The impact of truck repositioning on congestion and pollution in the LA basin

Final Report

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Abstract

Pollution and congestion caused by port related truck traffic is usually estimated based on careful transportation modeling and simulation. In these efforts, however, attention is normally focused on trucks on their way from a terminal at the Los Angeles or Long Beach ports to a delivery point or on their way from a pick up point to a terminal. In general empty, repositioning routes, however, are generally discarded in the overall analysis of a truck's pollution and congestion impact, or at best a simple estimate is used instead. This is reasonable as long as it can be assumed that the drivers live very close to the port, a fact that may potentially change, however, in the near future. Namely if drivers will be required to deliver to and pick up from more distant inland ports - such as Victorville - instead of the ports.

It is usually assumed that any inland port location, since it will reduce congestion at the ports automatically will lead to a reduction of congestion and pollution *near the ports*. Little, however, is so far known about the real impact a potential inland port site such as Victorville would have on pollution and congestion *in the Southern California region*. Also little is known about the potential subsequent behavior of trucking companies. What if, for example, a company decides not to move close to an inland port site and hence the length of empty repositioning drives increases?

In this project we develop accurate data about the repositioning costs of trucks under current and future conditions. Namely, we first survey truck drivers and trucking companies to determine the locations where trucks are currently parked when not in use, and then determine a trucking company's willingness to move closer to a place such as a future inland port where most of their container transactions would be conducted.

Most trucks serving the LA/LB ports used to be owner operated. In interviews conducted with truck drivers inside the port complex and trucking company representatives we found that most drivers moving containers to and from the ports are no longer identifying themselves as owner operators and are now working for large or small trucking companies either as employees or subcontractors. As a result drivers are now repositioning their trucks – when not in use – to and from the yards of such trucking companies.

Second, at the example of the proposed Victorville inland port and using the California Air resource Boards EMFAC 2007 model we analyze the pollution impact of several possible repositioning and container distribution scenarios. We also discuss the resulting net impact on congestion and pollution in the LA basin under different assumptions about potential trucking company behavior. We develop several example scenarios that allowed us to test different hypotheses associated with inland ports.

We show that while an inland port such as Victorville has the potential to significantly reduce pollution and congestion in the region immediately surrounding the ports of Los Angeles / Long Beach; it also has the potential to be a catalyst for a dramatic spike in congestion and pollution in the Southern California region as a whole. We furthermore show that any effort to establish and set up an inland port must be executed in close cooperation and coordination with warehouse owners and the drayage industry. If warehouses and drayage companies do not follow the inland port it will have a negative effect on congestion and pollution in the region as a whole.

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Disclosure

Project was funded in entirety under this contract to California Department of Transportation.

1. Introduction

In recent months and years the effects of truck draying of containers on the air quality in the LA basin has received tremendous attention. Environmental concerns stalled expansion projects at the ports of Los Angeles and Long Beach. The twin ports of Los Angeles and Long Beach began on February 18, 2009 to collect new clean-truck fees that are funding a massive truck replacement program aimed at cutting diesel emissions. A $35 per-TEU fee is being collected on all inbound and outbound containers that are pulled by older, polluting trucks. PortCheck [17], an agency established by marine terminal operators to process fee collection, is billing cargo interests for the fees. Revenues are to be used to help motor carriers purchase 2007-model or newer clean diesel trucks or alternative fuel trucks that meet strict emission standards. The ports are committed to subsidizing up to 80 percent of the price of a new truck. Clean-diesel trucks cost about $100,000 each. The twin ports – which during prosperous times claimed to import 40 percent of the nation's goods – approved Clean Truck Programs in Fall 2008, which banned pre-1989 diesel engine trucks. The Clean Truck Programs [15, 16] furthermore banned pre-1994 trucks on Jan. 1, 2010. By January 2012, all diesel trucks with engines 2006 and older will be banned.

In 2007 the total number of containers handled at the ports of Los Angeles / Long Beach declined by 0.2% [4]. In 2008 the downturn accelerated with a decline of 8.5% while in 2009 the number of TEU's at the Los Angeles Port further declined by 14% and at the Port of Long Beach by 21.9% [8]. Through June 2010, however, container volume at the two ports increased again by 17%. At the Port of Long Beach import container volume (excluding empties) increased by 21.7% while export volume (excluding empties) increased by 16.2%. At the Port of Los Angeles import container volume (excluding empties) increased by 13% while export volume (excluding empties) increased by 17.2% [9]. While this represents a significant increase the total container volume remains below the peaks of 2006.

Given this newfound growth it is likely that the container volume at the local ports will soon reach and exceed these peak values. Hence to remain viable as the center of International trade for the United States the L.A. / L.B. ports and the Southern California region must look for alternative growth opportunities. One such promising approach that has received considerable attention and publicity in recent years is a so called inland port.

2. Background and Motivation

An inland port is a site located away from traditional land, air and coastal borders. It facilitates and processes international trade through strategic investments in multimodal transportation assets and by promoting value-added services as goods move through the supply chain [1]. Victorville, for example, has been suggested as a site for such an inland port. Victorville is about 80 miles from the ports (Figure 1), just north of the Cajon pass, one of the main surface road bottlenecks in the Southern California region.

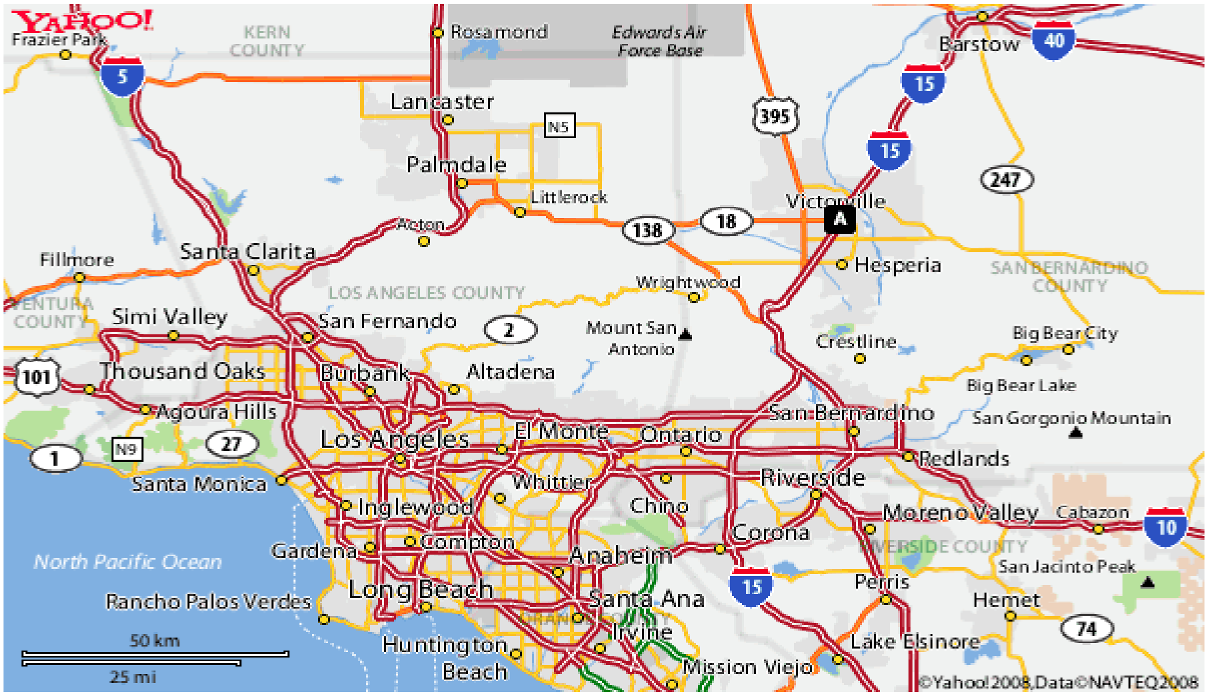

Figure 1: Southern California region including Victorville

Currently containers are transported by either truck or rail from the ports to their destinations or an intermodal or transloading facility. In general, containers whose destinations are east of the Rocky Mountains are transported by train. An inland port is attractive because it is believed that it would help divert most, if not all, truck traffic away from the marine terminals, thereby greatly reducing the congestion and pollution at or near the ports. Proponents of such an inland port at Victorville suggest that containers to be delivered by trucks could then first be transported by rail (using on dock rail whenever possible) to Victorville and then picked up by trucks there for transport to destinations within the LA basin or beyond. It is conjectured that this would not only allow the ports to grow through “offloading” but also lead to significant decrease in truck-based congestion and pollution near the ports, along the Alameda corridor (I-110 and I-710) and in the Los Angeles downtown area. Others, however, believe that at least initially most containers would be drayed by truck to Victorville and then from there delivered to their final destinations.

Rahimi, Asef-Vaziri, Harrison recently studied the general feasibility and requirements of potential inland port sites in Southern California and provided a guideline for integrating inland ports into the intermodal goods movement system based on the containers originating and terminating at the ports of Los Angeles and Long Beach (POLA/POLB) [2]. In this study the authors focused on the requirements on actual inland port sites. The conjecture that inland ports will lead to a reduction in congestion and pollution near the ports and the downtown area has never been really tested, however. In particular, it is not known whether an inland port such as for example, Victorville will actually lead to a reduction in congestion and pollution in the region as a whole even if in the ideal case containers are moved by rail from the ports to Victorville. While it appears likely that shipping most containers by rail directly out of the ports will lead to some reduction in air pollution and congestion near the ports, it is questionable whether such a reduction was not simply achieved by shifting traffic and pollution 50 to 60 miles further east. Consider the example of Victorville. Depending on the locations of the destinations of containers relative to Victorville, it is obvious that a certain percentage of goods would first flow out of the coastal area by rail and then flow back into the LA basin by trucks. Interstate 15 could suddenly become gridlocked, and the Cajon pass permanently congested.

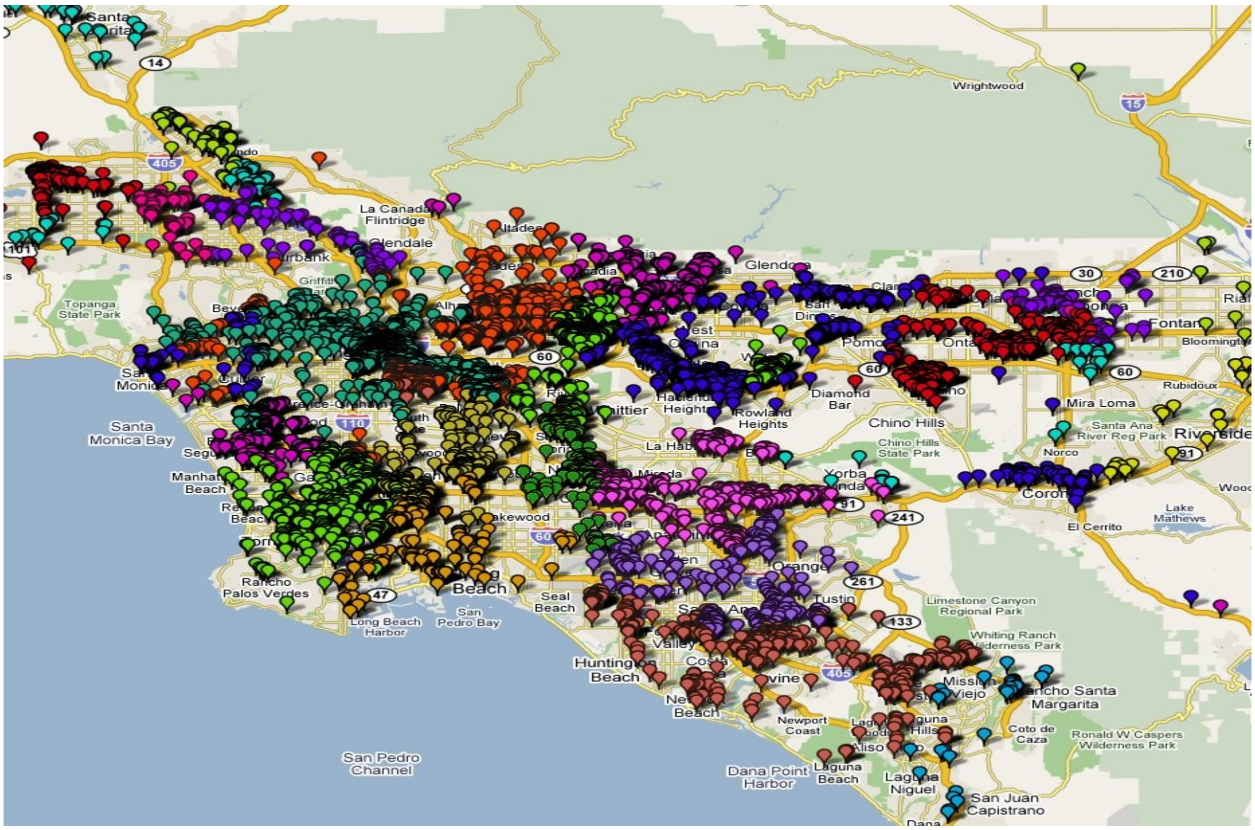

Figure 2: Location of warehouses in the Los Angeles basin

Also, what if - at least initially - mostly trucks instead of rail are used to deliver containers from the terminals to the Victorville inland ports site. Not much is known about the real impact of either scenario on congestion and pollution in the region.

Figure 2 shows the locations of warehouses and distribution centers in the LA basin that are serviced by trucks for deliveries to and pick-ups from the ports. An *empty repositioning route* is any unpaid route that a truck drives, for example to or from a truck driver's home or to or from a trucking company parking lot.
Many warehouses are in the western part of the region, so an inland port in Victorville may actually increase the length of repositioning routes and the distances trucks will have to drive. Congestion in the eastern part of the region may also significantly increase. Moreover, the distances that trucks will have to drive from pick up to drop off locations may increase significantly, leading to an increase in pollution in the eastern part of the Los Angeles basin. Truck drivers, furthermore may decide not to move close to the inland port site in Victorville. Hence the length of empty repositioning drives and hence

emissions may further increase. If finally mostly trucks are used to move containers from the ports to Victorville congestion and emissions everywhere may increase.

For several reasons, there are however, very few modeling results that allow to support or refute such claims:

1. There is no data about the length of empty repositioning routes under current conditions.
2. It is unknown how truck drivers and trucking companies will react once an inland port becomes a viable alternative. Will they move closer to the inland port site or simply decide to drive longer distances. Namely since the delivery and pick up points from and to the inland port will remain in their original locations most drivers and trucking companies may not see the need to move. As a result origins of traffic may not change, only the direction.
3. Because of a lack of repositioning data nothing is known about the impact of repositioning routes on pollution in the region. Moreover there is no good data about the repositioning route related impact of an inland port on pollution and congestion in the region.

In this study we provide this missing data set and develop modeling capabilities that allow us to test various hypotheses about the impact of inland ports on congestion and pollution in the region. While we only focus on empty repositioning routes in our pollution and congestion study, we believe that our results are indicative of the broader impact of such an inland port.
Performance measures are an important tool to compare the effectiveness of different strategies (whether to use an inland port and where to put it) in meeting given objectives. For this study, we chose performance measures that show how effective the given strategies are in mitigating pollution and congestion in the Southern California region. Since this is a planning study, the performance measures were also selected so that they could be implemented with existing tools and data. We evaluate the following measures:

- Changes in empty repositioning truck Vehicle Miles traveled (VMT). Truck VMT is directly related to the amount of congestion and pollution that can be attributed to port trucks.
- Changes in total fuel consumption. This will allow us to compare the impact of different scenarios on congestion and pollution in the region.
- Emissions (Pollution). Growth in empty repositioning port truck traffic leads to an increase in associated emissions of air pollutants. In this study, using the EMFAC 2007 model[18], we estimate the annual ton per year changes in emissions for the following pollutants: hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (C_{O2}), nitrogen oxides (N_{Ox}), and particulate matter 10 microns (P_{M10}) and fewer. All calculations are net changes taking into account all truck repositioning emission sources that are affected by a given strategy.

The performance measures are evaluated with reference to a set of baseline scenarios. The baseline scenarios result from the repositioning information obtained from truck drivers and trucking companies through interviews conducted with drivers inside the ports or with trucking company representatives through email.

Report outline:

1. We first take a closer look at the Port of Long Beach and Port of Los Angeles Clean Truck Programs (CTP). Our interviews with truck drivers and trucking companies show that the CTP already has had a tremendous impact on the drayage industry in the region.
2. We first determine the impact of an inland port such as Victorville on the length of empty repositioning routes. Through interviews with truck drivers and trucking companies we determine the current length of such repositioning routes. We then determine truck drivers and trucking company's willingness to move their home or place of business close to an inland port site. We make some prediction with respect to this willingness. This allows us to compute the current length of repositioning routes (baseline) and compare it with a predicted length of repositioning routes.
3. Using the information obtained in phase one and the California Air Resources Board's (CARB) EMFAC 2007 model [18] we determine the pollution and congestion impact of the current practice of truck repositioning. This will be our baseline for a comparison with potential inland port sites and inland port container feeding scenarios.
4. Again using EMFAC 2007[18] and based on our surveys and some choice predictions we next test different repositioning scenarios with respect to the Victorville inland port site to determine the pollution and congestion cost of each of these scenarios.
5. We conclude our study with recommendations.

In this study we perform a quantitative analysis of the net impact of an inland port on empty repositioning related distances driven and hence pollution and congestion in the Southern California region. In the consideration of establishing an inland port, one of the major stakeholders, the drayage industry must be involved. Their reaction to the proposed establishment of an inland port, wherever the final location may be, may help make or break the successful implementation of the proposal. Our findings in turn provide vital statistics that can help all stakeholders make informed decisions regarding their future operations.

2.1 Related Work

The Ports of Los Angeles and Long Beach recently conducted a truck driver survey that did not include empty repositioning routes [2].
Monaco and Grobar [3] completed a study about drayage at the ports. This study provides detailed information about truck drivers. They found, for example, that in 2004, 13.1% of truck drivers identified themselves as employees of trucking companies, 81.6% said they owned their trucks and 9.3% said their trucks were leased. Their study, however, does not consider the repositioning routes of trucks. Also given the rapid developments at the ports and as our interviews show some of the data provided in their study is already outdated.
Ergun, Kuyzu and Savelsbergh [6] developed optimization technology that can be used to assist in the identification of repeatable, dedicated truckload continuous move tours with little truck repositioning. Their study however assumes trucking companies and does not consider owner-operator trucks.

The government of British Columbia in Canada recently published a study that evaluates the effectiveness and impact of inland container terminals in British Columbia [7].

3. The Clean Trucks Program (CTP)

Our interviews with truck drivers and trucking companies inside the port complex show that the Port of Los Angeles (POLA) and Port of Long Beaches (POLB) Clean Trucks Program (CTP) has turned a large segment of the drayage industry in the Southern California area upside down. While in a survey as recently as 2004 [3], 81.6% of all truck drivers hauling containers to and from the ports identified themselves as owner-operators, in 2010 according to our survey this number has gone down to almost zero. What has caused – in the span of only 6 years - this dramatic change in the self perception of truck drivers? All indications point to the Clean Truck Programs.
Before discussing and analyzing our survey results in more detail we will hence first take a closer look at these programs.
There is strong evidence that the trucking ("drayage") system that serves the POLA and POLB negatively impacts the Southern California region through air pollution. Studies by the South Coast Air Quality Management District (AQMD) and the California Air Resources Board (CARB) have concluded that the more than two million people who live near the ports of Los Angeles and Long Beach face greater health risks than those who live in other parts of the region. According to the CARB study Southern Californians pay between $100 million and $590 million annually in health costs related to drayage truck pollution and will pay up to $10.1 billion between now and the year 2025.

3.1 The CTP at the Port of Long Beach

The POLB recently banned about 8,000 old, "dirty" diesel trucks under the stringent emissions limits of the Clean Trucks Program. At the time of writing (October 2010) it is estimated that about 90 percent of all truck engines now meet the strict U.S. Environmental Protection Agencies 2007 emissions standards, resulting in a pollution reduction of nearly 80 percent since the program began in 2008.

The Port of Long Beach started its Clean Trucks Program in October 2008 with a ban on all trucks built before 1989. As of January 1, 2010, all 1993 and older drayage trucks, as well as un-retrofitted 1994-2003 trucks are banned. However, following the California Air Resources Board's lead, about 1,300 trucks were granted temporary exemptions, for owners who have obtained grant funding but are still awaiting delivery. Approximately 250 more trucks have also been granted a temporary exemption if owners have executed a binding purchase agreement for a privately funded truck and are still awaiting delivery. For the exempted trucks, the owners had until the new truck is delivered or April 30, 2010, whichever came first.
The final deadline for implementation is Jan. 1, 2012, when all trucks entering Port shipping facilities must meet the EPA 2007 standard. The Clean Trucks Program was designed to cut emissions from big-rigs by 80 percent by January, 2012. However, the port now claims that the program has nearly achieved the 80 percent reduction already, because of a quicker-than-expected turnover of the trucking fleet [10]. Our surveys confirm these claims with respect to turnover speed.

3.1.1 CTP Overview

The Clean Trucks Program requires drayage truck owners to replace older, more polluting trucks working at the port. The Port of Long Beach CTP also includes truck registration requirements to identify so called "clean" trucks; ensures reliable short-haul service; and improves air quality, security, and safety[10]. It is estimated that trucks that meet the federal 2007 emission standard produce on average 80 percent less air pollution than older trucks.

3.1.2 Motor Carrier Registration

The program restricts access to the Port of Long Beach to port-permitted trucks. The port only grants access to trucking firms that:

• Submit a completed Motor Carrier Registration and Agreement form with $250 registration fee (if applicable).

• Register their trucks with the port through the Port Drayage Truck Registry (PDTR).

• Meet port "clean truck" standards.

• Use drivers that meet security requirements including enrollment in the federal Transportation Worker Identification Credential (TWIC) program.

• Tag their vehicles with radio-frequency identification devices so the port can monitor compliance.

The Port of Long Beach implementation of the Clean Trucks Program does, however, not explicitly exclude owner-operator truck drivers from working at the port. Licensed Motor Carriers are allowed to use employee drivers, independent contractor drivers, or a combination of employee and contractor drivers - as before.

3.1.3 Truck Ban Schedule

The following deadlines were established:

• On October 1, 2008: All pre-1989 trucks were banned.

• On January 1, 2010: All model year 1989-1993 trucks were banned from port terminals. Trucks with engine Model Years 1994 to 2003 are allowed access only if equipped with a level 3 verified diesel emission control system (VDECS) that also achieves a minimum 25 percent reduction in NOx emissions. Trucks with engine Model Years 2004 and newer will continue to have access until January 1, 2012

• On January 1, 2012: All trucks that do not meet the 2007 federal clean truck emission standard will be banned from port terminals.

3.1.4 Clean Trucks Fee

On February 18, 2009, the port began collecting a temporary Clean Trucks Fee of $35 per loaded twenty-foot equivalent container unit (TEU) to help finance truck replacement. Only loaded containers moved by trucks with 1994-2006 Clean Truck Program compliant engines are assessed the $35 per TEU fee and the fee is charged to cargo owners.
The fee will expire, or "sunset," in 2012 when all trucks are expected to have been replaced by 2007 or newer models. Cargo owners can be exempt from paying the Clean Trucks fee if they utilize a clean truck. The fee does not apply to containerized cargo moving through the port on rail. Unlike PierPass, the Clean Trucks Fee is also charged on

domestic cargo (for example, mainland trade destined for Hawaii, Guam, or Alaska). The Fee also applies to cargo trucked to rail yards outside the port. The fee is collected through PortCheck[17], an organization created specifically to collect the Clean Trucks Fee from cargo owners. PortCheck operates similar to the existing PierPass. Fees are collected from cargo owners via an online, internet based system. A cargo owner must "claim" cargo before it is allowed to be moved.

3.1.5 Port of Long Beach Clean Trucks Lease Subsidy Program

As part of the Port of Long Beach Clean Trucks Program, applicants seeking financial support to retrofit their old truck(s) or purchase new trucks were eligible to apply for any of three potential funding options:

1. Subsidized Lease-to-own

Applicants can receive funding for a pre-approved new truck under a 7-year lease agreement that is subsidized by up to 80% by the Port. The monthly payments for drivers could be as low as $300 for both diesel and alternative fuel/LNG trucks. This also includes prepaid preventative maintenance, paid by the Port. The port's maximum subsidy for LNG trucks ($137,000) is more than double that for diesel trucks ($68,000).

2. Subsidized Loan

In this case applicants receive funding for a pre-approved new truck, but must secure their own financing based on their credit. Successful applicants receive a Port grant of $67,000 for a clean diesel truck or $105,000 for an LNG truck. The Port's grant is paid out over seven years.

3. Retrofit Grant

Finally the Port provides a one-time upfront grant of up to $20,000 towards the purchase of retrofit equipment for trucks with 1994 – 2003 model year engines. The retrofit must be a California Air Resources Board (CARB) approved VDECS retrofit device that achieves at least a PM reduction of 85% and a NO_x reduction of 25%.

3.2 The Port of Los Angeles Clean Truck Program

We next briefly describe the POLA CTP.

3.2.1 POLA CTP Objectives

The POLA states as its goals to,

1. Encourage private investment and procurement of new trucks quickly [11].
2. Encourage investment in cleaner, greener trucks by providing logical exemptions and strong subsidies for both private and publicly funded alternative fuel trucks and trucks powered by emerging technologies[11].
3. Accelerate the transition of port drayage toward an asset-based system where proper truck maintenance will help ensure fewer emissions output over the life of the truck [11].

Especially the third goal led to the main difference of the port of LA's CTP and the Port of LB's CTP. Namely, the POLA eventually **bans all owner-operators** from access to the POLA with the need for proper maintenance as the main justification for this ban. The port argues for the need of the ban by claiming that the owner-operator model is not feasible for long term sustainability of the CTP. The port believes that an owner-operator will not have the funds to continue to properly maintain his/her clean truck.

3.2.2POLA CTP Long-Term Sustainability

The CTP argues that to ensure that truck drivers have the capital to maintain their new trucks and to fully leverage them as assets toward the purchase of future trucks it is not enough to provide truck funds to individual drivers who basically cannot afford new trucks. Therefore to fix the – in the Port of LA's view – broken drayage system the CTP is designed to, encourage private investment, accelerate the transition of port drayage toward an asset-based system and allow concessionaires to build equity that can be used to acquire funding for future truck investments.
The POLA claims that the ban of the owner-operator model is a sufficient condition to achieve these goals.

3.2.3 Operational Safety and Security

In the view of the POLA CTP the ban of owner-operators provides a greater degree of control over drivers so that concessionaires, since they are now employers, are responsible for and can ensure that drivers and trucks meet security and safety standards. In other words the POLA CTP wants to make drayage companies responsible for drivers instead of the Port itself being responsible for the drivers that access the port. The CTP is also designed to make it easier for California Highway Patrol and other authorities to identify and directly connect both the driver and the truck with their concessionaire employer/truck owner. The CTP pushes all driver accountability problems to intermediate companies that are required to track and supervise their employees.

3.2.4 Optimal Efficiency

The POLA CTP sees the burden of inefficiency (traffic, excessive fuel consumption, wasteful idling and extra truck trips) in the pre 2008 drayage system as being put on the truck driver. It sees no reason to support the drayage industry within the current system. The new regulations, however, are supposed to provide concessionaires with a structure that makes it efficient to dedicate trucks and resources to the drayage industry.
The CTP gives additional reasons why the new system will increase efficiency. It is mentioned that as a result of the CTP multiple employees would more commonly as before be able to drive a single truck. Hence fewer trucks could pick up more containers, and common trucking industry technology, like on-board GPS tracking, could help concessionaires operate in an efficient manner.

3.2.5 Accountability to the Port Adjacent Communities

To protect the port adjacent communities the POLA CTP also disallows on-street truck parking. This means that drivers will now be required to park their trucks on the parking lot of a port concessionaire instead of on a local street.

3.2.6 Financial Components

Unlike the POLB CTP, the POLA CTP only provides grants to Licensed Motor Carriers and not individual truck owner-operators. Only the network of approved concessionaires is allowed to access the ports terminals [12]. Instead of being based on a complex network of 1,000+ LMCs and 16,000+ independent owner-operators, the POLA CTP aims to create a system that is based on hundreds of employee-based concessionaires

A POLA funded study performed by the Boston Consulting Group (BCG) [13], concludes that the current drayage system imposes between $500 million and $1.7 billion of costs on the public each year through: operational inefficiencies (e.g. impact on truckers and trucking companies of truck under-utilization, traffic congestion and lack of driver health/benefits); city/community costs (e.g. road maintenance, environmental damage, vehicle and driving safety and residential impacts from truck traffic and parking); and, above all, public health (premature death, hospital admissions, workday and school-day loss, and restricted activity).

In this study the new costs created by the CTP are viewed as to be less than the externalized, public-borne costs ($500 million to $1.7 billion annually) and are hoped to be offset by a transformed drayage market. According to BCG's analysis the proposed employee based system is supposed to already deliver a positive cost-benefit ratio [13]. These changes are hoped to provide the foundation for a "green growth" strategy for moving projects forward successfully, increasing port capacity to accommodate future cargo volumes, significantly reducing port related air emissions in the decades ahead, and creating nearly 72,000 permanent jobs upon full build-out of a cleaner, modernized Port[11].

3.2.7 Owner-operator Controversy

Unlike the POLB CTP, the POLA's CTP requires truck drivers to be employees of trucking companies. The American Trucking Association (ATA) hence in 2008 sued the Port of LA arguing that the plan was not in compliance with federal laws dealing with transportation safety and interstate commerce. A federal judge, however, in the summer of 2010 upheld the Port of Los Angeles' "clean trucks" plan to require drivers moving through the port to comply with hiring and maintenance rules.

In her ruling, the judge rejected arguments from the ATA. ATA is appealing the ruling. ATA also plans to ask the court to maintain the legal status quo, keeping in place an injunction against the port's ban on independent owner-operators, off-street parking, and other provisions until an appeals court reviews the case.

The judge ruled that the employee provision would ensure that drivers have the available funds to maintain the environmentally friendly truck fleet, protecting the port's financial investment in subsidized vehicles. The ruling said the port's concession agreements were a "business necessity" that allowed harbor officials to protect its financial interests, and that air pollution from trucks had jeopardized the port's future as a commercial enterprise, with lawsuits over emissions stalling growth at the harbor for seven years.

As a result of the ruling the Port of Los Angeles board agreed to an amended timetable for implementing the terms of its CTP. Under the new timetable, the port would phase in its ban on owner-operators with a requirement that 20 percent of all truck moves be made by employee-drivers by the end of 2011, 66 percent by the end of 2012, and 100 percent by the end of 2013. Drayage companies will have until Jan. 1, 2011 to submit an off-street parking plan and until July 1, 2011 to implement that plan. The record-keeping provision for companies will begin immediately. The port has also started charging the

$2,500 first time concession application fee as well as the annual $100 per truck fee. All new companies applying for concessions will have to prove their financial capability.

4. Interviews with truck drivers and trucking companies

4.1 Impact of the POLA CTP on the POLB

Because of the close physical proximity of the POLA and the POLB the truck driver employee requirement of the POLA appears to already have had an immediate impact on the overall drayage industry that accesses both the POLA and the POLB. Our interviews with truck drivers inside the port complex and trucking company representatives via email show a striking picture.

During the summer of 2010 we interviewed drivers and trucking companies that account for approximately 26.5% of all trucks picking up and dropping off containers at the Ports of LA and LB. Our interviews were conducted in person inside the POLA/POLB or via email using the concessionaire's lists of the POLA [12] and POLB [16]. For our interviews inside the Port complex we used a central location (lunch truck) inside the POLA complex that was frequented by drivers on their way to and from a terminal. In these interviews we encountered almost no drivers or trucking company representatives that identified themselves as owner-operated. This is in stark contrast to 2004 when 13.1% of truck drivers identified themselves as employees of trucking companies while 81.6% said they owned their trucks and 9.3% said their trucks were leased[3]. Even in cases where a driver stated that his company owned a single truck he did not consider himself as an owner-operator in the pre 2008 sense but as a company employee or contractor.

Almost all drivers and company representatives we spoke to mentioned that - in their view - the drayage industry is going through a powerful transition phase. The drivers remarked that even without the owner-operator requirement of the POLA the terms of the CTP at both the Port of LA and Port of LB are such that owning a clean truck for an owner-operator is practically impossible. Drivers we spoke to said that even with a clean truck grant the remaining 20% of the cost of a new truck are unaffordable for owner-operators.

Hence to access additional financing the drivers were forced to either become employees of existing trucking companies or to join with fellow drivers in umbrella companies that would have the means to obtain truck financing and become port concessionaires. This combined with the POLA's decision to eventually completely ban owner-operators seems to have led to the faster than anticipated if not yet disappearance but at least change in self perception of owner-operators at the POLA and POLB.

Since most drivers serve the POLA as well as the POLB the fact that the POLB does not require drivers to be employees of a trucking company did not stop or slow this powerful shift. In addition the economic downturn of 2008/2009 likely also contributed to the accelerated demise of these owner-operators.

Initially the overall speed at which the self identification of owner operators has changed seems astounding but given this new set of powerful circumstances it is not surprising. The tremendous financial pressures of the CTP, the eventual ban of owner-operators and the economic downturn combined to a perfect storm for the port accessing drayage industry in the region. While owner-operators may still be working at the ports this change in self identification is likely indicative of a larger change still to come.

4.2 Survey results

The Port of Los Angeles Gate Move Data Analysis [14] and the Port of Long Beach's Truck Move Data Analysis [15] show that in August 2010 8254 distinct trucks were in use at the Port of Los Angeles, while 8831 trucks were in use at the Port of Long Beach. After cross referencing the trucking concessionaire's lists of the Port of Los Angeles [12] and Port of Long Beach [16], we arrived at 10,318 unique trucks that were accessing the twin ports in August 2010.

Our surveys of truck drivers and trucking companies were executed during the summer of 2010 both through in person interviews with drivers inside the port complex (lunch truck inside POLA) as well as through email interviews with trucking companies. We obtained email addresses of concessionaires from the concessionaire's lists [18, 21]. Our interview requests were answered by drivers and trucking company representatives that account for 65 trucking companies with 2736 trucks, a response rate of 26.5%.

In Table 1 we list the concessionaires that responded to our interview questions. All company names are replaced with numerals to protect the anonymity of the responding companies and drivers. In our interviews we asked the trucking companies how many port accessing trucks they operate and how many port trips each truck made per day. Because of restrictions on truck parking of the CTP, trucks –when not in use - are now, as we were told, exclusively parked on trucking companies yards. While this may not always be accurate it serves as a good baseline for our analysis. Hence given the address of each company and using Google Maps we computed the distance of each parking location from a fixed location on Terminal Island in the center of the twin port complex. The size of our sample ensures its representativeness for all the trucking companies in the region. The clusters of companies visible in Figure 3 coincide with trucking company locations in the region.

The POLA Cargo Move Analysis [19] breaks drayage companies down into three groups, small (less than 20 vehicles), medium (20 to 100) and large (100). Our survey shows a prevalence of companies of medium size. While a majority of companies registered have a small fleet (<20 trucks), the largest number of trucks is operated by the companies with a medium sized fleet. Moreover the largest percentage of gate moves is also done by the medium fleet sized companies.

In the first part of our survey we conducted interviews outside a lunch truck at the POLA. This survey hence is a random sample of trucks, not companies. It has to be skewed towards the companies that make the most container moves hence to the companies with larger populations. However, this is at the same time a representative sample of who is moving containers, not of companies who register. In the second part of our survey with emailed a questionnaire to all registered companies. This again skews to the companies that have staff to answer such emails and overall to the companies that make most of the container moves. Hence overall our survey is not a representative survey of trucking companies but rather of trucks that make gate moves. As such it is representative for our analysis of the impact of repositioning routes.

Number of Trucking Company	Number of trucks Accessing ports	Number of Trips per day per truck	Distance of truck parking location from port
1.)	15	1	11.1
2.)	40	1	136
3.)	28	4	8.2
4.)	20	3	7.8
5.)	11	1	5.5
6.)	24	2	22.1
7.)	33	3	21
8.)	35	3	11.4
9.)	33	3.5	4
10.)	28	3	3.8
11.)	1	2	41
12.)	2	3	5.8
13.)	33	0.2	20.5
14.)	37	1	3.9
15.)	128	2.5	12.6
16.)	75	2	8.6
17.)	52	4	11.2
18.)	3	0.2	76.8
19.)	37	2	8.3
20.)	35	2	26.9
21.)	10	2	11.2
22.)	100	3	87.7
23.)	10	2	24.7
24.)	10	2	12.6
25.)	10	2	20.1
26.)	50	4	3.8
27.)	50	4	3.6
28.)	53	3	61.5
29.)	54	4	13.4
30.)	55	2	3.4
31.)	65	3.5	4.7
32.)	100	2	13.5
33.)	9	2	65
34.)	15	1	13.5
35.)	5	10	3.3
36.)	500	3	2.9

37.)	6	1	109
38.)	3	2	131
39.)	60	2	57
40.)	50	2.5	53.4
41.)	1	2.5	12.5
42.)	15	4	1.8
43.)	12	4	16.4
44.)	20	4	3.4
45.)	100	2.5	4.4
46.)	135	2	1.9
47.)	30	3	13.6
48.)	8	2	21.3
49.)	70	1	130
50.)	12	2	11.3
51.)	1	2	8.9
52.)	3	3	22.1
53.)	45	1	49.4
54.)	3	3	3.4
55.)	40	4	3.4
56.)	15	5	9.1
57.)	45	3	3.8
58.)	30	2	9.3
59.)	15	3	8.2
60.)	5	3.5	13.8
61.)	15	3	3.4
62.)	150	2	67.4
63.)	30	3	6.4
64.)	25	1	3
65.)	26	2	8.2

Table 1: Interview results

In our interviews with trucking companies we found that most trucks make on average one empty repositioning trip – either from the port to a trucking companies yard or from the yard to the ports – per day. We met only two drivers at the ports that stated that they owned their trucks outright. Some drivers that previously worked at the ports but who are not in possession of a clean truck that can enter the port complex, may, for example, now move containers from rail yards to warehouses. There appear to be some drivers with old, so called "dirty" trucks that pick up (and deliver) containers from and to locations just outside the ports that were brought there or will be picked up from there by clean trucks. This practice, however does not seem to be very widespread at this time.

4.3 Future Truck yard location under Inland Port assumption

We also asked trucking companies / drivers whether they would consider to move closer to an inland port such as Victorville if such a Port would become reality. Almost all companies and drivers did not really have a satisfying answer to this question. A common answer was that they are in a fight for their survival that makes it very hard for them to realistically think about such a hypothetical scenario. The companies that answered the question seemed to be reluctant to immediately move near an inland port. They said that they would more likely follow their customers, that is, if their warehouse customers move they would also move. In general most trucking company yards and hence truck parking locations are close to their warehouse customers. It appears that the drayage industry in general follows its warehouse customers. Figure 3 shows the survey distribution of truck parking locations in the Southern California region. In our survey sample there are four noticeable clusters of trucking companies – (i) a cluster of companies within 30 miles of the ports, namely near port and downtown, (ii) a cluster of companies between 40 and 70 miles from the ports, namely Ontario and the Inland Empire, (iii) a cluster of companies between 80 and 90 miles from the ports, namely Hesperia and (iv) a cluster of companies between 120 and 140 miles from the ports, namely the San Diego area. Our survey shows a surprisingly large number of trucks that are based near San Diego and that pick up and drop off containers at the POLA and POLB.

4.4 Data Analysis under current conditions

Throughout the data analysis of our study we assumed for comparison purposes the inland port to be located in Victorville CA. Our methodology could easily be applied to any other potential inland port location. We initially divided all survey respondents into 15 subgroups based on the distance of their yard location from the ports. We will use this grouping for the first part of our analysis. So if, for example, a truck is parked between 0 to 10 miles from the ports it always is represented in the first column of figures 3-20. If it is parked 10-20 miles from the ports it is represented in the second column and so on. Figure 3 shows the number of trucks that are currently – when not in use - parked in 10 mile distance increments from the ports. That is the first bar represents all trucks parked up to 10 miles from the ports, the second bar from 10 to 20 miles from the ports, the third from 20 to 30 miles and so on.

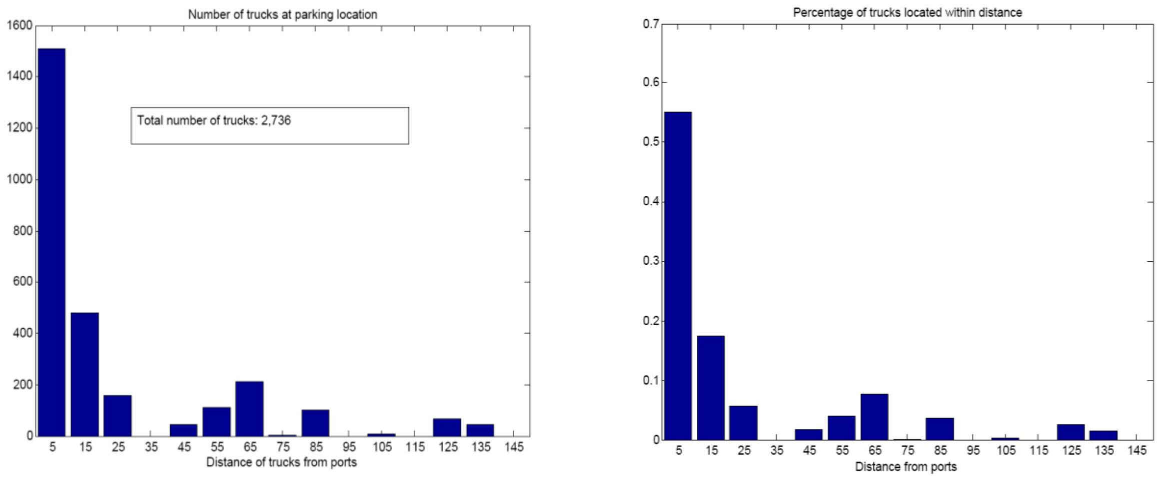

Figure 3: Number of trucks parked at different distances from the port

Figure 3 shows that our survey accounts for 2,736 trucks. About 55% of these trucks are parked within 10 miles of the ports when not in use. 18% are parked between 10 and 20 miles from the ports. There are several smaller groupings, most noticeably between 60 and 70 miles from the ports, representing the Inland Empire and between 80 and 90 miles, the Victorville-Hesperia area. A small number of trucks are also parked in the San Diego area when not in use, leading to empty repositioning routes to and from San Diego.

Based on our survey we assume that each truck makes on average one empty repositioning trip per day it is in use, either from the parking location to the port or from the port to its parking location. We furthermore assumed 310 truck working days per year. Under these assumptions we then studied the impact of these routes on congestion and pollution. For congestion we consider empty repositioning Vehicle Miles traveled (VMT). Figure 4 shows the current VMTs as empty repositioning routes per year based on the distance from the ports at which a truck is parked and the percentage of the total annual VMT generated.

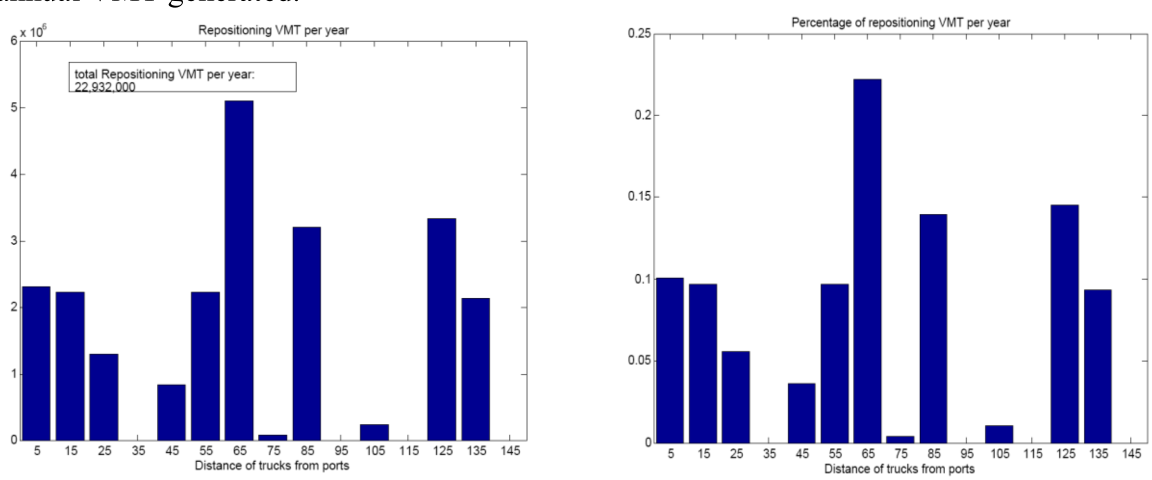

Figure 4: Current repositioning VMTs per year

We note that the trucks parked in the Inland Empire – at a distance of about 60-70 miles from the port generate the by far largest share of empty repositioning VMTs per year. These trucks would likely benefit the most from an inland port. They amount to less than 10% of the trucks surveyed but account for more than 20% of the annual VMT of all trucks. The trucks parked within 10 miles of the ports which amount to more than 50% of all trucks surveyed on the other hand account for only 10% of annual empty repositioning VMT. Another large contribution of about 25% to the annual VMT comes from the less than 5% of trucks parked in the San Diego area. The slightly more than 20% of all trucks that are parked more than 30 miles from the ports account for almost 75% of all empty repositioning caused congestion in the Southern California region.

4.4.1 Environmental Analysis under current conditions

The distribution of VMT from Figure 4 transfers directly to a pollutant analysis. Since within the next two years all trucks entering the ports must be model year 2007 or later we assume in our pollution analysis that all trucks are model year 2007 or later. For this analysis we again assume that each truck performs one empty repositioning trip per day it is in use (with 310 truck working days per year) from its parking location to the ports or vice versa. We only consider these empty repositioning routes in our analysis. This pollution data for empty repositioning routes under current conditions will serve as our baseline and allow us to evaluate several other hypothetical scenarios where we assume that some or all containers move to an inland port or that some or all trucks move closer to or near an inland port. All pollution numbers are generated using the California Air Resource Boards (CARB) EMFAC 2007 model [18]. Figure 5 shows the annual Hydro Carbon (HC) output in tons. We again use the same classification of trucks based on their parking distance from the ports.

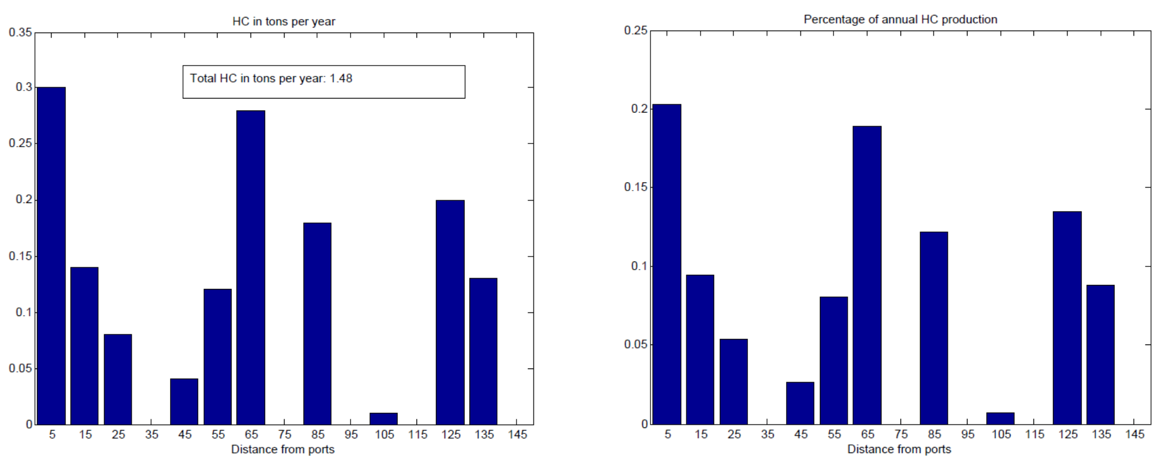

Figure 5: Annual HC output for one empty repositioning route per day (in tons) based on parking distance from port

Again the less than 10% of trucks located 60-70 miles from the ports account for almost 30% of all repositioning related HC pollution while the about 56% of trucks located within 10 miles of the ports account for “only” 20% of annual repositioning HC pollution. The contribution of trucks parked in Hesperia and San Diego is also very significant. At first glance it appears as if these trucks may benefit the most from an inland port in Victorville.

In Figure 6 we see the annual CO output. Here the previously made observation of the pollution contribution by the minority of trucks located more than 30 miles from the ports is even more striking. They account for almost 77% of all repositioning related CO pollution.

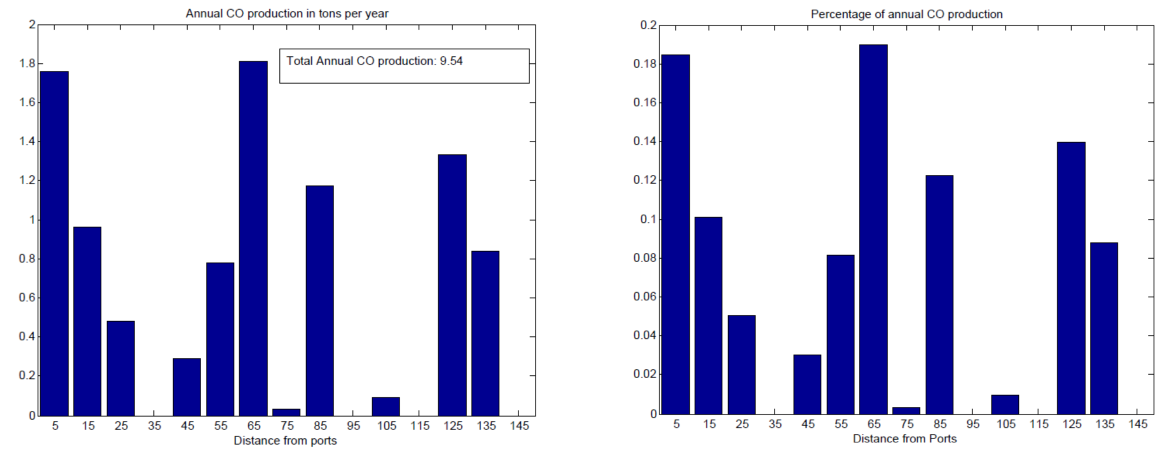

Figure 6: Annual CO output for one empty repositioning route per day (in tons) based on parking distance from ports

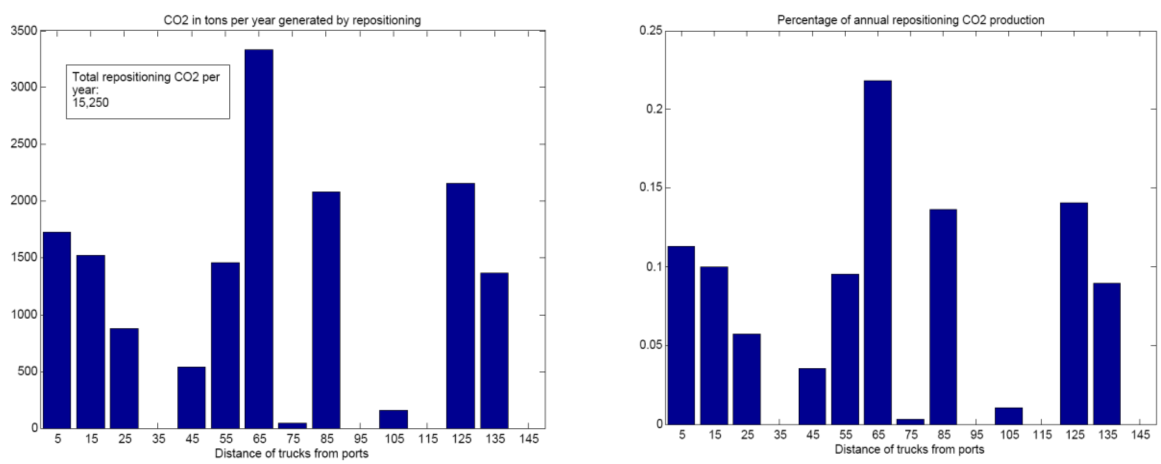

Figure 7: Annual CO_2 output for one empty repositioning route per day (in tons) based on parking distance from ports

Figure 7 mirrors the VMT numbers from Figure 4. The trucks parked between 60 and 70 miles from the ports (Inland Empire), between 80-90 miles from the ports and parked in the San Diego area account for 15% of all trucks but at the same time account for more than half of the CO_2 production. For these trucks a nearby inland port would likely lead to a significant reduction in CO_2 pollution.
The next figure, Figure 8 shows the Annual NO_X repositioning output (in tons) and percentage.
Here the repositioning related NO_X output of the trucks parked within 10 miles of the ports and the trucks parked in the Inland Empire is about the same.

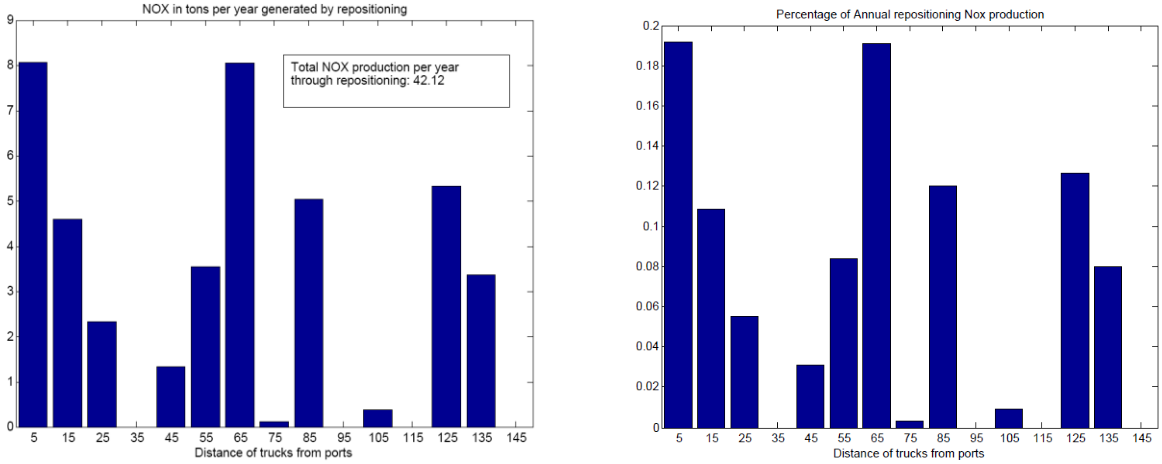

Figure 8: Annual repositioning NO_x output based on truck parking location

Our next baseline pollution measure considers the production of Particle Matter (PM). Figure 9 show the annual Particle Matter (PM) output in tons that results from one empty repositioning trip per day assuming that all trucks are parked at their current locations. Trucks parked in the Inland Empire account for almost 25% of the annual repositioning related PM production.

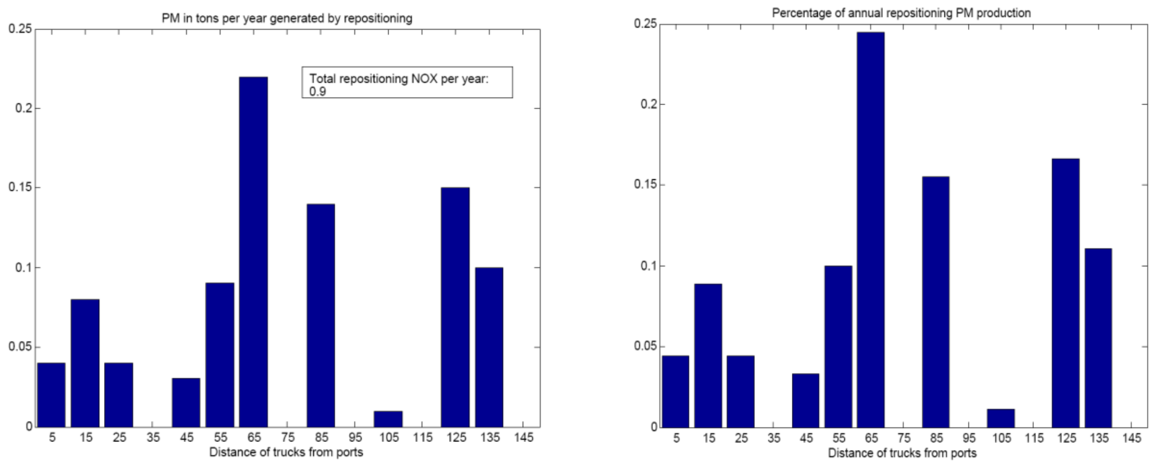

Figure 9: PM in tons per year generated by empty repositioning

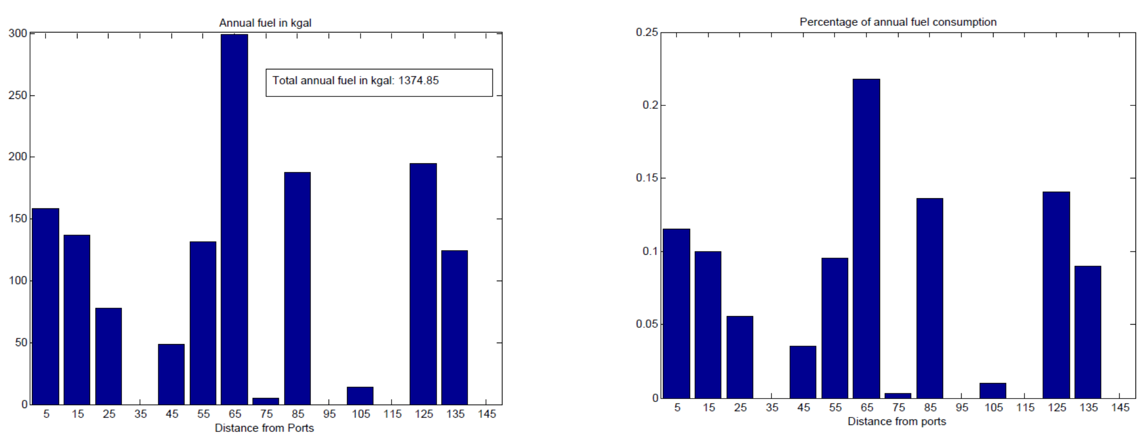

Figure 10: Fuel consumption kgal per year through empty repositioning

Figure 10 finally shows the annual repositioning related fuel consumption in kgal. The graphs closely mirror the VMT figure 4.

4.5 Scenario A: All container pick-ups and drop-offs move to an Inland Port

To study the potential impact of an inland port on repositioning routes we next consider a scenario where the trucking companies we interviewed remain located at their current location but are now picking up and dropping off containers from an inland port located in Victorville CA. Based on our interviews this may be a worst case scenario for the initial phase of a transition period towards an inland port since almost all trucking companies were very unsure about whether they would move closer to an inland port location if their customers would not move. The survey respondents indicated that they - at least initially - would attempt to transfer any additional costs caused by lengthened routes to their customers, potentially allowing them to – at least temporarily - remain in their current locations. To be able to compare the different scenarios we did not change the assignment of a trucking company to a group. That is we analyze the data based on the current parking location of a truck. Namely the x-axis still represents the current distance of a trucks parking location from the ports in increments of 10 miles. We do not consider the impact of the increase of repositioning related VMT in this scenario on pollution generated by other vehicles. This would require a congestion/pollution model that is beyond the scope of this study. We note however that increased repositioning related VMT will likely cause a further increase in non-repositioning related pollution caused by all other vehicles currently using the same roadways as the repositioning traffic. Figure 11 shows the new annual repositioning VMT's in this scenario.

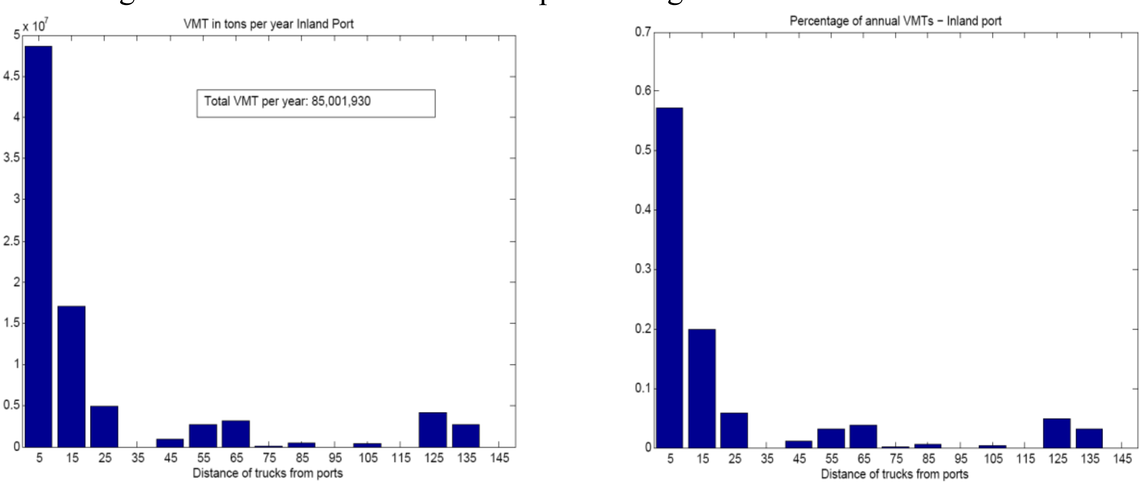

Figure 11: Total repositioning VMTs per year to an inland port from current location

Figure 11 shows that in this scenario that fact that more than 50% of trucks would remain located near the ports (within 10 miles) but would now have to pick up containers from a distant inland port would lead to an increase of almost 371% of annual VMTs. One could expect that in this scenario repositioning related pollution would also increase almost four-fold. At the same time we see significant VMT savings from the trucks located in the Inland Empire. These savings are by far not enough to offset the VMT increase caused by the trucks that remain parked near the ports. Now the trucks still located near the sea port would have the biggest impact on congestion in the region – an impact that directly reflects their numbers. Any savings we would get from the reduced VMT by the trucks from the Inland Empire are more than offset by the trucks close to the sea port. The pollution measures of HC, CO, CO_2, NO_x, PM and fuel consumption mirror this fact. We made no changes to our assumptions about trucks used (all are still clean trucks). Annual HC production (Figure 12) increased by 322%, CO production (Figure 13) increased by 328%, CO_2 production (Figure 14) increases by 357%, NO_x production by 316% (Figure 15), PM production by over 400% (Figure 16) and fuel consumption increased by 356% (Figure 17).

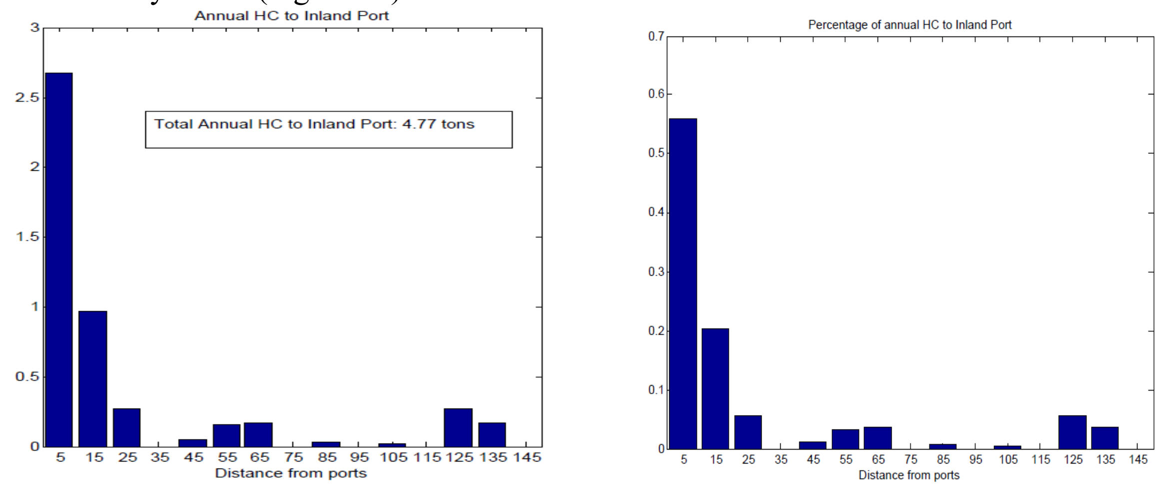

Figure 12: Repositioning generated HC output (tons per year) to inland port from current location

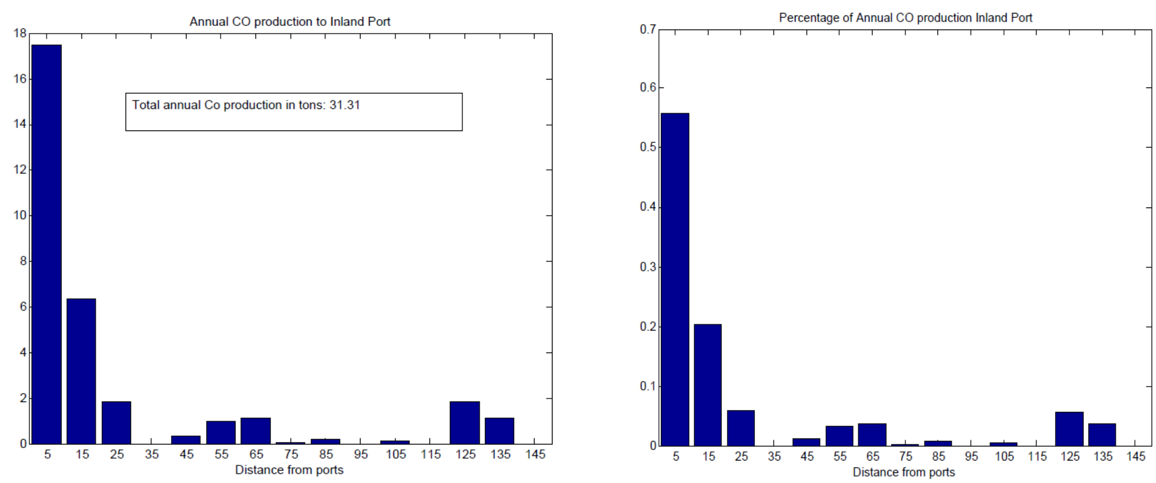

Figure 13: Repositioning generated CO output (tons per year) to inland port from current location

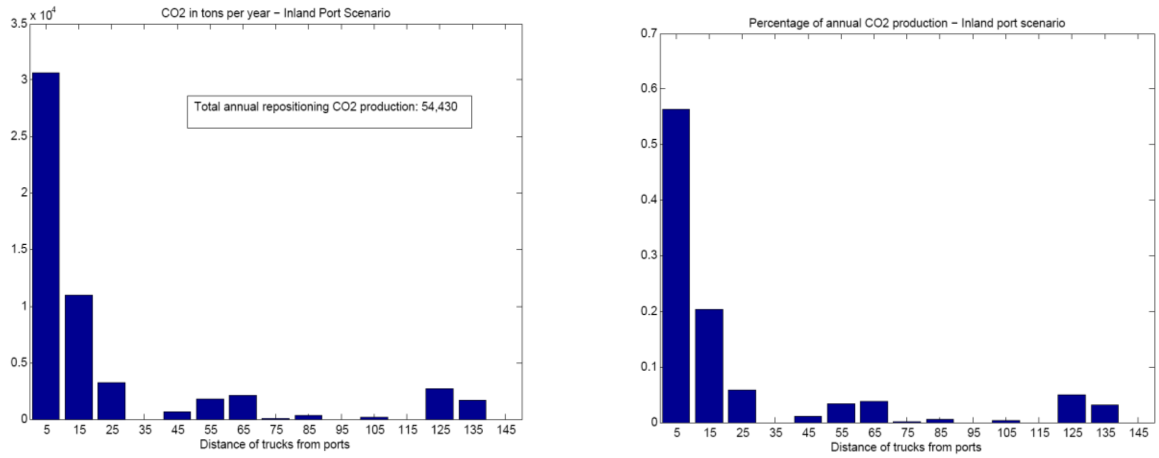

Figure 14: Repositioning generated CO_2 output (tons per year) to inland port from current location

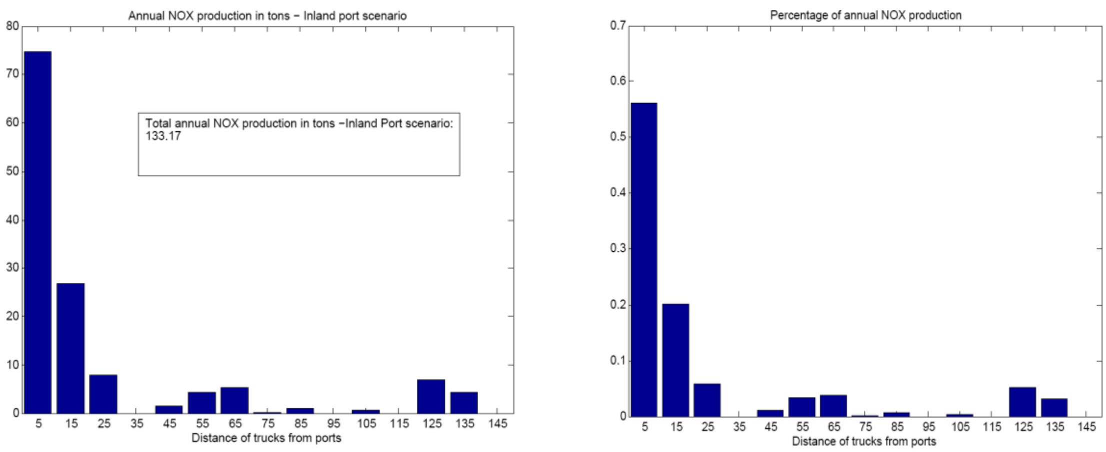

Figure 15: Repositioning generated NO_x output (tons per year) to an inland port from current location

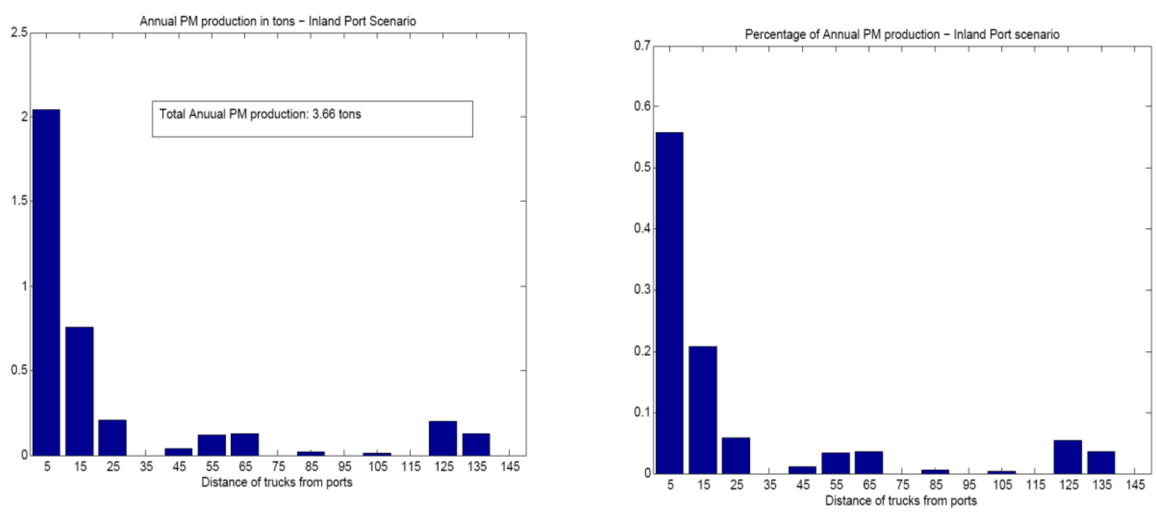

Figure 16: Repositioning generated PM output (tons per year) to an inland port from current location

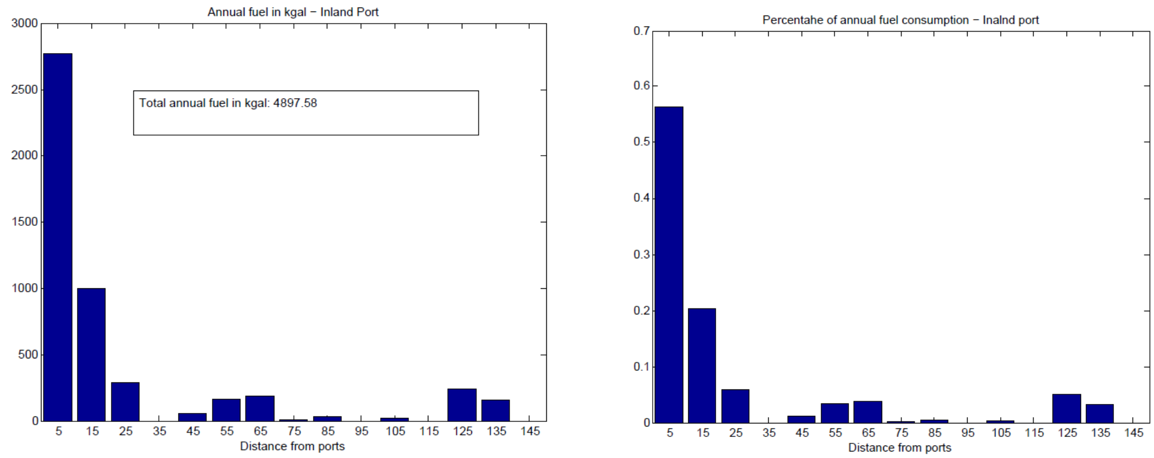

Figure 17: Repositioning generated fuel consumption (kgal per year) to an inland port from current location

4.6 Scenario B: All container pick-ups and drop-offs move to an Inland Port and all trucks are parked within 5 miles of the Inland Port

We next consider a scenario where all trucking companies move to within 5 miles of an inland port site. For inland port locations such as Victorville this is possible since the proposed site is surrounded by mostly undeveloped desert area.

In this scenario the annual empty repositioning related VMT are reduced by almost 78% compared to the baseline scenario (current situation). Now each truck – since they are parked at approximately the same distance from the inland port – has the same impact on repositioning related congestion and pollution. All pollution figures show the same distribution as the VMT figures (Figure 18). To illustrate this fact we only provide the figures for CO_2 (Figure 19) and NO_x (Figure 20). The annual repositioning related HC production is reduced by 61%, for CO by 63.5%, the CO_2 production is reduced by almost 76%, the annual repositioning related NO_x production shrinks by about 62%, the PM output is reduced by 87% and the annual repositioning related fuel consumption is reduced by 75.5% in scenario B compared to the current situation.

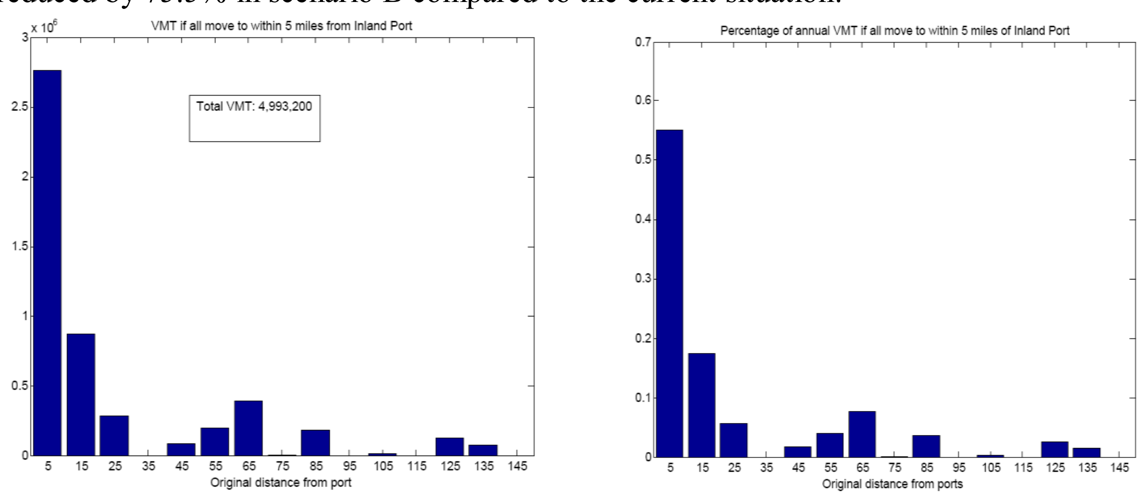

Figure 18: VMT if all trucks move within 5 miles of inland port (based on current location)

Figure 18 shows that this scenario minimizes the annual VMT compared to the baseline scenario and scenario A. Since all companies are located within 5 miles of the inland port each companies contribution to repositioning related congestion and pollution now only depends on their number of trucks. All pollution diagrams hence mirror the distribution of the VMT diagram for this scenario (Figure 18).

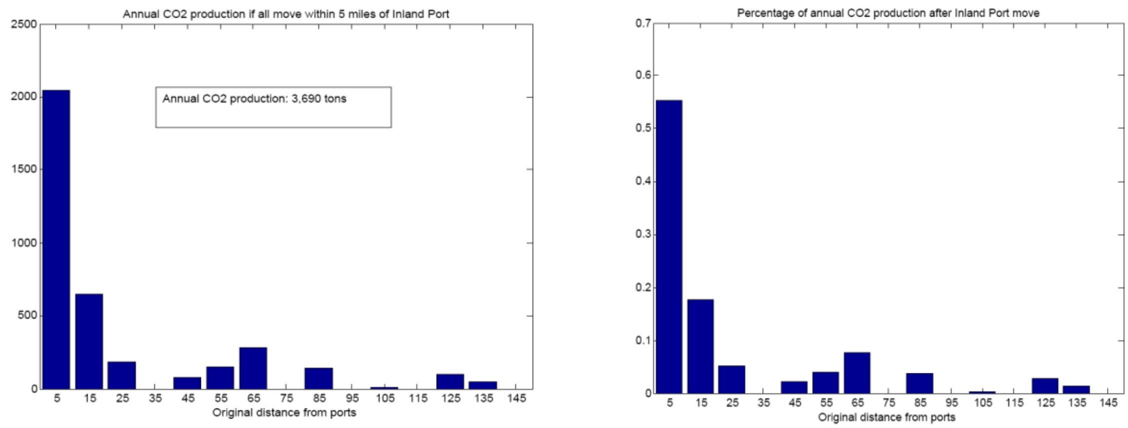

Figure 19: Annual CO_2 production if all trucks move within 5 miles of inland port (based on current location)

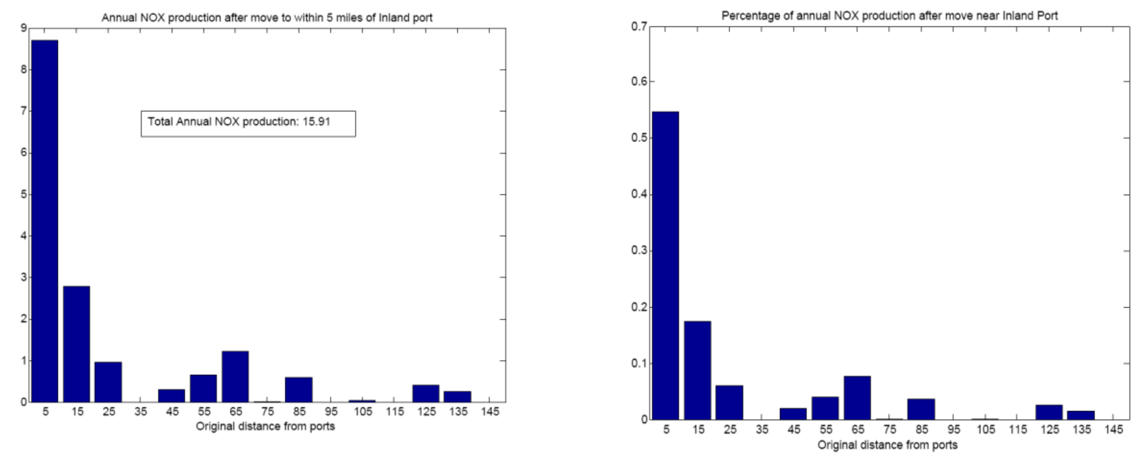

Figure 20: Annual NO_x production if all trucks move within 5 miles of inland port (based on current location)

We assumed in this scenario that all trucks are parked on the yards of trucking companies that are located within 5 miles of the inland port. The scenario requires that drivers pick up and drop off trucks from these parking locations. In case drivers attempt to take home their trucks the length of repositioning routes would increase. While the POLA CTP disallows such driver behavior it is certainly a possibility that merits consideration. We will hence study several more “mixed” scenarios.

Table 2 summarizes the results we have discussed so far.

	Baseline – Current Status	Scenario A: Trucks remain at current location – all containers move to Victorville Inland port	Change compared to baseline	Scenario B: Trucks move to within 5 miles of inland Port – all containers picked up from Inland Port	Change compared to baseline
VMT per year	22,932,000	85,001,930	+370.67%	4,993,200	-78.23%
HC production in tons per year	1.48	4.77	+322%	0.58	-61%
CO production in tons per year	9.54	31.31	+328%	3.48	-63.5%
CO_2 production in tons per year	15,250	54,430	+356.92%	3,690	-75.80%
Yearly NO_x production in tons	42.12	133.17	+316.17%	15.91	-62.2%
PM production in tons per year	0.9	3.66	+406.67%	0.12	-87%
Fuel consumption in kgal per year	1,374.85	4,897.58	+356%	336.24	-75.5%

Table 2: Summary of basic results

4.7 Pollution and congestion impact of Inland Port – Mixed Scenarios

We next proceed to compare five potential empty repositioning scenarios where either none or 50% or all trucking companies/trucks move near an inland port (Victorville) and either none or 50% or all containers (container pick-ups and drop offs) move to the same inland port (Table 3). All other assumptions remain the same as before: All trucks are clean trucks (model year 2007 or later). Each truck makes one empty repositioning drive per day each day it is in use (310 truck working days per year). The repositioning drive is either from the sea port/ inland port to a trucks parking location or from the parking location to the sea port / inland port. We focus on the comparison of the pollution and congestion impact of these scenarios. Hence any increase or decrease in VMT corresponds directly to an in or decrease in congestion.

Scenario 1: Status Quo

This represents the current empty repositioning situation, the baseline for our analysis.

Scenario 2: Half of all containers / No companies

In the first scenario we assume that 51% of all containers move to the inland port in Victorville while all companies remain at their current location. This means that for all companies now half of the repositioning routes would be relative to the sea ports, the other half relative to the inland port. In this scenario annual empty repositioning based VMT increase by 139%, HC increases by 109%, Co by 110%,CO_2 by 126%, NO_x by 106%, PM by 146% and fuel consumption by 126% compared to the status quo.

Scenario 3: Half of all containers / half of all companies/trucks In this scenario 49% of the containers move to the inland port as well as 49% of the companies trucks move near the inland port (within 5 miles). To calculate the pollution amounts for this scenario we assumed that the first block of companies (the companies that make up the first 49% of total trucks in our random list of companies from Table 1) would remain in their current location. We assumed furthermore that the second block of companies (the ones that make up the last 51% of total trucks in Table 1) would move to a location 5 miles from the inland port). We assumed that the set located close to the sea port would remain focused on the sea port with respect to container drop offs and pick-ups and that the set located close to the inland Port would be focused on the inland port with respect to container pick-ups and drop-offs, i.e. empty repositioning. We summed total pollution generated on these routes. This scenario can also be used to study the case where 50% of all drivers park their trucks at their current homes.

In this scenario annual empty repositioning based VMT decrease by 31%, HC by 23%, Co by 26%,CO_2 by 30%, NO_x by 25%, PM by 33% and fuel consumption by 30% compared to the status quo.

Scenario 4: All containers / half of all companies/trucks In this scenario we study the pollution generated by trucking companies under the assumption that all the pickups occurred at the inland port and half the companies/trucks moved to within 5 miles of the inland port.

To calculate the percent changes we compared the pollution generated in this scenario relative to the status quo. In this scenario annual empty repositioning based VMT increases by 101%, HC output by 86%, CO by 87%, CO_2 increases by 95%, NO_x by 81%, PM by 120% and fuel consumption by 94% compared to the status quo.

Scenario 5: All containers / all companies This is our second baseline scenario (see also the last scenario in Table 2). All containers are picked up from the inland port and all companies are located within 5 miles of this inland port. In this case annual empty repositioning based VMT decrease by 78%, HC by 61%, Co by 64%, CO_2 by 76%, NO_x by 62%, PM by 87% and fuel consumption by 76% compared to the status quo.

	Scenario 1: Status quo	Scenario 2: Half of all containers /no companies	Scenario 3: Half of containers / half of the trucks	Scenario 4: All containers / half of all trucks	Scenario 5: All containers / all companies
percentage of containers at sea port	100	51	51	0	0
percentage of containers at inland port	0	49	49	100	100
percentage of companies at current location	100	100	51	49	0
percentage of companies/trucks at desert location	0	0	49	51	100
VMT per year	22,932,038	54,775,842	15,860,564	46,086,652	4,993,200
VMT % change from status quo	0	139%	-31%	101%	-78%
HC tons/year	1.48	3.09	1.14	2.75	0.58
HC % change from status quo	0%	109%	-23%	86%	-61%
CO tons/year	9.54	20.08	7.06	17.82	3.48
CO % change from status quo	0%	110%	-26%	87%	-64%
NO_x tons/year	42.12	86.6	31.55	76.04	15.91
NO_x % change from status quo	0%	106%	-25%	81%	-62%
$C0_2$ tons/year	15250	34540	10710	29680	3690
CO_2 % change from status quo	0%	126%	-30%	95%	-76%
PM ton/year	0.9	2.21	0.6	1.98	0.12
PM % change from status quo	0%	146%	-33%	120%	-87%
fuel kgal/year	1374.85	3108.04	963.61	2670	336.24
fuel % change from status quo	0%	126%	-30%	94%	-76%

Table 3: Comparison of different repositioning and container distribution scenarios

In all these scenarios we do not consider the impact of the increase of repositioning related VMT on pollution generated by other vehicles. This would require a congestion/pollution model that is beyond the scope of this study. We note however that increased repositioning related VMT will likely cause a further increase in non-repositioning related pollution caused by all other vehicles currently using the same roadways as the repositioning traffic.

4.7.1 Comparison by pollution measure

In the following figures (Figure 21 for VMT, Figure 22 for HC, Figure 23 for CO, Figure 24 for CO_2, Figure 25 for NO_x, Figure 26 for PM and Figure 27 for fuel consumption) we compare the five scenarios for each pollution measure. We first show the pollution generated (left figure) followed by the pollution generated relative to the status quo (right figure).

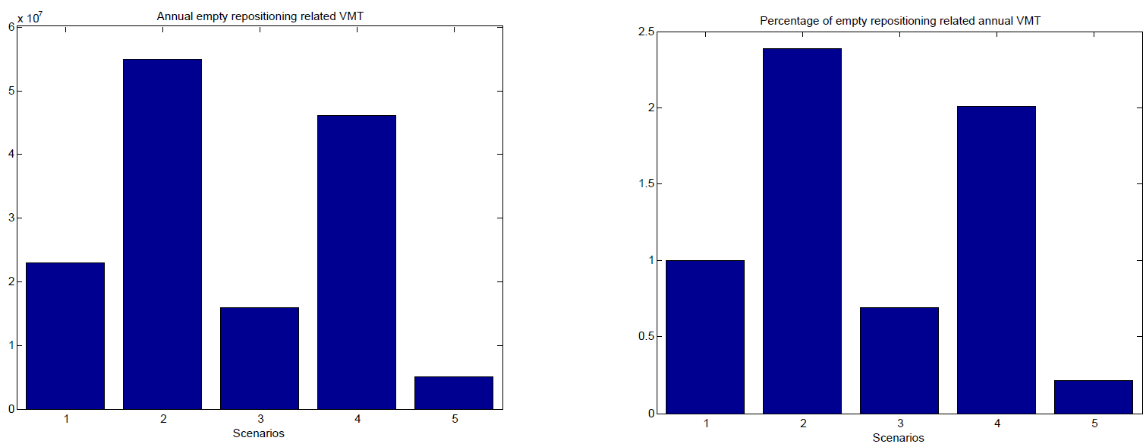

Figure 21: Comparison of repositioning scenarios with respect to annual VMT

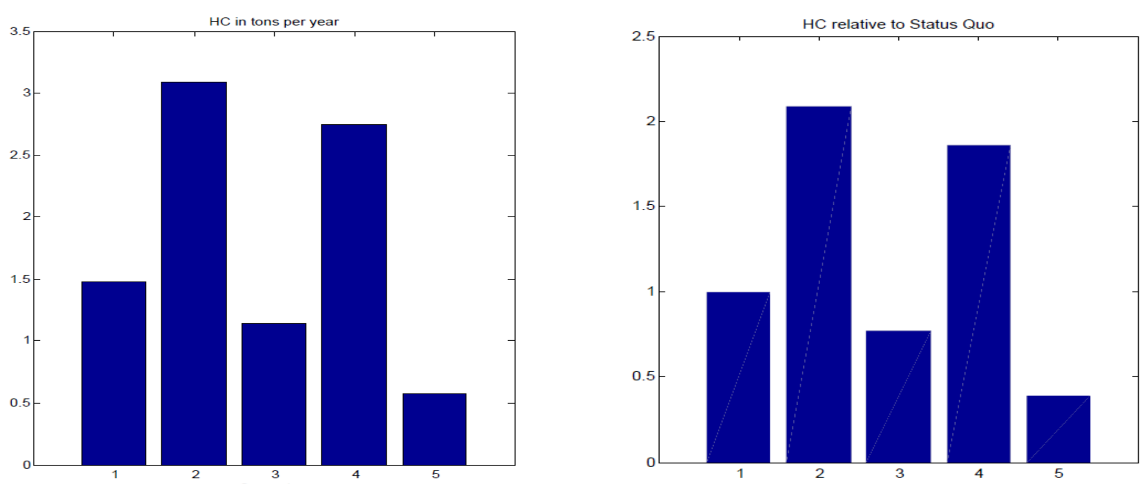

Figure 22: Comparison of repositioning scenarios with respect to annual HC output

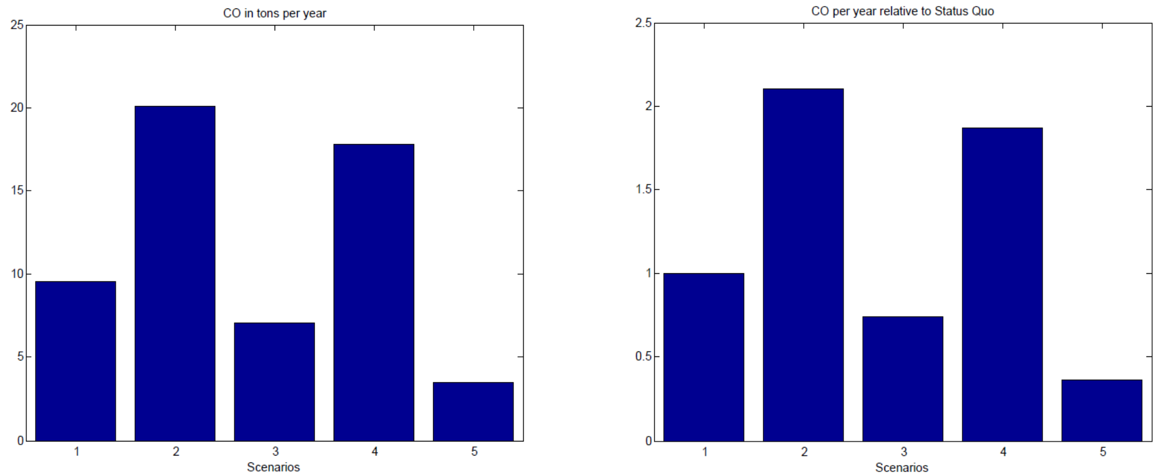

Figure 23: Comparison of repositioning scenarios with respect to annual CO output

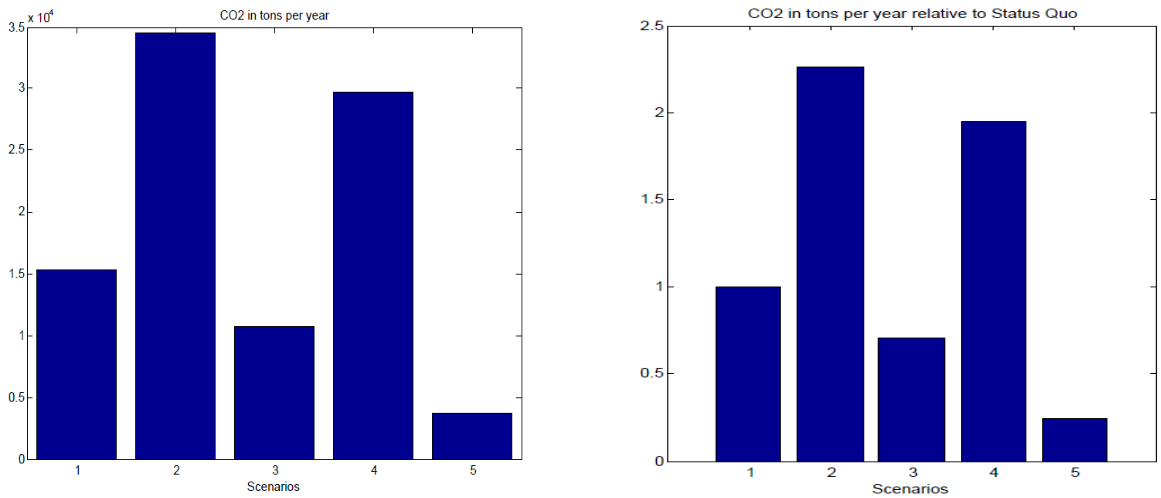

Figure 24: Comparison of repositioning scenarios with respect to annual CO_2 output

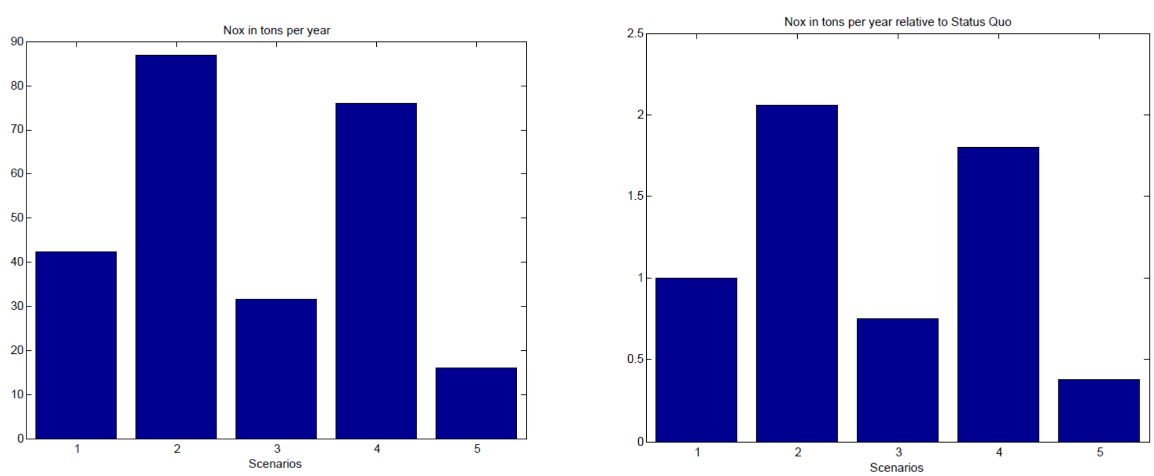

Figure 25: Comparison of repositioning scenarios with respect to annual NO_x output

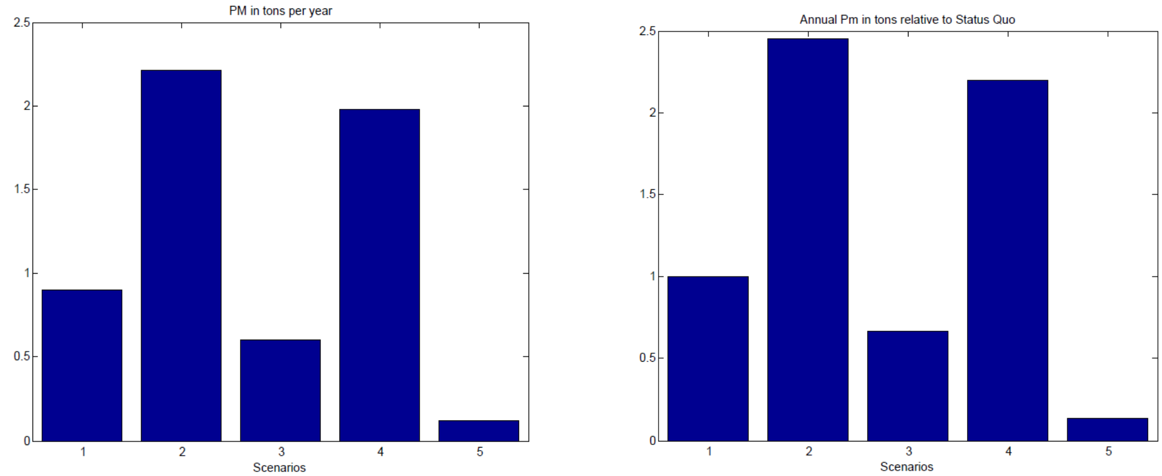

Figure 26: Comparison of repositioning scenarios with respect to annual PM output

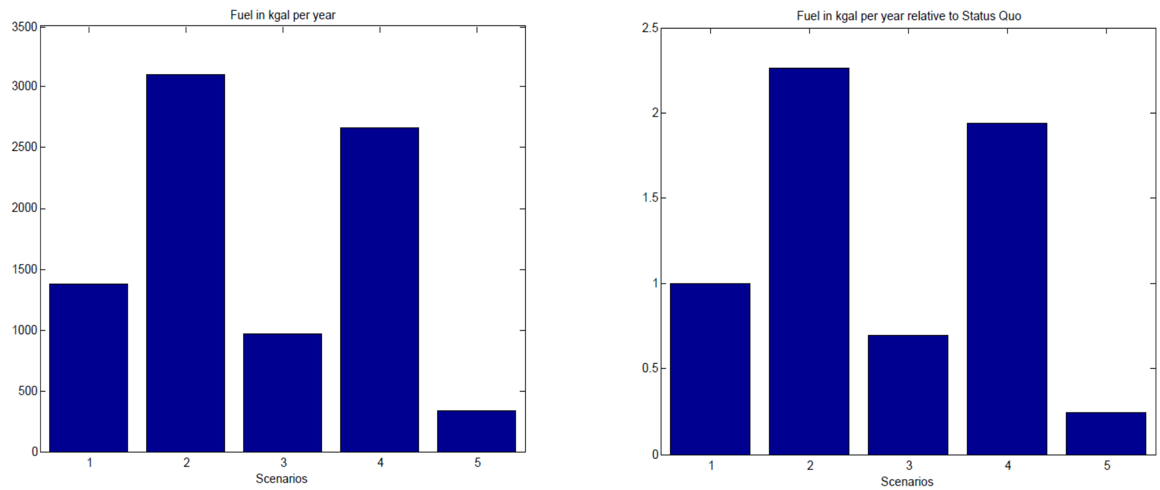

Figure 27: Comparison of repositioning scenarios with respect to fuel consumption

4.7.2 Analysis

We note that for all scenarios the congestion measure annual VMT and the six different pollution measures are about parallel. Figures 21-27 show that in all cases Scenarios 3 and 5 provide the best opportunities for savings, while scenario 2 and 4 would lead to a significant increase in the production of repositioning related pollution and congestion.

In **scenario 2** inefficiency is introduced since half of the containers would have to be picked up from an inland port while none of the companies trucks are moving closer to an inland port. The increase in congestion and pollution output occurs because currently the majority of companies is located closer to the sea port than to the inland port leading to an increase in annual repositioning related VMT and hence in pollution. The increase is moreover very significant. For all pollution (congestion) measures it is more than 100% compared to the current situation. This is important since according to our interviews scenario 2 is possible for the initial phase after the establishment of an inland port. Currently many trucking companies believe that, because of the uncertain economic situation and the radical changes that the drayage industry in the region is facing, that for them an immediate move closer to an inland port seems unlikely. The scenario shows that even if only 50% of containers move to an inland port but no companies move away from their current location closer to an inland port that empty repositioning caused pollution and congestion would double. This illustrates the need for careful planning of an inland port – planning that would need to involve the drayage industry to make the inland port contribute to a reduction of pollution and congestion in the region.

Scenario 4 where all containers move to an inland port but only 50% of companies/trucks move close to an inland port also leads to a significant increase in pollution and congestion. The scenario specifically illustrates that with respect to repositioning a full functioning inland port that replaces a sea port as a distribution point for containers can only lead to a reduction in pollution and congestion if a large majority of companies moves closer to such a port. Even if half of all companies move close to the inland port annual pollution and congestion would still be almost doubled. This calculation does not take into consideration the location of warehouses – which may make matters even worse if only few of the warehouses decide to move closer to an inland port and hence few of the drayage companies move.

Scenario 3 assumes that 50% of trucks/drayage companies move near an inland port and 50% of containers also move to an inland port. In addition the scenario assumes that the companies that remain in their current location would continue to use the sea port as their container access and drop off point and that the companies near the inland port would use the inland port in the same capacity. Under these conditions empty repositioning related pollution and congestion reductions of about 30% could be achieved. This scenario for its implementation clearly would require a significant amount of planning, since only the companies able to pick up all their containers at the inland port should move close to this port. All others should remain in their current location. It shows that we careful planning real savings can be achieved.
But it also illustrates that even if such careful planning is possible and the drayage companies close to a port can access their containers from this port, only savings of about 30% could be achieved. Likely, if the planning does not lead to the desired distribution and assignment of containers to ports based on the drayage companies that service these containers, an increase in repositioning related pollution and congestion can be expected.

Scenario 5 assumes that all containers move to an inland port and all trucking companies move close to an inland port. In this case annual repositioning related pollution and congestion could be reduced significantly, by between 60 and almost 90%. When only considering empty repositioning this is the ideal situation – at this point in time, however it does not yet appear to be a realistic possibility. Strong incentives would have to be provided for drayage companies to all move out close to the Victorville inland port. Moreover any repositioning related savings could be offset by longer routes to warehouses. For overall savings a move of drayage companies would have to be accompanied by a corresponding move of warehouses.

4.8 Scenarios without outliers

When analyzing trucking company data from Table 1 it appears that the very few companies near San Diego exude significant influence over the results of our analysis. This is because of the repositioning distance trucks drive and will have to drive from their parking location to the ports or an inland port. Moreover one company we surveyed, company 36, operates 500 trucks amounting to almost 20% of the trucks in our survey. Hence we next study whether the San Diego companies and company 36 – as outliers – are potentially skewing our results. We analyze our data after removing the San Diego companies (38, 2, 49, and 37) and company 36 from our data pool. All remaining companies in our pool are ordered alphabetically. Table 4 shows the new results.

	Scenario 1: Status quo	**Scenario 2: half containers /no companies**	**Scenario 3: half containers / half of all trucks/ companies**	**Scenario 4: all containers / half companies/trucks**	**Scenario 5: all containers / all companies**
percentage of containers pickup at sea port	100	50	51	0	0
percentage of containers pickup at inland port	0	50	49	100	100
percentage of trucks/ companies at current location	100	100	51	49	0
percentage of trucks <5m VicV.	0	0	49	51	100
VMT per year	22,402,788	51,176,212	18,779,287	38,844,505	4,080,700
VMT % change from status quo	0%	128%	-16%	73%	-82%
HC tons/year	1.05	2.56	0.9	1.87	0.44
HC % change	0	144%	-14%	78%	-58%

from status quo					
CO tons/year	6.75	16.71	5.72	12.29	2.7
CO % change from status quo	0	148%	-15%	82%	-60%
NO_x tons/year	30.69	72.34	25.84	53.15	12.34
NO_x % change from status quo	0	136%	-16%	73%	-60%
C02 tons/year	11140	29070	8870	20620	2850
CO_2 % change from status quo	0	161%	-20%	85%	-74%
particulate ton/year	0.62	1.87	0.47	1.33	0.07
part. % change from status quo	0	202%	-24%	115%	-89%
fuel kgal/year	1004.32	2615.8	799.94	1855.98	260.58
fuel % change from status quo	0	160%	-20%	85%	-74%

Table 4: Repositioning scenarios without outliers

4.8.1 Comparison by pollution measure – modified truck pool

Scenario 1: Status Quo

This is a basic summation of the current situation with the modified truck pool. We excluded company 36 since its 500 trucks carried too much weight (almost 20% of the sample). We also excluded the San Diego companies as they potentially skewed the results as well.

Scenario 2: Half containers / no companies

This focuses on the alphabetized set excluding outliers. By arranging them alphabetically we create a second random ordering of company locations to compare to the grouping

done before. As before, this scenario imagines that 50% of all container pick-ups move out to the inland port, but none of the companies follow.
In this scenario annual empty repositioning based VMT increase by 128%, HC by 144%, CO by 148%, CO_2 by 161%, NO_x by 136%, PM by 202% and fuel consumption by 160% compared to the status quo given the alphabetized list.

Scenario 3: Half containers / half companies/trucks

This again considers only the alphabetized set excluding outliers. We assume that the first 50% of these companies/trucks stayed in their current location while the other half moved. We assumed that the set that remained focused on the sea port and the set that moved focused on the inland port.
In this scenario annual empty repositioning based VMT are reduced by 16%, HC is reduced by 14%, CO by 15%, CO_2 is reduced by 20%, NO_x by 16%, PM by 24% and fuel consumption by 20% compared to the status quo given the alphabetized list.

Scenario 4: All containers / half companies

We next consider the company set without outliers assuming all pick-ups occur at the inland port while the first 50% of the companies in the alphabetized lists remain located in their original locations.
In this scenario annual empty repositioning based VMT increase by 73%, HC output increases by 78%, CO output by 82%, CO_2 output by 85%, NO_x by 73%, PM by 115% and fuel consumption by 85% compared to the status quo given the alphabetized list.

Scenario 5: All containers / all companies

We assumed all companies from the alphabetized list minus outliers moved to 5 miles from the inland port and all repositioning routes are relative to the inland port.
In this scenario annual empty repositioning based VMT decrease by 82%, HC by 58%, CO by 60%, CO_2 by 74%, NO_x by 60%, PM by 89% and fuel consumption by 74% compared to the status quo given the alphabetized list.

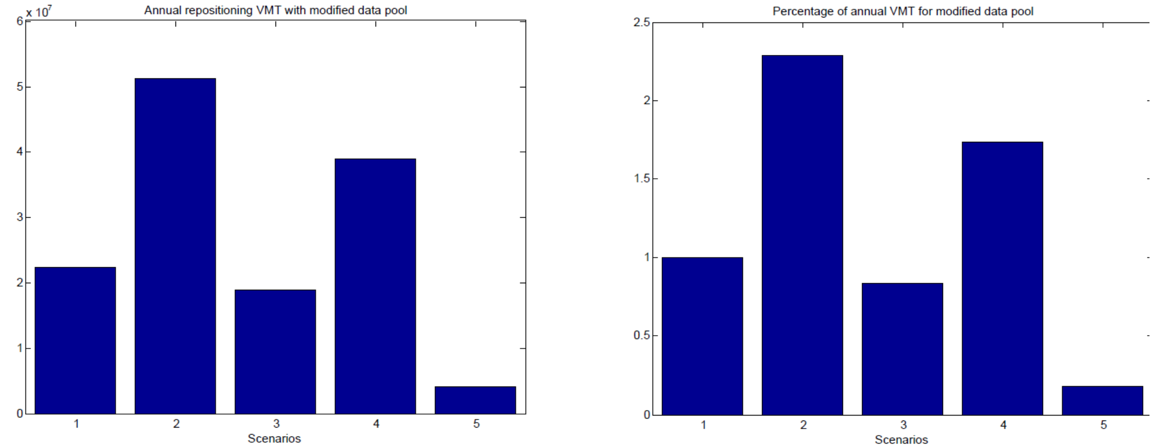

Figure 28: Comparison of repositioning scenarios with modified truck pool - VMT

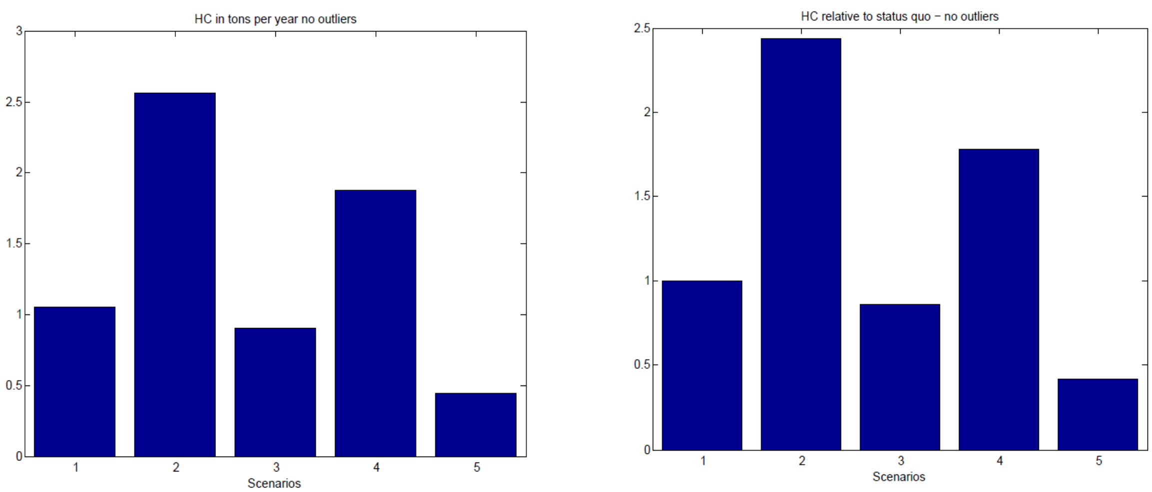

Figure 29: Comparison of repositioning scenarios with modified truck pool – HC

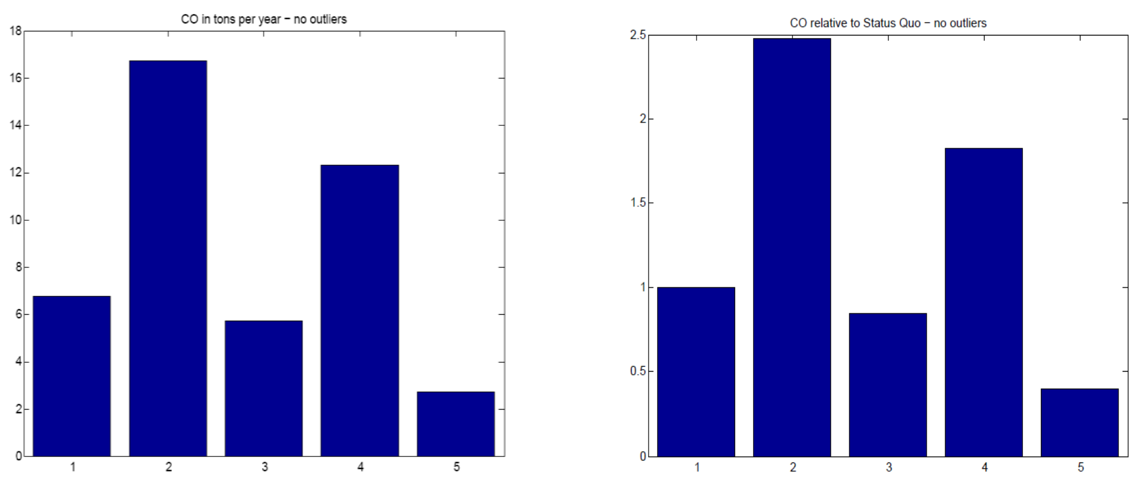

Figure 30: Comparison of repositioning scenarios with modified truck pool - CO

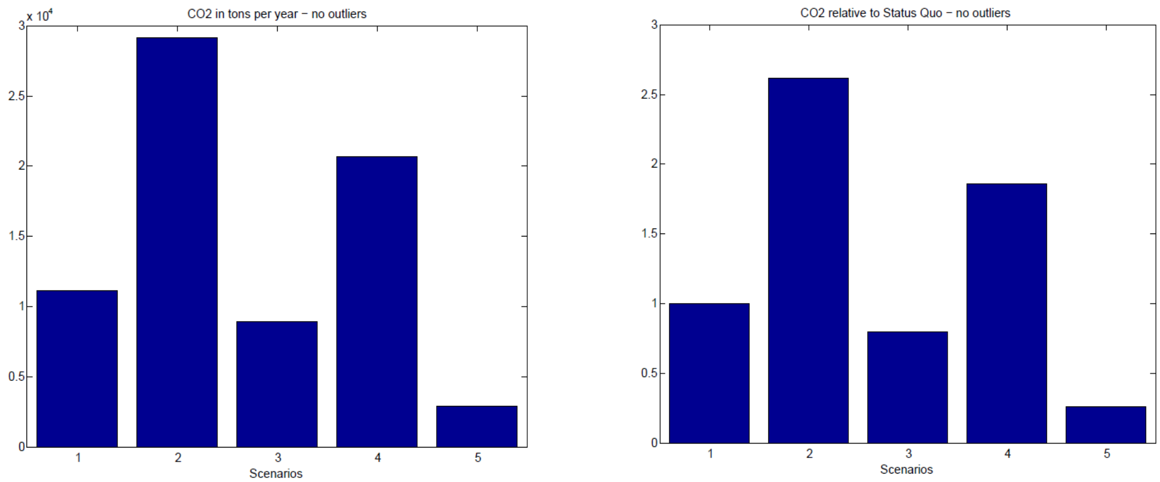

Figure 31: Comparison of repositioning scenarios with modified truck pool - CO_2

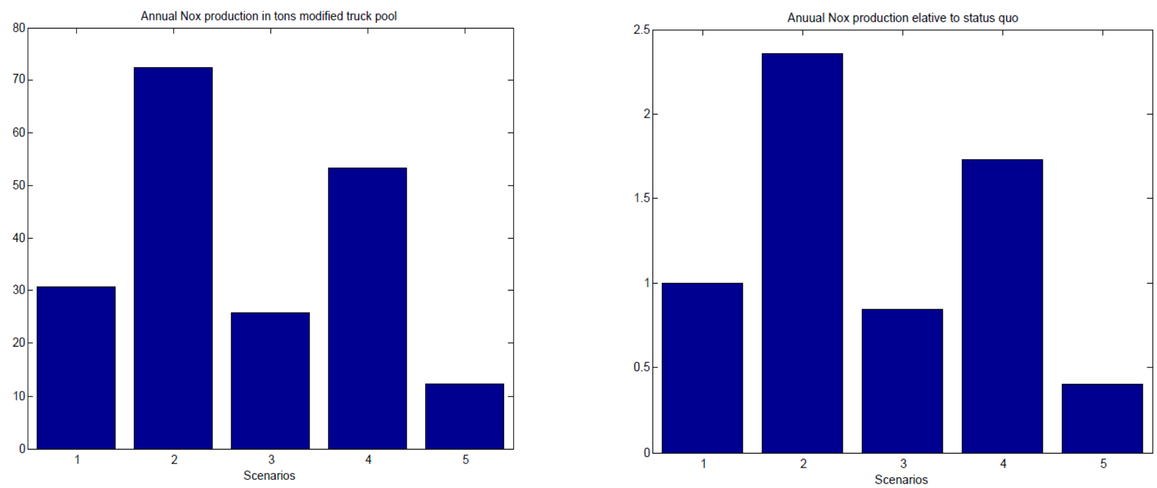

Figure 32: Comparison of repositioning scenarios with modified truck pool - NO_x

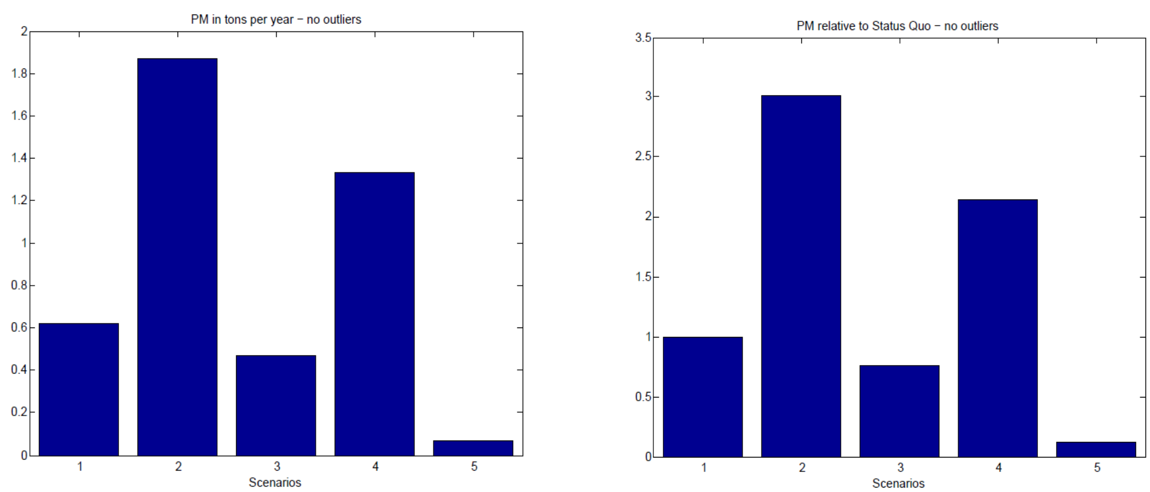

Figure 33: Comparison of repositioning scenarios with modified truck pool - PM

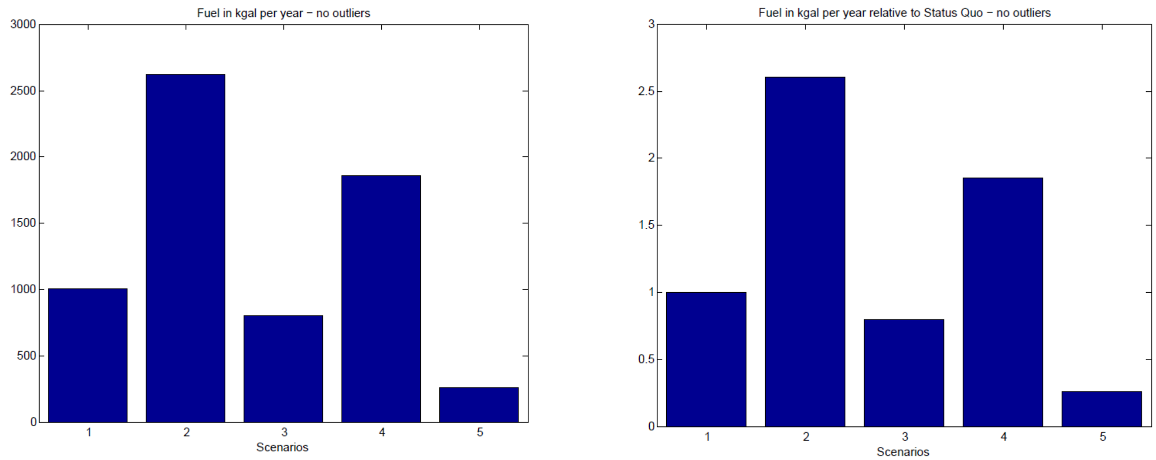

Figure 34: Comparison of repositioning scenarios with modified truck pool - fuel

4.8.2 Analysis

With modified data set the increase in pollutants is more pronounced in scenario 2, the increase in congestion (annual VMT) slightly less pronounced in scenario 2, about the same in scenario 4 and the improvements of scenario 3 and 5 are not as impressive. The increase in congestion (annual VMT) slightly less pronounced in scenario 2, the decrease in scenario 3 also slightly less pronounced, the increase in scenario 4 is less pronounced and the decrease in scenario 5 is slightly more pronounced. Overall there are no significant differences to the data set with outliers. Again, as figures 28-34 show Scenarios 3 and 5 provide the best opportunities for pollutant and congestion reductions, while scenario 2 and 4 lead to an increase of repositioning related pollutants and congestion.

In **scenario 2** (no companies move while half of the containers have to be picked up or delivered to an inland port) the introduced inefficiencies persist and dominate the scenario. Compared to the results we obtained for the complete survey with all companies included, the increase in repositioning related pollution is now even more significant, between 136 to around 200%. The increase in congestion is slightly less pronounced as with the full data set. Overall scenario 2 would at least double and potentially almost triple the current annual amount of repositioning related pollutants and at least double the repositioning related congestion. With the modified data set the trucks currently located near the sea port have more weight relative to data set size, leading to the worsened pollution numbers.

Scenario 4 where all containers move to an inland port but only 50% of companies/trucks move close to an inland port also leads to a significant increase in pollution and congestion although now without the outliers the increase is slightly less pronounced. We again conclude that with respect to repositioning a full functioning inland port that completely replaces a sea port as a distribution point for containers can only lead to a reduction in pollution and congestion if far more than a majority of companies moves closer to such a port. Even if half of all companies move near an inland port and it becomes the center of their container related activities, the related annual pollution and congestion would still be almost doubled. This calculation does not take into consideration the location of warehouses – which may make matters even worse if only few of the warehouses would move closer to an inland port. We calculated that in this scenario after all containers move to an inland port, 72% of all companies would have to move near this inland port to provide enough savings to match the repositioning pollution generated by the status quo.

Scenario 3 assumes that 50% of companies/trucks move close to an inland port and 50% of containers also move to this inland port. In addition the scenario assumes that the companies/trucks that remain in their current location would continue to use the sea port as their container distribution point while the companies near the inland port would use the inland port as their container distribution point. With the modified survey truck set without outliers somewhat smaller annual pollutant savings (between 14 and 24%) and VMT (congestion) savings could be achieved. The scenario indicates that for even relatively small savings a large amount of planning would be required. Namely, if drayage companies move close to an inland port - to achieve any kind of pollution or congestion savings - a large majority of containers must be available close to their new location. We will test this hypothesis next.

In **scenario 5** all containers move to an inland port and all trucking companies move close to an inland port. In this case annual repositioning related pollutant reduction is comparable with the non-normalized truck set - between 60 and almost 90%. Also the reduction in annual repositioning related VMT is almost identical. This scenario represents an ideal case where the inland port completely replaces the sea port for container distribution. It illustrates that the potential for significant repositioning related pollution savings exists. It is clear, however, that these savings can only become realized if the move not only involves drayage company trucks but also involves their customers.

4.9 Transition scenarios

In all scenarios that we considered so far we assumed that the empty repositioning routes of companies that remained close to the sea port would as much as possible only involve the sea port. Only after all containers from the sea port had been distributed would these companies access an inland port. Similarly the empty repositioning routes of companies that had moved near an inland port would as much as possible only involve this inland port. Only if absolutely necessary would these companies drive to a sea port to pick up or drop off a container. This assumption would require an almost perfect coordination between the ports, the drayage companies and their warehouse customers. It is questionable whether – especially in the short term – this type of coordination is realistic and possible. Hence we ask what would happen to empty repositioning related pollution if even after a move near an inland port a drayage company would execute some of its business at the sea port and vice versa a drayage company that remained in its current location would also access the inland port for container pick-ups and drop offs.

Therefore in scenario 6 we assume that 50% of companies/trucks remain in their current location and 50% move close to an inland port (within 5 miles). Of the companies that remain 50% of their trucks execute their empty repositioning drives to the sea port, 50% to the inland port in Victorville. Of the 50% that move near Victorville 50% of their trucks execute their empty repositioning drives to the sea port and 50% to the inland port. Such a scenario or some variations of it are potentially likely for a transitional period or until the ports and the drayage industry are able to coordinate container availability with a drayage companies location. Clearly one cannot expect for this scenario to provide the same savings as scenario 3 where all drayage companies are assumed to be close to the container availability location. But for an inland port such as Victorville to be truly viable one would hope that the empty repositioning pollution and congestion results in this mixed scenario are comparable to the status quo or only slightly worse. Unfortunately this is not the case. As table 5 shows with this scenario empty repositioning related pollution and congestion would increase quite drastically. The increase in congestion is comparable with scenario 2 where half of the containers but no drayage companies moved to the inland port. In other words the impact on congestion of this truly mixed scenario would be as bad as opening an inland port and making 50% of all containers available there with all companies remaining at their current locations. Again we conclude that an inland port will require very careful planning and coordination of container availability and drayage company / customer “assignment”. We again used only our modified data set with outliers removed. Again we do not consider the impact of the increase of repositioning related VMT on pollution generated by other vehicles. This would require a congestion/pollution model that is beyond the scope of this study. We note however that increased repositioning related VMT will likely cause a further increase in non-repositioning related pollution caused by all other vehicles currently using the same roadways as the repositioning traffic.

	Status quo	Scenario 6
percentage of container pickup at sea port	100	50
percentage of container pickup at inland port	0	50
percentage of companies at current location	100	50
percentage of companies at desert location	0	50
Annual VMT	22,402,788	50,130,305
VMT % change from status quo	0%	124%
HC tons/year	1.05	3
HC % change from status quo	0	186%
CO tons/year	6.75	19.64
CO % change from status quo	0	191%
NO_x tons/year	30.69	84
NO_x % change from status quo	0	174%
$C0_2$ tons/year	11140	33160
CO_2 % change from status quo	0	198%
particulate ton/year	0.62	2.19
PM % change from status quo	0	253%
fuel kgal/year	1004.32	2985.87
fuel % change status quo	0	197%

Table 5: Repositioning transition scenario compared with status quo

This scenario not only leads to a significant increase in empty repositioning related pollution it actually shows the largest increase in such pollution of all the scenarios that we considered. The pollution increases are even worse than the increases of scenario 2 where half of all containers moved to an inland port while all companies remained at their current locations. VMT increase by 124%, the annual output of repositioning related HC by 186%, of CO by 191%, of CO_2 by 198% of NO_x by 174%, of PM by 253% and the fuel consumption (congestion impact) by 197% (Figure 35-41).

4.9.1 Comparison by pollution measure

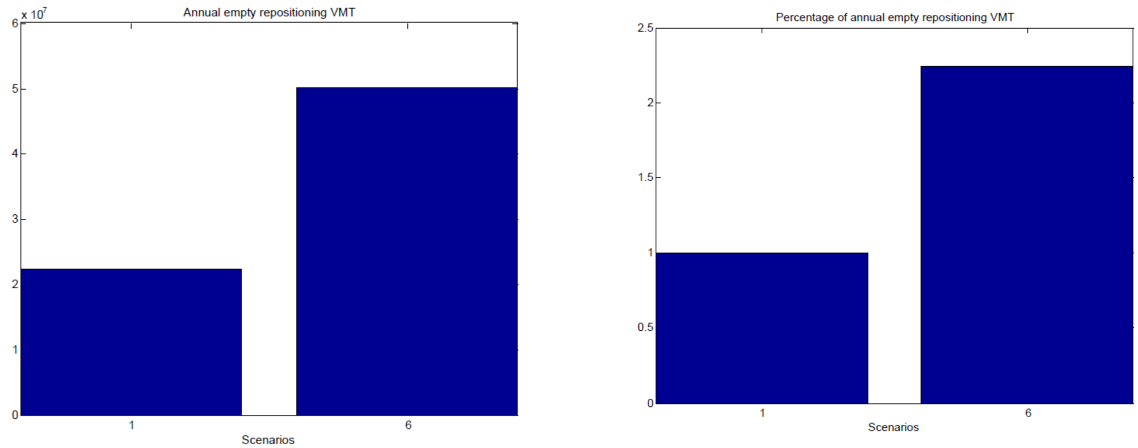

Figure 35: Annual empty repositioning VMT comparison with transition scenario

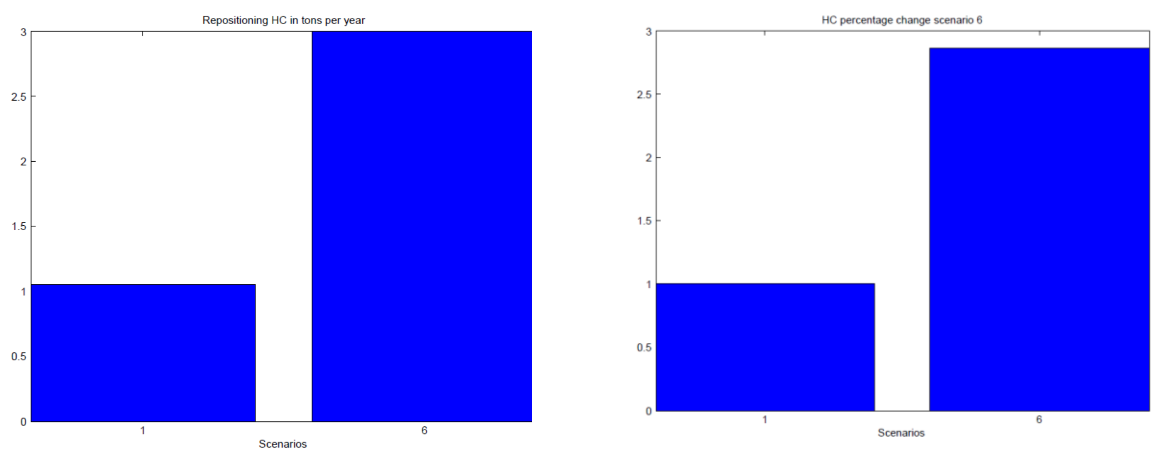

Figure 36: Annual empty repositioning HC output comparison with transition scenario

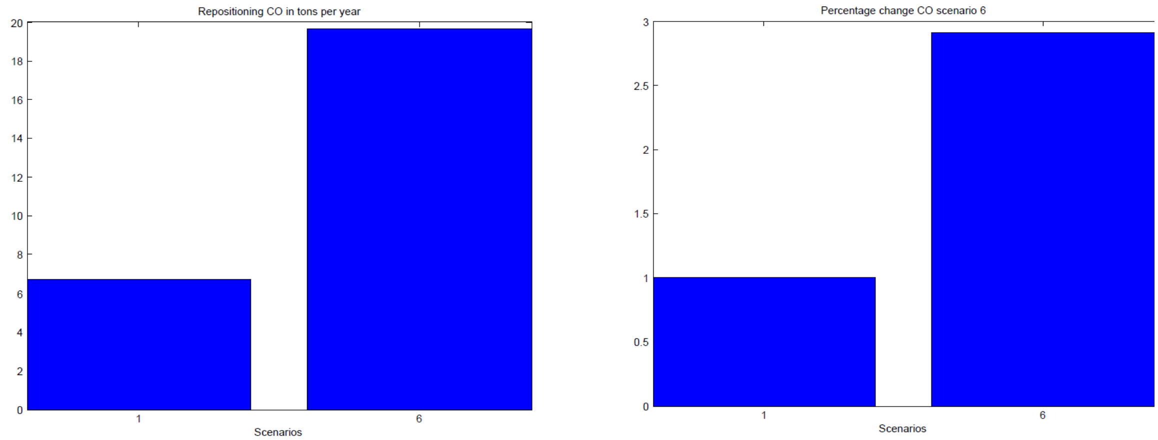

Figure 37: Annual empty repositioning CO output comparison with transition scenario

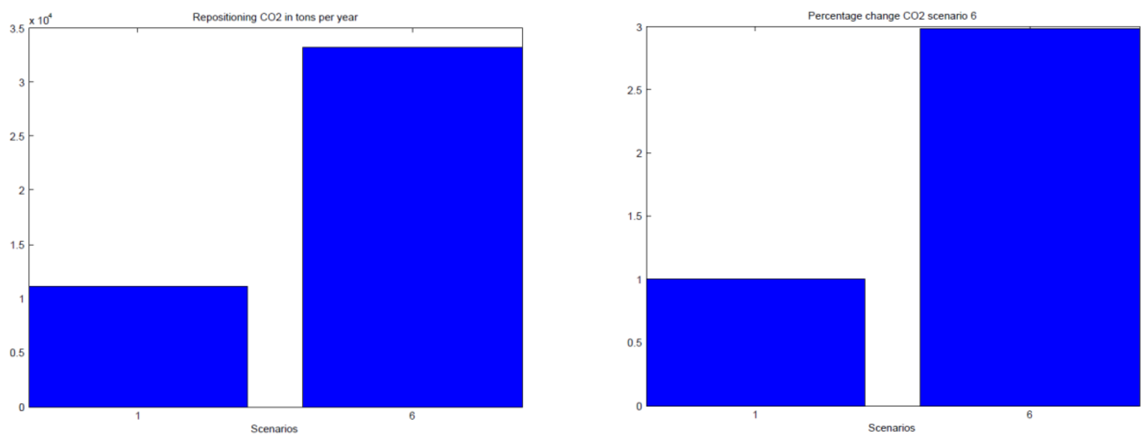

Figure 38: Annual empty repositioning CO_2 comparison with transition scenario

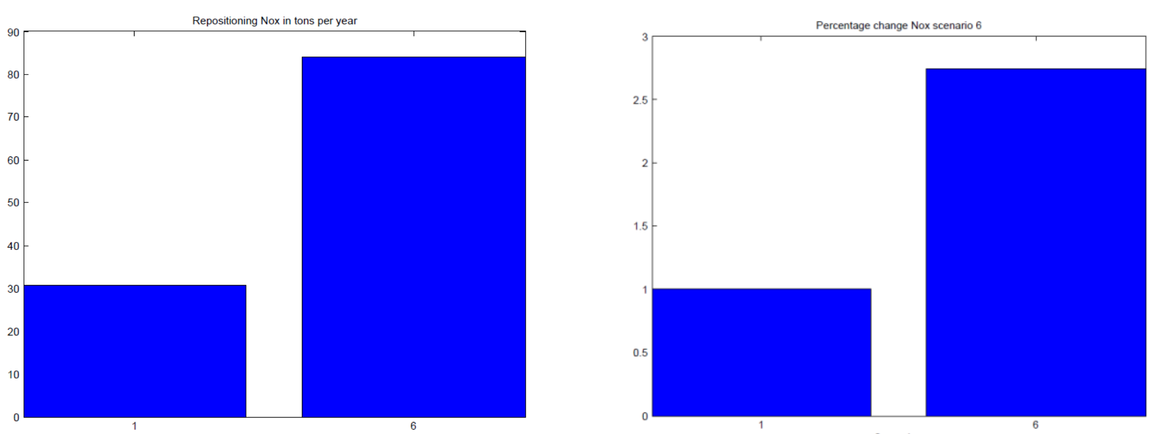

Figure 39: Annual empty repositioning NO_x comparison with transition scenario

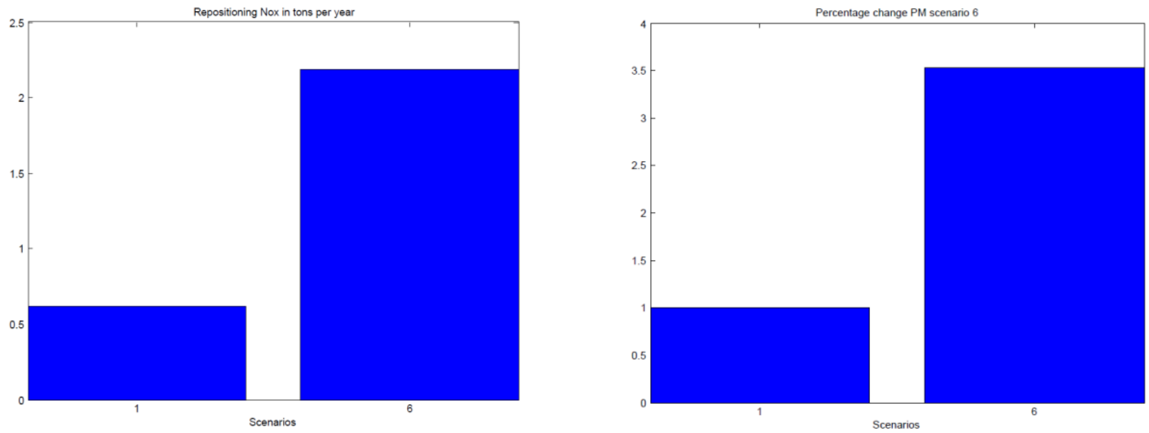

Figure 40: Annual empty repositioning PM comparison with transition scenario

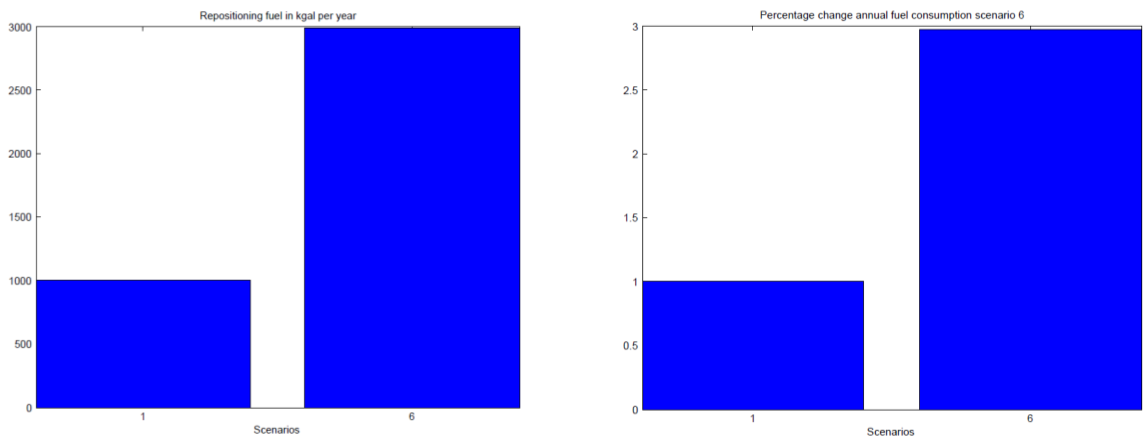

Figure 41: Annual empty repositioning fuel consumption comparison with transition scenario

4.9.2 Analysis

As table 5 and Figures 35-41 show in scenario 6, the mixed transition scenario, empty repositioning related pollution and congestion would increase drastically compared to the status quo. Annual empty repositioning VMT and pollutant release both would more than double. The increase in congestion is comparable with scenario 2 where half of the containers but no drayage companies moved to the inland port. In other words the impact on congestion of this truly mixed scenario would be as bad as opening an inland port and making 50% of all containers available there with all companies remaining at their current locations. The scenarios show that the only way to avoid this increase in congestion and pollution would be to make each trucking company reposition to the port that is closest to its truck parking location.

Hence a sustainable inland port will require very careful planning and coordination of container availability and drayage company / customer port “assignment”.

Without careful planning and coordination an inland port may at least temporarily significantly increase pollution and congestion in the Southern California region. The data shows that opening an inland port and moving some containers to this port may be enough to alleviate congestion and pollution problems near the sea ports. But, at the same time – at least temporarily – an inland port such as Victorville may create significant additional pollution and congestion for the Southern California region as a whole. Only if it is possible to move containers, drayage companies and warehouses in synch near an inland port will this port have a positive impact on repositioning related congestion and pollution in the Southern California region.

5. Recommendations

In this study we investigated the impact of empty repositioning on congestion and pollution in the Southern California region. We surveyed truck drivers and trucking companies to determine the locations where trucks are parked if not in use. The surveys showed that as of August 2010 the owner-operator model that used to be prevalent at the POLA/LB had almost completely disappeared for trucks that pick-up and drop off containers within the port complex. As a result all trucks are now parked on the truck yard of the trucking company that owns the truck.
In a second step we used this parking location to determine the length of empty repositioning routes under current condition. Based on information we obtained from drivers and trucking companies we assumed one empty repositioning run per truck working day (assuming 310 working days per year), either from the parking location to a port or from a port to the parking location. Since by 2012 all pre 2007 trucks will be banned from the ports we assumed in our analysis all trucks to be "clean" 2007 model year trucks. Using the EMFAC 2007 model [18] we determined the current impact of these empty repositioning runs on congestion and pollution in the region.
We then studied the impact of an inland port in Victorville CA on the length and pollution impact of these empty repositioning routes. We considered several scenarios where we varied the locations of trucking companies/trucks and the availability of containers at either the sea port or the inland port.
Our analysis showed that if half of all container pick-ups and drop offs would move to an inland port (Victorville) but all companies would remain parked in their current locations (scenario 2) that then both empty repositioning related congestion and pollution would more than double compared with the status quo (under the same assumptions). This is a potentially likely scenario since initially – after an inland port opens – many drayage companies may adopt a wait-and-see attitude to observe how their customers, the warehouses would react. If none of them moves – this may even become the new status quo.
Our analysis furthermore shows that if all the containers shifted to the inland port, but only half the trucking companies/trucks moved near this inland port (scenario 4), for example because of warehouse location friction, there would be a major increase (but overall smaller compared with scenario 2) in overall repositioning generated pollution and congestion. To offset this increase we calculated that at least 72% of all trucking companies would have to move close to the inland port and only pick up and drop off containers at the inland port to lead to a situation where the repositioning generated pollution matches the status quo.

On the positive side, if half the containers move to the inland port, half of all companies/trucks move within 5 miles of the inland ports and companies only reposition relative to the ports that are closest to them (scenario 3) pollution and congestion savings of around 20% can be obtained. As one would expect there is a very substantial reduction in empty repositioning pollution and congestion if all the container pickups moved to the inland port and all the trucking companies moved out to within five miles of the inland port location (scenario 5). CO_2 output, for example, would be reduced by 76% under this scenario. The empty repositioning generated pollution and congestion would also be localized at the inland port area.

When we exclude the outliers from the set of surveyed companies we note that then in most cases the overall percentages of change between the individual scenarios and the status quo are slightly smaller. For example, if half the containers and half the companies/trucks move, there is only a 20% reduction in $C0_2$ vs. the 30% reduction if the outliers were included. This supports our decision to exclude those outliers but also indicates on the other hand that the outliers are not significantly skewing the results.

We then studied the possibility that half of the containers operations move out to the inland port and half of the drayage companies/trucks move within 5 miles of the inland port (scenario 6). Moreover half of the trucks of the companies that remained in their original locations would reposition to the sea port, the other half to the inland port. Similarly, of the companies/trucks that moved out to the inland port location, half of the trucks of these companies would make empty repositioning runs to the sea port, the other half to the inland port. This is a reasonable assumption since it may take a good number of years before container routing is efficiently balanced between the two ports.
The increase in pollution over the status quo for this scenario is dramatic. For instance there is a 198% increase in $C0_2$ alone. The average increase for other pollutants is around 200%. Also congestion in the region would be doubled. More importantly a variation of this "mixed" scenario may become likely if after the establishment of an inland port companies would remain at their current location or move near the inland port without consideration of the pick-up/drop off location of the majority of their containers. Likely for a few years trucks may be servicing both the sea port and an inland port.

All our experiments show that if the drayage fleets (and their customers) are not carefully coordinated along with the development of an inland port, a potentially significant increase of empty repositioning related pollution and congestion in the Southern California region is likely. The only example scenarios that provided repositioning related savings, scenario 3 and 5 required that truck parking locations were coordinated with container availability locations. Namely trucks had to reposition only to the port (sea port or inland port) closest to their parking location. We studied empty repositioning routes only, but our results are indicative of the broader impact. If drayage trucks do not solely travel to the nearest port location, but instead hop between the two, overall pollution and congestion increases.
In the long run, it is likely that economic forces will push the drayage companies to localize around one port or the other, and conduct the majority of their business there. How quickly this situation is reached with an inland port such as Victorville will most likely be a function of how much of the customer base (warehouses, etc) and how fast this customer base relocates near the inland port area.
Very likely, there will be a time, early on, where the overall pollution and congestion in the Southern California region spikes. This will occur when the balance of containers, drayage companies, and customers are not well matched at the inland port.
Therefore, if an inland port is developed, there must be a holistic effort to coordinate the drayage fleet with the inland port. It would be beneficial if the drayage companies that

relocated closer to the inland port become the primary haulers of inland port containers. Likewise the companies that remain in their current location (with the exception of the few companies that are located closer to the inland port than the sea port) should be the primary haulers of containers to and from the sea port. They should be encouraged to continue their focus on the seaport and not pick up containers at the inland port.

Our results also indicate that, from a congestion and pollution standpoint, it will not be enough to disallow container pick-ups and drop offs from the sea port to establish the inland port. On the contrary our analysis shows that this could lead to a dramatic spike in congestion and pollution in the region. In scenario A which models this case we observe a spike in annual empty repositioning related VMT (congestion) by over 300%. Similarly pollution numbers also increase by over 300%.

Also the location of a future inland port may need to be considered. In this study we only considered Victorville as a potential location. Our analysis shows that if a future inland port site is located at a distance comparable to the distance of Victorville from the sea port (where the largest cluster of trucking companies is located), similar results can be expected. Such inland port sites are only viable if not only containers move to the inland port but also drayage companies and warehouses move near the inland port. On the other hand an inland port could be moved into the LA basin closer to the current locations of drayage companies and warehouses. But then it would likely be much more difficult to find a suitable location that would be able to handle and accept the ensuing increase in traffic, congestion, noise and pollution.

For a potential inland port site such as Victorville we therefore recommend that any attempt to establish an inland port site must be accompanied by a careful and detailed study of the warehouses and the drayage companies that serve them. The study should investigate how to best execute a move to this inland port so that this move involves all stakeholders – namely it must move not only containers but also drayage companies and warehouses. Only in the unlikely and unrealistic event that everybody moves at once close to the inland port would pollution and congestion in the region immediately decrease and not increase. Decisions about which containers to relocate to an inland port must be made in consultation and in coordination with warehouses and the drayage industry. Incentives should be given to warehouses to move closer to an inland port so that when the inland port is opened enough of its customers are located close enough to avoid a more dramatic spike in pollution and congestion in the region. To be viable and environmentally sensible the inland port in coordination with the sea ports may need to find ways to motivate drayage companies and the warehouses to only access the closest port. Looking at our survey results it is not likely that drayage companies will simply move near an inland port once such a port opens for business. They will more likely follow their customers, the warehouses and then pick up and drop off containers based on their customer's preferences. Hence to ensure that an inland port will not have a significant negative impact on congestion and pollution in the Southern California region, the sea ports and the inland ports may need to create regulations comparable to the clean trucks program that force warehouses and the drayage industry to make the repositioning move that is in the best interest of the region as a whole. This could involve restrictions with respect to delivery distance (if possible) and pick up origin.

6. Conclusion

In this study we focused on repositioning routes as an indicator of the overall impact of an inland port on pollution and congestion in the region it may be located in. While an inland port has the potential to significantly reduce pollution and congestion in the area immediately surrounding a sea port, it also has the potential to be a catalyst for a dramatic spike in congestion and pollution in the region as a whole. Any effort to establish and set up an inland port must therefore be executed in close cooperation and coordination with warehouse owners and the drayage industry. If drayage companies and warehouses do not follow the inland port it will have a negative effect on the region as a whole. Moving an inland port closer to warehouses and drayage companies on the other hand is more difficult and maybe at the current time not feasible in the Southern California region.

7. References

[1] Texas Transportation Institute and the Center for Transportation Research at the University of Texas.

[2] M. Rahimi, A. Asef-Vaziri, R. Harrison, Integrating Inland Ports into the Intermodal Goods Movement System for Ports of Los Angeles and Long Beach, METRANS 07-01.

[3] K. Monaco, L. Grobar, A Study of Drayage at the Ports of Los Angeles and Long Beach, METRANS AR 04-01.

[4] Economic Forecast and Industry Outlook: Los Angeles County Economic Development Corporation: The Southern California Region: http://www.laedc.org/reports/Forecast-2009-02.pdf

[5] Port of Long Beach Green Port Policy. Available at: http://www.polb.com/environment/green_port_policy/default.asp

[6] O. Ergun, G. Kuyzu, M. Savelsbergh**,** Reducing Truckload Transportation Costs Through Collaboration, TRANSPORTATION SCIENCE Vol. 41, No. 2, May 2007, pp. 206-221.

[7] Government of British Columbia. Inland container Terminal Analysis, available at: http://www.th.gov.bc.ca/PacificGateway/documents/061215_Inland_Container_Terminal_Analysis.pdf

[8] International Trade Trends and Impacts : The Southern California Region. 2009 Results and 2010 Outlook, available at: http://www.laedc.org/reports/Trade-2010.pdf

[9] 2010-2011 Midyear Update, Economic Forecast and Industry Outlook: Los Angeles County Economic Development Corporation: The Southern California Region: http://www.laedc.org/reports/Forecast-2010-07.pdf

[10] Long Beach Clean Trucks Program, available at:
http://www.polb.com/environment/cleantrucks/default.asp

[11] Port of Los Angeles Clean Trucks Program, available at:
http://www.portoflosangeles.org/CTP/idx_ctp.asp

[12] Port of Los Angeles Clean Trucks Program, Concessionaires with Clean Trucks, available at: http://www.portoflosangeles.org/CTP/CTP_Concessionaire_List.pdf

[13] Boston Consulting Group, San Pedro Bay Ports Clean Truck Program Options Analysis, available at: http://www.portoflosangeles.org/CTP/CTP_Analysis.pdf

[14] Port of Los Angeles – Clean Trucks Program – Gate Move Data Analysis, August 2010, available at:
http://www.portoflosangeles.org/CTP/CTP_Cargo_Move_Analysis.pdf

[15] Port of Long Beach – Clean Trucks Program – Truck Move Data Analysis, August 2010, available at: http://www.polb.com/civica/filebank/blobdload.asp?BlobID=6591

[16] Port of Long Beach – Concessionaires Applicant List, available at:
http://www.polb.com/civica/filebank/blobdload.asp?BlobID=5638

[17] PortCheck, available at: www.portcheck.org

[18] California Air Resources Boards EMFAC 2007 model, available at:
http://www.arb.ca.gov/msei/onroad/latest_version.htm

[19] Port of Los Angeles Cargo Move Analysis, available at:
http://www.portoflosangeles.org/ctp/ctp_Cargo_Move_Analysis.pdf