Barry M. Evans
Resource Technologies Corporation
State College, PA 16801

Aerial Photographic Analysis of Septic System Performance

Color aerial infrared photography is used to detect failing systems, followed by field visits for verification.

Abstract: *A useful aerial photographic/ground survey method for locating failing septic systems has recently been developed. As a result of its successful application in projects throughout the country, the technique has evolved from its R&D origins into a practical, cost-effective alternative to conventional sanitary surveys.*

Through the analysis of color infrared aerial photography, failing septic systems (i.e., surface breakouts) have been successfully detected in dozens of Federally-funded 201 wastewater facilities planning studies, environmental impact studies, and health department surveys. In the photointerpretation procedure, the film is analyzed to identify those manifestations associated with surface failures and distinguish them from unrelated ground phenomena. After the photo analysis is completed for a given area, field visits are made to suspect sites for verification.

Introduction

Historically, information on failing septic systems has been obtained by means of discussions with local sanitarians, questionnaires mailed to community residents, house-by-house investigations, examination of soil maps, and/or "windshield" surveys. Because of the high cost and questionable reliability of these conventional techniques, however, other methods are being sought by federal, state, and local government agencies to efficiently, economically, and quickly assess regional septic system problems. One method which appears to meet these requirements, based upon the results of numerous studies conducted over the past few years, utilizes an integrated aerial photographic/ground survey approach.

Initial research in aerial septic system analysis was undertaken by Crouch (1979) and personnel at two of the U.S. Environmental Protection Agency's field stations: the Environment Photographic Interpretation Center in Warrenton, Virginia and the Environmental Monitoring and Support Laboratory in Las Vegas, Nevada. As a result of its successful application in federally-funded 201 wastewater facilities planning studies, environmental impact studies, and health department surveys throughout the country, this aerial survey technique has now evolved from its R&D origins into a practical, cost-effective alternative to conventional sanitary surveys.

Septic System Types and Associated Problems

Three basic types of failures can occur with septic systems: (1) wastewater contained in the system backs up into the home, (2) wastewater "short-circuits" to underlying groundwater before it is adequately filtered and purified, and (3) wastewater makes its way to the soil surface in the form of a surface "breakout." Only the last type of failure is detectable using aerial photographic techniques. For subsurface failures, the use of a soil lysimeter (Hughes, 1978), "septic snooper" (Kerfoot, 1979), or similar apparatus and water quality sampling may be necessary to determine the existence and extent of a problem.

There are many types of on-lot septic systems currently being used in the United States. Most of

Photogrammetric Engineering and Remote Sensing,
Vol. 48, No. 11, November 1982, pp. 1709-1712.

0099-1112/82/4811-1709$02.25/0

the systems, however, can be categorized as either "leach pit" (Figure 1) or "absorption field" (Figure 2) systems. Because absorption field systems are usually shallower and have more surface area closer to the soil surface than leach pit systems, surface failures are more often associated with them than the latter. Conversely, leach pit systems, which are generally much deeper, sustain proportionately more problems with sewage effluent short-circuiting to underlying groundwater. However, surface breakouts related to both types of systems can be detected using aerial photography.

Surface failures can be attributed to a wide range of causes. Most of them, however, are related to high groundwater, poorly-drained soils, steep slopes, or overloading. The primary surface manifestations associated with this type of failure are (1) conspicuously lush vegetation, (2) dead vegetation (specifically grass), (3) standing wastewater or seepage, and (4) dark soil where organic matter has accumulated. All of these are a result of the upward movement of partially-treated wastewater to the soil surface, and usually appear either directly above or adjacent to one or more components of the septic system.

Oftentimes, two or more of these manifestations occur simultaneously at a homesite experiencing a system failure. In some cases, depending upon the soil makeup of a particular area, the outline of the drainage line(s) of a properly functioning septic system can be distinguished on aerial photography. This peculiarity points up the need for tailoring photointerpretation keys to specific areas.

Methodology

In a typical aerial septic system survey, 9-inch color infrared film (Aerochrome 2443) is acquired at a scale of 1:8,000 during a time when the number of surface breakouts is believed to be greatest. Throughout much of the United States, this occurs in mid-spring or late fall when water table levels are higher due to more frequent precipitation. In the photointerpretation procedure,

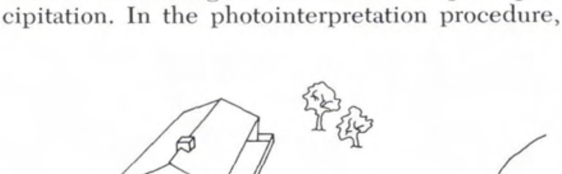

Fig. 1. Typical leach pit system.

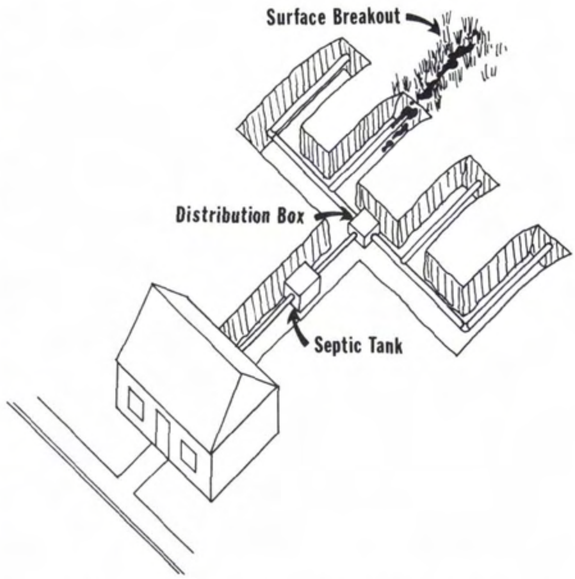

Fig. 2. Typical absorption field system.

positive transparencies are analyzed with the aid of a light table and pocket stereoscope in order to identify those manifestations associated with malfunctioning septic systems (i.e., lush vegetation, dead vegetation, standing wastewater or seepage, and very dark soil), and distinguish them from unrelated surface phenomena such as springs, low-lying bushes, heavily-fertilized areas, and drainage from roof gutters and sump pumps. These photo indicators are used in conjunction with a knowledge of the type and location of disposal systems associated with homes of various ages and styles to devise a photointerpretation key for detecting failing septic systems. After the photo analysis is completed for a given area, field visits are made to "suspect" sites to verify actual failures and discriminate them from false signatures.

During field verification, failing systems are normally evaluated as being "overt" or "marginal" failures. Overt failures are those which have problems with wastewater coming to the surface at the time of inspection. Marginal failures are those systems which are not necessarily failing at the time of inspection, but which do exhibit signs of having failed in the past, or of having the potential to fail during periods of excessive use or moderate to heavy rainfall. Plates 1 and 2 are examples of surface breakouts found during a recent aerial survey in Delaware. Note the bright red color and dark gray patches indicative of lush vegetative growth and seepage shown in the photos.

Other Comments

One of the greatest assets of this technique is the savings in time, money, and labor in compari-

(a)

(b)

PLATE 1. Malfunctioning septic system identified by lush vegetation. (a) Ground view. (b) Aerial view.

(a)

(b)

PLATE 2. Malfunctioning septic system identified by standing wastewater. (a) Ground view. (b) Aerial view.

son to conventional sanitary survey methods. This savings is derived from the fact that those homes which do not have septic system breakouts are "screened out" in the photointerpretation process. Thus, only those systems exhibiting failure indicators need to be field-checked. The cost-effectiveness of this aerial approach is particularly apparent when it is utilized to document problems for federally-funded community wastewater facilities planning studies such as those performed in connection with Section 201 of the Clean Water Act.

It has been estimated that consultant costs for conventional sanitary surveys for 201 studies currently range from about $10 to $30 per home for typical study areas ranging in size from 2,000 to 10,000 homes (Kerfoot, 1979; McKinney and Krause, 1979). A typical aerial septic system survey, however, can be performed for about $2 to $3 per house for the same number of homes. Of this cost, approximately 35 percent is for air photo acquisition and processing, 25 percent is for interpretation time, 30 percent is for field verification, and 10 percent is for report and map preparation. The reduced cost associated with the aerial approach is primarily a result of the far lesser amount of field work required in comparison to conventional survey methods.

In addition, the use of color infrared aerial photography has proven to be a quite reliable means for quantifying septic system problems within a given community. Past studies have demonstrated that interpretation accuracies ranging from 60 to 95 percent can be expected from such aerial surveys (Evans, 1979). In most cases, the number of commission errors far exceeds the number of ommission errors. This is not necessarily a weakness, however, because any false classifications are uncovered in the subsequent field work which has already been greatly reduced through the air photo analysis.

References

Crouch L. W., 1979. *Remote Sensing as a Field Method for Assessment of Soil Moisture*, M. S. Thesis, Miami University, Oxford, Ohio.

Evans, B. M., 1979. Aerial Sanitary Surveys in Rural Lake Wastewater Planning, *Proc. Of Sixth National Conference on Individual On-Site Wastewater Systems*, National Sanitation Foundation.

Hughes, K. 1978. Groundwater Sampling, *Proc. of Conference on Monitoring Techniques for On-Site Wastewater Treatment Systems*, University of Michigan Biological Station, Pellston, Michigan.

Kerfoot, W. B., 1979. Lower-Cost Lake Protection, *Environmental Science and Technology*, 13 (8): pp. 909-913.

McKinney, N., and A. Krause, 1979. Seven Lakes Examined in EIS, *Environmental Mid-West*, U.S. Environmental Protection Agency, Vol. 6: pp. 12-15.

(Received 30 October 1980; revised and accepted 9 June 1982)

CALL FOR PAPERS

Eighth Canadian Symposium on Remote Sensing
and
Fourth Congress of the Quebec Association of Remote Sensing

Montreal, Quebec, Canada
3-6 May 1983

Cosponsored by the Canadian Remote Sensing Society and l'Association Québécoise de Télédétection, the joint meeting will have as its general theme the integration of remote sensing in resources management, by opening discipline barriers and by using multisource geographic information systems.

Specific topics will include

- Instrumentation and methodology
- Environmental information systems as integration tools
- Cartography
- Atmosphere, climate, and meteorology
- Water, ice, oceans
- Agriculture and land use
- Forests, range lands, and wilderness areas
- Geology and geophysics
- Education and technology transfer

A special session will be devoted to simulation of data from future satellite programs such as Landsat-D, SPOT, and Radarsat.

Authors wishing to contribute papers must submit a 600-word abstract by *15 November 1982* to

Dr. Ferdinand J. Bonn
Laboratoire de Télédétection
Département de géographie
Université de Sherbrooke
Prov. de Québec, Canada
Tele. (819) 565-4523