INVENTORY

AND

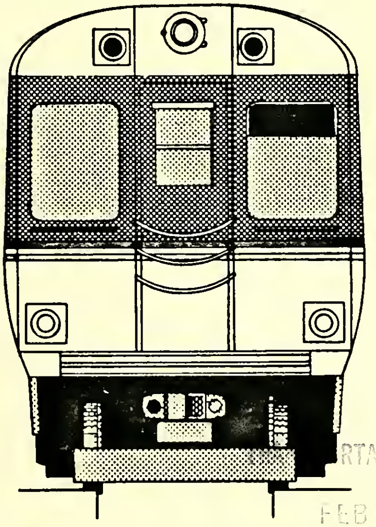
REPLACEMENT PLAN

FOR

NON-REVENUE

RAIL SERVICE VEHICLES

IL-09-0079
UWP 4323.13
CTA CONTRACT G40607



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a partner of Lea, Elliott, McGean & Company

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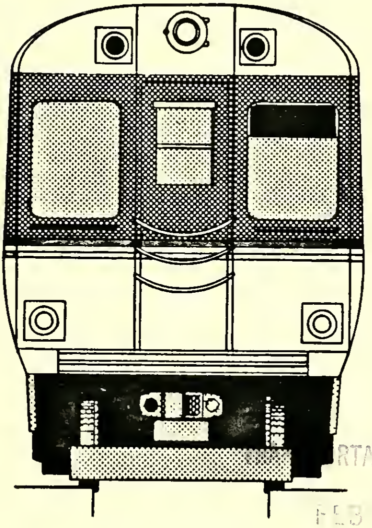

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cta

Date: June, 1985

To: All Concerned

From: J. R. Pankonen, Director, Engr. & Mtce. Program Development

Re: Inventory and Replacement Plan for Non-Revenue Service Vehicles

Reference: JO 9396, IL-09-0079, UWP 4323.13

This final report was reviewed and approved by the signees listed on the attached page. The recommendations and schedule for implementation are also approved and incorporated in the Authority's capital program funding plan.

If there are any additional questions regarding this plan please contact me on extension 4210.

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REPLACEMENT PLAN FOR NON-REVENUE RAIL SERVICE VEHICLES

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16. Abstract

Lea, Elliott, McGean & Company (LEM) has provided the Chicago Transit Authority with an inventory of and a replacement plan for its non-revenue rail service vehicles. The first phase of this project involved the development of an "optimum fleet" of service vehicles based on the Authority's current and projected needs. The second phase developed a plan to achieve the optimum fleet by 1995.

The development of the optimum fleet required that an analysis be made of the Authority's present and future needs for non-revenue rail vehicles, as well as an inventory of the functional capabilities and condition of the existing vehicle fleet. By identifying unsatisfied needs and excess capabilities, LEM was able to identify changes to the current non-revenue rail fleet necessary to optimize the vehicle roster.

The plan to achieve this optimum fleet by 1995 and maintain it through 2005 was developed by meshing the proposed roster with the anticipated availability of funding for vehicle procurements and overhauls. A needs priority was also incorporated in the plan.

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INVENTORY AND REPLACEMENT PLAN
FOR
NON-REVENUE RAIL SERVICE VEHICLES

IL-09-0079
UWP 4323.13
CTA CONTRACT G40607

JUNE 1985

Prepared by

LEA, ELLIOTT, McGEAN & COMPANY

WASHINGTON, D.C.

for

CHICAGO TRANSIT AUTHORITY

CHICAGO, IL

This report is the product of a study financed in part by the U.S. Department of Transportation, Urban Mass Transportation Administration.

The contents of this report reflects the views of the Chicago Transit Authority and Lea, Elliott, McGean & Company which are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the U.S. Department of Transportation. This report does not constitute a standard, specification or regulation.

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1.0 CTA NON-REVENUE RAIL TRANSPORTATION NEEDS

The Chicago Transit Authority currently operates approximately 1200 Rapid Transit cars on over 250 miles of track connecting 143 stations to serve many of the 1.2 million passengers who rely on the Authority each day for reliable and safe transportation throughout the Chicago area. To support this very large operation, the Authority has a highly capable engineering and maintenance staff to provide technical expertise and skilled hands to keep the system in good condition. To assist this staff, the Authority must have a reliable fleet of non-revenue rail service vehicles to fulfill a wide range of needs. However, most of the current fleet is old; many of the crucial vehicles are inadequate, obsolete or far beyond their economical service life. Maintaining these vehicles is difficult and expensive. Often repair parts are no longer manufactured and must be fabricated in the Authority's shops. Few vehicles have been replaced in the last 20 years, which has resulted in a fleet unable to provide satisfactory and reliable service. This project will identify and define the problems encountered by the Authority in this area and propose a plan to resolve them.

The first task in the development of a replacement plan for CTA's non-revenue rail vehicle fleet is the identification of the Authority's service needs for that fleet. These needs will be compared with the functions provided by the existing vehicles so that the fleet roster may be modified to optimize its ability to meet these needs. The list of needs identified in this section has been developed based on information obtained through interviews and meetings with CTA staff members who are familiar with various aspects of the fleet's operation.

1.1 TRANSPORTATION OF MATERIALS

The CTA's primary non-emergency need for non-revenue rail vehicles is to transport a wide variety of equipment, materials, and supplies between a variety of locations throughout the rail system. This need is divided into three groups, each of which differs from the others in the nature of the items being transported and the type of vehicle required to satisfy that group of needs.

1.1.1 Transportation of Material From the Lower Yard to Job Sites Along the Right-of-Way

A substantial need exists for the daily delivery and removal of work materials at various job sites along the Authority's right-of-way. Ongoing capital rail system renewal programs depend heavily on the ability of these work trains to deliver sufficient materials and equipment in a timely fashion. These projects, as well as maintenance projects, are often "bottlenecked" when material deliveries are delayed or curtailed due to work train equipment failures. Delays in material deliveries erode work force productivity and, in severe situations, can cause costly work stoppages. Also, when renewal projects are delayed, speed restrictions for revenue trains passing the work site are unnecessarily prolonged, delaying thousands of passengers each extra day.

These shipments of material and equipment generally originate from 63rd Street Lower Yard and are transported to various job sites. Shipments include three general classes of material:

- Heavy items, such as rails and ties. These items will be transported individually or in bundles on flatcars and must be loaded and unloaded by crane.

- Smaller items, such as lumber, track hardware or signal equipment. These items will be palletized and loaded on flatcars with a forklift and normally handled at the job site by crane.

- Bulk items, such as ballast or sand. These items must be transported in bins or hoppers and will most often be loaded and unloaded with a crane. Ballast may be required on the track in preparation for tamping and aligning. Other materials, including ballast, may be required in piles alongside the track.

There is also a need to collect debris at job sites and along the right-of-way and remove it to 63rd Street Lower Yard for disposal. This debris consists of scrap material left by work crews at job sites as well as such things as tree limbs and

litter. These items are unsightly and create an unattractive nuisance along the right-of-way. Generally such material would be accumulated in hoppers or truscan cans at the job site and loaded onto flatcars with derricks.

These needs are currently filled by two night work trains, each of which is scheduled to operate five times per week.

Two work trains consisting of reliable equipment would usually be capable of fulfilling the needs identified in this section. One train could not provide sufficient capacity to prevent significant backlogs, even if it were operated seven days per week. During the summer months, when construction work is at its heaviest, a third work train or a day work train may occasionally be needed.

The need also exists for the delivery of work materials and supplies to stations or terminals. Rail vehicles are used to deliver material which is too large or heavy to transport by truck or to reach locations which have poor accessibility from the street. Such deliveries include transporting bulk janitorial supplies twice monthly to central storage facilities in the State and Dearborn Subways and O'Hare Station, pick-up/delivery of large replacement parts for escalators, portable toilets, etc., which must be moved to locations throughout the system on an as-needed basis.

1.1.2 Pick-Up/Removal of Trash from Right-of-Way

There is a substantial need to pick up trash accumulating along the right-of-way, particularly in the subways or opposite passenger stations, and remove it to 63rd Street Lower Yard for disposal in order to maintain a clean, safe and healthful environment. Trash and debris which is allowed to accumulate in the subway creates a fire hazard and greatly increases the risk of rodent and insect infestation which is difficult and expensive to correct.

The present manual pickup of trash is very costly to CTA, requiring an estimated 23,000 labor hours annually. Automation could significantly reduce labor requirements for this operation and free the workers presently assigned to this task for use in other areas.

Trash picked up in the subways is held in drums until it can be removed by work train to 63rd Street Lower Yard for disposal. Based on information obtained by interviewing CTA staff members, the existing non-revenue service vehicle fleet is unable to provide regular drum pickup, requiring the holding of food wrappers and related wet garbage in the subway drums for weeks at a time.

1.1.3 Transportation of Vehicle Components Between Skokie Shops and Terminals

The final material transportation need to be identified in this section is the movement of large rail vehicle component assemblies and repair items between the overhaul shops at Skokie and the 11 railcar maintenance terminals throughout the system. This is a growing need which exceeds the capacity of the present non-revenue vehicle fleet. Based on information obtained through interviews with CTA staff members, it is estimated that the Skokie Shops can now generate three carload shipments per week, with the likelihood of increased volume in the future.

1.2 TRACK MAINTENANCE

The Authority has a need for modern equipment to properly maintain over 250 miles of track and roadbed. In addition to the replacement of worn and deteriorated track elements, periodic tamping, profiling, aligning and reconditioning of track is needed to help assure a fast, safe and comfortable ride to CTA passengers as well as to minimize wear and tear on the Authority's revenue vehicle fleet. Modern equipment will also improve machine production and further reduce unit labor costs for tamping, aligning, profiling, and undercutting track.

The Authority also has a periodic need for detailed technical analysis of track system geometry in order to verify system safety and to effectively manage maintenance and renewal resources.

To accomplish this, the following needs must be satisfied:

1.2.1 Rail Conditioning

Rail conditioning is required to restore the running surfaces of the track to a proper contour and smoothness. Unacceptable rail conditions such as corrugation

and side wear cause unnecessary vehicle vibration and noise and should be corrected periodically. Using a conventional railroad-type unit on vacant tangent track sections, rail grinding would be required no more often than once every two years; curved sections of track might require grinding twice each year. However, since the Authority operates revenue trains 24 hours per day on most routes, it is impractical to use this type of a rail grinding unit "under traffic" because of its slow operating speed. Instead, CTA currently uses a "rail smoother" car which applies abrasive blocks to the rails under light pressure. Since it is hauled by work motors at high speed, it can run in between revenue trains, even during rush periods, without delaying passenger service. This type of rail conditioning equipment must make about 120 passes over the system each year in order to adequately condition the rails. The present unit is scheduled to operate more than 30,000 miles per year; but, because of its poor condition, it falls far short of this requirement. It appears that one reliable rail smoothing unit would be able to fulfill the Authority's needs.

1.2.2 Ballasted Track Profiling and Aligning

In order to provide a comfortable ride for its passengers and reduce the likelihood of derailments, the Authority needs to profile and align the ballasted track on a periodic basis. Modern track maintenance equipment is essential if the Authority is to perform this work quickly and efficiently in order to control costs and minimize delays to passengers. To accomplish cyclical renewal requirements, CTA must have the capability to profile and align about 40 miles of track annually.

1.2.3 Track Renewal

CTA also needs equipment capable of safely and efficiently renewing track elements such as rails, ties and ballast. Typically, tangent track must be renewed every 25 years while curved track requires renewal every 15 years. As a result, the Authority must be equipped to renew about 10 miles of track each year to accomplish cyclical renewal requirements, in addition to correcting local track defects as they are discovered.

1.2.4 Track Geometry Analysis

Presently CTA makes visual inspections of all track sections twice each week in order to locate loose or missing hardware. However, there is also an important and largely unmet need for periodic quantitative analysis of track gauge, profile or alignment, fatigue in fastening systems, third rail profile or gauge, etc. Such detailed technical surveys can only be performed with a track geometry car equipped with extensive instrumentation and data recording devices. Making this level of scientific survey fulfills several functions. First, it provides early warning of the development of serious defects which are not apparent during visual inspection. Second, it provides detailed quantitative analysis as a substitute for subjective judgments in determining where track maintenance and renewal resources can best be focused to maximize their productivity. Finally, it provides an accurate evaluation of reconstructed or renewed track sections for contract compliance or to check the effectiveness of certain maintenance operations performed or new methods implemented.

The needs for a suitable track geometry car are not satisfied presently and require the rental or purchase of such a vehicle.

1.3 ROUTINE AND EMERGENCY TOWING OF VEHICLES

There is a need to be able to tow work cars, inoperative revenue vehicles, and even railroad freight cars at various times. Part of this need is to transfer inoperative revenue vehicles between the maintenance terminals and Skokie Shops for overhaul or major repair. It is also necessary to move revenue and service vehicles, and railroad freight cars, within the maintenance areas at Skokie Shops and the material storage areas at the 63rd Street Lower Yard as well as at the terminal inspection shops and related yards. Occasionally there is an emergency need to tow entire revenue trains which are disabled or in track sections where traction power has been lost or withdrawn.

1.3.1 Movement of Inoperable Vehicles to Skokie Shops

There is a need to be able to move inoperable revenue vehicles from the various maintenance terminals to the Skokie Shops for overhaul or major repair.

The CTA staff estimates that about three transfers occur every weekday. Since these movements are generally made during the day in between peak service hours, the equipment used to tow these cars must be able to maintain the system's minimum speed requirement of 25 miles per hour.

1.3.2 Movement of Vehicles Within Maintenance Areas

The need also exists to be able to move inoperable revenue vehicles within the maintenance areas at terminal, shop, and yard locations. The movement of such vehicles at the maintenance terminals is presently accomplished by pushing or pulling them with operational revenue vehicles, and is therefore not considered to be a potential need for non-revenue vehicles.

The locations which need non-revenue vehicles to tow (switch) cars are Skokie Shops and 63rd Street Lower Yard. At Skokie Shops, a tug is needed to move vehicles into the shop for repairs as well as to move various CTA vehicles and railroad freight cars around in the yard area. At the 63rd Street Lower Yard, railroad cars and CTA workcars must be moved to facilitate the loading and unloading of material. In both locations there are several track sections which do not have third rail, thus requiring that towing vehicles have self-contained propulsion systems. The loss of a towing vehicle due to equipment failure or maintenance would be a major impediment to the operation of either facility; therefore, a high degree of reliability plus some redundant towing capability is desirable.

1.4 SNOW REMOVAL

All of the Authority's trackage which is at grade level, on elevated embankment, or in expressway medians will require snow removal equipment to maintain rail service through winter storms. Since CTA has over 115 miles of such track, a large snow removal capacity must be maintained in the system. The Authority must have the ability to remove moderate accumulations while the transit system continues to operate, as well as the ability to remove heavy accumulations which have temporarily caused service to be halted.

1.4.1 Removal of Moderate Snow Accumulations

The Authority must be able to remove moderate amounts of snow and ice which accumulate between trains during a storm. Snow accumulations of about four or five inches above top-of-rail and light icing of the third rail can be cleared with the small snow plows and sleet scrapers installed on all revenue vehicles. More substantial accumulations require the use of "Road Opener" trains which can clear snow accumulations up to about eight inches above top-of-rail while operating at about 25 miles per hour (to minimize the interference with revenue service trains). In order to be effective, these road-opener trains should be operated at least once every few hours over each section of track where snow is accumulating during a storm. To provide this level of service, at least six two-car units must be operated continuously until after the end of the snowfall.

The same need exists for removal of snow from maintenance and storage track although the speed requirement is not as great. On both revenue and yard trackage, it is only necessary to remove snow down to top-of-rail to maintain normal operation; however, it is desirable to remove snow down to top-of-ties as soon as is reasonably possible to provide a "reserve capacity" for future snowfalls.

1.4.2 Removal of Heavy Snow Accumulations

CTA also has the need to remove heavy accumulations of snow and ice which have totally halted rail service. Therefore, the capability is needed to remove snow up to two feet above top-of-rail and cut through even higher drifts. The equipment used for removal of these heavy accumulations must be able to remove 1500 tons per hour in order to clear the entire system in less than four hours. To do this, a minimum of three units must be in operation.

1.5 HEAVY LIFTING

The need exists for the Authority's maintenance force to be able to perform a variety of heavy lifting tasks at various locations on the rail system. These tasks are sporadic and occasionally of an emergency nature. Typical routine lifting would include picking steel for structure repairs or renewal and handling prefabricated

track panels and switches during removal and new installation when large ground-based cranes cannot access the work site, loading/unloading rail strings, stripping track, loading/unloading track maintenance equipment from flatcars at job site, etc. Rail cranes are also used under emergency conditions to rerail revenue vehicles or perform other heavy lifting work. In this regard, the two cranes are deployed at opposite ends of the system (Skokie Shops and 63rd Lower Yard) and at least one is kept on standby at all times to provide prompt emergency service when required. Rail cranes must sometimes be used in tandem to lift heavy structural members or an entire rail car. Therefore, to properly fulfill these needs, two railborne cranes are required, each with the ability to lift 17.5 tons at a 12' radius.

2.0 NON-REVENUE RAIL VEHICLE FUNCTIONS

2.1 CURRENT FLEET CAPABILITIES

The Chicago Transit Authority presently operates a non-revenue rail service vehicle fleet of more than 60 vehicles. These vehicles include a wide variety of types used to fulfill the Authority's needs for workcar services. A roster of current non-revenue rail vehicles is shown in Figure 1, including a brief description of each car's function and an estimate of its priority for replacement. Vehicles which are in immediate need of replacement are shown with a "1" replacement priority. Vehicles which are in fairly good condition are shown with a "2" and vehicles which are in very good condition are shown with a "3" or "New" designation. Vehicles in the present fleet which will not be replaced are shown with a "N/R".

To facilitate the functional analysis of the non-revenue vehicle fleet, some of the cars have been grouped into sets. These sets combine individual cars which will almost always be used together. This will simplify the functional analysis by reducing the number of elements without diminishing the thoroughness of the study.

2.1.1 Work Motors/Revenue Cars

Work motors are needed to haul most of the non-revenue vehicles around the system. Of the current fleet, only the Snow Fighter Sets and the Snow Blower can propel themselves fast enough to operate between revenue trains.

One of the most demanding services required of work motors on the system is hauling work trains. In order to pull a fully-loaded 500,000-lb work train on level track at the speed of 25 miles per hour, or climb at five percent grade at five miles per hour, a 600-horsepower locomotive is required. When the present work motors are used for motive power, four cars (two married pairs) are used to fulfill this requirement. Therefore, for the purposes of this analysis, two married pairs of 6000-Series work motors will be considered roughly equivalent to one locomotive. However, it should be noted that two married pairs of 6000-Series work motors may not have sufficient braking capacity to safely stop a fully-loaded 500,000-pound train. The work motors were designed for passenger service and are not well suited

Figure 1 (Sheet 1 of 2)

Chicago Transit Authority Work Car Roster

Car No.	Description	Function	Replacement Priority *
S-361	Ballast Car	Ballasting Track	2
S-362	Ballast Car	Ballasting Track	2
S-4	Bolster Car	Used with S-3	2
S-212	Bolster Car	Used with S-367	2
S-214	Bolster Car	Used with S-363	N/R
S-109	Flat Car	General Hauling	1
S-110	Flat Car	General Hauling	1
S-300	Flat Car (Short)	Haul Veh. Components	2
S-324	Flat Car	General Hauling	1
S-329	Flat Car (Short)	Haul Veh. Components	2
S-331	Flat Car	General Hauling	1
S-213	Flat Car (Buffer)	Used with S-363	2
S-309	Flat Car (Buffer)	Used with S-367	2
S-107	Flat Car (Short)	General Hauling	1
S-1500	Flat Car (Short)	General Hauling	1
S-1501	Flat Car (Short)	General Hauling	1
S-314	Flat Car with Derrick	Unloading Work Train	1
S-332	Flat Car with Derrick	Unloading Work Train	1
S-1	Rail Smoother	Recondition rails	1
S-3	Self Propelled Crane Car	Heavy Lifting	New
S-363	Self Propelled Crane Car	Heavy Lifting	N/R
S-367	Self Propelled Crane Car	Heavy Lifting	2
S-500	Snow Blower Locomotive	Clear Heavy Snow	3
S-417	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-418	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-419	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-420	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-421	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-422	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-423	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-424	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-425	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-426	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-427	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R
S-428	Snow Fighter Car (ex 6000)	Clear Moderate Snow	N/R

* Replacement Priority: 1 - Immediate replacement should be scheduled
2 - Fairly good condition
3 - New or very good condition

Figure 1 (Sheet 2)

Car No.	Description	Function	Replacement Priority *
S-520	Snow Removal Vehicle	Clear Snow in Yards	2
S-521	Snow Removal Vehicle	Clear Snow in Yards	2
S-522	Snow Removal Vehicle	Clear Snow in Yards	2
S-523	Snow Removal Vehicle	Clear Snow in Yards	2
S-524	Snow Removal Vehicle	Clear Snow in Yards	2
S-525	Snow Removal Vehicle	Clear Snow in Yards	2
S-2	Tank Car	Weed Control	2
S-120	Vehicle Tug at Skokie Shop	Move cars in shop	1
MS-65	63rd Yard Locomotive	Car Shifting	2
S-401	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-402	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-403	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-404	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-412	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-413	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-414	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-415	Work Motor (ex 6000 Series)	Hauling Work Cars	N/R
S-429	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-430	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-431	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-432	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-433	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-434	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-435	Work Motor (ex 6000 Series)	Hauling Work Cars	3
S-436	Work Motor (ex 6000 Series)	Hauling Work Cars	3
FG-555	Bridge & Tie Crane	Track Maintenance	2
RX-119	Production Tamper	Track Maintenance	1
CIP-7978	Profiling Tamper	Track Maintenance	3
RX-118	Profiling Tamper	Track Maintenance	1
FG-554	Track Broom	Track Maintenance	1
RX-120	Track Liner	Track Maintenance	1
CIP-1773	Track Liner	Track Maintenance	2
CIP-8225	Track Undercutter	Track Maintenance	3

* Replacement Priority: 1 - Immediate replacement should be scheduled
2 - Fairly good condition
3 - New or very good condition

to heavy freight-hauling service. As a result, traction motor burnouts and other stress-related failures occur frequently requiring work motors to be replaced quite often.

The existing fleet of dedicated work motors includes 8 married pairs of 6000-Series cars, each specially equipped with controls for applying/releasing the air brakes on hauled work cars such as flats or rail crane sets.

In addition, 6000-Series reverse cars are often used to supplement work motors for light hauling during off-peak hours (e.g., the rail smoother, moving single flat cars between Skokie Shops and rail maintenance terminals, towing inoperable vehicles, etc.). The abundance of 6000-Series cars, thier availability in virtually every yard and the familiarity of all crews with their operation gives them considerable value and utility.

CTA currently has on order three 600-horsepower diesel hydraulic snow blower units which can be used as locomotives in non-winter seasons and are much better suited to hauling heavy consists of trailer cars than are the present work motors. Delivery of these locomotives would permit a reduction in the number of work motors in the fleet and eventually, when more locomotives are purchased, all dedicated work motors could be removed from the service vehicle fleet.

2.1.2 Rail Smoother

The Authority currently has one rail smoother, car number S-1, which is used to recondition rails throughout the system. The present rail smoothing equipment must make about 120 passes over the entire rail system each year to adequately recondition the running rails; this averages out to about 200 days of operation for six hours per day. The rail smoother consist includes a tank car, number S-2, which is used to spray water on the elevated structure during non-freezing weather to minimize the risk of fires due to sparks generated during the smoothing operation. Four work motors or revenue cars are currently used to tow the rail smoothing unit at revenue train speeds.

The rail smoother's frame and trucks are quite old and worn out beyond economical repair. As a result, this unit is shopped quite often and for long periods of time, causing it to fall far short of its stated goals for rail conditioning.

2.1.3 Tank Car

The Authority's tank car serves two functions. It is primarily used in conjunction with the rail smoother as a water tank car as described in Section 2.1.2. Additionally, it is used once each year for approximately one month to furnish water for the spraying of herbicides used to control undesirable vegetation along the right-of-way.

The present tank car, S-2, seems to be sufficient for both the rail smoothing and weed spraying operations. S-2 appears to be a much utilized vehicle and must, therefore, be a highly reliable car if the purchase of a second tank car is to be avoided.

2.1.4 Rail Crane Set

The rail crane set consists of a self-propelled crane car and a bolster car. The crane car is self-propelled only in the sense that it can move at low speed at a job site or in a maintenance yard area. A locomotive or set of work motors is needed to haul the crane at full system speed to and from job sites along the right-of-way in order to minimize its interference with revenue trains. The crane car has an internal combustion engine which supplies power to the nominal 17-ton capacity crane as well as the unit's propulsion equipment. The crane car does not require 600 dc traction power to operate.

The bolster car is a modified flatcar which is used to carry accessories for the crane as well as provide a means of cradling the crane's boom in a traveling position while the unit is being hauled to or from a job site. The bolster car is also equipped with an electrically driven air compressor. This compressor supplies air pressure for the unit's braking system. The brakes are controlled from the electrical trainline when hauled by work motors. The present non-revenue vehicle fleet consists of three rail crane sets; one set (S-363, S-214) is to be retired from service shortly.

2.1.5 Derrick Car

The derrick car is also a modified flatcar, with a nominal 2-1/4 ton capacity derrick, mounted near one end. The derrick cars are used primarily with the work trains to load and unload material which has been hauled to the work sites on flatcars. These cars can also be loaded with material, but they have less capacity than the flatcars. There are two derrick cars in the current fleet. One car is assigned to each work train and their availability is extremely important to the function of these trains.

Equipment failures on the derrick cars is the major cause of work train curtailment or cancellation. As a result, the Authority is currently in the process of purchasing two traversing derrick cars to replace the existing vehicles which are more than 30 years old, have become difficult to maintain, and are frequently out of service. Each new car will be equipped with a derrick mounted on a gantry which mounts on the car's sidesills and is able to traverse the entire length of the vehicle and store material as well. This feature will allow the derrick to unload flatcars, coupled to both ends of the car, which is not possible with the present derrick cars.

2.1.6 Flatcar

The flatcar fleet provides most of the material-hauling capacity of the Authority's non-revenue fleet. With the exception of track ballast, virtually all material transported by the work trains is carried on flatcars. The present fleet of eleven cars is not able to satisfy the demands placed on them by the system. Only four of the flatcars are full length (40'+) and able to carry 39' rail strings and other large wood and steel materials commonly used for track renewal or maintenance. These flatcars are used each night in work train service (if available). The remaining seven flatcars are too short in length to be suitable for many of the work train functions. Two of these flats are used to transport material between Skokie Shops and the rail maintenance terminals; two more flats are used as buffer cars in the rail crane sets, primarily to provide coupler interchangeability; and the remaining three flatcars are used whenever practical as spares for the night work train.

The present roster of flatcars contains some of the oldest and least maintainable vehicles in the Authority's non-revenue vehicle fleet and, as a result, has a relatively low availability rate. The lack of flatcars due to equipment failure is the second most common cause of worktrain curtailment or cancellation.

The Authority's FY '85 Capital Improvement Program application (which is now pending) requests funds for the purchase of up to three new flatcars to supplement the present fleet. Two would be replacements and the other would permit a third flatcar to be used for the shipment of rail vehicle components between Skokie Shops and the various rail terminals.

2.1.7 Ballast Car

The two ballast cars in the work car fleet are used primarily to distribute ballast along the track in preparation for tamping. These cars were purchased in 1966 and are in generally good condition. The two vehicles also appear to be sufficient to satisfy CTA's need to haul ballast for track maintenance.

2.1.8 Snow Fighter

CTA has modified six married pairs of 6000-series revenue cars to function as road openers. These cars have been outfitted with snow plows, equipped for spraying ice-melting chemicals on the third rail, and have propulsion system modifications which allow them to be used to clear moderate snow and ice accumulations from the right-of-way. These cars are approximately 35 years old, but because of their similarity to the 6000-series revenue vehicles, they remain reasonably maintainable. These cars are in good condition for their age largely because their dedication to this narrow purpose insures that they are operated relatively few miles each year. Snow fighter units may be deployed in a variety of ways depending on whether icing or snow conditions must be countered. For maximum coverage, snow fighter units could be deployed individually or as the head pair of revenue trains. For more severe weather conditions, snow fighters may be combined into multiple unit sets.

Currently there are numerous CIP projects to install heaters on contact rail throughout the rail system to preclude third rail icing. In the early 1990's when all of these projects are completed, it is likely that the snow fighters will be phased out and eventually removed from the fleet.

2.1.9 Snow Blower

The Authority recently purchased a locomotive (S-500) which has a semi-permanently attached snow blower or broom on each end. The unit is able to clear 24 inches of snow from the right-of-way as well as higher drifts. The broom can also remove snow down to the top-of-tie level. However, the unit in its present configuration cannot practicably be used for any purpose other than snow removal or perhaps low speed towing of vehicles in yard areas.

2.1.10 Snow Removal Vehicle

Six snow removal vehicles, called snow brooms, were purchased by CTA in 1982. Each of these vehicles is equipped with a single rotating broom which can be used to remove snow down to the top-of-tie level. The vehicles can be equipped with either rubber tires or steel railway wheels. These vehicles can be used to clear snow in the yard areas as well as remove snow on the right-of-way at grade crossings on the Skokie Swift, Ravenswood and Douglas Park branches which is well below the reach of the other snow removal equipment. These vehicles are prototypes which have not performed well. In fact, most of these units have still not been accepted by the Authority nearly three years after delivery. A different type of vehicle should be considered as a replacement.

2.1.11 Ballasted Track Equipment

The Authority has a number of aged maintenance units which are used to renew and align track. The most recent purchase, a Canron Profiling Tamper (CIP-7978), for which a lining attachment is currently being purchased, is substantially more productive than the combination of the older Jackson Profiling Tamper (RX 118), Production Tamper (RX 119), and Liner (RX 120) which perform

the same basic functions. Another recent purchase, the Canron Undercutter (CIP-8225), is a far more efficient way to remove ballast from beneath the track ties than the previous method of performing this task by hand. These two modern track mantenance unit-types should comprise the core of equipment used to renew and maintain the Authority's ballasted track system.

With the purchase of such equipment, the Authority will, for the first time, be able to initiate a spot tie and ballast renewal program for ballasted track which, if done an on-going cyclical basis, will eliminate the need for costly major renewals. Also, the equipmemt will provide improved machine production and will reduce unit labor costs by utilizing more modern equipment and methods.

The Authority presently has a need for two sets of track renewal and maintenance equipment. Each of these sets should include the following units:

- Profiling and Lining Tamper
- Track Undercutter
- Bridge/Tie Crane
- Tie Inserter and Remover
- Track Broom

This equipment will enable CTA to renew and maintain its present track system and provide a safe comfortable ride for its riders.

2.1.12 Vehicle Tug

The Authority currently has two vehicles which are used to move cars in the yard and shop areas. The vehicle assigned to the Skokie Shops (S-120) is used primarily to push revenue vehicles in and out of the shop. The other, M5-65, is assigned to the 63rd Street Lower Yard and is used to switch non-revenue cars. Both of these vehicles appear to be important to the operations of their respective facilities; the loss of use of either one would require the substitution of another piece of power equipment which might not be properly suited to this function. Vehicle Tug S-120 needs an overhaul during the next 12 months if it is to continue providing reliable service for Skokie Shops.

2.2 FUTURE FLEET CAPABILITIES

In addition to the types of vehicles listed in Section 2.1, which are either on the present roster or currently being purchased, CTA's staff has identified capabilities that can be fulfilled only by types of vehicles which are new to the system. Funding has been requested for a prototype control cab car and will be received in the Spring of 1986 through the Authority's FY 1985 Capital Improvement Program. The need for the services of side-dump cars, a track geometry car and a right-of-way cleaning vehicle are seen by the staff as being as pressing; but due to more fundamental replacement needs, such as locomotives, flatcars and derrick cars, these equipment purchases were not programmed prior to this study.

2.2.1 Control Cab Car

The CTA rail system is designed for trains which can be operated from either end; stub tracks are commonly found in terminals, car storage yards and repair shops. To leave a stub track, the motorman simply walks to the rear of the train and operates from the motor cab there. With the introduction of locomotives to haul work cars in place of work motors, some means of operating these trains from the rear end must be provided to avoid the necessity for reverse movements.

For this purpose, a Control Cab Car concept was developed by CTA Staff. This car would include a fully equipped motorman's position at the rear of locomotive driven work train consists, capable of controlling the locomotive's traction power in the pushing mode as well as the braking systems of the locomotive and the other work cars in between, through the use of trainwires and trainpipes. The Control Cab Car would be operated under full ATC protection.

The Control Cab Car would be configured as a standard flat car with the Control Cab at one end. The remainder of the car would include a crew cabin large enough to shelter a crew of ten as well as provide storage for bulky tools and equipment. Previously, these facilities were provided in the passenger compartments of work motors and must be duplicated in the new locomotive driven consists. Since Control Cab Cars are needed for virtually all locomotive operations except snow removal, the quantity required (3) must match the quantity of locomotives used for work service.

2.2.2 Side-Dump Car

A side-dump car would be able to perform several useful functions for the Authority. The car could be used to deliver bulk material such as sand and gravel to job sites and to collect scrap materials, trash and debris generated along the right-of-way. The side-dump feature would also be useful in snow removal operations. In each case, the side-dump capability would allow rapid unloading without the substantial labor effort in double handling presently required. The present need for these functions appears to be sufficient to justify two side-dump cars.

2.2.3 Track Geometry Car

A track geometry car would be able to satisfy the needs for detailed technical inspection and quantitative analysis of track systems identified in Section 1.2.4. These include providing the highest possible level of system safety assurance, improving the effectiveness of track maintenance and renewal resource management, provinding precise evaluation of track section conditions to test the contract compliance of reconstruction or renewal work, measure field force performance on maintenance work or analize new methods or procedures implemented. Track geometry cars are widely used by railroads to accurately and efficiently perform such technical surveys of track systems; in the past few years, the New York City Transit Authority (NYCTA) has purchased a track geometry car and is successfully operating it at this time.

A track geometry car would have a large first cost (over $1 million) as well as substantial ongoing costs for skilled technicians to operate and maintain the vehicle and its sophisticated instrumentation. And, though the track geometry car would survey the entire CTA rail system twice each year and make frequent spot surveys as required, it would not likely be utilized on a full-time basis. As a result, rental or lease of a track geometry car would be the preferred method of acquisition. In this regard, the Authority has made periodic contacts with various manufacturers througout the years, but to date has been unable to locate a suitable vehicle for rental due to the atypical size and clearance standards of the CTA rail system.

The ability to perform quantitive technical analysis of the track system is essential for effectively maintaining a 250 mile railroad; and, since the purchase of a "customized" track geometry car is the only feasible means of acquiring these important capabilities at this time, the procurement of this vehicle is justified. It is recommended, however, that the Authority continue its periodic polling of manufactureres to explore the rental or lease alternative up to the time of the actual purchase.

2.2.4 Track Vacuum Car

The function of picking up trash and litter from the right-of-way is presently performed manually. A substantial savings in labor-hours as well as an improvement in the cleanliness of the system could be realized with the addition of an effective track vacuum vehicle. A suitable track vacuum car must be capable of collecting trash and litter along the right-of-way, particularly in the subway track invert and along underpasses, and hauling it to the 63rd Street Lower Yard, thereby eliminating most of the manual pick-up and handling requirements as well as the need for 55-gallon containment drums along the right-of-way. The car would also be useful for cleaning yard areas where the revenue cars are swept out and debris inadvertantly falls on the track or in other areas where debris accumulates on the right-of-way. It has been estimated by CTA staff members that much of the 23,000 labor-hours now spent annually collecting trash along the right-of-way could be eliminated or reassigned to other much-needed maintenance tasks if a suitable track vacuum car could be purchased.

Since the passenger service is provided seven days per week, 24 hours per day on virtually the entire CTA rail system, a track vacuum car must be able to perform effectively under traffic. It would probably have to be self-propelled and would need to effectively clean the right-of-way at a minimum speed of two-to-five miles per hour. The trash and litter would be collected in a hopper which might be self-contained with the unit or carried on a flatcar.

In the mid-1970's, CTA requested and received a Capital Improvement Program grant to purchase a track vacuum car. Field testing during the project indicated that a track vacuum car could effectively vacuum debris from the subway

track invert only at speeds less than one-half mile per hour using the available technology of that period. Since the track vacuum car would need to perform effectively at much higher speeds to operate under traffic, the project was abandoned in 1979 as impractical.

Since that time, new track vacuum cars have been placed in service in New York City and Atlanta with some encouraging results. Other properties which have utilized track vacuum equipment for many years (BART, TTC, PATCO, SEPTA, Montreal, Paris Metro and London Transport) have improved the productivity of their units through design modifications and/or changes in operating procedures. Despite these positive developments, it is still not possible to purchase a track vacuum car which could meet CTA's performance requirments and yield the substantial productivity improvements necessary to justify procurement. As a result, a track vacuum car is not included in the replacement schedule.

It is recommended, however, that the Authority continue to make periodic contacts with other transit systems and manufacturers to follow the progress of track vacuum technology. Also, if the hours of CTA rail system operation were cut back at some future time and track vacuuming did not have to be performed under traffic, several of the track vacuum car types in service on other properties might be able to yeild the target productivity gains.

3.0 OPTIMUM FLEET ROSTER

3.1 INTEGRATION OF NEEDS AND FUNCTION

The first step in the process of developing an optimum roster for CTA's non-revenue rail vehicle fleet involves the integration of the need identified in Section 1.0 with the functions listed in Section 2.0. Figure 2 shows the matrix which combines these two files to determine the number of each type of vehicle which is necessary.

The upper section of the figure shows the number of each type of vehicle required to satisfy each of the needs identified. Each row in the matrix represents a system need and lists the number of vehicles providing a particular function required to fulfill that need. A need has also been identified for spare vehicles based on the utility of the particular type of vehicle and the importance of its function. Each column represents a vehicle function and identifies the needs satisfied by that function as well as the number of vehicles required.

The first row below the matrix, which is entitled "Total Vehicle Need", lists the totals of each column of the matrix and represents the number of vehicles that would be required if no multi-function vehicles were available and vehicles could not be "shared" by several needs. The row entitled "Fleet Adjusted Vehicle Needs" lists the minimum number of each type of vehicle necessary to satisfy the Authority's needs. This row represents the optimum non-revenue vehicle fleet. The row entitled "Current Fleet Size" shows, by function, the number of vehicles in the Authority's present work car fleet.

3.2 OPERATION OF OPTIMUM FLEET

The operation of the equipment which comprises the optimum fleet of non-revenue vehicles can be described more easily by analyzing the work trains than the individual cars. With the exceptions of the snow removal vehicles, the track maintenance equipment and the yard vehicle tugs, all of the vehicles operate as, or in, units which travel over the system in the performance of their respective functions.

NEEDS / FUNCTIONS MATRIX

Sect.	Need	Work Car Requirement														
1.1.1	Mat'l to R.O.W.	2				2	6	2						2	1	
1.1.2	Trash Removal	1				1	1							1	1	
1.1.3	Mat'l to Skokie	1					3							1		
1.2.1	Rail Smoothing	1	1	1										1		
1.2.2	Profile/Line Track											1				
1.2.3	Track Renewal											1				
1.2.4	Track Geom. Analysis															1
1.3.1	Tow Cars to Skokie	3												3		
1.3.2	Tow Cars in Yards												2			
1.4.1	Remove Mod. Snow								6		5					
1.4.2	Remove Heavy Snow									3						
1.5	Heavy Lifting	2			2		1							2		
	Spare Vehicles	1				1	1		2	1	1		1	1		
	Total Vehicle Need	11	1	1	2	4	12	2	8	4	6	2	3	11	2	1
	Fleet Adjusted Vehicle Needs	6	1	1	2	3	12	2	8	0*	6	2	2	3	0**	1
	Current Fleet Size	4	1	1	3	2	9	2	6	1	6	1+	2	0	0	0

2.1.1 Locomotive (Set)
2.1.2 Rail Smoother
2.1.3 Tank Car
2.1.4 Crane Car (Set)
2.1.5 Derrick Car

2.1.6 Flat Car
2.1.7 Ballast Car
2.1.8 Snow Fighter (Set)
2.1.9 Snow Blower
2.1.10 Snow Removal Vehicle

2.1.11 Track Maint. (Set)
2.1.12 Vehicle Tug
2.2.1 Control Cab Car
2.2.2 Side Dump Car
2.2.3 Track Geometry Car

* This function can be performed by the 4 locomotives with snow blower attachments.

** This function can be performed by flatcars with portable, removable pivioting dump units.

Figure 2

3.2.1 Night Work Train

Two nightly work train consists are scheduled by the Authority. Each train normally includes two flatcars and a derrick car. Motive power is currently provided by two married pairs of work motors at each end of the train which are trainlined together through electric couplers to allow control over all of the work motors from either end of the consist. When the locomotives and control cab cars are placed in service they will replace the work motors. At that time provision will have to be made for both electric and pneumatic trainlines in order to control propulsion power and braking from a locomotive or a work motor respectively. The side-dump car will generally be included in the night work train consists.

3.2.2 Rail Smoothing/Weed Control Train

The rail smoothing train presently consists of the rail smoother and tank car which are semi-permanently coupled and two married pairs of work motors or revenue cars. Because of the need to operate this train at high speeds in order to run between revenue trains without causing service delays and because of the relatively light weight of the rail smoother and tank car, it is advisable to continue to use work motors or revenue cars for motive power and braking. Once each year for about one month the tank car is used as a water reservoir for treating the right-of-way with herbicides to control undesirable vegetation.

3.2.3 Day Work Train

When the demand exceeds the capacity of the two night work trains, daytime work trains may be scheduled to service locations where revenue trains can be routed around them or where deliveries can be made to terminals or out-of-service tracks. These trains typically consist of one or two flatcars, and a derrick or rail crane which are hauled (currently) with four work motors. The two ballast cars and the side-dump car may also occasionally be included in this train. This train is a heavy unit and therefore, whenever possible, should be hauled by a locomotive and control cab car instead of work motors.

3.2.4 Trash and Litter Train

This train would consist of a flatcar and a derrick car (in addition to hauling vehicles). Drums of trash which would be collected by hand would be loaded on to the flatcar by derrick and replaced with empty drums. This operation would provide the fastest possible removal of trash and minimize delays to following revenue trains. An alternate method would employ a side-dump car in place of the flatcar. Drums of trash would be lifted by derrick, dumped into the side-dump car and returned to their position in the subway track invert. This alternative would eliminate the need for extra drums but would probably take a longer time at each stop.

If a competent track vacuum could be purchased at some future time, that car along with a flatcar or a self-contained hopper would be used to pick up trash and litter directly and thus eliminate the need for manual collections and temporary storage in drums.

The trash and litter train should operate several times per week at night concurrently with the night work trains.

3.2.5 Skokie Shop Trains

This type of train is used to transport large vehicle components and assemblies, such as air conditioning units and trucks, between Skokie Shops and the eleven maintenance shops at rail terminals. A total of three flatcars would be required to meet the known demand. Flatcars would be hauled singly by two pairs of work motors or revenue cars. This train will operate primarily on weekdays during the midday base service period.

3.2.6 Snow Removal Trains

The snow fighter trains will continue to operate, as they do presently, clearing ice and moderate accumulations of snow from the right-of-way. In the event of a heavy snowfall, the locomotives will be equipped with snow blowers and brooms and operate as single units. The snow removal vehicles will also operate individually to clear snow down to the top-of-tie level, as they do currently.

3.3 DETERMINING THE MINIMUM NUMBER OF VEHICLES

The numbers of vehicles in the row "Total Vehicle Need" are the maximum quantities required to fulfill the Authority's non-revenue vehicle needs. Each of the vehicle types is analyzed to determine if one vehicle can be used to perform two or three functions which are normally scheduled at different times. Analysis was also performed to determine if modifications can be made to some vehicles so that they can be used to perform infrequently required functions as well as their normal tasks. Differences between the numbers of vehicles listed in Figure 2 in the row entitled "Total Vehicle Need" and the numbers in the row entitled "Fleet Adjusted Vehicle Needs" results from allowing a vehicle to fill several needs or perform several functions.

3.3.1 Locomotives and Snow Blowers

Two locomotives will be used to haul the two nightly work trains and any occasional day work trains, fulfilling the largest and most crucial needs identified in Section 1.1.1, hauling material from 63rd Lower Yard to job sites. A third locomotive will be used to haul the trash and litter train several nights each week fulfilling the needs identified in Section 1.1.2, picking up trash and litter from the right-of-way and to haul a third night work train as required during peak track construction/maintenance periods, fulfilling the balance of needs identified in Section 1.1.1. The relatively light hauling requirements for moving flatcars between Skokie Shops and the various rail maintenance terminal shops, identified in Section 1,1,3 and hauling the rail smoother identified in Section 1.1.4 will continue to be fulfilled by revenue cars. Three locomotives will be used to haul inoperable cars from terminals to Skokie Shops for repairs, thus fulfilling the need identified in Section 1.3.1. When locomotives are not available for this task, revenue cars will be used as they are currently.

The Authority also needs to have available four snow blowers to clear heavy snow accumulations. The three locomotives with snow blowers currently being procured by CTA will be available, along with S-500, throughout the winter season for snow removal, fulfilling the needs of Section 1.4.2. These new units are tentatively to be stationed at Rosemont, Harlem, and Howard Terminals with S-500 assigned to Skokie Shops.

In order to satisfy a wide variety of needs, identified with the smallest possible capital and operating investment, a plan has been designed which best serves the needs for both locomotives and snow blowers which utilizes six locomotives along with four snow blower attachments. In the winter season when the need for work train service is lightest, two locomotives would be assigned to haul the work trains and the trash and litter train while three locomotives along with S-500 would be deployed (as described above) to provide snow removal service, emergency towing and, whenever possible, to haul inoperable revenue cars to Skokie Shops for repairs. During the rest of the year when work train support for right-of-way construction/maintenance is more pressing, three locomotives would be used to haul night and day work trains and the trash and litter train while two locomotives would be deployed at various terminals for emergency towing service and, whenever possible, hauling inoperable revenue cars to Skokie Shops for repairs. Because of its design limitations, S-500 cannot practicably be used for tasks other than snow removal and as a back-up switching locomotive at Skokie Shops. This scheme allows the five similar locomotives to be interchanged as required and reduces, to a reasonable level, potential idle time on each piece of equipment, resulting from the seasonal nature of various system needs.

3.3.2 Tank Car

A tank car is needed both to carry water used to control the sparks resulting from rail smoothing and to transport a water supply to mix with herbicides to be sprayed along the right-of-way to control vegetation. Presently, the Authority performs weed spraying once each year, during which time rail smoothing operations are suspended. Therefore, the current practice of using one tank car for both purposes can be continued.

3.3.3 Derrick Cars

The need for a derrick car to remove trash and litter identified in Section 1.1.2 can be combined with the spare car needed to replace either of the two derrick cars identified in Section 1.1.1 for the night work train. Thus, only three derrick cars are required for the optimum fleet roster.

3.3.4 Control Cab Car

The rationale for reducing the number of control cab cars to three is basically the same as that used for the locomotives. It is sufficient to have one cab car for each locomotive which will be assigned to work train service.

3.3.5 Side-Dump Cars

Side-dump cars would have irregular use in night work train consists and in the trash and litter train. For this reason, a portable, pivoting (two-way) dump unit which can be mounted on flatcars appears to be an effective way to satisfy the need for this type of vehicle without having the vehicle sitting idle most of the time.

4.0 PLAN TO ACHIEVE THE OPTIMUM FLEET

The roster for the optimum non-revenue rail vehicle fleet has been defined. This section develops a plan with the goal of achieving that optimum fleet. The plan has been assembled so that the Authority can reach the goal in an effective and expeditious manner, but within the limits set by the availability of capital improvement funds. To perform this task, the procurement and overhaul costs for each piece of equipment in the optimum fleet has been determined and expressed in constant 1986 dollars. The condition of each vehicle, as well as its importance to the system, has been assessed in order to establish the unit's priority for replacement or overhaul. The anticipated service life of each piece of equipment also has been determined so that an ongoing capital improvement program for non-revenue vehicles is projected for the 20-year period starting in 1986.

The plan to achieve the optimum fleet by 1995 and maintain it through 2005 is shown in Figure 3. Vehicle and equipment procurements and overhauls are listed for each of the fiscal years of the 20-year plan on Attachment A. The plan lists all of the units either currently operated by the Authority or those identified in the optimum fleet. The column heading shows the fiscal year that events occur for each vehicle. The column entitled "*" lists purchases which are currently in progress or for which funding has been requested. The column "Next Order" lists the year in which the unit on hand in 2005 should be replaced with a new one. The events are designated by letters which have the following meanings:

P	Indicates the procurement of a particular unit and shows the funding year in which the purchase order is placed. FY funds would be available in the Spring of the following calendar year.
D	Indicates the delivery of a particular unit to the Authority.
OH	Indicates that a unit should be overhauled to restore it to an acceptable performance level.
R	Indicates that the unit should be retired from service.

REPLACEMENT & OVERHAUL PLAN for NON-REVENUE RAIL VEHICLES

Vehicle		FY #	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	Next Order
S-1	Rail Smoother				P		D/R					C								OH			2014
S-2	Tank Car						P	D/R				C								OH			2015
S-3	Rail Crane	D										C			OH								2010
S-363	Rail Crane	R																					N/R
S-367	Rail Crane							P		D/R		C									OH		2017
S-4	Bolster Car							P	D/R			C								OH			2016
S-212	Bolster Car							P	D/R			C								OH			2016
S-214	Bolster Car	R																					N/R
S-107	Flatcar		P	D/R								C						OH					2006
S-109	Flatcar		P	D/R								C						OH					2006
S-110	Flatcar		P	D/R								C						OH					2006
S-213	Flatcar			P	D/R							C						OH					2006
S-300	Flatcar								P	D/R		C							OH				2012
S-309	Flatcar								P	D/R		C							OH				2012
S-324	Flatcar								P	D/R		C							OH				2012
S-329	Flatcar								P	D/R		C							OH				2012
S-331	Flatcar								P	D/R		C							OH				2012
S-1500	Flatcar	P	D/R									C			OH								2005
S-1501	Flatcar	P	D/R									C			OH								2005
New	Flatcar	P	D/R									C			OH								2005
S-401	Work Motor						R																N/R
S-402	Work Motor						R																N/R
S-403	Work Motor						R																N/R
S-404	Work Motor						R																N/R
S-413	Work Motor						R																N/R
S-414	Work Motor						R																N/R
S-415	Work Motor						R																N/R
S-416	Work Motor						R																N/R
S-429	Work Motor						R#					R											N/R
S-430	Work Motor						R#					R											N/R
S-431	Work Motor						R#					R											N/R
S-432	Work Motor						R#					R											N/R
S-433	Work Motor						R#					R											N/R
S-434	Work Motor						R#					R											N/R
S-435	Work Motor											R											N/R
S-436	Work Motor											R											N/R
S-500	Snow Blower												OH						OH				2008
New	Locomotive	D											OH						OH				2008
New	Locomotive		D										OH						OH				2010
New	Locomotive		D											OH						OH			2010
New	Locomotive					P	D							OH						OH			2013
New	Locomotive					P	D							OH						OH			2013
New	Trk Geom Car											P		D									2019

Figure 3 (Sheet 1 of 2)

Vehicle		FY #	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	Next Order
MS-65	Vehicle Tug									P	D/R							P	D/R				2011
S-120	Vehicle Tug									P	D/R							P	D/R				2011
S-417	Snow Fighter						R#																N/R
S-418	Snow Fighter						R#																N/R
S-419	Snow Fighter						R#																N/R
S-420	Snow Fighter						R#																N/R
S-421	Snow Fighter						R#																N/R
S-422	Snow Fighter						R#																N/R
S-423	Snow Fighter											R											N/R
S-424	Snow Fighter											R											N/R
S-425	Snow Fighter											R											N/R
S-426	Snow Fighter											R											N/R
S-427	Snow Fighter											R											N/R
S-428	Snow Fighter											R											N/R
S-520	Snow Broom				P	D/R								P	D/R						P	D/R	2013
S-521	Snow Broom				P	D/R								P	D/R						P	D/R	2013
S-522	Snow Broom				P	D/R								P	D/R						P	D/R	2013
S-523	Snow Broom						P	D/R							P	D/R							2006
S-524	Snow Broom						P	D/R							P	D/R							2006
S-525	Snow Broom						P	D/R							P	D/R							2006
S-314	Derrick Car	P		D/R						OH		C						OH				P	2025
S-332	Derrick Car	P		D/R						OH		C						OH				P	2025
New	Derrick Car						P	D				C			OH						OH		2010
S-361	Ballast Car									P	D/R										OH		2017
S-362	Ballast Car									P	D/R										OH		2017
New	Cab Car	P		D								C				OH							2012
New	Cab Car		P	D								C				OH							2012
New	Cab Car			P	D							C				OH							2012
New	Side Dump						P	D/R				OH						P	D/R				2011
New	Side Dump			P	D					OH								P	D/R				2011
F6-555	Tie Crane						P	D/R										P	D/R				2013
New	Tie Crane	P	D											P	D/R								2009
New	Tie Crane	P	D											P	D/R								2009
New	Tie Inserter	P	D											P	D/R								2009
New	Tie Inserter				P	D												P	D/R				2013
RX-118	Profil'g Tamp			R																			N/R
CIP-7978	Profil'g Tamp #1		D						R														N/R
RX-119	Prod Tamper			R																			N/R
New	P/L Tamper			P	D										P	D/R							2010
New	P/L Tamper							P	D									P	D/R				2013
RX-120	Track Liner			R																			N/R
CIP-1773	Track Liner								R														N/R
F6-554	Track Broom									P	D/R							P	D/R				2011
New	Track Broom									P	D							P	D/R				2011
CIP-8225	Undercutter									P	D/R								P	D/R			2012
New	Undercutter				P	D									P	D/R							2008

Figure 3 (Sheet 2)

D/R Indicates that the existing unit should be retired with the delivery and acceptance of the replacement unit.

N/R Indicates that a vehicle in the Authority's current non-revenue vehicle fleet will not be replaced.

C Indicates that in 1995 these cars will be converted from 6000 family type automatic electrical couplers to the 2000 family type.

#1 Indicates the purchase of just a profiling attachment for the existing lining tamper.

R* Indicates that in 1990 six of the twelve snow fighters will be retired from snow clearing services and possibly converted to work motors

4.1 VEHICLE PROCUREMENT AND OVERHAUL COSTS

The costs associated with the procurement and overhaul of each of the vehicles and pieces of equipment in the optimum fleet have been estimated and are shown in Figure 4. The cost of purchasing new vehicles has been divided, where possible, into two elements. The first of these, listed in Figure 4 in the column entitled "Engineering and Design Cost" is the one-time cost of setting up the manufacture of a particular type of vehicle. The column entitled "Manufacturing Cost" gives the cost of building each unit once the design is completed and the tooling is assembled. These costs are listed separately to show the savings realized by purchasing a particular type of vehicle in groups rather than one at a time. These costs, in many cases, are significantly higher than a standard railroad vehicle which performs the same function. This is due to the special clearance and weight restrictions imposed by the system which are shown in Figure 5. The final column in Figure 4, which is entitled "Overhaul Costs", shows the cost of a major overhaul of each type of vehicle or piece of equipment which can be realistically rehabilitated.

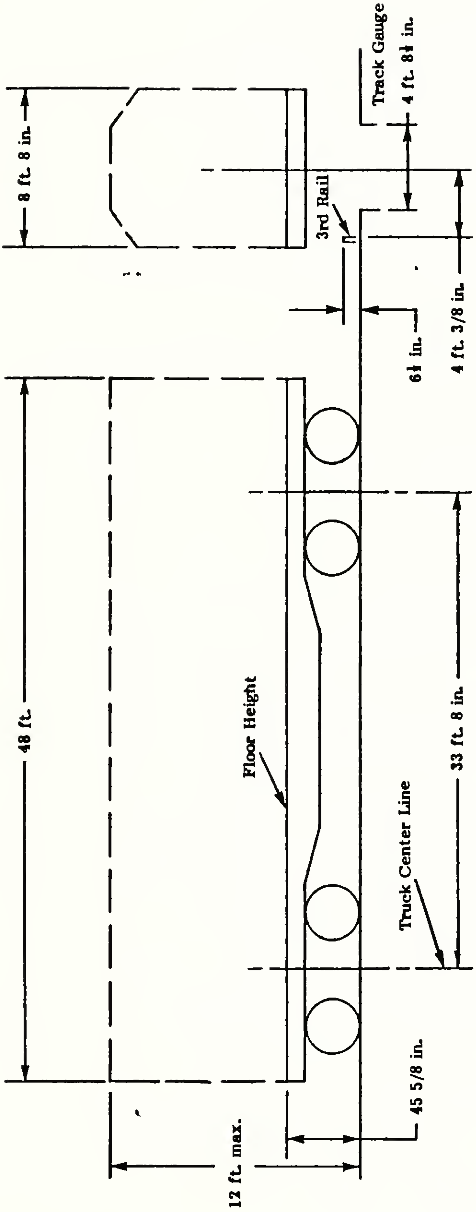
4.2 VEHICLE SERVICE LIFE

The service life of each of the units in the optimum fleet has been estimated and listed in Figure 6. The column entitled "Years to Replacement" gives an

VEHICLE PROCUREMENT COSTS

Vehicle Type	Engineering & Design Cost ($ x 1000)	Manufacturing Cost ($ x 1000)	Overhaul Cost ($ x 1000)
Rail Smoother	$150	$600	$200
Tank Car	$ 80	$300	$ 50
Rail Crane Car	$100	$750	$200
Bolster Car	$ 90	$250	$ 50
Flatcar	$ 80	$200	$ 50
Ballast Car	$ 90	$300	$ 50
Control Cab Car	$110	$325	$100
Track Geometry Car	$150	$950	$300
Vehicle Tug	$ 15	$100	N/A
Snow Removal Veh	$ 30	$100	N/A
Derrick Car	$100	$450	$125
Dump Attachment for Flatcar	N/A	$100	$ 35
Bridge/Tie Crane	N/A	$ 70	N/A
Tie Inserter	N/A	$ 85	N/A
Liner Attachment for CIP-7978	N/A	$ 55	N/A
Profiling/Lining Tamper	N/A	$230	N/A
Track Broom	N/A	$ 55	N/A
Track Undercutter	N/A	$190	N/A
Locomotive	$150	$750	$225

Figure 4



Maximum Gross Vehicle Weight 100,000 lb.

CTA RAIL CAR GEOMETRY

FIGURE 5

VEHICLE SERVICE LIFE

Vehicle Type	Years to Replacement	Delivery Time (Months)	Years to Overhaul
Rail Smoother	25	12 to 24	12
Tank Car	25	12 to 18	12
Rail Crane Car	25	12 to 24	12
Bolster Car	25	12 to 18	12
Flatcar	20	12 to 18	10
Ballast Car	25	12 to 18	12
Control Cab Car	25	12 to 24	12
Track Geometry Car	25	12 to 18	12
Vehicle Tug	10	6 to 12	N/A
Snow Removal Veh	8	6 to 12	N/A
Derrick Car	20	12 to 18	6
Dump Attachment for Flatcar	10	6 to 12	5
Bridge/Tie Crane	12	6 to 12	N/A
Tie Inserter	12	6 to 12	N/A
Liner Attachment for CIP-7978	12	4 to 6	N/A
Profiling/Lining Tamper	12	6 to 12	N/A
Track Broom	10	4 to 6	N/A
Track Undercutter	10	6 to 12	N/A
Locomotive	25	18 TO 36	1st O.H. @ 10 2nd O.H. @ 16

Figure 6

estimate of the number of years after the delivery of a new piece of equipment that it is no longer economically serviceable and should be replaced. The number of months required for the suppliers to deliver a vehicle to the Authority once an order has been placed is estimated in the column entitled "Delivery Time". The column "Years to Overhaul" gives the number of years after a particular piece of equipment is put in service, either as a new or overhauled vehicle, that it should be overhauled to maintain an acceptable level of performance. Several vehicles and pieces of equipment have been determined not to be worth overhauling because of the relatively high overhaul cost compared with the purchase cost of a new unit.

4.3 AVAILABLE CAPITAL IMPROVEMENT PROGRAM FUNDING

The anticipated Capital Improvement Program (CIP) funding available for the purchase and overhaul of non-revenue rail vehicles for fiscal years 1986 through 2005 is shown in Figure 7 in the column entitled "CIP Funding per Year". The projected funding for FY 1986 through 2001 is based on information from the Authority's "Recommended Replacement Plan for Service Vehicles" dated December 22, 1983, updated to 1986 dollars. Estimates for years 2002 through 2005 were not available, so the average of the preceding 16 years has been used. The average annual CIP funding for non-revenue rail vehicles is $1.2 million. The cumulative total of CIP funding for this 20-year period is $23.9 million in constant 1986 dollars as shown in the column entitled "CIP Funding to Date".

The column in Figure 7 headed "Projected Expenses" combines the equipment replacement and overhaul plan shown in Figure 3 with the procurement costs listed in Figure 4 and the cost of engineering and procurement management by the Authority to show the anticipated expenditures each year. The last column "Unspent Balance" gives the amount by which the projected funding differs from the projected expenditures over the term of the plan.

PLANNED USE OF PROJECTED CAPITAL IMPROVEMENT FUNDS

FY	CIP Funding per Year ($ x 1000)	CIP Funding to Date ($ x 1000)	Projected Expenses ($ x 1000)	Unspent Balance ($ x 1000)
1986	$ 1,185	$ 1,185	$ 1,171	$ 14
1987	$ 1,084	$ 2,268	$ 1,131	$ -47
1988	$ 1,451	$ 3,719	$ 1,558	$ -107
1989	$ 1,728	$ 5,447	$ 1,898	$ -170
1990	$ 1,666	$ 7,113	$ 1,645	$ 21
1991	$ 1,904	$ 9,017	$ 1,920	$ -16
1992	$ 1,132	$10,149	$ 1,242	$ -110
1993	$ 1,734	$11,883	$ 1,712	$ 22
1994	$ 0	$11,883	$ 0	$ 0
1995	$ 1,637	$13,520	$ 1,675	$ -38
1996	$ 720	$14,240	$ 811	$ -91
1997	$ 1,429	$15,669	$ 1,415	$ 14
1998	$ 1,428	$17,098	$ 1,409	$ 19
1999	$ 292	$17,390	$ 345	$ -53
2000	$ 0	$17,390	$ 0	$ 0
2001	$ 1,665	$19,054	$ 1,449	$ 216
2002	$ 1,200	$20,254	$ 1,282	$ -82
2003	$ 1,200	$21,454	$ 1,179	$ 21
2004	$ 1,200	$22,654	$ 868	$ 332
2005	$ 1,200	$23,854	$ 1,150	$ 50

Figure 7

5.0 RECOMMENDATIONS

The replacement and overhaul plan set forth in Section 4.0 for the Chicago Transit Authority's non-revenue rail vehicles provides the most rapid course to assemble the optimum fleet roster. This goal is reached in fiscal year 1995 with critical areas being addressed as early in the plan as the anticipated capital improvement funding is made available. It is recommended that the Authority make every attempt to standardize the vehicles purchased under the program as well as require that these vehicles be compatible with as many existing CTA vehicles as possible.

5.1 VEHICLE DESIGN STANDARDIZATION

Having standardized vehicles offers the Authority several significant advantages. It allows the Authority to maintain a smaller inventory of spare parts, thus potentially reducing its investment and increasing the probability of a needed component being in stock. Standardization also reduces the requirements for training of operating and maintenance personnel and for special tools thus avoiding considerable new out-of-pocket operating costs to the Authority. The goal of standardization can be achieved on the vehicle level as well as the subassembly level.

5.1.1 Standardized Vehicle

It is most advantageous for the Authority to strive for commonality in its vehicles and equipment. Procurement regulations which require competitive bidding limit the Authority's ability to negotiate with suppliers to achieve this goal. Means do exist, however, for the Authority to purchase standardized vehicles without violating the letter or the intent of these procurement regulations. One is to purchase as many similar vehicles in one procurement as possible. Allowing the supplier to manufacture a larger number of vehicles in a single lot not only will produce a family of similar vehicles, but also attracts more competition which will result in lower unit vehicle costs. To the extent that it was possible, this procurement approach has been incorporated in the vehicle replacement plan. The ability to do this has been restricted by the anticipated capital improvement

program funding levels and the severe need for a wide variety of vehicle and equipment types in the initial years of the plan.

Another means of achieving standardization is through option purchases. By including the option to purchase additional vehicles at some later date in the procurement documents and by requiring that they be identical to the initial lot, the Authority can gain a standardized group of vehicles delivered over several years without using procurement procedures which could be considered restrictive.

5.1.2 Standardized Subassemblies

The Authority can also strive for standardization at the subassembly level. By specifically defining subassembly interfaces and performance levels in the technical specifications for the vehicles, the Authority can achieve a high level of interchangeability between vehicle-types. Such subassemblies as trucks, air compressors and braking equipment can be controlled in this way. Since many of the vehicles in the optimum fleet are similar to conventional railroad freight cars, the use of applicable AAR standards for interfaces and performance will allow the Authority to purchase standard components and subassemblies from a large number of suppliers.

5.2 VEHICLE COMPATIBILITY

Having non-revenue rail vehicles which are compatible with a large number of existing CTA vehicles will allow greater operating flexibility for the Authority. There are three types of interfaces between vehicles which may be required to allow one vehicle to operate with another.

5.2.1 Couplers

The Authority currently has three different types of mechanical couplers in use. By far the predominant coupler is the Ohio Brass Form 5 which is used on all revenue cars and most non-revenue vehicles. It is therefore recommended that all new work cars be purchased with this coupler and that all current work cars be converted. This will allow any two CTA vehicles to be mechanically coupled together.

5.2.2 Air Brake Trainpipes

All new work cars ordered should be equipped with air brakes similar to those used on conventional railroad freight cars. The air brake system developed by the Authority utilizes two air brake trainpipes. A main reservoir pipe is trainlined in all operating modes to allow the train's compressor(s) to supply air to all of the reservoirs. A brake pipe is also trainlined for use when the vehicles are being hauled by a locomotive to permit application and release the brakes from either the locomotive or the control cab car. Neither of these air brake trainpipes need to be connected to work motors when these units are used in place of locomotives. In this case, the air brakes are controlled through the electrical trainwires and compressed air is supplied by electrically driven compressors on some or all of the work cars.

5.2.3 Electrical Trainwires

Two separate electrical trainwires will be needed to permit these vehicles to operate with both locomotives and work motors/revenue cars. To operate with a locomotive and control cab car, each vehicle will have an electrical trainwire consisting of approximately 50 wires which will be interconnected between vehicles through jumper cables. The purpose of this trainwire is to connect the control cab car with the locomotive.

The other electrical trainwire, which will consist of approximately 40 wires, is used when the vehicle is in a train propelled by work motors or revenue cars. This trainline is interconnected between vehicles through one of the two types of automatic electric couplers currently used by the Authority. This electrical train wire will enable the work motor cab at either end of the consist to control the brakes on the other work motors and work cars in the train.

It is presumed that vehicles belonging to the 6000 family of revenue vehicles will be available for use as work motors through about 1995. After this date only vehicles in the 2000 family of revenue vehicles will remain in operation. It is, therefore, recommended that vehicles delivered prior to 1995 should be equipped with automatic electrical couplers which are compatible with 6000 family vehicles. These vehicles should also be designed to facilitate conversion to 2000 family

electrical couplers. The capital improvement program budget, shown in Figure 7, includes $390,000 in the projected expenses for 1995 which is sufficient to convert the 24 vehicles in service with 6000 family electrical couplers to the 2000 family type. All vehicles delivered after 1995 should be equipped with 2000 family electrical couplers.

ATTACHMENT A

NON-REVENUE VEHICLE PROCUREMENT AND OVERHAUL PLAN

FY 1986 Through FY 2005

FY 1986		
Purchase of 3 Flatcars*		$ 680,000
Purchase of 1 Control Cab Car*		435,000
CTA Engineering and Procurement Administration		56,000
	FY 1986 Total	$1,171,000
FY 1987		
Purchase of 1 Flatcar*		$ 280,000
Purchaseof 1 Control Cab Car*		435,000
Purchase of 1 Side-dump Attachment for Flatcar		100,000
Purchase of 1 Profiling and Lining Tamper		230,000
CTA Engineering & Procurement Administration		86,000
	FY 1987 Total	$1,131,000
FY 1988		
Purchase of 1 Tie Inserter		$ 85,000
Purchase of 1 Track Uncercutter		190,000
Purchase of 1 Rail Smoother Car		750,000
Purchase of 3 Snow Removal Vehicles		330,000
CTA Engineering & Procurement Administration		203,000
	FY 1988 Total	$1,558,000
FY 1989		
Purchase of 2 Locomotives		$1,650,000
CTA Engineering & Procurement Administration		248,000
	FY 1989 Total	$1,898,000
FY 1990		
Purchase of 1 Water Tank Car		$ 380,000
Purchase of 1 Traversing Derrick Car		550,000
Purchase of 1 Side-Dump Attachment for Flat Car		100,000
Purchase of 1 Bridge/Tie Crane		70,000
Purchase of 3 Snow Removal Vehicles		330,000
CTA Engineering & Procurement Administration		215,000
	FY 1990 Total	$1,645,000
FY 1991		
Purchase of 1 Rail Crane Car		$ 850,000
Purchase of 2 Bolster Cars		590,000
Purchase of 1 Profiling and Lining Tamper		230,000
CTA Engineering & Procurement Administration		250,000
	FY 1991 Total	$1,920,000

* Indicates that this purchase is an option on a previous purchase.

NON-REVENUE VEHICLE PROCUREMENT AND OVERHAUL PLAN

FY 1986 Through FY 2005
(continued)

FY 1992		
Purchase of 5 Flatcars		$1,080,000
CTA Engineering & Procurement Administration		162,000
	FY 1992 Total	$1,242,000
FY 1993		
Purchase of 2 Vehicle Tugs		$ 215,000
Purchase of 2 Ballast Cars		690,000
Purchase of 2 Track Brooms		110,000
Purchase of 1 Track Undercutter		190,000
Overhaul of 2 Traversing Derrick Cars		250,000
Overhaul of 1 Side-dump Attachment for Flatcar		35,000
CTA Engineering & Procurement Administration		222,000
	FY 1993 Total	$1,712,000
FY 1994		
No Available Funding		
FY 1995		
Purchase of 1 Track Geometry Car		$1,100,000
Conversion of Electrical Trainwire Couplers on 26 Cars		390,000
CTA Engineering & Procurement Administration		185,000
	FY 1995 Total	$1,675,000
FY 1996		
Overhaul of 3 Locomotives		$ 675,000
Overhaul of 1 Side-Dump Attachment for Flat Car		35,000
CTA Engineering & Procurement Administration		101,000
	FY 1996 Total	$ 811,000
FY 1997		
Overhaul of 2 Bridge/Tie Cranes		$ 140,000
Overhaul of 1 Tie Inserter		85,000
Purchase of 3 Snow Removal Vehicles		330,000
Overhaul of 3 Locomotives		675,000
CTA Engineering & Procurement Administration		185,000
	FY 1997 Total	$1,415,000
FY 1998		
Purchase of 1 Profiling & Lining Tamper		$ 230,000
Purchase of 1 Track Undercutter		190,000
Purchase of 3 Snow Removal Vehicles*		330,000
Purchase of 1 Rail Crane Car		200,000
Overhaul of 3 Flatcars		150,000
Overhaul of 1 Traversing Derrick Car		125,000
CTA Engineering & Procurement Administration		184,000
	FY 1998 Total	$1,409,000

* Indicates that this purchase is an option on a previous purchase.

NON-REVENUE VEHICLE PROCUREMENT AND OVERHAUL PLAN

FY 1986 Through FY 2005
(continued)

FY 1999		
Overhaul of 3 Control Cab Cars		$ 300,000
CTA Engineering & Procurement Administration		45,000
	FY 1999 Total	$ 345,000
FY 2000		
No Available Funding		
FY 2001		
Purchase of 1 Side-dump Attachment for Flatcar		$ 100,000
Purchase of 1 Bridge/Tie Crane		70,000
Purchase of 1 Tie Inserter		85,000
Purchase of 2 Vehicle Tugs		215,000
Purchase of 1 Profiling and Lining Tamper		230,000
Purchase of 2 Track Brooms		110,000
Overhaul of 4 Flatcars		200,000
Overhaul of 2 Traversing Derrick Cars		250,000
CTA Engineering & Procurement Administration		189,000
	FY 2001 Total	$1,449,000
FY 2002		
Purchase of 1 Track Undercutter		$ 190,000
Overhaul of 3 Locomotives		675,000
Overhaul of 5 Flatcars		250,000
CTA Engineering & Procurement Administration		167,000
	FY 2002 Total	$1,282,000
FY 2003		
Overhaul of 1 Rail Smoother Car		$ 200,000
Overhaul of 2 Bolster Cars		100,000
Overhaul of 3 Locomotives		675,000
Overhaul of 1 Water Tank Car		50,000
CTA Engineering & Procurement Administration		154,000
	FY 2003 Total	$1,179,000
FY 2004		
Purchase of 3 Snow Removal Vehicles		$ 330,000
Overhaul of 1 Rail Crane Car		200,000
Overhaul of 1 Traversing Derrick Car		125,000
Overhaul of 2 Ballast Cars		100,000
CTA Engineering & Procurement Administration		113,000
	FY 2004 Total	$ 868,000
FY 2005		
Purchase of 2 Traversing Derrick Cars		1,000,000
CTA Engineering & Procurement Administration		150,000
	FY 2005 Total	$1,150,000