

APRIL 1982
A PROPOSED

REGIONAL SEWER SYSTEM

TO SERVE THE

MAMMOTH CAVE AREA

CAVELAND SANITATION AUTHORITY

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CONTENTS

A. THE PROBLEM:

A History of Sewage Pollution of
Caves in the Mammoth Cave Area.

Thomas Aley - Ozark Underground Laboratory

B. THE SOLUTION:

A Regional Sewer System to Abate Cave
Pollution in the Mammoth Cave Area.

David G. Derrick - Haworth, Meyer & Boleyn, Inc

THE PROBLEM

A History of Sewage Pollution of Caves in the Mammoth Cave Area

Thomas Aley - Ozark Underground Laboratory

Introduction

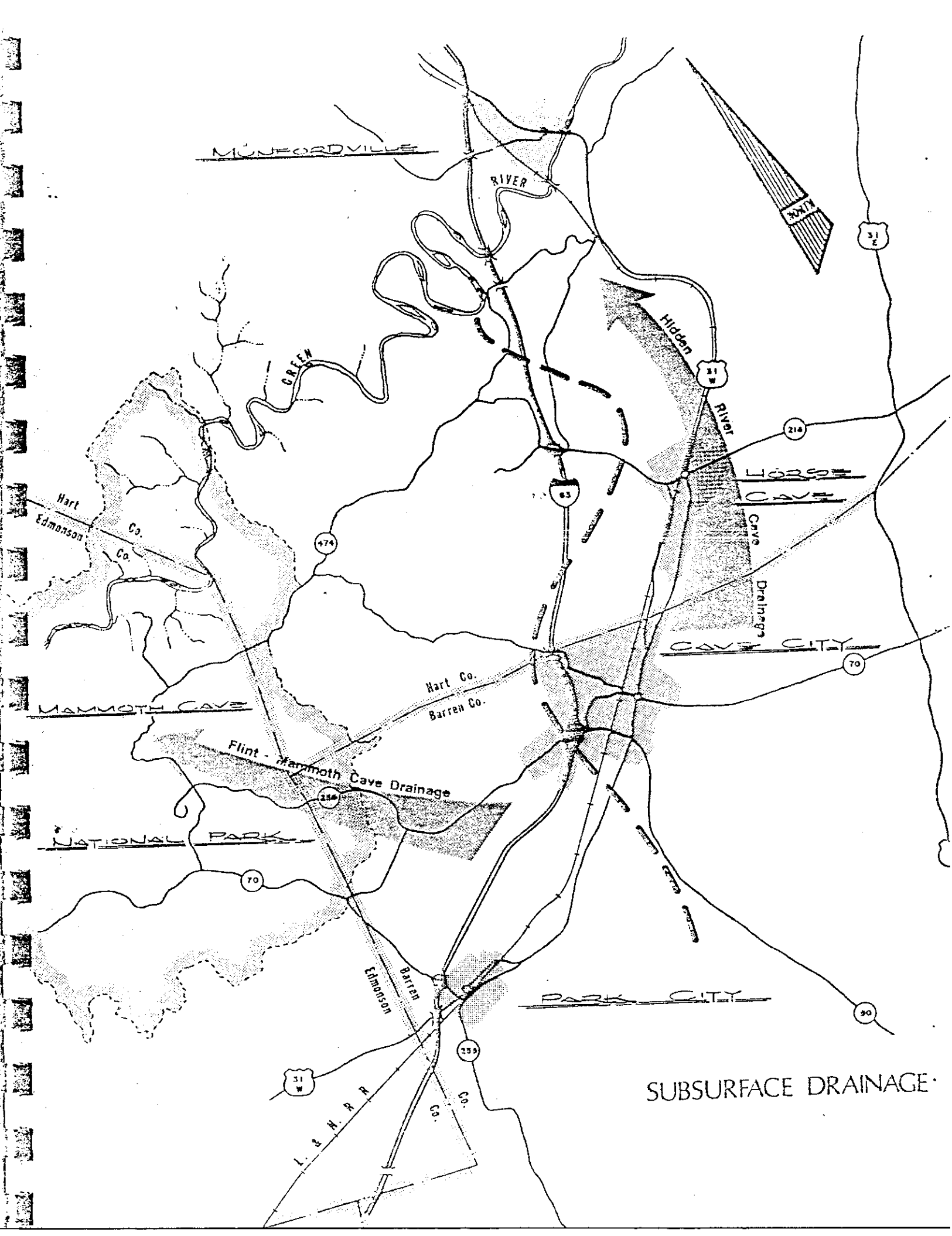
On April 24, 1982 ceremonies will be held in Mammoth Cave National Park commemorating the inclusion of the Flint-Mammoth Cave System in UNESCO's list of world heritage sites. This is a recognition of what many individuals have realized for over a century; this cave system is a highly significant natural feature of our planet.

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Much of the water which passes through the underground streams in the Flint-Mammoth Cave System enters the subsurface on private lands to the south and southeast of Mammoth Cave National Park. This has been well demonstrated by the extensive groundwater tracing work of Dr. James Quinlan. It is thus the privately owned lands which primarily control the quality of water within the Flint-Mammoth Cave System. The National Park Service cannot maintain the natural integrity of the cave system without becoming significantly involved in steps to insure that significant water pollutants are not introduced into the underground streams in areas which contribute water to the Flint-Mammoth Cave System.

History of Cave Streams Pollution by Sewage in the Caveland Area

Man's activities in the Caveland Area of Central Kentucky have resulted in serious and sometimes persistent pollution of underground streams on a number of occasions. Serious problems



SUBSURFACE DRAINAGE

have resulted from activities ranging from inadequate plugging of oil and gas test wells to illicit dumping of waste products. Serious pollution problems in the area have also resulted from municipal sewage; it is these problems which we have considered in detail in this analysis.

The most appalling example of sewage pollution of underground streams in the Caveland Area is provided by Hidden River Cave and the magnificent underground river which flows through this cave. Two underground streams join in the cave to form the cave river. The City of Horse Cave was built around the giant entrance to Hidden River Cave. In Old English usage, the word "horse" means large; the town of Horse Cave was named for the large cave which the town encircled. The underground river in Hidden River Cave was a vital asset to the town of Horse Cave, since water for the town was pumped from this stream.

Underground streams in cave areas have many open and direct connections with the surface, particularly in areas where sinkholes and other discrete recharge zones are abundant. Waters entering underground streams through discrete recharge zones do not receive effective natural cleansing by either filtration or absorption. In reality, the quality of water in underground streams is scarcely better than the sum total of the quality of water which disappears from the surface. If the quality of water entering the subsurface is good, then the quality of water in underground streams is also good. Conversely, if poor quality waters are permitted to enter the underground streams, then the quality of water in these streams is degraded.

In the case of Hidden River Cave, the quality of water in the cave river deteriorated as land development increased in the recharge area for the underground river. Ultimately, a sewage treatment plant was constructed by the City of Horse Cave. This would have been beneficial to the cave river except for three important factors. First, the sewage treatment plant was constructed inside of the recharge area for the cave river instead of outside of the recharge area. Secondly, discharge from the sewage plant was not transported out of the area, but instead was allowed to enter the groundwater system through a sinkhole. Thirdly, the presence of a sewage treatment plant attracted industries which produced wastes that created major problems for the treatment plant. One industry in town is a creamery; a substantial amount of biological treatment is necessary at a sewage treatment plant in order to break down creamery wastes. A second industry in town is a metal plating plant which discharges heavy metals in the wastewater it contributes to the treatment plant. At the concentrations involved, heavy metals are harmful and sometimes toxic to the biological life which enables a biological sewage treatment plant to function adequately.

The sewage treatment plant for the City of Horse Cave has had disastrous consequences on the underground river in Hidden River Cave. No longer is the river one of the natural wonders of Kentucky; instead, it is all too commonly a putrid sewer which discharges fetid fumes into the downtown area of the City of Horse Cave. The odors which emanate from this once-magnificent cave

river are one of the prime reasons that a major regional sewage treatment plant is being designed for the Caveland Area.

Hidden River Cave also receives sewage effluents from the treatment plant serving Cave City; this plant also discharges to a sinkhole because there are no surface streams in the area. As envisaged under the regional sewage treatment plan, the Cave City treatment plant will be improved, and its effluent will be transported through a pipeline to the Green River. Under the regional sewage treatment plan, the Horse Cave sewage treatment plant will also be upgraded, and its effluent will also be transported to the Green River. If the quality of water in the underground river in Hidden River Cave is to be restored, treated sewage effluents must not be discharged into the subsurface in the recharged area for this cave river,

Once the regional sewage treatment system is put into operation, it is my conclusion that the quality of water in Hidden River Cave will show marked improvement. Potentially some of the animal life which once inhabited this cave can be re-established. Still, the cave will never return to its original natural condition. Furthermore, there are other factors (such as railroad or highway spills) which will always be potential threats to the water quality of the underground river in Hidden River Cave.

Can Underground Streams in the Flint-Mammoth Cave System Withstand Increasing Sewage Flows?

I have discussed the pollution history of Hidden River Cave in substantial detail because it provides important evidence for predicting the fate of underground streams in the Flint-Mammoth Cave System. The old bromide that those who do not learn from

history are destined to repeat it is certainly applicable to this case. If we do not learn from the Hidden River experience, we will learn the lesson again in the underground screams of the Flint-Mammoth Cave System.

Although industries were implicated in the gross pollution of Hidden River Cave, the absence of such industries would not have insured acceptable water quality conditions in Hidden River Cave. Domestic sewage alone in the Cave City-Horse Cave area would, under present conditions, seriously affect the cave river. We cannot be lulled into complacency by assuming that the minor extent of industrial development in the recharge areas for underground streams in the Flint-Mammoth Cave Systems will insure the water quality protection of these systems; it is simply not so.

How much sewage can you tolerate in the cave streams of caves with international natural significance? An answer to such a question obviously involves philosophical as well as complex technical considerations. However, from a policy position, I think we can develop some "ballpark" values which will help us better understand the extent and significance of domestic sewage impacts on the Flint-Mammoth Cave System.

The reason Hidden River Cave has horrible odors is that the waters in the cave river have been depleted of their dissolved oxygen. Under natural conditions, the typical minimum concentration of dissolved oxygen in cave systems of the Caveland Area is probably about 6 **parts** per million. For the purposes of our "ballpark" calculation, let us assume that we are willing to suffer up to a 33% depletion of this dissolved oxygen concentration. If such a depletion occurred occasionally, it would probably not seriously . . . life, and would not create any significant

odors in the toured portions of the cave systems of the area.

Per capita sewage production is about 75 gallons per day; untreated domestic sewage has a biochemical oxygen demand of about 200 parts per million. If we assume that all of this wastewater enters a cave stream and that the cave stream supplies all the oxygen necessary to satisfy the biochemical oxygen demand of the sewage, and further assume that there is negligible re-oxygenation of waters in the cave streams, we calculate that about 7,500 gallons of "natural" cave stream water is needed to supply the dissolved oxygen necessary to break down the daily sewage production of each person who contributes his sewage directly into the cave stream systems of the area. To express it another way, we need a low flow in an underground stream of about 5 gallons per minute to handle the sewage production of each person in the recharge area.

The above values are certainly open to technical criticism. Because of natural assimilative capacities of the cave streams and some biochemical oxygen demand removal before sewage reaches the cave stream, we may be able to accept more sewage in the cave streams than our "ballpark" estimate indicates. Still, if we are to insure the protection of cave systems of international significance, it seems prudent to err on the side of caution.

What Should We Do?

The answer to this question is simple; keep as much sewage and as much treated sewage effluent out of the cave systems as possible. Sewage needs to receive effective treatment, and sewage effluents need to be transported out of the recharge areas for the important cave streams. With the present stage of planning for a

regional sewage treatment system we now have an opportunity to protect and enhance the water quality of the cave streams of the area.

A regional sewage system serving Cave City and Horse Cave will be highly beneficial to Hidden River Cave. Based upon the groundwater tracing work of Dr. Quinlan, the cities of Cave City and Horse Cave lie outside the recharge areas for the Flint-Mammoth Cave System.

Sewage collection and treatment for Park City and the area along Kentucky Route 70 west of Cave City would result in water quality benefits to the underground streams in the Flint-Mammoth Cave System. I fear that if this opportunity is missed for financial reasons, that those who miss the opportunity have also missed the lesson of Hidden River Cave. The lesson is that any time you mix sewage and cave water together you generally get sewage, not cave water. The underground streams flowing through the Flint-Mammoth Cave System deserve something better than sewage, and the opportunity to make this decision is at hand. The critical need is for money in to get the sewage out.

THE SOLUTION

A Regional Sewer System to Abate Cave Pollution in the Mammoth Cave Area

David G. Derrick - Haworth, Meyer & Boleyn, Inc.

Planning the Regional Sewer System

The foregoing discussion demonstrates that the delicate cave systems of the Mammoth Cave Area have a very limited capacity to assimilate the intrusion of wastewater generated by human occupancy. Unfortunately, almost all surface drainage in the area flows to the subsurface cave systems. Consequently, at the present time, almost all wastewater generated in the area is also discharged to the cave systems. The one exception to the subsurface drainage system of the area is the Green River. This river is at an elevation below the major cave systems and flows through the area to ultimately join the Ohio River. In fact, most of the subsurface drainage from the Mammoth Cave Area eventually enters the Green River after flowing through the cave systems. From this discussion, one concludes that the logical means of preventing sewage pollution of the cave systems is to discharge wastewater to the Green River rather than to the subsurface cave systems. A regional sewer system to prevent pollution of the cave systems has been under consideration for a number of years.

In 1977, the **U.S.** Environmental Protection Agency and the Kentucky Department for Natural Resources and Environmental Protection recognized the water pollution problems existing in the Mammoth Cave Area and the need for additional wastewater treatment facilities. These agencies also recognized that a regional approach to the wastewater disposal problem should be considered. The US EPA awarded a grant to prepare a wastewater facilities plan

(201 Plan) for the Mammoth Cave Area. This plan is a master sewer plan which considers existing and future needs for sewers and sewage treatment in the area. The 201 Plan was to be jointly developed by Mammoth Cave National Park and the cities of Park City, Cave City, Horse Cave and Munfordville. (Munfordville is located north of the Green River. Munfordville sewage is discharged to the Green River and does not directly impact the area caves.) Recognizing the sensitivity of area's cave environment and the impact of wastewater on a cave environment, the US EPA also funded an Environmental Impact Statement to be prepared concurrently with the 201 Plan.

Both the 201 Plan and the Environmental Impact Statement were completed in 1981. Each of the studies recommended construction of a regional sewer system as a means of abating pollution of the area's caves. The studies also anticipated difficulties in finding funding for the full regional system and discussed the possibility of building only a semi-regional sewer system, with reduced environmental benefits, in the event that funding is not available for the full regional system.

Upon completion of the 201 Plan and the Environmental Impact Statement, the Caveland Sanitation Authority was formed as an interlocal agency to implement the proposed regional sewer system.

Description of Regional and Semi-Regional Sewer Systems

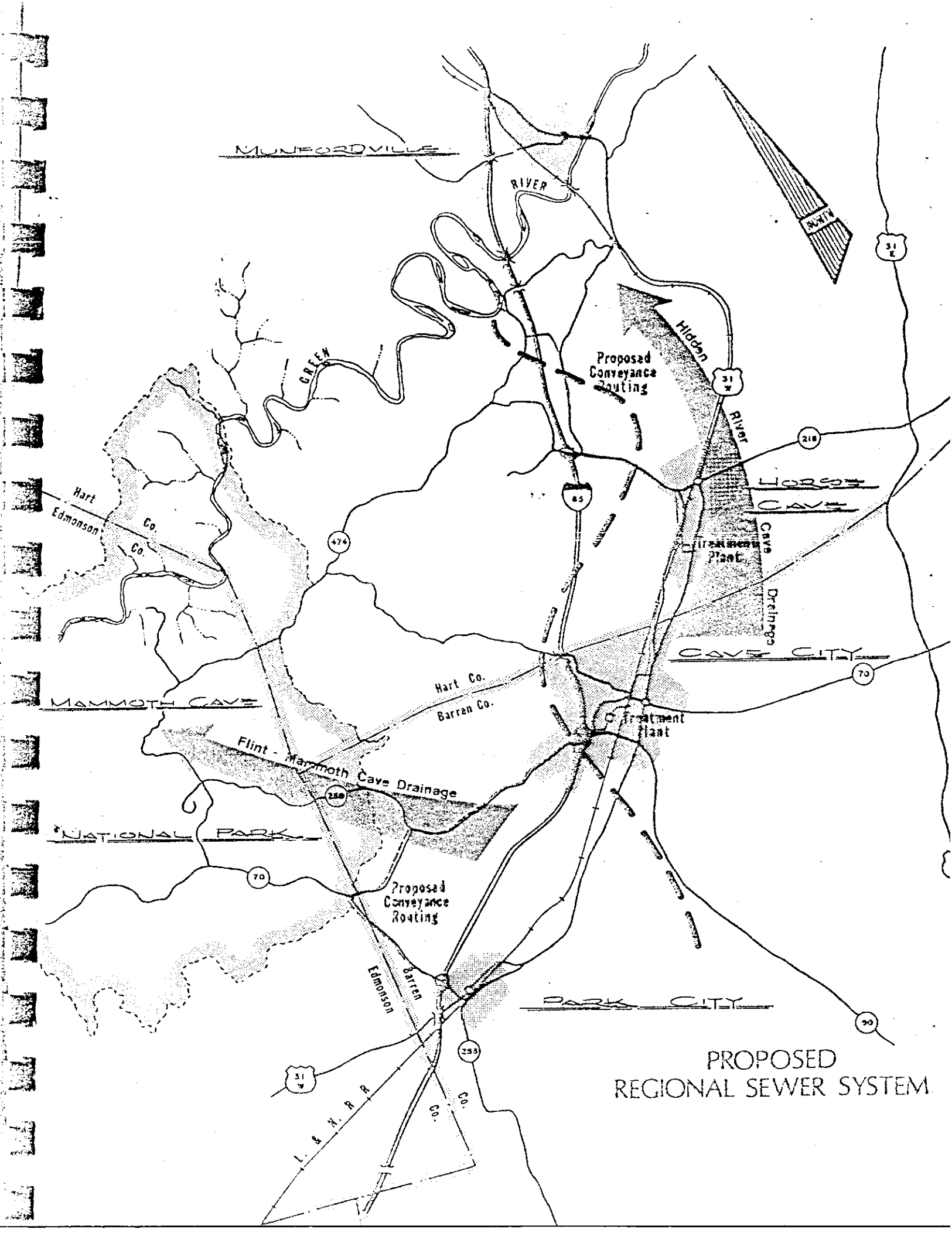
The proposed regional sewer system for the Mammoth Cave Area will include facilities to collect all major sources of wastewater, adequately treat the wastewater, and convey the treated wastewater to the Green River for discharge.

Park City currently has no sewage collection system. Some sewage from Park City is partially treated by septic tank systems before discharge to the subsurface drainage. However, most sewage is discharged directly to the subsurface drainage without treatment. It will be necessary to construct a complete sewage collection and treatment system for Park City. Treated sewage will then be pumped to Cave City via a conveyance line following Routes 255 and 70. The conveyance line will pass the National Park Boundary and be available to serve future park facilities.

During the past two decades, a large number of tourist oriented businesses have been constructed along Route 70 between Interstate 65 and Mammoth Cave National Park. These businesses have individual sewage treatment systems which discharge to the subsurface drainage systems of the area. As part of the regional sewer system, a conveyance line will be built to carry sewage from the Route 70 Area to Cave City for treatment.

Cave City currently has both a sewage collection system and sewage treatment plant. However, the existing sewage treatment plant is not capable of adequately treating the city's sewage. Effluent from the existing plant is discharged to an adjacent sinkhole. The regional sewer system will upgrade the Cave City Treatment Plant to adequately treat wastewater from both Cave City and the Route 70 Area. A pumping station will be constructed at Cave City to convey treated sewage from Park City, the Route 70 Area, and Cave City to Horse Cave via a proposed conveyance line.

Horse Cave also has an existing sewage collection system and sewage treatment plant. Like the Cave City Plant, this treatment plant will require upgrading to adequately treat Horse Cave's sewage. An additional pumping station will be constructed at Horse



PROPOSED
REGIONAL SEWER SYSTEM

Cave. This pumping station will pump treated sewage from Park City, the Route 70 Area, Case City, and Horse Cave through a new conveyance line to a discharge point on the Green River.

If the full regional sewer system described above is not funded, a semi-regional system will convey wastewater from Cave City and Horse Cave to the Green River for discharge. However, wastes from Park City and the Route 70 Area will continue to be discharged to the area's subsurface cave system.

The semi-regional system will eliminate most sewage discharges to the Hidden River Cave System. However, sewage from Park City and the Route 70 Area will continue to be discharged to the Flint-Mammoth Cave System of Mammoth Cave National Park.

Problems in Funding the Regional System

Most sewer systems currently being built in the U. S. are financed by a combination of local funds (i.e. bond issues or loans to be amortized through user charges) and construction grants made by the U.S. Environmental Protection Agency.

The regional sewer system described above will cost roughly 10 million dollars to construct. Treatment and conveyance facilities to serve only Horse Cave and Cave City can be built for approximately 5 million dollars. The U. S. EPA has already funded 75% of design costs for the facilities to serve Horse Cave and Cave City. The EPA has also scheduled 75% funding for construction of these facilities to serve Horse Cave and Cave City. It appears that the remaining 25% of design and construction costs for this semi-regional system can be financed locally by Horse Cave and Cave City without placing an unacceptable burden on the sewer customers of these cities (i.e. average sewer bills are projected to remain under \$10

per month).

The current outlook for funding of the balance of the regional sewer system to serve Park City and the Routs TO Area is much more tenuous. The EPA has made no committment to fund this second half of the regional system due to concerns as to the ability of local governmental entities to raise the necessary local funds to supplement an EPA Construction Grant. It has been estimated that if EPA does fund the entire regional system at current levels of funding for eligible facilities (75%), the amoritiz'ation of the local share of construction costs for facilities will require Park City residents to pay sewer bills of approximately \$40 per month. Both the EPA and Park City residents agree that a sewer charge of this magnitude makes the full regional sewer system infeasible without additional funding to lessen the local financial burden.

At the present time, it appears that as a minimum, the semi-regional sewer system will be built to serve the Mammoth Cave Area. This system will eliminate sewage pollution of the Hidden River Cave System, but will do little to prevent a similiar pollution catastrophe from ultimately occurring in the Flint-Mammoth Cave System of Mammoth Cave National Park. To prevent this sewage pollution of the Flint-Mammoth Cave System, it is essential that the Caveland Sanitation Authority build the full regional sewer system to serve the Mammoth Cave Area. In order to build the full regional system, the Caveland Sanitation Authority must find a third source of public or private funding to supplement funds available locally and from the U. S. Environmental Protection Agency.