water-quality is unknown.

Step	Question/Direction	Response/Comment
11	Are the ground waters so contaminated as to be untreatable? (Note: If water quality is unknown then this question must be answered no.) . Yes, go to next step . No, then the ground water is CLASS IIB-POTENTIAL SOURCE OF DRINKING WATER	No, the water-quality is unknown.

FINAL CLASS DETERMINATION: CLASS IIB - POTENTIAL SOURCE OF DRINKING WATER

CASE STUDY 3

Introduction

This case study is an example of a Class IIB Potential Source of Drinking Water. The standard Classification Review Area, defined by a two-mile radius from the proposed facility, is used in this example. No drinking water wells are present within the Classification Review Area. Also absent are any ecologically vital areas.

Preliminary Information with Respect to the Classification Review Area

General

A permit application is being submitted for a site in the Armadillo Desert in the Basin and Range physiographic province. The standard Classification Review Area is shown in Figure C3-1. The U.S. Geological Survey characterizes the regional landscape as broad, open, relatively flat-floored valleys, separated by rugged mountain ranges. Valley-fill deposits are sands, gavels, and cobbles of local origin, transported to the site by alluvial and colluvial processes. Figure C3-2 is a generalized cross-section of the hydrogeology in the Classification Review Area determined from a limited number of borings.

The climate of the Armadillo Desert is characterized as arid. Average annual evapotranspiration exceeds average-annual precipitation by an order of magnitude; hence, the area is normally water deficient.

Well/Reservoir Survey

No ground water wells or drinking water reservoirs are present in the Classification Review Area (Figure C3-1). If the permit is approved for the facility to begin operation, bottled drinking water will be delivered to the site for employee use.

Demography

The nearest town is ten miles north of the proposed site and has an approximate population of 5,000. There are no known rural dwellings within a two-mile radius of the proposed site.

Ecologically Vital Areas

No ground-water discharge areas, or Federal lands designated for ecological protection, are present in the two-mile Classification Review Area.

FIGURE C3-1
BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

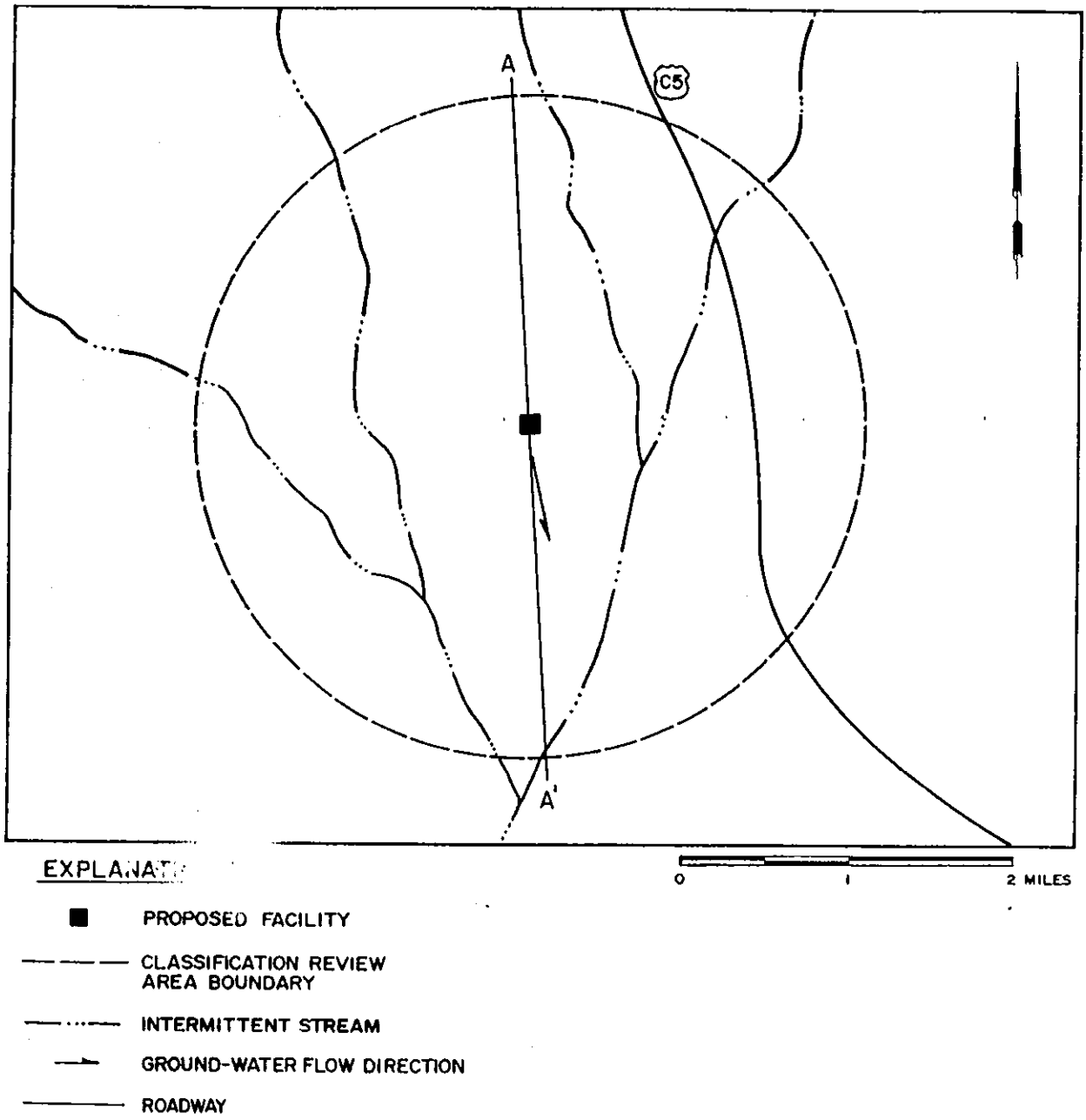
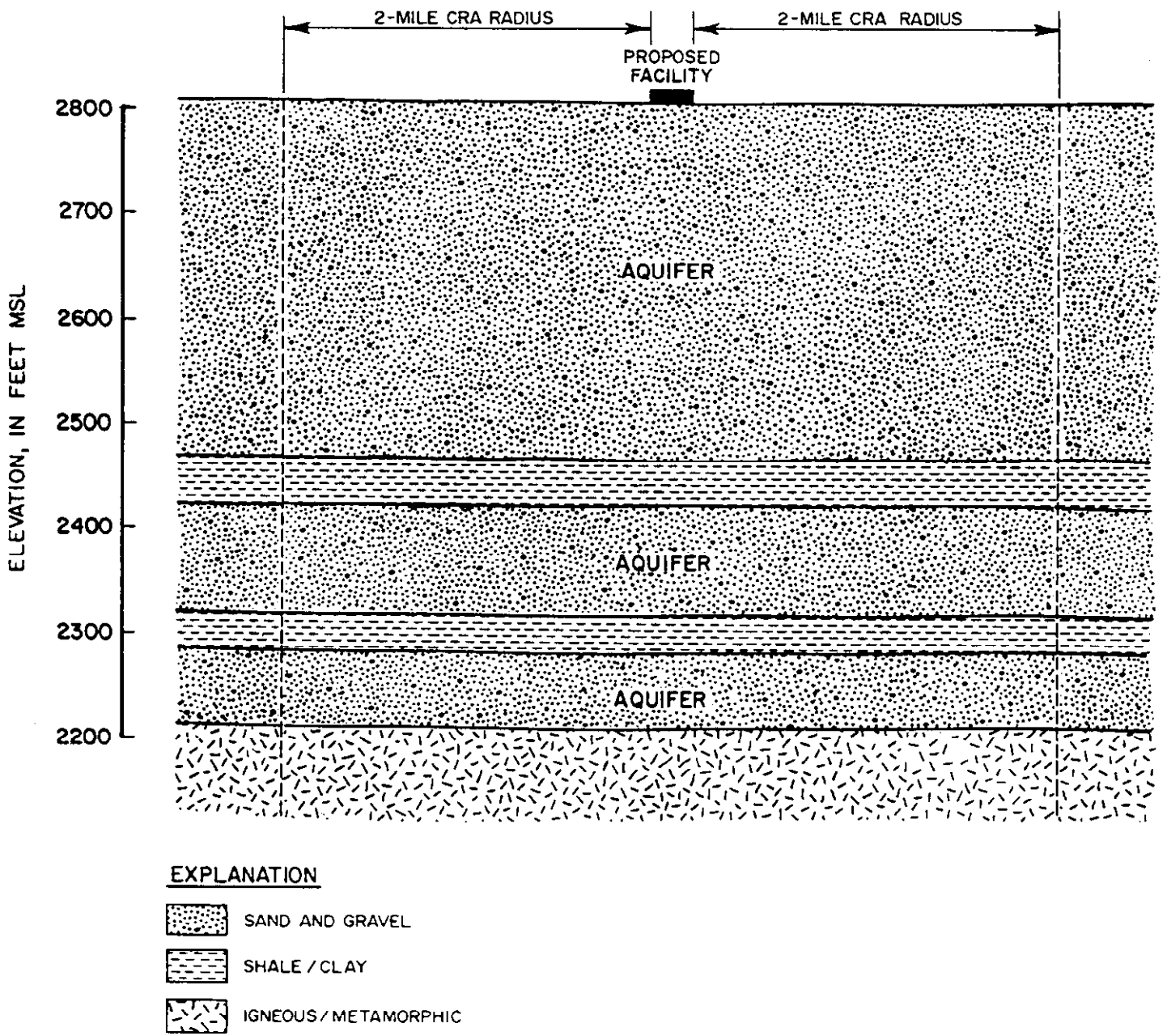


FIGURE C3-2
GENERALIZED CROSS SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



Referring to the procedural chart shown in Figure 4-1 and the associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility. No CRA subdivision has been performed.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area? . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water? . Yes, go to next Step . No, go to Step 8	No drinking water wells are present in the CRA.
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water? . Yes, go to next step . No, go to Step 9	No, there are no reservoirs present within the CRA.

Step	Question/Direction	Response/Comment
9	Determine yield from ground water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well? . Yes, go to next step . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)	Yes, in the absence of data, sufficient yield is assumed.
10	Determine water-quality characteristics within the CRA or appropriate subdivision. Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)? (Note: If water quality is unknown then this question must be answered no.) . Yes, go to Step 12 . No, go to next step	No, water-quality characteristics within the CRA are unknown.
11	Are the ground waters so contaminated as to be untreatable? (Note: If water quality is unknown then this question must be answered no.) . Yes, go to next step . No, then the ground water is CLASS IIB-POTENTIAL SOURCE OF DRINKING WATER	No, water-quality characteristics within the CRA are unknown.

FINAL CLASS DETERMINATION: CLASS IIB - POTENTIAL SOURCE OF DRINKING WATER

CASE STUDY 4

Introduction

This case study was developed from Case Study 3 in order to demonstrate an expanded Classification Review Area for an alluvial setting. The classification decision with a two-mile Classification Review Area was Class IIB Potential Source of Drinking Water. No sources of drinking water were found in the two-mile Classification Review Area (Figure C4-1). An expanded review area as demonstrated in this case study may lead to a different classification decision.

Preliminary Information with Respect to the Classification Review Area

Expanded Classification Review Area

This setting is found in the alluvial basin ground-water region (after Heath, 1984) and based on the above information matches the conditions for an expanded Classification Review Area. These conditions are:

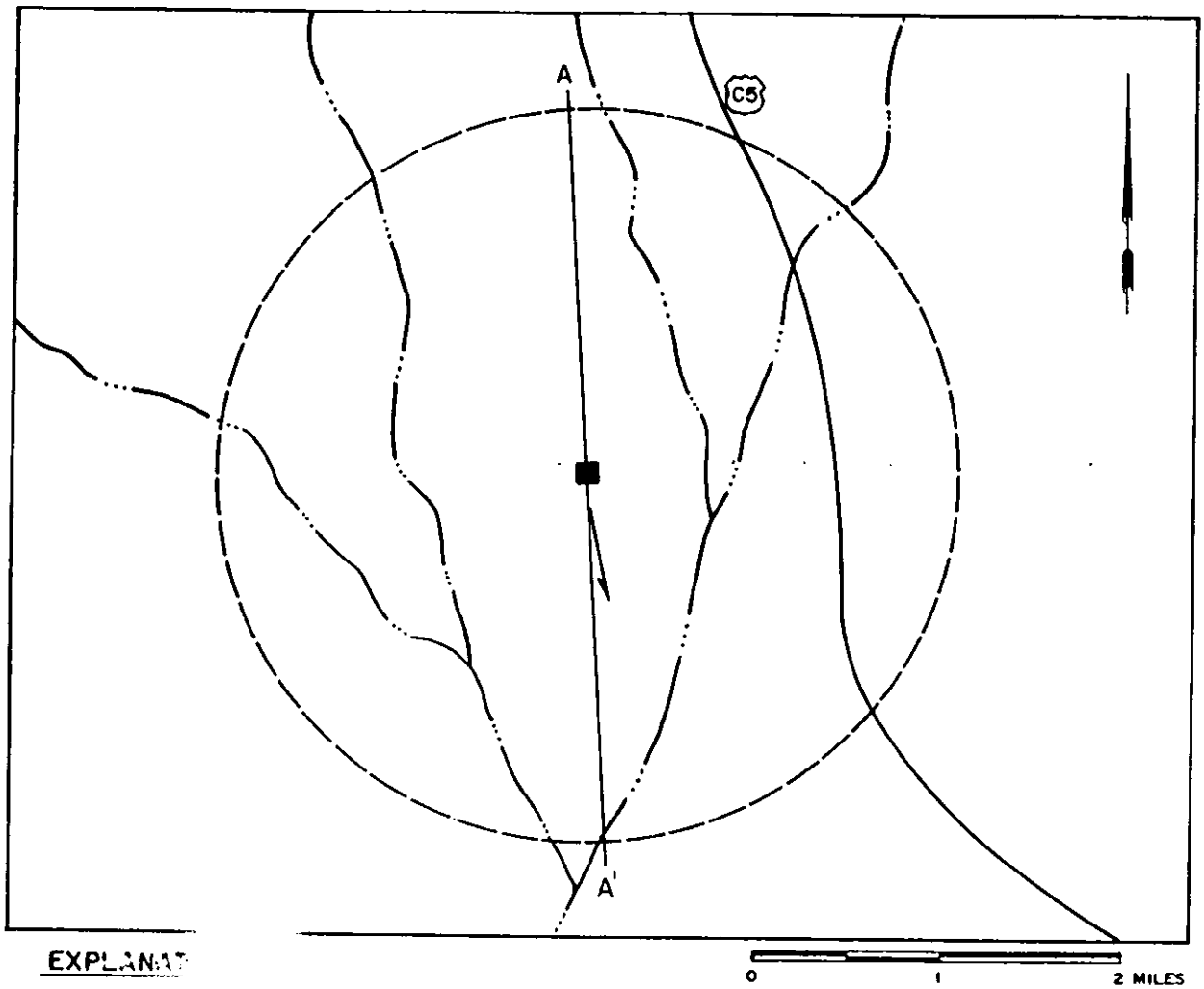
- An unconfined aquifer as the dominant aquifer
- Losing streams as the predominant source of ground-water discharge
- Transmissivities and flow velocities that are moderate to high (>250 m^2/d and >60 m/yr, respectively)
- Relatively low annual rainfall (less than 20 inches-per-year)

The expanded review area is based on a five-mile radius from the activity boundary. A five-mile radius was selected because calculation of ground-water velocities near the proposed facility was not possible due to a lack of information on ground-water gradients. Where velocity is known, the expanded review area radius is the distance water will flow in 50 years. Figure C4-2 shows the expanded review area.

General

A permit application is being submitted for a site in the Armadillo Desert in the Basin and Range physiographic province. The U.S. Geological Survey characterizes the regional landscape as broad, open, relatively flat-floored valleys, separated by rugged mountain ranges. Valley-fill

FIGURE C4-1
BASE MAP ENCOMPASSING THE TWO-MILE CLASSIFICATION REVIEW AREA



EXPLANATION

PROPOSED FACILITY

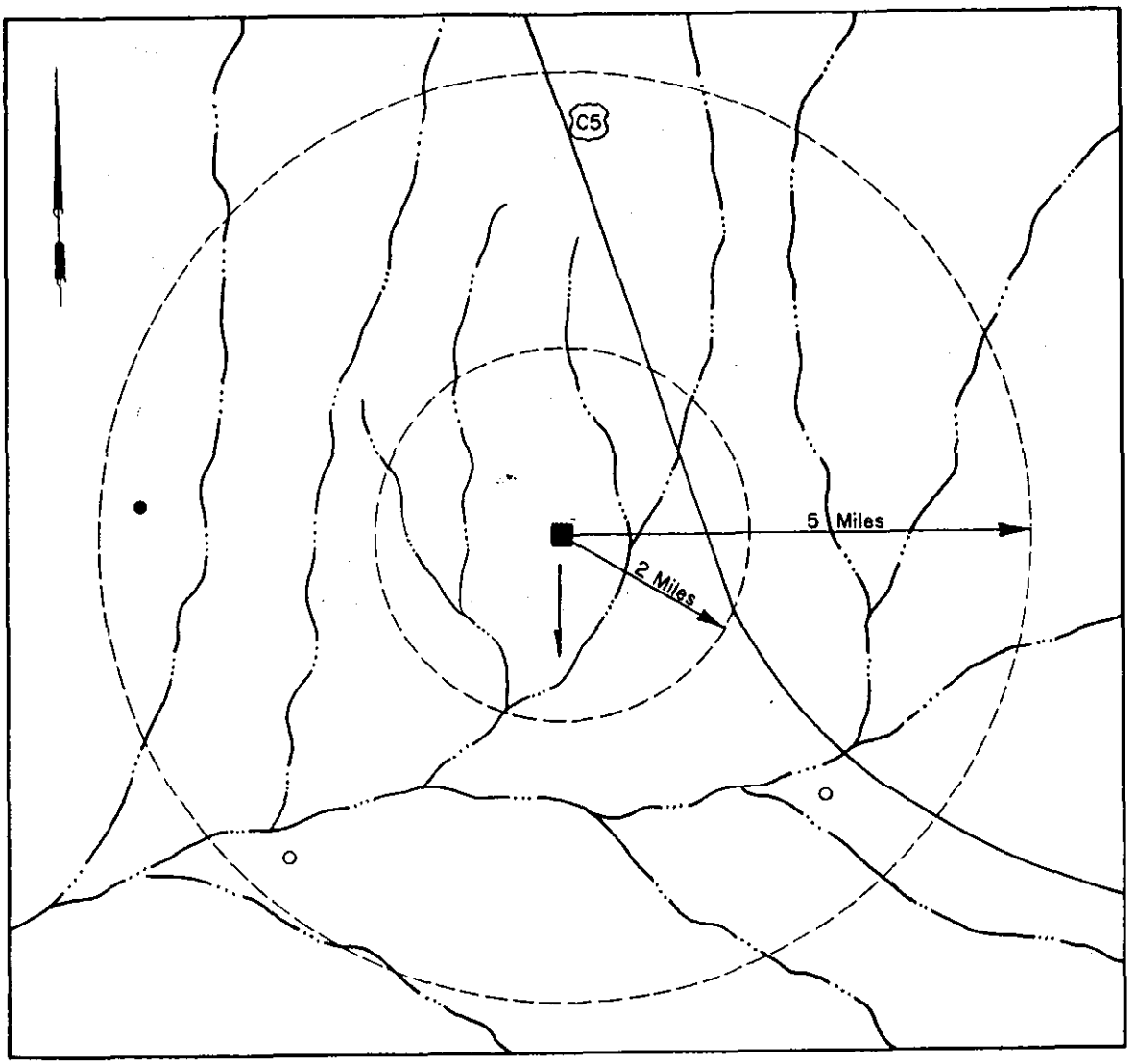
CLASSIFICATION REVIEW AREA BOUNDARY

INTERMITTENT STREAM

GROUND-WATER FLOW DIRECTION

ROADWAY

FIGURE C4-2
BASE MAP ENCOMPASSING THE EXPANDED CLASSIFICATION REVIEW AREA



EXPLANATION

- PROPOSED FACILITY
- CLASSIFICATION REVIEW AREA BOUNDARY
- INTERMITTENT STREAM
- GROUND-WATER FLOW DIRECTION
- ROADWAY
- RESIDENTIAL WELL
- IRRIGATION WELL

0 1 2 4 MILES

deposits are sands, gravels, and cobbles of local origin, transported to the site by alluvial and colluvial processes. A generalized cross-section of the hydrogeology within the five-mile Classsification Review Area was assembled based on a review of literature and well logs available for the region (see Figure C4-3). The uppermost aquifer is unconfined and has a transmissivity greater than 300 m^2/d.

The climate of the Armadillo Desert is characterized as arid. Average annual evapotranspiration exceeds average annual precipitation by an order of magnitude; hence, the area is normally water deficient. Ground-water recharge occurs primarily at the higher elevations as snow melt charged streams lose water into the ground.

Well/Reservoir Survey

No ground-water wells or drinking water reservoirs are present in the two-mile Classification Review Area. However, within the expanded Classification Review Area, there are two wells used for irrigration and one well used for water supply to a residence. If the permit is approved for the facility to begin operation, bottled drinking water will be delivered to the site for employee use.

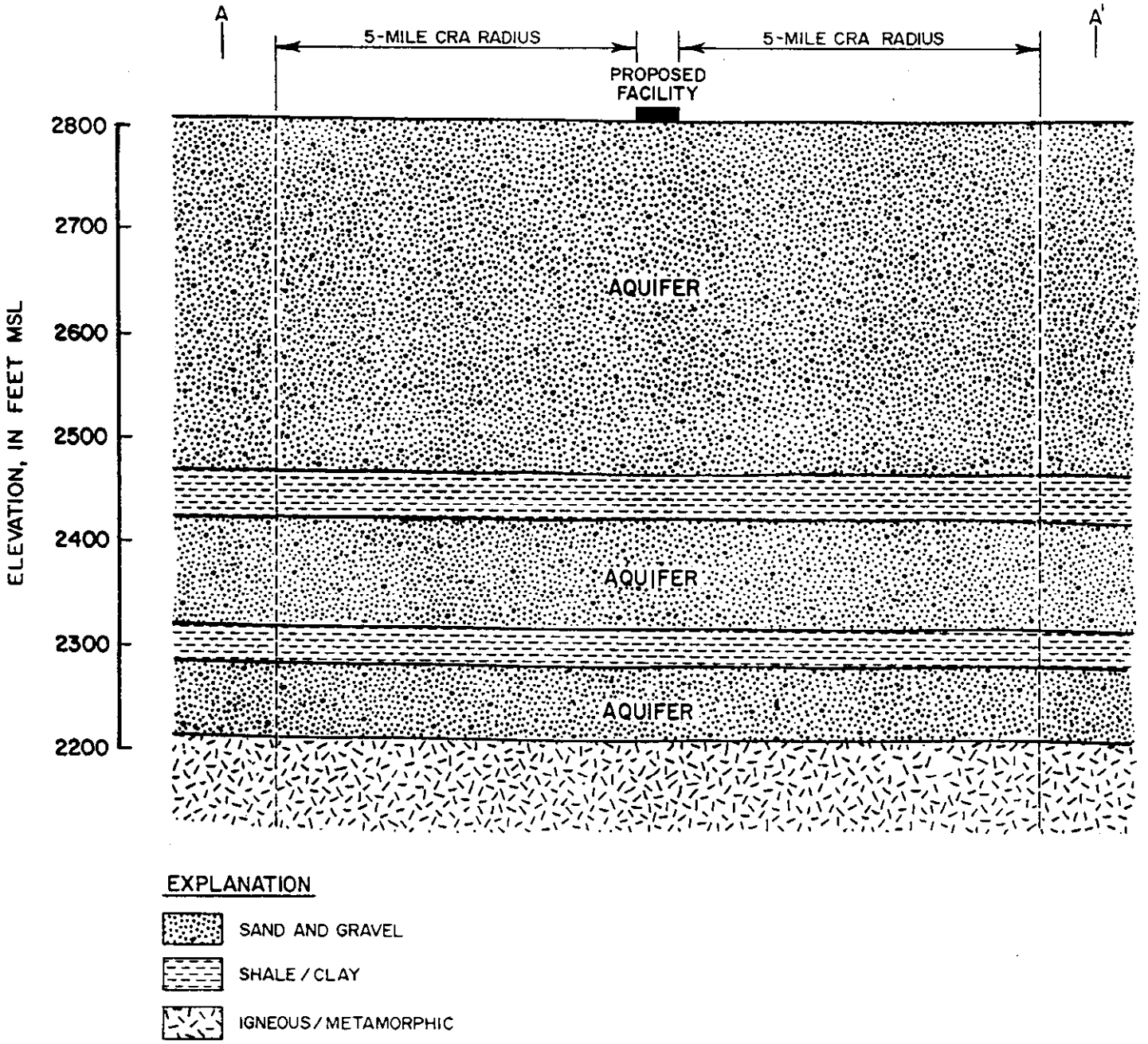
Demography

The nearest town is ten miles north of the proposed site and has an approximate population of 5,000. There are no known rural dwellings within a two-mile radius of the proposed site. There is one dwelling within the expanded review area.

Ecologically Vital Areas

No ground-water discharge areas, or Federal lands designated for ecological protection, are present in either the two-mile or expanded Classification Review Area.

FIGURE C4-3
GENERALIZED CROSS-SECTION OF THE HYDROGEOLOGY WITHIN THE EXPANDED CLASSIFICATION REVIEW AREA



Expanded Classification Review Area Decision

Referring to the Procedural Chart shown in Figure 4-1 and associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA has been expanded to a five-mile radius from the activity boundary because of an alluvial hydrogeological setting and a lack of information on ground-water velocities. No CRA subdivision has been performed.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area? . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water? . Yes, go to next Step . No, go to Step 8	Yes, one drinking-water well is present in the expanded CRA.
5	Inventory population served by well(s). Does the well(s) serve a substantial population? . Yes, go to next step . No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER	No, the well does not serve a substantial population as determined by Option A.

FINAL CLASS DETERMINATION: CLASS IIA-CURRENT SOURCE OF DRINKING WATER