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OPEN-FILE REPORT 80-UR – No. 2: BROOKINGS CITY - PROPOSED

STATEWIDE LANDFILL STUDY:
BROOKINGS CITY – PROPOSED LANDFILL SITE CHARACTERISTICS

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INTRODUCTION

Purpose and Scope

The purpose of this report is to summarize the geologic data, hydrologic data, and other site characteristics of the Brookings City landfill – Proposed locations 1, 2, and 3. This information was compiled as a part of the Statewide Landfill Study.

In 1984, the state of South Dakota had 38 permitted solid waste landfills, both private and public, that accepted waste other than ordinary household waste. A study was undertaken in an effort to evaluate selected landfills in South Dakota and identify those that may be best suited for the disposal of these special wastes.

This study was conducted by the South Dakota Geological Survey and the Office of Air Quality and Solid Waste of the Department of Water and Natural Resources, now known as the Department of Environment and Natural Resources. The Office of Air Quality and Solid Waste contracted with the South Dakota Geological Survey for certain geological services. The South Dakota Geological Survey contribution to this study was three-fold. First, available geologic and hydrologic data from landfills in South Dakota were reviewed and evaluated. Second, monitoring well systems were designed and installed at four landfills which were selected by the Office of Air Quality and Solid Waste. Finally, the geology was evaluated in more detail at these four landfills.

Selection of Sites

Existing information concerning 38 permitted and 2 proposed landfill sites was reviewed by the Office of Air Quality and Solid Waste in order to prioritize the sites. The Office of Air Quality and Solid Waste used this preliminary screening to reduce the number of potential sites from 40 to 26 (table 1 and fig. 1).

TABLE 1. List of sites considered for further evaluation

1. Belle Fourche City	14. Miedema City
2. Brookings City - Proposed	15. Milbank City
3. Brown County	16. Miller City
4. Brule County	17. Pierre City - Proposed
5. Byre (Private)	18. Pierre City - Old Site
6. Davison County	19. Ralph Dawson (Private)
7. De Smet City	20. Rapid City
8. Gregory County	21. Sioux Falls (Runge) City
9. Haarstad (Private)	22. Vermillion City
10. Huron City	23. Walworth County
11. John Clements (Private)	24. Watertown City
12. Kadoka City	25. Winner City
13. Marshall County	26. Yankton County

Subsequently, the South Dakota Geological Survey evaluated these 26 sites and prepared a draft report describing each site. No field checking was done. Topics such as topography, drainage, climate, soils, geology, hydrology, water quality, adjacent land use, hazardous waste records, and operational practices were addressed. These reports included copies of available maps, lithologic logs, and water quality analyses. Draft copies of these unpublished reports are on file at the Department of Environment and Natural Resources in Pierre and the South Dakota Geological Survey in Vermillion. The individual report on the Brookings City landfill – Proposed locations 1, 2, and 3 is the basis for this report.

After the initial assessment of the 26 sites, the Office of Air Quality and Solid Waste established criteria for further prioritizing the sites. Four sites were selected for the installation of monitoring wells. The South Dakota Geological Survey conducted detailed investigations at the Brown County, Watertown City, Yankton County, and Rapid City landfills (fig. 1). A draft copy of the unpublished summary report is on file at the Department of Environment and Natural Resources in Pierre and the South Dakota Geological Survey in Vermillion. The following information was available regarding the Brookings City landfill - Proposed locations 1, 2, and 3 in 1986.

BROOKINGS CITY LANDFILL – PROPOSED LOCATIONS 1, 2, AND 3

In 1985, the city of Brookings was in the process of locating a new landfill site and was considering three locations (fig. 2). The South Dakota Geological Survey conducted preliminary drilling at two of the three locations under consideration. Please refer to Frykman (1986) for detailed information.

Location

The city of Brookings in Brookings County considered the following three locations as potential landfill sites.

PROPOSED LOCATION 1 is 2½ miles north of Brookings. Its legal location is W½ sec. 36, T. 111 N., R. 50 W. (fig. 2),

PROPOSED LOCATION 2 is 1½ miles north of Brookings. Its legal location is SW¼ and E½ sec. 3, T. 110 N., R. 50 W. (fig. 2), and

PROPOSED LOCATION 3 is 1½ miles north of Brookings. Its legal location is S½ sec. 2, T. 110 N., R. 50 W. (fig. 2).

Topography, Drainage, and Climate

Information on topography and drainage was taken from the Brookings Quadrangle and the Brookings NE Quadrangle (United States Geological Survey, 1964 and 1968).

PROPOSED LOCATION 1: The topography at this proposed site slopes gently to the northwest (fig. 3). The elevation ranges from 1,669 to 1,732 feet for a maximum relief of 63 feet at the site.

Two intermittent streams drain Proposed location 1. One intermittent stream is located in the northeast corner of the site, and the other cuts across the southern half of the site. Both intermittent streams drain into North Deer Creek and subsequently into the Big Sioux River.

PROPOSED LOCATION 2: The topography at Proposed location 2 is a single hilltop (fig. 4) gently sloping downward in all directions. The elevation ranges from 1,654 to 1,710 feet for a maximum relief of 56 feet at the site.

Intermittent streams drain this topographic high. A portion of one intermittent stream drains the north-central part of section 4. This stream drains into North Deer Creek and subsequently into the Big Sioux River.

PROPOSED LOCATION 3: The topography at Proposed location 3 is a broad, shallow valley (fig. 5). The elevation ranges from 1,656 to 1,697 feet for a maximum relief of 41 feet at the site.

An intermittent stream cuts across the western half of Proposed location 3. This stream drains into North Deer Creek and subsequently into the Big Sioux River.

The average annual temperature in Brookings County is 44 degrees Fahrenheit. Precipitation averages 22 inches per year. The average annual class A pan evaporation is 48 inches. Climatological data are from Spuhler and others (1971).

Geology

Locations of test holes drilled near the three proposed landfill locations are given in figure 6 and a listing of the legal locations for the corresponding lithologic logs are given in appendix A. Only data meeting South Dakota Geological Survey criteria were used in this study. Lithologic logs were utilized if the legal locations were known to four quarter sections (2.5 acres) and if they were located within the landfill site or within 1 mile of the site boundaries. Also, the source of a log must have been known or the log was not utilized; for example, all logs of test holes drilled by the South Dakota Geological Survey identify the drilling company as "SDGS."

PROPOSED LOCATION 1: Surficial deposits at this prospective site consist of ground moraine (fig. 7). Thirty-four test holes were drilled within the proposed site boundaries in the western half of section 36 (fig. 8, app. B). In general, 2 to 3 feet of topsoil was found overlying clay (till) to a depth of 48 feet. Test hole A2-85-201 encountered sand from 45 to 48 feet within the till. Test hole CO-85-105 encountered sand and gravel from 84 to 100 feet within the till.

Within 1 mile, four additional drilling logs were found (fig. 6, app. A). At test hole A2-82-45 north of the landfill, 2 feet of soil were found overlying alternating layers of clay and sand or gravel. The hole was completed in clay (till) at 28 feet. At test hole A2-82-56 northeast of the landfill, 2 feet of soil were found overlying 3 feet of alluvium (clay). Gravel was encountered from 5 to 14 feet and the hole was completed at 28 feet in clay (till). Test hole A2-82-46 was drilled in a terrace deposit northwest of the landfill and it encountered 1 foot of soil overlying 5 feet of clay. Sand was present between 6 and 10 feet followed by gravel from 10 to 15 feet. The hole was completed in clay (till) at 28 feet. Test hole A2-82-47 was drilled in the Big Sioux aquifer west of the landfill and it encountered 1 foot of soil overlying 10 feet of clay. Sand was present between 11 and 20 feet, followed by gravel to 24 feet. The hole was completed in clay (till) at 30 feet. At test hole A2-82-149, a 28-foot hole was drilled. Topsoil 1 foot thick was found overlying 3 feet of clay, 7 feet of sand, and 17 feet of clay (till).

PROPOSED LOCATION 2: Surficial deposits at this prospective site consist of ground moraine with outwash (sand and gravel) at the southeast boundary of the site (fig. 9). Forty-six test holes were drilled within the proposed site boundaries (fig. 10, app. C). In general, 1 to 4 feet of topsoil was found overlying clay (till) to a depth of 48 feet. Sand or gravel layers from 1 to 10 feet thick were encountered in eight of these test holes.

Seven additional test holes have been completed within 1 mile of this proposed site (fig. 6, app. A). Test holes A2-82-150, A2-82-49, and A1-82-300 encountered only clay till to a depth of 28 feet. Test holes A2-84-13, 6, A2-82-48, and A2-82-47 contained between 5 and 27 feet of sand or gravel at depths less than 28 feet from the surface.

PROPOSED LOCATION 3: There is no site specific test hole geological information available for Proposed location 3. As shown in figure 11, surface deposits in this area consist of ground moraine with a minor amount of alluvium in the southwest corner. Permission was not granted to the South Dakota Geological Survey to drill at this location in 1985 when the other two sites were investigated.

Numerous test holes have been drilled within 1 mile of Proposed location 3 (fig. 6, app. A). At test hole A2-82-149, a 28-foot hole was drilled. Topsoil 1 foot thick was found overlying 3 feet of clay, 7 feet of sand, and 17 feet of clay (till). To the north and east, refer to Proposed location 1 (fig. 8, app. B). To the west and south, refer to Proposed location 2 (fig. 10, app. C).

Hydrology

The material at the base of the proposed landfill sites consists primarily of clay-rich till. The permeability of till is difficult to characterize due to the highly variable nature of its physical composition and texture (i.e., grain size) in both the vertical and horizontal directions. Fractures, if any, in the upper weathered portion of the till can also contribute to significant spatial changes in permeability. Let it suffice to say that till, as a unit, generally has much lower permeability than sand or gravel. No site specific permeability data are available.

No monitoring wells are present within 1 mile of these three proposed landfill locations. Without the presence of adequately constructed monitoring wells (a minimum of three) in the proper locations and at the proper depths, the lateral hydraulic gradient and direction of potential ground water movement cannot be estimated for the area. The nearest ground water supply (aquifer) is unknown.

Water Quality

No water quality data were available for these three proposed landfill locations or within 1 mile of the site boundaries.

Adjacent Land Use and Features

Information about adjacent land use and features was taken from the Brookings Quadrangle and the Brookings NE Quadrangle (United States Geological Survey, 1964 and 1968) and the General Highway Map - Brookings County (South Dakota Department of Transportation, 1977).

PROPOSED LOCATION 1:

- * Interstate 29 is located 1 mile east of Proposed location 1. Old Highway 77 is adjacent to Proposed location 1, forming the western boundary.
- * There is no surface water near Proposed location 1.

PROPOSED LOCATION 2:

- * There is no surface water near Proposed location 2.

PROPOSED LOCATION 3:

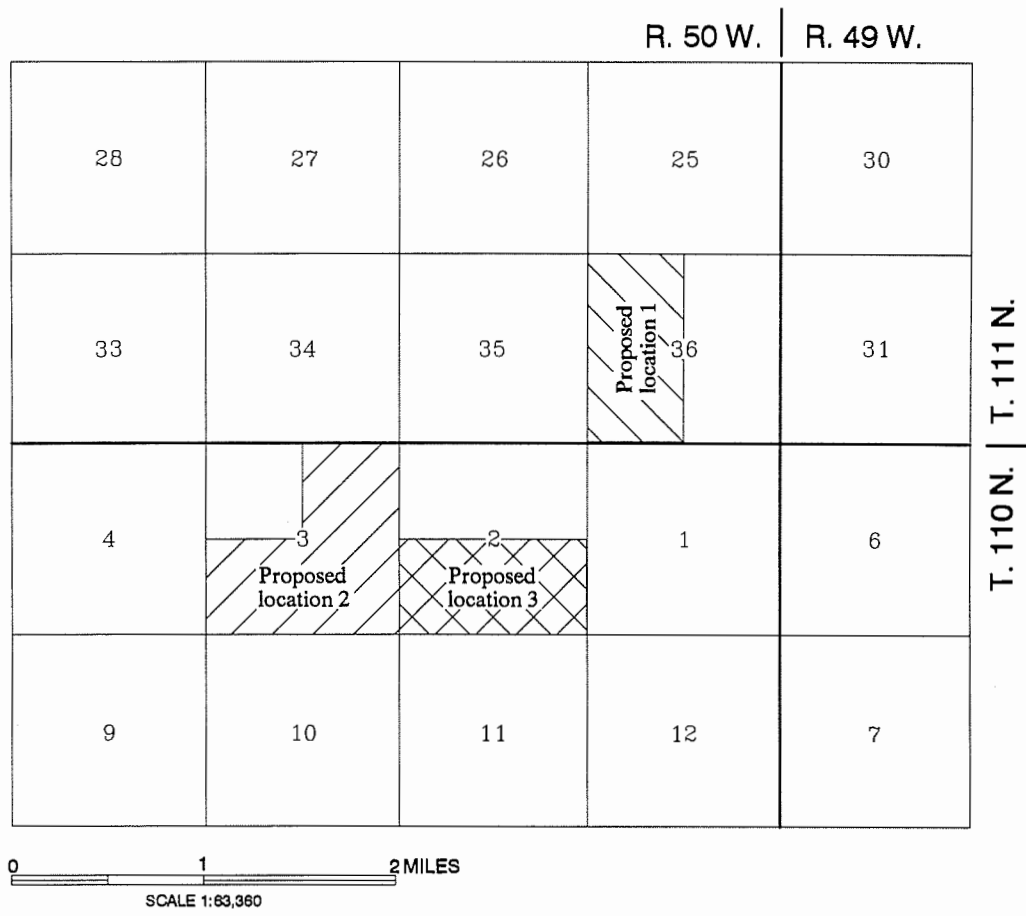
- * Two power stations are located within half a mile of Proposed location 3.
- * There is no surface water near Proposed location 3.




SUMMARY

- * The geology of this area generally consists of topsoil overlying till. Sand or gravel intervals of variable thickness are present at various depths in the till. The lateral continuity of the sand and gravel intervals is unknown. Outwash and alluvial deposits are also present in the area.
- * Many test hole data were available near all three proposed locations.
- * No monitoring wells were present near these three proposed locations.
- * No water level data were available near these three proposed locations.
- * No water quality data were available near these three proposed locations..

REFERENCES CITED

- Frykman, L., 1986, Sanitary landfill investigation for the city of Brookings, South Dakota: South Dakota Geological Survey Open-File Report 42-UR, 64 p.
- Lee, K.Y., 1958, Geology of the Brookings quadrangle: South Dakota Geological Survey Geologic Quadrangle Map, scale 1:62,500, text.
- South Dakota Department of Transportation, 1977, General Highway Map Brookings County, South Dakota: South Dakota Department of Transportation in cooperation with the United States Department of Transportation, (revisions as of June 15, 1978).
- Spuhler, W., Lytle, W.F., and Moe, D., 1971, Climate of South Dakota: Brookings, South Dakota, South Dakota State University Agricultural Experiment Station Bulletin 582, 30 p.
- United States Geological Survey, 1964, Brookings quadrangle, South Dakota: 7.5 minute series (topographic), scale 1:24,000, (photorevised in 1981).
- _____, 1968, Brookings NE quadrangle, South Dakota: 7.5 minute series (topographic), scale 1:24,000, (photorevised in 1981).



-  Proposed location 1
-  Proposed location 2
-  Proposed location 3

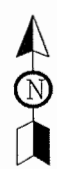
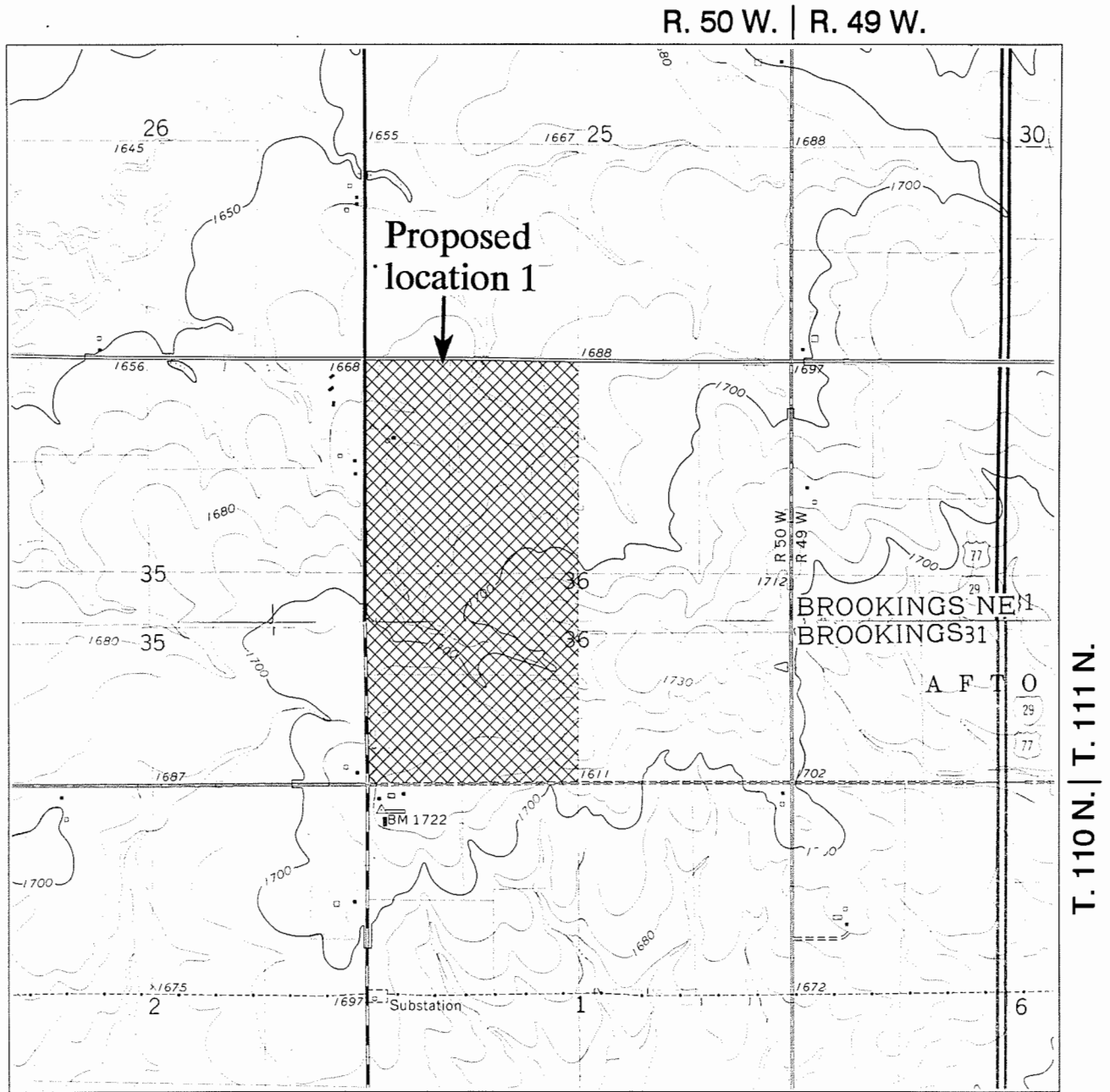
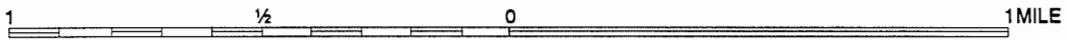


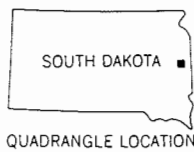
Figure 2. Proposed locations 1, 2, and 3 for the Brookings City landfill.



SCALE 1:24000



CONTOUR INTERVAL 10 FEET, BROOKINGS NE QUADRANGLE
 CONTOUR INTERVAL 10 FEET, BROOKINGS QUADRANGLE



Proposed location 1: W $\frac{1}{2}$ sec. 36,
 T. 111 N., R. 50 W.
 Brookings County



Adapted from United States
 Geological Survey (1964 and 1968)

Figure 3. Location of the Brookings City landfill - Proposed location 1.

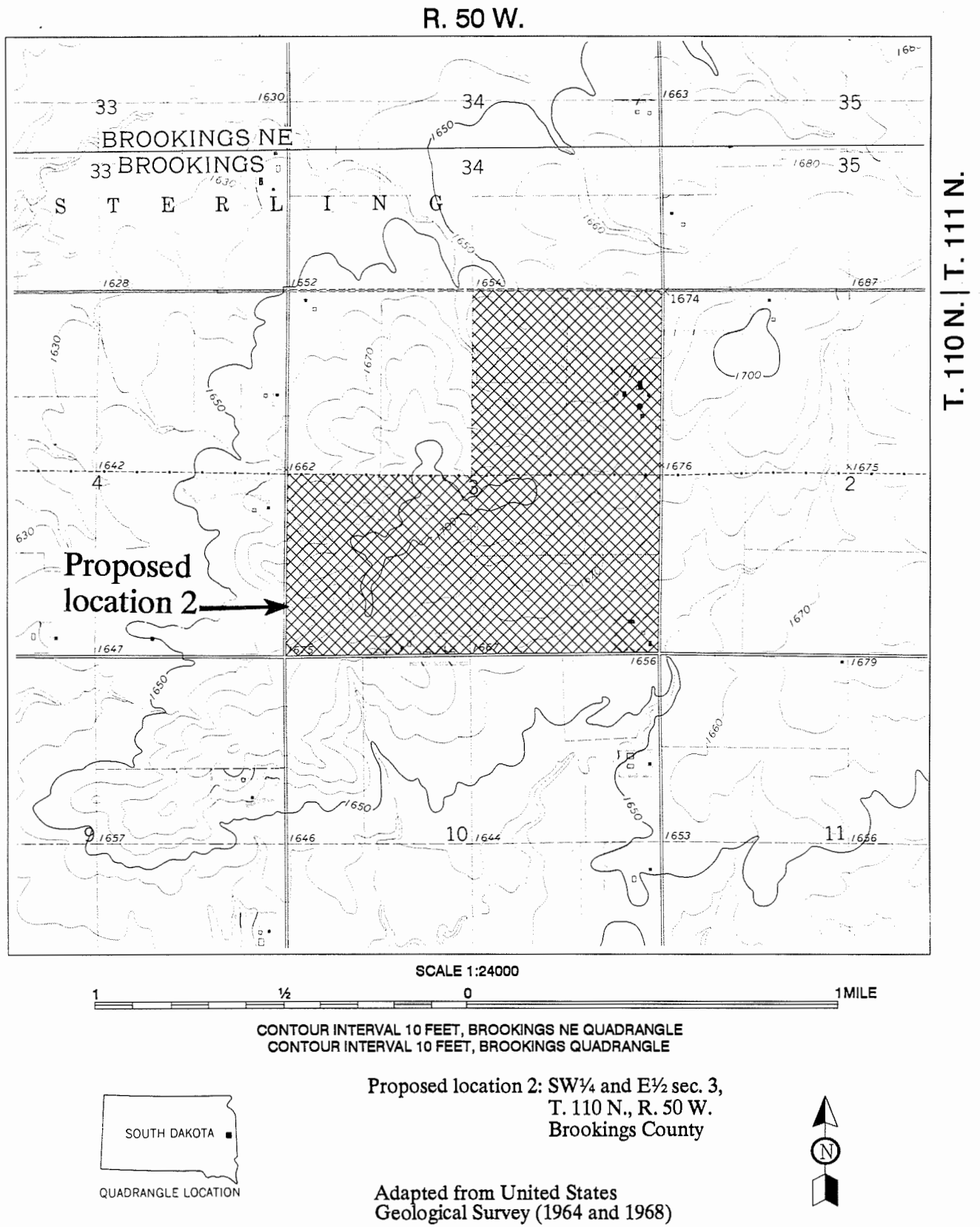
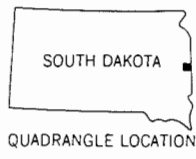
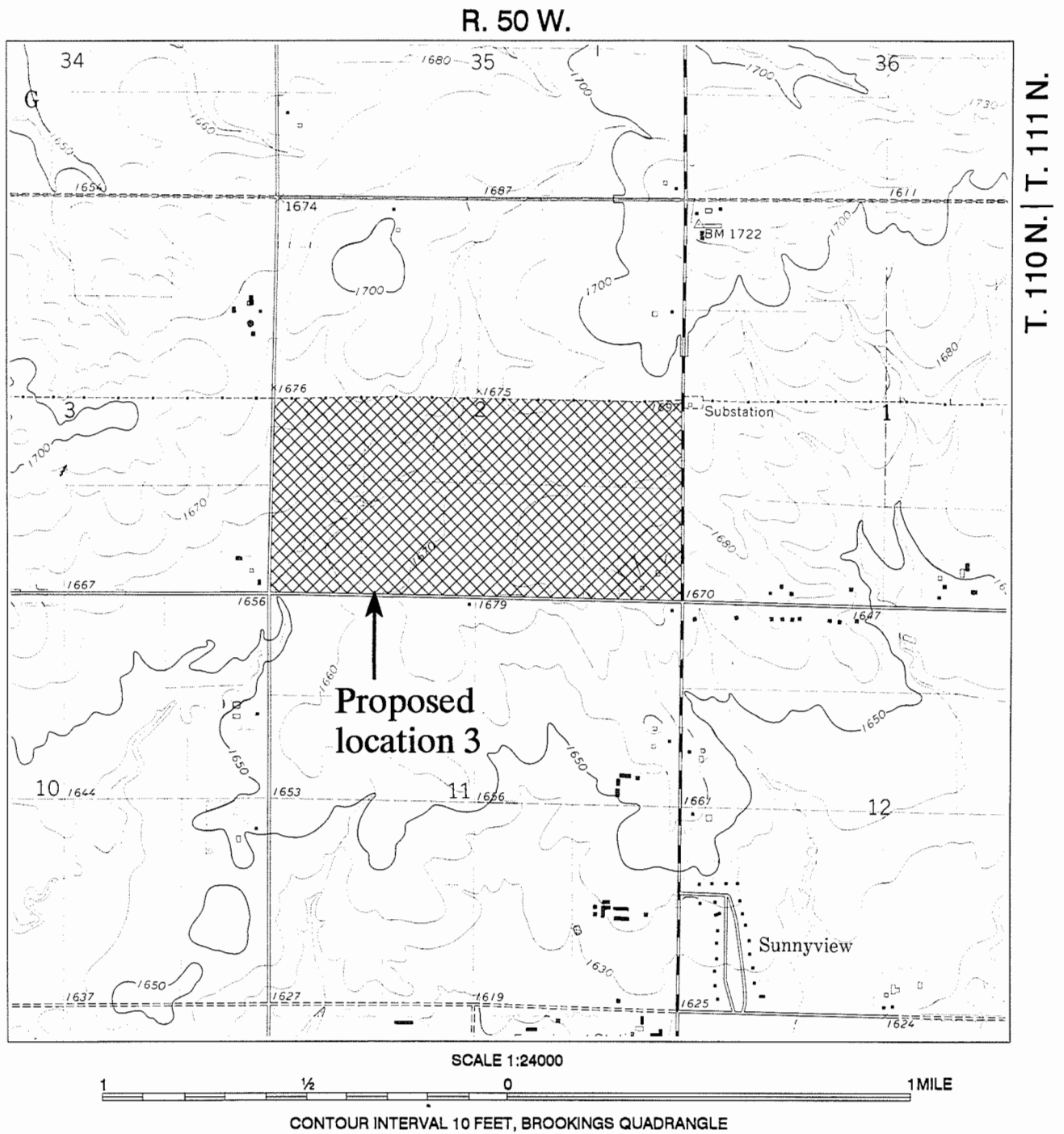
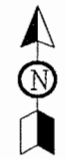


Figure 4. Location of the Brookings City landfill - Proposed location 2.

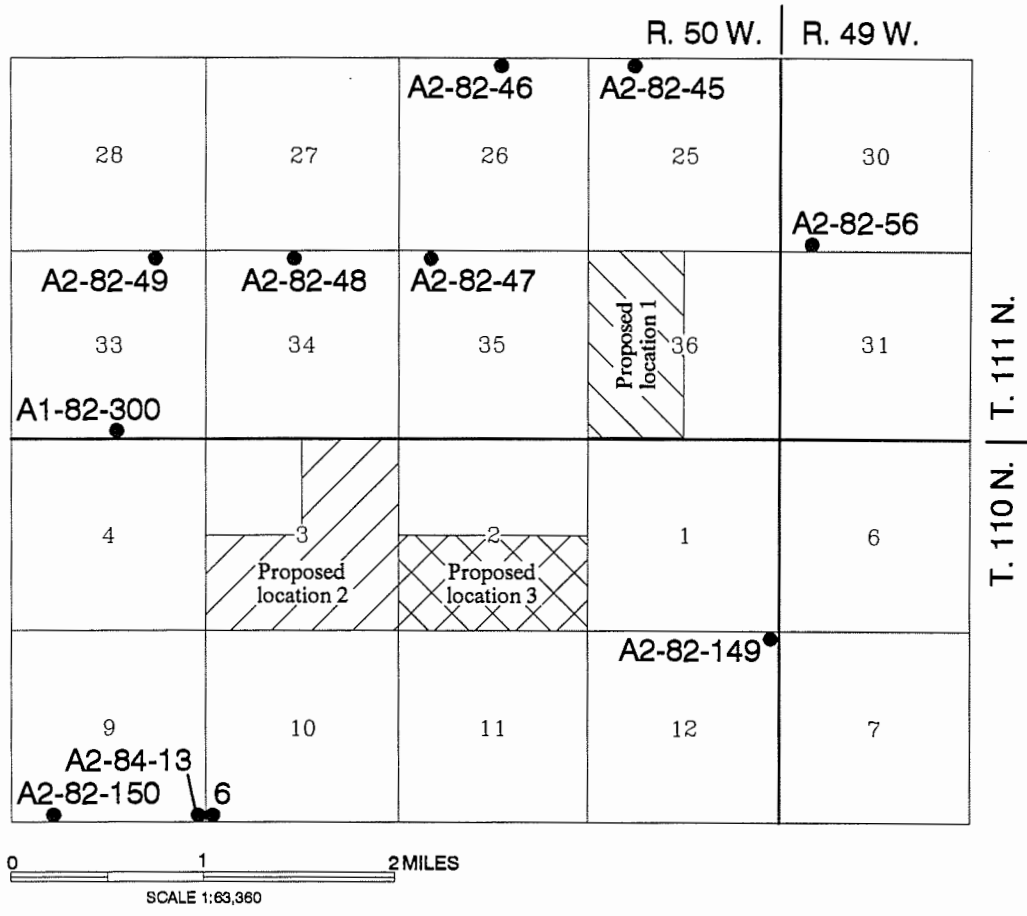


Proposed location 3: S½ sec. 2,
T. 110 N., R. 50 W.
Brookings County



Adapted from United States
Geological Survey (1968)

Figure 5. Location of the Brookings City landfill - Proposed location 3.

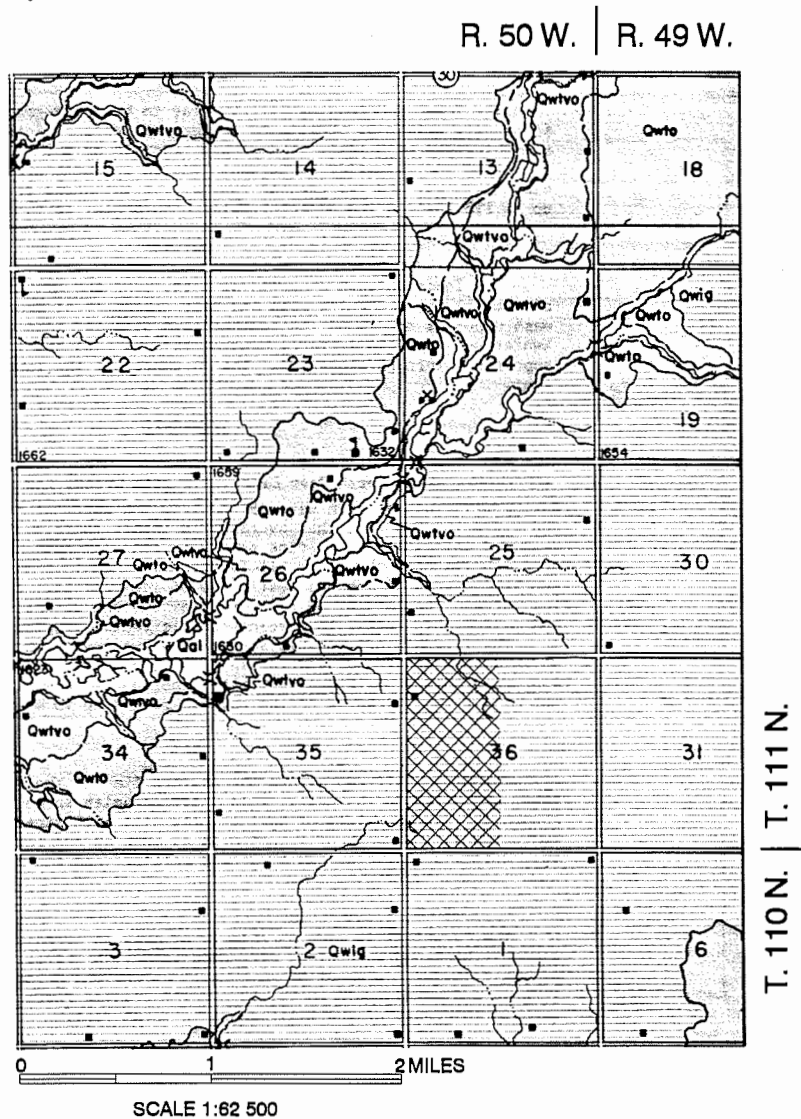


A2-82-47 ● Test hole. Letter and numbers are the test hole identifier.

- Proposed location 1
- Proposed location 2
- Proposed location 3



Figure 6. Locations of test holes drilled near the Brookings City landfill - Proposed locations 1, 2, and 3.



Qal..... Alluvium

Qwtvo..... Tazewell outwash - valley train

Qwto..... Tazewell outwash - kame terrace

Qwig..... Iowan ground moraine

Proposed location 1

Adapted from Lee (1958)



Figure 7. Geology near the Brookings City landfill - Proposed location 1.

R. 50 W.

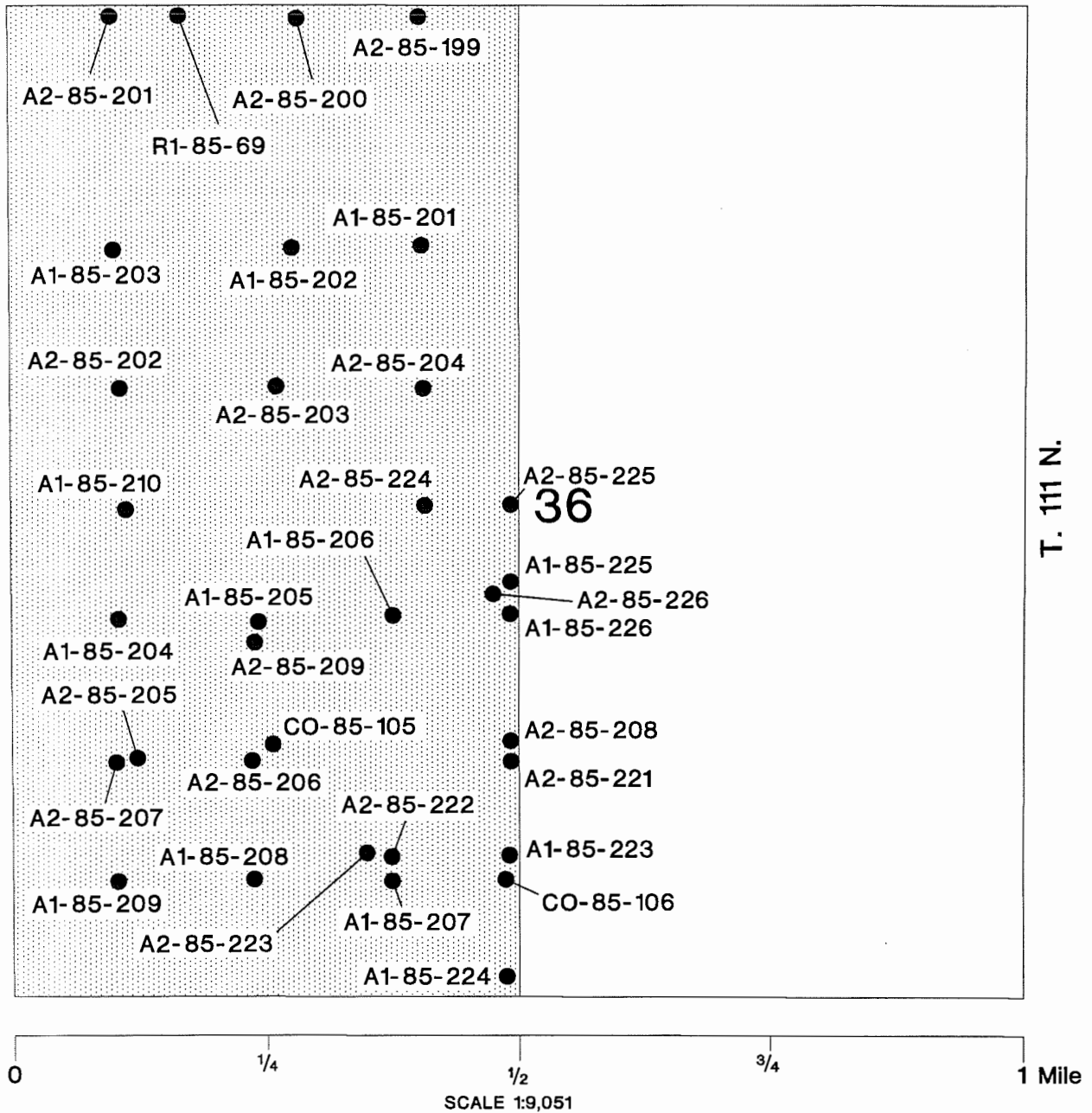
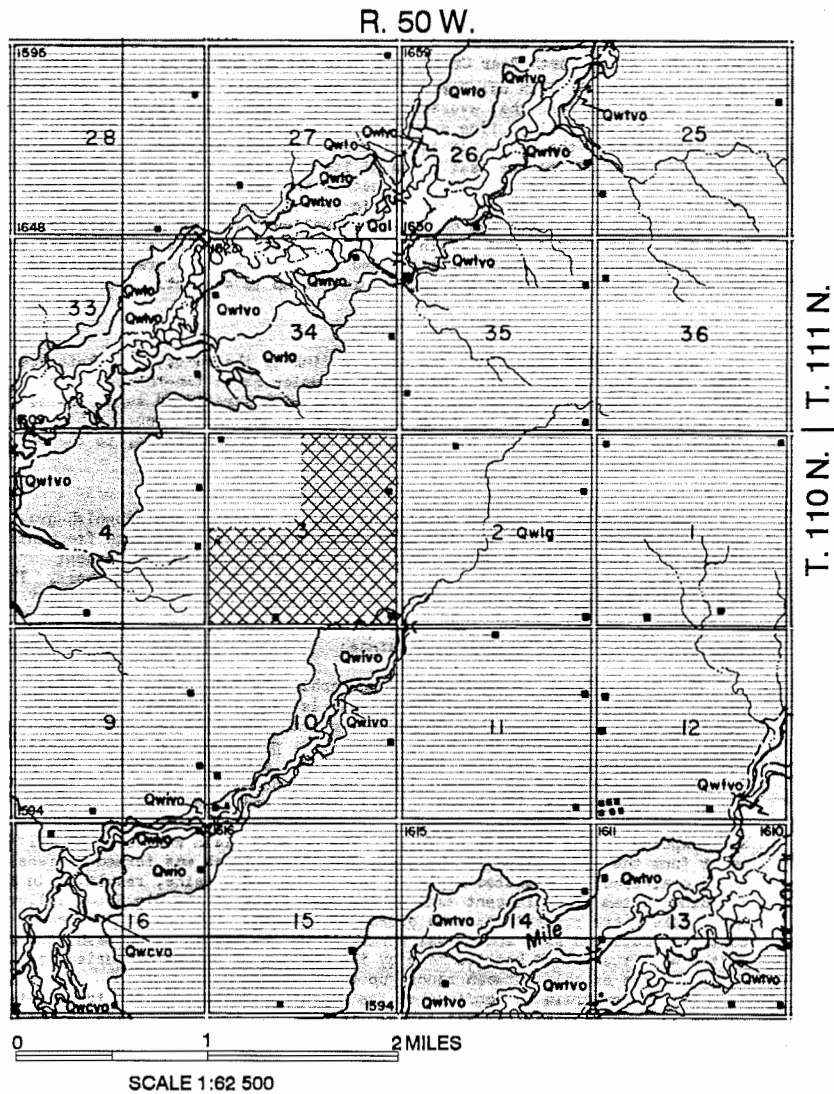


Figure 8. Locations of test holes drilled at the Brookings City landfill - Proposed location 1.



Qal..... Alluvium

Qwcvo..... Cary outwash - valley train

Qwtvo..... Tazewell outwash - valley train

Qwto..... Tazewell outwash - kame terrace

Qwivo..... Iowan outwash - valley train

Qwio..... Iowan outwash - terrace

Qwig..... Iowan ground moraine

▣ Proposed location 2

Adapted from Lee (1958)



Figure 9. Geology near the Brookings City landfill - Proposed location 2.

R. 50 W.

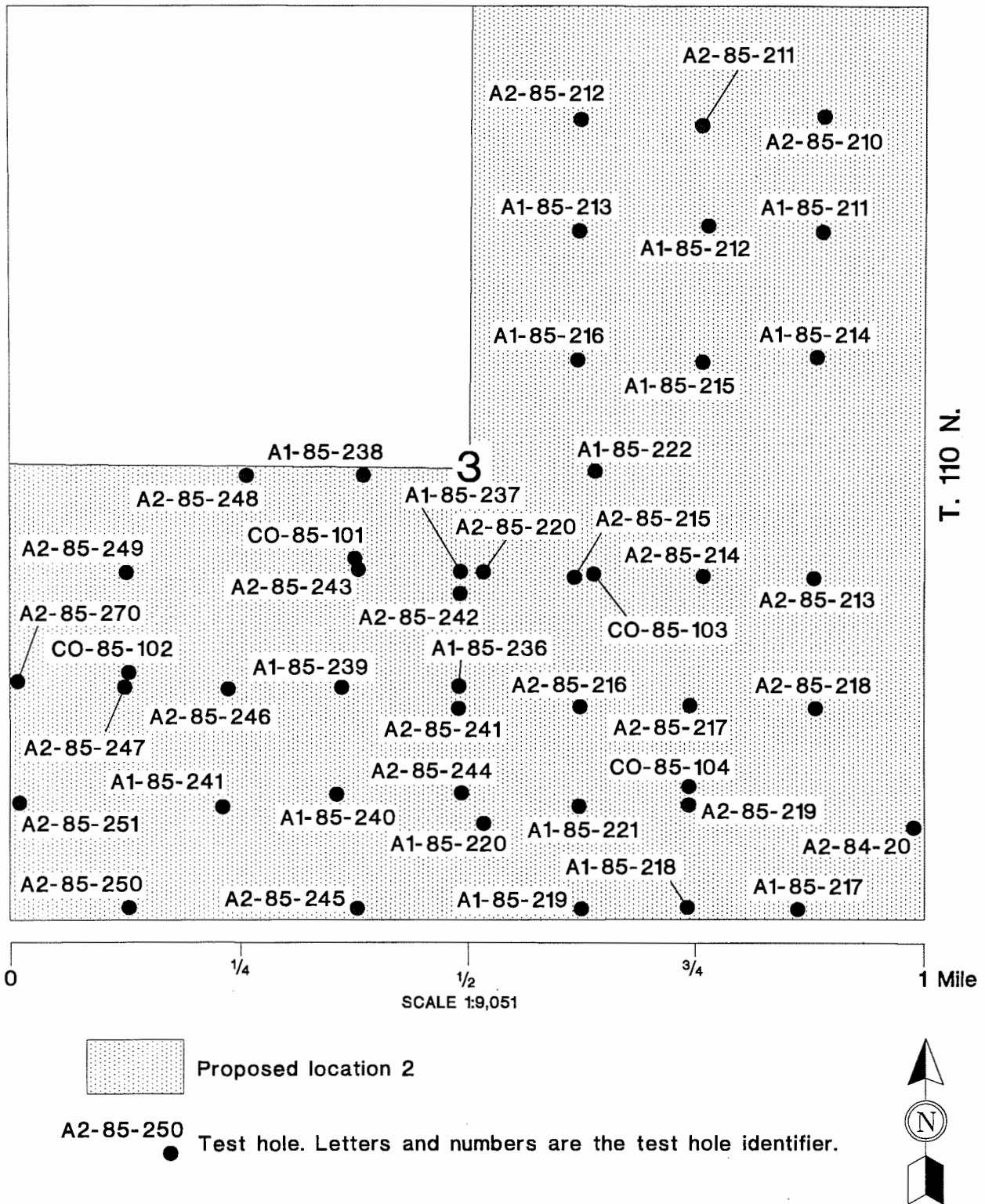
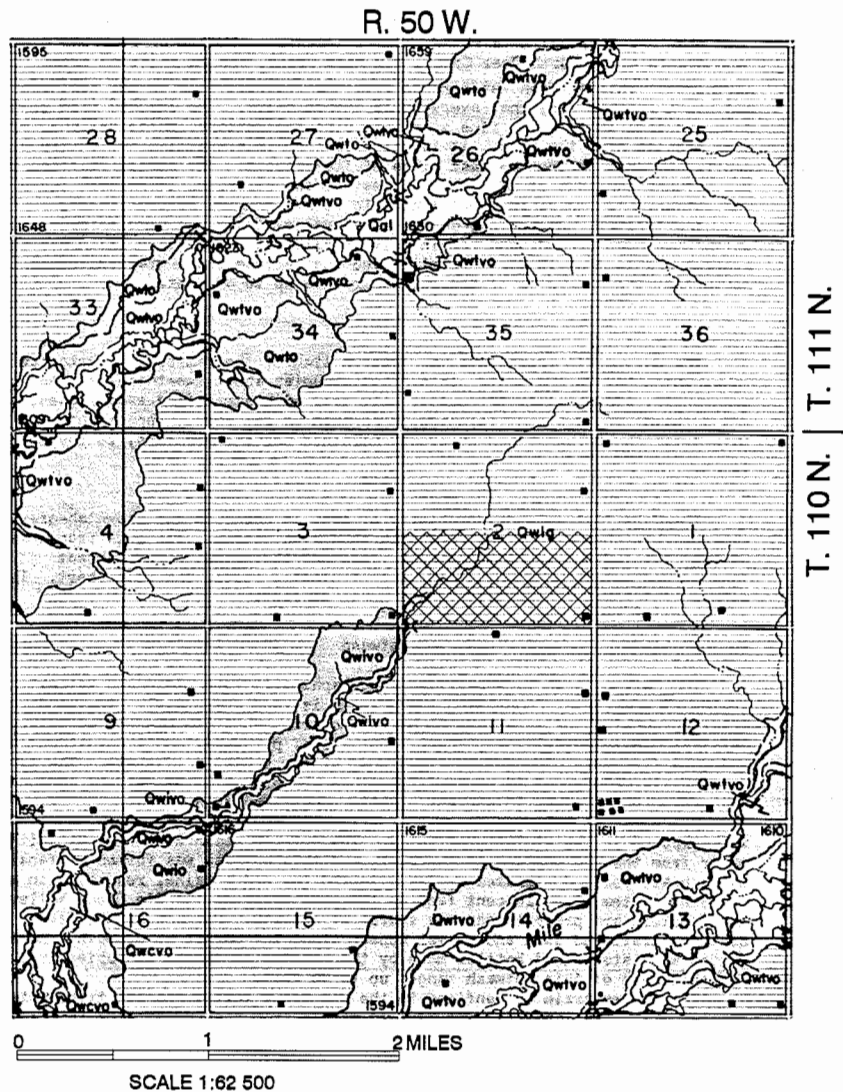


Figure 10. Locations of test holes drilled at the Brookings City landfill - Proposed location 2.



- Qal..... Alluvium
- Qwvo..... Cary outwash - valley train
- Qwto..... Tazewell outwash - valley train
- Qwto..... Tazewell outwash - kame terrace
- Qwivo..... Iowan outwash - valley train
- Qwio..... Iowan outwash - terrace
- Qwig..... Iowan ground moraine
- ▣ Proposed location 3

Adapted from Lee (1958)

Figure 11. Geology near the Brookings City landfill - Proposed location 3.

APPENDIX A

Legal locations of lithologic logs for the area near the three proposed Brookings City landfill locations

Listed below are the legal locations of those test holes cited in this report. Please contact the South Dakota Geological Survey if a copy of a lithologic log is needed.

SW	SE	SW	SW	sec. 09,	T. 110 N.,	R. 50 W.
SE	SE	SE	SE	sec. 09,	T. 110 N.,	R. 50 W.
SW	SW	SW	SW	sec. 10,	T. 110 N.,	R. 50 W.
NE	NE	NE	NE	sec. 12,	T. 110 N.,	R. 50 W.
SE	SW	SW	SW	sec. 30,	T. 111 N.,	R. 49 W.
NE	NE	NW	NW	sec. 25,	T. 111 N.,	R. 50 W.
NE	NE	NE	NW	sec. 26,	T. 111 N.,	R. 50 W.
NE	NE	NW	NE	sec. 33,	T. 111 N.,	R. 50 W.
SW	SE	SW	SE	sec. 33,	T. 111 N.,	R. 50 W.
NW	NW	NW	NE	sec. 34,	T. 111 N.,	R. 50 W.
NE	NE	NW	NW	sec. 35,	T. 111 N.,	R. 50 W.

APPENDIX B

Legal locations of test hole logs within the Brookings City landfill – Proposed location 1

Listed below are the legal locations of those test holes cited in this report. Please contact the South Dakota Geological Survey if a copy of a lithologic log is needed. If a legal location is duplicated, that means more than one test hole has been drilled at that location.

NW NE NE NW	sec. 36,	T. 111 N.,	R. 50 W.
NW NW NE NW	sec. 36,	T. 111 N.,	R. 50 W.
SW SW NE NW	sec. 36,	T. 111 N.,	R. 50 W.
SW SE NE NW	sec. 36,	T. 111 N.,	R. 50 W.
NW NE NW NW	sec. 36,	T. 111 N.,	R. 50 W.
NE NW NW NW	sec. 36,	T. 111 N.,	R. 50 W.
SE SW NW NW	sec. 36,	T. 111 N.,	R. 50 W.
NE SW SW NW	sec. 36,	T. 111 N.,	R. 50 W.
NW SW SE NW	sec. 36,	T. 111 N.,	R. 50 W.
NW SE SE NW	sec. 36,	T. 111 N.,	R. 50 W.
NE NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
NW NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SW NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SW SW NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE SE NE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NE NW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE NW NW SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NW NW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE SE NW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE NE SW SW	sec. 36,	T. 111 N.,	R. 50 W.
NW NE SW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE NW SW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE SW SW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE SE SW SW	sec. 36,	T. 111 N.,	R. 50 W.
NE NE SE SW	sec. 36,	T. 111 N.,	R. 50 W.
SW NE SE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NE SE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE NW SE SW	sec. 36,	T. 111 N.,	R. 50 W.
NE SE SE SW	sec. 36,	T. 111 N.,	R. 50 W.
NW SE SE SW	sec. 36,	T. 111 N.,	R. 50 W.
SE SE SE SW	sec. 36,	T. 111 N.,	R. 50 W.

APPENDIX C

Legal locations of test hole logs within the Brookings City landfill – Proposed location 2

Listed below are the legal locations of those test holes cited in this report. Please contact the South Dakota Geological Survey if a copy of a lithologic log is needed. If a legal location is duplicated, that means more than one test hole has been drilled at that location.

SW NE NE NE	sec. 03,	T. 110 N.,	R. 50 W.
SW NW NE NE	sec. 03,	T. 110 N.,	R. 50 W.
SW SW NE NE	sec. 03,	T. 110 N.,	R. 50 W.
SW SE NE NE	sec. 03,	T. 110 N.,	R. 50 W.
SE NW NW NE	sec. 03,	T. 110 N.,	R. 50 W.
SE SW NW NE	sec. 03,	T. 110 N.,	R. 50 W.
NE SW SW NE	sec. 03,	T. 110 N.,	R. 50 W.
NW SW SE NE	sec. 03,	T. 110 N.,	R. 50 W.
NW SE SE NE	sec. 03,	T. 110 N.,	R. 50 W.
NW NE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SW NE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SW NE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SE NE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
NW NW NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SE SW NE SW	sec. 03,	T. 110 N.,	R. 50 W.
NE SE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SE SE NE SW	sec. 03,	T. 110 N.,	R. 50 W.
SW NE NW SW	sec. 03,	T. 110 N.,	R. 50 W.
SW SW NW SW	sec. 03,	T. 110 N.,	R. 50 W.
SW SE NW SW	sec. 03,	T. 110 N.,	R. 50 W.
SW SE NW SW	sec. 03,	T. 110 N.,	R. 50 W.
SE SE NW SW	sec. 03,	T. 110 N.,	R. 50 W.
NW SW SW SW	sec. 03,	T. 110 N.,	R. 50 W.
NE SE SW SW	sec. 03,	T. 110 N.,	R. 50 W.
SW SE SW SW	sec. 03,	T. 110 N.,	R. 50 W.
NE NE SE SW	sec. 03,	T. 110 N.,	R. 50 W.
SE NE SE SW	sec. 03,	T. 110 N.,	R. 50 W.
SE NW SE SW	sec. 03,	T. 110 N.,	R. 50 W.
SW SE SE SW	sec. 03,	T. 110 N.,	R. 50 W.
SW NE NE SE	sec. 03,	T. 110 N.,	R. 50 W.
SW NW NE SE	sec. 03,	T. 110 N.,	R. 50 W.
NW NE NW SE	sec. 03,	T. 110 N.,	R. 50 W.
SW NE NW SE	sec. 03,	T. 110 N.,	R. 50 W.
SW NW NW SE	sec. 03,	T. 110 N.,	R. 50 W.
SE NW NW SE	sec. 03,	T. 110 N.,	R. 50 W.

APPENDIX C – continued.

NE NE SW SE sec. 03, T. 110 N., R. 50 W.
SE NE SW SE sec. 03, T. 110 N., R. 50 W.
SE NE SW SE sec. 03, T. 110 N., R. 50 W.
NE NW SW SE sec. 03, T. 110 N., R. 50 W.
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