



Item #9

DATE November 7, 2018
TO GCTD Board of Directors
FROM Matt Miller, Planning Manager *MM*
SUBJECT **Receive and File report on the Comprehensive Efficiency Analysis from Dan Boyle, of Dan Boyle & Associates**

SUMMARY

In May, GCTD awarded Dan Boyle & Associates, Inc. a contract to conduct a Comprehensive Efficiency Analysis of GCTD's operations & service planning practices. The effort is being conducted as part of GCTD's relocation from 301 East 3rd Street to the new Operations and Maintenance Facility located at 1901 Auto Center Drive in north Oxnard.

In early June, Mr. Boyle spent two days at GCTD's current facility interviewing planning staff, operations supervisors and bus operators. In addition, Mr. Boyle spent some time observing transit center activity, and collecting other relevant data to gain a strong understanding of current GCTD operations. In July, Mr. Boyle presented the Board his firm's approach to the study, potential cost saving strategies and solicited feedback that would help in the preparation of the final analysis. The final analysis has been completed, and staff is now working on utilizing the results into its planning process.

Staff has asked Mr. Boyle to come back and provide a report to the Board to discuss the findings of the study and top cost saving scenarios that GCTD could implement to increase its operational and planning efficiency.

RECOMMENDATION

It is recommended that the Board of Directors receive and file the Comprehensive Efficiency Analysis of GCTD Operations & Service Planning.

GENERAL MANAGER'S CONCURRENCE

Steven P. Brown
General Manager

GOLD COAST TRANSIT DISTRICT

COMPREHENSIVE EFFICIENCY ANALYSIS OF GCTD OPERATIONS & SERVICE PLANNING

October 30, 2018



GOLD COAST TRANSIT DISTRICT

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Gold Coast Transit District Comprehensive Efficiency Analysis

Chapter One: Introduction

This study provides a comprehensive analysis of operational and scheduling practices at Gold Coast Transit District (GCTD) in conjunction with its relocation from the 301 East 3rd Street Bus Operations Facility in Downtown Oxnard, to the new Gold Coast Transit District Maintenance and Operations Facility located at 1901 Auto Center Drive in North Oxnard. The study specifically analyzes the effects of this move on deadhead trips and driver relief locations and reviews run-cutting processes and practices.

The goals for this study are to:

1. Identify cost savings opportunities;
2. Identify potential efficiency gains through alternative operational planning solutions;
3. Create improved work runs for operators by improving deadhead trips, relief and break locations, and blocking and run-cutting practices (as feasible).

Most routes begin, end, and have operator reliefs at one of three locations: Oxnard Transit Center (OTC), C Street Transit Center (CTC), and Ventura Transit Center (VTC). Some mid-route reliefs are made at stops that are closer to the new facility. The distance from the new facility location to OTC and CTC is significantly greater than the distance from the current facility.

The relocation will create alternate deadhead trips using new starting and ending locations. This study analyzes the new deadhead trips, operator relief locations and procedures, and recommends optimal locations and deadhead routes to minimize costs. In conjunction with this focus on changes necessitated by the move to Auto Center Drive, the study includes a broader examination of current layover, blocking, and run-cutting practices.

As a first step in the analysis, the project team interviewed personnel from GCTD's Operations and Planning Departments to obtain an in-depth understanding of operating issues, scheduling impacts, previous studies, and operating and capital costs. The project team also engaged bus operators in a wide-ranging informal discussion in their break room. The interviews and discussion are summarized in Chapter Two. A more detailed description of the conversations is included in Appendix A. Phillip Boyle also met with GCTD planning staff regarding the actual analysis in an on-site visit on July 10.

Chapter Three is the heart of this report. This chapter addresses:

- Relevant impacts of the changed facility location on deadheading, operating costs and overall operations
- Considerations around optimized relief types/locations
- An assessment of current efficiency levels
- A review of current scheduling practices
- Suggestions for changes to scheduling approaches to improve efficiency or enhance operational performance.

Gold Coast Transit District Comprehensive Efficiency Analysis Chapter Two: Input from Meetings and Interviews

2.1 Introduction

The kickoff meeting on May 30, meetings with GCTD staff from the Operations and Planning Departments, and an informal discussion with bus operators all provided useful information regarding how the new facility location could impact the transit network. Assuming no change to current relief locations or start/end locations, operating costs would increase by approximately nine percent and would require budget and service cuts in future years. This chapter focuses on input directly related to the facility relocation. Appendix A includes complete notes from the meetings and discussion.

2.2 Interviews with GCTD Staff from the Operations and Planning Departments

St. John's Hospital at Rose Avenue & Gonzalez Road is a potential relief point. Three routes terminate here and four other routes serve this location. Another potential relief point is the Esplanade. Two routes terminate here and one other route serves this location. The closest relief point to the new facility location is at Nyeland Avenue & Ventura Boulevard, but only one route is at this location.

While reliefs at the route terminus are simpler, mid-route reliefs can be considered as an option. Mid-route reliefs delay the bus (typically five minutes is added to the schedule for the relief), but if done at a transit center and tied to an improvement in timed transfers, the delay could be acceptable. Off-street locations, or at the very least a stop with a pull-out, are preferable for reliefs.

Staff raised the possibility of streamlining reliefs by using a larger vehicle such as a passenger van to make reliefs at multiple points (e.g., St. John's Hospital and OTC). This is a practical as well as a theoretical concern, since there may not be enough cars in the fleet to make reliefs reliably over longer distances.

Staff also raised concerns regarding timed transfers, with a general consensus that there is room for improvement. There is interest in exploring the possibility of more interlining of routes. Staff also noted the importance of rest room availability at route termini, and taking the walk distance to and from rest rooms into consideration in scheduling layover time.

2.3 Bus Operator Meeting

The project team met with GCTD bus operators in their break room on Thursday, May 31 between 11:45 a.m. and 4:30 p.m. Bus operators stopped by the table to talk before or after their assignments.

Operators expressed a strong preference for relief locations at the beginning or end of routes. They offered two reasons against mid-route reliefs: the delay causing routes to be late, and the undesirability of making reliefs with passengers on the bus. Lunch breaks in the field have been discussed in the past, and operators are clearly not convinced that this is a workable idea.

Bus operators had several suggestions for new deadhead routes. For routes starting or ending at OTC, the preference is to use Rice instead of Rose for “dead runs” due to less congestion on Rice, especially in the afternoon. More broadly, several operators noted the success of starting early morning trips on Route 16 at the OTC instead of a dead run from the facility to Ventura or Ojai. They suggested converting dead runs to/from the relocated facility into revenue service wherever possible.

Several operators suggested St. John’s Hospital as a new relief point, although approval was not unanimous. Esplanade was also mentioned as a relief point.

Operators requested new and possibly larger relief cars. Operators also requested an increase in report time in the morning at the new facility due to a longer walk to get to the buses.

The bus operators share staff concerns about timed transfers. They also raised concerns about the number of transfers required for long trips. A direct connection between VTC and St. John’s Hospital would help. One operator stated that the solution to poor crosstown connections is not a new crosstown route, but a renewed effort to make sure that the major connections to Route 6 and Route 16 are timed correctly. Operators identified specific needs for timed transfers in the current network.

Interlining was a popular topic in the operator discussions, with general support for the concept (“the workday is less monotonous”). Several suggestions were offered for new interlines, along with a few requests to discontinue the current interline of Routes 15 and 17 that causes confusion among operators and passengers.

In the course of the discussion, operators had a lot to say about specific stops, schedules, desirable and undesirable work assignments, security at certain locations, and restroom availability. Appendix A reports the conversations in greater detail.

2.4 Summary of Interviews Regarding This Study

The interviews and meetings gave the project team a greater understanding of current GCTD operations. Participants have clearly thought about the issues in the facility relocation and offered useful observations that have been incorporated into the analysis and recommendations presented in the next chapter.

The project team has conducted similar outreach efforts to staff and bus operators at numerous transit agencies. There are always negatives to be expressed, and these actually help the team to understand some of the more contentious issues. GCTD stands out for the thoughtful and constructive nature of so many comments and suggestions. The facility relocation is a major change, and everyone who spoke with the team was willing to grapple with the issues raised by the relocation and to think about changes in their daily routines that can contribute to its success.

**Gold Coast Transit District Comprehensive Efficiency Analysis
Chapter Three: Minimizing Impacts of New Facility Location**

3.1 Introduction

There are two primary operating resource increases likely to be caused by the facility relocation from Third Street to the new Gold Coast Transit District Maintenance and Operations Facility in North Oxnard. These are:

- Increased dead run times for vehicles pulling out to commence Am service and pulling in at the end of the day
- Increased dead times to relief locations for operator reliefs, related to meal breaks and middle-of-day AM/PM duty handovers

The first of these is unavoidable without a network or timetable change to ensure vehicles begin or end service closer to the new facility location. For this study we have assumed existing timetables and vehicle blocks will remain unchanged. Therefore the AM pull-out & PM pull-in cost increases are incurred under any scheduling scenario.

Table 1 presents a summary of the change to pull in/pull out hours where existing blocks are retained and pulled into or out of the new facility. At a marginal average hourly rate of \$54.84 this represents an operating cost increase of \$169,400 annually. Assuming no change to routes, schedules or blocks, this cost is unavoidable.

**Table 1
Change to Pull-in/Pull-out Hours Due to Move to New Facility**

Day of Week	Vehicle Pull-in and Pull-out Hours			
	Current Facility	New Facility	Change	% Change
Weekday	19.7	28.9	9.2	47%
Saturday	11.6	18.3	6.7	58%
Sunday	11.4	18.2	6.8	60%
Annual	6,288	9,377	3,089	49%

The second major impact is the travel time to relief locations for meals and operator changeovers. The combined impacts affect the majority of existing duties.

The project team, after reviewing all the input, identified options to minimize the cost involved in the move to the new facility. Staff estimates that operating cost will increase by approximately seven percent in the absence of mitigation efforts. Options include:

- Review of existing blocking and run-cutting
- New relief locations
- Mid-route reliefs
- Operate in service instead of deadhead
- Interlining routes

- Grouping reliefs
- Meal breaks in the field
- Combine trippers into regular runs
- Relax duty type counts

Each option is described in the following sections. The DBA team imported existing schedules into the *HASTUS* computerized scheduling software package. *HASTUS* has a powerful optimization module that can identify and test various options in vehicle blocking and run-cutting.

3.2 Relief Analysis

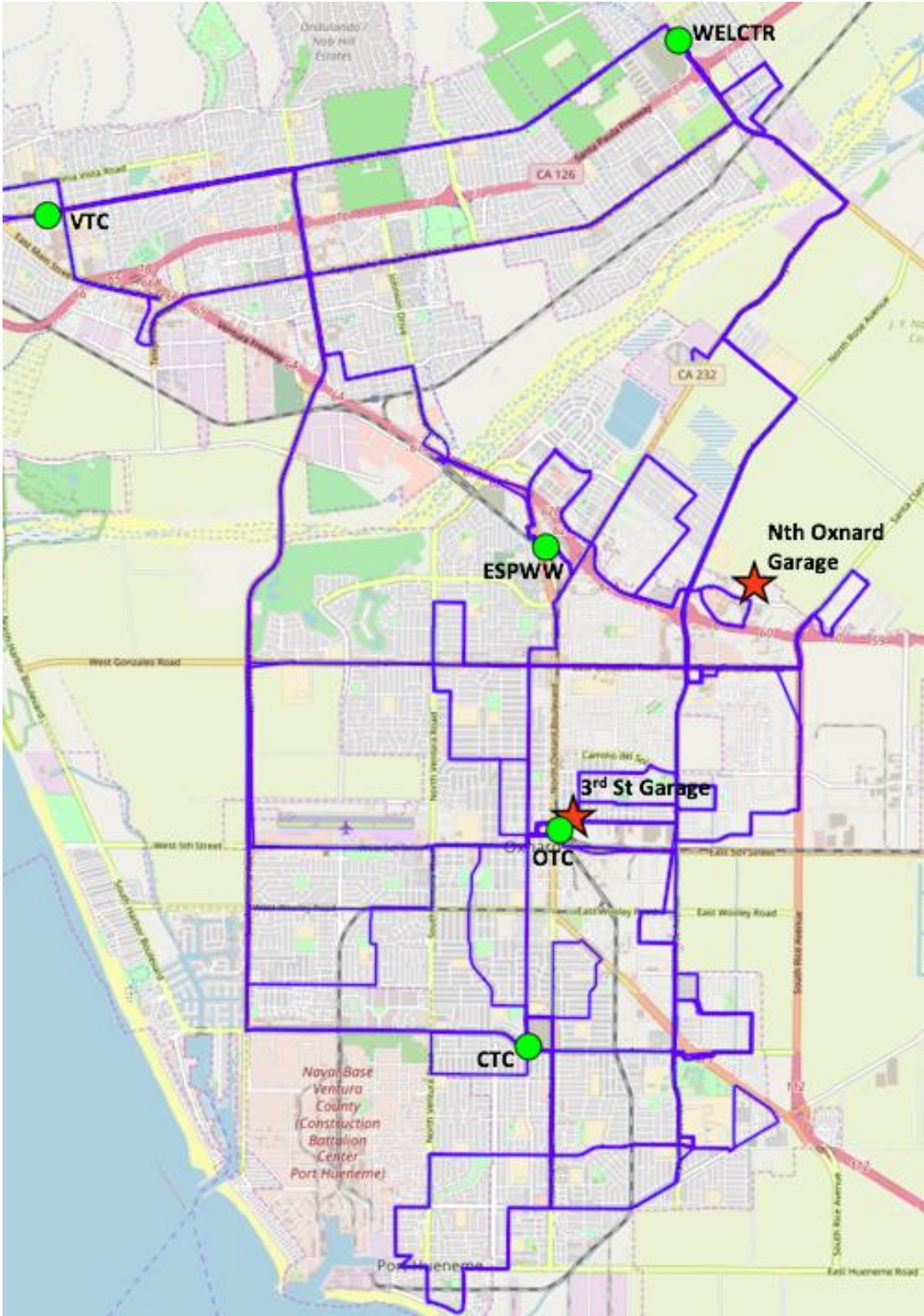
GCTD currently uses 'car reliefs' as a means for drivers to travel between the facility and relief locations, generally for meals or at the end of AM/start of PM straight duties. Figure 1 clearly indicates that travel times to and from current relief locations will increase, because the new facility is farther away from OTC and (CTC), where 49 of 70 weekday operator reliefs occur.

An obvious solution to reduce the operating cost impacts is to reduce travel times to reliefs through application of alternate relief locations. St. John's Hospital and the Esplanade are the transit centers closest to the new facility, but fewer routes serve these locations compared to the number of routes at OTC.

Mid-route relief points are also considered. These are relief points along a route, not at the end of a route. GCTD does not currently use mid-route reliefs, but they are common at other transit agencies. A few extra minutes is typically added to the trip time to allow the relief to take place. The benefit is that reliefs can be made closer to the new facility without the need for travel to the end of a route. Use of mid-route reliefs is practical on Routes 4A, 4B, 6, 17, 19, 20, and 21. The disadvantage is that the relief is made while passengers are on the bus, delaying their trip and making the relief less convenient for the operators. Off-street locations are preferred for relief points, but stops with a pull-out bay would be considered for on-street mid-route reliefs.

Mid-route reliefs increase the number of relief locations. To simplify deadhead patterns, many transit agencies limit the number of relief locations used. In our analysis, we use both a limited and unlimited number of mid-route relief points.

Figure 1: Location of Current and New Facilities and Current Relief Locations



Green Circle – Current Relief Location
Star – Locations of GCTD Facilities

3.3 Operation In-service instead of Deadhead

This option was noted in the Board presentation on July 11. The first two morning trips on Route 16 are examples of this option. These trips begin at OTC and operate express in-service to the Ventura Transit Center (VTC), after which they operate along Route 16. This option does not reduce costs, but instead converts deadhead time to in-service time. It is a viable option for routes south of OTC, but is not considered in this analysis because it does not reduce costs.

3.4 Interlining Routes

Interlining means that a route arrives at a terminal as one route and leaves as another route. Interlining is often done to enhance efficiency by reducing excessive layover time. This analysis has maintained existing blocks and thus has not created new interlines. New interlines could be designed to bring buses closer to the new facility for mid-route reliefs. For example, a route south of OTC could be interlined with Route 4A, 4B, or 6 to permit mid-route reliefs close to the new facility.

Currently Routes 1A and 1B, 2 and 3, 10 and 16, and 15 and 17 are interlined. Bus operators offered several suggestions for additional interlining.

3.5 Grouping Reliefs

Operators currently use automobiles to drive to their relief point, and the operators relieved return to the facility using the same automobile. The fleet of relief cars is aging. Grouping reliefs, with multiple operators using the same vehicle to get to and from a relief point where multiple reliefs are timed close together, is a more efficient solution especially when the distance to/from the relief point is greater. Grouping reliefs would require larger vehicles such as vans, but fewer vehicles would be needed in the relief fleet.

3.6 Meal Breaks in the Field

Currently, all bus operators return to the facility to take their meal breaks, resulting in travel to and from the facility for each meal relief. This analysis explores the option of allowing meal breaks in the field. Instead of returning to the facility, an operator would either be relieved or park the bus, begin his/her meal break at the point of relief, and then either relieve another operator in the field or resume operation of the bus.

As noted earlier, GCTD bus operators are not convinced that meal breaks in the field are viable. It is included in the analysis with several variations to understand the potential for cost savings. One option is to allow meal breaks only at OTC, VCTC, and CTC. A second option would allow meal breaks only at OTC. Within each of these options are sub-options: to limit meal breaks to 45 minutes and to 60 minutes in length. There could also be a limit of no more than three simultaneous meal breaks in the field.

3.7 Combine Trippers with Regular Runs

A “tripper” is a short piece of work, typically involving no more than one or two one-way trips. GCTD typically uses trippers to provide school service on Routes 18A, 18C, 18E, and 18F. These are selected as additional work pieces by operators during the bid process.

This analysis explores the option of combining trippers with regular runs. For example, an operator could make a Route 18A trip, then provide service on a full-time route. The benefit is a reduction in deadhead time by integrating the pieces into workdays without needing to return to the facility. To mitigate the possible confusion this could cause during school vacation or days off, it may be possible to create duties that are the same in both periods, albeit shorter when the tripper does not operate.

3.8 Relax Current Duty Type Counts

GCTD currently has a requirement for 15 percent of all operator assignments to be approximately 10 hours in length. The benefit of this requirement is to allow four-day work packages to be created in the weekly duties. The analysis tests the results if this assumption is relaxed.

3.9 Combinations of Actions

Obviously, a large number of combinations of specific actions can be defined. The combination of these factors resulted in completion of 25 unique operating scenarios for weekdays alone. The scenarios and results are shown in the next section.

3.10 Results of Analysis

Modelling of results was completed using the *HASTUS* scheduling system. The existing trips and blocks were imported directly, and operator duties recreated. This allowed modelling of existing operating resources to be verified.

The DBA team then modeled existing labor rules to produce an automated solution that approximated existing operating approaches. This allowed a more direct comparison as it presented a HASTUS-optimized baseline. Note that the DBA team modeled weekday service only and extrapolated the results to weekend service.

A matrix of the potential actions was then applied to produce results for all likely combinations of approaches. Importantly, this enabled the impacts of each actions to be isolated as well as paired with other actions. The ability to understand where combinations create synergies that lead to the whole being greater than the sum of its parts is critical to an effective analysis.

Below we describe the approaches in more detail and provide a summary of operating cost impacts.

3.10.1 Relief Locations

GCTD provided a list of potential new relief locations. The DBA team added eight new relief locations to be modeled. These additional locations include:

- Rose & Camino del Sol
- Gonzales & Rose
- Victoria & Telephone
- Victoria & Avocet
- Rose & Bard
- Westar & Rose
- Outside new facility (Auto Center & Paseo Mercado)
- Central & Rio Mesa

Reliefs at the current Transit Centers were maintained as an option.

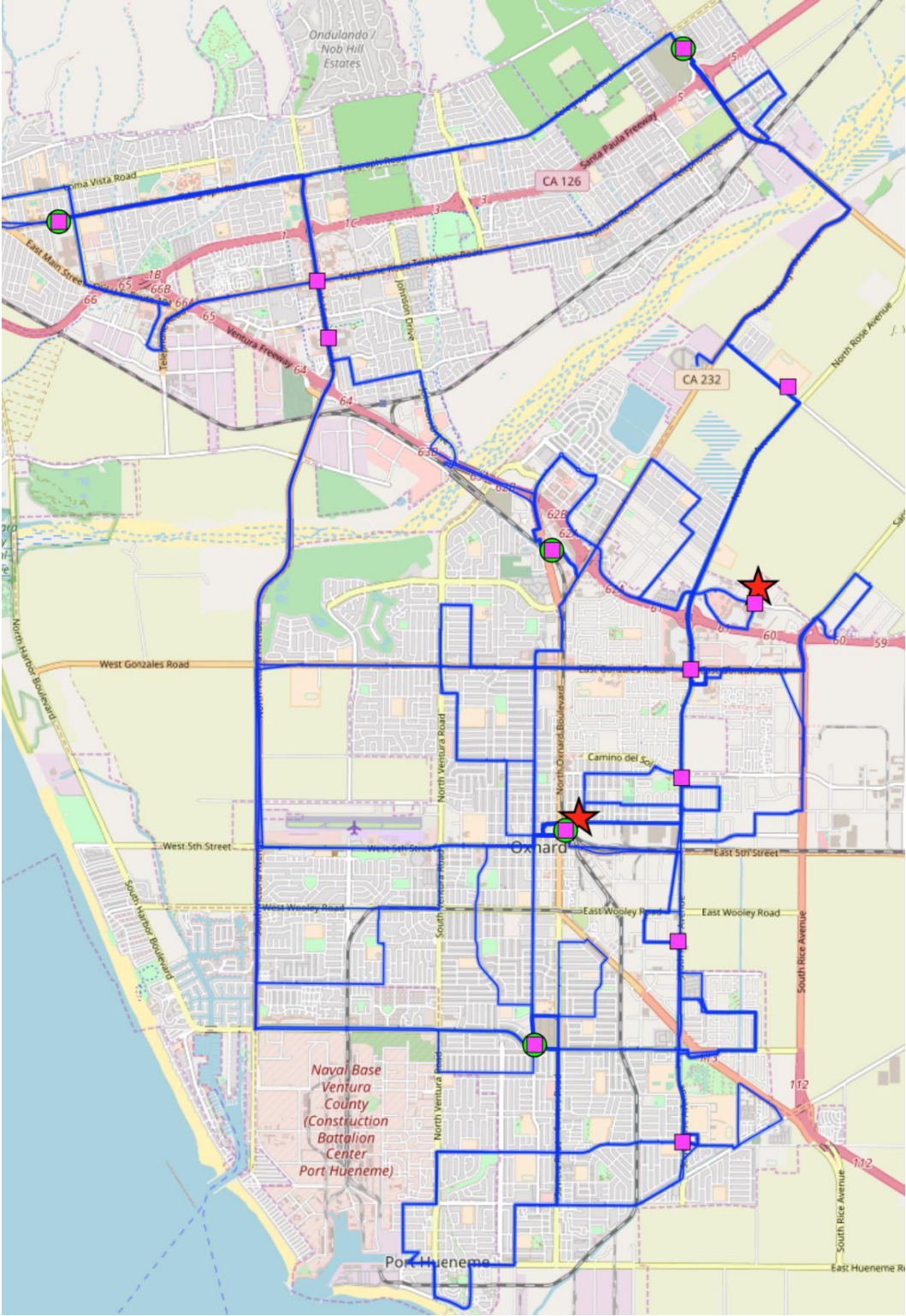
Further options could be considered on a per-route basis. However, there are operational challenges related to adjusting relief points that need to be carefully considered. For example, several of the new relief locations are at trip midpoints, or away from Transit Centers.

A further detailed route-by-route assessment of possible relief locations may be warranted to achieve the best mix of efficiency and operational outcomes.

The relief locations tested are shown in Figure 2. A square inside a circle indicates a current relief location. A square by itself is a new relief location. The stars represent the current and future locations of the maintenance and operation facility.

Analysis results indicate that use of new relief locations could reduce the cost impact of the facility relocation by between 32 and 39 percent, with the lower estimate for limited relief locations and the higher estimate for unlimited relief locations.

Figure 2: Location of Current and New Relief Locations



Square & Green Circle – Current Relief Location
Square – Proposed Relief Location
Star – Locations of GCTD Facilities

3.10.2 Meal Locations & Durations

One of the parameters tested was the ability to have operator breaks or meals away from the facility. “Pull” reliefs were applied where meals away from the depot were tested. This allows operators to keep their bus for the day, including during the meal. All pull reliefs tested were outside of peak periods to avoid any peak vehicle increases.

The DBA team ran several solutions testing options for operator breaks away from the facility. The factors considered within this option included:

- Limiting the length of breaks to avoid long ‘away meals’
- Limiting the number of potential locations to those with acceptable facilities (e.g. OTC, CTC, VTC)
- Allowing operators to keep their vehicle during meal breaks
- Limiting the number of simultaneous meal breaks allowed at any given location
- Controlling times of day when ‘away from facility’ meal breaks would occur

The modelling runs suggest that allowing some meals away from the facility could provide a reduction in the impacts of the facility relocation. Depending on the nature of these breaks, the cost impact of the relocation could be cut in half. Allowing meals away from the facility resulted in between two and four thousand paid hours to be saved.

Our analysis found that meals could be limited to OTC and VTC, with a preference to not be longer than 60 minutes. This would provide a substantial amount of the potential benefits without being operationally untenable.

3.10.3 Duty Type Counts

The analysis of relaxing the requirement for 15 percent of all operator assignments to be approximately 10 hours in length found a relatively minor impact on over operator hours. Typically the impact was around 500-800 hours annually. The impact was higher when other parameters could not be relaxed.

3.10.4 Trippers

The DBA team tested the integration of trippers into regular runs. The analysis indicated potentially significant benefits in allowing this integration, between 1,000 and 2,000 paid hours annually, depending on other parameters being included.

3.10.5 Summary of Operational Impacts

Table 2 presents the impacts of the 25 scenarios tested in terms of annual paid hours and cost. Scenario 1 (the base scenario) changes only the facility location. The remaining scenarios include one or more of the proposed changes. Cost is calculated using a marginal unit cost of \$54.84 per paid hour.

Table 2
Impacts of the Scenarios on Paid Hours and Cost

Scenario	Reliefs Used	Meals on Road	Duration limits	Trippers mixed in	Relax duty type	Annual Paid Hours	Change in Paid Hours	% Change	\$ Impact	Reduction from Base Scenario
Current	Existing	--	--	--	--	235,808	--	--	--	--
1 - Base	Existing	--	--	--	--	244,674	8,866	3.76%	\$486,211	--
2	New/ Multiple	--	--	--	--	241,226	5,418	2.30%	\$297,123	-39%
3	New/ Reduced	--	--	--	--	241,846	6,038	2.56%	\$331,124	-32%
4	New/ Reduced	Allowed OTC	--	--	--	237,344	1,536	0.65%	\$84,234	-83%
5	New/ Reduced	Allowed 3 TCs	--	--	--	238,254	2,446	1.04%	\$134,139	-72%
6	New/ Reduced	--	--	Yes	--	240,061	4,253	1.80%	\$233,235	-52%
7	New/ Reduced	Allowed OTC	--	Yes	--	237,112	1,304	0.55%	\$71,511	-85%
8	New/ Reduced	Allowed OTC	Limit 45 mins	Yes	--	238,404	2,596	1.10%	\$142,365	-71%
9	New/ Reduced	Allowed 3 TCs	--	Yes	--	235,449	-359	-0.15%	(\$19,688)	-104%
10	New/ Reduced	Allowed 3 TCs	Limit 45 mins	Yes	--	237,471	1,663	0.71%	\$91,199	-81%
11	New/ Reduced	--	--	Yes	Yes	239,551	3,743	1.59%	\$205,266	-58%
12	New/ Reduced	--	--		Yes	243,121	7,313	3.10%	\$401,045	-18%
13	New/ Reduced	Allowed OTC	--	Yes	Yes	237,013	1,205	0.51%	\$66,082	-86%
14	New/ Reduced	Allowed OTC	--		Yes	241,348	5,540	2.35%	\$303,814	-38%
15	New/ Reduced	Allowed OTC	Limit 45 mins	Yes	Yes	238,004	2,196	0.93%	\$120,429	-75%
16	New/ Reduced	Allowed OTC	Limit 45 mins	--	Yes	241,829	6,021	2.55%	\$330,192	-32%
17	New/ Reduced	Allowed OTC	Limit 60 mins	--	--	241,319	5,511	2.34%	\$302,223	-38%
18	New/ Reduced	Allowed OTC	Limit 60 & 3 Max	--	--	240,809	5,001	2.12%	\$274,255	-44%
19	New/ Reduced	Allowed 3 TCs	--	Yes	Yes	235,466	-342	-0.15%	(\$18,755)	-104%
20	New/ Reduced	Allowed 3 TCs	--	--	Yes	238,016	2,208	0.94%	\$121,087	-75%
21	New/ Reduced	Allowed 3 TCs	Limit 45 mins	Yes	Yes	237,691	1,883	0.80%	\$103,264	-79%
22	New/ Reduced	Allowed 3 TCs	Limit 45 mins	--	Yes	240,751	4,943	2.10%	\$271,074	-44%
23	New/ Reduced	Allowed 3 TCs	Limit 45 mins	--	--	239,731	3,923	1.66%	\$215,137	-56%
24	New/ Reduced	Allowed 3 TCs	Limit 60 mins	--	--	238,711	2,903	1.23%	\$159,201	-67%
25	New/ Reduced	Allowed 3 TCs	Limit 60 & 3 Max	--	--	240,496	4,688	1.99%	\$257,090	-47%
26	New/ Reduced	Allowed OTC	Limit 45- 75 mins; 3 max	AM Trippers Only	Yes	237,790	1,982	0.84%	\$108,693	-78%

Table 3 highlights the ten most efficient scenarios in reducing the cost of the move to a new facility. Each of these ten scenarios includes a reduced number of new relief points and meals on the road. Seven of the ten scenarios mix trippers with regular runs, and five relax restrictions on duty types. The most efficient scenario allows meals on the road at three locations with no limit on the duration of the meal breaks, and mixes trippers with regular runs. This scenario actually reduces paid hours and cost from current levels (measured by the optimized HASTUS results to ensure consistency). Several scenarios in Table 3 include a limit of 45 minutes on meal breaks in the field, which may make these options more acceptable.

**Table 3
Ten Most Efficient Scenarios to Minimize Paid Hours and Cost**

Scenario	Reliefs Used	Meals on Road	Duration limits	Trippers mixed in	Relax duty type	Annual Paid Hours	Change in Paid Hours	% Change	\$ Impact	Reduction from Base Scenario
9	New/Reduced	Allowed 3 TCs	--	Yes	--	235,449	-359	-0.15%	(\$19,688)	-104%
19	New/Reduced	Allowed 3 TCs	--	Yes	Yes	235,466	-342	-0.15%	(\$18,755)	-104%
13	New/Reduced	Allowed OTC	--	Yes	Yes	237,013	1,205	0.51%	\$66,082	-86%
7	New/Reduced	Allowed OTC	--	Yes	--	237,112	1,304	0.55%	\$71,511	-85%
4	New/Reduced	Allowed OTC	--	--	--	237,344	1,536	0.65%	\$84,234	-83%
10	New/Reduced	Allowed 3 TCs	Limit 45 mins	Yes	--	237,471	1,663	0.71%	\$91,199	-81%
21	New/Reduced	Allowed 3 TCs	Limit 45 mins	Yes	Yes	237,691	1,883	0.80%	\$103,264	-79%
26	New/Reduced	Allowed OTC	Limit 45-75 mins; 3 max	AM Trippers Only	Yes	237,790	1,982	0.84%	\$108,693	-78%
15	New/Reduced	Allowed OTC	Limit 45 mins	Yes	Yes	238,004	2,196	0.93%	\$120,429	-75%
20	New/Reduced	Allowed 3 TCs	--	--	Yes	238,016	2,208	0.94%	\$121,087	-75%

3.11 Summary of Findings

Meals away from the facility provide the potential for the highest savings. At the extreme, if we allow meals at multiple locations, mix trippers with regular routes, and relax the constraint on number of long (4-day) shifts, the analysis indicates an actual reduction in paid hours compared to today (optimized by HASTUS).

As shown in Table 3, we can limit meal breaks to OTC only, limit their duration to 45 minutes, keep the number of 4-day weeks, mix trippers into regular runs, and reduce the cost impact to \$120,000, 75 percent less than in the base scenario.

With this information, GCTD can make an informed decision on which options to include in going forward while minimizing costs and paid hours. After considering all options, this study recommends Scenario 26: limit meal breaks to OTC only, limit their duration to between 45 and

75 minutes, allow a maximum of three meal breaks at OTC at any one time, mix AM Trippers with regular runs, and relax the constraints on 4-day work weeks. This scenario results in a cost impact of \$109,000, 78 percent less than in the base scenario.

In the future, GCTD may be able to achieve greater efficiency by considering further interline pairs. Additionally, interline pairs could be create to ensure each vehicle passes closer to the new facility on a regular basis. For example, a route south of OTC could be interlined with Route 4A, 4B, or 6 to permit reliefs close to the new facility and thus reduce relief travel times. Existing interline pairs could be revisited and potentially revised to create desired outcomes. GCTD might also reconsider the network and timetables, to align service start/end times toward the new facility.