

**Septic Tank Inventory for
Bryan, Liberty and McIntosh Counties, Georgia**

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The statements, findings, conclusions, and recommendations are those of the author and do not necessarily reflect the views of DNR, OCRM or NOAA.

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Foreword

This report was written in the first person plural to acknowledge all of the individuals who contributed to the completion of the project.

Thanks need to be directed to Tim Callahan at the state level (Evaluation Support Program Director, Georgia Department of Public Health), Todd Driver (District Environmental Health Director), and to the Environmental Health Managers: Skip Youmans in Bryan County, Linus Woodard in Liberty County and Eric Rumer in McIntosh County. Special thanks need to be given to the workers who endured the tiring work of going through drawer after drawer of paper documents, looking up parcels on tax assessor websites and performing data entry: Darlene Shuman, Lee Ann Callahan, Hugh Coleman, Ashley Carpenter, Sheree Sheppard, Eric Ransom, Katherine Doster, Helen Lowes and Callie Jo Fowler.

In this report, there are acknowledgements of discoveries that we made and unforeseen problems that we encountered during the execution of the work. Figuring out what to do, how to do it, and what to do next was an ongoing process. The completion of the inventory in Bryan, Liberty and McIntosh Counties will make the same work far easier in other counties.

Introduction

Three geographic datasets are being delivered as a requirement of the completion of this project. Due to the fact that they are tangible (well, as tangible as an electronic dataset can get), it is possible to mistake the datasets as being the most important deliverable of the project. In fact, the most important deliverable is that each septic tank in Bryan, Liberty and McIntosh Counties, Georgia is now represented in an online database for septic tank records management.

Our colloquial term for the online database is “Garrison”. Its formal name is “Digital Health Department” and it was developed by Garrison Enterprises, Inc for the Georgia Department of Public Health. It is used by more than 140 of Georgia’s 159 counties.

Actually, the septic tank inventory should be thought of as existing in two forms, one that is internal within Garrison and one that is external to Garrison. The internal form of the inventory is the one of the two forms that the Georgia Department of Public Health and the Environmental Health Departments have committed themselves to using. If their use of Garrison continues, the internal inventory will always be up to date.

The external inventory, on the other hand, is not something that is continuously up to date. Instead, it is a static product that exists only when it has been constructed by assembling data from two sources: data from the internal inventory that is specific to the septic tank installations, and data from an outside source that is specific to the geographic locations of the septic tanks. The installation-specific data can be exported from Garrison at any time, by official personnel. Regarding the geography-specific data, it can be acquired from the tax assessor in each county, also at any time.

Desired Outcomes (Objectives) of the Project

During the course of the project, our understanding of many aspects of the project changed. Naturally, the terminology that we used changed as well. The following outcomes are restatements of the outcomes that were stated in the original proposal. For a comparison of the language that appears below and the original language as it appeared in the proposal, see Appendix A: How the Language That We Used to State the Project Outcomes Changed as We Learned More About the Project.

Outcome 1: The existing property records in Garrison, each of which represents a single septic tank, will be edited such that each property record will have a correct parcel identification number (PIN).

Status: Completed.

Outcome 2: If possible, data from previously used information systems for septic tank documentation, will be migrated into Garrison.

Prior to Garrison, the Environmental Health Departments (EHDs) utilized a desktop computer-based system called TEC.

At the time of the proposal, we knew that GDPH was trying or had tried to migrate data electronically from TEC to Garrison, but we were not sure of the outcome of those efforts. GDPH eventually determined that it was not possible. We had planned to assist, if possible, with the data migration in Bryan, Liberty and McIntosh Counties.

It needs to be made clear that, during the course of the project, the equivalent of this outcome was accomplished anyway. During the period of time in which TEC was used, septic tank inspection reports that had been entered into TEC were printed and kept on file in the Environmental Health Departments. During the course of the project, as we processed the paper documents, we encountered not only the documents that originated during the time prior to any electronic management of septic tank data (see Outcome 3, below), but also the printed TEC inspection reports. Thus, even though an electronic migration of data would have been more elegant and perhaps more cost-effective, none of the septic tanks that had been documented during the TEC era were lost. All of the TEC documents were entered manually into Garrison.

Status: The equivalent of this outcome has been completed for all three counties.

Outcome 3: All historic septic tank inspection reports that exist as paper files in the Environmental Health Departments will be entered into Garrison.

Explanation: Each county has several filing cabinet drawers full of paper documents, most of which are either septic tank permits or septic tank inspection reports. The task was to process

each document, with the processing consisting of the following: Use the documents themselves and the websites that are provided by the county tax assessors, to determine first an address, and then a parcel number. Enter a property record in Garrison that will contain location information about the septic tank location, such as parcel number, address, city, county, zip, etc. Enter an inspection record that will contain information about the septic tank installation, such as tank size, distance to water table, etc.

Status: This outcome has been completed, although with a modified approach in McIntosh County. (A fuller description of the procedure, and a description of the modified approach used in McIntosh County, can be found in Appendix B: Garrison's Data Structure and How It Relates to the Various Workflows.)

Outcome 4: All buildings that seem to require wastewater treatment and that are not served by sewer will be assumed to be served by a septic tank. Data from the tax assessor will be compared to the existing data in Garrison. The comparison will enable the identification of any building (septic tank) that is not in Garrison but should be. Based on the comparison, and following an investigation of each such building, an entry representing a septic tank will be made in Garrison and each such entry will be identified as a *possible* septic tank.

Status: Completed.

**The Septic Tank Inventory in Bryan, Liberty and McIntosh Counties:
Its Creation, Description and Summarization**

Creation of the “Internal” Inventory

Part 1. Pursuit of Outcome 3

As we were writing the proposal for this project and formulating the budget, we had to derive an estimate of the number of septic tanks in each county. To do this, we first acquired data from the tax assessor that told us how many parcels in the county had taxable structures. From this number, we subtracted the number of parcels that we estimated were served by sewer, thus giving us our estimate for the number of septic tanks. (Actually, we know now that this didn’t give us the number of septic tanks, it gave us the number of parcels with septic tanks. The fact that there could be multiple septic tanks on a single parcel was something that we had not known or planned for. We’ll say more about this later in this report.)

Upon beginning the project, we counted the number of paper records that would need to be processed in each county. Processing the paper records would satisfy Outcome 3, described earlier. Table 1 presents the number of septic tanks that we were expecting in the internal inventory and our counts of the paper records. At this point, it seemed that this part of the work would progress more or less as we had anticipated.

<i>Category</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Number of septic tanks expected in final inventory (from the project proposal)	5,529	9,096	4,500
Number of paper records to be processed (counted after the project began)	5,765	10,923	3,500
Percent difference	104%	120%	78%

Table 1. Number of septic tanks expected in the final inventory, number of paper records to be processed.

Later, we would refer to the records that we entered into Garrison while in pursuit of completing Outcome 3 as the *documented* septic tanks. Table 2 shows the number of paper records that we processed, and the yield from that work, in terms of documented septic tanks that were entered into Garrison as property records. (In Garrison, each property record represents a septic tank. For more about Garrison’s data structure, see Appendix B: Garrison’s Data Structure and How It Relates to the Various Workflows.)

<i>Category</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Number of paper records to be processed	5,765	10,923	3,500
Number of documented septic tanks in final inventory	6,245	3,092	2,910
Percent difference	108%	28%	83%

Table 2. Number of paper records to be processed, number of documented septic tanks in final inventory

The numbers in Table 2 suggest that less work was needed in Liberty and McIntosh Counties than was budgeted. In McIntosh, this was true, but as we’ll see later, it was more than compensated for by the amount of work that we needed to do later to satisfy Outcome 4.

In Liberty County, however, the numbers don’t represent the true picture. The anomalous numbers can be explained by a characteristic of the Liberty County EHD’s filing system - the fact that each event in the history of any septic tank (each inspection, each existing system evaluation, each repair, etc.) was filed separately in the paper files, with no cross-referencing. There were many septic tanks for which we processed paper documents many different times. This led to a certain amount of redundant work during our pursuit of Objective 3 – the time consuming process of looking up parcel numbers for paper documentation.

We are recommending to the EHDs that they place a very high priority on identifying, as early as possible, a correct parcel number for any property record that is being entered into Garrison. A parcel number is to a parcel what a social security number is to a person. It is a fundamental, unambiguous piece of identifying information. It is the piece of information that makes Garrison data connectible to parcel data from other sources.

Also, MAREX is suggesting to the EHDs that they file their paper documents by parcel numbers. The Georgia counties of Glynn and Camden already do this. And during the inventory project, upon the recommendation of MAREX, McIntosh County changed to doing this as well.

During our pursuit of Outcome 3, we began to encounter, occasionally, septic tanks that seemed to be no longer in operation. Perhaps a building was no longer there. Or perhaps a building was there, but was obviously not in use. For the sake of the external inventory, we started tagging these property records. As a favor to the EHDs, we tried to figure out all of the possible reasons that a septic tank might be no longer in use. More will be said about this later.

Part 2. Pursuit of Outcome 4

Following the completion of Outcome 3, we were free to pursue Objective 4 – identifying the septic tanks that existed in the real world, but, for some reason, were not documented in the EHD’s records. Our terminology for these changed during the course of the project. As we were in the process of

simply identifying them, we called them the *missings*. They were supposed to be in Garrison, but they weren't - they were missing. Then, as we were entering them into Garrison, we called them the *possibles*. We called them this because we wanted to not overstep our privilege of having access to Garrison. We wanted it to be clear that, for the sake of the external inventory, we were identifying them as septic tanks that were possible (or probable or potential), but we also wanted the EHDs to be able to easily identify them as entries that were made, not by EHD staff, but by MAREX staff during the inventory project. (And if the EHD staff wanted to verify that those property records did, in fact, officially represent septic tanks in their jurisdictions, and indicate them accordingly, they would be able to easily do so.) Finally, by the time of this report, we had begun to think of them as *undocumented* septic tanks, existing in the real world but not documented in the county's filing system.

Our methodology for identifying the missings required us to do three things, in no particular order. One thing we did was export the property records from Garrison, each representing a single septic tank, and then summarize them by parcel number. This yielded a list of all of the parcels that had at least one septic tank and the list included the actual number of septic tanks that had been documented so far. Another thing we did was acquire data from the tax assessor from which we could create a list of all of the parcels in the county that had taxable improvements. An improvement in this sense means that there is something of value in addition to the land itself, and in most cases, the improvement is a dwelling of some kind. Improvements that require wastewater disposal include built homes, mobile homes, small businesses, swimming pools and guest houses. They typically do not include garages, shops, warehouses and mini-warehouses, although exceptions do exist. (Larger improvements, such as retail centers office buildings and apartment complexes all seemed to be in areas served by sewer.) A third thing we did was approximate a map layer of the parcels that are served by sewer and from this layer we extracted a list of parcels that are served by sewer. Using the three lists, we were able to calculate the difference, on any parcel not served by sewer, between the number of septic tanks that were officially thought to exist and the number of septic tanks that had been documented so far in the internal inventory.

We had expected that this list would only include the missings. Something we had not expected was that the list would also include what we called the *extras*, parcels on which there were more septic tanks documented than the number that the tax assessor data suggested that we should expect to find. So we ended up with two lists.

Using our list of missings, we looked up each parcel on the website of the county tax assessor. Within the website, we checked the description of the property's improvements, we checked ground-level photographs when they were available and we checked aerial photography. If we were confident that there was a septic tank on the property that had not yet been entered into Garrison, we entered it, tagging it as a *possible*. Actually, we used the acronym POSS, standing for *possible on-site septic system*.

Similarly, we used the tax assessor's website to check in the same way each of the parcels in the list of extras. As we did so, when we found that a septic tank seemed to no longer be in active use, we tagged it in Garrison as STATU, standing for *status unknown*.

Initially, we made an effort to specifically identify the reason by which we were assuming that the septic tank was no longer actively in use. It seemed that we were able to identify a definitive list of reasons:

- the septic system had been replaced by sewer service
- a house or mobile home was still there, but was clearly not in use
- a house or mobile home which had been there in the past (and sometimes was visible on historic aerial photography) was simply no longer there
- a mobile home park was present but with mobile homes on only some of the available spaces

It was difficult to positively identify the actual cause of a septic tank's inactivity and this ultimately led us to simply refer to them each as *status unknown*. This would satisfy the requirement of the external inventory, since all we needed was to know whether to include or exclude any particular septic tank entry in Garrison. And we felt that our responsibility to the EHD was met if we simply identified a septic tank as having an unknown status so that the manager could make his own more definitive assessment later.

With the *missings* and the *extras*, or, if you prefer, the POSS and STATU entries, we were faced with the problem of not knowing where to identify them accordingly in Garrison. Our preference would be for a STATUS field to be added to Garrison, but that is not the kind of change that GDPH can pursue quickly or without cost. So we experimented with various available fields in the property record that seemed to be unused for their original purpose. We finally settled on a location that would be consistent in all three counties: the OTHER ADDRESS INFORMATION field. We chose this field for two reasons, both of which are related to Garrison's user interface: it was searchable, and its contents were displayed at advantageous times.

Generating and processing the lists of missings and extras in the counties turned out to be an iterative process, so we don't have exact tallies for those. However, Table 3 presents the number of missings that we predicted (in the proposal) that we would find and it also includes the actual number of undocumented septic tanks that we ended up with in Garrison. The numbers show that, in all three counties, we greatly underestimated, and this contributed significantly to our inability to complete the project on time. Table 4 presents the percentages of documented versus undocumented septic tanks, as they existed in the inventory at the time of this report.

Table 5 presents the numbers of septic tanks that were predicted to be in the final inventory and the actual final number. The numbers in Bryan and McIntosh probably reflect reality, which is that the job was about a third larger than expected.

The number in Liberty is not at all reflective of the size of the task. First, the number of paper files that had to be processed redundantly (as was mentioned in the discussion surrounding Table 2, above) accounted for a lot extra work.

<i>Category</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Number of expected missings, as estimated in the project proposal. (These would be entered into Garrison as POSS entries.)	200	455	1,000
Number of POSS entries in final inventory. (These are also tabulated elsewhere as <i>undocumented</i> septic systems.)	1,376	2,850	3,250
Percent difference	688%	626%	325%

Table 3. Number of expected missings, number of POSS entries in final inventory

<i>Category</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Number of documented septic tanks. These were entered based on paper inspection reports that are on file. (These are included in the deliverable)	6,245 (82%)	3,092 (52%)	2910 (47.2%)
Number of undocumented septic tanks. These represent possible septic tanks and they were entered based on data from the tax assessor. (These are also included in the deliverable)	1,376 (18%)	2,850 (48%)	3,250 (52.8%)
Total	7,621	5,942	6,160

Table 4. Number of documented septic tanks, number of undocumented septic tanks

Second, there was also another phenomenon in Liberty that caused us to do redundant work. Many of the septic tanks for which we searched for a parcel number, and then entered a property record into Garrison, turned out later to be inactive due to having been replaced by sewer. Liberty County has four municipal sewer systems (as opposed to two in Bryan and one in McIntosh), several of which have recently undergone significant expansions. Thus, we found ourselves having to edit these records a second time.

Both of these factors contributed to the overall task in Liberty being far larger than had been predicted. It was only after we had completed Objective 3 and were working on Objective 4, that it became obvious that we were having to again edit many of the records that we had entered. It may interest readers of this report to know that we have proposed a continuation of the septic tank inventory in two more counties (Glynn and Long) in Georgia's coastal area, and the proposal has been approved. More importantly, in the workflow that we will pursue in the upcoming project, the order of Objectives 3 and 4 will be reversed. We will first fully populate Garrison with property record entries for all possible septic tanks in the counties, based on tax assessor data, and we will make every effort to take sewer

service areas into consideration as we do so. Following that, we will process the paper records in each county EHD, and will change the status of the property records from undocumented to documented only as we find actual documentation.

<i>Category</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Number of septic tanks predicted to be in final inventory (from the project proposal)	5,529	9,096	4,500
Number of septic tanks in final inventory (active septic tanks in Garrison)	7,621	5,942	6,160
Percent difference	138%	65%	136.9%

Table 5. Number of septic tanks predicted to be in final inventory, number of septic tanks in final inventory

Creation of the “External” Inventory

Creating the external inventory of septic tanks that is being delivered as a final requirement of this project was a multi-step process. In general, the steps are:

1. Export the property records from Garrison.
2. Remove all property records from that are tagged as STATU. (Those are the ones that represent inactive septic tanks.)
3. Export, also, the *confirming document* tables from Garrison - inspections, existing system evaluations, repairs, sewage complaints. (Those are the ones that contain a confirmation of some kind that the septic tank actually exists.)
4. Match up the property record table and the confirming document tables.
5. Use the confirming document tables and the POSS tags to identify, respectively, the property records that represent documented and undocumented septic tanks.
6. Eliminate all property records that represent something other than septic tanks.
7. Join the property records with parcel polygon centroids.
8. Put the results into a geodatabase.

Step 1 is illustrated by Table 6, which shows that 8,040, 8,635 and 6,583 property records were exported from Garrison for the three counties.

In the future, if GDPH adopts a way to identify active septic tanks in Garrison, it will not be necessary to export the confirming document tables and use them to identify active septic tanks. It will be possible to simply identify property records that represent active septic tanks and export them, effectively leaving behind all STATU and non-septic tank entries.

<i>Garrison Property Records</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Total number exported from Garrison	8,040	8,635	6,583
Number representing septic tanks	7,892 (98.2%)	8,590 (99.5%)	6,524 (99.1%)
Number representing other (permits, non-sewage complaints, wells, etc.)	148 (1.8%)	45 (0.5%)	59 (0.9%)

Table 6. Number of property records exported from Garrison, number representing septic tanks, number representing other

Step 2 is illustrated by Table 7. In Bryan and McIntosh, there were similar percentages of inactive septic tanks (3.4% and 5.6%, respectively). However, in Liberty County, the number is very high at 30.8%. The only plausible explanation would seem to be that some of the sewer systems pre-dated the practice of requiring permits for septic tanks, while the others post-dated the practice. The former group would include Richmond Hill and Pembroke in Bryan County, Hinesville in Liberty County and Darien in McIntosh County. There were not many property records for properties within those sewer service areas. The latter group would include Midway, Riceboro, and Walthourville, all in Liberty County. It seems that those sewer service areas account for the large number of inactive septic tanks in Liberty County. It would be interesting to do an analysis to find out.

<i>Garrison Property Records</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
All septic tanks	7,892	8,590	6,524
Active septic tanks	7,621 (96.6%)	5,942 (69.2%)	6,160 (94.4%)
Inactive septic tanks	271 (3.4%)	2,648 (30.8%)	364 (5.6%)

Table 7. Number of septic tanks, number of active septic tanks, number of inactive septic tanks

Steps 3 through 5 are illustrated by Table 4, earlier in this report. The percentage of documented septic tanks ranged from 47.2% to 82%. The percentage of undocumented septic tanks ranged from 18% to 52.8%.

Step 6 is illustrated by Table 6. The table shows that in Bryan, Liberty and McIntosh Counties, 1.8%, 0.5% and 0.9% of the property records, respectively, were non-septic tank records. Overall, more than 98.2% of the exported records represented septic tanks.

After the property records have been exported from Garrison and pared down to just the active septic tanks, they are just a list. Each septic tank in the list is identified by the parcel number of the property on which it is located. The only way to put the list into geographic format is to assign or attach the list

of septic tanks to a list of geographic points, with the parcel number being the item that is common to both lists.

Each point is defined by a pair of coordinates from a coordinate system. The coordinate system of the delivered geodatabases is state plane.

Ideally, the coordinate pair would represent the actual location of the septic tank. However, there are multiple obstacles to the idea of being able to represent a septic tank with a point. (For an expanded discussion on this topic, see Appendix D: What is the Best Way to Represent Septic Tanks Geographically?) As a substitute for the *actual* location, we have decided to use the geometric centroid of the polygon that represents the boundaries of the parcel on which the septic tank is located. The centroids are far more affordable to create and not subjective with regard to accuracy (because none is claimed).

We mentioned earlier that we had not anticipated that there would be parcels with more than one septic tank. Table 8 shows that 82.1% of the septic tanks in the three counties are alone on a parcel and 17.9% of the septic tanks are on a parcel that has two or more.

There is a problem in the external inventory that arises when the parcel centroid is used as a proxy for the actual location of the septic tank. It occurs when there are multiple septic tanks on a single parcel. On any parcel for which this is true, we end up with multiple points in a stack.

The simple way that we have chosen to deal with this limitation is to include two versions of the final data. Each county geodatabase has two geographic point layers. One is a full version of the data, the other is a summarization.

The summary version is a point layer that includes a single point for each parcel, and each point has in its attributes the number of septic tanks that are represented by the point. This version is best suited for cartographic representation of the septic tanks. Map 1 was created using this version of the data. The name that we gave the summarized table of property records is `septic_systems_summary_features`.

The full version is a point layer that includes a separate point for each septic tank and the attributes include a certain amount of information about the location of that particular septic tank. This version is the one in which the points end up in the stack, with the number of points in the stack being determined by the number of septic tanks on that parcel. This version would be better suited for spatial analysis in a GIS. The name that we gave to the full version of property records is `septic_systems_all_features`.

Step 7 (Join the property records with parcel polygon centroids) is illustrated by Table 9. It shows the numbers of records and features that were present in the various components during the construction process of the external inventory.

The reason that the number of parcel centroids is sometimes smaller than the number of polygons is that, in the real world, a tax parcel can exist as multiple polygons. As can be seen in the table, this is true in Bryan and McIntosh Counties. Thus, the number of centroids that we created was determined, not by

the number of polygons from which they were derived, but by the number of unique parcel numbers. When we created the parcel centroids, we made sure that, in all parcels, including the instances of multiple-polygon parcels, the centroid was calculated to be within one of the polygons.

<i>Number of Septic Tanks on Parcel</i>	<i>Total Number of Parcels</i>	<i>Total Number of Septic Tanks</i>	<i>Percentage of Septic Tanks</i>
1	16,191	16,191	82.1%
2	1,046	2,092	10.6%
3	165	495	2.5%
4	57	228	1.2%
5	15	75	0.4%
6	9	54	0.3%
7	8	56	0.3%
8	6	48	0.2%
9	2	18	0.1%
10	4	40	0.2%
11	4	44	0.2%
12	1	12	0.1%
13	2	26	0.1%
14	1	14	0.1%
15	3	45	0.2%
16	3	48	0.2%
17	1	17	0.1%
18	1	18	0.1%
21	2	42	0.2%
23	1	23	0.1%
24	1	24	0.1%
28	1	28	0.1%
30	1	30	0.2%
55	1	55	0.3%
Total	17,526	19,723	100%

Table 8. Summary of Septic Tanks Per Parcel

As we would expect, the summarized tables of septic tank records have fewer records than the tables from which they were summarized. This is true in all three counties, by varying degrees, and will always be true if there is at least one parcel with more than one septic tank. (In other words, septic_systems_summary_features is always going to have fewer records than septic_systems_all_features.)

At this point, what we hope is for every septic tank table record to have a corresponding parcel centroid. That said, we can see, in Table 9, that it is not true. In instances in which the full septic tank file or the summary septic tank file was joined with the centroids, only between 97.8% and 99.8%. of the records had corresponding centroids. This is unfortunate because it means that some of the septic tanks that are in the internal inventory will end up being left out of the external inventory.

The reason for the disparity has to do with workflow in the office of the tax assessor, in general. Whenever a parcel number is assigned to a newly created parcel, there may be weeks, or perhaps months, before an updated GIS map layer that contains the new parcel is available for release by the department. Thus, the property record for a new septic tank, complete with a parcel number for a newly created parcel, might exist in Garrison (the internal inventory) long before it can be mapped (in the external inventory).

<i>Layer Name</i>	<i>Unit</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>	<i>Included in deliverable geodatabase</i>
Parcel_polys	Polygons	17,172	24,583	12,894	
Parcel_centroids	Points	16,551	24,583	12,651	
Septic_systems_all	Table records	7,621	5,942	6,160	
Septic_systems_all_features (the percentage indicates how many of the table records that could be connected to corresponding polygon centroids)	Points	7,551 (99%)	5,928 (99.8%)	6,045 (98.1%)	Yes
Septic_systems_summary	Table records	7,051	5,260	5,215	
Septic_systems_summary_features (the percentage indicates the number of table records that could be connected to corresponding polygon centroids)	Points	6,982 (99%)	5,249 (99.8%)	5,101 (97.8%)	Yes

Table 9. Number of features or records within each layer of the final geodatabase

The good news is that 98% really isn't so bad. During the course of this project, over 4,000 parcels were added to the county parcel map layer in Bryan County! If that hadn't happened, the number of points resulting from the match would probably have been far fewer than 7,551.

Step 8 (Put the results in a geodatabase) is illustrated by Tables 10 and 11.

The external geographic septic tank inventory is being delivered as three separate geodatabases, one for each county. Table 10 presents the names of the geodatabases and the size of each.

Creating the external inventory is a straightforward process, but creating it while the internal inventory was still being worked on made the process somewhat complex. Thus, the dates on which the components of the external inventory were exported varied somewhat. Table 11 presents the export dates of the components that were used to create the final inventory in each county.

<i>Geodatabase Name</i>	<i>Description</i>	<i>Size</i>
OSS_Bryan.gdb	Septic tank inventory for Bryan County, Georgia	6.1 MB
OSS_Liberty.gdb	Septic tank inventory for Liberty County, Georgia	3.3 MB
OSS_McIntosh.gdb	Septic tank inventory for McIntosh County, Georgia	10.8 MB

Table 10. Final deliverables of the project: The geodatabases

<i>Layer Name</i>	<i>Bryan</i>	<i>Liberty</i>	<i>McIntosh</i>
Parcel polygons	5/1/2014	1/14/2014	5/13/2014
Garrison property records	5/6/2014	5/21/2014	5/12/2014

Table 11. Characteristics of the geodatabases: Export dates of the component datasets

Table 12 is offered as additional information to enhance the reader's understanding of the situation. It shows a breakdown of the parcels in each county and the number of septic tanks on each parcel.

One Initial Observation About the Final External Inventory

The biggest surprise is probably the number of septic tanks that were undocumented, particularly in Liberty and McIntosh Counties. No one had predicted that the percentages would be almost half in Liberty and more than half in McIntosh (as shown in Table 4).

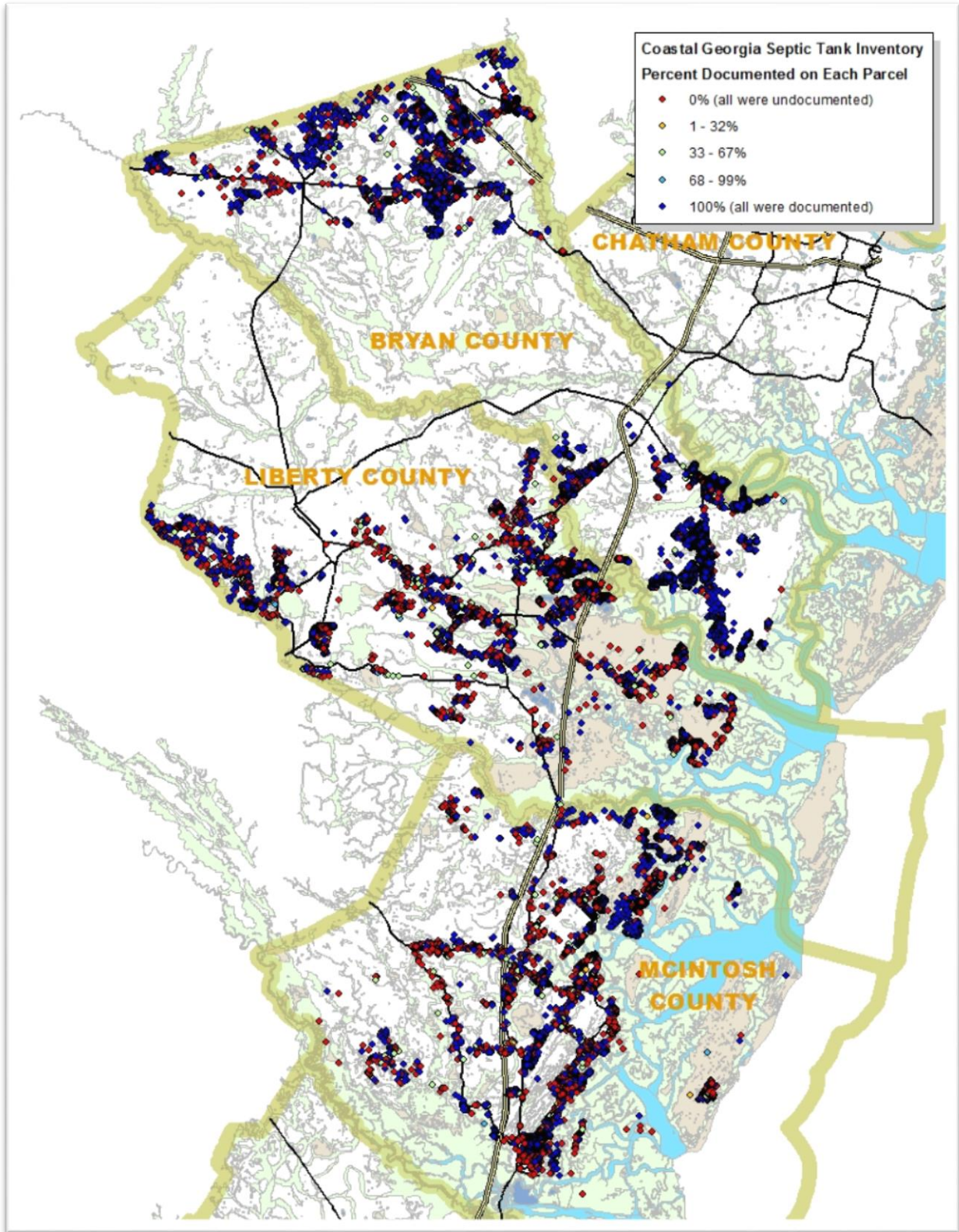
The obvious question is "Is there a spatial pattern to the distribution of the undocumented septic tanks (or are they geographically random)?"

Map 1 might reveal an answer. On the map, the red dots are the undocumented septic tanks and the blue dots are the documented ones. It looks as if the highest concentration of undocumented septic tanks is near Darien, but outside the area served by the Darien sewer system. And it looks like the highest concentration of documented septic tanks is in southern Bryan County.

<i>Number of Septic Tanks on Parcel</i>	<i>Bryan</i>		<i>Liberty</i>		<i>McIntosh</i>		<i>Total</i>	
	<i>Parcels</i>	<i>Septic Tanks</i>	<i>Parcels</i>	<i>Septic Tanks</i>	<i>Parcels</i>	<i>Septic Tanks</i>	<i>Parcels</i>	<i>Septic Tanks</i>
1	6,663	6,663	4,861	4,861	4,667	4,667	16,191	16,191
2	311	622	318	636	417	834	1,046	2,092
3	45	135	42	126	78	234	165	495
4	17	68	16	64	24	96	57	228
5	7	35	2	10	6	30	15	75
6	1	6	6	36	2	12	9	54
7	1	7	0	0	7	49	8	56
8		0	4	32	2	16	6	48
9		0	2	18	0	0	2	18
10	1	10	1	10	2	20	4	40
11	1	11	1	11	2	22	4	44
12		0	0	0	1	12	1	12
13		0	1	13	1	13	2	26
14		0	0	0	1	14	1	14
15	1	15	2	30	0	0	3	45
16	2	32	0	0	1	16	3	48
17	1	17	0	0	0	0	1	17
18		0	1	18	0	0	1	18
21		0	0	0	2	42	2	42
23		0	1	23	0	0	1	23
24		0	1	24	0	0	1	24
28		0	0	0	1	28	1	28
30		0	1	30	0	0	1	30
55		0	0	0	1	55	1	55
Total	7,051	7,621	5,260	5,942	5,215	6,160	17,526	19,723

Table 12. Final Inventory: Frequency of Septic Tanks Per Parcel

It's probably the case that, within the three counties, the Darien area has the highest concentration of older homes, homes that would pre-date the era in which septic tanks required permits. And it's probably the case that southern Bryan County has the highest concentration of new homes. An analysis of the data, if one were to be done, might reveal that there is a correlation between the age of a home and the likelihood of it having an undocumented septic tank.



Map 1. Documented vs. Undocumented Septic Tanks (Percent, by Parcel)

Appendix A:

How the Language That We Used to State the Project Outcomes Changed as We Learned More About the Project

The proposal to undertake this project declared that four outcomes, listed below, would be achieved. During the course of the project, our understanding of many aspects of the project changed and, naturally, our terminology changed as well. What follows is a comparison of the language that was used in the proposal to describe the four outcomes and the language that was used on page 4 of this report.

Outcome 1

Language used in the proposal: Any septic tank permit that has already been entered into Garrison (an online information system that has been adopted by the Georgia Division of Public Health) will be edited such that it includes a valid parcel identification number (PIN).

Language used in this report: Garrison is the online information system that has been created by the Georgia Department of Public Health [GDPH] and made available to the Environmental Health Department [EHD] in each of Georgia's counties. The existing property records, each of which represents a single septic tank, will be edited such that they will each have a correct parcel identification number (PIN).

Explanation: During the crafting of the proposal, we mistakenly thought that a septic tank permit was sufficient evidence to prove that a septic tank exists. We learned, during our processing of the paper files, that we would encounter two types of documents, those that *confirm* a septic tank's existence and those that don't actually confirm, but instead indicate the *possibility* of, a septic tank's existence. Permits, it turned out, are non-confirming documents, as are Well Reports and Soils Reports. Confirming documents include Inspection Reports, Existing Systems Evaluations, Sewage Complaints, and Failure Reports.

At the outset of the project, we saw that within Garrison's data structure, the parent record for any septic tank was called the property record. We accepted the implication that, within Garrison, a piece of property and the septic tank that is on it could be considered to be synonymous and that each property contains a single septic tank. It didn't take us long to realize that it is definitely not true that each parcel has only one septic tank. Examples of multiple septic tanks on a single parcel include all of the following: mobile homes in mobile home parks, mobile homes that are an additional dwelling on a parcel with a built house as the primary dwelling, swimming pools with accompanying bathrooms, guest cottages, multiple built homes on a parcel and so on. Even though it is probably not feasible, we now think that Garrison would benefit from a change in the record structure. We will be discussing this with GDPH.

Outcome 2

In the Proposal: If possible, any septic tank permits that have been previously entered into other information systems will be migrated into Garrison

In the Final Report: If possible, data from TEC, a previously used information systems for septic tank documentation, will be migrated into Garrison.

Explanation: Garrison was adopted in 2009. Prior to Garrison, the EHDs utilized a desktop computer-based system called TEC.

At the time of the proposal, we knew that GDPH was trying, or had tried, to migrate data electronically from TEC to Garrison, but we were not sure of the outcome of those efforts. We were planning to undertake or assist with, if possible, the data migration in Bryan, Liberty and McIntosh Counties. GDPH eventually determined that it was not possible.

However, it needs to be made clear that, during the course of the project, the equivalent of this outcome was accomplished anyway. Prior to the use of TEC, dating back to the mid-1970s, septic tank inspection reports were paper forms with blanks, into which the pertinent septic tank information was written by hand by the EHD inspector. After the forms were completed, they were kept in filing cabinets in the EHD offices. During the period of time in which TEC was used, septic tank inspection reports that had been entered into TEC were printed and kept on file in the EHDs, along with the septic tank inspection reports that were already there.

During the course of the project, we worked our way through the filing cabinets and examined each paper document that was on file. Naturally, we encountered documents from the period of time that preceded the TEC era and from the TEC era itself. For any confirming document that we encountered, we created a property record in Garrison (if one had not already been created). For any inspection report, after we entered a property record in Garrison, we also entered an inspection record in Garrison.

Even though an electronic migration of data from TEC into Garrison would have been more elegant and might also have been more cost-effective than manual data entry, none of the septic tanks that were documented in TEC were lost. All of the TEC documents were entered manually into Garrison.

Outcome 3

In the Proposal: All septic tank permits that exist on paper in the county Health Department files will be entered into Garrison

In the Final Report: All paper files in the EHDs will be reviewed. For any files that are confirming documents, appropriate entries will be made in Garrison. For any files that are non-

confirming documents, the website of the tax assessor in that county will be consulted. If it is determined that there is a building that probably requires wastewater disposal associated with a non-confirming document, then a property record, with the designation of *possible on-site septic system*, will be entered into Garrison.

Explanation: Again, we eventually realized that a permit is not a confirming document. It was thought that this would be the largest portion of the work, and it was. For more on the completion of this outcome, see Appendix B: Garrison’s Data Structure and How It Relates to the Various Workflows.

Outcome 4

In the Proposal: Any tax parcel that has a building and is not served by a sewer system will be assumed to have a septic tank. Of these, the parcels that do not have a permit will be visited and if it appears that there is a septic tank present, a paper permit will be created and the septic tank permit will be entered into Garrison.

In the Final Report: All buildings that seem to require wastewater treatment and that are not served by sewer will be assumed to be served by a septic tank. Data from the tax assessor will be compared to the existing data in Garrison. The comparison will enable the identification of any building (septic tank) that is not in Garrison but should be. Based on the comparison, and following an investigation of each such building, an entry representing a septic tank will be made in Garrison and each such entry will be identified as a POSS, a *possible on-site septic system*.

Explanation: The main difference here is that in the proposal, we believed that after we used the tax assessor data to identify the missing septic tanks, we would verify them by visiting them in the field. It turns out that, thanks to all kinds of photography that is available on the tax assessors’ websites – ground level photography and aerial photography from several sources – we could do a better job of confirming the possibility of a septic tank by using online resources that were available to us.

APPENDIX B:

Garrison's Data Structure and How It Relates to the Various Workflows

Relational Database and Parent and Child Records

Garrison is a relational database. A relational database contains two or more tables, often many more. Each table is connected to at least one other table by a piece of information that is shared by both of them. A record is an entry in a table.

Usually, a relational database contains many pairs of tables that have a parent-child relationship. A parent record can connect to many child records. A child record can connect to only one parent record. A child record is entirely dependent on its parent record for its existence. If the parent record is deleted, the child record is also deleted. A child record can also be a parent to some other child record.

Workflow of the Permit and Construction Process in the Environmental Health Department

The first step in installing a septic tank on a piece of property is to apply for a construction permit from the county environmental health department. At the environmental health department, the EHD staff will first enter a property record in Garrison. The property record, true to its name, holds information about the piece of property where the septic tank is located. Next, the EHD staff will make an entry in Garrison for a permit. The permit record is a child record to the property record.

After a permit has been issued, construction can take place. After the septic tank has been constructed (installed), but before the last step, which is covering it up with dirt, it must pass the inspection of the environmental health manager. Once the inspection has taken place, the manager enters an inspection report into Garrison. The inspection record is a child record to the permit record.

As is mentioned in the body of the report, a permit is a non-confirming document and an inspection report is a confirming document. A non-confirming document might exist without the septic tank ever having been installed. A confirming document is conclusive evidence that a septic tank was installed.

Historically (prior to Garrison), permits were kept until an inspection of the septic system was performed. At that point, the permit may or may not have been kept. Inspection reports were always kept.

Workflow During the Septic Tank Inventory Project

An inspection report that was issued at some time in the past can be entered into Garrison, but it will not be entered as an inspection record that is a child record to a permit record. Instead, it will be entered as a historic inspection record that is a child to the property record. All of the inspection records that were entered into Garrison during the inventory project were entered as historic inspections.

The most valuable data that was going to be yielded by this project was going to be data from inspection reports that would be entered into Garrison as historic inspection records. It was assumed that the number of missings/POSS/undocumented septic tanks would be small and that the majority of septic tanks in the three final county inventories would have inspection data.

Modified Workflow in McIntosh County

By the time the work got going in McIntosh County, we were far enough along in Bryan and Liberty Counties to realize that the percentage of undocumented septic systems in those counties was much higher than we had anticipated. We were investing a great deal of time entering inspection record data into a dataset that would have limited value. It would be geographically robust and it would have great value, administratively, and it would have great potential in terms of spatial analysis. However, the data being entered directly from the inspection reports would have limited value because the overall population of septic tanks in the three counties would be so poorly represented.

For this reason, and in the interest of saving time, we opted for a shortcut. Instead of entering the full inspection report in Garrison, we entered a shorthand entry. On the property record, in the parcel number field, separated from the parcel number by a comma and a space, we entered a code that indicated whatever paperwork was found. The code consisted of a letter and a four digit indication of the year. The letters were 'E' for existing system evaluation, 'N' for new septic tank installation, 'R' for a septic tank repair, 'S' for sewage complaint and 'V' for septage removal permit. Examples are: N2001 would mean that a new septic tank was installed in 2001; R1999 would mean that an inspection for a repair was done in 1999; E2003 would mean that an existing system evaluation was done in 2003; and so on.

APPENDIX C:

What is the Best Way to Represent Septic Tanks Geographically?

Strictly speaking, it is not the septic tank that interacts with the natural environment that surrounds it, it is the drainfield. The effluent that has passed through the septic system exits the septic system through small holes in the drainfield pipes and percolates downward through the soil.

Drainfields are almost always rectangular. They vary somewhat in size, but in the coastal area the average dimensions are probably approximately 25 feet wide by 65 feet long.

It seems obvious that, if the purpose is to understand the relationship between a group of septic systems and the environment, the best way to represent the septic systems geographically would be to have the data for each septic system attached to a polygon that accurately delineates the outer boundary of the drainfield.

If the boundary of the drainfield was recorded at the time of the installation of the septic system, with GPS, then the polygon will be as good as it can be. If a polygon was not captured at the time of installation, but a good drawing was made by the inspector at the final inspection then the two ways to delineate a polygon later would be either by using GPS or by digitizing against aerial photography. The accuracy of GPS would probably be better than digitizing, but both would depend on the quality of the drawing. Digitizing would also be dependent upon the accuracy of the photography. All of that said, digitizing would be far less expensive than visiting every site with a GPS unit.

One more thing to keep in mind is that all of the polygon options would have to be accompanied by the act of recording the parcel number of the polygon as an attribute of the polygon, a task that is probably not as easy as it sounds.

If recording a polygon to represent the drainfield is not possible, the next best options would involve placing a point that will, as closely as possible, approximate the middle of the drainfield.

There are some options for recording a point that are analogous to the options for recording a polygon. The best option would be to record a GPS point at the time of installation; the second best would be to record a point afterwards by GPS, based on the drawing done by the inspector; the third best would be to digitize a point against aerial photography, again based on the inspector's drawing. And as with the polygons, each of these options would have to be accompanied by the act of recording the parcel number of the point as an attribute of the point.

There are actually three more options that are also available for placing a point. All begin with acquiring a map layer of parcel polygons and then generating a centroid for each polygon. Generating centroids is a very inexpensive task and it comes with the built-in advantage of having a parcel number already attached to each point as an attribute.

The first of these options would be to generate a centroid point in each parcel polygon and then, using aerial photography and first-hand knowledge of where the drainfield is, move the point from its centroid position to its better position. This option could only be pursued if someone with first-hand knowledge (in other words, the inspector) was the person doing the point-moving.

The second of these options would be to generate a centroid point in each parcel polygon and then, using the inspector's drawing in conjunction with aerial photography interpretation skills, move each point from its centroid position to a better position. What would be the qualifications for the so-called *better position*? It would have to be an appropriate distance from the building. It would have to be in a cleared rather than vegetated area. It would have to be downhill from the building. There may be others, as well.

Finally, the last of these options would be to generate the centroids and then just not do anything. The work required to acquire a parcel polygon layer and generate centroids is so easy that, cost-wise, it is virtually free. There would always be the option of improving the point locations by one of the methods described above.

For reasons of cost, we chose this third option for the septic tank inventory project. And it has the flexibility that comes with the fact that it can be improved later.