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COST ANALYSIS OF SELECTED ALTERNATIVE CONFIGURATIONS FOR THE IN--ETC(U)

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FINAL REPORT

COST ANALYSIS OF SELECTED ALTERNATIVE CONFIGURATIONS FOR THE INTERNAL REVENUE SERVICE TOLL-FREE TELEPHONE SYSTEM

April 1977

Prepared for
INTERNAL REVENUE SERVICE
1111 CONSTITUTION AVENUE, N.W.
WASHINGTON, D. C. 20224
under Contract TIR 7T-64

ARINC RESEARCH CORPORATION

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by

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FOREWORD

This final report presents the results of Task One of a two-task effort for the Internal Revenue Service. Task One was a study of various levels of site consolidation for the Toll-Free Telephone System (TFTS) and the resultant economic/service benefits of such consolidation. The Task Two report, on comparative ACD evaluations, will be issued separately.

We are indebted to R. Layel, P. Smith, and G. McDonald of the Internal Revenue Service for their assistance in providing information, guidance, and the benefit of their many years of association with the TFTS. We are also grateful for the assistance of R. Pickering and L. Toner in accumulating much of the data used in this study. Special assistance in evaluation of the study approach was provided by J. Ambrose and J. Jones.

We are also indebted to J. Nalewaik for his initiation and support of the present study.

GLOSSARY

Abandoned Call - Call on which the calling party disconnects or hangs up before a TSR completes the call.

Automatic Call Distributor (ACD) - A type of answering equipment used for automatic distribution of incoming calls to persons designated to receive calls. The calls are served in the approximate order of arrival and routed to TSRs in order of availability.

Average Speed of Answer (ASA) - The average length of time a caller has to wait in order to reach an employee. This is measured from the time a call is received by the ACD to the time it is answered by a TSR.

Busy Hour - The peak 60-minute period during a business day when the largest volume of telephone traffic is handled.

CCS - A unit of measurement of telephone traffic. One CCS is equivalent to one telephone conversation lasting 100 seconds, two telephone conversations lasting 50 seconds each, or some other combination.

FX - A service that connects a caller's telephone to a remote exchange. This service provides the equivalent of local service from the distant exchange and is paid for on the basis of miles per line per month.

Grade of Service - Grade of service is related to basically the availability of incoming lines. It is expressed as the percentage of calls that receive a busy signal.

Hold Time - Related to circuit engineering, hold time is an essential element in the computation of line requirements. It is the length of time a communication channel is in use for each transmission from pick-up to disconnect of call.

Key Set - Another name for push-button telephones, wherein the buttons are used for intercom, holding, signaling, or pick-up of additional lines. Example: 6-button sets, Call Directors.

Toll-Free Telephone System (TFTS) - All answering sites and the telephone communications network that serves these answering sites.

WATS - A telephone company abbreviation for Wide Area Telephone Service. It refers to long-distance service that permits all taxpayers in one or more states to dial direct, with no toll charge, into a central answering point, i.e., district headquarters office (In-WATS) or a similar service (Out-WATS).

ABSTRACT

This report describes a generalized cost model for the nationwide Toll-Free Telephone System (TFTS) used by the Internal Revenue Service (IRS) in providing tax information and assistance to the U.S. public. The model is evaluated to provide an economic comparison of the potential savings for several candidate levels of consolidation for TFTS answering sites. The result of this comparison is a set of recommendations to the IRS concerning the preferred site-consolidation options in each of the ten IRS areas of the contiguous U.S.

SUMMARY

This report describes the work performed for the Facilities Management Division of the Internal Revenue Service under Task One of Contract TIR 7T-64. The broad purpose of this task was to provide telecommunications engineering services directly related to the design of a communications network for the IRS Toll-Free Telephone System (TFTS). The specific objectives were:

- To develop a methodology for more detailed analysis and continued assessment of TFTS site configurations and communications networks by the IRS
- To determine the cost of an improved and uniform level of service to the public through design of an improved communications network
- To investigate potential cost reductions through several levels of answering-site consolidation

To accomplish these objectives, a generalized cost model was developed for the TFTS system. This model included both personnel-related costs (such as wages, benefits, office space, telephone equipment, etc.) and communications costs (such as local business lines, WATS lines, and Foreign Exchange lines). The cost model was developed on the basis of data supplied by the IRS about their TFTS operations and the results of many meetings with IRS personnel for review and guidance.

A cull analysis methodology was developed in support of the generalized cost-model configuration of sites in the TFTS. The purpose of the cull analysis was to reduce the number of consolidation options to a reasonable number so that it would not be necessary to consider every combination of sites (more than 1200 different combinations are possible). The cull analysis is a process of TFTS site ranking and selection based on traffic and communications cost considerations. The output of the analysis was a subset of all possible site-consolidation combinations that would yield cost-effective consolidation options for the IRS.

Both the cost model and the cull analysis were applied to the TFTS sites in each Service Center to permit a financial comparison of various site-consolidation alternatives. The results of these financial comparisons are shown in a series of bar graphs representing costs in each

of four categories (Personnel, Facility, ACD, and Communications) for each of three site-consolidation alternatives. They are described separately for each of the ten Service Center areas as well as for the single case of nationwide consolidation. The results generally indicate that the IRS could reduce costs by $3.8 million per year by consolidating to no more than 20 sites. Specific recommendations were developed concerning the preferred consolidation option in each Service Center area and other areas of potential cost savings, e.g., WATS-to-FX diversion.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The Internal Revenue Service (IRS) operates a nationwide telecommunications system that provides federal tax information and assistance to the U.S. public. As currently configured, the system consists of 70 individual telephone answering offices, each with its own network of local and Foreign Exchange (FX) and/or WATS telephone lines (See Figure 1-1). Most of these Toll Free Telephone System (TFTS) sites have an Automatic Call Distributor (ACD) to distribute the incoming calls on a load-leveling basis to the Taxpayer Service Representatives (TSRs). Some of the smaller sites, however, are not large enough to warrant the installation of an expensive ACD. These sites use a key telephone system with many line-pickup buttons in order to distribute the calls equitably. Each of the 48 contiguous states contains one or more answering sites that service calls exclusively from within that state -- with the exception of the Denver answering site, which currently serves both Colorado and Wyoming.

The IRS has also divided the 48 contiguous states into ten Service Center areas for the processing of tax returns. Each Service Center area has its own Integrated Data Retrieval System (IDRS). For purposes of this study, the IDRS is a data base retrieval system that can be used only by a TFTS answering site in its own Service Center area. To accommodate this constraint, the TFTS network is configured so that each answering site serves a geographic area completely contained in one of the ten Service Center areas (see Figure 1-1).

1.2 REASON FOR STUDY

The IRS recognizes that this system requires substantial expenditures for communications circuits, communications equipment, and personnel, and that there are many feasible variations or trade-offs among these expenditures that could result in a system that provides the same or better level of service to the public at a significant reduction in total cost.

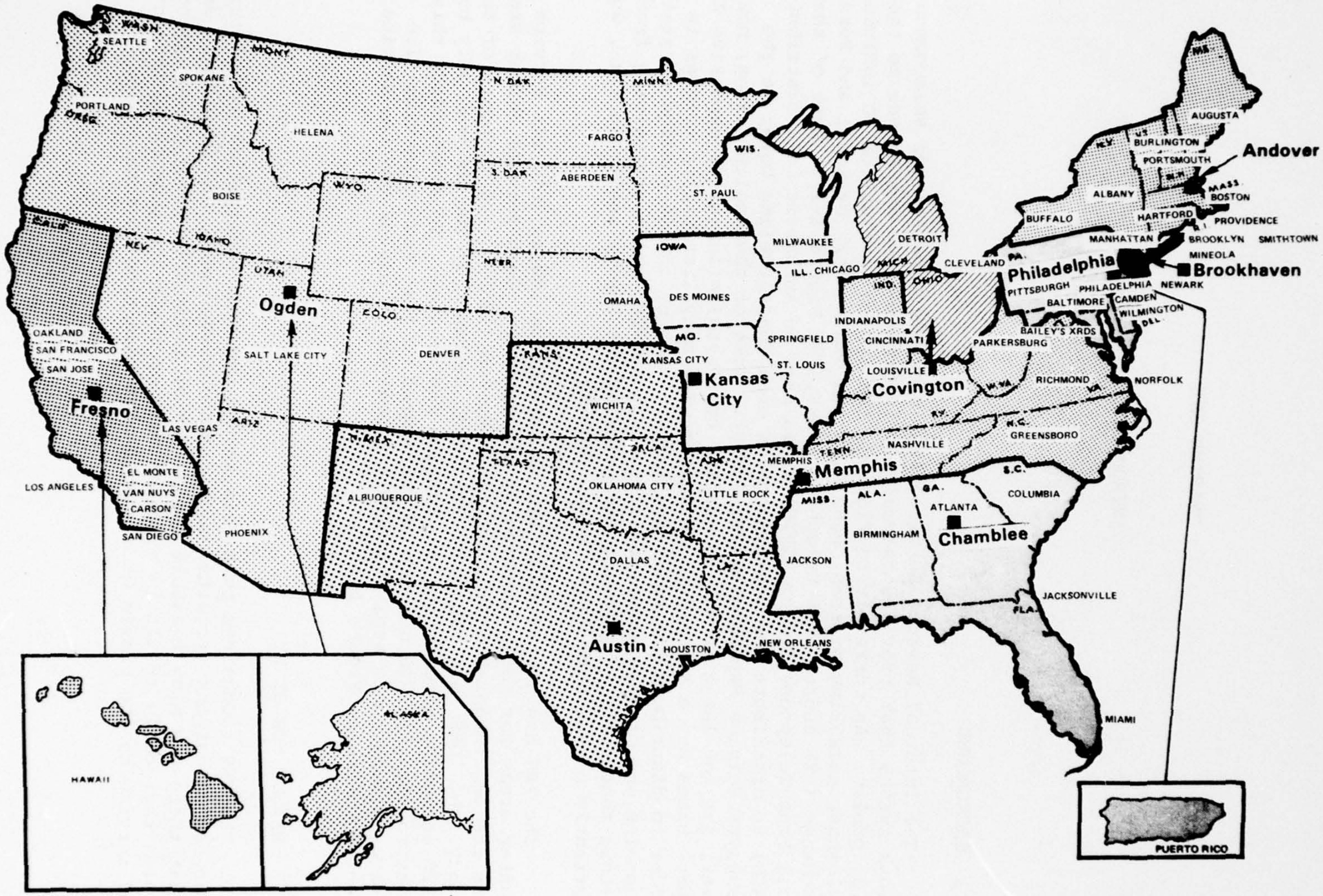

Figure 1-1. TFTS SITE NETWORK

There are a number of techniques that have the potential for reducing costs and maintaining or increasing the level of service being provided to the calling public:

- A more effective TFTS system configuration in terms of the number and locations of answering sites
- The collection and utilization of more accurate and timely traffic data to develop traffic projections that permit dynamic reordering of communications circuits on a monthly or seasonal basis
- The optimization of communications network configurations based on traffic statistics and projections.
- The utilization of newer, more economical telephone communications system developments (e.g., the use of computer-controlled electronic automatic call-distribution systems and their interconnection in lateral transfer arrangements, or LATA)

1.3 PURPOSE AND OBJECTIVES

The general purpose of this study is to provide to the IRS a management tool that can be used to gain insight into the cost economies and service improvements that can result from various levels of answering-site consolidation. The specific objectives are:

- To develop a methodology for detailed analysis of TFTS costs
- To apply the methodology to the investigation of major and moderate levels of site consolidation and resultant communications networks
- To make recommendations concerning the preferred TFTS site-consolidation plan
- To make recommendations in areas that might need further investigation before a consolidation plan is implemented

1.4 SCOPE AND ASSUMPTIONS

This study was conducted with a number of constraints, limitations, and assumptions. The more important of these are listed here (a comprehensive list of study ground rules is presented in Appendix A):

- The study was performed in a limited (six-month) period.
- No new or non-TFTS site locations were considered.
- The study was limited to voice communications within the 48 contiguous states.
- The study was based on traffic data for the period 1 May 1975 through 30 April 1976. (The word "present" as used in this report refers to the system as configured during this period.)

- No traffic growth or redistribution was considered.
- The primary focus of the study was on *intra* Service Center consolidation (as opposed to *inter* Service Center consolidation).
- Three levels of site consolidation were considered for each Service Center area: major, moderate, and no consolidation. In addition, one case of nationwide consolidation was considered.

CHAPTER TWO

PROJECT APPROACH

2.1 OVERALL APPROACH

The broad purpose of the study is to develop a management tool that can be used to provide insight into the cost economies and service improvements that would result from various levels of answering-site consolidation. The goal is to identify, and then to quantify, the cost elements that are the driving cost factors in any site-consolidation decision. There are many cost elements that can be used to describe the TFTS, with variations and additions from site to site. These include costs associated with the following:

- ACD features such as extra call-transfer capability, music-on-hold, etc.
- Methods of differentiating calls such as forms only, referral (as opposed to front line)
- Load-leveling techniques such as "call back" or transfer to non-TFTS sites
- Indirect costs associated with transferring TSRs from other IRS functions to TFTS duties during peak telephone traffic hours

These features (and their associated costs) vary from site to site and, to some extent, from one period of the year to another.

Because of the limited availability of cost information and the time and resource constraints of this study, it was decided to eliminate many of these detailed (and minor) cost differences from consideration. Hence, it was necessary to form some broad cost models that would be indicative of the "typical" IRS TFTS answering site. This approach, by design, precludes a more exact costing of the various consolidation options. It does, however, enable costing and comparison (within the time and resource constraints of the study) of a number of different levels of site consolidation, each with its own communications network configuration.

The overall approach has been to develop two analysis tools and then apply these tools to three levels of site consolidation in order to determine the relative importance of the various cost elements in any consolidation/reconfiguration plan. The two tools developed were a cull analysis methodology and a generalized cost model. The cull analysis was used to define an orderly approach to TFTS site consolidation. The generalized cost model was applied to several levels of TFTS site consolidation as defined by the cull analysis (see Ground Rule 8 in Appendix A). The result of this model application was a financial comparison of these various site-consolidation alternatives.

2.2 GENERAL COST TRADE-OFFS CONSIDERED

At the outset of the study, it was necessary to identify the critical cost elements that would be combined to calculate the total costs of each consolidation option. To meet this requirement, the following generalized cost model was developed:

$$\text{TFTS Monthly Costs} = \sum_{i=1}^{N} (\text{TFTS Personnel Costs})_i + (\text{Telephone Equipment Costs})_i + (\text{Facility Costs})_i + (\text{TFTS Communications Costs})_i$$

where

N = Number of Sites Within Each Consolidation Option

Telephone Equipment Costs = ACD Common Equipment Costs + TSR Attendant Console Costs + *Supervisory* Console Costs

TFTS Personnel Costs = TSR Salary Costs + Management/Clerical Salary Costs + Overhead Costs (Fringe Benefits, Training, etc.)

Facility Costs = Office Space Costs (Includes Desks, Chairs, Floor Space, Light, Heat, Power, etc.)

TFTS Communications Costs = WATS (Inter- and/or Intra-State) Costs + Local Business Line Costs + Foreign Exchange (FX) Line Costs + LATA (if used) Costs

Three of these four cost factors can be directly related to each other: TFTS Personnel Costs, Telephone Equipment Costs, and Facility Costs. The amount of telephone equipment (and hence the cost) at a TFTS answering site is directly related to the number of TFTS personnel answering calls. The facility costs are likewise related directly to the number of TSRs that staff a given answering site. These three cost categories can be lumped together into one broad category, personnel-related costs. The fourth cost category, TFTS Communications Costs, is related more directly to the traffic volumes and to the distance from the TFTS answering site to the calling public.

From previous ARINC Research experience with large networks and call-answering sites, these two broad cost categories, personnel-related costs and communications costs, can be related to network consolidation alternatives as shown in Figure 2-1. In this general figure, communications costs and personnel-related costs are plotted as a function of the number of sites remaining in any given consolidation plan. Also plotted are total costs, which are simply the sum of personnel-related costs and communications costs. The communications costs represent the sum of the costs for all communications circuits (WATS, FX, local) for each of the sites remaining in any given consolidation plan. The personnel-related costs include TSR costs, facilities costs, and ACD costs.

As the graph illustrates, communications costs tend to increase as a network is consolidated, but personnel-related costs tend to decrease. The increase in communications costs is caused by the increased length of the telephone circuits (WATS and FX). The decrease in personnel-related costs is directly related to the increase in serving efficiency of a larger serving group (more calls handled per TSR).

The total cost curve (the sum of personnel-related and communications costs), as illustrated by this generalized model, has a minimum at some point of moderate consolidation -- a point between the case of no consolidation of answering sites and full consolidation to one answering site. This generalized model applies to the IRS TFTS in each Service Center area. In some areas, the curves are slightly different in magnitude from those in other areas, but the principle remains the same throughout the areas.

The general approach to this study was to collect data, to develop a detailed costing methodology to apply to each of the four cost categories, and then to determine the costs for each of several levels of TFTS answering-site consolidation. In addition, three cost-reduction techniques were applied to the consolidation options to increase the cost-effectiveness of the resulting consolidation configurations.

2.3 PROJECT ACTIVITIES

Figure 2-2 shows the flow of project activities during the Task 1 study, divided into four phases:

- Phase 1 - Planning and Data Identification
- Phase 2 - Data Acquisition
- Phase 3 - Cost Model Development and Network Configuration
- Phase 4 - Cost Analysis and Report Preparation

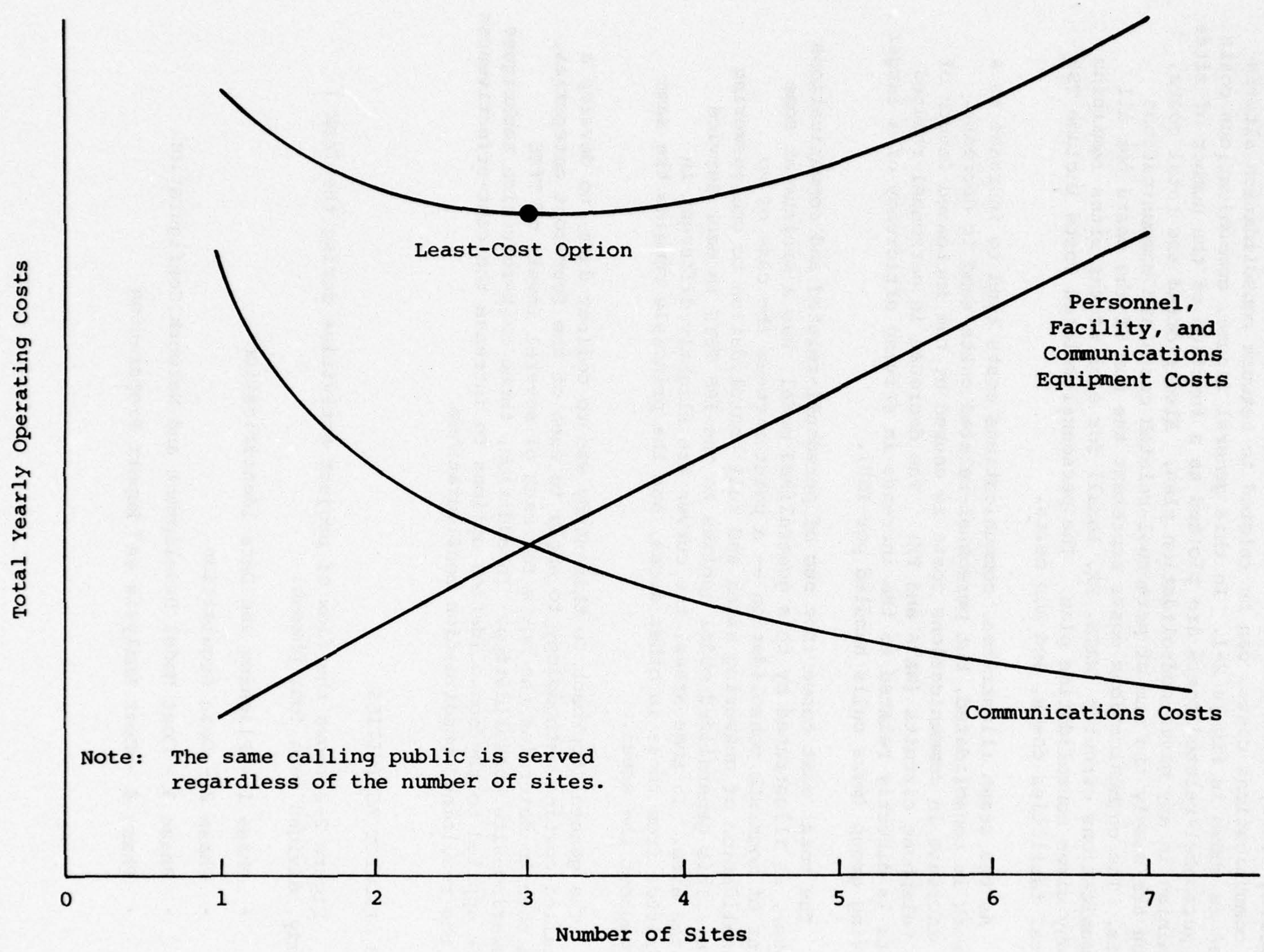

Figure 2-1. COST AS A FUNCTION OF THE NUMBER OF SITES REMAINING IN TOLL-FREE TELEPHONE SYSTEM NETWORK: TYPICAL ANALYSIS OUTPUT

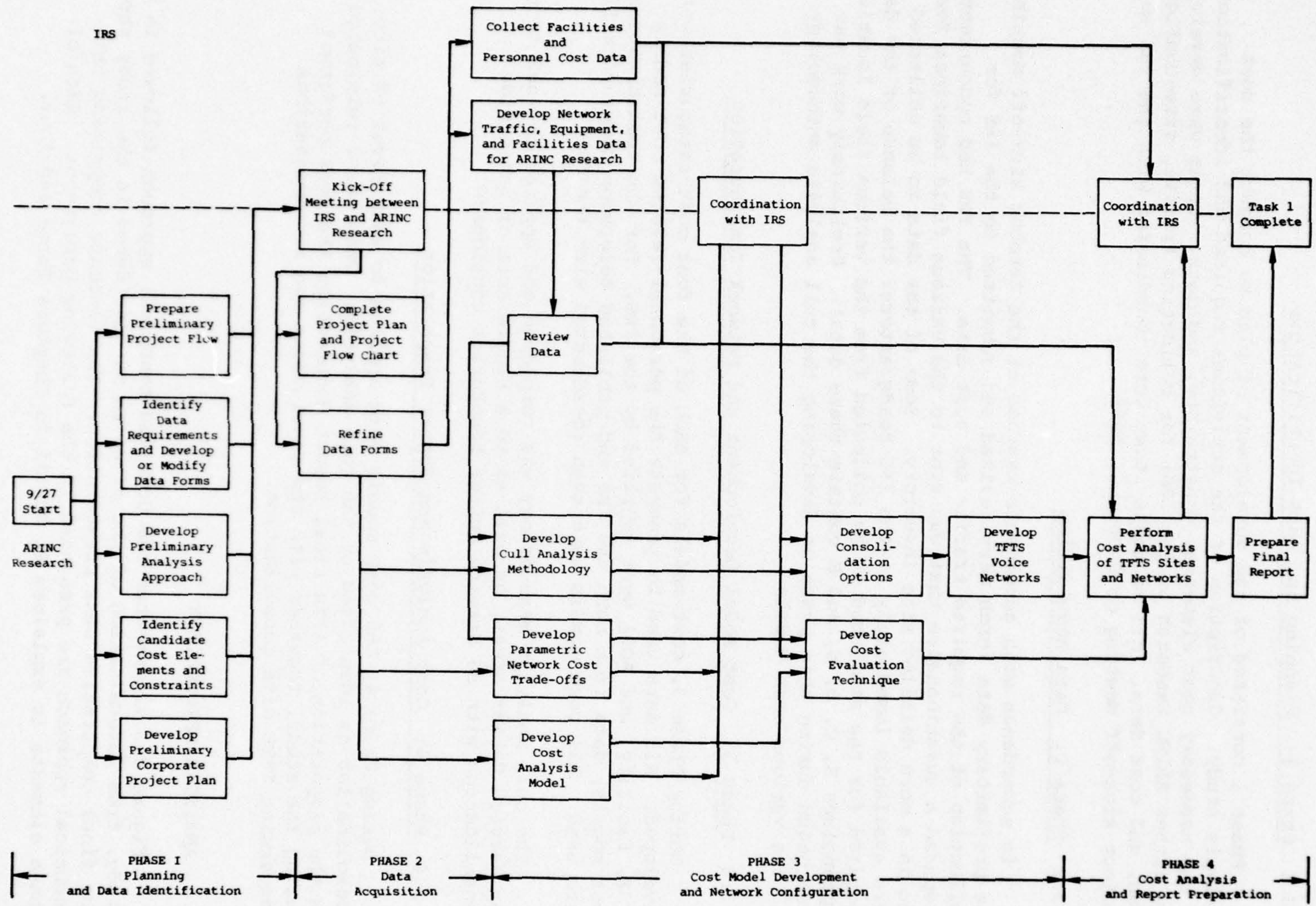

Figure 2-2. PROJECT ACTIVITIES FLOW CHART

2.3.1 Phase 1: Planning and Data Identification

Phase 1 consisted of the development of plan to conduct the cost analysis study: description of the activities required and identification of the necessary cost elements, constraints, and data. Forms were developed (by either ARINC Research or the IRS) for collecting traffic, site-configuration, and cost data. All of these items were coordinated with the IRS at a project kick-off meeting on 8 October 1976.

2.3.2 Phase 2: Data Acquisition

In accordance with agreements reached at the October kick-off meeting, the preliminary data forms were revised and submitted to the IRS for collection of the required traffic and cost data. The IRS had concurrently prepared a questionnaire that was sent to the various field locations for use in a more detailed site inventory. Some of the data to be collected were available immediately at the IRS headquarters; the balance of the data required for the study had to be collected from the various field locations (Appendixes B, C, D, E, and F contain these data). Preliminary work was also begun during this phase on developing the cull analysis methodology and the various cost models.

2.3.3 Phase 3: Cost Model Development and Network Configuration

During Phase 3, cost models for each of the four cost categories were developed. All data used to generate the personnel-related cost models (TSR, Facility, and ACD) were supplied by the IRS. For the communications cost models, data from both the IRS and published telephone company tariffs were used. All cost models were then coordinated with the IRS.

The cull analysis methodology was completed and applied to each of the ten Service Center areas, as well as to a single case of nationwide consolidation with no Service Center boundaries considered.

2.3.4 Phase 4: Cost Analysis and Report Preparation

During Phase 4, the cost models were applied to each level of site consolidation as identified by the cull analysis. This phase culminated in the preparation of this final report documenting the work performed during the study, together with the conclusions and recommendations concerning TFTS site consolidation.

2.4 ANALYSIS METHODOLOGY

Figure 2-3 illustrates the detailed technical approach followed in the study, from determination of the sites to be considered in the study through the final comparative cost presentation. The elements comprising this technical approach are presented in the following paragraphs. Each of these elements is explained in detail in Chapters Three and Four.

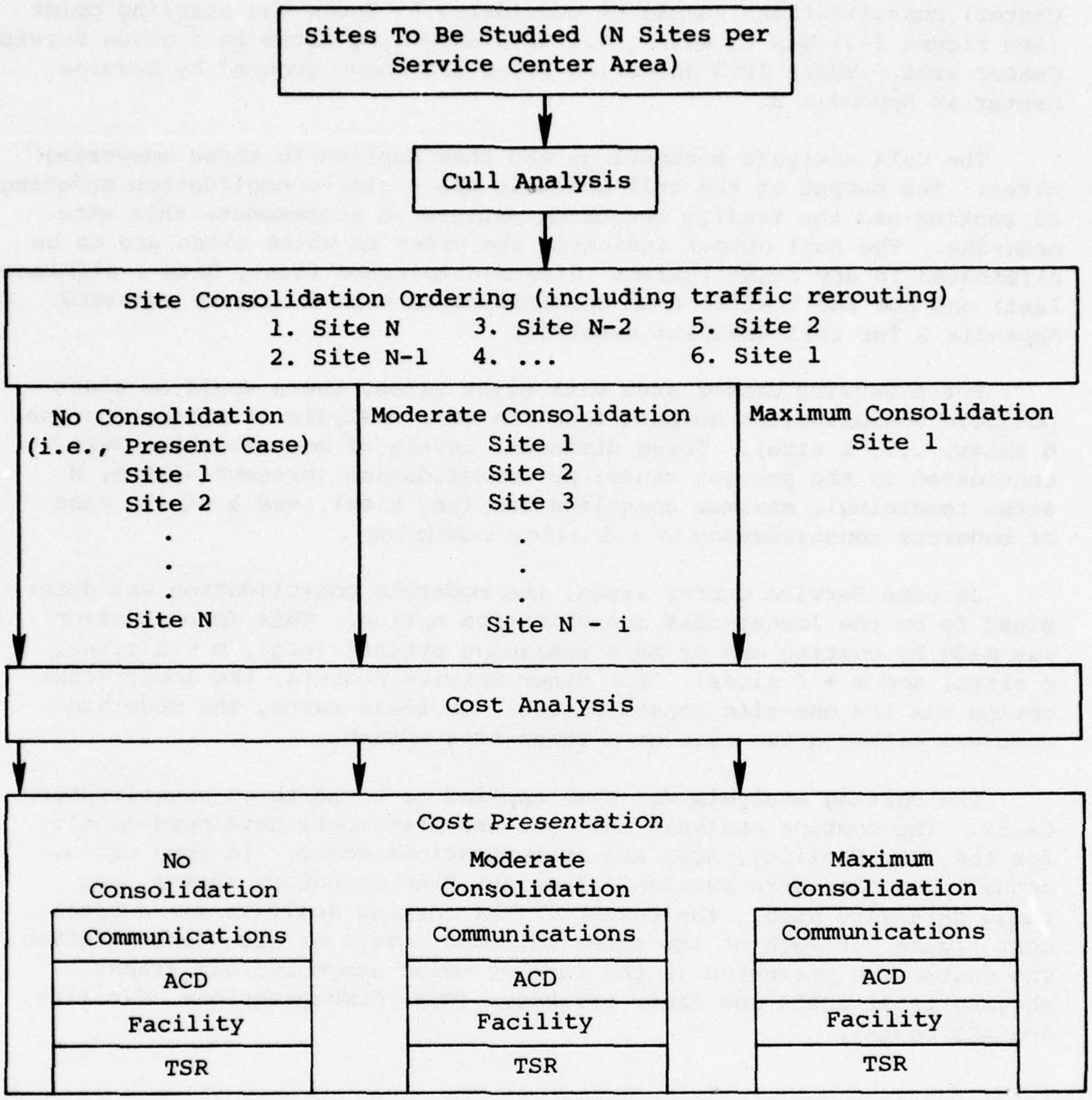

Figure 2-3. TECHNICAL APPROACH

As the figure illustrates, the starting point for a consolidation study is the selection of sites to be considered. In this particular case, the IRS has divided the continental United States into ten Service Center areas, each with its own Integrated Data Retrieval System (IDRS). The IRS indicated that the TFTS answering sites should serve the same geographic area that is served by a single IDRS -- that no inter-IDRS (inter-Service

Center) consolidations should be considered.* Hence the starting point (see Figure 2-3) was to select all TFTS answering sites in a given Service Center area. These TFTS answering sites are shown grouped by Service Center in Appendix B.

The cull analysis methodology was then applied to these answering sites. The output of the cull analysis was a site-consolidation ordering or ranking and the traffic rerouting pattern to accommodate this site ordering. The cull output indicates the order in which sites are to be eliminated in any consolidation (Site N eliminated first, Site 2 eliminated last) and how the traffic from the eliminated site should be rerouted. (See Appendix G for cull analysis results.)

For a Service Center area with eight sites, there would be eight possible consolidation outputs from the cull analysis (8 sites, 7 sites, 6 sites, ..., 1 site). Three different levels of consolidation were considered in the present study: no consolidation (present system, N sites remaining), maximum consolidation (one site), and a single case of moderate consolidation (N - i sites remaining).

In some Service Center areas, the moderate consolidation was determined to be the lowest-cost consolidation option. This determination was made by costing one or more remaining options (e.g., m - 1 sites, m sites, and m + 1 sites). For other Service Centers, the lowest-cost option was the one-site consolidation. In these cases, the moderate case was either a two-site or a three-site option.

The costing analysis was then applied to these three consolidation cases. The costing analysis employed the previously developed models for the TSR, Facility, ACD, and communications costs. In some cases, actual cost data were available from the Site Inventory sheets, and these data were used. The result of the costing analysis was a total cost figure for each of the three selected levels of site consolidation. The costs were presented in the form of three composite bar graphs, showing total costs and their breakdown (TSR, Communications, Facility, and ACD costs).

2.5 COSTING REFINEMENTS

Three other potential cost-reduction techniques were examined for the consolidation options in order to assess their impact on overall TFTS costs:

- LATA (Lateral transfer, sometimes called dynamic load balancing or interflow)
- WATS-to-FX diversion
- Full-time/measured-time WATS optimization

*A single case of inter-Service Center consolidation was considered for comparison purposes only.

2.5.1 LATA

LATA is implemented by interconnecting two or more ACDs in such a way that the incoming-call volume, or load, is shared among these ACDs. This increases the total number of TSRs available to handle any particular incoming call and, hence, increases serving-group size. Large serving groups can operate more efficiently than small serving groups. Interconnecting ACDs by this technique has the effect of combining two or more smaller ACDs into one large ACD -- a "virtual consolidation" -- without physically moving the ACDs or consolidating sites. To maintain the same grade of service for the larger, more efficient serving group would require fewer TSRs and, hence, reduced personnel (and personnel-related) costs. The additional cost incurred would be for the trunk lines connecting the ACDs to each other. This is a minor variation of the personnel-communications cost trade-off discussed in Section 2.2. The results of the LATA cost analyses are presented along with those of the consolidation options, although LATA does not represent a true consolidation option but simply a cost-reducing option.

2.5.2 WATS-to-FX Diversion

An investigation was made into whether a new FX group could be created to carry, at lower cost, some of the traffic previously handled on a WATS group. An example is a city that is currently served by WATS lines but could be handled with less expensive FX lines.

The cost economies resulting from WATS-to-FX diversion can be realized by the IRS regardless of site consolidations. Therefore, these results were computed and included in the overall summary tables only.

2.5.3 Full-Time/Measured-Time WATS Optimization

Some of the TFTS sites currently use a combination of WATS lines that are costed at a full-time rate and lines that are costed at a measured-time rate.

By correctly choosing the combination of full-time and measured-time WATS lines used, the total WATS charges can be minimized. An investigation was made of the cost reduction that could be effected if all sites used the optimum mix of full-time and measured-time WATS lines. These cost economies have been automatically included in both the moderate and one-site consolidation options.

2.6 TIME PERIOD USED FOR STUDY

This study was based on TFTS telephone traffic statistics collected for the period 1 May 1975 through 30 April 1976: number of calls handled at each TFTS site, number of calls abandoned (caller hangs up before he is served), and number of calls for which the caller received a busy signal. These three factors were combined by the IRS into one composite traffic figure called "adjusted demand". The adjusted demand traffic figure represents the total potential number of calls (traffic load) offered to the TFTS site under consideration.

An internal IRS study determined that the year under study could be divided into seven periods such that the telephone traffic variation within each of these periods was relatively small. Period 2 and Period 6 are representative of the highest and lowest traffic intensity and correspond roughly to the filing and nonfiling seasons, respectively. To study either period by itself might lead to erroneous conclusions concerning the preferred consolidation option. For example, to study only a high-traffic period might tend to favor no consolidation; to study only a low-traffic period might tend to favor maximum site consolidation. Therefore, it was decided to study both periods and combine their results. Since all costs for both Periods 2 and 6 were normalized to "monthly costs", the annual costs were obtained by using the following algorithm, which assumes a four-month filing season and an eight month nonfiling season:

$$\text{Annual costs} = 4 \times \text{Period 2 costs} + 8 \times \text{Period 6 costs}$$

CHAPTER THREE

CULL ANALYSIS

This chapter describes the methodology used to establish the consolidation options for the ten IRS Service Center areas that warrant detailed evaluation with the TFTS cost model. Instead of costing all possible options for each of the areas, a procedure was required to cull from among all of the various site combinations the subset of site combinations that should be costed to determine the least expensive TFTS option. For an N-site region, the cull analysis procedure produces a list of the N-sites ordered on the basis of the relative desirability of site elimination. In addition to this output, the cull analysis produces a routing plan for each level of site elimination (or consolidation option) to indicate where the traffic from each eliminated site goes. Thus the cull analysis defines the list of remaining sites and the plans for network reconfiguration for each consolidation option.

3.1 CULL ANALYSIS ASSUMPTIONS

The cull analysis methodology is based on the general assumption that the communications cost associated with routing traffic over Foreign Exchange (FX) lines is proportional to the number of circuit-miles. The methodology examines each of the N(N-1) possible combinations of N candidates (sites to be closed) and N-1 hosts (sites to receive the traffic from a closed site) to determine which pair has the lowest circuit-miles total and hence the lowest cost. This lowest-cost candidate/host pair is then selected as the preferred consolidation if one site is to be eliminated. The process is repeated until all but one of the sites have been eliminated. However, it should be noted that only a portion of the communications costs is being considered in the cull analysis and that detailed analysis is required to evaluate the preferred consolidation from this ordered list of options.

Once the candidate site has been eliminated, its traffic is routed to the host site and the cull analysis continues until one site has received all of the traffic in the Service Center area (an exception to this general rule will be noted in the discussion on backtracking in Section 3.3.3). The cull analysis routine models only Foreign Exchange (FX) costs and is therefore driven only by FX traffic for a given site. WATS costs are also a major portion of communications costs, but they are nonlinear functions and are only an indirect function of distance.

One result of the cull analysis is that each successive site elimination results in a higher communications cost; the cost function is, therefore, a monotonically increasing one. WATS costs, though very unpredictable, are basically monotonically increasing with increased traffic and distance. The other three personnel-related cost components (TSR, Facility, and ACD) are all monotonically decreasing functions; combining their sum with the communications (FX and WATS) cost for each consolidation option, therefore, defines a curve that has, at most, one point of inflection. This important feature is used as a basis for the costing as described in Section 2.2.

3.2 GENERAL APPROACH

The first stage of the cull analysis consists of generating a figure of merit for each site in the Service Center area. These figures of merit represent the cost to close that site and reroute all of its traffic to the closest remaining site. The figure of merit is calculated for each site pair by using the following algorithm:

$$F_{CH} = \frac{T_C \times D_{CH}}{10^6}$$

where

C = subscript defining which site is the candidate
H = subscript defining which site is the host
T_C = yearly adjusted demand on FX local lines of candidate site
D_{CH} = distance in miles between the candidate and the host site

Distances (in miles) between are given by the equation:

$$D_{CH} = \sqrt{\frac{\left(V_C - V_H\right)^2 + \left(H_C - H_H\right)^2}{10}}$$

where

V_C, H_C = the V and H coordinates, respectively, for the candidate site*
V_H, H_H = the V and H coordinates, respectively, for the host site

The specific details of the cull analysis algorithm used in this report are illustrated in Figures 3-1, 3-2, and 3-3, and they are described in Section 3.3.

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*V and H are coordinates used by the Bell System in computing mileage charges for long-distance communications costs. They constitute a coordinate system (similar to latitude and longitude) that covers the United States and is used to calculate distance.

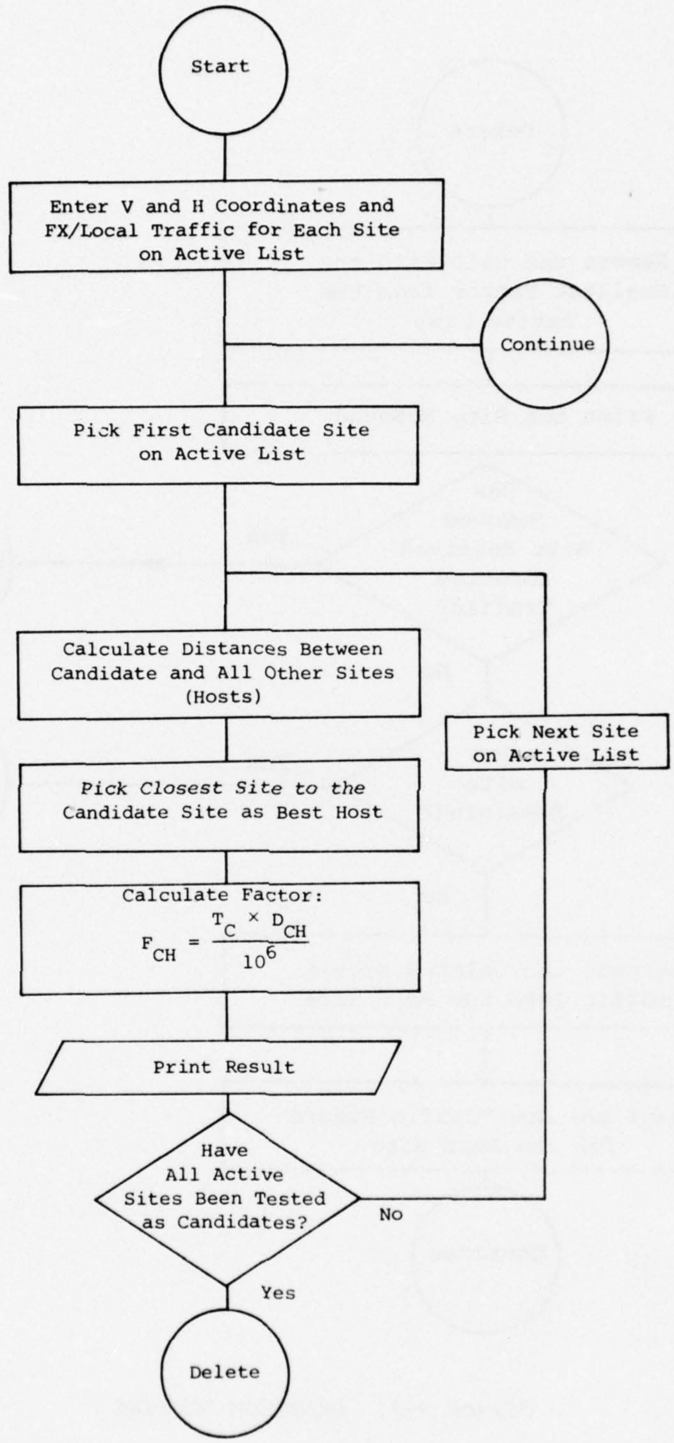


Figure 3-1. FACTOR-CREATION ROUTINE

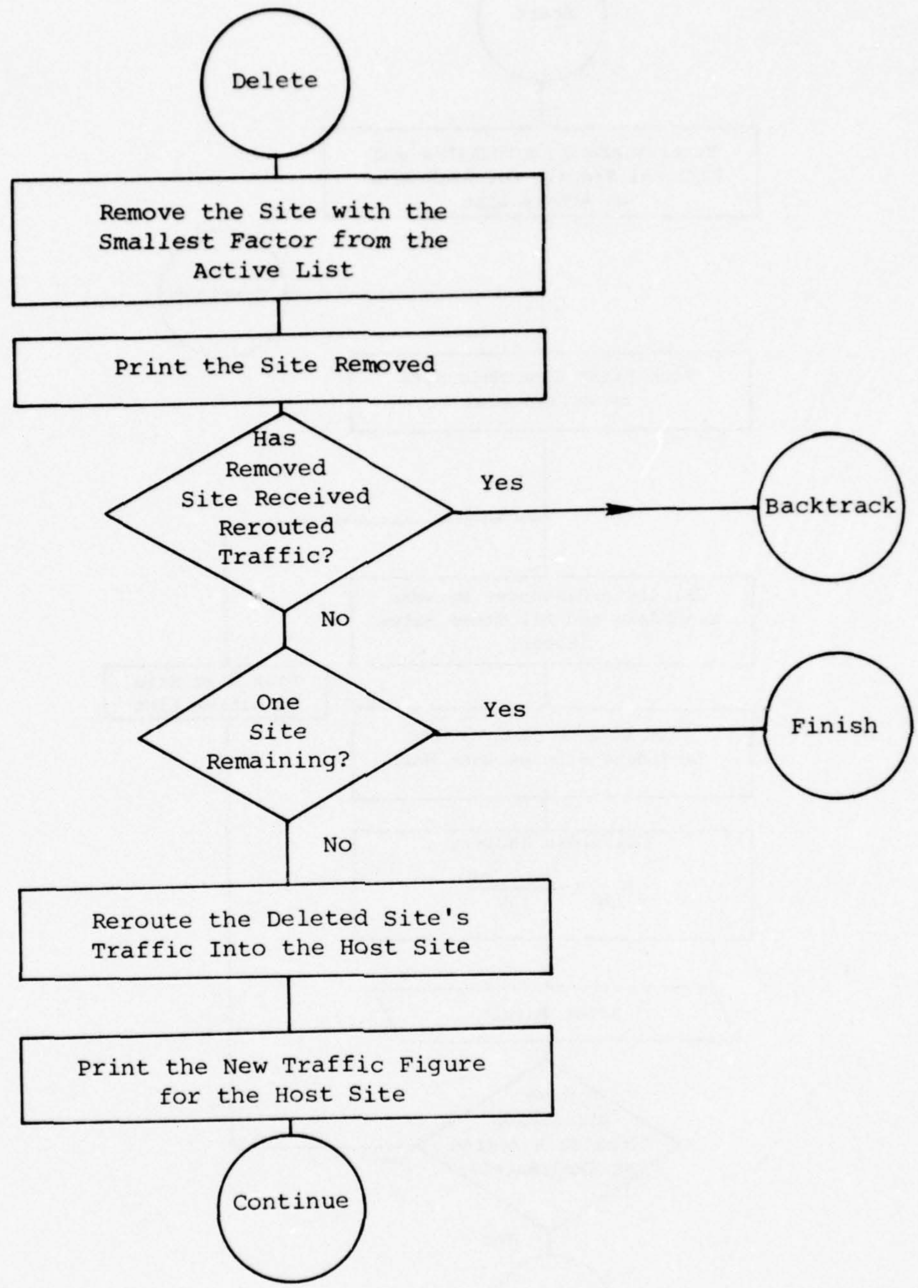


Figure 3-2. DELETION ROUTINE

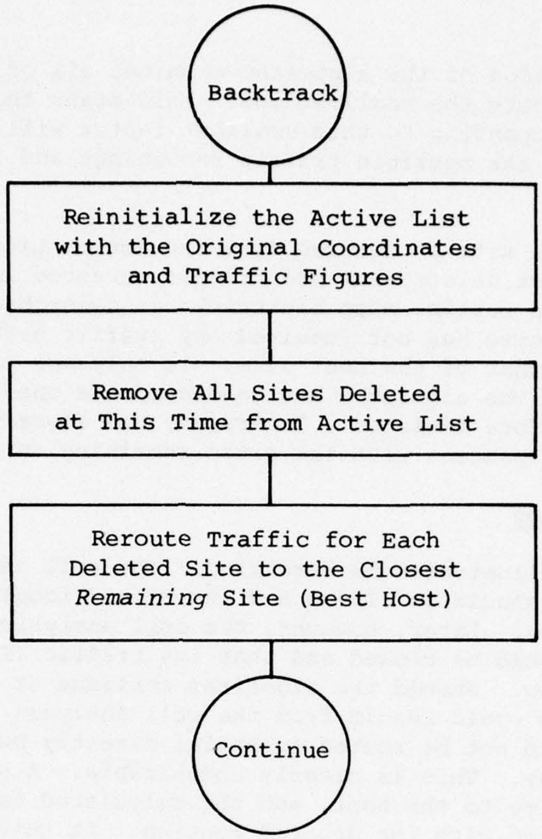


Figure 3-3. BACKTRACKING ROUTINE

3.3 DESCRIPTION OF THE ALGORITHM

3.3.1 Factor Creation

The first stage of the algorithm is concerned with generation of the factors. The V and H coordinates and traffic figures for each site in a given Service Center area are listed on an "Active List". When a site is closed, it is removed from this list and its traffic is added to that of a host site.

The first site on the Active List is chosen as a candidate. The distances between it and all of the other sites on the Active List are calculated to determine which site is the closest; this closest site becomes the best host site. A factor is then calculated from the distance between these two selected sites and the traffic of the candidate site. A similar factor is calculated for each site on the Active List.

3.3.2 Deletion

The next section of the algorithm examines all of the factors (one per site) and selects the smallest one. This means that the site elimination corresponding to this smallest factor will involve the lowest-cost FX of all of the possible traffic reroutings and is therefore the most desirable.

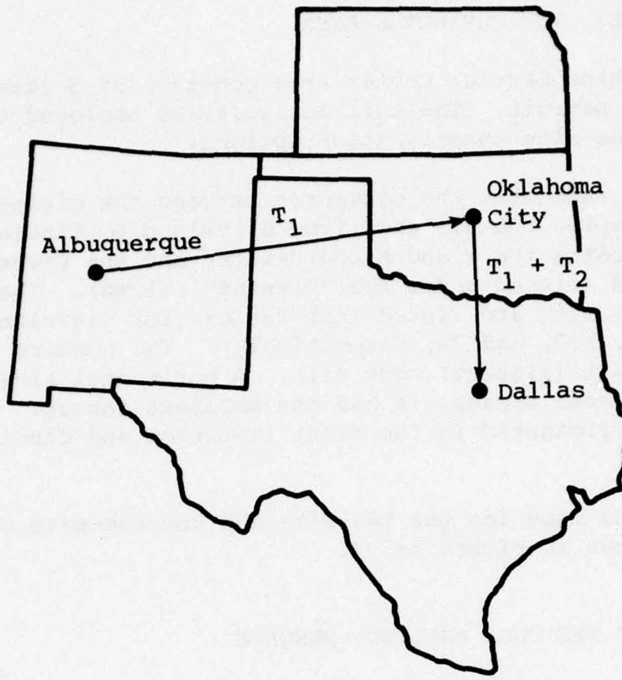
The candidate site is deleted from the Active List. If, however, the candidate site just deleted has had traffic rerouted into it prior to its deletion, then the routine must backtrack, as described in Section 3.3.3. If the candidate site has not received any traffic before, its traffic then is added to that of the host site. If only one site remains on the Active List, then the algorithm has generated the one-site consolidation case and is therefore finished. Otherwise, the algorithm repeats the factor-generation process with the sites remaining on the Active List.

3.3.3 Backtracking

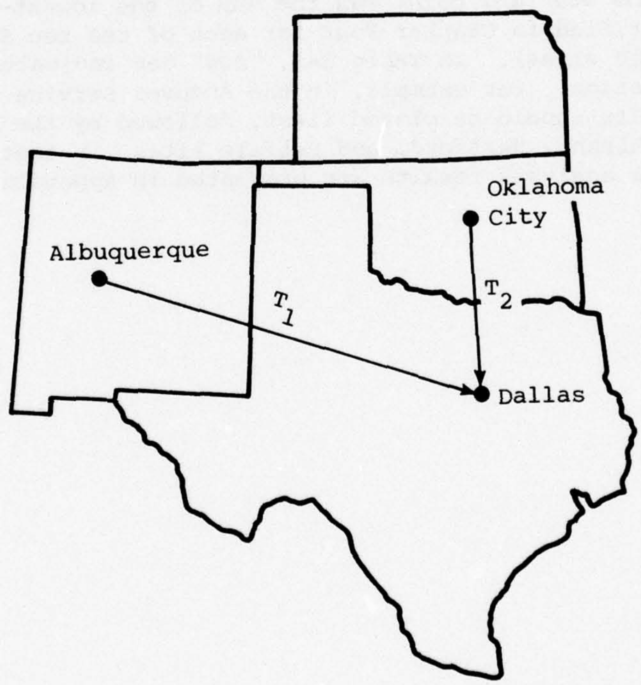
Figure 3-4 illustrates backtracking. The cull analysis has indicated that Albuquerque should be closed and its FX and local traffic (T_1) routed into Oklahoma City. Later, however, the cull analysis indicates that Oklahoma City should be closed and that its traffic (T_1 + T_2) should be routed into Dallas. Should the algorithm continue at this point, an incorrect routing would result from the cull analysis in that Albuquerque's traffic (T_1) would not be routed to Dallas directly but to Oklahoma City and then to Dallas. This is clearly undesirable. A straight run should be made from a site to the host, and the calculated factor should reflect the cost associated with the desired routing. At this point, the cull analysis must backtrack.

The backtrack routine restores the Active List to its original state, with all sites appearing with their coordinates and their original traffic figures. The sites that were deleted (closed) at the time of the backtracking are removed from the Active List. The traffic for each of those sites is then added to that of the nearest site on the Active List. In Figure 3-4(b), this corresponds to Oklahoma City traffic (T_2) being routed directly to Dallas and Albuquerque traffic (T_1) being routed directly to Dallas. At this point, the backtracking has been completed, and the routine selects the first candidate from the Active List and calculates the next series of factors. The routing initiates another backtrack when it is determined that a site which has received traffic after this point must be eliminated.

The example indicates why the creation of the next consolidation option, by the elimination of one site, does not necessarily imply that the new traffic routing pattern is a direct extension of the previous one.



(a) Improper Routing (Before Backtracking)



(b) Proper Routing (After Backtracking)

Figure 3-4. BACKTRACKING

3.4 AN EXAMPLE: THE COVINGTON AREA

The Covington Service Center area consists of 3 sites: Cincinnati, Cleveland, and Detroit. The cull analysis was employed to produce the two-site and one-site consolidation options.

Table 3-1 indicates the distances between the cities in the Covington area. For example, the distance from Cleveland to Cincinnati is 222 miles. Table 3-2 indicates the V and H coordinates and the present FX/Local Yearly Adjusted Demand (listed under the "Present" column). The factors for each site for each option are listed (the factors for Cleveland, Cincinnati, and Detroit are 50, 130, and 79, respectively). The numbers below the factors indicate the best (closest) host site. A horizontal line indicates that a site was eliminated because it had the smallest factor. In this case, Cleveland was eliminated in the first iteration and Cincinnati in the second.

The routing maps for the two-site and the one-site consolidation options are shown in Figure 3-5.*

3.5 SUMMARY OF THE CULL ANALYSIS RESULTS

Table 3-3 summarizes the cull analysis results for each of the ten Service Center areas and the one nationwide consolidation. In the nationwide case, the starting point was the sum of the lowest-cost consolidation options identified in Chapter Four for each of the ten Service Center areas (a total of 18 sites). In Table 3-3, "row" one indicates the preferred one-site location. For example, in the Andover Service Center, the Portsmouth site should be closed first, followed by the Burlington, Augusta, Providence, Albany, Hartford, and Buffalo sites, in that order. The detailed cull analysis results are presented in Appendix G.

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*The WATS traffic was routed to the site for which the WATS costs were lowest.

Table 3-1. COVINGTON DISTANCE TABLE			
	Cincinnati	Cleveland	Detroit
Cincinnati		222	235
Cleveland	222		91
Detroit	235	91	

Table 3-2. COVINGTON CULL SHEET						
Site and Coordinates	Number of Sites Remaining					
	3 (Present)		2 (Moderate)		1 (One Site)	
	Number of Calls	Factor / Host Site Number	Number of Calls	Factor / Host Site Number	Number of Calls	Factor / Host Site Number
Site 1, Cleveland: 5574-2543	551,021 (27%)*	50 / 3	————		————	
Site 2, Cincinnati: 6263-2679	386,285 (29%)	130 / 1	586,285 (29%)	137 / 3	————	
Site 3, Detroit: 5536-2828	882,856 (44%)	79 / 2	1,433,877 (71%)	336 / 2	2,020,162 (100%)	

*Percentage of regional traffic.

(a) Two-Site Consolidation Option

(b) One-Site Consolidation Option

Figure 3-5. TRAFFIC ROUTING

Table 3-3. CULL ANALYSIS SUMMARY

Number of Sites in Consolidation Option*	Answering Sites Within Service Centers (SC)										
	Andover SC	Austin SC	Brookhaven SC	Chamblee SC	Covington SC	Fresno SC	Kansas City SC	Memphis SC	Ogden SC	Philadelphia SC	Nationwide SC
1	Boston	Dallas	Manhattan	Atlanta	Detroit	Los Angeles	Chicago	Indianapolis	Denver	Baltimore	Indianapolis
2	Buffalo	Houston	Smithtown	Miami	Cincinnati	San Francisco	St. Louis	Norfolk	Seattle	Philadelphia	Los Angeles
3	Hartford	New Orleans	Camden	Jacksonville	Cleveland	San Jose	Kansas City, MO	Nashville	St. Paul	Pittsburgh	Manhattan
4	Albany	Oklahoma City	Newark	Birmingham		Carson, CA	Des Moines	Bailey's Crossroads	Phoenix	Wilmington	Dallas
5	Providence	Albuquerque	Mineola	Columbia		Van Nuys	Milwaukee	Memphis	Salt Lake City		Miami
6	Augusta	Little Rock	Brooklyn	Jackson		El Monte	Springfield, IL	Louisville	Portland		Seattle
7	Burlington	Wichita				Oakland		Greenboro, NC	Omaha		Atlanta
8	Portsmouth							Richmond	Las Vegas		Denver
9								Parkersbury	Spokane		Houston
10									Fargo		Detroit
11									Boise		San Francisco
12									Helena		St. Paul
13									Aberdeen		Baltimore
14											St. Louis
15											Jacksonville
16											Chicago
17											Norfolk
18											Cincinnati

*The names of the N sites remaining in a Service Center area appear in the Nth row and in all other rows above it.

CHAPTER FOUR

DETAILED ANALYSIS

This chapter presents a description of the cost models, the costing procedure, the costing refinements (LATA, WATS/FX diversion, and FT/MT WATS optimization), and the results of the costing for each of the consolidation options considered.

The results of the costing are presented in 11 parts: ten Service Center consolidations plus one single case of consolidation without Service Center boundaries (nationwide consolidation). The nationwide case contains the costing results of the present case (70 sites), the ten-site consolidation (corresponding to a single site in each of the ten Service Center areas), and two cases of "modest" consolidation (both with and without Service Center boundaries). Thus this case presents not only what economies are possible without Service Center boundaries but also a summary of the ten Service Center consolidations.

4.1 COST MODELS

The TFTS has four main cost categories, as noted in Chapter Two, and a cost analysis procedure or model was developed for each.

4.1.1 Personnel Costs

The first step taken to determine the personnel costs was to determine the size of its staff needed to operate a given TFTS answering site with the required level of service to the public. The level-of-service criterion established by the IRS for the TFTS sites was that the average delay for all calls entering the ACD should be 20 seconds (delay equals the time elapsed from entry of a call into the ACD until that call is answered by a TSR). This standard can be stated as "Average Speed of Answer (ASA) equals 20 seconds". Queuing theory was applied to generate a graph relating the number of TSRs required (for ASA = 20 seconds) to the incoming telephone traffic volume (see Appendix D). The incoming telephone traffic volume for each hour of the day during both Period 2 (19 January to 6 February and Period 6 (4 August to 28 November) was then determined on the basis of telephone traffic statistics supplied by the IRS. The graph and the number of calls during each hour of the day were used to determine the number of TSRs required for each hour and the daily total.

Data were supplied by the IRS on average wage rates for TSR, clerical, and management personnel. The IRS also supplied algorithms for calculating the number of clerical and management personnel required as a function of the TSR staff size. Overhead factors for such items as training, leave, and scheduling inefficiencies were included in these algorithms. These factors were combined in an algorithm that related TSR cost to the number of TSRs required according to the following formula:

$$\text{TSR Cost (TSR + Management + Clerical)} = \$11.89 \times \text{TSR hours}$$

Appendix D provides the detailed formulation of the staffing model.

4.1.2 Facility Costs

Facility costs are costs for desks, chairs, tables, floor space, light, heat, power, etc. They are directly related to the number of personnel that staff a given TFTS answering site. These costs were supplied by the IRS, in a format identical to that of the TSR cost model discussed in Section 4.1.1, for each site in the present TFTS. Like TSR costs, the facility costs include costs for management and clerical support. (The facility costs vary from \$144/TSR/month to \$220/TSR/month.) Appendix F presents a detailed listing of facilities costs used.

4.1.3 ACD Costs

The ACD cost model used was derived from the Toll Free Telephone Site Inventory data that were collected from the IRS District Offices. A sample of sites was chosen, and monthly ACD costs were computed. In most cases examined, the number of ACD TSR consoles was adjusted to match filing season/nonfiling season requirements. Therefore, in the sampling of ACD cost data, a weighted average of filing/nonfiling season ACD costs was used for purposes of deriving an ACD cost model. These ACD cost data were plotted on a graph in the form of a scatter diagram, and a least-squares curve fit was made to determine the most appropriate model to use. The following ACD cost model was used to relate monthly ACD costs to the peak number of TSRs required:

$$\text{ACD costs (\$)} = \$93.60\, e^{-\frac{\text{TSRs required}}{483}}$$

Appendix E describes the ACD cost model.

4.1.4 Communications Costs

Communications costs were more difficult to model since there were three different types of communications lines to be considered:

- Local
- FX
- WATS

The Toll Free Telephone Site Inventory sheets contained the costs for local lines for each site considered in this study. In all cases, these local-line costs were used (they varied by site from a low of \$4 per line per month to a high of \$55 per line per month).

The costing for FX lines was not immediately available from the Site Inventory sheets; therefore, a cost model had to be developed. The vast majority of FX lines in the TFTS are routed over the TELPAK network at a GSA-supplied rate of 54¢/mile. Channel-termination charges and local-line charges are independent of distance and generally run approximately \$80 per line per month for intrastate FX lines and \$110 per line per month for interstate FX lines. The two FX cost models used were:

- Intrastate FX monthly cost = (\$80 + 54¢/mile) per line
- Interstate FX monthly cost = (\$110 + 54¢/mile) per line

Intrastate WATS costs were available for the present TFTS system directly from the Site Inventory sheets. These costs were used in the costing of the present case and in the costing of intrastate WATS lines used in the various consolidation options. Published intrastate tariffs were used to supplement the site inventory data in some cases. Interstate WATS rates were obtained from published AT&T tariffs dated 28 February 1976.

When a customer procures WATS lines (generally, either intra- or interstate), he can elect to be billed for the WATS lines either on a "Full Time" or on a "Measured Time" basis. Generally speaking, the optimum choice of either all Full Time (FT) lines, all Measured Time (MT) lines, or some combination thereof, depends directly on the monthly traffic and indirectly on the hourly traffic distribution on those WATS lines. In the case of the IRS hourly distribution, which was assumed to be the same for each TFTS site, the optimum FT/MT split is approximately 3:4 (3 FT lines to 4 MT lines). (This ratio is varied to a very small degree by the WATS tariff structure for each geographic area.) By selecting the correct mix of FT/MT WATS lines, the aggregate WATS costs can be reduced by 10 to 40 percent from the charges that would be incurred if all of the lines were FT lines.

In the case of interstate WATS lines, AT&T provides to the customer one free line per WATS line group. This has the effect of reducing WATS charges by 50 percent for a 2-line group, 33-1/3 percent for a 3-line group, 25 percent for a 4-line group, and so forth. In order to take both of these WATS charge-reducing factors into account, an interstate WATS charge reduction factor of 25 percent and an intrastate factor of 10 percent were selected. WATS charges were computed as though all WATS lines were FT lines, and then a reduction factor of 25 percent (or 10 percent for intrastate) was applied to reflect both of the above cost-reduction techniques. While a more precise analysis could have been performed, it was determined that the simplification made the analysis more straightforward and easy to document and had little effect on the accuracy of the relative cost results.

In the present TFTS, some sites are now mixing the FT and MT WATS lines to take advantage of this cost-reduction technique. These reduced WATS costs are reflected in the "present case" costs as well as in any consolidation configuration costs. As agreed upon with the IRS, to reflect the actual present system as closely as possible, this WATS-charge reduction was not applied in the "present case" costing to sites that do not now mix FT and MT WATS.

4.2 OTHER COST-REDUCTION TECHNIQUES

Two additional cost-reduction techniques were also investigated: LATA and WATS-to-FX Diversion.

4.2.1 LATA

To estimate the savings that might be realized if LATA were fully implemented in any Service Center area, the following approach was used. Full implementation of LATA would be the same as virtual site consolidation within a Service Center area. This, in turn, would be equivalent to a one-site consolidation; i.e., the TSR requirements (and costs) would be the same as those for the one-site consolidation case. The Facilities and ACD costs, on the other hand, would be only slightly (if at all) reduced because there would be no physical consolidation and it would still be necessary to maintain separate facilities and ACDs at each TFTS site. Communications costs would be increased by the cost of the tie lines needed to interconnect each ACD in the Service Center area to the other ACDs within that area.

A full, virtual consolidation could be implemented only if there were LATA lines to interconnect each ACD with every other ACD in the Service Center area. Furthermore, each ACD in the virtual-consolidation plan would need the capability to automatically switch overflow calls to any of the other ACDs in the system. Since the present Bell System ACDs in the TFTS do not now have this full LATA (or interflow) capability, and since the tie line network required to interconnect each ACD would be quite complicated and impractical, this "full virtual consolidation" was not costed. On the other end of the full spectrum of LATA consolidation possibilities is the case of only two sites being connected to each other in a "two-site virtual consolidation" LATA (or interflow) between only two TFTS answering sites. This case could be implemented for one or more site-pairs within a Service Center area. If several site-pairs were so interconnected, the TSR costs would be roughly equivalent to the TSR costs for the "moderate consolidation" case. The Facility and ACD costs would remain essentially the same as those of the "present case". Communications costs would be those of the "present case" plus the added costs for the tie lines to interconnect the two-site pairs. An upper limit for the communications cost would be the communications cost for the "moderate consolidation" case. Hence, an estimate of the present case with LATA consists of "moderate" case TSR and communications costs, and "present" case ACD and facility costs. Appendix H provides a more detailed approach to calculating LATA costs.

4.2.2 WATS-to-FX Diversion

To determine the size of the FX group necessary to serve a given city or metropolitan area, it is necessary to know the TFTS telephone traffic that would be generated by that area. To make an initial determination of the traffic that would be generated in a given city or metropolitan area, 1970 population statistics were used. Traffic estimates were made according to the following formula as determined by regression analysis on available data:

CCS (average busy hour during Period 2) = population (in thousands)

where CCS = hundreds of call seconds (a measure of communications load used to determine the required number of telephone circuits). This estimate of traffic correlates very closely with actual TFTS experience. It was used to determine the number of FX lines required for P10 service.* This amount of traffic was then subtracted from the WATS traffic, and the required number of WATS lines was recomputed.

Since these savings could be realized in the present system by simply creating new FX groups, and since these savings would not influence the preferred consolidation option, this cost-reduction technique is not reflected in the consolidation-option comparison in the following sections. As a result of discussions with the IRS, it was decided that the savings to be achieved would simply be calculated and presented separately in order to demonstrate that WATS-to-FX diversion is a cost-effective technique that is generally independent of site consolidation.

4.3 COSTING WORKSHEET

This section describes the costing worksheets and how they were used in implementing the TFTS cost model. Completing a costing worksheet corresponds to calculating costs by using the TFTS cost model. Figure 4-1, a sample costing sheet for the Albuquerque answering site, should be consulted throughout the following discussion.

All personnel-related costs are calculated on the right side of the sheet (TSR Cost, ACD Cost, Facility Cost), and communications costs are calculated on the left side (Comm Cost). As discussed in Section 2.6, annual costs were calculated on the basis of both Period 2 and Period 6 costs. Period 2 and Period 6 data entries are to the left and right of the diagonal lines, respectively. All costs have been "normalized" to monthly costs except on the extreme right side of the worksheet, where a summary block has been provided to indicate annual site costs (based on four times the total Period 2 costs plus eight times the total Period 6 costs. There is a space in the upper right-hand corner to indicate the

---

*A measure of the grade of service of a telephone system. P10 service represents callers getting through to the called number 90 percent of the time and getting a busy signal 10 percent of the time.

Period 2/6
Annual Demand 198 397
(all $ in 000) 119 038 Local
79 359 WATS

Site Albuquerque
Consolidation Present

Comm Cost

Line Type	# lines present	CCS/bh	# lines for P10	$/mo/line	$/mo
Local	9	336 / 54	14 / 4	.154	2.15 / .616
WATS (intra)	6	224 / 36	10 / 3	.738	7.38 / 2.21
WATS (inter)					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
FX-					
Σ monthly comm $					9.53 / 2.83

TSR Cost

hr ending	# Calls	# TSR's req'd	WATS	No N WATS
7				
8				
9	162 / 25	11 / 4	65 / 10	97 / 16
10	262 / 41	16 / 5	105 / 17	157 / 25
*11	279 / 46	18 / 5	116 / 19	173 / 28
12	273 / 43	17 / 5	109 / 17	164 / 26
13	231 / 36	15 / 4	92 / 15	139 / 22
14	270 / 43	17 / 5	108 / 17	162 / 26
15	267 / 42	17 / 5	107 / 17	160 / 26
16	262 / 41	16 / 5	105 / 17	157 / 25
17	205 / 32	13 / 4	82 / 13	123 / 20
Σ TSR-hrs		140 / 42		
(x20 $\frac{da}{mo}$ x $\frac{\$}{hr}$)		33.3 / 9.99		

Annual $	
TSR	21.3
Comm	60.9
Fac	36.1
ACD	102
Σ	320.1

Σ TSR = 3459.6
Σ Comm 713.2
Σ Fac 823
Σ ACD 158.6
5155
cost of option

ACD Cost

pk # TSR's	x	ACD $\frac{\$}{TSR}$	=	ACD $/mo
18 / 5	x	90.2 / 92.6	=	162 / .46

Facility Cost

pk # TSR's (period 2 only)	x	$\frac{\$}{TSR}$	=	$\frac{Fac\ \$}{mo}$
18	x	.167	=	3.01

Figure 4-1. SAMPLE COSTING WORKSHEET

site name and the consolidation option being costed (present system, one-site consolidation, etc.). In this case, the sheet is for the Albuquerque site and the present system.

In applying the model, the first step is to determine the annual adjusted demand for the site and consolidation option under consideration. The number to use for the adjusted demand (hereafter referred to simply as annual demand) depends on the consolidation option being considered. In the example shown here, the annual demand figure is simply the figure supplied by the IRS for the Albuquerque site. If this were a consolidated site, the annual demand would be the sum of the annual demands for the sites that had been absorbed into the site.

The next step is to complete the TSR cost block as follows. Determine the number of calls received at the site during the one-hour period ending at 9 AM, 10 AM, 11 AM, etc., during Period 2. Enter these numbers in the column headed "TSR cost, #calls" for Period 2. These numbers were determined by using the factors supplied by the IRS for traffic distribution by hour and by period. In this example, 162 calls were received during the average hour ending at 9 AM local time during Period 2, 262 calls during the hour ending at 10 AM, etc. The corresponding number of calls for Period 6 are 25 and 41. At this point, the staffing model (Appendix D) was used to determine the number of TSRs required to provide an ASA 20 grade of service. In this example, 11 TSRs were required during the hour ending at 9 AM and 16 during the hour ending at 10 AM during Period 2 (Period 6 figures are 4 and 5, respectively). The "Σ TSR-hours" block provides a space to sum the total number of TSR-hours required during an average day of Period 2 and Period 6. This is translated into the TSR costs by multiplying by an average of 20 business days per month and $11.89 per TSR-hour. The resultant figure is monthly TSR cost (including management and clerical cost) for both Period 2 and Period 6 of $33,300 and $99,900, respectively.

ACD cost was determined by using the peak number of TSRs required during both Period 2 and Period 6 (in this case, 18 and 5, respectively). The ACD cost per TSR was calculated from the ACD cost model. In this example, the ACD costs were $90.20 per TSR (P2) and $92.60 per TSR (P6). The total monthly ACD costs in this case were $1,620 and $463. The annual ACD cost was $10,200.

The Facility cost is tied to the peak number of TSRs for Period 2 (the peak period of the year) because the amount of office space, etc., cannot be readjusted seasonally to correspond to filing season/nonfiling season requirements). In this case, the peak number of TSRs is 18. The facility cost ($/TSR/mo.) was calculated by using the facility cost model supplied by the IRS. In this case, the facility cost is $167/mo./TSR. The monthly facility cost is $3,010. The annual cost is simply 12 times the monthly cost ($36,100).

Communications costs were calculated as follows: The traffic during the busy hours of the day was split into local, WATS, and FX according to the number of lines currently installed during Period 2. In this case, there were 9 local, 6 intrastate WATS, and no FX lines into the Albuquerque site. These proportions were used to split the 289 calls (Period 2 peak-hour calls) among the various line groups. The average call-holding times supplied by the IRS for Period 2 and Period 6 were 194 and 187 seconds, respectively. The Period 2 busy-hour traffic on the local trunk group was 336 CCS (289 calls × 184 seconds/call/100 × 9/(15), where 100 is a CCS conversion factor, 9 is the number of local circuits, and 6 is the number of FX circuits). For a grade of service of P10, instead of the present P50, 14 local trunks would be required during Period 2 and 4 during Period 6. In a like manner, Period 2 and Period 6 intrastate WATS lines requirements are 10 and 3, respectively. The local and WATS line charges per line per month are $15 and $738, respectively. If there had been FX lines, the FX costs would have been calculated on the basis of the FX cost models as previously discussed. In each case, the number of lines was multiplied by the monthly charge per line to give the total monthly cost (e.g., Period 2 local line charges are $215 per month). These charges are all summed to provide the aggregate monthly communications expenses for Period 2 and Period 6 ($7,060 and $2,710, respectively). Total annual communications cost in this case is $52,100.

Costing for each site, both "present" and consolidated, was accomplished by using the costing worksheet (a complete set of costing worksheets is available at ARINC Research). The annual costs in each category (TSR, Comm., Facility, and ACD) were added together to obtain the costs used in the bar-graph presentations shown in Section 4.4. For example, the TSR costs for Albuquerque were added to the TSR costs for all of the other sites in the Austin Service Center area to obtain the aggregate TSR cost for the present configuration.

In some cases, it was necessary to divide the telephone traffic at a site into WATS and non-WATS traffic so that WATS and non-WATS traffic could be routed to two different sites where there would be a cost advantage in doing so. An example of such division is Nebraska, from which the WATS traffic was routed to Denver and the non-WATS traffic to St. Paul.

4.4 COSTING RESULTS

This section presents the results of the costing for each consolidation option of the ten Service Center areas and also for a single case of nationwide consolidation without regard to Service Center boundaries. In each case, the costing worksheets were used to develop the costs. The results of the costing are presented as a series of bar charts depicting aggregate TFTS annual costs. These charts have been divided into the four component costs: TSR, Facility, ACD, and Communications. (These four component costs are always shown in the same order on the bar charts from the bottom to the top.) Also shown for each region is a bar chart of the annual savings for each consolidation option.

The site used for the one-site consolidation was determined by the cull analysis. This site handles all traffic from each of the other sites in the Service Center area on either WATS or FX lines. Since FX is generally less expensive than WATS, FX lines were used in lieu of WATS lines whenever possible. For example, when a site was eliminated, the (formerly) local lines from that eliminated site were run as FX lines (and not WATS lines) to the new site. All (formerly) intrastate WATS traffic was summed and run on one interstate WATS line group except where otherwise noted. Interstate WATS does not cover the state in which the answering site is located; therefore, intrastate WATS lines were used to cover that one state.

In general, traffic for the "moderate consolidation" cases was routed as follows: all FX line groups were routed to the closest remaining site, minimizing the mileage (and hence the cost); WATS traffic was routed on an intrastate basis where possible since intrastate WATS, in general, is less expensive than interstate WATS. Where it was not possible to route WATS traffic on an intrastate basis, the WATS traffic was routed in one or more interstate WATS line groups so as to minimize the WATS costs.

For all of the ten Service Center areas, both the moderate and the one-site cases involve closing sites, terminating ACD leases, and, in some cases, relocating employees. There are one-time expenses associated with each of these options. LATA, on the other hand, could be implemented without incurring most of these one-time expenses.

4.4.1 Andover

The results of the costing for the Andover Service Center area are shown in Figure 4-2. The annual aggregate cost of the present system* is $3.48 million ($2,482,000 for personnel, $448,000 for facilities, $117,000 for ACD, and $433,000 for communications). The one-site case is Boston; the moderate case consists of two sites, Boston and Buffalo. For this Service Center area, the lowest-cost consolidation option is the one-site case (Boston), although a two-site consolidation would provide almost as great a saving. In Figure 4-2a all costs have been normalized to $3,480,000 per year for the present sites in the Andover Center.

As shown in the figure, the annual saving for the "Present with LATA" case is $251,000.

4.4.2 Austin

The results of the costing for the Austin Service Center are shown in Figure 4-3. The effects of the two time zones were considered in the costing for this case. The aggregate annual cost of the present system is $5.155 million (TSR, $3,460,000; Facility, $823,000; ACD, $159,000; Communications, $713,000). The one-site case is Dallas; the moderate consolidation case is a two-site case consisting of Dallas and Houston. In this Service Center area, the lowest-cost option is a one-site option. As shown in the bar graph depicting savings over the present system, the annual saving for the one-site case is $405,000.

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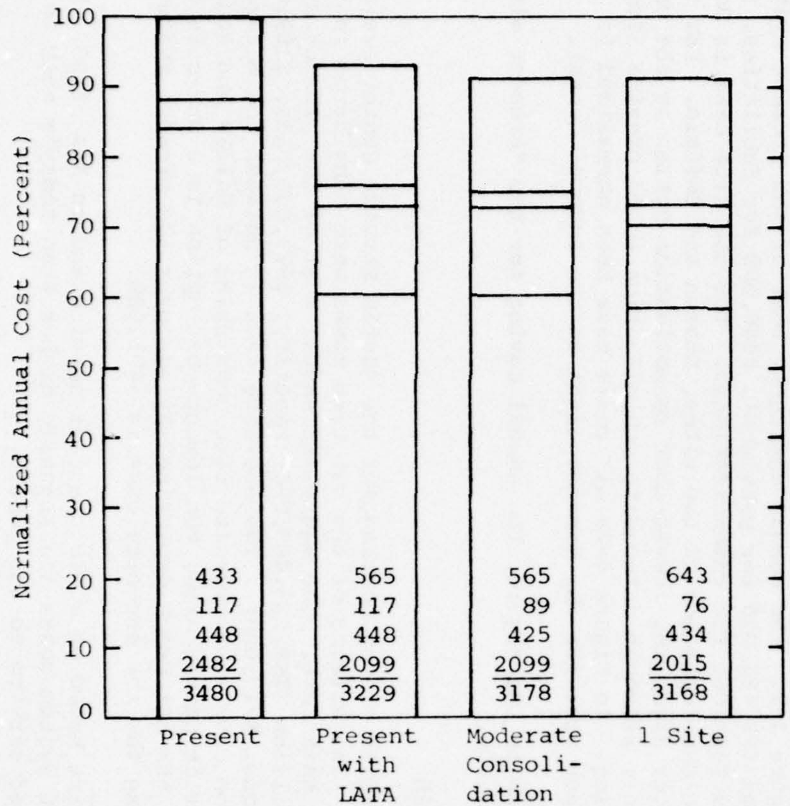
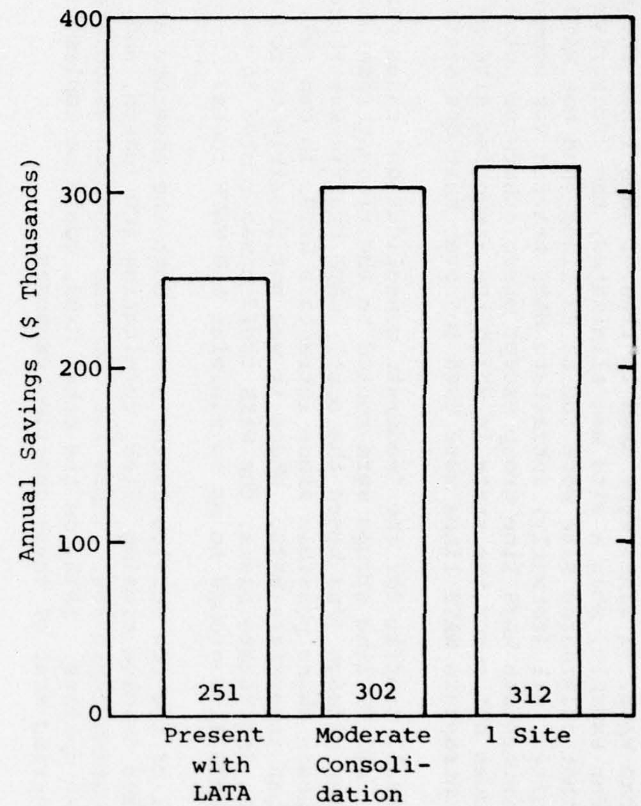
*All costs are based on a P10 grade-of-service and an ASA of 20. Therefore, the present system costs are actually higher than today's cost to reflect the improved service to the public.

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.

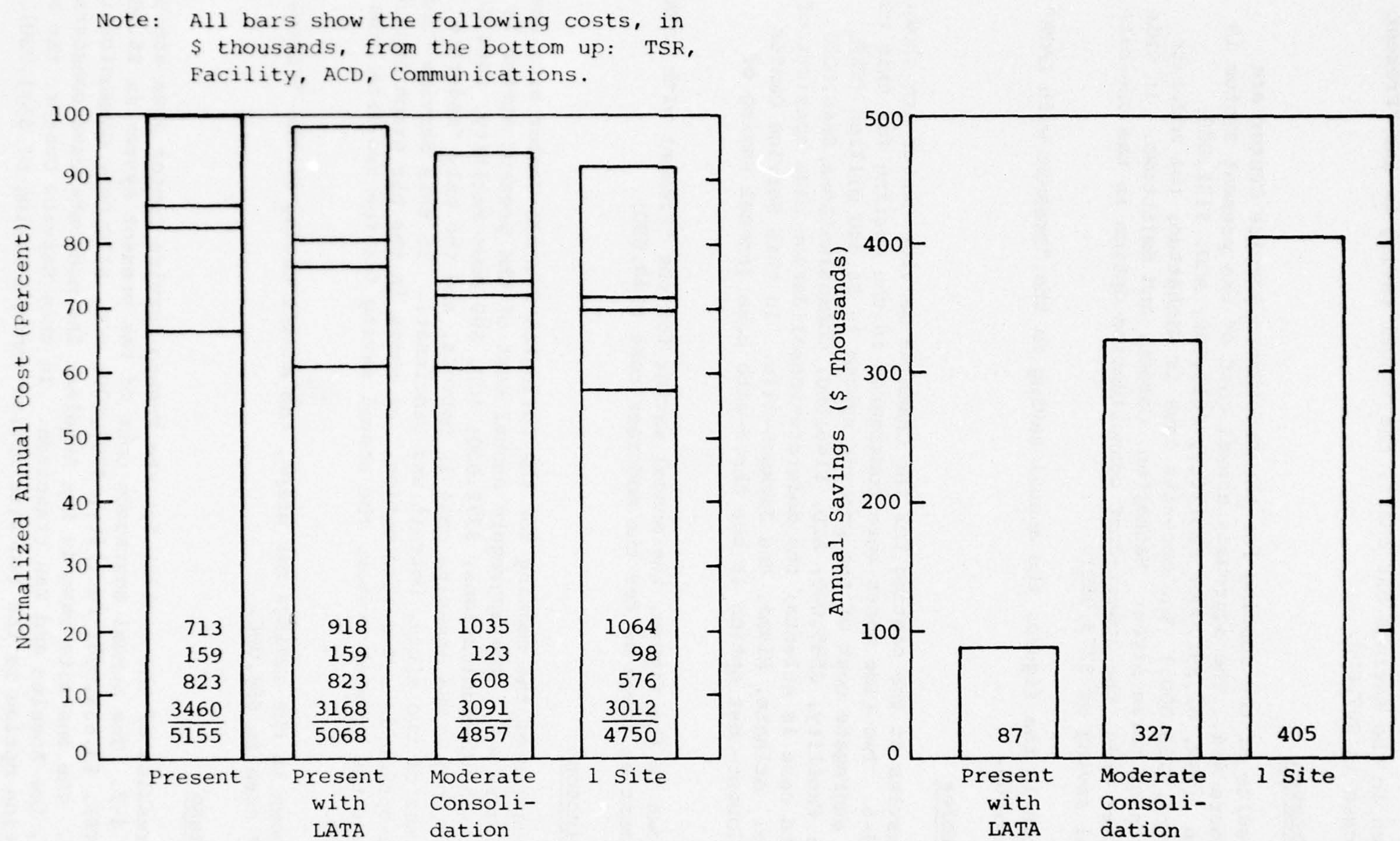


(a) TFTS Reconfiguration Financial Comparison



(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-2. ANDOVER SERVICE CENTER RESULTS



(a) TFTS Reconfiguration Financial Comparison

(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-3. AUSTIN SERVICE CENTER RESULTS

As shown in the savings bar chart, the annual saving in the "Present with LATA" case is $87,000.

4.4.3 Brookhaven

The results of the costing for the Brookhaven Service Center are shown in Figure 4-4. The aggregate annual cost of the present system is $3.8 million (TSR, $2,891,000; Facility, $619,000; ACD, $132,000; Communications, $158,000.) The one-site case is Manhattan; the moderate case consists of three sites: Manhattan, Camden, and Smithtown. In this Service Center area, the lowest-cost consolidation option is the one-site case (annual saving of $273,000).

As shown in the figure, the annual saving in the "Present with LATA" case is $202,000.

4.4.4 Chamblee

The results of the costing for the Chamblee Service Center are shown in Figure 4-5. Two time zones were considered in the costing for this case. The annual aggregate cost of the present system is $4.549 million (TSR, $3,170,000; Facility, $585,000; ACD, $146,000; Communications, $648,000). The one-site case is Atlanta; the moderate-consolidation case consists of three sites: Atlanta, Miami, and Jacksonville. In this Service Center area, the lowest-cost option is the three-site case (annual saving of $178,000).

As shown in the figure, the annual saving for the "Present with LATA" case is almost as large as for the moderate case $148,000).

4.4.5 Covington

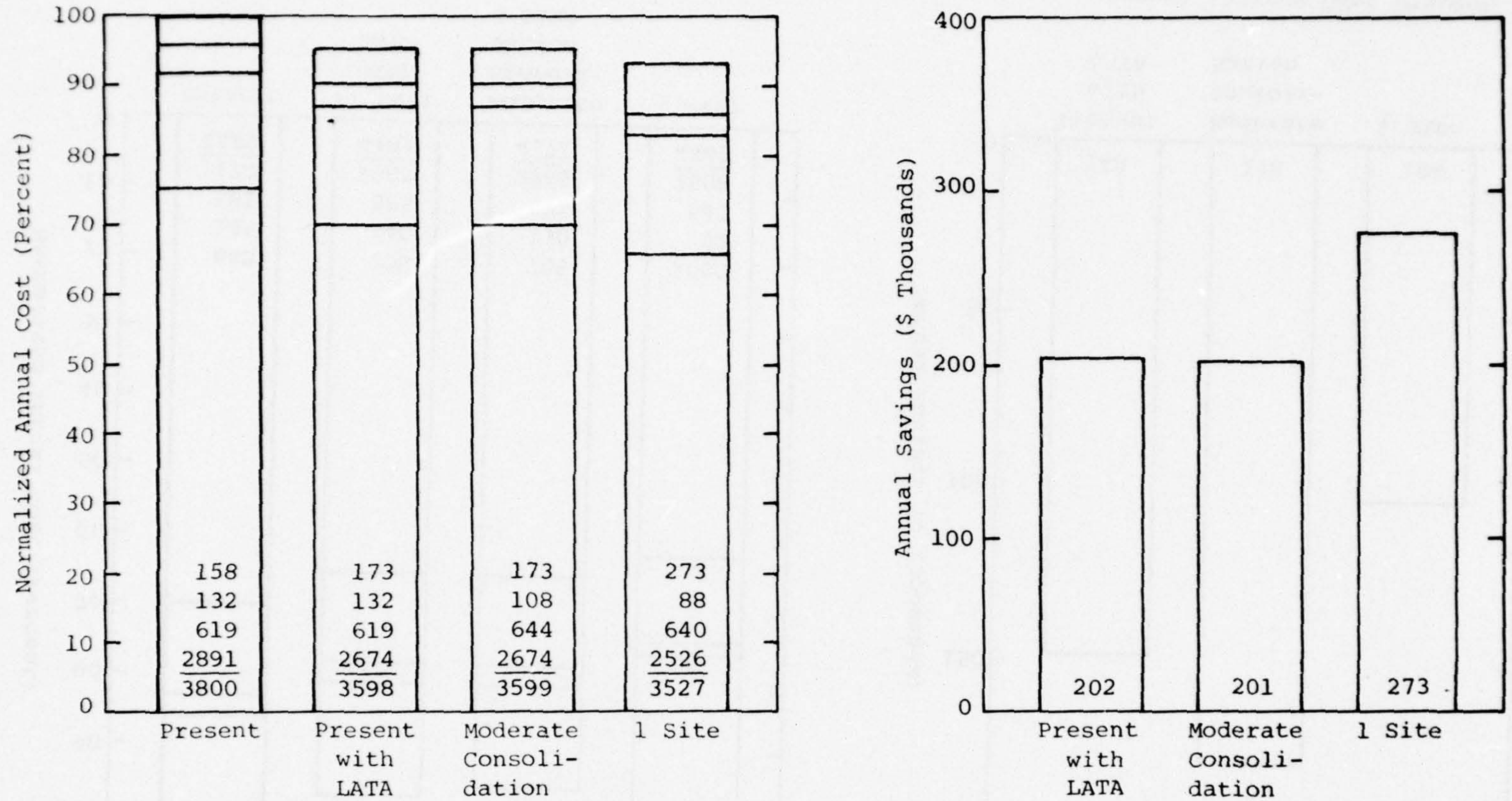
The results of the costing for the Covington Service Center area are shown in Figure 4-6. The aggregate annual cost of the present system is $3.118 million (Communications, $372,000; ACD, $99,000; Facility, $464,000; TSR, $2,183,000). The one-site case is Detroit, and the only "moderate" case consists of two sites, Detroit and Cincinnati. In this Service Center, the lowest-option is a two-site option. As shown in the bar graph depicting savings over the present system, the annual saving for the two-site case is $114,000.

As shown in the savings bar graph, the annual saving in the "Present with LATA" case is $86,000.

4.4.6 Fresno

The results of the costing for the Fresno Service Center area are shown in Figure 4-7. The annual aggregate cost of the present system is $5.087 million (TSR, $3,633,000; Facility, $796,000; ACD, $170,000; Communications, $488,000). The one-site case is Los Angeles; the moderate case consists of two sites, Los Angeles and San Francisco. In this Service Center, the best consolidation option is the two-site option (annual saving of $531,000).

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.

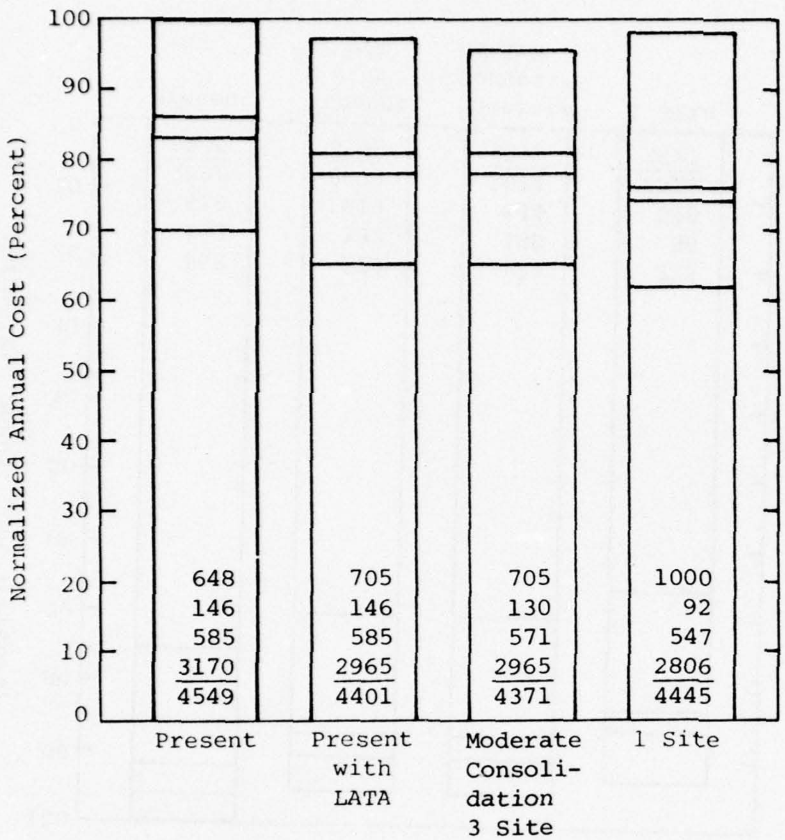


(a) TFTS Reconfiguration Financial Comparison

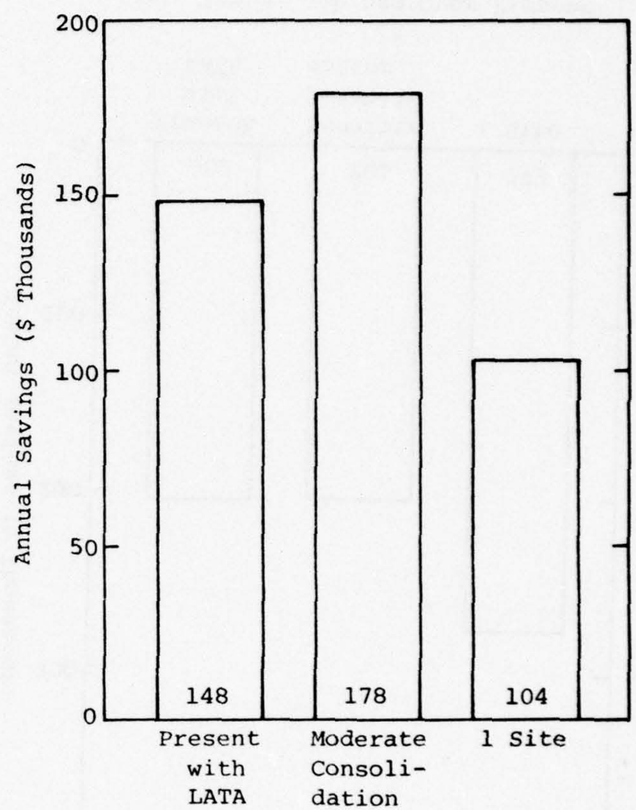
(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-4. **BROOKHAVEN SERVICE CENTER RESULTS**

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



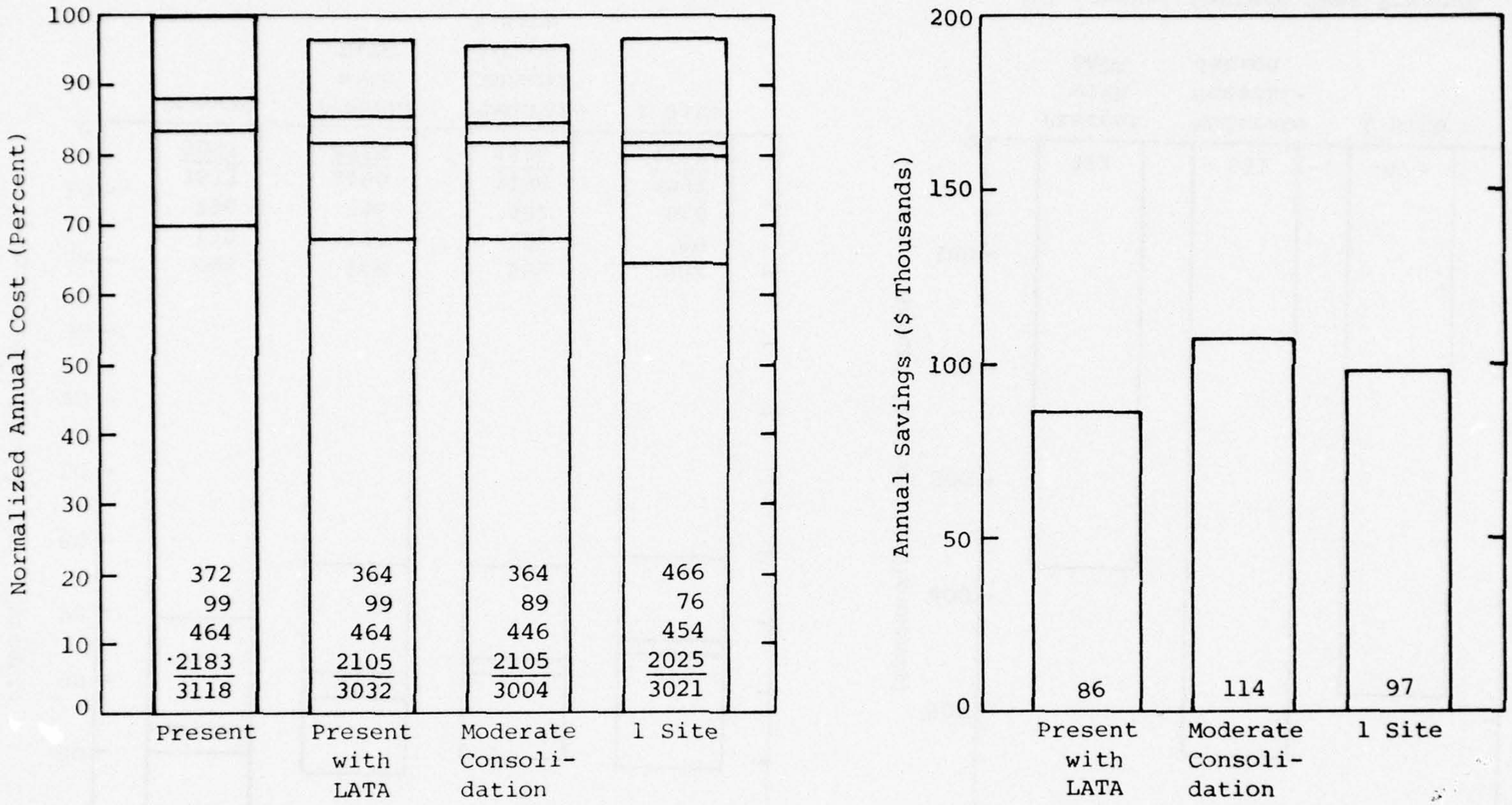
(a) TFTS Reconfiguration Financial Comparison



(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-5. CHAMBLEE SERVICE CENTER RESULTS

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.

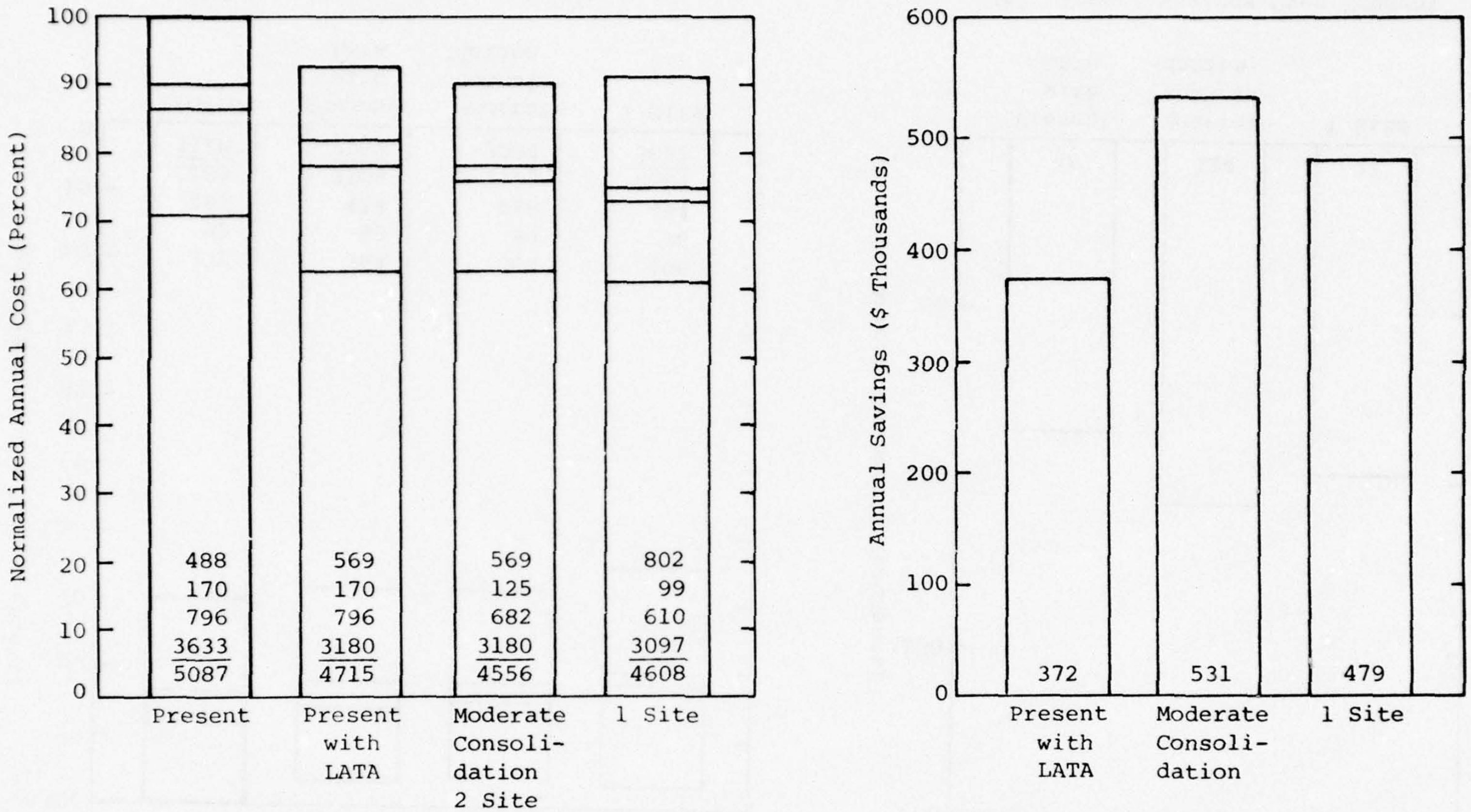


(a) TFTS Reconfiguration Financial Comparison

(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-6. COVINGTON SERVICE CENTER RESULTS

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



(a) TFTS Reconfiguration Financial Comparison

(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-7. FRESNO SERVICE CENTER RESULTS

As shown in the figure, the annual saving for the "Present with LATA" case is substantial ($372,000).

4.4.7 Kansas City

The results of the costing for the Kansas City Service Center are shown in Figure 4-8. The aggregate annual cost of the present system is $3.791 million (TSR, $2,684,000; Facility, $482,000; ACD, $125,000; Communications, $500,000). The one-site case is Chicago; the moderate-consolidation case consists of two sites, Chicago and St. Louis. In this Service Center area, the lowest-cost consolidation option is the two-site case, although both the one-site and "Present with LATA" cases are substantially equivalent in cost savings to the moderate case. As shown in the bar graph, the annual cost saving in the moderate-consolidation case is $244,000.

As shown in the savings bar chart, the annual saving in the "Present with LATA" case is $210,000.

4.4.8 Memphis

The results of the costing for the Memphis Service Center area are shown in Figure 4-9. The aggregate annual cost of the present system is $4,182,000 (TSR, $2,889,000; Facility, $494,000; ACD, $136,000; Communications, $663,000). The one-site case is Indianpolis; the moderate-consolidation case is a two-site case consisting of Indianapolis and Norfolk. In this Service Center area, the lowest-cost option is the moderate-consolidation case (annual saving of $419,000).

As shown in the savings bar chart, the annual saving in the "Present with LATA" case is $351,000.

4.4.9 Ogden

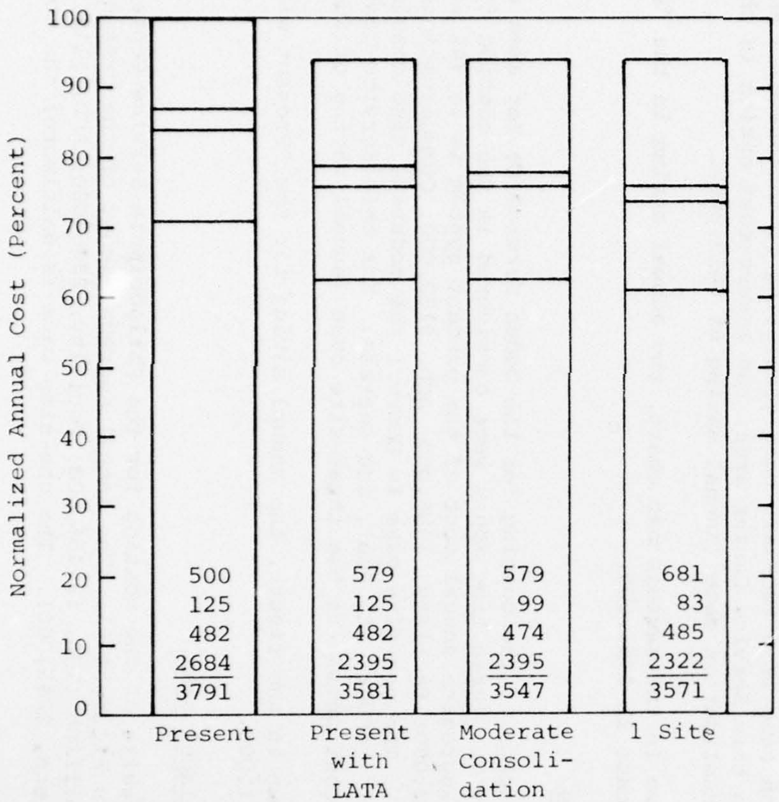
The results of the costing for the Ogden Service Center area are shown in Figure 4-10. Three time zones were considered in the costing for this case. The aggregate annual cost of the present system is $5.944 million (TSR, $3,832,000; Facility, $686,000; ACD, $182,000; Communications, $1,244,000). The one-site case is Denver; the moderate case consists of three sites: Denver, St. Paul, and Seattle. For this Service Center area, the lowest-cost option is the three-site case (annual saving of $844,000).

As shown in the figure, the annual saving for the "Present with LATA" case is $741,000.

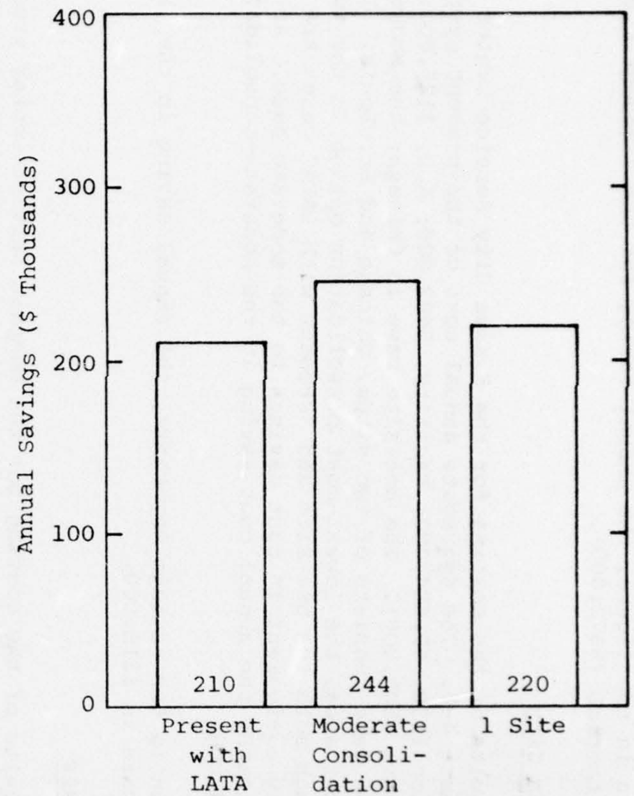
4.4.10 Philadelphia

The results of the costing for the Philadelphia Service Center area are shown in Figure 4-11. The annual aggregate cost of the present system is $3.367 million (TSR, $2,465,000; Facility, $546,000; ACD, $111,000; Communications, $245,000). The one-site case is Baltimore; the moderate

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



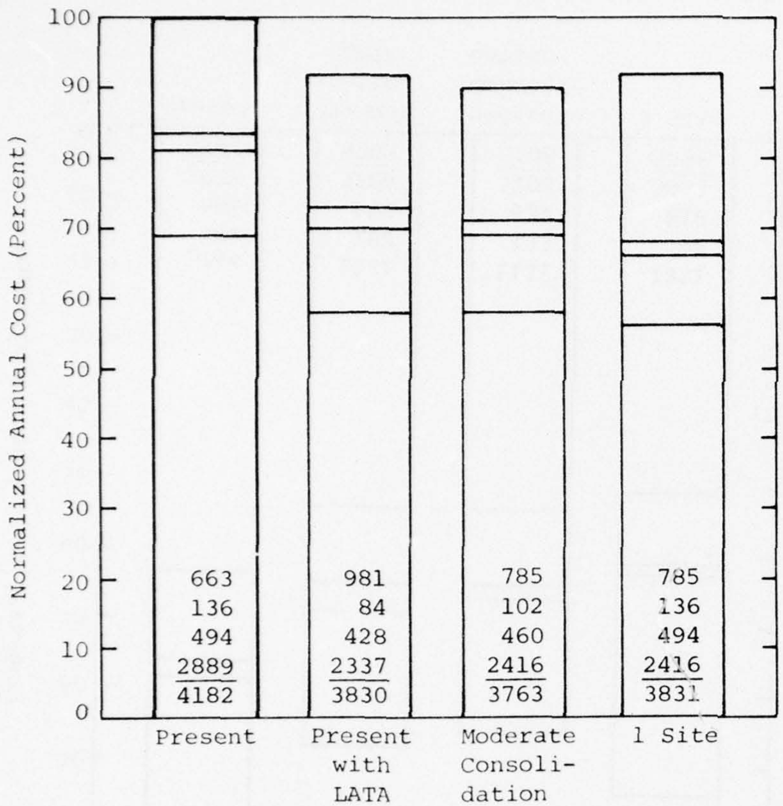
(a) TFTS Reconfiguration Financial Comparison



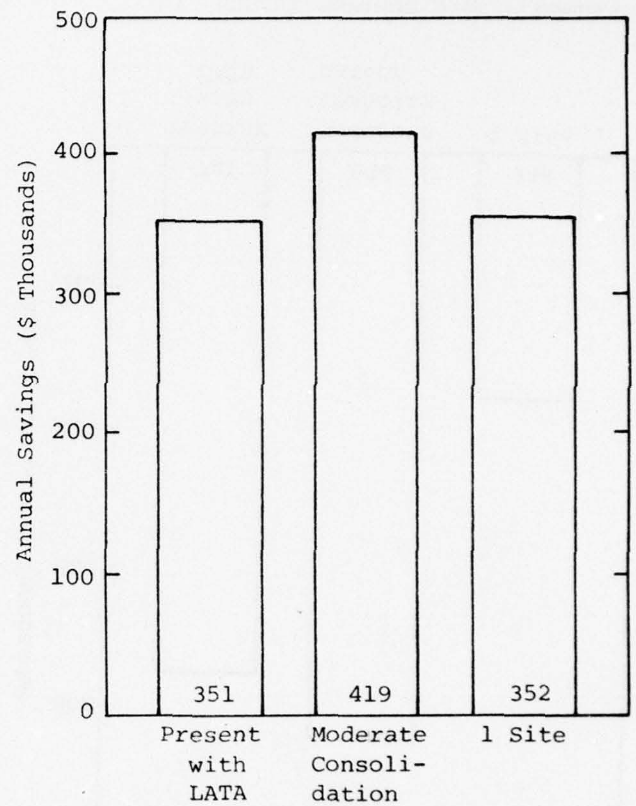
(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-8. KANSAS CITY SERVICE CENTER RESULTS

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



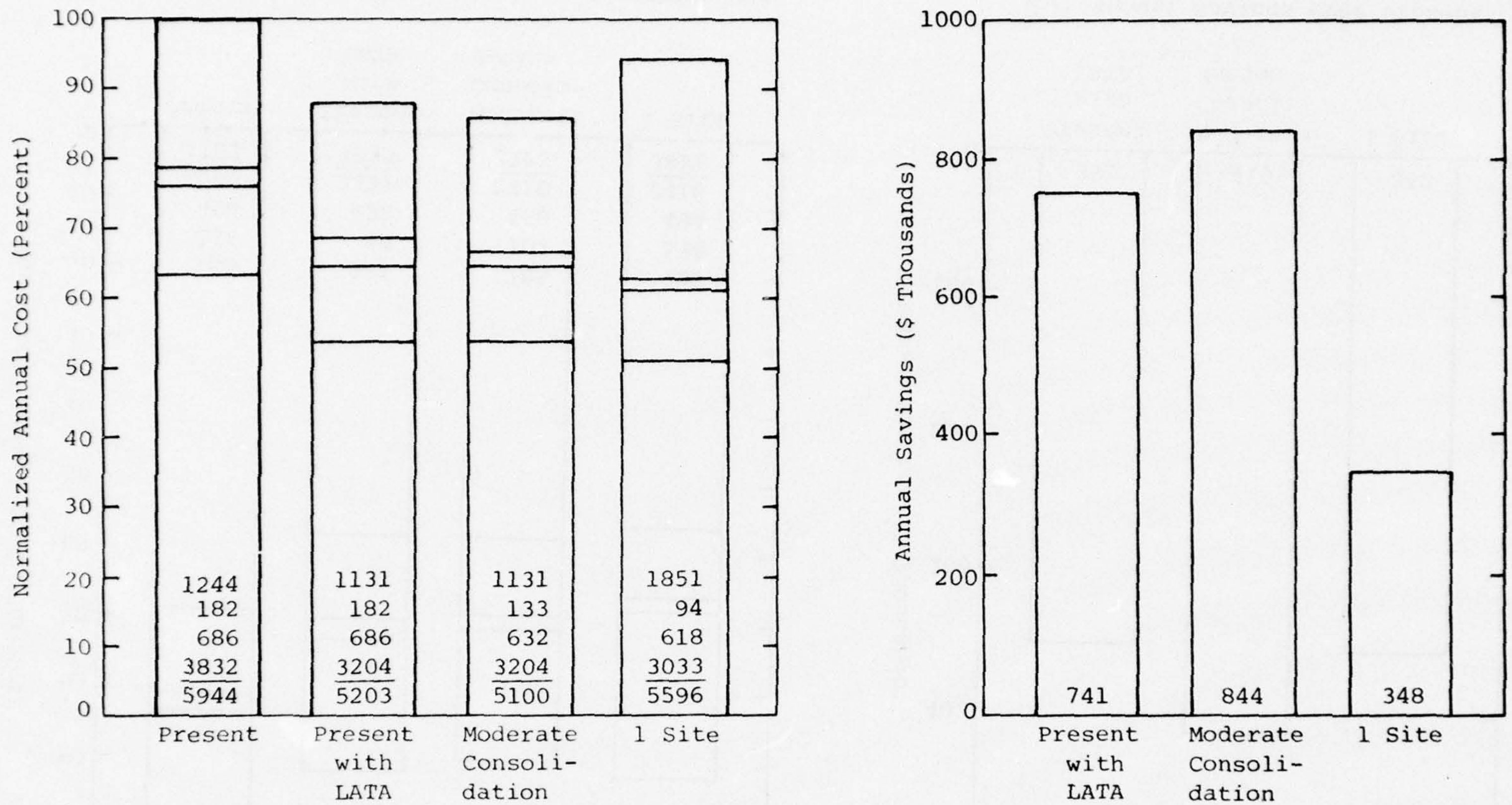
(a) TFTS Reconfiguration Financial Comparison



(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-9. MEMPHIS SERVICE CENTER RESULTS

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.

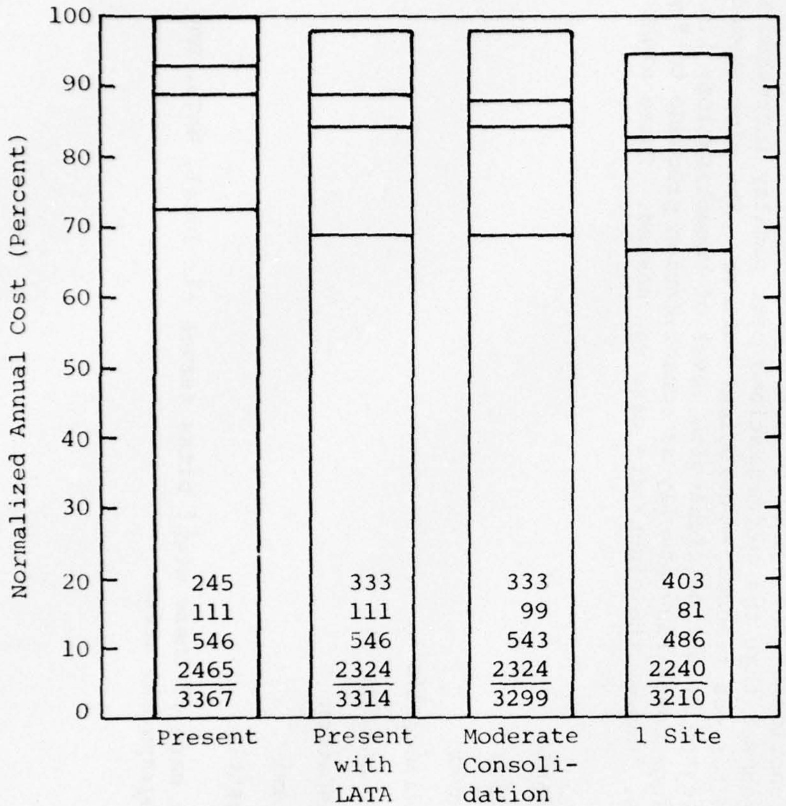


(a) TFTS Reconfiguration Financial Comparison

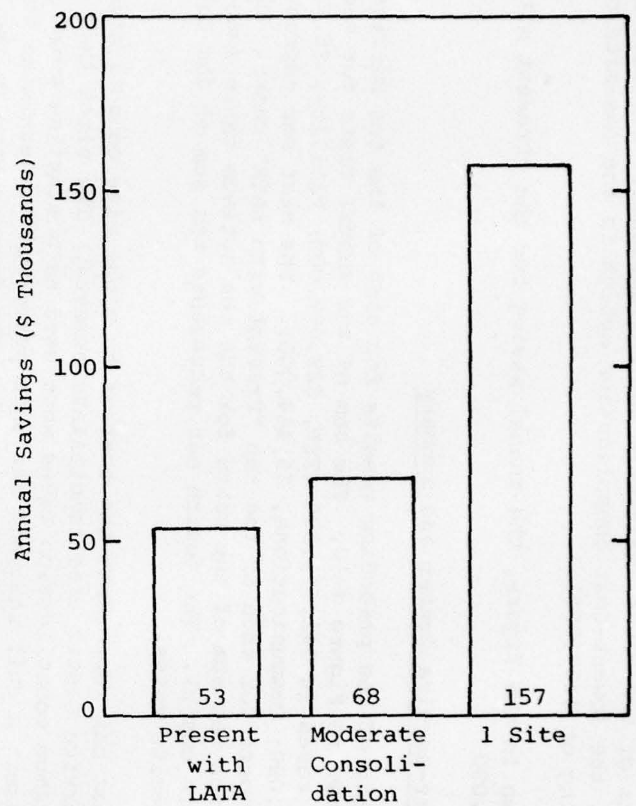
(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-10. OGDEN SERVICE CENTER RESULTS

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



(a) TFTS Reconfiguration Financial Comparison



(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-11. PHILADELPHIA SERVICE CENTER RESULTS case consists of two sites, Baltimore and Philadelphia. For this Service Center area, the lowest-cost consolidation option is the one-site case (annual saving of $157,000).

As shown in the figure, the annual saving for the "Present with LATA" case is $53,000.

4.4.11 Inter-Service Center and Summary

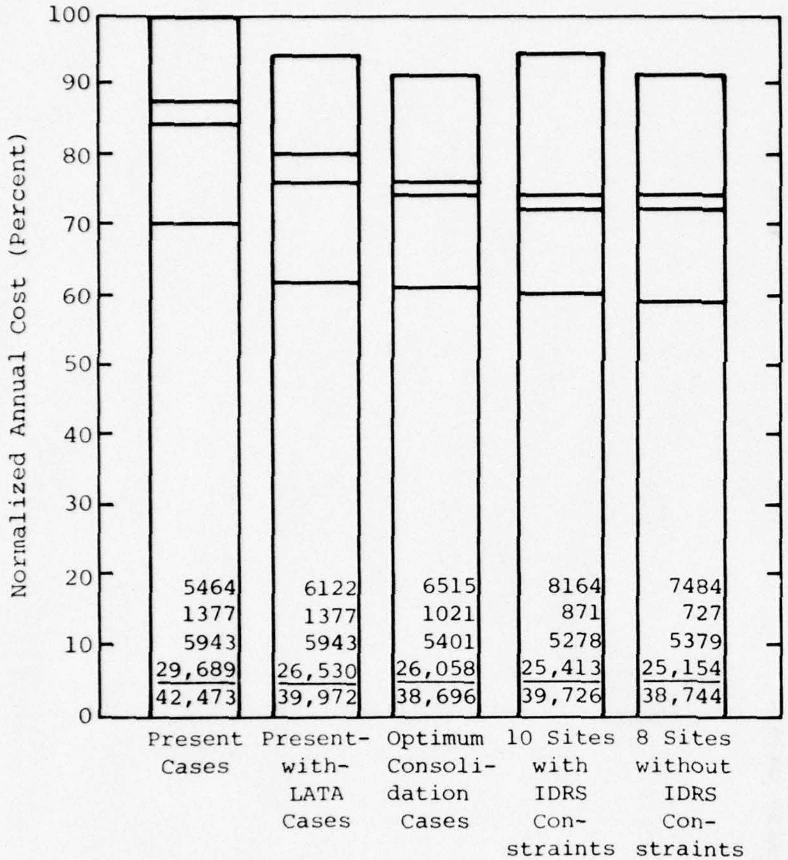
A summary of the preceding results for each of the ten Service Center areas is shown in Figure 4-12. The sum of the annual costs for each of the ten present cases is $42,473,000 (TSR, $29,689,000; Facility, $5,943,000; ACD, $1,377,000; Communications, $5,464,000). The next bar represents the sum of the costs for each of the ten "Present with LATA" cases. The third bar represents the sum of the costs for the ten optimum cases (one-, two-, or three-site cases). The fourth bar represents the sum of the costs for the ten one-site cases.

The last bar represents the cost of an eight-site consolidation option with the Service Center area constraints removed. The sites that comprise the ten optimum consolidation cases were used as a starting point for this non-IDRS case. A cull analysis was then performed to determine the site ordering, as explained in Chapter Three. The factors used in the cull analysis are indicative of the cost penalties associated with the various levels of site consolidation. These factors were plotted for the non-IDRS case as a function of the number of sites remaining. This plot was non-linear and showed that the communications cost penalty increased as the number of sites was reduced -- a logical outcome. The plot showed a definite breakpoint at the eight-site level of consolidation; i.e., the communications costs rise steeply as consolidation proceeds to fewer than eight sites. Hence, the eight-site case was costed. These eight sites are:

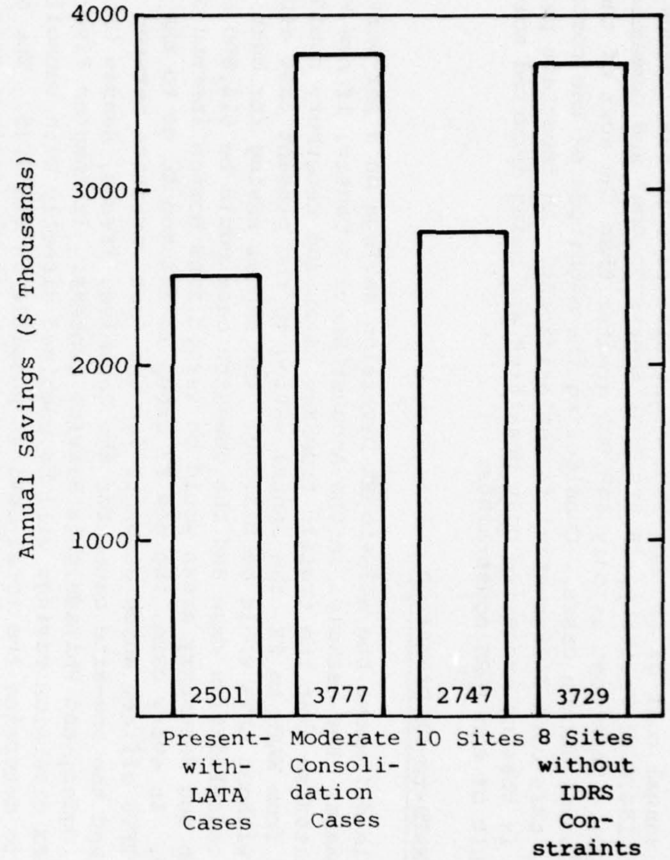
- Atlanta
- Dallas
- Denver
- Indianapolis
- Los Angeles
- Manhattan
- Miami
- Seattle

Basically, each of these eight sites serves all local, WATS, and FX calls in its geographical area.

Note: All bars show the following costs, in $ thousands, from the bottom up: TSR, Facility, ACD, Communications.



(a) TFTS Reconfiguration Financial Comparison



(b) Annual Savings Over Present TFTS Site Configuration

Figure 4-12. NATIONWIDE CONSOLIDATION AND SUMMARY

The annual cost of the non-IRDS eight-site case is $38,744,000 (TSR, $25,154,000; Facility, $5,379,000; ACD, $727,000; and Communications, $7,484,000). This cost is only $48,000 greater than the cost of the ten optimum consolidation cases. Considering the magnitude of the costs involved, this cost differential is insignificant. An important point, however, is that no excessive cost penalties are being incurred solely as a result of the IDRS constraints.

4.4.12 WATS-to-FX Diversion

Table 4-1 shows the WATS-to-FX Diversion savings on a per-Service Center basis. For example, in the Andover Service Center, if new FX groups were created so that the traffic from New Haven and Waterbury could be diverted from WATS to FX, the annual saving in the present case either with or without LATA would be $12,900. The annual saving for both the optimum consolidation case and the one-site case would be $14,800 because New Haven and Waterbury areas would be served from Boston instead of Hartford. In every case, the new FX group is assumed to go to the closest TFTS office, which accounts for the cost variation between the optimum and the one-site cases for the Chamblee, Fresno, Kansas City, Memphis, Ogden, and Philadelphia Service Centers. In Chapter Five, these WATS-to-FX diversion savings will be combined directly with consolidation savings to determine the total savings possible in the TFTS. The saving in the one-site case is generally greater than in the optimum case because telephone traffic is being diverated from more expensive WATS lines in the one-site cases.

Table 4-1. WATS-TO-FX DIVERSION SAVINGS

Service Center	New FX Groups Serving	Annual Savings in Present Case	Annual Savings in Present with LATA Case	Annual Savings in Optimum Consolidation Case	Annual Savings in One-Site Cases
Andover	New Haven, Waterbury, CT	$ 12,900	$ 12,900	$ 14,800	$ 14,800
Austin	Corpus Christi, TX	23,000	23,000	13,500	13,500
Brookhaven	---	---	---	---	---
Chamblee	Hollywood, FL Macon, Savannah, GA	44,300	44,300	37,000	163,300
Covington	---	---	---	---	---
Fresno	Fresno, Sacramento, Riverside, San Bernardino	53,600	53,600	53,600	71,900
Kansas City	Rockford, Peoria, IL Madison, WI	24,500	24,500	19,600	97,800
Memphis	Charlotte, Raleigh, Winstron-Salem, NC	38,900	38,900	36,200	17,600
Odgen	Colorado Springs, CO; Tucson, AZ; Duluth, MN	53,500	53,500	32,000	184,000
Philadelphia	Scranton, Erie, PA	9,600	9,600	4,300	33,100
	Total	$260,300	$260,300	$211,000	$596,000

CHAPTER FIVE

RECOMMENDATIONS

This chapter contains a recommended plan of action that the IRS should implement for each of the ten Service Center areas in order to obtain the maximum savings in TFTS operating cost. Included with these recommendations are observations concerning alternative cost-saving measures that could be taken, such as load sharing (LATA) and diversion of traffic from more expensive WATS to less expensive FX.

5.1 GROUND RULES AND GENERAL OBSERVATIONS

A fundamental ground rule followed throughout this study is that each TFTS site will provide enough TSRs to ensure an average speed of answer (ASA) of 20 seconds for incoming calls. All cost-saving figures are based on the assumption that the present system now provides or will provide an ASA of 20 seconds. The degree of error in the cost-saving estimates is directly related to the degree of error in this ground rule (which varies from site to site).

Two general observations can be made concerning the study results. First, the load-sharing technique of LATA should be carefully considered by the IRS. If the IRS is now providing ASA 20 service, then considerable cost savings are possible through the introduction of LATA ($2,501,000/year) with little or no one-time expenses. If, on the other hand, the present service is poorer than ASA 20, the LATA technique offers a method of improving the grade of service offered to the U.S. public by the present offices (to the IRS objective of ASA 20) with a minimum cost increase.

The second general observation is that the annual saving for the recommended consolidation options summed over all ten Service Center areas is approximately $3,800,000, which corresponds to a saving of roughly 9 percent of present nationwide system operating costs. The percentage saving varies by Service Center area from a low of 4 percent to a high of 14 percent. All recommendations are made on a per-Service Center basis.

5.2 DETAILED RECOMMENDATIONS

Recommendations for the ten Service Center areas are presented individually in Subsections 5.2.1 through 5.2.10. The recommendations address (1) the lowest-cost consolidation plan, (2) the LATA cost-saving alternatives not involving site consolidations, and (3) the WATS-to-FX diversion recommendations where applicable.

A summary table is presented in Section 5.2.11. It shows the cost savings that could be obtained by combining all of the possible cost-reduction techniques as applicable. For example, the WATS-to-FX diversion cost savings have been added to those savings possible in the "Present with LATA" case and the moderate-consolidation case where applicable.

5.2.1 Andover

A two-site consolidation (Boston and Buffalo) is the recommended option in the Andover Service Center area, with an annual saving of $302,000. This recommendation is made because the present ACDs in these two sites could be expanded relatively easily to handle the increased traffic. Although a one-site (Boston) consolidation is slightly less expensive (the difference of $10,000 per year is not significant), that option would require installation of a new ACD either to augment or to replace the present ACD.

Alternatively, it is recommended that the IRS consider implementing some form of LATA among the present sites in this area. This would require relatively small one-time expenditures, no site moves, and no other relocations, and could potentially result in annual savings of $251,000.

It is further recommended that two new FX line groups be created to serve the New Haven and Waterbury areas. These new line groups would divert traffic from the present WATS line group at the estimated annual saving of $12,900 in the present case.

5.2.2 Austin

A one-site consolidation into the Dallas answering site is the recommended consolidation option, with an annual saving of $405,000. This site would require 298 TSRs during the peak period of the year, necessitating installation of another ACD either to replace or to augment the present 3A ACD in Dallas. Substantial one-time installation costs would be incurred. A larger-capacity Collins ACD has just been installed in the Houston answering site. It is recommended that if the IRS desires to implement a one-site consolidation in this Service Center area, Houston should be considered as the site to consolidate into. Although the communications costs would be somewhat higher in a Houston one-site consolidation, many of the other cost benefits would be retained.

Alternatively, it is recommended that the IRS consider implementing some form of load sharing, interflow, or LATA among the present sites in this area. This would require relatively small one-time expenditures, no site moves, and no other relocations, and could result in an annual saving of $87,000.

Regardless of the consolidation option, routing the present Corpus Christi area traffic over FX lines instead of WATS lines would involve very low one-time installation charges, and this WATS-to-FX diversion would result in an annual saving of $23,000 in the present case. Both the LATA and the WATS-to-FX diversion could be implemented immediately and independently of any eventual plans for site consolidation.

5.2.3 Brookhaven

The one-site consolidation (Manhattan) is the recommended consolidation option in the Brookhaven Service Center area (annual saving of $273,000). It would require installation of a new ACD in the Manhattan office either to augment or to replace the existing 3A ACD at that site. There would be one-time expenses associated with this new ACD, as well as with existing ACD terminations and possible employee relocation.

As an alternative to site relocation, LATA could be implemented, with a potential annual saving of $202,000. To implement LATA would require only a minimal one-time set-up expense.

5.2.4 Chamblee

A one-site consolidation (Atlanta) is the preferred option (annual saving of $267,300). Although the three-site case involves the lowest cost not considering WATS-to-FX diversion, when that diversion is considered, the one-site case is the preferred option. The one-site option, however, will require either augmenting or replacing the present ACD in Atlanta.

Alternatively, it is recommended that the IRS consider implementing some form of LATA among the present sites in this area. This would require relatively small one-time expenditures, no site moves, and no other relocations, and could result in an annual saving $148,000.

It is further recommended that new FX line groups be created for the traffic from Hollywood, Florida, and Savannah, Macon, and Columbus, Georgia. This would result in estimated annual savings of $44,300 in the present case.

5.2.5 Covington

A two-site consolidation (Detroit and Cincinnati) is the recommended consolidation option in the Covington Service Center area (annual saving of $114,000). The 3A ACDs in each of these sites would need to be expanded, but these ACDs have adequate capacity for this expansion. To implement this site consolidation, there would be a one-time relocation expense.

As an alternative to site consolidation, LATA could be implemented, with a potential annual saving of $86,000. This would require only a minimal one-time set-up expense.

There are no specific recommendations for the Covington Service Center area concerning WATS-to-FX diversion. However, as new areas of population concentration develop in the future, consideration should be given to serving that segment of the public with FX lines instead of WATS lines.

5.2.6 Fresno

A two-site consolidation (Los Angeles and San Francisco) is the lowest-cost consolidation option for the Fresno Service Center area (annual saving of $479,000). This option would require larger ACDs at both sites, however. There are currently 3A ACDs at both Oakland (San Francisco metropolitan area) and El Monte (Los Angeles metropolitan area). These ACDs could handle the TSR requirements for these two areas (117 and 193, respectively). It is therefore recommended that the IRS consider a two-site consolidation using these two sites (Oakland and El Monte).

An alternative to the consolidation would be LATA, which would involve minimal one-time rearrangement expenses but would yield a potential annual saving of $372,000.

ARINC Research recommends that new FX groups be created for the traffic from Riverside, San Bernardino, Fresno, and Sacramento. This would result in estimated savings of $53,600 in the present case.

5.2.7 Kansas City

The one-site consolidation (Chicago) is the recommended consolidation option in the Kansas City Service Center area (annual saving of $436,000). Although the two-site case is the lowest-cost option not considering WATS-to-FX diversion, when that diversion is considered, the one-site case is the preferred option. It would require either replacing or augmenting the ACD at this site.

As an alternative to site consolidation, LATA could be implemented, with a potential annual saving of $210,000. To implement LATA would require only a minimal one-time set-up expense.

We recommend that the IRS consider serving the following areas with FX lines instead of WATS lines: Rockford and Peoria, Illinois; and Madison, Wisconsin. This would result in estimated annual savings of $24,500 in the present case.

5.2.8 Memphis

A two-site consolidation (Indianapolis and Norfolk) is the recommended option in the Memphis Service Center area (annual saving of $419,000). This option would require replacing the existing key system at the Norfolk site with a large ACD such as a 3A. The existing 3A ACD at Indianapolis could be expanded to handle the added traffic there. A two-site consolidation as proposed would involve substantial one-time expenses for a new ACD installation, ACD-termination liabilities, and office-closing expenses.

It is recommended that the IRS consider implementing LATA in the present system as a method of achieving annual savings of up to $351,000, with little or no one-time expenses.

It is also recommended that some of the present North Carolina WATS traffic be diverted to new FX groups. These new FX groups would serve Charlotte, Raleigh, and Winston-Salem, North Carolina, at the estimated annual saving of $38,900 in the present case.

5.2.9 Ogden

A three-site consolidation (Denver, St. Paul, and Seattle) is the recommended option in the Ogden Service Center (annual saving of $844,000). This option would require replacing or augmenting the existing 2B ACD at Denver with a larger-capacity machine. The existing 3A ACDs at St. Paul and Seattle could be expanded to handle the extra traffic resulting from consolidation. This three-site consolidation would involve substantial one-time expenses for a new ACD installation (Denver), ACD-termination liabilities, and office-closing expenses.

It is recommended that the IRS consider implementing LATA in the present system as a method of achieving annual savings of up to $741,000, with little or no one-time expenses.

It is also recommended that three new FX groups be created to serve the Colarado Springs, Colorado; Tucson, Arizona; and Duluth, Minnesota areas. Diverting this traffic from WATS to FX would result in the estimated annual saving of $53,500 in the present case.

5.2.10 Philadelphia

A one-site consolidation (Baltimore) is the recommended option for the Philadelphia Service Center area (annual saving of $157,000). This option would require augmenting or replacing the existing 3A ACD (peak Baltimore TSR requirement would be 220). It would involve substantial one-time expenses for new ACD installation, ACD-termination liabilities at the other three sites, and office-closing expenses.

It is recommended that the IRS consider implementing LATA in the present system as a method of achieving annual savings of up to $53,000, with little or no one-time expenses.

It is also recommended that some of the present Pennsylvania WATS traffic be diverted to new FX groups. These new FX groups would serve Scranton and Erie, with the estimated annual cost saving of $9,600 in the present case.

5.2.11 Summary of Recommendations

Table 5-1 summarizes the recommendations and savings on a per-Service Center basis. The recommended consolidation options are shown for each of the ten Service Center areas, along with the annual savings potential for each of the alternative reconfigurations. For example, if the IRS implemented the recommended two-site consolidation in the Andover Service Center Area, the annual savings potential, including the savings from WATS-to-FX diversion as recommended, would be $326,800. If the IRS did not consolidate, but rather implemented LATA with the present system, the annual savings potential would be $263,900. If the IRS chose only to implement the recommended WATS-to-FX diversion with the present system, the annual savings potential would be $12,900.

Table 5-1. SUMMARY OF RECOMMENDATIONS AND SAVINGS

Service Center Area	Recommended Action	Annual Savings, Including, WATS-to-FX Diversion	Annual Savings for "Present with LATA" and WATS-to-FX Diversion	Annual Savings, WATS-to-FX Diversion Only
Andover	Two-site consolidation to Boston and Buffalo	$ 316,800	$ 263,900	$ 12,900
Austin	One-site consolidation to Dallas	418,500	110,300	23,300
Brookhaven	One-site consolidation to Manhattan	273,000	202,000	
Chamblee	One-site consolidation to Atlanta	267,300	192,300	44,300
Covington	Two-site consolidation to Detroit and Cincinnati	114,000	86,000	---
Fresno	Two-site consolidation to Los Angles and San Francisco	584,600	425,600	53,600
Kansas City	One-site consolidation to Chicago	317,800	234,500	24,500
Memphis	Two-site consolidation to Indianapolis and Norfolk	455,200	389,900	38,900
Ogden	Three-site consolidation to Denver, St. Paul, and Seattle	876,000	794,500	53,500
Philadelphia	One-site consolidation to Baltimore	190,100	62,600	9,600
	Totals	$3,813,300	$2,761,600	$260,600

APPENDIX A

IRS TELECOMMUNICATIONS SUPPORT GROUND RULES

The following ground rules were established for the Task One study:

1. The telephone system under consideration is dedicated entirely to tax information service.
2. There are 10 IRS Service Regions, each with its own data retrieval system. All consolidation options except one will preserve these Service Region boundaries; i.e., there will be no inter-region traffic. A single case of major consolidation will be considered where the Service Region boundary constraints are removed.
3. The study will not consider DDD or FTS switched telephone service, but only FX, WATS, local, and, in some cases, tie lines (LATA).
4. The IRS standard for service is P10 (Poisson Tables) for telephone lines, with ASA of 20 seconds,
5. "Forms only" traffic or telephone service will not be considered in the study.
6. Transfer of calls to and from nonanswering sites will not be considered.
7. Call-back will not be included in the study.
8. The following consolidation options will be evaluated for each of the ten Service Regions:
   - (a) No consolidation of answering sites, but number of lines and TSRs enhanced to provide P10 and ASA of 20 seconds
   - (b) Consolidation to one site per Service Center Region
   - (c) Consolidation to an intermediate number of sites (exact number of sites to be determined by ARINC Research on a per-Service-Center basis)

   In addition, there will be one case of major nationwide consolidation with no Service Center boundary restraints. The maximum number of cases to be costed is 31. LATA will be considered in each case.
9. There will be no scheduling constraints on TSR availability -- as many TSRs as are required during any given hours will be available.
10. Any after-hours traffic volume in the present system is insignificant. Extended working hours can be arranged to accommodate any inter-time zone traffic.

11. The relative proportions of WATS/FX/local lines during the filing period should be used in allocating aggregate adjusted demand to each trunk group.

12. The consolidation options will be compared financially on the basis of one-time costs (e.g., BTC, ACD installation) and recurring costs. One-time costs such as employee relocation, construction, etc., will not be considered.

13. It is recognized that the IRS, for the purposes of matching the number of circuits to the amount of traffic, can adjust the number of circuits as often as once a month. This seasonal circuit readjustment will be considered in formulation of the cost-analysis approach for the various consolidation options.

14. The study period is FY 1976, and no traffic growth projections will be included for the Task One report. Observations and recommendations on traffic-growth sensitivity will be made in the final report.

15. The adjusted demand will be reduced by 7 percent, per IRS directive, in calculating the number of TSRs required for ASA 20 service. This factor is to account for blockage on the incoming telephone trunks and some abandoned calls.

16. Referral TSRs will be included with the front-line TSRs in determining the staffing requirements.

17. A 2- to 3-percent traffic growth rate will be used for the Task Two study of ACDs. The Philadelphia answering site will be used as the basis of sizing/features/costing for the Task Two effort. Non-ACD features (e.g., local PBX service) will not be considered.

18. Interstate WATS charges will be reduced by 25 percent to reflect savings resulting from Full-Time/Measured-Time economies and the one free line; intrastate charges will be reduced by 10 percent for the same reason.

19. Diversion from WATS to FX will be considered. Adjusted demand for the cities to be added to the network will be calculated on the basis of the regression equation: CCS during a period 2 busy hour is population in thousands.

20. For purposes of computerized costing, both the Poisson trunking and Erlang C staffing curves will be piecewise-modeled by curvilinear functions.

21. The round-off rule for both trunking and staffing is as follows: fractional part > .1, round up; otherwise, round down.

22. The intrastate FX cost model is \$80 + .54¢ per mile. The interstate FX cost model is \$110 + .54¢ per mile.

23. The single case of inter-IDRS consolidation will start with the optimum consolidation options for each of the ten IDRS regions.

24. Where Full-Time WATS rates were not available, they were estimated on the basis of rates for a state with comparable measured time rates.

25. States divided by a time zone were considered to be wholly contained in the time zone of the major portion of the Service Center area. The only exception to this rule was Ogden, for which each state split by a time zone was considered to be in the time zone containing the major portion of that state.

APPENDIX B

TRAFFIC DATA PROVIDED BY THE IRS

The IRS provided traffic data in several different forms. Table B-1 represents the annual adjusted demand. Table B-2 lists the factors used in converting annual adjusted demand into hourly demand during Periods 2 and 6. These factors reflect the traffic ratios that were supplied by the IRS.

Table B-1. ANNUAL ADJUSTED DEMAND

Albany	273341	Bailey's Xrds	280586
Augusta	97397	Greensboro	524077
Boston	681885	Indianapolis	587018
Buffalo	661035	Louisville	297742
Burlington	76184	Memphis	211931
Hartford	497800	Nashville	414871
Portsmouth	122634	Norfolk	168046
Providence	210232	Parkersburg	149389
		Richmond	422540
Brooklyn	524937	Atlanta	601438
Camden	265851	Birmingham	498720
Manhattan	1182770	Columbia	287970
Mineola	231853	Jackson	281708
Newark	852592	Jacksonville	697094
Smithtown	254332	Miami	1311577
Baltimore	1167598	Cleveland	875151
Philadelphia	1064671	Cincinnati	679751
Pittsburgh	529130		
Wilmington	162286	Detroit	841139
Aberdeen	92255	Chicago	996330
Boise	111468	Des Moines	285585
Denver	439503	Kansas City	237765
Fargo	124815	Milwaukee	569098
Helena	103875	Springfield	361609
Las Vegas	238616	St. Louis	582112
Omaha	264145		
Phoenix	382324	Carson	536075
Portland	517087	El Monte	706289
Salt Lake City	263256	Los Angeles	652542
Seattle	702907	Oakland	881765
Spokane	105032	San Diego	313875
St. Paul	562760	San Francisco	341772
		San Jose	305409
Albuquerque	198397	Van Nuys	351368
Dallas	1186756		
Houston	1086507		
Little Rock	285236		
New Orleans	506930		
Oklahoma City	432475		
Wichita	279256		

Table B-2. FACTORS USED FOR CONVERSION		
Hour Ending	Ratio of Hourly Traffic to Annual Adjusted Demand	
	Period 2	Period 6
9	8.167×10^{-4}	1.321×10^{-4}
10	1.320×10^{-3}	2.135×10^{-4}
11	1.454×10^{-3}	2.352×10^{-4}
12	1.376×10^{-3}	2.226×10^{-4}
13	1.164×10^{-3}	1.882×10^{-4}
14	1.365×10^{-3}	2.208×10^{-4}
15	1.343×10^{-3}	2.171×10^{-4}
16	1.320×10^{-3}	2.135×10^{-4}
17	1.029×10^{-3}	1.665×10^{-4}

APPENDIX C

SITE INVENTORY DATA PROVIDED BY THE IRS

A Toll-Free Telephone Site inventory sheet is presented on the following pages as an example of the data supplied by the IRS for use in this site consolidation study. One Toll-Free Telephone Site inventory was supplied for each site in the present system.

Toll-Free Telephone Site Inventory

Report Symbol NO-A:FM-14(OT)

District Atlanta

Page 1

PART I EQUIPMENT OPERATIONAL FEATURES

Answering Site Atlanta, Georgia

A. Trunk Group Registers	Installation Costs	Number of Individual Line Registers Min.	Max.	Monthly Unit Cost	Number of Totalizers	Monthly Unit Cost	Annual Connect/ Disconnect Charges
1. Local Lines: n/a							
a. Total Calls Received	$			$		$	$
b. Overflow/Busy							
c. All Trunks Busy							
2. WATS Lines: n/a							
a. Total Calls Received							
b. Overflow/Busy							
c. All Trunks Busy							
3. Foreign Exchange Lines:* n/a							
a. Total Calls Received							
b. Overflow/Busy							
c. All Trunks Busy							

*If more than one trunk grouping, supply the information on the space below for each such grouping.

4. Other Type Circuit Registers: (Secify)							
B. Position Registers		40	80				
1. Total Calls Received at All Work Stations							
2. Calls Received at an Individual Work Station							

FORCED ADMINISTRATION DATA SYSTEM
Rented from Telephone Company and obtained from Digital Products Incorporated. Unit contains 200 digital count registers and 50 time measuring circuit registers. The first 90 registers count the number of calls received at the answering stations. The next 60 registers count the number of calls received on local trunks. The next 40 registers count the number of calls received on the WATS Trunks. Five of the next 10 are used to give total position call count, registers 00 through 89; total local trunk count, registers 90 through 149 total WATS trunk count, registers 150 through 189; local overflow and WATS overflow. Only 9 circuit measuring registers, out of the next 50, are being used at this time. They measure (1) Total time positions manned, (2) Total time positions busy, (3) Total time positions talk, (4) Local trunk waiting time, (5) WATS trunk waiting time, (6) Local trunk Busy Usage, (7) WATS trunk Busy Usage, (8) Transfer trunk busy usage, (9) Cycle Count.

C. Systems Registers	Installation Cost	Number of Registers	Monthly Unit Cost
1. ACD Package*			
a. Total Calls Received			
b. All Trunks Busy			
c. Lost/Abandoned Calls			

*Attach listing of ACD registers broken down by seperate trunk groupings with associated costs.

	Installation Cost	Number of Registers	Monthly Unit Cost
2. FADS Registers			
a. 6 Register Package			
b. 7 Register Package			
c. Other	750.00	250	363.55
No. of Cycles Per Period 9(X) 18( ) 36( )			
Automatic Printout Feature? (X)Yes ( )No			
3. General Systems Registers			
a. Total Calls Received			
b. All Trunks Busy			
c. Lost/Abandoned Calls			
d. Other			

D. Special Management Information Systems ( )Star ( )IBM-7 (X)ESS/ACD ( )Collins

Initial One Time Cost $

Annual Cost $ 4362.60 Maintenance $ n/a

Form M-0116

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LOCAL

Types of Incoming Circuitry	Suspended Cost	Unit Cost Installation	Monthly	Number of Circuits (FY'76) Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.
1. Business Lines	n/a	40.00 ea	47.08	23	23	23	23	23	23	40	50	35	50	24	24
2. House/Lobby															
3.															
4.															

LONG DISTANCE

Types of Incoming Circuitry	Suspended Cost	Unit Cost Installation	Monthly	Number of Circuits (FY'76) Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.
1. WATS (Intra State)															
a. Full Time (240 hrs in base period)	n/a	50.00 ea	600.00	6	6	6	6	6	6	15	20	20	20	6	6
b. Measured															
______ hours in base rate															
______ prem rate/per hour															
______ hours in base rate															
______ prem rate/per hour															
2. Foreign Exchange — Origin City / Mileage															
a.															
b.															
c.															
d.															
e.															
f.															
g.															
h.															
3. Other Special Long Distance Lines (Forms Only) n/a															
a.															
b.															
c.															
TOTAL INCOMING CIRCUITS															
REVERSE CHARGE SERVICES				$	$	$	$	$	$	$	$	$	$	$	$

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PART III ANSWERING EQUIPMENT

Answering Equipment	Installation Cost	Annual Recurring	Delayed Announcement Recording Monthly Costs 1 st	2 nd	Night/Weekend	Music on Hold
1. Type of ACD						
a. 2A 58						
b. 2B 70						
c. 3A 102	2,000.00	11,040.00	137.00	42.80	n/a	n/a
d. 4A						
e. (Other Specify)						
2. Type of Key System n/a						
a. 6 Button						
b. 10-12 Button						
c. 18-20 Button						
d. 30 Button						
e. (Other Specify)						

3. Position Equipment (per unit cost)	Suspended Cost	Installation Cost	Monthly Recurring	Number of Positions (FY'76) Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.
a. Front Line Consoles (Attendant Positions)	*	35.00 ea	20.00 ea	40	40	40	40	40	40	86	86	86	86	86	86
b. Referral Stations n/a															
c. Monitoring/Supervisory Consoles		50.00 ea	35.00 ea	2	2	2	2	2	2	4	4	4	4	2	2
TOTAL															

4. Supplemental Equipment	Number of Units	Installation Cost	Monthly Recurring
a. Lamp Cabinets	2		20.00 ea
b. Emergency Power Source			
c. (Other Specify)			

* Minimum number allowed 40 - remaining 46 suspended six months per year.

PART IV TRANSFER CAPABILITIES AND SUPPLEMENTAL EQUIPMENT

Front Line Station Transfer Features Capability to transfer call:	Type of Transfer Capability (specify, e g, Dial, Automatic or Operator Assist)	Number of Transfer Circuits Available Min.	Max	Monthly Unit Cost Per Circuit
1. Within Telephone Answering Unit				
a. To other Front Line Stations				
b. To general Referral Stations				
c. To Technical Tax Referral Stations				
d. To IDRS Referral Stations				
e. To Microfilm Referral Stations				
f. To Any Switchboard Station (Other Specify)		10	20	13.35 ea.

2. Outside Answering Unit n/a	If Limited, Specify Number of Stations	Type of Transfer Capability (specify, e.g, Dial, Automatic or Operator Assist)	Number of Transfer Circuits Available Min.	Max.	Monthly Unit Cost Per Circuit
a. To other IRS Function's Referral Station					
b. To "Forms Only" Station					
c. To IDRS Referral Station					
d. To Microfilm Referral Station					
e. To Walk - in Area Referral Station					
f. To other Government Agency					
g. To (Other Specify)					

Type of Call Waiting Analysis Devices	Analysis of Number of Callers Waiting	Analysis of Amount of Time Callers are Waiting	No. of Units	Unit Costs Installation	Unit Costs Monthly Recurring
1. Pagode Lamps	yes ( ) no ( )	yes (xx) no ( )	2	50.00 ea	26.75 ea
2. Chimes/Bells	yes ( ) no ( )	yes ( ) no ( )			
3. Digital Display Device	yes ( ) no ( )	yes ( ) no ( )			
4. (Other Specify)	yes ( ) no ( )	yes ( ) no ( )			

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The preceding four-part inventory is a one time only request for detailed information from every Toll-Free Telephone System (TFTS) Site as it was configured on 6/30/76. Each page deals with a different aspect of the system's equipment and capability. Most of this information will be available in either the Regional or District Offices; however, some sections may require information available from your local telephone service representative.

Coordination between Facilities Management and Taxpayer Service will be necessary for completion of the inventory.

Because of the comprehensive nature of the inventory, not every line will pertain to all the sites. If a category does not apply to your system, please indicate with the notation Not Applicable (N/A). If the information requested does apply to your system but you are unable to obtain the data, please provide a brief narrative explaining why the information is unavailable. In those sections requiring the number of circuits or positions for a particular month, use the figure for the equipment in use at the beginning of the month.

Attached are some explanatory notes for use in completion of the inventory. Any questions concerning completion of the form should be directed to Gordon McDonald, A:FM:I, 376-0521 or Harold Miller, ACTS:T:F, 964-4550.

Part I. Equipment Operational Features

Annual Connect/Disconnect Charges - include all charges for connection or disconnection of lines as a result of changes in the number or configuration of lines during the year.

Part II. Incoming Circuitry

Measured WATS - in completing premium rate/per hour, monhtly data will be total monthly premium costs. Base rate values will be number of measured circuits per month.

House/Lobby - (sometimes known as one-digit dialers) includes phones that are located outside of the TFTS area (often situated at small POD's) but which are tied directly into the telephone system.
Other Local Circuitry - includes any other trunk groups which enter the TFTS locally (i.e., Government Switchboard/Centrex, Local Forms Only Lines).
Suspended Costs - total annual cost associated with suspension of circuits. Include all connect and/or disconnect charges as well as any monthly charge for suspended equipment.

Part III. Answering Equipment

Position Equipment - if headsets are leased rather than purchased include the cost for them in the monthly recurring column for each type of position.
Referral Stations - include only those referral positions within the TFTS that are different from the Front-Line attendant consoles.
Monitoring/Supervisory Consoles - if necessary, define any differences between these two types of consoles and indicate difference in associated cost.
Suspended Costs - total annual costs for suspended position equipment. See Suspended Costs, Part II.
Supplemental Equipment (Other) - include any equipment unique to your system which is not covered elsewhere (i.e., diverting devices, also known as trans-a-call).

Part IV. Transfer Capabilities and Supplemental Equipment

Complete only those sections of Part IV that have an associated cost clearly identified with the capability to transfer from the front-line station to the particular type of station in question.

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APPENDIX D

STAFFING COST MODEL

The TFTS staffing model was developed by using the following assumptions:

- Erlang C assumptions (calls not answered upon arrival are held in queue)
- ASA = 20 seconds
- Weighted call value = 195 seconds for Period 2 (214 seconds for Period 6)

The staffing curve shown was derived by using the following equations:

$$E(c,a) = \frac{\frac{a^c}{c!}\ \frac{c}{c-a}}{1+a+\frac{a^2}{2!}+\ldots+\frac{a^c}{c!}\ \frac{c}{c-a}}$$

$$\bar{d} = E(c,a) \times \frac{h}{c-a}$$

where

$E(c,a)$ = probability of delay

c = number of servers (TSRs)

a = total incoming traffic (in erlangs)

= number of calls × serving time per call

$\bar{d}$ = mean or average delay of all calls (=20 seconds)

h = service time (ACWV)

To account for some calls being blocked from entering the ACD (due to trunk blockage) and some callers being impatient and hanging up before they are served, the number of incoming calls was reduced by 7 per cent per IRS directive before the TSR requirements were determined.

The curve (Figure D-1) was modeled in four segments for purposes of machine computation. The staffing model equations are shown in Table D-1.

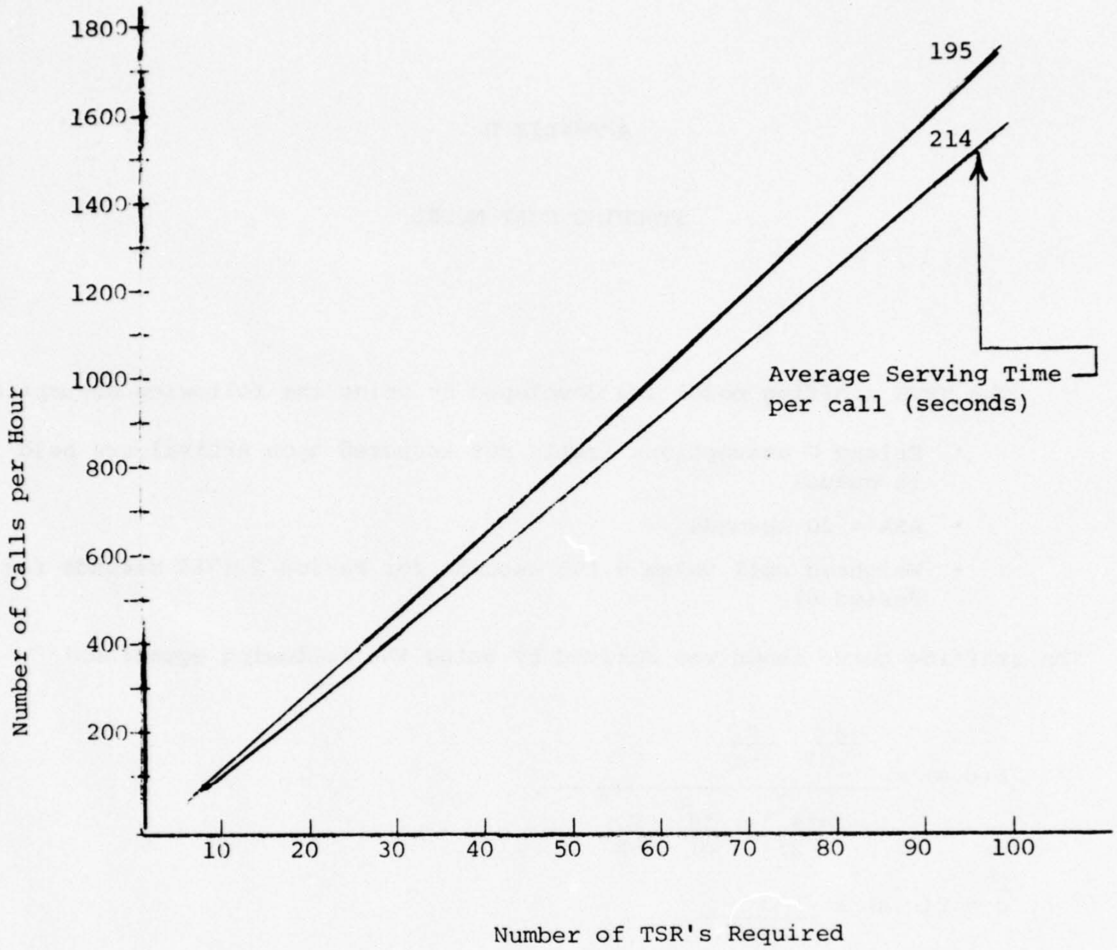


Figure D-1. STAFFING CURVE

The staffing costs were computed by using the staffing cost model (staffing subroutine) developed by the IRS. The following hourly rates were employed:

TSR	\$5.13
Clerical	\$3.79
Management	\$8.58

Table D-1. STAFFING MODEL EQUATIONS	
Traffic (x) (Calls/Hour)	Number of TSR's Required (y)
Period 2 Staffing Model	
9-40	$y = \left(\frac{0.93x}{2.02}\right)^{0.465}$
41-173	$y = \left(\frac{0.93x}{6.47}\right)^{0.752}$
174-665	$y = \frac{0.93x + 35.47}{17.55}$
Over 665	$y = \frac{0.93x + 66.79}{18.32}$
Period 6 Staffing Model	
9-35	$y = \left(\frac{0.93x}{2.33}\right)^{0.508}$
36-158	$y = \left(\frac{0.93x}{5.64}\right)^{0.746}$
159-605	$y = \frac{0.93x + 36.46}{15.93}$
Over 605	$y = \frac{0.93x + 62.39}{16.58}$

Other factors were used to account for overhead items as follows:

Category	Factor
Shrinkage (scheduling inefficiencies, etc.)	0.6
Training	0.095
Leave	0.14
Benefits	0.095

The number of management and clerical staff required as a function of TSR staff size (x) was calculated by using the following IRS guidelines:

$$\text{Clerical staff size} = 1 + \frac{x-23}{15} \text{ (round to next higher integer)}$$

$$\text{Management staff size} = \text{clerical staff size}$$

From the staffing model developed and the wage rates as shown above, the composite staff costs (management, clerical, overhead, etc.) were calculated to be $11.89/TSR hour. This figure was used in the costing work sheets.

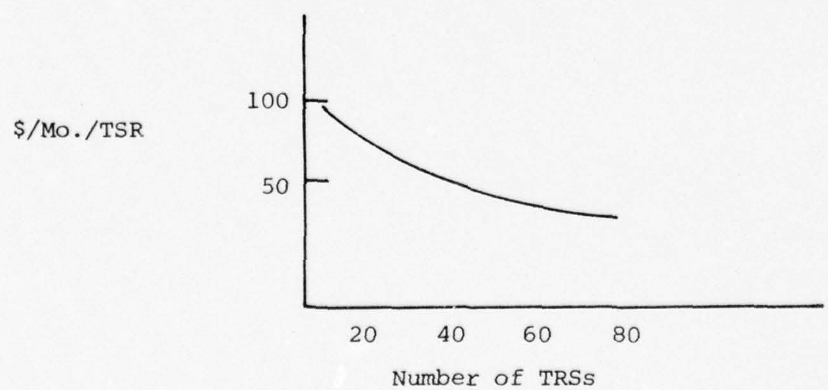
APPENDIX E

ACD COST MODEL

The ACD cost model was derived on the basis of a least-squares regression curve fit of the ACD cost data as reported in the Toll-Free Telephone Site inventory sheets. The least-squares curve that best described the sample ACD cost data was an exponential curve as shown.

$$\text{ACD cost/TSR/mo (\$)} = \$93.60 \times e^{-\frac{\#\text{TSRs}}{483}}$$

ACD costs were calculated for a sample of 20 ACDs based on the data supplied by the IRS. This sample included 2A, 2B, 3A, 4A, and ESS ACDs. The ACD costs were adjusted to account for the fact that ACD sizes were adjusted throughout the year to match the telephone-call volume. These costs were then plotted on a graph in the form of a scatter diagram. As expected, there is a wide variation from site to site in ACD costs. In order to generate a uniform cost model that could be used in the site-consolidation costing, a least-squares regression was performed. The resulting curve is shown below.



APPENDIX F

FACILITIES COST MODEL

Facility costs were provided by the IRS in a format that could be directly combined with the staffing model to yield facility costs as a function of the number of TSRs required. However, these facility costs cover not only TSR, but also clerical and management personnel. These cost categories were combined according to the staffing criteria provided by the IRS. Following is a list of Facility Costs per month per TSR for all sites.

Site Name	Facility Cost ($/TSR/mo.)	Site Name	Facility Cost ($/TSR/mo.)
Albany	170	Bailey's X'rds	177
Augusta	155	Greensboro	151
Boston	183	Indianapolis	155
Buffalo	157	Louisville	171
Burlington	154	Memphis	151
Hartford	173	Nashville	151
Portsmouth	154	Norfolk	170
Providence	173	Parkersburg	170
		Richmond	170
Brooklyn	214		
Camden	187	Atlanta	168
Manhatten	214	Birmingham	155
Mineola	214	Columbia	151
Newark	187	Jacksonville	151
Smithtown	214	Jackson	151
		Miami	181
Baltimore	184		
Philadelphia	220	Cleveland	189
Pittsburgh	190	Cincinnati	169
Wilmington	169	Detroit	191
Aberdeen	144	Albuquerque	167
Boise	156	Dallas	161
Denver	182	Houston	172
Fargo	160	Little Rock	144
Helena	144	New Orleans	161
Las Vegas	177	Oklahoma	144
Omaha	157	Wichita	157
Phoenix	177		
Portland	165	Carson	212
Salt Lake City	156	El Monte	212
Seattle	174	Los Angeles	166
Spokane	156	Oakland	212
St. Paul	171	San Diego	177
		San Francisco	212
Chicago	177	San Jose	177
Des Moines	157	Van Nuys	212
Kansas City	160		
Milwaukee	155		
Springfield	157		
St. Louis	157		

APPENDIX G

CULL ANALYSIS RESULTS
FOR
EACH SERVICE CENTER AREA

The cull analysis work sheets are reproduced on the following pages.

COST TO CONSOLIDATE CULL SHEET 1/3 ANDOVER	8 traffic %	8 factor site	7 traffic %	7 factor site	6 traffic %	6 factor site	5 traffic %	5 factor site	4 traffic %	4 factor site	traffic %	factor site	traffic %	factor site
1. BURLINGTON	49,246	6	49,24[illegible]	6										
4270.1808		4 ALB		4 ALB										
2. AUGUSTA	42,263 52,177	5	42,26[illegible] 52,177	8	42,263 52,177	8								
3961-1370		3 PORTS		8 BOS		8 BOS								
3. PORTSMOUTH	74,943	4												
4270-1313		8 BOS												
4. ALBANY	194,216	16	194,216	16	243,512	20	243,512	20	243,512	20				
4639-1629		6 HART		6 HART		6 HART		6 HART		6 HART				
5. PROVIDENCE	210,232	1	210,232	9	210,232	9	210,232	9						
4550-1219		3 BOS		3 BOS		3 BOS		3 BOS						
6. HARTFORD	331,867	22	331,867	22	331,367	22	331,867	22	331,867	27				
4637-1273		5 PRO		5 PRO		5 PRO		5 PRO		4 ALG				
7. BUFFALO	520,014	135	520,014	135	520,014	135	520,014	135	[illegible]	135				
5075.2326		4 ALB		4 ALB		4 ALB		4 ALB		4 ALB				
8. BOSTON	534,006	22	608,949	25	608,949	25	661,126	27	871,353	30				
4422-1249		5 PRO		5 PRO		5 PRO		5 PRO		6 HART				
9.														
10.														
11.														
12.														
13.														
14.														
15.														
	1,966,751													

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COST TO CONSOLIDATE CALL SHEET ANDOVER 2/3			3		2									
	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. BURLINGTON	49,246													
		8												
2. AUGUSTA	52,177													
		8												
3. PORTSMOUTH	74,943													
		8												
4. ALBANY	194,216													
		6												
5. PROVIDENCE	210,232													
		8												
6. HARTFORD	331,867		526,083	48										
				8 BOS										
7. BUFFALO	520,014		520,314	169										
				6 HART										
8. BOSTON	534,006		920654	85										
				6 HART										
9.														
10.														
11.														
12.														
13.														
14.														
15.														

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COST TO CONSOLIDATE CULL SHEET ANDOVER 3/3	traffic %	factor site	2 traffic %	factor site	1 traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. BURLINGTON	49,296													
		8												
2. AUGUSTA	52,177													
		8												
3. PORTSMOUTH	74,943													
		8												
4. ALBANY	194,216													
		8												
5. PROVIDENCE	210,232													
		8												
6. HARTFORD	331,867													
		8												
7. [illegible]	520,014		520,014	207										
				, [illegible]										
8. BOSTON	534,506		1,446,737	576	1,966,751									
				7 [illegible]										
9.														
10.														
11.														
12.														
13.														
14.														
15.														

AR Form 64, January 1976

COST TO CONSOLIDATE ... AUSTIN 1/2	7 traffic %	7 factor site	6 traffic %	6 factor site	5 traffic %	5 factor site	4 traffic %	4 factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. LITTLE ROCK	116,687	34	116,689	34										
7721.3451		6		6										
2. ALBUQUERQUE	119,038	61	119,038	61	119,038	61								
8549.5887		4		4		4								
3. WICHITA	178,724	27												
7489.4520		4												
4. OK CITY	281,109	43	459,833*	36	459,833	36	578,871*	109						
7947.4373		3		6		6		6						
5. NEW ORLEANS	358,560	114	358,560	114	358,560	114	358,560	114						
8483.2638		7		7		7		7						
6 DALLAS	826,491	155	826,491	155	943,178*	177	943,178	177						
8436.4034		4		4		4		4						
7. HOUSTON	1,086,507	242	1,086,507	242	1,086,507	242	1,086,507	242						
8938.3536		6		6		6		6						
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
AF Form 641 January 1976	2,967,112													

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COST TO CONSOLIDATE [illegible] AUSTIN 2/2	traffic %	factor site	3 traffic %	3 factor site	2 traffic %	2 factor site	1 traffic %	1 factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. LITTLE ROCK														
		6 DAL												
2. ALBUQUERQUE														
		6 DAL												
3. WICHITA														
		6 DAL												
4. OK CITY														
		6 DAL												
5. NEW ORLEANS			358,560	114										
				7										
6. DALLAS			1,522,049	339	1,522,049	339	2,967,116							
				7		7								
7. HOUSTON			1,086,507	242	1,445,067	322								
				6		6								
8.														
9.														
0.														
.														
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COST TO CONSOLIDATE ... BROOKHAVEN	6 traffic	6 factor site	5 traffic %	5 factor site	4 traffic %	4 factor site	3 traffic %	3 factor site	2 traffic %	2 factor site	1 traffic %	1 factor site	traffic %	factor site
1. CAMDEN	126,596	9.4	126,596	9.4	126,596	9.4	126,596	10.6						
		5		5		5		6						
2. MINEOLA	231,853	4.6	231,853	4.6										
		4 or 6		6										
3. SMITHTOWN	254,332	6.1	254,332	6.1	254,332	10.9	254,332	10.9	254,332	10.9				
		2: MIN		2:		6		6		6				
4. BROOKLYN	524,937	4.2												
(Prospect Park)		6												
5. NEWARK	599,479	6.6	599,479	6.6	599,479	6.6								
		6 or 4		6		6								
6 MANHATTAN	1,183,770	9.5	1,707,707*	18.8	1,939,560*	19.4	2,539,039*	106.6	2665,6[illegible]	112.0	2,919,967			
(Central Park)		4		5		5		3		2				
7.														
8. Δ Cost of consolid...				4.2		4.6		6.6		10.6		10.9		
9. Cumulative ...				4.2		8.8		15.4		26.0		36.9		
10. Δ Cost ...				100		52		43		41		30		
11.														
12.														
13.														
14.														
15.														
	2,919,967													

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G-8

COST TO CONSOLIDATE CALL SHEET CHAMBLEE 1/2	6 traffic %	factor site	5 traffic %	factor site	4 traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. JACKSON JAN	148,287	32												
8035.2880		4 : BHM												
2. COLUMBIA CAE	185,787	36	185,787	36										
6901.1589		5 : ATL		5 : ATL										
3. JACKSONVILLE JAX	697,094	178	697,094	178	697,094	197								
7649.1276		2 : CAE		2 CAE		5 ATL								
4. BIRMINGHAM BHM	390,889	55	539,176	75	539,176	75								
7518.2446		5 : ATL		5 ATL		5 ATL								
5. ATLANTA ATL	429,599	60	429,599	60	615,386	86								
7260.2083		4 : BHM		4 : BHM		4 : BHM								
6. MIAMI MIA	1,311,577	425	1,311,577	425	1,311,577	425								
8351.0527		3 : JAX		3 : JAX		3 JAX								
7.														
8.														
9.														
10.														
11.														
12.														
13.														
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COST TO CONSOLIDATE CULL SHEET CHAMBLEE 2/2	traffic %	factor site	3 traffic %	factor site	2 traffic %	factor site	1 traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. JACKSON	148,287	5 ATL												
2. COLUMBIA	185,787	5 ATL												
x 3. JACKSONVILLE JAX	697,094		697,094	197 5: ATL										
4. BIRMINGHAM	340,889	5 ATL												
x 5. ATLANTA ATL	429,599		1,154,562	327 3: JAX	1,851,656	1111 6: MIA	3,163,233							
x 6. MIAMI MIA	1,311,577		1,311,577	425 3: JAX	1,311,577	787 5: ATL								
7.														
8.														
9.														
10.														
11.														
12.														
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14.														
15.														

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COST TO CONSOLIDATE [illegible] COVINGTON	3 traffic %	factor-site	2 traffic %	factor-site	1 traffic %	factor-site	traffic %	factor-site	traffic %	factor-site	traffic %	factor-site	traffic %	factor-site
1. Cleveland	551,021	50												
5574.2543		3												
2. Cincinnati	586,285	130	586,285	137										
6263.2679		1		3										
3. Detroit	882,856	79	1,433,877	336										
5536.2828		1		2										
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
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13.														
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COST TO CONSOLIDATE CULL SHEET FRESNO	8 traffic %	8 factor site	7 traffic %	7 factor site	6 traffic %	6 factor site	5 traffic %	5 factor site	4 traffic %	4 factor site	3 traffic %	3 factor site	2 traffic %	2 factor site
1. OAKLAND	271,312	2.17												
8486.8695		5:SF												
2. SAN JOSE	305,409	12	305,409	13	305,409	13	305,409	13	305,409	13				
8583.8619		1:OAK		5 SF		5 SF		5:SF		5:SF				
3. EL MONTE	306,503	4	306,503	4										
9202.7840		8 LA		8:LA										
4. SAN DIEGO	313,875	34	313,875	34	313,875	35	313,875	35	313,875	35	313,875	35		
9468.7629		3:ELm		3:ELm		3:LA		8:LA		8:LA		8:LA		
5. SAN FRANCISCO	341,722	2.75	613034*	26	613,034	26	613,034	26	613,034	26	913,443*	321	918,443	321
8492.8719		1:OAK		2:SJ		2:SJ		2:SJ		2:SJ		8:LA		8 LA
6. VAN NUYS	351,368	5	351,368	5	351,368	5								
9197.7919		8:LA		8:LA		8:LA								
7. CARSON	536,075	11*	536,075	11*	536,075	11*	536,075	11*						
(not available)		8:LA		3:LA		8:LA		8:LA						
8. LOS ANGELES	652,542	8	652,542	8	959,045*	12	[illegible]*	147	1,846,486*	207	1,846,486	207	2160,363	756
9213.7878		3:ELm		3 ELm		6:VN		4:SD		4:SD		4:SD		5:SF
9.														
10.														
11.														
12.														
13.														
14.														
15.														

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COST TO CONSOLIDATE CULL SHEET KANSAS CITY 1/2	6 traffic %	6 factor site	5 traffic %	5 factor-site	4 traffic %	4 factor site	3 traffic %	3 factor site	traffic %	factor-site	traffic %	factor-site	traffic %	factor site
1. DES MOINES	176,791	31	176,791	31	176,791	31								
6471-4275		2: KC		2: KC		2								
2. KANSAS CITY, MO	237,765	42	237,765	42	237,765	42	*414,556	99						
7027-4203		1: DES M		1: DES M		1 DES M		4 STL						
3. SPRINGFIELD, ILL	251,367	21												
6539-3513		4 STL												
4. ST LOUIS	273,052	23	*524,419	125	524,419	125	524,419	125						
6807-3482		3: SPR		2: KC		2 KC		2 KC						
5. MILWAUKEE	301,287	24	301,287	24										
5788-3589		6: CHI		6: CHI										
6. CHICAGO	671,440	54	671,440	54	*972,727	53	972,727	253						
5986-3426		5: MIL		5: MIL		4		4						
7.														
8.														
9.														
10.														
11.														
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15.														
	1,911,702													

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COST TO CONSOLIDATE CULL SHEET KANSAS CITY %	traffic %	factor site	2 traffic %	factor-site	1 traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. DES MOINES	176,791													
		4												
2. KANSAS CITY, MO	237,765													
		4												
3. SPRINGFIELD, ILL	251,367													
		4												
4. ST LOUIS	273,052		938,975	244										
				6.04										
5. MILWAUKEE	3[illegible],237													
		6												
6. CHICAGO	671,440		972,727	253	1,9[illegible].70[illegible]									
				4.572										
7.														
8.														
9.														
10.														
11.														
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January 1976

AD-A052 238 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/2
COST ANALYSIS OF SELECTED ALTERNATIVE CONFIGURATIONS FOR THE IN--ETC(U)
APR 77 P WOODIE, D SWANN TIR-7T-64
UNCLASSIFIED 1329-01-1-1605 NL

2 OF 2
AD
A052 238

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COST TO CONSOLIDATE CALL SHEET MEMPHIS 44	9 traffic %	9 factor site	8 traffic %	8 factor site	7 traffic %	7 factor site	6 traffic %	6 factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. PARKERSBURG, WV	32,476	8												
5976.2268		5												
2. GREENSBORO N.C.	104,815	17	104,815	17	104,815	21								
6400.1638		3		3		4								
3. RICHMOND	140,847	12	140,847	12										
5906.1472		4		4										
4. NORFOLK	168,046	15	168,046	15	308,893*	49	413908*	65						
5936.1198		3		3		7		7						
5. LOUISVILLE	201,177	21	233,653*	25	233653	25	233,653	25						
6529.2772		9		9		9		9						
6. MEMPHIS	211,931	42	211,931	42	211,931	42	211,931	42						
7471.3125		8		8		9		8						
7. BAILEYS CROSSROADS	280,586	26	280,586	26	280,586	44	280,586	44						
5636.1600		3		3		4		4						
8. NASHVILLE	283,959	43	283,959	43	283,959	43	283,959	43						
7010.2710		5		5		5		5						
9. INDIANAPOLIS	518,227	55	518,227	55	518,227	55	518,227	55						
6272.2992		5		5		5		5						
10.														
11.														
12.														
13.														
14.														
15.														
	1,942,064		1,942,064		1,942,064									

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COST TO CONSOLIDATE CALL SHEET MEMPHIS 3/4	traffic %	factor site	5 traffic %	5 factor site	4 traffic %	4 factor site	BACK TRACK traffic %	BACK TRACK factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. PARKERSBURG, WV	52,476	7												
2. GREENSBORO, N.C	104,815	4												
3. RICHMOND	140,847	4												
4. NORFOLK	168,046		*413,708	65 7	413,708	65 7								
5. LOUISVILLE	201,177	9												
6. MEMPHIS	211,931		211,931	42 8										
7. BAILEY'S CROSSROADS	289,586		*313,062	49 4	313,062	49 4								
8. NASHVILLE	283,959		283,959	56 6	*495,890	123 9								
9. INDIANAPOLIS	518,229		*719,404	179 8	719,404	179 8								
10.														
11.														
12.														
13.														
14.														
15.														
					1,942,064									

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COST TO CONSOLIDATE CULL SHEET MEMPHIS 3/4	traffic %	factor site	3 traffic %	factor site	BACKTRACK traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. PARKERSBURG, WV	30,476	9												
2. GREENSBORO, NC	104,815	4												
3. RICHMOND	140,849	4												
4. NORFOLK	168,046		694,294*	401 9										
5. LOUISVILLE	201,177	9												
6. MEMPHIS	211,931	8												
7. BAILEY'S CROSSROADS	280,586	4												
8. NASHVILLE	283,959		495,890*	123 9										
9. INDIANAPOLIS	518,227		751,880*	187 8										
10.														
11.														
12.														
13.														
14.														
15.														

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COST TO CONSOLIDATE
CULL SHEET 4/4

2

	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. PARKERSBURG, WV	32,476	9												
2. GREENSBORO, NC	104,815	4												
3. RICHMOND	149,847	4												
4. NORFOLK	168,046		*694,294	401 9										
5. LOUISVILLE	201,177	9												
6. MEMPHIS	211,931	9												
7. BAILEY'S CROSSROADS	280,586	4												
8. NASHVILLE	283,959	9												
9. INDIANAPOLIS	518,227		*1,247,770	720 4	← one site									
10.														
11.														
12.														
13.														
14.														
15.														
			1,942,064											

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COST TO CONSOLIDATE CULL SHEET
OGDEN 1/6

	13		12		11		10							
	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. HELENA	18,886	5.0	18,886	5.0										
6336.7348		5		5										
2. ABERDEEN	27,677	3.5												
5992.5308		3												
3. FARGO	41,605	5.2	*69,282	15.4	69,282	15.4	69,282	15.4						
5615.5132		2		11		11		11						
4. BOISE	46,445	13.3	46,445	13.3	46,445	13.3								
7096.7969		5		5		5								
5. SPOKANE	105,032	23.7	105,032	23.7	*123,918	28.3	*170,363	38.8						
6247.3182		13		13		13		13						
6. SALT LAKE	162,004	48.0	162,004	48.0	162,004	48.0	162,004	58.5						
7576.7065		4		4		4		8						
7. OMAHA	178,686	51.8	178,686	51.8	178,686	51.8	178,686	51.8						
6687.4595		11		11		11		11						
8. LAS VEGAS	190,893	49.1	190,893	49.1	190,893	49.1	190,893	49.1						
8665.7411		9		9		9		9						
9. PHOENIX	278,054	71.5	278,054	71.5	278,054	71.5	278,054	71.5						
9135.6748		8		8		8		8						
10. DENVER	354,034	130.6	354,034	130.6	354,034	130.6	354,034	130.6						
7501.5899		6		6		6		6						
11. ST PAUL	375,173	83.3	375,173	83.3	375,173	83.3	375,173	83.3						
5776.4498		3		3		3		3						
12. PORTLAND	445,490	65.5	445,490	65.5	445,490	65.5	445,490	65.5						
6799.894		13		13		13		13						
13. SEATTLE	551,512	81.1	551,512	81.1	551,512	81.1	551,512	81.1						
6336.3890		12		12		12		12						
14.														
15.														
	2,775,491													

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COST TO CONSOLIDATE CULL SHEET OGDEN 2/6	Continuing traffic %	factor site	9 traffic %	factor site	BACKTRACK traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. FARGO 5615.5187	41,605	8												
2. SPOKANE 6247.8180	105,032	10	170,363*	39 / 10										
3. SA[illegible] LA[illegible] 7576.7065	162,004	5	162,004	58 / 5										
4. OMAHA 6687.4595	173,86[illegible]	8	178,686	52 / 8										
5. LAS VEGAS 8665.7411	190,993	6	190,993	49 / 6										
6. PHOENIX 9135.6748	278,054	5	278,054	71 / 5										
7. DENVER 7501.5899	354,034	3	354,034	131 / 3										
8. ST PAUL x 5776.4498	375,173	4	444,455*	128 / 4										
9. PORTLAND 6799.3914	445,493	10	445,493	65 / 10										
10. SEATTLE 6336.8896	551,512	9	551,512	81 / 9										
11. HELENA	18,086	2												
12. ABERDEEN	27,677	8												
13. BOISE	46,445	2												
14.														
15.														
	2,775,491		2,775,491											

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COST TO CONSOLIDATE
CULL SHEET
OGDEN 2/6

	traffic %	factor site	8 traffic %	8 factor site	7 traffic %	7 factor site	6 traffic %	6 factor site	5 traffic %	5 factor site	BACKTRACK traffic %	BACKTRACK factor site	traffic %	factor site
1. FARGO	41,605	8												
2. SPOKANE	105,632	10												
3. SALT LAKE	162,004	5	*227,335	82 / 5	227,335	84 / 7	227,335	84 / 7	227,335	84 / 7				
4. OMAHA	178,686	8	178,686	5- / 9	178,686	52 / 8								
5. LAS VEGAS	190,893	6	190,893	47 / 6										
6. PHOENIX	279,054	5	279,054	71 / 5	*468,947	230 / 3	468,947	236 / 3	468,947	236 / 3				
7. DENVER	354,034	3	354,034	131 / 3	354,034	131 / 3	354,034	131 / 3	354,034	131 / 3				
8. ST PAUL	375,173	4	*444,455	128 / 4	444,455	128 / 4	*623,141	437 / 7	623,141	437 / 7				
9. PORTLAND	445,490	10	445,490	65 / 10	445,490	65 / 10	445,490	65 / 10						
10. SEATTLE	551,512	9	*656,544	96 / 9	656,544	96 / 9	656,544	96 / 9	*1,102,034	770 / 3				
11. HELENA	18,886	3												
12. ABERDEEN	27,677	8												
13. BOISE	46,445	3												
14.														
15.														
			2,775,491		2775491		2775491		2775491					

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COST TO CONSOLIDATE
CULL SHEET

OGDEN 4/6	traffic 90	factor site	traffic 90	factor site	traffic 90	factor site	traffic 90	factor site	traffic 90	factor site	traffic 90	factor site	traffic 90	factor site
			4											
1. FARGO	41,605	8												
2. SPOKANE	105,032	10												
3. SALT LAKE	162,004	7												
4. OMAHA	178,686	8												
5. LAS VEGAS	190,893	6												
6. PHOENIX	278,054		*468,947	273 7										
7. DENVER	354,034		*516,038	300 6										
8. ST. PAUL	375,173		*623,141	437 7										
9. PORTLAND	445,490	10												
10. SEATTLE	551,512		*1,167,365	1186 7										
11. HELENA	18,836	10												
12. ABERDEEN	27,677	8												
13. BOISE	46,445	10												
14.														
15.														
			2,775,491											

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COST TO CONSOLIDATE CULL SHEET OGDEN%	traffic %	factor site	3 traffic %	factor site	BACK TRACK traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. FARGO	41,605	8												
2. SPOKANE	105,032	10												
3. SALT LAKE	162,004	7												
4. OMAHA	178,686	8												
5. LAS VEGAS	190,893	7												
6. PHOENIX	278,054	7												
7. DENVER	354,034		*984,985	691 8										
8. ST PAUL	375,173		*623,141	439 7										
9. PORTLAND	445,490	10												
10. SEATTLE	551,512		*1,167,365	1186 7										
11. HELENA	18,886	10												
12. ABERDEEN	27,677	8												
13. BOISE	46,445	10												
14.														
15.														
			2775 491											

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COST TO CONSOLIDATE CULL SHELF OGDEN 6/6

			2		1									
	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. FARGO	41,605	7												
2. SPOKANE	105,032	10												
3. SALT LAKE	162,004	7												
4. OMAHA	178,686	7												
5. LAS VEGAS	190,893	7												
6. PHOENIX	278,054	7												
7. DENVER	354,034		1,609,126 *	1634 10	2,775,491		← one site option							
8. ST PAUL	375,173	7												
9. PORTLAND	445,490	10												
10. SEATTLE	551,512		1,147,365 *	1186 7										
11. HELENA	18,986	10												
12. ABERDEEN	27,677	7												
13. BOISE	46,445	10												
14.														
15.														
			2,775,491											

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[illegible] PHILADELPHIA	4 traffic	4 factor site	3 traffic	3 factor site	2 traffic	2 factor site	1 traffic	1 factor site	traffic	factor site	traffic	factor site	traffic	factor site
1 WILMINGTON	121,715	3												
5326 . 1485		3: PHL												
2. PITTSBURGH	284,916	56	284,916	56										
5621 . 2185		4: BAL		4: BAL										
3. PHILADELPHIA	776,922	19	898,637	80 *	898,637	80								
5251 . 1458		1: WIL		4: BAL		4: BAL								
4. BALTIMORE	1,042,498	67	1,042,498	93	1,327,414	118 *	2,226,051							
5510 . 1575		1: WIL		3: PHI		3: PHI								
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COST TO CONSOLIDATE [illegible] 48	18 traffic %	18 factor site	17 traffic %	17 factor site	16 traffic %	16 factor site	15 traffic %	15 factor site	14 traffic %	14 factor site	13 traffic %	13 factor site	BACKTRACK traffic %	BACKTRACK factor site
1. CINCINNATI 6263.2679	586,285	6 IND												
2. ST PAUL 5776.4498	623,141	21 CHI	623,141	21 CHI	623,141	21 CHI	623,141	29 STL	623,141	29 STL	623,141	31 IND		
3. NORFOLK 5936.1198	694,294	12 BAL	694,294	12 BAL										
4. JACKSONVILLE 7649.1276	697,094	20 ATL	697,094	20 ATL	697,094	20 ATL	697,094	20 ATL						
5. SAN FRANCISCO 8492.8719	910,443	32 LAX	910,443	32 LAX	910,443	32 LAX	910,443	32 LAX	910,443	32 LAX	910,443	32 LAX		
6. ST. LOUIS 6807.3482	938,975	22 IND	938,975	22 IND	938,975	22 IND	938,975	22 IND	938,975	22 IND				
7. CHICAGO 5986.3426	972,727	16 IND	972,727	16 IND	972,727	16 IND								
8. DENVER 7501.5899	984,985	65 DAL	984,995	65 DAL	984,985	65 DAL	984,985	65 DAL	984,985	65 DAL	984,985	65 DAL		
9. BALTIMORE 5510.1575	1,042,498	18 MAN	1,042,498	18 MAN	*1,736,792	29 MAN	1,736,792	29 MAN	1,736,792	29 MAN	1,736,792	29 MAN		
10. ATLANTA 7260.2083	1,154,562	33 JVILLE	1,154,562	33 JVILLE	1,154,502	33 JVILLE	1,154,502	33 JVILLE	*1,851,656	79 IND	1,851,656	79 IND		
11. SEATTLE 6336.8896	1,167,365	80 SFO	1,167,365	80 SFO	1,167,365	80 SFO	1,167,365	80 SFO	1,167,365	80 SFO	1,167,365	80 SFO		
12. INDIANAPOLIS 6272.2992	1,247,770	12 CIN	1,834,055	30 CHI	1,934,055	30 CHI	*2,806,782	64 STL	2,806,782	64 STL	*3,745,757	89 DET		
13. MIAMI 8351.0527	1,311,577	43 JVILLE	1,311,577	43 JVILLE	1,311,577	43 JVILLE	1,311,577	43 JVILLE	1,311,577	79 ATL	1,311,577	79 ATL		
14. DETROIT 5536.2828	1,433,877	34 CIN	1,433,877	34 CHI/IND	1,433,877	34 CHI/IND	1,433,877	34 IND	1,433,877	34 IND	1,433,877	34 IND		

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COST TO CONSOLIDATE CULL SHEET NATIONWIDE 2/8	18 continued traffic %	factor site	17 traffic %	factor site	16 traffic %	factor site	15 traffic %	factor site	14 traffic %	factor site	traffic %	factor site	traffic %	factor site
15 BOSTON	1,966,751	38	1,966,751	38	1,966,751	38	1,966,751	38	1,966,751	38	1,966,751	38		
4422-1249		MAN		MAN		MAN		MAN		MAN		MAN		
16. LOS ANGELES	2,160,363	76	2,160,363	76	2,160,363	76	2,160,363	76	2,160,363	76	2,160,363	76		
9213-7879		SFO		SFO		SFO		SFO		SFO		SFO		
19. MANHATTAN	2,919,967	49	2,919,967	49	2,919,967	49	2,919,967	49	2,919,967	49	2,919,967	49		
5014-1383		BAL		BAL		[illegible]		BAL		BAL		BAL		
18. DALLAS	2,967,116	161	2,967,116	161	2,967,116	161	2,967,116	161	2,967,116	161	2,967,116	196		
8436-4034		STL		STL		STL		STL		STL		DEN		
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COST TO CONSOLIDATE
CULL SHEET
NATIONWIDE 3/8

	traffic %	factor site	12 traffic %	12 factor site	11 traffic %	11 factor site	10 traffic %	10 factor site	9 traffic %	9 factor site	8 traffic %	8 factor site	7 traffic %	7 factor site
1. CINCINNATI	586,285	17 IND												
2. ST PAUL	623,141		623,141	31 IND										
3. NORFOLK	694,294	17 MAN												
4. JACKSONVILLE	697,094	10 ATL												
5. SAN FRANCISCO	918,443		918,443	32 LA	918,443	32 LA								
6. ST. LOUIS	938,975	12 IND												
7. CHICAGO	972,727	12 IND												
8. DENVER	984,985		984,985	65 DAL	984,985	65 DAL	984,985	65 DAL	984,985	65 DAL	984,985	65 DAL		
9. BALTIMORE	1,041,498	17 MAN												
10. ATLANTA	1,154,556		*1,851,656	79 IND	1,851,656	79 IND	1,851,656	79 IND	1,851,656	79 IND	1,851,656	79 IND	1,851,658	79.1 IND
11. SEATTLE	1,167,365		1,167,365	80 SFO	1,167,365	80 SFO	1,167,365	113 LAX	1,167,365	113 LAX	1,167,365	113 LAX	1,167,365	113 LAX
12. INDIANAPOLIS	1,247,770		*3,745,757	89 DET	*4,368,993	104 DET	4,368,993	104 DET	*5,802,775	247 ATL	5,802,775	247 ATL	5,802,775	247 ATL
13. MIAMI	1,311,577		1,311,577	79 ATL	1,311,577	79 ATL	1,311,577	79 ATL	1,311,577	79 ATL	1,311,577	79 ATL	1,311,577	79.13 ATL
14. DETROIT	1,433,877		1,433,877	34 IND	1,433,877	34 IND	1,433,877	34 IND						

AR Form 64.
January 1976

COST TO CONSOLIDATE
CULL SHEET
NATIONWIDE 4/8

	traffic %	factor site	12 traffic %	12 factor site	11 traffic %	11 factor site	10 traffic %	10 factor site	9 traffic %	9 factor site	8 traffic %	8 factor site	7 traffic %	7 factor site
15 ~~1~~. BOSTON	1,966,751		1,966,751	38 MAN	1,966,751	38 MAN	1,966,751	38 MAN	1,966,751	38 MAN				
16 ~~2~~. LOS ANGELES	2,160,363		2,160,363	76 SFO	2,160,363	76 SFO	*3,078,906	255 DEN	3,078,906	255 DEN	3,078,906	255 DEN	3,078,806	297 SEA
17 ~~3~~ MANHATTAN	2,919,967		*9,656,759	89 BOS	4,656,759	89 BOS	4,656,759	89 BOS	4,658,759	89 BOS	*6,623,510	428 IND	6,623,510	428 IND
18 ~~4~~ DALLAS	2,967,116		2,967,116	196 DEN	2,967,116	196 DEN	2,967,116	196 DEN	2,967,116	196 DEN	2,967,116	196 DEN	*3,952,101	285 ATL
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COST TO CONSOLIDATE
CULL SHEET 3/8
NATIONWIDE

	BACKTRACK		6		5		BACK TRACK		4		BACK TRACK→			
	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site	traffic %	factor site
1. CINCINNATI	586,385	12 IND						10 IND						
2. [illegible] PAUL	623,141	12 IND						12 IND						
3. [illegible]	654,294	17 MAN						17 MAN						
4. JACKSONVILLE	647,974	13 MIA						12 IND						
5. SAN FRANCISCO	718,443	16 LA						16 LAX						
6. ST LOUIS	938,975	12 IND						12 IND						
7. CHICAGO	972,727	12 IND						12 IND						
8. DENVER	984,935	18 DAL						19 DAL						
9. BALTIMORE	1,042,493	17 MAN						17 MAN						
10. ATLANTA	1,154,562	12 IND						12 IND						
11. SEATTLE	1,167,365		1,167,365	113 LAY				16 LAY						
12. INDIANAPOLIS	1,247,770		*6,957,337	449 MAN	6,957,337	449 MAN			*8,966,008	579				
13. MIAMI	1,311,577		*2,927,114	299 IND	2,927,114	299 IND		12 IND						
14. DETROIT	1,433,877	12 IND						12 IND						
14														

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January 1976

COST TO CONSOLIDATE CULL SHEET NATIONWIDE 6/8	BACKTRACK traffic %	BACKTRACK factor site	6 traffic %	6 factor site	5 traffic %	5 factor site	BACKTRACK traffic %	BACKTRACK factor site	4 traffic %	4 factor site	BACKTRACK traffic %	BACKTRACK factor site	traffic %	factor site
15 1. BOSTON	1,966,751	17 MAN						17 MAN						
16 2. LOS ANGELES	2,160,363		2,160,363	208 SEA	* 3,327,728	413 DAL			* 4,246,171	527 DAL				
17 3. MANHATTAN	2,919,969		* 6,623,510	428 IND	6,623,510	428 IND			* 6,623,510	428 IND				
18 4. DALLAS	2,967,114		* 3,952,101	300 IND	3,952,101	300 IND			* 3,952,101	300 IND				
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COST TO CONSOLIDATE CULL SHEET NATIONAL DC 7/8	BACKTRACK traffic %	BACKTRACK factor-site	3 traffic %	3 factor-site	BACKTRACK traffic %	BACKTRACK factor site	2 traffic %	2 factor site	1 traffic %	1 factor-site	traffic %	factor-site	traffic %	factor site
1. CINCINNATI	586,285	12 IND				12 IND								
2. ST PAUL	623,141	12 IND				12 IND								
3. NORFOLK	694,294	17 MAN				12 IND								
4. JACKSONVILLE	697,094	12 IND				12 IND								
5. SAN FRANCISCO	918,443	16 LAX				16 LAX								
6. ST LOUIS	938,975	12 IND				12 IND								
7. CHICAGO	972,727	12 IND				12 IND								
8. DENVER	994,985	12 IND				12 IND								
9. BALTIMORE	1,042,498	17 MAN				12 IND								
10. ATLANTA	1,154,563	12 IND				12 IND								
11. SEATTLE	1,167,365	16 LAX				16 LAX								
12. INDIANAPOLIS	1,247,770		* 12,918,109 835	MAN			† 16,621,652/2997		20,867,823		one site option			
13. MIAMI	1,311,577	12 IND				12 IND								
14. DETROIT	1,433,877	12 IND				12 IND								
15.														

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January 1976

COST TO CONSOLIDATE CULL SHEET NATIONAL DS 8/8	BACKTRACK traffic %	factor site	3 traffic %	factor site	BACKTRACK traffic %	factor site	2 traffic %	factor site	1 traffic %	factor site	traffic %	factor site	traffic %	factor site
15 BOSTON	1,966,75.	17 MAN				12 IND								
16 LOS ANGELES	2,160,363		*4,246,171	766 IND			*4,246,171	766						
17 MANHATTAN	2,919,967		*6,623,510	428 IND										
18 DALLAS	2,967,110	18 IND				12 IND								
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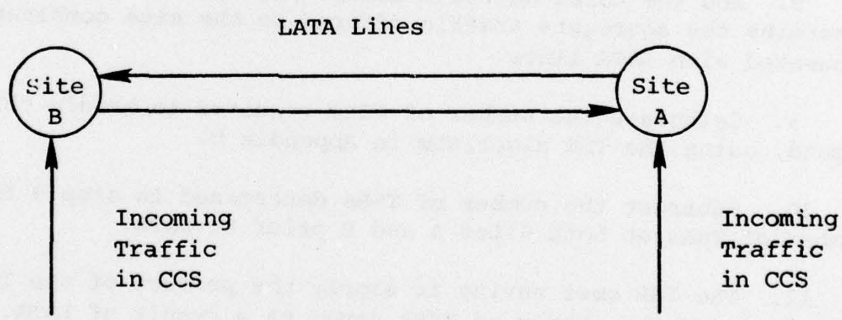
APPENDIX H

CALCULATION OF SAVINGS DUE TO LATA

In Chapter Four, the costs to implement LATA in the present system were approximated by adding the TSR and Communications costs of the moderate-consolidation cases to the Facility and ACD costs for the present cases. This appendix presents a more precise method of determining costs (and savings) attributable to LATA. A detailed approach to determining LATA network requirements will be presented. This approach will be applied, as an example, to the sites in the Philadelphia Service Center area. It will be demonstrated that the costs (and hence the savings) are within 4 percent of those estimated by using the approach taken in Chapter Four.*

Following is a general procedure for determining the number of LATA lines required to handle overflow (or LATA) traffic, the TSR reduction, and the resultant cost savings for TFTS Sites A and B.



*This procedure can be used to determine the TSR savings and LATA trunk costs. It does not provide a detailed implementation plan.

1. Determine the probability that a call arriving at Site A will receive an "all TSRs busy" condition (will be a candidate for LATA). This is simply the Erlang C probability calculated by using the incoming traffic and the number of TSRs at Site A.

2. Determine the probability that there are one or more idle TSRs at Site B. This is simply $1 - P_B$, where P_B = the Erlang C probability for Site B. This is calculated by using the incoming traffic and number of TSRs at Site B.

3. Multiply the probabilities determined above to find the probability that there will be an "all TSRs busy" condition at Site A and a "TSR idle" condition at Site B *at the same instant*.

4. Multiply the probability determined in step 3 by the incoming traffic load (in CCS) at Site A to determine the traffic offered to the LATA trunk group from Site A to Site B.

5. Determine the number of trunks required to handle the traffic load calculated in step 4. This can be found by consulting a Poisson table for a P10 grade of service.

6. Repeat steps 1 through 5 to determine the number of trunks required to handle the traffic diverted from Site B to Site A.

7. Multiply the cost of a line connecting the two sites by the total number of lines as determined in steps 5 and 6. This represents the added communications cost to implement a two-site LATA.

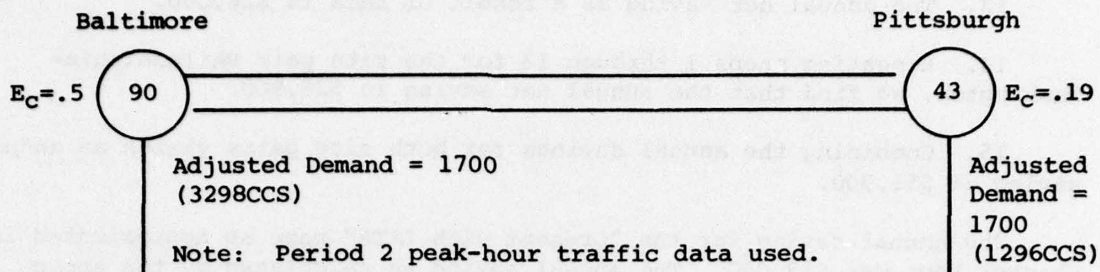
8. Add the total adjusted-demand figures for both sites A and B to determine the aggregate traffic offered to the site combination now interconnected with LATA lines.

9. Calculate the number of TSRs required to handle this total adjusted demand, using the TSR algorithm in Appendix D.

10. Subtract the number of TSRs determined in step 9 from the total number of TSRs at both Sites A and B prior to LATA.

11. The TSR cost saving is simply the product of the TSR composite wage rate and the number of TSRs saved as a result of LATA.

As an example of the foregoing procedure, we calculate the savings due to LATA for the Philadelphia Service Center area. Two site pairs will be formed: Philadelphia-Wilmington and Baltimore-Pittsburgh.



1. The probability that all TSRs will be busy at Pittsburgh is .19.

2. The probability that there will be one or more idle TSRs at Pittsburgh is 1 - .5 = .5.

3. The product of the above probabilities is .5 × .19 = .095. This is the probability that there will be no TSRs available at Pittsburgh and one or more idle TSRs at Baltimore *at the same time*.

4. The product of the traffic offered to Pittsburgh and the above-determined probability (.095 × 1296 CCS) is 123 CCS. This is the traffic that would be offered to the LATA trunk group from Pittsburgh to Baltimore.

5. To provide a P10 grade of service for this traffic load would require 7 trunks.

6. Repeating steps 1 through 5 for the Baltimore to Pittsburgh traffic shows that 46 trunks are required.

7. The communications cost for these trunks is 53 lines × $218/line/month = $11,500/month.

8. The total adjusted demand for the two sites is 2,471 calls.

9. From the staffing model shown in Appendix D, 129 TSRs would be required to handle this traffic load.

10. The total TSR reduction due to LATA during Period 2 is 90 + 43 - 129 = 4 TSRs.

11. The TSR cost saving is 4 TSR × $11.89/hour × 9 hours/day × 20 days/month = $8,600/month.

12. Repeating the above procedure for period 6, we find that the total LATA trunk costs and TSR savings are $1,700/month and $6,400/month, respectively.

13. The annual net saving as a result of LATA is $26,000.

14. Repeating steps 1 through 13 for the site pair Philadelphia-Washington, we find that the annual net saving is $25,900.

15. Combining the annual savings for both site pairs yields an annual saving of $51,900.

The annual saving for the "present with LATA" case as approximated in Chapter Four was $53,000. The annual saving as calculated by the above procedure is $51,900. This difference is approximately 4 percent (0.03 percent when compared with the present system costs of $3,367,000).

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This report describes a generalized cost model for the nationwide Toll-Free Telephone System(TFTS) used by the Internal Revenue Service(IRS) in providing tax information and assistance to the U.S. public. The model is evaluated to provide an economic comparison of the potential savings for several candidate levels of consolidation for TFTS answering sites. The result of this comparison is a set of recommendations to the IRS concerning the preferred site-consolidation options in each of the ten IRS areas of the contiguous U.S.

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