SAVE - ACKER

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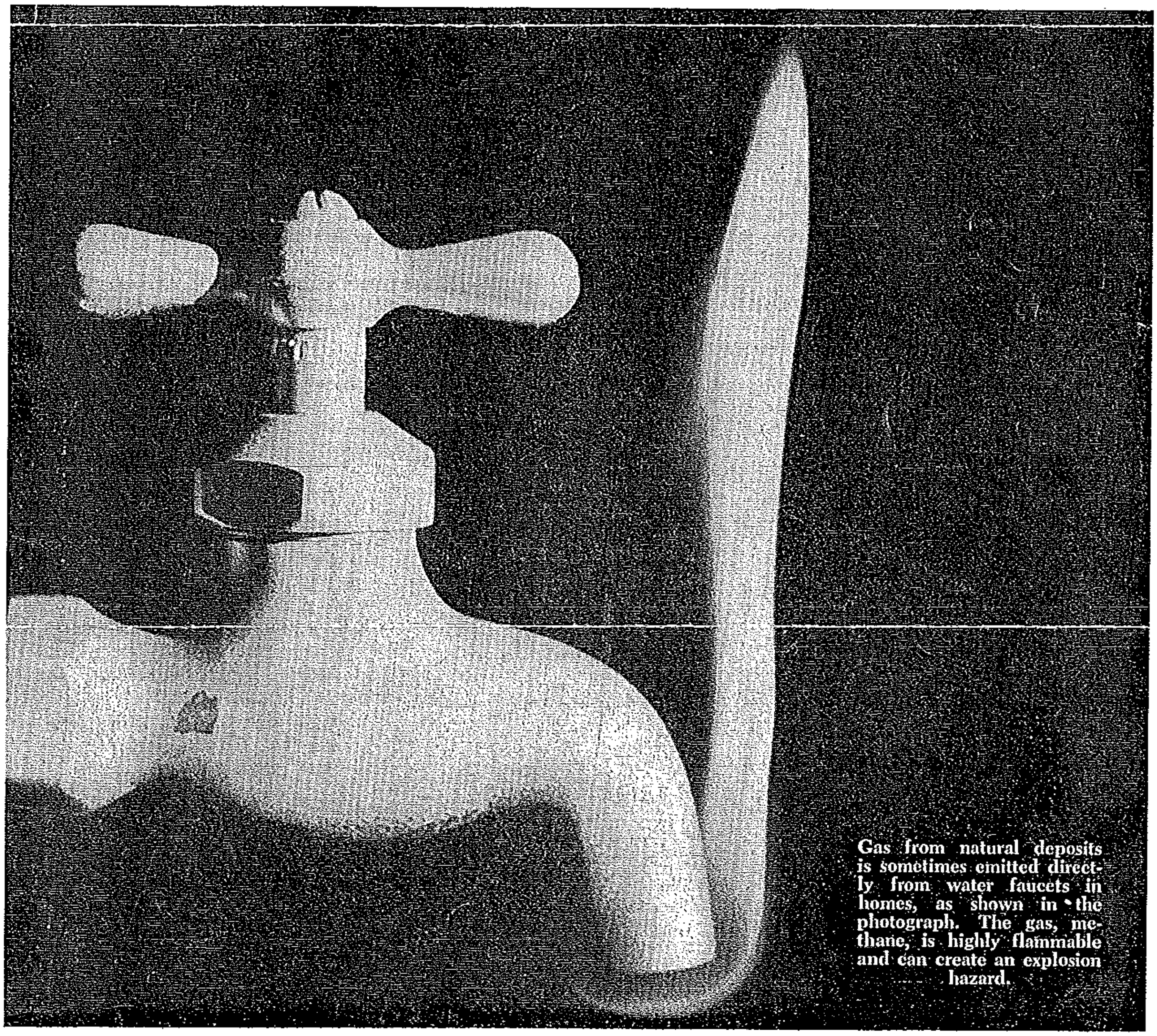
# Problems Associated With Natural Gas in Michigan



Gas from natural deposits is sometimes emitted directly from water faucets in homes, as shown in the photograph. The gas, methane, is highly flammable and can create an explosion hazard.

The occurrence of methane in water supply wells and as ground seepage in various localities in the state has been recognized for many years. Although in certain locations, mostly confined to Wayne County, hydrogen sulfide ($H_2S$), the "rotten egg" odor of the chemistry laboratory, has been found to accompany the methane, the author has never investigated a situation involving this gas. The major problem has been the presence of methane with the flammable and explosive hazards associated with this gas as the primary hazard.

Methane is the first member of the paraffin series of saturated hydrocarbons. The following physical properties identify this gas:

| | |
|---|---|
| Formula | $CH_4$ |
| Molecular Weight | 16.04 |
| Boiling Point | −161.49 |
| Explosive Limits (% by vol. in air) | 5.00-15.00 (approx.) |
| Vapor Density (air=1) | 0.55 |

Methane is known as the "fire damp" of the coal-mining industry and has presented an explosive hazard in mining when it has collected in a sufficiently high concentration and ignited. When methane is generated by the decomposition of carbonaceous matter in swampy or marshy areas it has been termed "marsh gas."

Although the problems inherent in gas-bearing water supplies have been recognized for many years, the division only became actively involved in 1950 as a result of a request from the State Fire Marshal. Since that first referral, gas problems have been investigated in theaters, stores, schools and private residences.

A breakdown of the types of problems investigated permits the following classification:

1. The presence of a flammable gas, essentially methane, in water wells.
2. Flammable gas wells.
2. Gas seepage from the soil:
   (a) Wide-spread,
   (b) Local point source.

Figure 1 indicates the locations of gas sources in two of the counties in southeast Michigan. Not all such sources are identified as many, we are sure, have not been called to our attention. The major purpose of this illustration is to outline or define the area of gas distribution rather than a collection of point sources.

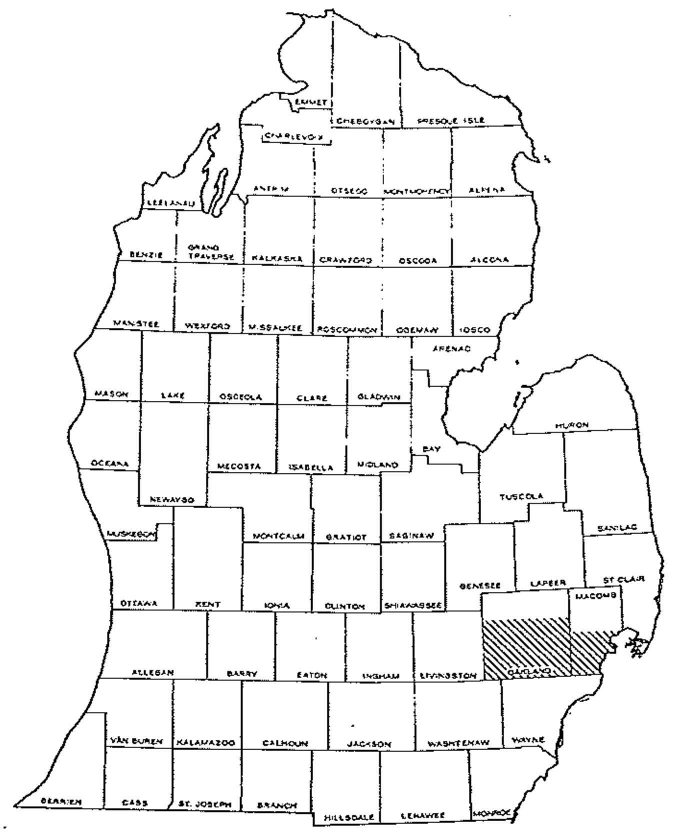



**Figure 1: The shaded portions of the map show the areas of greatest gas concentration.**

## GEOLOGY OF THE AREA

The presence of gas in the water supplies and other locations as identified on the map (Figure 1) can be determined by referring to a paper entitled "The Hydrologic Units in Oakland County, Michigan" written by Andrew J. Mozola.

In a study of the area, Dr. Mozola defines the possible sources of ground water as follows:

1. Underlying bed rock
2. Interlobate outwash deposits
3. Unassorted fill deposits
4. Glacial lake plains

In describing the glacial lake plains and their characteristics in relation to suitability for water supplies, the following information is given: "The quality of the water within this unit is further impaired by the presence of gas in the drift. Gas wells, and water wells with gas shows, are found only within the limits of the lake plain. Gas was detected mostly in coarse sediments interbedded with the clays and fills, and occasionally in clays described as soft, soupy, or putty-like. The gas-bearing zones occur at various depths beneath the surface and with pressures as high as 30 pounds. These wells, when plotted on a base map, are mainly in that portion of the mantle immediately overlying the Antrim shale, and particularly in sediments filling or covering the rock valleys carved in the Antrim shale. . . . The source of the gas in the drift is principally the Antrim shale. It is not believed to be marsh gas of more recent origin since logs of holes drilled within the unit fail to show occurrences of peat or other organic matter in sufficient quantity to produce the amount of gas present."

This paper also contains base maps which delineate the location of the glacial lake plain and the Antrim shale.

Examples of the presence of gas in typical areas investigated follow:

## I. RESIDENTIAL

### A. Where well casing is available.

Assistance was requested to investigate the presence of a flammable gas in the basement of a home in the Royal Oak area. It was discovered that a well had been installed immediately adjacent to the home basement wall in order to provide gas for heating and cooking. Figure 2 shows the well location next to the house. This well had been installed approximately 60 years earlier. Investigation revealed that the gas was seeping up through the ground alongside the casing presumably from a casing leak and thence into the basement. Analysis of this gas obtained directly from the gas piping of the distribution system and analyzed by the Orsat method revealed 69% methane, with no ethane, carbon dioxide or hydrogen sulfide. (Sample No. 9, Table I).

Inasmuch as the gas volume and pressure of the well in recent years had become quite unreliable and the home owner had found it necessary to install commercial utility gas, it was recommended that the well be filled its entire length with quick-setting cement. The procedure resulted in an immediate cessation of the escape of gas.

In general, this has been our recommended procedure whenever a leaking or abandoned gas well or water well has been encountered. The method of

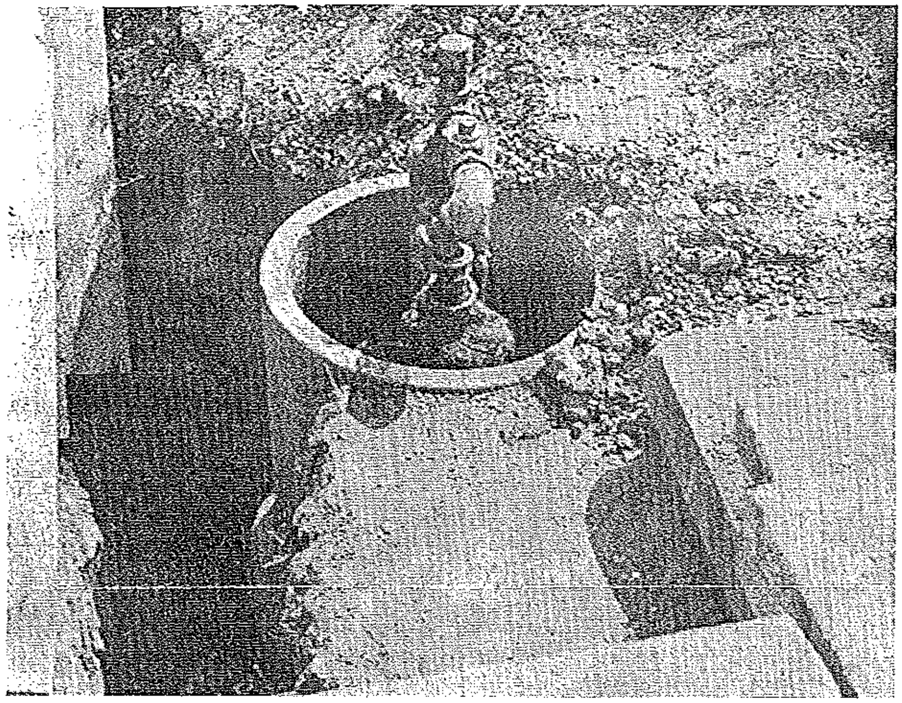


Figure 2: A gas well located adjacent to a residence foundation wall. The well casing had corroded and was leaking explosive volumes of gas into the basement.

TABLE I

| Location | Type and Depth of Well | | Gas Composition—Percent by Volume | | | | | | | Gas/Water Ratio Percent Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Methane | Ethane | Oxygen | Carbon Monoxide | Carbon Dioxide | Nitrogen | Hydrogen Sulfide | |
| 1. Harrison Twp., Macomb Co. | Water | 120′ | 87.0 | 0.0 | 2.4 | ... | 0.0 | 10.6 | ... | 0.78 |
| 2. Clawson, Oakland Co. | Gas | ? | 87.0 | 5.0(?) | 0.2 | ... | 0.8 | 7.0 | ... | ... |
| 3. Pontiac Twp., Oakland Co. | Water | 91′ | 0.0 | 0.0 | 6.0 | ... | 6.0 | 88.0 | ... | ... |
| 4. Centerline, Macomb Co. | Water | | 95.0 | None | 1.4 | 0.2 | 0.2 | 3.2 | ... | 1.1 |
| 4a. Duplicate of No. 4 | Water | | 93.0 | None | 1.2 | 0.4 | 0.4 | 5.0 | ... | 1.8 |
| * 5. Southfield, Oakland Co. | Water | 138′ | 94.00 | None | 0.13 | ... | 0.24 | 5.58 | ... | ... |
| * 5a. Southfield, Oakland Co. | Air Diluted | 138′ | 7.22 | None | 19.28 | ... | None | 73.5 | ... | ... |
| 6. Berkley, Oakland Co. | Abandoned | ? | 5.5-8.4 | None | ... | 1.2 | 3.6 | ... | ... | ... |
| * 7. Berkley, Oakland Co. | Gas | ? | 99.0 | None | ... | ... | 0.1 | 0.9 | ... | ... |
| * 8. Berkley—Schoolyard seepage | .... | ... | 8.5 | None | ... | 6.2 | ... | 85.3 | ... | ... |
| 9. Royal Oak, Oakland Co. | Gas | 100′ | 69.0 | None | ... | ... | None | ... | None | ... |
| ** 10. East Detroit, Macomb Co. | Gas | ? | 96.3 | None | ... | ... | 3.7 | ... | ... | ... |
| **10a. East Detroit, Macomb Co. | Gas | ... | 96.4 | None | ... | ... | 3.6 | ... | ... | ... |
| 11. Clinton Twp., Macomb Co. | Water | 50′ | 85.0 | None | ... | ... | ... | ... | ... | 1.55 |
| 12. St. Clair Shores, Macomb Co. | Water | ... | 100.00(approx.) | | ... | ... | ... | ... | ... | 6.6 |
| 13. Van Dyke, Macomb Co. | Water | ... | 100.00 | ... | ... | ... | ... | ... | ... | 1.2 |
| 13a. Van Dyke, Macomb (duplicate) | Water | ... | 100.00 | ... | ... | ... | ... | ... | ... | 1.8 |
| 14. Fraser, Macomb Co. | Water | ... | 80.00 | ... | ... | ... | ... | ... | ... | 2.4 |
| 14a. Fraser, Macomb (duplicate) | Water | ... | 80.00 | ... | ... | ... | ... | ... | ... | 4.2 |
| 15. Fraser, Macomb Co. | Water | ... | 100.00 | ... | ... | ... | ... | ... | ... | ... |
| 16. Southfield, Oakland Co. | Water | ... | 65.00 | ... | ... | ... | ... | ... | ... | 3.5 |
| 17. Southfield, Oakland Co. | Water | ... | 100.00 | ... | ... | ... | ... | ... | ... | 0.3 |
| 18. Oak Park, Oakland Co. | Gas | ... | 30.00 | None | ... | None | None | ... | None | ... |
| 18a. Oak Park, Oakland (duplicate) | Gas | | 35.00 | None | ... | None | None | ... | None | ... |
| 19. Southfield, Oakland Co. | Water | | 5.8 | 2.4 | 14.00 | ... | None | ... | ... | 3.0 |
| 19a. Southfield, Oakland (duplicate) | Water | ... | 2.8 | 6.4 | 13.00 | ... | None | ... | ... | 3.0 |
| 20. Southfield, Oakland Co. | Water | | 74.0 | 3.0(?) | 5.0 | ... | None | ... | ... | 5.0 |
| 21a. Southfield, Oakland (duplicate) | Water | | 55.0 | 4.0(?) | 4.0 | ... | None | ... | ... | 5.0 |
| 21b. Southfield, Oakland (duplicate) | Water | | 79.0 | 9.0(?) | 2.4 | ... | None | ... | ... | 5.5 |

* Analysis by means of Mass Spectrometer.
** Analysis by means of Gas Chromatograph.
All others by Orsat method.

control is that recommended by the Michigan Conservation Department, Geology Division for the sealing of gas or oil wells. Contractors have been those who routinely are engaged in closing off gas and oil wells.

B. Where no well casings may be found.

Occasionally we are called to investigate a gas problem where the only evidence is the bubbling of gas through water in a hole in the ground. The presence of the gas is usually noted during excavation operations when, because of a rain during the night, the gas evolution through the water in the excavation becomes visible. Such bubbling sources have been observed in the basement and immediately outside the basement walls. (See figures 3 and 4). Usually, the practice has been to check the surrounding ground. If no other indication of gas is found the role is treated as a point source.

Our recommendation for control has been to install a solid enclosure around the seepage area with a vent. (See figures 5 and 6).

The enclosure construction should be of reinforced concrete with the space within the enclosure filled with highly porous material. One-and-one-half to two inch rock has been found acceptable. The vent pipe should be a minimum of 2″ I.D. with 3″ I.D. preferred when it is possible to install the larger size. The larger size is preferred to lessen the possible occurrence of back-pressure which could conceivably cause the gas to be released at another site. We recommend that the vent stack be treated by the installer as a "gas-pipe" with joints and elbows kept to a minimum and sealed with gas-pipe sealing compound. Such stacks should extend a minimum of five feet above the high point of the building roof.

## II. WATER SYSTEMS

A. Municipal water systems

A number of municipal water systems in the south areas of Oakland and Macomb Counties contained natural gas. Most of them in recent years have been abandoned in favor of Detroit water which, being treated river water, does not contain gas. Figures 7, 8, 9 and 10 show the facilities installed to control the gas problem at Fraser, Michigan, i.e., gas removal equipment, explosion-proof heaters and schematic of the gas removing tank.

In view of the high volume of entrained gas in this supply, it was determined that the gas would have to

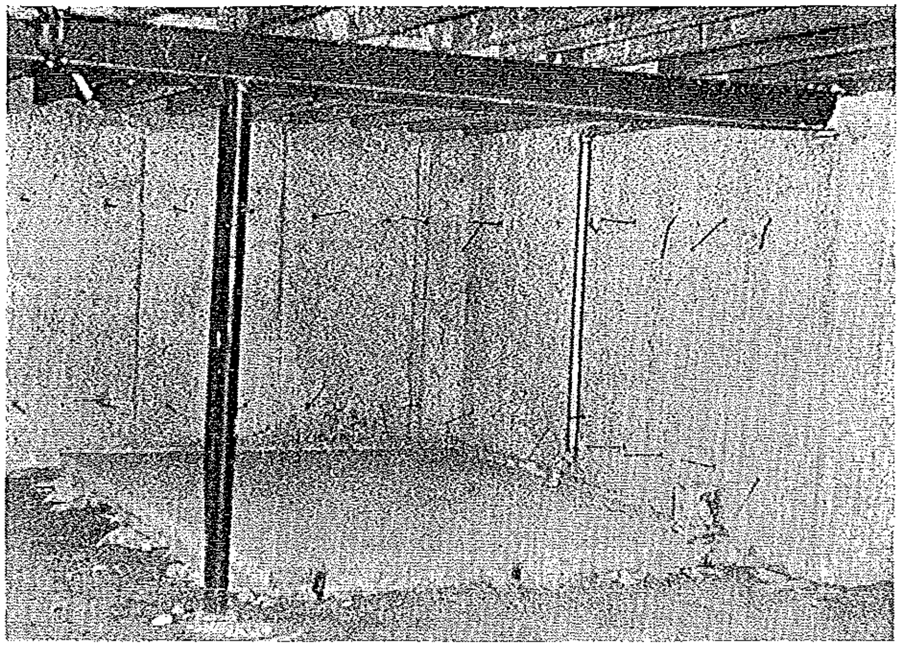


Figure 3: A gas seepage control installation. The slab caps a natural gas seepage source located in the residence. Vent pipe is also shown.

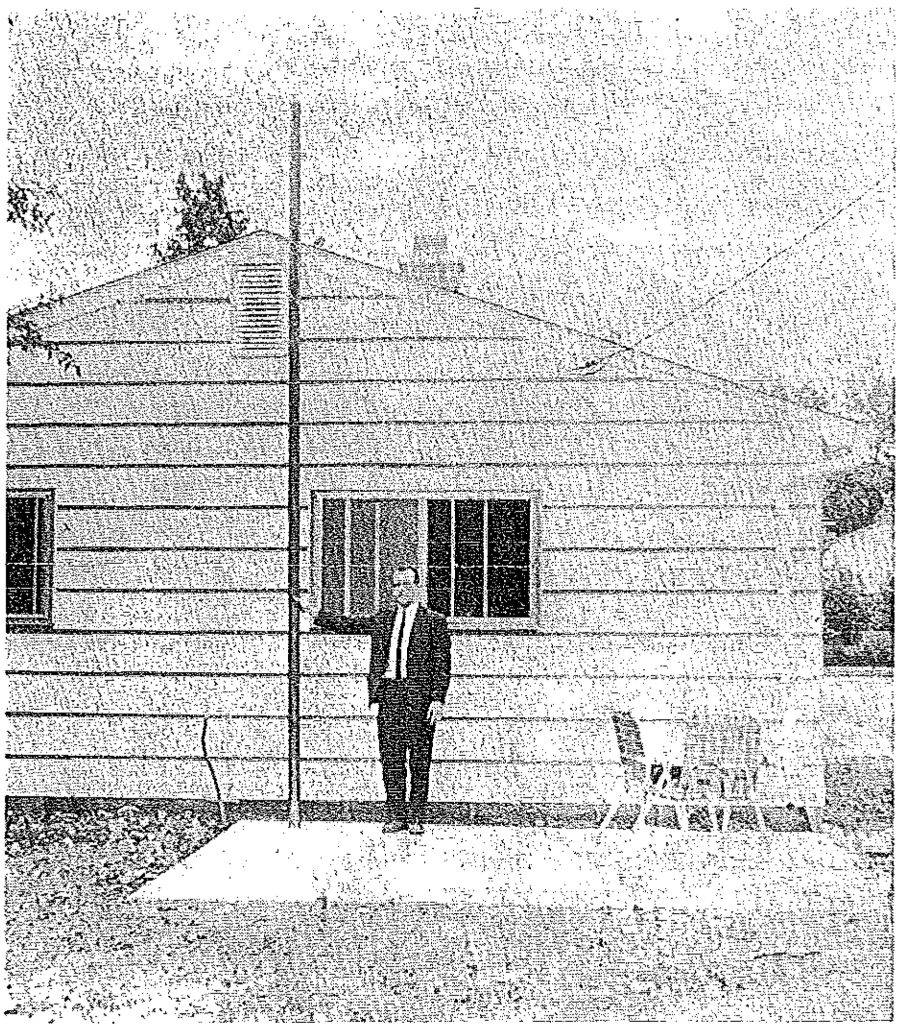


Figure 4: This illustrates a residential gas seepage control installation, showing the top slab and vent pipe. The slab serves nicely as a patio.

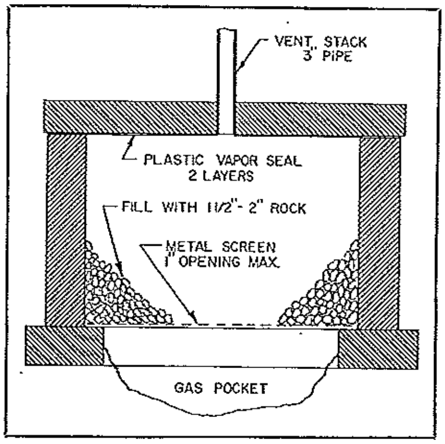



Figure 5: Enclosure scheme for containing and venting gas seepage from a point source.

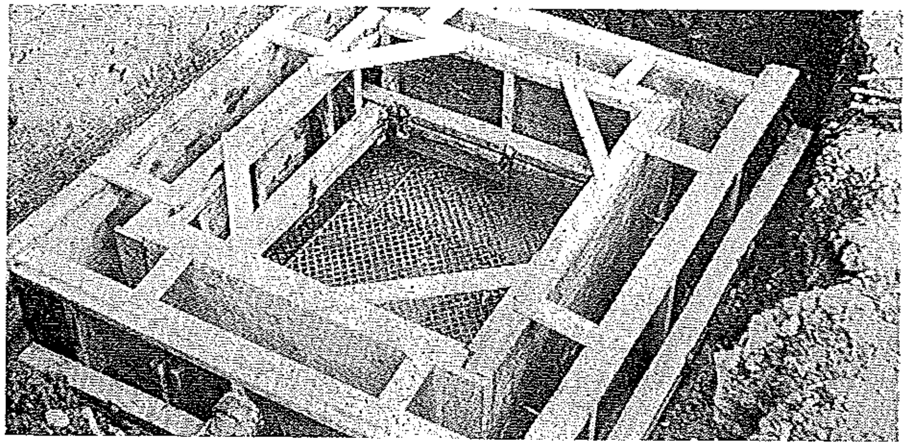


Figure 6: The picture shows construction forms for a gas seepage sump being installed adjacent to a school.

be removed before being pumped into the distribution system. The existence of an explosion hazard was not simply based on conjecture; there were many reports of explosions in homes in the area from gas in domestic well systems. The degassing equipment was predicated on the observation that methane appears to dissociate rapidly from the water with increase in temperature and a decrease of pressure.

In addition to the above equipment for removing the gas from the water, it has also been recommended that well casing vents be provided to vent gas collected within the casing to a point outside of the building. Electrically, the interior of pump houses have been treated as a Class I, Division I location according to the National Electrical Code. Figure 10 shows an explosion-proof electric heater used at the Fraser pump house.

When water storage tanks containing gas-bearing water are located inside buildings their pressure relief valves should be extended to the outside.

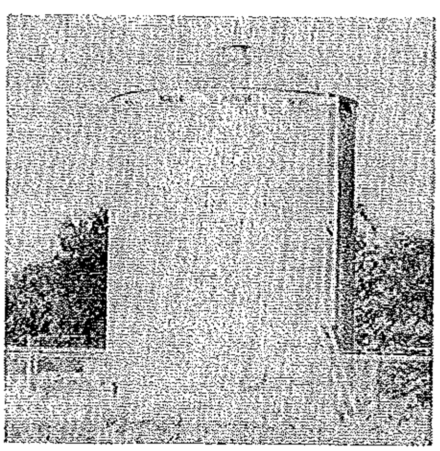


Figure 7: This is an exterior view of a vertical gas removal tank detailed in Figure 8.

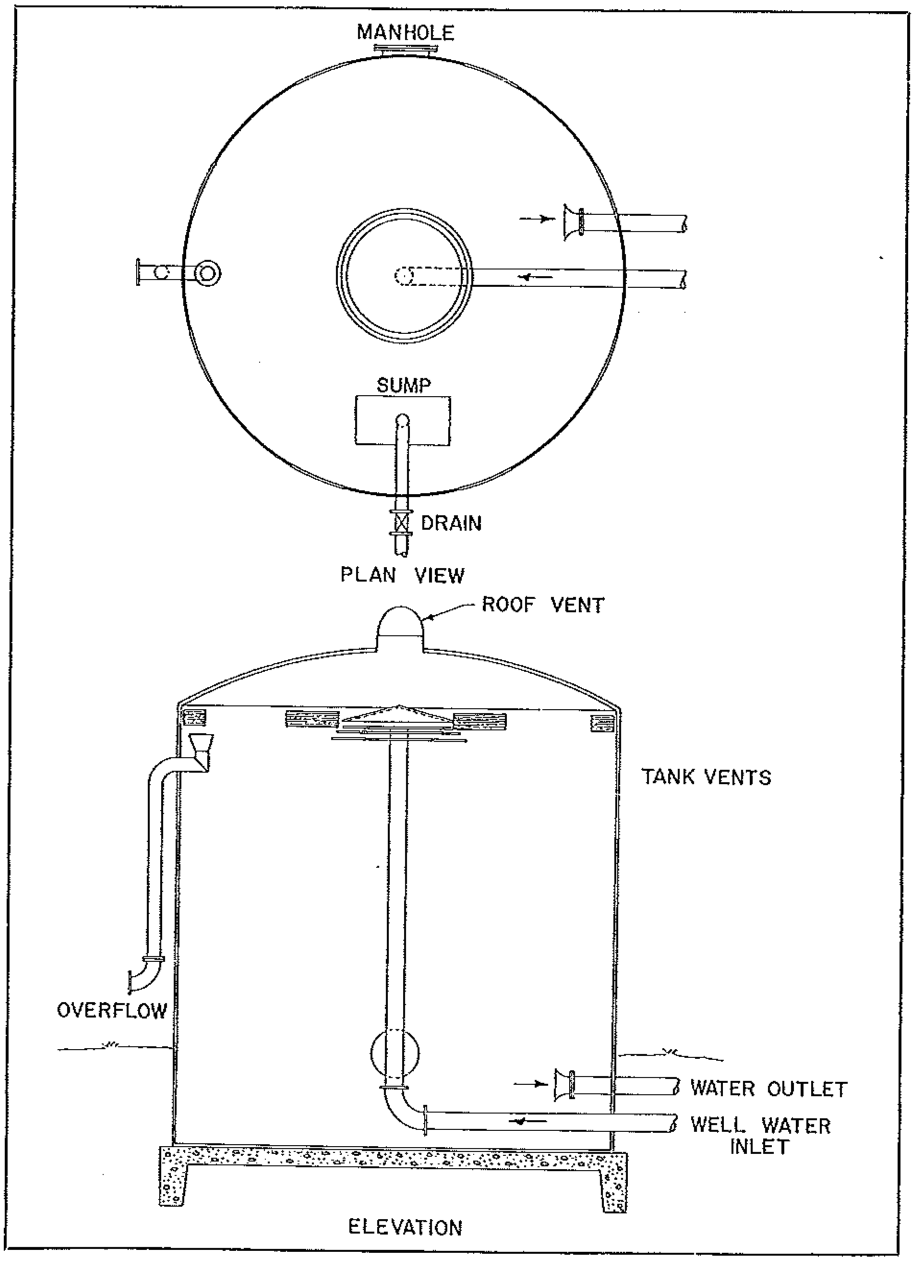



Figure 8: Schematic drawing showing interior and gas-removal equipment of tank shown in Figure 7.

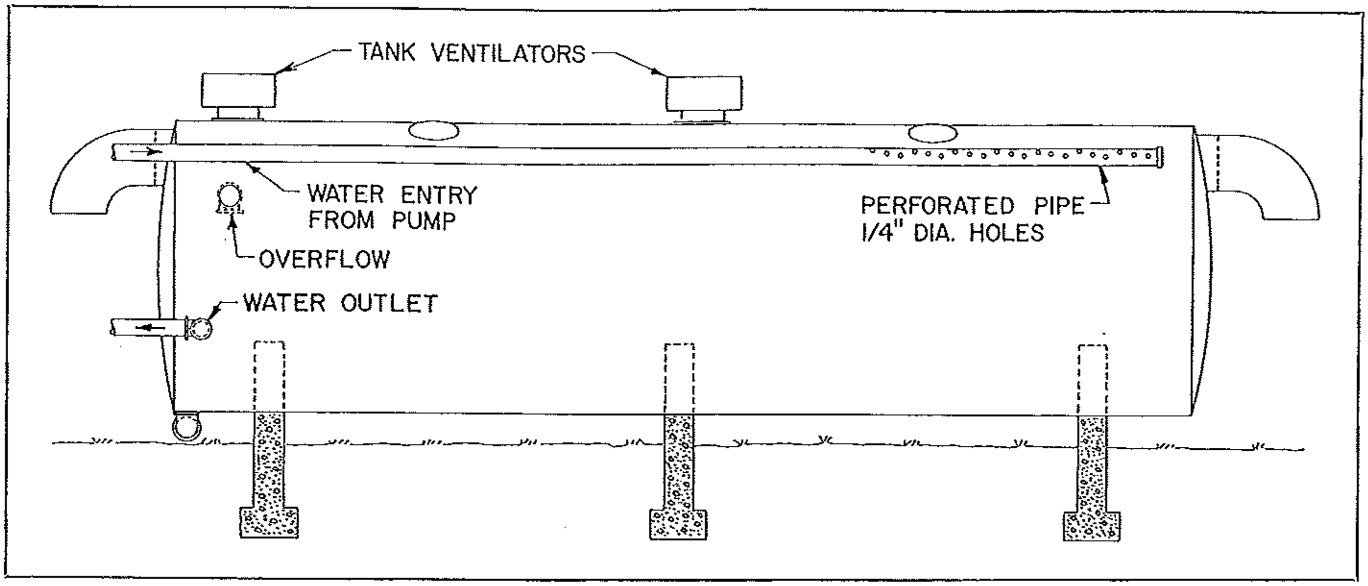



Figure 9: Gas elimination tank illustrating horizontal method of installation.

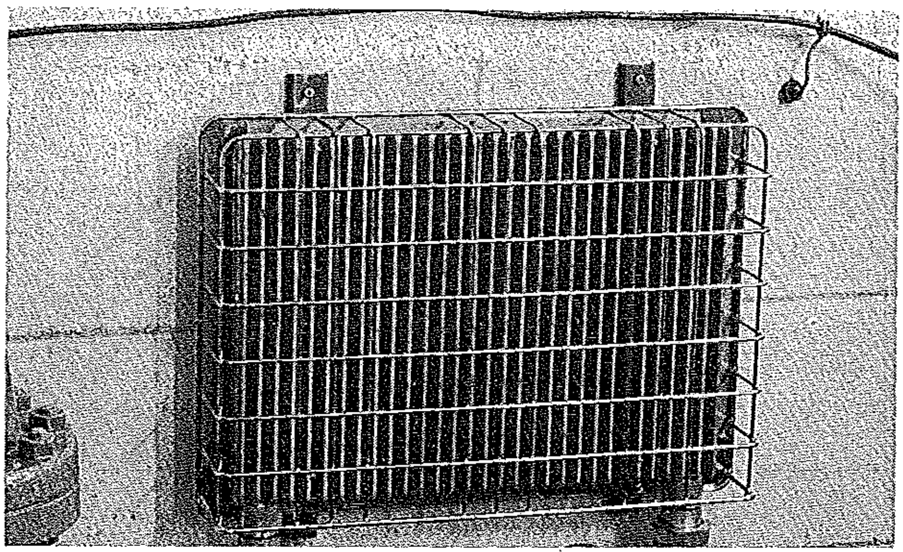


Figure 10: Explosion proof Pump House electric heater at the Fraser Water Works, Fraser, Michigan.

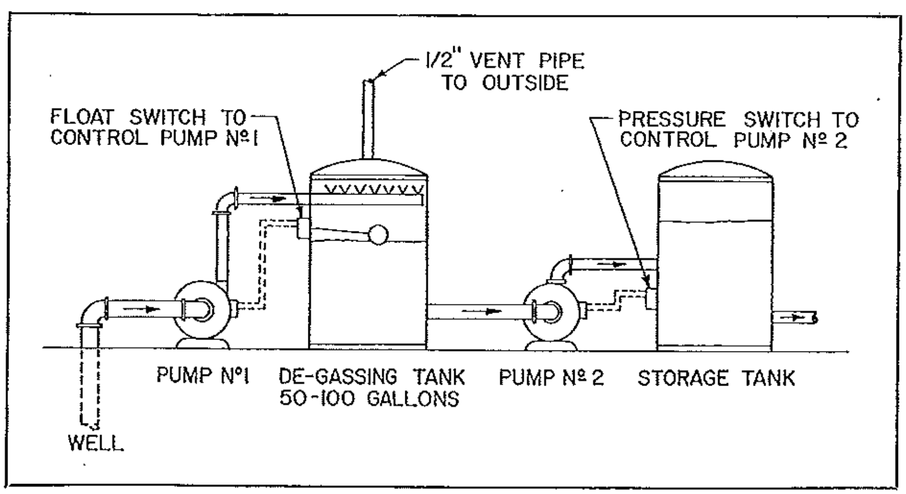



Figure 11: Schematic plan of equipment for removal of gas from well water.

B. Domestic water systems.

Several homes have required the installation of equipment to remove gas from the well water. Figure 11 shows a schematic plan of the equipment necessary for this purpose. If the well is located inside the house or in a pit adjacent to the basement, a casing vent is necessary in some instances to prevent gas being released into the basement where it could be ignited by open flames or electrical equipment. Figure 12 shows details of a casing vent. This one precaution should be rigidly observed in all gas-bearing water installations.

## III. GROUND SEEPAGE PROBLEMS

Our first experience with a ground seepage problem occurred in 1953 when we were requested by a city to investigate the seepage of gas in two school yards.

This condition was discovered by the gas utility company when conducting a routine check of the gas service lines into the buildings. A procedure is employed by this utility company to check for possible pipe leaks known as bar testing. They routinely do this type of test on all public buildings.

Bar testing consists of piercing the ground to a depth of 24 inches, or through the frost, and checking the hole for combustible gas by means of a combustible gas indicator provided with a metal probe.

In this instance, when pressure testing and physical examination failed to indicate any leaks in the gas service pipe, further tests in other areas of the school yards were made and gas was also found there. Indications of gas were found up to 30 feet from the buildings.

This was the first instance of widespread gas seepage and its presence in school yards, where conceivably great loss of life might occur if the gas entered the schools. This made it a matter of great concern.

In view of the location of the schools the following possibilities of the gas source were considered:

1. Utility gas from a nearby distribution main.

2. Marsh gas from decomposition of underlying organic matter.

3. Seepage of gas from the underlying gas-bearing shales.

Samples were obtained by means of water displacement methods from holes driven into the school yard. The samples were analyzed by means of the Orsat method and later confirmed by mass spectrometer analysis. The absence of ethane in the samples obtained in this manner ruled out the possibility of utility gas.

It was determined by the mass spectrometer analyses that in all probability this gas was formed by the decomposition of decaying organic matter. The possibility of shale gas also contributing to the problem could not be ignored in view of the underlying geology of the area.

In order to minimize or eliminate the potential hazard in the schools, the following steps were inaugurated:

1. The boiler rooms at both schools, which were below grade, were provided with full time exhaust ventilation and air supply.

2. A new addition, under construction at one school, was provided with an underfloor venting system, ventilated above the roof.

3. The interiors of the schools were checked by means of combustible gas indicators before the start of classes and several times during the day. Records were kept of these surveys.

4. Exterior shut-offs for electricity, telephone and utility gas services were provided so all power and gas to the schools could be shut off in an emergency.

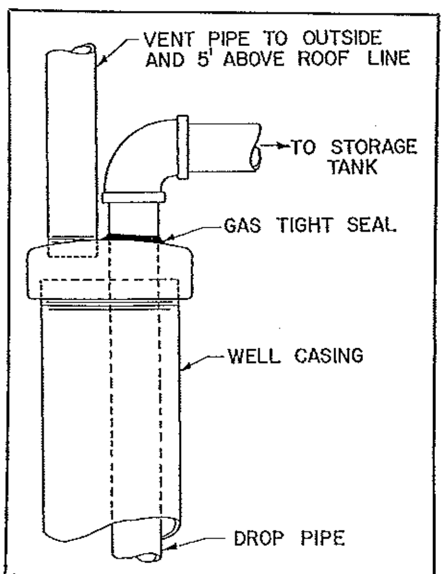



Figure 12: Detail of casing vent. The vent is necessary because the return of the water to static level, after pumping, results in a "slug" of gas being released.

Although a considerable period of time has elapsed, and gas has regularly, although intermittently, been found outside the schools, no gas has been detected in either building.

Such widespread seepage conditions have also been investigated in several other areas in the vicinity of homes or schools.

Ground seepage of flammable gas was investigated in a total of 56 lots in a new subdivision. Bar-tests revealed the emanation of flammable gas throughout the lots and along the roadsides of the area.

In another relatively new subdivision gas was detected in the rear of the lots. Fortunately, no gas was found near the homes. All of the houses were of slab construction, which also tended to minimize the problem. In this case the gas distribution and the topography made us suspect the occurrence of organic decay.

## IV. ABANDONED GAS WELLS

Occasionally, abandoned gas wells show up in unexpected places. It is usual to find casings between the sidewalk and the curb as old farms or homesteads have been subdivided and streets installed.

Figure 13 shows how casings in such locations may be safely vented. The vent is camouflaged to prevent tampering.

Figures 14 and 15 illustrate two of the many abandoned wells found in the two-county area.

A study of the gas produced by the decomposition of organic matter in landfills has been investigated, most recently by Melvin First et.al. A paper titled "Toxic and Explosive Hazards Inside Buildings Erected on Landfills" was presented at the Philadelphia meeting of the American Industrial Hygiene Conference in 1964. Their findings are

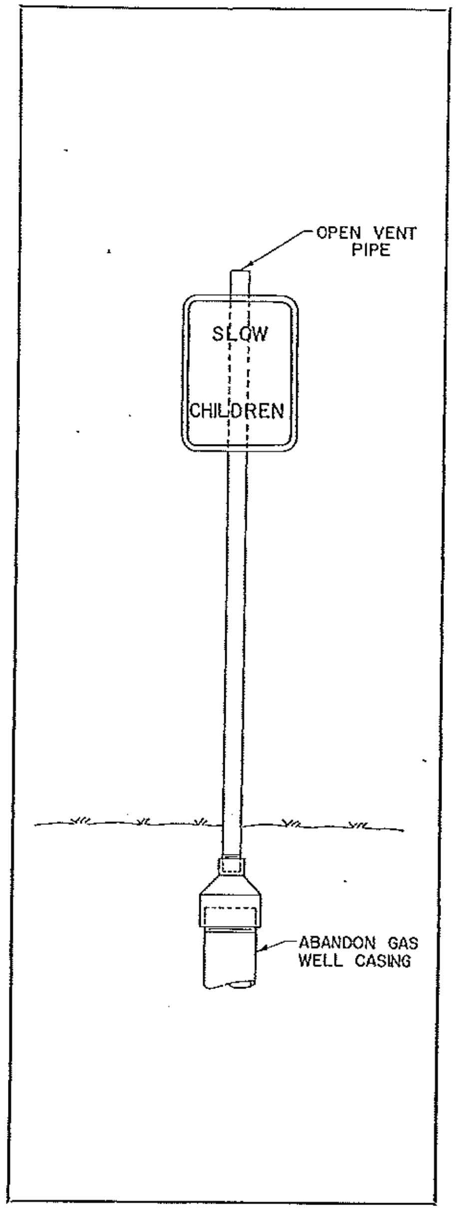



Figure 13: Plan for concealing vented abandoned gas well casing. The casing is shown under ground level.

similar to our own, particularly in regard to widespread gas seepage containing methane as the predominant flammable gas. The differentiating elements in our gas appear to be the occasional presence of hydrogen sulfide and much higher methane concentrations.

In conclusion, the state's gas problems are subject to control with a study of the circumstances involved in each case. History has shown that the gas in water wells and gas wells can be a destructive and lethal agent when uncontrolled. This article was written primarily to call attention to the problem and indicate some of the approaches to control which have been found to be effective.

Figure 14: An abandoned gas well.

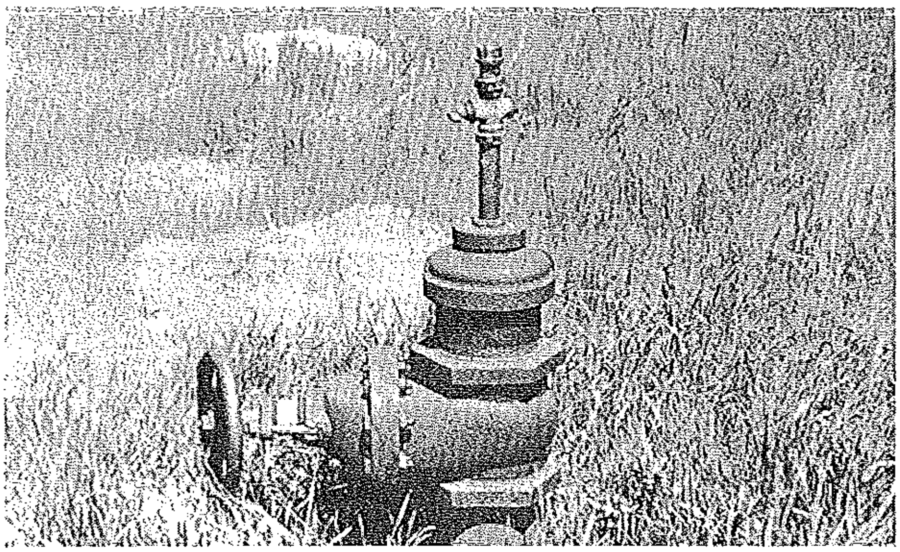


Figure 15: Abandoned natural gas well with 6″ casing. The entire length of the casing is sealed by approved methods.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The cooperation of Consumers Power Company personnel in informing the author of locations where they have encountered natural gas is also gratefully acknowledged.

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